3100-3300 MHz

1. Band Introduction

The Department of Defense (DoD) uses the band 3100-3300 MHz for operating various types of shipborne, land-based, and aeronautical mobile radar systems for national defense purposes.

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)
3100-3300 RADIOLOCATION G59 Earth exploration-satellite (active) Space research (active) US342	3100-3300 Earth exploration-satellite (active) Space research (active) Radiolocation US342	Private Land Mobile (90)

2b. Additional Allocation Table Information

G59 In the bands 902-928 MHz, 3100-3300 MHz, 3500-3650 MHz, 5250-5350 MHz, 8500-9000 MHz, 9200-9300 MHz, 13.4-14.0 GHz, 15.7-17.7 GHz and 24.05-24.25 GHz, all Federal non-military radiolocation shall be secondary to military radiolocation, except in the sub-band 15.7-16.2 GHz airport surface detection equipment (ASDE) is permitted on a co-equal basis subject to coordination with the military departments.

US342 In making assignments to stations of other services to which the bands:

13360-13410 kHz 42.77-42.87 GHz*
25550-25670 kHz 43.07-43.17 GHz*
37.5-38.25 MHz 43.37-43.47 GHz*
322-328.6 MHz* 48.94-49.04 GHz*
1330-1400 MHz* 76-86 GHz
1610.6-1613.8 MHz* 92-94 GHz
1660-1660.5 MHz* 94.1-100 GHz
1668.4-1670 MHz* 102-109.5 GHz
3260-3267 MHz* 111.8-114.25 GHz
3332-3339 MHz* 128.33-128.59 GHz*
3345.8-3352.5 MHz* 129.23-129.49 GHz*

4825-4835 MHz* 130-134 GHz
4950-4990 MHz 136-148.5 GHz
6650-6675.2 MHz* 151.5-158.5 GHz
14.47-14.5 GHz* 168.59-168.93 GHz*
22.01-22.21 GHz* 171.11-171.45 GHz*
22.21-22.5 GHz 172.31-172.65 GHz*
22.81-22.86 GHz* 173.52-173.85 GHz*
23.07-23.12 GHz* 195.75-196.15 GHz*
31.2-31.3 GHz 209-226 GHz
36.43-36.5 GHz* 241-250 GHz
42.5-43.5 GHz 252-275 GHz

are allocated (*indicates radio astronomy use for spectral line observations), all practicable steps shall be taken to protect the radio astronomy service from harmful interference. Emissions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service (*see* ITU *Radio Regulations* at Nos. 4.5 and 4.6 and Article 29).

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.

