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**UNWANTED EMISSION INTERFERENCE FROM MOBILE EARTH STATIONS INTO
FIXED SERVICE RECEIVERS IN THE 2 GHz BAND**

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ABSTRACT

WG-SE has studied the ETS 300 734 unwanted emission limits for S-PCN Mobile Earth Stations (MES) from the point of view of protecting the Fixed Service (FS). A methodology was developed to assess the impact of MES unwanted emissions on FS receivers in terms of the probability of interference. These probabilities were compared to relevant ITU-R FS performance objectives. WG-SE concludes that ETS 300 734 would provide adequate protection of adjacent band Fixed Service receivers.

1 INTRODUCTION

This document studies the potential for interference from unwanted emissions of Mobile Earth Stations, operating in Satellite Personal Communication Networks (S-PCN) systems in the 1980 - 2010 MHz band, into Fixed Service receivers operating outside the same band, when the MES conform to the unwanted emission limits of ETS 300 734¹.

2 METHODOLOGY

The following methodology for the calculation of the probability that a given criterion of $C/(N+I) \geq X$ dB is breached, has been agreed by WG-SE.

- 1: Compute the statistical distribution of the wanted signal C at the output of the FS receiver antenna, based on the fading distribution derived from ITU-R Recommendation 530.
- 2: For $C = \text{min to max}$ (in steps of for example 0.5 dB)
- 3: Compute the maximum interference level (I) at the output of the FS receiver antenna to achieve $C/(N+I) \geq X$, using the following equation.

$$I = 10 \log \left[\frac{10^{C/10}}{10^{X/10}} - 10^{N/10} \right]$$

where N is the FS system noise power (W) at the output of the FS receiver antenna.

- 4: For $i = 1$ to n (where i is the MES channel number)
- 5: For $az = 0^\circ$ to 360° (where az is the azimuth direction from the FS receiver boresight to the interfering MES and the step size is for example 1°)
- 6: Compute the required propagation loss L_b using the following equation:

$$L_b = EIRP_i + G_r - I$$

¹ The version approved for public vote at the Edinburgh SES meeting, Nov. 1996

where:

- $EIRP_i$ is the unwanted EIRP, within the receiver bandwidth of the FS system, from an MES operating on channel i ;
- G_r is the FS receiver antenna gain in the direction of the interfering MES.

- 7: Compute the interference distance (d) assuming free space propagation for distances less than the maximum line-of-sight distance, and the spherical earth diffraction model in Recommendation ITU-R 526-2 for distances greater than the maximum line-of-sight distance. The maximum line-of-sight distance can be calculated from the antenna heights of the FS and MES stations.
- 8: Next az
- 9: Compute the interference area, $A_i(C)$ by adding area segments based on the interference distances obtained in step 7.
- 10: Next i
- 11: Next C
- 12: Compute the probability that $C/N < X$ dB by the following equation:

$$P_0 = \sum_{C=\min}^{X+N} p(C)$$

where:

$p(C)$ is the discrete probability density function of C , obtained in Step 1;

\min is the minimum C value represented in $p(C)$.

- 13: Compute the probability that $C/N > X$ and $C/(N+I) < X$

$$P_1 = \sum_{i=1}^n \delta_i \sum_{C=N+X}^{\max} p(C) \cdot A_i(C)$$

where:

δ_i is the density of MES transmitting on channel i ;

\max is the maximum C value represented in $p(C)$.

- 14: Compute the probability that $C/(N+I) < X$:

$$P\left[\frac{C}{N+I} < X\right] = P_0 + P_1$$

3 INTERFERENCE CALCULATIONS

3.1 Example Fixed Service (FS) system

A theoretical example FS system was studied to assess the interference impact of the proposed unwanted emission limits. The example system was chosen to be quite tightly designed, i.e. the criteria are just met in the absence of interference, in order to represent the worst case.

Parameters for the example FS system were taken from Recommendation ITU-R 758, see Table 1. The cumulative distribution function (CDF) of C/N, derived from Recommendation ITU-R 530, can be seen in Figure 1.

