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Technical Specification

GEO-Mobile Radio Interface Specifications (Release 3);
Third Generation Satellite Packet Radio Service;
Part 5: Radio interface physical layer specifications;
Sub part 5: Radio Transmission and Reception;
GMR-1 3G 45.005

Reference

RTS/SES-00309-5-5

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Foreword

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The present document is part 5, sub-part 5 of a multi-part deliverable covering the GEO-Mobile Radio Interface Specifications (Release 3); Third Generation Satellite Packet Radio Service, as identified below:

Part 1: "General specifications";

Part 2: "Service specifications";

Part 3: "Network specifications";

Part 4: "Radio interface protocol specifications";

Part 5: "Radio interface physical layer specifications":

Sub-part 1: "Physical Layer on the Radio Path: General Description";

Sub-part 2: "Multiplexing and Multiple Access; Stage 2 Service Description";

Sub-part 3: "Channel Coding";

Sub-part 4: "Modulation";

Sub-part 5: "Radio Transmission and Reception";

Sub-part 6: "Radio Subsystem Link Control";

Sub-part 7: "Radio Subsystem Synchronization";

Part 6: "Speech coding specifications";

Part 7: "Terminal adaptor specifications".

Introduction

GMR stands for GEO (Geostationary Earth Orbit) Mobile Radio interface, which is used for Mobile Satellite Services (MSS) utilizing geostationary satellite(s). GMR is derived from the terrestrial digital cellular standard GSM and supports access to GSM core networks.

The present document is part of the GMR Release 3 specifications. Release 3 specifications are identified in the title and can also be identified by the version number:

- Release 1 specifications have a GMR 1 prefix in the title and a version number starting with "1" (V1.x.x).
- Release 2 specifications have a GMPRS 1 prefix in the title and a version number starting with "2" (V2.x.x).
- Release 3 specifications have a GMR-1 3G prefix in the title and a version number starting with "3" (V3.x.x).

The GMR release 1 specifications introduce the GEO-Mobile Radio interface specifications for circuit mode Mobile Satellite Services (MSS) utilizing geostationary satellite(s). GMR release 1 is derived from the terrestrial digital cellular standard GSM (phase 2) and it supports access to GSM core networks.

The GMR release 2 specifications add packet mode services to GMR release 1. The GMR release 2 specifications introduce the GEO-Mobile Packet Radio Service (GMPRS). GMPRS is derived from the terrestrial digital cellular standard GPRS (included in GSM Phase 2+) and it supports access to GSM/GPRS core networks.

The GMR release 3 specifications evolve packet mode services of GMR release 2 to 3rd generation UMTS compatible services. The GMR release 3 specifications introduce the GEO-Mobile Radio Third Generation (GMR-1 3G) service. Where applicable, GMR-1 3G is derived from the terrestrial digital cellular standard 3GPP and it supports access to 3GPP core networks.

Due to the differences between terrestrial and satellite channels, some modifications to the GSM or 3GPP standard are necessary. Some GSM and 3GPP specifications are directly applicable, whereas others are applicable with modifications. Similarly, some GSM and 3GPP specifications do not apply, while some GMR specifications have no corresponding GSM or 3GPP specification.

Since GMR is derived from GSM and 3GPP, the organization of the GMR specifications closely follows that of GSM or 3GPP as appropriate. The GMR numbers have been designed to correspond to the GSM and 3GPP numbering system. All GMR specifications are allocated a unique GMR number. This GMR number has a different prefix for Release 2 and Release 3 specifications as follows:

- Release 1: GMR n xx.zyy.
- Release 2: GMPRS n xx.zyy.
- Release 3: GMR-1 3G xx.zyy

where:

xx.0yy (z = 0) is used for GMR specifications that have a corresponding GSM or 3GPP specification. In this case, the numbers xx and yy correspond to the GSM or 3GPP numbering scheme.

xx.2yy (z = 2) is used for GMR specifications that do not correspond to a GSM or 3GPP specification. In this case, only the number xx corresponds to the GSM or 3GPP numbering scheme and the number yy is allocated by GMR.

n denotes the first (n = 1) or second (n = 2) family of GMR specifications.

A GMR system is defined by the combination of a family of GMR specifications and GSM and 3GPP specifications as follows:

- If a GMR specification exists it takes precedence over the corresponding GSM or 3GPP specification (if any). This precedence rule applies to any references in the corresponding GSM or 3GPP specifications.

NOTE: Any references to GSM or 3GPP specifications within the GMR specifications are not subject to this precedence rule. For example, a GMR specification may contain specific references to the corresponding GSM or 3GPP specification.

- If a GMR specification does not exist, the corresponding GSM or 3GPP specification may or may not apply. The applicability of the GSM and 3GPP specifications is defined in GMR 1 3G 41.201 [6].

1 Scope

The present document defines the performance requirements for the Mobile Earth Station (MES) radio transceiver for the GMR-1 3G Mobile Satellite System.

Requirements are defined for two categories of parameters:

- Those that are required to provide compatibility among the radio channels, connected either to separate or common antennas, which are used in the system. This category also includes parameters providing compatibility with existing systems in the same or adjacent frequency bands.
- Those that define the transmission quality of the system.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
  - for informative references.

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2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] GMPRS-1 01.004 (ETSI TS 101 376-1-1): "GEO-Mobile Radio Interface Specifications (Release 2) General Packet Radio Service; Part 1: General specifications; Sub-part 1: Abbreviations and acronyms".

NOTE: This is a reference to a GMR-1 Release 2 specification. See the introduction for more details.

[2] GMR-1 3G 45.004 (ETSI TS 101 376-5-4): "GEO-Mobile Radio Interface Specifications (Release 3); Third Generation Satellite Packet Radio Service; Part 5: Radio interface physical layer specifications; Sub-part 4: Modulation".

[3] GMR-1 3G 45.008 (ETSI TS 101 376-5-6): "GEO-Mobile Radio Interface Specifications (Release 3); Third Generation Satellite Packet Radio Service; Part 5: Radio interface physical layer specifications; Sub-part 6: Radio Subsystem Link Control".

[4] ETSI EN 301 681 (V1.3.2): "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 essential requirements under Article 3.2 of the R&TTE Directive".

[5] GMR-1 05.005 (ETSI TS 101 376-5-5) (V1.3.1): "GEO-Mobile Radio Interface Specifications (Release 1); Part 5: Radio interface physical layer specifications; Sub-part 5: Radio Transmission and Reception".

[6] GMR-1 3G 41.201 (ETSI TS 101 376-1-2): "GEO-Mobile Radio Interface Specifications (Release 3); Third Generation Satellite Packet Radio Service; Part 1: General specifications; Sub-part 2: Introduction to the GMR-1 Family".

[7] 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 under Article 3.2 of the R&TTE directive".

[8] GMR-1 3G 45.010 (ETSI TS 101 376-5-7): "GEO-Mobile Radio Interface Specifications (Release 3); Third Generation Satellite Packet Radio Service; Part 5: Radio interface physical layer specifications; Sub-part 7: Radio Subsystem Synchronization".

[9] GMR-1 3G 45.002 (ETSI TS 101 376-5-2): "GEO-Mobile Radio Interface Specifications (Release 3); Third Generation Satellite Packet Radio Service; Part 5: Radio interface physical layer specifications; Sub-part 2: Multiplexing and Multiple Access; Stage 2 Service Description".

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area**.** For non-specific references, the latest version of the referenced document (including any amendments) applies.

Not applicable.

3 Definitions, abbreviations and symbols

3.1 Definitions

For the purposes of the present document, the terms and definitions given in GMR-1 3G 41.201 [6] and the following apply:

active transmission: defined as the combination of the ramp-up, ramp-down, and active burst transmission periods

average EIRP: burst EIRP averaged over at least 200 bursts

burst EIRP: instantaneous EIRP measured over 90 % of the active portion of a burst

carrier-off state: an MES is in this state when it does not transmit any signal and it is more than 20 ms away from any active transmission (i.e. the carrier-off state excludes the carrier-standby state)

carrier-on state: a MES is in this state when it transmits a signal (i.e. the carrier-on state corresponds to an active transmission)

carrier-standby state: a MES is in this state when it does not transmit any signal but it is within 20 ms of the carrier-on state (i.e. the carrier-standby state occurs for up to 20 ms immediately before, and up to 20 ms immediately after the carrier-on state)

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in GMPRS-1 01.004 [1] apply.

3.3 Symbols

For the purposes of the present document, the following symbols apply:

E_b Average energy per bit in the wanted signal.
E_s Average energy per symbol in the wanted signal.
N_o Average channel noise (the noise power spectral density integrated over the channel bandwidth).

4 Frequency bands and channel arrangement

GMR-1 operation is defined for L-Band and S-Band LMSS frequency allocations.

4.1 Frequency bands and duplex method

MESs operate in frequency division multiplexing (FDM) mode at L-band in two paired 34 MHz frequency bands, which are allocated world-wide for land mobile satellite service (LMSS). The frequency bands are:

- MES receives: 1 525,0 MHz to 1 559,0 MHz;
- MES transmits: 1 626,5 MHz to 1 660,5 MHz.

In the FDM scheme, L-band downlink (forward) radio frequency (RF) carriers in the satellite-to-MES direction are paired with L-band uplink (return) RF carriers in the MES-to-satellite direction at a frequency offset of 101,5 MHz for circuit switched operation.

MESs operate at S-band frequencies, which are allocated world-wide for land mobile satellite service (LMSS). The frequency bands are:

- MES receives (Space-to-Earth): 2 170,0 MHz to 2 200,0 MHz;
- MES transmits (Earth-to-Space): 1 980,0 MHz to 2 020,0 MHz.

For packet switched operation, the FDM scheme may be operated in full duplex with any downlink (forward) RF carrier used with any uplink (return) RF carrier without necessarily having a fixed frequency offset between the two carriers.

4.2 RF carrier spacing and designation

The 34 MHz of L-band operating band is divided into 1 087 paired carriers, with carrier spacing of 31,250 kHz.

The 40 MHz of S-band spectrum in Earth-to-Space direction is divided into 1 280 carriers with carrier spacing of 31,250 kHz. The 30 MHz of S-Band spectrum in Space-to-Earth direction is divided into 960 carriers with carrier spacing of 31,250 kHz.

Absolute Radio Frequency Channel Numbers (ARFCN), N, are assigned to each carrier pair and take the values from 1 through 1 087 ($1 \le N \le 1\ 087$) when operating in L-Band.

ARFCNs, N, are numbered from 1 through 1 280 ($1 \le N \le 1\ 280$) when operating in S-Band for earth-to-space and from 1 through 960 ($1 \le N \le 960$) when operating in S-Band for space-to-earth.

The centre frequency of the carriers in kHz corresponding to an ARFCN is given by the expressions in table 4.1 for L-band and in table 4.1a for S-band.

Table 4.1: ARFCNs for L-Band

	Carrier centre frequencies (kHz)	ARFCN
Mobile earth station receive	1 525 000,00 + 31,25 x N	$1 \le N \le 1\ 087$
Mobile earth station transmit	1 626 500,00 + 31,25 x N	$1 \le N \le 1\ 087$

Table 4.1a: ARFCNs for S-Band

	Carrier centre frequencies (kHz)	ARFCN
Mobile earth station receive	2 170 000,00 + 15,625 + 31,25 x (N_{RX} - 1)	1 $\leq$ N_{RX} $\leq$ 960
Mobile earth station transmit	1 980 000,00 + 15,625 + 31,25 x (N_{TX} - 1)	1 $\leq$ N_{TX} $\leq$ 1 280

The ARFCN and centre frequency of the carriers are given in table 4.2 for L-band and table 4.2a for S-band space-to-earth and table 4.2b for S-band earth-to-space. The RF channels are spaced at 31,25 kHz intervals, which provides 32 carriers per MHz.

Table 4.2: ARFCN and frequencies for L-Band

MES-RX centre frequencies (kHz)	MES-TX centre frequencies (kHz)	ARFCN (N)
1 525 031,25	1 626 531,25	1
1 525 062,50	1 626 562,50	2
1 529 937,50	1 631 437,50	158
1 529 968,75	1 631 468,75	159
1 530 000,00	1 631 500,00	160
1 530 031,25	1 631 531,25	161
1 532 937,50	1 634 437,50	254
1 532 968,75	1 634 468,75	255
1 533 000,00	1 634 500,00	256
1 543 968,75	1 645 468,75	607
1 544 000,00	1 645 500,00	608
1 544 968,75	1 646 468,75	639
1 545 000,00	1 646 500,00	640
1 554 968,75	1 656 468,75	959
1 555 000,00	1 656 500,00	960
1 558 968,75	1 660 468,75	1 087

Table 4.2a: Receive ARFCNs and frequencies for S-Band

MES-RX centre frequency (kHz)	RX ARFCN (N_{RX})
2 170 015,625	1
2 170 046,875	2
2 199 984,375	960

Table 4.2b: Transmit ARFCNs and frequencies for S-Band

MES-TX centre frequency (kHz)	TX ARFCN (N_{TX})
1 980 015,625	1
1 980 046,875	2
2 009 984,375	960
2 019 984,375	1 280

The packet services use nominal transmission bandwidths that are multiples of the 31,25 kHz basic transmission bandwidth. These different transmission bandwidths defined over the sub bands are used to support transmission symbol rates that are multiples of the basic symbol rate of 23,4 ksps. A 3-bit bandwidth suffix is added to the AFRCN to indicate the bandwidth and transmission rate of the modulated carrier. The association of transmission bandwidths to transmission rates is given in table 4.3.

If the transmission bandwidth is an even multiple of 31,25 kHz, then the carrier frequency shall be shifted by + 15,625 kHz.

Table 4.3: Transmission bandwidth and associated transmission symbol rates

Bandwidth suffix	Transmission bandwidth (kHz)	Transmission Symbol rate (ksps)
000	reserved	Reserved
001	31,25	23,4
010	62,50	46,8
011	reserved	Reserved
100	125,00	93,6
101	156,25	117,0
110	312,5	234,0
111	reserved	Reserved

4.3 RF carrier used for synchronization and spot beam selection

To minimize the time spent by MESs during spot beam synchronization, identification, and selection, a subset of RF carriers called Broadcast Control CHannel (BCCH) carriers may be used by the network to broadcast BCCHs. MES synchronization to the BCCH carrier is defined in GMR-1 3G 45.008 [3] and GMR-1 3G 45.010 [8].

