TTC Spectrum Management SWG **SMS-04-GSV-02-E**

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TITLE: Overlap OL Quad Spectrum System Spectral Compatibility

ABSTRACT

The present contribution introduces the Overlap OL Quad Spectrum System for high speed ADSL and evaluates its spectral compatibility according to the 2003 revised TTC-Soumusho spectral compatibility rules. The OL Quad Spectrum System combines an extended downstream Bandwidth PSD (from~ 25.875KHz up to ~3.75MHz) and an Upstream PSD with steep side lobes: -95dB per octave slope. The Upstream PSD complies with g.992.5 mask. The Quad spectrum Downstream channel total power is equal to 20dBm.

The contribution proves that the Quad Spectrum Overlap system has always a smaller spectral compatibility Impact than g.992.1 OL with protected systems.

We recommend that Quad Spectrum Overlap System shall be deployed in the same quad as protected systems up to 3.25km.

The spectral compatibility simulations contained in this contribution fully match a cross check done by SEI.

[1] Contact: JLDSL working Group Coordinator.
Patrick DUVAUT: pdu@globespanvirata.com; Tel: 1 732 345 6119; Fax: 1 732 345 7503

1 Introduction

The present contribution introduces the Overlap Quad Spectrum System for high speed ADSL and evaluates its spectral compatibility according to the 2003 revised TTC-Soumusho spectral compatibility rules. The OL Quad Spectrum System combines an extended downstream Bandwidth PSD (from~ 25.875KHz up to ~3.75MHz) and an Upstream PSD with steep side lobes: -95dB per octave slope. The Upstream PSD complies with g.992.5 Mask. The Quad spectrum Downstream channel total power is equal to 20dBm.

2 Overlap OL Quad Spectrum Masks Definition

2.1 Downstream

Figure 1 and table 2-1 display the Overlap Quad Spectrum Mask features, based on peak values.

Figure 1. OL Quad Spectrum Mask Plot, Peak Values

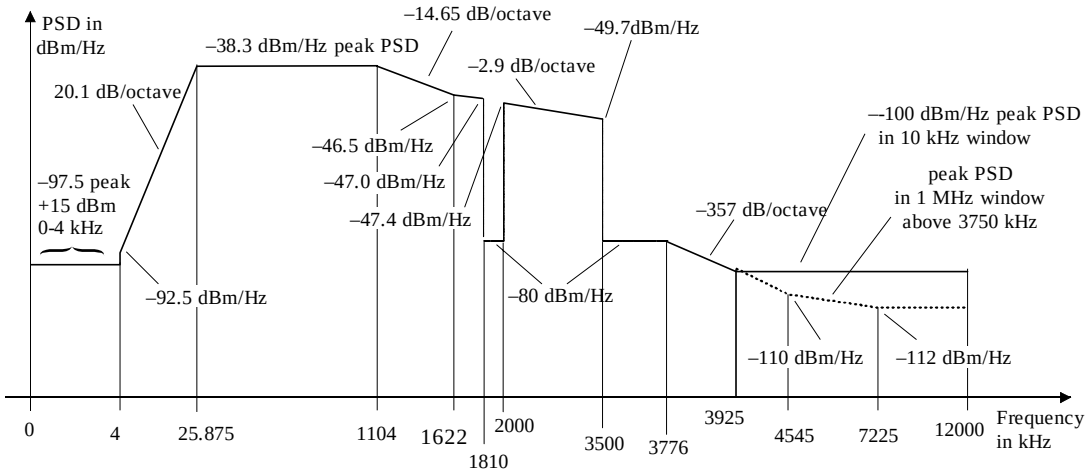


Table 2-1 OL Quad Spectrum Mask definition, Peak Values

(kHz)	PSD(dBm/Hz)
0	-97.5
4	-97.5
4	-92.5
10	Interpolated
25.875	-38.3
1104	-38.3
1622	-46.5
1810	-47.0
1810	-80.0
2000	-80.0
2000	-47.4
3500	-49.7
3500	-80.0
3776	-80.0
3925	-100
4545	-110
7225	-112
12000	-112

