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SERIES G: INTERNATIONAL ANALOGUE CARRIER SYSTEMS

Transmission media – Characteristics

Estimating the signal load margin of FDM wideband amplifier equipment and transmission systems

ITU-T G-series Recommendations – Supplement 26

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NOTES

1 Supplement 26 to the G-series Recommendations was approved in Málaga-Torremolinos (1984) and published in Fascicle III.2 of the *Red Book*. This file is an extract from the *Red Book*. While the presentation and layout of the text might be slightly different from the *Red Book* version, the contents of the file are identical to the *Red Book* version and copyright conditions remain unchanged (see below).

2 In this Supplement, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Supplement No. 26

ESTIMATING THE SIGNAL LOAD MARGIN OF FDM WIDEBAND AMPLIFIER EQUIPMENT AND TRANSMISSION SYSTEMS

(Malaga-Torremolinos, 1984)
(referred to in Recommendation G.223)

This Supplement contains information supplied by British Telecom describing the test methods that they have adopted for their national networks in order to estimate the signal load margin of wideband amplifier equipment and analogue transmission systems. As such, it may be of interest to other Administrations.

1 Test methods used by British Telecom

Both single tone and white noise tests are used to determine the load margins of systems and repeaters, and these tests are applied as follows:

	Single tone	*White noise*
Prototype testing of amplifier equipment in British Telecom laboratories	Yes	Yes
Acceptance testing of amplifier equipment in factories	Yes	No
Acceptance testing of systems in the field	Yes	Yes

2 Single tone testing

a) Single tone testing is used to determine empirically a point on the input level versus output level curve at which a 1 dB increase in the input level results in an output level change of 1 ± 0.25 dB. This point is referred to as the "overload point" but clearly this is a convention adopted for the sake of convenience and is not intended to be an expression of some fundamental law of physics. It is a reasonably easy measurement to instrument, not requiring filters, and once the region in which the change in slope occurs has been found, it can be more closely explored to determine the position of the point to within a few tenths of a decibel. Hence, there is in practice no ambiguity in the result of the test.

Again it should be emphasized that this conventional point is not a technical definition but has more the force of an agreement between interested parties as to what constitutes something of contractual importance. Consequently, the following type of clause can be found in purchasing specifications:

"For the purposes of this specification, the overload point is that point at which . . ., etc."

b) When the apparatus or system has an attenuation-frequency response that is not flat, it is tested:

- at various frequencies within the working band,
- at the frequency of maximum relative gain,
- at the frequency at which the power density is equal to the average power density over the band. (This is restricted to monotonic emphasis and de-emphasis curves.)

c) Usually it is required that the single-tone overload point, as described, should be some few decibels higher than the level of the equivalent peak power as defined in Recommendation G.223, appropriate to the item being tested; for example, 6 dB higher. Such a margin is conventionally referred to as the "single-tone overload margin".

3 White noise testing

a) White noise testing is used to define or determine, as appropriate, the margin the system has against excess signal load. Noise testing is not used to define or determine any "overload point". The essential features of the method are as follows:

i) The noise power ratio (NPR) curve is plotted for the system under test as a function of the channel loading as in Figure A-2/G.228 – Annex A (Yellow Book, Volume III.2).

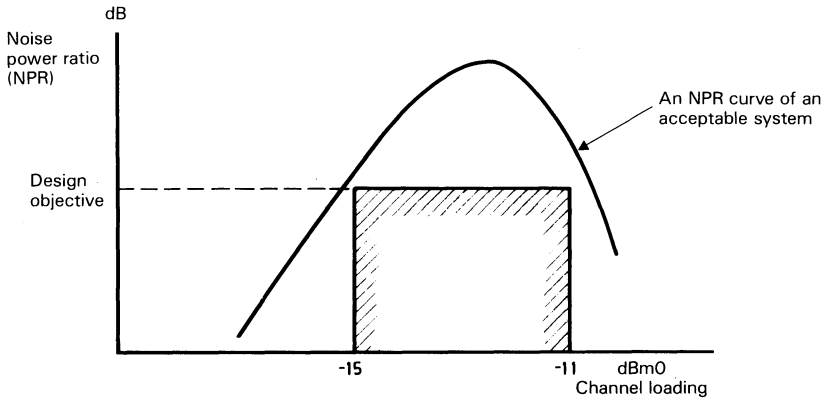
ii) At a loading of −15 dBm0 per channel, the NPR should not be less than the value corresponding to the design objective for the system at this loading (e.g., 3 pW0p/km).

i.e.: NPR (−15) < Theoretical NPR corresponding to the design objective for noise.

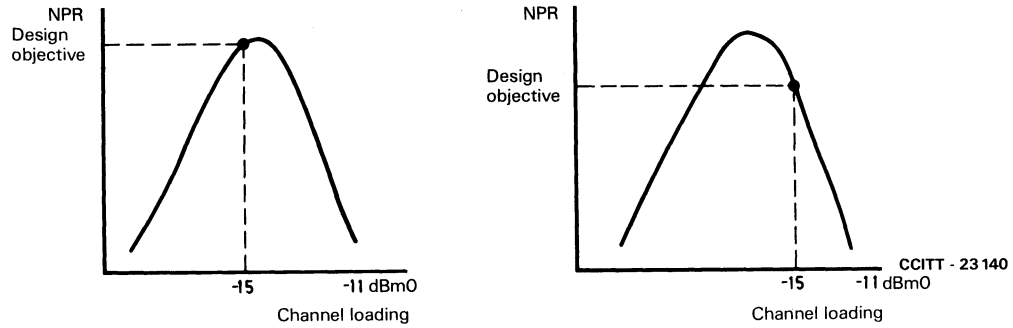
iii) The loading is increased by 4 dB to −11 dBm0 per channel and the NPR value noted. It is also required that:

NPR (−11)< Theoretical NPR corresponding to the design objective for noise.

The sketch below illustrates an acceptable result:



b) In this way some confidence is given that an adequate margin exists and, in particular, that systems with the following NPR characteristics are excluded:



c) The characteristics of the noise signal and the various filters required all comply with the provisions of Recommendation G.228 (Yellow Book, Volume III.2).

4 Discussion

It will be apparent that these definitions and practices are essentially empirical and have the following features:

i) capable of being performed in a relatively straightforward manner by field staff;

ii) capable of yielding unambiguous results that can be understood and agreed between the testing officers of British Telecom and a contractor.

The methods used should be distinguished from purely theoretical studies of what constitutes an overload point and it is recognized that it might not be possible to easily relate the measurement results to some theoretical (although still arbitrary) value obtained by an analysis of the statistical properties of the output signal or the level of some harmonic component. Nevertheless, it has been found that these empirical methods yield perfectly satisfactory information about equipment and system designs.

Geneva, 2004