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Digital cellular telecommunications system (Phase 2+);
CTS-FP Radio Sub-system
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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

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  - 1 presented to TSG for information;
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1 Scope

The present document specifies the requirements for the CTS-Fixed Part (CTS-FP) transceiver of the digital mobile cellular and personal communication systems operating in the 900 MHz (P-GSM and E-GSM) and 1 800 MHz band (GSM 900 and DCS 1 800), and specifies the Radio subsystem frequency control implemented in the CTS-Fixed Part.

Unless otherwise stated, the requirements defined in the present document apply to the full range of environmental conditions specified for the CTS-FP equipment (see annex C).

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, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

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

[2] GSM 03.22: "Digital cellular telecommunications system (Phase 2+); Functions related to Mobile Station (MS) in idle mode and group receive mode".

[3] GSM 03.52 : "Digital cellular telecommunications system (Phase 2+); GSM Cordless Telephony System (CTS); Lower layers of the CTS radio interface; Stage 2".

[4] GSM 04.56 : "Digital cellular telecommunications system (Phase 2+); GSM Cordless Telephony System (CTS); CTS radio interface layer 3 specification".

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

[6] GSM 05.02: "Digital cellular telecommunications system (Phase 2+); Multiplexing and multiple access on the radio path".

[7] GSM 05.04: "Digital cellular telecommunications system (Phase 2+); Modulation".

[8] GSM 05.05: "Digital cellular telecommunications system (Phase 2+); Radio transmission and reception".

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

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

[11] GSM 11.56: "Digital cellular telecommunications system (Phase 2+); CTS-Fixed Part conformance specification".

[12] GSM 03.56: "Digital cellular telecommunications system (Phase 2+); GSM Cordless Telephony System (CTS); CTS Architecture Description; Stage 2".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

CTS Mobile Station: GSM-MS supporting CTS.

CTS Fixed Part: CTS-FP is a device which acts as a link between the CTS-MS and the fixed network.

GSM-CTS: Cordless Telephony System based on GSM.

3.2 Abbreviations

Abbreviations used in the present document are listed in GSM 01.04. In addition, the following abbreviations are used:

AFA	Adaptive Frequency Allocation
CTS	Cordless Telephony System
CTS-FP	CTS-Fixed Part
CTS-MS	CTS-Mobile Station
GFL	Generic Frequency List
TFH	Total Frequency Hopping

4 Radio transmission and reception

4.1 Frequency band and channels arrangements

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

- for Standard GSM 900 band, the CTS-FP is required to operate in the following frequency band:
  - 890 MHz to 915 MHz: CTS-FP receive;
  - 935 MHz to 960 MHz: CTS-FP transmit.

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

- for Extended GSM 900 band, the CTS-FP is required to operate in the following frequency band:
  - 880 MHz to 915 MHz: CTS-FP receive;
  - 925 MHz to 960 MHz: CTS-FP transmit.

iii) DCS 1 800 Band:

- for DCS 1 800 band, the CTS-FP is required to operate in the following band:
  - 1 710 MHz to 1 785 MHz: CTS-FP receive;
  - 1 805 MHz to 1 880 MHz: CTS-FP transmit.

The carrier spacing is 200 kHz.

The carrier frequency is designated by the absolute radio frequency channel number (ARFCN) as specified in GSM 05.05 clause 2.

4.2 Reference configuration

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

4.3 Transmitter characteristics

Throughout this clause, unless otherwise stated, requirements are given in terms of power levels at the antenna connector of the equipment. If an active device is added to the CTS-FP antenna connector, the requirements of this clause shall also be met at the output of this active device. 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.

4.3.1 Output power

The CTS-FP maximum output power and lowest nominal output power shall be, as defined in the following table.

	GSM 900	**DCS 1 800**	**Tolerance (dB) for conditions**	
			normal	**extreme**
Maximum Nominal output power	11 dBm	12 dBm	+0/-2	+0,5/-2,5
Lowest Nominal output power	-9 dBm	-8 dBm	±4	±5

The different power control levels needed to support downlink adaptive RF power control (seeGSM 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 as defined in the table above.

GSM 900			
Power control level	**Nominal Output power (dBm)**	**Tolerance (dB) for conditions**	
		normal	**extreme**
1	11	+0/-2	+0,5/-2,5
2	9	±2	±3
3	7	±3	±4
4	5	±3	±4
5	3	±3	±4
6	1	±3	±4
7	-1	±3	±4
8	-3	±4	±5
9	-5	±4	±5
10	-7	±4	±5
11-14	-9	±4	±5

DCS 1 800			
Power control level	Nominal Output power (dBm)	Tolerance (dB) for conditions	
		normal	extreme
1-4	12	+0/-2	+0,5/-2,5
5	10	±2	±3
6	8	±3	±4
7	6	±3	±4
8	4	±3	±4
9	2	±3	±4
10	0	±3	±4
11	-2	±4	±5
12	-4	±4	±5
13	-6	±4	±5
14	-8	±4	±5

NOTE: The above definition of the power control levels for GSM 900 and DCS 1800 allows to have an equivalent indoor coverage when the same power control level is applied in GSM 900 and DCS 1800.

