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Reference

DTS/SES-002-05005

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IPRs:

Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,715,365	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,754,974	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,226,084	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,701,390	US
TS 101 377 V1.1.1	Digital Voice Systems Inc		US	US 5,826,222	US

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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Ericsson Mobile Communication	Improvements in, or in relation to, equalisers	GB	GB 2 215 567	GB
TS 101 377 V1.1.1	Ericsson Mobile Communication	Power Booster	GB	GB 2 251 768	GB
TS 101 377 V1.1.1	Ericsson Mobile Communication	Receiver Gain	GB	GB 2 233 846	GB
TS 101 377 V1.1.1	Ericsson Mobile Communication	Transmitter Power Control for Radio Telephone System	GB	GB 2 233 517	GB

IPR Owner: Ericsson Mobile Communications (UK) Limited
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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Hughes Network Systems		US	Pending	US

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Project	Company	Title	Country of Origin	Patent n°	Countries Applicable
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	2.4-to-3 KBPS Rate Adaptation Apparatus for Use in Narrowband Data and Facsimile Communication Systems	US	US 6,108,348	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Cellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic ThroughputCellular Spacecraft TDMA Communications System with Call Interrupt Coding System for Maximizing Traffic Throughput	US	US 5,717,686	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Enhanced Access Burst for Random Access Channels in TDMA Mobile Satellite System	US	US 5,875,182	
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,314	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System	US	US 5,974,315	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System with Mutual Offset High-argin Forward Control Signals	US	US 6,072,985	US
TS 101 377 V1.1.1	Lockheed Martin Global Telecommunic. Inc	Spacecraft Cellular Communication System with Spot Beam Pairing for Reduced Updates	US	US 6,118,998	US

IPR Owner: Lockheed Martin Global Telecommunications, Inc.
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Foreword

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

The contents of the present document are subject to continuing work within TC-SES and may change following formal TC-SES approval. Should TC-SES modify the contents of the present document, it will then be republished by ETSI with an identifying change of release date and an increase in version number as follows:

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- the third digit (n) is incremented when editorial only changes have been incorporated in the specification;
- the second digit (m) is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.

The present document is part 5, sub-part 5 of a multi-part deliverable covering the GEO-Mobile Radio Interface Specifications, 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; GMR-2 05.001";

Sub-part 2: "Multiplexing and Multiple Access on the Radio Path; GMR-2 05.002";

Sub-part 3: "Channel Coding; GMR-2 05.003";

Sub-part 4: "Modulation; GMR-2 05.004";

Sub-part 5: "Radio Transmission and Reception; GMR-2 05.005";

Sub-part 6: "Radio Subsystem Link Control; GMR-2 05.008";

Sub-part 7: "Radio Subsystem Synchronization; GMR-2 05.010";

Part 6: "Speech coding 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.

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

Since GMR is derived from GSM, the organization of the GMR specifications closely follows that of GSM. The GMR numbers have been designed to correspond to the GSM numbering system. All GMR specifications are allocated a unique GMR number as follows:

GMR-n xx.zyy

where:

- xx.0yy (z = 0) is used for GMR specifications that have a corresponding GSM specification. In this case, the numbers xx and yy correspond to the GSM numbering scheme.
- xx.2yy (z = 2) is used for GMR specifications that do not correspond to a GSM specification. In this case, only the number xx corresponds to the GSM 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 specifications as follows:

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

NOTE: Any references to GSM 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 specification.

- If a GMR specification does not exist, the corresponding GSM specification may or may not apply. The applicability of the GSM specifications is defined in GMR-n 01.201.

1 Scope

The present document defines the requirements for the GMR-2 Mobile Earth Station-to-satellite terminal uplink/downlink operating in the 1 500/1 600 MHz bands.

Operating frequencies for the GMR-2 Ground Terminal (Gateway or NCC) -to-Satellite Terminal (ST) uplink/downlink are not specified, however, for ease of understanding, the present document describes the requirements for a GMR-2 Ground Terminal-to-Satellite Terminal uplink/downlink operating in the 3 000/6 000 MHz C-Band.

Requirements are defined for two categories of parameters:

a) those that are required to provide compatibility between the Mobile Earth Station, ground terminal, and satellite channels, connected either to separate or common antennas, that are used in the system. This category also includes parameters providing compatibility with existing systems in adjacent frequency bands;

b) those that define the transmission quality of the system.

The present document defines RF characteristics for the Mobile Earth Station (MES), satellite terminal (ST), and ground terminal (GT-Gateway or NCC).

Unless otherwise stated, the requirements defined in the present document apply to the full range of environmental conditions specified for the equipment (see clause A.4).

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- 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.
- For a non-specific reference, the latest version applies.

[1] GMR-2 01.004 (ETSI TS 101 377-1-1): "GEO-Mobile Radio Interface Specifications; Part 1: General specifications; Sub-part 1: Abbreviations and Acronyms; GMR-2 01.004".

[2] GMR-2 05.001 (ETSI TS 101 377-5-1): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 1: Physical Layer on the Radio Path; GMR-2 05.001".

[3] GMR-2 05.004 (ETSI TS 101 377-5-4): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 4: Modulation; GMR-2 05.004".

[4] GMR-2 05.008 (ETSI TS 101 377-5-6): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 6: Radio Subsystem Link Control; GMR-2 05.008".

[5] GMR-2 05.010 (ETSI TS 101 377-5-7): "GEO-Mobile Radio Interface Specifications; Part 5: Radio interface physical layer specifications; Sub-part 7: Radio Subsystem Synchronization; GMR-2 05.010".

[6] ITU-T Recommendation 0.153: "Basic parameters for the measurement of error performance at bit rates below the primary rate".

[7] IEEE Std. 149-1979: "IEEE Standard Test Procedures for Antennas".

[8] IEC Publication 68-2-36: "Environmental testing. Part 2: Tests. Test Fdb: Random vibration wide band - Reproducibility Medium".

[9] IEC Publication 68-2-1: "Environmental testing - Part 2: Tests. Tests A: Cold".

[10] IEC Publication 68-2-2: "Environmental testing - Part 2: Tests. Tests B: Dry heat".

3 Abbreviations

For the purposes of the present document, the abbreviations given in GMR-2 01.004 [1] apply.

4 Frequency Bands and Channel Arrangement

The GMR-2 system is required to operate, at least, in the following frequency bands with polarization schemes as specified:

1 525,0 - 1 559,0 MHz	Satellite Transmit, Mobile Earth Station receive (forward link - downlink) Right Hand Circular Polarization, as defined by IEEE Std. 149-1979 [7].
1 626,5 - 1 660,5 MHz	Mobile Earth Station Transmit, Satellite Receive (return link - uplink) Right Hand Circular Polarization, as defined by IEEE Std. 149-1979 [7].
3 400,0 - 3 700,0 MHz	Satellite Transmit, Ground Terminal Receive (return link - downlink) Linear Vertical Polarization, as defined by IEEE Std. 149-1979 [7].
6 425,0 - 6 725,0 MHz	Ground Terminal Transmit, Satellite Receive (forward link - uplink) Linear Horizontal Polarization, as defined by IEEE Std. 149-1979 [7].

The carrier spacing is 200 kHz on the forward link. The carrier spacing is 50 kHz on the return link.

The carrier frequency is designated by the absolute radio frequency channel number (ARFCN) defined as nL for the L-Band channels and n_C for the C-Band channels. For the forward links, definition of the carrier frequency also requires specification of the Frequency Offset (FO) parameter which identifies either the baseline frequency plan (FO = 0), or the offset frequency plan (FO = 1), where the offset plan is obtained by shifting the baseline plan by 75 kHz. For the return links, the definition of the carrier frequency also requires specification of the TN (Timeslot Number) in order to identify which of the four 50 kHz carriers is selected from the corresponding 200 kHz channel. Therefore, the L-Band and C-Band carrier frequencies are calculated as follows:

a) L-Band Mobile Earth Station to Satellite Links:

- $Fd_L (n_L) = 1\,525{,}1 + n_L * 0{,}2$ for $0 \le n_L \le 169$, FO = 0;
- $Fd_L (n_L) = 1\,525{,}1 + n_L * 0{,}2 + 0{,}075$ for $0 \le n_L \le 168$, FO = 1;
- $Fu_L (n_L) = Fd_L (n_L) + 101{,}5$;
- $fu_L (n_L, TN) = Fd_L (n_L) + 101{,}425 + (TN \text{ modulo } 4) * 0{,}05$.

b) C-Band Ground to Satellite Links:

- $Fu_C (n_C) = 6\,425{,}1 + n_C*0.2$ for $0 \le n_C \le 1\,499$;
- $Fd_C (n_C) = Fu_C (n_C) - 3\,025{,}0$;
- $fd_C (n_C, TN) = Fu_C (n_C) - 3\,025{,}075 + (TN \text{ modulo } 4) * 0{,}05$,

where

- Fd_L (n_L) = frequency of carrier n_L on the L-Band downlink based on 200 kHz carrier spacing;
- Fu_L (n_L) = frequency of channel centre n_L on the L-Band uplink based on 200 kHz channel spacing;
- fu_L (n_L, TN) = frequency of carrier n_L for timeslot TN on the L-Band uplink based on 50 kHz carrier spacing;
- Fu_C (n_C) = frequency of carrier n_C on the C-Band uplink based on 200 kHz carrier spacing;
- Fd_C (n_C) = frequency of channel centre n_C on the C-Band downlink based on 200 kHz channel spacing;
- fd_C (n_C, TN) = frequency of carrier n_C for timeslot TN on the C-Band downlink based on 50 kHz carrier spacing,

and where units for all frequencies are in MHz.

The L-Band and C-Band frequency plans are graphically depicted in figure 4.1 through figure 4.6:

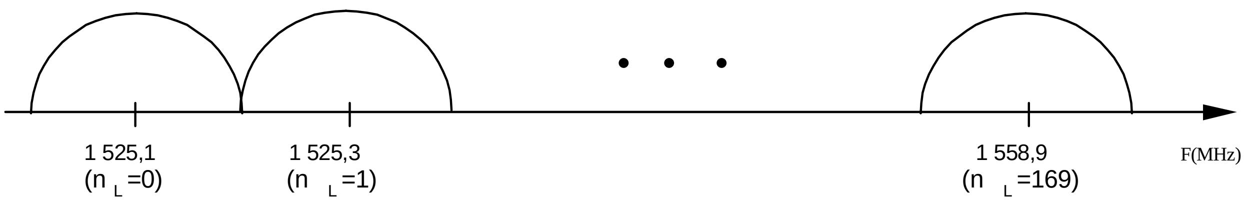


Figure 4.1: L-Band Downlink Frequency Plan for FO = 0

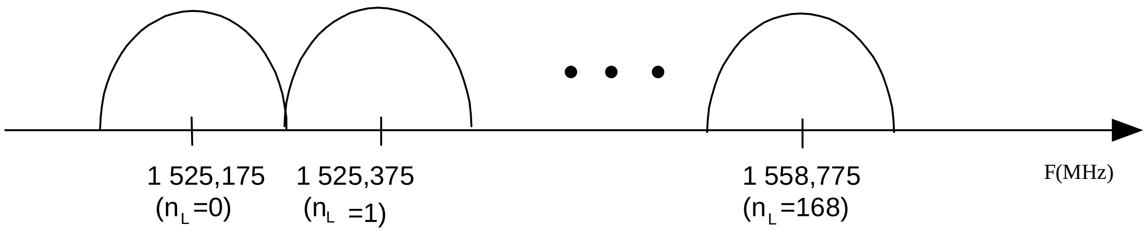


Figure 4.2: L-Band Downlink Frequency Plan for FO = 1

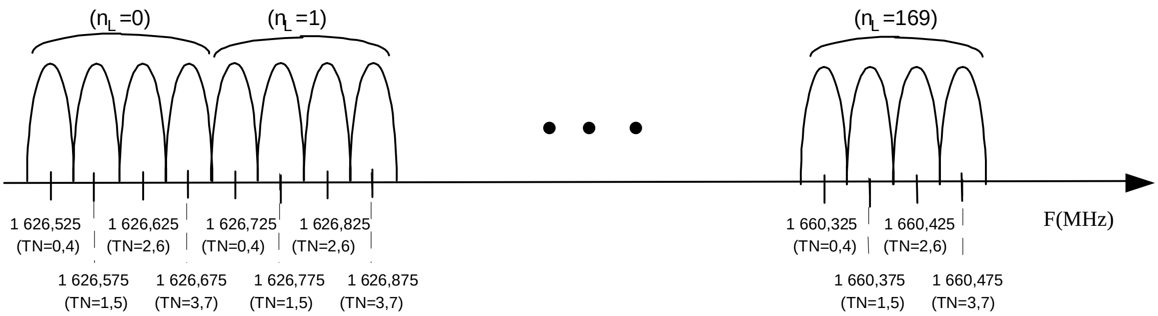


Figure 4.3: L-Band Uplink Frequency Plan for FO = 0

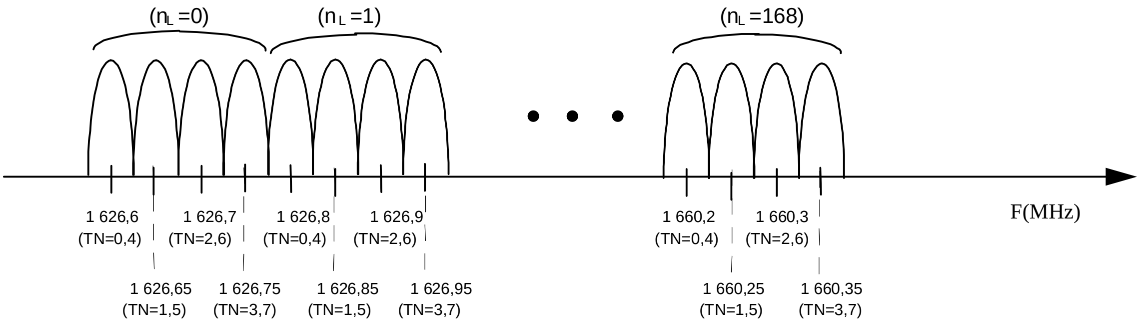


Figure 4.4: L-Band Uplink Frequency Plan for FO = 1

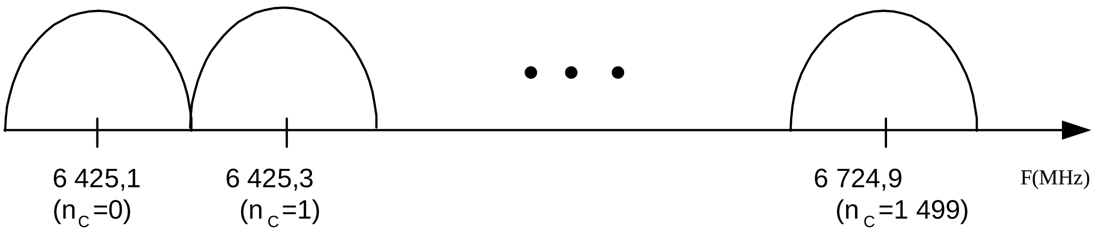


Figure 4.5: C-Band Uplink Frequency Plan

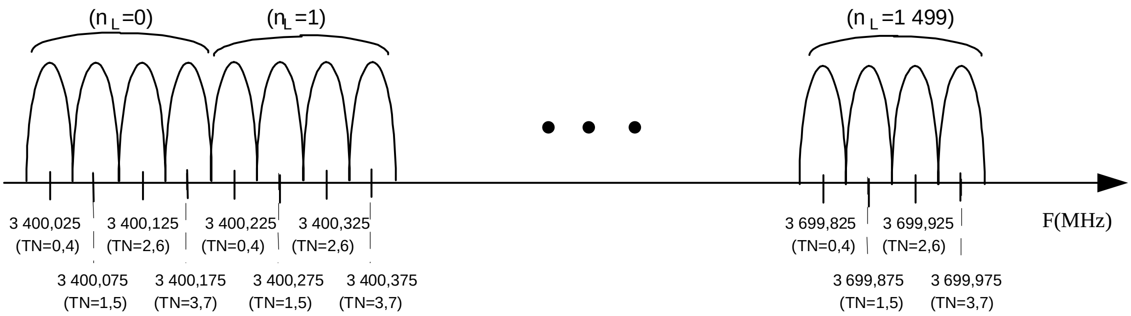


Figure 4.6: C-Band Downlink Frequency Plan

5 Reference configuration

The reference configuration for the radio subsystem is described in GMR-2 05.001 [2].

6 Transmitter characteristics

Throughout this clause, unless otherwise stated, the requirements for mobile earth stations (MES) are given in terms of power levels at the antenna connector of the equipment. For mobile user terminal equipment with integral antenna only, a reference antenna with 0 dBi gain shall be assumed. For fixed Mobile Earth Stations, Ground Terminals, and satellite transmitters the requirements are specified in terms of EIRP (Effective Isotropic Radiated Power).

The term transmit power refers to the measure of the power when averaged over the useful part of the burst (see clause A.2).

The term peak hold refers to a measurement where the maximum is taken over a sufficient time that the power level would not significantly increase if the holding time were longer.

6.1 Transmit Power

6.1.1 Mobile Earth Station (MES)

6.1.1.1 Mobile Terminal

The MES output power and corresponding power class shall be as defined in table 6.1.1.

Table 6.1.1: Mobile User Terminal Power Class

Power Class	Maximum Output Power	Tolerance (dB) for Conditions	
		Normal	Extreme
2	39 dBm	+1,5, - 0,0	+1,5, - 1,5
3	37 dBm	+1,5, - 0,0	+1,5, - 1,5
4	33 dBm	+1,5, - 0,0	+1,5, - 1,5

Power Class 4 shall correspond to a handset. The handset shall have > 2,0 dBi antenna gain, and < 4,5 dB axial ratio, over the range of 0 to 360 degrees azimuth and 20 to 90 degrees elevation (where this coverage is obtained through a combination of antenna field of view and proper handset orientation). Note that the handset antenna gain specification shall be met when the handset antenna is tested with a perfect circularly polarized test antenna.

Each MES shall support a number of different levels for adaptive power control. The different power levels needed for adaptive power control (see GMR-2 05.008 [4]) shall have the nominal output power as defined in the table 6.1.2, starting from the lowest power control level up to the maximum output power corresponding to the power class of the particular Mobile Earth Station.

Table 6.1.2: Mobile User Terminal Adaptive Power Control Output Power

Power Control Level	Output Power (dBm)	Tolerance (dB) for Conditions	
		Normal	Extreme
4	39,0	+1,5, - 0,0	+1,5, -1,5
5	38,5	+1,5, - 1,0	+2,0, - 2,0
6	38,0	+1,5, - 1,5	+2,0, - 2,0
7	37,5	+1,5, - 1,5	+2,0, - 2,0
8	37,0	+1,5, - 1,5	+2,0, - 2,0
9	36,5	+1,5, - 1,5	+2,0, - 2,0
10	36,0	+1,5, - 1,5	+2,0, - 2,0
11	35,5	+1,5, - 1,5	+2,0, - 2,0
12	35,0	+1,5, - 1,5	+2,0, - 2,0
13	34,5	+1,5, - 1,5	+2,0, - 2,0
14	34,0	+1,5, - 1,5	+2,0, - 2,0
15	33,5	+1,5, - 1,5	+2,0, - 2,0
16	33,0	+1,5, - 1,5	+2,0, - 2,0
17	32,5	+1,5, - 1,5	+2,0, - 2,0
18	32,0	+1,5, - 1,5	+2,0, - 2,0
19	31,5	+1,5, - 1,5	+2,0, - 2,0
20	31,0	+1,5, - 1,5	+2,0, - 2,0
21	30,5	+1,5, - 1,5	+2,0, - 2,0
22	30,0	+1,5, - 1,5	+2,0, - 2,0
23	29,5	+1,5, - 1,5	+2,0, - 2,0
24	29,0	+1,5, - 1,5	+2,0, - 2,0
25	28,5	+1,5, - 1,5	+2,0, - 2,0
26	28,0	+1,5, - 1,5	+2,0, - 2,0
27	27,5	+1,5, - 1,5	+2,0, - 2,0
28	27,0	+1,5, - 1,5	+2,0, - 2,0
29	26,5	+1,5, - 1,5	+2,0, - 2,0
30	26,0	+1,5, - 1,5	+2,0, - 2,0
31	25,5	+1,5, - 1,5	+2,0, - 2,0
32	25,0	+1,5, - 1,5	+2,0, - 2,0
33	24,5	+1,5, - 1,5	+2,0, - 2,0
34	24,0	+1,5, - 1,5	+2,0, - 2,0
35	23,5	+1,5, - 1,5	+2,0, - 2,0
36	23,0	+1,5, - 1,5	+2,0, - 2,0
37	22,5	+1,5, - 1,5	+2,0, - 2,0
38	22,0	+1,5, - 1,5	+2,0, - 2,0
39	21,5	+1,5, - 1,5	+2,0, - 2,0
40	21,0	+1,5, - 1,5	+2,0, - 2,0

Furthermore, the output power actually transmitted by the MES at each power control level shall form a monotonic sequence, where the typical step size between power levels is 0,5 dB and the maximum step size between power levels shall be < 1,0 dB over the full range of power levels.

When a change between two power levels is required by the Gateway Terminal, the maximum time to execute this change is as specified in GMR-2 05.008 [4].

6.1.1.2 Fixed Terminal

The MES maximum EIRP shall be 5 dBW, with a tolerance of +1,5, - 0,0 dB. The fixed MES shall be designated as Power Class 1.

Each MES shall support a number of different levels for adaptive power control. The different power levels needed for adaptive power control (see GMR-2 05.008 [4]) shall have the nominal EIRP as defined in the table 6.1.3.

Table 6.1.3: Fixed Mobile Earth Station Adaptive Power Control Power Levels

Power Control Level	EIRP (dBW)	Tolerance (dB)
4	11,0	+1,5, - 1,5
5	10,5	+1,5, - 1,5
6	10,0	+1,5, - 1,5
7	9,5	+1,5, - 1,5
8	9,0	+1,5, - 1,5
9	8,5	+1,5, - 1,5
10	8,0	+1,5, - 1,5
11	7,5	+1,5, - 1,5
12	7,0	+1,5, - 1,5
13	6,5	+1,5, - 1,5
14	6,0	+1,5, - 1,5
15	5,5	+1,5, - 1,5
16	5,0	+1,5, - 1,5
17	4,5	+1,5, - 1,5
18	4,0	+1,5, - 1,5
19	3,5	+1,5, - 1,5
20	3,0	+1,5, - 1,5
21	2,5	+1,5, - 1,5
22	2,0	+1,5, - 1,5
23	1,5	+1,5, - 1,5
24	1,0	+1,5, - 1,5
25	0,5	+1,5, - 1,5
26	0,0	+1,5, - 1,5
27	-0,5	+1,5, - 1,5
28	-1,0	+1,5, - 1,5
29	-1,5	+1,5, - 1,5
30	-2,0	+1,5, - 1,5
31	-2,5	+1,5, - 1,5
32	-3,0	+1,5, - 1,5
33	-3,5	+1,5, - 1,5
34	-4,0	+1,5, - 1,5
35	-4,5	+1,5, - 1,5
36	-5,0	+1,5, - 1,5
37	-5,5	+1,5, - 1,5
38	-6,0	+1,5, - 1,5
39	-6,5	+1,5, - 1,5
40	-7,0	+1,5, - 1,5

Furthermore, the EIRP actually transmitted by the MES at each power control level shall form a monotonic sequence, where the typical stepsize between EIRP levels is 0,5 dB and the maximum stepsize between EIRP levels shall be < 1,0 dB over the full range of EIRP levels. When a change between two power levels is required by the Gateway Terminal, the maximum time to execute this change is as specified in GMR-2 05.008 [4].

6.1.2 Satellite

For PSTN to MES calls, the satellite connects each of the 200 kHz channels on the C-band uplink to a 200 kHz channel in one of the L-band spotbeams. Signals sharing the same 200 kHz channel will therefore incur the same fixed gain through the satellite's transponder. For the forward link portion of these circuits the nominal L-band burst EIRP from the satellite shall be 50,7 dBW based on a nominal RSSi from the C-band uplink of -145,4 dBW. For the return link portion of these circuits the nominal C-band burst EIRP from the satellite shall be 5,6 dBW based on a nominal RSSi from the L-band uplink of -183,8 dBW. The burst EIRP for each 200 kHz channel will vary dB for dB as the uplink RSSi varies. Note that the transponder gain for each of the individual 200 kHz channels shall be adjustable over a 16,0 dB range in < 1,0 dB steps, where the nominal gain specified above shall correspond to the midpoint of this gain adjustment range. The tolerance for the nominal gain setting shall be +0,7 dB over 24 hours, and +2,2 dB over the life of the satellite.

For MES to MES calls, the satellite connects each individual TDMA circuit from the L-band uplink to an individual TDMA circuit in one of the L-band downlink spotbeams. For each individual TDMA circuit, the transponder provides automatic gain control to maintain a constant downlink EIRP in the presence of uplink RSSi variation. The downlink EIRP shall be adjustable over a 15,0 dB range in steps of 0,3 dB as shown in the table 6.1.4. The tolerance for the EIRP levels listed below shall be +0,3 dB over 24 hours, and +1,4 dB over the life of the satellite.

Table 6.1.4: Mobile to Mobile Downlink EIRP Levels

Mobile to Mobile Burst AGC Level	L-Band Burst EIRP (dBW)
0	55,5
1	55,2
2	54,9
3	54,6
4	54,3
5	54,0
6	53,7
7	53,4
8	53,1
9	52,8
10	52,5
11	52,2
12	51,9
13	51,6
14	51,3
15	51,0
16	50,7
17	50,4
18	50,1
19	49,8
20	49,5
21	49,2
22	48,9
23	48,6
24	48,3
25	48,0
26	47,7
27	47,4
28	47,1
29	46,8
30	46,5
31	46,2
32	45,9
33	45,6
34	45,3
35	45
36	44,7
37	44,4
38	44,1
39	43,8
40	43,5
41	43,2
42	42,9
43	42,6
44	42,3
45	42
46	41,7
47	41,4
48	41,1
49	40,8
50	40,5

The axial ratio for L-band downlinks shall be < 2,5 dB over the full L-band coverage region.