4.4 Frequency assignment to spot beams

L-band RF or S-band RF carriers are configured for each spot beam, depending on traffic demand, frequency reuse considerations, and available spectrum as a result of coordination with other systems using the same spectrum. Any RF channel can be used in any spot beam.

5 Stability requirements

5.1 Frequency and symbol timing stability

Same as clause 5.1 in GMR-1 05.005 [5].

5.1.1 Definition of operating conditions

Same as clause 5.1.1 in GMR-1 05.005 [5] for MESs operating in the L-band. For MESs operating in the S-Band, the carrier frequency, f_c, is 2,0 GHz.

5.1.2 Frequency and timing stability requirement

Same as clause 5.1.2 in GMR-1 05.005 [5].

5.1.3 Frequency and timing stability requirements for packet data mode

In the tests of this clause, the MES shall be receiving the logical channel specified in table 5.1 and shall be transmitting a PDCH logical channel. In all test cases, AWGN shall be used.

The rms frequency and symbol timing error of the transmitted signal from the MES shall not exceed the values given in table 5.1 when the unit is receiving the logical channels given in the table with the E_s/N_o values listed in the table.

Table 5.1: Frequency and timing stability requirements

Received logical channel	Operational condition (see note)	E_s/N_o (dB)	RMS Frequency Error (Hz)	RMS timing error (μs)
PDCH (at 23,4 ksps)	Steady state	5	10	0,9
PDCH (at 46,8 ksps)	Steady state	5	10	0,9
PDCH (at 93,6 ksps)	Steady state	5	10	0,9
PDCH (at 117,0 ksps)	Steady state	5	10	0,9
PDCH (at 234,0 ksps)	Steady state	5	10	0,9
NOTE: The Steady State operational condition is defined in GMR-1 05.005 [5].				

5.2 Frequency switching time

MESs shall be capable of switching from any receive frequency to any other receive frequency in less than 1,6 ms and maintain the frequency stability in clause 5.1. MESs shall be capable of switching from any transmit (receive) frequency to any receive (transmit) frequency in less than 2,2 ms and maintain the frequency stability in clause 5.1. During frequency switching, the MES transmit level corresponds to the carrier-off conditions defined in clause 6.4. These requirements apply to MES type A, C and D.

MES types E, and above shall be capable of switching from any transmit (receive) frequency to any receive (transmit) frequency in less than 1,0 ms and maintain the frequency stability in clause 5.1. During frequency switching, the MES transmit level corresponds to the carrier-off conditions defined in clause 6.4.

These requirements shall be met under the extreme environmental conditions defined in annex B.

For full duplex operation, the transmit (receive) to receive (transmit) frequency switching time is not applicable. In addition, the MES shall be capable of switching from any transmit frequency to any other transmit frequency with the same specification as the receiver frequency switching.

5.3 MES time alignment accuracy

Same as clause 5.3 in GMR-1 05.005 [5].

6 Transmitter characteristics

6.1 Power output characteristics and power class

Same as clause 6.1 in GMR-1 05.005 [5] with the additional specifications for new power classes for packet mode operation.

Table 6.1: Average EIRP for terminal types - extreme conditions

Power class	Minimum EIRP (dBW), PAS = 0 dB (see note 1)	Maximum EIRP (dBW), PAS = 0 dB (see note 1)	Terminal type
1	See GMR-1 05.005 [5]	See GMR-1 05.005 [5]	Data terminal type C
8	11,1	14,9	Data terminal type A
9	7	10,8	Data terminal type D
9 (see note 2)	14	17,8	Data terminal type D
1	-3	0,8	Data terminal type E
1	-2	1,8	Data terminal type F
1	0	3,8	Data terminal type G
2	3	6,8	Data terminal type H
9	11	14,8	Data terminal type I
1	-8,3	-4,5	Data terminal type J
1	-3,3	0,5	Data terminal type K
1	-1,0	2,8	Data terminal type L
9	10,0	13,8	Data terminal type M
NOTE 1: Power Attenuation Setting (PAS) is defined in GMR-1 3G 45.008 [3]. NOTE 2: With external antenna.			

Table 6.2: Average EIRP for terminal types - normal conditions

Power class	Minimum EIRP (dBW), PAS = 0 dB (see note 1)	Maximum EIRP (dBW), PAS = 0 dB (see note 1)	Terminal type
1	See GMR-1 05.005 [5]	See GMR-1 05.005 [5]	Data terminal type C
8	12,1	14,9	Data terminal type A
9	8	10,8	Data terminal type D
9 (see note 2)	15	17,8	Data terminal type D
1	-2	0,8	Data terminal type E
1	-1	1,8	Data terminal type F
1	1	3,8	Data terminal type G
2	4	6,8	Data terminal type H
9	12	14,8	Data terminal type I
1	-7,3	-4,5	Data terminal type J
1	-2,3	0,5	Data terminal type K
1	0,0	2,8	Data terminal type L
9	11,0	13,8	Data terminal type M
NOTE 1: PAS (Power Attenuation Setting) is defined in GMR-1 3G 45.008 [3]. NOTE 2: With external antenna.			

In addition, the single burst EIRP shall satisfy the following:

a) Each of the bursts in the first five frames of each transmit activity that are not preceded in the past 60 seconds by a transmit activity of at least ten bursts long shall satisfy the limits in table 6.3.

NOTE: Each of these first five frames contains at least two bursts per frame (i.e. a total of at least ten burst in these first five frames).

b) Each of the remaining bursts shall satisfy the limits in table 6.4.

Requirements in tables 6.3 and 6.4 shall be met under the extreme environmental conditions defined in annex B.

Table 6.3: Single burst EIRP - each burst in the first 5 frames with at least 2 bursts per frame

Power class	EIRP range (dBW), with PAS = 0 dB	Terminal type
1	See GMR-1 05.005 [5]	Data terminal type C
8	9,1 to 14,9	Data terminal type A
9	5 to 10,8	Data terminal type D
9 (see note)	12 to 17,8	Data terminal type D
1	-5 to 0,8	Data terminal type E
1	-4 to 1,8	Data terminal type F
1	-2 to 3,8	Data terminal type G
2	1 to 6,8	Data terminal type H
9	9 to 14,8	Data terminal type I
1	-10,3 to -4,5	Data terminal type J
1	-5,3 to 0,5	Data terminal type K
1	-3,0 to 2,8	Data terminal type L
9	8,0 to 13,8	Data terminal type M
NOTE: With external antenna.		

Table 6.4: Single burst EIRP - frames 6 and on

Power class	EIRP range (dBW), with PAS = 0 dB	Terminal type
1	See GMR-1 05.005 [5]	Data terminal type C
8	10,1 to 14,9	Data terminal type A
9	6 to 10,8	Data terminal type D
9 (see note)	13 to 17,8	Data terminal type D
1	-4 to 0,8	Data terminal type E
1	-3 to 1,8	Data terminal type F
1	-1 to 3,8	Data terminal type G
2	2 to 6,8	Data terminal type H
9	10 to 14,8	Data terminal type I
1	-9,3 to -4,5	Data terminal type J
1	-4,3 to 0,5	Data terminal type K
1	-2,0 to 2,8	Data terminal type L
9	9,0 to 13,8	Data terminal type M
NOTE: With external antenna.		

In addition, the output power of an access burst for a packet mode terminal shall comply with the limits defined in table 6.5, table 6.5a and table 6.5b.

Table 6.5: Access burst EIRP

Burst types	EIRP range (dBW) for Data terminal type A	EIRP range (dBW) for Data terminal type C	EIRP range (dBW) for Data terminal type D	
			Internal Antenna	External Antenna
RACH	$5{,}0^{+6{,}8}_{-0{,}7}$ (see note 1)	Same as handheld MES. See GMR-1 05.005 [5]	$5{,}0^{+6{,}8}_{-0{,}7}$	$5{,}0^{+6{,}8}_{-0{,}7}$
PRACH	$12{,}1^{+2{,}8}_{-3}$ (see note 2)	Same as RACH used by handheld MES. See GMR-1 05.005 [5]	$8{,}0^{+2{,}8}_{-3}$	$15{,}0^{+2{,}8}_{-3}$
NOTE 1: RACH EIRP for Data terminal type A ranges from -0,7 dBW to +6,8 dBW around the nominal EIRP. NOTE 2: PRACH EIRP ranges from -3 dBW to +2,8 dBW around the nominal EIRP.				

Table 6.5a: Access burst EIRP

Burst types	EIRP range (dBW) for Data terminal type E	EIRP range (dBW) for Data terminal type F	EIRP range (dBW) for Data terminal type G	EIRP range (dBW) for Data terminal type H	EIRP range (dBW) for Data terminal type I
RACH3	$-2{,}0^{+2{,}8}_{-3}$	$-1{,}0^{+2{,}8}_{-3}$	$1{,}0^{+2{,}8}_{-3}$	$4{,}0^{+2{,}8}_{-3}$	$12{,}0^{+2{,}8}_{-3}$
PRACH3	$-2{,}0^{+2{,}8}_{-3}$	$-1{,}0^{+2{,}8}_{-3}$	$1{,}0^{+2{,}8}_{-3}$	$4{,}0^{+2{,}8}_{-3}$	$12{,}0^{+2{,}8}_{-3}$

Table 6.5b: Access burst EIRP

Burst types	EIRP range (dBW) for Data terminal type J	EIRP range (dBW) for Data terminal type K	EIRP range (dBW) for Data terminal type L	EIRP range (dBW) for Data terminal type M
RACH3	$-7{,}3^{+2{,}8}_{-3}$	$-2{,}3^{+2{,}8}_{-3}$	$0{,}0^{+2{,}8}_{-3}$	$11{,}0^{+2{,}8}_{-3}$
PRACH3	$-7{,}3^{+2{,}8}_{-3}$	$-2{,}3^{+2{,}8}_{-3}$	$0{,}0^{+2{,}8}_{-3}$	$11{,}0^{+2{,}8}_{-3}$

6.2 Antenna radiation pattern

Same as clause 6.2 of GMR-1 05.005 [5] with the addition of the following text.

The antenna for the various packet terminals have the following gains when fully deployed with no conduction objects in the vicinity of the MES antenna:

Table 6.5c Transmit Antenna Gain

Terminal type	Antenna gain (dBi)
Data terminal type A	12,0
Data terminal type C	Same as handheld MES. See GMR-1 05.005 [5]
Data terminal type D	8,5
Data terminal type D (see note)	15,0
Data terminal type E	-1
Data terminal type F	0
Data terminal type G	2
Data terminal type H	2
Data terminal type I	13
Data terminal type J	-4
Data terminal type K	1
Data terminal type L	1
Data terminal type M	12
NOTE: With passive external antenna.	

For terminal types A and C, and terminal type D with passive external antenna, the axial ratio of radiated wave over the operational frequency range shall be better than 2 dB at boresight and better than 5 dB over the 3 dB coverage of the antenna.

For terminal type D with internal antenna or active external antenna, the axial ratio of radiated wave over the operational frequency range shall be better than 4 dB at boresight and better than 5 dB over the 3 dB coverage of the antenna.

For all terminal types E and above with circularly polarized antennas, the axial ratio of radiated wave over the operational frequency range shall be better than 2 dB at boresight and better than 5 dB over the 3 dB coverage of the antenna.

Antenna characteristics for terminal types E and above are given in table 6.5d.

Table 6.5d Antenna characteristics for terminal types E and above

Terminal type	Azimuth	Elevation
Data terminal type E	Cardioid (120°)	70° @ -3 dB
Data terminal type F	Omni	70° @ -3 dB
Data terminal type G	Omni	70° @ -3 dB (null off end of whip)
Data terminal type H	Omni	Hemispheric
Data terminal type I	41° @ -3 dB	50° @ -3 dB

6.3 Transmit polarization

The transmit polarization shall be either circular or linear as defined in table 6.5e. The circular polarization is the same as clause 6.3 of GMR-1 05.005 [5].

Table: 6.5e Transmit antenna polarization

Terminal type	Polarization
Data terminal type A	Circular
Data terminal type C	Circular
Data terminal type D	Circular
Data terminal type D (see note)	Circular
Data terminal type E	Linear
Data terminal type F	Linear
Data terminal type G	Circular
Data terminal type H	Circular
Data terminal type I	Circular
Data terminal type J	Linear
Data terminal type K	Circular
Data terminal type L	Circular
Data terminal type M	Circular
NOTE: With external antenna.	

6.4 Carrier-off conditions

Same as clause 6.4 of GMR-1 05.005 [5] with the following additional text:

- The maximum EIRP from an MES in the carrier-off state shall be less than -30 dBm.
- This requirement shall be met under the extreme environmental conditions defined in annex B.

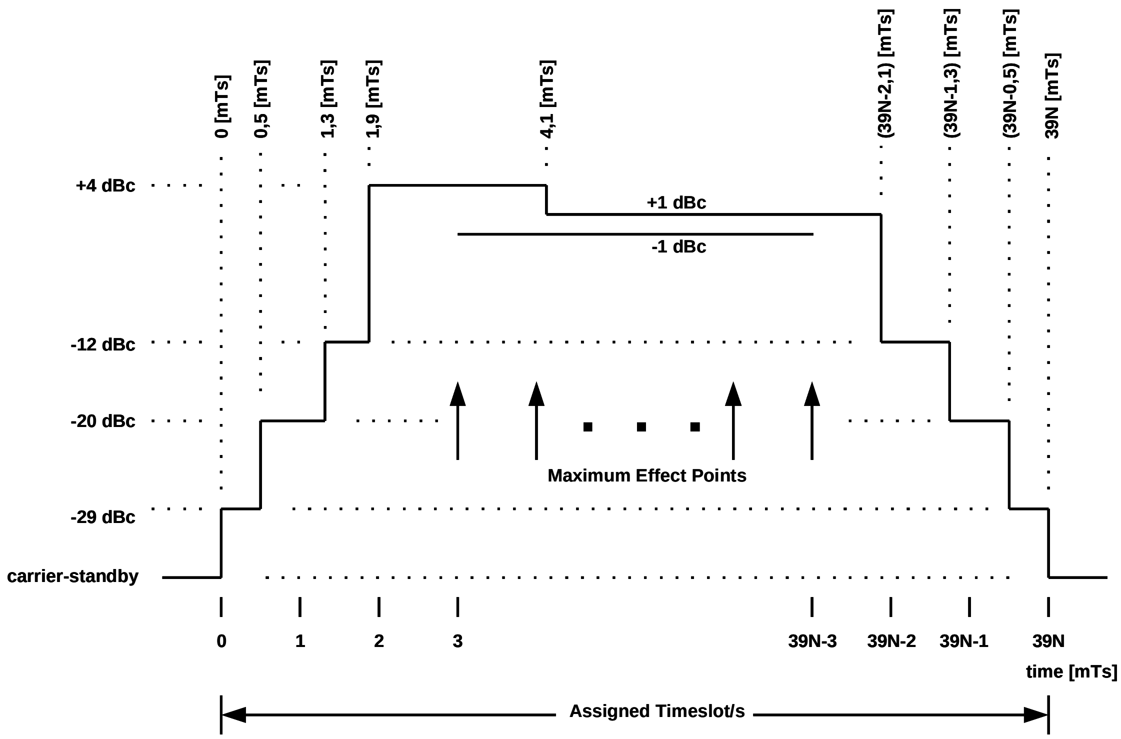
6.4a Carrier-standby conditions

The maximum EIRP from an MES in the carrier-standby state shall be less than -8 dBm.

