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Satellite Earth Stations and Systems (SES);
Family SL Satellite Radio Interface (Release 1);
Part 2: Physical Layer Specifications;
Sub-part 2: Radio Transmission and Reception

Reference

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Contents

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

The present document is part 2, sub-part 2 of a multi-part deliverable. Full details of the entire series can be found in ETSI TS 102 744-1-1 [i.1].

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

This multi-part deliverable (Release 1) defines a satellite radio interface that provides UMTS services to users of mobile terminals via geostationary (GEO) satellites in the frequency range 1 518,000 MHz to 1 559,000 MHz (downlink) and 1 626,500 MHz to 1 660,500 MHz and 1 668,000 MHz to 1 675,000 MHz (uplink).

1 Scope

The present document defines the radio reception and transmission requirements for all classes of UE that comply with the Family SL physical layer specifications as defined in ETSI TS 102 744-2-1 [11]. The Family SL radio interface operates in spectrum allocated to mobile satellite services (see ETSI TS 102 744-2-1 [11], clauses 5.1.2 and 6.1.2).

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 reference document (including any amendments) applies.

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

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

[1] Recommendation ITU-R M.1480: "Essential technical requirements of mobile Earth stations of geostationary mobile-satellite systems that are implementing the Global mobile personal communications by Satellite (GMPCS) - Memorandum of understanding arrangements in parts of the frequency band 1-3 GHz".

[2] Recommendation ITU-R M.1091: "Reference off-axis radiation patterns for mobile earth station antennas operating in the land mobile-satellite service in the frequency range 1 to 3 GHz".

[3] Recommendation ITU-R M.694: "Reference radiation pattern for ship earth station antennas".

[4] ETSI EN 301 444: "Satellite Earth Stations and Systems (SES); Harmonized EN for Land Mobile Earth Stations (LMES) operating in the 1,5 GHz and 1,6 GHz bands providing voice and/or data communications covering essential requirements of article 3.2 of the R&TTE directive".

[5] ETSI EN 301 681: "Satellite Earth Stations and Systems (SES); Harmonized EN for Mobile Earth Stations (MESs) of Geostationary mobile satellite systems, including handheld earth stations, for Satellite Personal Communications Networks (S-PCN) in the 1,5/1,6 GHz bands under the Mobile Satellite Service (MSS) covering the essential requirements of article 3.2 of the R&TTE Directive".

[6] ETSI EN 301 473: "Satellite Earth Stations and Systems (SES); Aircraft Earth Stations (AES) operating below 3 GHz under the Aeronautical Mobile Satellite Service (AMSS)/Mobile Satellite Service (MSS) and/or the Aeronautical Mobile Satellite on Route Service (AMS(R)S)/Mobile Satellite Service (MSS)".

[7] RTCA DO-210D: "Minimum Operational Performance Standards (MOPS) for Geosynchronous Orbit Aeronautical Mobile Satellite Services (AMSS) Avionics".

[8] International Civil Aviation Organisation, Global Navigation Satellite System, Standards and Recommended Practices (ICAO GNSS SARPs).

NOTE: This reference is contained in Volume 1 (Radio Navigation Aids) of Annex 10 (International Standards and Recommended Practices for Aeronautical Telecommunications) of the Chicago Convention on International Civil Aviation.

[9] ETSI TS 102 744-1-4: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 1: General Specifications; Sub-part 4: Applicable External Specifications, Symbols and Abbreviations".

[10] ETSI TS 102 744-1-2: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 1: General Specifications; Sub-part 2: System Operation Overview".

[11] ETSI TS 102 744-2-1: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 2: Physical Layer Specifications; Sub-part 1: Physical Layer Interface".

[12] ETSI TS 102 744-3-1: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 1: Bearer Control Layer Interface".

[13] ETSI TS 102 744-3-2: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 3: Control Plane and User Plane Specifications; Sub-part 2: Bearer Control Layer Operation".

