



**SLOVENSKI STANDARD**  
**SIST EN 16603-50-05:2014**  
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**Vesoljska tehnika - Radijske frekvence in modulacija**

Space engineering - Radio frequency and modulation

Raumfahrttechnik - Funkfrequenzen und -modulation

Ingénierie spatiale - Radio fréquence et modulation

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## Space engineering - Radio frequency and modulation

Ingénierie spatiale - Radio fréquence et modulation

Raumfahrttechnik - Funkfrequenzen und -modulation

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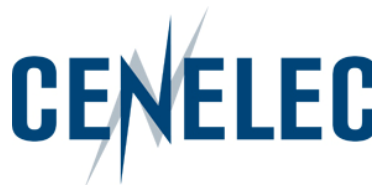
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## Foreword

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This document (EN 16603-50-05:2014) has been prepared by Technical Committee CEN/CLC/TC 5 "Space", the secretariat of which is held by DIN.

This standard (EN 16603-50-05:2014) originates from ECSS-E-ST-50-05C Rev. 2.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2015, and conflicting national standards shall be withdrawn at the latest by March 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document has been developed to cover specifically space systems and has therefore precedence over any EN covering the same scope but with a wider domain of applicability (e.g. aerospace).

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



## Introduction

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This Standard contains requirements to ensure the following:

- Compatibility of frequency usage and modulation schemes between space agencies' spacecraft and Earth stations for the Space Operation, Space Research and Earth Exploration-Satellite services.
- Compatibility between the spacecraft and the networks that they interact with, as far as possible.
- Standardization of frequency usage and modulation schemes within the space projects.
- Conformity of spacecraft and Earth station parameters to international radio regulatory provisions (Radio Regulations of the International Telecommunication Union (ITU)), and with national regulatory provisions (e.g. national frequency plans).
- Selection of the appropriate parameters of spacecraft and Earth stations that are listed in advance of their use, thus enabling coordination with other interested parties.
- Optimization of the frequency usage and modulation schemes within the above limitation.

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# 1 Scope

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This Standard defines the radio communication techniques used for the transfer of information between spacecraft and Earth stations in both directions, and for the tracking systems used for orbit determination. It includes the following:

- frequency allocation, assignment and use;
- requirements on transmitted signals concerning, for example, spectral occupation, RF power levels, protection of other radio services;
- definition of the permissible modulation methods and parameters;
- specification of the major technical requirements relevant for the interface between spacecraft and Earth stations;
- operational aspects, such as acquisition;
- cross-support.

This Standard is applicable to all spacecraft supported by Earth stations<sup>1</sup> and to all controlled Earth stations operating in the Space Operation, Space Research and Earth Exploration-Satellite services as defined in the ITU Radio Regulations.<sup>2</sup>

Other space telecommunication services are not covered in this issue.

All requirements in this Standard are equally applicable to both the customer and the supplier with exception of clauses 4.3.1 and 4.3.2 which are applicable to the customer only.

Further provisions and guidance on the application of this Standard can be found, respectively, in ECSS-E-ST-50 "Communications", and in the handbook ECSS-E-HB-50A "Communications guidelines".

ECSS-E-ST-50 defines the principle characteristics of communication protocols and related services for all communication layers relevant for space communication (physical- to application-layer), and their basic relationship to each other. The handbook ECSS-E-HB-50 provides information on specific implementation characteristics of these protocols in order to support the choice of a certain communications profile for the specific requirements of a space mission. Users of the present standard are invited to consult these documents before taking decisions on the implementation of the present one.

This Standard may be tailored for the specific characteristics and constraints of a space project in conformance with ECSS-S-ST-00.

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<sup>1</sup> This Standard is not applicable to spacecraft supported by data relay satellites.

<sup>2</sup> Under the term Earth Exploration-Satellite service, the Meteorological Satellite service is also included.

## 2

## Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revisions of any of these publications, do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the publication referred to applies.

EN reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system - Glossary of terms
EN 16603-10-03	ECSS-E-ST-10-03	Space engineering - Testing
EN 16603-50	ECSS-E-ST-50	Space engineering - Communications
EN 16603-50-01	ECSS-E-ST-50-01	Space engineering - Space data links - Telemetry synchronization and channel coding
	ITU/RR:2004 <sup>3,4</sup>	ITU Radio Regulations

<sup>3</sup> In this Standard the relevant articles are specified after the reference name. For example, ITU/RR/1.23 refers to Article 1.23.

<sup>4</sup> For possible changes to the ITU/RR, contact the responsible frequency coordinator.

## Terms, definitions and abbreviated terms

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### 3.1 Terms from other standards

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 and ECSS-E-ST-50 apply.

