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Satellite Earth Stations and Systems (SES);
Harmonised Standard for tracking
Earth Stations on Trains (ESTs)
operating in the 14/12 GHz frequency bands
covering the essential requirements
of article 3.2 of the Directive 2014/53/EU

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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.5] 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 [4].

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:	16 May 2016
Date of latest announcement of this EN (doa):	31 August 2016
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	28 February 2017
Date of withdrawal of any conflicting National Standard (dow):	28 February 2018

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

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 equipment within the scope of the Directive 2014/53/EU [4]. The modular structure is shown in ETSI EG 201 399 [i.3].

1 Scope

The present document applies to Earth Stations located on board Trains, which have the following characteristics.

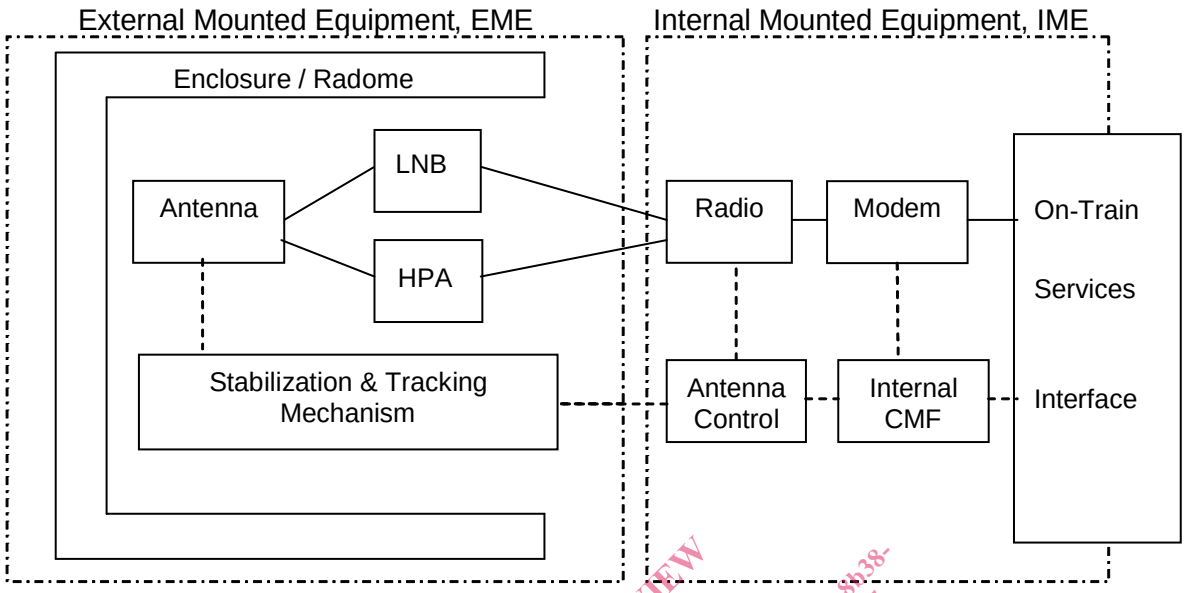

Figure 1: EST System Overview

- The EST may transmit and receive data when the train is in motion and also when the train is stationary.
- The EST operates in a railway environment and, therefore, may be subject to occasional disturbances and interruptions in the satellite link.
- The EST is operating as part of a satellite network (e.g. star, mesh or point-to-point) used for the distribution and/or exchange of information.
- The EST is comprised of all the equipment, electrical and mechanical, from the antenna itself to the interface with other communications equipment on a train (usually referred to as the terrestrial interface).
- The EST transmits on single carrier in the frequency range 14,00 GHz to 14,25 GHz, which is a portion of a band allocated to the Fixed Satellite Services (FSS) (Earth-to-space).
- The EST receives in one or more frequencies within the range from 10,70 GHz to 12,75 GHz in bands allocated to the Fixed Satellite Services (FSS) (space-to-Earth) or the Broadcast Satellite Service (BSS) (space-to-Earth), depending on the ITU Region where the EST is located.
- The EST uses linear or circular polarization.
- The EST is designed to operate through a geostationary satellite (or a cluster of co-located geostationary satellites) that is at least 3° away from any other geostationary satellite operating in the same frequencies and over the same coverage area.
- The EST transmits at elevations greater than or equal to 7° relative to the local horizon.
- The EST is designed for unattended operation.
- The EST is controlled and monitored by a Network Control Facility (NCF). The NCF is outside the scope of the present document.

