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| U.S. Radiocommunications Sector  Fact Sheet | |
| **Working Party:** ITU-R WP 5B | **Document No:** USWP5B31-04 |
| **Ref:**  **Annex 6 to Document 5B/731-E** | **Date:** March 08, 2023 |
| **Document Title:** PRELIMINARY DRAFT REVISION OF RECOMMENDATION ITU-R M.1851-1  Mathematical models for radiodetermination radar and aeronautical mobile systems antenna patterns for use in interference analyses | |
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| **Purpose/Objective:** The purpose of this contribution is to show that the proposed cosine on a pedestal does not need to be included in M.1851 | |
| **Abstract:** We should leave M.1851 as it is without the inclusion of cosine on a pedestal pattern as this just adds unneeded complications. The parabolic patterns are expected to also show similar results and are not included in this contribution. Also, there are editorial changes in the beamforming antenna pattern in Section 6.2. | |
| **Fact Sheet Preparer:** Raafat Nasser, ACES Inc. for US Army. | |

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| **Radiocommunication Study Groups** | Logo  Description automatically generated |
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| PRELIMINARY DRAFT REVISION OF RECOMMENDATION ITU-R M.1851-1 | |
| Mathematical models for radiodetermination radar and aeronautical mobile systems antenna patterns for use in interference analyses  Additional Information on Cosine on a Pedestal | |

Mathematical models for radiodetermination radar and aeronautical mobile systems antenna patterns for use in interference analyses   
Additional Information on Cosine on a Pedestal

Introduction

At the last meeting of WP-5B a cosine on a pedestal pattern was introduced. There are problems of its applicability and how to select the proper pattern. There is a need to discuss removing the new cosine on a pedestal antenna patterns from consideration.

**Proposal**

The United States of America would like to propose removing the new cosine on a pedestal information after discussion with WP-5B delegates.

Also, in section 6.2 Planar phased antenna array, the US would like to add the following text below figure 27: “The parameters Nx, Ny, dx, and dy used in the above equations are not currently defined in any ITU-R Recommendation related to radar characteristics. In the absence of these parameters, it is recommended that sharing and capability studies associated with radar and aeronautical mobile systems (with single or multiple interferers) use peak or average masks, as described in section 2.1.1.”

**Attachment: 1**

**Attachment 1**

**Additional Information on Cosine on a Pedestal**

**Proposal**

We should leave M.1851 as it is without the inclusion of cosine on a pedestal pattern as this just adds unneeded complications. The parabolic patterns are expected to also show similar types of results and are not included in this contribution.

**Analysis**

At the last meeting of WP-5B, cosine on a pedestal procedure was introduced. The radiation patterns for a raised cosine to the power n are formed by adding the uniform pattern multiplied by the pedestal edge illumination plus (1- pedestal edge illumination) multiplied by the cosine to the power n pattern. The equations of the uniform and the cosine to the power n are found in ITU-R Recommendation M.1851.

The problem with cosine on a pedestal is that there could be several ways to obtain the peak sidelobe levels and this makes it difficult to choose the appropriate pattern for compatibility analysis. For example, if an ITU-R Recommendation has only the peak sidelobe (SLL) of about 21 dB below the antenna peak gain and the actual pattern type is not provided, then what should be chosen for the pattern. The highlighted cell in table-1 shows that a possible choices could include Cos with pedestal edge factor of 0.2, or Cos2 with pedestal edge value of 0.5 or Cos3 with pedestal edge value of 0.4. These patterns may be similar but checking whether they are or not requires extra analysis.

To plot the radiation patterns with pedestal edge illumination the following beamwidth factor, K, should be used. If other pedestal edge illumination values are needed those can also be derived.

