

RECOMMENDATION ITU-R RS.577-7

Frequency bands and required bandwidths used for spaceborne active sensors operating in the Earth exploration-satellite (active) and space research (active) services

(1982-1986-1990-1994-1995-1997-2006-2009)

Scope

In this Recommendation frequency bands and bandwidths for five basic types of spaceborne active sensors are given. Although the discussion in Annex 1 mainly concentrates on Earth observation, it is generally believed that the measurement techniques are equally valid on other planets. Therefore, this Recommendation covers both Earth exploration-satellite (active) and space research (active) services.

The ITU Radiocommunication Assembly,

considering

- a) that spaceborne active microwave sensors can provide unique information on physical properties of the Earth and other planets;
- b) that the sensing of different physical properties requires the use of different frequencies;
- c) that the spatial resolution of the measurement determines the required bandwidth;
- d) that simultaneous measurements at a number of frequencies are often needed to distinguish between the various properties;
- e) that sharing is generally feasible between spaceborne active microwave sensors operating in the Earth exploration-satellite (active) and space research (active) services and terrestrial radars operating in the radiolocation service,

recommends

- 1 that frequency bands and required bandwidths for spaceborne active sensing should be in accordance with Annex 1;
- 2 that the frequency bands and bandwidths given in Table 1 should be used for active sensing measurements of the Earth for:
 - soil moisture;
 - vegetation mapping;
 - snow distribution, depth and water content;
 - geological mapping;
 - land use mapping;
 - ice boundaries, depth, type and age;
 - ocean wave structure;
 - ocean wind speed and direction;

- mapping of ocean circulation (currents and eddies);
- oil spills;
- geodetic mapping;
- rain rates;
- cloud height and extent;
- surface pressure;
- measurement of biomass in tropical forests;
- etc.

TABLE 1

Frequency band as allocated in Article 5 of the Radio Regulations	Application bandwidths				
	Scatterometer	Altimeter	Imager	Precipitation radar	Cloud profile radar
432-438 MHz			6 MHz		
1 215-1 300 MHz	5-500 kHz		20-85 MHz		
3 100-3 300 MHz		200 MHz	20-200 MHz		
5 250-5 570 MHz	5-500 kHz	320 MHz	20-320 MHz		
8 550-8 650 MHz	5-500 kHz	100 MHz	20-100 MHz		
9 300-9 900 MHz ⁽¹⁾	5-500 kHz	300 MHz	20-600 MHz		
13.25-13.75 GHz	5-500 kHz	500 MHz		0.6-14 MHz	
17.2-17.3 GHz	5-500 kHz			0.6-14 MHz	
24.05-24.25 GHz				0.6-14 MHz	
35.5-36 GHz	5-500 kHz	500 MHz		0.6-14 MHz	
78-79 GHz					0.3-10 MHz
94-94.1 GHz					0.3-10 MHz
133.5-134 GHz					0.3-10 MHz
237.9-238 GHz					0.3-10 MHz

⁽¹⁾ See the relevant decision of WRC-07.

Annex 1

Factors related to determination of frequency bands and required bandwidths used for spaceborne active sensing

1 Introduction

Active sensors differ from passive sensors in that they illuminate the object under observation and respond to the reflected energy.

There are 5 basic types of active sensors:

- scatterometers;
- altimeters;
- imagers (synthetic aperture radars);
- precipitation radars;
- cloud profile radars.

Radar scatterometers are useful for determining the roughness of large objects. When operating at frequencies higher than 300 MHz, the scatterometer measures the amount of backscatter from the surface roughness in broad categories ranging from smooth to very rough. At frequencies around 200 MHz, reflectivity depends upon the dielectric constant of the object; at lower frequencies, reflectivity depends primarily upon electrical conductivity. These lower frequencies can be used to penetrate the surface of the Earth to detect sub-surface structures.

Radar altimetry has yielded three possible operation concepts for practical systems. One of these techniques is based upon the use of a very narrow beamwidth (2 mrad) and a very short transmitted pulse (2 ns). Timing of the round-trip delay of the transmitted pulse leading edge is used to provide altitude information. A technique that is similar to the short pulse system is the pulse compression technique. A short impulse pulse generates a longer frequency modulated pulse and the return, which has a wide bandwidth, is compressed back to a short pulse which is then leading edge detected. The third technique requires moderate antenna size and spacecraft stabilization, with radar return from the nadir point obtained by a time-gating technique. In this system, altitude information is extracted by measuring the centroid of the early portion of the radar waveform rather than the leading edge of a very short pulse.

Radar imaging systems are employed to produce high resolution images required by users in such fields as geology, oceanography and agriculture. To achieve reasonable resolution from space, synthetic aperture focused radars will be employed for many applications as they have resolutions independent of range. In the area of meteorology scanning Doppler radars may also be employed.

Knowledge of the global rainfall and cloud distributions is required to understand and predict global climate change. Microwave sensors have a clear advantage over visible/infrared sensors in that they have the capability to penetrate the cloud cover, thereby providing direct information of rain and cloud volume. Active sensors are especially important because they are the only instruments which provide vertical rain and cloud structures, and therefore are essential to study large-scale atmospheric circulation and the radiation budget. Moreover, the active sensors can provide quantitative rain and cloud information independent of the microwave emission properties of background surfaces.