SLOVENSKI STANDARD

SIST EN 60835-3-2:2002

01-oktober-2002

Methods of measurement for equipment used in digital microwave radio transmission systems - Part 3: Measurements on satellite earth stations - Section 2: Antenna (IEC 60835-3-2:1995)

Methods of measurement for equipment used in digital microwave radio transmission systems -- Part 3: Measurements on satellite earth stations -- Section 2: Antenna

Meßverfahren für Geräte in digitalen Mikrowellen-Funkübertragungssystemen -- Teil 3: Messungen an Satelliten-Erdfunkstellen -- Hauptabschnitt 2: Antenne

Méthodes de mesure applicables au matériel utilisé pour les systèmes de transmission numérique en hyperfréquence -- Partie 3: Mesures applicables aux stations terriennes de télécommunications par satellite -- Section 2: Antenne

Ta slovenski standard je istoveten z: **EN 60835-3-2:1996**

ICS:

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

SIST EN 60835-3-2:2002 **en**

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 60835-3-2

March 1996

ICS 33.060.30

Descriptors: Telecommunications, radiocommunications, communication equipment, antenna, earth station, microwave frequencies, digital technics, measurements, characteristics

English version

Methods of measurement for equipment used in digital microwave radio transmission systems Part 3: Measurements on satellite earth stations Section 2: Antenna (IEC 835-3-2:1995)

Méthodes de mesure applicables au matériel utilisé pour les systèmes de transmission numérique en hyperfréquence
Partie 3: Mesures applicables aux stations terriennes de télécommunications par satellite
Section 2: Antenne
(CEI 835-3-2:1995)

Meßverfahren für Geräte in digitalen Mikrowellen-Funkübertragungssystemen
Teil 3: Messungen an Satelliten-Erdfunkstellen
Hauptabschnitt 2: Antenne
(IEC 835-3-2:1995)

This European Standard was approved by CENELEC on 1996-03-05. 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.

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, 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 60835-3-2:1996 E

Foreword

The text of document 12E/247/FDIS, future edition 1 of IEC 835-3-2, 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 EN 60835-3-2 on 1996-03-05.

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)	1996-12-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	1996-12-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annex A is informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 835-3-2:1995 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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 revisions 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 (including amendments).

NOTE: When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 50(60)	1970	International Electrotechnical Vocabulary (IEV) Chapter 60: Radiocommunications	-	-
IEC 50(712)	1992	Chapter 712: Antennas	-	-
IEC 835-1-2	1992	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	EN 60835-1-2	1993
IEC 835-3-4	1993	Part 3: Measurements on satellite earth stations Section 4: Low noise amplifier	EN 60835-3-4	1995
IEC 835-3-7	1995	Section 7: Figure-of-merit of receiving system	EN 60835-3-7	1995
ITU-R S.465-5	1993	Reference earth-station radiation pattern for use in coordination and interference assessment in the frequency range from 2 to about 30 GHz	-	-
ITU-R S.580-4	1993	Radiation diagrams for use as design objectives for antennas of earth stations operating with geostationary satellites	-	-
ITU-R S.731	1992	Reference earth-station cross-polarized radiation pattern for use in frequency coordination and interference assessment in the frequency range from 2 to about 30 GHz	-	-
ITU-R S.732	1992	Method for statistical processing of earth-station antenna side-lobe peaks	-	-

Publication	Year	Title	EN/HD	Year
ITU-R S.733-1	1993	Determination of the G/T ratio for earth stations operating in the fixed-satellite service	-	-

NORME INTERNATIONALE

INTERNATIONAL STANDARD

CEI IEC 60835-3-2

Première édition
First edition
1995-12

Méthodes de mesure applicables au matériel utilisé pour les systèmes de transmission numérique en hyperfréquence

Partie 3:
Mesures applicables aux stations terriennes de télécommunications par satellite
Section 2: Antenne

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

Part 3:
Measurements on satellite earth stations
Section 2: Antenna

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

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE XA

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

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

METHODS OF MEASUREMENT FOR EQUIPMENT USED IN DIGITAL MICROWAVE RADIO TRANSMISSION SYSTEMS –

Part 3: Measurements on satellite earth stations –

Section 2: Antenna

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international cooperation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of the IEC on technical matters, express as nearly as possible an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.