Furthermore, the difference in output power actually transmitted by the CTS-FP 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 nominal maximum and lowest output powers), shall be +2 ± 1,5 dB. Similarly, if the difference in output power actually transmitted by the CTS-FP 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 nominal maximum and lowest output powers), shall be -2 ± 1,5 dB.

4.3.2 Output RF spectrum

The specifications contained in this clause apply to CTS-FP, in frequency hopping as well as in non 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 11.56. 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.

4.3.2.1 Spectrum due to the modulation and wide band noise

The output RF modulation spectrum is specified in the following tables. A mask representation of the present document is shown in annex A. The present document 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 specification shall be met under the following measurement conditions:

- zero frequency scan, filter bandwidth and video bandwidth of 30 kHz up to 1800 kHz from the carrier and 100 kHz at 1800 kHz and above from the carrier, 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 1800 kHz from the carrier only measurements centred on 200 kHz multiples are taken with averaging over 50 bursts;

- 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 power level is the "actual absolute output power" defined in clause 4.3.1.

The figures in tables a) and b) below, at the horizontally listed frequency offset from the carrier (kHz), are then the maximum allowed level (dB) relative to a measurement in 30 kHz on the carrier.

a) GSM 900 CTS-FP:

	100	200	250	400	≥ 600 <1 800	≥ 1 800 <6 000	≥ 6 000
dBc	+0,5	-30	-33	-60	-60	-68	-71

b) DCS 1800 CTS-FP:

	100	200	250	400	≥ 600 < 1 800	≥ 1 800 < 6 000	≥ 6 000
dBc	+0,5	-30	-33	-60	-60	-63	-67

The following exceptions shall apply, using the same measurement conditions as specified 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.

Using the same measurement conditions as specified above, if a requirement in tables a) and b) is tighter than the limit given in the following, the latter shall be applied instead.

Frequency offset from the carrier	GSM 900	DCS 1 800
< 1 800 kHz	-69 dBm	-64 dBm
≥ 1 800 kHz	-64 dBm	-59 dBm

4.3.2.2 Spectrum due to switching transient

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 in the figure 1 of GSM 05.05.

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

	Maximum level measured			
	400 kHz	**600 kHz**	**1 200 kHz**	**1 800 kHz**
GSM 900 / DCS 1 800	-36 dBm	-36 dBm	-36 dBm	-36 dBm

4.3.3 Spurious emission

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

4.3.3.1 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. The bandwidth is increased as the frequency offset between the measurement frequency and, either the carrier, or the edge of the CTS-FP 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 11.56. The frequency bands where these are actually measured may differ from one type to the other (see GSM 11.56).

a)

Band	**Frequency offset** (offset from carrier)	**Measurement bandwidth**
relevant transmit band	≥ 1,8 MHz	30 kHz
	≥ 6 MHz	100 kHz

b)

Band	**Frequency offset**	**Measurement bandwidth**
100 kHz to 50 MHz	-	10 kHz
50 MHz to 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.

4.3.3.2 Requirements

The power measured in the conditions specified in clause 4.3.3.1a, for a CTS-FP when allocated a channel, shall be no more than -36 dBm.

The power measured in the conditions specified in clause 4.3.3.1b for a CTS-FP, when allocated a channel, shall be no more than:

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

When allocated a channel, the power emitted by the CTS-FP, when measured using the measurement conditions specified in 4.3.2.1, 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 880 MHz to 915 MHz shall be no more than -75 dBm, and in the band 1 710 MHz to 1 785 MHz, shall be no more than -69 dBm.

As exceptions up to five measurements with a level up to -36 dBm are permitted in each of the bands 880 MHz to 915 MHz and 1 710 MHz to 1 785 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 clause 4.3.2.1.

4.3.4 Radio frequency tolerance

The radio frequency tolerance for the CTS-FP is defined in GSM 05.10.

4.3.5 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.

The output power can be reduced by steps of 2 dB as defined in clause 4.3.1.

The transmitted power level relative to time when sending a burst is shown in annex B. 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;
- -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.

4.3.6 Phase accuracy

The same requirements as defined in GSM 05.05 clause 4.6 shall apply.

4.3.7 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.

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 CTS-FP 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.

4.4 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 $E = P + 20\log F_{(MHz)} + 77.2$):

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 clauses 4.4.1 and 4.4.2, values given in dBm are indicative, and calculated assuming a 50 ohms impedance.

