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Satellite Earth Stations and Systems (SES);
Fixed and in-motion Earth Stations communicating with non-geostationary satellite systems (NEST) in the 11 GHz to 14 GHz frequency bands;
Harmonised Standard for access to radio spectrum

Reference
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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

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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.1] 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.6].

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.

National transposition dates	
Date of adoption of this EN:	6 May 2021
Date of latest announcement of this EN (doa):	31 August 2021
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Date of withdrawal of any conflicting National Standard (dow):	28 February 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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

The present document is part of a set of standards developed by ETSI and is designed to fit in a modular structure to cover all radio and telecommunications terminal equipment within the scope of the RE Directive [i.6]. The modular structure is shown in ETSI EG 201 399 [i.2].

The present document is largely based on ETSI EN 303 979 [i.4], for ESOMPs operating with NGSO satellites.

The present document may also be applicable to the frequency band 14,0 GHz to 14,50 GHz (Earth-to-space) and 10,70 GHz to 12,75 GHz (space-to-Earth) subject to national regulation.

Annex A (informative) provides HS Requirements specifications.

Annex B (normative) describes methods of taking radiated measurements.

Annex C (normative) describes methods of taking conducted measurements.

Annex D (informative) describes requirements for RF measurement cables.

Annex E (informative) describes use of RF waveguides.

Annex F (informative) describes measurement equipment.

Annex G (informative) describes the applicability of parameters in ETSI EG 203 336 [i.7].

Annex H (informative) Bibliography covers other supplementary information.

Recital 10 of Directive 2014/53/EU [i.6] states that "*in order to ensure that radio equipment uses the radio spectrum effectively and supports the efficient use of radio spectrum, radio equipment should be constructed so that: in the case of a transmitter, when the transmitter is properly installed, maintained and used for its intended purpose it generates radio waves emissions that do not create harmful interference, while unwanted radio waves emissions generated by the transmitter (e.g. in adjacent channels) with a potential negative impact on the goals of radio spectrum policy should be limited to such a level that, according to the state of the art, harmful interference is avoided; and, in the case of a receiver, it has a level of performance that allows it to operate as intended and protects it against the risk of harmful interference, in particular from shared or adjacent channels, and, in so doing, supports improvements in the efficient use of shared or adjacent channels*".

Recital 11 of Directive 2014/53/EU [i.6] states that "*although receivers do not themselves cause harmful interference, reception capabilities are an increasingly important factor in ensuring the efficient use of radio spectrum by way of an increased resilience of receivers against harmful interference and unwanted signals on the basis of the relevant essential requirements of Union harmonisation legislation*".

As a consequence, the present document includes both transmitting and receiving parameters aiming to maximize the efficient use of radio spectrum.

1 Scope

The present document specifies technical characteristics and methods of measurements for fixed and in-motion Earth Stations communicating with non-geostationary satellite systems (NEST) in the 11 GHz to 14 GHz FSS frequency bands, which have the following characteristics:

- The NEST is designed for both in-motion and stationary operation.
- The NEST operates in-motion on various platforms such as trains, maritime vessels, aircraft and other vehicles and, therefore, may be subject to occasional disturbances and interruptions in the satellite link.
- The NEST is operating as part of a satellite system used for the provision of broadband communications.
- The NEST is comprised of all the equipment, electrical and mechanical, from the antenna itself to the interface with other communications equipment on a mobile platform.
- The NEST comprises one or more emitters and the system overview as given in Figure 1 should be interpreted accordingly.
- The transmit and receive frequencies are shown in Table 1.

Table 1: Frequency bands

	Frequency Bands
Transmit (Earth-to-space)	14,0 GHz to 14,50 GHz
Receive (space-to-Earth)	10,70 GHz to 12,75 GHz

- The NEST transmits within the frequency range from 14,0 GHz to 14,50 GHz.
- The NEST receives within the range from 10,70 GHz to 12,75 GHz. The NEST transmits at elevation angles of 35° or greater, relative to the horizontal plane.

- The NEST uses linear or circular polarization.
- The NEST communicates with non-geostationary satellites.
- The NEST is designed for unattended operation.
- The NEST is controlled and monitored by a Network Control Facility (NCF). The NCF is outside the scope of the present document.