6.1.3 Gateway Terminal

The Gateway Terminal shall have the capability to adjust the burst EIRP for each individual TDMA circuit in support of adaptive power control (see GMR-2 05.008 [4]). In addition, the Gateway Terminal shall have the capability to compensate for uplink rain loss by automatically adjusting the burst EIRP with an accuracy of +0,5 dB. The burst EIRP range required to support adaptive power control shall be as defined in the table 6.1.5 during clear sky channel conditions (i.e., no uplink rain loss). During rainy sky conditions, the range defined in the table 6.1.5 shall be biased upward by an amount equal to the uplink rain loss. The maximum level of compensation for uplink rain loss shall be consistent with providing 99,99 % availability on the uplink.

Table 6.1.5

Power Control Level	Gateway Burst EIRP (dBW)	Tolerance (dB)
0	62,0	±1,0 dB
1	61,5	±1,0 dB
2	61,0	±1,0 dB
3	60,5	±1,0 dB
4	60,0	±1,0 dB
5	59,5	±1,0 dB
6	59,0	±1,0 dB
7	58,5	±1,0 dB
8	58,0	±1,0 dB
9	57,5	±1,0 dB
10	57,0	±1,0 dB
11	56,5	±1,0 dB
12	56,0	±1,0 dB
13	55,5	±1,0 dB
14	55,0	±1,0 dB
15	54,5	±1,0 dB
16	54,0	±1,0 dB
17	53,5	±1,0 dB
18	53,0	±1,0 dB
19	52,5	±1,0 dB
20	52,0	±1,0 dB
21	51,5	±1,0 dB
22	51,0	±1,0 dB
23	50,5	±1,0 dB
24	50,0	±1,0 dB
25	49,5	±1,0 dB
26	49,0	±1,0 dB
27	48,5	±1,0 dB
28	48,0	±1,0 dB
29	47,5	±1,0 dB
30	47,0	±1,0 dB
31	46,5	±1,0 dB
32	46,0	±1,0 dB
33	45,5	±1,0 dB
34	45,0	±1,0 dB

Note that the tolerance specified in table 6.1.5 accounts for both the accuracy in initial settability and for stability over a period of > 30 days.

Furthermore, the output EIRP actually transmitted by the Gateway Terminal at each power control level shall form a monotonic sequence, and the interval between power steps shall be 0,5 dB +0,2 dB.

The maximum time to adjust between any two EIRP levels is specified in GMR-2 05.008 [4].

6.1.4 NCC Terminal

The NCC Terminal shall have the capability to adjust the burst EIRP for each of the individual TDMA control channels (S-BCCH, S-AGCH, S-PCH, S-HBCCH, S-SCH, S-HPACH, and S-HMSCH) over the following range during clear sky conditions:

Table 6.1.6: NCC Uplink EIRP Levels

Level	NCC Burst EIRP (dBW)	Tolerance (dB)
0	69,0	±1,0 dB
1	68,5	±1,0 dB
2	68,0	±1,0 dB
3	67,5	±1,0 dB
4	67,0	±1,0 dB
5	66,5	±1,0 dB
6	66,0	±1,0 dB
7	65,5	±1,0 dB
8	65,0	±1,0 dB
9	64,5	±1,0 dB
10	64,0	±1,0 dB
11	63,5	±1,0 dB
12	63,0	±1,0 dB
13	62,5	±1,0 dB
14	62,0	±1,0 dB
15	61,5	±1,0 dB
16	61,0	±1,0 dB
17	60,5	±1,0 dB
18	60,0	±1,0 dB
19	59,5	±1,0 dB
20	59,0	±1,0 dB
21	58,5	±1,0 dB
22	58,0	±1,0 dB
23	57,5	±1,0 dB
24	57,0	±1,0 dB
25	56,5	±1,0 dB
26	56,0	±1,0 dB
27	55,5	±1,0 dB
28	55,0	±1,0 dB
29	54,5	±1,0 dB
30	54,0	±1,0 dB
31	53,5	±1,0 dB
32	53,0	±1,0 dB
33	52,5	±1,0 dB
34	52,0	±1,0 dB

In addition, the NCC Terminal shall have the capability to compensate for uplink rain fades by automatically adjusting the burst EIRP with an accuracy of +0,5 dB. During rainy sky conditions the range defined in table 6.1.6 shall be biased upward by an amount equal to the uplink rain loss. The maximum level of compensation for uplink rain loss shall be consistent with providing 99,99 % availability on the uplink.

Note that the tolerance specified in table 6.1.6 accounts for both the accuracy in initial settability and for stability over a period of > 30 days. The differential burst EIRP tolerance between two different control channels, after initial alignment to the same transmit level, shall be < 1,4 dB peak to peak after accounting for both the tolerance in initial settability and for stability over a period of > 30 days.

Furthermore, the output EIRP actually transmitted by the NCC Terminal at each power control level shall form a monotonic sequence, and the interval between power steps shall be 0,5 dB +0,2 dB.

6.2 Output RF Spectrum

The specifications contained in this clause apply to the Mobile Earth Station, the Gateway Terminal, and the NCC Terminal.

Due to the burst nature of the signal, the output RF spectrum results from two effects:

a) the modulation process;

b) the power ramping up and down (switching transients).

The two effects are specified separately; the measurement method used to analyze separately those two effects is based on the "ringing effect" during the transients, and is a measurement in the time domain, at each point in frequency.

6.2.1 Spectrum Due to the Modulation and Wide Band Noise

The output RF modulation spectrum is specified in tables 6.2.1 and 6.2.2. A mask representation of the present document is shown in clause A.1. This mask applies for all RF channels mentioned in clause 4.

The specification applies to the entire transmit band and up to 2 MHz on either side.

a) Mobile Earth Station

The figures in table 6.2.1, at the listed frequencies from the carrier (in kHz), are the maximum level (dB) relative to a measurement in 7,5 kHz on the carrier for Mobile Earth Stations. For fixed Mobile Earth Stations the specifications are identical to the specifications for mobile terminals with power levels < 33 dBm.

Table 6.2.1: Mobile Earth Station Out of Band Modulation Requirements

Power Level (dBm)	**Measurement Bandwidth**								
	7,5 kHz						**25 kHz**		
	25	50	62,5	100	150 to < 300	300 to < 450	450 to < 750	750 to < 1 500	≥ 1 500
≥ 39	-4,0	-30	-33	-55	-61	-61	-69	-71	-71
38,5	-4,0	-30	-33	-55	-60,5	-60,5	-68,5	-70,5	-70,5
38	-4,0	-30	-33	-55	-60	-60	-68	-70	-70
37,5	-4,0	-30	-33	-55	-59,5	-59,5	-67,5	-69,5	-69,5
37	-4,0	-30	-33	-55	-59	-59	-67	-69	-69
36,5	-4,0	-30	-33	-55	-58,5	-58,5	-66,5	-68,5	-68,5
36	-4,0	-30	-33	-55	-58	-58	-66	-68	-68
35,5	-4,0	-30	-33	-55	-57,5	-57,5	-65,5	-67,5	-67,5
35	-4,0	-30	-33	-55	-57	-57	-65	-67	-67
34,5	-4,0	-30	-33	-55	-56,5	-56,5	-64,5	-66,5	-66,5
34	-4,0	-30	-33	-55	-56	-56	-64	-66	-66
33,5	-4,0	-30	-33	-55	-55,5	-55,5	-63,5	-65,5	-65,5
≤ 33	-4,0	-30	-33	-47	-52	-55	-63	-65	-65

b) Ground Terminal

The figures in table 6.2.2, at the listed frequencies from the carrier (in kHz), are the maximum level (dB) relative to a measurement in 30 kHz on the carrier. These specifications apply to all power control levels less than or equal to power control level 14 specified in clauses 6.1.3 and 6.1.4 of the present document. For all power control levels greater than power control level 14, the absolute maximum levels shall be no worse than the levels indicated in table 6.2.2 at power control level 14.

Table 6.2.2: Ground Terminal Out of Band Modulation Requirements

Measurement Bandwidth							
30 kHz					100 kHz		
100	200	400	600 to < 1 200	1 200 to < 1 800	1 800 to < 3 000	3 000 to < 6 000	≥ 6 000
-15	-40	-55	-55	-55	-55	-55	-55

These specifications assume the following measurement conditions:

- For Ground Terminals up to 1 800 kHz from the carrier:

  Zero frequency scan with filter bandwidth and video bandwidth of 30 kHz with averaging done over 50 % to 90 % of the useful part of the transmitted bursts, excluding sync bits, and then averaged over at least 200 such burst measurements.

- For Ground Terminals above 1 800 kHz from the carrier:

  Swept measurement with filter bandwidth and video bandwidth of 100 kHz, minimum sweep time of 75 ms, averaging over 200 sweeps. All slots active.

- For the Mobile Earth Station:

  Zero frequency scan (i.e., span), filter bandwidth and video bandwidth of 7,5 kHz up to 450 kHz from the carrier and 25 kHz beyond 450 kHz, with averaging done over 50 % to 90 % of the useful part of the transmitted bursts, excluding sync bits, and then averaged over at least 200 such burst measurements. Above 450 kHz from the carrier only measurements centred on 50 kHz multiples are taken with averaging over 50 bursts.

6.2.2 Spectrum Due to Switching Transients

The effects of switching transients are also measured in the time domain and the specifications assume the following measurement conditions: zero frequency scan, peak hold, filter bandwidth of 7,5 kHz for the Mobile Earth Station and 30 kHz for the Ground Terminal, and a video bandwidth of 25 kHz for the Mobile Earth Station and 100 kHz for the Ground Terminal.

a) Mobile Earth Station (MES)

The values in table 6.2.3, at the indicated offsets from the carrier, are the maximum allowable levels (dBm). These requirements apply to all power control levels specified in clause 6.1.1.

Table 6.2.3: Mobile Earth Station Maximum Switching Transient Level

Maximum Level Measured (dBm)			
100 kHz	150 kHz	300 kHz	450 kHz
-23	-26	-32	-36

b) Ground Terminal

The figures in table 6.2.4, at the listed frequencies from the carrier (in kHz), are the maximum level (dB) relative to a measurement in 30 kHz on the carrier. These specifications apply to all burst EIRP levels specified in clauses 6.1.3 and 6.1.4.

Table 6.2.4: Ground Terminal Maximum Switching Transient Level

Maximum level measured			
400 kHz	600 kHz	1 200 kHz	1 800 kHz
-55	-60	-65	-70

An example of the waveform due to a Transmitter burst as seen in a 30 kHz filter offset from the carrier is shown in figure 4.2-1/05.05.

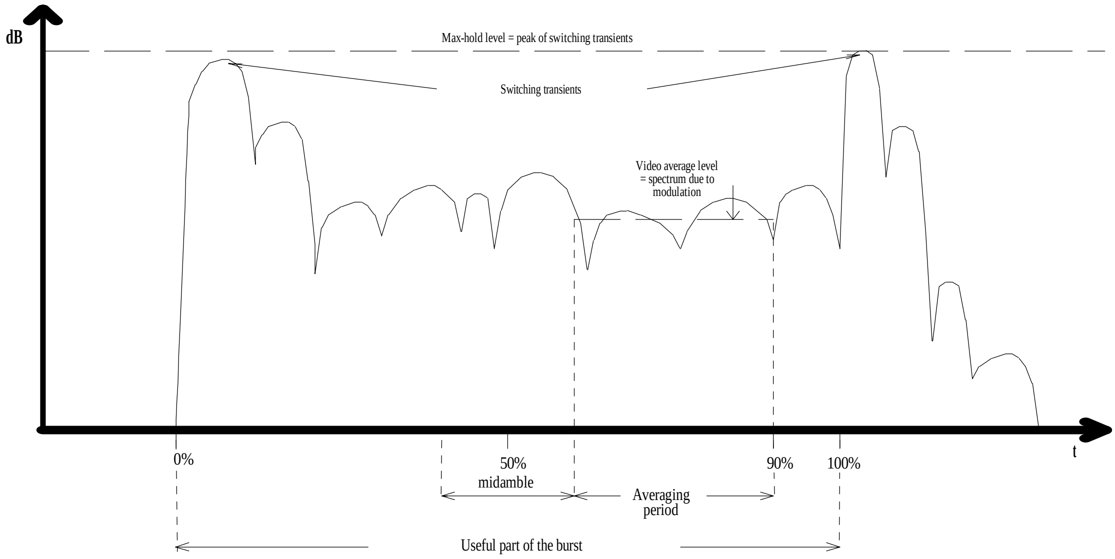


Figure 6.2.1: Example of a Waveform Due to a Burst as Seen in a 30 kHz Filter Offset From Carrier

6.3 Spurious Emissions

6.3.1 Principle of the Specification

In this clause, the spurious transmissions (whether modulated or unmodulated) and the switching transients are specified together by measuring the peak power in a given bandwidth at various frequencies.