4.4.1 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 CTS-FP	**GSM 1 800 CTS-FP**
in-band	860 - 925	1 690 - 1 805
out-of-band (a)	0.1 - < 860	0.1 - 1 610
out-of-band (b)	N/A	> 1 610 - < 1 690
out-of band (c)	N/A	> 1 805 - 1 865
out-of band (d)	> 925 - 12,750	> 1 865 - 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 clause 4.5.2;
- 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	GSM 900 CTS-FP		DCS 1 800 CTS-FP	
	dBµV (emf)	dBm	dBµV (emf)	dBm
in-band				
600 kHz ≤ $\|f-f_0\|$ < 800 kHz	70	-43	70	-43
800 kHz ≤ $\|f-f_0\|$ < 1.6 MHz	70	-43	70	-43
1.6 MHz ≤ $\|f-f_0\|$ < 3 MHz	80	-33	80	-33
3 MHz ≤ $\|f-f_0\|$	90	-23	87	-26
out-of-band				
(a)	113	0	113	0
(b)	-	-	101	-12
(c)	-	-	101	-12
(d)	113	0	113	0

The following exceptions to the level of the sine wave signal (f) in the above table shall apply:

for E-GSM CTS-FP, in the band 925 - 935 MHz	**-5 dBm**

4.4.2 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 clause 4.5.2.

- 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 O.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.

	CTS-FP (dBm)
GSM 900	-31
DCS 1 800	-31

4.4.3 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_0, 3 dB above the reference sensitivity level as specified in clause 4.5.2;

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

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

NOTE: For clauses 4.4.2 and 4.4.3 instead of any 148-bits subsequence of the 511-bits pseudo-random sequence, defined in CCITT Recommendation O.153 fascicle IV.4, it is also allowed to use a more random pseudo-random sequence.

4.5 Transmitter / receiver performance

In order to assess the error rate performance that is described in this clause it is required for a CTS-FP 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 11.56.

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 clause 4.3.6). All the values given are valid if any of the features: discontinuous transmission (DTx), discontinuous reception (DRx), or frequency hopping (FH) 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 CTS-FPs with integral antennas.

According to the CTSARCH operation specified in GSM 05.02 clause 6.5.1 ix), the receiver performance specified in this clause for the CTSARCH shall be met for at least one of the two bursts sent on the CTSARCH.

4.5.1 Nominal error rate

This clause 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 GSM 05.05 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: $BER \leq 10^{-4}$.

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.

4.5.2 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. Propagation conditions other than static and TI5 no FH are for CTS-FP not relevant and need not be tested.

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 GSM 900 CTS-FP : -102 dBm
- for DCS 1 800 CTS-FP : -102 dBm

The reference sensitivity performance specified above need not be met in the following cases:

- for CTS-FP at the static channel, if the received level on either of the two adjacent timeslots to the wanted exceed the wanted timeslot by more than 20 dB.

The interfering adjacent time slots shall be static with valid GSM signals in all cases.

NOTE: in the TI5 no FH propagation channel, the CTS-FP shall meet a performance equal to that for the TU50 no FH (900MHz) for a useful signal 3dB greater than the relevant reference sensitivity.

4.5.3 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. Propagation conditions other than static and TI5 no FH are for CTS-FP not relevant and need not be tested.

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 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

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. However, the CTS-FP 900MHz and 1800MHz need only meet, measured in the TI5 no FH propagation channel, an interference performance equal to that for the TU50 no FH channel (900MHz) with a useful C/I of 4dB greater than the relevant interference performance.

In any case the wanted and interfering signals shall be subject to the same propagation profiles (see GSM 05.05 annex C), independent on the two channels.

For adjacent channel interference, if in order to ease measurement, a TI5 (no FH) faded wanted signal, and a static adjacent channel interferer are used, the 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 %

when a margin of 4dB above reference sensitivity is included.

4.5.4 Erroneous frame indication performance

a) On a speech TCH (TCH/FS or TCH/HS) with a random RF input, of the frames believed to be FACCH or SACCH, 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.

c) On a speech TCH (TCH/FS or TCH/HS), when DTX is activated with SID frames and SACCH frames received 20 dB above the reference sensitivity level and with no transmission at the other bursts of the TCH, the overall reception 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 CTS-FP.

d) For a CTS-FP on a CTSARCH 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.

4.5.5 Access performance at high input levels

Under static propagation conditions with a received input level from 20 dB above the reference sensitivity level up to -15 dBm for GSM900 and -23 dBm for DCS1800, and a single CTS-MS sending an access request, the CTS-FP FER shall be less than 1% for CTSARCH.

4.5.6 Frequency hopping performance under interference conditions

Under the following conditions:

- a useful signal, cyclic frequency hopping over four carriers under static conditions, with equal input levels 20 dB above reference sensitivity level;
- a random, continuous, GMSK-modulated interfering signal on only one of the carriers at a level 10 dB higher than the useful signal.

The FER for TCH/FS shall be less than 5%.