### 3.2 Terms specific to the present standard

#### 3.2.1 category A

category of spacecraft having an altitude above the Earth's surface of less than  $2 \times 10^6$  km

#### 3.2.2 category B

category of spacecraft having an altitude above the Earth's surface of equal to, or greater than  $2 \times 10^6$  km

#### 3.2.3 deep space

space at distances from the Earth of equal to, or greater than  $2 \times 10^6$  km

[ITU/RR/1.177]

#### 3.2.4 Earth Exploration-Satellite service

a radio communication service between Earth stations and one or more space stations, which may include links between space stations, in which:

- information relating to the characteristics of the Earth and its natural phenomena, including data relating to the state of the environment, is obtained from active sensors or passive sensors on Earth orbiting satellites;
- similar information is collected from airborne or ground-based platforms;
- such information may be distributed to Earth stations within the system concerned;
- platform interrogations may be included.

This service may also include feeder links necessary for its operation.

[ITU/RR/1.51]

**3.2.5 frequency coordinator**

manager responsible for ensuring conformity with ITU/RR

**3.2.6 Meteorological-Satellite service**

an Earth Exploration-Satellite service for meteorological purposes

[ITU/RR/1.52]

**3.2.7 necessary bandwidth**

for a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at a rate and with the quality required under the specified conditions

[ITU/RR/1.152]

NOTE This is taken to be equal to the occupied bandwidth.

**3.2.8 occupied bandwidth**

the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0,5 % of the total mean power of a given emission

[ITU/RR/1.153]

**3.2.9 out-of-band emission**

emission on a frequency or frequencies immediately outside the necessary bandwidth, which results from the modulation process, but excluding spurious emissions

[ITU/RR/1.144]

**3.2.10 proximate orbits**

two circular orbits whose difference in altitude is smaller than 500m and whose difference in orbital plane angle is smaller than 1,5°.

**3.2.11 Space Operation service (SO)**

a radio communication service concerned exclusively with the operation of spacecraft, in particular space tracking, space telemetry and space telecommand (TTC)

NOTE These functions are normally provided as part of the service in which the spacecraft is operating.

[ITU/RR/1.23]

**3.2.12 Space Research service (SR)**

a radio communication service in which spacecraft and other objects in space are used for scientific and technological research

[ITU/RR/1.55]

**3.2.13 spurious emission**

emissions on a frequency, or frequencies, which are outside  $\pm 2,5$  times the occupied bandwidth and the level of which may be reduced without affecting the corresponding transmission of information

NOTE Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

[ITU/RR/1.145]

**3.2.14 symbol rate**

reciprocal of the symbol duration

NOTE See Figure 6-1.

**3.2.15 unwanted emissions**

consists of spurious emissions and out-of-band emissions

[ITU/RR/1.146]

**3.3 Abbreviated terms**

For the purpose of this Standard, the abbreviated terms from ECSS-ST-00-01 and the following apply:

Abbreviation	Meaning
2B <sub>L</sub>	double sideband noise bandwidth
8PSK	phase shift keying of 8 states
BPSK	binary phase shift keying (see PSK)
BT <sub>s</sub>	product of bandwidth and symbol duration
CCSDS	Consultative Committee for Space Data Systems
CLCW	command link control word
dB	decibel
dB <sub>i</sub>	dB with respect to isotropic emission
dB <sub>c</sub>	dB with respect to the unmodulated carrier
dBW	dB with respect to power
DRS	data relay satellite
DS	deep space
DSN	Deep Space Network of NASA
EES	Earth Exploration-Satellite service
EHF	extremely high frequency, frequency from 30 GHz to 300 GHz
EIRP	equivalent isotropically radiated power

<b>epfd</b>	equivalent power flux density
<b>ESA</b>	European Space Agency
<b>E/S</b>	Earth station
<b>FIR</b>	finite impulse response
$f_N$	Nyquist frequency
$f_t$	ranging tone frequency
<b>GMSK</b>	Gaussian minimum shift keying
<b>GSO</b>	geostationary orbit
<b>G/T</b>	ratio of antenna gain to system noise temperature
<b>ITU</b>	International Telecommunication Union
<b>ITU-R</b>	radio communication sector of the ITU
<b>ITU/RR</b>	ITU radio regulations
<b>ksp/s</b>	kilo symbol per second
<b>LHC</b>	left hand circular
<b>LSB</b>	least significant bit
<b>MSB</b>	most significant bit
<b>Msp/s</b>	mega symbol per second
<b>NASA</b>	National Aeronautics and Space Administration
<b>NRZ</b>	non return to zero
<b>NRZ-L</b>	non return to zero-level
<b>NRZ-M</b>	non return to zero-mark
<b>OQPSK</b>	offset quadrature phase shift keying
<b>PCM</b>	pulse code modulation
<b>PFD</b>	power flux density
<b>PLL</b>	phase locked loop
<b>PM</b>	phase modulation
<b>PSK</b>	phase shift keying
<b>Q-DNRZ</b>	quaternary differential NRZ
<b>QPSK</b>	quadrature phase shift keying
<b>RF</b>	radio frequency
<b>RFI</b>	radio frequency interference
<b>RHC</b>	right hand circular
<b>r.m.s.</b>	root-mean-square
<b>R<sub>s</sub></b>	symbol rate
<b>R<sub>chs</sub></b>	channel symbol rate
<b>R<sub>ES</sub></b>	equivalent symbol rate
<b>RSS</b>	root-sum-square