Space Frequency

Coordination Group

Report SFCG 37-2R1

TECHNICAL INFORMATION OF EESS (ACTIVE) SENSORS IN THE BAND 1215-1300 MHZ

Abstract

This report presents the technical information of EESS (active) sensors in the frequency band 1215-1300 MHz, for the protection of RNSS receivers in the same frequency band.

The information in this report may be used for discussions in accordance with the resolves of Resolution SFCG A35-1.

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1. Introduction

This document contains the technical information of EESS (active) sensors submitted in accordance with RESOLVES 1 and 2 of Resolution SFCG A35-1.

The information in this document may also be used for the discussion among EESS (active) operators, which is suggested in RESOLVES 4 of Resolution SFCG A35-1.

2. Technical Information of EESS (active) Sensors

The EESS (active) sensors submitted based on Resolution SFCG A35-1 are summarized in Table 1.

Table 1

EESS (active) sensors submitted based on Resolution SFCG A35-1

EESS (active) sensor	Operator	Operational Status	Technical characteristics	Submission	Note
ALOS-2	JAXA	Operational since 2014	Table 2 (Table 2-1, 2-2, 2-3)	SFCG-36	
ALOS-4	JAXA	Planned in 2020	Table 3 (Table 3-1, 3-2, 3-3)	SFCG-37	Note1
NISAR	NASA	Planned in 2021	Table 4 (Table 4-1, 4-2)	SFCG-38	Note2

Note1: The operator of ALOS-2 and ALOS-4 expects that there will be no aggregate interference as a result of the joint operations of these two systems, since no simultaneous illumination over the Earth's surface occurs. This is because the orbit phases of ALOS-2 and ALOS-4 are separated with approximately180 degrees.

Note2: The operator of NISAR expects that there will be no aggregate interference as a result of the joint operations of these three systems, since preliminary analysis shows that no simultaneous illumination over the Earth's surface occurs. This is because the orbits of NISAR and ALOS-2 / ALOS-4 are orthogonal (6am/6pm versus 12am/12pm sun-synchronous orbits).

Tables 2 (2-1, 2-2, 2-3) , 3 (3-1, 3-2, 3-3) and 4 (4-1, 4-2) in the Annex contain the characteristics of EESS (active) sensors that should be used to assess the potential aggregate interference from multiple EESS (active) sensors into RNSS receivers in the frequency band 1215-1300 MHz.

3. Summary

One EESS (active) sensor is currently in operation. Two EESS (active) sensors are planned to start their operations in 2020 and 2021, respectively.

The operators of NISAR and ALOS-2 / ALOS-4 expect that there will be no aggregate interference as a result of the joint operations of these two systems, since no simultaneous illumination over the Earth's surface occurs.

ANNEX

TABLE 2-1

ALOS-2 EESS (active) sensor parameters

GENERAL EESS SENSOR PARAMETERS	Spotlight	ScanSAR	Fine, High-Sensitive	Ultra-Fine
Sensor type	SAR (SAR4)	SAR (SAR5)	SAR (SAR6)	SAR
Orbit Parameters:				
Type of orbit	Sun-synchronous			
Altitude, km	628			
Inclination, deg	97.9			
Ascending/Descending Node LST	12:00, descending node			
Eccentricity	0 (circular)			
Repeat period, days	14 days			
Sensor Antenna Parameters:				
Polarization	H and V	H and V	H, V, Circular and 45 degrees linear	H and V
Azimuth scan rate, rpm (Scatterometers)	Not Applicable	Not Applicable	Not Applicable	
Antenna beam look angle, deg	+/- 7.2 to 59	+/- 7.2 to 59	+/- 7.2 to 59	
Antenna beam azimuth angle, deg	+/- 3.5	0	0	
Sensor antenna pattern	See Table 2	See Table 3	See Table 3	See Table 2
Transmit Pulse Parameters:				
RF Center Frequency, MHz	1257.5	1236.5, 1257.5, 1278.5 (selectable)		1257.5
RF Bandwidth, MHz (chirp-width)	84	14, 28	28, 42	84
Transmit Pk pwr, W	3 944	6 120	6 120	3 944
Pulsewidth, µsec	43 to 71	37 to 67	18 to 43	50 to 74
Pulse Repetition Frequency (PRF), Hz	1620 to 2670	1050 to 1860	1550 to 3640	1360 to 1970
Transmit duty cycle, %	11.5	7.0	6.8	10

TABLE 2-2

ALOS-2 antenna gain equations (Spotlight, Ultra-Fine)

