5 470 - 5 570 MHz

1. Band Introduction

The military agencies use this band for a wide variety of radar applications including anti-air warfare radars, which are part of an advanced ground-based air defense missile system. Other uses in this band include shipborne radars for surface search, navigation and weapons fire control. In addition the Coast Guard uses this band for maritime radionavigation aids.

Meteorological radars are also operated in this band to provide area precipitation measurements used in hydrological, meteorological, and environmental forecasting. Many applications can be critical to safety and security of military operations. Airborne radars are used for both hurricane research and reconnaissance.

Additionally, the military agencies and the National Aeronautics and Space Administration (NASA) use this band for test and launch range instrumentation radars to track rockets, missiles, satellites, launched vehicles, and other targets. These radars are usually the prime coverage system for range safety.

NASA also uses satellite based transmitters to perform space-based observations and measurements of surface topography, soil moisture, sea surface height, etc.

2. Allocations

2a. Allocation Table

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

Table of Frequency Allocations

5 470 – 5 570 MHz

United States Table

5 470 - 5 570 MARITIME RADIONAVIGATION US65 EARTH EXPLORATION-SATELLITE (active) SPACE RESEARCH (active) RADIOLOCATION G56 5.448B US50 G131	5 470 - 5 570 MARITIME RADIONAVIGATION US65 RADIOLOCATION Earth exploration-satellite (active) Space research (active) US50	RF Devices (15) Maritime (80) Private Land Mobile (90)

2b. Additional Allocation Table Information

5.448B The Earth exploration-satellite service (active) operating in the band 5 350 - 5 570 MHz and space research service (active) operating in the band 5 460 - 5 570 MHz shall not cause harmful interference to the aeronautical radionavigation service in the band 5 350-5 460 MHz, the radionavigation service in the band 5 460 - 5 470 MHz and the maritime radionavigation service in the band 5 470 - 5 570 MHz.

G56 Federal radiolocation in the bands 1 215 - 1 300, 2 900 - 3 100, 5 350 - 5 650 and 9 300 - 9 500 MHz is primarily for the military services; however, limited secondary use is permitted by other Federal agencies in support of experimentation and research programs. In addition, limited secondary use is permitted for survey operations in the band 2 900 - 3 100 MHz.

G131 Federal stations in the radiolocation service operating in the band 5 470 - 5 650 MHz, with the exception of ground-based radars used for meteorological purposes operating in the band 5 600 - 5 650 MHz, shall not cause harmful interference to, nor claim protection from, Federal stations in the maritime radionavigation service.

US50 In the band 5 470 - 5 650 MHz, the radiolocation service may be authorized for non-Federal use on the condition that harmful interference is not caused to the maritime radionavigation service or to the Federal radiolocation service.

US65 The use of the band 5 460 - 5 650 MHz by the maritime radionavigation service is limited to shipborne radars.

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.

