

Methods of measurement for equipment used in digital microwave radio transmission systems —

**Part 1: Measurements common to
terrestrial radio-relay systems and
satellite earth stations —**

**Section 1.3 Transmission
characteristics**

The European Standard EN 60835-1-3:1995, together with its amendment A1:1995, has the status of a British Standard

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Electronic Equipment Standards Policy Committee (EEL/-) to Technical Committee EEL/25, upon which the following bodies were represented:

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

The following body was also represented in the drafting of the standard, through subcommittees and panels:

ERA Technology Ltd.

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National foreword

This Section of BS EN 60835 has been prepared by Technical Committee EPL/102 (formerly EEL/25), and is the English language version of EN 60835-1-3:1995, *Methods of measurement for equipment used in digital microwave radio transmission systems — Part 1: Measurements common to terrestrial radio-relay systems and satellite earth stations — Section 3: Transmission characteristics*, including amendment A1:1995, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 835-1-3:1992, including amendment No. 1:1995, published by the International Electrotechnical Committee (IEC).

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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, page 2 to 18 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.

Methods of measurement for equipment used in digital
microwave radio transmission systems
Part 1: Measurements common to terrestrial radio-relay
systems and satellite earth stations
Section 3: Transmission characteristics

(includes amendment A1:1995)
(IEC 835-1-3:1992 + A1:1995)

Méthodes de mesure applicables au matériel
utilisé pour les systèmes de transmission
numérique en hyperfréquence
Partie 1: Mesures communes aux faisceaux
hertziens terrestres et aux stations terriennes
de télécommunications par satellite
Section 3: Caractéristiques de transmission
(inclut l'amendement A1:1995)
(CEI 835-1-3:1992 + A1:1995)

Meßverfahren for Geräte in digitalen
Mikrowellen-Funkübertragungssystemen
Teil 1: Messungen an terrestrischen
Richtfunksystemen und
Satelliten-Erdfunkstellen
Hauptabschnitt 3: Übertragungseigenschaften
enthält Änderung A1:1995)
(IEC 835-1-3:1992 + A1:1995)

This European Standard was approved by CENELEC on 1994-03-08. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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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.

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CENELEC

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

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Foreword

The text of the International Standard IEC 835-1-3:1992, prepared by SC 12E, Radio-relay and fixed satellite communications systems, of IEC TC 12, Radiocommunications, was submitted to the formal vote and was approved by CENELEC as EN 60835-1-3 on 1994-03-08 without any modification.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1995-12-15
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1995-12-15

Foreword to amendment A1

The text of document 12E(CO)167, future amendment 1 to IEC 835-1-3:1992, prepared by SC 12E, Radio relay and fixed satellite communication systems, of IEC TC 12, Radiocommunications, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60835-1-3:1992 on 1995-05-15.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1996-02-15
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 1996-02-15

Introduction

In the following clauses, the equipment under test is any carrier-frequency part of the digital microwave transmission system such as an i.f. or r.f. amplifier, a filter or a transmit-receive section between the output port of the digital modulator and the input port of the following digital demodulator. The methods described are applicable to complete systems or to sub-systems. No restrictions are made with respect to intermediate or radio frequency ranges so that measurements between terminals of the same frequency range (i.f. or r.f.) or different ranges (i.f. to r.f. or r.f. to i.f.) are possible using the methods of measurement described.

When adaptive equalizers are employed they should be rendered inoperative, if possible, before carrying out any of the measurements described in this section. Methods of measurement for adaptive equalizers are described in IEC 835-2-8 (under consideration).

1 Scope

This section of IEC 835-1 deals with methods of measurement of the characteristics which may be of importance for the transmission performance of microwave systems with digital modulation. The need to carry out any particular measurement and the limits to be met depend, for example, on the bit rate and the method of modulation.

2 Amplitude/frequency characteristic

2.1 Definition and general considerations

The amplitude/frequency characteristic is given by the curve representing the difference, expressed in decibels, between the output level and a nominal level, as a function of frequency for a constant input level. The significance of the measurement made on linear equipment differs from that made on equipment incorporating non-linear devices. For example, when the equipment incorporates a limiter or an amplifier with automatic gain control (a.g.c.), the amplitude/frequency characteristic of the stages preceding these devices will appear to be compressed; therefore the a.g.c. should be disconnected before making the measurement.

