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Satellite Earth Stations and Systems (SES);
Satellite broadcast reception equipment;
Part 1: Outdoor unit receiving in the
10,7 GHz to 12,75 GHz frequency band;
Harmonised Standard for access to radio spectrum

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Foreword

This Harmonised European Standard (EN) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.9] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

The present document is part 1 of a multi-part deliverable covering satellite broadcast reception equipment, as identified below:

Part 1: "Outdoor unit receiving in the 10,7 GHz to 12,75 GHz frequency band";

Part 2: "Indoor unit".

National transposition dates	
Date of adoption of this EN:	21 June 2021
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Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 March 2022
Date of withdrawal of any conflicting National Standard (dow):	31 March 2023

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

Today, satellite communications is an important means for broadcast distribution of television and radio programs to homes. Satellites transmit signals that can be received directly by mass deployed consumer electronics equipment. The present document concerns the performance of this kind of equipment with regard to harmful interference. The avoidance of receiving or transmitting interfering signals is considered in the present document, whereas reception of the wanted signals is not considered. Satellite operators or broadcasters may create specifications for the latter purpose.

The present document is intended to cover the provisions of Radio Equipment Directive [i.1] article 3.2, which states that *"Radio equipment shall be so constructed that it both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference"*. The directive requires that unwanted radio wave emissions of transmitters are limited in order to avoid harmful interference. It requires that receivers are resilient against harmful interference from radio waves in shared and adjacent frequency channels. In addition to the present document, other ENs that specify technical requirements in respect of essential requirements under other parts of article 3 of the Radio Equipment Directive [i.1] may apply to equipment within the scope of the present document.

The R&TTE Directive [i.3], which is the predecessor of the Radio Equipment Directive [i.1], contains no receiver requirements. Moreover, broadcast reception equipment is explicitly not covered. The present document becomes necessary with the adoption of the Radio Equipment Directive.

An overview of satellite broadcast reception equipment is given in the following. Typically, the equipment comprises an OutDoor Unit (ODU), and InDoor Unit (IDU), an Inter-Facility Link (IFL) between these units, and optionally multi-switches for connecting multiple IDUs to an ODU. The ODU comprises an antenna and a Low Noise Block converter (LNB). The frequency down-conversion by the LNB enables transmission on a coaxial cable to the IDU. A frequency range that contains several modulated carriers is down-converted as one block. The most popular kind of antenna is a parabolic reflector antenna with offset feed. In that case the feed horn is often integrated with the LNB into one unit called Low Noise Block converter with Feed (LNBF). The IDU demodulates one of the carriers, de-multiplexes the retrieved bit stream and decodes digital audio video and audio for display on a TV screen. Common terms for the IDU are set-top box or satellite receiver. IDUs may contain a hard disk for recording programs. An IDU may be capable of processing multiple carriers for direct viewing and recording. The IDU functionality may be integrated into a TV set. Typically, the satellite transmits two electromagnetic waves with orthogonal polarization at the same time. In case the satellite transmits a large frequency band, it is divided up for frequency conversion with different local oscillator frequencies. The IDU selects by control signals which polarization and frequency band the ODU provides on the IFL. An ODU may work with multiple IDUs or IDUs with multiple tuners via separate IFLs. Multi-switches connected to an ODU allow connecting a large number of IDUs.

Frequency bands are re-used by satellites on different orbital positions of the Geostationary Orbit arc. Discrimination between signals from wanted and adjacent orbital positions is provided by the directivity of the ODU antenna. The actually required discrimination depends on the specific scenario of satellite spacing and Equivalent Isotropically Radiated Power (EIRP), as well as on the robustness of the wanted signals. Moreover, a certain on-axis gain is required for receiving the wanted signals with the target availability. In general, a larger antenna provides better discrimination and gain, but on the other hand small antennas are better accepted by users and the public. Requirements on the antenna are often given by means of the minimum antenna diameter. The meaning of such a requirement is "*that the antenna gain pattern shall be compliant with a reference pattern or mask that includes the nominal antenna diameter as a parameter*". The nominal diameter is a means for specifying and classifying antennas and in an easy way, but the actual antenna diameter may be different from it, or the antenna might not be circular. The concept of gain pattern definition with nominal antenna diameter is applied in the present document.

