ETSI/GSM

GSM Recommendation: 05.05
version: 3.16.0

Title: RADIO TRANSMISSION AND RECEPTION

Release date: October, 1993

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Number of pages: 19

RECOMMENDATION 05.05
RADIO TRANSMISSION AND RECEPTION

1. SCOPE:

This recommendation defines the requirements for the transceiver of the pan-european digital mobile cellular system operating in the 900 MHz band.

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 recommendation is related to RF characteristics. All parameters specified should be measured over the full range of environmental conditions specified for the equipment (see GSM Recs. 11.10 and 11.20).

The precise measurement methods are specified in GSM Recs 11.10 and 11.20, as well as the normal and extreme environmental conditions. Unless otherwise stated, the requirements defined in this recommendation apply to both those conditions.

2. FREQUENCY BANDS AND CHANNEL ARRANGEMENT:

The system is required to operate in the following frequency bands:

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

with a carrier spacing of 200 kHz. In the future, extension bands may be available. In this case, the band that is specified hereabove shall be band number 0 (cell allocation number, CA_NO = 0).

In order to ensure the compliance with the radio regulations outside the band, a guard band of 200 kHz between the edge of the band and the first carrier is needed at the bottom of each of the two subbands. Consequently, if we call Fl(n) the nth carrier frequency in the lower band, and Fu(n) the nth carrier frequency in the upper band, we have:

- $Fl(n) = 890.2 + 0.2*(n-1)$ (MHz) $(1 \leq n \leq 124)$
- $Fu(n) = Fl(n) + 45$ (MHz)

The value n is called the ABSOLUTE RADIO FREQUENCY CHANNEL NUMBER (ARFCN). To protect other services, channels 1 and 124 will not normally be used, except for local arrangements.

3. REFERENCE CONFIGURATION:

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

4. TRANSMITTER CHARACTERISTICS:

Throughout this section, 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 peak output power refers to the measure of the power when averaged over the useful part of the burst (see annex 2).

4.1 Output power:

4.1.1 Mobile station:

The mobile station maximum peak power shall be, according to its class, as defined in the following table (see also Rec.02.06).

Power class	Maximum peak power	Tolerance (dB) for conditions normal	Tolerance (dB) for conditions extreme
1	20 W (43 dBm)	± 2	± 2.5
2	8 W (39 dBm)	± 2	± 2.5
3	5 W (37 dBm)	± 2	± 2.5
4	2 W (33 dBm)	± 2	± 2.5
5	0.8 W (29 dBm)	± 2	± 2.5

The different power steps needed for adaptive power control (see Rec.05.08) shall have the nominal peak power levels as defined in the table below, starting from level 15 (13 dBm) up to the maximum peak power corresponding to the class of the particular mobile station. Whenever a power control level corresponds to the power class of the mobile, the tolerance of ± 2 or 2.5 dB (see above) shall apply.

Power control level	Peak power (dBm)	Tolerance (dB) for conditions normal	Tolerance (dB) for conditions extreme	Power control level	Peak power (dBm)	Tolerance (dB) for conditions normal	Tolerance (dB) for conditions extreme
0	43	± 2	± 2.5	8	27	± 3	± 4
1	41	± 3	± 4	9	25	± 3	± 4
2	39	± 3	± 4	10	23	± 3	± 4
3	37	± 3	± 4	11	21	± 3	± 4
4	35	± 3	± 4	12	19	± 3	± 4
5	33	± 3	± 4	13	17	± 3	± 4
6	31	± 3	± 4	14	15	± 3	± 4
7	29	± 3	± 4	15	13	± 3	± 4

Furthermore the peak power actually transmitted by the MS at each of the power control steps shall form a monotonic sequence, and the intervall between power steps shall be 2±1.5 dB.

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 Rec.05.08.

