

平成 16 年 7 月 22 日  
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LongReach2-VDSL(LR2-VDSL)のスペクトル適合性について

LR1-VDSL の 1.104MHz 以上の周波数帯域での PSD を -49.5dBm/Hz に変更した LongReach2-VDSL (以降、システム名称を「LR2-VDSL」とする)のスペクトル適合性確認を行い、その結果を報告する。スペクトル適合性計算のクロスチェックをお願いする。

LR2-VDSL は、1.104MHz 以下の周波数帯域では、ADSL(G.992.1AnnexA/FDM)の PSD と互換性を有する。1.104MHz 以上の周波数帯域では、VDSL(F-1/G.993.1M2)の PSD と互換性を有する。

## 1. PSD 定義

### LR2-VDSL 下り PSD mask

| Band attribute | Frequency band f[MHz]    | Maximum PSD limitation (PSD mask) [dBm/Hz] |
|----------------|--------------------------|--|
|                | $0 < f < 0.004$          | $-97.5 + 15 \text{ dBm}$                   |
|                | $0.004 \leq f < 0.08$    | $-92.5 + 4.63 \times \log_2(f/0.004)$      |
|                | $0.08 \leq f \leq 0.138$ | $-72.5 + 36 \times \log_2(f/0.08)$         |
| DS1            | $0.138 < f < 1.104$      | $-40 + 3.5 (= -36.5)$                      |
| DS1            | $1.104 \leq f < 1.622$   | $-36.5 - (13/0.518) \times (f - 1.104)$    |
| DS1            | $1.622 \leq f < 1.8$     | $-53 + 3.5 (= -49.5)$                      |
|                | $1.8 \leq f < 2$         | $-80$                                      |
| DS1            | $2 \leq f < 3.5$         | $-53 + 3.5 (= -49.5)$                      |
|                | $3.5 \leq f \leq 3.925$  | $-80$                                      |
|                | $3.925 < f < 5.025$      | $-100$                                     |
|                | $5.025 \leq f \leq 5.2$  | $-80 + (20/0.175) \times (f - 5.2)$        |
| DS2            | $5.2 < f < 7$            | $-54 + 3.5 (= -50.5)$                      |
|                | $7 \leq f \leq 7.3$      | $-80$                                      |
| DS2            | $7.3 < f < 8.5$          | $-54 + 3.5 (= -50.5)$                      |
|                | $8.5 \leq f \leq 8.675$  | $-80 - (20/0.175) \times (f - 8.5)$        |
|                | $8.675 < f < 30$         | $-100$                                     |
|                | $30 \leq f < \infty$     | $-120$                                     |

NOTE 1 – All PSD and power measurements are in 100 Ω.  
NOTE 2 – The maximum PSD shall be measured with a 10 kHz resolution bandwidth.

