

Methods of

Measurement for radio equipment used in satellite earth stations —

Part 3: Methods of measurement on
combinations of sub-systems —

Section 3.4 Measurements for frequency
division multiplex (f.d.m.) transmission

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- British Broadcasting Corporation
- British Radio and Electronic Equipment Manufacturers' Association
- British Telecommunications plc
- ERA Technology Ltd.
- Institution of Electrical Engineers
- Radio, Electrical and Television Retailers' Association
- Radiocommunications Agency

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National foreword

This Section of BS EN 60510 has been prepared by Subcommittee EPL/12/5 and is the English language version of EN 60510-3-4:1994 *Methods of measurement for radio equipment used in satellite earth stations — Part 3: Method of measurement on combinations of sub-systems — Section 4: Measurements for frequency division multiplex (f.d.m.) transmission* published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 510-3-4:1992, published by the International Electrotechnical Commission (IEC).

This standard is published in three Parts. The other Parts are:

- *Part 1: Methods common to sub-systems and combinations of sub-systems;*
- *Part 2: Measurements for sub-systems.*

Cross-references

Publication referred to	Corresponding British Standard
IEC 50(55):1987	BS 4727 <i>Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms</i> Part 3 <i>Terms particular to telecommunications and electronics</i> Group 01:1971 ^a <i>General telecommunication and electronics terminology</i>

^a IEC 50(55): 1987 has not been implemented as a British Standard. The cross-reference cited is technically equivalent to an earlier edition of that standard.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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English version

Methods of measurement for radio equipment used
in satellite earth stations
Part 3: Methods of measurement on combinations
of sub-systems
Section 4: Measurements for frequency division
multiplex (f.d.m.) transmission

(IEC 510-3-4:1992)

Méthodes de mesure pour les équipements
radioélectriques utilisés dans les stations
terriennes de télécommunication par satellites
Partie 3: Méthodes de mesure applicables aux
combinaisons de sous-ensembles
Section quatre: Mesures pour la transmission
de la téléphonie multivoie à multiplexage par
répartition en fréquence (m.r.f.)
(CEI 510-3-4:1992)

Meßverfahren für Funkgerät in
Satelliten-Erdfunkstellen
Teil 3: Meßverfahren für Kombinationen von
Untersystemen
Hauptabschnitt Vier: Messungen für
Frequenzmultiplex (FDM)-Übertragung
(IEC 510-3-4:1992)

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This European Standard exists in three official versions English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The CENELEC questionnaire procedure, performed for finding out whether or not the International Standard IEC 510-3-4:1992 could be accepted without textual changes, has shown that no common modifications were necessary for the acceptance as European Standard.

The reference document was submitted to the CENELEC members for formal vote and was approved by CENELEC as EN 60510-3-4 on 8 March 1994.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1995-03-15
- latest date of withdrawal of conflicting national standards (dow) 1995-03-15

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given only for information. In this standard, Appendix A is informative and Annex ZA is normative.

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1 Scope

This section deals with baseband-to-baseband measurements for frequency division multiplex (f.d.m) telephony. These measurements are additional to those already given in part 1, section 4 of this publication: Measurements in the baseband, which are common to telephony and to television, for example group-delay and amplitude/frequency characteristics.

All of the following measurements are carried out on a system loop either by establishing a transmission path through the transmitting and receiving chain via a test loop translator or by means of an i.f. loop.

2 Noise-loading performance

2.1 Definitions and general considerations

The noise-loading performance of a system is the noise power measured in a chosen narrow measuring channel, which simulates an unloaded telephone channel, when the baseband is loaded with random noise of uniform spectrum (white noise) at a conventional loading level (see 2.1.1). The white noise applied to the baseband input of the system under test is limited to the frequency band occupied by the telephone channels by means of a high-pass and a low-pass filter. Noise-measuring channels are provided by means of narrow band-stop filters which allow performance to be measured at several frequencies including channels located close to the bottom, middle and top of the baseband, frequency range.

The total noise appearing within a noise-measuring channel at the system output comprises basic noise and intermodulation noise (sometimes referred to as “idle noise” and “distortion noise” respectively). It is, therefore, common practice to measure the noise within each noise-measuring channel with the baseband loaded with noise and then unloaded, in order to obtain the total noise and basic noise separately; from these results the intermodulation noise may be obtained.