4.1.2 Base station:

The base station transmitter maximum peak power, measured at the input of the BSS Tx combiner, shall be, according to its class, as defined in the following table:

TRX power class	Maximum peak power	Tolerance (dB)	TRX power class	Maximum peak power	Tolerance (dB)
1	320 W	-0,+3	5	20 W	-0,+3
2	160 W	-0,+3	6	10 W	-0,+3
3	80 W	-0,+3	7	5 W	-0,+3
4	40 W	-0,+3	8	2.5 W	-0,+3

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 ±0.5 dB, to allow a fine adjustment of the coverage by the network operator

As an option the BSS can utilise downlink RF power control. In addition to the six power control steps described above, the BSS may then utilise up to 15 steps of power control levels with the same step sizes and tolerances as defined for the mobile station, power class 1, for power levels other than 0. The power control level 0 shall be the set power according to the TRX power class and the six power settings defined above.

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

4.2 Output RF spectrum:

The specifications contained in this section apply to both BS and MS, 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 analyze separately those two effects is specified in Recs 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 hereunder are based on a 5-pole synchronously tuned measurement filter.

4.2.1 Spectrum due to the modulation:

The output RF modulation spectrum is specified in the following table. At points 400 kHz and above away from the carrier, the specifications are different for equipment with antenna connector and with integral antenna, and may depend upon the power control level in use (the specification is tighter when the level is higher, and is tighter for equipment with antenna connector than for equipment with integral antenna). A mask representation of this specification is shown in annex 1. This mask applies for all RF channels mentioned in section 2.

Power level (dBm)	maximum level relative to measurement on the carrier(dB) in a 30 kHz bandwidth at the listed frequencies from the carrier (kHz)						
	100	200	250	400		600 to 1800	
				ant.con.	int.ant.	ant.con.	int.ant.
≥ 43	+ 0.5	- 30	- 33	- 60	-	- 70	-
41	+ 0.5	- 30	- 33	- 60	-	- 68	-
39	+ 0.5	- 30	- 33	- 60	-	- 66	-
37	+ 0.5	- 30	- 33	- 60	- 58	- 64	- 58
35	+ 0.5	- 30	- 33	- 60	- 56	- 62	- 56
≤ 33	+ 0.5	- 30	- 33	- 60	- 54	- 60	- 54

In the combined range 400 to 1800 kHz above and below the carrier, in one GSM RF channel of 200 kHz, exceptions at up to -36 dBm are permitted.
The specifications assume the following measurement conditions: zero frequency scan, filter bandwidth and video bandwidth of 30 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 500 such burst measurements.

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.

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 hereunder (figure 1).

a) Mobile station:

POWER LEVEL	MAXIMUM LEVEL MEASURED			
	400 kHz	600 kHz	1200 kHz	1800 kHz
43 dBm	- 17 dBm	- 26 dBm	- 32 dBm	- 36 dBm
41 dBm	- 19 dBm	- 26 dBm	- 32 dBm	- 36 dBm
39 dBm	- 21 dBm	- 26 dBm	- 32 dBm	- 36 dBm
≤ 37 dBm	- 23 dBm	- 26 dBm	- 32 dBm	- 36 dBm

Notes:
1) The relaxations for power levels 39, 41 and 43 dBm are in line with the modulated spectra and thus cause negligible additional interference to an analogue system by a GSM signal.
2) {The near-far dynamics with this specification has been estimated to be approximately 62 dB for mobiles operating at a power level of 20 W. This near-far dynamics then gradually decreases with 2 dB per power level down to 32 dB for mobiles operating in cells with a maximum allowed output power of 20 mW.}
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).
4) This mask is believed to be feasible to implement, both for high and low power mobiles, with respect to both cost and power consumption.