This requirement shall be met under the extreme environmental conditions defined in annex B.

6.5 Ramp-up and ramp-down

The transition from the carrier-standby state to the active transmit state is the burst ramp-up, and the corresponding transition at the end of the burst is the burst ramp-down. The precise structure of the burst and the mapping of data bits into data symbols and transmit waveform is defined in GMR-1 3G 45.004 [2]. The positions of the ramp-up and ramp-down periods relative to the slot boundaries and the maximum effect points of the transmitted symbols from the MES are shown in figure 6.1.



NOTE: T_S is the symbol period and is equal to 5/(117 x m) msec; i.e. (1/(23,4 x m)) ksps.

Figure 6.1: Ramp-up and ramp-down in relation to the rest of the burst

6.6 Power control range and accuracy

6.6.1 Approach

Same as clause 6.6.1 in GMR-1 05.005 [5].

6.6.2 Procedures and timing

Same as clause 6.6.2 in GMR-1 05.005 [5].

6.6.3 Range

Same as clause 6.6.3 in GMR-1 05.005 [5].

6.6.4 Accuracy

Same as clause 6.6.4 in GMR-1 05.005 [5].

6.6.5 Attenuation step size

Same as clause 6.6.5 in GMR-1 05.005 [5].

6.6.6 Monotonicity

Same as clause 6.6.6 in GMR-1 05.005 [5].

6.6.7 Initial power level P_{init}

The definition and the usage of the initial power level, P_{init}, is given in GMR-1 3G 45.008 [3]. The P_{init} for each terminal type is given in table 6.5f.

Table: 6.5f Initial Power Level

Terminal type	P_{init} (dBW)
Data terminal type A	12,1
Data terminal type C	5,0
Data terminal type D	8,0
Data terminal type D (see note)	15,0
Data terminal type E	-2,0
Data terminal type F	-1,0
Data terminal type G	1,0
Data terminal type H	4,0
Data terminal type I	12,0
Data terminal type J	-7,3
Data terminal type K	-2,3
Data terminal type L	0
Data terminal type M	11,0
NOTE: With external antenna.	

6.7 Adjacent channel interference

Same as clause 6.7 in GMR-1 05.005 [5].

6.7.1 Interference due to modulation

Terminals with Maximum EIRP less than or equal to 15 dBW shall meet the following requirements:

Same as clause 6.7.1 in GMR-1 05.005 [5] with the following additional text:

- A factor "m" defines the transmitted signal symbol rate. "m" is equal to the ratio of the signal's transmit symbol rate to 23 400 symbols/sec. The interference shall be less than the levels given in table 6.6 as seen by a matched filter with a bandwidth of m × 23,4 kHz. The channel centres for measurement are also scaled by the factor "m", as given in table 6.6.

Table 6.6: Adjacent channel interference due to modulation

Power class	1st Adjacent channels, ± m x 31,25 kHz	2nd Adjacent channels, ± m x 62,5 kHz	3rd Adjacent channels, ± m x 93,75 kHz	4th Adjacent channels and Beyond (see note)	Terminal type
1	-25 dBc	-40 dBc	-53 dBc	-60 dBc	Data terminal type C
8	-25 dBc	-40 dBc	-53 dBc	-60 dBc	Data terminal type A
9	-25 dBc	-40 dBc	-53 dBc	-60 dBc	Data terminal type D (see note 2)
1	-25 dBc	-40 dBc	-53 dBc	-60 dBc	Data terminal type E
1	-25 dBc	-40 dBc	-53 dBc	-60 dBc	Data terminal type F
1	-25 dBc	-40 dBc	-53 dBc	-60 dBc	Data terminal type G
2	-25 dBc	-40 dBc	-53 dBc	-60 dBc	Data terminal type H
9	-25+ΔI dBc	-40+ΔI dBc	-53+ΔI dBc	-60+ΔI dBc	Data terminal type I (see note 3)
1	-25 dBc	-40 dBc	-53 dBc	-60 dBc	Data terminal type J
1	-25 dBc	-40 dBc	-53 dBc	-60 dBc	Data terminal type K
1	-25 dBc	-40 dBc	-53 dBc	-60 dBc	Data terminal type L
9	-25+ΔM dBc	-40+ΔM dBc	-53+ΔM dBc	-60+ΔM dBc	Data terminal type M (see note 4)

NOTE1: This requirement applies to all adjacent channels that are integrally contained in the band that extends from 2 MHz below the lower end of the transmit band to 2 MHz above the upper end of the transmit band.

NOTE 2: The total energy in any adjacent voice carrier bandwidth (23,4 kHz) due to terminal type D connected to an external antenna capable of 15 dBW EIRP shall be at most -35 dBc. The first adjacent voice carrier will be located at ± (m+1) x 15,625 kHz.

NOTE 3: ΔI equals -7 dB for a 31,25 kHz carrier; -4 dB for a 62,5 kHz carrier; 0 dB for a 156,25 kHz carrier, and 0 dB for a 312,5 kHz carrier transmitted by Data terminal type I.

NOTE 4: ΔM equals -6 dB for a 31,25 kHz carrier; -3 dB for a 62,5 kHz carrier, -1 dB for a 156,25 kHz carrier, and 0 dB for a 312,5 kHz carrier transmitted by Data terminal type M.

For L-band the transmitter shall meet the following requirements:

- For terminals with Maximum EIRP less than or equal to 15 dBW, the unwanted emissions within the band 1 626,5 MHz to 1 660,5 MHz band shall not exceed the carrier-on limits defined in clause 4.2.2 of EN 301 681 [4]. In the event of any conflict the more stringent limit shall apply.

- For terminals with Maximum EIRP greater than 15 dBW, the unwanted emissions within the band 1 626,5 MHz to 1 660,5 MHz band shall not exceed the carrier-on limits defined in clause 4.2.2.2 of EN 301 444 [7]. In the event of any conflict the more stringent limit shall apply.

6.7.2 Interference due to switching transients

Same as clause 6.7.2 in GMR-1 05.005 [5] with the following additional text:

Table 6.7: Adjacent channel interference due to switching transients

Power class	1st Adjacent channels, ± m x 31,25 kHz	2nd Adjacent channels, ± m x 62,5 kHz	3rd Adjacent channels, ± m x 93,75 kHz	4th Adjacent channels and beyond (see note)	Terminal type
1	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type C
8	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type A
9	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type D
1	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type E
1	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type F
1	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type G
2	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type H
9	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type I
1	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type J
1	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type K
1	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type L
9	-18 dBc	-33 dBc	-46 dBc	-53 dBc	Data terminal type M
NOTE: This requirement applies to all adjacent channels that are integrally contained in the band that extends from 2 MHz below the lower end of the transmit band to 2 MHz above the upper end of the transmit band.					

6.8 Unwanted emissions

6.8.1 Unwanted emissions in the carrier-on state and carrier-standby state (L-band)

This clause applies to MES operating in L-band.

Terminals with Maximum EIRP less than or equal to 15 dBW shall meet the following requirements:

For an MES in the carrier-on state, or in the carrier-standby state, the maximum EIRP density of the unwanted emissions from the MES outside the band 1 626,5 MHz to 1 660,5 MHz shall not exceed the carrier-on limits defined in table 3 of EN 301 681 [4].

Terminals with Maximum EIRP greater than 15 dBW shall meet the following requirements:

- For an MES in the carrier-on state, or in the carrier-standby state, the maximum EIRP density of the unwanted emissions from the MES outside the band 1 626,5 MHz to 1 660,5 MHz shall not exceed the carrier-on limits defined in table 2b of EN 301 444 [7].

6.8.2 Unwanted emissions in the carrier-off state (L-band)

This clause applies to MES operating in L-band.

Terminals with Maximum EIRP less than or equal to 15 dBW shall meet the following requirements:

For an MES in the carrier-off state, the maximum EIRP density of the unwanted emissions from the MES shall not exceed the carrier-off limits defined in table 5 of EN 301 681 [4].

Terminals with Maximum EIRP greater than 15 dBW shall meet the following requirements:

For an MES in the carrier-off state, the maximum EIRP density of the unwanted emissions from the MES shall not exceed the carrier-off limits defined in table 2b of EN 301 444 [7]. In addition, the EIRP in any 3 kHz band within the 1 626,5 MHz to 1 660,5 MHz band shall not exceed -63 dBW.

6.8.3 Unwanted emissions in the carrier-on state and carrier-standby state (S-Band)

Void.

6.8.4 Unwanted emissions in the carrier-off state (S-band)

Void.

7 Receiver characteristics

7.1 Receive antenna pattern

Same as clause 7.1 in GMR-1 05.005 [5] with the following addition.

The antenna for the various packet terminals have the following gains when fully deployed and with no conduction objects in the vicinity of the MES antenna:

Table 7.1: Receive Antenna Gain

Terminal type	Antenna gain (dBi)
Data terminal type A	12,0
Data terminal type C	Same as handheld MES. See GMR-1 05.005 [5].
Data terminal type D	8,5
Data terminal type D (see note)	15,0
Data terminal type E	-1
Data terminal type F	0
Data terminal type G	2
Data terminal type H	2
Data terminal type I	13
Data terminal type J	-4
Data terminal type K	1
Data terminal type L	1
Data terminal type M	12
NOTE: With passive external antenna.	

For terminal types A and C, and terminal type D with passive external antenna, the axial ratio of radiated wave over the operational frequency range shall be better than 2 dB at boresight and better than 5 dB over the 3 dB coverage of the antenna.

For terminal type D with internal antenna or active external antenna, the axial ratio of radiated wave over the operational frequency range shall be better than 4 dB at boresight and better than 5 dB over the 3 dB coverage of the antenna.

For all terminal types E and above with circularly polarized antennas, the axial ratio of radiated wave over the operational frequency range shall be better than 2 dB at boresight and better than 5 dB over the 3 dB coverage of the antenna.

Antenna characteristics for terminal types E and above are given in table 7.1a.

Table 7.1a Antenna characteristics for terminal types E and above

Terminal type	Azimuth	Elevation
Data terminal type E	Cardioid (120°)	70° @ -3 dB
Data terminal type F	Omni	70° @ -3 dB
Data terminal type G	Omni	70° @ -3 dB (null off end of whip)
Data terminal type H	Omni	Hemispheric
Data terminal type I	41° @ -3 dB	50° @ -3 dB

7.2 Receive polarization

The receive polarization shall be either circular or linear as defined in table 7.1b. The circular polarization is the same as clause 7.2 of GMR-1 05.005 [5].

Table: 7.1b Receive antenna polarization

Terminal type	Polarization
Data terminal type A	Circular
Data terminal type C	Circular
Data terminal type D	Circular
Data terminal type D (see note)	Circular
Data terminal type E	Linear
Data terminal type F	Linear
Data terminal type G	Circular
Data terminal type H	Circular
Data terminal type I	Circular
Data terminal type J	Linear
Data terminal type K	Circular
Data terminal type L	Circular
Data terminal type M	Circular
NOTE: With passive external antenna..	

7.3 Receiver figure of merit

Same as clause 7.3 in GMR-1 05.005 [5] with the following additional text.

The Gain/Temperature (G/T) ratio of the various packet data terminals in the direction of the peak antenna gain under clear sky conditions, with the antenna fully deployed and with no conducting objects in the vicinity of the unit, at 20 °C, will exceed the following G/T values at elevations over 20 degrees.

Table 7.2: Gain/Temperature (G/T) ratio

Terminal type	G/T
Data terminal type A	-16,2 dB/K
Data terminal type C	Same as handheld MES. See GMR-1 05.005 [5]
Data terminal type D	-18,0 dB/K
Data terminal type D (see note)	-18,0 dB/K
Data terminal type E	-30 dB/K
Data terminal type F	-29 dB/K
Data terminal type G	-27 dB/K
Data terminal type H	-27 dB/K
Data terminal type I	-17 dB/K
Data terminal type J	-31 dB/K
Data terminal type K	-26 dB/K
Data terminal type L	-26 dB/K
Data terminal type M	-17 dB/K
NOTE: With passive external antenna.	

7.4 Receiver sensitivity

Same as clause 7.4 in GMR-1 05.005 [5] with the following additional text.

The receiver sensitivity is defined for the various transmission rates used for the packet services as the maximum power required at the antenna connector to provide the required performance with the nominal antenna.

7.4.1 Receiver BER in static conditions

Same as clause 7.4.1 of GMR-1 05.005 [5] with the following additional text:

1) Data Terminal Types A and C shall meet or exceed the coded bit error rate (BER) requirements in table 7.3a at 20 °C for the channel types supported as per GMR-1 3G 45.002 [9].

2) Data Terminal Type D shall meet or exceed the frame error rate (FER) requirements in table 7.3b at 20 °C for the channel types supported as per GMR-1 3G 45.002 [9].

3) Data Terminal Types E, F, G, H and I shall meet or exceed the frame error rate (FER) requirements in table 7.3c at 20 °C for the channel types supported as per GMR-1 3G 45.002 [9].