3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 835-3-2 has been prepared by sub-committee 12E: Radio relay and satellite communication systems, of IEC technical committee 12: Radiocommunications.

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

FDIS	Report on voting
12E/247/FDIS	12E/262/RVD

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

Annex A is for information only.

METHODS OF MEASUREMENT FOR EQUIPMENT USED IN DIGITAL MICROWAVE RADIO TRANSMISSION SYSTEMS –

Part 3: Measurements on satellite earth stations –

Section 2: Antenna

1 Scope

This section of IEC 835-3 gives definitions and methods of measurement of the electrical characteristics of satellite earth-station antennas for frequencies above about 1 GHz. The methods are applicable to reflector type antennas for digital and analog signal transmission.

The purpose of the measurements is mainly to confirm that earth-station antenna performance complies with the requirements generally given by the satellite system provider based on the Radio Regulations and applicable international standards such as ITU-R Recommendation S.733-1 and the CCIR Recommendations 465-4, 580-3, 731 and 732. The measurement procedures are often prescribed by international satellite service organizations.

Measurements are performed under the condition that all antenna subsystem equipment is connected unless otherwise stated.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this section of IEC 835-3. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this section of IEC 835-3 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 50(60): 1970, *International Electrotechnical Vocabulary (IEV) – Chapter 60: Radiocommunications*

IEC 50(712): 1992, *International Electrotechnical Vocabulary (IEV) – Chapter 712: Antennas*

IEC 835-1-2: 1992, *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 835-3-4: 1993, *Methods of measurement for equipment used in digital microwave radio transmission systems – Part 3: Measurements on satellite earth stations – Section 4: Low noise amplifier*

IEC 835-3-7: 1995, *Methods of measurement for equipment used in digital microwave radio transmission systems – Part 3: Measurements on satellite earth stations – Section 7: Figure-of-merit of receiving system*

ITU-R S.465-5: 1993, *Reference earth-station radiation pattern for use in coordination and interference assessment in the frequency range from 2 to about 30 GHz*

ITU-R S.580-4: 1993, *Radiation diagrams for use as design objectives for antennas of earth stations operating with geostationary satellites*

ITU-R S.731: 1992, *Reference earth-station cross-polarized radiation pattern for use in frequency coordination and interference assessment in the frequency range from 2 to about 30 GHz*

ITU-R S.732: 1992, *Method for statistical processing of earth-station antenna side-lobe peaks*

ITU-R S.733-1: 1993, *Determination of the G/T ratio for earth stations operating in the fixed-satellite service*

3 Definitions

For the purpose of this section of IEC 835-3, the following definitions apply.

For definitions of the general terms used in this section, reference should be made to IEC 60 and IEC 50(712). In case of conflict, the definition given here takes precedence.

3.1 *Antenna subsystem*

An antenna subsystem is that part of the earth-station communication equipment which comprises the antenna and the feed network, as shown in figure 1. The antenna considered in this section is a reflector antenna consisting of the main reflector, secondary reflectors, if any, and the primary radiator. The feed network usually may contain frequency diplexers, transmit reject filters, hybrids, and a polarization diplexer (orthomode transducer) or a polarizer, to which are connected the waveguide feeders to the transmit and receive multiplexing and switching equipment and to the tracking receiver. The antenna subsystem may also include provisions for pointing the antenna. The terminals of the antenna subsystem should be specified for a given measurement.

3.2 *Antenna port (antenna terminal)*

An antenna port may be defined at any interface of the feed network where r.f. measurements are usually made. To separate antenna and feed network properties, sometimes the feed horn waveguide flange is defined as the antenna port, but in that case additional measurements including the whole feed network may be important.

3.3 *Antenna gain*

The gain of a transmitting antenna is the ratio of the power flux density produced in the far-field region, in a given direction and at a given distance from the antenna, to the power flux density which would be produced at the same distance by a loss-free isotropic antenna which accepts the same power from the same source as the antenna under test.