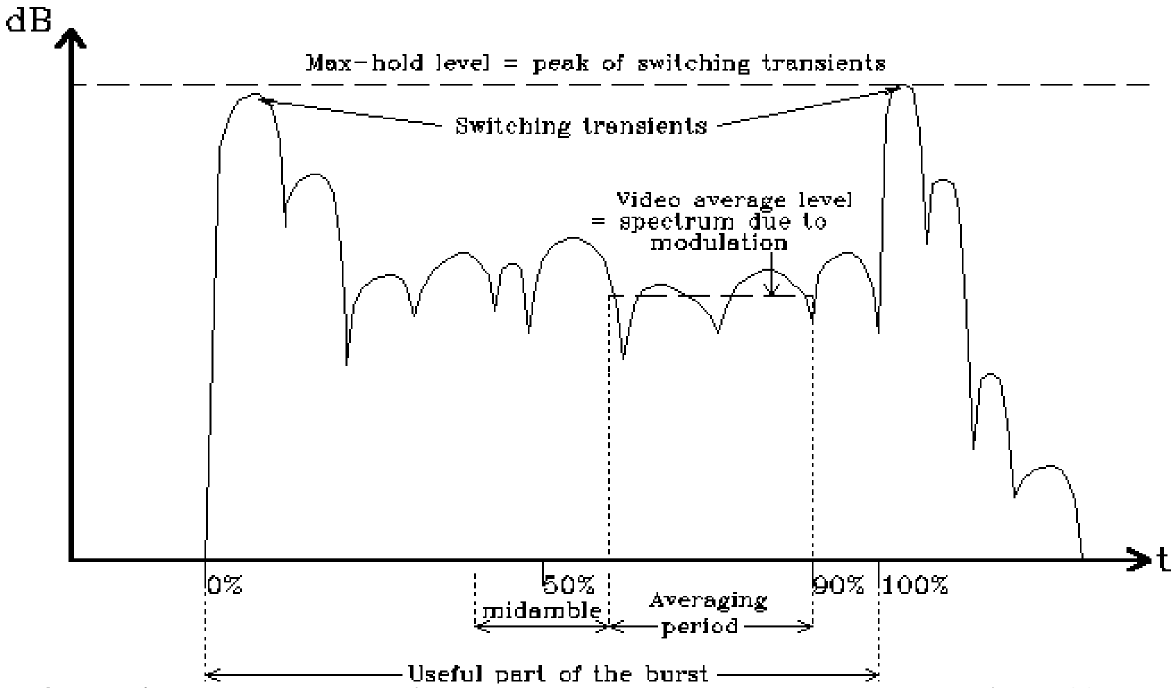


Figure 1: Example of a time waveform due to a burst as seen in a 30 kHz filter offset from the carrier.

b) Base station:

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

- at 400 kHz: -60 dBc (or -36 dBm, whichever the higher);
- at 600 kHz: -69 dBc (or -36 dBm, whichever the higher);
- at 1200 kHz: -75 dBc (or -36 dBm, whichever the higher);
- at 1800 kHz: -79 dBc (or -36 dBm, whichever the higher);
  (dBc means relative to the maximum peak power at the BS, measured at the same point).

Note: some of the above requirements are different from those specified in section 4.3.2.

4.3 Spurious emissions:

The limits specified hereunder 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 transmitted 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 BS 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 max-hold measurement being assumed.

The measurement conditions for radiated and conducted spurious are specified separately in Recs. 11.10 and 11.20. The frequency bands where these are actually measured may differ from one type to the other (see Recs. 11.10 and 11.20).

Band	Frequency offset	Measurement bandwidth
in-band frequencies	(offset from carrier)	
890 - 915 MHz (MS)	≥ 600 kHz	10 kHz
or	≥ 1.8 MHz	30 kHz
935 - 960 MHz (BS)	≥ 6 MHz	100 kHz
Outside the relevant above 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 MSs with antenna connectors, and for all spurious emissions for MSs 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 station:

The power measured in the conditions specified in 4.3.1 shall be no more than (see also note in 4.3.1 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 the conditions specified in 4.2.1 shall be no more than 0.05 pW (-103 dBm) in the frequency band 890 - 915 MHz.
These values assume a 30 dB coupling loss between transmitter and receiver.

4.3.3 Mobile station:

The power measured in the conditions specified in 4.3.1 for a mobile, when allocated a channel, shall be no more than (see also note in 4.3.1 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 band 9 kHz - 1 GHz
- 20 nW (-47 dBm) in the frequency band 1 - 12.75 GHz

Under all conditions, the power emitted by the MS in the band 935-960 MHz, when measured using the measurement conditions specified in section 4.2.1, shall be no more than:

- 25 pW (- 76 dBm) for class 1 mobile stations;
- 4 pW (- 84 dBm) for class 2, class 3, class 4 or class 5 mobile stations;

  except in five GSM RF channels of 200 kHz, where exceptions at up to -36 dBm are permitted. When hopping, this applies to each set of measurements, grouped by the hopping frequencies as described in 4.2.1.