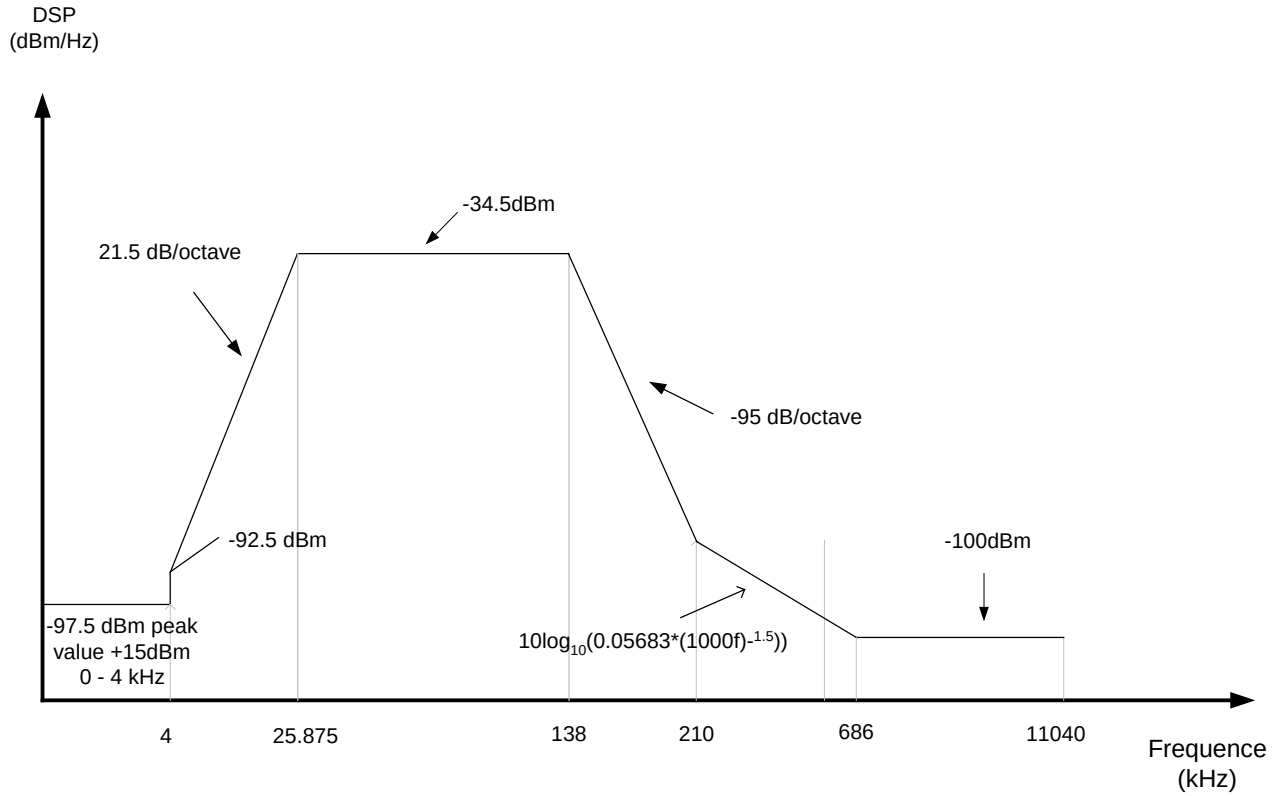
2.2 Upstream

Figure 2 and table 2-2 display the Upstream Mask features, based on peak values. This mask complies with the g.992.5 Upstream mask.

Table 2-2. Upstream Mask Definition, Peak Values, f is in Kilo Hertz

Frequency (kHz)	PSD (dBm/Hz) Peak values
0<f<4	-97.5
4<f<25.875	"-92.5 + 21.5.log2.(f/4)"
25.875<f<138	-34.5
138<f<f_int	"-34.5 - 95.log2.(f/138)"
f_int<f<686	10log10(0.05683*((1000f)^(-1.5)))
f>686	-100

Figure 2. Upstream Mask Plot, Peak Values



3 OL Quad Spectrum Spectral Compatibility Tables

3.1 Reference Tables

Table 3-1 gives the Spectral Compatibility reference performance of protected systems, according to the Revised 2003 Soumusho-TTC rules.