6.3.2 Mobile Earth Station (MES)

6.3.2.1 Mobile Earth Station Measurement Conditions

For the following MES spurious requirements, the measurement bandwidth is increased as the frequency offset between the measurement frequency and, either the carrier, or the edge of the MES transmit band, increases. The effect of widening the measurement bandwidth (for spurious signals) is to reduce the allowed total spurious energy per MHz. The effect for switching transients is to effectively reduce the allowed level of the switching transients (the peak level of a switching transient increases by 6 dB for each doubling of the measurement bandwidth). The conditions are specified in tables 6.3.1 and 6.3.2, a peak-hold measurement being assumed.

a) In-Band Spurious:

Table 6.3.1: Mobile Earth Station In-Band Spurious Emission Conditions

Band	Frequency Offset (Offset from carrier)	Measurement Bandwidth
Transmit Band	≥ 0,45 MHz ≥ 1,5 MHz	7,5 kHz 25 kHz

b) Out-of-Band Spurious:

Table 6.3.2: Mobile Earth Station Out-of-Band Spurious Emission Conditions

Band	Frequency Offset	Measurement bandwidth
100 kHz - 50 MHz	-	10 kHz
50 MHz - 500 MHz	-	100 kHz
Above 500 MHz and outside the transmit band	(Offset from edge of the transmit band)	
	≥ 2 MHz	30 kHz
	≥ 5 MHz	100 kHz
	≥ 10 MHz	300 kHz
	≥ 20 MHz	1 MHz
	≥ 30 MHz	3 MHz

For measurement, the resolution bandwidth is set to the value of the measurement bandwidth in the table, and the video bandwidth to approximately three times this value.

NOTE: For radiated spurious emissions for a Mobile Earth Station with antenna connectors, and for all spurious emissions for a Mobile Earth Station with integral antennas, the specifications currently only apply to the frequency band 30 MHz to 4 GHz. The specification and method of measurement outside this band are under consideration.

6.3.2.2 Mobile Earth Station Spurious Limits

6.3.2.2.1 Mobile Mobile Earth Stations

The power measured in the conditions specified in clause 6.3.2.1a, when the Mobile Earth Station is allocated a channel, shall be no more than -26 dBm.

The power measured in the conditions specified in clause 6.3.2.1b, when the Mobile Earth Station is allocated a channel, shall be no more than (see note in clause 6.3.2.1b):

- -36 dBm in the frequency band 9 kHz - 1,0 GHz;
- -30 dBm in the frequency band 1,0 - 12,75 GHz.

The power measured in conditions in clause 6.3.2.1a, when the Mobile Earth Station is not allocated a channel (i.e., idle mode), shall be no more than -56 dBm.

The power measured in the conditions in clause 6.3.2.1b, when the Mobile Earth Station is not allocated a channel (idle mode), shall be no more than (see note in clause 6.3.2.1 above):

- -57 dBm in the frequency bands 9 kHz - 1,0 GHz;
- -47 dBm in the frequency bands 1,0 GHz - 12,75 GHz.

NOTE: The idle mode spurious emissions in the receive band are covered by the case for the Mobile Earth Station allocated a channel (see below).

When allocated a channel, the power emitted by the Mobile Earth Station, when averaging over at least 50 burst measurements with a filter and video bandwidth of 100 kHz, for measurements centred on the receive channels as specified in clause 4, shall be no more than -75 dBm (with a goal of -79 dBm).

6.3.2.2.2 Fixed Mobile Earth Stations

The EIRP measured in the conditions specified in clause 6.3.2.1a, when the Mobile Earth Station is allocated a channel, shall be no more than -54 dBW.

The EIRP measured in the conditions specified in clause 6.3.2.1b, when the Mobile Earth Station is allocated a channel, shall be no more than (see note in clause 6.3.2.1b above):

- -64 dBW in the frequency band 9 kHz - 1,0 GHz;
- -58 dBW in the frequency band 1,0 GHz - 12,75 GHz.

The EIRP measured in conditions in clause 6.3.2.1a, when the Mobile Earth Station is not allocated a channel (i.e., idle mode), shall be no more than -84 dBW.

The EIRP measured in the conditions in clause 6.3.2.1b, when the Mobile Earth Station is not allocated a channel (idle mode), shall be no more than (see note in clause 6.3.2.1):

- -85 dBW in the frequency bands 9 kHz - 1,0 GHz;
- -75 dBW in the frequency bands 1,0 GHz - 12,75 GHz.

NOTE: The idle mode spurious emissions in the receive band are covered by the case for the Mobile Earth Station allocated a channel (see below).

When allocated a channel, the EIRP emitted by the Mobile Earth Station, when averaging over at least 50 burst measurements with a filter and video bandwidth of 100 kHz, for measurements centred on the receive channels as specified in clause 4 shall be no more than -101 dBW (with a goal of -106 dBW).

6.3.3 Satellite Terminal

6.3.3.1 Forward Link Spurious Emissions

6.3.3.1.1 Sub-Band Spurious Emissions

With the transponder gain control in the nominal position, the total RMS power resulting from the sum of all spurious signals in any 4 kHz band within any sub-band shall not exceed +40 dBm EIRP at the L-band antenna output, and in any 200 kHz channel within any sub-band shall not exceed +46 dBm EIRP.

With the transponder gain control in the nominal position, any beam, when loaded with a carrier up to a level representing 20 % of the AEIRP of the satellite, shall not have sidebands due to spurious modulation higher than 37 dB below the level of the carrier.

6.3.3.1.2 L-Band In-Band Spurious Emissions

With the transponder gain control in the nominal position, the sum of all spurious signals in any 4 kHz bandwidth, radiated inside the MSS L-band spectrum, but outside of the sub-bands, shall not exceed 30 dBm at the L-band antenna output.

6.3.3.1.3 Out of Band Emissions

With the transponder gain control in the nominal position, the EIRP, produced by the sum of all spurious signals in any 4 kHz bandwidth outside the GMR-2 C and L transmit and receive frequency bands, shall not exceed 45 dBm at the L-band antenna output, within the frequency range 1 480 MHz to 1 610 MHz. These specifications shall be met with any beam excited to its maximum allowed AEIRP and with a CW test signal level of:

- -124 dBW at the transponder input swept over the entire MSS L-band spectrum.

With the transponder gain control in the nominal position, the EIRP, produced by the harmonics of the L-band downlink transmission shall be less than 15 dBm in any 4 kHz bandwidth at the L-band antenna output. These specifications shall be met with any beam excited to its maximum allowed AEIRP and with a CW test signal level of -124 dBW at the transponder input swept over the entire MSS L-band spectrum.

6.3.3.2 Return Link Spurious Emissions

6.3.3.2.1 Sub-Band Spurious Emissions

With the transponder gain control in the nominal position, the total RMS power resulting from the sum of all spurious signals in any 4 kHz band within any sub-band shall not exceed 0,0 dBm EIRP, and within any 50 kHz band within any sub-band shall not exceed 3,0 dBm EIRP, for any transponder traffic load up to saturation of the C-band power amplifier, at the C-band antenna output.

With the transponder gain control in the nominal position, any transponder, when loaded with a carrier at a level representing full C-band AEIRP of the satellite shall not have sidebands due to spurious modulation higher than 37 dB below the level of the carrier.

6.3.3.2.2 C-Band In-Band Spurious Emissions

With the transponder gain control in the nominal position, the sum of all spurious signals in any 4 kHz bandwidth, radiated inside the feeder link C-band spectrum but outside of the active sub-bands, shall not exceed -26 dBm at the C-band antenna output.

6.3.3.2.3 Out of Band Emissions

With the transponder gain control in the nominal position, the EIRP, produced by the sum of all spurious signals in any 4 kHz bandwidth outside the GMR-2 C and L transmit and receive frequency bands, shall not exceed -26 dBm at the C-band antenna output.

With the transponder gain control in the nominal position, the EIRP, produced by the harmonics of the C-band downlink transmission shall be less than -14 dBm in any 4 kHz bandwidth at the C-band antenna output.

With the transponder gain control in the nominal position, the specifications shall be met with any transponder excited to full C-band AEIRP, with the C-band power amplifier appropriately backed-off, using a CW test signal swept over the entire feeder-link downlink spectrum.

6.3.4 Gateway

6.3.4.1 C-Band In-Band Spurious Emissions

The in-band spurious emission requirements shall be met with test (reference) carrier signal(s) active and set to the maximum level specified in clause 6.1.3 and spaced per the channel allocations specified in clause 4.

6.3.4.1.1 C-Band In-Channel Spurious Emissions

The total RMS power resulting from the sum of all spurious signals in any 200 kHz channel (where the channel allocations are specified in clause 4) surrounding a reference carrier (i.e. 100 kHz either side of a reference carrier) shall not exceed -37dBc, exclusive of intermodulation noise as specified in clause 6.7.2. Note that the reference carrier level shall be consistent with the maximum carrier level specified in clause 6.1.3.

6.3.4.1.2 C-Band Out of Channel Spurious Emissions

The total RMS power resulting from the sum of all spurious signals in any 200 kHz band (where the frequency bands are specified in clause 4) other than the in-channel spurious surrounding a reference carrier as defined in clause 6.3.4.1.1, shall not exceed -52 dBc, exclusive of intermodulation noise as specified in clause 6.7.2. Note that the reference carrier level shall be consistent with the maximum carrier level specified in clause 6.1.3.

6.3.4.2 Out of Band Spurious Emissions

The total RMS power resulting from the sum of all spurious signals in any 4 kHz bandwidth outside the GMR-2 C-band uplink frequency bands shall not exceed -50 dBc, exclusive of intermodulation noise as specified in clause 6.7.2. Note that the reference carrier level shall be consistent with the maximum carrier level specified in clause 6.1.3.

6.3.5 NCC

6.3.5.1 C-Band In-Band Spurious Emissions

The in-band spurious emission requirements shall be met with test (reference) carrier signal(s) set to the maximum level specified in clause 6.1.4 and spaced per the channel allocations specified in clause 4.

6.3.5.1.1 C-Band In-Channel Spurious Emissions

The total RMS power resulting from the sum of all spurious signals in any 200 kHz channel (where the channel allocations are specified in clause 4) surrounding a reference carrier (i.e. 100 kHz either side of a reference carrier) shall not exceed -37 dBc, exclusive of intermodulation noise as specified in clause 6.7.2. Note that the reference carrier level shall be consistent with the maximum carrier level specified in clause 6.1.4.

6.3.5.1.2 C-Band Out of Channel Spurious Emissions

The total RMS power resulting from the sum of all spurious signals in any 200 kHz band (where the frequency bands are specified in clause 4) other than the in-channel spurious surrounding a reference carrier as defined in clause 6.3.5.1.1, shall not exceed -52 dBc, exclusive of intermodulation noise as specified in clause 6.7.2. Note that the reference carrier level shall be consistent with the maximum carrier level specified in clause 6.1.4.

6.3.5.2 Out of Band Spurious Emissions

The total RMS power resulting from the sum of all spurious signals in any 4 kHz bandwidth outside the GMR-2 C-band uplink frequency bands shall not exceed -50 dBc, exclusive of intermodulation noise as specified in clause 6.7.2. Note that the reference carrier level shall be consistent with the maximum carrier level specified in clause 6.1.4.

6.4 Radio Frequency Tolerance

The radio frequency tolerance for the satellite terminal, ground terminal, and the Mobile Earth Station is defined in GMR-2 05.010 [5].

6.5 Output Level Dynamic Operation

NOTE: The term "any transmit band channel" is used here to mean any of the GMR-2 RF channels defined in clause 4.

6.5.1 Mobile Earth Station

The output power can be reduced in 0,5 dB steps in accordance with clause 4.1.

The transmitted power level relative to time when sending a burst is shown in clause A.2. The timing of the transmitted burst is specified in GMR-2 05.010 [5]. Between the active bursts, for mobile Mobile Earth Stations, the residual output power shall be maintained at, or below, the level of -36 dBm in any transmit band. Between the active bursts, for fixed Mobile Earth Stations, the residual EIRP shall be maintained at, or below, the level of -64 dBW in any transmit band.

A measurement bandwidth of at least 75 kHz is assumed.

The transmitter, when in idle mode, will respect the conditions of clause 6.3.2.

6.5.2 Ground Terminal

The Ground Terminal shall be capable of not transmitting a burst in a time slot not used by a logical channel or where DTX applies. The output power relative to time when sending a burst is shown in clause A.2. The residual output power, if a timeslot is not activated, shall be maintained at, or below, a level of -51 dBc on the frequency channel in use. The present document is applicable at the power control levels 0 through 14 per table 6.1.5 for the Gateway segment and power control levels 0 through 28 per table 6.1.6 for the NCC segment. All emissions related to other frequency channels shall be in accordance with the wide band noise and spurious emissions requirements.

A measurement bandwidth of at least 200 kHz is assumed.

6.6 Signal Impairments

When transmitting a burst, the phase accuracy of the signal, relative to the theoretical modulated waveforms as specified in GMR-2 05.004 [3], is specified in the following way:

For any 148-bit subsequence of the 511-bit pseudo-random sequence, defined in ITU-T Recommendation O.153 fascicle IV.4 [6], the phase error trajectory on the useful part of the burst (including tail bits), shall be measured by computing the difference between the phase of the transmitted waveform and the phase of the expected one. For the Ground Terminals, the reference phase trajectory is obtained after transmit filtering as specified in GMR-2 05.004 [3].

NOTE: Using the encryption (ciphering mode) is an allowed means to generate the pseudo-random sequence.

The burst timing of the modulated carrier in the active part of the time slot shall be chosen to ensure that all the modulating bits in the useful part of the burst (see GMR-2 05.004 [3]) influence the output phase in a time slot.

6.6.1 Ground Terminal Phase Accuracy

The RMS phase error (where phase error is defined as the difference between the phase error trajectory and its linear regression on the active part of the time slot) shall not be greater than 5° with a maximum peak deviation during the useful part of the burst less than 20°. Note that static phase and frequency offsets are estimated through linear regression of the phase error trajectory, and therefore are not considered sources of phase error.

