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GLOBAL SYSTEM FOR
MOBILE COMMUNICATIONS

Digital cellular telecommunications system (Phase 2+);
Radio transmission and reception
(GSM 05.05 version 5.4.0)

ETSI

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Foreword

This draft European Telecommunication Standard (ETS) has been produced by the Special Mobile Group (SMG) Technical Committee (TC) of the European Telecommunications Standards Institute (ETSI) and is now submitted for the One-step Approval Procedure (OAP) of the ETSI standards approval process.

This ETS defines the requirements for the transceiver of the pan-European digital mobile cellular and personal communication systems operating in the 900 MHz (P-GSM, E-GSM and R-GSM) and 1 800 MHz band (GSM 900 and DCS 1 800).

This ETS is a GSM technical specification version 5, which incorporates GSM Phase 2+ enhancements/features to the version 4 GSM technical specification. The ETS from which this Phase 2+ ETS has evolved is Phase 2 GSM ETS 300 577 edition 10 (GSM 05.05 version 4.17.1).

The contents of this ETS is subject to continuing work within TC-SMG and may change following formal TC-SMG approval. Should TC-SMG modify the contents of this ETS, it will be resubmitted for OAP by ETSI with an identifying change of release date and an increase in version number as follows:

Version 5.x.y

where:

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

The specification from which this ETS has been derived was originally based on CEPT documentation, hence the presentation of this ETS may not be entirely in accordance with the ETSI rules.

Proposed transposition dates	
Date of latest announcement of this ETS (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

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1 Scope

This European Telecommunication Standard (ETS) defines the requirements for the transceiver of the pan-European digital mobile cellular and personal communication systems operating in the 900 MHz and 1 800 MHz band (GSM 900 and DCS 1 800).

Requirements are defined for two categories of parameters:

- Those that are required to provide compatibility between the radio 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 the same or adjacent frequency bands.

- Those that define the transmission quality of the system.

This ETS defines RF characteristics for the Mobile Station (MS) and Base Station System (BSS). The BSS will contain either Base Transceiver Stations (BTS) or microcell base transceiver stations (micro-BTS). The precise measurement methods are specified in GSM 11.10 and GSM 11.20.

Unless otherwise stated, the requirements defined in this ETS apply to the full range of environmental conditions specified for the equipment (see annex D).

In this ETS some relaxations are introduced for GSM 900 MSs which fulfil the following conditions:

- pertain to power class 4 or 5 (see subclause 4.1.1);
- not designed to be vehicle mounted (see GSM 02.06).

In this ETS these Mobile Stations are referred to as "small MS".

NOTE: In this ETS, a handheld which can be connected to a car kit is not considered to be vehicle mounted.

MSs may operate on more than one of the frequency bands specified in clause 2. These MSs, defined in GSM 02.06, are referred to as "Multi band MSs" in this ETS. Multi band MSs shall meet all requirements for each of the bands supported. The relaxation on GSM 900 for a "small MS" are also valid for a multi band MS if it complies with the definition of a small MS.

The RF characteristics of repeaters are defined in annex E of this ETS. Annexes D and E are the only clauses of this ETS applicable to repeaters. Annex E does not apply to the MS or BSS.

1.1 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1] GSM 01.04 (ETR 350): "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] GSM 02.06 (ETS 300 919): "Digital cellular telecommunications system; Types of Mobile Stations (MS)".

[3] GSM 05.01: "Digital cellular telecommunications system (Phase 2+); Physical layer on the radio path General description".

[4] GSM 05.04 (ETS 300 959): "Digital cellular telecommunications system; Modulation".

[5] GSM 05.08 (ETS 300 911): "Digital cellular telecommunications system (Phase 2+); Radio subsystem link control".

[6] GSM 05.10 (ETS 300 579): "Digital cellular telecommunications system (Phase 2+); Radio subsystem synchronization".

[7] GSM 11.10 (ETS 300 607): "Digital cellular telecommunications system (Phase 2); Mobile Station (MS) conformity specification".

[8] GSM 11.11 (ETS 300 977): "Digital cellular telecommunications system (Phase 2+); Specification of the Subscriber Identity Module - Mobile Equipment (SIM - ME) interface".

[9] CCITT Recommendation O.153: "Basic parameters for the measurement of error performance at bit rates below the primary rate".

[10] ETS 300 019-1-3: "Equipment engineering; Environmental conditions and Environmental tests for telecommunications equipment Part 1-3: Classification of Environmental conditions Stationary use at weather protected locations".

[11] ETS 300 019-1-4: "Equipment engineering; Environmental conditions and Environmental tests for telecommunications equipment Part 1-4: Classification of Environmental conditions Stationary use at non-weather protected locations".

1.2 Abbreviations

Abbreviations used in this ETS are listed in GSM 01.04.

2 Frequency bands and channel arrangement

i) Standard or primary GSM 900 Band, P-GSM:

For Standard GSM 900 band, the system is required to operate in the following frequency band:

890 - 915 MHz: mobile transmit, base receive
935 - 960 MHz: base transmit, mobile receive

ii) Extended GSM 900 Band, E-GSM (includes Standard GSM 900 band):

For Extended GSM 900 band, the system is required to operate in the following frequency band:

880 - 915 MHz: mobile transmit, base receive
925 - 960 MHz: base transmit, mobile receive

iii) Railways GSM 900 Band, R-GSM (includes Standard and Extended GSM 900 Band);

For Railways GSM 900 band, the system is required to operate in the following frequency band:

876 - 915 MHz: mobile transmit, base receive
921 - 960 MHz: base transmit, mobile receive

iv) DCS 1 800 Band:

For DCS 1 800, the system is required to operate in the following band:

1 710 - 1 785 MHz: mobile transmit, base receive
1 805 - 1 880 MHz: base transmit, mobile receive

NOTE: The term GSM 900 is used for any GSM system which operates in any 900 MHz band.

Operators may implement networks which operates on a combination of the frequency bands above to support multi band mobile terminals which are defined in GSM 02.06.

The carrier spacing is 200 kHz.

The carrier frequency is designated by the absolute radio frequency channel number (ARFCN). If we call Fl(n) the frequency value of the carrier ARFCN n in the lower band, and Fu(n) the corresponding frequency value in the upper band, we have:

P-GSM 900	Fl(n) = 890 + 0.2*n	$1 \le n \le 124$	Fu(n) = Fl(n) + 45
E-GSM 900	Fl(n) = 890 + 0.2*n Fl(n) = 890 + 0.2*(n-1024)	$0 \le n \le 124$ $975 \le n \le 1023$	Fu(n) = Fl(n) + 45
R-GSM 900	Fl(n) = 890 + 0.2*n Fl(n) = 890 + 0.2*(n-1024)	$0 \le n \le 124$ $955 \le n \le 1023$	Fu(n) = Fl(n) + 45
DCS 1 800	Fl(n) = 1710.2 + 0.2*(n-512)	$512 \le n \le 885$	Fu(n) = Fl(n) + 95

Frequencies are in MHz.

3 Reference configuration

The reference configuration for the radio subsystem is described in GSM 05.01.

The micro-BTS is different from a normal BTS in two ways. Firstly, the range requirements are much reduced whilst the close proximity requirements are more stringent. Secondly, the micro-BTS is required to be small and cheap to allow external street deployment in large numbers. Because of these differences the micro-BTS needs a different set of RF parameters to be specified. Where the RF parameters are not different for the micro-BTS the normal BTS parameters shall apply.

4 Transmitter characteristics

Throughout this clause, unless otherwise stated, requirements are given in terms of power levels at the antenna connector of the equipment. For equipment with integral antenna only, a reference antenna with 0 dBi gain shall be assumed.

The term output power refers to the measure of the power when averaged over the useful part of the burst (see annex B).

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

4.1 Output power

4.1.1 Mobile station

The MS maximum output power and lowest power control level shall be, according to its class, as defined in the following table (see also GSM 02.06).

Power class	**GSM 900 Nominal Maximum output power**	**DCS 1 800 Nominal Maximum output power**	**Tolerance (dB) for conditions**	
			normal	**extreme**
1	- - - - - -	1 W (30 dBm)	±2	±2.5
2	8 W (39 dBm)	0.25 W (24 dBm)	±2	±2.5
3	5 W (37 dBm)	4 W (36 dBm)	±2	±2.5
4	2 W (33 dBm)		±2	±2.5
5	0.8 W (29 dBm)		±2	±2.5
NOTE: The lowest nominal output power for all classes of GSM 900 MS is 5 dBm and for all classes of DCS 1 800 MS is 0 dBm.				

A multi band MS has a combination of the power class in each band of operation from the table above. Any combination may be used.

The different power control levels needed for adaptive power control (see GSM 05.08) shall have the nominal output power as defined in the table below, starting from the power control level for the lowest nominal output power up to the power control level for the maximum nominal output power corresponding to the class of the particular MS as defined in the table above. Whenever a power control level commands the MS to use a nominal output power equal to or greater than the maximum nominal output power for the power class of the MS, the nominal output power transmitted shall be the maximum nominal output power for the MS class, and the tolerance of ±2 or 2.5 dB (see table above) shall apply.

GSM 900

Power control level	Nominal Output power (dBm)	Tolerance (dB) for conditions	
		normal	extreme
0-2	39	±2	±2.5
3	37	±3	±4
4	35	±3	±4
5	33	±3	±4
6	31	±3	±4
7	29	±3	±4
8	27	±3	±4
9	25	±3	±4
10	23	±3	±4
11	21	±3	±4
12	19	±3	±4
13	17	±3	±4
14	15	±3	±4
15	13	±3	±4
16	11	±5	±6
17	9	±5	±6
18	7	±5	±6
19-31	5	±5	±6

DCS 1 800

Power control level	Nominal Output power (dBm)	Tolerance (dB) for conditions	
		normal	extreme
29	36	±2	±2.5
30	34	±3	±4
31	32	±3	±4
0	30	±3	±4
1	28	±3	±4
2	26	±3	±4
3	24	±3	±4
4	22	±3	±4
5	20	±3	±4
6	18	±3	±4
7	16	±3	±4
8	14	±3	±4
9	12	±4	±5
10	10	±4	±5
11	8	±4	±5
12	6	±4	±5
13	4	±4	±5
14	2	±5	±6
15-28	0	±5	±6

NOTE 1: For DCS 1 800, the power control levels 29, 30 and 31 are only used "in call" for power control purposes. These levels are not used when transmitting the parameter TX PWR MAX CCH, for cross phase compatibility reasons. If levels greater than 30 dBm are required from the MS during a random access attempt, then these shall be decoded from parameters broadcast on the BCCH as described in GSM 05.08.

Furthermore, the difference in output power actually transmitted by the MS between two power control levels where the difference in nominal output power indicates an increase of 2 dB (taking into account the restrictions due to power class), shall be +2 ± 1.5 dB. Similarly, if the difference in output power actually transmitted by the MS between two power control levels where the difference in nominal output power indicates an decrease of 2 dB (taking into account the restrictions due to power class), shall be -2 ± 1.5 dB.

NOTE 2: A 2 dB nominal difference in output power can exist for non-adjacent power control levels e.g. power control levels 18 and 22 for GSM 900; power control levels 31 and 0 for class 3 DCS 1 800 and power control levels 3 and 6 for class 4 GSM 900.

A change from any power control level to any power control level may be required by the base transmitter. The maximum time to execute this change is specified in GSM 05.08.

4.1.2 Base station

The Base Station Transmitter maximum output power, measured at the input of the BSS Tx combiner, shall be, according to its class, as defined in the following tables:

GSM 900

TRX power class	Maximum output power
1	320 - (< 640) W
2	160 - (< 320) W
3	80 - (< 160) W
4	40 - (< 80) W
5	20 - (< 40) W
6	10 - (< 20) W
7	5 - (< 10) W
8	2.5 - (< 5) W

DCS 1 800

TRX power class	Maximum output power
1	20 - (< 40) W
2	10 - (< 20) W
3	5 - (< 10) W
4	2.5 - (< 5) W

The micro-BTS maximum output power per carrier measured at the antenna connector after all stages of combining shall be, according to its class, defined in the following table.

GSM 900 micro-BTS		DCS 1 800 micro-BTS	
TRX power class	**Maximum output power**	**TRX power class**	**Maximum output power**
M1	(> 19) - 24 dBm ((> 0.08) - 0.25 W)	M1	(> 27) - 32 dBm ((> 0.5) - 1.6 W)
M2	(> 14) - 19 dBm ((> 0.03) - 0.08 W)	M2	(> 22) - 27 dBm ((> 0.16) - 0.5 W)
M3	(> 9) - 14 dBm ((> 0.01) - 0.03 W)	M3	(> 17) - 22 dBm ((> 0.05) - 0.16 W)

The tolerance of the actual maximum output power of the BTS shall be ±2 dB under normal conditions and ±2.5 dB under extreme conditions. Settings shall be provided to allow the output power to be reduced from its maximum level in at least six steps of nominally 2 dB with an accuracy of ±1 dB to allow a fine adjustment of the coverage by the network operator. In addition, the actual absolute output power at each static RF power step (N) shall be 2*N dB below the absolute output power at static RF power step 0 with a tolerance of ±3 dB under normal conditions and ±4 dB under extreme conditions. The static RF power step 0 shall be the actual output power according to the TRX power class.