4) Data Terminal Types J, K, L and M shall meet or exceed the frame error rate (FER) requirements in table 7.3d at 20 °C for the channel types supported as per GMR-1 3G 45.002 [9].

Table 7.3a: BER in static conditions

Power Class	C/No at antenna connector (dB/Hz)	G/T (dB/K) (see note 1)	BER	User data rate (kbps) (see note 2)	Convolutional coding constraint length	Coding rate	Data terminal type and burst type
1	53,1	-24	$1,0 \times 10^{-6}$	47,2	9	3/5	Data terminal type C, PNB(2,6)
1	54,2	-24	$1,0 \times 10^{-6}$	56,0	9	7/10	Data terminal type C, PNB(2,6)
1	55,4	-24	$1,0 \times 10^{-6}$	64,0	9	4/5	Data terminal type C, PNB(2,6)
8	58,8	-16,2	$1,0 \times 10^{-6}$	116,8	7	3/4	Data terminal type A, PNB(4,3)
8	57,8	-16,2	$1,0 \times 10^{-6}$	97,6	7	5/8	Data terminal type A PNB(4,3)
8	56,2	-16,2	$1,0 \times 10^{-6}$	78,4	7	1/2	Data terminal type A PNB(4,3)
8	59,8	-16,2	$1,0 \times 10^{-6}$	148,8	7	3/4	Data terminal type A PNB(5,3)
8	58,8	-16,2	$1,0 \times 10^{-6}$	124,8	7	5/8	Data terminal type A PNB(5,3)
8	57,2	-16,2	$1,0 \times 10^{-6}$	99,2	7	1/2	Data terminal type A PNB(5,3)

NOTE 1: This G/T value applies for elevations over 20 degrees.
NOTE 2: This includes 16 bits of CRC.

Table 7.3b: FER in static conditions

Power Class	C/No at antenna connector (dB/Hz)	G/T (dB/K) (see notes 1 and 2)	FER	User data rate (kbps) (see note 3)	FEC/ Modulation	Coding rate	Data terminal type and burst type
9	67,06	-18	$1,0 \times 10^{-4}$	444	LDPC/ 32 APSK	0,818	Data terminal type D PNB2(5,12)
9	66,13	-18	$1,0 \times 10^{-4}$	415,6	LDPC/ 32 APSK	0,765	Data terminal type D PNB2(5,12)
9	63,96	-18	$1,0 \times 10^{-4}$	355,2	LDPC/ 16 APSK	0,818	Data terminal type D PNB2(5,12)
9	61,75	-18	$1,0 \times 10^{-4}$	296	LDPC/ 16 APSK	0.681	Data terminal type D PNB2(5,12)
9	58,68	-18	$1,0 \times 10^{-4}$	199,6	LDPC/ π/4-QPSK	0,919	Data terminal type D PNB2(5,12)
9	56,78	-18	$1,0 \times 10^{-4}$	177,6	LDPC/ π/4-QPSK	0,818	Data terminal type D PNB2(5,12)
9	55,04	-18	$1,0 \times 10^{-4}$	148	LDPC/ π/4-CQPSK	0,681	Data terminal type D PNB2(5,12)
9	53,21	-18	$1,0 \times 10^{-4}$	110,4	LDPC/ π/4-CQPSK	0,508	Data terminal type D PNB2(5,12)
9	67,28	-18	$1,0 \times 10^{-4}$	382,4	LDPC/ 32 APSK	0,798	Data terminal type D PNB2(5,3)
9	66,46	-18	$1,0 \times 10^{-4}$	358,4	LDPC/ 32 APSK	0,748	Data terminal type D PNB2(5,3)
9	64,18	-18	$1,0 \times 10^{-4}$	305,6	LDPC/ 16 APSK	0,797	Data terminal type D PNB2(5,3)
9	62,13	-18	$1,0 \times 10^{-4}$	254,4	LDPC/ 16 APSK	0,664	Data terminal type D PNB2(5,3)
9	59,10	-18	$1,0 \times 10^{-4}$	171,2	LDPC/ π/4-QPSK	0,894	Data terminal type D PNB2(5,3)
9	57,28	-18	$1,0 \times 10^{-4}$	152,0	LDPC/ π/4-QPSK	0,793	Data terminal type D PNB2(5,3)
9	55,58	-18	$1,0 \times 10^{-4}$	126,4	LDPC/ π/4-CQPSK	0,660	Data terminal type D PNB2(5,3)
9	53,93	-18	$1,0 \times 10^{-4}$	97,6	LDPC/ π/4-CQPSK	0,509	Data terminal type D PNB2(5,3)

NOTE 1: This G/T value applies for elevations over 20 degrees.
NOTE 2: With passive external antenna the G/T is -11 dB/K.
NOTE 3: This includes 8 bits of CRC.

Table 7.3c: FER in static conditions

Power Class (see note 4)	C/No at antenna connector (dB/Hz)	G/T (dB/K) (see notes 1 and 2)	FER	User data rate (kbps) (see note 3)	FEC/ Modulation	Coding rate	Terminal type and burst type (see note 5)
1	47,24	-30	$1,0 \times 10^{-2}$	2,45	Conv. K = 9/ π/4-QPSK	0,54	Data terminal type E PNB3(1,3)
1	50,74	-30	$1,0 \times 10^{-2}$	4,0	Conv. K = 9/ π/4-QPSK	0,8	Data terminal type E PNB3(1,3)
1	43,64	-30	$1,0 \times 10^{-2}$	2,45	Conv. K = 9/ π/2-BPSK	0,53	Data terminal type E PNB3(1,6)
1	45,84	-30	$1,0 \times 10^{-2}$	4,0	Conv. K = 9/ π/4-QPSK	0,41	Data terminal type E PNB3(1,6)
1	51,45	-30	$1,0 \times 10^{-3}$	47	Conv. K = 7/ π/4-QPSK	0,6	Data terminal type E PNB3(2,6)
1	52,85	-30	$1,0 \times 10^{-3}$	56	Conv. K = 7/ π/4-QPSK	0,7	Data terminal type E PNB3(2,6)
1	54,25	-30	$1,0 \times 10^{-3}$	64	Conv. K = 7/ π/4-QPSK	0,8	Data terminal type E PNB3(2,6)
1	53,63	-30	$1,0 \times 10^{-3}$	96	Turbo/ π/4-QPSK	0,5	Data terminal type E PNB3(5,3)
1	55,13	-30	$1,0 \times 10^{-3}$	120	Turbo/ π/4-QPSK	0,63	Data terminal type E PNB3(5,3)
1	57,03	-30	$1,0 \times 10^{-3}$	144	Turbo/ π/4-QPSK	0,75	Data terminal type E PNB3(5,3)
1	58,08	-30	$1,0 \times 10^{-3}$	160	Turbo/ π/4-QPSK	0,83	Data terminal type E PNB3(5,3)
1	62,58	-30	$1,0 \times 10^{-3}$	256	Turbo/ 16-APSK	0,67	Data terminal type E PNB3(5,3)
1	64,58	-30	$1,0 \times 10^{-3}$	307	Turbo/ 16-APSK	0,8	Data terminal type E PNB3(5,3)
1	52,83	-30	$1,0 \times 10^{-3}$	111	Turbo/ π/4-QPSK	0,5	Data terminal type E PNB3(5,12)
1	54,53	-30	$1,0 \times 10^{-3}$	139	Turbo/ π/4-QPSK	0,63	Data terminal type E PNB3(5,12)
1	56,43	-30	$1,0 \times 10^{-3}$	166	Turbo/ π/4-QPSK	0,75	Data terminal type E PNB3(5,12)
1	57,63	-30	$1,0 \times 10^{-3}$	186	Turbo/ π/4-QPSK	0,83	Data terminal type E PNB3(5,12)
1	62,48	-30	$1,0 \times 10^{-3}$	296	Turbo/ 16-APSK	0,67	Data terminal type E PNB3(5,12)
1	57,84	-30	$1,0 \times 10^{-3}$	261	Turbo/ π/4-QPSK	0,61	Data terminal type E PNB3(10,3)
1	65,79	-30	$1,0 \times 10^{-3}$	590	Turbo/ 16-APSK	0,69	Data terminal type E PNB3(10,3)

NOTE 1: This G/T value applies for elevations over 20 degrees.
NOTE 2: For data terminal types F, G, H, and I the G/T is -29, -27, -27, and -17 dB/K respectively.
NOTE 3: This includes 16 bits of CRC for packet data channels and 5 bits of CRC for DCH voice channels.
NOTE 4: For data terminal types F and G the power class is 1; for data terminal type H the power class is 2 and for data terminal type I the power class is 9.
NOTE 5: This table also applies to data terminal types F, G, H, and I, subject to the differences given in notes 2 and 4.

Table 7.3d: FER in static conditions

Power Class (see note 4)	C/No at antenna connector (dB/Hz)	G/T (dB/K) (see notes 1 and 2)	FER	User data rate (kbps) (see note 3)	FEC/ Modulation	Coding rate	Terminal type and burst type (see note 5)
1	44,39	-31	$1,0 \times 10^{-2}$	4,0	Conv. K = 9/ π/2-BPSK	0,57	Data terminal type J PNB3(1,8)
1	43,49	-31	$1,0 \times 10^{-2}$	2,45	Conv. K = 9/ π/2-BPSK	0,53	Data terminal type J PNB3(1,6)
1	45,59	-31	$1,0 \times 10^{-2}$	4,0	Conv. K = 9/ π/4-QPSK	0,41	Data terminal type J PNB3(1,6)
1	51,90	-31	$1,0 \times 10^{-3}$	47	Conv. K = 7/ π/4-QPSK	0,6	Data terminal type J PNB3(2,6)
1	53,40	-31	$1,0 \times 10^{-3}$	56	Conv. K = 7/ π/4-QPSK	0,7	Data terminal type J PNB3(2,6)
1	54,80	-31	$1,0 \times 10^{-3}$	64	Conv. K = 7/ π/4-QPSK	0,8	Data terminal type J PNB3(2,6)
1	53,38	-31	$1,0 \times 10^{-3}$	96	Turbo/ π/4-QPSK	0,5	Data terminal type J PNB3(5,3)
1	55,08	-31	$1,0 \times 10^{-3}$	120	Turbo/ π/4-QPSK	0,63	Data terminal type J PNB3(5,3)
1	56,73	-31	$1,0 \times 10^{-3}$	144	Turbo/ π/4-QPSK	0,75	Data terminal type J PNB3(5,3)
1	57,88	-31	$1,0 \times 10^{-3}$	160	Turbo/ π/4-QPSK	0,83	Data terminal type J PNB3(5,3)
1	62,44	-31	$1,0 \times 10^{-3}$	256	Turbo/ 16-APSK	0,67	Data terminal type J PNB3(5,3)
1	65,55	-31	$1,0 \times 10^{-3}$	590	Turbo/ 16-APSK	0,67	Data terminal type J PNB3(10,3)

NOTE 1: This G/T value applies for elevations over 20 degrees.
NOTE 2: For data terminal types K, L and M the G/T is -26, -26, and -17 dB/K respectively.
NOTE 3: This includes 16 bits of CRC for packet data channels and 5 bits of CRC for DCH voice channels.
NOTE 4: For data terminal types K and L the power class is 1; for data terminal type M the power class is 9.
NOTE 5: This table also applies to data terminal types K, L and M, subject to the differences given in notes 2 and 4.

7.4.2 Receiver BER in Rician fading

Same as clause 7.4.2 in GMR-1 05.005 [5].

7.4.3 FER of logical channels

Same as clause 7.4.3 in GMR-1 05.005 [5].

7.4.4 FER of PUI

The Frame Error Rate (FER) of the PUI and extended PUI shall not exceed the values specified in table 7.4a for the given E_s/N_0 values in a static channel. A PUI and extended PUI frame shall be considered to be in error if there are any decoded PUI and extended PUI bits in error. All tests shall be conducted in the steady-state operational conditions (OC_1), defined in clause 5.1 of GMR-1 05.005 [5] under normal environmental conditions. The E_s/N_0 values may be mapped into power levels into the antenna port for each type of MES using the formulas in annex A of GMR-1 05.005 [5].

Table 7.4a PUI and Extended PUI FER Requirement

Power Class	Max. FER Allowed	E_s/N_0 (dB) at input of baseband demodulator
1	0,01 %	3,5
8	0,01 %	3,5
9	0,01 %	2,8
2	0,01 %	2,8

7.4.5 FER of ULMAP

The Frame Error Rate (FER) of the ULMAP shall not exceed the values specified in table 7.4b for the given Es/No values in a static channel. A ULMAP frame shall be considered in error if there are any decoded ULMAP bits in error. All tests shall be conducted in the steady-state operational conditions (OC_1), defined in clause 5.1 of GMR-1 05.005 [5] under normal environmental conditions.

Table 7.4b ULMAP FER Requirement

Burst	Max. FER Allowed	E_s/N_0 (dB) at input of baseband demodulator
PNB3(5,3)	0,005 %	1,8
PNB3(5,12)	0,005 %	1,8
PNB3(10,3)	0,005 %	1,8

7.5 Receiver selectivity

Receiver selectivity is a measure of a receiver's ability to operate in the presence of a single modulated interferer at some power level and at some defined frequency spacing from the received signal. The interferer will be modulated as defined in GMR-1 3G 45.004 [2] with random data, and a symbol rate of 23,4 ksym/sec.

Under the interference conditions in table 7.5, the receiver performs as defined in the static sensitivity requirement with 0,5 dB greater signal power.

Table 7.5: Receiver Selectivity Interference Conditions

Case	Interference level relative to sensitivity	Interference frequency offset
1	+ 15 dB	m × 31,25 kHz
2	+ 25 dB	m × 93,75 kHz
3	+ 45 dB	> 500 kHz

Where "m" defines the bandwidth of the received signal in units of 31,25 kHz channels.

7.6 Receiver intermodulation

Same as clause 7.6 in GMR-1 05.005 [5].

7.7 Receiver blocking characteristics

7.7.1 L-Band

This clause applies to MES operating in L-band.

Same as clause 7.7 in GMR-1 05.005 [5].

7.7.2 S-Band

This clause applies to MES operating in S-band.

