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(12/2013)

**Characteristics of terrestrial IMT-Advanced
systems for frequency sharing/
interference analyses**

M Series
**Mobile, radiodetermination, amateur
and related satellite services**



International
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Foreword

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REPORT ITU-R M.2292-0

**Characteristics of terrestrial IMT-Advanced systems for
frequency sharing/interference analyses**

(2013)

1 Introduction

IMT systems have been the main method of delivering wide area mobile broadband applications. In order to accommodate increasing amount of mobile traffic and user demand for higher data rates, IMT-Advanced which is evolution of IMT-2000, is planned to be deployed in the world.

Frequency sharing studies and interference analyses involving IMT systems and other systems and services operating in the same or the adjacent bands may need to be undertaken within ITU-R. To perform the necessary sharing studies between IMT systems and systems in other services, characteristics of the terrestrial component of IMT-Advanced systems are needed.

This Report provides the baseline characteristics of terrestrial IMT-Advanced systems for use of sharing and compatibility studies between IMT-Advanced systems and other systems and services.

It should be noted that in case of parameters having a range of values, “typical” values should be used in sharing studies, where applicable.

2 Acronyms

ACLR	Adjacent channel leakage power ratio
ACS	Adjacent channel selectivity
EIRP	Equivalent isotropically radiated power
FDD	Frequency division duplex
FFR	Fractional frequency reuse
IMT	International Mobile Telecommunications
LTE	Long-term evolution
OOBE	Out-of-band emission
TDD	Time division duplex
OFDM	Orthogonal frequency division multiplexing
SC-FDMA	Single carrier frequency division multiple access

3 Related Recommendations and Reports

- Recommendation ITU-R F.1336: Reference radiation patterns of omnidirectional, sectoral and other antennas in point-to-multipoint systems for use in sharing studies in the frequency range from 1 GHz to about 70 GHz
- Recommendation ITU-R P.1238: Propagation data and prediction methods for the planning of indoor radiocommunication systems and radio local area networks in the frequency range 900 MHz to 100 GHz

Report ITU-R M.2039:	Characteristics of terrestrial IMT-2000 systems for frequency sharing/interference analyses
Report ITU-R M.2241:	Compatibility studies in relation to Resolution 224 in the bands 698-806 MHz and 790-862 MHz.

4 Specification-related parameters

The following parameters in Table 1 are specification-related parameters of IMT-Advanced.

TABLE 1
IMT-Advanced specification related parameters

		IMT-Advanced			
		FDD		TDD	
No.	Parameter	Base station	Mobile station	Base station	Mobile station
1	Access technique	OFDM	SC-FDMA	OFDM	SC-FDMA
2	Modulation parameters	QPSK 16-QAM 64-QAM			
3	Channel spacing	Nominal channel spacing = $(BW_{Channel(1)} + BW_{Channel(2)})/2$			
4	Channel bandwidth (MHz)	(1)	(1), (19)	(1)	(1), (19)
5	Signal bandwidth (MHz)	(1)	(1), (19)	(1)	(1), (19)
6	Transmitter characteristics				
6.1	Power dynamic range (dB)	(2)	63 ⁽¹⁸⁾	(2)	63 ⁽¹⁸⁾
6.2	Spectral mask	(3), (17)	(4), (17)	(3), (17)	(4), (17)
6.3	ACLR	(5), (17)	(6), (17)	(5), (17)	(6), (17)
6.4	Maximum output power	(7)	(8)	(7)	(8)
6.5	Spurious emissions	(15), (17)	(16), (17)	(15), (17)	(16), (17)

TABLE 1 (*end*)

		IMT-Advanced			
Duplex mode		FDD		TDD	
No.	Parameter	Base station	Mobile station	Base station	Mobile station
7	Receiver characteristics				
7.1	Noise figure	5 dB (macro) 10 dB (micro) 13 dB (pico/femto)	9 dB	5 dB (macro) 10 dB (micro) 13 dB (pico/femto)	9 dB
7.2	Sensitivity	(9)	(10)	(9)	(10)
7.3	Blocking response	(11)	(12)	(11)	(12)
7.4	ACS	(13)	(14)	(13)	(14)

Notes to the Table:

- (1) See 3GPP Document TS 36.101 v.11.2.0, § 5.6. Signal bandwidth in MHz corresponds to “Transmission bandwidth configuration*0.180”.
- (2) See 3GPP Document TS 36.104 v.11.2.0, § 6.3.2.1.
- (3) See 3GPP Document TS 36.104 v.11.2.0, § 6.6.3.
- (4) See 3GPP Document TS 36.101 v.11.2.0, §§ 6.6.2.1, 6.6.2.1A, 6.6.2.2 and 6.6.2.2A describe UE spectrum emissions masks for different channel bandwidths. In case multiple UEs are transmitting simultaneously on the same channel they will share the available radio resource blocks. As the actual transmission bandwidth is thus decreased the unwanted emissions performance might be improved. This may be taken into account during sharing analysis when measurements or detailed models are available.
- (5) See 3GPP Document TS 36.104 v.11.2.0, § 6.6.2.
- (6) See 3GPP Document TS 36.101 v.11.2.0, § 6.6.2.3.
- (7) See 3GPP Document TS 36.104 v.11.2.0, § 6.2.
- (8) See 3GPP Document TS 36.101 v.11.2.0, § 6.2.
- (9) See 3GPP Document TS 36.104 v.11.2.0, § 7.2.
- (10) See 3GPP Document TS 36.101 v.11.2.0, § 7.3.
- (11) See 3GPP Document TS 36.104 v.11.2.0, § 7.6.
- (12) See 3GPP Document TS 36.101 v.11.2.0, § 7.6 and § 7.7.
- (13) See 3GPP Document TS 36.104 v.11.2.0, § 7.5.
- (14) See 3GPP Document TS 36.101 v.11.2.0, § 7.5.
- (15) See 3GPP Document TS 36.104 v.11.2.0, § 6.6.4.
- (16) See 3GPP Document TS 36.101 v.11.2.0, § 6.6.3.
- (17) These unwanted emission limits are the upper limits from SDO specifications for laboratory testing with maximum transmitting power. It is assumed that when the in-band transmitting power is reduced by x dB through power control, the unwanted emission levels would be reduced by x dB in consequence in the coexistence simulations.
- (18) See 3GPP Document TS 36.101 v.11.2.0, § 6.3.
- (19) In case multiple UEs are transmitting simultaneously on the same channel they will share the available radio resource blocks. As the actual transmission bandwidth is thus decreased the unwanted emissions performance might be improved. This may be taken into account during sharing analysis when measurements or detailed models are available.

References

(Documents publically available at <http://www.3gpp.org/specification-numbering>)

- [1] TR 25.942 v.11.0.0 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; RF System Scenarios (Release 11).
- [2] TS 36.101 v.11.2.0, 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (Release 11).
- [3] TS 36.104 v.11.2.0, 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (Release 11).
- [4] TR 36.942 v.11.0.0 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Frequency (RF) system scenarios (Release 11) – Note this is a working document.
- [5] 3GPP TR 36.912 v.11.0.0 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Feasibility study for Further Advancements for E-UTRA (LTE-Advanced) (Release 11) – Section 16.

5 Deployment-related parameters

This section describes and proposes values for typical deployment parameters for different deployment scenarios and in different frequency bands. In many cases, the values of these parameters vary within a range, but to facilitate sharing studies wherever possible a single value has been chosen that is representative for use in sharing studies.

These parameter values are appropriate for studies concerning the impact of a single IMT cell operating in the presence of another system/service. For some parameters such as transmitted power levels, however, studies to assess the impact of an entire IMT network will in some cases need to take account of the varying nature of an IMT network, in particular power control. Inter-cell interference must be minimized and parameters such as power levels adjusted in order to optimize the operational performance and capacity of the network.

5.1 Base station characteristics and cell structure

Deployment-dependent parameters describing the cell structure and other base station related parameters needed to conduct sharing studies are summarized below. In addition, it should be stressed that in the sharing studies it is necessary to select the appropriate deployment type (macro rural/suburban/urban, small cell outdoor/indoor), that corresponds to expected usage of a certain frequency band, as indicated in the parameter tables. For nationwide studies a combination of deployment types could be considered.