As an option the BSS can utilize downlink RF power control. In addition to the static RF power steps described above, the BSS may then utilize up to 15 steps of power control levels with a step size of 2 dB ±1.5 dB, in addition the actual absolute output power at each power control level (N) shall be 2*N dB below the absolute output power at power control level 0 with a tolerance of ±3 dB under normal conditions and ±4 dB under extreme conditions. The power control level 0 shall be the set output power according to the TRX power class and the six power settings defined above.

Network operators may also specify the BTS output power including any Tx combiner, according to their needs.

4.2 Output RF spectrum

The specifications contained in this subclause apply to both BTS and MS, in frequency hopping as well as in non frequency hopping mode, except that beyond 1 800 kHz offset from the carrier the BTS is not tested in frequency hopping mode.

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

- the modulation process;
- the power ramping up and down (switching transients).

The two effects are specified separately; the measurement method used to analyse separately those two effects is specified in GSM 11.10 and 11.20. It is based on the "ringing effect" during the transients, and is a measurement in the time domain, at each point in frequency.

The limits specified thereunder are based on a 5-pole synchronously tuned measurement filter.

Unless otherwise stated, for the BTS, only one transmitter is active for the tests of this section.

4.2.1 Spectrum due to the modulation and wide band noise

The output RF modulation spectrum is specified in the following table. A mask representation of this specification is shown in annex A. This specification applies for all RF channels supported by the equipment.

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

The figures in the table below, at the listed frequencies from the carrier (kHz), are the maximum level (dB) relative to a measurement in 30 kHz on the carrier.

For the BTS, the power level is the "actual absolute output power" defined in subclause 4.1.2. If the power level falls between two of the values in the table, the requirement shall be determined by linear interpolation.

a) GSM 900

Power level (dBm)	Measurement bandwidth										
	30 kHz						100 kHz MS and normal BTS			100 kHz Micro-BTS	
3	100	200	250	400	600 to <1 200	1 200 to <1 800	1 800 to <3 000	3 000 to <6 000	≥ 6 000	≥ 1 800	
≥ 43	+0.5	-30	-33	-60	-70	-73	-75	-75	-80		BTS
41	+0.5	-30	-33	-60	-68	-71	-73	-73	-80		BTS
39	+0.5	-30	-33	-60	-66	-69	-71	-71	-80		BTS
37	+0.5	-30	-33	-60	-64	-67	-69	-69	-80		BTS
35	+0.5	-30	-33	-60	-62	-65	-67	-67	-80		BTS
≤ 33	+0.5	-30	-33	-60	-60	-63	-65	-65	-80	-70	BTS
≥ 39	+0.5	-30	-33	-60	-66	-66	-69	-71	-77		MS
37	+0.5	-30	-33	-60	-64	-64	-67	-69	-75		MS
35	+0.5	-30	-33	-60	-62	-62	-65	-67	-73		MS
≤ 33	+0.5	-30	-33	-60	-60	-60	-63	-65	-71		MS

b) DCS 1 800

Power level (dBm)	**Measurement bandwidth**									
	30 kHz						**100 kHz MS and normal BTS**		**100 kHz Micro-BTS**	
	100	**200**	**250**	**400**	**600 to <1 200**	**1 200 to <1 800**	**1 800 to <6 000**	**≥6 000**	**≥ 1 800**	
≥ 43	+0.5	-30	-33	-60	-70	-73	-75	-80		
41	+0.5	-30	-33	-60	-68	-71	-73	-80		
39	+0.5	-30	-33	-60	-66	-69	-71	-80		
37	+0.5	-30	-33	-60	-64	-67	-69	-80		BTS
35	+0.5	-30	-33	-60	-62	-65	-67	-80	-76	
≤ 33	+0.5	-30	-33	-60	-60	-63	-65	-80	-76	
≥ 36	+0.5	-30	-33	-60	-60	-60	-71	-79		
34	+0.5	-30	-33	-60	-60	-60	-69	-77		
32	+0.5	-30	-33	-60	-60	-60	-67	-75		MS
30	+0.5	-30	-33	-60	-60	-60	-65	-73		
28	+0.5	-30	-33	-60	-60	-60	-63	-71		
26	+0.5	-30	-33	-60	-60	-60	-61	-69		
≤ 24	+0.5		-33	-60	-60	-60	-59	-67		

The specifications shall be met under the following measurement conditions.

For BTS up to 1 800 kHz from the carrier and for MS in all cases:

Zero frequency scan, filter bandwidth and video bandwidth of 30 kHz up to 1 800 kHz from the carrier and 100 kHz beyond 1 800 kHz, with averaging done over 50 % to 90 % of the useful part of the transmitted bursts, excluding the midamble, and then averaged over at least 200 such burst measurements. Above 1 800 kHz from the carrier only measurements centred on 200 kHz multiples are taken with averaging over 50 bursts.

For BTS above 1 800 kHz from the carrier swept measurement with:

Filter and video bandwidth of 100 kHz, minimum sweep time of 75 ms, averaging over 200 sweeps. All slots active, frequency hopping disabled.

When tests are done in frequency hopping mode, the averaging shall include only bursts transmitted when the hopping carrier corresponds to the nominal carrier of the measurement. The specifications then apply to the measurement results for any of the hopping frequencies.

The following exceptions and minimum measurement levels shall apply; all absolute levels in dBm shall be measured using the same bandwidth as that used in the tables a) and b) above:

i) In the combined range 600 kHz to 6 MHz above and below the carrier, in up to three bands of 200 kHz width centred on a frequency which is an integer multiple of 200 kHz, exceptions at up to -36 dBm are allowed.

ii) Above 6 MHz offset from the carrier in up to 12 bands of 200 kHz width centred on a frequency which is an integer multiple of 200 kHz, exceptions at up to -36 dBm are allowed. For the BTS only one transmitter is active for this test.

iii) For MS measured below 600 kHz from the carrier, if the limit according to the above table is below -36 dBm, a value of -36 dBm shall be used instead. For 600 kHz up to less than 1 800 kHz this limit shall be -56 dBm for DCS 1 800 MS and -51 dBm for GSM 900 MS. At 1 800 kHz and beyond, this limit shall be -51 dBm for DCS 1 800 MS and -46 dBm for GSM 900 MS.

iv) For normal BTS, if the limit according to the above table is below L, a value L shall be used instead, where L is L1 dB relative to the output power of the BTS at the lowest static power level measured at 30 kHz, or L2 dBm, whichever is higher.

For up to 1 800 kHz from the carrier: L1 = -88 dB
Beyond 1 800 kHz: L1 = -83 dB

For GSM 900 BTS: L2 = -65 dBm
For DCS 1 800 BTS: L2 = -57 dBm

v) For the micro-BTS, for offsets beyond 1 800 kHz from the carrier, if the limit according to the above table is below the values in the following table, then the values in the following table will be used instead.

Microcell BTS Power Class	**Maximum spectrum due to modulation and noise in 100 kHz (dBm)**	
	GSM 900	**DCS 1 800**
M1	-59	-57
M2	-64	-62
M3	-69	-67

4.2.2 Spectrum due to switching transients

Those effects are also measured in the time domain and the specifications assume the following measurement conditions: zero frequency scan, filter bandwidth 30 kHz, peak hold, and video bandwidth 100 kHz.

The example of a waveform due to a burst as seen in a 30 kHz filter offset from the carrier is given thereunder (figure 1).

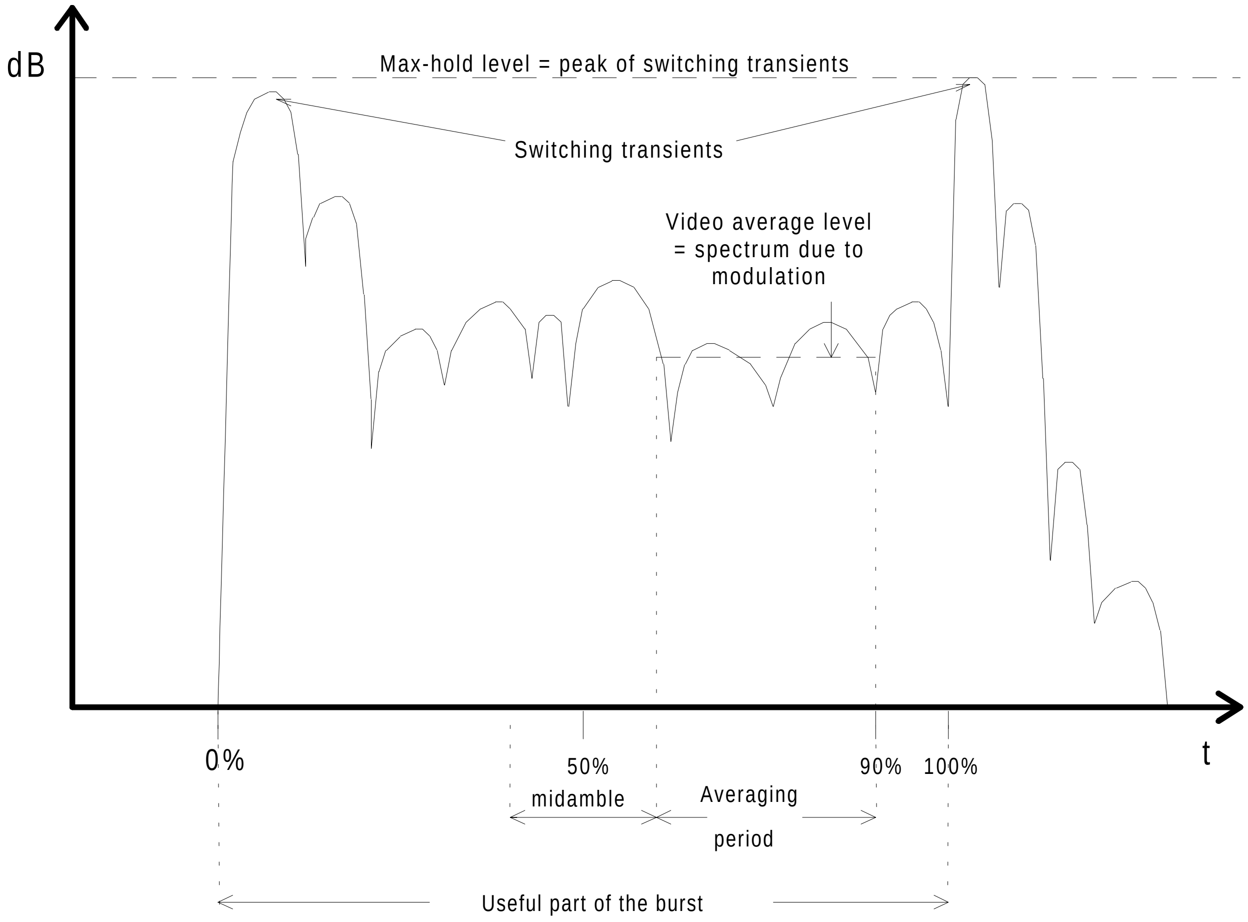


Figure 1: Example of a time waveform due to a burst as seen in a 30 kHz filter offset from the carrier

a) Mobile Station:

Power level	Maximum level measured			
	400 kHz	600 kHz	1 200 kHz	1 800 kHz
39 dBm	-21 dBm	-26 dBm	-32 dBm	-36 dBm
≤ 37 dBm	-23 dBm	-26 dBm	-32 dBm	-36 dBm

NOTE 1: The relaxations for power level 39 dBm is in line with the modulated spectra and thus causes negligible additional interference to an analogue system by a GSM signal.

NOTE 2: The near-far dynamics with this specification has been estimated to be approximately 58 dB for MS operating at a power level of 8 W or 49 dB for MS operating at a power level of 1 W. The near-far dynamics then gradually decreases by 2 dB per power level down to 32 dB for MS operating in cells with a maximum allowed output power of 20 mW or 29 dB for MS operating at 10 mW.

NOTE 3: The possible performance degradation due to switching transient leaking into the beginning or the end of a burst, was estimated and found to be acceptable with respect to the BER due to cochannel interference (C/I).

b) Base transceiver station:

The maximum level measured, after any filters and combiners, at the indicated offset from the carrier, is:

	Maximum level measured			
	400 kHz	600 kHz	1 200 kHz	1 800 kHz
GSM 900	-57 dBc	-67 dBc	-74 dBc	-74 dBc
DCS 1 800	-50 dBc	-58 dBc	-66 dBc	-66 dBc

or -36 dBm, whichever is the higher.

dBc means relative to the output power at the BTS, measured at the same point and in a filter bandwidth of at least 300 kHz.

NOTE 4: Some of the above requirements are different from those specified in subclause 4.3.2.

4.3 Spurious emissions

The limits specified thereunder are based on a 5-pole synchronously tuned measurement filter.

4.3.1 Principle of the specification

In this section, 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. The bandwidth is increased as the frequency offset between the measurement frequency and, either the carrier, or the edge of the MS or BTS transmit band, increases. The effect for spurious signals of widening the measurement bandwidth 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 the following table, a peak-hold measurement being assumed.

The measurement conditions for radiated and conducted spurious are specified separately in GSM 11.10 and 11.2x series. The frequency bands where these are actually measured may differ from one type to the other (see GSM 11.10 and 11.2x series).

a)

Band	Frequency offset	Measurement bandwidth
relevant transmit band	(offset from carrier) ≥ 1.8 MHz ≥ 6 MHz	 30 kHz 100 kHz

b)

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

The measurement settings assumed correspond, for the resolution bandwidth to the value of the measurement bandwidth in the table, and for the video bandwidth to approximately three times this value.