Receiver blocking characterizes the ability of the receiver to receive the desired signal in the presence of other signals that can be located anywhere over a wide portion of the spectrum. Receiver blocking is specified separately for in-band and out-of-band signals.

In-band signals are signals in the 2 150 MHz to 2 220 MHz band, i.e. signals in the MSS and neighbouring bands. Out-of-band signals are signals outside this band.

The receiver will perform as defined in the sensitivity requirement when these two signals are applied at its input:

- a desired signal with power 3 dB greater than that defined in the static sensitivity section;
- a continuous, static sine wave signal at the level in table 7.6 and at frequencies that are integer multiples of 31,25 kHz.

Table 7.6: Receiver blocking requirement

Band of blocking signal	Frequency range	Level	Distance from desired signal (kHz)
In-band	2 150 MHz to 2 220 MHz	-70 dBm	>1 600 kHz
Out-of-band	0,1 kHz tp 2 150 MHz or 2 220 MHz to 12 750 MHz	-35 dBm	N/A

The requirement in table 7.7 shall be relaxed at a set of frequencies called spurious response frequencies. The number and level of spurious response frequencies is defined in table 7.7.

Table 7.7: Spurious response requirement

Band of spurious response	Frequency range	Max. number of frequencies	Level
In-band	2 150 MHz to 2 220 MHz	Six	-100 dBm
Out-of-band	0,1 kHz - 2 150 MHz or 2 220 MHz to 12 750 MHz	Twelve (see note)	-55 dBm
Out-of-band	0,1 kHz to 2 150 MHz or 2 220 MHz to 12 750 MHz	Four (see note)	-70 dBm
NOTE: These two sets of out-of-band spurious responses are separate allowances: a lower level response does not also count as a higher level response.			

7.8 Receive signal strength

Same as clause 7.8 in GMR-1 05.005 [5].

7.9 Erroneous frame Indication Performance

For an MES receiving a valid PDCH signal with a random USF not equal to an allocated USF, the probability of the MES detecting USF equal to the allocated USF shall not be more than 1e-05. This requirement shall be met for all input Es/No levels up to 3,5 dB.

For an MES receiving a valid PDCH3 signal with a random USF not equal to an allocated USF, the probability of the MES detecting USF equal to the allocated USF shall not be more than 1e-05. This requirement shall be met for all input Es/No levels up to 2,5 dB.

8 GPS receiver characteristics

Same as clause 8 in GMR-1 05.005 [5].

Annex A (informative): Antenna factor equation

Same as annex A in GMR-1 05.005 [5].

Annex B (normative): Environmental conditions

Same as annex B in GMR-1 05.005 [5].

Annex C (normative): Channel model

Same as annex C in GMR-1 05.005 [5].

Annex D (informative): Derivation of receiver sensitivity specifications

D.1 Introduction

This annex describes the derivation of the sensitivity specifications used elsewhere in the present document. The purpose is to clearly define the meaning of the specification and the calculations used in the derivation.

The system requirements define transmissions at two symbol rates (one for PNB(4,3) and one for PNB(5,3), PNB2(5,3), and PNB2(5,12)) and different coding rates which provide a specification for the E_b/N_o at the input to the demodulator that is required to achieve a Bit Error Rate specification. Calculations have been provided for all combinations of symbol and coding rates.

D.2 Definitions

Three definitions of the receiver sensitivity are defined as follows.

D.2.1 Integral sensitivity

The integral sensitivity is the conducted power collected by the receiver antenna that achieves the desired BER assuming the antenna remains connected to the receiver. The integral sensitivity is specified in dBm.

The integral sensitivity may be considered to be that conducted power incident at the input of the receiver that has been collected by the antenna at the radiated sensitivity specification, considering the performance parameters of the antenna.

The integral sensitivity may be calculated from the definition and specification of G/T. The system noise temperature of the receiver may be calculated from the following formula expressed in logarithmic form:

$$G/T = G - 10\log(T_S)$$

where G/T is specified:

G = Antenna Gain (dBi);

T_s = System Noise Temperature (referred to the antenna connector).

The integral sensitivity is defined as the product of the system noise floor (kT_s) and the required C/N_o.

$$Integral\ Sensitivity = 10\log(kT_S) + (C/N_0)$$

where k is the Boltzman constant (1,38 x 10^{-23} J/K) and (C/N_o) is expressed in logs. The (C/N_o) may then be expanded to give:

$$Integral\ Sensitivity = 10\log(kT_S) + (E_b/N_0) + 10\log(R_b)$$

$$Integral\ Sensitivity = 10\log(kT_S R_b) + (E_b/N_0)$$

where R_b is the bit rate and (E_b/N_o) is expressed in logs.

D.2.2 Radiated sensitivity

The radiated sensitivity is the radiated power flux density incident at the receiver antenna that achieves the desired BER. The radiated sensitivity is specified in dBm/m^2.

The radiated sensitivity is calculated from the integral sensitivity and including the effective area of the receive antenna as follows:

$$Radiated\ Sensitivity = Integral\ Sensitivity - 10\log(A_e)$$

Where A_e is the effective antenna area.

Using the definition of effective antenna area:

$$A_e = \frac{G_l \lambda^2}{4\pi}$$

where G_l is the gain of the antenna relative to an isotropic radiator in linear form, and the formula for integral sensitivity derived above, the Radiated Sensitivity can be expressed as follows:

$$Radiated\ Sensitivity = 10\log\left(\frac{4\pi k T_s R_b}{\lambda^2}\right) + (E_b / N_0) - G$$

where λ is the free space wavelength and G is the gain G_l expressed in logarithmic form (dBi).

D.2.3 Conducted sensitivity

The conducted sensitivity is the conducted power incident at the receiver connector, with the receive antenna disconnected, assuming a signal source at the ambient temperature has been impedance matched (to 50 Ω) to the receiver. The conducted sensitivity is specified in dBm.

The calculation of conducted sensitivity is similar to the integral sensitivity, with a noise temperature that considers the signal source, such that:

$$T_{cond} = T_S - T_{ant} + T_{amb}$$

where T_{cond} = Noise Temperature of Conducted System (referred to the connector):

T_{ant} = Noise Temperature of Antenna;

T_{amb} = Ambient Temperature (e.g. 290 K);

T_s = System Noise Temperature (referred to the antenna connector).

All temperatures are expressed in Kelvin (K).

$$\therefore Conducted\ Sensitivity = 10\log(k T_{cond} R_b) + (E_b / N_0)$$

D.3 Parameters

Table D.3.1 shows the parameters used in the calculations that are common to all modulation rates and coding schemes for terminal type A.

Table D.3.1: Common parameters for terminal type A

Parameter	Symbol	Value	Derivation
G/T	G/T	-16,2 dB/K	The present document
Antenna Gain	G	12 dBi	The present document
Boltzmann Constant	k	1,38 x 10^{-23} J/K	Physical Constant
Free Space Wavelength	λ	0,194 m	Calculated using frequency at the centre of the Rx band
Effective Antenna Area	A_e	-13,22 dB m^2	Calculated from antenna gain and wavelength
Antenna Noise Temperature	T_{ant}	150 K	Antenna Specification
System Noise Temperature	T_s	660,7 K	Calculated from G/T and antenna gain
System Noise Floor	$10\log(kT_s)$	-170,4 dBm/Hz	Calculated
Conducted Noise Temperature	T_{cond}	800,7 K	Calculated with Tamb at 290 K
Conducted Noise Floor	$10\log(kT_{cond})$	-169,6 dBm/Hz	Calculated

Table D.3.1a shows the parameters used in the calculations that are common to all modulation rates and coding schemes for terminal type C.

Table D.3.1a: Common parameters for terminal type C

Parameter	Symbol	Value	Derivation
G/T	G/T	-24 dB/K	The present document
Antenna Gain	G	3,5 dBi	Antenna Specifications
Boltzmann Constant	k	1,38 x 10^{-23} J/K	Physical Constant
Free Space Wavelength	λ	0,194 m	Calculated using frequency at the centre of the Rx band
Effective Antenna Area	A_e	-21,72 dB m^2	Calculated from antenna gain and wavelength
Antenna Noise Temperature	T_{ant}	150 K	Antenna Specification
System Noise Temperature	T_s	562,34 K	Calculated from G/T and antenna gain
System Noise Floor	$10\log(kT_s)$	-171,1 dBm/Hz	Calculated
Conducted Noise Temperature	T_{cond}	702,34 K	Calculated with T_{amb} at 290 K
Conducted Noise Floor	$10\log(kT_{cond})$	-170,14 dBm/Hz	Calculated

Tables D.3.1b and D.3.1c show the parameters used in the calculations that are common to all modulation rates and coding schemes for terminal type D.

Table D.3.1b: Common parameters for terminal type D (with internal antenna)

Parameter	Symbol	Value	Derivation
G/T	G/T	-18,00 dB/K	The present document
Antenna Gain	G	8,50 dBi	Antenna Specifications
Boltzmann Constant	k	1,38 x 10^{-23} J/K	Physical Constant
Free Space Wavelength	λ	0,194 m	Calculated using frequency at the centre of the Rx band
Effective Antenna Area	A_e	-16,74 dB m^2	Calculated from antenna gain and wavelength
Antenna Noise Temperature	T_{ant}	120,00 K	Antenna Specification
System Noise Temperature	T_s	446,68 K	Calculated from G/T and antenna gain
System Noise Floor	$10log(kT_s)$	-172,10 dBm/Hz	Calculated
Conducted Noise Temperature	T_{cond}	616,68 K	Calculated with T_{amb} at 290 K
Conducted Noise Floor	$10log(kT_{cond})$	-170,70 dBm/Hz	Calculated

Table D.3.1c: Common parameters for terminal type D (with passive external antenna)

Parameter	Symbol	Value	Derivation
G/T	G/T	-11,00 dB/K	The present document
Antenna Gain	G	15,50 dBi	Antenna Specifications
Boltzmann Constant	k	1,38 x 10-23 J/K	Physical Constant
Free Space Wavelength	λ	0.194 m	Calculated using frequency at the centre of the Rx band
Effective Antenna Area	A_e	-9,74 dB m^2	Calculated from antenna gain and wavelength
Antenna Noise Temperature	T_{ant}	120,00 K	Antenna Specification
System Noise Temperature	T_s	446,68 K	Calculated from G/T and antenna gain
System Noise Floor	$10log(kT_s)$	-172,10 dBm/Hz	Calculated
Conducted Noise Temperature	T_{cond}	616,68 K	Calculated with T_{amb} at 290 K
Conducted Noise Floor	$10log(kT_{cond})$	-170,70 dBm/Hz	Calculated

Table D.3.1d shows the parameters used in the calculations that are common to all modulation rates and coding schemes for terminal type E.

Table D.3.1d: Common parameters for terminal type E

Parameter	Symbol	Value	Derivation
G/T	G/T	-30 dB/K	The present document
Antenna Gain	G	-1 dBi	Antenna Specifications
Boltzmann Constant	k	1,38E-23 J/K	Physical Constant
Free Space Wavelength	λ	0,136 m	Calculated using frequency at the centre of the Rx band
Effective Antenna Area	A_e	-29,30 m^2	Calculated from antenna gain and wavelength
Antenna Noise Temperature	T_{ant}	150 K	Antenna Specification
System Noise Temperature	T_s	794,33 K	Calculated from G/T and antenna gain
System Noise Floor	$10log(kT_s)$	-169,60 dBm/Hz	Calculated
Conducted Noise Temperature	T_{cond}	934,33K	Calculated with T_{amb} at 290 K
Conducted Noise Floor	$10log(kT_{cond})$	-168,90 dBm/Hz	Calculated

Table D.3.1e shows the parameters used in the calculations that are common to all modulation rates and coding schemes for terminal type F.

Table D.3.1e: Common parameters for terminal type F

Parameter	Symbol	Value	Derivation
G/T	G/T	-29 dB/K	The present document
Antenna Gain	G	0 dBi	Antenna Specifications
Boltzmann Constant	k	1,38E-23 J/K	Physical Constant
Free Space Wavelength	λ	0,136 m	Calculated using frequency at the centre of the Rx band
Effective Antenna Area	A_e	-28,30 m^2	Calculated from antenna gain and wavelength
Antenna Noise Temperature	T_{ant}	150 K	Antenna Specification
System Noise Temperature	T_s	794,33 K	Calculated from G/T and antenna gain
System Noise Floor	$10\log(kT_s)$	-169,60 dBm/Hz	Calculated
Conducted Noise Temperature	T_{cond}	934,33 K	Calculated with T_{amb} at 290 K
Conducted Noise Floor	$10\log(kT_{cond})$	-168,90 dBm/Hz	Calculated

Table D.3.1f shows the parameters used in the calculations that are common to all modulation rates and coding schemes for terminal types G and H.

Table D.3.1f: Common parameters for terminal type G,H

Parameter	Symbol	Value	Derivation
G/T	G/T	-27 dB/K	The present document
Antenna Gain	G	2 dBi	Antenna Specifications
Boltzmann Constant	k	1,38E-23 J/K	Physical Constant
Free Space Wavelength	λ	0,136 m	Calculated using frequency at the centre of the Rx band
Effective Antenna Area	A_e	-26,30 m^2	Calculated from antenna gain and wavelength
Antenna Noise Temperature	T_{ant}	150 K	Antenna Specification
System Noise Temperature	T_s	794,33 K	Calculated from G/T and antenna gain
System Noise Floor	$10\log(kT_s)$	-169,60 dBm/Hz	Calculated
Conducted Noise Temperature	T_{cond}	934,33 K	Calculated with T_{amb} at 290 K
Conducted Noise Floor	$10\log(kT_{cond})$	-168,90 dBm/Hz	Calculated

Table D.3.1g shows the parameters used in the calculations that are common to all modulation rates and coding schemes for terminal type I.

Table D.3.1g: Common parameters for terminal type I

Parameter	Symbol	Value	Derivation
G/T	G/T	-17 dB/K	The present document
Antenna Gain	G	13 dBi	Antenna Specifications
Boltzmann Constant	k	1,38E-23 J/K	Physical Constant
Free Space Wavelength	λ	0,136 m	Calculated using frequency at the centre of the Rx band
Effective Antenna Area	A_e	-15,30 m^2	Calculated from antenna gain and wavelength
Antenna Noise Temperature	T_{ant}	150 K	Antenna Specification
System Noise Temperature	T_s	1000,00 K	Calculated from G/T and antenna gain
System Noise Floor	$10\log(kT_s)$	-168,60 dBm/Hz	Calculated
Conducted Noise Temperature	T_{cond}	1140,00 K	Calculated with T_{amb} at 290 K
Conducted Noise Floor	$10\log(kT_{cond})$	-168,03 dBm/Hz	Calculated

Table D.3.1h shows the parameters used in the calculations that are common to all modulation rates and coding schemes for terminal type J.

