



**Satellite Earth Stations and Systems (SES);
Earth Stations on Trains (ESTs)
operating in the 11/12/14 GHz frequency bands;
Harmonised Standard for access to radio spectrum**

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ETSI650 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
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Foreword

This draft Harmonised European Standard (EN) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES), and is now submitted for the combined Public Enquiry and Vote phase of the ETSI Standardisation Request deliverable Approval Procedure (SRdAP).

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 [i.12].

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.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	18 months after doa

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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1 Scope

The present document specifies technical characteristics and methods of measurements for Earth Stations located on board Trains, which have the following characteristics.

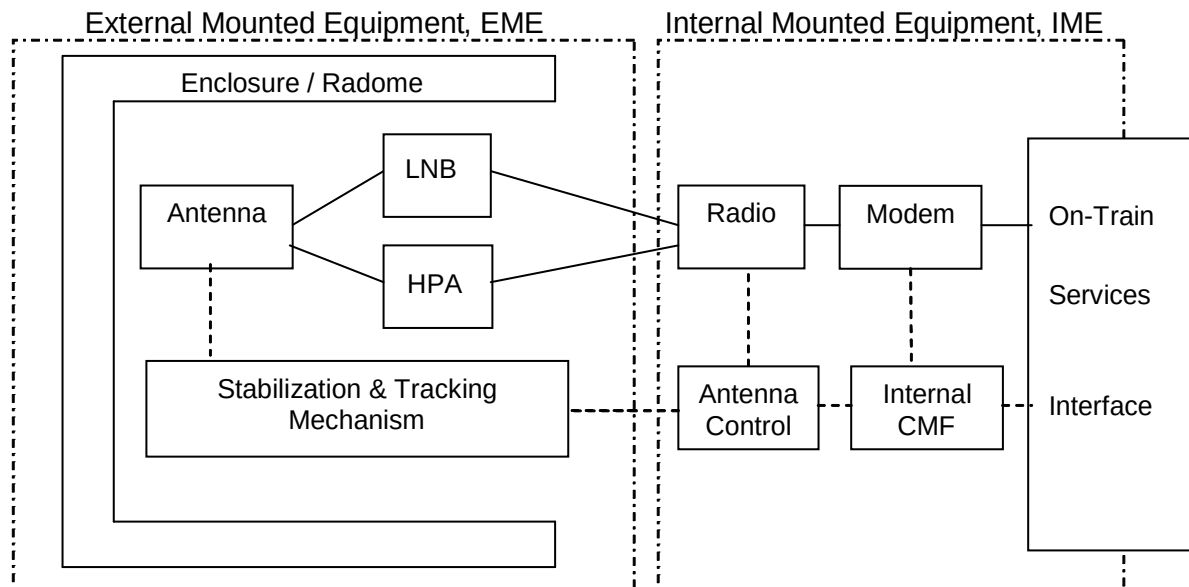


Figure 1: EST System Overview

- 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 allocated to the Mobile Satellite Service (Earth-to-space), as secondary service.
- The EST receives in one or more frequencies within the range from 10,70 GHz to 12,75 GHz.
- 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 defined for the intended use of the EST and when installed as required by the defined intended use of the EST or in the user documentation.

NOTE: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53 [i.12] 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.

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

- [1] Void.
- [2] Void.
- [3] [CISPR 16-1-5:2014+AMD1:2016](#): "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".

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 may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

- [i.1] Void.
- [i.2] [ECC Decision \(20\)02](#): "Harmonised use of the paired frequency bands 874.4- 880.0 MHz and 919.4-925.0 MHz and of the unpaired frequency band 1900-1910 MHz for Railway Mobile Radio (RMR)".
- [i.3] Void.
- [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] EN 50155: "Railway applications - Electronic equipment used on rolling stock", (produced by CEN).
- [i.7] BS EN 60068 Parts 2-6, 2-57, 2-65: "Environmental testing. Test methods for vibration and shock", (produced by CEN).

- [i.8] EN 61373: "Railway applications. Rolling stock equipment. Shock and vibration tests", (produced by CEN).
- [i.9] EN 60945: "Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results", (produced by CEN).
- [i.10] EN 55022: "Limits and methods of measurement of radio disturbance characteristics of information technology equipment", (produced by CEN).
- [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".
- [i.12] [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).
- [i.13] ETSI EG 203 336: "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".

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.12] and the following apply:

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

- a) 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
- b) the equipment cannot be used on a stand alone basis, to provide user functions independently of the EST; and
- c) the absence of the equipment does not inhibit the operation of the EST

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 defined for the intended use of the EST

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 defined for the intended use of the EST, 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 EUT documentation

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: diameter of the antenna defined for the intended use of the EST

NOTE 1: An antenna with a nominal antenna diameter D has the same technical characteristics as a circular aperture antenna of diameter D . For non circular aperture antenna, the nominal antenna diameter is defined for the intended use of the EST.