4.4 Radio frequency tolerance:

The radio frequency tolerance for the base station and the mobile station is defined in Rec. 05.10.

4.5 Output level dynamic operation:

4.5.1 Base station:

The peak power relative to time when sending a burst is shown in annex 2. 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 2 shall be respected at the beginning and the end of the series of consecutive bursts. The residual carrier peak power,if a time slot is not activated, shall be maintained at, or below, the level of -70 dBc. In any case, no requirement more stringent than -36 dBm shall apply. A measurement bandwidth of at least 300 kHz is assumed.

4.5.2 Mobile station:

The peak power can be reduced by steps of 2 dB, down to a minimum level of 13 dBm. The power levels that shall be achieved, according to the class of the mobile station, are listed in section 4.1.

The output power relative to time when sending a burst is shown in annex 2. The timing of the transmitted burst is specified in recommendation 05.10. Between the active bursts, the residual carrier peak power shall be maintained at, or below, the level of -70 dBc; in any case no requirement more stringent than -36 dBm shall apply. A measurement bandwidth of at least 300 kHz is assumed.

The transmitter, when in idle mode, will respect the conditions of section 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 Rec. 05.04, is specified in the following way.

For any 148-bits subsequence of the 511-bits pseudo-random sequence, defined in CCITT Rec V52, 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°.

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 Rec. 05.04) influence the output phase in a time slot.

4.7 Intermodulation attenuation:

The intermodulation attenuation 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 with its antenna.

4.7.1 Base transceiver station:

The intermodulation attenuation (ratio of the power level of the wanted signal to the power level of an intermodulation component) shall be at least 70 dB for any intermodulation component, when an interfering CW signal is applied within the GSM band at a frequency offset of 800 kHz, and with a power level 30 dB below the power level of the transmitted (GSM modulated) signal.

4.7.2 Intra BTS intermodulation attenuation:

In a BTS intermodulation may be caused by combining several transmitters and carriers to feed a single antenna, or when operating them in the close vicinity of each other. For each transmitter operating at the maximum allowed power, and with the minimum carrier spacing, the peak power of intermodulation components, when measured in a 300 kHz bandwidth, shall not exceed -70 dBc or 250 nW (-36 dBm), whichever is the higher, in the frequency band 935 - 960 MHz.

The other requirements of section 4.3.2 in the band 9 kHz to 12.75 GHz shall still be met.

4.7.3 Mobile PBx:

In a mobile PBX intermodulation may be caused when operating transmitters in the close vicinity of each other. For each transmitter operating at the maximum allowed power, and with the minimum carrier spacing, the peak power of intermodulation components, when measured in a 300 kHz bandwidth, shall not exceed -70 dBc or 250 nW (-36 dBm), whichever is the higher, in the frequency band 890 - 915 MHz.

The power measured in the conditions specified in 4.2.1 shall be no more than 0.05 pW (- 103 dBm) in the frequency band 935 to 960 MHz. This value assumes a 30 dB coupling loss between transmitter and receiver.

The other requirements of section 4.3.3 in the band 9 kHz to 12.75 GHz shall still be met.

5. RECEIVER CHARACTERISTICS:

In this section, the requirements are given in terms of power levels at the receiver input. 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):

$$E\ (dB\mu V/m) = P\ (dBm) + 136.5$$

Static propagation conditions are assumed in all cases, for both wanted and unwanted signals. Through sections 5.1 to 5.3, 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. The in-band performance specification shall apply to the receive band frequencies and frequencies up to 20 MHz either side of the receive band. The out-of-band performance specification shall apply at all frequencies in the range of 100 kHz to 12.75 GHz, excluding the in-band frequencies defined above.

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, 3 dB above the reference sensitivity level as specified in section 6.2;
- a continuous sine wave signal at a level as in the table below.

Notes:
1) MS (3/4/5) is a mobile station with power class 3, 4 or 5 (see 4.1.1).
2) MS (1/2) is a mobile station with power class 1 or 2 (see 4.1.1).
3) f is the continuous wave signal frequency.
4) f_0 is the wanted signal frequency.
5) at the spurious response frequencies (see 5.3), the relaxed requirements of section 5.3 replace these values.