The present document applies to the EST 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 applicant and when installed as required by the applicant's declaration or in the user documentation.

The present document is intended to cover the provisions of Directive 2014/53/EU [4] (RE Directive) 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*".

NOTE 1: Operational requirements are defined by national administrations and by relevant ECC Decisions.

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 Directive 2014/53 [4] (RE Directive) may apply to equipment within the scope of the present document.

NOTE 2: A list of such ENs is included on the web site http://www.newapproach.org/.

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] Void.

[2] Void.

[3] CISPR 16-1-5 (2014): "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1-5: Radio disturbance and immunity measuring apparatus - Antenna calibration sites and reference test sites for 5 MHz to 18 GHz".

[4] 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 (RE Directive).

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.

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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] Void.

[i.2] CEPT Recommendation T/R 25-09: "Designation of frequencies in the 900 MHz band for railway purposes".

[i.3] 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.4] ETSI TR 102 215 (2004): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Recommended approach, and possible limits for measurement uncertainty for the measurement of radiated electromagnetic fields above 1 GHz".

[i.5] 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/EU of the European Parliament and of the Council.

[i.6] CENELEC EN 50155: "Railway applications - Electronic equipment used on rolling stock".

[i.7] CENELEC BS EN 60068: "Environmental testing. Test methods for vibration and shock".

[i.8] CENELEC EN 61373: "Railway applications. Rolling stock equipment. Shock and vibration tests".

[i.9] CENELEC EN 60945: "Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results".

[i.10] CENELEC EN 55022: "Limits and methods of measurement of radio disturbance characteristics of information technology equipment".

[i.11] ETSI TR 102 375 (2005): "Satellite Earth Stations and Systems (SES); Guidelines for determining the parts of satellite earth station antenna radiation patterns concerned by the geostationary satellite orbit protection".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in Directive 2014/53/EU [4] and the following apply:

ancillary equipment: equipment used in connection with an EST is considered as ancillary if the three following conditions are met:

- the equipment is intended for use in conjunction with the EST to provide additional operational and/or control features (e.g. to extend control to another position or location); and
- the equipment cannot be used on a stand alone basis, to provide user functions independently of the EST; and
- the absence of the equipment does not inhibit the operation of the EST.

applicant: manufacturer or his authorized representative within the European Community or the person responsible for placing the apparatus on the market

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

NOTE 1: The phrase "the EST may transmit" means that all the conditions for transmission are satisfied (e.g. in a state where transmissions are permitted, no failure detected, and the EST is correctly pointed towards the satellite).

NOTE 2: The existence of a "Carrier-off" radio state depends on the system of transmission used. For ESTs designed for continuous transmission mode there may be no "Carrier-off" state.

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

Control Channel (CC): channel or channels by which ESTs receive control information from the NCF

$EIRP_{max}$: maximum e.i.r.p. capability of the EST as declared by the applicant

emissions disabled radio state: radio state in which the EST does not emit

NOTE: Examples of cases where the EST is in this radio state: before system monitoring pass, before the control channel is received, when a failure is detected, when an EST is commanded to disable, and when the EST is in a location requiring cessation of emissions.

external control channel: control channel which is either (i) carried by the EST network via the same or another satellite, but not within the internal protocol of the EST system, or (ii) carried by any other radio communication system

external response channel: response channel which is either (i) carried by the EST network via the same or another satellite, but not within the internal protocol of the EST system, or (ii) carried by any other radio communication system

Externally Mounted Equipment (EME): that part of the EST intended to be installed on the outside of the train (usually the roof), as declared by the applicant, or as indicated in the user documentation

NOTE 1: The EME unit is usually comprised of the following main parts:

a) The antenna sub-system which converts the incident radiation field into a guided wave and vice versa.

b) The Low Noise Block (LNB) down converter, which is a device that amplifies, with very low internal noise, the received signals in the Radio Frequency (RF) band and converts them to intermediate frequencies.

c) The up-converter and the power amplifier which convert from the intermediate frequency to RF and amplify the low level RF signals for transmission through the antenna subsystem.

d) The stabilization and tracking mechanics that ensure pointing of the antenna main beam towards the satellite within the required accuracy.

NOTE 2: The installation equipment (means of attachment) is outside the scope of the present document. However, the antenna structures and other components directly mounted on the antenna and forming an integral part of it, are subject to the specifications of the present document.

