SLOVENSKI STANDARD
SIST EN 60835-1-2:2002/A1:2002
01-oktober-2002

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 2: Basic characteristics - Amendment A1 (IEC 60835-1-2:1992/A1:1995

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 2: Basic characteristics

Meßverfahren für Geräte in digitalen Mikrowellen-Funkübertragungssystemen -- Teil 1: Messungen an terrestrischen Richtfunksystemen und Satelliten-Erdfunkstellen -- Hauptabschnitt 2: Grundlegende Eigenschaften

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 2: Caractéristiques de base

Ta slovenski standard je istoveten z: **EN 60835-1-2:1993/A1:1995**

ICS:

33.060.30	Radiorelejni in fiksni satelitski komunikacijski sistemi	Radio relay and fixed satellite communications systems

SIST EN 60835-1-2:2002/A1:2002 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60835-1-2/A1

March 1995

UDC 621.396.6:629.783:621.317.08
ICS 33.060.30

IEC/sc 12E

Descriptors: Radiocommunications, telecommunications, satellite broadcasting, communication equipment, earth stations, radio-relay systems, microwave frequencies, tests, characteristics, measurements

English version

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 2: Basic characteristics (IEC 835-1-2:1992/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 2: Caractéristiques de base
(CEI 835-1-2:1992/A1:1995)

Meßverfahren für Geräte in digitalen Mikrowellen-Funkübertragungssystemen
Teil 1: Messungen an terrestrischen Richtfunksystemen und Satelliten-Erdfunkstellen
Hauptabschnitt 2: Grundlegende Eigenschaften
(IEC 835-1-2:1992/A1:1995)

This amendment A1 modifies the European Standard EN 60835-1-2:1993; it was approved by CENELEC on 1995-03-06. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This amendment 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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 60835-1-2:1993/A1:1995 E

Foreword

The text of document 12E(CO)164, future amendment 1 to IEC 835-1-2:1992, prepared by SC 12E, Radio-relay and satellite communications systems, of IEC TC 12, Radiocommunications, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60835-1-2:1993 on 1995-03-06.

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)	1996-03-01
– latest date by which the national standards conflicting with the amendment have to be withdrawn	(dow)	1996-03-01

Endorsement notice

The text of amendment 1:1995 to the International Standard IEC 835-1-2:1992 was approved by CENELEC as an amendment to the European Standard without any modification.

NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI
IEC
60835-1-2

1992

AMENDEMENT 1
AMENDMENT 1

1995-02

Amendement 1

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 2: Caractéristiques de base

Amendment 1

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 2: Basic characteristics

Bureau Central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève, Suisse

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE L

Pour prix, voir catalogue en vigueur
For price, see current catalogue

FOREWORD

This amendment has been prepared by sub-committee 12E: Radio relay and satellite communication systems, of IEC technical committee 12: Radiocommunications.

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

DIS	Report on voting
12E(CO)164	12E/250/RVD

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

Page 3

CONTENTS

Add the title of clause 6 as follows:

6 Noise temperature and noise figure

Page 29

Add, after 5.2.5, the following new clause:

6 Noise temperature and noise figure

6.1 *Introduction*

This clause concentrates on the methods of measurement to be used in order to evaluate the noise figure of sub-systems and/or combinations of sub-systems under linear conditions where appropriate ports are available.

Noise temperature is an important parameter in satellite systems and is a convenient indication of the noise power produced by a system or sub-system. It is usually expressed in terms of an "equivalent" temperature rather than an "actual" temperature, since it is a measure of the effects of all the thermal and non-thermal noise sources.

6.2 *Definitions*

The performance of a receiver is generally characterized by its noise figure *NF*, expressed in decibels. For a two-port device it is defined as the ratio of the signal-to-noise ratio at the input to the signal-to-noise ratio at the output under matched conditions. The noise figure therefore indicates how much the signal-to-noise ratio at the output is lower than at the input. *NF* is therefore always greater than 0 dB.

The equivalent noise temperature, T_E, is related to the noise figure F, expressed in linear numerals, by the expression:

$$T_E = 290\ (F-1) \qquad (7\text{-}1)$$

The noise figure NF, expressed in decibels, is defined as:

$$NF = 10 \log_{10} \left(1 + \frac{T_E}{290}\right) \qquad (7\text{-}2)$$

6.2.1 *Equivalent noise temperature of a two-port device*

The equivalent noise temperature T_E of a two-port device is a fictitious noise temperature which, when added to that of the input source connected to a theoretically ideal noise-free, two-port device having the same input impedance and gain as the actual device, will produce the same output noise power density as the actual device.

The output noise power density N_o of a two-port device with an equivalent noise temperature T_E when connected to a noise source of temperature T_{SOURCE} is given by:

$$N_o = (T_{SOURCE} + T_E)\ kG \quad (W/Hz) \qquad (7\text{-}3)$$

where

k is the Boltzmann's constant, $1{,}38 \times 10^{-23}$ Ws/K;

G is the gain of the two-port device.