Frequency (f)	MS (3/4/5)		MS (1/2)		BS	
	dBµV (emf)	dBm	dBµV (emf)	dBm	dBµV (emf)	dBm
in-band 915 - 980 MHz (MS) or 870 - 935 MHz (BS)						
600 kHz ≤ $\|f-f_0\|$ < 800 kHz	70	- 43	75	- 38	90	- 23
800 kHz ≤ $\|f-f_0\|$ < 1.6 MHz	70	- 43	80	- 33	100	- 13
1.6 MHz ≤ $\|f-f_0\|$ < 3 MHz	80	- 33	90	- 23	100	- 13
3 MHz ≤ $\|f-f_0\|$	90	- 23	90	- 23	100	- 13
out-of-band (MS)						
100 kHz ≤ f ≤ 915 MHz	113	0	113	0	-	-
980 MHz ≤ f ≤ 12.75 GHz	113	0	113	0	-	-
out-of band (BS)						
100 kHz ≤ f ≤ 870 MHz	-	-	-	-	113	0
935 MHz ≤ f ≤ 12.75 GHz	-	-	-	-	113	0

NOTE: The blocking requirements may be measured only within 100 MHz from the edges of the relevant receive band.

5.2 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 section 6.2;
- a continuous sine wave signal at frequency f_1 and a level of 70 dBµV (emf) (ie. -43 dBm);
- any 148-bits subsequence of the 511-bits pseudo-random sequence, defined in CCITT Rec V52 modulating a signal at frequency f_2, and a level of 70 dBµV (emf) (ie. -43 dBm);

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

For hand-held units this value is relaxed to 64 dBµV (emf).

5.3 Spurious response rejection:

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, 3 dB above the reference sensitivity level as specified in section 6.2;
- a continuous sine wave signal at a level of 70 dBµV (emf) (ie. -43 dBm) at a frequency which is an integer multiple of 200 kHz.

a) in the frequency bands [f_0 - 45 MHz, f_0 - 800 kHz] and [f_0 + 800 kHz, f_0 + 45 MHz], f_0 being the frequency of the wanted signal, for a maximum of six GSM RF channels (which, if grouped, may not exceed three GSM RF channels per group).

b) in the band 9 kHz to 12.75 GHz, excluding the frequencies f_0 ± 45 MHz, at no more than 24 channels of 200 kHz bandwidth (which, if below f_0 and grouped, shall not exceed three 200 kHz channels per group).
For MSs with integral antennas, the relevant frequency band is 30 MHz to 4 GHz. Specifications and methods of measurement outside this band are under consideration.

At all other frequencies, the more stringent requirements of section 5.1 (blocking) shall apply.

5.4 Spurious emissions:

The spurious emissions for a BS or an MS receiver, measured in the conditions specified in 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

6. TRANSMITTER/RECEIVER PERFORMANCE:

In order to assess the error rate performance that is described in this section 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 Recommendation 11.10.

This section aims at specifying the receiver performance, taking into account that transmitter errors must not occur, and that the transmitter shall be tested separately (see 4.6). In the case of base 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 section power levels are given also in terms of field strength, assuming a 0 dBi gain antenna, to apply for the test of mobiles with integral antennas.

6.1 Nominal error rates (NER):

This section describes the transmission requirements in terms of error rates in nominal conditions i.e. without interference and with an input level of -85 dBm (52 dBμV/m). The relevant propagation conditions appear in annex 3.

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.

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 hand-helds: -102 dBm (35 dBμV/m)
- for other MSs and BSs: -104 dBm (33 dBμV/m)

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 BS and all types of MSs:

- 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 section 5.1.

These specifications apply for a wanted signal input level of -85 dBm, 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 3), independant on the two channels.

