



Report ITU-R SA.2067
(11/2005)

**Use of the 13.75 to 14.0 GHz band by the
space research service and the
fixed-satellite service**

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***Note:** This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.*

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1 Introduction

This Report explains the use of the 13.75-14 GHz band by the space research service (SRS) data relay satellite systems, reviews the permissible levels of interference for SRS data relay satellite systems from Earth-to-space links operating in the fixed satellite service (FSS), and reviews the interference to FSS satellites in geostationary orbit from SRS data relay satellite systems.

2 Use of the 13.75-14.0 GHz band by data relay satellite systems of the space research service

The purpose of this section is to address the use by the space research service of frequencies near 14 GHz and to describe the bandwidth requirements.

2.1 Data relay satellite networks

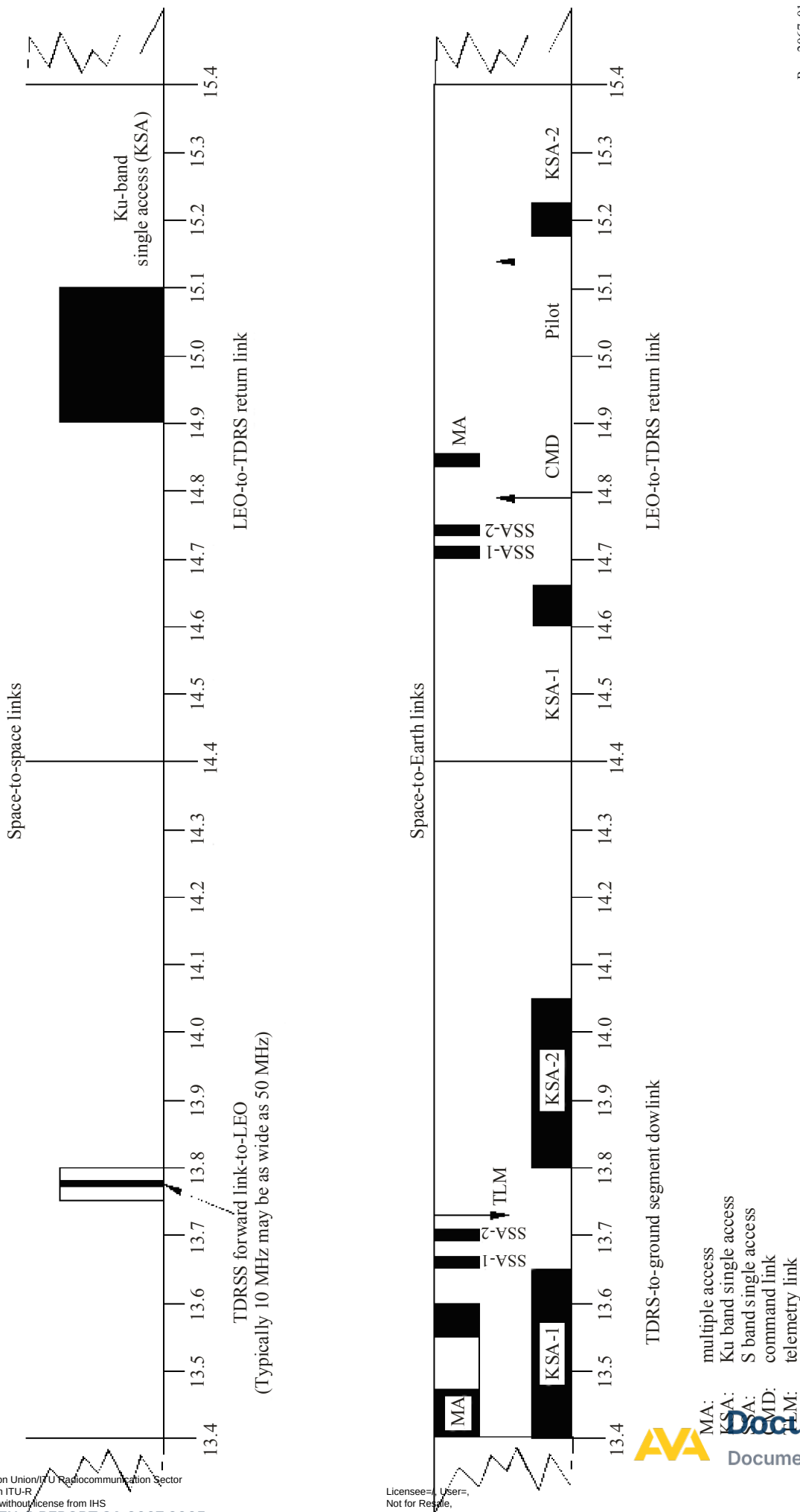
2.1.1 Use of the 13.75-14 GHz band

In 1983, the United States of America launched the first satellite in its global tracking and data relay satellite system (TDRSS) data relay satellite network. TDRSS relays commands, scientific data and spacecraft health and safety information for a number of NASA low-Earth orbit (LEO) satellites such as the International Space Station, space shuttle, Landsat as well as a number of non-NASA flight missions, including international or joint venture missions.

The TDRSS network uses frequencies around 2 GHz, 13/15 GHz and 23/26 GHz to operate and to receive data from low-orbiting satellites. The 13/15 GHz bands are also used for feeder links for the geostationary TDRSS network.

Operational tracking and data relay satellites (TDRS) are located at the orbital positions: 41°, 46°, 171° and 174° W longitude on the geostationary orbit. The forward link from the TDRS to a LEO spacecraft, relaying critical command, control and ranging data, is centred at 13.775 GHz in the lower portion of the band 13.75-14 GHz. Furthermore, the 13.75-14 GHz band is one segment of several allocations to the space research service between 13.4 and 15.35 GHz that are extensively used for forward and return links to low-Earth orbiting satellites