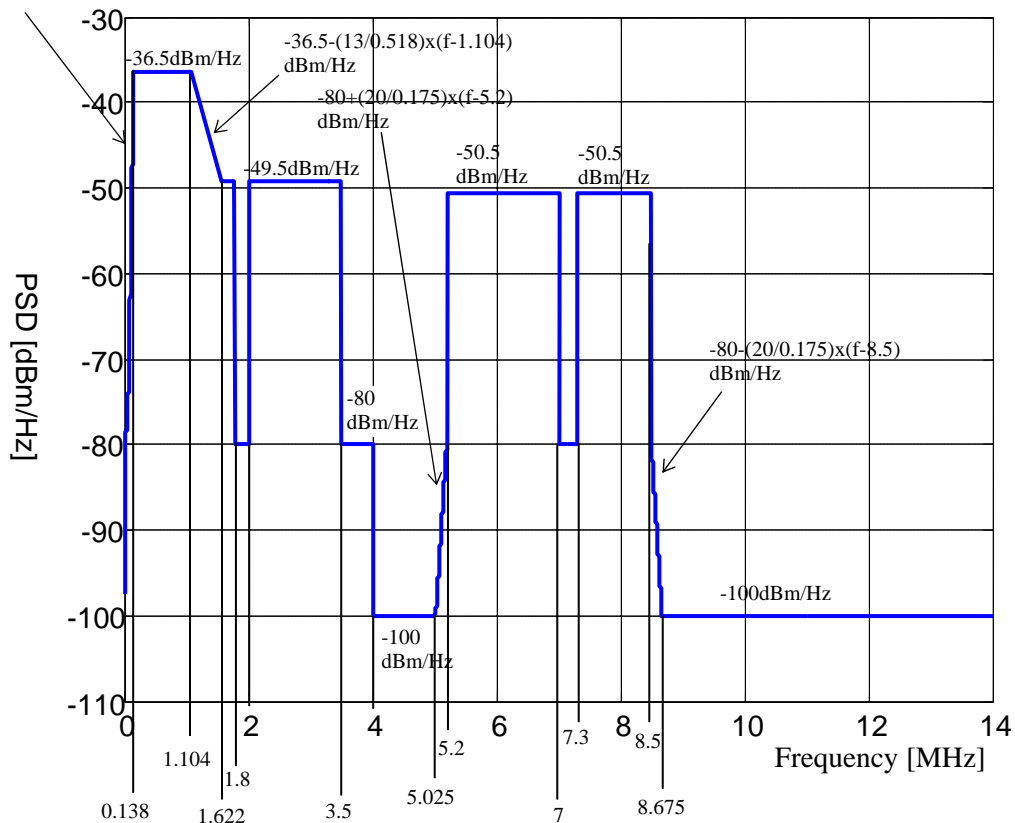
### LR2-VDSL 上り PSD mask

| Band attribute | Frequency band f[MHz]     | Maximum PSD limitation (PSD mask) [dBm/Hz] |
|----------------|---------------------------|--|
|                | $0 < f < 0.004$           | $-97.5 + 15 \text{ dBm}$                   |
|                | $0.004 \leq f < 0.025875$ | $-92.5 + 21.5 \times \log_2(f/0.004)$      |
| US0            | $0.025875 \leq f < 0.138$ | $-34.5$                                    |
|                | $0.138 \leq f < 0.307$    | $-34.5 - 48 \times \log_2(f/0.138)$        |
|                | $0.307 \leq f < 3.575$    | $-100$                                     |
|                | $3.575 \leq f \leq 3.75$  | $-80 + (20/0.175) \times (f - 3.75)$       |
|                | $3.75 < f \leq 4$         | $-80$                                      |
| US1            | $4 < f < 5.2$             | $-53 + 3.5 (= -49.5)$                      |
|                | $5.2 \leq f \leq 5.375$   | $-80 - (20/0.175) \times (f - 5.2)$        |
|                | $5.375 < f < 8.325$       | $-100$                                     |
|                | $8.325 \leq f \leq 8.5$   | $-80 + (20/0.175) \times (f - 8.5)$        |
| US2            | $8.5 < f < 10.1$          | $-54 + 3.5 (= -50.5)$                      |
|                | $10.1 \leq f \leq 10.15$  | $-80$                                      |
| US2            | $10.15 < f < 12$          | $-54 + 3.5 (= -50.5)$                      |
|                | $12 \leq f \leq 12.175$   | $-80 - (20/0.175) \times (f - 12)$         |
|                | $12.175 < f < 30$         | $-100$                                     |
|                | $30 \leq f < \infty$      | $-120$                                     |

NOTE 1 – All PSD and power measurements are in 100 Ω.  
NOTE 2 – The maximum PSD shall be measured with a 10 kHz resolution bandwidth.