NOTE 2: 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.

nominated bandwidth: bandwidth of the EST radio frequency transmission nominated for the intended use of the EST. 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 EUT documentation

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):

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

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
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
CW	Continuous Wave
EIRP	Equivalent Isotropically Radiated Power
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
LNB	Low Noise Block down converter
LO	Local Oscillator
NCF	Network Control Facility
OATS	Open Area Test Site
RC	Response Channel
RF	Radio Frequency
SMF	System Monitoring Fail
SMP	System Monitoring Pass
SNR	Signal to Noise Ratio
STE	Special Test Equipment
TDMA	Time Division Multiple Access
TxD	Transmission Disable command
TxE	Transmission Enable command

4 Technical requirements specifications

4.1 General

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, but as a minimum, shall be that specified in the test conditions contained in the present document. 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.

The environmental profile shall include, the conditions regarding the train velocity, tangential and longitudinal acceleration, temperature range, damp heat, dry heat, relative humidity stress, shock and vibration, antenna pressure pulses and pressure gradients.

The equipment shall comply with the performance requirements of the present document under all operational environmental conditions defined by its intended use.

NOTE: For guidance on the range of values for parameters in the environmental profile, consultation to the following standards: EN 50155 [i.6]; BS EN 60068 [i.7]; EN 61373 [i.8] is recommended. For certain environmental parameters not covered in these standards, it may be useful to consult EN 60945 [i.9].

4.1.2 Operational configurations

Under operational conditions an EST may dynamically change the occupied bandwidth and other transmission parameters (e.g. FEC, modulation, symbol rate) of the transmitted signal. For each occupied bandwidth an $EIRP_{max}$ and a nominated bandwidth shall be provided with the documentation of the EUT. For the purposes of verifying that the EST complies with the specifications in the present document, the worst case combination of transmission parameters shall be identified. However, the specifications in the present document apply to the EST for each occupied bandwidth and other transmission parameters.

4.1.3 EST states and radio states

For the purpose of the present document the following four EST states are defined, without presuming the effective implementation of the EST state machine:

- "Non valid";
- "Initial phase";
- "Transmission disabled"; and

- d) "Transmission enabled".

The four EST states are represented on figure 2 and are used in clause 4.2.8 for the specification of the Control and Monitoring Functions (CMFs).

In the "Non-valid" state and in the "Transmission disabled" state the EST is not allowed to transmit. In the "Transmission-enabled" state the EST is allowed to transmit. In the "Initial phase" state the EST is only allowed to transmit initial bursts or is waiting for a transmit enable/disable command.

The "Initial phase" is divided into three substates:

- a) "Initial phase-Standby" prior to the transmission of the first initial burst or when no initial bursts are transmitted;
- b) "Initial phase-BurstOn" during the transmission of the initial bursts;
- c) "Initial phase-BurstOff" between initial bursts.

NOTE: ESTs which do not transmit initial bursts have no "Initial phase-BurstOn" state and no "Initial phase-BurstOff" state.

The EST can transmit when all the conditions for transmission are satisfied (e.g. in a state where transmissions are permitted, no failure detected, correctly pointed towards the satellite and there is no requirement for cessation of emissions).

The following radio states of the EST are defined:

- a) "Emissions disabled" when the EST does not transmit any carrier;
- b) "Carrier-off" when the EST may transmit and does not transmit any carrier;
- c) "Carrier-on" when the EST may transmit and transmits a carrier.

Table 1a gives the only possible combinations of the EST states and radio states which shall apply, with some examples of associated events.

When the EST transmits several carriers having different frequencies, an EST state machine as described above may be associated with each carrier or each set of carriers.

Table 1a: EST states and radio states of the EST

EST states and substates	Radio states	Examples of events
"Non valid"	"Emissions disabled"	After-power on, or After any failure, or During the checking phase
"Initial phase"		When waiting for a transmission enable or disable command from the NCF
"Initial phase-Standby"	"Emissions disabled"	Before the first initial burst transmissions; or In locations where no transmission is allowed
"Initial phase-BurstOn"	"Carrier-on"	During the transmission of each initial burst, and the pointing is correct
"Initial phase-BurstOff"	"Carrier-off"	Between initial bursts, or When the pointing threshold is exceeded
"Transmission enabled"	"Carrier-off"	When no carrier is transmitted, or When receive synchronization is lost, or When the pointing threshold is exceeded
	"Carrier-on"	During transmission of carrier(s), and the pointing is correct
"Transmission disabled"	"Emissions disabled"	When a disable command from the NCF has been received and waiting for a transmission enable command from the NCF, or In locations where no transmission is allowed