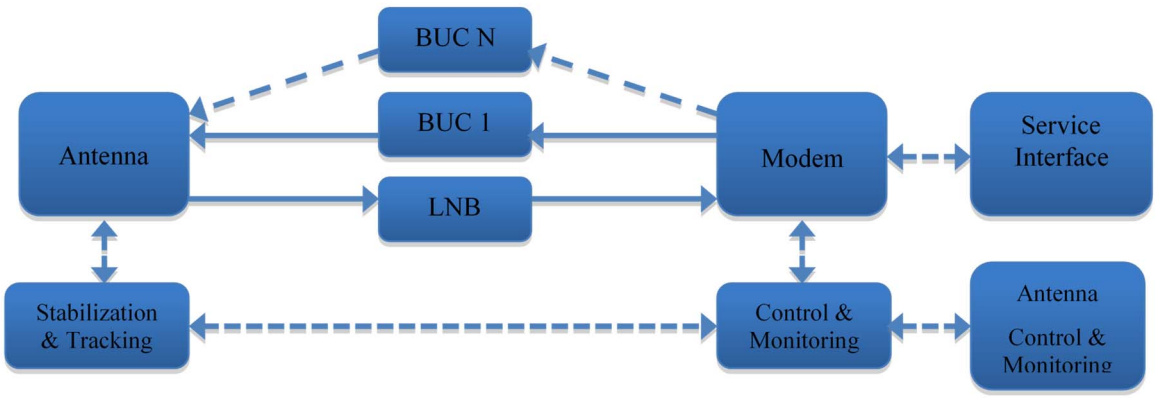

Figure 1: NEST System Overview

The present document applies to the NEST with its ancillary equipment and its various telecommunication ports, and when operated within the boundary limits of the operational environmental profile as declared by the manufacturer and when installed as required by the manufacturer's declaration or in the user documentation.

NOTE: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU [i.6] is given in annex A.

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] CISPR 16-1-1:2019: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus".

[2] CISPR 16-1-4:2019: "Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements".

[3] Recommendation ITU-R S.1503-3 (01/2018), Section 3.1: "Generation of Earth Station e.i.r.p density masks".

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] Commission Implementing Decision C(2015) 5376 final of 04.08.2015 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/EU of the European Parliament and of the Council.

[i.2] ETSI EG 201 399: "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of Harmonized Standards for application under the Radio & Telecommunication Terminal Equipment Directive 1999/5/EC (R&TTE) and a first guide on the impact of the Radio Equipment Directive 2014/53/EU (RED) on Harmonized Standards".

[i.3] ETSI TS 103 052: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radiated measurement methods and general arrangements for test sites up to 100 GHz".

[i.4] ETSI EN 303 979 (V2.1.2): "Satellite Earth Stations and Systems (SES); Harmonised Standard for Earth Stations on Mobile Platforms (ESOMP) transmitting towards satellites in non-geostationary orbit, operating in the 27,5 GHz to 29,1 GHz and 29,5 GHz to 30,0 GHz frequency bands covering the essential requirements of article 3.2 of the Directive 2014/53/EU".

[i.5] Void.

[i.6] 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.7] 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.8] IEC 60153 (parts 1 to 7): "Hollow metallic waveguides".

[i.9] 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.10] ETSI TR 102 273 (all parts) (V1.2.1) (2001-12): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".

[i.11] ANSI C63.5 (2006): "American National Standard for Electromagnetic Compatibility Radiated Emission Measurements in Electromagnetic Interference (EMI) Control Calibration of Antennas (9 kHz to 40 GHz)".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in Directive 2014/53/EU [i.6] and the following apply:

ancillary equipment: equipment used in connection with a NEST

NOTE: See clause 5.2.

antenna controller: equipment used to maintain antenna stabilization and tracking accuracy based on inputs from the Control and Monitoring Function

carrier-off radio state: radio state in which the NEST may transmit and does not transmit any carrier

NOTE: See clause 4.2.8.

carrier-on radio state: radio state in which the NEST may transmit and transmits a carrier

Control Channel (CC): channel or channels by which NESTs receive and send control information from and to the NCF

$EIRP_{max}$: maximum EIRP capability of the NEST as declared by the manufacturer

emissions disabled radio state: radio state in which the NEST may not emit

NOTE: Examples of cases where the NEST is in this radio state:

- before system monitoring pass, before the control channel is received;
- when a failure is detected;
- when a NEST is commanded to disable; and
- when the NEST is in a location requiring cessation of emissions.

external control channel: control channel which is either:

(i) carried by the NEST network via the same or another satellite, but not within the internal protocol of the NEST system; or

(ii) carried by any other radio communication system.

external response channel: response channel which is either:

(i) carried by the NEST network via the same or another satellite, but not within the internal protocol of the NEST system; or

(ii) carried by any other radio communication system.

integral antenna: antenna which may not be removed during the tests according to the manufacturer's declaration

internal control channel: control channel which is carried by the NEST network via the same satellite as used for transmission of user data and within the internal protocol structure of the NEST system

internal response channel: response channel which is carried by the NEST network via the same satellite as used for transmission of user data and within the internal protocol structure of the NEST system

manufacturer: means any natural or legal person who manufactures radio equipment or has radio equipment designed or manufactured, and markets that equipment under his name or trade mark

Network Control Facility (NCF): set of functional entities that, at system level, monitor and control the correct operation of the NEST and, if appropriate, all of the NESTs in a network

nominated bandwidth: bandwidth of the NEST radio frequency transmission declared by the manufacturer

NOTE: See clause 5.3.

off-axis angle: angle between the direction of the axis of the antenna main beam and the considered direction

removable antenna: antenna which may be removed during the tests according to the manufacturer's declaration

Response Channel (RC): channel by which the NEST transmit monitoring information to the NCF

spurious radiation: in the present document, any radiation outside the nominated bandwidth

transmission disabled state: radio state in which the NEST is not authorized to transmit by the NCF

transmission enabled state: radio state in which the NEST is authorized to transmit by the NCF

Wanted signal occupied Bandwidth (BW):

- for a digital modulation scheme: the width of the signal spectrum 10 dB below the maximum in-band power density;
- for an analogue modulation scheme: the width of a frequency band such that, below the lower and above the upper frequency limits, the mean power emitted is equal to 0,5 % of the total mean power of the emission.

3.2 Symbols

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

dBi	ratio of an antenna gain to the gain of an isotropic antenna, expressed in decibels
dBsd	ratio expressed in decibels relative to the spectral density
dBW	ratio of a power to 1 watt, expressed in decibels
dBpW	ratio of a power to 1 picowatt, expressed in decibels
dBµV/m	ratio of an electric field to 1 µV/m, expressed in decibels (20 log(electric field /1 µV/m))

3.3 Abbreviations

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

BW	Wanted signal occupied Bandwidth
CATR	Compact Antenna Test Range
CC	Control Channel
CCF	Control Channel reception Failure
CCR	Control Channel correctly Received

CENR	Cessation of Emissions Not Required
CER	Cessation of Emissions Required
CISPR	Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference)
CMF	Control and Monitoring Functions
DC	Direct Current
EFTA	European Free Trade Association
EIRP	Effective Isotropic Radiated Power
$EIRP_{max}$	Maximum EIRP transmitted by the NEST
EMC	Electro-Magnetic Compatibility
EUT	Equipment Under Test
FEC	Forward Error Correction
FSS	Fixed Satellite Service
GEUT	Gain of EUT
GSO	Geostationary Satellite Orbit
HPA	High Power Amplifier
IFF	Indirect Far Field
IPR	Intellectual Property Rights
IT_{max}	maximum Inhibit Time
LO	Local Oscillator
LV	Low Voltage
NCF	Network Control Facility
NEST	Earth Station communicating with NGSO satellite system
NFTF	Near Field To Far Field Transform
NGSO	Non Geostationary Satellite Orbit
OATS	Open Area Test Site
R&TTE	Radio and Telecommunications Terminal Equipment
RBW	Reference BandWidth
RC	Response Channel
RE	Radio Equipment
RED	Radio Equipment Directive
RF	Radio Frequency
RMS	Root Mean Square
SMF	System Monitoring Fail
SMP	System Monitoring Pass
SNR	Signal to Noise Ratio
STE	Special Test Equipment
T_{trans}	time to transition from "Carrier off" to "Carrier on" radio state
TxD	Transmission Disable command
TxE	Transmission Enable command
VBW	Video BandWidth
VSWR	Voltage Standing Wave Ratio

4 Technical requirements specifications

4.1 General

4.1.0 Objective

Clause 4 includes information for the test house to be able to conduct the tests.

