

# **Review of Spectrum Support Information for U.S. Air Force Telemetry Equipment Development and Procurement**

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## **ABSTRACT**

This paper presents a review of spectrum support information as it pertains to the development and procurement of U. S. Air Force Telemetry Equipment. Highlights of this review include: Definitions of terms used in this paper that are peculiar to spectrum management; frequency bands encouraged by the U. S. Air Force for Telemetry Equipment Development and Procurement for use in the United States including station, channeling, and bandwidth information; frequency bands discouraged by the U. S. Air Force for Telemetry Equipment Development and Procurement for use in the United States; summary of Telemetry Equipment Electromagnetic Compatibility (EMC) Parameters required when requesting certification of spectrum support in the United States; and finally a summary of telemetry equipment EMC standards associated with the certification of spectrum support in the United States.

## **INTRODUCTION**

Two main sources of spectrum management regulations and procedures for telemetry equipment are the International Telecommunication Union (ITU) Radio Regulations and the National Telecommunication and Information Administration (NTIA) Manual of Regulations and Procedures for Federal Radio Frequency Management. The ITU Radio Regulations are important to USAF telemetry equipment as this equipment must frequently operate at U.S. test ranges within line of sight range of other nation's borders. Also, many of the definitions used internationally have been adopted for U.S. federal use by the NTIA.

## **DEFINITIONS**

Spectrum Support. This term does not have an "official" definition; however, it indicates that space in the radio frequency spectrum required for a communication-electronics

system is available. Certification of this is necessary before Air Force can develop or procure any telemetry equipment. Spectrum support is not authority to operate. Operation of telemetry equipment requires a frequency assignment.

Telemetry. The use of telecommunication for automatically indicating or recording measurements at a distance from the measuring instrument. (ITU Radio Regulations)

Telecommand. The use of telecommunication for the transmission of signals to initiate, modify or terminate functions of equipment at a distance. (ITU Radio Regulations)

Radiocommunication Service. A service involving the transmission, emission and/or reception of radio waves for specific telecommunication purposes. Unless otherwise stated, any radiocommunication service relates to terrestrial radiocommunication. (ITU Radio Regulations)

Mobile Service. A radiocommunication service between mobile and land stations, or between mobile stations. (ITU Radio Regulations)

Station. One or more transmitters or receivers, including the accessory equipment, necessary at one location for carrying on a radiocommunication service, or the radio astronomy service. Each station shall be classified by the service in which it operates permanently or temporarily. (ITU Radio Regulations)

Aeronautical Telemetry Mobile Station (MOEA). A telemetry mobile station used for transmitting data directly related to the airborne testing of the vehicle, (or major components) on which the station is installed. (NTIA Manual)

Flight Telemetry Mobile Station (MOEB). A telemetry mobile station used for transmitting data from an airborne vehicle, excluding data related to airborne testing of the vehicle itself, (or major components thereof). (NTIA Manual)

Aeronautical Telemetry Land Station (FLEA). A telemetry land station used in the flight testing of manned or unmanned aircraft, missiles, or major components thereof. (NTIA Manual)

Flight Telemetry Land Station (FLEB). A Telemetry land station the emissions of which are used for telemetry to a balloon; to a booster or rocket, excluding a booster or rocket in orbit about the Earth or in deep space; or to an aircraft, excluding a station used in the flight testing of an aircraft. (NTIA Manual)

Telecommand Mobile Station (MOD) A mobile station in the mobile service the emissions of which are used for terrestrial telecommand. (NTIA Manual)

Telecommand Land Station (FLD). A land station in the mobile service the emissions of which are used for terrestrial telecommand. (NTIA Manual)

Space Telemetry. The use of telemetry for the transmission from a space station of results of measurements made in a spacecraft, including those relating to the functioning of spacecraft. (ITU Radio Regulations)

Radiolocation. The determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relative to these parameters, by means of the propagation properties of radiowaves other than radionavigation ( including obstruction warning). (ITU Radio Regulations)

## **SPECTRUM ENCOURAGED FOR AERONAUTICAL AND FLIGHT TELEMETRY EQUIPMENT DEVELOPMENT AND PROCUREMENT FOR AIR FORCE USE IN THE U.S.**

1435-1530 MHZ Frequency Band. This band is encouraged for Air Force Telemetering use subject to time following conditions:

- a. Ninety-four (94) one-megahertz channels are designated for use primarily for telemetering and associated telecommand during the flight testing of manned or unmanned aircraft, missiles, or major components thereof (Station Classes MOEA, FLEA, MOD, FLD, see definition above).
- b. All assignments will be centered on frequencies at standard intervals of 1MHz, beginning at 1435.5 MHz, and will be authorized bandwidths of 1,3, or 5 MHz. Assignments with bandwidths greater than 1 MHz will be centered so that they do not extend outside the allocated band.
- c. The frequencies 1444.5, 1453.5, 1501.5, 1515.5, 1524.5 and 1525.5 MHz will be shared with flight telemetering mobile stations (Station Classes MOEB, FLEB, MOD, FLD-see definitions above).
- d. Included as permissible use of the 1435-1530 MHz band is telemetry associated with launching and reentry into the Earth's atmosphere, as well as any incidental orbiting prior to reentry, of manned or unmanned objects undergoing flight tests (Station Classes MOEA, FLEA, MOD, FLD apply).

- e. Telecommand stations authorized operation in the 1435-1530 MHz band will:
  - (1) Directly support flight test aeronautical telemetering functions;
  - (2) Be limited to 1 MHz bandwidth; and,
  - (3) Use antennas having a half power beamwidth of no more than 8 degrees and a front-to-back ratio of at least 20 dB.
- f. In the band 1435-1530 MHz, the channels designated for aeronautical telemetering are also available for space telemetering on a shared basis.

2200-2290 MHz Frequency Band. This band is encouraged for Air Force Telemetering use subject to the following conditions:

In the band 2200-2290 MHz, 90 one-megahertz narrowband channels are designated, centered on 2200.5 MHz and each one megahertz increment thereafter, through and including 2289.5 MHz. The use of emission bandwidths greater than 1 MHz is permitted, provided the assigned frequencies are centered on the center frequencies of narrowband channels. These channels are available for a) telemetering from space research space stations irrespective of their trajectories and b) aeronautical telemetering, including telemetry associated with launch vehicles, missiles, and upper atmosphere research rockets. Such use is on a coequal shared basis with fixed and mobile line-of-sight operations in the band conducted in accordance with the Government Table of Frequency Allocations. No provision is made in this band for the flight testing of manned aircraft.

2310-2390 MHz Frequency Band. This band is encouraged for Air Force Telemetering use subject to the following conditions:

- a. Seventy-nine (79) one-megahertz channels are designated for use primarily for telemetering and associated telecommand during the flight testing of manned or unmanned aircraft, missiles, or major components thereof (Station Classes MOEA, FLEA, MOD, FLD-see definitions above).
- b. All assignments will be centered on frequencies at standard intervals of 1 MHz, beginning at 2310.5 MHz, and will be authorized bandwidths of 1, 3, or 5 MHz. Assignments with bandwidths greater than 1 MHz will be centered so that they do not extend outside the allocated band.
- c. Included as permissible use of the 2310-2390 MHz band is telemetry associated with launching and reentry into the Earth's atmosphere, as well as any incidental orbiting

prior to reentry, of manned or unmanned objects undergoing flight tests (Station Classes MOEA, FLEA, MOD, FLD apply).

d. Telecommand stations authorized operation in the 2310-2390 MHz band will:

(1) Directly support flight test aeronautical telemetering functions;

(2) Be limited to 1 MHz bandwidth; and,

(3) Use antennas having a half power beamwidth of no more than 8 degrees and a front-to-back ratio of at least 20dB.

3100-3700, 5250-5925, 8500-10,000 MHz, 13.4-14.0 and 15.7 - 17.7 Ghz Bands. These bands are encouraged for Air Force telemetering use when operations are conducted as an integral part of a radiolocation system subject to the following conditions:

In order to transmit command signals to airborne vehicles being tracked and to receive status information from the vehicles, military telemetering and terrestrial telecommand operations are authorized in the bands 3100 - 3700, 5250-5925, 8500-10,000 MHz, 13.4 - 14.0 and 15.7 - 17.7 GHz when conducted as an integral part of the operation of authorized stations in the radiolocation service. Such telemetering and terrestrial telecommand operations shall be on a secondary basis to authorized stations operating in accordance with the National Table of Frequency Allocations.

