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Nationales Vorwort

Dieses Dokument (EN 16603-50-05:2014) wurde vom Technischen Komitee CEN/CLC/TC 5 „Raumfahrt“ erarbeitet, dessen Sekretariat vom DIN (Deutschland) gehalten wird.

Das zuständige deutsche Normungsgremium ist der Arbeitsausschuss NA 131-10-01 AA „Interoperabilität von Informations-, Kommunikations- und Navigationssystemen“ im DIN-Normenausschuss Luft- und Raumfahrt (NL).

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Dieses Dokument enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die englische Originalfassung von EN 16603-50-05:2014.

Dieses Dokument wurde speziell zur Behandlung von Raumfahrtsystemen erarbeitet und hat daher Vorrang vor jeglicher Europäischer Norm, da es denselben Anwendungsbereich hat, jedoch über einen größeren Geltungsbereich (z. B. Luft- und Raumfahrt) verfügt.

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Nationaler Anhang NA
(informativ)

Begriffe und Abkürzungen

3 Begriffe und Abkürzungen

3.1 Begriffe aus anderen Normen

Für die Anwendung dieses Dokuments gelten die Begriffe nach ECSS-S-ST-00-01 und ECSS-E-ST-50 sowie die folgenden Begriffe.

3.2 Für diese Norm spezifische Begriffe

3.2.1
Kategorie A
Kategorie von Raumfahrzeugen, deren Höhe über der Erdoberfläche weniger als 2×10^6 km beträgt

3.2.2
Kategorie B
Kategorie von Raumfahrzeugen mit einer Höhe über der Erdoberfläche gleich oder größer 2×10^6 km

3.2.3
ferner Weltraum
Weltraum in Entfernungen von der Erde, die gleich groß oder größer sind als 2×10^6 km

[QUELLE: ITU/RR/1.177]

3.2.4
Erderkundungsfunkdienst über Satelliten
ein Funkkommunikationsdienst zwischen Erdfunkstellen und einer oder mehreren Weltraumfunkstellen, der Verbindungen zwischen Weltraumfunkstellen umfassen kann, in denen:

— Informationen über Eigenschaften der Erde und Naturerscheinungen auf der Erde, einschließlich Daten zum Umweltzustand, mit aktiven oder passiven Sensoren gewonnen werden, die sich an Bord von Erdsatelliten befinden;

— ähnliche Informationen, die von Sonden in Luftfahrzeugen oder auf der Erdoberfläche gesammelt werden;

— solche Informationen innerhalb des betreffenden Systems an Erdfunkstellen verteilt werden können;

— die Stationsabfrage eingeschlossen sein kann.

Dieser Dienst kann auch die zu seinem Betrieb notwendigen Speisestrecken umfassen.

[QUELLE: ITU/RR/1.51]

3.2.5
Frequenzkoordinator
Manager, verantwortlich für die Sicherstellung der Übereinstimmung mit ITU/RR

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3.2.6
Wetterfunkdienst über Satelliten
ein Erderkundungsfunkdienst über Satelliten für meteorologische Zwecke

[QUELLE: ITU/RR/1.52]

3.2.7
erforderliche Bandbreite
Breite des Frequenzbandes, die bei einer bestimmten Sendeart zur Sicherstellung der Informationsübertragung mit der erforderlichen Geschwindigkeit und Qualität unter festgelegten Bedingungen gerade ausreichend ist

[QUELLE: ITU/RR/1.152]

Anmerkung 1 zum Begriff: Dies gilt als der belegten Bandbreite entsprechend.

3.2.8
belegte Bandbreite
Breite eines Frequenzbandes, bei dessen Überschreiten der Frequenzobergrenze nach oben und der Frequenzuntergrenze nach unten die mittlere ausgesendete Energie jeweils 0,5 % der gesamten mittleren Leistung einer bestimmten Aussendung beträgt

[QUELLE: ITU/RR/1.153]

3.2.9
Außerband-Aussendung
eine Aussendung auf einer oder mehreren Frequenzen unmittelbar außerhalb der erforderlichen Bandbreite, die durch den Modulationsprozess erzeugt werden, jedoch ohne Nebenaussendungen

[QUELLE: ITU/RR/1.144]

3.2.10
nahe Umlaufbahnen
zwei kreisförmige Umlaufbahnen, deren Höhenunterschied geringer als 500 m ist und deren Unterschied im Winkel der Bahnebenen weniger als 1,5° beträgt

3.2.11
Weltraumfernwirkfunkdienst (SO)
ein Funkdienst, der ausschließlich dem Betrieb von Raumfahrzeugen dient, insbesondere der Weltraumbahnverfolgung, dem Weltraumfernmessen und dem Weltraumfernsteuern (TTC, en: tracking, telemetry, telecommand)

Anmerkung 1 zum Begriff: Diese Funktionen werden üblicherweise als Teil des Dienstes bereitgestellt, in welchem das Raumfahrzeug eingesetzt wird.