5.1.1 Cell size and base station density

FIGURE 1
Macro cell geometry

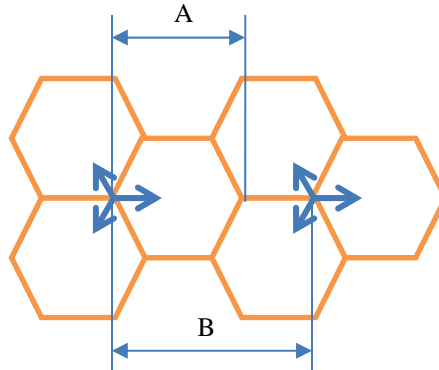


Figure 1 illustrates the geometry for a 3-sector deployment, and defines the parameters cell radius (A) and inter-site distance (B). Each cell (also referred to as a sector) is shown as a hexagon, and in this figure there are three cells/sectors per base station site. Cell sizes in IMT networks can vary considerably depending on the environment the network is deployed in. Tables 2, 3, and 4 indicate typical cell sizes for different types of networks. Sharing studies using cell radii corresponding to urban and suburban deployment should take into account that those are only deployed in limited areas, central areas of large cities and suburban areas. Furthermore, rural deployments often do not cover all areas in a country/region, as coverage may be provided by other frequency bands, therefore assuming that rural cells which have complete coverage will overestimate interference in most of the cases.

Indoor urban cell sizes will also vary depending on frequency band and the configuration of the building interior.

5.1.2 Antenna height

Typical antenna heights above ground level when deploying IMT networks are indicated in Tables 2, 3, and 4 for each type of network. Antennas deployed in indoor urban environments may vary in height depending on the building configuration.

5.1.3 Sectorization

The number of sectors used per site is an important factor to take into account when undertaking sharing studies for compatibility between IMT and other services. It is assumed that the most common way to deploy macro base stations in an IMT network is to use three sectors with an azimuthal spacing of 120 degrees at each site. For small cell deployments, it is assumed that one sector is being used.

5.1.4 Downtilt

Typical downtilt used in IMT networks are indicated in the Tables. This includes both the electrical downtilt which is built into the antenna as well as the mechanical downtilt which is applied when mounting the antenna on the cell site (tilt brackets).

5.1.5 Frequency reuse

Typical frequency reuse figures used for IMT networks are 1 or 3 but a frequency reuse of 1 is the most common one and it is proposed to be used for all scenarios. Fractional frequency reuse (FFR) may also be used in some IMT network deployments but this option is not included in the Tables.

5.1.6 Antenna pattern

Recommendation ITU-R F.1336 has been used in the past when conducting sharing studies. It should be noted that the Recommendation states that “it is essential that every effort be made to utilize the actual antenna pattern in coordination studies and interference assessment” (Note 1 to *recommends* 1). In the Tables below, parameters to be used with Recommendation ITU-R F.1336 are proposed. These parameters apply to *recommends* 3.1 of Recommendation ITU-R F.1336. The parameters are intended for use in sharing studies. The parameter values are applicable for both average and peak side lobes, noting that the equations for average and peak side lobes are not identical, and are valid in the frequency range 400-6 000 MHz. To implement a tilt it is only necessary to apply a tilt angle value in the equations for the vertical patterns in *recommends* 3.1 to obtain the corresponding tilted antenna pattern.

5.1.7 Indoor base station deployment

Base stations are often installed indoors especially in urban areas. Typical percentages of base stations deployed indoors for the different deployment scenarios are indicated in Tables 3 and 4. Values for indoor penetration loss reflect values used for network planning based on practical experience. It is proposed that the floor loss model of Recommendation ITU-R P.1238 be used to determine building penetration loss in the vertical direction (§ 3.1, Table 3). Building entry loss values in horizontal direction for certain frequency ranges could be found in Recommendation ITU-R P.1812 (Table 6).

5.1.8 Below rooftop base station antenna deployment

When conducting sharing studies it is also important to account for how the antennas are deployed in relation to the surrounding environment, including the clutter. If the antennas are deployed below the rooftop level it might be necessary to use a different propagation model compared to the scenario when the antennas are installed above the roof top level. Tables 2, 3, and 4 indicate the typical percentage of base station antennas installed below the rooftop level. An alternative approach could be to add clutter loss to propagation loss calculations.

