

RECOMMENDATION ITU-R S.1427-1

Methodology and criterion to assess interference from terrestrial wireless access system/radio local area network* transmitters to non-geostationary-satellite orbit mobile-satellite service feeder links in the band 5 150-5 250 MHz**

(Question ITU-R 248/4)

(2000-2006)

Scope

This Recommendation provides a methodology and criterion that allow assessment of interference from terrestrial WAS/RLAN transmitters into non-GSO MSS feeder links (Earth-to-space) in the band 5 150-5 250 MHz, reflecting also results of WRC-03 as regards this issue.

The ITU Radiocommunication Assembly,

considering

- a) that the potential large-scale deployment of wireless access system/radio local area network WAS/RLAN transmitters in the band 5 150-5 250 MHz could cause interference to non-geostationary-satellite orbit mobile-satellite service GSO MSS satellite systems operating their feeder uplinks in this band;
- b) that the potential large-scale deployment of WAS/RLAN transmitters in the band 5 150-5 250 MHz could cause significant reduction in MSS satellite transponder capacity;
- c) that WAS/RLAN transmitters in the band 5 150-5 250 MHz are operating on a license-exempt or class-licensed basis in many countries;
- d) that the non-GSO MSS feeder-link beam coverage is of a regional and/or global nature;
- e) that WAS/RLAN interference can only be accounted for in terms of an aggregate and constant increase in the non-GSO MSS feeder-link noise floor and its consequences to reduction in satellite capacity;
- f) that *resolves* 3 of Resolution 229 (WRC-03) states that administrations may monitor whether the aggregate pfd levels given in Recommendation ITU-R S.1426 have been, or will be, exceeded in the future, in order to enable a future competent conference to take appropriate action;
- g) that a method of assessing the interference from WAS/RLAN emissions to non-GSO MSS satellite feeder-link receivers, as well as, a method of processing the measurements, is required;

* In this Recommendation WAS/RLAN is to mean wireless access system/radio local area network, or any other transportable or fixed devices offering local network connectivity (e.g. high performance RLANS (HIPERLANs), U-NII, wireless local area network (WLAN), or others; see also Recommendations ITU-R F.1244 and ITU-R M.1450).

** This Recommendation should be brought to the attention of Radiocommunication Study Groups 8 and 9 for information.

- h) that the evolution of WAS/RLANs in the marketplace will occur independently on a national or regional basis;
- j) that there is a need to protect the non-GSO MSS feeder links from WAS/RLAN interference,

noting

- a) that the 5 150-5 250 MHz band is subject to other sources of interference (including unwanted emissions from transmitters in nearby bands) to non-GSO MSS feeder links, in addition to that from WAS/RLAN transmitters;
- b) that the methodologies given in Annexes 1, 2 and 3 are only applicable to non-GSO constellations with a large number of satellites which are sufficiently spaced,

recognizing

- a) that the band 5 150-5 250 MHz is allocated worldwide to FSS (Earth-to-space) for use by non-GSO MSS feeder links on a co-primary basis without restriction in time as per No. 5.447A of the Radio Regulations (RR);
- b) that the band 5 150-5 250 MHz is also allocated on a worldwide primary basis to the aeronautical radionavigation service (ARNS);
- c) that the band 5 150-5 216 MHz is also allocated to feeder links of the radiodetermination-satellite service (space-to-Earth) subject to RR No. 5.446;
- d) that the band 5 150-5 216 MHz, under RR No. 5.447B and the provisions of RR No. 9.11A, is also allocated to the fixed-satellite service (FSS) (space-to-Earth) for use by non-GSO MSS feeder links on a worldwide primary basis;
- e) that the band 5 150-5 250 MHz has been allocated to the mobile service in accordance with RR No. 5.446A, RR No. 5.446B, and Resolution 229 (WRC-03);
- f) that the band 5 150-5 250 MHz is allocated via RR No. 5.447 to the mobile service in a number of countries subject to coordination under RR No. 9.21;
- g) that Resolution 229 (WRC-03) limits the WAS/RLAN transmission to indoor transmissions,

recommends

- 1 that the assessment of interference from WAS/RLAN emissions to non-GSO MSS satellite feeder-link receivers, operating in the band 5 150-5 250 MHz, should be based on the increase ($\Delta T_{\text{satellite}}$) in satellite noise temperature ($T_{\text{satellite}}$);
- 2 that in order to ensure the adequate protection for the non-GSO MSS feeder links in the band 5 150-5 250 MHz the aggregate $\Delta T_{\text{satellite}}/T_{\text{satellite}}$ from WAS/RLAN emissions should be no more than 3%;
- 3 that if the measurement of interference from WAS/RLAN emissions to a non-GSO MSS satellite feeder-link receiver is made, the methodology described in either Annex 2 or 3 to this Recommendation could be used for that purpose by the interfered-with non-GSO feeder-link system. Background information regarding such methodologies can be found in Annex 1;
- 4 that the following Notes are considered as part of the Recommendation.