**Table-1 Values of K (Beamwidth Factor) and Sidelobe Level**

| **Pedestal**  **Value** | **K COS** | **SLL COS** | **K COS2** | **SLL COS2** | **K COS3** | **SLL COS3** | **K COS4** | **SLL COS4** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 68.1365 | -23 | 82.5443 | -31.46 | 95.0555 | -39.2954 | 106.1805 | -46.7411 |
| 0.1 | 64.56 | -22.7166 | 73.13 | -40.0616 | 78.57 | -34.0733 | 82.11 | -32.3622 |
| 0.2 | 61.72 | -21.65 | 67 | -31.596 | 69.63 | -25.09 | 70.87 | -28.176 |
| 0.3 | 59.46 | -20.2855 | 62.81 | -26.7936 | 64.09 | -23.3392 | 64.52 | -20.2195 |
| 0.4 | 57.6 | -18.9125 | 59.7 | -24.076 | 60.37 | -21.8747 | 60.44 | -19.7713 |
| 0.5 | 55.95 | -17.6515 | 57.34 | -21.2063 | 57.67 | -20.7696 | 57.63 | -19.3178 |
| 0.6 | 54.64 | -16.5321 | 55.47 | -18.644 | 55.62 | -19.9149 | 55.55 | -18.9205 |
| 0.7 | 53.47 | -15.5496 | 53.98 | -16.774 | 54.02 | -17.4181 | 53.95 | -17.7341 |
| 0.8 | 52.45 | -14.6882 | 52.71 | -15.3382 | 52.74 | -15.6399 | 52.67 | -15.7713 |
| 0.9 | 51.58 | -13.9308 | 51.69 | -14.1955 | 51.65 | -14.3056 | 51.67 | -14.3498 |
| 1 | 50.7741 | -13.2615 | 50.7741 | -13.2615 | 50.7741 | -13.2615 | 50.7741 | -13.2615 |

The effect of pedestal edge illumination on different patterns combinations is shown in table-2.

**Table-2 Effect of pedestal edge illumination on different patterns combinations.**

| **Pattern** | **Effect of pedestal edge illumination (C)** |
| --- | --- |
| Cos | * The peak sidelobe increases up to the uniform pattern peak sidelobe level as the pedestal edge illumination is increased. * The sidelobe pattern slopes down from the first peak sidelobe similar to the case where the pedestal edge illumination. * This pattern may be used for sharing and compatibility analysis. * The peak and average pattern equations are not provided at this time. |
| Cos2 | * The peak sidelobe increases up to the uniform pattern level as the pedestal edge illumination is increased. * The first sidelobe can be below its adjacent sidelobes depending on the pedestal value. * It is preferred to use pedestal edge illumination greater than 0.5 to obtain a usable pattern for radar antennas. * The peak and average pattern equations are not provided at this time. |
| Cos3 | * The peak sidelobe increases up to the uniform pattern level as the pedestal edge illumination is increased. * The first sidelobe is below the adjacent sidelobes. In some cases, the first sidelobe is merged with the main lobe. * This pattern is not useful for sharing and compatibility analysis. * The peak and average pattern equations are difficult to provide. |
| Cos4 | * The peak sidelobe increases up to the uniform pattern level as the pedestal edge illumination is increased. * The first sidelobe is below the adjacent sidelobes. In some cases, the first sidelobe is merged with the main lobe. * This pattern is not useful for sharing and compatibility analysis. * The peak and average pattern equations are difficult to provide. |

Plots of radiation patterns with different pedestal edge illuminations.

**Table-3 Table of Figures for different patterns with varying pedestal edge illuminations**

|  |  |  |
| --- | --- | --- |
| No Pedestal |  |  |
| Hamming C=0.08 |  |  |
| C=0.1 |  |  |
| C=0.2 |  |  |
| C=0.3 |  |  |
| C=0.4 |  |  |
| C=0.5 |  |  |
| C=0.6 |  |  |
| C=0.7 |  |  |
| C=0.8 |  |  |
| C=0.9 |  |  |
| C=1 |  |  |

In section 6.2 Planar phased antenna array, the US would like to add the following text below figure 27,

“The parameters Nx, Ny, dx, and dy used in the above equations are not currently defined in any ITU-R Recommendation related to radar characteristics. In the absence of these parameters, it is recommended that sharing and capability studies associated with radar and aeronautical mobile systems (with single or multiple interferers) use peak or average masks, as described in section 2.1.1.”