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| **Recommendation ITU-R M.2134-0**  **(10/2019)** |
| **Receiver characteristics and protection criteria for systems in the mobile service in the frequency range 27.5-29.5 GHz for  use in sharing and compatibility studies** |
| **M Series**  **Mobile, radiodetermination, amateur**  **and related satellite services** |

Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

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| **Series** | Title |
| **BO** | Satellite delivery |
| **BR** | Recording for production, archival and play-out; film for television |
| **BS** | Broadcasting service (sound) |
| **BT** | Broadcasting service (television) |
| **F** | Fixed service |
| M | Mobile, radiodetermination, amateur and related satellite services |
| **P** | Radiowave propagation |
| **RA** | Radio astronomy |
| **RS** | Remote sensing systems |
| **S** | Fixed-satellite service |
| **SA** | Space applications and meteorology |
| **SF** | Frequency sharing and coordination between fixed-satellite and fixed service systems |
| **SM** | Spectrum management |
| **SNG** | Satellite news gathering |
| **TF** | Time signals and frequency standards emissions |
| **V** | Vocabulary and related subjects |

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| ***Note***: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.* |

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RECOMMENDATION ITU-R M.2134-0

Receiver characteristics and protection criteria for systems   
in the mobile service in the frequency range 27.5-29.5 GHz for   
use in sharing and compatibility studies

(2019)

Scope

This Recommendation provides the receiver characteristics and protection criteria for systems of the mobile service in the frequency range 27.5-29.5 GHz. These technical and operational characteristics should be utilized in sharing and compatibility studies.[[1]](#footnote-1)

Keywords

Mobile service, technical characteristics, protection criteria

Abbreviations/Glossary

AAS Advanced antenna system

ACS Adjacent channel selectivity

AP Access point

AR Augmented reality

BS Base station

FS Fixed service

FSS Fixed satellite service

LDPC Low density parity check

MCS Modulation and coding schemes

MIMO Multiple input multiple output

TDD Time division duplex

UHD Ultra high definition

UE User equipment

VR Virtual reality

The ITU Radiocommunication Assembly,

considering

*a)* that mobile use of the frequency range 27.5-29.5 GHz or parts thereof, inter alia, for high speed data links, mainly used to convey high definition multi-media, is planned in several countries;

*b)* that representative receiver technical and operational characteristics of systems in frequency bands allocated to the mobile service are required for use in sharing and compatibility studies;

*c)* that procedures and methodologies are needed to analyze the impact of systems in other services on receivers of systems in the mobile service,

noting

*a)* that the frequency range 27.5-29.5 GHz is allocated worldwide on a primary basis to the mobile service;

*b)* that the frequency range 27.5-29.5 GHz is also allocated worldwide on a primary basis to the fixed satellite service (Earth-to-space) and the fixed service,

recommends

**1** that the technical and operational characteristics of receivers in the mobile service as described in Annex 1 should be used for sharing and compatibility studies involving the mobile service and systems in other services in the frequency range 27.5-29.5 GHz;

**2** that the criteria of interfering signal power to mobile system receiver noise power level, in Annex 1should be used as the required protection level(s) for the mobile systems in the frequency range 27.5-29.5 GHz.

Annex 1   
  
Receiver technical and operational characteristics of systems in the mobile service in the frequency range 27.5-29.5 GHz   
for use in sharing and compatibility studies

# 1 Introduction

In the frequency range 27.5-29.5 GHz or parts thereof, mobile systems support a variety of applications including reliable transmission of several gigabits of data for mobile voice, data, and video wideband links, with video-related applications, e.g. ultra-high-definition video streaming, Virtual Reality, etc., as the main driver for the development of these systems.

# 2 Characteristics of mobile systems in the frequency range 27.5-29.5 GHz

## 2.1 Introduction

Technology advancements in signal processing, complex modulations, antenna design, and solid‑state components are enabling the design and manufacture of communication systems in the frequency range 27.5-29.5 GHz or parts thereof, which are intended to be used to bring about multi-gigabit access to mobile/portable devices. These devices communicate with base station/access point installed mainly in populated areas, providing connectivity to users, households, and enterprises using wide channel bandwidth as large as 100 MHz or larger, e.g. through aggregation.

