

## 2110-2120 MHz

### 1. Band Introduction

The National Aeronautics and Space Administration (NASA) operates the Deep Space Network (DSN) in this band to track and command deep space probes such as Voyager 1 and Voyager 2. The DSN is part of an international network of earth stations supporting interplanetary spacecraft missions and radio and radar astronomy observations for the exploration of the solar system and the universe. The DSN also supports selected Earth-orbiting missions and is used to help track space debris and asteroids that may come near the Earth.<sup>1</sup> NASA also collaborates with the European Space Agency (ESA) and other foreign space agencies in support of deep space missions in this band.

### 2. Allocations

#### 2a. Allocation Table

The frequency allocation table shown below is extracted from the Manual of Regulations and Procedures for Federal Radio Frequency Management, Chapter 4 – Allocations, Allotments and Plans.

*Table of Frequency Allocations*

*United States Table*

Federal Table	Non-Federal Table	FCC Rule Part(s)
2110-2120  US252	2110-2120 FIXED MOBILE  US252	Public Mobile (22) Wireless Communications (27) Fixed Microwave (101)

#### 2b. Additional Allocation Table Information

**US252** The band 2110-2120 MHz is also allocated to the space research service (deep space) (Earth-to-space) on a primary basis at Goldstone, CA (35° 20' N, 116° 53' W).

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<sup>1</sup>

<http://solarsystem.nasa.gov/missions/profile.cfm?Sort=Chron&StartYear=2020&EndYear=2029&MCode=DSN>

### 3. Federal Agency Use

#### 3a. Federal Agency Frequency Assignments Table

The following table identifies the frequency band, types of allocations, types of applications, and the number of frequency assignments by agency.

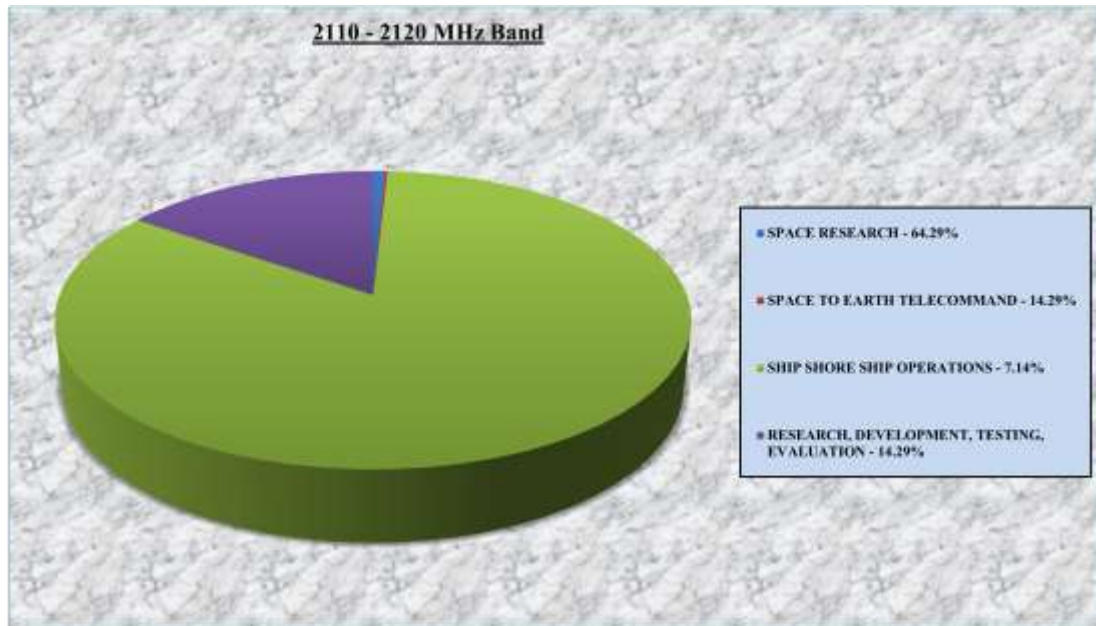
*Federal Frequency Assignment Table*

2110-2120 MHz Band						
NON-FEDERAL EXCLUSIVE BAND						
AGENCY	TYPE OF APPLICATION					
	SPACE RESEARCH	SPACE TELECOMMAND	SHIP-SHORE-SHIP OPERATIONS	RESEARCH, DEVELOPMENT, TESTING EVALUATION	TOTAL	
	AF				2	2
	N			1		1
NASA	9	2			11	
<b>TOTAL</b>	<b>9</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>14</b>	

The number of actual systems, or number of equipments, may exceed and sometimes far exceed, the number of frequency assignments in a band. Also, a frequency assignment may represent, aq local, state, regional, or nationwide authorization. Therefore, care must be taken in evaluating bands strictly on the basis of assignment counts or percentages of assignments.