NOTE: For radiated spurious emissions for MS with antenna connectors, and for all spurious emissions for MS 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.

4.3.2 Base Transceiver Station

The power measured in the conditions specified in subclause 4.3.1a shall be no more than -36 dBm.

The power measured in the conditions specified in subclause 4.3.1b shall be no more than:

- 250 nW (-36 dBm) in the frequency band 9 kHz - 1 GHz;
- 1 µW (-30 dBm) in the frequency band 1 - 12.75 GHz.

NOTE 1: For radiated spurious emissions for BTS, 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.

In the BTS receive band, the power measured using the conditions specified in 4.2.1, with a filter and video bandwidth of 100 kHz shall be no more than:

	GSM (dBm)	DCS (dBm)
Normal BTS	-98	-98
Micro BTS M1	-91	-96
Micro BTS M2	-86	-91
Micro BTS M3	-81	-86
R-GSM 900 BTS	-89	

These values assume a 30 dB coupling loss between transmitter and receiver. If BTSs of different classes are co-sited, the coupling loss must be increased by the difference between the corresponding values from the table above.

Measures must be taken for mutual protection of receivers when GSM 900 and DCS 1 800 BTS are co-sited.

NOTE 2: Thus, for this case, assuming the coupling losses are as above, then the power measured in the conditions specified in subclause 4.2.1, with a filter and video bandwidth of 100 kHz should be no more than the values in the table above for the GSM 900 transmitter in the band 1 710 - 1 785 MHz and for DCS 1 800 transmitter in the band 876 - 915 MHz.

In any case, the powers measured in the conditions specified in subclause 4.2.1, with a filter and video bandwidth of 100 kHz shall be no more than -47 dBm for the GSM BTS in the band 1 805 - 1 880 MHz and -57 dBm for a DCS 1 800 BTS in the band 921 - 960 MHz.

4.3.3 Mobile Station

The power measured in the conditions specified in subclause 4.3.1a, for a MS when allocated a channel, shall be no more than -36 dBm. For R-GSM 900 MS except small MS the corresponding limit shall be -42 dBm.

The power measured in the conditions specified in subclause 4.3.1b for a MS, when allocated a channel, shall be no more than (see also note in subclause 4.3.1b above):

- 250 nW (-36 dBm) in the frequency band 9 kHz - 1 GHz;
- 1 µW (-30 dBm) in the frequency band 1 - 12.75 GHz.

The power measured in a 100 kHz bandwidth for a mobile, when not allocated a channel (idle mode), shall be no more than (see also note in 4.3.1 above):

- 2 nW (-57 dBm) in the frequency bands 9 kHz - 880 MHz, 915 - 1 000 MHz;
- 1.25 nW (-59 dBm) in the frequency band 880 - 915 MHz;
- 5 nW (-53 dBm) in the frequency band 1.71 - 1.785 GHz;
- 20 nW (-47 dBm) in the frequency bands 1 - 1.71 GHz, 1.785 - 12.75 GHz.

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

When allocated a channel, the power emitted by the MS, when measured using the measurement conditions specified in 4.2.1, but with averaging over at least 50 burst measurements, with a filter and video bandwidth of 100 kHz, for measurements centred on 200 kHz multiples, in the band 935 - 960 MHz shall be no more than -79 dBm, in the band 925-935 MHz shall be no more than -67 dBm and in the band 1 805 - 1 880 MHz, shall be no more than -71 dBm. For R-GSM 900 mobiles, in addition, a limit of -60 dBm shall apply in the frequency band 921 - 925 MHz.

As exceptions up to five measurements with a level up to -36 dBm are permitted in each of the bands 925 - 960 MHz and 1 805 - 1 880 MHz for each ARFCN used in the measurements.

When hopping, this applies to each set of measurements, grouped by the hopping frequencies as described in subclause 4.2.1.

4.4 Radio frequency tolerance

The radio frequency tolerance for the base transceiver station and the MS is defined in GSM 05.10.

4.5 Output level dynamic operation

NOTE: The term "any transmit band channel" is used here to mean:
any RF channel of 200 kHz bandwidth centred on a multiple of 200 kHz which is within the relevant transmit band.

4.5.1 Base Transceiver Station

The BTS 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 annex B. In the case where the bursts in two (or several) consecutive time slots are actually transmitted, at the same frequency, no requirements are specified to the power ramping in the guard times between the active time slots, and the template of annex B shall be respected at the beginning and the end of the series of consecutive bursts. The residual output power, if a timeslot is not activated, shall be maintained at, or below, a level of -30 dBc on the frequency channel in use. 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 300 kHz is assumed.

4.5.2 Mobile Station

The output power can be reduced by steps of 2 dB as listed in subclause 4.1.

The transmitted power level relative to time when sending a burst is shown in annex B. In the case of Multislot Configurations where the bursts in two or more consecutive time slots are actually transmitted at the same frequency, no requirements are specified to the power ramping in the guard times between the active slots, and the template of annex B shall be respected at the beginning and the end of the series of consecutive bursts. The timing of the transmitted burst is specified in GSM 05.10. Between the active bursts, the residual output power shall be maintained at, or below, the level of:

- -59 dBc or -54 dBm, whichever is the greater for GSM 900, except for the time slot preceding the active slot, for which this value is equal to -36 dBm;

- -48 dBc or -48 dBm, whichever is the greater for DCS 1 800;

in any transmit band channel.

A measurement bandwidth of at least 300 kHz is assumed.

The transmitter, when in idle mode, will respect the conditions of subclause 4.3.3.

4.6 Phase accuracy

When transmitting a burst, the phase accuracy of the signal, relative to the theoretical modulated waveforms as specified in GSM 05.04, is specified in the following way.

For any 148-bits subsequence of the 511-bits pseudo-random sequence, defined in CCITT Recommendation O.153 fascicle IV.4, 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. The RMS phase error (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: 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 GSM 05.04) influence the output phase in a time slot.

4.7 Intermodulation attenuation

The intermodulation attenuation is the ratio of the power level of the wanted signal to the power level of an intermodulation component. It is a measure of the capability of the transmitter to inhibit the generation of signals in its non-linear elements caused by the presence of the carrier and an interfering signal reaching the transmitter via the antenna.

4.7.1 Base transceiver station

An interfering CW signal shall be applied within the relevant BTS TX band at a frequency offset of $\geq$ 800 kHz, and with a power level 30 dB below the power level of the wanted signal.

The intermodulation products shall meet the requirements in subclause 4.7.2

4.7.2 Intra BTS intermodulation attenuation

In a BTS intermodulation may be caused by combining several RF channels to feed a single antenna, or when operating them in the close vicinity of each other. The BTS shall be configured with each transmitter operating at the maximum allowed power, with a full complement of transceivers and with modulation applied. For the measurement in the transmit band the equipment shall be operated at equal and minimum carrier frequency spacing specified for the BSS configuration under test. For the measurement in the receive band the equipment shall be operated with such a channel configuration that at least 3rd order intermodulation products fall into the receive band.

All the following requirements relate to frequency offsets from the uppermost and lowermost carriers. The peak hold value of intermodulation components over a timeslot, shall not exceed -70 dBc or -36 dBm, whichever is the higher, for frequency offsets between 6 MHz and the edge of the relevant Tx band measured in a 300 kHz bandwidth. 1 in 100 timeslots may fail this test by up to a level of 10 dB. For offsets between 600 kHz to 6 MHz the requirements and the measurement technique is that specified in subclause 4.2.1.

The other requirements of subclause 4.3.2 in the band 9 kHz to 12,75 GHz shall still be met.

4.7.3 Intermodulation between MS (DCS 1 800 only)

The maximum level of any intermodulation product, when measured as peak hold in a 300 kHz bandwidth, shall be 50 dB below the wanted signal when an interfering CW signal is applied within the DCS 1 800 MS transmit band at a frequency offset of 800 kHz with a power level 40 dB below the power level of the wanted (DCS 1 800 modulated) signal.

4.7.4 Mobile PBX (GSM 900 only)

In a mobile PBX intermodulation may be caused when operating transmitters in the close vicinity of each other. The intermodulation specification for mobile PBXs (GSM 900 only) shall be that stated in subclause 4.7.2.

5 Receiver characteristics

In this clause, the 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 fields strengths (E) related to the power levels (P) specified, by the following formula (derived from the formula E = P + 20log$F_{(MHz)}$ + 77.2):

assuming F = 925 MHz	:	E (dBµV/m) = P (dBm) + 136.5	for GSM 900
assuming F = 1 795 MHz	:	E (dBµV/m) = P (dBm) + 142.3	for DCS 1 800

Static propagation conditions are assumed in all cases, for both wanted and unwanted signals. For subclauses 5.1 and 5.2, values given in dBm are indicative, and calculated assuming a 50 ohms impedance.

5.1 Blocking characteristics

The blocking characteristics of the receiver are specified separately for in-band and out-of-band performance as identified in the following tables.

Frequency band	Frequency range (MHz)			
	GSM 900		E-GSM 900	R-GSM 900
	MS	BTS	BTS	BTS
in-band	915 - 980	870 - 925	860 - 925	856 - 921
out-of-band (a)	0.1 - < 915	0.1 - < 870	0.1 - < 860	0.1 - < 856
out-of-band (b)	N/A	N/A	N/A	N/A
out-of band (c)	N/A	N/A	N/A	N/A
out-of band (d)	> 980 - 12,750	> 925 - 12,750	> 925 - 12,750	> 921 - 12,750

Frequency band	Frequency range (MHz) DCS 1 800	
	MS	BTS
in-band	1 785 - 1 920	1 690 - 1 805
out-of-band (a)	0.1 - 1705	0.1 - < 1 690
out-of-band (b)	> 1 705 - < 1 785	N/A
out-of band (c)	> 1 920 - 1 980	N/A
out-of band (d)	> 1 980 - 12,750	> 1 805 - 12,750

The reference sensitivity performance as specified in table 1 shall be met when the following signals are simultaneously input to the receiver:

- a useful signal at frequency f_o, 3 dB above the reference sensitivity level as specified in subclause 6.2;

- a continuous, static sine wave signal at a level as in the table below and at a frequency (f) which is an integer multiple of 200 kHz.

with the following exceptions, called spurious response frequencies:

a) GSM 900: in band, for a maximum of six occurrences (which if grouped shall not exceed three contiguous occurrences per group);

DCS 1 800: in band, for a maximum of twelve occurrences (which if grouped shall not exceed three contiguous occurrences per group).

b) 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 performance shall be met when the continuous sine wave signal (f) is set to a level of 70 dBµV (emf) (i.e. -43 dBm).

Frequency band	P-, E- and R-GSM 900						DCS 1 800			
	other MS		small MS		BTS		MS		BTS	
	dBµV (emf)	dBm	dBµV (emf)	dBm	dBµV (emf)	dBm	dBµV (emf)	dBm	dBµV (emf)	dBm
in-band										
600 kHz ≤ $\|f-f_o\|$ < 800 kHz	75	-38	70	-43	87	-26	70	-43	78	-35
800 kHz ≤ $\|f-f_o\|$ < 1.6 MHz	80	-33	70	-43	97	-16	70	-43	88	-25
1.6 MHz ≤ $\|f-f_o\|$ < 3 MHz	90	-23	80	-33	97	-16	80	-33	88	-25
3 MHz ≤ $\|f-f_o\|$	90	-23	90	-23	100	-13	87	-26	88	-25
out-of-band										
(a)	113	0	113	0	121	8	113	0	113	0
(b)	-	-	-	-	-	-	101	-12	-	-
(c)	-	-	-	-	-	-	101	-12	-	-
(d)	113	0	113	0	121	8	113	0	113	0
NOTE: For definition of small MS, see subclause 1.1.										

The following relaxations to the blocking level in the above table shall apply:

- for E-GSM MS, in the band 905 - 915 MHz: -5 dBm;
- for R-GSM 900 MS, in the band 880 - 915 MHz: -5 dBm;
- for R-GSM 900 small MS, in the band 876 - 915 MHz: -7 dBm;
- for GSM 900 and E-GSM 900 BTS, in the band 925 - 935 MHz: 0 dBm.

The blocking characteristics of the micro-BTS receiver are specified for in-band and out-of-band performance. The out-of-band blocking remains the same as a normal BTS leaving the in-band blocking to be defined here for the micro-BTS.

Frequency band	GSM 900 micro-BTS			DCS 1 800 micro-BTS		
	M1 (dBm)	M2 (dBm)	M3 (dBm)	M1 (dBm)	M2 (dBm)	M3 (dBm)
in-band						
600 kHz ≤ $\|f-f_0\|$ < 800 kHz	-31	-26	-21	-40	-35	-30
800 kHz ≤ $\|f-f_0\|$ < 1.6 MHz	-21	-16	-11	-30	-25	-20
1.6 MHz ≤ $\|f-f_0\|$ < 3 MHz	-21	-16	-11	-30	-25	-20
3 MHz ≤ $\|f-f_0\|$	-21	-16	-11	-30	-25	-20

5.2 AM suppression characteristics

The reference sensitivity performance as specified in table 1 shall be met when the following signals are simultaneously input to the receiver.

- A useful signal at f_0, 3dB above reference sensitivity level as specified in subclause 6.2.

- A single frequency (f), in the relevant receive band, $| f-f_0 | > 6$ MHz, which is an integer multiple of 200 kHz, a GSM TDMA signal modulated by any 148-bit sequence of the 511-bit pseudo random bit sequence, defined in CCITT Recommendation 0.153 fascicle IV.4, at a level as defined in the table below. The interferer shall have one timeslot active and the frequency shall be at least 2 channels separated from any identified spurious response. The transmitted bursts shall be synchronized to but delayed in time between 61 and 86 bit periods relative to the bursts of the wanted signal.