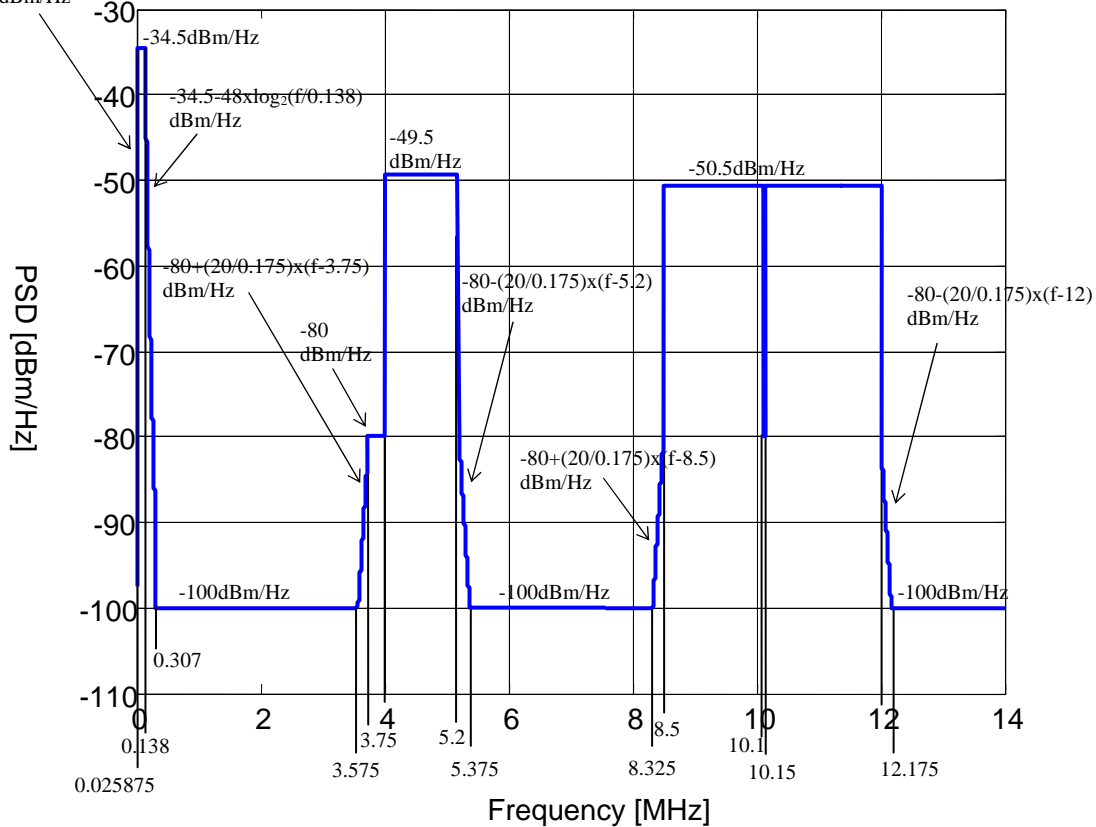
$$-72.5 + 36 \log_2(f/0.08)$$

LR2-VDSL 下ノ PSD Mask

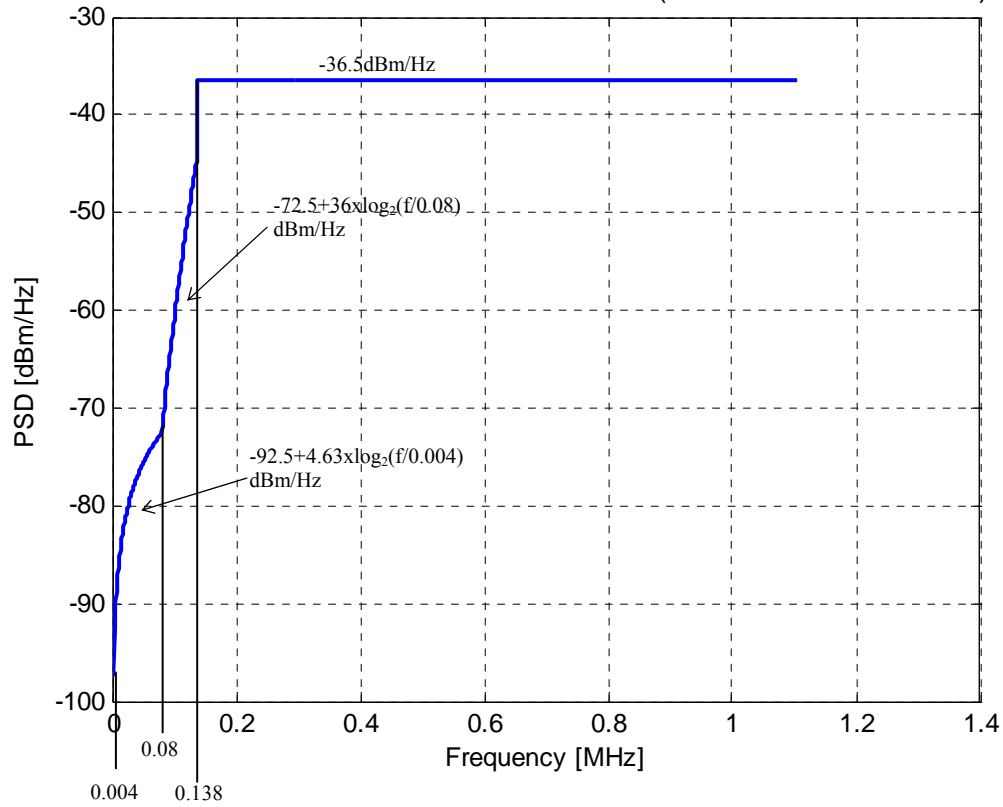


$$-92.5 + 21.5 \log_2(f/0.004)$$

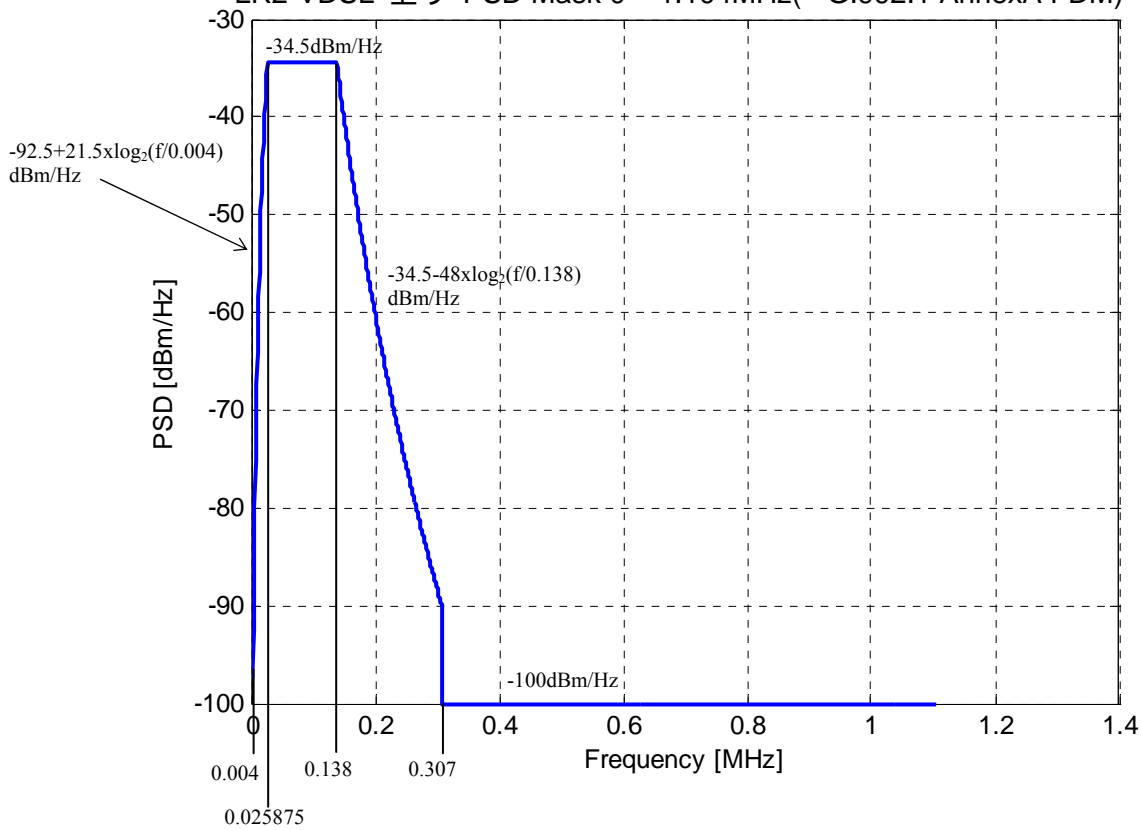
LR2-VDSL 上ノ PSD Mask



LR2-VDSL 下ノ PSD Mask 0 – 1.104MHz(= G.992.1 AnnexA FDM)



LR2-VDSL 上ノ PSD Mask 0 – 1.104MHz(= G.992.1 AnnexA FDM)



## 2. スペクトル適合性計算結果

| Dist | ISDN |     | G.992.1 AnnexA (FDM) |     | G.992.2 AnnexA |     | G.992.1 AnnexC |     |      |     | G.992.2 AnnexC |     |      |     |
|------|------|-----|----------------------|-----|----------------|-----|----------------|-----|------|-----|----------------|-----|------|-----|
|      |      |     |                      |     |                |     | 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 |
| 1.0  | 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 | 6496                 | 832 | 2976           | 832 | 6496           | 832 | 2400 | 288 | 2976           | 832 | 1088 | 288 |
| 2.0  | 144  | 144 | 6368                 | 832 | 2976           | 832 | 6368           | 832 | 2336 | 288 | 2976           | 832 | 1088 | 288 |
| 2.25 | 144  | 144 | 6208                 | 832 | 2944           | 832 | 6208           | 832 | 2304 | 288 | 2944           | 832 | 1088 | 288 |
| 2.5  | 144  | 144 | 5984                 | 832 | 2912           | 832 | 5984           | 832 | 2208 | 288 | 2912           | 832 | 1056 | 288 |
