SLOVENSKI STANDARD
# SIST EN 50083-3:1999

01-julij-1999

**Cable networks for television signals, sound signals and interactive services - Part 3: Active wideband equipment for coaxial cable networks**

Cable networks for television signals, sound signals and interactive services -- Part 3: Active wideband equipment for coaxial cable networks

Kabelnetze für Fernsehsignale, Tonsignale und interaktive Dienste -- Teil 3: Aktive Breitbandgeräte für koaxiale Kabelnetze



Réseaux de distribution par câbles pour signaux de télévision, signaux de radiodiffusion sonore et services interactifs -- Partie 3: Matériels actifs à large bande utilisés dans les réseaux de distribution coaxiale



**Ta slovenski standard je istoveten z: EN 50083-3:1998**

**ICS:**

| | | |
|---|---|---|
| 33.060.40 | Kabelski razdelilni sistemi | Cabled distribution systems |
| 33.120.10 | Koaksialni kabli. Valovodi | Coaxial cables. Waveguides |

**SIST EN 50083-3:1999 en**

EUROPEAN STANDARD
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# EN 50083-3

August 1998

ICS 33.060.40

Descriptors: Telecasting, cable television, sound broadcasting, television broadcasting, community aerial systems, coaxial cables, components, measuring techniques, specifications

English version

# Cable networks for television signals, sound signals and interactive services
# Part 3: Active wideband equipment for coaxial cable networks

Réseaux de distribution par câbles pour signaux de télévision, signaux de radiodiffusion sonore et services interactifs
Partie 3: Matériels actifs à large bande utilisés dans les réseaux de distribution coaxiale

Kabelnetze für Fernsehsignale, Tonsignale und interaktive Dienste
Teil 3: Aktive Breitbandgeräte für koaxiale Kabelnetze



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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 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, Czech Republic, 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 50083-3:1998 E

## FOREWORD

This second edition of the European Standard was prepared by CENELEC Technical Committee TC 209, "Cable networks for television signals, sound signals and interactive services" on the basis of EN 50083-3:1994 and the first amendment to EN 50083-3.

The text of the first amendment was approved by CENELEC on 1998-01-01 with the request to prepare a second edition of EN 50083-3, by incorporating this amendment into the European standard EN 50083-3:1994.

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) | 1999-03-01 |
| - latest date by which national standards conflicting with the EN have to be withdrawn | (dow) | 1999-12-01 |

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given only for information.
In this standard, annexes A, B, C and D are normative, annex E is informative.

## CONTENTS

# 1 Scope

## 1.1 General

Standards of EN 50083 series deal with cable networks for television signals, sound signals and interactive services including equipment, systems and installations

- for headend reception, processing and distribution of television and sound signals and their associated data signals and
- for processing, interfacing and transmitting all kinds of signals for interactive services

using all applicable transmission media.

All kinds of networks like

- CATV-networks,
- MATV-networks and SMATV-networks,
- Individual receiving networks

and all kinds of equipment, systems and installations installed in such networks, are within this scope.

The extent of this standardization work is from the antennas, special signal source inputs to the headend or other interface points to the network up to the system outlet or the terminal input, where no system outlet exists.

The standardization of any user terminals (i.e. tuners, receivers, decoders, multimedia terminals etc.) as well as of any coaxial and optical cables and accessories therefor is excluded.



## 1.2 Specific scope of this part 3



This standard

- applies to all broadband amplifiers used in cable networks;
- covers the frequency range 5 MHz to 3000 MHz;
- applies to one-way and two-way equipment;
- lays down the basic methods of measurement of the operational characteristics of the active equipment in order to assess the performance of this equipment;
- identifies the performance specifications that shall be published by the manufacturers;
- states the minimum performance requirements of certain parameters.

Amplifiers are divided into the following two quality levels:

Grade 1: Amplifiers typically intended to be cascaded.
Grade 2: Amplifiers for use typically within an apartment block, or within a single residence, to feed a few outlets.

Practical experience has shown these types meet most of the technical requirements necessary for supplying a minimum signal quality to the subscribers. This classification shall not be considered as a requirement but as the information for users and manufacturers on the minimum quality criteria of the material required to install networks of different sizes. The system operator has to select appropriate material to meet the minimum signal quality at the subscriber´s outlet, and to optimise cost/performance, taking into account the size of the network and local circumstances.

All requirements and published data are understood as guaranteed values within the specified frequency range and in well matched conditions.