For receiving antennas, a definition of gain can be derived from that of effective area A_e (see 3.5) by the equation:

$$G = \frac{4 \pi A_e}{\lambda^2} \quad (3\text{-}1)$$

where λ is the wavelength.

For the same antenna used for transmitting and receiving on the same frequency and with the same terminals, the gains defined above for transmitting and for receiving will be equal, because of the reciprocity of the antenna.

Theoretically, gain does not include losses arising from polarization mismatches and from impedance mismatches at the gain-reference plane of the feed system. However, in practical measurements these effects normally are very small and may then be neglected. Nevertheless it may sometimes be necessary to give that part of the antenna gain (partial gain as defined in IEV 712-02-44) corresponding to a specified polarization. In this case the reference polarization should be indicated for example by "right-hand circular polarization gain" or "horizontal linear polarization gain". The partial gain is the gain multiplied with the polarization efficiency corresponding to the specified polarization. It may be measured, for example, with a bore-sight antenna radiating with the specified polarization towards the antenna under test. If the antenna polarization is split into two orthogonal components (which is always possible), then the antenna gain is the sum of the partial gains corresponding to the polarizations of the components.

NOTE – Unless otherwise specified, gain will be defined as the gain in bore-sight direction (maximum gain).

3.4 *Antenna pattern*

The antenna (radiation) pattern is an angular plot of the signal strength radiated from or received by the antenna with respect to a specified port. It normally corresponds to co- or cross-polarization.

3.5 *Effective area of an antenna*

For a specified direction, the effective (active) area of an antenna is the ratio between the power delivered to a matched load at the antenna terminals and the power flux density in a polarization matched plane wave incident on the antenna.

NOTE – The effective area is normally determined by a gain measurement using equation (3-1).

3.6 *Antenna efficiency*

The antenna efficiency η is the ratio of the maximum effective area to the projected area A of the antenna in a plane perpendicular to the direction of maximum radiation. The maximum effective area is related to the maximum gain G as defined in 3.3. So:

$$\eta = \frac{A_e}{A} = \frac{G\lambda^2}{4\,\pi\,A} \qquad (3\text{-}2)$$

where λ is the wavelength.

NOTE – The reference plane for the efficiency should be the same as for the gain.

3.7 *Gain-reference antenna*

An antenna with precisely known gain. The gain of the antenna under test may be compared with the gain of a reference antenna by switching between these antennas. The reference antenna is often much smaller than the antenna under test.

3.8 *Bore-sight direction*

For tracking antennas, the bore-sight direction is the direction of the tracking null. For non-tracking directive antennas, the bore-sight direction is the direction of the beam maximum.

NOTE – Bore-sight measurements are measurements with an ancillary antenna (bore-sight antenna) usually mounted on a tower (bore-sight tower), located at the bore-sight direction.

3.9 *Antenna polarization*

The antenna polarization is the polarization of the electric far-field in a specified direction of a radiating antenna. It is also that polarization of a plane wave, incident from a given direction and having a given power flux density, which results in maximum available power at the antenna terminals.

NOTE – If not otherwise defined, the specified direction is the bore-sight direction. The polarization is characterized by the polarization ellipse, or by a sum of a co- and a cross-polarized component. Therefore, the polarization properties for all directions are also given by co- and cross-polarized antenna patterns.

3.10 *Axial ratio*

Axial ratio (or ellipticity ratio) r is defined as the ratio of the major axis to the minor axis of the polarization ellipse (linear polarization is given by $r = \infty$, circular polarization by $r = 1$).

3.11 *Co-polarization (nominal polarization)*

Co-polarization (of an antenna) is that polarization which the antenna is intended to radiate (or receive).

In view of maximum power transfer under operational conditions the intended polarization for earth-station antennas is the co-polarization of the satellite antenna in the direction of this earth-station antenna. For linear polarization the direction of the satellite polarization depends on the positions of the earth station and the satellite and, to a small amount, on the polarization characteristic and direction stability of the satellite antenna.

NOTE – The co-polarization is normally exactly circular or linear. Linear co-polarization is usually specified with respect to the ground or the earth meridian plane belonging to the satellite position. In practice, an antenna is also called co-polarized, even if it is only approximately co-polarized with the intended polarization (for example, the far-field electric vector can move slightly with the frequency).