5.1.9 Maximum and average base station output power

Maximum output powers from base stations are indicated in Tables 2, 3, and 4 for each environment. Additionally, typical average activity of a base station and corresponding average output powers during busy hour are indicated in the Tables. For further details, see Report ITU-R M.2241, § 2.2.3.2. The choice between maximum or average output power depends on the type of study.

In case TDD is used, base station downlink transmission occurs only part of the time, which will further reduce average base station power.

5.2 User terminal parameters

5.2.1 Indoor user terminal usage and indoor user terminal penetration loss

A large proportion of IMT user terminals are used indoors. Tables 2, 3, and 4 indicate suitable figures for the percentage of terminals that are expected to be used indoors. Additionally, suitable figures for the indoor penetration attenuation are indicated. Note that the indoor penetration losses here include not only the building entry/wall loss but also additional attenuation for the signal to penetrate deeper into the building. This penetration loss may be frequency dependent.

5.2.2 User terminal density in active mode

By “active mode” it should be understood that these are terminals with an active communication session but are not necessarily transmitting.

5.2.3 Average transmit power of user terminals transmitting

The average transmit power of terminals should be understood as the average transmit power of the terminals in active mode (i.e. when they have an active communication session). The figures given are including power control and activity factor of the user terminal. See also § 2.2.3 of Report ITU-R M.2241. It should be noted that as average user terminal transmitter output power is much lower than the maximum transmitter output power in the transmitting frequency band, an average out-of-band emission (OOBE) level would be much lower than the specified OOBE level.

5.2.4 Antenna gain for user terminals

Typical values for the antenna gain of a user terminal are indicated in Tables 2, 3, and 4. The antenna gain is dependent on operating frequency and type of terminal.

5.2.5 Body loss

Proposed values for body loss are indicated in Tables 2, 3, and 4. The figure indicated is representative of all different user cases (i.e. speech position, browsing position, etc.)

5.3 Parameters

The following Tables of deployment parameters should be read in conjunction with the descriptions in § 4 and the footnotes.

TABLE 2

Deployment-related parameters for bands below 1 GHz

Base station characteristics/Cell structure	
Cell radius	> 5 km (typical 8 km) for macro rural scenario 0.5-5 km (typical 2 km) for macro urban/suburban scenario
Antenna height	30 m (See Note 1)
Sectorization	3 sectors
Downtilt	3 degrees
Frequency reuse	1

TABLE 2 (*end*)

Base station characteristics/Cell structure	
Antenna pattern	Recommendation ITU-R F.1336 (<i>recommends</i> 3.1) <ul style="list-style-type: none"> • $k_a = 0.7$ • $k_p = 0.7$ • $k_h = 0.7$ • $k_v = 0.3$ Horizontal 3 dB beamwidth: 65 degrees Vertical 3 dB beamwidth: determined from the horizontal beamwidth by equations in Recommendation ITU-R F.1336. Vertical beamwidths of actual antennas may also be used when available.
Antenna polarization	Linear/ ± 45 degrees
Feeder loss	3 dB
Maximum base station output power	46 dBm in 10 MHz
Base station antenna gain	15 dBi
Base station EIRP/sector	58 dBm in 10 MHz
Average base station activity factor	50%
Average base station EIRP/sector taking into account activity factor	55 dBm in 10 MHz
User terminal characteristics	
Indoor user terminal usage	50% for macro rural scenario 70% for macro urban/suburban scenario
Average indoor user terminal penetration loss	15 dB for macro rural scenario 20 dB for macro urban/suburban scenario
User terminal density in active mode to be used in sharing studies	0.17/5 MHz/km ² for macro rural scenario 2.16/5 MHz/km ² for urban/suburban scenario
Maximum user terminal transmitter output power	23 dBm
Average user terminal transmitter output power	2 dBm for macro rural scenario -9 dBm for macro urban/suburban scenario
Antenna gain for user terminals	-3 dBi
Body loss	4 dB

NOTE 1 – In macro rural cases in various regions, typical antenna heights could vary depending on the notion of rural territory, i.e. population density, actual distribution of settlements, infrastructure availability, etc.