2.2 Methods of measurement

Measurements may be made using either point-by-point or swept-frequency methods. For the latter case, an example of the measurement arrangement is shown in Figure 1.

When using the sweep-frequency method, the repetition rate of the sweep-frequency within the generator is normally in the range of 10 Hz to 100 Hz with a sinusoidal wave-form. The centre frequency and sweep deviation should be adjusted to the nominal values.

The test arrangement in Figure 1 may also be used for end-to-end measurements, and the sweep voltage for the X-deflection of the display can be obtained from the receiver part. The i.f. bandwidth of the i.f. envelope detector should be at least 50 to 100 times the chosen sweep rate. The Y-axis should be calibrated in decibels in different ranges from only a few decibels for measurements in the pass-band, up to some tens of decibels for filter measurements in the stop-band. These features are normally to be found in test equipment of the link analyser type.

With a constant input level, the output level is determined as a function of the frequency.

The measurements may be repeated for a restricted number of different input levels within the normal range of input levels specified for the equipment under test.

The measurement may be extended to include frequencies on either side of the pass-band. In such cases, the signal will be appreciably attenuated and it will be necessary therefore to use a selective voltmeter or selective level-meter to avoid errors caused by harmonics.

2.3 Presentation of results

2.3.1 Amplitude/frequency characteristic

The results of the measurements should be presented, preferably, as an XY-record or photograph of the oscilloscope display as shown in Figure 2. Both the horizontal and the vertical scales of the oscilloscope display should be calibrated.

When the results of the measurements are not presented graphically, they should be given as in the following example for an i.f. sub-system:

Amplitude/frequency characteristic is within $-0,2$ dB to $+0,1$ dB with reference to 70 MHz, from 60 MHz to 80 MHz.

2.3.2 Ripple components

When ripple components are easily identifiable from the measured characteristic, they should be expressed in decibels, peak-to-peak and the ripple frequency should be stated.

2.4 Details to be specified

The following items should be included as required in the detailed equipment specification:

- a) permitted limits of amplitude variation;
- b) frequency limits;
- c) reference frequency;
- d) input levels;
- e) peak-to-peak amplitude and frequency of ripple components, if applicable.

3 Group-delay/frequency characteristic

3.1 Definition and general considerations

The group-delay/frequency characteristic of a network is the first derivative of the phase/angular frequency characteristic and is expressed in seconds.

It is usual to measure group-delay variation, which is the difference between the group-delay as stated above and the group-delay at a reference frequency.

The significance of the measurement when made on linear equipment is different from that made on equipment incorporating non-linear devices. When the equipment incorporates a limiter exhibiting amplitude modulation/phase modulation conversion effects, “coupled” or “indirect” distortion will be introduced: for example amplitude/frequency variation prior to such a limiter will result in an apparent change of group-delay.

3.2 Method of measurement

In the preferred method shown in Figure 1, a sweep-signal having a frequency f_s between 10 Hz and 100 Hz and a baseband test-signal having a frequency f_t (below 1 MHz but higher than f_s), are fed to the baseband input(s) of a high-quality (test) modulator which generates a frequency-modulated i.f. signal at a high modulation index by the sweep-signal, and at a low modulation index by the baseband test signal.

The modulated i.f. signal is fed to the equipment under test and is then demodulated by a high-quality (test) demodulator which recovers the baseband test-signal (f_t). As the i.f. signal is swept over the i.f. bandwidth, the demodulated baseband test signal undergoes amplitude and phase variations.

The signal from the phase detector is proportional to the i.f. group-delay. For testing r.f. equipment, up-and-down convertors with negligible inherent distortion are used between the i.f. ports of the measuring equipment and the r.f. port of the equipment under test.

The following conditions should apply:

- a) The modulation index and test signal frequency (f_t) should be small enough to ensure that the corresponding spectrum occupies a bandwidth within which the group-delay characteristics of the network under test can be approximated by a straight line.
- b) Synchronous amplitude modulation generated by the modulator should be negligible in order to avoid amplitude to phase conversion effects. The demodulator should be insensitive to synchronous amplitude modulation and demodulators of the frequency-following type are well suited to this purpose.
- c) The phase detector should be insensitive to amplitude modulation which is synchronous with the sweep frequency and should not require a reference phase input signal.
- d) The measurement frequency-modulator and the measurement frequency-demodulator shown in Figure 1 should be designed for a sufficiently constant group-delay response.