

RECOMMENDATION ITU-R RS.1347*

FEASIBILITY OF SHARING BETWEEN RADIONAVIGATION-SATELLITE SERVICE RECEIVERS AND THE EARTH EXPLORATION-SATELLITE (ACTIVE) AND SPACE RESEARCH (ACTIVE) SERVICES IN THE 1 215-1 260 MHz BAND

(Question ITU-R 218/7)

(1998)

The ITU Radiocommunication Assembly,

considering

- a) that the radionavigation-satellite (space-to-Earth) service is allocated on a primary basis in the 1 215-1 260 MHz frequency band;
- b) that active spaceborne sensors operating in the Earth exploration-satellite and space research services are allocated on a secondary basis, according to Footnote S5.333, in the 1 215-1 300 MHz frequency band;
- c) that sharing studies have shown compatibility between the radionavigation-satellite service receivers, including L5 receivers, and active spaceborne sensors in the acquisition and tracking phases (refer to annex);
- d) that compatibility tests have demonstrated compatibility between the radionavigation-satellite service GPS receivers in the tracking phase and synthetic aperture radars (refer to annex),

recommends

- 1 that, in view of *considering* c) and d), sharing be considered feasible between the radionavigation-satellite service and spaceborne synthetic aperture radars in the 1 215-1 260 MHz frequency band.

ANNEX

Potential interference from spaceborne active sensors into radionavigation-satellite service receivers in the 1 215-1 260 MHz band

1 Introduction

The 1 215-1 260 MHz frequency band is allocated to the radionavigation-satellite service (RNSS) and is used by both the Global Positioning System (GPS) and the Global Navigation Satellite System (GLONASS-M). The 1 215-1 300 MHz band is used by spaceborne active microwave sensors under the provisions of Footnote S5.333 of the Radio Regulations. The only active sensor requiring use of this band is the synthetic aperture radar (SAR). This annex presents the compatibility analyses of typical spaceborne synthetic aperture radars (SARs) into GPS and GLONASS-M receivers for both acquisition and tracking phases and presents the compatibility test results between the SAR and GPS for the tracking phase. In addition, the GPS L5 is under consideration for this band.

2 Technical characteristics of a spaceborne SAR

The technical characteristics for two standard synthetic aperture radars which use the 1 215-1 300 MHz band are given in Table 1. The parameters of these systems offer a range of possible characteristics to use as representative for an operational SAR. The characteristics chosen in this analysis are those which would result in the worst case interference to a radionavigation-satellite service receiver.

* Radiocommunication Study Group 7 made editorial amendments to this Recommendation.

3 Characteristics and protection criteria of GPS and GLONASS-M systems

Recommendation ITU-R M.1088 gives the characteristics and system description for the Global Positioning System (GPS) to be used in assessing sharing between other services and a GPS receiver. Recommendation ITU-R M.1317 gives the characteristics and system description for the Global Navigation Satellite System (GLONASS-M) to be used in assessing sharing between a GLONASS-M receiver and other services. The GPS L5 is under consideration for this band. The characteristics of GPS L5 have been presented as being similar to those of the GPS Coarse Acquisition (C/A) code described in Recommendation ITU-R M.1088. Operation of GPS L5 is expected to behave as the GPS C/A code in the presence of interference signals.

TABLE 1

Technical characteristics of spaceborne synthetic aperture radars in the 1 215-1 300 MHz band

	Standard SAR 1	Standard SAR 2
Peak radiated power (W)	3 200	1 200
Pulse modulation	Linear FM Chirp	Linear FM Chirp
Pulse bandwidth (MHz)	40.0	15.0
Pulse duration (μs)	33.8	35.0
Pulse repetition rate (pps)	1 736.0	1 607.0
Duty cycle (%)	5.9	5.6
Maximum antenna gain (dBi)	36.4	33.0
Antenna orientation (degrees from nadir)	20.0	35.0
Antenna polarization	Linear vertical/horizontal	Linear horizontal
Orbital altitude (km)	400	568

