

DIN EN 16603-50-05:2017-06 (E)

Space engineering - Radio frequency and modulation; English version EN 16603-50-05:2014 + AC:2017

Inhalt	Seite
Foreword	6
Introduction	7
1 Scope	8
2 Normative references	9
3 Terms, definitions and abbreviated terms	10
3.1 Terms from other standards.....	10
3.2 Terms specific to the present standard	10
3.3 Abbreviated terms.....	12
4 Frequency allocations, assignment and use	15
4.1 Frequency allocations to the Space Operation, Space Research and Earth Exploration-Satellite services	15
4.1.1 Overview	15
4.1.2 Frequency bands allocated to the Space Radiocommunications services.....	15
4.2 Specific conditions for the use of certain frequency bands.....	17
4.2.1 2 025 MHz – 2 120 MHz and 2 200 MHz – 2 300 MHz bands	17
4.2.2 8 025 MHz – 8 400 MHz band.....	18
4.2.3 8 400 MHz - 8 450 MHz band	19
4.2.4 8 450 MHz – 8 500 MHz band.....	19
4.2.5 25,5 GHz – 27,0 GHz, 37,0 GHz – 38 GHz and 40,0 GHz – 40,5 GHz bands	19
4.3 Frequency assignment procedure.....	20
4.3.1 Choice of frequencies	20
4.3.2 Advance publication, coordination and notification of frequencies	21
5 Transmitted signals	22
5.1 Turnaround frequency ratio for coherent transponders	22
5.1.1 Generation of the transmitted carrier	22
5.1.2 Band pairs.....	22
5.2 Carrier frequency stability	24
5.2.1 Spacecraft transmitter	24

5.2.2	Spacecraft receiver	25
5.2.3	Ground station equipment.....	25
5.3	Polarization.....	26
5.4	Occupied bandwidth considerations	26
5.5	Emissions	28
5.5.1	Unwanted emission power level	28
5.5.2	Cessation of emissions	32
5.5.3	Power flux density limits at the Earth's surface.....	32
5.5.4	Power flux density limits at the GSO in the 25,5 GHz - 27,0 GHz band	33
5.5.5	Power limits for Earth station emissions	34
5.5.6	Time limitations on transmissions.....	35
6	Modulation	36
6.1	Phase modulation with residual carriers.....	36
6.1.1	Application	36
6.1.2	Modulating waveforms	36
6.1.3	PCM waveforms and data rates	37
6.1.4	Use of subcarriers	39
6.1.5	Data transition density.....	41
6.1.6	Carrier modulation index	42
6.1.7	Sense of modulation	42
6.1.8	Modulation linearity	42
6.1.9	Residual amplitude modulation	42
6.1.10	Carrier phase noise.....	43
6.1.11	Residual carrier, out-of-band emission and discrete spectral lines	43
6.2	Suppressed carrier modulation	44
6.2.1	Application and modulation schemes	44
6.2.2	Modulating waveforms	45
6.2.3	Carrier modulation.....	45
6.2.4	Data transition density.....	51
6.2.5	Symbol rate stability	51
6.2.6	Carrier phase noise.....	51
6.2.7	Carrier suppression, out-of-band emission and discrete spectral lines	51
6.3	Spectral roll-off	52
7	Link acquisition procedures.....	53
7.1	Space-Earth.....	53
7.1.1	Normal operation	53

7.1.2	Alternative mode of operation	53
7.1.3	Coherent mode	53
7.2	Earth-space	54
7.2.1	2 025 MHz - 2 110 MHz category A	54
7.2.2	2 110 MHz - 2 120 MHz category B	55
7.2.3	7 145 MHz - 7 190 MHz category B	55
7.2.4	7 190 MHz – 7 235 MHz category A.....	55
8	RF interface control.....	57
8.1	RF interface control documents	57
8.2	Spacecraft-Earth station interface control document.....	57
8.2.1	Overview.....	57
8.2.2	Process.....	57
8.3	Link budget tables.....	58
8.3.1	General.....	58
8.3.2	Parameters	58
8.4	Spacecraft-ground network compatibility test.....	61
9	GMSK and 8PSK TCM modulation formats	63
9.1	GMSK modulation format.....	63
9.2	8PSK TCM modulation format	64
9.2.1	General principles	64
9.2.2	4 dimensional 8PSK-TCM encoder	64
9.2.3	Differential encoders for SEF = 2 and 2,5.....	65
9.2.4	Trellis encoder structure.....	66
9.2.5	Constellation mapper for 4 dimensional 8PSK-TCM.....	66
9.2.6	Channel filtering	68
Annex A (normative)	Spacecraft-Earth station interface control document - DRD	71
Annex B (informative)	Cross-support from other networks	72
Annex C (informative)	Protection of Ariane-5 RF system	73
Annex D (informative)	Differences from CCSDS recommendations.....	76
Annex E (informative)	Tailoring guidelines.....	78
Bibliography.....		79

Figures

Figure 4-1: Maximum allowable bandwidth in the band 8 400 MHz - 8 450 MHz	20
Figure 6-1: PCM waveforms and symbol duration definition	38
Figure 6-2: Symbol rate reference point	39
Figure 6-3: QPSK/OQPSK constellation mapping	46
Figure 6-4: OQPSK post-amplifier filter transfer function	49
Figure 6-5: Spectral emission masks for telemetry transmission at symbol rates above 60 ksp/s	52
Figure 8-1: Parameter distributions and their equations.....	60
Figure 9-1: General principle of the 4D-8PSK TCM modulator	65
Figure 9-2: Codes to eliminate 22,5° phase ambiguity on carrier synchronization	66
Figure 9-3: Representation of a 64 state L=7, rate 3/4 systematic trellis encoder	66
Figure 9-4: Constellation mapper for SEF = 2.....	67
Figure 9-5: Constellation mapper for SEF = 2,5.....	67
Figure 9-6: Transmit structure for baseband, square root raised-cosine shaping.....	69
Figure 9-7: Transfer function for a 4 poles/2 zeros elliptic filter	69
Figure 9-8: Transmit structure for post-amplifier shaping.....	70

Tables

Table 4-1: Frequency allocations to the Space Operation, Space Research and Earth Exploration-Satellite services	16
Table 5-1: Turnaround frequency ratios for coherent transponder operation	23
Table 5-2 Alternative turnaround frequency ratios for coherent transponder operation	24
Table 5-3: Frequency stability for spacecraft transmitters.....	24
Table 5-4: Frequency stability for spacecraft receivers	25
Table 5-5: Occupied bandwidth	27
Table 5-6: Maximum level of spurious emissions.....	28
Table 5-7: Threshold levels of interference detrimental to radio astronomy spectral line (i.e. narrow bandwidth) observations at the surface of the Earth due to terrestrial interference sources (Recommendation ITU-R RA.769-2).....	30
Table 5-8: Threshold levels of interference detrimental to radio astronomy continuum (i.e. wide bandwidth) observations at the surface of the Earth due to terrestrial interference sources (Recommendation ITU-R RA.769-2).....	31
Table 5-9: Harmful interference levels at deep space antenna sites	32
Table 5-10: Power flux density limits at the Earth's surface	33
Table 6-1: PCM waveforms and rates for residual carrier modulation.....	37
Table 6-2: Subcarriers used with phase-modulated carriers	39
Table 6-3: Limits of the peak modulation index.....	42
Table 6-4: PCM waveforms	45
Table 8-1: Probability density functions for link budgets	60