NOTE 1 – The impact of the aggregate long-term interference due to WAS/RLANs into non-GSO MSS feeder links, in terms of the reduction in non-GSO MSS satellite capacity, should also be considered in conjunction with the methodology proposed in the above *recommends*. This is to ensure that the interference power captured by the non-GSO MSS satellites should account for a

reduction in available satellite capacity less than or equal to 1%. This value may require further study.

NOTE 2 – By the term “aggregate” it is meant that the interference to the satellite receiving beam is to be calculated from all of the WAS/RLAN devices within the field of view of the non-GSO satellite feeder-link receiving beam.

NOTE 3 – Annexes 2 and 3 to this Recommendation describe two alternative implementations of a measurement payload on board a satellite to determine the aggregate noise and interference that would be received at an operational satellite of the same type as the rest of the satellites in the constellation. Furthermore, the Annexes also describe the respective methods to process, on the ground, the measurements made at the satellite.

NOTE 4 – The methodologies described in Annexes 2 and 3 may be used to measure the aggregate interference into the space station receiver of the feeder link of any non-GSO MSS satellite system. To provide explicit results, the technical parameters of the LEO-D constellation as described in Recommendation ITU-R M.1184 are used. Further study may be required to determine what portion of that aggregate interference comes from WAS/RLAN transmitters. That study can best be carried out when the results of the measurements obtained using one of the methodologies described in Annexes 2 and 3 are available.

Annex 1

The measurement of the aggregate noise and interference into the space-station receiver of the 5 GHz Earth-to-space feeder link of a LEO-D MSS satellite system

1 Introduction

This Annex describes how the aggregate interference into the receiving antenna of the space-station receiver of a 5 GHz Earth-to-space feeder link of a non-GSO MSS satellite system is measured. Given that the overall objective of Annex 2 or 3 is to be able to estimate the magnitude of the aggregate RLAN interference with high accuracy, this Annex describes in general terms how the measurement of the total power received at the satellite antenna may be made with an r.m.s. error of about 0.03% of the thermal and background noise in the uplink.

2 The Dicke radiometer receiver

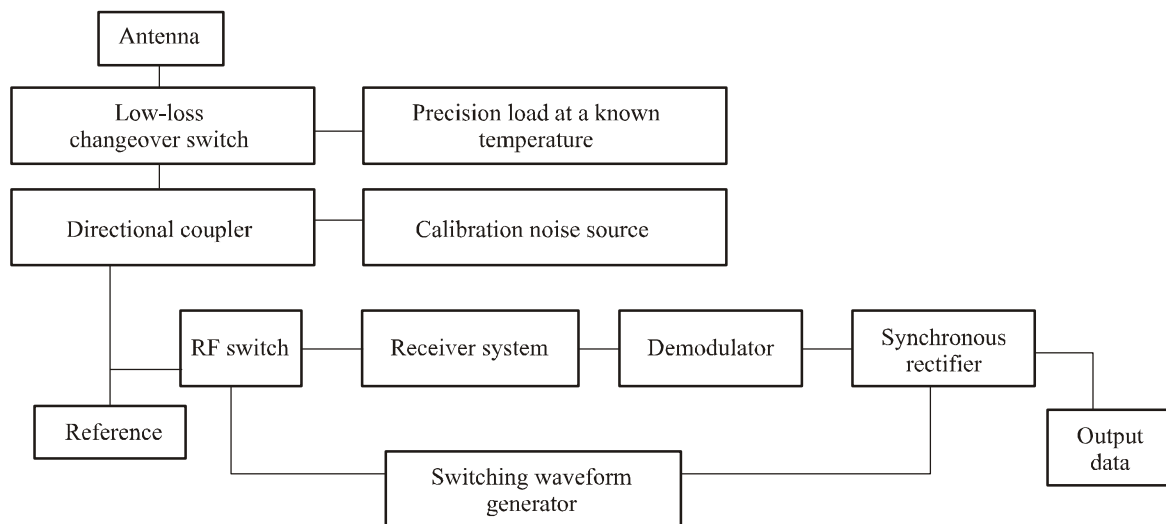
The Dicke radiometer receiver has been used for decades by the radio astronomy community and others to measure very low levels of Gaussian noise in an environment of much higher levels of Gaussian noise in the receiver itself. The application considered here is almost identical, in that the aggregate interference signal from a very large number of transmitting RLAN devices would have Gaussian stochastic characteristics, independent of the detailed characteristics of an individual transmission. Similarly, the stochastic characteristics of the background receiver noise would be Gaussian in Earth exploration-satellite (passive) applications, space research (passive) applications, radio astronomy applications, and the interference measurement of WAS/RLAN interference application described in this Recommendation.