### 3b. Percentage of Frequency Assignments Chart

The following chart displays the percentage of frequency assignments in the Government Master File (GMF) for the systems operating in the band 2110-2120 MHz.



## 4. Frequency Band Analysis

The NASA DSN is part of an international network of earth stations that support selected Earth-orbiting missions, interplanetary spacecraft missions and radio and radar astronomy observations for the exploration of the solar system and the universe. A collaborative project between the United States, Spain, and Australia, the DSN consists of three deep-space command facilities located approximately 120 degrees apart around the world: at Goldstone, CA; Madrid, Spain; and Canberra, Australia.<sup>2</sup> The DSN currently supports the Mars Reconnaissance Orbiter and Mars Exploration Rover ‘Opportunity’, Dawn, Cassini, Voyager 1, and Voyager 2 spacecraft. The DSN also supports NASA/ESA cooperative missions by providing tracking, telecommand, and ranging for the ESA’s Mars and Venus Express, Rosetta satellites, as well as other international programs.

Though the band is allocated to various space service applications for transmissions in the Earth-to-space and space-to-space directions, several geostationary satellites in

<sup>2</sup> <http://deepspace.jpl.nasa.gov/dsn/features/wherearethey.html>

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conjunction with Tracking and Data Relay Satellite System (TDRSS) operate in the space-to-Earth direction. The frequency assignments for these space applications are permitted on an unprotected non-interference basis. These satellites transmit to ground station receivers located at Merritt Island, FL, Greenbelt, MD, White Sands Missile Range, NM, Finegayan, GUM, and American Samoa and are used for test and simulation associated with tracking and command functions for TDRSS.

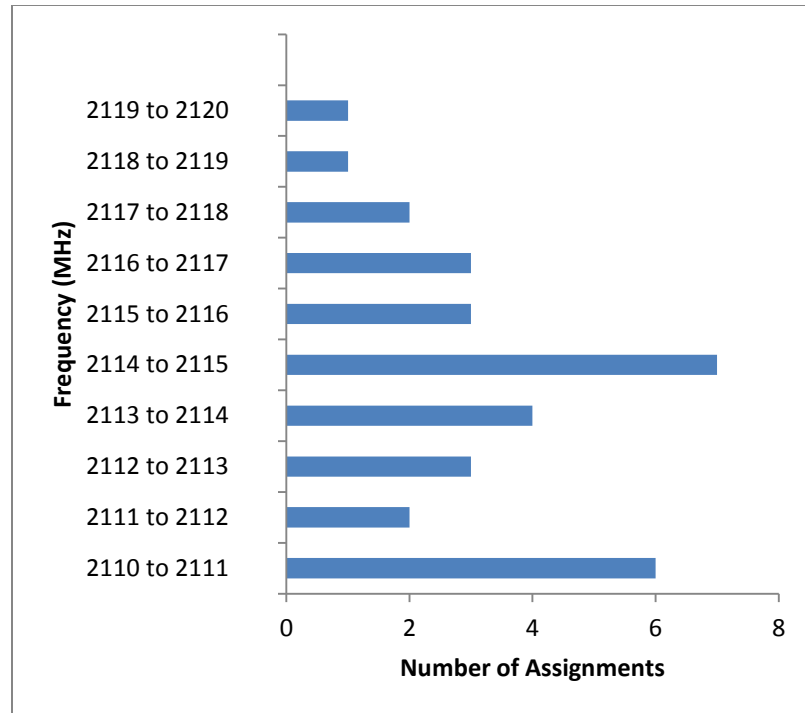
### 4a. Frequency Use

The DSN complex located at Goldstone, CA has one band assignment for the entire band 2110-2120 MHz paired with a similar assignment in the 2290-2300 MHz and provides deep space command for space research stations. In addition to the band assignment, fourteen frequency assignments for earth stations at other locations support DSN command operations. Table 1 shows locations and frequencies of the assignments at the Goldstone, CA DSN facility.

**Table 1. Geographic Distribution of DSN Frequency Assignment**

Frequency (MHz)	Number of Assignments	Latitude	Longitude
2110.5841	2		
2110.9252	2		
2111.6072	1		
2114.3356	1	352024 N	1165229 W
2114.6766	1		
2114.6767	1		
2115.0177	1		
2114.3356	1	352529 N	1165324 W
2114.6766	1		
2115.0177	1	352533 N	1165322 W
2110-2120	1		
2111.6072	1	352533 N	1165319 W
2114.6767	1		

Figure 1 shows the distribution of GMF frequency assignments in the band 2110-2120 MHz divided into 1-MHz segments. When a frequency assignment overlapped multiple segments, the assignment was counted in each segment. In cases where an assignment is authorized to operate anywhere in the band 2110-2120 MHz, it was counted in every 1-MHz segment.