The noise performance may be expressed as a noise power ratio (*n.p.r.*), a signal-to-noise ratio, in units of noise power or noise power level referred to the system zero relative level point. The units used may be picowatts, decibels above 1 pW or decibels below 1 mW, and they may be specified as a weighted or unweighted psophometric value.

Noise power ratio is defined as the ratio of the noise power in a measuring channel when the baseband is fully loaded with the white noise load, to the power in that channel either with all the baseband loaded except the measuring channel (i.e. total noise) or with all the baseband unloaded (i.e. basic noise); *n.p.r.* is always expressed as a positive number of decibels.

Signal-to-noise ratio is defined as the ratio of the power of the standard test tone (0 dBm0) to the noise power, in a specified bandwidth within the noise-measuring channel, both being referred to the same point in the circuit. Signal-to-noise ratio may be measured weighted or unweighted and is expressed as a positive number in decibels.

Conversion between commonly encountered noise-loading measurement units may be made by reference to Appendix A.

2.1.1 Conventional load

The conventional loading level, which is defined by the CCITT (reference 1, see clause 6) and recommended by the CCIR (reference 2, see clause 6), is shown in Table 1 for some typical channel capacities. For other channel capacities the mean power level L_c of the conventional load may be calculated from the following expressions:

$$L_c = -15 + 10 \log_{10} N \text{ dBm0} \quad \text{for } N \geq 240 \quad (2-1)$$

$$L_c = -1 + 4 \log_{10} N \text{ dBm0} \quad \text{for } 12 \leq N < 240 \quad (2-2)$$

where N is the system channel capacity.

NOTE 1 These levels simulate the mean power of speech plus signalling currents, etc., transmitted over the system during the busy hour. Where a significant proportion of the baseband is used for v.f. telegraphy or data transmission, these expressions do not apply.

NOTE 2 Equations 2-1 and 2-2 give a good approximation to actual signals when $N \geq 60$. For smaller channel capacities, however, tests with white noise are less realistic owing to the differing nature of actual signals and test signals.

Table 1 — Level of the conventional load

Number of telephone channels	Level of the conventional load (dBm0)
24	+ 4,5
36	+ 5,2
60	+ 6,1
72	+ 6,4
96	+ 6,9
132	+ 7,5
192	+ 8,1
252	+ 9,1
312	+ 9,9
372	+ 10,7
432	+ 11,4
492	+ 11,9
552	+ 12,4
612	+ 12,9
792	+ 14,0
972	+ 14,9
1 092	+ 15,4
1 872	+ 17,7

A conventionally loaded system is one which is loaded at the conventional loading level with a uniform spectrum random noise signal which is band-limited to correspond with the total bandwidth of the f.d.m. signal.

The test signal level, in most cases, is chosen to equal the conventional load.

2.1.2 Noise components

The total noise measured within the baseband of a simulated satellite system includes the following three components:

- Residual noise which is independent of path attenuation and loading. This is normally referred to as path-loss-independent basic noise.
- Thermal noise which varies with path attenuation. This is normally referred to as path-loss-dependent basic noise.
- Intermodulation noise which is dependent upon the baseband noise loading level.

Basic noise a) + b) is measured without noise loading as described below in 2.3.4. Total noise a) + b) + c) is measured with noise loading as described below in 2.3.2 or 2.3.3.

2.2 Measuring equipment

2.2.1 General considerations

Equipment for the measurement of noise-loading performance is commercially available and known either as “white noise test sets” or “noise-loading test sets”. A white noise test set comprises a noise generator and a noise receiver; a typical circuit arrangement is shown in Figure 1.

To ensure test equipment compatibility and to achieve good measurement accuracy, the relevant characteristics of white noise test sets are closely specified by both CCIR (reference 2, see clause 6) and the CCITT (reference 3, see clause 6).

Commercial white noise test sets are normally sufficiently accurate for measurements on simulated satellite systems without making allowance for test equipment errors. However, where the required accuracy of measurement is comparable with the intrinsic accuracy of the test equipment, due allowance for measurement error should be made in the presentation of results.

Measurement accuracy depends upon many factors, including the following:

- generator and receiver attenuator and monitor accuracies;
- number of band-stop filters inserted and the effective bandwidths of the noise-measuring channels;
- region of the loading curve at which the measurement is being made (i.e. whether basic or intermodulation noise predominates);