2.2 Informative references

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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] ETSI TS 102 744-1-1: "Satellite Earth Stations and Systems (SES); Family SL Satellite Radio Interface (Release 1); Part 1: General Specifications; Sub-part 1: Services and Architectures".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

Block Error Rate (BLER): probability that a received FEC Block contains uncorrectable error(s)

NOTE: In the present document, the term Block Error Rate (BLER) always refers to FEC Blocks.

global beam: satellite beam that covers the full satellite coverage footprint

NOTE: A global beam is provided on each satellite to support (amongst other things) terminal access in spot beams that currently are not activated to support data services.

narrow spot beam: satellite beam that covers the smallest portion of the satellite coverage footprint

regional beam: satellite beam that covers a medium portion of the satellite coverage footprint

3.2 Symbols

For the purposes of the present document, the symbols given in ETSI TS 102 744-1-4 [9], clause 3 apply.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI TS 102 744-1-4 [9], clause 3 apply.

4 General

4.1 UE classes

The requirements for the various UE classes are defined in groups as shown in Table 4.1.

Table 4.1: UE classes

Group	Subgroup	UE Class	Antenna Type	Clause
Land Class	N/A	Class 1 Class 2 Class 3	Land A3 size Land A4 size Land A5 size	Clause 5
Extension Class	Aeronautical	Class 4 Class 6 Class 7 Class 15	Future Aeronautical Enhanced Low Gain (see note) Aeronautical High Gain Aeronautical Intermediate Gain Aeronautical Low Gain	Clause 6
	Maritime	Class 5 Class 8 Class 9	Future Maritime Low Gain (see note) Maritime High Gain Maritime Low Gain	Clause 7
	Land Mobile (e.g. vehicles)	Class 10 Class 11 Class 12	Land-Mobile High Gain Land-Mobile Low Gain Future Land Low Gain (see note)	Clause 8
NOTE: Class 4, Class 5 and Class 12 UEs are defined as future Low Gain Antenna (LGA) terminals that are designed to make use of the LGA bearers.				

The requirements for the Land Class are defined in full. The requirements for other classes are then defined relative to this baseline (i.e. differences from the Land Class requirements).

4.2 RF transceiver general capabilities

The requirements in the following clauses require a UE to provide the following general capabilities:

1) The transceiver shall be designed to operate as a full duplex transceiver supporting the channelisation defined in ETSI TS 102 744-2-1 [11].

2) The transceiver shall be able to tune to narrow signalling channels using nominal bandwidth sizes of 10,5 kHz, 21 kHz, 42 kHz, 84 kHz and 189 kHz wide band traffic channels as defined in ETSI TS 102 744-2-1 [11].

3) The transceiver shall receive a full 200 kHz multi-bearer subband and from this 200 kHz bandwidth pick out (one) "narrow" channel using nominal bandwidth sizes of 10,5 kHz, 42 kHz and 189 kHz width as defined in ETSI TS 102 744-2-1 [11].

4) The transceiver shall have a transmitter, which is capable of burst-by-burst re-tuning inside the assigned 200 kHz sub-band.

Some requirements in the present document are defined in terms of test conditions, which correspond to the worst case impairments. The UE shall meet the performance requirements under these test conditions with the expectation that equal or better performance will be achieved under less stringent impairments.

4.3 Antenna parameters

The terms medium elevation and low elevation shall be understood as follows in the present document:

- Low Elevation: $5° \leq \text{Elevation} \leq 10°$
- Medium Elevation: $10° < \text{Elevation} \leq 20°$

5 Land Class UE requirements

5.1 Antenna requirements

5.1.1 Radiation Pattern

Class 1 and 2 UE shall comply with the antenna radiation pattern restrictions as defined in Recommendation ITU-R M.1091 [2].

A Class 3 UE shall meet the following requirement:

- $G \leq -5$ dBi for $\theta > 90°$

  where θ and G are as defined as follows:

  - θ: angle (degrees) between the direction of maximum gain and the direction considered.
  - G: gain relative to an isotropic antenna.

5.1.2 Polarization

Right-hand circular polarization (RHCP) shall be used for receive and transmit directions.