and for feeder links to connect TDRS satellites to their earth stations. This extensive use is evident in the frequency plan for the TDRSS data relay satellite network shown in Fig. 1, particularly between 13.4-14.05 GHz and 14.6-15.225 GHz. This use is the culmination of substantial investments that have been made in system trade-off studies, the development and qualification of space hardware, and the development and implementation of satellite systems and earth stations comprising the TDRSS data relay network.

FIGURE 1
13.4-15.4 GHz segment of the frequency plan for the United States of America
TDRSS data relay satellite network



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2.1.2 Bandwidth requirements

The bandwidth requirements are pictured in Fig. 1. The top portion of this figure shows the links between the TDRS and the LEO satellites in the 13.75-14.0 GHz band. The forward service links (two independent links per TDRS spacecraft) from the TDRS to low-Earth orbit satellites are used for command, control and ranging and for transmission of data and video. The forward link design is capable of supporting a 25 MSymbol/s transmission rate at a centre frequency of 13.775 GHz.

The bandwidth is typically 6 MHz in the case of command and control data, where in most cases the low-rate information data is spread with a 3.08 Mchip/s pseudo-random noise (PN) code. However, in the case of the International Space Station, a bandwidth of 10 MHz is the minimum required to provide for the high-speed TCP/IP data protocols needed for payload telescience, payload management and additional Earth-to-space voice transmission capability effected via the TDRSS network. A 50 MHz bandwidth is required for sending higher rate data to a spacecraft or high resolution digital video information to the space shuttle or space station for tele-science and tele-medicine. Reliable transmissions of commands in the 10 MHz around 13.775 MHz are the most critical. The bottom portion of Fig. 1 shows a feeder link used to transmit wideband signals received by the TDRS from LEO satellites to the TDRSS data relay satellite network earth station. The signals consist primarily of scientific data and spacecraft telemetry. The bandwidth of this link may be up to 225 MHz centred around 13.9 GHz.