## 2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revision of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

| | | |
|---|---|---|
| EN 50083 | | Cable networks for television signals, sound signals and interactive services |
| EN 50083-1<br>+ A1 | 1993<br>1997 | Part 1: Safety requirements |
| EN 50083-2<br>+ A1 | 1995<br>1997 | Part 2: Electromagnetic compatibility for equipment |
| EN 50083-5 | 1998 | Part 5: Headend equipment |
| EN 60068 /<br>HD 323 | series | Environmental testing/Basic environmental testing procedures |
| EN 60529 | 1991 | Degrees of protection provided by enclosures (IP Code)<br>NOTE: Basic Safety Publication<br>(IEC 529:1989) |
| HD 243 S12 | 1995 | Graphical symbols for use on equipment - Index, survey and compilation of single sheets (IEC 417:1973 + IEC 417A:1974 to IEC 417M:1994) |
| HD 571 S1 | 1990 | General principles for the creation of graphical symbols for use on equipment (IEC 416:1988) |

# 3 Terms, definitions, symbols and abbreviations

## 3.1 Terms and definitions

For the purpose of this standard, the following definitions apply.

### 3.1.1 equaliser

A device designed to compensate over a certain frequency range for the amplitude/frequency distortion or phase/frequency distortion introduced by feeders or equipment.

NOTE: This device is for the compensation of linear distortions only.

### 3.1.2 feeder

A transmission path forming part of a cable network. Such a path may consist of a metallic cable, optical fibre, waveguide or any combination of them. By extension, the term is also applied to paths containing one or more radio links.

### 3.1.3 decibel ratio

Ten times the logarithm of the ratio of two quantities of power $P_1$ and $P_2$, i.e.

$$10 \lg \frac{P_1}{P_2} \quad \text{(dB)}$$



### 3.1.4 standard reference power and voltage

In cable networks the standard reference power, $P_0$, is 1/75 pW.



NOTE: This is the power dissipated in a 75 ohm resistor with a voltage drop of 1µ$V_{RMS}$ across it.

The standard reference voltage, $U_0$, is 1µV.

### 3.1.5 level

The level of any power $P_1$ is the decibel ratio of that power to the standard reference power $P_0$, i.e.

$$10 \lg \frac{P_1}{P_0}$$

The level of any voltage $U_1$ is the decibel ratio of that voltage to the standard reference voltage $U_0$, i.e.

$$20 \lg \frac{U_1}{U_0}$$

This may be expressed in decibel (relative to 1µV in 75 ohm) or more simply in dB (µV) if there is no risk of ambiguity.

### 3.1.6 attenuation

The ratio of the input power to the output power of an equipment or system, usually expressed in decibel.

### 3.1.7 gain

The decibel ratio of the output power to the input power.

### 3.1.8 amplitude frequency response

The gain or loss of an equipment or system plotted against frequency.

**3.1.9 slope**

The difference in gain or attenuation at two specified frequencies between any two points in an equipment or system.

**3.1.10 crossmodulation**

The undesired modulation of the carrier of a desired signal by the modulation of another signal as a result of equipment or system non-linearities.

**3.1.11 carrier to noise ratio**

The difference in decibel between the vision or sound carrier level at a given point in an equipment or system and the noise level at that point (measured within a bandwidth appropriate to the television or radio system in use).

**3.1.12 noise factor/noise figure**

The noise factor/noise figure are used as figures of merit describing the internally generated noise of an active device.

The noise factor (*F*) is the ratio of the carrier to noise ratio at the input, to the carrier to noise ratio at the output of an active device, assuming the incoming carrier is noise free.



$$F = \frac{C_1 / N_1}{C_2 / N_2}$$



where

| | | | |
|---|---|---|---|
| | $C_1$ | = | signal power at the input |
| | $C_2$ | = | signal power at the output |
| | $N_1$ | = | noise power at the input (ideal thermal noise) |
| | $N_2$ | = | noise power at the output |

In other words, the noise factor is the ratio of noise power at the output of an active device to the noise power at the same point if the device had been ideal and added no noise.

$$F = \frac{N_{2\,actual}}{N_{2\,ideal}}$$

The noise factor is dimensionless and is often expressed as noise figure (*NF*) in dB

$$NF = 10 \lg F \text{ (dB)}$$

**3.1.13 ideal thermal noise**

The noise generated in a resistive component due to the thermal agitation of electrons.