If T_E is the equivalent *average* input noise temperature over a given bandwidth B, the output noise power P_{no} of a two-port device is then:

$$P_{no} = (T_{SOURCE} + T_E)\ kGB \qquad (7\text{-}4)$$

where B is the noise bandwidth in hertz.

T_{SOURCE} is assumed constant over the noise bandwidth B.

Unless otherwise specified, the term "equivalent noise temperature" will be taken to mean the average input noise temperature over a given bandwidth.

6.2.2 *Average noise figure*

The average noise figure $\bar{F}$ of a two-port device is the ratio of the total noise power P_o delivered by the device into a matched load, when the noise temperature of its input termination is 290 K, to the noise power P_s available under the same conditions at the output port of an ideal noise-free device.

$$\bar{F} = \frac{P_o}{P_s} = \frac{P_o}{kTGB} \qquad (7\text{-}5)$$

where T is equal to 290 K.

For equipment having gain in more than one frequency band, such as an image frequency in a heterodyne system, the denominator P_s includes only the noise power from the input termination which lies in the same frequency band as the modulated signal. This case is applicable to satellite communication systems and is known as the "single-sideband noise figure".

The relationship between the average noise figure $\bar{F}$ and the average equivalent input noise temperature T_E can be obtained as follows:

$$P_o = \mathrm{k}GB \cdot 290 + \mathrm{k}T_E GB = \mathrm{k}GB\,(290 + T_E) \qquad (7\text{-}6)$$

From the above equations:

$$\bar{F} = \frac{\mathrm{k}GB\,(290 + T_E)}{\mathrm{k}GB \cdot 290} = 1 + \frac{T_E}{290} \qquad (7\text{-}7)$$

where

$$T_E = 290\,(\bar{F} - 1) \qquad (7\text{-}8)$$

Unless otherwise specified, the term "noise figure" will be taken to mean the average noise figure over a given bandwidth.

6.3 *General considerations*

The methods employed to measure the noise figure F are divided into two groups: broadband and narrowband techniques. Broadband techniques typically use noise generators as measurement signals, whereas narrowband techniques employ continuous wave (c.w.) signal generators.

The most widely used methods for broadband measurements are:

a) the Y-factor method;

b) the 3 dB loss method.

As a narrowband technique the c.w. method using an unmodulated signal is the most widely used single-sideband measurement. This method is applicable from very low frequencies to tens of GHz.

Automatic noise figure measuring equipment is available which uses the above measurement techniques. Such equipment usually switches the noise generator (or signal generator) periodically between two known output levels and measures the receiver output noise levels. The noise figure is then computed automatically and is displayed directly on an indicator.

The choice of method for a given situation will depend upon many factors including:

a) desired accuracy;

b) instrumentation required;

c) frequency range;

d) type of equipment under test;

e) convenience;

f) speed of measurement.

These methods are described in 6.4 together with their advantages and disadvantages, with the intention of providing a general understanding of the basic procedures involved for each method. The "equipment under test" can therefore be either a single sub-system, for example a low-noise amplifier, or a combination of sub-systems, for example a low-noise amplifier followed by a down-converter.

6.4 *Method of measurement*

Methods for measuring the noise figure are presented in the following subclauses. If required, the equivalent noise temperature can then be calculated by equation (7-1) given in 6.2.

All measurements are based on methods where either a broadband noise or sinusoidal c.w. signal is applied to the input of the equipment under test and the increase in output power due to the applied signal is recorded. The noise figure is then obtained either by calculation or by directly reading a display, depending on the specific method used, as given in the following.

6.4.1 *Y-factor method*

A pair of random noise generators and a power-meter are connected to the equipment under test as shown in figure 7. One of the noise generators, designated "hot", has a higher noise temperature, T_h, than that of the other generator, designated "cold", which has a noise temperature, T_c.

NOTE 1 – "Hot" or "cold" noise generator means the relative difference in noise temperatures between the generators. The noise generator may be a simple matched load of ambient temperature.

Examples of cold and hot noise generator are as follows:

cold: a matched load cooled in the liquid nitrogen;

hot: a matched load heated in the oven, a current-saturated diode or a gas discharge tube.

The hot and the cold noise generators provide known available noise powers to the equipment under test. The output noise power levels of the equipment under test are measured by the power meter. The *Y*-factor is the ratio of the two noise output power levels, corresponding to the two input conditions. T_E and F are calculated from the measured *Y*-factor and the known noise temperature of the two noise sources.

The method is capable of high accuracy and measurement uncertainties as small as 1 % (0,04 dB) are possible under optimum conditions. Typical measurement uncertainties lie between 2 % (0,1 dB) and 8 % (0,36 dB). This method is therefore usually chosen when high accuracy and precision are required.