GPS and GLONASS-M receivers are susceptible to both pulsed and continuous interference for both acquisition and tracking phases. In the case of potential interference from a SAR, the interference falls into the category of pulsed interference. Pulsed interference can affect an RNSS receiver in two ways: by causing preamplifier saturation or preamplifier burnout. The principle interference effect is that the pulsed interference causes limiting in the receiver. This occurs when a signal level is received that is strong enough to cause the high-level limiter diode, located in the RF front-end of the receiver, to saturate in order to prevent burnout of the following receiver stages. When this limiting occurs, the relatively low desired signal would be blocked during the transmission pulse period and any recovery time that is necessary for the RNSS receiver. If this period of lost signal is short relative to the GPS information bit length, there should be no appreciable impact on the performance of the receiver. The other possible interference effect occurs when either the peak or average RF power level is high enough to cause the diode to fail. If this occurs, preamplifier burnout is possible and damage to the receiver may occur. The relevant technical characteristics for the two RNSS systems are summarized in Table 2. The saturation power level (preamplifier limiting level) and the power level required for preamplifier burnout for each of the systems is also given in Table 2. Also in the acquisition phase, the spaceborne SAR at orbit altitudes illuminates a given location on Earth in the mainbeam for only 1-2 seconds, which is typically less time than required for acquisition.

Any pulsed signal power level received that is below the preamplifier limiting levels of the RNSS receivers is assumed to have a negligible effect on the performance of the receiver since the SAR transmitted pulse period is relatively short compared to the RNSS information bit length and the SAR transmitter duty cycle is very low.

TABLE 2

**Characteristics and protection criteria for navigation user equipment
of the GPS and GLONASS-M systems**

	GPS	GLONASS-M
Carrier frequencies (MHz)	1 227.6	1 237-1 261
RF 3 dB filter bandwidth (MHz)	± 17.0	± 20.0
Polarization	RHC	RHC
Maximum antenna gain (dBi)	0.0	0.0
Preamplifier burnout level (average) (dBW)	0.0	-1.0
Preamplifier burnout level (peak) (dBW)	10.0	0.0
Preamplifier limiting level (dBW)	-70.0	-80.0

4 Compatibility analyses

4.1 Compatibility analysis with consideration of SNR degradation

The first step in analysing the interference potential from a spaceborne SAR to a GPS or GLONASS-M receiver is to determine if the peak signal power from the SAR is great enough to cause the high-level clipper diode to fail and possibly cause preamplifier burnout and damage the receiver. The maximum interfering signal power levels received from a spaceborne SAR occur when an RNSS receiver is located in the mainbeam of the SAR antenna. The peak interfering signal power levels from a SAR into a GPS or a GLONASS-M receiver are calculated in Table 3. The calculations assume co-frequency operation.

These levels for maximum peak power at the receiver input of an RNSS receiver are well below the levels that would cause the high-level clipper diode to fail. Thus, the emissions from a spaceborne SAR will not cause high-level clipper diode burnout or damage to either a GPS or GLONASS-M receiver. The interfering signal level at the GPS receiver input at which the diode will saturate and cause a temporary loss of signal is -70 dBW. For the acquisition phase, this level is 6 dB lower, or -76 dBW. Even in the worst case configuration, this interfering signal level will not be reached.

The interfering signal level at the GLONASS-M receiver input at which the diode will saturate and cause a temporary loss of signal is -80 dBW. In the worst case configuration depicted in Table 3, this interfering signal level may be exceeded by 1.5 dB due to the transmissions of a SAR. Taking into account the fan-beam shape of the SAR antenna, the resultant necessary off-axis angle to produce 1.5 dB of discrimination is 0.28° . A simulation of 15 000 orbits was run (400 km altitude, 57° inclination) to determine how often a stationary GLONASS-M receiver would be within 0.56° of the SAR antenna mainbeam (0.28° on either side). The results showed that this would occur for less than 0.0019% of the time. This means that an interfering signal level greater than the diode saturation level would be received for less than 2 seconds per day assuming this worst case interference situation. The compatibility analysis for the GLONASS-M showed that the service should be compatible with multiple spaceborne SAR interference sources, up to four SARs illuminating the GLONASS receivers in the mainbeam of the SAR at the same time, assuming the cumulative duty factor is 20% for four SARs. Given the small number of spaceborne SARs likely to be in orbit and in operation at the same time, and also given the likely diversity in orbital altitudes, orbital velocities, and orbital periods of the SARs from different administrations, the probability is extremely low that four or even two spaceborne SARs will illuminate a GLONASS-M receiver at the same time. Further, two or more SARs would never simultaneously observe the same scene because the resulting mutual interference would preclude acquisition of usable data.