NOTE: When testing this requirement, a notch filter may be necessary to ensure that the co-channel performance of the receiver is not compromised.

	MS (dBm)	BTS (dBm)	Micro-BTS M1 (dBm)	Micro-BTS M2 (dBm)	Micro-BTS M3 (dBm)
GSM 900	-31	-31	-34	-29	-24
DCS 1 800	-29	-35	-33	-28	-23

5.3 Intermodulation characteristics

The reference sensitivity performance as specified in table 1 shall be met when the following signals are simultaneously input to the receiver:

- a useful signal at frequency f_o, 3 dB above the reference sensitivity level as specified in subclause 6.2;

- a continuous, static sine wave signal at frequency f_1 and a level of 70 dBµV (emf) (i.e. -43 dBm):
  - for GSM 900 small mss and DCS 1 800 MS and BTS this value is relaxed to 64 dBµV (emf) (i.e. -49 dBm);
  - for the DCS 1 800 class 3 MS this value is relaxed to 68 dBµV (emf) (i.e. -45 dBm);

- any 148-bits subsequence of the 511-bits pseudo-random sequence, defined in CCITT Recommendation O.153 fascicle IV.4 modulating a signal at frequency f_2, and a level of 70 dBµV (emf) (i.e. -43 dBm):
  - for GSM 900 small mss and DCS 1 800 MS and BTS this value is relaxed to 64 dBµV (emf) (i.e. -49 dBm);
  - for the DCS 1 800 class 3 MS this value is relaxed to 68 dBµV (emf) (i.e. -45 dBm);

such that $f_0 = 2f_1 - f_2$ and $|f_2-f_1| = 800$ kHz.

NOTE: For subclauses 5.2 and 5.3 instead of any 148-bits subsequence of the 511-bits pseudo-random sequence, defined in CCITT Recommendation 0.153 fascicle IV.4, it is also allowed to use a more random pseudo-random sequence.

5.4 Spurious emissions

The spurious emissions for a BTS receiver, measured in the conditions specified in subclause 4.3.1, shall be no more than:

- 2 nW (-57 dBm) in the frequency band 9 kHz - 1 GHz;
- 20 nW (-47 dBm) in the frequency band 1 - 12.75 GHz.

NOTE: For radiated spurious emissions for the BTS, 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 Transmitter/receiver performance

In order to assess the error rate performance that is described in this clause it is required for a mobile equipment to have a "loop back" facility by which the equipment transmits back the same information that it decoded, in the same mode. This facility is specified in GSM 11.10.

This clause aims at specifying the receiver performance, taking into account that transmitter errors must not occur, and that the transmitter shall be tested separately (see subclause 4.6). In the case of base transceiver stations the values apply for measurement at the connection with the antenna of the BTS, including any external multicoupler. All the values given are valid if any of the features: discontinuous transmission (DTx), discontinuous reception (DRx), or slow frequency hopping (SFH) are used or not. The received power levels under multipath fading conditions given are the mean powers of the sum of the individual paths.

In this clause power levels are given also in terms of field strength, assuming a 0 dBi gain antenna, to apply for the test of MS with integral antennas.

6.1 Nominal Error Rates (NER)

This subclause describes the transmission requirements in terms of error rates in nominal conditions i.e. without interference and with an input level of 20 dB above the reference sensitivity level. The relevant propagation conditions appear in annex C.

Under the following propagation conditions, the chip error rate, equivalent to the bit error rate of the non protected bits (TCH/FS, class II) shall have the following limits:

- static channel: BER $\leq 10^{-4}$;
- EQ50 channel: BER $\leq$ 3 %.

This performance shall be maintained up to -40 dBm input level for static and multipath conditions. Furthermore, for static conditions, a bit error rate of 10^{-3} shall be maintained up to -15 dBm for GSM 900, -23 dBm for DCS 1 800.

6.2 Reference sensitivity level

The reference sensitivity performance in terms of frame erasure, bit error, or residual bit error rates (whichever appropriate) is specified in table 1, according to the type of channel and the propagation condition. The actual sensitivity level is defined as the input level for which this performance is met. The actual sensitivity level shall be less than a specified limit, called the reference sensitivity level. The reference sensitivity level shall be:

- for DCS 1 800 class 1 or class 2 MS : -100 dBm
- for DCS 1 800 class 3 MS : -102 dBm
- for GSM 900 small MS : -102 dBm
- for other GSM 900 MS and normal BTS : -104 dBm
- for GSM 900 micro BTS M1 : -97 dBm
- for GSM 900 micro BTS M2 : -92 dBm
- for GSM 900 micro BTS M3 : -87 dBm
- for DCS 1 800 micro BTS M1 : -102 dBm
- for DCS 1 800 micro BTS M2 : -97 dBm
- for DCS 1 800 micro BTS M3 : -92 dBm

The above specifications for BTS shall be met when the two adjacent timeslots to the wanted are detecting valid GSM signals at 50 dB above the power on the wanted timeslot. For MS the above specifications shall be met with the two adjacent timeslots 20 dB above the own timeslot and the static channel.

6.3 Reference interference level

The reference interference performance (for cochannel, C/Ic, or adjacent channel, C/Ia) in terms of frame erasure, bit error or residual bit error rates (whichever appropriate) is specified in table 2, according to the type of channel and the propagation condition. The actual interference ratio is defined as the interference ratio for which this performance is met. The actual interference ratio shall be less than a specified limit, called the reference interference ratio. The reference interference ratio shall be, for BTS and all types of MS:

-	for cochannel interference	:	C/Ic	=	9 dB
-	for adjacent (200 kHz) interference	:	C/Ia1	=	-9 dB
-	for adjacent (400 kHz) interference	:	C/Ia2	=	-41 dB
-	for adjacent (600 kHz) interference	:	C/Ia3	=	-49 dB

NOTE: The C/Ia3 figure is given for information purposes and will not require testing. It was calculated for the case of an equipment with an antenna connector, operating at output power levels of +33 dBm and below. Rejection of signals at 600 kHz is specified in subclause 5.1.

These specifications apply for a wanted signal input level of 20 dB above the reference sensitivity level, and for a random, continuous, GSM-modulated interfering signal. In case of frequency hopping, the interference and the wanted signals shall have the same frequency hopping sequence. In any case the wanted and interfering signals shall be subject to the same propagation profiles (see annex C), independent on the two channels.

For a GSM 900 MS and a DCS 1 800 MS the reference interference performance according to table 2 for co-channel interference (C/Ic) shall be maintained for RA250/130 propagation conditions if the time of arrival of the wanted signal is periodically alternated by steps of 8µs in either direction. The period shall be 32 seconds (16 seconds with the early and 16 seconds with the late time of arrival alternately).

For adjacent channel interference propagation conditions other than TU50 need not be tested. If, in order to ease measurement, a TU50 (no FH) faded wanted signal, and a static adjacent channel interferer are used, the reference interference performance shall be:

	GSM 900	DCS 1 800
TCH/FS (FER):	10,2α %	5,1α %
Class Ib (RBER):	0,72/α %	0,45/α %
Class II (RBER):	8,8 %	8,9 %
FACCH (FER):	17,1 %	6,1 %

6.4 Erroneous frame indication performance

a) On a speech TCH (TCH/FS or TCH/HS) or a SDCCH with a random RF input, of the frames believed to be FACCH, SACCH, or 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 a speech TCH (TCH/FS or TCH/HS) 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) shall be measured in one minute for MS. The requirement for BTS is for further study.

c) On a speech TCH (TCH/FS or TCH/HS), when DTX is activated with frequency hopping through C0 where bursts comprising SID frames, SACCH frames and Dummy bursts are received at a level 20 dB above the reference sensitivity level and with no transmission at the other bursts of the TCH, the overall reception performance shall be such that, on average less than one undetected bad speech frame (false bad frame indication BFI) shall be measured in one minute for MS. The requirement for BTS is for further study.

d) For a BTS on a 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 1: Reference sensitivity performance

GSM 900						
Type of channel		**Propagation conditions**				
		static	**TU50**	**TU50**	**RA250**	**HT100**
			(no FH)	(ideal FH)	(no FH)	(no FH)
FACCH/H	(FER)	0,1 %	6,9 %	6,9 %	5,7 %	10,0 %
FACCH/F	(FER)	0,1 %	8,0 %	3,8 %	3,4 %	6,3 %
SDCCH	(FER)	0,1 %	13 %	8 %	8 %	12 %
RACH	(FER)	0,5 %	13 %	13 %	12 %	13 %
SCH	(FER)	1 %	16 %	16 %	15 %	16 %
TCH/F9,6 & H4,8	(BER)	10^{-5}	0,5 %	0,4 %	0,1 %	0,7 %
TCH/F4,8	(BER)	-	10^{-4}	10^{-4}	10^{-4}	10^{-4}
TCH/F2,4	(BER)	-	$2\ 10^{-4}$	10^{-5}	10^{-5}	10^{-5}
TCH/H2,4	(BER)	-	10^{-4}	10^{-4}	10^{-4}	10^{-4}
TCH/FS	(FER)	0,1α %	6α %	3α %	2α %	7α %
	class Ib (RBER)	0,4/α %	0,4/α %	0,3/α %	0,2/α %	0,5/α %
	class II (RBER)	2 %	8 %	8 %	7 %	9 %
TCH/EFS	(FER)	< 0,1 %	8 %	3 %	3 %	7 %
	(RBER Ib)	< 0,1 %	0,21 %	0,11 %	0,10 %	0,20 %
	(RBER II)	2,0 %	7 %	8 %	7 %	9 %
TCH/HS	(FER)	0,025 %	4,1 %	4,1 %	4,1 %	4,5 %
	class Ib (RBER, BFI=0)	0,001 %	0,36 %	0,36 %	0,28 %	0,56 %
	class II (RBER, BFI=0)	0,72 %	6,9 %	6,9 %	6,8 %	7,6 %
	(UFR)	0,048 %	5,6 %	5,6 %	5,0 %	7,5 %
class Ib (RBER,(BFI or UFI)=0)		0,001 %	0,24 %	0,24 %	0,21 %	0,32 %
	(EVSIDR)	0,06 %	6,8 %	6,8 %	6,0 %	9,2 %
	(RBER, SID=2 and (BFI or UFI)=0)	0,001 %	0,01 %	0,01 %	0,01 %	0,02 %
	(ESIDR)	0,01 %	3,0 %	3,0 %	3,2 %	3,4 %
	(RBER, SID=1 or SID=2)	0,003 %	0,3 %	0,3 %	0,21 %	0,42 %
DCS 1 800						
Type of channel		**Propagation conditions**				
		static	**TU50 (no FH)**	**TU50 (ideal FH)**	**RA130 (no FH)**	**HT100 (no FH)**
FACCH/H	(FER)	0,1 %	7,2 %	7,2 %	5,7 %	10,4 %
FACCH/F	(FER)	0,1 %	3,9 %	3,9 %	3,4 %	7,4 %
SDCCH	(FER)	0,1 %	9 %	9 %	8 %	13 %
RACH	(FER)	0,5 %	13 %	13 %	12 %	13 %
SCH	(FER)	1 %	19 %	19 %	15 %	25 %
TCH/F9,6 & H4,8	(BER)	10^{-5}	0,4 %	0,4 %	0,1 %	0,7 %
TCH/F4,8	(BER)	-	10^{-4}	10^{-4}	10^{-4}	10^{-4}
TCH/F2,4	(BER)	-	10^{-5}	10^{-5}	10^{-5}	10^{-5}
TCH/H2,4	(BER)	-	10^{-4}	10^{-4}	10^{-4}	10^{-4}
TCH/FS	(FER)	0,1α %	3α %	3α %	2α %	7α %
	class Ib (RBER)	0,4/α %	0,3/α %	0,3/α %	0,2/α %	0,5/α %
	class II (RBER)	2 %	8 %	8 %	7 %	9 %
TCH/EFS	(FER)	< 0,1 %	4 %	4 %	3 %	7 %
	(RBER Ib)	< 0,1 %	0,12 %	0,12 %	0,10 %	0,24 %
	(RBER II)	2,0 %	8 %	8 %	7 %	9 %

(continued)

Table 1 (concluded): Reference sensitivity performance

GSM 900					
TCH/HS (FER)	0,025 %	4,2 %	4,2 %	4,1 %	5,0 %
class Ib (RBER, BFI=0)	0,001 %	0,38 %	0,38 %	0,28 %	0,63 %
class II (RBER, BFI=0)	0,72 %	6,9 %	6,9 %	6,8 %	7,8 %
(UFR)	0,048 %	5,7 %	5,7 %	5,0 %	8,1 %
class Ib (RBER, (BFI or UFI)=0)	0,001 %	0,26 %	0,26 %	0,21 %	0,35 %
(EVSIDR)	0,06 %	7,0 %	7,0 %	6,0 %	9,9 %
(RBER, SID=2 and (BFI or UFI)=0)	0,001 %	0,01 %	0,01 %	0,01 %	0,02 %
(ESIDR)	0,01 %	3,0 %	3,0 %	3,2 %	3,9 %
(RBER, SID=1 or SID=2)	0,003 %	0,33 %	0,33 %	0,21 %	0,45 %

NOTE 1: The specification for SDCCH applies also for BCCH, AGCH, PCH, SACCH. The actual performance of SACCH, should be better.