Table D.3.1h: Common parameters for terminal type J

Parameter	Symbol	Value	Derivation
G/T	G/T	-31 dB/K	The present document
Antenna Gain	G	-4 dBi	Antenna Specifications
Boltzmann Constant	k	1,38E-23 J/K	Physical Constant
Free Space Wavelength	λ	0,136 m	Calculated using frequency at the centre of the Rx band
Effective Antenna Area	A_e	-32,30 m^2	Calculated from antenna gain and wavelength
Antenna Noise Temperature	T_{ant}	150 K	Antenna Specification
System Noise Temperature	T_s	501,19 K	Calculated from G/T and antenna gain
System Noise Floor	$10\log(kT_s)$	-171,60 dBm/Hz	Calculated
Conducted Noise Temperature	T_{cond}	641,19 K	Calculated with T_{amb} at 290 K
Conducted Noise Floor	$10\log(kT_{cond})$	-170,53 dBm/Hz	Calculated

Table D.3.1i shows the parameters used in the calculations that are common to all modulation rates and coding schemes for terminal types K and L.

Table D.3.1i: Common parameters for terminal type K,L

Parameter	Symbol	Value	Derivation
G/T	G/T	-26 dB/K	The present document
Antenna Gain	G	1 dBi	Antenna Specifications
Boltzmann Constant	k	1,38E-23 J/K	Physical Constant
Free Space Wavelength	λ	0,136 m	Calculated using frequency at the centre of the Rx band
Effective Antenna Area	A_e	-27,30 m^2	Calculated from antenna gain and wavelength
Antenna Noise Temperature	T_{ant}	150 K	Antenna Specification
System Noise Temperature	T_s	501,19 K	Calculated from G/T and antenna gain
System Noise Floor	$10\log(kT_s)$	-171,60 dBm/Hz	Calculated
Conducted Noise Temperature	T_{cond}	641,19 K	Calculated with T_{amb} at 290 K
Conducted Noise Floor	$10\log(kT_{cond})$	-170,53 dBm/Hz	Calculated

Table D.3.1j shows the parameters used in the calculations that are common to all modulation rates and coding schemes for terminal type M.

Table D.3.1j: Common parameters for terminal type M

Parameter	Symbol	Value	Derivation
G/T	G/T	-17 dB/K	The present document
Antenna Gain	G	12 dBi	Antenna Specifications
Boltzmann Constant	k	1,38E-23 J/K	Physical Constant
Free Space Wavelength	λ	0,136 m	Calculated using frequency at the centre of the Rx band
Effective Antenna Area	A_e	-16,30 m^2	Calculated from antenna gain and wavelength
Antenna Noise Temperature	T_{ant}	150 K	Antenna Specification
System Noise Temperature	T_s	794,33 K	Calculated from G/T and antenna gain
System Noise Floor	$10\log(kT_s)$	-169,60 dBm/Hz	Calculated
Conducted Noise Temperature	T_{cond}	934,33 K	Calculated with T_{amb} at 290 K
Conducted Noise Floor	$10\log(kT_{cond})$	-168,90 dBm/Hz	Calculated

D.4 Calculations

The following tables present the calculations for each burst type, modulation and transmitted symbol rate in turn. Unless otherwise stated, the tables apply to all terminal types.

Table D.4.1: PNB(2,6)

Number of channels	2		
Transmission Symbol Rate (sps)	46 800		
Coding Rate (K = 9)	4/5	7/10	3/5
Target E_b/N_o for 10^{-6} BER (dB)	5,7	4,5	3,4
C/N_0 (dB)	55,4	54,2	53,1
Integral Sensitivity (dBm)	-115,7	-116,9	-118,0
Radiated Sensitivity (dBm/m^2)	-94,0	-95,2	-96,3
Conducted Sensitivity (dBm)	-114,8	-116,0	-117,1

Table D.4.2: PNB(4,3)

Number Of Channels	4		
Transmission Symbol Rate (sps)	93 600		
Coding Rate (K = 7)	3/4	5/8	1/2
Target E_b/N_o for 10^{-6} BER (dB)	6,1	5,1	3,5
C/N_0 (dB)	58,8	57,8	56,2
Integral Sensitivity (dBm)	-111,6	-112,6	-114,2
Radiated Sensitivity (dBm/m^2)	-98,4	-99,4	-101,0
Conducted Sensitivity (dBm)	-110,7	-111,7	-113,3

Table D.4.3: PNB(5,3)

Number Of Channels	5		
Transmission Symbol Rate (sps)	117 000		
Coding Rate (K = 7)	3/4	5/8	1/2
Target E_b/N_o for 10^{-6} BER (dB)	6,1	5,1	3,5
C/N_0 (dB)	59,8	58,8	57,2
Integral Sensitivity (dBm)	-110,6	-111,6	-113,2
Radiated Sensitivity (dBm/m^2)	-97,4	-98,4	-100,0
Conducted Sensitivity (dBm)	-109,8	-110,8	-112,4

Table D.4.4: PNB2(5,12) - π/4-QPSK, with internal antenna

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,919	0,818	0,681	0,508
Target E_b/N_o for 10^{-} FER (dB)	4,99	3,09	1,35	-0,48
C/N_0 (dB)	58,68	56,78	55,04	53,21
Integral Sensitivity (dBm)	-113,42	-115,32	-117,06	-118,89
Radiated Sensitivity (dBm/m^2)	-96,68	-98,58	-100,32	-102,15
Conducted Sensitivity (dBm)	-112,02	-113,92	-115,66	-117,49

Table D.4.5: PNB2(5,12) - π/4-QPSK, with external antenna

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,919	0,818	0,681	0,508
Target E_b/N_o for 10^{-4} FER (dB)	4,99	3,09	1,35	-0,48
C/N_0 (dB)	58,68	56,78	55,04	53,21
Integral Sensitivity (dBm)	-113,42	-115,32	-117,06	-118,89
Radiated Sensitivity (dBm/m^2)	-89,68	-91,58	-93,32	-95,15
Conducted Sensitivity (dBm)	-112,02	-113,92	-115,66	-117,49

Table D.4.6: PNB2(5,12) - 16APSK, with internal antenna

Number Of Channels	5	
Transmission Symbol Rate (sps)	117 000	
Coding Rate	0,818	0,681
Target E_b/N_o for 10^{-} FER (dB)	7,26	5,04
C/N_0 (dB)	63,96	61,74
Integral Sensitivity (dBm)	-108,14	-110,36
Radiated Sensitivity (dBm/m^2)	-91,40	-93,62
Conducted Sensitivity (dBm)	-106,74	-108,96

Table D.4.7: PNB2(5,12) - 16APSK, with external antenna

Number Of Channels	5	
Transmission Symbol Rate (sps)	117 000	
Coding Rate	0,818	0,681
Target E_b/N_o for 10^{-4} FER (dB)	7,26	5,04
C/N_0 (dB)	63,96	61,74
Integral Sensitivity (dBm)	-108,14	-110,36
Radiated Sensitivity (dBm/m^2)	-84,40	-86,62
Conducted Sensitivity (dBm)	-106,74	-108,96

Table D.4.8: PNB2(5,12) - 32APSK, with internal antenna

Number Of Channels	5	
Transmission Symbol Rate (sps)	117 000	
Coding Rate	0,818	0,765
Target E_b/N_o for 10^{-} FER (dB)	7,26	5,04
C/N_0 (dB)	63,96	61,74
Integral Sensitivity (dBm)	-108,14	-110,36
Radiated Sensitivity (dBm/m^2)	-91,40	-93,62
Conducted Sensitivity (dBm)	-106,74	-108,96

Table D.4.9: PNB2(5,12) - 32APSK, with external antenna

Number Of Channels	5	
Transmission Symbol Rate (sps)	117 000	
Coding Rate	0,818	0,765
Target E_b/N_o for 10^{-4} FER (dB)	9,39	8,46
C/N_0 (dB)	67,06	66,13
Integral Sensitivity (dBm)	-105,0	-105,97
Radiated Sensitivity (dBm/m^2)	-81,30	-82,23
Conducted Sensitivity (dBm)	-103,64	-104,57

Table D.4.10: PNB2(5,3) - π/4-QPSK, with internal antenna

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,894	0,793	0,660	0,509
Target E_b/N_o for 10^{-4} FER (dB)	5,41	3,59	1,89	0,24
C/N_0 (dB)	59,10	57,28	55,58	53,93
Integral Sensitivity (dBm)	-113,00	-114,82	-116,52	-118,17
Radiated Sensitivity (dBm/m^2)	-96,26	-98,08	-99,78	-101,43
Conducted Sensitivity (dBm)	-111,60	-113,42	-115,12	-116,77

Table D.4.11: PNB2(5,3) - π/4-QPSK, with external antenna

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,894	0,793	0,660	0,509
Target E_b/N_o for 10^{-4} FER (dB)	5,41	3,59	1,89	0,24
C/N_0 (dB)	59,10	57,28	55,58	53,93
Integral Sensitivity (dBm)	-113,00	-114,82	-116,52	-118,17
Radiated Sensitivity (dBm/m^2)	-89,26	-91,08	-92,78	-94,43
Conducted Sensitivity (dBm)	-111,60	-113,42	-115,12	-116,77

Table D.4.12: PNB2(5,3) - 16APSK, with internal antenna

Number Of Channels	5	
Transmission Symbol Rate (sps)	117 000	
Coding Rate	0,797	0,664
Target E_b/N_o for 10^{-4} FER (dB)	7,48	8,44
C/N_0 (dB)	64,18	65,14
Integral Sensitivity (dBm)	-107,92	-106,96
Radiated Sensitivity (dBm/m^2)	-91,18	-90,22
Conducted Sensitivity (dBm)	-106,52	-105,56

Table D.4.13: PNB2(5,3) - 16APSK, with external antenna

Number Of Channels	5	
Transmission Symbol Rate (sps)	117 000	
Coding Rate	0,797	0,664
Target E_b/N_o for 10^{-4} FER (dB)	7,48	8,44
C/N_0 (dB)	64,18	65,14
Integral Sensitivity (dBm)	-107,92	-106,96
Radiated Sensitivity (dBm/m^2)	-84,18	-83,22
Conducted Sensitivity (dBm)	-106,52	-105,56

Table D.4.14: PNB2(5,3) - 32APSK, with internal antenna

Number Of Channels	5	
Transmission Symbol Rate (sps)	117 000	
Coding Rate	0,798	0,748
Target E_b/N_o for 10^{-4} FER (dB)	9,61	8,79
C/N_0 (dB)	67,28	66,46
Integral Sensitivity (dBm)	-104,82	-105,64
Radiated Sensitivity (dBm/m^2)	-88,08	-88,90
Conducted Sensitivity (dBm)	-103,42	-104,24

Table D.4.15: PNB2(5,3) - 32APSK, with external antenna

Number Of Channels	5	
Transmission Symbol Rate (sps)	117 000	
Coding Rate	0,798	0,748
Target E_b/N_o for 10^{-4} FER (dB)	9,61	8,79
C/N_0 (dB)	67,28	66,46
Integral Sensitivity (dBm)	-104,82	-105,64
Radiated Sensitivity (dBm/m^2)	-81,08	-81,90
Conducted Sensitivity (dBm)	-103,42	-104,24

Table D.4.16: PNB3(5,3) - π/4-QPSK (terminal type E)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target E_b/N_o for 10^{-3} FER (dB)	-0,06	1,44	3,34	4,39
C/N_0 (dB)	53,63	55,13	57,03	58,08
Integral Sensitivity (dBm)	-115,97	-114,47	-112,57	-111,52
Radiated Sensitivity (dBm/m^2)	-86,67	-85,17	-83,27	-82,22
Conducted Sensitivity (dBm)	-115,26	-113,76	-111,86	-110,81

Table D.4.17: PNB3(5,3) - 16 APSK (terminal type E)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67	0,80		
Target Eb/No for 10^{-3} FER (dB)	5,88	7,88		
C/N_0 (dB)	62,58	64,58		
Integral Sensitivity (dBm)	-107,02	-105,02		
Radiated Sensitivity (dBm/m^2)	-77,72	-75,72		
Conducted Sensitivity (dBm)	-106,31	-104,31		

Table D.4.18: PNB3(5,12) - π/4-QPSK (terminal type E)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,86	0,84	2,74	3,94
C/N_0 (dB)	52,83	54,53	56,43	57,63
Integral Sensitivity (dBm)	-116,77	-115,07	-113,17	-111,97
Radiated Sensitivity (dBm/m^2)	-87,47	-85,77	-83,87	-82,67
Conducted Sensitivity (dBm)	-116,06	-114,36	-112,46	-111,26

Table D.4.19: PNB3(5,12) - 16 APSK (terminal type E)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67	0,80		
Target Eb/No for 10^{-3} FER (dB)	5,78	7,68		
C/N_0 (dB)	62,48	64,38		
Integral Sensitivity (dBm)	-107,12	-105,22		
Radiated Sensitivity (dBm/m^2)	-77,82	-75,92		
Conducted Sensitivity (dBm)	-106,41	-104,51		

Table D.4.20: PNB3(10,3) - π/4-QPSK (terminal type E)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,50	0,61	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,96	1,14	3,14	3,94
C/N_0 (dB)	55,74	57,84	59,84	60,64
Integral Sensitivity (dBm)	-113,86	-111,76	-109,76	-108,96
Radiated Sensitivity (dBm/m^2)	-84,56	-82,46	-80,46	-79,66
Conducted Sensitivity (dBm)	-113,15	-111,05	-109,05	-108,25

Table D.4.21: PNB3(10,3) - 16 APSK (terminal type E)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,69	0,80		
Target Eb/No for 10^{-3} FER (dB)	6,08	8,28		
C/N_0 (dB)	65,79	67,99		
Integral Sensitivity (dBm)	-103,81	-101,61		
Radiated Sensitivity (dBm/m^2)	-74,51	-72,31		
Conducted Sensitivity (dBm)	-103,10	-100,90		

