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Radiocommunication Sector of ITU

Recommendation ITU-R S.1587-3
(09/2015)

Technical characteristics of earth stations on board vessels communicating with FSS satellites in the frequency bands 5 925-6 425 MHz and 14-14.5 GHz which are allocated to the fixed-satellite service

S Series
Fixed-satellite service

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Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

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SM	Spectrum management
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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R S.1587-3

Technical characteristics of earth stations on board vessels communicating with FSS satellites in the frequency bands 5 925-6 425 MHz and 14-14.5 GHz which are allocated to the fixed-satellite service

(2002-2003-2007-2015)

Scope

This Recommendation and its associated electronic databank provide representative technical characteristics of existing and planned ESVs communicating with FSS satellites in the frequency bands 5 925-6 425 MHz and 14-14.5 GHz.

Keywords

FSS, technical characteristics, earth stations on board vessels

Related ITU Recommendations, Reports

Recommendation ITU-R S.524-9	Maximum permissible levels of off-axis e.i.r.p. density from earth stations in geostationary-satellite orbit networks operating in the fixed-satellite service transmitting in the 6 GHz, 13 GHz, 14 GHz and 30 GHz frequency bands
Recommendation ITU-R S.580-6	Radiation diagrams for use as design objectives for antennas of earth stations operating with geostationary satellites
Recommendation ITU-R S.731-1	Reference earth-station cross-polarized radiation pattern for use in frequency coordination and interference assessment in the frequency range from 2 to about 30 GHz
Recommendation ITU-R S.732-1	Method for statistical processing of earth station antenna side-lobe peaks to determine excess over antenna reference patterns and conditions for acceptability of any excess
Recommendation ITU-R SF.1006-0	Determination of the interference potential between earth stations of the fixed-satellite service and stations in the fixed service
Recommendation ITU-R SM.1448-0	Determination of the coordination area around an earth station in the frequency bands between 100 MHz and 105 GHz

The ITU Radiocommunication Assembly,

considering

a) that the World Radiocommunication Conference (Geneva, 2003) (WRC-03) agreed Resolution 902 (WRC-03) concerned with earth stations on board vessels (ESVs);

b) that ESVs may operate under Radio Regulations (RR) No. 4.4 in the fixed-satellite service (FSS) in part of the frequency band 5 925-6 425 MHz;

c) that ESVs may operate under RR No. 4.4 in the FSS in part of the frequency band 14-14.5 GHz;

d) that there is a requirement to protect existing and planned geostationary (GSO) FSS systems;

e) that to ensure efficient use of the spectrum and to facilitate sharing ESVs must operate with certain constraints as called for in Resolution 902 (WRC-03),

recognizing

a) that ESVs may operate in FSS networks under RR No. 4.4 and shall not claim protection from, nor cause interference to services having allocations in the band, until their status is modified by a competent radiocommunication conference,

noting

a) that Resolution 902 (WRC-03) gives regulatory and operational provisions and technical limitations for ESVs transmitting in the bands 5 925-6 425 MHz and 14-14.5 GHz,

recommends

1 that representative technical characteristics of existing and planned ESVs communicating with FSS satellites in the frequency bands 5 925-6 425 MHz and 14-14.5 GHz are compiled in an electronic databank available from the Radiocommunication Bureau (BR)[1] and may be used in frequency sharing studies involving ESVs;

2 that the Tables contained in Annexes 1 and 2 hereto, which have also been incorporated in the databank, should be used *pro forma* for the submission of technical characteristics of ESVs.

Annex 1

Technical characteristics of ESVs operating in the frequency band 5 925-6 425 MHz which is allocated to the FSS

1 Introduction

At present, ESVs are in operation in all ITU Regions on a variety of sea-going vessels and mobile platforms, utilizing existing FSS space segment in the band 5 925-6 425 MHz on an experimental basis. The broadband signal capacity, ubiquitous coverage, dependable operation, resistance to weather-related interruptions and ready availability afforded by existing FSS networks in the 5 925-6 425 MHz band make them desirable for ESV operations.

This Annex provides a description of existing and planned earth stations on vessels that operate in the band 5 925-6 425 MHz in FSS networks.

[1] http://www.itu.int/itu-r/go/rsg4/recs1587data/.

2 Description of deployed ESV systems and their operations

2.1 Description of ESV systems

ESV operations utilizing 5 925-6 425 MHz FSS frequencies are now employed in all ITU Regions on a variety of large vessels such as passenger ships, seismic research and petroleum exploration ships, and naval vessels. (The size, weight and expense associated with ESV systems in the 5 925-6 425 MHz band dictate that only the largest vessels are candidates for such facilities.) In addition, movable oil and gas drilling platforms employ ESVs for the exchange of high-speed data essential to their operations. An ESV utilizes an extremely reliable stabilized platform and proven very small aperture terminal (VSAT) technology. Each ESV installation on board vessels is individually controlled by a land earth station (hub).