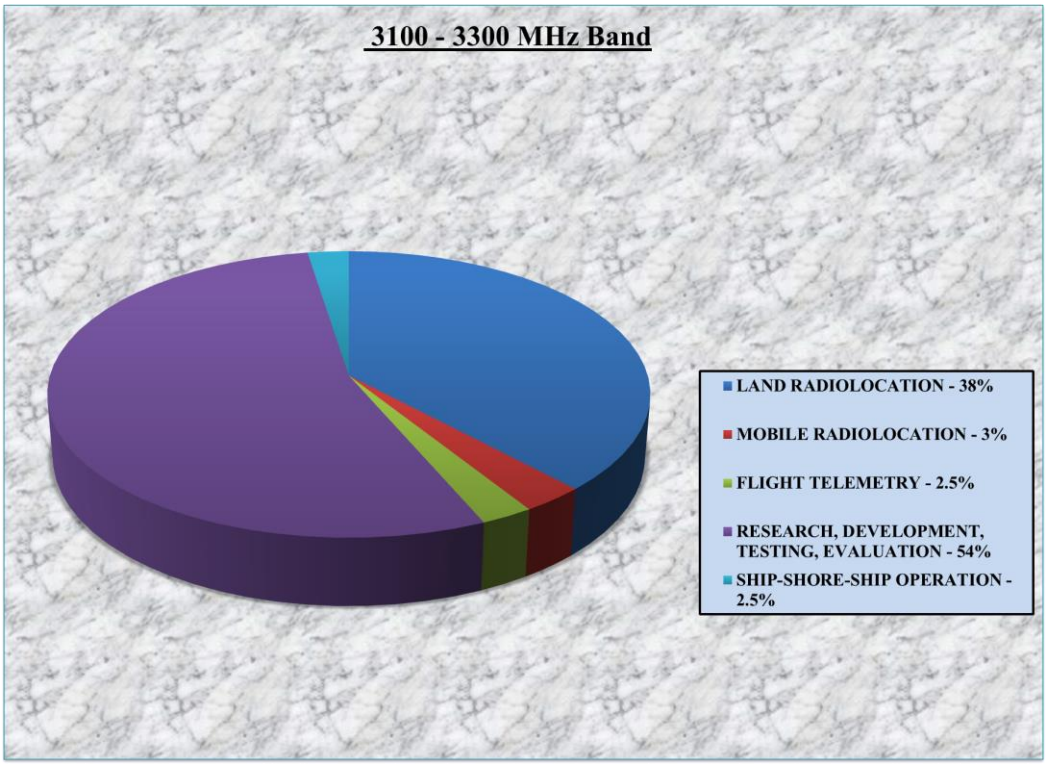
Federal Frequency Assignment Table

3100-3300 MHz Band						
SHARED BAND						
	EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active)					
	TYPE OF APPLICATION					
AGENCY	LAND RADIOLOCATION	MOBILE RADIOLOCATION	FLIGHT TELEMETRY	SHIP-SHORE-SHIP OPERATIONS	RESEARCH DEVELOPMENT TESTING EVALUATION	TOTAL
AF		1	2		30	33
AR	46	3	1		26	76
DOC					2	2
N				3	7	10
TOTAL	46	4	3	3	65	121

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, a 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 frequency band 3100 – 3300 MHz.



4. Frequency Band Analysis By Application

4a. Shipborne Radiolocation

The Navy uses the 3100-3300 MHz band along the coasts of the United States, as well as on the high seas worldwide, for ship-based, three-dimensional air search and surveillance radar systems to provide accurate information on aircraft and missiles. These high-powered radar systems detect airborne objects, and measure target altitude, range, and bearing. Some of the airborne targets are small and some targets are detected at ranges as great as 300 nautical miles. These radar systems operate in the radiolocation service. The Navy also operates these radars in port for test and measurement in support of sea operations and navigation.

The NTIA report, "An Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, and 4200-4220 MHz, 4380-4400 MHz Bands," discusses the Navy's use of this band.

ITU-R Recommendation M.1465-1 provides technical characteristics for radiolocation radars in this frequency range.[1] The example system data provided in this recommendation is typical for U.S. use. Table 1 summarizes the frequency range, peak power, mainbeam antenna gain, maximum EIRP, duty cycle and emission 3 dB bandwidth for a ship-based radar operating in the band 3100-3300 MHz.

Table 1. Characteristics of Shipborne Radar Systems

Parameter	Ship systems
	B
Use	Surface and air search
Modulation	Q7N
Tuning range (GHz)	3.1-3.5
Tx power into antenna (kW) (Peak)	4 000-6 400
Pulse width (μs)	6.4-51.2
Repetition rate (kHz)	0.152-6.0
Compression ratio	64-512
Type of compression	CPFSK
Duty cycle (%)	0.8-2.0
Tx bandwidth (MHz) (–3 dB)	4
Antenna gain (dBi)	42
Antenna type	PA
Beamwidth (H,V) (degrees)	1.7, 1.7
Vertical scan type	Random
Maximum vertical scan (degrees)	90

[1] *See*, Recommendation ITU-R M.1465-1, "Characteristics of and protection criteria for radars operating in the radiodetermination service in the frequency band 3 100-3 700 MHz" (Geneva, 2007).

Parameter	Ship systems
	B
Vertical scan rate (degrees/s)	Not available
Horizontal scan type	Rotating
Maximum horizontal scan (degrees)	360
Horizontal scan rate (degrees/s)	Not applicable
Polarization	V
Rx sensitivity (dBm)	Not available
S/*N* criteria (dB)	Not available
Rx noise figure (dB)	5.0
Rx RF bandwidth (MHz) (–3 dB)	Not available
Rx IF bandwidth (MHz) (–3 dB)	10
Deployment area	Worldwide
CPFSK: Continuous-phase FSK PA: Phased array	

The radar systems in this band are mobile (including on ships transiting littoral waters), and there is no way to know exactly where and when they will operate or what frequencies they will use.