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:

TCH/FS (FER):	10.2α%
Class Ib (RBER):	0.72/α%
Class II (RBER):	8.8%
FACCH (FER):	17.1%

6.4 Erroneous frame indication performance:

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

c) For a BS 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

Type of channel		Propagation conditions				
		static	TU50 (no FH)	TU50 (ideal FH)	RA250 (no FH)	HT100 (no FH)
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)	-	$2\ 10^{-4}$	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 %

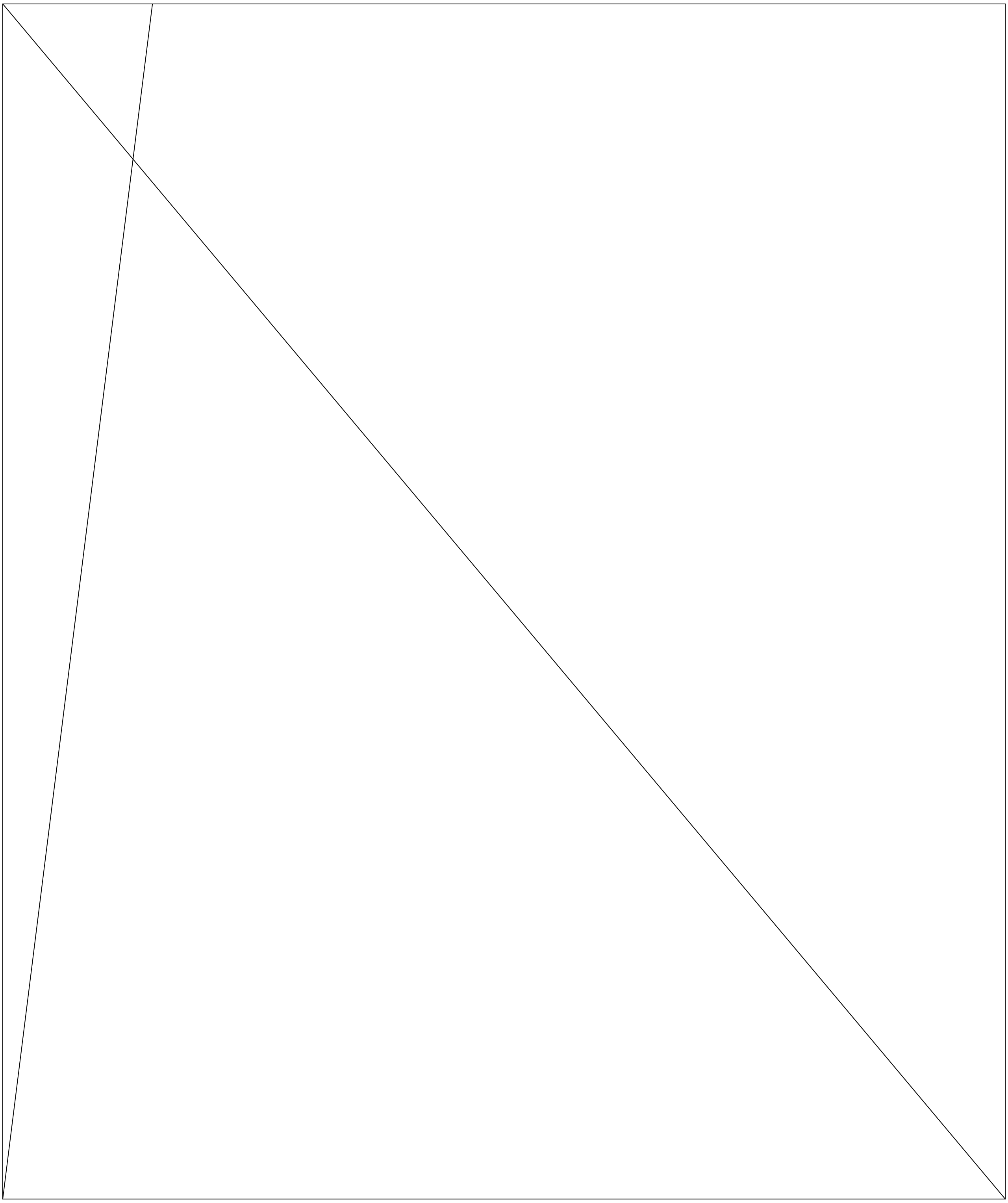
TABLE 2: REFERENCE INTERFERENCE PERFORMANCE

Type of channel		Propagation conditions TU3 (no FH)	TU3 (ideal FH)	TU50 (no FH)	TU50 (ideal FH)	RA250 (no FH)
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}	$3\ 10^{-5}$	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)	$2/\alpha$ %	$0.2/\alpha$ %	$0.4/\alpha$ %	$0.2/\alpha$ %	$0.2/\alpha$ %
class II	(RBER)	4 %	8 %	8 %	8 %	8 %