[QUELLE: ITU/RR/1.23]

3.2.12
Weltraumforschungsfunkdienst (SR)
ein Funkdienst, bei dem Raumfahrzeuge und andere Weltraumkörper für die wissenschaftliche und technologische Forschung verwendet werden

[QUELLE: ITU/RR/1.55]

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3.2.13
Nebenaussendung
Strahlung, die auf einer oder mehreren Frequenzen außerhalb des ± 2,5fachen der belegten Bandbreite liegt, wobei der Pegel dieser Aussendung herabgesetzt werden kann, ohne dass die Übertragung der zugehörigen Information beeinträchtigt wird

Anmerkung 1 zum Begriff: Nebenaussendungen umfassen harmonische Aussendungen, parasitäre Aussendungen, Intermodulationsprodukte und Frequenzumsetzungsprodukte, nicht jedoch Außerband-Aussendungen.

[QUELLE: ITU/RR/1.145]

3.2.14
Symbolrate
Kehrwert der Symboldauer

Anmerkung 1 zum Begriff: Siehe Bild 6-1.

3.2.15
unerwünschte Aussendungen
Gesamtheit der Nebenaussendungen und Außerband-Aussendungen

[QUELLE: ITU/RR/1.146]

3.3 Abkürzungen

Für die Anwendung dieses Dokuments gelten die Abkürzungen nach ECSS-ST-00-01 und die folgenden Abkürzungen:

@	At (en: at)
$2B_L$	Zweiseitenband-Rauschbandbreite (en: double sideband noise bandwidth)
8PSK	Achtphasenumtastung (en: phase shift keying of 8 states)
BPSK	binäre Phasenumtastung (siehe PSK) (en: binary phase shift keying)
BTs	Produkt aus Bandbreite und Symboldauer (en: product of bandwidth and symbol duration)
CCSDS	Beratender Ausschuss für Raumfahrtdaten-Systeme (en: Consultative Committee for Space Data Systems)
CLCW	Steuerbefehl der Kommandoverbindung (en: command link control word)
dB	Dezibel (en: decibel)
dBi	dB in Bezug auf isotrope Aussendungen (en: dB with respect to isotropic emission)
dBc	dB in Bezug auf den unmodulierten Träger (en: dB with respect to the unmodulated carrier)
dBW	dB in Bezug auf Leistung (en: dB with respect to power)
DRS	Datenrelaissatellit (en: data relay satellite)
DS	ferner Weltraum (en: deep space)
DSN	Deep-Space-Netzwerk der NASA (en: Deep Space Network of NASA)
EES	Erderkundungsfunkdienst über Satelliten (en: Earth Exploration-Satellite service)

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EHF	Millimeterwellen, Frequenz zwischen 30 GHz und 300 GHz (en: extremely high frequency)
EIRP	äquivalente isotrope Strahlungsleistung (en: equivalent isotropically radiated power)
epfd	äquivalente Leistungsflussdichte (en: equivalent power flux density)
ESA	Europäische Weltraumorganisation, Europäische Raumfahrtagentur (en: European Space Agency)
E/S	Erdfunkstelle (en: Earth station)
FIR	endliche Impulsantwort (en: finite impulse response)
f_N	Nyquist-Frequenz (en: Nyquist frequency)
f_t	Frequenz des Entfernungsmesstons (en: ranging tone frequency)
GMSK	Gaußsche Minimumumtastung (en: Gaussian minimum shift keying)
GSO	geostationäre Satellitenumlaufbahn (en: geostationary orbit)
G/T	Verhältnis von Antennengewinn zu Systemrauschtemperatur (en: ratio of antenna gain to system noise temperature)
ITU	Internationale Fernmeldeunion (en: International Telecommunication Union)
ITU-R	ITU–Funkkommunikationssektor (en: radio communication sector of the ITU)
ITU/RR	ITU–Vollzugsordnung (en: ITU radio regulations)
ksps	Kilosymbole je Sekunde (en: kilo symbol per second)
LHC	linksdrehend zirkular (en: left hand circular)
LSB	niedrigstwertiges Bit (en: least significant bit)
MSB	höchstwertiges Bit (en: most significant bit)
Msps	Megasymbole je Sekunde (en: mega symbol per second)
NASA	Nationale Luft- und Raumfahrtbehörde (en: National Aeronautics and Space Administration)
NRZ	Non-Return-to-Zero (en: non return to zero)
NRZ-L	Non-Return-to-Zero-Level (en: non return to zero-level)
NRZ-M	Non-Return-to-Zero-Mark (en: non return to zero-mark)
OQPSK	Offset-Quadratur-Phasenumtastung (en: offset quadrature phase shift keying)
PCM	Pulscodemodulation (en: pulse code modulation)
PFD	Leistungsflussdichte (en: power flux density)
PLL	Phasenregelkreis (en: phase locked loop)
PM	Phasenmodulation (en: phase modulation)