6.6.2 Mobile Earth Station Phase Accuracy

The RMS phase error (where phase error is defined as the difference between the phase error trajectory and its linear regression on the active part of the time slot) shall not be greater than 5° with a maximum peak deviation during the useful part of the burst less than 20°. Note that static phase and frequency offsets are estimated through linear regression of the phase error trajectory, and therefore are not considered sources of phase error.

6.7 Intermodulation Noise

6.7.1 Satellite Terminal

6.7.1.1 Forward Link Intermodulation Noise

6.7.1.1.1 Noise Power Ratio (NPR)

With the transponder gain control in the nominal position, the system linearity shall be designed so that sub-band intermodulation noise shall give a system NPR of at least 21 dB at the maximum power output in any beam.

With the transponder gain control in the nominal position, the linearity of the individual high power amplifiers shall give an NPR of at least 13 dB at maximum operating point.

6.7.1.1.2 Passive Intermodulation (PIM)

With the transponder gain control in the nominal position, the summation of all high order PIM products generated by two CW carriers and falling within the C-band receive band shall not exceed -152 dBm in any 4 kHz band at the C-band receive antenna output.

With the transponder gain control in the nominal position, the summation of all high order PIM products generated by two CW carriers and falling within the L-band receive band shall not exceed -152 dBm in any 4 kHz band at the L-band receive antenna output.

6.7.1.1.3 High Order Active Intermodulation (AIM)

With the transponder gain control in the nominal position, the summation of all high order AIM products generated by the spacecraft and falling within the C-band receive band shall not exceed -152 dBm in any 4 kHz band at the C-band receive antenna output.

With the transponder gain control in the nominal position, the summation of all high order AIM products generated by the spacecraft and falling within the L-band receive band shall not exceed -152 dBm in any 4 kHz band at the L-band receive antenna output.

6.7.1.2 Return Link Intermodulation Noise

6.7.1.2.1 Noise Power Ratio (NPR)

With the transponder gain control in the nominal position, the transponder linearity shall be such that sub-band intermodulation noise shall give a system NPR of at least 23 dB at the specified aggregate EIRP output level.

6.7.1.2.2 Passive Intermodulation (PIM)

With the transponder gain control in the nominal position, the summation of all high order PIM products generated by two CW carriers and falling within the C-band receive band shall not exceed -152 dBm in any 4 kHz band at the C-band receive antenna output.

With the transponder gain control in the nominal position, the summation of all high order PIM products generated by two CW carriers and falling within the L-band receive band shall not exceed -152 dBm in any 4 kHz band at the L-band receive antenna output.

6.7.1.2.3 High Order Active Intermodulation (AIM)

With the transponder gain control in the nominal position, the summation of all high order AIM products generated by the spacecraft and falling within the C-band receive band shall not exceed -152 dBm in any 4 kHz band at the C-band receive antenna output.

With the transponder gain control in the nominal position, the summation of all high order AIM products generated by the spacecraft and falling within the L-band receive band shall not exceed -152 dBm in any 4 kHz band at the L-band receive antenna output.

6.7.2 Ground Terminal NPR

With the transmitter operating at maximum output power (i.e. with maximum traffic/signalling load and maximum uplink rain loss compensation), the NPR shall be at least 30 dB.

7 Receiver Characteristics

In this clause, the Mobile Earth Station requirements are given in terms of power levels at the antenna connector of the receiver. Equipment with integral antenna may be taken into account by converting these power level requirements into field strength requirements, assuming a 0 dBi gain antenna. This means that the tests on equipment on integral antenna will consider field strengths (E) related to the power levels (P) specified, by the following formula:

$$E = P + 20*\log F(MHz) + 77,2:$$

Assuming F = 1 525 MHz:

$$E\ (dB\mu V/m) = P\ (dBm) + 140,9$$

Static (AWGN) propagation conditions are assumed in all cases, for both wanted and unwanted signals. For clauses 7.1 and 7.2, values given in dBm are indicative, and calculated assuming a 50 ohms impedance.

7.1 Mobile Earth Station Blocking Characteristics

The blocking characteristics of the MES receiver are specified separately for in-band and out-of-band performance as identified in table 7.1.1.

Table 7.1.1: Mobile Earth Station Receiver Blocking Conditions

Frequency Band	Frequency (MHz)
In-Band	1 475,0 to 1 609,0
Out-of-Band (a)	0,1 to < 1 475,0
Out-of-Band (b)	> 1 609,0 to 12 750

The reference sensitivity performance as specified in clause 8.2 shall be met when the following signals are simultaneously input to the receiver:

- useful signal at frequency f_0, 3 dB above the reference sensitivity level as specified in clause 8.2;
- a continuous, static sine wave signal at a level as specified in table 6.1.2 and at a frequency (f) which is an integer multiple of 200 kHz,

with the following exceptions, called spurious response frequencies:

- in-band, for a maximum at twelve occurrences (which, if grouped, shall not exceed three contiguous occurrences per group);
- out-of-band, for a maximum of 24 occurrences (which, if below f_0, and grouped shall not exceed three contiguous occurrences per group),

where the above spurious responses shall be met when the continuous sine wave signal (f) is set to a level of -55 dBm.

Table 7.1.2: Mobile Earth Station Receiver Blocking Requirements

Frequency Band	dB µV (emf)	dBm
In-Band 600 kHz ≤ $\lvert f-f_0 \rvert$ < 800 kHz 800 kHz ≤ $\lvert f-f_0 \rvert$ < 1,6 MHz 1,6 MHz ≤ $\lvert f-f_0 \rvert$	 55 60 70	 -58 -53 -43
Out-of-Band 0,1 MHz to < 1 000 MHz 1 000 MHz to < 2 120 MHz Transmit Band specified in clause 4 > 2 250 MHz to < 12 750 MHz	 103 83 73 83	 -10 -30 -40 -30

7.2 Ground Terminal Blocking Characteristics

There shall be no degradation in receiver sensitivity thresholds specified in clause 8.2 when a continuous static sine wave is received at a frequency which is > 10 MHz outside of the receive band defined in clause 4 and which is at a level of 30 dB above the reference sensitivity levels specified in clause 8.2.

7.3 Mobile Earth Station AM Suppression Characteristics

The reference sensitivity performance as specified in table 8.2.1, shall be met when the following signals are simultaneously input to the receiver:

a) a useful signal at frequency f_0, 3 dB above reference sensitivity level as specified in clause 8.2.

b) a signal frequency (f), in the relevant receive band, $|f-f_0| > 6$ MHz, which is an integer multiple of 200 kHz, an GMR-2 TDMA forward signal modulated by any 148-bit sequence of the 511-bit pseudo-random bit sequence, defined in ITU-T Recommendation O.153 fascicle IV.4 [6], at a level of -46 dBm. This interferer shall have one time slot active and the frequency shall be at least two channels away from any identified spurious response. The transmitted bursts shall be synchronized to, but delayed between 61 and 66 bit periods, relative to the bursts of the useful signal.

7.4 Mobile Earth Station Intermodulation Characteristics

The reference sensitivity performance as specified in table 8.2.1 shall be met when the following signals are simultaneously input to the receiver:

a) a useful signal at frequency f_0, 3 dB above the reference sensitivity level as specified in clause 8.2;

b) a continuous, static sine wave signal at frequency f_1 and a level of 49 dBμV (emf) (i.e., -64 dBm);

c) any 148-bits subsequent of the 511-bits pseudo-random sequence, defined in ITU-T Recommendation O.153 fascicle IV.4 [6], modulating a signal at frequency f_2 and a level of 49 dBμV (emf) (i.e., -64 dBm) such that $f_0 = 2f_1 - f_2$ and $|f_2 - f_1| = 800$ kHz.

NOTE: Instead of any 148 bit subsequent of the 511 bit pseudo random sequence, defined in the ITU-T Recommendation O.153 fascicle IV.4 [6], use of a more random pseudo random sequence is allowed.

7.5 G/T Performance

7.5.1 Satellite Terminal

The satellite terminal shall provide a minimum L-Band G/T of 15,3 dBi/K over the L-band coverage region. The satellite terminal axial ratio shall be 2,5 dB maximum over the L-band coverage region.

The satellite terminal shall provide a minimum C-Band G/T of -6,5 dBi/K edge of coverage.

7.5.2 Mobile Earth Station

The Mobile Earth Station shall provide a minimum G/T as specified in table 7.5.1.

Table 7.5.1: Minimum Mobile Earth Station G/T

Mobile Earth Station Type	G/T
Handset	-26 dBi/K
Fixed	-14,0 dBi/K

For handsets, the G/T shall be as specified above and the axial ratio shall be < 4,5 dB over the range of 0 to 360 degrees azimuth and 20 to 90 degrees elevation (where this coverage is obtained through a combination of antenna field of view and proper handset orientation). Note that the handset G/T specification shall be met when the handset antenna is tested with a perfect circularly polarized test antenna.

7.5.3 Gateway Terminal

The Gateway terminal shall provide a minimum G/T of 30,5 dBi/K under clear sky conditions.

7.5.4 NCC Terminal

The NCC terminal shall provide a minimum G/T of 32,7 dBi/K under clear sky conditions.

8 Transmitter/Receiver Performance

This clause aims at specifying the error rate performance achieved by the receiver under various channel conditions, and taking into account that transmitter errors must not occur. Note that the receiver performance specified in this clause must be met with a signal which is distorted to the limits specified in clause 6.6, and which propagates through the channels defined in clause A.3. In addition, the receiver must meet the specified performance criteria given a test signal which is offset from the absolute channel frequencies specified in clause 4 by as much as 0,5 kHz for the forward link (with the maximum offset between Gateway and NCC forward links of 0,2 kHz), 1,0 kHz for the return link, and 3,8 kHz for the mobile to mobile link (with maximum offset between Gateway forward and mobile to mobile links of 3,4 kHz).

For both Mobile Earth Station and Ground Terminal receivers, the C/No values should be measured after the LNA at the point in the receiver chain where components contributing to the noise temperature of the G/T specified in clause 7.5 of the present document precede the point, and components that do not contribute to the noise temperature of the G/T follow the point. All of the values given are valid whether or not discontinuous transmission (DTX) or discontinuous reception (DRX) is used. The received C/No levels under multipath fading conditions correspond to the direct path power. When no direct path exists (i.e., Rayleigh channel), the received C/No corresponds to the mean value.

In order to assess the error rate performance that is described in this clause, it is required for a Mobile Earth Station to have a "loop back" facility by which the equipment transmits back the same information that it decoded, in the same mode.

8.1 Nominal Error Rates (NER)

This clause describes the transmission requirements in terms of error rates in nominal conditions, i.e., without interference and with an input level ranging from 10 dB to 20 dB above the reference sensitivity level in an AWGN channel specified for traffic channels.

For the conditions specified above, the chip error rate, equivalent to the bit error rate prior to error correction decoding, shall be $< 10^{-4}$.

For the conditions specified above, the decoded bit error rate for data traffic shall be $< 10^{-7}$.

8.2 Reference Sensitivity Performance

The reference sensitivity performance in terms of frame erasure rate (FER), bit error rate (BER), residual bit error rate (RBER), or residual channel error rate (RCER), whichever appropriate, is specified below according to the type of channel. Note that RBER is defined as the ratio of the number of Class I & II decoded bits in error to the total number of Class I & II decoded bits in those frames determined to be valid frames by the receiver's BFI (Bad Frame Indicator). Note that the RCER is defined as the ratio of the number of Class III bits in error to the total number of Class III bits in those frames determined to be valid frames by the receiver's BFI.

1) S-SDCCH, S-BCCH, S-AGCH, S-PCH, S-SACCH, S-FACCH: FER = 1,5 % for all channel conditions and mobile speeds ranging from 2 to 100 Km/Hour;

2) S-SCH: FER = 1,0 % for all channel conditions and mobile speeds ranging from 2 to 100 Km/Hour;

3) S-RACH: FER = 5 % for all channel conditions (except the Flat Rician Channel, K = 6 dB, for which FER = 8 %) and mobile speeds ranging from 2 to 100 Km/Hour;

4) S-HBCCH: FER = 16 % for all channel conditions and mobile speeds ranging from 2 to 100 Km/Hour;

5) S-HPACH: FER = 4 % for all channel conditions and mobile speeds ranging from 2 to 100 Km/Hour;

6) S-TCH/QBS:

Table 8.2.1: Error Rate Requirements for S-TCH/QBS

	AWGN	**Flat Rician Channel k = 9 dB**		**Flat Rician Channel k = 6 dB**		**Dispersive Rician Channel k = 6 dB**	
		2 km/hr	100 km/hr	2 km/hr	100 km/hr	2 km/hr	100 km/hr
RCER	7,6 %	3,2 %	3,8 %	3,2 %	5,2 %	3,2 %	3,8 %
RBER	0,4 %	0,18 %	0,1 %	0,35 %	0,35 %	0,18 %	0,25 %
FER	2,9 %	3,0 %	1,2 %	6,8 %	5,5 %	2,4 %	2,0 %

1) S-TCH/HES: Reserved;

2) S-TCH/HRS: Reserved;

3) S-TCH/ELS: Reserved;

4) S-TCH/Q2.4: BER = 10^{-5} for all channel conditions and mobile speeds ranging from 15 to 100 Km/Hour;

5) S-TCH/H4.8: Reserved;

6) S-TCH/F9.6: Reserved.