Table 3-1. Spectral Compatibility Reference Performance, Protected Systems

	TCM-ISDN	G.992.1 Annex A		G.992.2 Annex A		G.992.1 Annex C				G.992.2 Annex C				
Dist		(FDM)				DBM			FBM	DBM			FBM	
	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US
0.5	144	144	7104	832	3008	832	7104	832	2624	288	3008	832	1088	288
0.75	144	144	6784	832	2944	832	6912	832	2592	288	2944	832	1088	288
1	144	144	5952	832	2624	832	6368	832	2528	288	2752	832	1088	288
1.25	144	144	4896	800	2272	800	5696	800	2496	288	2528	800	1088	288
1.5	144	144	3840	768	1824	768	5024	800	2432	288	2272	800	1088	288
1.75	144	144	2496	736	1440	736	4192	768	2400	288	2016	768	1088	288
2	144	144	1696	704	960	704	3680	736	2336	288	1696	736	1088	288
2.25	144	144	1088	640	640	640	3296	704	2240	288	1504	704	1088	288
2.5	144	144	704	576	352	576	3008	672	2080	288	1312	672	1056	288
2.75	144	144	480	512	160	512	2720	640	1856	288	1216	640	1056	288
3	144	144	320	448	96	448	2368	576	1536	288	1184	576	1024	288
3.25	144	144	224	352	64	352	1984	512	1280	288	1152	512	992	288
3.5	144	0	128	288	32	288	1632	480	1056	288	1120	480	928	288
3.75	0	0	64	224	32	224	1344	448	832	256	1088	448	832	256
4	0	0	32	192	0	192	1088	416	640	256	1024	416	704	256
4.25	0	0	0	160	0	160	928	416	480	256	928	416	576	256
4.5	0	0	0	128	0	128	768	384	352	224	832	384	416	224
4.75	0	0	0	96	0	96	608	352	224	224	704	352	288	224
5	0	0	0	64	0	64	416	352	128	224	544	352	192	224

3.2 G.992.1 OL Spectral Compatibility Impact Tables

Table 3-2 gives the performance of protected systems in the presence of 5 g.992.1 OL systems disturbers.

Table 3-2. Protected Systems performance with 5 g.992.1 OL Systems (1 Intra-Quad,4 Inter-Quad)

	TCM-ISDN	G.992.1 Annex A		G.992.2 Annex A		G.992.1 Annex C				G.992.2 Annex C				
Dist		(FDM)				DBM			FBM		DBM		FBM	
	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US
0.5	144	144	7104	832	3008	832	7104	832	2624	288	3008	832	1088	288
0.75	144	144	7008	832	3008	832	7008	832	2592	288	3008	832	1088	288
1	144	144	6880	832	3008	832	6880	832	2528	288	3008	832	1088	288
1.25	144	144	6784	832	3008	832	6784	832	2496	288	3008	832	1088	288
1.5	144	144	6624	832	2976	832	6624	832	2432	288	2976	832	1088	288
1.75	144	144	6464	800	2976	800	6464	800	2400	288	2976	800	1088	288
2	144	144	6336	768	2976	768	6336	768	2336	288	2976	768	1088	288
2.25	144	144	6080	736	2944	736	6080	736	2240	256	2944	736	1088	256
2.5	144	144	5664	672	2912	672	5664	672	2080	256	2912	672	1056	256
2.75	144	144	5024	608	2880	608	5024	608	1856	224	2880	608	1056	224
3	144	144	4192	544	2816	544	4192	544	1536	192	2816	544	1024	192
3.25	144	144	3488	480	2688	480	3488	480	1280	160	2688	480	992	160
3.5	144	0	2848	384	2528	384	2848	384	1056	128	2528	384	928	128
3.75	0	0	2304	288	2272	288	2304	288	832	96	2272	288	832	96
4	0	0	1792	224	1984	224	1792	224	640	64	1984	224	704	64
4.25	0	0	1344	160	1568	160	1344	160	480	64	1568	160	576	64
4.5	0	0	960	128	1152	128	960	128	352	32	1152	128	416	32
4.75	0	0	672	96	832	96	672	96	224	32	832	96	288	32
5	0	0	416	64	544	64	416	64	128	0	544	64	192	0