Table D.4.22: PNB3(2,6) - π/4-QPSK(terminal type E)

Number Of Channels	2			
Transmission Symbol Rate (sps)	46 800			
Coding Rate	0,60	0,70	0,80	
Target Eb/No for 10^{-3} FER (dB)	1,74	3,14	4,54	
C/N_0 (dB)	51,45	52,85	54,25	
Integral Sensitivity (dBm)	-118,15	-116,75	-115,35	
Radiated Sensitivity (dBm/m^2)	-88,85	-87,45	-86,05	
Conducted Sensitivity (dBm)	-117,44	-116,04	-114,64	

Table D.4.23: PNB3(1,6) - π/4-QPSK (4 kbps vocoder) (terminal type E)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,86			
C/N_0 (dB)	45,84			
Integral Sensitivity (dBm)	-123,76			
Radiated Sensitivity (dBm/m^2)	-94,46			
Conducted Sensitivity (dBm)	-123,05			

Table D.4.24: PNB3(1,6) - π/2-BPSK (2,45 kbps vocoder) (terminal type E)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,05			
C/N_0 (dB)	43,64			
Integral Sensitivity (dBm)	-125,96			
Radiated Sensitivity (dBm/m^2)	-96,66			
Conducted Sensitivity (dBm)	-125,25			

Table D.4.25: PNB3(1,3) - π/4-QPSK (4 kbps vocoder) (terminal type E)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	4,04			
C/N_0 (dB)	50,74			
Integral Sensitivity (dBm)	-118,86			
Radiated Sensitivity (dBm/m^2)	-89,56			
Conducted Sensitivity (dBm)	-118,15			

Table D.4.26: PNB3(1,3) - π/4-QPSK (2,45 kbps vocoder) (terminal type E)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	0,54			
C/N_0 (dB)	47,24			
Integral Sensitivity (dBm)	-122,36			
Radiated Sensitivity (dBm/m^2)	-93,06			
Conducted Sensitivity (dBm)	-121,65			

Table D.4.27: PNB3(5,3) - π/4-QPSK(terminal type F)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,06	1,44	3,34	4,39
C/N_0 (dB)	53,63	55,13	57,03	58,08
Integral Sensitivity (dBm)	-115,97	-114,47	-112,57	-111,52
Radiated Sensitivity (dBm/m^2)	-87,67	-86,17	-84,27	-83,22
Conducted Sensitivity (dBm)	-115,26	-113,76	-111,86	-110,81

Table D.4.28: PNB3(5,3) - 16 APSK(terminal type F)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67	0,80		
Target Eb/No for 10^{-3} FER (dB)	5,88	7,88		
C/N_0 (dB)	62,58	64,58		
Integral Sensitivity (dBm)	-107,02	-105,02		
Radiated Sensitivity (dBm/m^2)	-78,72	-76,72		
Conducted Sensitivity (dBm)	-106,31	-104,31		

Table D.4.29: PNB3(5,12) - π/4-QPSK (terminal type F)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,86	0,84	2,74	3,94
C/N_0 (dB)	52,83	54,53	56,43	57,63
Integral Sensitivity (dBm)	-116,77	-115,07	-113,17	-111,97
Radiated Sensitivity (dBm/m^2)	-88,47	-86,77	-84,87	-83,67
Conducted Sensitivity (dBm)	-116,06	-114,36	-112,46	-111,26

Table D.4.30: PNB3(5,12) - 16 APSK (terminal type F)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67	0,80		
Target Eb/No for 10^{-3} FER (dB)	5,78	7,68		
C/N_0 (dB)	62,48	64,38		
Integral Sensitivity (dBm)	-107,12	-105,22		
Radiated Sensitivity (dBm/m^2)	-78,82	-76,92		
Conducted Sensitivity (dBm)	-106,41	-104,51		

Table D.4.31: PNB3(10,3) - π/4-QPSK (terminal type F)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,50	0,61	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,96	1,14	3,14	3,94
C/N_0 (dB)	55,74	57,84	59,84	60,64
Integral Sensitivity (dBm)	-113,86	-111,76	-109,76	-108,96
Radiated Sensitivity (dBm/m^2)	-85,56	-83,46	-81,46	-80,66
Conducted Sensitivity (dBm)	-113,15	-111,05	-109,05	-108,25

Table D.4.32: PNB3(10,3) - 16 APSK (terminal type F)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,69	0,80		
Target Eb/No for 10^{-3} FER (dB)	6,08	8,28		
C/N_0 (dB)	65,79	67,99		
Integral Sensitivity (dBm)	-103,81	-101,61		
Radiated Sensitivity (dBm/m^2)	-75,51	-73,31		
Conducted Sensitivity (dBm)	-103,10	-100,90		

Table D.4.33: PNB3(2,6) - π/4-QPSK (terminal type F)

Number Of Channels	2			
Transmission Symbol Rate (sps)	46 800			
Coding Rate	0,60	0,70	0,80	
Target Eb/No for 10^{-3} FER (dB)	1,74	3,14	4,54	
C/N_0 (dB)	51,45	52,85	54,25	
Integral Sensitivity (dBm)	-118,15	-116,75	-115,35	
Radiated Sensitivity (dBm/m^2)	-89,85	-88,45	-87,05	
Conducted Sensitivity (dBm)	-117,44	-116,04	-114,64	

Table D.4.34: PNB3(1,6) - π/4-QPSK (4 kbps vocoder) (terminal type F)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,86			
C/N_0 (dB)	45,84			
Integral Sensitivity (dBm)	-123,76			
Radiated Sensitivity (dBm/m^2)	-95,46			
Conducted Sensitivity (dBm)	-123,05			

Table D.4.35: PNB3(1,6) - π/2-BPSK (2,45 kbps vocoder) (terminal type F)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,05			
C/N_0 (dB)	43,64			
Integral Sensitivity (dBm)	-125,96			
Radiated Sensitivity (dBm/m^2)	-97,66			
Conducted Sensitivity (dBm)	-125,25			

Table D.4.36: PNB3(1,3) - π/4-QPSK (4 kbps vocoder) (terminal type F)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	4,04			
C/N_0 (dB)	50,74			
Integral Sensitivity (dBm)	-118,86			
Radiated Sensitivity (dBm/m^2)	-90,56			
Conducted Sensitivity (dBm)	-118,15			

Table D.4.37: PNB3(1,3) - π/4-QPSK (2,45 kbps vocoder) (terminal type F)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	0,54			
C/N_0 (dB)	47,24			
Integral Sensitivity (dBm)	-122,36			
Radiated Sensitivity (dBm/m^2)	-94,06			
Conducted Sensitivity (dBm)	-121,65			

Table D.4.38 PNB3(5,3) - π/4-QPSK (terminal type G,H)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,06	1,44	3,34	4,39
C/N_0 (dB)	53,63	55,13	57,03	58,08
Integral Sensitivity (dBm)	-115,97	-114,47	-112,57	-111,52
Radiated Sensitivity (dBm/m^2)	-89,67	-88,17	-86,27	-85,22
Conducted Sensitivity (dBm)	-115,26	-113,76	-111,86	-110,81

Table D.4.39: PNB3(5,3) - 16 APSK (terminal type G,H)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67	0,80		
Target Eb/No for 10^{-3} FER (dB)	5,88	7,88		
C/N_0 (dB)	62,58	64,58		
Integral Sensitivity (dBm)	-107,02	-105,02		
Radiated Sensitivity (dBm/m^2)	-80,72	-78,72		
Conducted Sensitivity (dBm)	-106,31	-104,31		

Table D.4.40: PNB3(5,12) - π/4-QPSK (terminal type G,H)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,86	0,84	2,74	3,94
C/N_0 (dB)	52,83	54,53	56,43	57,63
Integral Sensitivity (dBm)	-116,77	-115,07	-113,17	-111,97
Radiated Sensitivity (dBm/m^2)	-90,47	-88,77	-86,87	-85,67
Conducted Sensitivity (dBm)	-116,06	-114,36	-112,46	-111,26

Table D.4.41: PNB3(5,12) - 16 APSK (terminal type G,H)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67	0,80		
Target Eb/No for 10^{-3} FER (dB)	5,78	7,68		
C/N_0 (dB)	62,48	64,38		
Integral Sensitivity (dBm)	-107,12	-105,22		
Radiated Sensitivity (dBm/m^2)	-80,82	-78,92		
Conducted Sensitivity (dBm)	-106,41	-104,51		

Table D.4.42: PNB3(10,3) - π/4-QPSK (terminal type G,H)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,50	0,61	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,96	1,14	3,14	3,94
C/N_0 (dB)	55,74	57,84	59,84	60,64
Integral Sensitivity (dBm)	-113,86	-111,76	-109,76	-108,96
Radiated Sensitivity (dBm/m^2)	-87,56	-85,46	-83,46	-82,66
Conducted Sensitivity (dBm)	-113,15	-111,05	-109,05	-108,25

Table D.4.43: PNB3(10,3) - 16 APSK (terminal type G,H)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,69	0,80		
Target Eb/No for 10^{-3} FER (dB)	6,08	8,28		
C/N_0 (dB)	65,79	67,99		
Integral Sensitivity (dBm)	-103,81	-101,61		
Radiated Sensitivity (dBm/m^2)	-77,51	-75,31		
Conducted Sensitivity (dBm)	-103,10	-100,90		

Table D.4.44: PNB3(2,6) - π/4-QPSK (terminal type G,H)

Number Of Channels	2			
Transmission Symbol Rate (sps)	46 800			
Coding Rate	0,60	0,70	0,80	
Target Eb/No for 10^{-3} FER (dB)	1,74	3,14	4,54	
C/N_0 (dB)	51,45	52,85	54,25	
Integral Sensitivity (dBm)	-118,15	-116,75	-115,35	
Radiated Sensitivity (dBm/m^2)	-91,85	-90,45	-89,05	
Conducted Sensitivity (dBm)	-117,44	-116,04	-114,64	

Table D.4.45: PNB3(1,6) - π/4-QPSK (4 kbps vocoder) (terminal type G,H)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,86			
C/N_0 (dB)	45,84			
Integral Sensitivity (dBm)	-123,76			
Radiated Sensitivity (dBm/m^2)	-97,46			
Conducted Sensitivity (dBm)	-123,05			

Table D.4.46: PNB3(1,6) - π/2-BPSK (2,45 kbps vocoder) (terminal type G,H)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,05			
C/N_0 (dB)	43,64			
Integral Sensitivity (dBm)	-125,96			
Radiated Sensitivity (dBm/m^2)	-99,66			
Conducted Sensitivity (dBm)	-125,25			

Table D.4.47: PNB3(1,3) - π/4-QPSK (4 kbps vocoder) (terminal type G,H)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	4,04			
C/N_0 (dB)	50,74			
Integral Sensitivity (dBm)	-118,86			
Radiated Sensitivity (dBm/m^2)	-92,56			
Conducted Sensitivity (dBm)	-118,15			

Table D.4.48: PNB3(1,3) - π/4-QPSK (2,45 kbps vocoder) (terminal type G,H)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	0,54			
C/N_0 (dB)	47,24			
Integral Sensitivity (dBm)	-122,36			
Radiated Sensitivity (dBm/m^2)	-96,06			
Conducted Sensitivity (dBm)	-121,65			

Table D.4.49: PNB3(5,3) - π/4-QPSK (terminal type I)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,06	1,44	3,34	4,39
C/N_0 (dB)	53,63	55,13	57,03	58,08
Integral Sensitivity (dBm)	-114,97	-113,47	-111,57	-110,52
Radiated Sensitivity (dBm/m^2)	-99,67	-98,17	-96,27	-95,22
Conducted Sensitivity (dBm)	-114,40	-112,90	-111,00	-109,95

Table D.4.50: PNB3(5,3) - 16 APSK (terminal type I)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67	0,80		
Target Eb/No for 10^{-3} FER (dB)	5,88	7,88		
C/N_0 (dB)	62,58	64,58		
Integral Sensitivity (dBm)	-106,02	-104,02		
Radiated Sensitivity (dBm/m^2)	-90,72	-88,72		
Conducted Sensitivity (dBm)	-105,45	-103,45		

Table D.4.51: PNB3(5,12) - π/4-QPSK (terminal type I)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,86	0,84	2,74	3,94
C/N_0 (dB)	52,83	54,53	56,43	57,63
Integral Sensitivity (dBm)	-115,77	-114,07	-112,17	-110,97
Radiated Sensitivity (dBm/m^2)	-100,47	-98,77	-96,87	-95,67
Conducted Sensitivity (dBm)	-115,20	-113,50	-111,60	-110,40

Table D.4.52: PNB3(5,12) - 16 APSK (terminal type I)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67	0,80		
Target Eb/No for 10^{-3} FER (dB)	5,78	7,68		
C/N_0 (dB)	62,48	64,38		
Integral Sensitivity (dBm)	-106,12	-104,22		
Radiated Sensitivity (dBm/m^2)	-90,82	-88,92		
Conducted Sensitivity (dBm)	-105,55	-103,65		

Table D.4.53: PNB3(10,3) - π/4-QPSK (terminal type I)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,50	0,61	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,96	1,14	3,14	3,94
C/N_0 (dB)	55,74	57,84	59,84	60,64
Integral Sensitivity (dBm)	-112,86	-110,76	-108,76	-107,96
Radiated Sensitivity (dBm/m^2)	-97,56	-95,46	-93,46	-92,66
Conducted Sensitivity (dBm)	-112,29	-110,19	-108,19	-107,39

Table D.4.54: PNB3(10,3) - 16 APSK (terminal type I)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,69	0,80		
Target Eb/No for 10^{-3} FER (dB)	6,08	8,28		
C/N_0 (dB)	65,79	67,99		
Integral Sensitivity (dBm)	-102,81	-100,61		
Radiated Sensitivity (dBm/m^2)	-87,51	-85,31		
Conducted Sensitivity (dBm)	-102,24	-100,04		

Table D.4.55: PNB3(2,6) - π/4-QPSK (terminal type I)