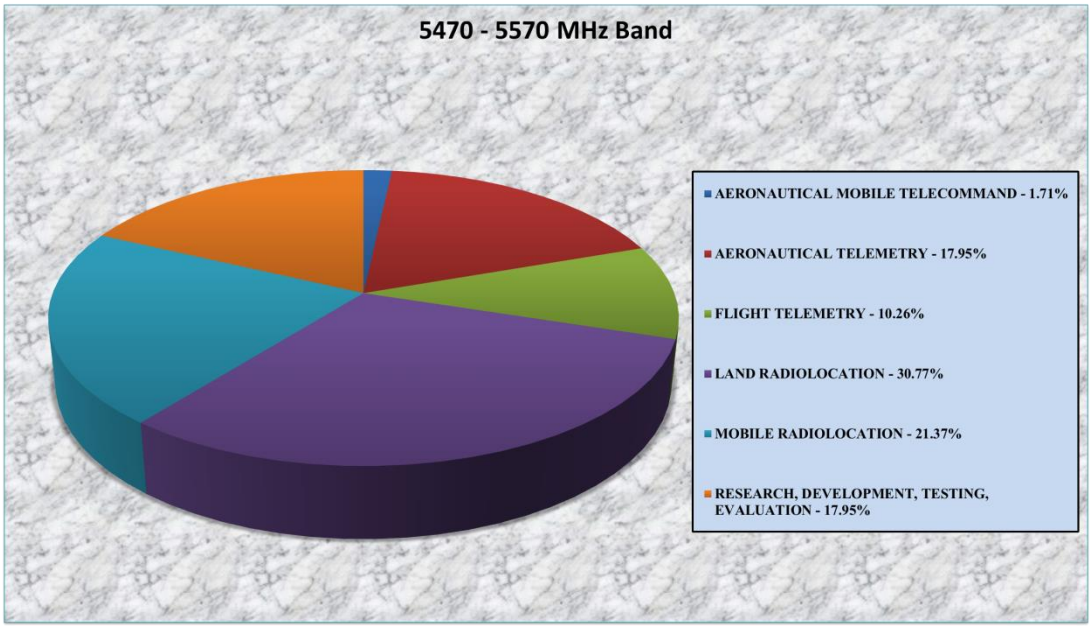
Federal Agency Assignment Table

5470 - 5570 MHz Band							
SHARED BAND							
	EARTH EXPLORATION-SATELLITE (active) MARITIME RADIONAVIGATION RADIOLOCATION SPACE RESEARCH (active)						
	TYPE OF APPLICATION						
AGENCY	AERONAUTICAL MOBILE TELECOMMAND	AERONAUTICAL TELEMETRY	FLIGHT TELEMETRY	LAND RADIOLOCATION	MOBILE RADIOLOCATION	RESEARCH DEVELOPMENT TESTING EVALUATION	TOTAL
AF	2	16	2	2	6	10	38
AR		4		12	2		18
DHS		1					1
DOE					3	1	4
MC				3			3
N				1	13	9	23
NASA			10	18	1	1	30
TOTAL	2	21	12	36	25	21	117

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 assignment.

3b. Percentage of Frequency Assignments Chart

The following chart displays the percentage of assignments for the applications listed in the chart legend below for frequency band 5 470 - 5 570 MHz. The greatest use in this band is land radiolocation.



4. Frequency Band Analysis by Application

4a. Aeronautical Mobile Telemetry and Telecommand

DoD operates aeronautical telemetering mobile stations in this band for transmitting data directly related to the airborne testing of vehicles or major components. This band supports the testing of Unmanned Aerial Vehicle (UAV) line-of-sight (LOS) downlinks to ground control stations. This testing ensures proper functioning of the command and control link to the control UAV. Also testing ensures that the transmit payload imagery and system data path are processing correctly and relayed to intelligence collection center. DoD uses this band for UAV telemetry and video uplink supporting research, development, testing and evaluation and flight operations.

Test range instrumentation radars are used to provide highly accurate position data on space launch vehicles and aeronautical vehicles undergoing developmental and operational testing. These radars are typified by high transmitter powers and large aperture parabolic reflector antennas with very narrow pencil beams. The radars have autotracking antennas which either skin track or beacon track the object of interest. (Note that radar beacons have not been presented in the Tables; they normally are tuneable over 5 400 - 5 900 MHz, have transmitter powers in the range 50-200 W peak, and serve to rebroadcast the received radar signal.) Periods of operation can last from minutes up to

4-5 h, depending upon the test program. Operations are conducted at scheduled times 24 h/day, 7 days/week.

Characteristics given in Table 1 are from Recommendation ITU-R M.1638-1 which provides technical and operational characteristics of radar systems operating in the 5 250 - 5 850 MHz band.

Table 1: Telemetry Radar Characteristics

Characteristics	Radar 2	Radar 3	Radar 4	Radar 5
Function	Instrumentation	Instrumentation	Instrumentation	Instrumentation
Tuning range (MHz)	5 350 - 5 850	5 350 - 5 850	5 400 - 5 900	5 400 - 5 900
Tx power into antenna	2.8 MW	1.2 MW	1.0 MW	165 kW
Pulse width (μs)	0.25, 1.0, 5.0	0.25, 0.5, 1.0	0.25 - 1 (plain) 3.1 - 50 (chirp)	100
Pulse rise/fall time (μs)	0.02 - 0.5	0.02 - 0.05	0.02 - 0.1	0.5
Pulse repetition rate (pps)	160, 640	160, 640	20 - 1 280	320
Chirp bandwidth (MHz)	N/A	N/A	4.0	8.33
RF emission bandwidth –3 dB –20 dB (MHz)	0.5 - 5	0.9 - 3.6 6.4 - 18	0.9 - 3.6 6.4 - 18	8.33 9.9
Antenna main beam gain (dBi)	54	47	45.9	42

4b. Radars

The 5 470 - 5 570 MHz band contains Radiolocation, meteorological and Earth Exploration Satellite Service (EESS) radiodetermination systems.