The wide available bandwidth and state-of-the-art antenna array technology enables delivery of significant amount of content at very high speeds, making applications such as Ultra-High-Definition (UHD) video, virtual reality (VR) and augmented reality (AR) possible. These systems enable connecting thousands of devices in very dense use areas such as stadiums or other arenas, public transportation stops, and other places with large, concentrated numbers of smart device users. Other applications include high speed radio links from the curb to the home, connecting mobile/portable modems and devices inside homes to a network.

## 2.2 Receivers

The new-generation mobile systems in the frequency range 27.5-29.5 GHz or parts thereof use state-of-the-art digital receiver technology to enhance system performance using advanced modulation and coding techniques. Modulation and Coding Schemes (MCS) for these systems generally encompass BPSK, QPSK, 16QAM, and 64QAM coupled with convolutional, low density parity check (LDPC), and turbo coding.

These systems predominantly use OFDM as the multiple access technique in a time division duplex (TDD) scheme and utilize power control in the uplink.

Receiver filter response of these systems is characterized through adjacent channel selectivity (ACS). Table 1 contains ACS values for base stations and mobile stations in the mobile service in the frequency range 27.5-29.5 GHz.

TABLE 1

Receiver adjacent channel selectivity (ACS)

|  |  |  |
| --- | --- | --- |
| Receiver adjacent channel selectivity (ACS) (dB) | Base station | Mobile station |
| 24 | 23 |

## 2.3 Antennas

Mobile systems in the frequency range 27.5-29.5 GHz or parts thereof utilize advanced antenna array technology using patch elements that can be arranged in a variety of forms. Typically, base station antennas use larger arrays (e.g. up to 256 elements) to achieve higher gain, whereas mobile stations use smaller array sizes due to form factor and power limitations (e.g. up to 32 elements).

The information in Table 2 and associated information in § 4.1 can be used to model the directional antenna pattern for these antennas for use in sharing and compatibility studies.

Base station antennas are typically mounted on street lamps posts or other low‑height urban structures with the height in the range of a few floors of buildings. Typical antenna heights for these systems, therefore, range from 10 m (roughly a three-floor building) to 20 metres (roughly a six‑floor building) above ground level, depending on the deployment environment. Mobile stations are assumed to operate by users at the street level, hence a height of 1.5 metres is assumed.

# 3 Protection criteria

Protection criteria of *I*/*N* values are provided in Table 2. The specified tolerable *I*/*N* is referenced to the mobile receiver input and requires taking in to account all sources of interference. If a single interference source is present, protection of the mobile systems requires that this criterion is not exceeded due to the interference from the single source. If multiple interference sources are present, protection of the mobile systems requires that this criterion is not exceeded due to the aggregate interference from the multiple sources.

# 4 Summary

The technical parameters of representative mobile systems in the frequency range 27.5-29.5 GHz are presented in Table 2.

TABLE 2

Receiver characteristics of Base Stations and Mobile Stations in the   
frequency range 27.5-29.5 GHz

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | System A  (represents deployments in some countries) | | System B  (represents deployments in some countries) | | System C  (represents deployments in some countries) | | System D  (represents deployments in some countries) | |
| Characteristics | Base station | Mobile station | Base station | Mobile station | Base station | Mobile station | Base station | Mobile station |
| Frequency range (GHz) | 27.5-28.35 | | 27.5-29.5 | | 27.5-29.5 | | 27.5-29.5 | |
| Receiver bandwidth (MHz) | 100 | | 100 | | 200 | | 200 | |
| Antenna pattern type | Directional | | Directional | | Directional | | Directional | |
| Antenna polarization | Linear | | Linear | | Linear | | Linear | |
| Peak antenna gain (dBi) | 29 | 14 | 29 | 20 | 23 | 17 | 23 | 14 |
| Antenna pattern model | See antenna pattern in § 4.1 below | | | | | | | |
| Antenna height (m) | 10-20 | 1.5 | 10-20 | 1.5 | 6 or 15 | 1.5 | 6-10 | 1.5 |
| Receiver noise figure (dB) | 6.5 | 8.5 | 6 | 6 | 10 | 10 | 10 | 10 |
| Protection criterion (dB) | −6 | | −6 | | −6 | | −6 | |
| Base station antenna downtilt (degrees) | 10 | | 10 | | 10 | | 10 | |
| Body loss (for handheld UE scenario) | N/A | 4 dB | N/A | 4 dB | N/A | 4 dB | N/A | 4 dB |
| Feeder loss for BS | 0 | N/A | 0 | N/A | 3 dB | N/A | 3 dB | N/A |