Besides the concept of ODU, IDU, IFL and optionally multi-switches, new concepts with different allocation of functionality exist. With channel stacking or SatCR, frequency channels are re-arranged by the ODU or an additional unit, so that all relevant channels can be carried on a single coaxial cable. IDUs or additional cables are connected by simple splitters. With Sat>IP, the ODU or an additional device performs demodulation and conversion to video over Internet Protocol. Common connected devices including tablet computers can be used to watch broadcast television inside a home network. Another concept applies optical fibre to carry signals between ODU and multi-switches. In conjunction with these and further concepts, the same requirements on the ODU characteristics exist.

The present document consists of multiple parts that apply to different kinds of equipment units, including ODUs for specific frequency bands and IDUs.

1 Scope

The present document applies to ODUs for satellite broadcast reception from geostationary satellites in the frequency band 10,7 GHz to 12,75 GHz. An ODU receives electromagnetic waves from a satellite. It amplifies the receive signal at low noise, converts it to a lower frequency band and makes it available to the IDU on an interface.

Part of the IDU functionality may be integrated with the ODU. In that case the present document applies only to the ODU functionality that is defined above.

The present document contains requirements to demonstrate that radio equipment both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI ETS 300 457 (Edition 1) (11-1995): "Satellite Earth Stations and Systems (SES); Test methods for Television Receive Only (TVRO) operating in the 11/12 GHz frequency bands".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

[i.2] ETSI ETS 300 784: "Satellite Earth Stations and Systems (SES); Television Receive-Only (TVRO) satellite earth stations operating in the 11/12 GHz frequency bands".

[i.3] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.

[i.4] ETSI EG 203 336 (V1.2.1): "Guide for the selection of technical parameters for the production of Harmonised Standards covering article 3.1(b) and article 3.2 of Directive 2014/53/EU".

[i.5] EN 50585:2014: "Communications protocol to transport satellite delivered signals over IP networks", produced by CENELEC.

[i.6] Recommendation ITU-R BO.1213: "Reference receiving Earth station antenna pattern for the broadcasting-satellite service in the 11.7-12.75 GHz band".

[i.7] EN 61319-1:1996: "Interconnections of satellite receiving equipment - Part 1: Europe", produced by CENELEC.

[i.8] EN 50607:2015: "Satellite signal distribution over a single coaxial cable - second generation", produced by CENELEC.

[i.9] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53 of the European Parliament and of the Council.

[i.10] EN 61319-1:1996/A11:1999: "Interconnections of satellite receiving equipment - Part 1: Europe", produced by CENELEC.

[i.11] ETSI EN 303 372-1 (V1.1.1) (08-2016): "Satellite Earth Stations and Systems (SES); Satellite broadcast reception equipment; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 1: Outdoor unit receiving in the 10,7 GHz to 12,75 GHz frequency band".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

LNB input level range: range of LNB input signal level with low end of the range equal to the level of LNB effective noise power and the high end of the range being the input level that causes 1 dB gain compression

nominal antenna diameter: antenna diameter specified by the manufacturer that is a parameter in performance characteristics and that allows reference to a certain performance

NOTE: An antenna with circular aperture of diameter equal to the nominal diameter does typically have the performance specified.

off-axis angle: angle between the antenna boresight axis and the direction of interest

taper: ratio of field strength in the center and at the edge of an antenna aperture expressed in dB

3.2 Symbols

For the purposes of the present document, the following symbols apply:

D	nominal antenna diameter
F	focal length of the antenna reflector
λ	wave length

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

DC	Direct Current
EIRP	Equivalent Isotropically Radiated Power
EUT	Equipment Under Test
IDU	InDoor Unit
IFL	InterFacility Link
IP	Internet Protocol

LNB	Low Noise Block down-converter
LNBF	Low Noise Block down-converter with Feed
LO	Local Oscillator
ODU	OutDoor Unit
RF	Radio Frequency
SAT>IP	SATellite over Internet Protocol
TV	TeleVision

4 Technical requirements specifications

4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be in accordance with its intended use. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the operational environmental profile defined by its intended use.