The equipment comprising an earth station installed on board a vessel can be subdivided into three subsystems:

– antenna subsystem;

– RF subsystem; and

– digital/modem subsystem.

The antenna subsystem is mounted above decks and it possesses characteristics unique to maritime applications. The digital/modem subsystem is located below decks while the RF subsystem is installed above decks with the antenna subsystem. The components used for the digital/modem and the RF subsystems are conventional pieces of equipment used for land earth stations.

2.2 Antenna subsystem

The antenna subsystem consists of a stabilized platform and an antenna. These components are mounted above decks and are covered by a rigid radome composed of composite foam/fibreglass. In an illustrative system, the antenna is a steerable 2.4 m aluminium axis-symmetrical parabola with either a circular or a linear polarized prime focus feed. The antenna gain towards the horizon ranges from 4 to 7 dBi. The G/T is 16.5 dB/K or greater. The antenna centreline is a fixed value, such as 26 m above mean sea level. The antenna operating characteristics meet Recommendations ITU-R S.524, ITU-R S.580, ITU-R S.731 and ITU-R S.732.

The antenna subsystem must be designed such that it is able to compensate for the motion of the vessel. The pointing accuracy shall be better than ±0.2° peak. It is noted that in order to meet antenna performance recommendations with current antenna designs, antenna size must be 2.4 m or more.

The stabilized platform uses a microprocessor-based antenna control unit. It stabilizes the earth station on a mobile seaborne platform to maintain signal lock and maintains the pointing accuracy within ±0.2° peak. The unit adjusts for the relative position of the mobile platform and the movements caused by wind and waves.

2.3 RF subsystem

The RF subsystem consists of standard transmitters and receivers, and conventional up- and down-converters certified for performance with satellites. The up- and down-converters are mounted above decks with the antenna in the rigid radome.

2.4 Digital/modem subsystem

The digital/modem subsystem, which is located below decks in the radio room, consists of an antenna control unit, and other conventional, readily available electronic equipment designed to work in accordance with the above-specified operational parameters.

2.5 Terminating capability

– In order to adequately safeguard against inadvertent interference with stations in the terrestrial service, the technical design of ESVs must include automatic features capable of either limiting or terminating operations when certain conditions are met. Those operating conditions are discussed in § 3.

– The system is set up to terminate transmissions instantaneously in the event antenna system losses pointing lock on the satellite.

2.6 Description of ESV hub function

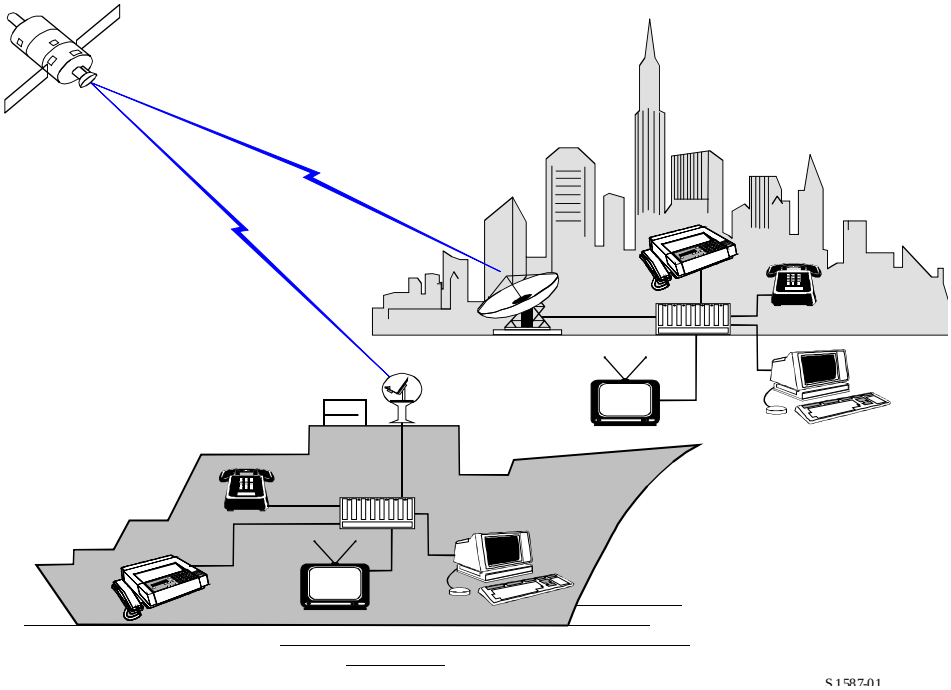
Figure 1 illustrates the operating relationship of a typical ESV and its HUB. The system is a closed user group network with the ships communicating only through the hub earth station, without a direct connection to the public switched telephone network. The hub operator is responsible for requests to discontinue service on a ship for any given reason. Control of the ship's transmission by the hub is maintained 24 hours a day, seven days a week.