| 2.75 | 144  | 144 | 5568                 | 800 | 2880           | 800 | 5568           | 800 | 2048 | 288 | 2880           | 800 | 1056 | 288 |
| 3.0  | 144  | 144 | 4992                 | 800 | 2848           | 800 | 4992           | 800 | 1824 | 288 | 2848           | 800 | 1024 | 288 |
| 3.25 | 144  | 144 | 4128                 | 800 | 2752           | 800 | 4128           | 800 | 1536 | 288 | 2752           | 800 | 992  | 288 |
| 3.5  | 144  | 0   | 3424                 | 768 | 2624           | 768 | 3424           | 768 | 1248 | 288 | 2624           | 768 | 960  | 288 |
| 3.75 | 0    | 0   | 2752                 | 736 | 2432           | 736 | 2752           | 736 | 1024 | 256 | 2432           | 736 | 896  | 256 |
| 4.0  | 0    | 0   | 2176                 | 736 | 2176           | 736 | 2176           | 736 | 800  | 256 | 2176           | 736 | 800  | 256 |
| 4.25 | 0    | 0   | 1664                 | 704 | 1824           | 704 | 1664           | 704 | 608  | 256 | 1824           | 704 | 672  | 256 |
| 4.5  | 0    | 0   | 1216                 | 672 | 1440           | 672 | 1216           | 672 | 448  | 224 | 1440           | 672 | 544  | 224 |
| 4.75 | 0    | 0   | 864                  | 640 | 1024           | 640 | 864            | 640 | 320  | 224 | 1024           | 640 | 384  | 224 |
| 5.0  | 0    | 0   | 544                  | 608 | 704            | 608 | 544            | 608 | 192  | 224 | 704            | 608 | 256  | 224 |