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PSK	Phasenumtastung (en: phase shift keying)
Q-DNRZ	quaternäre differentielle NRZ (en: quaternary differential NRZ)
QPSK	Quadratur-Phasenumtastung (en: quadrature phase shift keying)
RF	Hochfrequenz, Funkfrequenz (en: radio frequency)
RFI	Funkstörung (en: radio frequency interference)
RHC	rechtsdrehend zirkular (en: right hand circular)
r.m.s.	Effektivwert (en: root-mean-square)
RS	Symbolrate (en: symbol rate)
Rchs	Kanalsymbolrate (en: channel symbol rate)
RES	Äquivalentsymbolrate (en: equivalent symbol rate)
RSS	Quadratwurzel aus der Summe der Quadrate (en: root-sum-square)
Rx	Empfänger (en: receiver)
S/C	Raumfahrzeug, Weltraumfahrzeug (en: spacecraft)
SEF	Spektraleffizienzfaktor (en: spectral efficiency factor)
SFCG	Koordinierungsgruppe für Weltraumfrequenzen (en: Space Frequency Co-ordination Group)
SHF	Zentimeterwellen, Frequenz von 3 GHz bis 30 GHz (en: super high frequency)
SP-L	geteilter Phasenpegel (en: split phase-level)
sps	Symbole je Sekunde (en: symbol per second)
SO	Weltraumfernwirkfunkdienst (en: Space Operation service)
SR	Weltraumforschungsfunkdienst (en: Space Research service)
SRRC	Quadratwurzel-Kosinus (en: square-root raised-cosine)
TCM	Trellis-Code-Modulation (en: trellis-coded modulation)
TTC	Telemetrie, Nachführung und Fernsteuern (en: telemetry, tracking and telecommand)
Tx	Sender (en: transmitter)
UHF	Ultrahochfrequenz, Frequenz von 300 MHz bis 3 000 MHz (en: ultra high frequency)
UQPSK	unsymmetrische Quadratur-Phasenumtastung (en: unbalanced quadrature phase shift keying)

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Raumfahrttechnik - Funkfrequenzen und -modulation

This European Standard was approved by CEN on 1 March 2014.

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Foreword

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.

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Introduction

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

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[1] 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.[2]

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.

[1] This Standard is not applicable to spacecraft supported by data relay satellites.
[2] Under the term Earth Exploration-Satellite service, the Meteorological Satellite service is also included.

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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 [3,4]	ITU Radio Regulations

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

[4] For possible changes to the ITU/RR, contact the responsible frequency coordinator.

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3 Terms, definitions and abbreviated terms

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 2×10^6 km

3.2.2 category B

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

3.2.3 deep space

space at distances from the Earth of equal to, or greater than 2×10^6 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]

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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]

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3.2.13 spurious emission

emissions on a frequency, or frequencies, which are outside ±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
@	at
$2B_L$	double sideband noise bandwidth
8PSK	phase shift keying of 8 states
BPSK	binary phase shift keying (see PSK)
BTs	product of bandwidth and symbol duration
CCSDS	Consultative Committee for Space Data Systems
CLCW	command link control word
dB	decibel
dBi	dB with respect to isotropic emission
dBc	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