5.1.3 Axial Ratio

The antenna circular polarization axial ratio shall be no greater than the requirements stated in Table 5.1 for a UE within the portion of the UE antenna main beam that could be directed towards the satellite position, taking into account beam pointing tolerances. For all UEs, this value is for antennas in 'free space' but with the antenna integrated in the final unit.

Table 5.1: UE Maximum Axial Ratio

UE Class	Axial Ratio Requirement
Class 1	3 dB
Class 2	5 dB
Class 3	5 dB

5.1.4 UE antenna pointing loss

Provision shall be made to aid the user in accurately pointing the antenna in the direction of the satellite.

The design target is that a user is expected to be able to point the UE to achieve pointing losses with respect to maximum gain in transmit and receive less than those stated in Table 5.2, in a short time with only a little practice.

Table 5.2: UE Maximum Antenna Pointing loss

UE Class	Maximum Antenna Pointing Loss
Class 1	0,5 dB
Class 2	0,3 dB
Class 3	0,3 dB

For antenna pointing adjustment, audio and/or visual feedbacks shall be provided during initial deployment to indicate C/No level or equivalent.

NOTE: For Class 3 UEs, a LED indication may be sufficient, whereas for Class 1 and Class 2 UEs a LCD bargraph or similar may be needed.

The UE shall ensure that the optimum pointing is found for both the uplink and downlink. Hence for low antenna gain UEs, a C/No measurement should be supplemented with estimates of carrier plus noise power changes due to changes in the antenna pointing.

5.2 Receiver requirements

5.2.1 Gain-to-Noise Temperature Ratio

The RF receiving system gain-to-noise-temperature ratio (G/T) shall be in accordance with Table 5.3 for the relevant UE type in the direction of the satellite and under the following simultaneous conditions:

1) clear sky climatic conditions;

2) including noise contribution of the full receiver from antenna to base band;

3) with the transmitter power amplifier at maximum specified output level;

4) if a dry radome is fitted then including the loss and noise temperature contributions;

5) including the loss and noise temperature contributions of the antenna feed system and associated cables and filters (such as a Diplexer);

6) the environmental conditions for which the UE is to be used;

7) including noise contribution of 290 K ground temperature with the satellite at 5° elevation.

The antenna gain G, measured over the appropriate frequency range and RHCP, is expressed in dB relative to an ideal (no ohmic loss) isotropic antenna, and the receiving system noise temperature T is expressed in dB relative to 1 K. G and T shall be referred to a suitable common point within the receiving system.

Table 5.3: Minimum G/T Requirements for Land Class UEs

UE Class	Minimum Receiver G/T (dB/K) (Forward Link) with sat ≥ 5° elevation
Class 1	-10,5
Class 2	-13,5
Class 3	-18,5

The above G/T requirements shall apply for integrated antenna and shall also apply when using a supported external antenna i.e. it includes the cable loss.

5.2.2 Received Signal Levels

The receiver design shall be such as to ensure full compliance with the performance requirements for the following range of received power flux densities (PFD) at the earth's surface given in Table 5.4.

Table 5.4: Power Flux Density per Single Forward Bearer

Satellite Beam	Minimum Single Carrier PFD (dBW/m^2)	Maximum Single Carrier PFD (dBW/m^2)
Global	-143	-131
Regional	-138	-126
Spot	-125	-113

The receiver design shall take into account existence and possible deployment of other mobile communications systems operating at or near L-band (see the examples below). The power flux densities (PFD) of such systems in the proximity of the UE operating bands, both composite and per-carrier, may be higher than the PFD of the wanted carriers. Particular attention needs to be paid to the dynamic range of possible UE LNA elements and the following mixer (to avoid saturation and consequent inter-modulation products in the UE operating bands), and to the provision of as much selectivity as possible, as early as possible in the receiver down-conversion process.

NOTE 1: Examples of potentially interfering systems are:

a) Mobile Satellite Service (MSS) networks operating in the 1 520 MHz to 1 560 MHz band, using geostationary earth orbit (GEO) satellites with orbital locations such that the UE antenna will provide little if any discrimination, and which it is estimated may result in a composite flux density as high as -95 dBW/m^2.