LR2-VDSL システムはスペクトル適合性を満足することを確認した。

尚、1.104MHz以上の周波数帯域ではVDSL (F-1/G.993.1M2) のPSDと互換性を有するが、5.2MHz以上の周波数帯域ではVDSL (F-1/G.993.1M1) のPSDと互換性を有するLongReach1.5-VDSL(以降、システム名称を「LR1.5-VDSL」とする)のスペクトル適合性確認結果も報告する。本日のSWG会合でLR2-VDSLの収容が容認されない場合は、LR1.5-VDSLのスペクトル適合性計算のクロスチェックをお願いする。

## 1. PSD 定義

### LR1.5-VDSL 下り PSD mask

| Band attribute | Frequency band f[MHz]    | Maximum PSD limitation (PSD mask) [dBm/Hz] |
|----------------|--------------------------|--|
|                | $0 < f < 0.004$          | $-97.5 + 15 \text{ dBm}$                   |
|                | $0.004 \leq f < 0.08$    | $-92.5 + 4.63 \times \log_2(f/0.004)$      |
|                | $0.08 \leq f \leq 0.138$ | $-72.5 + 36 \times \log_2(f/0.08)$         |
| DS1            | $0.138 < f < 1.104$      | $-40 + 3.5 (= -36.5)$                      |
| DS1            | $1.104 \leq f < 1.622$   | $-36.5 - (13/0.518) \times (f - 1.104)$    |
| DS1            | $1.622 \leq f < 1.8$     | $-53 + 3.5 (= -49.5)$                      |
|                | $1.8 \leq f < 2$         | $-80$                                      |
| DS1            | $2 \leq f < 3.5$         | $-53 + 3.5 (= -49.5)$                      |
|                | $3.5 \leq f \leq 3.925$  | $-80$                                      |
|                | $3.925 < f < 5.025$      | $-100$                                     |
|                | $5.025 \leq f \leq 5.2$  | $-80 + (20/0.175) \times (f - 5.2)$        |
| DS2            | $5.2 < f < 7$            | $-60 + 3.5 (= -56.5)$                      |
|                | $7 \leq f \leq 7.3$      | $-80$                                      |
| DS2            | $7.3 < f < 8.5$          | $-60 + 3.5 (= -56.5)$                      |
|                | $8.5 \leq f \leq 8.675$  | $-80 - (20/0.175) \times (f - 8.5)$        |
|                | $8.675 < f < 30$         | $-100$                                     |
|                | $30 \leq f < \infty$     | $-120$                                     |

NOTE 1 – All PSD and power measurements are in 100 Ω.  
NOTE 2 – The maximum PSD shall be measured with a 10 kHz resolution bandwidth.