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

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Rx	receiver
S/C	spacecraft
SEF	spectral efficiency factor
SFCG	Space Frequency Co-ordination Group
SHF	super high frequency, frequency from 3 GHz to 30 GHz
SP-L	split phase-level
sps	symbol per second
SO	Space Operation service
SR	Space Research service
SRRC	square-root raised-cosine
TCM	trellis-coded modulation
TTC	telemetry, tracking and telecommand
Tx	transmitter
UHF	ultra high frequency, frequency from 300 MHz to 3 000 MHz
UQPSK	unbalanced quadrature phase shift keying

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4 Frequency allocations, assignment and use

4.1 Frequency allocations to the Space Operation, Space Research and Earth Exploration-Satellite[5] services

4.1.1 Overview

The use of frequencies by radio communication services is governed by the provisions of the Radio Regulations of the International Telecommunication Union (ITU/RR), which:

- define the various radio communication services (see clause 3.2);
- allocate frequency bands to them (see clause 4.1.2);
- lay down procedures to be followed for a frequency assignment and the frequency notification with the Radio communications Bureau of the ITU (see clause 4.3);
- specify technical conditions for the frequency use (see clause 5).

NOTE Any frequency assignment made to a particular user (spacecraft) is, as a consequence, in conformance with the ITU/RR.

4.1.2 Frequency bands allocated to the Space Radiocommunications services

4.1.2.1 Overview

Table 4-1 lists the recommended frequency bands among the available ITU bands, along with their allocated radio communication service, direction and status.

For the applicability of this Standard to the frequency bands allocated to the Meteorological-Satellite service not listed in Table 4-1, interested users can contact the responsible frequency coordinator.

[5] Under the term Earth Exploration-Satellite service, the Meteorological Satellite service is also included.

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Table 4-1: Frequency allocations to the Space Operation, Space Research and Earth Exploration-Satellite services

Frequency band (MHz) (see 4.1.2.2)	Allocated service (see 4.1.2.3)	Direction (see 4.1.2.4)	Allocation status (see 4.1.2.5)
2 025 – 2 110	SR, SO, EES	Earth–space	Primary
2 110 – 2 120	SR (DS)	Earth–space	Primary
2 200 – 2 290	SR, SO, EES	Space–Earth	Primary
2 290 – 2 300	SR (DS)	Space–Earth	Primary
7 145 – 7 190	SR (DS)	Earth–space	Primary
7 190 – 7 235	SR	Earth–space	Primary
8 025 – 8 400	EES	Space–Earth	Primary
8 400 – 8 450	SR (DS)	Space–Earth	Primary
8 450 – 8 500	SR	Space–Earth	Primary
25 500 – 27 000	SR, EES	Space–Earth	Primary
31 800 – 32 300	SR (DS)	Space–Earth	Primary
34 200 – 34 700	SR (DS)	Earth–space	Primary
37 000 – 38 000	SR	Space–Earth	Primary
40 000 – 40 500	SR	Earth–space	Primary

NOTE: To use the frequency bands given in this table, the interested users can contact the network operation manager in charge of the ground network for availability of the service at the stations of interest.

4.1.2.2 Special conditions governing the use of particular frequency bands

4.1.2.2.1 Overview

The use of certain frequency bands is governed by specific conditions that are laid down in the ITU-RR and in the Recommendations of the SFCG and CCSDS RF and Modulation Working Group (see Bibliography).

4.1.2.2.2 Evolution of the conditions

a. The frequency coordinator shall inform applicants for frequency assignments about any evolution of the conditions stated in 4.1.2.2 that have occurred since the issue of this Standard.

NOTE See also clause 4.3.

4.1.2.3 Use of frequency bands allocated to the Space Research (deep space) service

a. The frequency bands allocated to the Space Research (deep space) service shall only be used by category B spacecraft.

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4.1.2.4 Direction indicator

a. Frequency bands shall be used in conformance with the direction indicated in Table 4-1.

4.1.2.5 Allocation status

4.1.2.5.1 Primary allocation

a. A service with a primary allocation status shall only share and coordinate with other co-primary services which can be allocated in the same band.

b. A service with a primary allocation status has priority over other allocations, such as secondary and therefore it need not protect them or accept interference caused by them, or coordinate with them.

4.1.2.5.2 Secondary allocation

a. A service with a secondary allocation status shall not cause harmful interference to any station of a primary service allocated in the same band.

b. A service with a secondary allocation status shall not claim protection from interference caused by stations of a primary service allocated in the same frequency band.