The actual sensitivity level is defined as the input signal to noise spectral density (C/No) burst level for which the performance specified above is met. The actual sensitivity level shall be less than a specified limit, called the reference sensitivity level. The reference sensitivity level shall be as specified in table 8.4.1 for the Mobile Earth Station and table 8.4.2 for the Ground Terminal as a function of the channel conditions described in clause A.3.

The above specifications for the Ground Terminal shall be met when the two time slots adjacent to the wanted are detecting valid GMR-2 signals at 12 dB above the power on the wanted timeslot. For the Mobile Earth Station, the above specifications shall be met with the two adjacent timeslots 12 dB above their own timeslot.

8.3 Reference Interference Level

The reference sensitivity performance in clause 8.2 shall be upheld under the following conditions with co-channel or adjacent channel interference present in the channel.

8.3.1 Mobile Earth Station

For the Mobile Earth Station, the reference sensitivity performance specified in clause 8.2 shall be upheld when co-channel or adjacent channel interference is present in the channel, where the ratio of signal to interference ratio is given by:

a) C/Ic = 16 dB for co-channel interference;

b) C/Ia = -16 dB for adjacent interference (200 kHz offset for forward link);

where the interfering signal is a random, continuous forward-modulated signal per GMR-2 05.004 [3], where the interfering signal shall be subject to the same propagation environment as the non-interfering signal per A.3 of the present document, and where the desired sensitivity level is boosted 0,5 dB above the reference sensitivity levels specified in table 8.4.1.

8.3.2 Ground Terminal

For the ground terminal, the reference sensitivity performance specified in clause 8.2 shall be upheld when co-channel or adjacent channel interference is present in the channel, where the ratio of signal to interference ratio is given by:

a) C/Ic = 10 dB for co-channel interference based on a reference burst C/No of 50 dB-Hz;

b) C/Ia = -10 dB for adjacent interference (50 kHz offset for return link) based on a reference burst C/No of 50 dB-Hz;

where the interfering signals is a random, continuous return-link modulated signal per GMR-2 05.004 [3], where the interfering signal shall be subject to only the static channel environment, as per clause A.3 of the present document, relative to the non-interfering signal, and where the desired sensitivity level is boosted 1,5 dB above the reference sensitivity levels specified in table 8.4.1.

8.4 Erroneous Frame Indication Performance

a) On satellite basic speech, S-TCH (S-TCH/QBS) or an S-SDCCH with a random RF input, of the frames believed to be S-FACCH, S-SACCH, or S-SDCCH frames, the overall reception performance shall be such that no more than 0,002 % of the frames are assessed to be error free.

b) On satellite basic speech, S-TCH (S-TCH/QBS) with a random RF input, the overall reception performance shall be such that, on average, less than one undetected bad speech frame (false bad frame indication, BFI) in 10 seconds will be measured.

c) For the Ground Terminal, on an S-RACH with a random RF input, the overall reception performance shall be such that less than 0,02 % of frames are assessed to be error free.

Table 8.4.1: Reference Sensitivity Levels for the Mobile Earth Station

Logical Channel	Reference Sensitivity Levels (dB-Hz) versus Propagation conditions				
	Static (AWGN)	Flat Rician Channel, K = 9 dB	Flat Rician Channel, K = 6 dB	Flat Rayleigh Channel	Dispersive Rician Channel, K = 6,0 dB
S-SDCCH	56,0	61,0	62,0	-	62,0
S-BCCH	56,5	61,0	63,0	-	63,0
S-SCH	55,5	60,0	62,5	-	62,5
S-HBCCH	44,0	47,0	49,0	50,0	49,0
S-HPACH	44,0	47,0	49,0	56,0	49,0
S-TCH/QBS	56,0	59,0	59,0	-	61,0
S-TCH/HES	Reserved	Reserved	Reserved	-	Reserved
S-TCH/HRS	Reserved	Reserved	Reserved	-	Reserved
S-TCH/ELS	Reserved	Reserved	Reserved	-	Reserved
S-TCH/Q2.4	58,0	60,0	61,5	-	61,5
S-TCH/H4.8	Reserved	Reserved	Reserved	-	Reserved
S-TCH/F9.6	Reserved	Reserved	Reserved	-	Reserved

NOTE 1: The specification for S-SDCCH applies also for S-SACCH and S-FACCH.
NOTE 2: The specification for S-BCCH applies also for S-AGCH and S-PCH.
NOTE 3: The levels specified above are in terms of burst C/No. (See annex A for conversion to signal levels for testing).
NOTE 4: For all S-TCH channels, this table refers to forward link communications (Ground Terminal to mobile). For mobile to mobile communications the numbers in this table should be increased by 0,5 dB.

Table 8.4.2: Reference Sensitivity Levels for the Ground Terminal

Logical Channel	Reference Sensitivity Levels (dB-Hz) versus Propagation conditions			
	Static (AWGN)	Flat Rician Channel, K = 9 dB	Flat Rician Channel, K = 6 dB	Dispersive Rician Channel, K = 6,0 dB
S-SDCCH	50,0	55,0	58,0	58,0
S-RACH	49,0	52,0	54,0	54,0
S-TCH/QBS	50,0	53,0	53,0	55,0
S-TCH/HES	Reserved	Reserved	Reserved	Reserved
S-TCH/HRS	Reserved	Reserved	Reserved	Reserved
S-TCH/ELS	Reserved	Reserved	Reserved	Reserved
S-TCH/Q2.4	52,0	54,5	56,5	56,5
S-TCH/H4.8	Reserved	Reserved	Reserved	Reserved
S-TCH/F9.6	Reserved	Reserved	Reserved	Reserved

NOTE 1: The specification for S-SDCCH applies also for S-SACCH, and S-FACCH.
NOTE 2: The levels specified above are in terms of burst C/No. Note that a Burst C/No of 50 dB-Hz corresponds to a minimum RSS (Received Signal Strength at the output of the Ground Terminal antenna) of -151,5 dBW.

Annex A (normative): Spectrum Characteristics, Transmit Power versus Time and Channel Conditions

A.1 Spectrum Characteristics (Spectrum Due to the Modulation)

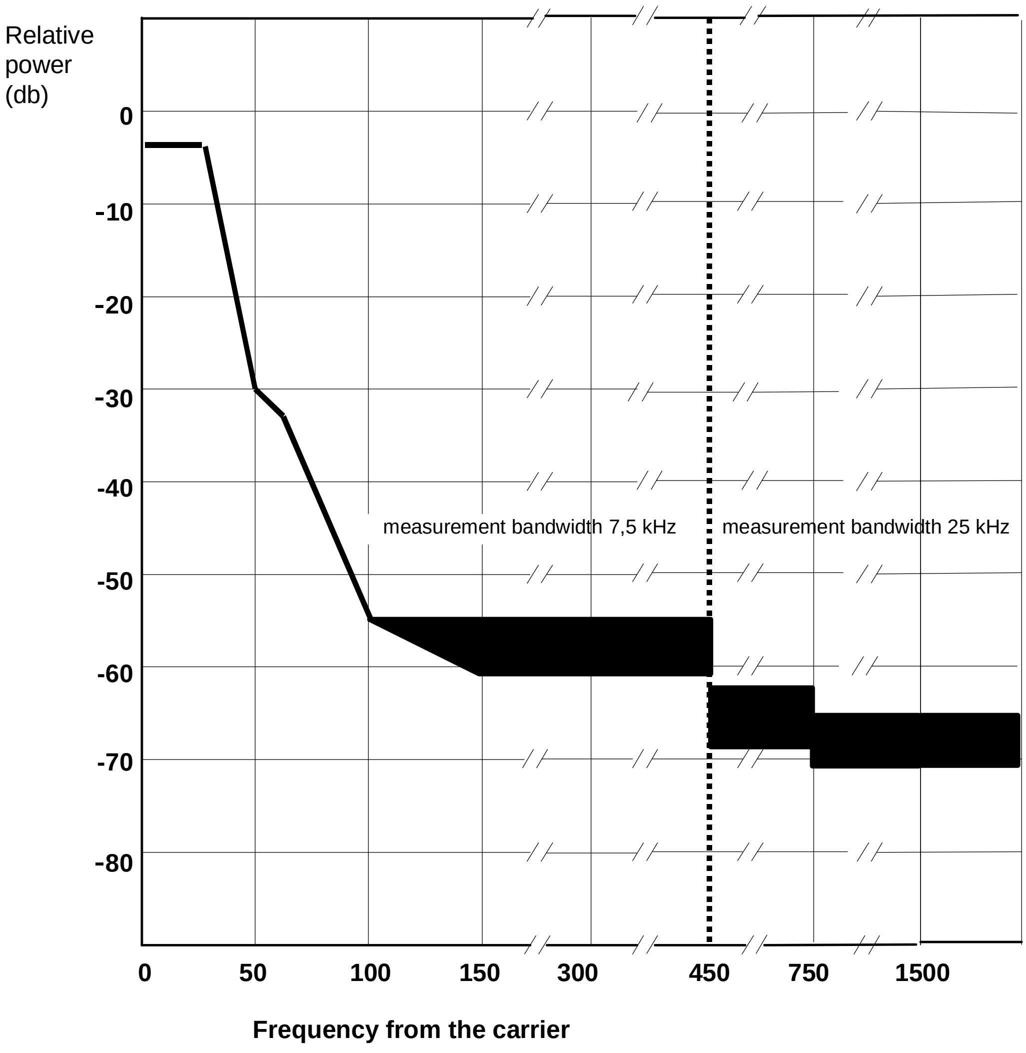


Figure A.1.1: Mobile Earth Station Transmit Spectrum Due to Modulation

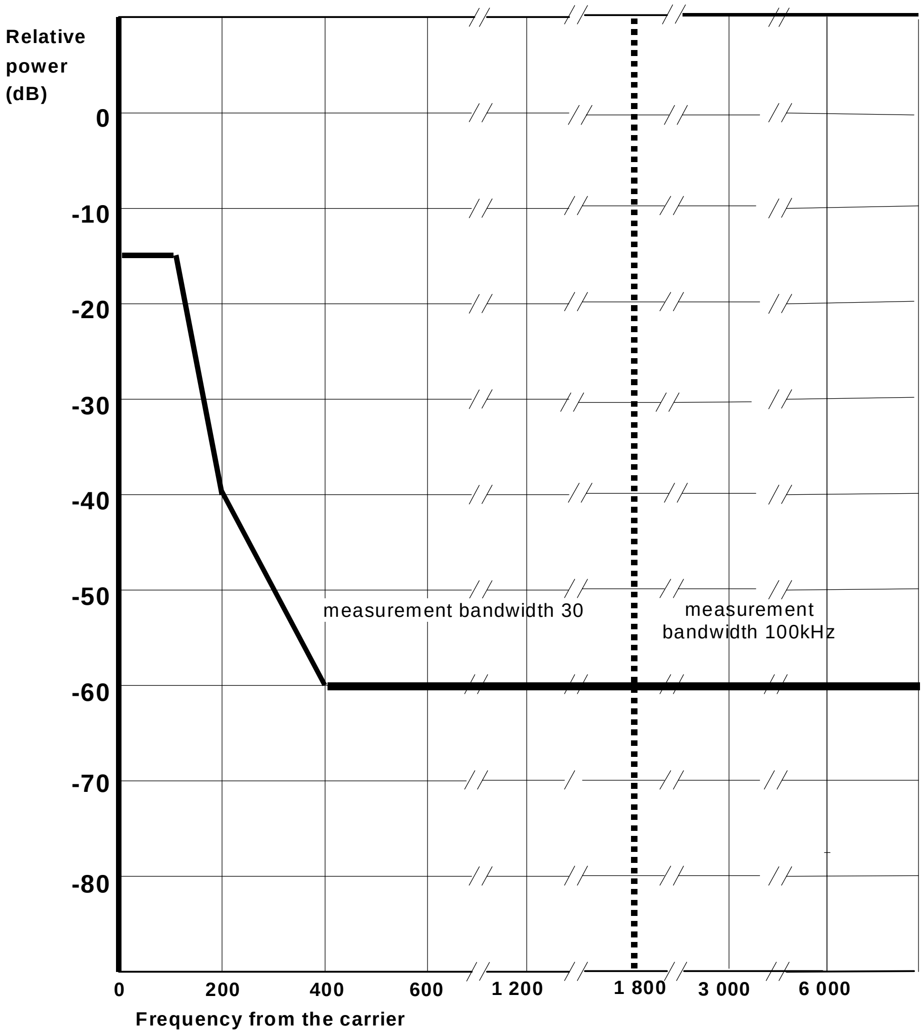
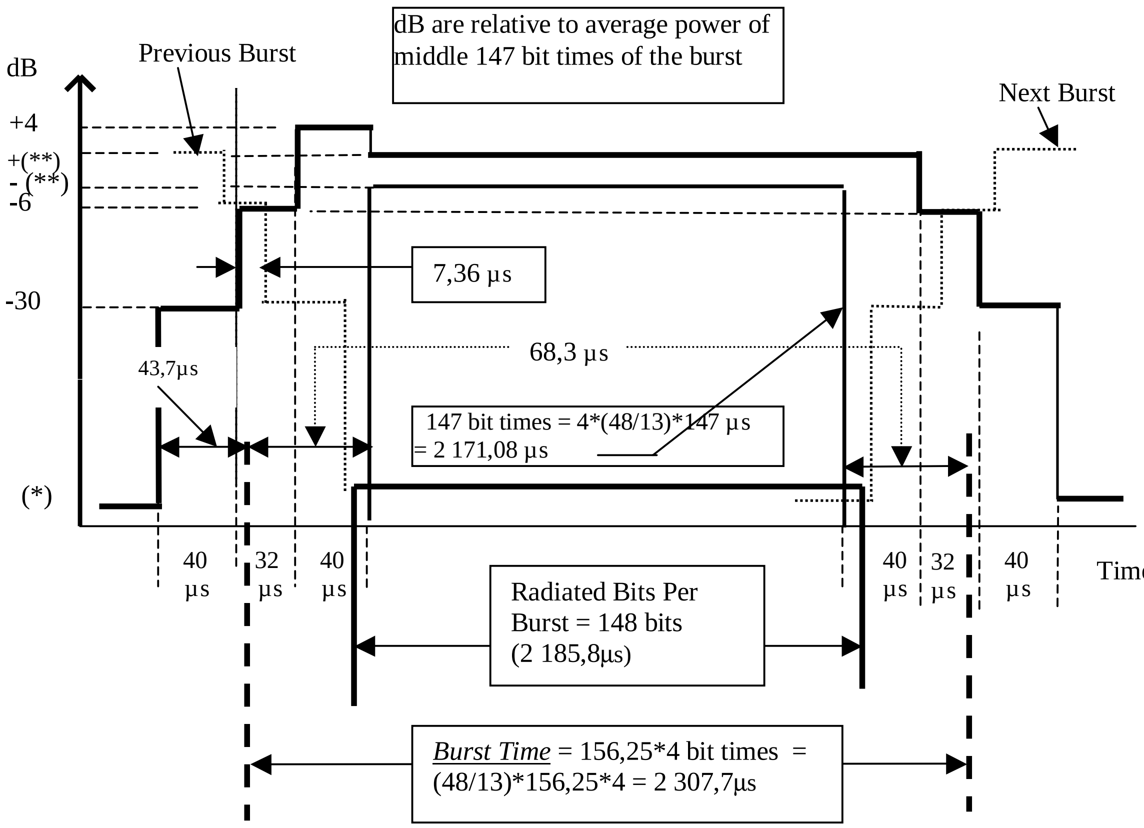


