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|  | **Radiocommunication Study Groups** |  |
| **INTERNATIONAL TELECOMMUNICATION UNION** |  |
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| Annex 19 to Working Party 5A Chairman’s Report |
| WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW RECOMMENDATION ITU-R M.[MS-RXCHAR-28] |
| Receiver characteristics and protection criteria for systems (excluding IMT) in the mobile service in the frequency range 27.5-29.5 GHz for use in sharing studies |

Scope

This Recommendation provides the receiver characteristics and protection criteria for systems (excluding IMT) of the mobile service in the frequency range 27.5-29.5 GHz. These technical and operational characteristics should be utilized in analyzing sharing and compatibility between systems in the mobile service and systems in other services.

Keywords

Mobile service, technical characteristics, protection criteria.

Abbreviations/Glossary

[TBD]

The ITU Radiocommunication Assembly,

considering

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

*b)* that the technical characteristics of systems in the mobile service are determined by the purpose of the system;

*c)* 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;

*d)* that procedures and methodologies are needed to analyze the impact of operation 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

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

2that 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. This protection level(s) also applies for aggregate interference if multiple interferers are present.

Annex 1

Receiver technical and operational characteristics of systems (excluding IMT)
in the mobile service in the frequency range 27.5-29.5 GHz
for use in sharing 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 27.5-29.5 GHz frequency range or parts thereof, that are intended to be used to bring about multi-gigabit access to mobile/portable devices. These devices communicate with base station/access points 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 video, virtual reality (VR) and augmented reality (AR) possible.

*[Editor’s note: To be expanded.]*

## 2.2 Receivers

The new-generation mobile systems in the 27.5-29.5 GHz frequency range or parts thereof use state-of-the-art digital receiver technology to enhance system performance using advanced modulation and coding techniques.

*[Editor’s note: to be expanded.]*

## 2.3 Antennas

*[Editor’s note: There were discussions on the applicability of Rec. ITU-R F.1336, which addresses peak and average patterns of omni-directional and sectoral antennas in the frequency range 400 MHz-70 GHz as well as low-gain directional antennas in the frequency range 1 GHz- ~ 3 GHz for the Fixed and Mobile Services to be used in sharing studies.]*

Mobile systems in the 27.5-29.5 GHz frequency range 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. 256 elements) to achieve higher gain, whereas mobile stations use smaller array sizes due to form factor and power limitations (e.g. 8 elements).

No current ITU-R Recommendation adequately addresses the reference antenna pattern for mobile systems in the 27.5-29.5 GHz frequency range. However, as an interim measure, the information in Table 1 and associated information can be used to model the directional antenna pattern for these antennas for use in compatibility studies and sharing analyses.

*[See Editor’s note above.]*

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 3-floor building) to 20 meters (roughly a 6-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 meters is assumed.

# 3 Protection criteria

*[Editor’s note: Further studies are needed to determine the appropriate protection criteria for sharing studies]*

Under noise-limited conditions, a protection criteria of *I/N* = [TBD] limits the increase in the noise floor in the receiver by [TBD] dB and corresponds to an (*I* + *N*)/*N* ratio of [TBD]. The [TBD] dB rise in the noise floor would yield to degradation of the receiver sensitivity, which could lead to degradation of the receiver’s performance in the form of reducing the operating Signal to Noise and Interference Ratio (SINR). Protection criteria of I/N values are provided in Table 1. The specified tolerable *I/N* ratio 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 1.

TABLE 1

Mobile system receiver characteristics in the 27.5-29.5 GHz

|  |  |
| --- | --- |
|  | System A |
| Characteristics | Base Station | Mobile Station |
| Frequency range (GHz) | 27.5-28.35 |
| Channel bandwidth (MHz) | 100 |
| Antenna pattern type | Directional |
| Antenna polarization | Linear |
| Peak antenna gain (dBi) | 29 | 14 |
|  |  |  |
| Antenna pattern model | See System A antenna pattern in section 4.2.1 below | See System A antenna pattern in section 4.2.1 below |
| Antenna height (m) | 10-20 | 1.5 |
| Receiver noise figure (dB) | 6.5 | 8.5 |
| Protection Criterion (dB) | [TBD] |
| Base station antenna downtilt (degrees) | 10 |
| IF filter bandwidth (MHz) | 800 |

*[Editor’s note: Other mobile system characteristics can be inserted into Table 1 as System B, system C, system X as needed based on input contributions]*

## 4.1 Reference Antenna Pattern Model

***[See Editor’s note for section 2.3 above.]***

**4.1.1 System A Antenna Pattern**

The beamforming antenna is based on an antenna array and consists of a number of identical radiating elements located in the yz-plane with a fixed separation distance (e.g. /2), all elements having identical radiation patterns and “pointing” (having maximum directivity) along the x-axis. Total antenna gain is the sum (logarithmic scale) of the array gain and the element gain.

The  and definition is based on the coordinate system are illustrated in Figure A.

Figure A

Antenna Model Geometry, : elevation, range from 0 to 180 degree
 : Azimuth, range from -180 to 180 degree



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

One difference between a passive antenna system (e.g. based on Recommendation ITU-R F.1336) and an active Advanced Antenna System (AAS) is that for the AAS, the unwanted (out of block) emission will see a different antenna behaviour compared to the wanted (in block) emission.

A system using an AAS will actively control all individual signals being fed to individual antenna elements in the antenna array in order to shape and direct the antenna emission diagram to a wanted shape, e.g. a narrow beam towards a user. In other words, it creates a correlated wanted emission from the antenna. The unwanted signal, caused by transmitter OOB modulation, intermodulation products and spurious emission components will not experience the same correlated situation from the antenna and will have a different emission pattern. A non-correlated AAS has an antenna emission pattern similar to a single antenna element.

### Element pattern

Table A1

Element pattern for antenna array model[[1]](#footnote-1)

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

### Composite antenna pattern

Table A2 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 MSs with one or more beams, with each beam indicated by the parameter *i.*

Table A2

Composite antenna pattern for BS and MS 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, mobile station: 4x2 |
| Horizontal radiating element spacing d/lambda | 0.5 |
| Vertical radiating element spacing d/λ | 0.5 |

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1. The table represents a reference antenna pattern, and as such does not represent a maximum or average envelope. [↑](#footnote-ref-1)