4.2 Specific conditions for the use of certain frequency bands[6]

4.2.1 2 025 MHz – 2 120 MHz and 2 200 MHz – 2 300 MHz bands

4.2.1.1 2 025 MHz – 2 120 MHz band

4.2.1.1.1 2 025 MHz - 2 110 MHz band

a. The EIRP transmitted from the Earth station shall be selected to allow for a margin of 3 dB on the link budget, in order to minimize interference to the Earth-space links of other spacecraft or to the space-space links from data relay satellites to user satellites, which are particularly susceptible to RFI.

b. The use of an EIRP value higher than the one specified in 4.2.1.1.1a shall be analysed and justified.

c. Earth station transmitters shall provide the functionality for adjustable RF output power in steps of 3 dB or less.

d. Operators shall not activate the Earth-space links during periods when no tracking and telecommand operations are performed in order to alleviate the frequency sharing situation.

[6] These conditions are derived from recommendations of the SFCG (see Bibliography).

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NOTE Excessive Earth station EIRP not only complicates frequency co-ordination with other users, but can also prevent operations totally at some sites. As a means of RFI mitigation, if requested by priority users, ITU/RR specifies the interruption of Earth-space transmissions during the periods when they cause RFI.

4.2.1.1.2 2 110 MHz – 2 120 MHz band

a. New assignments in the 2 110 MHz - 2 120 MHz band shall only be requested after agreement with the frequency coordinator.

NOTE The 2 110 MHz - 2 120 MHz band is part of the IMT-2000 or UMTS core band for third generation mobile telecommunication systems. Given the importance of this band for mobile telecommunications, administrations have imposed extremely severe limitations on the use of this band for Earth-space transmissions of the Space Research (deep space) service. Therefore, new assignments in this band are formally discouraged.

4.2.1.2 2 200 MHz – 2 300 MHz band

4.2.1.2.1 2 200 MHz - 2 290 MHz

a. The maximum occupied bandwidth for spacecraft in this band shall not exceed 6 MHz.

b. Operators shall not activate the space-to-Earth links during periods when no operational ground station is in visibility of the satellite, in order to alleviate the frequency sharing situation.

c. The devices on spacecraft used to switch-off emissions shall have a reliability which is commensurate with the mission lifetime.

NOTE The 2 200 MHz – 2 290 MHz band is one of the most densely occupied bands allocated to the space science services with an average occupation density in excess of 25 MHz assigned per each 1 MHz allocated.

4.2.1.2.2 2 290 MHz - 2 300 MHz

There are no special requirements for this band. However, due to the constraints of the paired 2 110-2 120 MHz band given in 4.2.1.1.2 the usefulness of this band can be limited.

4.2.2 8 025 MHz – 8 400 MHz band

a. The same RFI mitigation methods specified in 4.2.1.2.1 for the 2 200 MHz – 2 290 MHz band shall be applied to the 8 025 MHz – 8 400 MHz band.

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NOTE The 8 025 MHz – 8 400 MHz band is the only direct data transmission band allocated to the Earth Exploration Satellite service below 20 GHz. Its occupation density is similar to that of the 2 200 MHz – 2 290 MHz band; additionally the interference situation is aggravated by the fact that most of the Earth Exploration-Satellites use very similar (polar) orbits.

4.2.3 8 400 MHz - 8 450 MHz band

a. The maximum allowable bandwidth for spacecraft in this band, as a function of the symbol rate, shall not exceed the masks in Figure 4-1, where RES shall be as follows:

1. For SP-L modulation, two times the NRZ symbol rate R_S, reciprocal of the symbol duration defined in Figure 6-1 and Figure 6-2 ($R_{ES} = 2 \times R_S$).
2. For all other cases, equal to R_S, reciprocal of the symbol duration defined in Figure 6-1 and Figure 6-2.

4.2.4 8 450 MHz – 8 500 MHz band

a. The maximum occupied bandwidth for spacecraft in the 8 450 MHz – 8 500 MHz band shall not exceed 10 MHz.

NOTE In the use of this band, priority is given to Lagrangian point missions.

4.2.5 25,5 GHz – 27,0 GHz, 37,0 GHz – 38 GHz and 40,0 GHz – 40,5 GHz bands

a. The bands 25,5 GHz – 27,0 GHz, 37,0 GHz – 38 GHz and 40,0 GHz – 40,5 GHz bands shall be used as agreed with the frequency coordinator.

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