NOTE 2: Definitions:

FER: Frame erasure rate (frames marked with BFI=1)

UFR: Unreliable frame rate (frames marked with (BFI or UFI)=1)

EVSIDR: Erased Valid SID frame rate (frames marked with (SID=0) or (SID=1) or ((BFI or UFI)=1) if a valid SID frame was transmitted)

ESIDR: Erased SID frame rate (frames marked with SID=0 if a valid SID frame was transmitted)

BER: Bit error rate

RBER, BFI=0: Residual bit error rate (defined as the ratio of the number of errors detected over the frames defined as "good" to the number of transmitted bits in the "good" frames).

RBER, (BFI or UFI)=0: Residual bit error rate (defined as the ratio of the number of errors detected over the frames defined as "reliable" to the number of transmitted bits in the "reliable" frames).

RBER, SID=2 and (BFI or UFI)=0: Residual bit error rate of those bits in class I which do not belong to the SID codeword (defined as the ratio of the number of errors detected over the frames that are defined as "valid SID frames" to the number of transmitted bits in these frames, under the condition that a valid SID frame was sent).

RBER, SID=1 or SID=2: Residual bit error rate of those bits in class I which do not belong to the SID codeword (defined as the ratio of the number of errors detected over the frames that are defined as "valid SID frames" or as "invalid SID frames" to the number of transmitted bits in these frames, under the condition that a valid SID frame was sent).

NOTE 3: $1 \le \alpha \le 1.6$. The value of α can be different for each channel condition but must remain the same for FER and class Ib RBER measurements for the same channel condition.

NOTE 4: FER for CCHs takes into account frames which are signalled as being erroneous (by the FIRE code, parity bits, or other means) or where the stealing flags are wrongly interpreted.

NOTE 5: Ideal FH case assumes perfect decorrelation between bursts. This case may only be tested if such a decorrelation is ensured in the test. For TU50 (ideal FH), sufficient decorrelation may be achieved with 4 frequencies spaced over 5 MHz.

Table 2: Reference interference performance

GSM 900						
Type of channel		**Propagation conditions**				
		TU3 (no FH)	**TU3 (ideal FH)**	**TU50 (no FH)**	**TU50 (ideal FH)**	**RA250 (no FH)**
FACCH/H	(FER)	22 %	6,7 %	6,7 %	6,7 %	5,7 %
FACCH/F	(FER)	22 %	3,4 %	9,5 %	3,4 %	3,5 %
SDCCH	(FER)	22 %	9 %	13 %	9 %	8 %
RACH	(FER)	15 %	15 %	16 %	16 %	13 %
SCH	(FER)	17 %	17 %	17 %	17 %	18 %
TCH/F9,6 & H4,8	(BER)	8 %	0,3 %	0,8 %	0,3 %	0,2 %
TCH/F4,8	(BER)	3 %	10^{-4}	10^{-4}	10^{-4}	10^{-4}
TCH/F2,4	(BER)	3 %	10^{-5}	10^{-4}	10^{-5}	10^{-5}
TCH/H2,4	(BER)	4 %	10^{-4}	$2\ 10^{-4}$	10^{-4}	10^{-4}
TCH/FS	(FER)	21α %	3α %	6α %	3α %	3α %
	class Ib (RBER)	2/α %	0,2/α %	0,4/α %	0,2/α %	0,2/α %
	class II (RBER)	4 %	8 %	8 %	8 %	8 %
TCH/EFS	(FER)	23 %	3 %	9 %	3 %	4 %
	(RBER Ib)	0,20 %	0,10 %	0,20 %	0,10 %	0,13 %
	(RBER II)	3 %	8 %	7 %	8 %	8 %
TCH/HS	(FER)	19,1 %	5,0 %	5,0 %	5,0 %	4,7 %
	class Ib (RBER, BFI=0)	0,52 %	0,27 %	0,29 %	0,29 %	0,21 %
	class II (RBER, BFI=0)	2,8 %	7,1 %	7,1 %	7,1 %	7,0 %
	(UFR)	20,7 %	6,2 %	6,1 %	6,1 %	5,6 %
	class Ib (RBER,(BFI or UFI)=0)	0,29 %	0,20 %	0,21 %	0,21 %	0,17 %
	(EVSIDR)	21,9 %	7,1 %	7,0 %	7,0 %	6,3 %
	(RBER, SID=2 and (BFI or UFI)=0)	0,02 %	0,01 %	0,01 %	0,01 %	0,01 %
	(ESIDR)	17,1 %	3,6 %	3,6 %	3,6 %	3,4 %
	(RBER, SID=1 or SID=2)	0,5 %	0,27 %	0,26 %	0,26 %	0,20 %
DCS 1 800						
Type of channel		**Propagation conditions**				
		TU1,5 (no FH)	**TU1,5 (ideal FH)**	**TU50 (no FH)**	**TU50 ideal FH)**	**RA130 (no FH)**
FACCH/H	(FER)	22 %	6,7 %	6,9 %	6,9 %	5,7 %
FACCH/F	(FER)	22 %	3,4 %	3,4 %	3,4 %	3,5 %
SDCCH	(FER)	22 %	9 %	9 %	9 %	8 %
RACH	(FER)	15 %	15 %	16 %	16 %	13 %
SCH	(FER)	17 %	17 %	19 %	19 %	18 %
TCH/F9,6 & H4,8	(BER)	8 %	0,3 %	0,8 %	0,3 %	0,2 %
TCH/F4,8	(BER)	3 %	10^{-4}	10^{-4}	10^{-4}	10^{-4}
TCH/F2,4	(BER)	3 %	10^{-5}	10^{-5}	10^{-5}	10^{-5}
TCH/H2,4	(BER)	4 %	10^{-4}	10^{-4}	10^{-4}	10^{-4}
TCH/FS	(FER)	21α %	3α %	3α %	3α %	3α %
	class Ib (RBER)	2/α %	0,2/α %	0,25/α %	0,25/α %	0,2/α %
	class II (RBER)	4 %	8 %	8,1 %	8,1 %	8 %
TCH/EFS	(FER)	23 %	3 %	3 %	3 %	4 %
	(RBER Ib)	0,20 %	0,10 %	0,10 %	0,10 %	0,13 %
	(RBER II)	3 %	8 %	8 %	8 %	8 %

(continued)

Table 2 (concluded): Reference interference performance

GSM 900					
TCH/HS (FER)	19,1 %	5,0 %	5,0 %	5,0 %	4,7 %
class Ib (RBER, BFI=0)	0,52 %	0,27 %	0,29 %	0,29 %	0,21 %
class II (RBER, BFI=0)	2,8 %	7,1 %	7,2 %	7,2 %	7,0 %
(UFR)	20,7 %	6,2 %	6,1 %	6,1 %	5,6 %
class Ib (RBER, (BFI or UFI)=0)	0,29 %	0,20 %	0,21 %	0,21 %	0,17 %
(EVSIDR)	21,9 %	7,1 %	7,0 %	7,0 %	6,3 %
(RBER, SID=2 and (BFI or UFI)=0)	0,02 %	0,01 %	0,01 %	0,01 %	0,01 %
(ESIDR)	17,1 %	3,6 %	3,6 %	3,6 %	3,4 %
(RBER, SID=1 or SID=2)	0,5 %	0,27 %	0,26 %	0,26 %	0,20 %

NOTE 1: The specification for SDCCH applies also for BCCH, AGCH, PCH, SACCH. The actual performance of SACCH, particularly for the C/I TU3 (no FH) and TU 1.5 (no FH) cases should be better.

NOTE 2: Definitions:

FER: Frame erasure rate (frames marked with BFI=1)

UFR: Unreliable frame rate (frames marked with (BFI or UFI)=1)

EVSIDR: Erased Valid SID frame rate (frames marked with (SID=0) or (SID=1) or ((BFI or UFI)=1) if a valid SID frame was transmitted)

ESIDR: Erased SID frame rate (frames marked with SID=0 if a valid SID frame was transmitted)

BER: Bit error rate

RBER, BFI=0: Residual bit error rate (defined as the ratio of the number of errors detected over the frames defined as "good" to the number of transmitted bits in the "good" frames).

RBER, (BFI or UFI)=0: Residual bit error rate (defined as the ratio of the number of errors detected over the frames defined as "reliable" to the number of transmitted bits in the "reliable" frames).

RBER, SID=2 and (BFI or UFI)=0: Residual bit error rate of those bits in class I which do not belong to the SID codeword (defined as the ratio of the number of errors detected over the frames that are defined as "valid SID frames" to the number of transmitted bits in these frames, under the condition that a valid SID frame was sent).

RBER, SID=1 or SID=2: Residual bit error rate of those bits in class I which do not belong to the SID codeword (defined as the ratio of the number of errors detected over the frames that are defined as "valid SID frames" or as "invalid SID frames" to the number of transmitted bits in these frames, under the condition that a valid SID frame was sent).

NOTE 3: $1 \leq \alpha \leq 1.6$. The value of α can be different for each channel condition but must remain the same for FER and class Ib RBER measurements for the same channel condition.

NOTE 4: FER for CCHs takes into account frames which are signalled as being erroneous (by the FIRE code, parity bits, or other means) or where the stealing flags are wrongly interpreted.

NOTE 5: Ideal FH case assumes perfect decorrelation between bursts. This case may only be tested if such a decorrelation is ensured in the test. For TU50 (ideal FH), sufficient decorrelation may be achieved with 4 frequencies spaced over 5 MHz. The TU3 (ideal FH) and TU1.5 (ideal FH), sufficient decorrelation cannot easily be achieved. These performance requirements are given for information purposes and need not be tested.

Annex A (informative): Spectrum characteristics (spectrum due to the modulation)