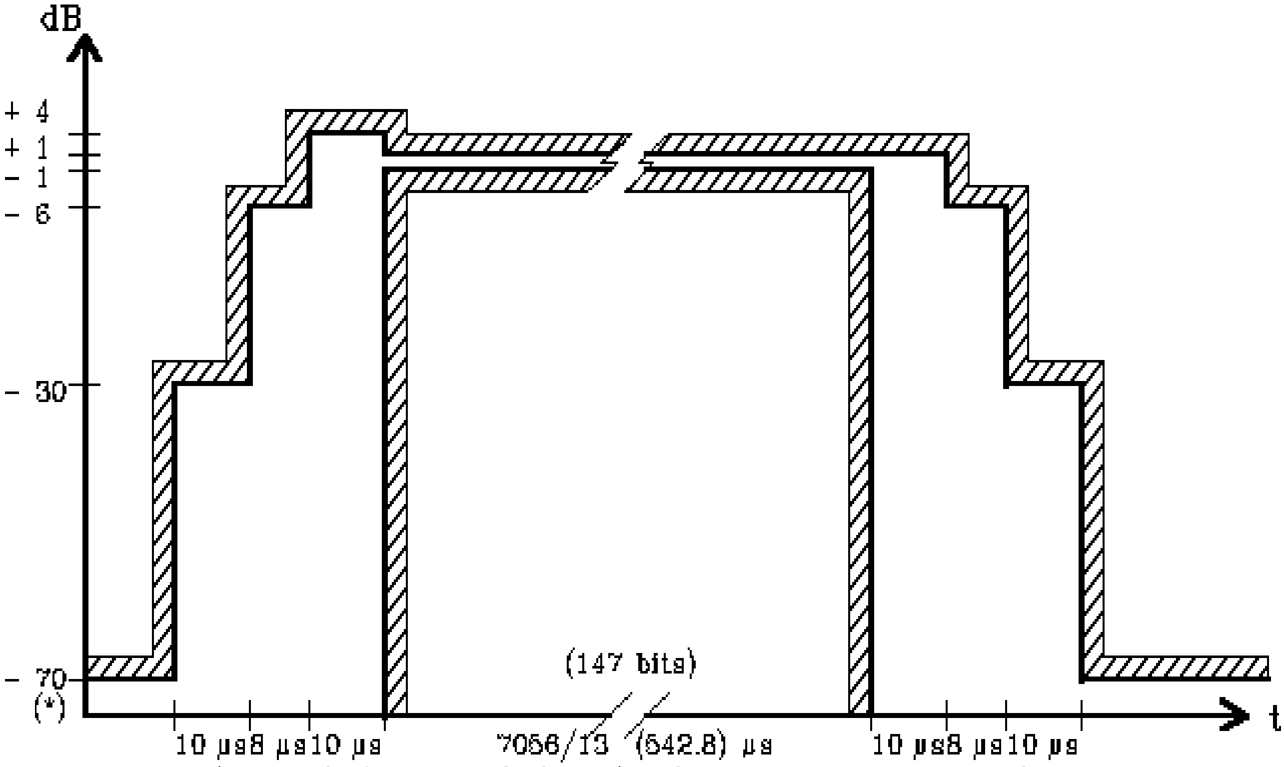
NOTES:

1) The specification for SDCCH applies also for BCCH, AGCH, PCH, SACCH, FACCH. The actual performance of SACCH, particularly for the C/I TU3 (no FH) case should be better.
2) Definitions:
   FER: Frame erasure rate
   BER: Bit error rate
   RBER: 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).
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.
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.
5) Ideal FH case assumes perfect decorrelation between bursts. This case may only be tested if such a decorrelation is ensured in the test.

