



Recommendation ITU-R SF.675-4
(01/2012)

**Calculation of the maximum power density
(averaged over 4 kHz or 1 MHz)
of angle-modulated and digital carriers**

SF Series
**Frequency sharing and coordination between
fixed-satellite and fixed service systems**



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Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

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Series	Title
BO	Satellite delivery
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BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R SF.675-4

**Calculation of the maximum power density (averaged over 4 kHz or 1 MHz)
of angle-modulated and digital carriers**

(1990-1992-1993-1994-2012)

Scope

This Recommendation provides methods for calculating the maximum power density of various types of carriers averaged over 4 kHz or 1 MHz.

The ITU Radiocommunication Assembly,

considering

- a) that administrations are requested to prepare the information listed in Appendices 3 and 4 to the Radio Regulations (RR) for coordination and notification purposes;
- b) that one item of the information listed in RR Appendices 3 and 4 is the maximum power density per Hz at the input of the antenna;
- c) that RR Appendix 4 prescribes that the maximum power density per Hz of a carrier is averaged over the worst 4 kHz band for frequencies below 15 GHz and is averaged over the worst 1 MHz band for frequencies above 15 GHz;
- d) that generalized methods are necessary for the calculation of the maximum power density of an angle-modulated carrier;
- e) that tracking, telemetry and telecommand (TT&C) carriers generally have modulation characteristics, and hence spectral density characteristics, that differ from other types of carriers,

recommends

- 1** that the methods described in Annex 1 should be used for the calculation of the maximum power density, averaged over 4 kHz, of angle-modulated, digital or tracking, telemetry and telecommand (TT&C) carriers;
- 2** that the methods described in Annex 2 should be used for calculation of the maximum power density, averaged over 1 MHz, of digital or TT&C carriers;
- 3** that for the determination of the maximum spectral power density, with agreement of the other administrations concerned, the objectives of Resolution 703 (Rev.WRC-07) should be followed.

Annex 1

Calculation of the maximum power density (averaged over 4 kHz) of an angle-modulated carrier

Given below is the method of calculating the power level in the worst 4 kHz (W/4 kHz). The power density per Hz required by the RR is obtained by dividing this value by 4 000.

1 FM carrier

1.1 FM carrier modulated by a multi-channel telephony signal

The maximum power spectral density at full baseband loading is determined either by the residual carrier or by the peaks of the continuous spectrum, depending upon the nature of the modulation.

The power of the residual carrier is given by the expression:

$$P_t \cdot e^{-\psi_0} \quad W \quad (1)$$

where:

$$\psi_0 = \frac{m^2}{\epsilon} \left[C_0 + C_2 \cdot \epsilon + \frac{C_4}{3} (\epsilon + \epsilon^2 + \epsilon^3) \right] \quad (2)$$

In equation (2), m is the multi-channel r.m.s. modulation index and the constants C_0 , C_2 and C_4 describe the prevailing pre-emphasis characteristic in the general expression for the pre-emphasis:

$$p(f/f_h) = C_0 + C_2(f/f_h)^2 + C_4(f/f_h)^4 \quad (3)$$

where f is the specific baseband frequency under consideration, to be given in the same units as f_h . In the range $\epsilon \leq f/f_h \leq 1$, the pre-emphasis characteristic is well approximated by:

$$p(f/f_h) = 0.4 + 1.35(f/f_h)^2 + 0.75(f/f_h)^4 \quad (4)$$

Thus, for a system with pre-emphasis:

$$\psi_0 \approx \frac{m^2}{\epsilon} (0.4 + 1.6 \epsilon + 0.25 \epsilon^2 + 0.25 \epsilon^3) \quad (5)$$

Where $m = f_\Delta/f_h$.

NOTE 1 – Administrations should make available details of the spectrum shape and the value of the coefficients used in equations (2) and (3), for detailed coordination purposes.

The maximum power of the spectral density in the continuous part of the spectrum can be obtained approximately from Figs 1 and 2.