4b1. Radiolocation

This band is used by an air defense system. This surface-to-air missile defense multi-function radar system can detect and track targets, and respond to threats by quickly establishing defensive measures.

Shipboard sea and air surveillance radars are used for ship protection and operate continuously while the ship is underway as well as entering and leaving port areas. These surveillance radars usually employ moderately high transmitter powers and antennas which scan electronically in elevation and mechanically a full 360° in azimuth. Operations can be such that multiple ships are operating these radars simultaneously in a given geographical area.

Other special-purpose radars are also operated in the band 5 250 - 5 850 MHz. These are airborne synthetic aperture radar which is used in land-mapping and imaging, environmental and land-use studies, and other related research activities. They are

operated continuously at various altitudes and with varying look-down angles for periods of time up to hours in duration which depends upon the specific measurement campaign being performed.

Characteristics of typical radiolocation radars given in Table 2 are from Recommendation ITU-R M.1638-1 which provides technical and operational characteristics of radar systems operating in the 5 250 - 5 850 MHz band.

Table 2: Radiolocation Radar Characteristics

Characteristics	Radar 7	Radar 9
Function	Surface and air search	Search
Tuning range (MHz)	5 450 - 5 825	5 250 - 5 725
Tx power into antenna	285 kW	100 - 400 W
Pulse width (μs)	0.1/0.25/1.0	1.0
Pulse rise/fall time (μs)	0.03/0.05/0.1	0.05
Pulse repetition rate (pps)	2 400/1 200/ 750	200 - 1 500
Chirp bandwidth (MHz)	N/A	N/A
RF emission bandwidth –3 dB –20 dB (MHz)	5.0/4.0/1.2 16.5/12.5/7.0	4.0 10.0
Antenna main beam gain (dBi)	30.0	30 - 40

4b2. Meteorological

Both airborne and ground-based meteorological radars operate within the frequency range 5 250 - 5 850 MHz. The characteristics given in Table 3A below are from Recommendation ITU-R M.1849-1 which provides technical and operational characteristics of ground based meteorological radar systems operating in the 5 250 – 5 725 MHz band.

Meteorological radars provide quantitative area precipitation measurements and in most cases belong to networks which coordinate such measurements over national or regional areas. Those which use Doppler radar technology also observe precipitation velocity, which indicates the presence and motion of severe weather elements such as tornadoes, hurricanes and violent thunderstorms as well as wind shear and turbulence. Quantitative measurements from both kinds of radar are used in real time as a critical and unique data source for hydrological, meteorological and environmental forecasting. Through numerical data assimilation, modelling and forecasting of weather, flooding and pollution, particularly on the occasion of damaging events, the data are used to increase the accuracy and timeliness of forecasts and warnings. The data may be used directly, for example to assess lightning risk. Many applications can be critical to safety and protection of the general public (both life and property) and the safety and security of military operations.

Table 3A: Ground-based Meteorological Radar Characteristics (from Rec. ITU-R M.1849-1)

Characteristics	Radar 3	Radar 4	Radar 5	Radar 6	Radar 7	Radar 8
Function	Meteorological	Meteorological	Meteorological	Meteorological	Meteorological	Meteorological
Tuning range (MHz)	5 600 - 5 650	5 300 - 5 700	5 600 - 5 650	5 600 - 5 650	5 600 - 5 650	5 250 - 5 725
Tx power into antenna	250 kW Peak	250 kW Peak	250 kW Peak	250 kW Peak 150 W Avg.	250 kW Peak 150 W Avg.	2.25 kW Peak
Pulse width (μs)	1.1	0.8-2.0	3.0	0.8 - 5	0.8 - 5	0.1
Pulse rise/fall time (μs)	0.11	0.08	0.3	0.2 - 2	0.2 - 2	0.005
Pulse repetition rate (pps)	2 000	250 - 1 180	259	250 - 1 200	50 - 1 200	100 000
Antenna main beam gain (dBi)	50	40	40	40 - 50	40 - 50	35 - 45