3.3 Quad Spectrum OL Spectral Compatibility Impact Tables

Table 3-3 gives the performance of protected systems in the presence of 5 OL Quad Spectrum systems disturbers.

Table 3-3. Protected Systems performance with 5 OL Quad Spectrum Systems (1 Intra-Quad,4 Inter-Quad)

	TCM-ISDN	G.992.1 Annex A		G.992.2 Annex A		G.992.1 Annex C				G.992.2 Annex C				
Dist		(FDM)				DBM			FBM		DBM		FBM	
	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US
0.5	144	144	7104	832	3008	832	7104	832	2624	288	3008	832	1088	288
0.75	144	144	7104	832	3008	832	7104	832	2624	288	3008	832	1088	288
1	144	144	7072	832	3008	832	7072	832	2592	288	3008	832	1088	288
1.25	144	144	6944	832	3008	832	6944	832	2560	288	3008	832	1088	288
1.5	144	144	6880	832	3008	832	6880	832	2528	288	3008	832	1088	288
1.75	144	144	6816	832	2976	832	6816	832	2528	288	2976	832	1088	288
2	144	144	6688	800	2976	800	6688	800	2464	288	2976	800	1088	288
2.25	144	144	6560	768	2976	768	6560	768	2400	288	2976	768	1088	288
2.5	144	144	6304	704	2976	704	6304	704	2336	256	2976	704	1088	256
2.75	144	144	5888	672	2944	672	5888	672	2176	224	2944	672	1088	224
3	144	144	5280	608	2944	608	5280	608	1952	224	2944	608	1088	224
3.25	144	144	4416	512	2912	512	4416	512	1632	192	2912	512	1056	192
3.5	144	0	3712	448	2816	448	3712	448	1376	160	2816	448	1024	160
3.75	0	0	3104	352	2688	352	3104	352	1152	128	2688	352	992	128
4	0	0	2560	288	2496	288	2560	288	928	96	2496	288	896	96
4.25	0	0	2112	224	2240	224	2112	224	768	64	2240	224	800	64
4.5	0	0	1696	160	1920	160	1696	160	608	32	1920	160	704	32
4.75	0	0	1344	96	1536	96	1344	96	480	32	1536	96	576	32
5	0	0	1024	64	1216	64	1024	64	352	32	1216	64	448	32

3.4 Delta Reference - Quad Spectrum OL Spectral Compatibility Tables

Table 3-4 gives the delta between the reference performance (table 3-1) and the performance in the presence of 5 OL quad spectrum systems (Table 3-3).