Number Of Channels	2			
Transmission Symbol Rate (sps)	46 800			
Coding Rate	0,60	0,70	0,80	
Target Eb/No for 10^{-3} FER (dB)	1,74	3,14	4,54	
C/N_0 (dB)	51,45	52,85	54,25	
Integral Sensitivity (dBm)	-117,15	-115,75	-114,35	
Radiated Sensitivity (dBm/m^2)	-101,85	-100,45	-99,05	
Conducted Sensitivity (dBm)	-116,58	-115,18	-113,78	

Table D.4.56: PNB3(1,6) - π/4-QPSK (4 kbps vocoder) (terminal type I)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,86			
C/N_0 (dB)	45,84			
Integral Sensitivity (dBm)	-122,76			
Radiated Sensitivity (dBm/m^2)	-107,46			
Conducted Sensitivity (dBm)	-122,19			

Table D.4.57: PNB3(1,6) - π/2-BPSK (2,45 kbps vocoder) (terminal type I)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,05			
C/N_0 (dB)	43,64			
Integral Sensitivity (dBm)	-124,96			
Radiated Sensitivity (dBm/m^2)	-109,66			
Conducted Sensitivity (dBm)	-124,39			

Table D.4.58: PNB3(1,3) - π/4-QPSK (4 kbps vocoder) (terminal type I)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	4,04			
C/N_0 (dB)	50,74			
Integral Sensitivity (dBm)	-117,86			
Radiated Sensitivity (dBm/m^2)	-102,56			
Conducted Sensitivity (dBm)	-117,29			

Table D.4.59: PNB3(1,3) - π/4-QPSK (2,45 kbps vocoder) (terminal type I)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	0,54			
C/N_0 (dB)	47,24			
Integral Sensitivity (dBm)	-121,36			
Radiated Sensitivity (dBm/m^2)	-106,06			
Conducted Sensitivity (dBm)	-120,79			

Table D.4.60: PNB3(5,3) - π/4-QPSK (terminal type J)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,31	1,39	3,04	4,19
C/N_0 (dB)	53,38	55,08	56,73	57,88
Integral Sensitivity (dBm)	-118,22	-116,52	-114,87	-113,72
Radiated Sensitivity (dBm/m^2)	-85,92	-84,22	-82,57	-81,42
Conducted Sensitivity (dBm)	-117,15	-115,45	-113,80	-112,65

Table D.4.61: PNB3(5,3) - 16 APSK (terminal type J)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67			
Target Eb/No for 10^{-3} FER (dB)	5,74			
C/N_0 (dB)	62,44			
Integral Sensitivity (dBm)	-109,16			
Radiated Sensitivity (dBm/m^2)	-76,86			
Conducted Sensitivity (dBm)	-108,09			

Table D.4.62: PNB3(10,3) - 16 APSK (terminal type J)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,67			
Target Eb/No for 10^{-3} FER (dB)	5,84			
C/N_0 (dB)	65,55			
Integral Sensitivity (dBm)	-106,05			
Radiated Sensitivity (dBm/m^2)	-73,75			
Conducted Sensitivity (dBm)	-104,98			

Table D.4.63: PNB3(2,6) - π/4-QPSK(terminal type J)

Number Of Channels	2			
Transmission Symbol Rate (sps)	46 800			
Coding Rate	0,60	0,70	0,80	
Target Eb/No for 10^{-3} FER (dB)	2,19	3,69	5,09	
C/N_0 (dB)	51,90	53,40	54,80	
Integral Sensitivity (dBm)	-119,70	-118,20	-116,80	
Radiated Sensitivity (dBm/m^2)	-87,40	-85,90	-84,50	
Conducted Sensitivity (dBm)	-118,63	-117,13	-115,73	

Table D.4.64: PNB3(1,6) - π/4-QPSK (4 kbps vocoder) (terminal type J)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-1,11			
C/N_0 (dB)	45,59			
Integral Sensitivity (dBm)	-126,01			
Radiated Sensitivity (dBm/m^2)	-93,71			
Conducted Sensitivity (dBm)	-124,94			

Table D.4.65: PNB3(1,6) - π/2-BPSK (2,45 kbps vocoder) (terminal type J)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,20			
C/N_0 (dB)	43,49			
Integral Sensitivity (dBm)	-128,11			
Radiated Sensitivity (dBm/m^2)	-95,81			
Conducted Sensitivity (dBm)	-127,04			

Table D.4.66: PNB3(1,8) - π/2-BPSK (4 kbps vocoder) (terminal type J)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	0,70			
C/N_0 (dB)	44,39			
Integral Sensitivity (dBm)	-127,21			
Radiated Sensitivity (dBm/m^2)	-94,91			
Conducted Sensitivity (dBm)	-126,14			

Table D.4.67: PNB3(5,3) - π/4-QPSK (terminal type K)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,31	1,39	3,04	4,19
C/N_0 (dB)	53,38	55,08	56,73	57,88
Integral Sensitivity (dBm)	-118,22	-116,52	-114,87	-113,72
Radiated Sensitivity (dBm/m^2)	-90,92	-89,22	-87,57	-86,42
Conducted Sensitivity (dBm)	-117,15	-115,45	-113,80	-112,65

Table D.4.68: PNB3(5,3) - 16 APSK (terminal type K)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67			
Target Eb/No for 10^{-3} FER (dB)	5,74			
C/N_0 (dB)	62,44			
Integral Sensitivity (dBm)	-109,16			
Radiated Sensitivity (dBm/m^2)	-81,86			
Conducted Sensitivity (dBm)	-108,09			

Table D.4.69: PNB3(10,3) - 16 APSK (terminal type K)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,67			
Target Eb/No for 10^{-3} FER (dB)	5,84			
C/N_0 (dB)	65,55			
Integral Sensitivity (dBm)	-106,05			
Radiated Sensitivity (dBm/m^2)	-78,75			
Conducted Sensitivity (dBm)	-104,98			

Table D.4.70: PNB3(2,6) - π/4-QPSK(terminal type K)

Number Of Channels	2			
Transmission Symbol Rate (sps)	46 800			
Coding Rate	0,60	0,70	0,80	
Target Eb/No for 10^{-3} FER (dB)	2,19	3,69	5,09	
C/N_0 (dB)	51,90	53,40	54,80	
Integral Sensitivity (dBm)	-119,70	-118,20	-116,80	
Radiated Sensitivity (dBm/m^2)	-92,40	-90,90	-89,50	
Conducted Sensitivity (dBm)	-118,63	-117,13	-115,73	

Table D.4.71: PNB3(1,6) - π/4-QPSK (4 kbps vocoder) (terminal type K)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-1,11			
C/N_0 (dB)	45,59			
Integral Sensitivity (dBm)	-126,01			
Radiated Sensitivity (dBm/m^2)	-98,71			
Conducted Sensitivity (dBm)	-124,94			

Table D.4.72: PNB3(1,6) - π/2-BPSK (2,45 kbps vocoder) (terminal type K)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,20			
C/N_0 (dB)	43,49			
Integral Sensitivity (dBm)	-128,11			
Radiated Sensitivity (dBm/m^2)	-100,81			
Conducted Sensitivity (dBm)	-127,04			

Table D.4.73: PNB3(1,8) - π/2-BPSK (4 kbps vocoder) (terminal type K)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	0,70			
C/N_0 (dB)	44,39			
Integral Sensitivity (dBm)	-127,21			
Radiated Sensitivity (dBm/m^2)	-99,91			
Conducted Sensitivity (dBm)	-126,14			

Table D.4.74: PNB3(5,3) - π/4-QPSK (terminal type L)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,31	1,39	3,04	4,19
C/N_0 (dB)	53,38	55,08	56,73	57,88
Integral Sensitivity (dBm)	-118,22	-116,52	-114,87	-113,72
Radiated Sensitivity (dBm/m^2)	-90,92	-89,22	-87,57	-86,42
Conducted Sensitivity (dBm)	-117,15	-115,45	-113,80	-112,65

Table D.4.75: PNB3(5,3) - 16 APSK (terminal type L)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67			
Target Eb/No for 10^{-3} FER (dB)	5,74			
C/N_0 (dB)	62,44			
Integral Sensitivity (dBm)	-109,16			
Radiated Sensitivity (dBm/m^2)	-81,86			
Conducted Sensitivity (dBm)	-108,09			

Table D.4.76: PNB3(10,3) - 16 APSK (terminal type L)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,67			
Target Eb/No for 10^{-3} FER (dB)	5,84			
C/N_0 (dB)	65,55			
Integral Sensitivity (dBm)	-106,05			
Radiated Sensitivity (dBm/m^2)	-78,75			
Conducted Sensitivity (dBm)	-104,98			

Table D.4.77: PNB3(2,6) - π/4-QPSK(terminal type L)

Number Of Channels	2			
Transmission Symbol Rate (sps)	46 800			
Coding Rate	0,60	0,70	0,80	
Target Eb/No for 10^{-3} FER (dB)	2,19	3,69	5,09	
C/N_0 (dB)	51,90	53,40	54,80	
Integral Sensitivity (dBm)	-119,70	-118,20	-116,80	
Radiated Sensitivity (dBm/m^2)	-92,40	-90,90	-89,50	
Conducted Sensitivity (dBm)	-118,63	-117,13	-115,73	

Table D.4.78: PNB3(1,6) - π/4-QPSK (4 kbps vocoder) (terminal type L)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-1,11			
C/N_0 (dB)	45,59			
Integral Sensitivity (dBm)	-126,01			
Radiated Sensitivity (dBm/m^2)	-98,71			
Conducted Sensitivity (dBm)	-124,94			

Table D.4.79: PNB3(1,6) - π/2-BPSK (2,45 kbps vocoder) (terminal type L)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,20			
C/N_0 (dB)	43,49			
Integral Sensitivity (dBm)	-128,11			
Radiated Sensitivity (dBm/m^2)	-100,81			
Conducted Sensitivity (dBm)	-127,04			

Table D.4.80: PNB3(1,8) - π/2-BPSK (4 kbps vocoder) (terminal type L)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	0,70			
C/N_0 (dB)	44,39			
Integral Sensitivity (dBm)	-127,21			
Radiated Sensitivity (dBm/m^2)	-99,91			
Conducted Sensitivity (dBm)	-126,14			

Table D.4.81: PNB3(5,3) - π/4-QPSK (terminal type M)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,50	0,63	0,75	0,83
Target Eb/No for 10^{-3} FER (dB)	-0,31	1,39	3,04	4,19
C/N_0 (dB)	53,38	55,08	56,73	57,88
Integral Sensitivity (dBm)	-116,22	-114,52	-112,87	-111,72
Radiated Sensitivity (dBm/m^2)	-99,92	-98,22	-96,57	-95,42
Conducted Sensitivity (dBm)	-115,51	-113,81	-112,16	-111,01

Table D.4.82: PNB3(5,3) - 16 APSK (terminal type M)

Number Of Channels	5			
Transmission Symbol Rate (sps)	117 000			
Coding Rate	0,67			
Target Eb/No for 10^{-3} FER (dB)	5,74			
C/N_0 (dB)	62,44			
Integral Sensitivity (dBm)	-107,16			
Radiated Sensitivity (dBm/m^2)	-90,86			
Conducted Sensitivity (dBm)	-106,45			

Table D.4.83: PNB3(10,3) - 16 APSK (terminal type M)

Number Of Channels	10			
Transmission Symbol Rate (sps)	234 000			
Coding Rate	0,67			
Target Eb/No for 10^{-3} FER (dB)	5,84			
C/N_0 (dB)	65,55			
Integral Sensitivity (dBm)	-104,05			
Radiated Sensitivity (dBm/m^2)	-87,75			
Conducted Sensitivity (dBm)	-103,34			

Table D.4.84: PNB3(2,6) - π/4-QPSK(terminal type M)

Number Of Channels	2			
Transmission Symbol Rate (sps)	46 800			
Coding Rate	0,60	0,70	0,80	
Target Eb/No for 10^{-3} FER (dB)	2,19	3,69	5,09	
C/N_0 (dB)	51,90	53,40	54,80	
Integral Sensitivity (dBm)	-117,70	-116,20	-114,80	
Radiated Sensitivity (dBm/m^2)	-101,40	-99,90	-98,50	
Conducted Sensitivity (dBm)	-116,99	-115,49	-114,09	

Table D.4.85: PNB3(1,6) - π/4-QPSK (4 kbps vocoder) (terminal type M)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-1,11			
C/N_0 (dB)	45,59			
Integral Sensitivity (dBm)	-124,01			
Radiated Sensitivity (dBm/m^2)	-107,71			
Conducted Sensitivity (dBm)	-123,30			

Table D.4.86: PNB3(1,6) - π/2-BPSK (2,45 kbps vocoder) (terminal type M)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	-0,20			
C/N_0 (dB)	43,49			
Integral Sensitivity (dBm)	-126,11			
Radiated Sensitivity (dBm/m^2)	-109,81			
Conducted Sensitivity (dBm)	-125,40			

Table D.4.87: PNB3(1,8) - π/2-BPSK (4 kbps vocoder) (terminal type M)

Number Of Channels	1			
Transmission Symbol Rate (sps)	23 400			
Coding Rate	N/A			
Target Eb/No for 10^{-2} FER (dB)	0,70			
C/N_0 (dB)	44,39			
Integral Sensitivity (dBm)	-125,21			
Radiated Sensitivity (dBm/m^2)	-108,91			
Conducted Sensitivity (dBm)	-124,50			

Annex E (informative): Bibliography

- GMR-1 3G 43.022 (ETSI TS 101 376-3-10): "GEO-Mobile Radio Interface Specifications (Release 3) Third Generation Satellite Packet Radio Service Part 3: Network specifications; Sub-part 10: Functions related to Mobile Earth Station (MES) in idle mode".
- GMR-1 3G 45.010 (ETSI TS 101 376-5-7): "GEO-Mobile Radio Interface Specifications (Release 3) Third Generation Satellite Packet Radio Service Part 5: Radio interface physical layer specifications; Sub-part 7: Radio Subsystem Synchronization".
- William C. Jakes "Microwave Mobile Communications", ed. IEEE Press, 1994.
- Interface Control Document (ICD 200c): "Navstar GPS Space Segment / Navigation User Interfaces".

NOTE: See http://www.navcen.uscg.gov/pubs/gps/icd200/icd200cw1234.pdf.

History

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