4.2 Equipment capabilities

The technical requirements of the present document apply under the capabilities of the equipment, which shall be specified by the manufacturer. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the specified equipment capabilities.

Equipment capabilities comprise the following characteristics:

- Receive frequency band
- Polarization states
- Local oscillator frequency
- Nominal antenna diameter *D*
- Specific satellite network - if applicable
- LNB input level range

An ODU might be capable of receiving multiple frequency bands. The local oscillator frequency and the polarization states may be different in each frequency band. The specification shall include all combinations of frequency band, polarization states and local oscillator frequency.

Polarization state can take the values horizontal linear, vertical linear, left hand circular and right hand circular. An ODU may receive multiple states in one frequency band.

If an ODU is designed for use in a specific satellite network only, then certain conformance requirements are not relevant with regard to harmful interference. Therefore, a conformance requirement in clause 4.3 may include a statement that the requirement is not applicable to such ODUs. (In the present document this is the case for clause 4.3.5.)

4.3 Conformance requirements

4.3.1 Unwanted radiation including Local Oscillator (LO) leakage radiated from the antenna

Purpose:

To limit the unwanted radiation level from the outdoor unit in order to protect adjacent satellites that use different frequency bands and are located near-by.

The power of the unwanted radiation, including the LO frequency as well as its second harmonic, measured at the antenna flange (including the polarizer, ortho-mode transducer, band-pass filter, RF waveguides) shall not exceed the following limits:

- -60 dBm in a 120 kHz bandwidth at the fundamental frequency of the LO
- -50 dBm in a 120 kHz bandwidth at the second harmonic of the LO
- -60 dBm in any other 120 kHz bandwidth

This requirement applies to the frequency range from 2,5 GHz to 25 GHz.

Verification:

The test method specified in clause 6.2 in ETSI ETS 300 457 [1] shall apply.

NOTE 1: If LNB and feed horn of a reflector antenna are integrated, then no antenna flange exists. In that case the radiated signal may be accessed by a feed horn adapter. The LNB manufacturer should supply the feed horn adaptor and characterization frequency and gain data. The data supplied should be used to correct the measurements taken.

NOTE 2: The specified test method in clause 6.2 of ETSI ETS 300 457 [1] includes provisions for the case that the antenna is an integral part which cannot be detached. In that case the specified test method defines that the reverberation chamber method of measurement is used.

NOTE 3: Version 1.1.1 of the present document [i.11] contained a requirement "Specification 2: Radiation from the outdoor unit (EIRP)". The requirement has been deleted because this kind of requirement is in the scope of harmonised standards covering essential requirements on electromagnetic compatibility.

4.3.2 Antenna gain pattern

Purpose:

To protect the wanted signals from interference from terrestrial services and from other satellites.

Specification:

The relative co-polar and cross-polar off-axis antenna gain shall comply with the following masks.