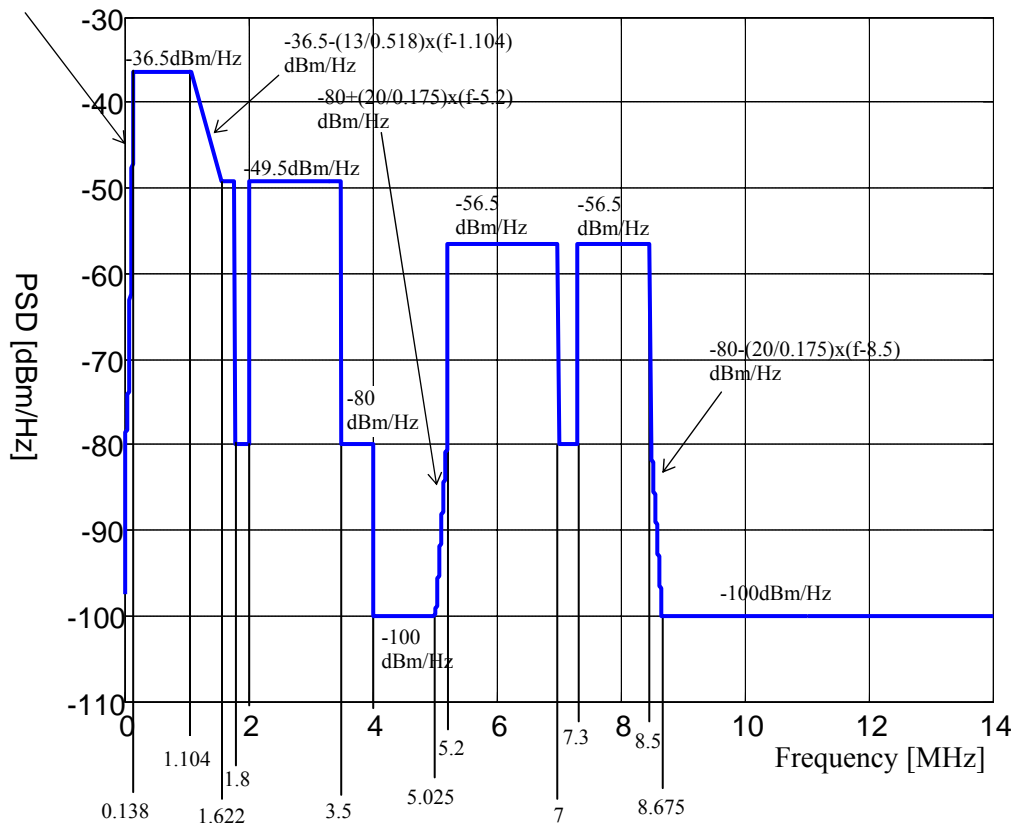
### LR1.5-VDSL 上り PSD mask

| Band attribute | Frequency band f[MHz]     | Maximum PSD limitation (PSD mask) [dBm/Hz] |
|----------------|---------------------------|--|
|                | $0 < f < 0.004$           | $-97.5 + 15 \text{ dBm}$                   |
|                | $0.004 \leq f < 0.025875$ | $-92.5 + 21.5 \times \log_2(f/0.004)$      |
| US0            | $0.025875 \leq f < 0.138$ | $-34.5$                                    |
|                | $0.138 \leq f < 0.307$    | $-34.5 - 48 \times \log_2(f/0.138)$        |
|                | $0.307 \leq f < 3.575$    | $-100$                                     |
|                | $3.575 \leq f \leq 3.75$  | $-80 + (20/0.175) \times (f - 3.75)$       |
|                | $3.75 < f \leq 4$         | $-80$                                      |
| US1            | $4 < f < 5.2$             | $-53 + 3.5 (= -49.5)$                      |
|                | $5.2 \leq f \leq 5.375$   | $-80 - (20/0.175) \times (f - 5.2)$        |
|                | $5.375 < f < 8.325$       | $-100$                                     |
|                | $8.325 \leq f \leq 8.5$   | $-80 + (20/0.175) \times (f - 8.5)$        |
| US2            | $8.5 < f < 10.1$          | $-60 + 3.5 (= -56.5)$                      |
|                | $10.1 \leq f \leq 10.15$  | $-80$                                      |
| US2            | $10.15 < f < 12$          | $-60 + 3.5 (= -56.5)$                      |
|                | $12 \leq f \leq 12.175$   | $-80 - (20/0.175) \times (f - 12)$         |
|                | $12.175 < f < 30$         | $-100$                                     |
|                | $30 \leq f < \infty$      | $-120$                                     |

NOTE 1 – All PSD and power measurements are in 100 Ω.  
NOTE 2 – The maximum PSD shall be measured with a 10 kHz resolution bandwidth.