3 Operational characteristics of typical ESVs operating in the 5 925-6 425 MHz frequency band

Because these earth stations are rather large they are deployed on heavy, deep draft ships. ESVs have the capability to operate 24 hours per day while in port, in transit in the deep-water channel to and from port, and while on the high seas. When in port these vessels are assigned to predetermined piers that can facilitate large tonnage vessels. While transiting between the port facility and the open seas, these ships must maintain adequate speed, usually a minimum of 5 knots, for effective steerage, and stay in the deep-water channel. Antennas, which are sea stabilized, have their main beams directed toward the satellite in geostationary orbit.

FIGURE 1

Operating relationship of a typical ESV and its HUB



S1587-01

The ESV transmitter is to be inhibited when any of the following conditions occur:

– the antenna subsystem loses lock on the satellite and/or the ability to maintain tracking accuracy; e.g. during heavy wave conditions when pointing accuracy is lost;

– the ESV e.i.r.p. towards the horizon exceeds the recommended value;

– when the ESV is within certain predefined geographical boundaries where the use of ESVs is prohibited.

3.1 In general: three distinct operational phases

For purposes of studying the interference potential between ESVs and the terrestrial service, there are three distinct phases of operation:

Phase 1: operations in open sea;

Phase 2: operations while at a specific, fixed location, such as when a ship is docked in port;

Phase 3: operations in-motion in the sea lanes and port channels near shore when a ship approaches or departs from a port.

3.2 ESV operations in open sea

When ESVs operate in open sea, they should be sufficiently far from terrestrial services and FSS stations that they do not represent a source of potential interference to those stations, nor are they concerned with interference from terrestrial 4 GHz transmitters. It would be desirable and practical from an operational perspective to select a fixed distance from shore where it may be safely presumed that ESVs may operate without the need to coordinate with terrestrial service stations.

3.3 ESV operations in stationary mode

Vessels equipped with ESVs that are stationary in port can be coordinated, employing applicable procedures and technical parameters set forth in Recommendations ITU-R SM.1448 (coordination area) and ITU-R SF.1006 (interference potential). ESV-equipped vessels are inevitably large, with

all of their operations confined as a matter of necessity to specified port channels (the path into and out of a port, generally surrounded by land), sea lanes (the limits marked just outside a port beyond the port channels indicating where a ship may safely operate while approaching or departing from a port), and piers. For purposes of coordination, the entire area of the identified pier in which an ESV-equipped ship is located can be specified with precision, analysed and coordinated for interference. The ESV-equipped vessels usually dock at the same piers on every trip, so it is possible to coordinate operations at the pertinent piers using existing coordination procedures.

3.4 ESV operations in motion

While ESV-equipped vessels are under way in the channel or within the sea-lane limits, they are constantly in motion, travelling at speeds ranging from 5 to 15 knots. The large vessels which employ ESVs require identified piers, defined port channels, and specified sea-lanes. These port channels and sea lanes are clearly physically demarcated in every case so that they may be observed and followed by large vessels, and they are also set forth on maps and charts. Large vessels typically spend some time docked at identified piers, and periodically go to sea. Multiple vessels that are equipped with earth stations may operate at the same port, but each ship of a given type operates with the same parameters as others of its type, including pier locations and limits of the path travelled in and out of the port (i.e. the port channel and limits of the sea lanes). These in-motion ESV operations near shore present a potential for interference to terrestrial fixed station receivers in the 6 GHz band, and also potential for interference from terrestrial transmitters in the 4 GHz band to the ESV receiver.

4 ESV technical characteristics

The technical characteristics to be submitted to the electronic databank associated with this Recommendation for ESVs operating in the band 5 925-6 425 MHz are presented in Table 1. This Table also provides example data.