A more detailed description of the technical characteristics of shipborne radiolocation radars that operate in the band 3100-3300 MHz can be found in ITU-R Recommendation M.1465-1.[2]

4b. Land-Based Radiolocation

The Army uses the 3100-3300 MHz band for transportable, land-based radar systems to provide accurate information on artillery, rockets, missiles, mortars, and other threats, and their launch points. These high-powered radar systems detect airborne objects, and measure target altitude, range, and bearing.

The Army operates the ground radar in the 3100-3300 MHz band on 30 or more frequencies for range operations and testing of modifications and upgrades of existing systems. ITU-R Recommendation M.1465-1 provides technical characteristics for land-

[2] *Ibid.*

based radars. Table 2 summarizes the tuning range, peak power, emission 3 dB bandwidth, mainbeam antenna gain, maximum equivalent isotropically radiated power (EIRP), and duty cycle for land-based radars operating in the band 3100-3300 MHz. [3] Though Recommendation M.1465-1 indicates the tuning range for these systems is from 3100-3700 MHz, in the United States, these land-based radiolocation radars operate up to 3500 MHz.

Table 2. **Basic Characteristics of Land-Based Radiolocation Radars**

Parameter	Land-based systems	
	A	B
Use	Surface and air search	Surface search
Modulation	P0N/Q3N	P0N
Tuning range (GHz)	3.1-3.7	
Tx power into antenna (kW) (Peak)	640	1 000
Pulse width (μs)	160-1 000	1.0-15
Repetition rate (kHz)	0.020-2	0.536
Compression ratio	48 000	Not applicable
Type of compression	Not available	Not applicable
Duty cycle (%)	2-32	0.005-0.8
Tx bandwidth (MHz) (–3 dB)	25/300	2
Antenna gain (dBi)	39	40
Antenna type	Parabolic	
Beamwidth (H,V) (degrees)	1.72	1.05, 2.2
Vertical scan type	Not available	Not applicable
Maximum vertical scan (degrees)	93.5	Not applicable

[3] *Ibid*.

Parameter	Land-based systems	
	A	B
Vertical scan rate (degrees/s)	15	Not applicable
Horizontal scan type	Not applicable	Rotating
Maximum horizontal scan (degrees)	360	
Horizontal scan rate (degrees/s)	15	25.7
Polarization	RHCP	V
Rx sensitivity (dBm)	Not available	–112
S/N criteria (dB)	Not applicable	0
Rx noise figure (dB)	3.1	4.0
Rx RF bandwidth (MHz) (–3 dB)	Not available	2.0
Rx IF bandwidth (MHz) (–3 dB)	380	0.67
Deployment area	Worldwide	Worldwide

The land-based radiolocation radars are likely to operate only a small percentage of time except in a few fixed areas.

A more detailed description of the technical characteristics of land-based radiolocation radars that operate in the band 3100-3300 MHz can be found in ITU-R Recommendation M.1465-1.[4]

4c. Airborne Radiolocation

The 3100-3300 MHz band is used by Department of Defense radar systems with installations on aircraft. These radar systems operate throughout the United States and possessions, recognizing that tactical necessities ultimately determine operational requirements. Functions performed by these systems include search for near-surface and high altitude airborne objects, tracking of airborne objects. [5]

Air Force operates systems in this band designed for airborne target gunnery weapon system evaluation and training. This system is designed for bullet counting, relaying telemetry regarding these measurements to ground stations. Air Force operates these systems in California, New Mexico and Florida.

[4] *Ibid.*

[5] *See*, "An Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, and 4200-4220 MHz, 4380-4400 MHz Bands", NTIA Fast Track Report, Nov. 2010. URL: http://www.ntia.doc.gov/report/2010/assessment-near-term-viability-accommodating-wireless-broadband-systems-1675-1710-mhz-17, at 55.

ITU-R Recommendation M.1465-1 provides technical characteristics for airborne radars. Table 3 summarizes the tuning range, frequency at horizon, peak power, emission 3 dB bandwidth, mainbeam antenna gain, maximum EIRP, and duty cycle for airborne radars operating in the band 3100-3300 MHz.[6] Though Recommendation M.1465-1 indicates the tuning range for these systems is from 3100-3700 MHz, the airborne radiolocation radars in the United States, operating in the band 3100-3300 MHz, utilize a single center frequency.