The thermal power generated is given by:

$$P = 4 \times B \times k \times T$$

where

| | | | | |
|---|---|---|---|---|
| $P$ | = | noise power in watts | | |
| $B$ | = | bandwidth in hertz | | |
| $k$ | = | Boltzmann's constant | = | $1{,}38 \times 10^{-23}$ J/K |
| $T$ | = | absolute temperature in kelvins | | |

It follows that:

$$\frac{U^2}{R} = 4 \times B \times k \times T$$

and

$$U = \sqrt{4 \times R \times B \times k \times T}$$

where

$U$ = noise voltage
$R$ = resistance in ohms

In practice it is normal for the source to be terminated with a load equal to the internal resistance value, the noise at the input is then $U/2$.

### 3.1.14 chrominance / luminance delay inequality

The delay inequality in nanoseconds, between the luminance and chrominance (4,43 MHz) within a single PAL/SECAM television channel. The worst case channels shall be identified by frequency.

### 3.1.15 well-matched

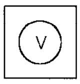
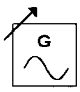
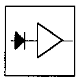
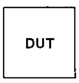
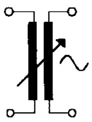
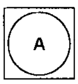
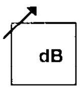
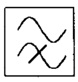
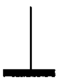
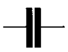
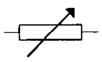
The matching condition when the return loss of the equipment complies with the requirements of table 1.



NOTE: Through mismatching of measurement instruments and the measurement object measurement errors are possible. Comments to the estimation of such errors are given in annex E.



## 3.2 Symbols

| Symbols | Terms | Symbols | Terms |
|---|---|---|---|
|  | voltmeter |  | oscilloscope |
|  | variable Generator |  | detector with LF-amplifier |
|  | Device under Test |  | adjustable AC voltage source |
|  | amperemeter |  | low pass filter |
|  | variable attenuator |  | high pass filter |
|  | ground |  | RF choke |
|  | capacitor |  | variable resistor |

### 3.3 Abbreviations

| | |
|---|---|
| AC | alternating current |
| AF | audio frequency |
| AM | amplitude modulation |
| AGC | automatic gain control |
| CATV | community antenna television (system) |
| CSO | composite second order |
| CTB | composite triple beat |
| CW | continuous wave |
| DUT | device under test |
| EMC | electromagnetic compatibility |
| HP | high pass |
| IF | intermediate frequency |
| IP | international protection |
| LF | low frequency |
| LP | low pass |
| MATV | master antenna television (system) |
| MTBF | meantime between failure |
| PAL | phase alternating line |
| RF | radio frequency |
| RMS | root mean square |
| RS | rotary switch |
| SECAM | séquentiel couleur à mémoire |
| SG | signal generator |
| SMATV | satellite master antenna television (system) |
| TV | television |
| VSWR | voltage standing wave ratio |
| XMOD | crossmodulation |



NOTE: Only the abbreviations used in the English version of this part of EN 50083 are mentioned in this subclause. The German and the French versions of this part may use other abbreviations. Refer to 3.3 of each language version for details.

## 4 Methods of measurement

This clause defines basic methods of measurement. Any equivalent method that ensures the same accuracy may be used for assessing performance.

Unless stated otherwise, all measurements shall be carried out with 0 dB plug-in attenuators and equalisers. The position of variable controls used during the measurements shall be published.

The test set-up shall be well matched over the specified frequency band.

### 4.1 Linear distortion

#### 4.1.1 Return loss

The method described is applicable to the measurement of the return loss of equipment operating in the frequency range 5 MHz to 3 000 MHz.

All input and output ports of the unit shall meet the specification under all conditions of automatic and manual gain controls and with any combination of plug-in equalisers and attenuators fitted.

#### 4.1.1.1 Equipment required

a) A signal generator or sweep generator, adjustable over the frequency range of the equipment to be tested.

   Care must be taken to ensure that the signal generator or sweep generator output does not have a high harmonic content as this can cause serious inaccuracy.

b) A voltage standing wave ratio bridge with built-in or separate RF detector.

   The accuracy of measurement is dependent on the quality of the bridge; in particular on the directivity and on the return loss of the test port of the bridge. For example figure 2 shows the maximum accuracy achieved by a bridge with 46 dB directivity and 26 dB return loss.

c) An oscilloscope.

d) Calibrated mismatches.

#### 4.1.1.2 Connection of equipment

The equipment shall be connected as in figure 1.

