

RECOMMENDATION ITU-R S.483-3*

**MAXIMUM PERMISSIBLE LEVEL OF INTERFERENCE IN A TELEVISION
CHANNEL OF A GEOSTATIONARY-SATELLITE NETWORK IN THE FIXED-
SATELLITE SERVICE EMPLOYING FREQUENCY MODULATION, CAUSED
BY OTHER NETWORKS OF THIS SERVICE**

(Question ITU-R 48/4)

(1974-1978-1992-1997)

The ITU Radiocommunication Assembly,

considering

- a) that TV/FM carriers are sensitive to interference from other fixed-satellite service (FSS) carriers;
- b) that in particular, TV/FM carriers are sensitive to interference from other TV/FM carriers;
- c) that interference between networks in the FSS contributes to the noise in the system;
- d) that it is desirable that the interference noise in television channels of networks in the FSS caused by transmitters of different networks of this service should be such as to give a reasonable orbit utilization efficiency;
- e) that the overall performance of a network should essentially be under the control of the system designer;
- f) that it is necessary to protect a network in the FSS from interference by other networks of this service;
- g) that it is necessary to specify the maximum permissible interference power in a television channel, in order to determine space station and earth station characteristics such as required protection ratios and minimum orbital spacing;
- h) that protection ratio masks are useful to determine minimum orbital spacing and in coordination exercises;
- j) that for direct to home (DTH) reception quality grade 4, as defined in Recommendation ITU-R BT.500, is usually adequate,

recommends

- 1 that different geostationary-satellite networks, in the FSS operating in the same frequency bands, be designed in such a manner that the interference noise power in a hypothetical reference circuit for television of a network in the FSS employing frequency modulation caused by the aggregate of the earth station and space station transmitters of other networks, should not exceed 15% of the permissible video noise in the hypothetical reference circuit for more than 1% of any month;
- 2 that the maximum level of interference noise power caused by any one satellite network into another satellite network should not exceed 4/10 of the interference noise allowance recommended in § 1 but in some cases it may be necessary to limit the single entry value to less than 4/10 of the interference noise allowance quoted above;
- 3 that the protection ratio masks in Annex 2 (§ 8) be used in cases where the interferer is another TV/FM carrier (see Note 6);
- 4 that the maximum level of interference noise power caused to that network should be calculated on the basis of the following values for the receiving earth station antenna gain in a direction at an angle ϕ (degrees) referred to the main beam direction:

$$G = 32 - 25 \log \phi \quad \text{dBi} \quad \text{for} \quad 1^\circ \leq \phi < 48^\circ$$

$$G = -10 \quad \text{dBi} \quad \text{for} \quad 48^\circ \leq \phi \leq 180^\circ$$

except when the actual gain is known and is less than the above value, in which case the actual value should be used;

* This Recommendation should be brought to the attention of Radiocommunication Working Party 10-11S.

5 that the following Notes should be regarded as part of the Recommendation:

NOTE 1 – The above values of interference noise shall be included in the total noise allowances as defined in Recommendation ITU-R S.354.

NOTE 2 – In segments of the geostationary-satellite orbit not likely to be crowded, interference allowances less than those recommended above may be utilized, allowing a corresponding increase in other noise contributions within total acceptable noise limits.

NOTE 3 – Particularly in cases where interference is caused by transmitters using code-division-multiple-access techniques, the interference from another fixed-satellite network referred to in § 2 is the composite interference from all transmissions having overlapping spectra in that network.

NOTE 4 – The methods referred to in Recommendation ITU-R S.741 and other relevant ITU-R texts can be used to calculate the carrier-to-interference ratio.

NOTE 5 – Annexes 1 and 2 contain further information relevant to this Recommendation.

NOTE 6 – The masks provided in Annex 2 do not take into account the TV audio requirements of certain systems. When there are such requirements, the protection ratio masks may be replaced with other masks specific for such requirements, if necessary. This needs to be further studied.

ANNEX 1

1 Multiple carrier interference

As TV is generally a wideband transmission, there will be cases where the interference will consist of a number of narrower bandwidth carriers. In such cases the analysis and calculation should take account of the total power of the interfering carriers that are contained within the TV bandwidth to determine the C/I .

2 TV sound

Television sound can be transmitted along with the TV carrier using a subcarrier frequency modulated by the programme signal and multiplexed with the composite video signal with the subcarrier placed above the TV baseband or using sound-in-sync techniques (SIS). A single, high quality 15 kHz audio channel is commonly provided.

For techniques of transmitting TV sound on a separate carrier, such as SCPC, there is no specific criterion in ITU-R texts and study is needed.

ANNEX 2

Interference between TV/FM signals

1 Introduction

Interference between TV/FM signals is of special importance because the impairments introduced by a TV/FM interferer have a different subjective effect on a TV picture than the effect caused by thermal noise. This Annex provides a method to evaluate the impairments caused by thermal noise and TV/FM interference and the derivation of the protection ratio masks.