Sharing studies can assume that the BS antenna beam could vary in a ±60 degrees range in the azimuth plane. Depending on the scenario to be studied[[2]](#footnote-2), in the elevation plane, with respect to the horizontal plane: a range of −6 degrees to −60 degrees for 20 m BS and −3 degrees to −60 degrees for the 10 m BS can be used for System A; a range of −5 to −60 degrees for 20 m BS and −2 degrees to −60 degrees for the 10 m BS for System B; a range of −6 to −60 degrees for 15 m BS and −3 degrees to −60 degrees for the 6 m BS for System C; and a range of −6 to −60 degrees for 10 m BS and −3 degrees to −60 degrees for the 6m BS for System D.

## 4.1 Reference antenna pattern model

The beamforming antenna pattern is expressed based on an array configuration consisting of a number of identical radiating elements arranged in a planar way with a fixed separation distance (e.g. /2). The elements are assumed to have identical radiation patterns and with maximum directivity perpendicular to the plane housing the elements. Total antenna gain is the sum (logarithmic scale) of the array gain and the element gain.

The formulas that express the element and composite patterns are expressed in Tables 3 and 4 below. In the Tables, the angles θ and φ are defined based on the coordinate system expressed as follows.

The radiation elements are placed uniformly in the y-z plane along the vertical z-axis in a Cartesian coordinate system. The x-y plane denotes the horizontal plane. The elevation angle is denoted as θ (defined between 0° and 180°, with 90° representing perpendicular angle to the array antenna aperture). The azimuth angle is denoted as φ (defined between −180° and 180°).

In an active Advanced antenna system (AAS), the unwanted (out of block) response are different compared to the wanted (in block) response. AAS systems actively control individual signals being fed to individual antenna elements in the array in order to shape and direct the antenna pattern to a wanted shape.

Element pattern

TABLE 3

Element pattern for antenna array model[[3]](#footnote-3)

|  |  |
| --- | --- |
| Horizontal radiation pattern |  |
| Horizontal 3 dB beamwidth of single element / degree () | 80 |
| Front-to-back ratio: *Am* and *SLAv* | 30 |
| Vertical radiation pattern | dB |
| Vertical 3 dB beamwidth of single element / degree () | 65 |
| Single element pattern |  |
| Element Gain (dBi), *GE*,max | 5 |

Composite antenna pattern

Table 4 illustrates the derivation of the composite antenna pattern, .  is the resulting beamforming antenna pattern from logarithmic sum of the array gain, , and the element gain . The composite pattern for the base station antenna should be used where the array serves one or more mobile stations with one or more beams, with each beam indicated by the parameter *i.*

TABLE 4

Composite antenna pattern for base stations and mobile stations beam forming

|  |  |
| --- | --- |
| Configuration | Multiple columns (*NV* × *NH* elements) |
| Composite array radiation pattern in dB | For beam i:    the super position vector is given by:    the weighting is given by: |
| Antenna array configuration (row × column) | Base station: 16x16 (System A and B), 8x8 (System C and D)  Mobile station: 4x2 (System A and D) / 8x4 (System B)/ 4x4 (System C) |
| Horizontal radiating element spacing d/λ | 0.5 |
| Vertical radiating element spacing d/λ | 0.5 |

In the absence of particular information concerning the radiation pattern, Recommendation ITU-R F.1336 addresses peak and average patterns of sectoral antennas in the frequency range 400 MHz‑70 GHz.

1. This Recommendation does not cover any technical characteristics and protection criteria of ESIM and HAPS under agenda items 1.5 and 1.14 of WRC-19. [↑](#footnote-ref-1)
2. Noting the above figures, protection measures of the mobile service should be derived for all elevation angles and utilize, inter alia, the wavelength, the receiver antenna gain pattern, and the receiver noise figure for Mobile service systems and should apply to all azimuth angles. [↑](#footnote-ref-2)
3. Table 3 represents a reference antenna pattern, and as such does not represent a maximum or average envelope. [↑](#footnote-ref-3)