NOTE 3: Certain configurations may include more than one EME per EST. As for example, the EST may have separate transmit and receive antennas or it may have redundant transmit/receive antenna units.

integral antenna: antenna which may not be removed during the tests according to the applicant's statement

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

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

Internally Mounted Equipment (IME): part of the EST equipment which is installed inside the train and its connection cables with the EME

NOTE: The IME is usually comprised of:

a) the modem and the IF radio equipment;

b) the control logic, including that for the internal control and monitoring subsystem and the antenna tracking subsystem; and

c) the interfaces to equipment and services onboard the train.

maximum relative wind speed: addition of the magnitudes of the maximum wind speed and the maximum train velocity

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

nominal antenna diameter: antenna diameter declared 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.

Network operators might request antennas of a certain diameter. Then an antenna that is compliant with the requirement for nominal antenna diameter equal to the requested antenna diameter can be used. Manufacturers can mark their equipment with antenna diameters used in the requirements during compliance test.

nominated bandwidth: bandwidth of the EST radio frequency transmission nominated by the applicant. The nominated bandwidth is centred on the transmit frequency and does not exceed 5 times the occupied bandwidth

NOTE: The nominated bandwidth is wide enough to encompass all spectral elements of the transmission which have a level greater than the specified spurious radiation limits. The nominated bandwidth is wide enough to take account of the transmit carrier frequency stability. This definition is chosen to allow flexibility regarding adjacent channel interference levels which will be taken into account by operational procedures depending on the exact transponder carrier assignment situation.

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 applicant's statement

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

spurious radiation: any radiation outside the nominated bandwidth

transmission disabled state: EST is in this state when it is not authorized by the NCF to transmit

transmission enabled state: EST is in this state when it is authorized by the NCF to transmit

Wanted signal occupied Bandwidth (BW):

- for a digital modulation scheme: the width of the signal spectrum 10 dB below the maximum in-band 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:

dBc	ratio expressed in decibels relative to the e.i.r.p. of the unmodulated carrier
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	Bandwidth
BSS	Broadcast Satellite Service
CC	Control Channel
CCF	Control Channel reception Failure
CCR	Control Channel correctly Received
CENR	Cessation of Emissions Not Requested
CEPT	Conférence Européenne des Postes et Télécommunications (European Conference of Postal and Telecommunications Administrations)
CER	Cessation of Emissions Requested

CISPR	Comité International Spécial des Perturbations Radioélectriques (International Special Committee on Radio Interference)
CMF	Control and Monitoring Functions
e.i.r.p.	equivalent isotropically radiated power
EIRP	Equivalent Isotropically Radiated Power
ECC	Electronic Communications Committee (of CEPT)
EMC	Electro-Magnetic Compatibility
EME	Externally Mounted Equipment
EN	European Standard
EST	Earth Station on board a Train
EUT	Equipment Under Test
FEC	Forward Error Correction
FS	Fixed Service
FSS	Fixed Satellite Service
GSM-R	Global System for Mobile Communications - Railway
GSO	Geostationary Satellite Orbit
IME	Internally Mounted Equipment
IPR	Intellectual Property Rights
ITU	International Telecommunications Union
LNB	Low Noise Block down converter
LO	Local Oscillator
LV	Low Voltage
NCF	Network Control Facility
R&TTE	Radio and Telecommunications Terminal Equipment
RC	Response Channel
RE	Radio Equipment
RED	RE Directive
RF	Radio Frequency
SMF	System Monitoring Fail
SMP	System Monitoring Pass
STE	Special Test Equipment
TDMA	Time Division Multiple Access
TxD	Transmission Disable command
TxE	Transmission Enable command
XPD	Cross-Polarization Discrimination
XPDEST	Cross-Polarization Discrimination of the EST

4 Technical requirements specifications

4.1 General

4.1.1 Environmental profile

The applicant shall declare the environmental profile of the EST equipment and it shall include conditions for both survivability and operation. The declared environmental profile shall include, but not be limited to, a statement of conditions regarding: train velocity, tangential and longitudinal acceleration, temperature range, damp heat, dry heat, relative humidity stress, shock and vibration, antenna pressure pulses and pressure gradients.

NOTE: For guidance on the range of values for parameters in the environmental profile, applicants should consult the following standards: CENELEC EN 50155 [i.6]; CENELEC BS EN 60068 [i.7]; CENELEC EN 61373 [i.8]. For certain environmental parameters not covered in these standards, it may be useful to consult CENELEC EN 60945 [i.9]. The equipment should comply with the performance requirements of the present document under all operational environmental conditions.