4c. Earth Exploration-Satellite Systems

Several Federal Agencies make use of active remote sensing data for a variety of applications. NASA has operated the Spaceborne Imaging Radar-C/X-Band Synthetic Aperture Radar (SIR-C/X-SAR) onboard the Space Shuttle to take detailed topographic images of the Earth's surface for scientific study. NASA has been involved in two joint missions with the French space agency (CNES) operating spaceborne altimeters on the TOPEX and Jason-1 satellites to measure ocean surface height to study climatological events such as the El Niño and La Niña phenomena. This spaceborne altimeter operates in the 5 250 - 5 460 MHz band.

5. Low Power Devices

Responding to industry requests for spectrum in which to operate unlicensed devices, e.g., primarily wireless LANS and WiFi, in June 2006, the Federal Communications Commission (FCC) adopted rules allowing commercial users to employ opportunistic sharing techniques to share 355 MHz of radio spectrum[1]. Using Dynamic Frequency Selection (DFS) detect-and-avoid algorithms, commercial interests are now able to operate Wireless Access Systems (WAS) in the 5 250 - 5 350 MHz and 5 470 - 5 725 MHz bands. In addition, sharing is allowed with low power WAS devices without DFS in the 5 150 - 5 250 MHz and 5 725 - 5 825 MHz bands. Federal agencies operate unlicensed devices that are authorized for use under the FCC Part 15 Rules or Annex K of the NTIA Manual.

6. Planned Use

The 5 250 - 5 925 MHz band is used extensively for radar systems, and these spectrum requirements are likely to continue for the foreseeable future.

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[1] *See, Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) devices in the 5 GHz band*, ET Docket 03-122, Report And Order, 18 FCC Rcd. 24484 (November 18, 2003) , *available at* http://fjallfoss.fcc.gov/edocs_public/attachmatch/FCC-03-287A1.pdf; *Revision of Parts 2 and 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) devices in the 5 GHz band*, ET Docket 03-122, Memorandum Opinion and Order, 21 FCC Rcd. 7672 (June 30, 2006), *available at* http://fjallfoss.fcc.gov/edocs_public/attachmatch/FCC-06-96A1.pdf . In earlier decisions the Commission designated 3 spectrum bands for sharing. See *Amendment of the Commission's Rules to Provide for Operation of Unlicensed NII Devices in the 5 GHz Frequency Range*, ET Docket 96-102, Report and Order, 12 FCC Rcd. 1576 (January 9, 1997), *available at* http://www.fcc.gov/Bureaus/Engineering_Technology/Orders/1997/fcc97005.txt ; *Amendment of the Commission's Rules to Provide for Operation of Unlicensed NII Devices in the 5 GHz Frequency Range*, ET Docket No. 96-102, Memorandum Opinion and Order, 13 FCC Rcd 14355 (June 24, 1998), *available at* http://www.fcc.gov/Bureaus/Engineering_Technology/Orders/1998/fcc98121.txt.

NASA has a need for availability of properly protected electromagnetic spectrum to support the implementation of the agency's communication and space research systems.[2] Because of the nature of NASA's activities, its spectrum planning is geared to the missions it has planned for up to thirty years in the future. This includes the United States' vision for space exploration -- to implement a sustained and affordable human and robotic program to explore the solar system and beyond.[3]

Over the next ten to thirty years spectrum is needed to support future U.S. deep space missions which utilize data rate capability in the range of hundreds of megabits-per-second to support the large amount of on-board generated data. Downlink data rate requirements expected for these future missions are: 150 Mbps in the year 2020; and 1 500 Mbps in the year 2030. Moreover, the number of deep space missions is expected to increase as more space agencies explore the solar system and beyond which will create additional demands on existing allocations.

[2] NASA Long Range Electromagnetic Spectrum Forecast at 6 (Nov. 1, 2007).
[3] *Id.*