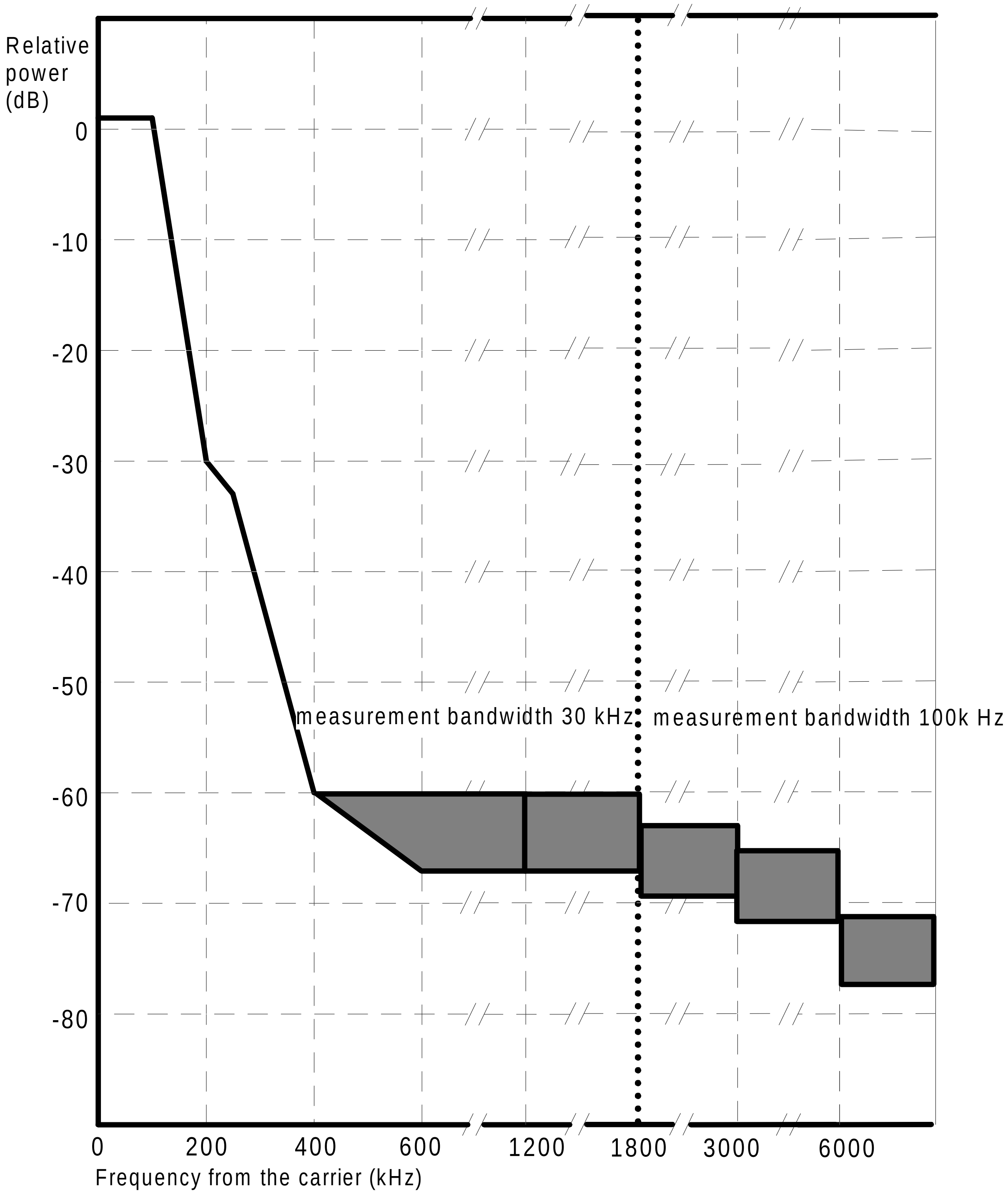


Figure A.1: GSM 900 MS spectrum due to modulation

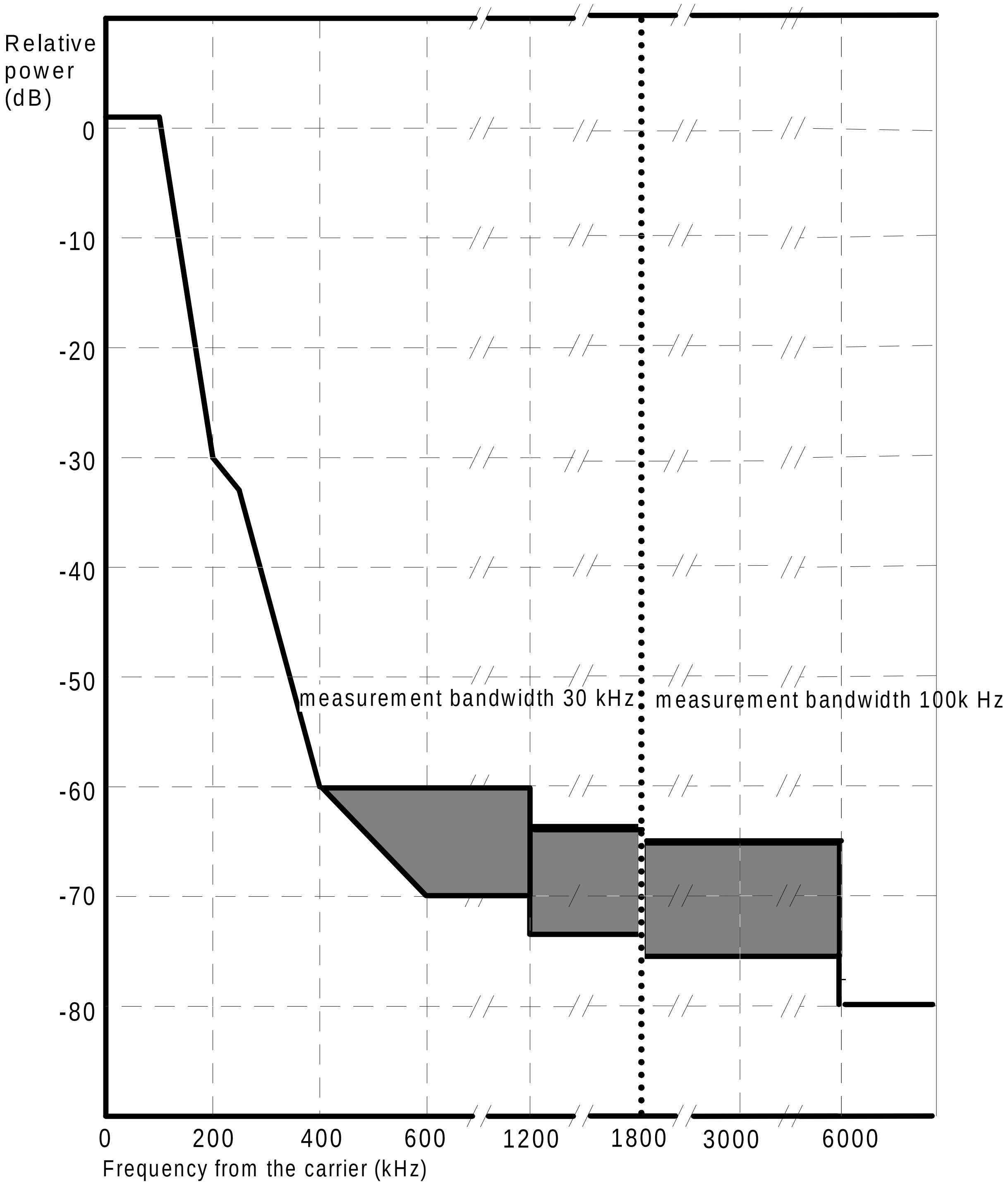


Figure A.2: GSM 900 BTS spectrum due to modulation

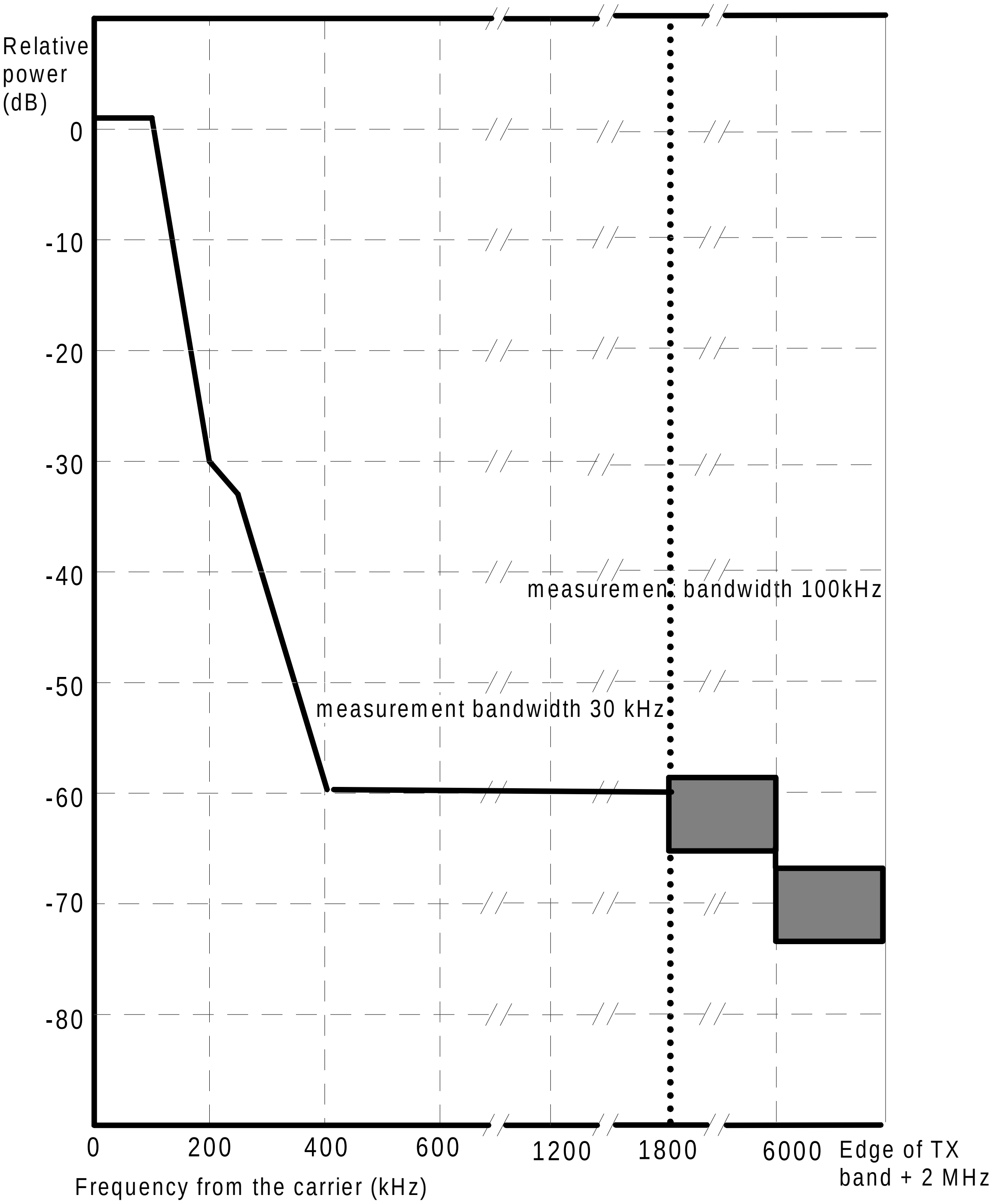


Figure A.3: DCS 1 800 MS spectrum due to modulation

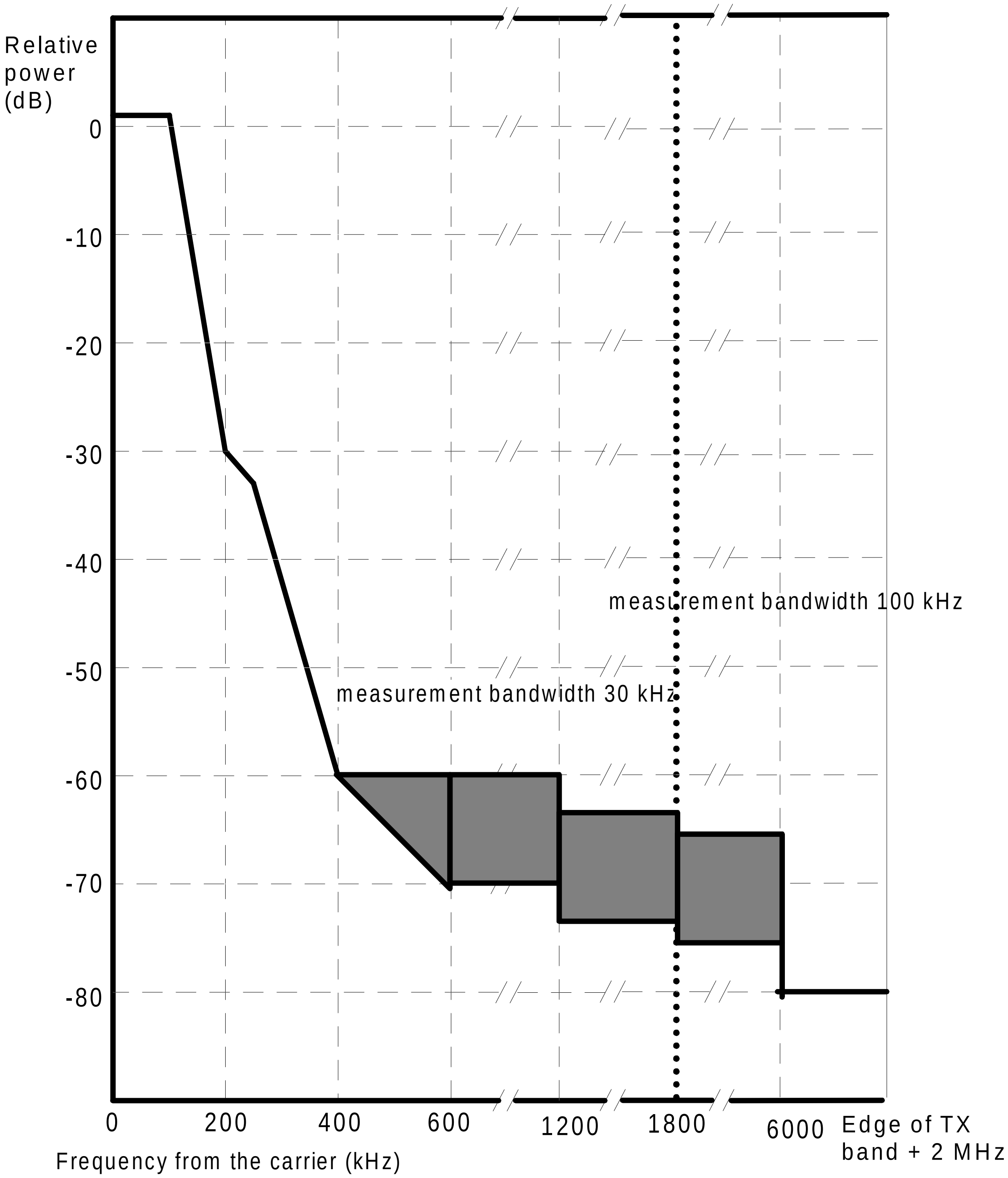
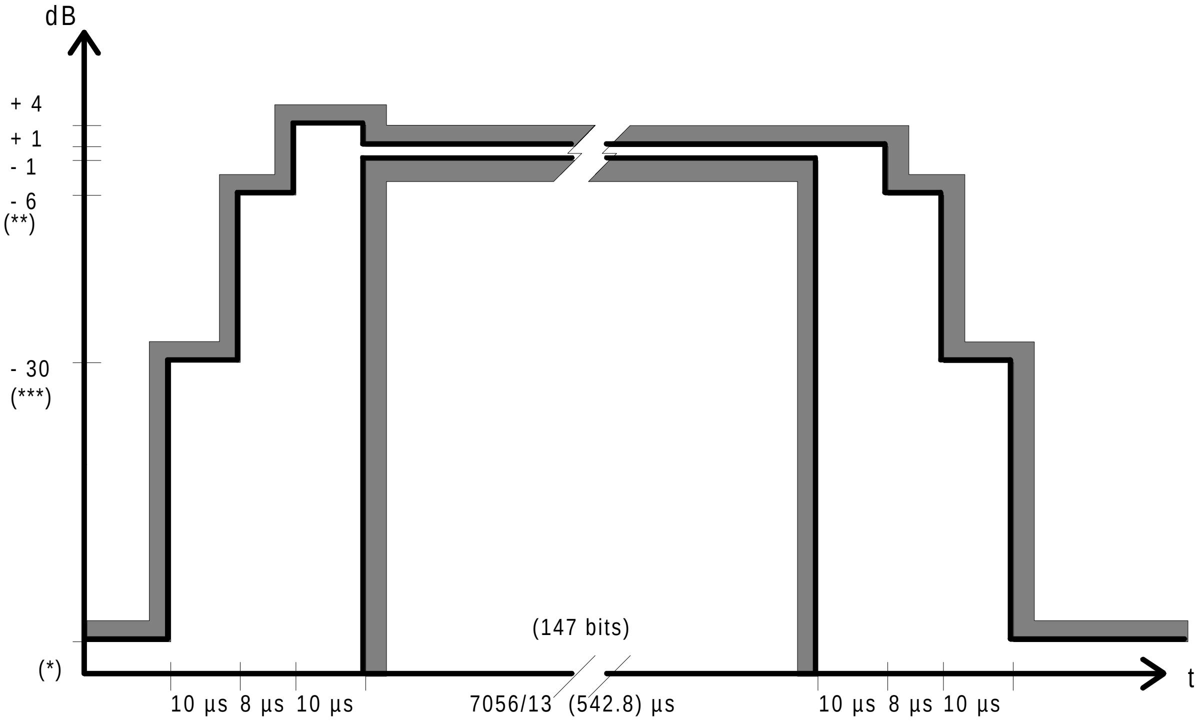
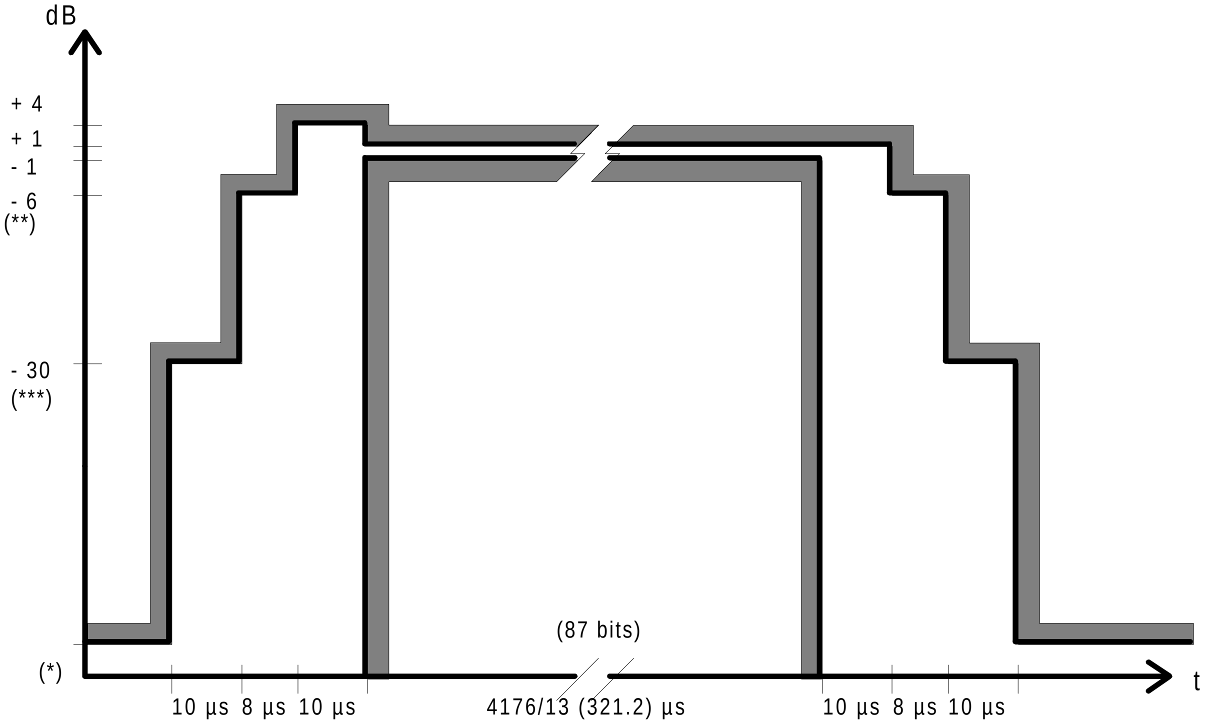


