

REPORT ITU-R RA.2131

**Supplementary information on the detrimental threshold levels
of interference to radio astronomy observations
in Recommendation ITU-R RA.769**

(2008)

1 Introduction

Detrimental threshold levels of interference for radio astronomy were first adopted in 1963 and were given in ex-CCIR Report 224. Ex-CCIR Report 224 was revised repeatedly in response to advances in radio astronomy techniques and its contents were incorporated into Recommendation ITU-R RA.769 in 1992, when ITU-R replaced the International Radio Consultative Committee (CCIR) within the ITU structure. Recommendation ITU-R RA.769 was first revised in 1995 (Recommendation ITU-R RA.769-1) after some experience had been gained with its use. The current version of the Recommendation ITU-R RA.769-2, was adopted in 2003¹ in response to the realignment of allocations above 71 GHz and continuing advances in millimetre receiver technology.

This Report provides supplementary information on the threshold levels of interference detrimental to radio astronomy observations. The threshold levels contained in the tables in Recommendation ITU-R RA.769 are expressed as power flux density (pfd) and/or spectral power flux density (spfd) in units of dB(W/m²) and dB(W/(m² · Hz)), respectively. However, for some applications it is more useful to express these thresholds in terms of the electric field strength: for instance, propagation studies express signal level in those terms.

Section 2 provides the conversion formulae necessary to convert pfd and spfd values to electric field strength. Section 3 summarizes the transition from Recommendations ITU-R RA.769-1 to ITU-R RA.769-2. Section 4 gives tables of pfd, spfd and electric field values. To assist in interpolating threshold values between the rather widely-spaced entries in the tables of Recommendation ITU-R RA.769, these thresholds are also shown graphically in § 5.

2 Conversion formulae

The basic relation between electric field strength E (V/m) and the pfd (W/m²) is:

$$\text{pfd} = E^2/120\pi \quad (1)$$

where the factor 120π represents the impedance of free space. The electric field strength expressed in microvolts/m is $E(\mu\text{V/m}) = 10^6 (120\pi \text{ pfd})^{1/2}$, which on being expressed in dB, according to generally understood engineering usage², is $E(\text{dB}(\mu\text{V/m})) = 20 \log \{10^6 (120\pi \text{ pfd})^{1/2}\}$ or:

$$E(\text{dB}(\mu\text{V/m})) = 145.7633 + 10 \log \text{pfd} \quad (2)$$

¹ Egypt and Syria in conformity with the Arab position at Radiocommunication Assembly 2003 regarding Recommendation ITU-R RA.769-2 will object to the content of this Report being based on the language used in this Recommendation, especially the use of the word “detrimental”.

² Engineering convention in the electro-magnetic context relates voltage ratios of E , when expressed in dB, to the change in E that corresponds to the same dB change in radiated power: hence equation (2).

3 Threshold level comparison of Recommendations ITU-R RA.769-1 and ITU-R RA.769-2

Recommendation ITU-R RA.769-1 and the more recent version Recommendation ITU-R RA.769-2 each contain tables entitled “Threshold levels of interference detrimental to radioastronomy observations” (Tables 1 and 2, in both versions), and “Threshold interference levels for VLBI observations” (Table 3 in Recommendation ITU-R RA.769-2, that corresponds to Table 4 in Recommendation ITU-R RA.769-1). The differences between the two versions of the Recommendation (and the values in the tables) are slight and may be summarized as follows:

- The bands, bandwidths and thresholds in Tables 1 and 2 of both versions of Recommendation ITU-R RA.769 are *identical* below 89 GHz, except for the introduction of the 23.8 GHz band, that was added to the tables in Recommendation ITU-R RA.769-2.
- At or above 89 GHz, the threshold values in Tables 1 and 2 of Recommendation ITU-R RA.769-2 are 2-6 dB more stringent than in Recommendation ITU-R RA.769-1 owing to lower system temperatures and increased bandwidths reflecting advances in technology. The set of bands above 89 GHz in Recommendation ITU-R RA.769-2 is more directly reflective of the primary bands allocated to the RAS after the reallocation of spectrum above 71 GHz at WRC-2000.
- For the VLBI case detrimental threshold levels are given only up to 86 GHz in the Tables. The threshold levels in Recommendation ITU-R RA.769-2 are a few dB more stringent than in the earlier version, in some cases this is due only to the correction of roundoff errors.

The detrimental threshold levels below 89 GHz remained unchanged between Recommendations ITU-R RA.769-1 and ITU-R RA.769-2. Two compensating changes were made in the formulae and system noise values employed in the two versions:

- a) The rms power fluctuation in the RAS receiver in a given time and bandwidth (specified by equation (1) in either version of the Recommendation) is *smaller* in Recommendation ITU-R RA.769-1 by a factor $1/\sqrt{2}$, corresponding to the assumption that an unpolarized signal is observed simultaneously in two independent polarizations which are co-added. This assumption was removed in Recommendation ITU-R RA.769-2, recognizing that astronomical signals may be polarized, and that observations are commonly performed independently in cross polarized channels in order to measure the polarization, which is an important astronomical parameter. Thus the polarization channels of a radio astronomy receiver must be treated independently even when two polarizations are being observed.
- b) The assumed receiver noise values were lowered, corresponding to advances in the state of the art of receiver construction. A factor $\sqrt{2} = 1.5$ dB reduction in the system noise was deemed to be appropriate and this generalized reduction was applied.

4 Tables of threshold values as pfd, spfd and dB(μV/m)

Tables 1 and 2 in this Report correspond to Tables 1 and 2 in Recommendation ITU-R RA.769. They repeat the centre frequencies, bandwidths, pfd and spfd values from Recommendation ITU-R RA.769, making clear the differences which exist at/above 89 GHz, and add a column of electric field values derived using equations (2) and (3). The tables are split into two parts. Tables 1a and 1b list the bands where the detrimental level remains unchanged in going from Recommendation ITU-R RA.769-1 to Recommendation ITU-R RA.769-2, while Tables 1b and 2b list the bands where the detrimental level did change. Table 3 of this Report provides a similar conversion of spfd values, for the more interference-tolerant VLBI continuum case.