4.1.1 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.

4.1.2 Void

4.1.3 Operating configurations

Operation of the NEST shall be able to comply with national regulations, including the use of sub-bands as authorized. The manufacturer shall declare all operational parameters including the maximum EIRP, EIRP densities in use, modulation, wanted signal occupied bandwidth and polarization.

The manufacturer shall declare the number of carrier signals of the NEST that may be radiated simultaneously. The specifications in this clause 4 shall be applied to such configuration as declared by the manufacturer.

Under operational conditions a NEST may dynamically change the wanted signal occupied bandwidth and other transmission parameters (e.g. FEC, modulation, symbol rate) of the transmitted signal.

For the purposes of verifying that the NEST complies with these specifications, the manufacturer shall declare the worst-case combination of transmission parameters that would produce the EIRP density mask, as declared by the manufacturer.

4.1.4 Presentation of equipment for testing purposes

NEST equipment submitted for testing, where applicable, shall fulfil the requirements of the present document on all frequencies over which it is intended to operate.

The manufacturer shall submit one or more samples of the equipment as appropriate for testing.

Additionally, technical documentation and operating manuals, sufficient to allow testing to be performed, shall be supplied.

The performance of the NEST equipment submitted for testing shall be representative of the performance of the corresponding production model. The manufacturer shall offer equipment complete with any auxiliary equipment needed for testing.

The manufacturer shall declare the frequency range(s), the range of operation conditions and power requirements, as applicable, in order to establish the appropriate test conditions.

4.1.5 Choice of model for testing

If a NEST equipment has several optional features, considered not to affect the RF parameters then the tests need only to be performed on one sample of the equipment configured with that combination of features considered to create the highest unintentional emissions.

In addition, when a device has the capability of using different dedicated antennas or other features that affect the RF parameters, at least the worst combination of features from an emission point of view as agreed between the manufacturer and the test laboratory shall be tested.

Where the transmitter is designed with adjustable output power, then all transmitter parameters shall be measured using the highest maximum mean power spectral density level, as declared by the manufacturer.

The choice of model(s) for testing shall be recorded in the test report.

4.1.6 Operation of multiple NEST on a single frequency

The manufacturer shall declare if the design and operation of the satellite network permits more than one NEST to transmit simultaneously on a given carrier frequency, from a signal location. In such a case, the manufacturer shall also declare the maximum number N of NEST that may transmit simultaneously on a given carrier frequency.

4.2 Conformance requirements

4.2.1 Void

4.2.2 Antenna beam pointing

4.2.2.1 Pointing accuracy

4.2.2.1.1 Purpose

To validate that the antenna points correctly within the $\delta\phi_{max}$.

4.2.2.1.2 Antenna Beam Pointing error

The antenna beam pointing error is a difference between true azimuth and elevation position related to a given RF boresight of the NEST and the azimuth and elevation reported by the antenna control and tracking system.

The manufacturer shall declare the maximum antenna beam pointing error $\delta\phi_{max}$.

4.2.2.2 Pointing error detection

4.2.2.2.1 Purpose

Protection to GSO satellites from NEST emissions caused by erroneous beam pointing.

4.2.2.2.2 Pointing error detection specification

Pointing error detection:

- The NEST shall have the means to detect antenna beam pointing errors specified in clause 4.2.2.1.2. This detection shall be performed over the range of azimuth and elevation angles for the intended purposes.
- The NEST, when in the "Carrier-on" radio state, shall enter the "Carrier-off" radio state when the antenna beam pointing error has exceeded the maximum pointing error, $\delta\phi_{max}$. The NEST shall not re-enter the "Carrier-on" radio state until the pointing error is within $\delta\phi_{max}$.
- The manufacturer shall declare the maximum inhibit time (IT_{max}) that the NEST can remain in "Transmission enabled" state and "Carrier off" radio state (see also clause 4.2.8.8). If the pointing error threshold is exceeded for more than IT_{max} then the NEST shall enter the "Initial phase" state.

NOTE: $\delta\phi_{max}$ could be exceeded when the NEST is in any other state other than "Carrier-on" radio state. In this case, the behaviour of the NEST is in accordance with clause 4.2.6.

4.2.2.3 Conformance tests

Conformance tests shall be carried out in accordance with clause 6.6.