Table 1: Reference sensitivity performance

GSM 900		
Type of channel	**Propagation conditions**	
	static	**TI5 (no FH)**
FACCH/H (FER)	0,1 %	6,9 %
FACCH/F (FER)	0,1 %	8,0 %
CTSAGCH, CTSPCH, SACCH (FER)	0,1 %	13 %
CTSBCH-SB, CTSARCH (FER)	1 %	16 %
TCH/FS (FER)	0,1α %	6α %
class Ib (RBER)	0,4/α %	0,4/α %
class II (RBER)	2 %	8 %
TCH/EFS (FER)	< 0,1 %	8 %
(RBER Ib)	< 0,1 %	0,21 %
(RBER II)	2,0 %	7 %
TCH/HS (FER)	0,025 %	4,1 %
class Ib (RBER, BFI=0)	0,001 %	0,36 %
class II (RBER, BFI=0)	0,72 %	6,9 %
(UFR)	0,048 %	5,6 %
class Ib (RBER,(BFI or UFI)=0)	0,001 %	0,24 %
(EVSIDR)	0,06 %	6,8 %
(RBER, SID=2 and (BFI or UFI)=0)	0,001 %	0,01 %
(ESIDR)	0,01 %	3,0 %
(RBER, SID=1 or SID=2)	0,003 %	0,3 %
DCS 1 800		
Type of channel	**Propagation conditions**	
	static	**TI5 (no FH)**
FACCH/H (FER)	0,1 %	7,2 %
FACCH/F (FER)	0,1 %	3,9 %
CTSAGCH, CTSPCH, SACCH (FER)	0,1 %	9 %
CTSBCH-SB, CTSARCH (FER)	1 %	19 %
TCH/FS (FER)	0,1α %	3α %
class Ib (RBER)	0,4/α %	0,3/α %
class II (RBER)	2 %	8 %
TCH/EFS (FER)	< 0,1 %	4 %
(RBER Ib)	< 0,1 %	0,12 %
(RBER II)	2,0 %	8 %

(continued)

Table 1 (concluded): Reference sensitivity performance

DCS 1 800		
Type of Channel	**Propagation conditions**	
	static	**TI5 (no FH)**
TCH/HS (FER)	0,025 %	4,2 %
class Ib (RBER, BFI=0)	0,001 %	0,38 %
class II (RBER, BFI=0)	0,72 %	6,9 %
(UFR)	0,048 %	5,7 %
class Ib (RBER, (BFI or UFI)=0)	0,001 %	0,26 %
(EVSIDR)	0,06 %	7,0 %
(RBER, SID=2 and (BFI or UFI)=0)	0,001 %	0,01 %
(ESIDR)	0,01 %	3,0 %
(RBER, SID=1 or SID=2)	0,003 %	0,33 %

NOTE 1: 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 2: $1 \leq \alpha \leq 1{,}6$. 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 3: FER for CTSCCHs 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.

Table 2: Reference interference performance

GSM 900		
Type of channel		**Propagation conditions**
		TI5 (no FH)
FACCH/H	(FER)	6,7 %
FACCH/F	(FER)	9,5 %
CTSAGCH, CTSPCH, SACCH	(FER)	13 %
CTSBCH-SB, CTSARCH	(FER)	17 %
TCH/FS	(FER)	6α %
class Ib (RBER)		0,4/α %
class II (RBER)		8 %
TCH/EFS	(FER)	9 %
	(RBER Ib)	0,20 %
	(RBER II)	7 %
TCH/HS	(FER)	5,0 %
class Ib (RBER, BFI=0)		0,29 %
class II (RBER, BFI=0)		7,1 %
	(UFR)	6,1 %
class Ib (RBER,(BFI or UFI)=0)		0,21 %
	(EVSIDR)	7,0 %
(RBER, SID=2 and (BFI or UFI)=0)		0,01 %
	(ESIDR)	3,6 %
(RBER, SID=1 or SID=2)		0,26 %
DCS 1 800		
Type of channel		**Propagation conditions**
		TI5 (no FH)
FACCH/H	(FER)	6,9 %
FACCH/F	(FER)	3,4 %
CTSAGCH, CTSPCH, SACCH	(FER)	9 %
CTSBCH-SB, CTSARCH	(FER)	19 %
TCH/FS	(FER)	3α %
class Ib (RBER)		0,25/α %
class II (RBER)		8,1 %
TCH/EFS	(FER)	3 %
	(RBER Ib)	0,10 %
	(RBER II)	8 %

(continued)

Table 2 (concluded): Reference interference performance

DCS 1 800	
Type of channel	**Propagation conditions**
	TI5 (no FH)
TCH/HS (FER)	5,0 %
class Ib (RBER, BFI=0)	0,29 %
class II (RBER, BFI=0)	7,2 %
(UFR)	6,1 %
class Ib (RBER, (BFI or UFI)=0)	0,21 %
(EVSIDR)	7,0 %
(RBER, SID=2 and (BFI or UFI)=0)	0,01 %
(ESIDR)	3,6 %
(RBER, SID=1 or SID=2)	0,26 %

NOTE 1: 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 2: $1 \leq \alpha \leq 1,6$. 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 3: FER for CTSCCHs 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.

5 Radio subsystem frequency control

Procedures shall be implemented in the CTS-FP by which it manages the radio frequency channels used for traffic or signalling between the CTS-FP and its attached CTS-MS. Those procedures shall be:

- adaptive Frequency Allocation (AFA) algorithm;
- TFH carrier list selection;
- CTS Beacon channel carrier selection;
- timeslot assignment for dedicated connection.

5.1 Void

5.2 General

The list of carriers on which the CTS-FP and CTS-MS are allowed to operate is called the Generic Frequency List (GFL). Different mechanisms are specified, in order to ensure that the CTS-FP and CTS-MS are using the most appropriate frequencies for transmission and reception.