Table 3. Basic Characteristics of Airborne Radiolocation Radars

Parameter	Airborne system
	A
Use	Surface and air search
Modulation	Q7N
Tuning range (GHz)	3.1-3.7
Tx power into antenna (kW) (Peak)	1 000
Pulse width (μs)	1.25(1)
Repetition rate (kHz)	2
Compression ratio	250
Type of compression	Not available
Duty cycle (%)	5
Tx bandwidth (MHz) (–3 dB)	> 30
Antenna gain (dBi)	40
Antenna type	SWA
Beamwidth (H,V) (degrees)	1.2, 6.0
Vertical scan type	Not available
Maximum vertical scan (degrees)	± 60

[6] *See supra*, n. 1.

Parameter	Airborne system
	A
Vertical scan rate (degrees/s)	Not available
Horizontal scan type	Rotating
Maximum horizontal scan (degrees)	360
Horizontal scan rate (degrees/s)	36
Polarization	Not available
Rx sensitivity (dBm)	Not available
S/*N* criteria (dB)	Not available
Rx noise figure (dB)	3
Rx RF bandwidth (MHz) (–3 dB)	Not available
Rx IF bandwidth (MHz) (–3 dB)	1
Deployment area	Worldwide
(1) 100 ns compressed. SWA: Slotted waveguide array	

A more detailed description of the technical characteristics of airborne radiolocation radars that operate in the band 3100-3300 MHz can be found in ITU-R Recommendation M.1465-1.[7]

4d. Frequency Use

Radiolocation radars operate with a high degree of mutual compatibility with other radars in the 3100-3300 MHz band. This is due to the capability of radar systems to preferentially detect the echoes of their own transmitters and to reject the low duty-cycle pulse echoes of other radars.[8, 9] This immunity to low duty cycle pulsed emissions allows radar systems to operate compatibly in the band, whereas other non-pulsed signals would

[7] *Ibid.*

[8] *See*, "Effects of RF interference on radar receivers", NTIA Technical Report TR-06-444, Sep. 2006. URL: http://www.its.bldrdoc.gov/pub/ntia-rpt/06-444/

[9] Duty cycle is a measure of the fraction of the time that a radar is transmitting in relation to the overall time between pulses. The maximum duty cycle occurs with the longest pulse width and the maximum number of pulses per second.

cause interference. Given that these radars are used on ships where location information is either unknown or constantly changing it is difficult to quantify their spectrum use.

Many older radar systems use high power tube output devices to generate short duration pulses transmitted at a low duty cycle.[10] Newer radar systems use solid state output devices to generate pulses. Radars using solid state devices must transmit longer duration pulses as compared to radars using high power tube output devices. The longer duration pulses, increase the transmit duty cycle of the radar system. As the duty cycle for a radar increases, the distance and frequency separation requirements for compatible operation among radar system will also tend to increase. To overcome possible interference from other radars, frequency hopping and frequency agility features can be employed. Radars using klystrons or magnetrons tube based output devices are fixed tuned at the factory and cannot be easily re-tuned to other operating frequencies. There are also other components associated with the tube based systems such as the output filters or diplexers that must also be re-tuned when the operating frequency is changed. Radars using solid state output devices have the capability to be re-tuned are more easily and quickly.

5. Planned Use

The DoD employs radar systems in the 3100-3300 MHz band for critical national security applications such as long-range air search and surveillance radars, missile and aircraft surveillance radars, and associated radar target tracking applications. The U.S. Government has invested billions of dollars in these systems. These are critical national security applications, and safety-of-life systems, and the associated spectrum requirements to support such systems will continue for the foreseeable future.

The DoD also expects to increase use of the 3100-3300 MHz band in the future. The Navy has plans for radar systems, operating on frequencies including in this band, to be used on the next generation destroyers. Thus, continued access to the 3100-3300 MHz band is critical to national defense, safety, and security for the foreseeable future.

[10] Magnetrons and klystrons are examples of tube-type output devices used in older radar systems.