A block diagram of a generic Dicke radiometer is shown in Fig. 1. In general, the Dicke radiometer is built around the “receiver system” block, which is the actual 5 GHz MSS feeder-link receiver before the addition of Dicke radiometer blocks. The additional blocks are added to enable the receiver to:

- integrate the detected envelope of the wideband Gaussian signal in the RF and IF stages of the satellite receiver itself for a measurement time τ ;
- calibrate its measurements so that gain variations of the receiver over time do not affect the accuracy of the measurement, and so that the estimates of the noise level being measured do not include the receiver internal noise.

To do these tasks two reference noise sources are used, and compared with the incoming Gaussian signal to be measured. One of these reference signals is comparable with the noise in the receiver; the other is comparable with the external signal being measured.

FIGURE 1
A generic Dicke radiometer



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3 Performance of the Dicke radiometer

A Dicke radiometer is designed to switch rapidly between the antenna and a reference load or noise source, at a rate faster than the most rapid gain variations. Typically, gain fluctuations have a spectrum extending out to at least 5 Hz, so the RF switch should switch between the antenna and reference at a rate of at least 30 Hz or so. The gain variations then only act upon the difference between the inputs. Ideally, therefore, the reference temperature should be as close to the antenna temperature as possible. An antenna looking at the ground will always have an antenna temperature of at least 150 K or so (if the antenna beam is not filled by the ground – if it is something like 250 K is more likely). A matched load or noise source would therefore be a practical reference. Indeed, a PIN diode attenuator could be driven to match the inputs to the receiver so that the receiver is always balanced.

A calibration noise source adds a known amount of noise to the receiver, increasing the input by a known amount. Switching to a matched load is a useful adjunct to the calibration process, so that the basic noise level can be calibrated. However, when the matched load is connected, the antenna is not, so the baseline noise level will change.

The Dicke radiometer output is an unbiased measurement of the power level of the signal received by the 5 GHz satellite antenna over the bandwidth B of the receiver. The r.m.s. error of that measurement is:

$$\Delta T_{\text{error}} = T_{\text{sys}} / (B\tau)^{0.5} \quad (1)$$

where:

- ΔT_{error} : r.m.s. error in the measurement of the noise temperature of the random signal at the antenna output
- T_{sys} : noise temperature of the total noise in the receiver, the sum of the satellite receiver noise temperature and the noise temperature of the received signal, as described in Recommendation ITU-R RS.515
- B : bandwidth (Hz) of the receiver
- τ : integration time of the receiver (s).

If the noise level being measured is 3% of the total noise in the receiver, and the r.m.s. error in the measurement of that quantity is required to be in the order of 1% of the measurement, the quantity $(B\tau)^{-0.5}$ must be in the order of 3×10^{-4} .

4 Radiometers appropriate for use in the LEO-D system

The design of the radiometers used in the LEO-D system can be simplified if the measurement can use as reference-channel measurement of the noise in nearby reference-band spectrum immediately below 5 150 MHz, and use of those measurements in estimating the interference above 5 150 MHz. Application of this possibility allows a simplification of the in-orbit radiometer required to accurately measure the aggregate interference into the satellite receiver in the 5 150-5 250 MHz band, compared to the general-purpose Dicke radiometer in Fig. 1. Further, this modification in the measurements made by the radiometer modifies what on-ground data-processing of in-orbit measurements are necessary to make those aggregate-interference measurements.

This simplification of the radiometer used in the LEO-D satellite is based on the following five observations:

- Recommendation ITU-R S.1427 does not place a limit on the aggregate interference I from WAS/RLAN devices as such. Rather, it rather limits the ratio of that interference to the baseline noise level N , or the ratio I/N , equivalent to the ratio $\Delta T/T$ at the satellite receiver, which should not exceed 3%.
- In the LEO-D system that operates from 5 091 MHz to 5 250 MHz there are eight RF channels, each 16.5 MHz wide. Channels 1 and 2 operate completely below 5 150 MHz, the lowest frequency at which WAS/RLAN devices operate. Channel 3 operates at the 5 150 MHz boundary, and Channels 4 to 8 inclusive operate above 5 150 MHz in an environment in which there may be WAS/RLAN interference.
- The background noise N does not change appreciably over the frequency range from 5 091 MHz to 5 250 MHz, although there may be a slight variation.
- All of the slowly time-varying variations in N are common between the background noise N in the lower two RF channels and the upper five channels. The reasons for this time-variation of N may not be known, but the variations are embedded in variations in the noise in the lower two RF channels.
- There may be more rapid variations in the gains of satellite components at rates up to about 10 Hz, which must be taken into account in making observations that would lead to estimates of the interference I .