Variables:

φ: off-axis angle of the antenna relative to boresight (degrees)

$g_{\mathrm{co}}(\varphi)$: Co-polar antenna gain at off-axis angle φ relative to co-polar on-axis gain (decibel)

$g_{\mathrm{cross}}(\varphi)$: Cross-polar antenna gain at off-axis angle φ relative to co-polar on-axis gain (decibel)

Parameters:

D: nominal antenna diameter

λ: wavelength expressed in the same unit as the diameter

Co-polar mask:

$$g_{\mathrm{co}}(\varphi) \leq -2{,}5 \times 10^{-3} \left(\frac{D}{\lambda}\varphi\right)^2 \text{ for } 0 \leq \varphi < \varphi_m$$

$$g_{\mathrm{co}}(\varphi) \leq g_1 \text{ for } \varphi_m \leq \varphi < \varphi_r$$

$$g_{\mathrm{co}}(\varphi) \leq 29 - 25 \log \varphi - G_0 \text{ for } \varphi_r \leq \varphi < \varphi_b$$

$$g_{\mathrm{co}}(\varphi) \leq -5 - G_0 \text{ for } \varphi_b \leq \varphi < 70°$$

$$g_{\mathrm{co}}(\varphi) \leq -G_0 \text{ for } 70° \leq \varphi < 180°$$

Where:

$$\varphi_r = 95\frac{\lambda}{D}$$

$$G_0 = 8 + 20\log\frac{D}{\lambda}$$

$$g_1 = 29 - 25\log\varphi_r - G_0$$

$$\varphi_m = \frac{\lambda}{D}\sqrt{\frac{-g_1}{0{,}0025}}$$

$$\varphi_b = 10^{34/25}$$

NOTE 1: G_0 is the lowest expected on-axis gain. It corresponds to an antenna efficiency of 64 %.

Cross-polar mask:

$$g_{\text{cross}}(\varphi) \le -19 \quad \text{for} \quad 0 \le \varphi < 0{,}25\,\varphi_0$$

$$g_{\text{cross}}(\varphi) \le -19 + 3\left(\frac{\varphi - 0{,}25\varphi_0}{0{,}19\varphi_0}\right) \quad \text{for} \quad 0{,}25\,\varphi_0 \le \varphi < 0{,}44\varphi_0$$

$$g_{\text{cross}}(\varphi) \le -16 \quad \text{for} \quad 0{,}44\,\varphi_0 \le \varphi < \varphi_0$$

$$g_{\text{cross}}(\varphi) \le -16 + C\left|\frac{\varphi - \varphi_0}{\varphi_1 - \varphi_0}\right| \quad \text{for} \quad \varphi_0 \le \varphi < \varphi_1$$

$$g_{\text{cross}}(\varphi) \le 21 - 25\log\varphi - G_0 \quad \text{for} \quad \varphi_1 \le \varphi < \varphi_2$$

$$g_{\text{cross}}(\varphi) \le -5 - G_0 \quad \text{for} \quad \varphi_2 \le \varphi < 70°$$

$$g_{\text{cross}}(\varphi) \le -G_0 \quad \text{for} \quad 70° \le \varphi < 180°$$

Where:

$$\varphi_0 = 2\frac{\lambda}{D}\sqrt{\frac{3}{0{,}0025}}$$

$$\varphi_1 = \frac{\varphi_0}{2}\sqrt{10{,}1875}$$

$$C = 21 - 25\log\varphi_1 - (G_0 - 16)$$

$$\varphi_2 = 10^{26/25}$$

NOTE 2: Equations are not valid in the unlikely case where $\frac{D}{\lambda} > 15\,708$.

NOTE 3: The present document is derived from Recommendation ITU-R BO.1213 [i.6]. The cross-polar mask takes into account degradation due to LNB cross-polar discrimination and cross talk of 20 dB.

Verification:

The test method specified in clause 6.5.2 of ETSI ETS 300 457 [1] shall apply.

The receive signal level may be measured at the output of the LNB.

NOTE 4: If the antenna feed or the complete antenna is integrated with the LNB, then measuring at the antenna flange is not possible. Measuring at the LNB output delivers valid results, since relative gain is specified.

4.3.3 Pointing accuracy capability

Purpose:

To enable an accurate pointing of the antenna to the wanted satellite at the installation in order to provide the best possible reception of the wanted signal and to better avoid interference from signals transmitted on other satellites.