**Figure 1. Distribution of Frequency Assignments in the Band 2110-2120 MHz**

#### 4b. Technical Characteristics

Transmitter power levels as shown in Figure 2 range from 20 kilowatts to 500 kilowatts. The frequency assignment records in the GMF indicate that the DSN uses two antenna gains. There are three 34-meter diameter antennas designated DSS-24 that have 56 dBi gain and one 70 meter diameter antenna designated DSS-14 that has 63 dBi gain.<sup>3</sup> Figure 3 shows the number of assignments with each gain. The choice of the transmitter power and antenna gain depends on how far the spacecraft is away from the Earth and on the attitude of the spacecraft. If for some reason, the spacecraft is in an unfavorable attitude, higher transmitter power levels can be used to ensure that commands are received.

<sup>3</sup> <http://deepspace.jpl.nasa.gov/dsn/antennas/index.html>

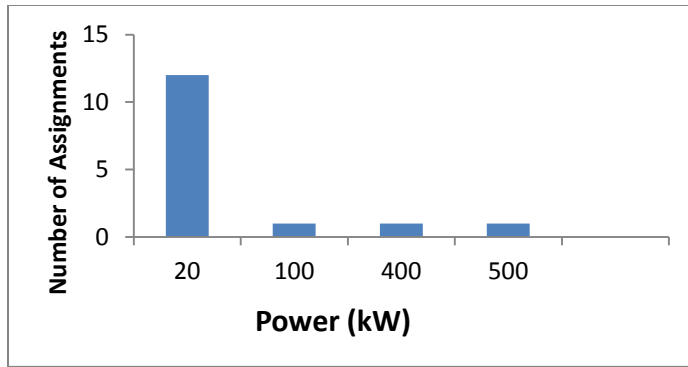


Figure 2. Distribution of Transmitter Power Levels in the Band 2110-2120 MHz

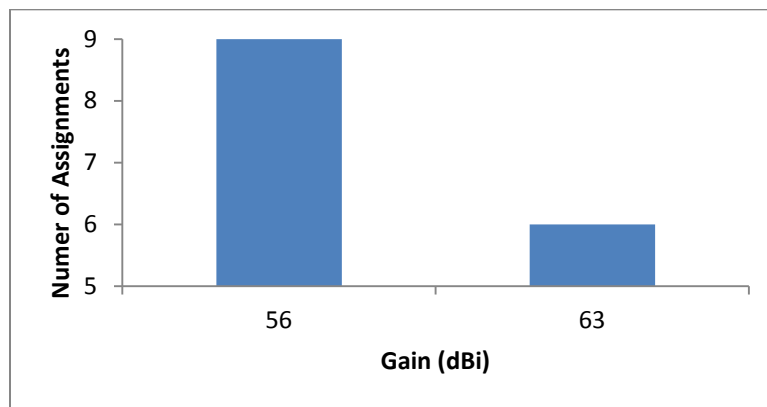


Figure 3. Distribution of Antenna Gain Values in the Band 2110-2120 MHz

The transmitter bandwidths used by the DSN range from 3 kHz to 5 MHz. The distribution of bandwidths is shown in Figure 4.

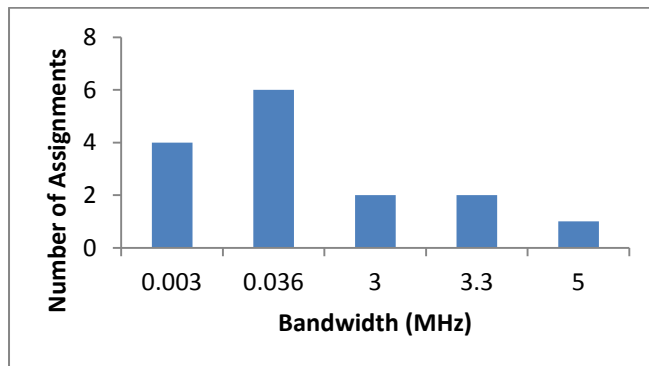


Figure 4. Distribution of Transmitter Bandwidths in the Band 2110-2120 MHz

#### **4c. Research Development Testing and Evaluation**

The Air Force has one band assignment to support training of combat aircrews. These training operations are on a non-interference basis.

#### **5. Planned Use**

NASA will continue to operate earth station transmitters in the band 2110-2120 MHz in support of domestic and international DSN mission operations for the foreseeable future.