5.3 Adaptive Frequency Allocation (AFA)

An Adaptive Frequency Allocation (AFA) algorithm shall be implemented in the CTS-FP. The input of the AFA algorithm shall be the table of interference levels measured by the CTS-MS during the AFA monitoring procedure (see GSM 05.08) on a subset of carriers of the GFL. These interference levels shall be filtered by the AFA algorithm, so that an ordered list of frequency carriers called the AFA table is generated.

The use of the AFA algorithm shall be controlled by the parameter AFA_USE; in the case where the AFA algorithm is not used, the AFA table shall contain the complete GFL.

5.4 TFH carrier list selection

A set of frequencies shall be selected from the AFA table by the CTS-FP for effective use by the CTS-FP and CTS-MS performing frequency hopping. This subset of frequencies is called the TFH carrier list. The decision for the carriers to be included in the TFH carrier list shall be defined by performing the acceptance procedure, which is controlled by the parameters given in table 3.

In the case where the AFA algorithm is not used, the TFH carrier list shall contain the complete GFL.

5.4.1 Acceptance procedure

The absolute received signal level of a carrier shall be considered by defining different ranges in which different approaches with different parameters shall be applied. The algorithm shall start at the lowest range up to the highest until the stop condition of the applied criteria is reached. If the upper bound of the range is reached, the next range shall be processed. When one approach stops or the last range is finished, the list extension check shall be performed. The following approaches are defined.

5.4.1.1 Basic threshold

The basic threshold approach shall always start from the carrier with the lowest interference level in the AFA table. All carriers below the higher bound of this range shall be included in the TFH carrier list. The second purpose is to assure that a minimum number of carriers is used. Therefore, the maximum from both conditions shall be used.

5.4.1.2 Sliding window technique

Within a window containing a fixed number (SWT_SIZE_WIN) of the last carriers which were accepted, the average interference level shall be calculated. The interference level of the next carrier to be added shall be compared with the calculated average interference level. If the difference exceeds a distinct threshold INTERF_THRESHOLD, the stop condition is reached, otherwise the carrier shall be added to the TFH carrier list.

5.4.1.3 Fixed window technique

Within a window initially containing a fixed number (FWT_SIZE_WIN) of the last carriers which were accepted, the average interference level shall be calculated. The interference level of the next carrier to be added shall be compared with the calculated average interference level. If the difference exceeds a distinct threshold INTERF_THRESHOLD, the stop condition is reached. Otherwise, the carrier shall be added to the TFH carrier list and the window size shall be increased.

5.4.1.4 List extension check

After one of the other techniques stopped, the next carriers shall be compared with the last added carrier where the stop condition occurs. If the difference does not exceed a distinct threshold INTERF_THRESHOLD, the carrier shall be added to the TFH carrier list.

5.4.2 Parameters

At least one range shall be defined by using the parameters given in the table 3. When only one range is defined the basic threshold approach shall be applied. The sliding and fixed window technique can be used in more than only one range with a separate parameter set for each.

The first range defined shall start at a received signal level of -110 dBm and stop the upper bound defined in the parameter SEL_RANGE(1). The range k shall start at the upper bound of the previous range (k-1) and stop at the upper bound defined in the parameter SEL_RANGE(k).

5.4.3 AFA and TFH selection performance requirements

Considering the following scenario:

- the GFL of the CTS-FP shall be a list of 9 carriers (f_1 to f_9);
- a table of received interference levels measured by the CTS-MS shall be reported to the CTS-FP (see GSM 05.08) with the following values:

	Received interference level (in dBm)
f_1	-95 dBm
f_2	-80 dBm
f_3	-95 dBm
f_4	-85 dBm
f_5	-80 dBm
f_6	-95 dBm
f_7	-95 dBm
f_8	-95 dBm
f_9	-85 dBm

- the signal levels received by the CTS-FP on the 9 carriers of the GFL shall be less than -95 dBm;

- the parameters of the TFH carrier list selection shall be set as follows:

Parameter name	Value
SEL_RANGE (1)	-108 dBm
APPROACH_TYPE (1)	BASIC
MIN_NB_FREQ	4
SEL_RANGE (2)	-102 dBm
APPROACH_TYPE (2)	SWT
SWT_SIZE_WIN (2)	4
INTERF_THRESHOLD (2)	5 dB
SEL_RANGE (3)	-94 dBm
APPROACH_TYPE (3)	FWT
SWT_SIZE_WIN (3)	3
INTERF_THRESHOLD (3)	4 dB
SEL_RANGE (4)	-48 dBm
APPROACH_TYPE (4)	EXT
SWT_SIZE_WIN (4)	1
INTERF_THRESHOLD (4)	1 dB

With this scenario, after 6 successive AFA monitoring reports sent by the CTS-MS with the received interference levels specified above, the AFA and TFH carrier list selection procedures shall have selected the following TFH carrier list: (f_1, f_3, f_6, f_7, f_8).