Figure A.4: DCS 1 800 BTS spectrum due to modulation

Annex B (normative): Transmitted power level versus time



Time mask for normal duration bursts (NB, FB, dB and SB)



Time mask for access burst (AB)

(*)	For GSM 900 MS	:	see 4.5.2.
	For DCS 1 800 MS	:	-48 dBc or -48 dBm, whichever is the higher.
	For GSM 900 BTS and DCS 1 800 BTS	:	no requirement below -30 dBc (see 4.5.1).
(**)	For GSM 900 MS	:	-4 dBc for power control level 16; -2 dBc for power level 17; -1 dBc for power level controls levels 18 and 19.
(***)	For GSM 900 MS	:	-30 dBc or -17 dBm, whichever is the higher.

Annex C (normative): Propagation conditions

C.1 Simple wideband propagation model

Radio propagation in the mobile radio environment is described by highly dispersive multipath caused by reflection and scattering. The paths between base station and MS may be considered to consist of large reflectors and/or scatterers some distance to the MS, giving rise to a number of waves that arrive in the vicinity of the MS with random amplitudes and delays.

Close to the MS these paths are further randomized by local reflections or diffractions. Since the MS will be moving, the angle of arrival must also be taken into account, since it affects the doppler shift associated with a wave arriving from a particular direction. Echos of identical delays arise from reflectors located on an ellipse.

The multipath phenomenon may be described in the following way in terms of the time delays and the doppler shifts associated with each delay:

$$z(t) = \iint_{R^2} \mathrm{y(t - T)S(T, f)exp(2i\pi fT)dfdT}$$

where the terms on the right-hand side represent the delayed signals, their amplitudes and doppler spectra.

It has been shown that the criterion for wide sense stationarity is satisfied for distances of about 10 metres. Based on the wide sense stationary uncorrelated scattering (WSSUS) model, the average delay profiles and the doppler spectra are necessary to simulate the radio channel.

In order to allow practical simulation, the different propagation models will be presented here in the following terms:

1) a discrete number of taps, each determined by their time delay and their average power;

2) the Rayleigh distributed amplitude of each tap, varying according to a doppler spectrum S(f).

C.2 Doppler spectrum types

In this clause, we define the two types of doppler spectra which will be used for the modelling of the channel. Throughout this clause the following abbreviations will be used:

- $f_d = v/\lambda$, represents the maximum doppler shift, with v (in ms^{-1}) representing the vehicle speed, and λ (in m) the wavelength.

The following types are defined:

a) CLASS is the classical doppler spectrum and will be used in all but one case;

(CLASS) $S(f) = A/(1-(f/f_d)^2\,)^{0.5}$ for $f \in -f_d,f_d$;

b) RICE is the sum of a classical doppler spectrum and one direct path, such that the total multipath contribution is equal to that of the direct path. This power spectrum is used for the shortest path of the RA model;

(RICE) $S(f) = 0{,}41/(2\pi f_d(1-(f/f_d\,)^2\,)^{0,5}\,) + 0{,}91\,\delta(f - 0{,}7\,f_d\,)$ for $f \in\,]-f_d\,,\, f_d.[$

C.3 Propagation models

In this clause the propagation models that are mentioned in the main body of GSM 05.05 are defined. As a general principle those models are referred to as NAMEx, where NAME is the name of the particular model, which is defined thereunder, and x is the vehicle speed (in km/h) which impacts on the definition of fd (see clause C.2) and hence on the doppler spectra.

Those models are usually defined by 12 tap settings; however, according to the simulators available it may not be possible to simulate the complete model. Therefore a reduced configuration of 6 taps is also defined in those cases. This reduced configuration may be used in particular for the multipath simulation on an interfering signal. Whenever possible the full configuration should be used. For each model two equivalent alternative tap settings, indicated respectively by (1) and (2) in the appropriate columns, are given.

C.3.1 Typical case for rural area (RAx): (6 tap setting)

Tap number	Relative time (µs)		Average relative power (dB)		doppler spectrum
	(1)	(2)	(1)	(2)	
1	0,0	0,0	0,0	0,0	RICE
2	0,1	0,2	-4,0	-2,0	CLASS
3	0,2	0,4	-8,0	-10,0	CLASS
4	0,3	0,6	-12,0	-20,0	CLASS
5	0,4	-	-16,0	-	CLASS
6	0,5	-	-20,0	-	CLASS

C.3.2 Typical case for hilly terrain (HTx): (12 tap setting)

Tap number	Relative time (µs)		Average relative power (dB)		doppler spectrum
	(1)	(2)	(1)	(2)	
1	0,0	0,0	-10,0	-10,0	CLASS
2	0,1	0,2	-8,0	-8,0	CLASS
3	0,3	0,4	-6,0	-6,0	CLASS
4	0,5	0,6	-4,0	-4,0	CLASS
5	0,7	0,8	0,0	0,0	CLASS
6	1,0	2,0	0,0	0,0	CLASS
7	1,3	2,4	-4,0	-4,0	CLASS
8	15,0	15,0	-8,0	-8,0	CLASS
9	15,2	15,2	-9,0	-9,0	CLASS
10	15,7	15,8	-10,0	-10,0	CLASS
11	17,2	17,2	-12,0	-12,0	CLASS
12	20,0	20,0	-14,0	-14,0	CLASS

The reduced setting (6 taps) is defined thereunder.

Tap number	Relative time (µs)		Average relative power (dB)		doppler spectrum
	(1)	(2)	(1)	(2)	
1	0,0	0,0	0,0	0,0	CLASS
2	0,1	0,2	-1,5	-2,0	CLASS
3	0,3	0,4	-4,5	-4,0	CLASS
4	0,5	0,6	-7,5	-7,0	CLASS
5	15,0	15,0	-8,0	-6,0	CLASS
6	17,2	17,2	-17,7	-12,0	CLASS

C.3.3 Typical case for urban area (TUx): (12 tap setting)

Tap number	Relative time (µs)		Average relative power (dB)		doppler spectrum
	(1)	(2)	(1)	(2)	
1	0,0	0,0	-4,0	-4,0	CLASS
2	0,1	0,2	-3,0	-3,0	CLASS
3	0,3	0,4	0,0	0,0	CLASS
4	0,5	0,6	-2,6	-2,0	CLASS
5	0,8	0,8	-3,0	-3,0	CLASS
6	1,1	1,2	-5,0	-5,0	CLASS
7	1,3	1,4	-7,0	-7,0	CLASS
8	1,7	1,8	-5,0	-5,0	CLASS
9	2,3	2,4	-6,5	-6,0	CLASS
10	3,1	3,0	-8,6	-9,0	CLASS
11	3,2	3,2	-11,0	-11,0	CLASS
12	5,0	5,0	-10,0	-10,0	CLASS

The reduced TUx setting (6 taps) is defined thereunder.

Tap number	Relative time (µs)		Average relative power (dB)		doppler spectrum
	(1)	(2)	(1)	(2)	
1	0,0	0,0	-3,0	-3,0	CLASS
2	0,2	0,2	0,0	0,0	CLASS
3	0,5	0,6	-2,0	-2,0	CLASS
4	1,6	1,6	-6,0	-6,0	CLASS
5	2,3	2,4	-8,0	-8,0	CLASS
6	5,0	5,0	-10,0	-10,0	CLASS

C.3.4 Profile for equalization test (EQx): (6 tap setting)

Tap number	Relative time (µs)	Average relative power (dB)	doppler spectrum
1	0,0	0,0	CLASS
2	3,2	0,0	CLASS
3	6,4	0,0	CLASS
4	9,6	0,0	CLASS
5	12,8	0,0	CLASS
6	16,0	0,0	CLASS

Annex D (normative): Environmental conditions

D.1 General

This normative annex specifies the environmental requirements of GSM 900 and DCS 1 800, both for MS and BSS equipment, Within these limits the requirements of the GSM specifications shall be fulfilled.

D.2 Environmental requirements for the mss

The requirements in this clause apply to all types of MSs.

D.2.1 Temperature

The MS shall fulfil all the requirements in the full temperature range of:

+15°C	-	+35° C	for normal conditions (with relative humidity of 25 % to 75 %);
-10°C	-	+55°C	for DCS 1 800 MS and small MS units extreme conditions (see IEC publications 68-2-1 and 68-2-2);
-20°C	-	+55°C	for other units extreme conditions (see IEC publications 68-2-1 and 68-2-2).

Outside this temperature range the MS, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the MS exceed the transmitted levels as defined in GSM 05.05 for extreme operation.

D.2.2 Voltage

The MS 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 below.

Power source	Lower extreme voltage	Higher extreme voltage	Normal cond. voltage
AC mains	0,9 * nominal	1,1 * nominal	nominal
Regulated lead acid battery	0,9 * nominal	1,3 * nominal	1,1 * nominal
Non regulated batteries:			
Leclanché/lithium	0,85 * nominal	nominal	nominal
mercury/nickel cadmium	0,9 * nominal	nominal	nominal

Outside this voltage range the MS, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the MS exceed the transmitted levels as defined in GSM 05.05 for extreme operation. In particular, the MS shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shut-down voltage.

D.2.3 Vibration

The MS 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)

Outside the specified frequency range the MS, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the MS exceed the transmitted levels as defined in GSM 05.05 for extreme operation.

D.3 Environmental requirements for the BSS equipment

This clause applies to both GSM 900 and DCS 1 800 BSS equipment.

The BSS equipment shall fulfil all the requirements in the full range of environmental conditions for the relevant environmental class from the relevant ETSs listed below:

ETS 300 019-1-3: Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment, Part 1-3: Classification of environmental conditions, Stationary use at weatherprotected locations

ETS 300 019-1-4: Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment, Part 1-4: Classification of environmental conditions, Stationary use at non-weatherprotected locations

The operator can specify the range of environmental conditions according to his needs.