Figure A.1.2: Ground Terminal Transmit Spectrum Due to Modulation

A.2 Transmitted Power Level Versus Time



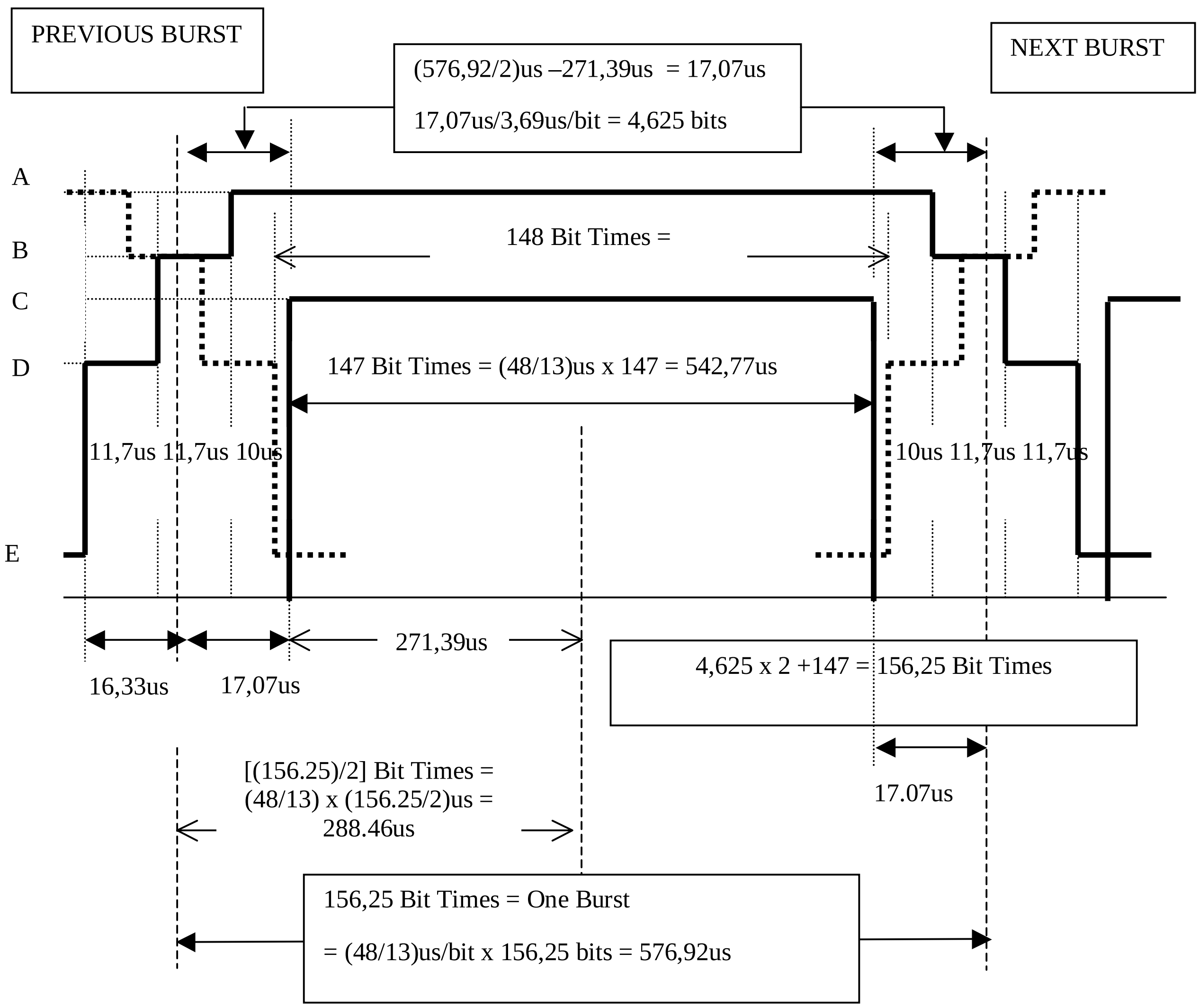
NOTES:

(*) For fixed MES: -64 dBW and for mobile MES: -66 dBW.

(**) For mobile and fixed MES: 1 dB.

(***) For the Access burst, where two consecutive time slots are actually transmitted by the MES, the power ramping requirements illustrated above only apply at the beginning and end of the two burst series. With respect to the guard time between the two active bursts, the only requirement is that the max transmit level shall not exceed +1 dB relative to the nominal transmit level.

Figure A.2.1: Time Mask for Single Time Slot Burst transmitted from MES



A = 4dB above the average power of 147 bit times centred in the 156.25 bit burst.

B = 10 dB below "A".

C = 12 dB below "A".

D = 34 dB below "A".

E = -51 dBc (i.e. below the 147 bit average power). It is the maximum permitted power output during unused burst periods.

Figure A.2.2: Time Mask for Single Time Slot Burst transmitted from Ground Terminal

A.3 Channel Conditions

This clause specifies the propagation models and Satellite channel responses referred to in clause 8 for the purposes of verifying receiver performance.

A.3.1 Propagation Conditions

A.3.1.1 Propagation Overview

Propagation in the Satellite-Mobile environment is represented by two components:

a) the direct component, which is the line-of-sight field directly between the satellite and the MES;

b) the diffuse component, which is the combination of multipath from all directions.

Doppler frequency shifts of the direct and diffuse components result from relative motion between the MES and the Satellite. The direct component frequency shift is given by:

$$fd = (v/c)\ fo\ (\cos y_1),$$

where fo is the transmitted carrier frequency, v is the MES speed, c is the speed of light and y_1, is the elevation angle from the MES to the satellite line-of-sight.

The diffuse component is a random accumulation of all field reflections from all horizontal directions. Each multipath component arrives with a random amplitude, random phase, and random horizontal angle. Doppler shifts of the reflected components are given by:

$$fdn = fd\ (\cos f_n),$$

where f_n is the arrival angle of the reflected component. The accumulation of a large number of such components creates an equivalent additive Gaussian band pass noise process, with a frequency spectrum corresponding to the Doppler shifts.

The diffuse signal spectrum S(f) is given by:

$$S(f) = (\sigma^2)/[\pi * (1-(f/fd)^{1/2})] \quad : |f| \leq fd;$$

$$S(f) = 0 \quad : |f| > fd,$$

where σ^2 is the average power of the Gaussian band-pass equivalent process. The auto-correlation (time domain) representation of this spectrum is given by:

$$r(\tau) = \sigma^2 J_0\ (2\pi\ fd\ \tau),$$

where J_0 is a zero-order Bessel function of the first kind.

The probability density for the Satellite-Mobile channel is Rician. It is given by:

$$p(x) = (1 + k)\ e^{-x(1 + k)\ -k}\ I_0\ [2\ (xk(1 + k)]^{1/2} : \quad x \geq 0,$$

where k = power in direct component/power in diffuse component, and I_0 is the zero-order modified Bessel function. The parameter k is referred to as the Rice parameter.

Note that when the Rice parameter is set to zero the Rician density collapses to the Rayleigh density. The Rayleigh density is characteristic of a channel which does not necessarily have a direct line of sight between the Mobile Earth Station and the satellite.

A.3.1.2 Propagation Models

This clause specifies the propagation models referred to in clause 8 for the purposes of verifying receiver performance. These models are described in general terms as a tap delay line structure where the delay, power, and profile (direct, Rician or Rayleigh) for each tap is specified.

A.3.1.2.1 Return Link & MES to MES Uplink

Table A.3.1: Return Link Static (AWGN) Channel Model

Model for Static (AWGN) Channel			
Tap	Delay (RB = return bit duration = 14,7 microsec)	Power	Profile
1	0	P_{DIRECT}	Direct

Table A.3.2: Return Link Flat Rician Channel (K = 9) Model

Model for Flat Rician Channel, K = 9 dB			
Tap	Delay (RB = return bit duration = 14,7 microsec)	Power	Profile
1	0	P_{DIRECT}	Direct
1	0	$P_{DIRECT}/8$	Rayleigh

Table A.3.3: Return Link Flat Rician Channel (K = 6) Model

Model for Flat Rician Channel, K = 6 dB			
Tap	Delay (RB = return bit duration = 14,7 microsec)	Power	Profile
1	0	P_{DIRECT}	Direct
1	0	$P_{DIRECT}/4$	Rayleigh

Table A.3.4: Return Link Dispersive Rician Channel (K = 6) Model

Model for Dispersive Rician Channel, K = 6 dB			
Tap	Delay (RB = return bit duration = 14,7 microsec)	Power	Profile
1	0	P_{DIRECT}	Direct
1	0	$P_{DIRECT}/20$	Rayleigh
2	RB/4	$P_{DIRECT}/20$	Rayleigh
3	RB/2	$P_{DIRECT}/20$	Rayleigh
4	3 RB/4	$P_{DIRECT}/20$	Rayleigh
5	RB	$P_{DIRECT}/20$	Rayleigh

A.3.1.2.2 Forward Link

Table A.3.5: Forward Link Static (AWGN) Channel Model

Model for Static (AWGN) Channel			
Tap	Delay (D = 12 microsec)	Power	Profile
1	0	P_{DIRECT}	Direct

Table A.3.6: Forward Link Flat Rician Channel (K = 9) Model

Model for Flat Rician Channel, K = 9 dB			
Tap	Delay (D = 12 microsec)	Power	Profile
1	0	P_{DIRECT}	Direct
1	0	$P_{DIRECT}/8$	Rayleigh

Table A.3.7: Forward Link Flat Rician Channel (K = 6) Model

Model for Flat Rician Channel, K = 6 dB			
Tap	Delay (D = 12 microsec)	Power	Profile
1	0	P_{DIRECT}	Direct
1	0	$P_{DIRECT}/4$	Rayleigh

Table A.3.8: Forward Link Flat Rayleigh Channel Model

Model for Flat Rayleigh Channel			
Tap	Delay (D = 12 microsec)	Power	Profile
1	0	$P_{DIFFUSE}$	Rayleigh

Table A.3.9: Forward Link Dispersive Rician Channel (K = 6) Model

Model for Dispersive Rician Channel, K = 6 dB			
Tap	Delay (D = 12 microsec)	Power	Profile
1	0	P_{DIRECT}	Direct
1	0	$P_{DIRECT}/20$	Rayleigh
2	D/4	$P_{DIRECT}/20$	Rayleigh
3	D/2	$P_{DIRECT}/20$	Rayleigh
4	3D/4	$P_{DIRECT}/20$	Rayleigh
5	D	$P_{DIRECT}/20$	Rayleigh

A.3.2 Satellite Channel Response

This clause specifies the Satellite channel frequency response to be used to verify the receiver performance requirements specified in clause 8. The Satellite channel frequency response is specified below in figure A.3-1/05.05 for the forward channel (for verification of Mobile Earth Stations) and figure A.3-2/05.05 for the return channel (for verification of the Ground Terminals). Note that for verification of the Mobile Earth Stations for mobile to mobile connections, the mobile to mobile satellite channel model should be assumed the same as return link satellite channel model.