#### 4.1.1.3 Measurement procedure

NOTE 1: All coaxial input and output ports, other than those under test, shall be terminated in 75 Ω.



NOTE 2: Ensure that there is no supply voltage on the port being measured as this could damage the bridge. If it is necessary to use a voltage blocking device, use one with a good return loss (10 dB above requirement).



NOTE 3: Only good quality calibrated connectors, adaptors and cables shall be used.

The measurement procedure comprises the following steps:

a) Connect the equipment as shown in figure 1.
b) Set the signal generator output level such that the device under test is not overloaded.
c) Use calibrated mismatches to calibrate the display on the oscilloscope.
d) Connect the device under test as shown in figure 1 and check the return loss over the specified frequency range.

### 4.1.2 Flatness

Methods of measurement are well known and a full description of the procedure is not necessary.

Measurement is commonly made with a 75 Ω scaler or vector network analyser. Care must be taken that all equipment used (connectors, adaptors, cable etc.) are well matched.

### 4.1.3 Chrominance / luminance delay inequality for PAL/SECAM only

The well known 20T pulse method of measurement is used as described in EN 50083-5.

## 4.2 Non-linear distortion

### 4.2.1 General

#### 4.2.1.1 Fundamentals

In a non-linear device, the expression for the output signal will, in general, have an infinity of terms, each generated from one or more of the (assumed sinusoidal) terms in the input, and particularly by the interaction of two or more terms.

The transfer function of the device can be expressed as:

$$V_{out} = a_0 + a_1 V_{in} + a_2 V^2_{in} + a_3 V^3_{in} + \ldots a_n V^n_{in} + \ldots \text{ etc.}$$

If the input signal $V_{in}$ has $m$ sinusoidal terms, then this can be expressed as:

$$V_{in} = V_1 \sin(\omega_1 t + \Phi_1) + V_2 \sin(\omega_2 t + \Phi_2) + \ldots V_m \sin(\omega_m t + \Phi_m)$$

The output signal is then a series of terms each of which can be expressed in the general form:

$$C V_i a_n \sin(\omega_i t + \Phi_i)$$

where:

$\omega_i$ is the sum or difference of integral positive multiples of one or more of the input frequencies, for example:

$$4\omega_2,\ 2\omega_1 - \omega_3,\ 4\omega_1 + \omega_2,\ 2\omega_1 + \omega_2 + \omega_3 .$$

This may be written in a general form as:

$$\omega_i = p_1\omega_1 \pm p_2\omega_2 \pm p_3\omega_3 \pm \ldots p_m\omega_m$$



where:

$\omega_i$ = angular velocity $2\pi f_i$ ;



$p_1, p_2, \ldots p_m$ are positive integers (including 0);

$\Phi_i$ is the relative phase of the output signals;

$a_n$ is a coefficient of the transfer function;

$V_i$ is a term dependent on the product of powers of the amplitudes of the input signals ($V_1$, $V_2$, etc.) where the sum of the powers equals $n$;

$C$ is a numerical multiplier.

It should be noted that terms at the same frequency may arise from several different terms in the transfer function, i.e. for several different values of $n$.

Each component of the output signal represented by such an expression with $n > 1$ is a non-linear distortion product, where $\omega_i$ is an integral multiple of a single term in the input signal, e.g. $4\omega_2$, the product is regarded as a harmonic distortion product. If it is formed from two or more terms, e.g. $2\omega_1 - \omega_3$, it is known as an intermodulation distortion product.

Since the values of $a_1$, $a_2$, $a_3$, etc., usually decrease relatively rapidly with increasing values of $n$, it is found that the predominant non-linear output signals arise from the terms in the transfer function in such a way that the sum $p_1 + p_2 + \ldots p_m = n$, and $n$ is defined as the order of the non-linear distortion product, e.g. $3\omega_1 - 2\omega_3$ is a fifth order product arising from the term $a_5 V_{in}^5$.
The $m$ input signals represented in the expression are not necessarily distinct signals. Any periodic signal may be represented by a series of sinusoidal terms as in the expression for $V_{in}$. For the predominant non-linear output signals it is found that:

$$V_i = V_1^{p_1} \pm V_2^{p_2} \pm V_3^{p_3} \pm \ldots V_m^{p_m}$$

so that if the amplitudes of all the input signals are multiplied by a common factor $K$, the amplitude of the $n^{th}$ order distortion products will be multiplied by $K^n$ (since $p_1 + p_2 + p_3 + \ldots p_n = n$). When the