5.5 CTS Beacon channel carrier selection

A particular carrier shall be selected from the TFH carrier list : the CTS Beacon channel carrier. This carrier shall be used for the transmission of the CTSBCH in the downlink as well as for the transmission of other channels, as specified in GSM 05.02.

Two selection techniques shall be used:

- a random carrier from the TFH carrier list shall be selected;
- the carrier of the TFH carrier list showing the lowest interference level shall be selected.

The specification of the selection technique to use shall be indicated in the CTSBCH_SEL_MODE parameter.

5.6 Timeslot assignment for dedicated connection

When the CTS-FP is attempting to establish a dedicated connection with a CTS-MS, the CTS-FP should select the timeslot showing the lowest received interference level. The selection should be based on measurements of received interference level performed by the CTS-FP on the uplink : a running average on at least 5 collected measurement samples should be maintained by the CTS-FP for each of the 8 timeslots of a TDMA frame, in order to assess the received interference level per timeslot.

5.7 Frequency control parameters

The parameters employed to control in frequency the radio link are shown in table 3.

Table 3: Radio sub-system frequency control parameters

Parameter name	Description	Range	Bits
GFL (1-m)	Generic Frequency List: contains m carriers represented by their ARFCN	0-1023	10
AFA_USE	Enable the use of the AFA algorithm: 0: used 1: not used	0-1	1
SEL_RANGE (1-n)	Upper bound of TFH carrier list selection range n°: -110, -108, ..., -48 dBm in steps of 2 dBm	0-31	5
APPROACH_TYPE (1-n)	Type of approach used in selection range n°: 00: Basic threshold (BASIC) 01: Sliding window technique (SWT) 10: Fixed window technique (FWT) 11: List extension check (EXT)	0-3	2
MIN_NB_FREQ	Minimum number of carrier which shall be selected for the TFH carrier list by the Basic threshold approach	0-31	5
FWT_SIZE_WIN (1-n)	Minimum size of the window to compute the average for the FWT	0-31	5
SWT_SIZE_WIN (1-n)	Fixed size of the window to compute the average for the SWT	0-31	5
INTERF_THRESHOLD (1-n)	Maximum allowed difference between the current carrier to add, and the average value for SWT, FWT, and EXT: 0, 2, ..., 62 dB in steps of 2 dB	0-31	5
CTSBCH_SEL_MODE	CTSBCH carrier selection mode: 0: best carrier of TFH carrier list 1: random carrier from TFH carrier list	0-1	1