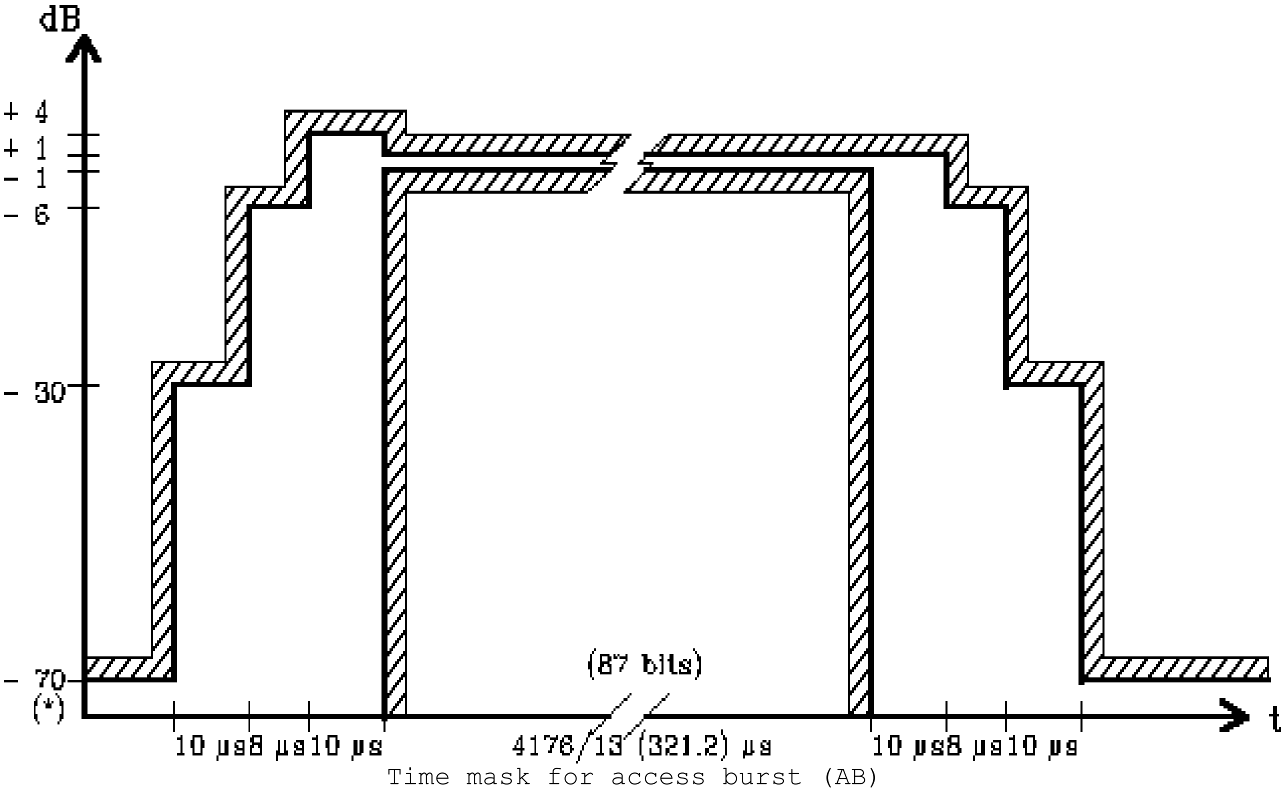
ANNEX 1: SPECTRUM CHARACTERISTICS
(spectrum due to the modulation)



ANNEX 2: TRANSMITTED LEVEL VERSUS TIME



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



Time mask for access burst (AB)

(*) or -36 dBm, whichever the higher.

ANNEX 3

PROPAGATION CONDITIONS

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 mobile station may be considered to consist of large reflectors and/or scatterers some distance to the mobile, giving rise to a number of waves that arrive in the vicinity of the mobile with random amplitudes and delays.

Close to the mobile these paths are further randomised by local reflections or diffractions. Since the mobile 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:

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

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).

2. DOPPLER SPECTRUM TYPES:

In this section, we define the two types of doppler spectra which will be used for the modeling of the channel. Throughout this section 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) $S(f) = A/\sqrt{(1-(f/f_d)^2)}$ 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 spectrum is used for the shortest path of the RA model;

(RICE) $S(f) = 0.41/(2pf_d\sqrt{(1-(f/f_d)^2)}) + 0.91\, d(f - 0.7\, f_d)$ for $f \in]-f_d, f_d[$.

3. PROPAGATION MODELS:

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

Those models are usualy 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.

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

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 hereunder.

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

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 hereunder.

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

3.4 **Profile for equalisation 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