Outside the specified range for any of the environmental conditions, the BTS shall not make ineffective use of the radio frequency spectrum. In no case shall the BTS exceed the transmitted levels as defined in GSM 05.05 for extreme operation.

Annex E (normative): Repeater characteristics

E.1 Introduction

A repeater receives amplifies and transmits simultaneously both the radiated RF carrier in the downlink direction (from the base station to the mobile area) and in the uplink direction (from the mobile to the base station).

This annex details the minimum radio frequency performance of GSM/DCS 1 800 repeaters. The environmental conditions for repeaters are specified in annex D.3, of GSM 05.05. Further application dependant requirements on repeaters need to be considered by operators before they are deployed. These network planning aspects of repeaters are covered in GSM 03.30.

The following requirements apply to the uplink and downlink directions.

In clauses 2 and 3 the maximum output power per carrier is the value declared by the manufacturer.

BTS and MS transmit bands are as defined in clause 2 of GSM 05.05.

E.2 Spurious emissions

At maximum repeater gain, with or without a continuous static sine wave input signal in the operating band of the repeater, at a level which produces the manufacturers maximum rated power output, the following requirements shall be met

The average power of any single spurious measured in a 3 kHz bandwidth shall be no greater than:

- 250 nW (-36 dBm) in the relevant MS and BTS transmit frequency bands for a GSM repeater at offsets of > 100 kHz from the carrier.

- 1 μW (-30 dBm) in the relevant MS and BTS transmit frequency bands for a DCS 1 800 repeater at offsets of > 100 kHz from the carrier.

Outside of the relevant transmit bands the power measured in the bandwidths according to table E.1 below, shall be no greater than:

- 250 NW (-36 dBm) in the frequency band 9 kHz - 1 GHz;

- 1 μW (-30 dBm) in the frequency band 1 - 12,75 GHz.

Table E.1

Band	Frequency offset	Measurement bandwidth
100 kHz - 50 MHz	-	10 kHz
50 MHz - 500 MHz	-	100 kHz
above 500 MHz outside the relevant BTS Transmit band or MS transmit band	(offset from edge of the relevant above band)	
	> 0 MHz	10 kHz
	≥ 2 MHz	30 kHz
	≥ 5 MHz	100 kHz
	≥ 10 MHz	300 kHz
	≥ 20 MHz	1 MHz
	≥ 30 MHz	3 MHz

The requirement applies to all ports of the repeater.

NOTE: For radiated spurious emissions, 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.

E.3 Intermodulation products

At maximum repeater gain, with two continuous static sine wave input signals in the operating band of the repeater, at equal levels which produce the maximum rated power output per carrier, the average power of any intermodulation products measured in a 3 kHz bandwidth shall be no greater than:

- 250 nW (-36 dBm) in the frequency band 9 kHz - 1 GHz;
- 1 µW (-30 dBm) in the frequency band 1 - 12,75 GHz.

When the two input signals are simultaneously increased by 10 dB each, the requirements shall still be met.

The requirement applies to all ports of the repeater.

E.4 Out of band gain

The following requirements apply at all frequencies from 9 kHz to 12.75 GHz excluding the relevant transmit bands.

The net out of band gain in both directions through the repeater shall be less than +50 dB at 400 kHz. +40 dB at 600 kHz, +35 dB at 1 MHz and +25 dB at 5 MHz offset and greater from the edges of the BTS and MS transmit bands.

In special circumstances additional filtering may be required out of band and reference should be made to GSM 03.30.

Annex F (normative): Antenna Feeder Loss Compensator Characteristics

F.1 Introduction

An Antenna Feeder Loss Compensator (AFLC) is physically connected between the MS and the antenna in a vehicle mounted installation. It amplifies the signal received in the downlink direction and the signal transmitted in the uplink direction, with a gain nominally equal to the loss of the feeder cable. Unless otherwise stated, the requirements defined in this specification apply to the full range of environmental conditions specified for the AFLC (see annex D2 of GSM 05.05).

This specification details the minimum radio frequency performance of GSM AFLC devices. The environmental conditions for the AFLC are specified in annex D.2 of GSM 05.05. It also includes informative guidelines on the use and design of the AFLC.

The following requirements apply to AFLC devices intended for use in the GSM 900 and DCS 1 800 frequency bands. For GSM 900, the requirements apply to an AFLC intended for use with a GSM 900 class mark 4 MS. For DCS 1 800, the requirements apply to an AFLC intended for use with a DCS 1 800 class mark 1 MS. For compatibility reasons, a GSM 900 AFLC is required to support the Extended GSM band.

The requirements apply to the AFLC, including all associated feeder and connecting cables. A 50 ohm measurement impedance is assumed.

When referred to in this specification:

- The maximum rated output power for a GSM 900 AFLC is +33 dBm and for a DCS 1 800 AFLC is +30 dBm.

- A GSM input signal, is a GMSK signal modulated with random data, which meets the performance requirements of GSM 05.05, for an MS of equivalent output power. The power level specified for the GSM input signal, is the power averaged over the useful part of the burst.

F.2 Transmitting path

Unless otherwise stated, the requirements in this clause apply at all frequencies in the transmit band 880 - 915 MHz for a GSM 900 AFLC, and at all frequencies in the transmit band 1 710 - 1 785 MHz, for a DCS 1 800 AFLC. For a dual band AFLC, which supports both the GSM and DCS bands, the requirements apply in both transmit bands.

F.2.1 Maximum output power

With a GSM input signal at a level of X dBm, the maximum output power shall be less than a level of Y dBm. The values of X and Y for GSM 900 and DCS 1 800 are given in table F.1.

Table F.1: Input and output levels for testing maximum output power

	GSM 900	DCS 1 800
X	+39 dBm	+36 dBm
Y	+35 dBm	+32 dBm

F.2.2 Gain

With a GSM input signal, at a level which produces the maximum rated output power, the AFLC gain shall be 0 dB with a tolerance of ±1 dB, over the relevant transmit band.

For a GSM 900 AFLC, with the input level reduced in 14 steps of 2 dB, the net path gain over the relevant transmit band shall be 0 dB, with a tolerance of ±1 dB, for the first 10 reduced input levels and ±2 dB for the 4 lowest input levels.

For a DCS 1 800 AFLC, with the input level reduced in 15 steps of 2 dB, the net path gain over the relevant transmit band shall be 0 dB, with a tolerance of ±1 dB, for the first 13 reduced input levels and ±2 dB for the 2 lowest input levels.

In frequency bands which are not supported, the gain shall be no greater than the maximum value in the relevant transmit band.

F.2.3 Burst transmission characteristics

With a GSM input signal, the shape of the GSM AFLC output signal related to this input signal shall meet the tolerances of tables F2a and F3. With a DCS input signal, the shape of the DCS AFLC shall meet the tolerances of tables F2b and F3.

NOTE: The tolerances on the output signal correspond to the time mask of GSM 05.05, with the input signal in the middle of the tolerance field.

Table F.2a: Timing tolerances between input and output signals for a GSM AFLC

Input signal level	Input signal time	Output signal level	Tolerances - output signal time
-59 dBc (or -54 dBm whichever is greater)	t59	-59 dBc	t59 ± 14 µs
-30 dBc	t30	-30 dBc	t30 ± 9 µs
-6 dBc	t6	-6 dBc	t6 ± 5 µs

Table F.2b: Timing tolerances between input and output signals for a DCS AFLC

Input signal level	Input signal time	Output signal level	Tolerances - output signal time
-48 dBc (or -48 dBm. whichever is greater)	t48	-48 dBc	t48 ± 14 µs
-30 dBc	t30	-30 dBc	t30 ± 9 µs
-6 dBc	t6	-6 dBc	t6 ± 5 µs

The input signal time is the time at which the input level crosses the corresponding signal level. The above requirements apply to both the rising and falling edge of the burst.

Table F.3: Signal level tolerances for both GSM and DCS AFLC

Range	Tolerances - output signal level
t6..........t6 ± 5 µs (rising edge)	-6..........+4 dB
t6..........t6 ± 5 µs (falling edge)	-6..........+1 dB
147 useful bits	± 1 dB

All input signal levels are relative to the average power level over the 147 useful bits of the input signal. All output signal levels are relative to the average power level over the 147 useful bits of the output signal.

F.2.4 Phase error

The increase in phase error of a GSM input signal, which meets the phase error requirements of GSM 05.05, shall be no greater than 2 degrees RMS and 8 degrees peak.

F.2.5 Frequency error

The increase in frequency error of a GSM input signal, which meets the frequency accuracy requirements of GSM 05.10, shall be no greater than 0,05 ppm.

F.2.6 Group delay

The absolute value of the group delay (signal propagation delay) shall not exceed 500 ns.

F.2.7 Spurious emissions

With a GSM input signal corresponding to a GSM classmark 2 MS, transmitting at +39 dBm for a GSM 900 AFLC, and a DCS classmark 3 MS, transmitting at +36 dBm for a DCS 1 800 AFLC, the peak power of any single spurious emission measured in a bandwidth according to table F.4, shall be no greater than -36 dBm in the relevant transmit band.

Table F.4: Transmit band spurious emissions measurement conditions

Band	Frequency	Measurement bandwidth
relevant transmit band and < 2 MHz offset from band edge	offset from test signal freq. ≥ 1,8 MHz ≥ 6,0 MHz	 30 kHz 100 kHz

Outside of this transmit band, the power measured in the bandwidths according to table F.5 below, shall be no greater than:

- 250 nW (-36 dBm) in the frequency band 9 kHz - 1 GHz;
- 1 mW (-30 dBm) in the frequency band 1 - 12,75 GHz

Table F.5: Out of band spurious emissions measurement conditions

Band	Frequency offset	Measurement Bandwidth
100 kHz - 50 MHz	-	10 kHz
50 MHz -500 MHz	-	100 kHz
above 500 MHz but excluding 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

In the band 935 - 960 MHz, the power measured in any 100 kHz band shall be no more than -79 dBm, in the band 925 - 935, shall be no more than -67 dBm and in the band 1 805 - 1 880 MHz, shall be no more than -71 dBm.

With no input signal and the MS input port terminated and unterminated, the peak power of any single spurious emission measured in a 100 kHz bandwidth shall be no greater than:

- 2 nW (-57 dBm) in the frequency bands 9 kHz - 880 MHz, 915 - 1 000 MHz;
- 1,25 nW (-59 dBm) in the frequency band 880 - 915 MHz;
- 5 nW (-53 dBm) in the frequency band 1 710 - 1 785 MH;
- 20 nW (-47 dBm) in the frequency bands 1 000 - 1 710 MHz, 1785 - 12 750 MHz.

F.2.8 VSWR

The VSWR shall be less than 1.7:1 at the RF port of the device which is intended to be connected to the MS. The VSWR shall be less than 2:1 at the RF port of the device which is intended to be connected to the antenna.

F.2.9 Stability

The AFLC shall be unconditionally stable.

F.3 Receiving path

Unless otherwise stated, the requirements in this clause apply at all frequencies in the receive band 925 - 960 MHz for a GSM 900 AFLC, and at all frequencies in the receive band 1 805 - 1 880 MHz, for a DCS 1 800 AFLC. For a dual band AFLC, which supports both the GSM and DCS bands, the requirements apply in both receive bands.

F.3.1 Gain

With a GSM input signal at any level in the range -102 dBm to -20 dBm for an GSM 900 AFLC and -100 dBm to -20 dBm for a DCS 1 800 AFLC, the gain shall be 0 dB with a tolerance of ±1 dB.

For test purposes, it is sufficient to use a CW signal to test this requirement.

F.3.2 Noise figure

The noise figure shall be less than 7 dB for a GSM 900 AFLC and less than 7 dB for a DCS 1 800 AFLC.

F.3.3 Group delay

The absolute value of the group delay (signal propagation delay) shall not exceed 500 ns.

F.3.4 Intermodulation performance

The output third order intercept point shall be greater than -10 dBm.

F.3.5 VSWR

The VSWR shall be less than 1.7:1 at the RF port of the device which is intended to be connected to the MS. The VSWR shall be less than 2:1 at the RF port of the device which is intended to be connected to the antenna.

F.3.6 Stability

The AFLC shall be unconditionally stable.

F.4 Guidelines (informative)

The specifications of the AFLC, have been developed to ensure that a generic AFLC causes minimal degradation of the parametric performance of the MS, to which it is connected.

The following should be clearly marked on the AFLC:

- The intended band(s) of operation.

- The classmark of the MS, to which it designed to be connected.

When installed correctly the AFLC can provide enhancement of the MS to BTS link in vehicular installations. However, it is not guaranteed that an AFLC, which meets the requirements of this specification, will provide a performance improvement for all of the different GSM MS implementations and installations.

Some MS implementations significantly exceed the performance requirements of GSM 05.05, e.g. with respect to reference sensitivity performance. A purely passive feeder of low loss cable, may provide the best performance for some implementations. The benefits of installing an AFLC in a vehicular application, can only be assessed on a case by case basis.

When used, the AFLC should only be installed in the type approved configuration, with the minimum amount of additional cabling.

When designing an AFLC to be used with a GSM MS, the best downlink performance will be obtained if the low noise amplifier is situated as closely as possible to the output of the antenna.

History

Document history			
December 1996	Unified Approval Procedure	UAP 60:	1996-12-02 to 1997-03-28
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