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

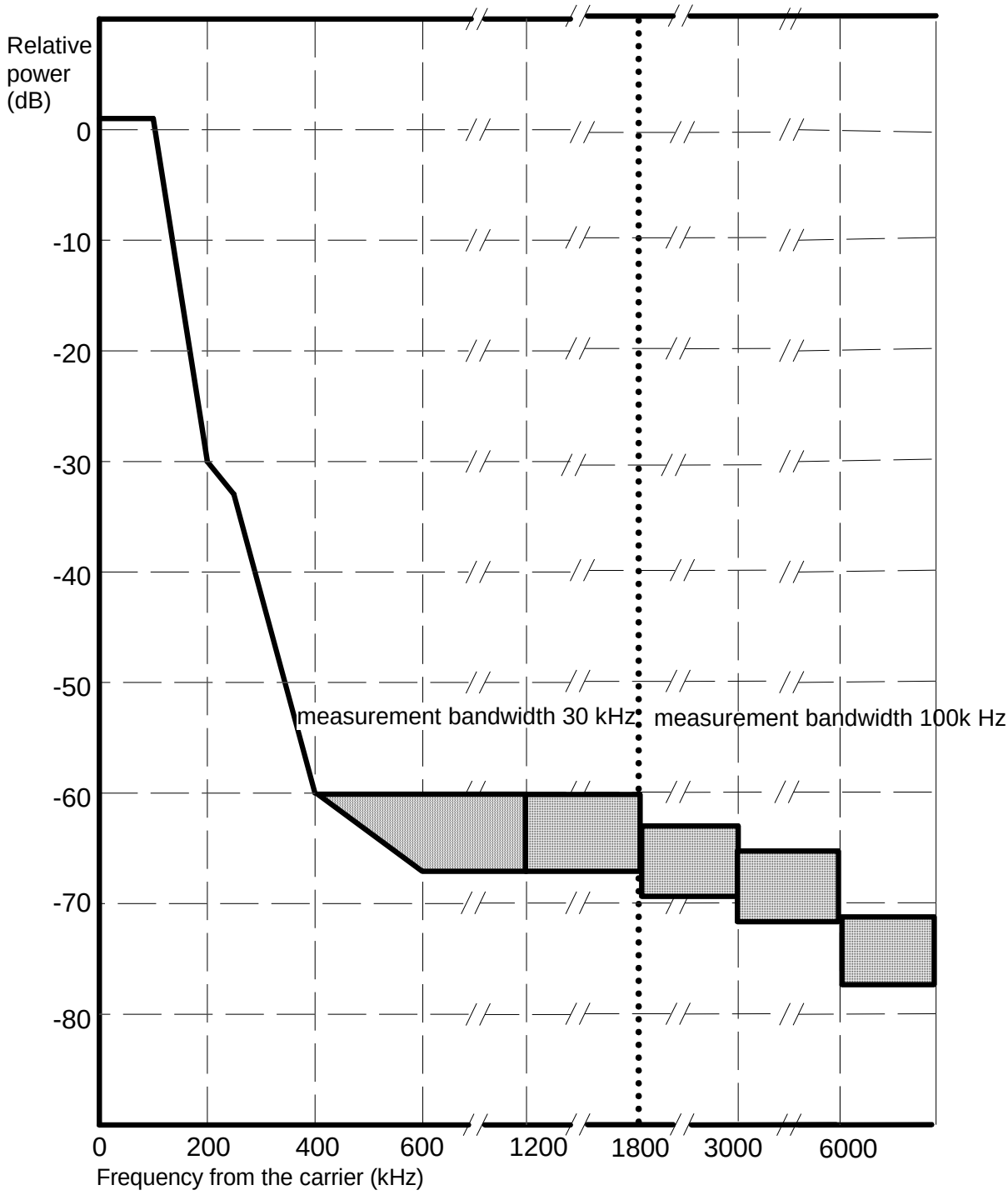


Figure A.1: GSM 900 CTS-FP spectrum due to modulation

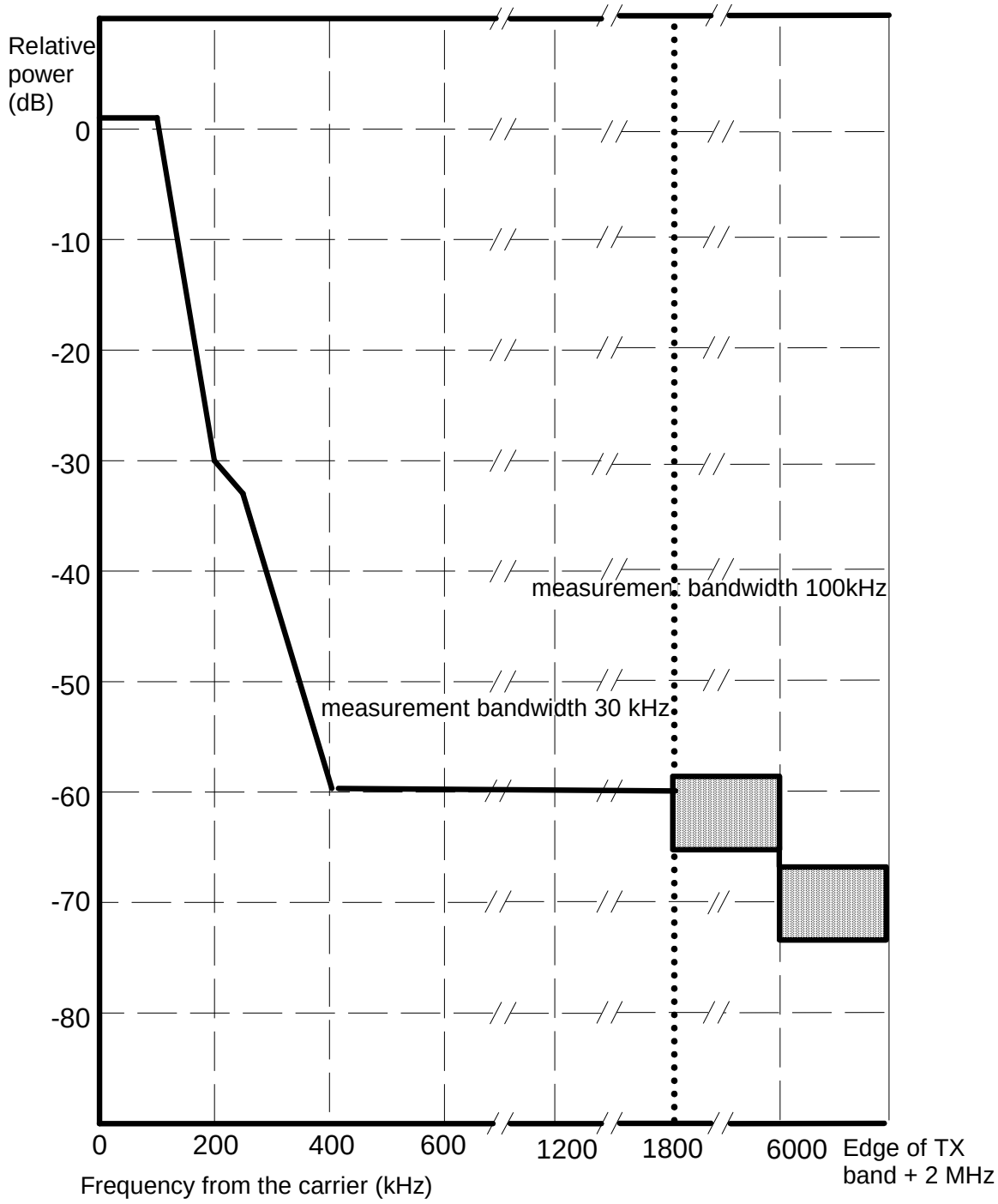
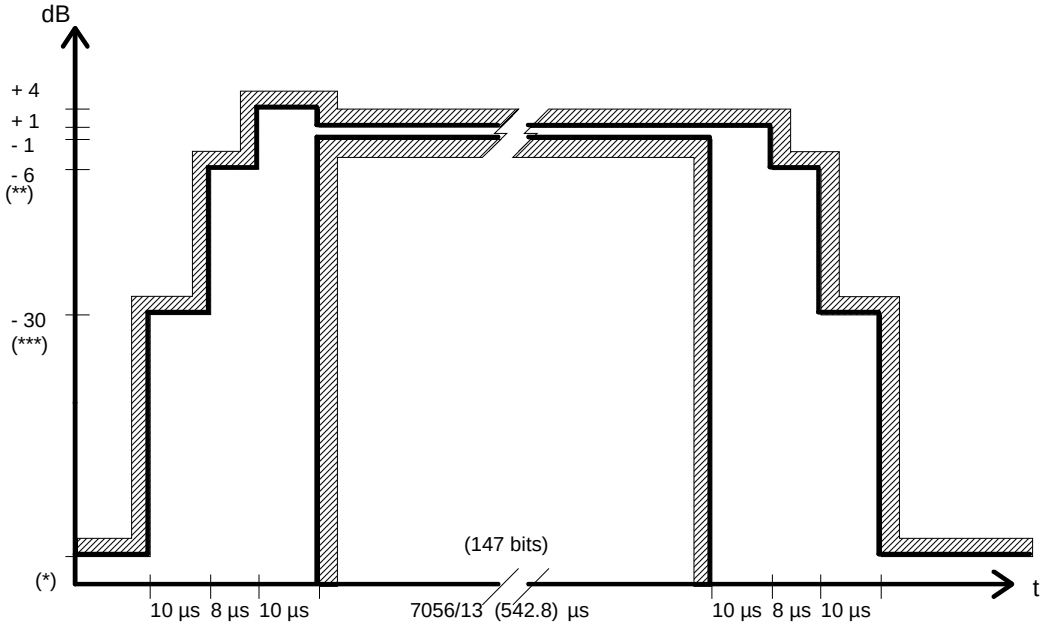