Based on the available statistics in many cases typical antenna height around 30 metres provides the most representative value for macro rural case. For some specific areas where statistics indicate significantly higher antenna heights than 30 metres, in those cases, antenna heights of 50 metres may be more representative.

TABLE 3

Deployment-related parameters for bands between 1 and 3 GHz

	Macro rural	Macro suburban	Macro urban	Small cell outdoor/ Micro urban	Small cell indoor/Indoor urban
Base station characteristics/Cell structure					
Cell radius/ Deployment density (for bands between 1 and 2 GHz)	> 3 km (typical figure to be used in sharing studies 5 km)	0.5-3 km (typical figure to be used in sharing studies 1 km)	0.25-1 km (typical figure to be used in sharing studies 0.5 km)	1-3 per urban macro cell <1 per suburban macro site	Depending on indoor coverage/ capacity demand
Cell radius/ Deployment density (for bands between 2 and 3 GHz)	> 2 km (typical figure to be used in sharing studies 4 km)	0.4-2.5 km (typical figure to be used in sharing studies 0.8 km)	0.2-0.8 km (typical figure to be used in sharing studies 0.4 km)	1-3 per urban macro cell <1 per suburban macro site	Depending on indoor coverage/ capacity demand
Antenna height	30 m	30 m (1-2 GHz) 25 m (2-3 GHz)	25 m (1-2 GHz) 20 m (2-3 GHz)	6 m	3 m
Sectorization	3 sectors	3 sectors	3 sectors	Single sector	Single sector
Downtilt	3 degrees	6 degrees	10 degrees	n.a.	n.a.
Frequency reuse	1	1	1	1	1
Antenna pattern	Recommendation ITU-R F.1336 (<i>recommends 3.1</i>) $k_a = 0.7$ $k_p = 0.7$ $k_h = 0.7$ $k_v = 0.3$ Horizontal 3 dB beamwidth: 65 degrees Vertical 3 dB beamwidth: determined from the horizontal beamwidth by equations in Recommendation ITU-R F.1336. Vertical beamwidths of actual antennas may also be used when available.			Recommendation ITU-R F.1336 (omni : <i>recommends 2</i>)	
Antenna polarization	Linear/ ± 45 degrees	Linear/ ± 45 degrees	Linear/ ± 45 degrees	Linear	Linear
Indoor base station deployment	n.a.	n.a.	n.a.	n.a.	100%
Indoor base station penetration loss	n.a.	n.a.	n.a.	n.a.	20 dB (horizontal) Rec. ITU-R P.1238, Table 3 (vertical)

TABLE 3 (continued)

	Macro rural	Macro suburban	Macro urban	Small cell outdoor/ Micro urban	Small cell indoor/Indoor urban
Base station characteristics/Cell structure					
Below rooftop base station antenna deployment	0%	0%	30% (1-2 GHz) 50% (2-3 GHz)	100%	n.a.
Feeder loss	3 dB	3 dB	3 dB	n.a	n.a
Maximum base station output power (5/10/20 MHz)	43/46/46 dBm	43/46/46 dBm	43/46/46 dBm	35 dBm	24 dBm
Maximum base station antenna gain	18 dBi	16 dBi	16 dBi	5 dBi	0 dBi
Maximum base station output power/sector (EIRP)	58/61/61 dBm	56/59/59 dBm	56/59/59 dBm	40 dBm	24 dBm
Average base station activity	50%	50%	50%	50%	50%
Average base station power/sector taking into account activity factor	55/58/58 dBm	53/56/56 dBm	53/56/56 dBm	37 dBm	21 dBm
User terminal characteristics					
Indoor user terminal usage	50%	70%	70%	70%	100%
Indoor user terminal penetration loss	15 dB	20 dB	20 dB	20 dB	20 dB
User terminal density in active mode	0.17/ 5 MHz/km ²	2.16/ 5 MHz/km ²	3/5 MHz/km ²	3/5 MHz/km ²	Depending on indoor coverage/ capacity demand
Maximum user terminal output power	23 dBm	23 dBm	23 dBm	23 dBm	23 dBm
Average user terminal output power	2 dBm	-9 dBm	-9 dBm	-9 dBm	-9 dBm