3.12 *Cross-polarization*

Cross-polarization (to a given co-polarization) is the polarization orthogonal to the co-polarization (with both waves having the same direction of propagation). Two polarizations are said to be orthogonal, if the polarization ellipses have opposite senses of rotation, the same axial ratios and orthogonal major axes.

Two antennas are said to be cross-polarized, if their polarizations are orthogonal. Two antennas are said to be nominally cross-polarized if their co-polarizations (nominal polarizations) are orthogonal.

NOTE – In practice, two antennas are sometimes also called cross-polarized, if they are only approximately orthogonal.

3.13 *Cross-polarization discrimination (XPD)*

For a given direction and a specified port, the cross-polarization discrimination XPD of an antenna is the power ratio in decibels of the co-polarized and cross-polarized component of the antenna polarization. The cross-polarization discrimination in decibels is given by $x = 10 \log X$. In the receive case, for example, this ratio may be measured by observing the power ratio, when the polarization of the transmitting antenna is switched over from co-polarization to the orthogonal cross-polarization, keeping the transmit power unchanged.

NOTE – Unless otherwise specified, the bore-sight direction is assumed. Cross-polarization is defined for each port of a multi-port antenna.

3.14 *Polarization efficiency*

The polarization efficiency η is a factor, of unity or less, which is employed in the following equation:

$$P_r(\Phi,\theta) = A_e(\Phi,\theta) \cdot S \cdot \eta \qquad (3\text{-}3)$$

where

$A_e(\Phi,\theta)$ is the effective area of a receiving antenna in a given direction (Φ,θ) of incidence;

S is the power flux density of an incident plane wave from the direction (Φ,θ);

$P_r(\Phi,\theta)$ is the power delivered by a specified port of the receiving antenna to a matched termination.

3.15 *Dual-polarized antenna*

A dual-polarized antenna is an antenna designed for simultaneously transmitting and/or receiving signals having two orthogonal (cross-polarized) polarizations. If it has one receive and one transmit port, then the co-polarizations related to these ports are orthogonal. If it operates with frequency re-use and therefore has four communication signal ports, the co-polarizations related to the two receive and the two transmit ports are orthogonal in each case.

NOTE – If only one of the two received or transmitted operational polarizations is considered, sometimes the ports corresponding to the same signal propagation direction are called "co-polar" and "cross-polar" ports. But the antenna polarizations related to these ports, despite approximating the intended co- and cross-polarization, should then be distinguished from these polarizations.

3.16 *Two-port discrimination (TPD)*

The two-port discrimination (port-to-port discrimination, isolation) of a dual polarized frequency re-use earth-station antenna is defined for the two receive ports and the two transmit ports.

If the satellite antenna radiates with one of the two operational polarizations, the receive two-port discrimination of the antenna under test related to this polarization is the ratio of the power received at the corresponding receive port to the power received at the other receive port (with both ports terminated with matched loads).

If the antenna under test radiates with one of the two operational polarizations to the satellite, the transmit two-port discrimination of the antenna under test related to this polarization is the ratio of the power received at the corresponding port of the satellite antenna to the power received at the same port when the power at the antenna under test is switched over from one to the other transmit port (satellite antenna ports terminated with matched loads).

The TPD depends on which of the two operational polarizations is transmitted or received respectively. It will also be affected by properties of the satellite or bore-sight antenna involved in the test and the transmission path. Therefore it is often not a sufficient measure of quality of the antenna under test, but it may be the only measurable quality in some practical situations.

NOTE – The two-port discrimination normally has to be distinguished from the transmit-receive isolation of a multi-port antenna (see 3.17), as well as from the cross-polarization discrimination (see 3.13, 7.2) defined for each of the antenna ports. Equal or approximately equal values for these quantities may exist only at special frequencies or for idealized antenna properties.

3.17 *Transmit-receive isolation (TRI)*

The transmit-receive isolation of an antenna is the power ratio of the power transmitted at a transmit port of the antenna to the power received at a receive port of the antenna (by coupling).

NOTE – The transmit-receive isolation may include the contribution of a transmit reject filter in the receive line.