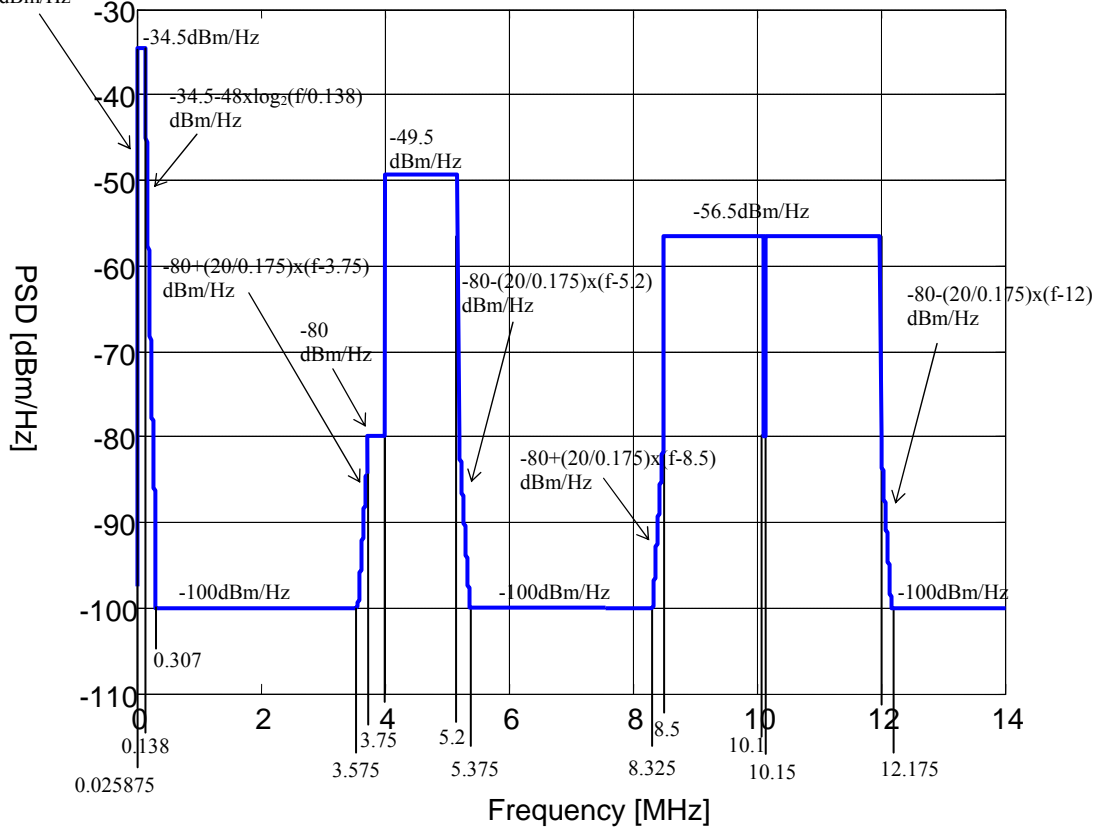
$$-72.5 + 36 \log_2(f/0.08)$$

LR1.5-VDSL 下ノ PSD Mask

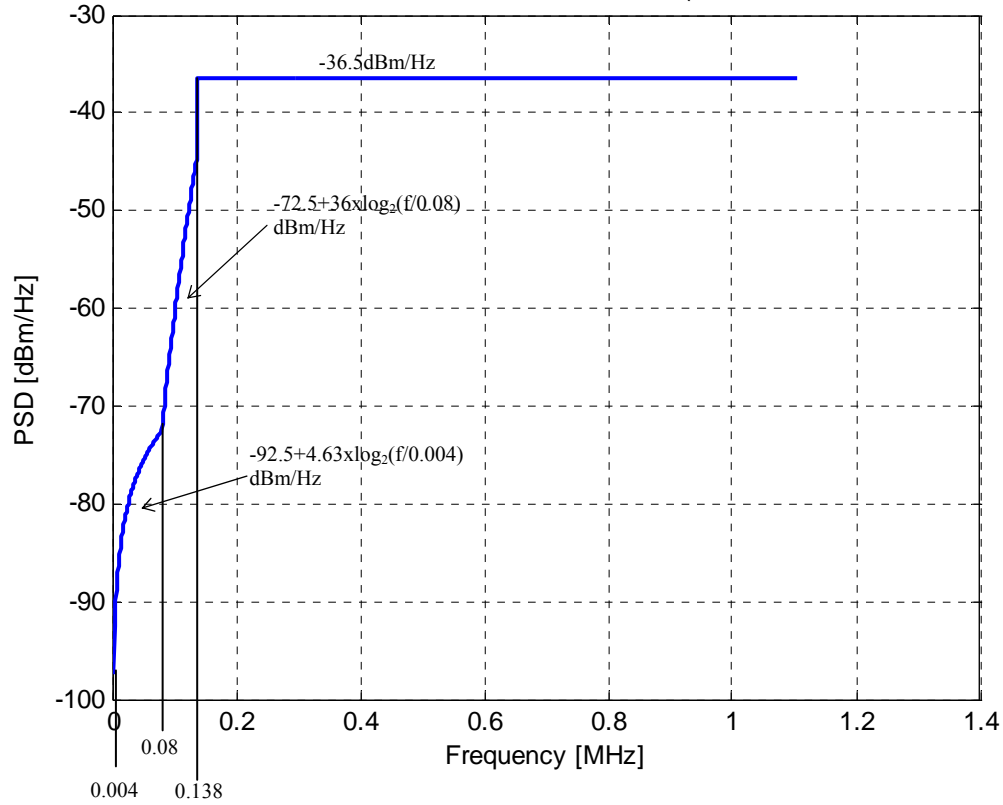


$$-92.5 + 21.5 \log_2(f/0.004)$$

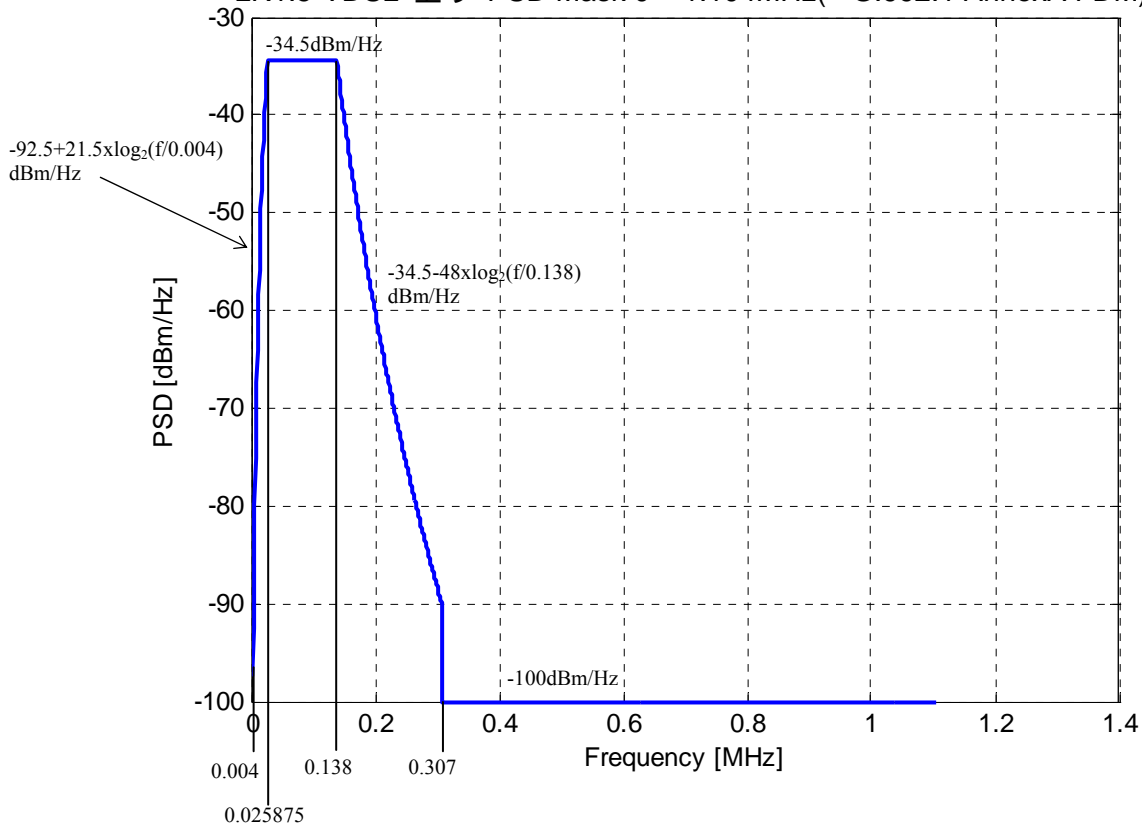
LR1.5-VDSL 上ノ PSD Mask



LR1.5-VDSL 下ノ PSD Mask 0 – 1.104MHz(= G.992.1 AnnexA FDM)



LR1.5-VDSL 上ノ PSD Mask 0 – 1.104MHz(= G.992.1 AnnexA FDM)





2. スペクトル適合性計算結果

| Dist | ISDN |     | G.992.1 AnnexA (FDM) |     | G.992.2 AnnexA |     | G.992.1 AnnexC |     |      |     | G.992.2 AnnexC |     |      |     |     |
|------|------|-----|----------------------|-----|----------------|-----|----------------|-----|------|-----|----------------|-----|------|-----|-----|
|      |      |     | DS                   | US  | DS             | US  | DS             | US  | DBM  |     | FBM            |     | DBM  |     | FBM |
|      | DS   | US  | DS                   | US  | DS             | US  | DS             | US  | DS   | US  | DS             | US  | DS   | US  | DS  |
| 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 |     |
| 1.0  | 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 | 6496                 | 832 | 2976           | 832 | 6496           | 832 | 2400 | 288 | 2976           | 832 | 1088 | 288 |     |
| 2.0  | 144  | 144 | 6368                 | 832 | 2976           | 832 | 6368           | 832 | 2336 | 288 | 2976           | 832 | 1088 | 288 |     |
| 2.25 | 144  | 144 | 6208                 | 832 | 2944           | 832 | 6208           | 832 | 2304 | 288 | 2944           | 832 | 1088 | 288 |     |