Figure A.2: DCS 1 800 CTS-FP spectrum due to modulation

Annex B (normative): Transmitted power level versus time



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

(*)	For GSM 900 CTS-FP	:	-59 dBc or -54 dBm, whichever is the higher.
	For DCS 1 800 CTS-FP	:	-48 dBc or -48 dBm, whichever is the higher.
(**)	For GSM 900 CTS-FP	:	-4 dBc for power control level 8,
		:	-2 dBc for power level 9,
		:	-1 dBc for power level controls levels 10 to 14.
	For DCS 1 800 CTS-FP	:	-4dBc for power control level 11,
		:	-2dBc for power level 12,
		:	-1dBc for power control levels 13 and 14.
(***)	For GSM 900 CTS-FP	:	-30 dBc or -27 dBm, whichever is the higher.
	For DCS 1 800 CTS-FP	:	-30dBc or -30dBm, whichever is the higher.

Annex C (normative): Environmental conditions

C.1 General

This normative annex specifies the environmental requirements of GSM 900 and DCS 1 800 CTS-FP equipment. Within these limits the requirements of the GSM specifications shall be fulfilled.

C.2 Temperature

The CTS-FP 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 - +40°C for extreme conditions;

Outside this temperature range the CTS-FP, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the CTS-FP exceed the output power levels as defined in GSM 05.56 for extreme operation.

C.3 Voltage

The CTS-FP 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.

Power source	**Lower extreme voltage**	**Higher extreme voltage**	**Normal cond. voltage**
AC mains	0,9 * nominal	1,1 * nominal	nominal

Outside this voltage range the CTS-FP, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the CTS-FP exceed the output power levels as defined in GSM 05.56 for extreme operation. In particular, the CTS-FP shall inhibit all RF transmissions when the power supply voltage is below the manufacturer declared shut-down voltage.

Annex D (informative): Change history

SPEC	SMG#	CR	PHASE	VERS	NEW_	SUBJECT
05.56	s29	A004	R98	7.0.1	7.1.0	Environmental conditions for the CTS-FP
05.56	s29	A005	R98	7.0.1	7.1.0	Clarification of AFA and TFH selection performance requirement
05.56	s29	A006	R98	7.0.1	7.1.0	Modification of receiver performance for CTSARCH
05.56	s31			7.1.0	8.0.0	Version for Release 1999
05.56				8.0.0	8.0.1	Update to Version 8.0.1 for Publication

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2001-04	4				Version for Release 4		4.0.0
2002-06	10				Version for Release 5	4.0.0	5.0.0
2005-01	23				Version for Release 6	5.0.0	6.0.0
2007-08	35				Version for Release 7	6.0.0	7.0.0
2008-12	40				Version for Release 8	7.0.0	8.0.0

History

Document history		
V8.0.0	February 2009	Publication