2 Subjective assessment of TV picture quality

The impact of various types of impairments on the picture quality is usually determined using subjective assessments of a number of viewers, mostly non-experts. The methodology for the assessments specifying the viewing conditions, grading scales and other details is recommended by the ITU-R in Recommendation ITU-R BT.500. A five-grade scale is usually used to describe the quality and level of impairment of the TV picture.

3 Impairments due to thermal noise

The results of extensive assessments of impairments in a NTSC signal introduced by thermal noise lead to the following expressions, which approximate the impairments introduced by thermal noise:

$$I_{th} = \exp [30.9 - 8.41 \ln(S/N_w)] \quad (1)$$

In equation (1), I_{th} denotes the impairments caused by thermal noise and is related to the impairment grade via a general equation:

$$I = (5 - Q)/(Q - 1) \quad (2)$$

where:

Q : impairment grade on the five-grade scale

S/N_w : weighted (unified) signal-to-noise ratio in (dB).

Expression (3) also provides a very good fit of the mean opinion scores as shown in Fig. 1:

$$I_{th} = [10^{(-S/N_w)/25} / 0.027]^{2.2} \quad (3)$$

4 Impairments due to co-channel interference caused by another TV/FM carrier

Many studies support the following conclusions in respect to interference from another TV/FM carrier:

- the impact of co-channel interference on the picture quality is more significant than the impact of the same amount of thermal noise;
- the subjective effects of the impairments caused by the co-channel interference are dependent on the desired TV picture content; the picture content of the interfering TV signal seems to play a less significant role;
- the deviation of the desired signal is an important factor.

Expression (4) has been suggested earlier to relate the impairments introduced into a TV picture and the protection ratio between two co-channel NTSC TV/FM signals:

$$PR_0 = 16.9 - 8.7 \log I_{int} - 20 \log (D/12) \quad (4)$$

where:

PR_0 : protection ratio

I_{int} : impairment introduced by co-channel interference

D : peak-to-peak deviation in (MHz) of the wanted TV signal

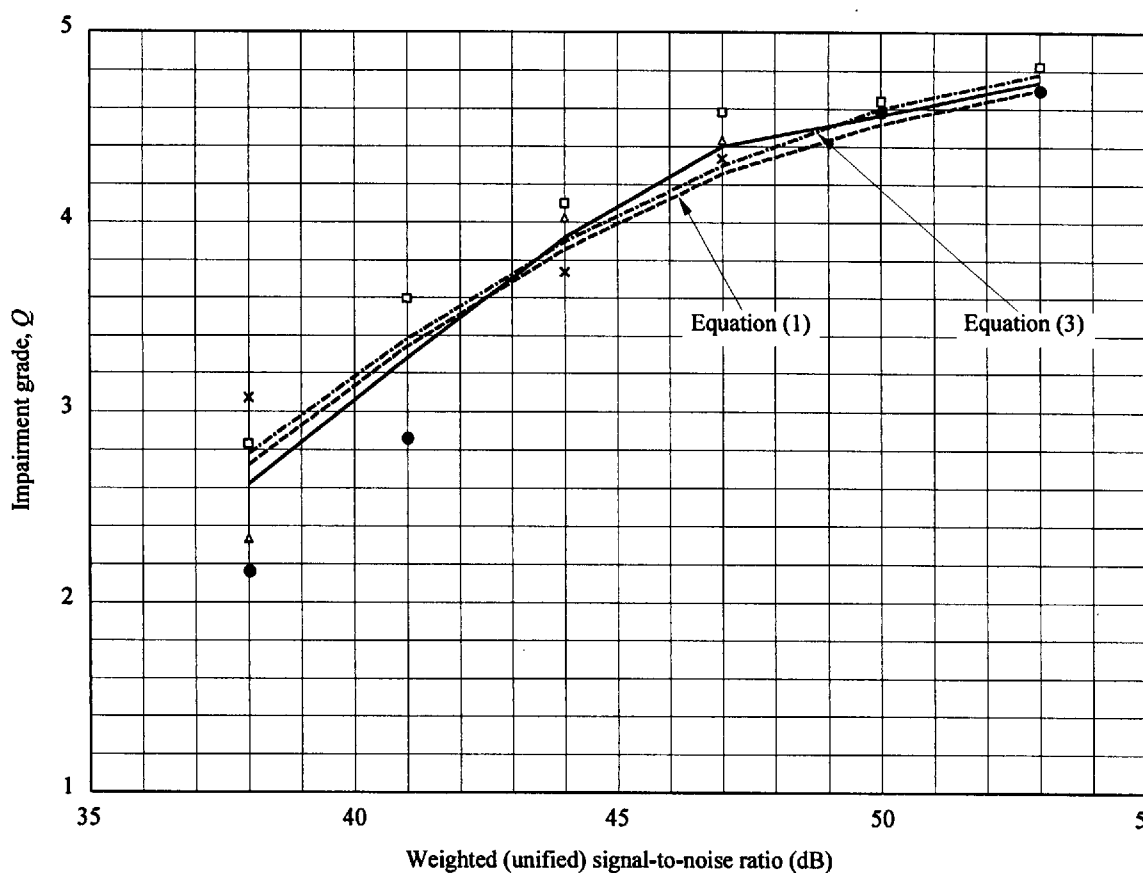
Equation (2) relates the impairments due to interference with the corresponding impairment grade Q .