Table 2 gives the assumed route parameters. The parameters for the fading model were set so that the link would meet the criteria of Recommendation ITU-R 697-1. The criteria points are plotted in Figure 1. The BER values of 10^{-3} and 10^{-6} were converted to equivalent C/N criteria of 10 dB and 14 dB respectively using ITU-R Report 388-6.

It should be noted that the choice of performance criteria is not critical for the result. The critical FS parameters are mainly:

- the margin by which the FS system meets the chosen criteria in the absence of interference;
- the FS system noise power density N_0 ;
- the fade margin, which depends on the hop length, the climate and the terrain.

3.2 Mobile Earth Station (MES) characteristics

Calculations were carried out for two assumed MSS systems, one TDMA system and one CDMA system, since the unwanted emission limits in ETS 300 734 are different for these two access techniques.

3.2.1 TDMA case

The TDMA system was assumed to operate in a 12 MHz contiguous spectrum segment, using 480 25 kHz RF carriers. Each TDMA carrier is assumed to carry 6 voice channels. The interfering EIRP in the 20 MHz band adjacent to the MSS operational band was calculated for each of these carriers by integrating the unwanted emission limit mask from ETS 300 734 over the appropriate bandwidth (20 MHz). The *nominated bandwidth* was assumed to be 25 kHz for the end channels (1 and 480) and 50 kHz for all other channels, see Figure 2. The results of the calculations are shown in Table 3. The carrier numbering is such that carrier 1 is closest to the band edge.

3.2.2 CDMA case

The CDMA system was assumed to operate in a 12 MHz contiguous spectrum segment, using 12 1 MHz RF carriers. The interfering EIRP in the 20 MHz band adjacent to the MSS operational band was calculated for each of these carriers by integrating the unwanted emission limit mask from ETS 300 734, over the appropriate bandwidth (20 MHz). The *nominated bandwidth* was assumed to be 1 MHz for the end channels (1 and 12) and 2 MHz for the other channels, see Figure 2. The results of the calculations are shown in Table 4. The carrier numbering is such that carrier 1 is closest to the band edge.

3.2.3 MES density

Taking into account the assumed operational bandwidth of 12 MHz, a busy hour MES density in a high traffic area of 0.001 MESs per km² is considered to be pessimistic from an interference point of view. This value was adopted for the calculations.

4 RESULTS

The results are presented in Table 5, which shows the computed probability of exceeding a BER of 10^{-3} and 10^{-6} in the two different cases.

5 CONCLUSIONS

The interference calculations carried out showed that the interference from MESs would not violate the interference criteria of the example FS system.

WG-SE thus concludes that ETS 300 734 will provide adequate protection of adjacent band Fixed Service receivers.

Parameter	Value	Unit
Frequency	2000	MHz
Modulation	4-PSK	-
Capacity	34	Mbit/s
Bandwidth	20	MHz
Receiver antenna gain	31	dBi
Antenna noise temperature	290	K
Feeder losses	1	dB
Feeder temperature	290	K
Receiver noise figure	4	dB
Receiver system noise temperature at the output of the antenna	917	K

Table 1: Example FS system

Parameter	Value	Unit
Hop length	75	km
Transmit antenna height above mean sea level	500	m
Receive antenna height above mean sea level	450	m
Percentage of time gradient, p_L	10	%
Latitude	50	° N
Longitude	Europe	-
Terrain	Over land	-

Table 2: FS route parameters

Carrier no.	Interfering EIRP
1	6.4 dBW
2	2.3 dBW
3	-6.0 dBW
4	-14.2 dBW
5	-21.9 dBW
...	...
63	-34.0 dBW
480	-34.0 dBW

Table 3: Interfering EIRP from TDMA MESs

Carrier no.	Interfering EIRP
1	-21.6 dBW
2	-25.6 dBW
3	-30.5 dBW
4	-31.0 dBW
12	-31.0 dBW

Table 4: Interfering EIRP from CDMA MESs

	P_0	(P_0+P_1) TDMA	(P_0+P_1) CDMA	Criteria for (P_0+P_1)
$BER > 10^{-3}$	0.0000510	0.0000600	0.0000717	0.00015
$BER > 10^{-6}$	0.000114	0.000133	0.000160	0.015