TABLE 3 (*end*)

	Macro rural	Macro suburban	Macro urban	Small cell outdoor/ Micro urban	Small cell indoor/Indoor urban
User terminal characteristics					
Typical antenna gain for user terminals	-3 dBi	-3 dBi	-3 dBi	-3 dBi	-3 dBi
Body loss	4 dB	4 dB	4 dB	4 dB	4 dB

TABLE 4

Deployment-related parameters for bands between 3 and 6 GHz

	Macro suburban	Macro urban	Small cell outdoor/Micro urban	Small cell indoor/Indoor urban
Base station characteristics/Cell structure				
Cell radius/Deployment density	0.3-2 km (typical figure to be used in sharing studies 0.6 km)	0.15-0.6 km (typical figure to be used in sharing studies 0.3 km)	1-3 per urban macro cell <1 per suburban macro site	Depending on indoor coverage/capacity demand
Antenna height	25 m	20 m	6 m	3 m
Sectorization	3 sectors	3 sectors	Single sector	Single sector
Downtilt	6 degrees	10 degrees	n.a.	n.a.
Frequency reuse	1	1	1	1
Antenna pattern	Recommendation ITU-R F.1336 (<i>recommends</i> 3.1) $k_a = 0.7$ $k_p = 0.7$ $k_h = 0.7$ $k_v = 0.3$ Horizontal 3 dB beamwidth: 65 degrees Vertical 3 dB beamwidth: determined from the horizontal beamwidth by equations in Recommendation ITU-R F.1336. Vertical beamwidths of actual antennas may also be used when available.		Recommendation ITU-R F.1336 omni	

TABLE 4 (continued)

	Macro suburban	Macro urban	Small cell outdoor/Micro urban	Small cell indoor/Indoor urban
Base station characteristics/Cell structure				
Antenna polarization	Linear/ ± 45 degrees	Linear/ ± 45 degrees	Linear	Linear
Indoor base station deployment	n.a.	n.a.	n.a.	100%
Indoor base station penetration loss	n.a.	n.a.	n.a.	20 dB (3-5 GHz) 25 dB (5-6 GHz) (horizontal direction) Rec. ITU-R P.1238, Table 3 (vertical direction)
Below rooftop base station antenna deployment	0%	50%	100%	n.a.
Feeder loss	3 dB	3 dB	n.a.	n.a.
Maximum base station output power (5/10/20 MHz)	43/46/46 dBm	43/46/46 dBm	24 dBm	24 dBm
Maximum base station antenna gain	18 dBi	18 dBi	5 dBi	0 dBi
Maximum base station output power/sector (EIRP)	58/61/61 dBm	58/61/61 dBm	29 dBm	24 dBm
Average base station activity	50%	50%	50%	50%
Average base station power/sector taking into account activity factor	55/58/58 dBm	55/58/58 dBm	26 dBm	21 dBm
User terminal characteristics				
Indoor user terminal usage	70%	7%	70%	100%
Indoor user terminal penetration loss	20 dB	20 dB	20 dB	20 dB (3-5 GHz) 25 dB (5-6 GHz) (horizontal direction) Rec. ITU-R P.1238, Table 3 (vertical direction)
User terminal density in active mode to be used in sharing studies	2.16/5 MHz/km ²	3/5 MHz/km ²	3/5 MHz/km ²	Depending on indoor coverage/capacity demand

TABLE 4 (*end*)

	Macro suburban	Macro urban	Small cell outdoor/Micro urban	Small cell indoor/Indoor urban
User terminal characteristics				
Maximum user terminal output power	23 dBm	23 dBm	23 dBm	23 dBm
Average user terminal output power	-9 dBm	-9 dBm	-9 dBm	-9 dBm
Typical antenna gain for user terminals	-4 dBi	-4 dBi	-4 dBi	-4 dBi
Body loss	4 dB	4 dB	4 dB	4 dB

6 Protection criterion for IMT-Advanced

Table 5 contains the IMT-Advanced protection criterion (irrespective of the number of cells and independent of the number of interferers).

TABLE 5

Protection criterion for IMT-Advanced

Protection criterion (I/N)	-6 dB
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