Comparing the impairments introduced by thermal noise and interference, an important observation can be made; the impairments caused by co-channel interference correspond to the impairments caused by the thermal noise whose level is about 6 dB higher than the interference noise. This observation suggests the use of equation (3) adjusted for the 6 dB higher impact in modelling the impairments due to co-channel interference. Applying this approach to the example in Fig. 2, the relation between the protection ratio and the impairments due to co-channel interference with an adjustment factor of 6.2 dB is given by equation (5). For this example, $S/N_w = C/N + 30$ (dB). Then, $S/N_{int} = C/I + 30 - 6.2 = C/I + 23.8 = PR_0 + 23.8$ (dB) and equation (5) follows:

$$I_{int} = [10^{-(PR_0 + 23.8)/25} / 0.027]^{2.2} \quad (5)$$

As shown in Fig. 3, this approach better describes the mean opinion scores for co-channel interference, especially at lower grades, than equation (4).

FIGURE 1
Impairments due to thermal noise



Measured:

□ Group A

△ Group B

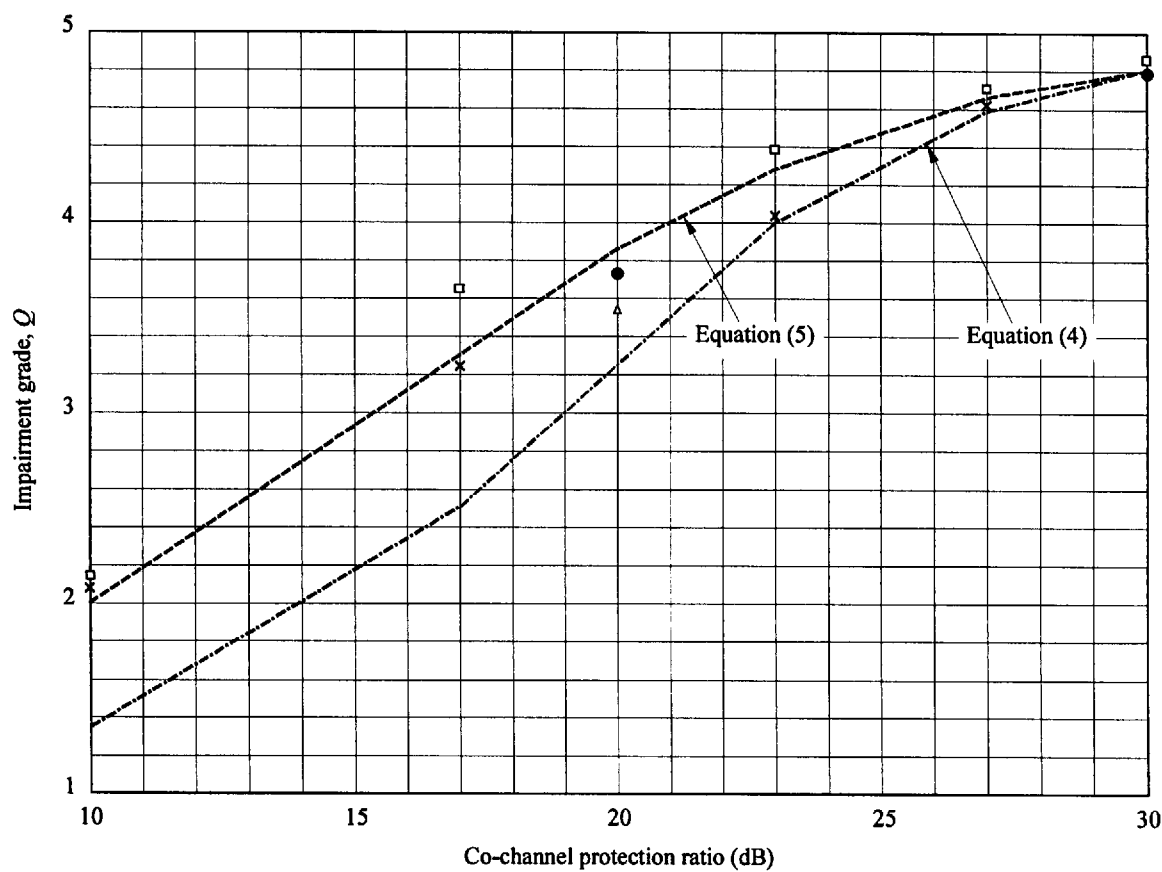
× Group C

● Group D

— Mean (A-D)

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FIGURE 2
Impairments due to co-channel interference



$$S/N_{wh} = C/N + 30 \text{ (dB)} = 56 \text{ dB}$$

Deviation: 9.5 MHz p-p

Measured:

□ Group A

△ Group B

× Group C

● Group D

--- Fit 1

--- Fit 2

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