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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 (IEC 60835-1-3:1992)

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Meßverfahren für Geräte in digitalen Mikrowellen-Funkübertragungssystemen -- Teil 1: Messungen an terrestrischen Richtfunksystemen und Satelliten-Erdfunkstellen -- Hauptabschnitt 3: Übertragungseigenschaften

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

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English version

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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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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- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1995-12-15

Endorsement notice

The text of the International Standard IEC 835-1-3:1992 was approved by CENELEC as a European Standard without any modification.

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International Electrotechnical Commission 3, rue de Varembé Geneva, Switzerland
Telefax: +41 22 919 0300 e-mail: inmail@iec.ch IEC web site http: //www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

This section of International Standard IEC 835-1 has been prepared by Sub-Committee 12E: Radio relay and fixed satellite communications systems, of IEC Technical Committee No. 12: Radiocommunications.

The text of this section is based on the following documents:

DIS	Report on Voting
12E(CO)121	12E(CO)131

Full information on the voting for the approval of this section can be found in the Voting Report indicated in the above table.

Annex A is for information only.

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).

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

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 waveform. 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.

When the above conditions are fulfilled, the output voltage (V) from the phase detector (figure 1) is related to the group-delay $\tau(\omega)$ of the network under test as follows:

$$V = k\mu\,\tau(\omega) \qquad (3\text{-}1)$$

where k is a constant representing the phase-detector slope (in V/rad) and

$$\mu = 2\,\pi \cdot f_t$$