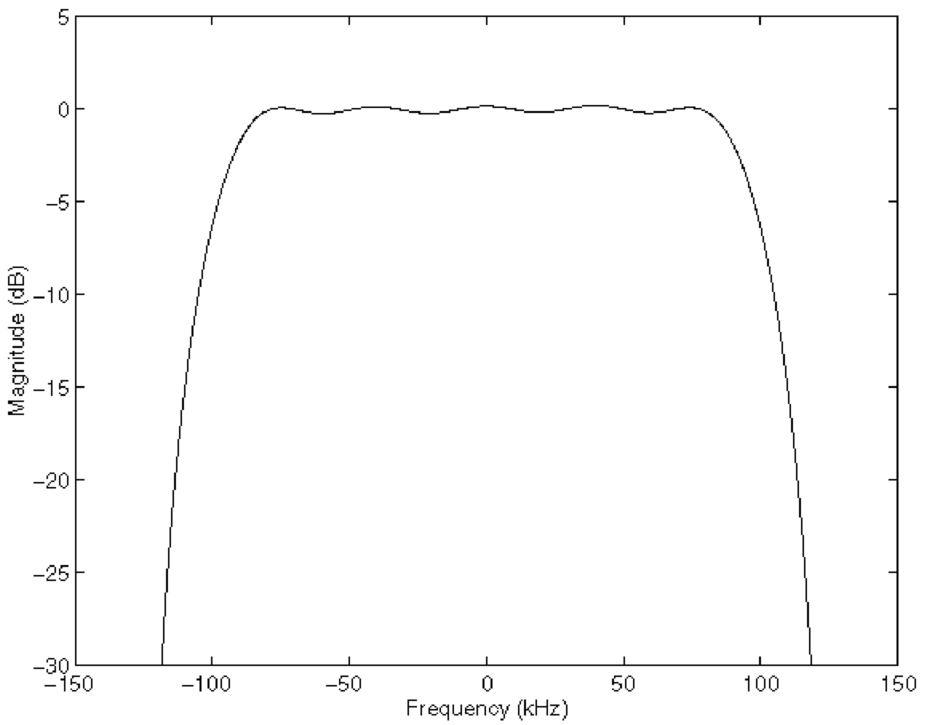


Figure A.3.1a: Satellite Magnitude Response for the Forward Channel

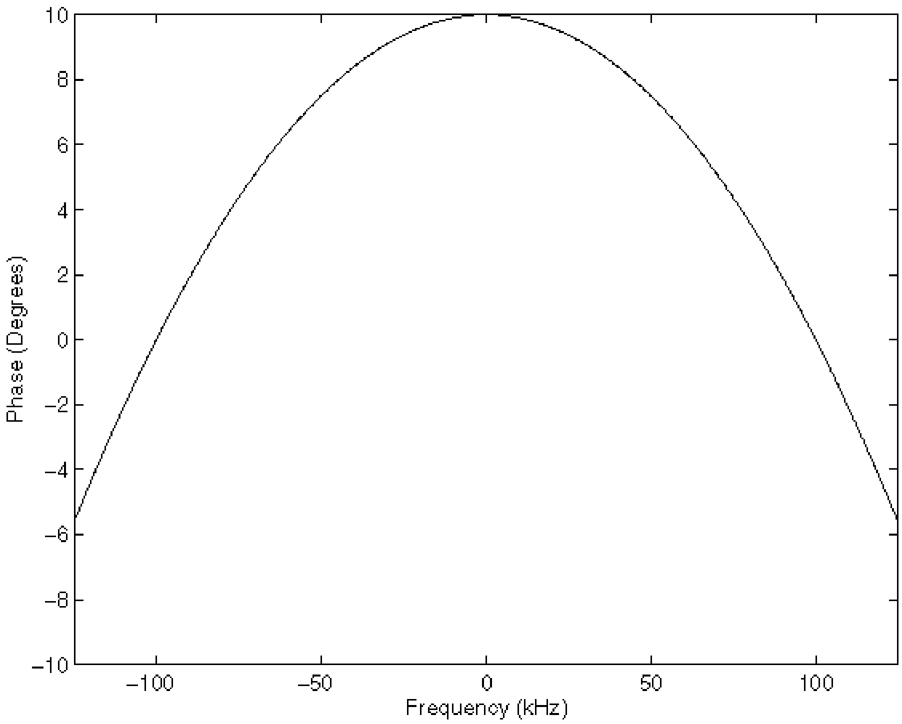


Figure A.3.1b: Satellite Phase Response for the Forward Channel

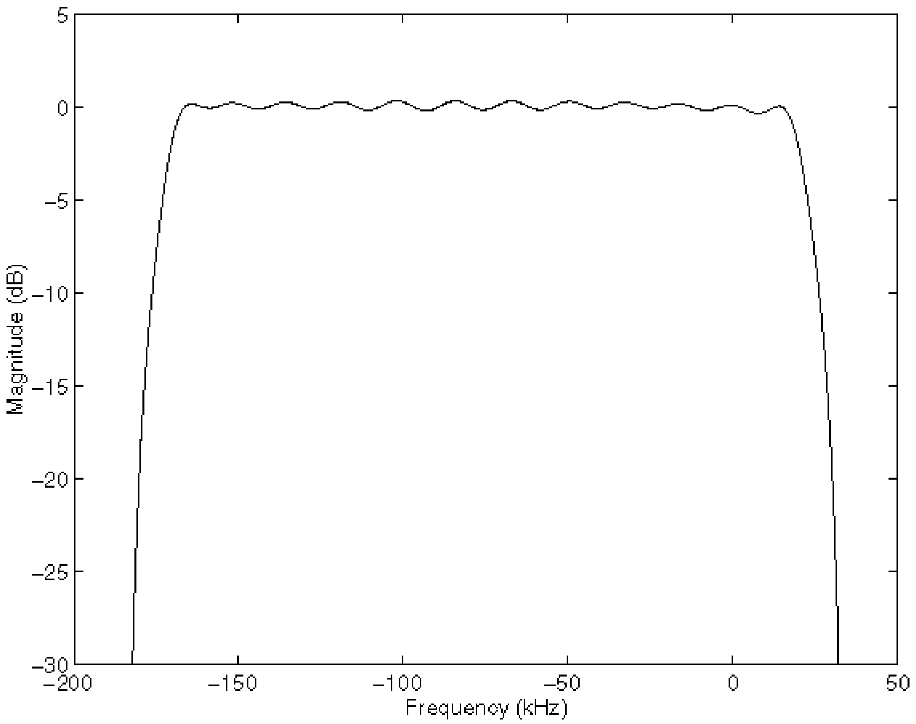


Figure A.3.2a: Satellite Magnitude Response for the Return Channel and Mobile to Mobile Channel

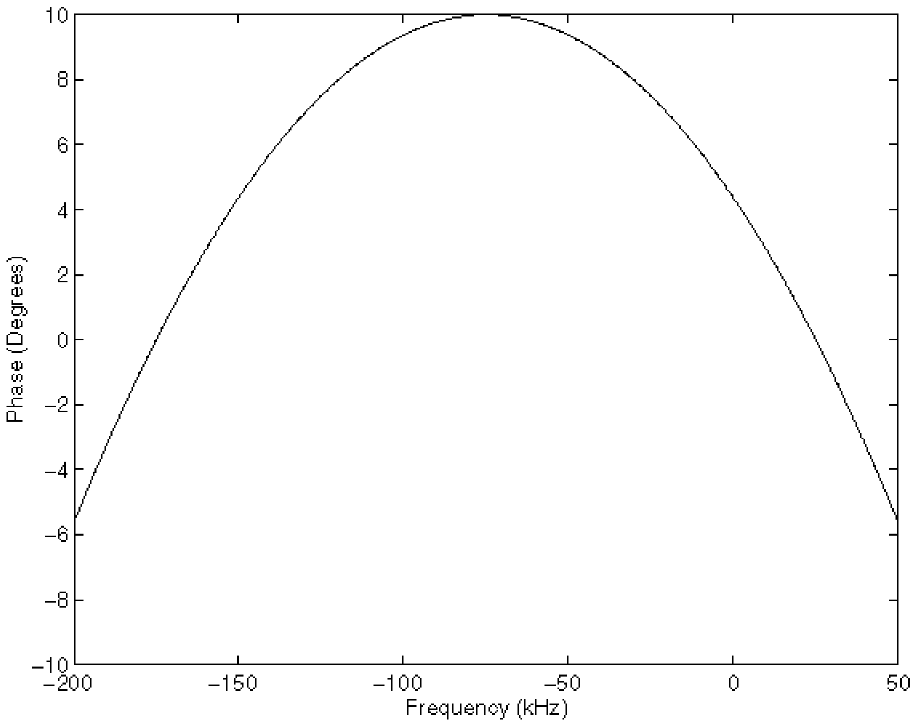


Figure A.3.2b: Satellite Phase Response for the Return Channel and the Mobile to Mobile Channel

A.4 Environmental Conditions

A.4.1 General

This normative annex specifies the environmental requirements of the system, both for Mobile Earth Station and Satellite/Ground equipment. Within these limits the requirements of the GSM specifications shall be fulfilled.

A.4.2 Environmental requirements for the Mobile Earth Stations

A.4.2.1 Temperature

The Mobile Earth Station shall fulfil all the requirements in the full temperature range of:

- +15° C to +35° C for normal conditions (with relative humidity of 25 % to 75 %);
- -20° C to +55° C for extreme conditions (see IEC Publications 68-2-1 [9] and 68-2-2 [10], with relative humidity up to 95 %).

Outside this temperature range the Mobile Earth Station, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the Mobile Earth Station exceed the transmitted levels, as defined in the present document, for extreme operation.

A.4.2.2 Voltage

The Mobile Earth Station shall fulfil all the requirements in the full voltage range, i.e., the voltage range between the extreme voltages.

The manufacturer shall declare the lower and higher extreme voltages and the approximate shut-down voltage. For the equipment that can be operated from one or more of the power sources listed below, the lower extreme voltage shall not be higher, and the higher extreme voltage shall not be lower than that specified in table A.4.1.

Table A.4.1: Mobile Earth Station Extreme Voltage Levels

Power source	Lower extreme voltage	Higher extreme voltage	Normal cond. voltage
AC mains	0,95 * nominal	1,1 * nominal	nominal
Regulated lead acid battery	0,95 * nominal	1,3 * nominal	1,1 * nominal
Non regulated batteries			
- lithium	0,85 * nominal	nominal	nominal
- nickel cadmium	0,95 * nominal	nominal	nominal

Outside this voltage range the Mobile Earth Station, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the Mobile Earth Station exceed the transmitted levels as defined in the present document for extreme operation. In particular, the Mobile Earth Station shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shutdown voltage.

A.4.2.3 Vibration

The Mobile Earth Station shall fulfil all the requirements when vibrated at the following frequency/amplitudes:

Frequency	ASD (Acceleration Spectral Density) random vibration
5 Hz to 20 Hz	0,96 m^2/s^3
20 Hz to 500 Hz	0,96 m^2/s^3 at 20 Hz,
	thereafter -3 dB/Octave
	(see IEC Publication 68-2-36 [8])

Outside the specified frequency range the Mobile Earth Station, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the Mobile Earth Station exceed the transmitted levels as defined in the present document for extreme operation.

A.4.3 Environmental Requirements for the Satellite/Ground Equipment

The satellite/ground equipment shall fulfil all the requirements in the full range of environmental conditions for the relevant environmental class as specified in the GMR-2 Satellite Specification and GMR-2 Ground Terminal Specification, respectively.

Outside the specified range for any of the environmental conditions, the Satellite/Ground Terminal shall not make ineffective use of the radio frequency spectrum. In no case shall the Satellite/Ground exceed the transmitted levels as defined in the present document for extreme operation.

A.5 Mobile Earth Station Reference Sensitivity Verification

Clause 8 specifies the sensitivity requirements for a Mobile Earth Station in the presence of signal impairments introduced by Ground Terminal transmitter, the Satellite and the Mobile Earth Station. To verify Mobile Earth Station performance in a production environment, the sensitivity requirements in clause 8 must be modified to represent the case when the input signal to the Mobile Earth Station is generated by a standard test set. The following paragraphs present the modified sensitivity requirements for the case when a Mobile Earth Station receives signals generated by the production floor test set.

Equation (1) below is used to calculate the minimum signal power level at the Mobile Earth Station's antenna output for which a Mobile Earth Station shall provide error rate performance no greater than the values specified in clause 8.2. Equation (1) holds for all channel types and conditions specified in table 8.4.1. Additionally, a Mobile Earth Station shall meet the sensitivity requirements in this clause for the case when the receive signal is offset by 1 KHz from the absolute channel frequency.

To simplify the test setup, signal-to-noise density (C/N_0) is converted to signal power level (P_{in}) using the following equation:

$$(P_{in})_{dBm} = \left(\frac{C}{N_0}\right)_{dB-Hz} + K + 10\log\left[T_{T/S} + \left[10^{F_r/10} - 1\right] * 290\right] \quad (1),$$

where

C/N_0 = Value from table 8.4.1;

K = -198,6 dBm (Hz-K) (Boltzmann's constant);

$T_{T/S}$ = Test set noise temperature;

F_r = MES receiver noise figure required to achieve G/T specified in clause 7.5.2.

For example, substituting these values into the equation above and assuming F_r = 4,0 dB and $T_{T/S}$ = 290K, yields:

$$(P_{in})_{dBm} = \left(\frac{C}{N_0}\right)_{dB-Hz} - 170,0 .$$

History

Document history		
V1.1.1	March 2001	Publication