| 2.5  | 144  | 144 | 5984                 | 832 | 2912           | 832 | 5984           | 832 | 2208 | 288 | 2912           | 832 | 1056 | 288 |     |
| 2.75 | 144  | 144 | 5568                 | 800 | 2880           | 800 | 5568           | 800 | 2048 | 288 | 2880           | 800 | 1056 | 288 |     |
| 3.0  | 144  | 144 | 4992                 | 800 | 2848           | 800 | 4992           | 800 | 1824 | 288 | 2848           | 800 | 1024 | 288 |     |
| 3.25 | 144  | 144 | 4128                 | 800 | 2752           | 800 | 4128           | 800 | 1536 | 288 | 2752           | 800 | 992  | 288 |     |
| 3.5  | 144  | 0   | 3424                 | 768 | 2624           | 768 | 3424           | 768 | 1248 | 288 | 2624           | 768 | 960  | 288 |     |
| 3.75 | 0    | 0   | 2752                 | 736 | 2432           | 736 | 2752           | 736 | 1024 | 256 | 2432           | 736 | 896  | 256 |     |
| 4.0  | 0    | 0   | 2176                 | 736 | 2176           | 736 | 2176           | 736 | 800  | 256 | 2176           | 736 | 800  | 256 |     |
| 4.25 | 0    | 0   | 1664                 | 704 | 1824           | 704 | 1664           | 704 | 608  | 256 | 1824           | 704 | 672  | 256 |     |
| 4.5  | 0    | 0   | 1216                 | 672 | 1440           | 672 | 1216           | 672 | 448  | 224 | 1440           | 672 | 544  | 224 |     |
| 4.75 | 0    | 0   | 864                  | 640 | 1024           | 640 | 864            | 640 | 320  | 224 | 1024           | 640 | 384  | 224 |     |
| 5.0  | 0    | 0   | 544                  | 608 | 704            | 608 | 544            | 608 | 192  | 224 | 704            | 608 | 256  | 224 |     |