2.2 Summary and conclusions

This section has addressed the use and bandwidth requirements of the TDRSS network within the 13.75-14 GHz band. Based on studies within ITU-R, the following are concluded for data relay satellite networks:

- a comprehensive frequency plan delineates the use of segments of the spectrum extending from 13.4 GHz to 15.225 GHz for service links to low-orbiting satellites and for feeder links to centrally located earth stations;
- the primary command and control link from the tracking and data relay satellite (TDRS) to the International Space Station is centred at 13.775 GHz with a bandwidth of 10 MHz;
- an important forward link to low-orbiting satellites operates with a centre frequency of 13.775 GHz and a bandwidth that can range from 6 MHz to 50 MHz depending on the application;

3 Permissible levels of interference in data relay satellite systems that use the 13.75-14 GHz band

This section presents criteria for protection of data relay satellite systems operating in the 13.75-14 GHz band from Earth-to-space links operating in the FSS. The criteria consist of a permissible level of interference signal power in a specified reference bandwidth at the output of the receiving antenna that is not to be exceeded for more than a specified percentage of time and locations. The largest possible reference bandwidths are specified in order to enable the greatest possible sharing benefit from averaging interfering signal power over bandwidth.

3.1 Protection criteria for data relay satellite systems

Recommendation ITU-R SA.1155 gives the permissible level of degradation to a data relay satellite link as a 0.4 dB reduction in link power margin, which occurs with an I/N of -10 dB. From this, an aggregate protection criteria of -178 dB(W/kHz) measured at the input to the victim receiver to be exceeded no more than 0.1% of the time is derived. This is equivalent to -138 dB(W/10 MHz). The I/N criterion of -10 dB is applicable over a bandwidth of 10 MHz centred at 13.775 GHz,

although operations can extend over a bandwidth of up to 50 MHz centred at the same frequency. In order to achieve the desired link availabilities, the interference threshold should not be exceeded for more than 0.1% of the time as a result of the emissions of FSS earth stations in the Earth-to-space direction. The 0.1% of the time is based on the orbital period of the low-orbiting satellites as given in Recommendation ITU-R SA.1155.

3.2 Characterization of interference to the international space station (ISS) from the emissions of a global deployment of FSS GSO earth stations

This section presents the results of an analysis to determine the probability of interference to the ISS for the worst-case orbit for a range of FSS earth station characteristics.

3.2.1 FSS earth station characteristics

Table 1 is a summary of the characteristics of the FSS earth station populations used in the simulations described within this section. The FSS earth station antenna pattern given in Recommendation ITU-R S.465-5 was used for the analysis presented in this section. A limited set of simulations were performed comparing results derived from the use of Recommendation ITU-R S.465-5 and Recommendation ITU-R S.1428 and it was found that the difference was less than 1 dB.

TABLE 1
Characteristics of FSS earth station populations

Earth station signal info data rate	Earth station transmit data rate	Signal bandwidth occupancy at satellite transponder	Antenna diameter	e.i.r.p. (includes 1 dB transmit loss)	Average e.i.r.p. density (dB(W/Hz))
16 kbit/s	32 kbit/s	33.6 kHz	0.5 m (34.6 dBi)	33.6 dBW	−11.7
64 kbit/s	128 kbit/s	134.4 kHz	1.0 m (41.0 dBi)	40 dBW	−11.3
1 Mbit/s	2 Mbit/s	2.1 MHz	1.8 m (45.7 dBi)	50.7 dBW	−12.5
2 Mbit/s	2 Mbit/s	2.1 MHz	3.0 m (50.2 dBi)	55.2 dBW	−8.0
34 Mbit/s	34 Mbit/s	35.7 MHz	4.5 m (53.7 dBi)	69.7 dBW (in 34 MHz)	−5.8

3.2.2 GSO satellite locations and distributions

A 120 FSS GSO satellite constellation, equally placed 3° apart in the geostationary orbit, was used in the analysis.

The 4.5 m FSS Gateway earth station distribution is based on the locations of Urban Population Center (UPC) around the world. The UPCs are obtained from the “*Urban Agglomerations, 1950-2015, United Nation Population Division, NY, USA*”. All the selected UPCs are projected to have a population of one million or more by the year 2015. A total of 326 UPCs were identified. Each satellite will be capable of supporting two links in the same channel using orthogonal polarizations. A total of 240 cities were selected from the urban agglomerations. The cities were selected based on the satellite capacity and that the elevation angle to the satellite was greater than 20°. The resultant distribution of earth stations is shown in Fig. 2.