Table 5: Computation results

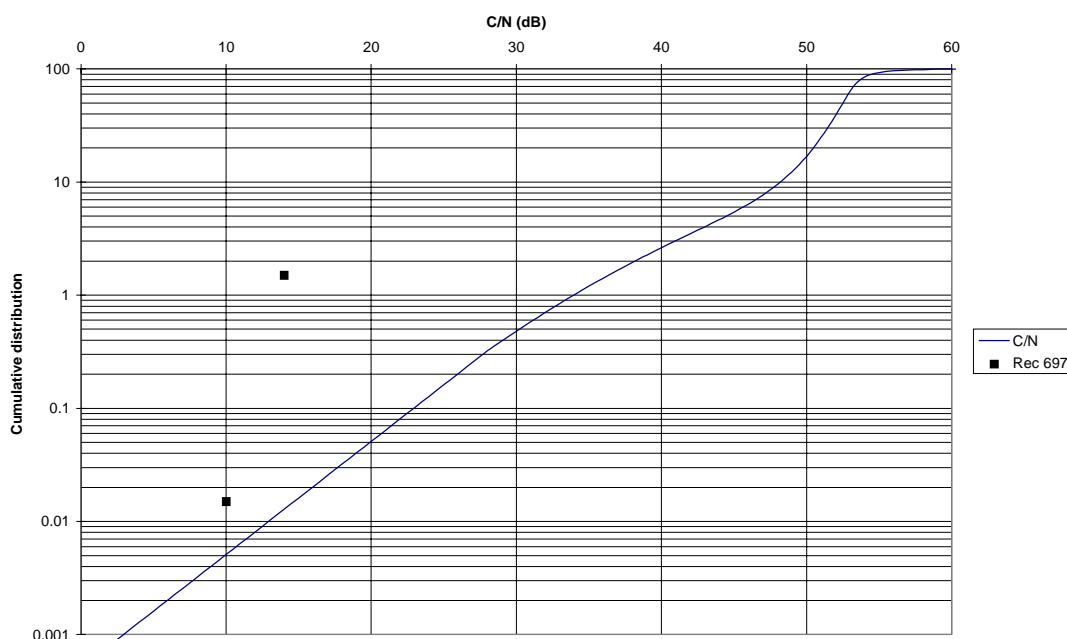


Figure 1: Example FS system C/N distribution (based on Recommendation 530)

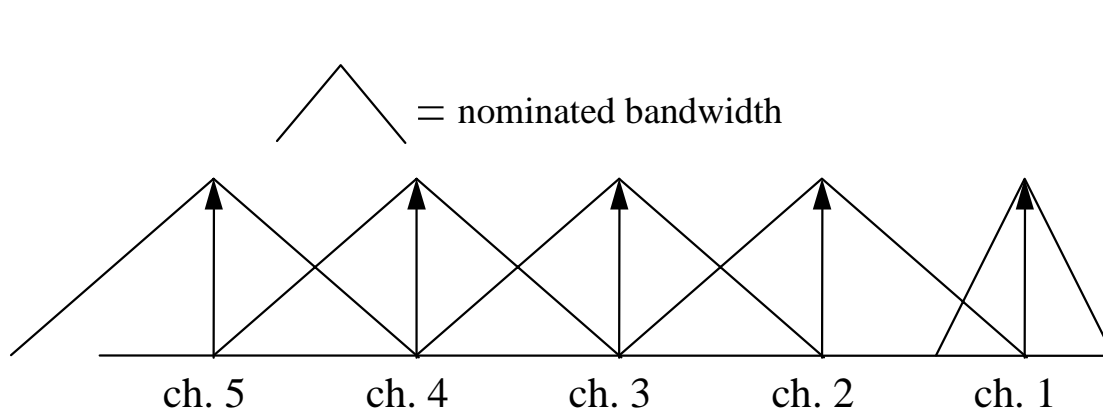


Figure 2: Illustration of the nominated bandwidth of MES carriers