### **SPECTRUM DISCOURAGED FOR AERONAUTICAL AND FLIGHT TELEMETRY EQUIPMENT DEVELOPMENT AND PROCUREMENT FOR AIR FORCE USE IN THE U.S.**

225-400 MHz Frequency Band. This band is discouraged for Air Force telemetering use because it was reallocated to fixed and mobile communication services on 1 January 1970. No new telemetry systems should be developed or procured for use in the United States in this frequency band.

1530-1535 MHz Frequency Band. This band is discouraged for Air Force telemetering use because the allocation to Maritime Mobile-Satellite Service will be Primary from 1 January 1990 and the Mobile service will be on a secondary basis from this date.

1700-1850 MHz Frequency Band. This band is discouraged for Air Force telemetering use because the development or procurement of flight test telemetry is discouraged in this band by the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management.

2290-2300 MHz Frequency Band. This band is discouraged for Air Force telemetering use because it is allocated on a primary basis to Space Research, Fixed and Mobile (except aeronautical mobile) services.

**SUMMARY OF TELEMETRY EQUIPMENT EMC PARAMETERS  
REQUIRED WHEN REQUESTING SPECTRUM SUPPORT**

<u>Transmitter</u>	<u>Receiver</u>
Tuning Range	Tuning Range
Method of Tuning	Method of Tuning
RF Channeling Capability	RF Channeling Capability
Frequency Tolerance	Frequency Tolerance
Emission Types	Emission Types
Emission Bandwidth	RF Selectivity
-3dB	-3dB
-20dB	-20dB
-60dB	-60dB
Occupied Bandwidth	Type of Preselection
Maximum Bit Rate	IF Selectivity
Maximum Modulation Frequency	-3dB
Pre-Emphasis	-20dB
Deviation Ratio	-60dB
Power	Maximum Bit Rate
Output Device	Maximum Detection Frequency
Spurious Level	De-Emphasis
Harmonic Level	IF Frequency
	Sensitivity and Criteria
	Spurious Rejection
	image Rejection
	<u>Antenna</u>
Type	Scan Characteristics
Frequency Range	Beam Width
Polarization	Horizontal
Gain	Vertical
Main Beam	
Side Lobe	

Above is a summary of the EMC parameters required when requesting spectrum support for telemetry equipment development or procurement for use in the United States. Details of these parameters may be found in Chapter 8.3 of the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management.

## **SUMMARY OF TELEMETRY EQUIPMENT EMC INTER-RANGE INSTRUMENTATION GROUP (IRIG) STANDARDS ASSOCIATED WITH THE CERTIFICATION OF SPECTRUM SUPPORT**

Transmitter Frequency Tolerance. For systems of 500 KHZ to 1 MHz assigned bandwidth (unless specified otherwise), the transmitter RF carrier (modulated or unmodulated), shall be within 0.003 percent of the assigned radio frequency under all operating conditions and environments. For systems with bandwidths outside this range, frequency tolerance shall be less than 10 percent of the modulated bandwidth.

Transmitter Output Power. The output power is as directed by the intended use and never more than absolutely necessary for reliable Telemetry Reception.

Transmitter Spurious Level.

a. For authorized bandwidths of 1 MHz or less

(1) In any 3KHz bandwidth outside twice the authorized bandwidth, the minimum required attenuation for all emissions is 60dB below the unmodulated transmitter power, except that it shall not be necessary in any case to attenuate below a level of -25dBm.

(2) In any 3KHz bandwidth outside twice the authorized bandwidth +1 MHz, all emissions must be less than -25dBm.

b. For authorized bandwidths of greater than 1 MHz.

(1) In any 3KHz bandwidth outside the authorized bandwidth +1 MHz, the minimum required attenuation for all emissions is 60dB below the unmodulated transmitter power, except that it shall not be necessary in any case to attenuate below a level of -25dBm.

(2) In any 3KHz bandwidth outside the authorized bandwidth +2 MHz, all emissions must be less than -25dBm.

Receiver Frequency Tolerance. The combined accuracy of all beat oscillators of the receivers shall be within 0.001 percent of the desired frequency under operating conditions during mission support.

Receiver Spurious Response. The spurious response shall be more than 60dB below the fundamental frequency response.

Tunability. The system shall be capable of operating throughout the entire frequency band without design modification.

Above is a summary of the EMC standards associated with certification of spectrum support for telemetry equipment developed or procured for use in the United States. Details of these standards may be found in IRIG Standard 106-80 and draft IRIG Standard 106-86.

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