TABLE 1

ID	Parameter	Example	Remarks
	Administration		
	Source		
1	Transmit tuning range (MHz)	5 925-6 425	
2	Emission type (modulation/multiple access scheme)	QPSK	
3	Data rate (kbit/s)	1 024-2 048	
4	Occupied bandwidth (MHz)	0.9-1.8	
5	Transmit power (dBW)	4-7	
6	Transmit power/bandwidth (dB(W/1 MHz))	4.4	assume single carrier in 1 MHz bandwidth =(5) for (4)<=1000 =(5)-10*log(4)+30 for (4)>1000
7	Feeder loss (dB)	0.4	
8	Transmitter power density at antenna input (dB(W/1 MHz))	4.0	assume single carrier in 1 MHz bandwidth =(6)-(7)
9	Antenna main beam gain, transmit (dBi)	39.1	includes radome loss
10	Transmit e.i.r.p. density (dB(W/1 MHz))	43.1	=(8)+(9)
11	Receiver tuning range (MHz)	3 700-4 200	
12	Receiver IF bandwidth (MHz)	500	tuning range of demodulator
13	Antenna type	Dual offset Gregorian	
14	Antenna size (m)	1.8	
15	Polarization	Dual linear	
16	Beamwidth, transmit (degrees)	1.94	
17	Beam positioning (degrees) azimuth	360	
18	Beam positioning (degrees) elevation	limited motion	
19	Antenna first-side lobe gain, transmit (dBi)	21.3	
20	Tracking stability (degrees) peak	0.2	
21	Tracking stability (degrees) r.m.s.	0.15	
22	Number of terminals	About 50	
23	Geographic area where deployed	All ocean regions	

Annex 2

Technical characteristics of ESVs communicating with FSS satellites in the frequency band 14-14.5 GHz which is allocated to the FSS

Description of example 12/14 GHz ESV systems

The ESVs comprise three elements:

– the antenna subsystem,

– the RF subsystem,

– modem subsystem.

The latter is normally installed below the deck while the antenna and the RF subsystems are mounted above decks and meet all maritime specifications for such equipment. The components used for modem and RF equipment are conventional pieces of equipment used for land earth stations.

1 Antenna subsystem

The antenna subsystem consists of a stabilized platform and a reflector antenna. These systems are mounted above decks and are covered by a rigid radome composed of composite foam/fibreglass. The diameter used in the shared bands of the antenna normally is from 0.6 m to 1.5 m. Off-set type of antennas are used as well as axis-symmetrical parabolas normally with linear feeds. The antenna horizon gain ranges from 0 to –10 dBi. The G/T is normally 17 dB(K^{-1}) or greater. The antenna operating characteristics meet Recommendations ITU-R S.524, ITU-R S.580, ITU-R S.731, and ITU-R S.732.

2 RF subsystem

The RF subsystem consists of standard transmitters and receivers, and conventional up- and down-converters certified for performance with satellites. The up- and down-converters are mounted above decks with the antenna in the rigid radome. The actual transmitting ESV psd number will depend on several parameters like:

– The location of the vessel with respect to the service area of the satellite beam.

– The antenna size of the ESV (transmitting antenna gain).

– The location of the receiving earth station with respect to the service area of the satellite beam.

– The antenna size of the receiving earth station (receiving G/T).

– The operational gain step of the satellite transponder, etc.

3 Modem subsystem

The modem subsystem, which is located below decks in the radio room, consists of an antenna control unit and other conventional, readily available electronic equipment designed to work in accordance with the above specified operational parameters.

4 ESV technical characteristics

Technical characteristics to be submitted to the electronic databank associated with this Recommendation for ESVs operating in the band 14-14.5 GHz are presented in Table 2. This Table also provides example data.

TABLE 2

ID	Parameter	Example	Remark
	Administration		
	Source		
1	Transmit tuning range (GHz)	14-14.5	
2	Emission type (modulation/multiple access scheme)	QPSK/CDMA	
3	Data rate (kbit/s)	1 024-2 048	
4	Occupied bandwidth (MHz)	1.843-8.271	
5	Transmit power (dBW)	6.5-9.4	
6	Transmit power/bandwidth (dB(W/1 MHz))	0.2 - 3.8	assume single carrier in 1 MHz bandwidth =(5) for (4)<=1000 =(5)-10*log(4)+30 for (4)>1000
7	Feeder loss (dB)	1.2	
8	Transmitter power density at antenna input (dB(W/1 MHz))	-1.0 - 2.6	assume single carrier in 1 MHz bandwidth =(6)-(7)
9	Antenna main beam gain, transmit (dBi)	36.8	includes radome loss
10	Transmit e.i.r.p. density (dB(W/1 MHz))	35.8 - 39.4	=(8)+(9)
11	Receiver tuning range (GHz)	10.95-12.75	
12	Receiver IF bandwidth (MHz)	500	tuning range of demodulator
13	Antenna type	Prime focus	
14	Antenna size (m)	0.6	
15	Polarization	Dual linear	
16	Beamwidth, transmit (degrees)	2.5	
17	Beam positioning (degrees) azimuth	360	
18	Beam positioning (degrees) elevation	limited motion	
19	Antenna first-side lobe gain, transmit (dBi)	19.8	
20	Tracking stability (degrees) peak	0.2	
21	Tracking stability (degrees) r.m.s.	0.15	
22	Number of terminals	26	
23	Geographic area where deployed	All ocean regions	