Table 3-4. Reference Performance minus Performance with 5 OL Quad Spectrum

	TCM-ISDN	G.992.1 Annex A		G.992.2 Annex A		G.992.1 Annex C				G.992.2 Annex C				
Dist		(FDM)				DBM			FBM		DBM		FBM	
	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.75	0	0	-320	0	-64	0	-192	0	-32	0	-64	0	0	0
1	0	0	-1120	0	-384	0	-704	0	-64	0	-256	0	0	0
1.25	0	0	-2048	-32	-736	-32	-1248	-32	-64	0	-480	-32	0	0
1.5	0	0	-3040	-64	-1184	-64	-1856	-32	-96	0	-736	-32	0	0
1.75	0	0	-4320	-96	-1536	-96	-2624	-64	-128	0	-960	-64	0	0
2	0	0	-4992	-96	-2016	-96	-3008	-64	-128	0	-1280	-64	0	0
2.25	0	0	-5472	-128	-2336	-128	-3264	-64	-160	0	-1472	-64	0	0
2.5	0	0	-5600	-128	-2624	-128	-3296	-32	-256	32	-1664	-32	-32	32
2.75	0	0	-5408	-160	-2784	-160	-3168	-32	-320	64	-1728	-32	-32	64
3	0	0	-4960	-160	-2848	-160	-2912	-32	-416	64	-1760	-32	-64	64
3.25	0	0	-4192	-160	-2848	-160	-2432	0	-352	96	-1760	0	-64	96
3.5	0	0	-3584	-160	-2784	-160	-2080	32	-320	128	-1696	32	-96	128
3.75	0	0	-3040	-128	-2656	-128	-1760	96	-320	128	-1600	96	-160	128
4	0	0	-2528	-96	-2496	-96	-1472	128	-288	160	-1472	128	-192	160
4.25	0	0	-2112	-64	-2240	-64	-1184	192	-288	192	-1312	192	-224	192
4.5	0	0	-1696	-32	-1920	-32	-928	224	-256	192	-1088	224	-288	192
4.75	0	0	-1344	0	-1536	0	-736	256	-256	192	-832	256	-288	192
5	0	0	-1024	0	-1216	0	-608	288	-224	192	-672	288	-256	192

3.5 G.992.1 OL Spectral Compatibility table - Quad Spectrum OL Spectral Compatibility Table

Table 3-5 gives the delta between the reference performance (table 3-2) and the performance in the presence of 5 OL quad spectrum systems (Table 3-3).

Table 3-5. g.992.1 OL SC Table minus Quad Spectrum OL SC Table

	TCM-ISDN	G.992.1 Annex A		G.992.2 Annex A		G.992.1 Annex C				G.992.2 Annex C				
Dist		(FDM)				DBM		FBM		DBM		FBM		
	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US
0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.75	0	0	-96	0	0	0	-96	0	-32	0	0	0	0	0
1	0	0	-192	0	0	0	-192	0	-64	0	0	0	0	0
1.25	0	0	-160	0	0	0	-160	0	-64	0	0	0	0	0
1.5	0	0	-256	0	-32	0	-256	0	-96	0	-32	0	0	0
1.75	0	0	-352	-32	0	-32	-352	-32	-128	0	0	-32	0	0
2	0	0	-352	-32	0	-32	-352	-32	-128	0	0	-32	0	0
2.25	0	0	-480	-32	-32	-32	-480	-32	-160	-32	-32	-32	0	-32
2.5	0	0	-640	-32	-64	-32	-640	-32	-256	0	-64	-32	-32	0
2.75	0	0	-864	-64	-64	-64	-864	-64	-320	0	-64	-64	-32	0
3	0	0	-1088	-64	-128	-64	-1088	-64	-416	-32	-128	-64	-64	-32
3.25	0	0	-928	-32	-224	-32	-928	-32	-352	-32	-224	-32	-64	-32
3.5	0	0	-864	-64	-288	-64	-864	-64	-320	-32	-288	-64	-96	-32
3.75	0	0	-800	-64	-416	-64	-800	-64	-320	-32	-416	-64	-160	-32
4	0	0	-768	-64	-512	-64	-768	-64	-288	-32	-512	-64	-192	-32
4.25	0	0	-768	-64	-672	-64	-768	-64	-288	0	-672	-64	-224	0
4.5	0	0	-736	-32	-768	-32	-736	-32	-256	0	-768	-32	-288	0
4.75	0	0	-672	0	-704	0	-672	0	-256	0	-704	0	-288	0
5	0	0	-608	0	-672	0	-608	0	-224	-32	-672	0	-256	-32

Table 3-5 proves that Quad Spectrum OL system has always a smaller spectral compatibility Impact than g.992.1OL with protected systems

4 Conclusions-Recommendations

The contribution proves that the Quad Spectrum Overlap system has always a smaller spectral compatibility Impact than g.992.1 OL with protected systems.

We recommend that Quad Spectrum Overlap System shall be deployed in the same quad as protected systems up to 3.25km.

The spectral compatibility simulations contained in this contribution fully match a cross check done by SEI.