Pattern	Gain $G(\theta)$ (dBi) as a function of off-axis angle θ (degrees)	Angle range
Vertical (elevation)	$G_v(\theta_v) = 0.0 - 0.38(\theta_v)^2$ $G_v(\theta_v) = 0.0 - 0.544\theta_v \quad -8.5$ $G_v(\theta_v) = -22.0$	$0° < \lvert\theta_v\rvert < 5.5°$ $5.5° \leq \lvert\theta_v\rvert < 24.75°$ $\lvert\theta_v\rvert \geq 24.75°$
Horizontal (azimuth)	$G_h(\theta_h) = 34.7 - 2.7(\theta_h)^2$ $G_h(\theta_h) = 34.7 - 0.95 \ \lvert\theta_h\rvert - 10.65$ $G_h(\theta_h) = 34.7 - 23.0$ $G_h(\theta_h) = 34.7 - 23.0 - 35\log(\lvert\theta_h\rvert /38)$ $G_h(\theta_h) = 34.7 - \quad 36.1$	$0° < \lvert\theta_h\rvert < 2.17°$ $2.17° \leq \lvert\theta_h\rvert < 13.0°$ $13.0° \leq \lvert\theta_h\rvert < 38.0°$ $38.0° \leq \lvert\theta_h\rvert < 90.0°$ $\lvert\theta_h\rvert \geq 90.0°$
Beam pattern	$G(\theta) = G_v(\theta_v) + G_h(\theta_h)$	-
Note	These equations cover the worst case envelope patterns with the maximum electric beam steering angle range in both elevation and azimuth directions. As the result, these equations contain some margins against actual antenna patterns. Therefore, the –3 dB beamwidth derived from these equations can be slightly different from the beamwidth (-3dB) specified in Table 1.	

TABLE 2-3

ALOS-2 antenna gain equations (ScanSAR, Fine, Hight-Sensitive)

Pattern	**Gain $G(\theta)$ (dBi) as a function of off-axis angle θ (degrees)**	**Angle range**
Vertical (elevation)	$G_v(\theta_v) = 0.0 - 0.30(\theta_v)^2$ $G_v(\theta_v) = 0.0 - 0.69 \mid\theta_v\mid -7.24$ $G_v(\theta_v) = -26.0$	$0° < \|\theta_v\| < 6.20°$ $6.20° \leq \|\theta_v\| < 27.00°$ $\|\theta_v\| \geq 27.00°$
Horizontal (azimuth)	$G_h(\theta_h) = 36.6 - 7.0(\theta_h)^2$ $G_h(\theta_h) = 36.6 - 1.43 \mid\theta_h\mid - 12.83$ $G_h(\theta_h) = 36.6 - 25.0$ $G_h(\theta_h) = 36.6 - 25.0 - 34 \log(\mid\theta_h\mid/40)$ $G_h(\theta_h) = 36.6 - 36.98$	$0° < \|\theta_h\| < 1.46°$ $1.46° \leq \|\theta_h\| < 8.47°$ $8.47° \leq \|\theta_h\| < 40.0°$ $40.0° \leq \|\theta_h\| < 90.0°$ $\|\theta_h\| \geq 90.0°$
Beam pattern	$G(\theta) = G_v(\theta_v) + G_h(\theta_h)$	-
Note	These equations cover the worst case envelope patterns with the maximum electric beam steering angle range in both elevation and azimuth directions. As the result, these equations contain some margins against actual antenna patterns. Therefore, the –3 dB beamwidth derived from these equations can be slightly different from the beamwidth (-3 dB) specified in Table 1.	

TABLE 3-1

ALOS-4 EESS (active) sensor parameters

GENERAL EESS SENSOR PARAMETERS	Spotlight	ScanSAR	Fine, High-Sensitive	Ultra-Fine
Sensor type	SAR	SAR	SAR	SAR
Orbit Parameters:				
Type of orbit	Sun-synchronous			
Altitude, km	628			
Inclination, deg	97.9			
Ascending/Descending Node LST	12:00, descending node (orbit phase difference from ALOS-2 is 180 degrees)			
Eccentricity	0 (circular)			
Repeat period, days	14 days			
Sensor Antenna Parameters:				
Polarization	H and/or V	H and/or V	H and/or V	H and/or V
Azimuth scan rate, rpm (Scatterometers)	Not Applicable	Not Applicable	Not Applicable	
Antenna beam look angle, deg	+/- 7.2 to 59	+/- 7.2 to 59	+/- 7.2 to 59	
Antenna beam azimuth angle, deg	+/- 3.5	0	0	
Sensor antenna pattern	See Table 2	See Table 3	See Table 3	See Table 3
Transmit Pulse Parameters:				
RF Center Frequency, MHz	1257.5	1236.5, 1257.5, 1278.5 (selectable)		1257.5
RF Bandwidth, MHz (chirp-width)	84	28	28, 42	84
Transmit Pk pwr, W	7 762	10 000	10 000	10 000
Pulsewidth, µsec	30 to 52	66	66 or 33	52 or 26
Pulse Repetition Frequency (PRF), Hz (variable)	1750 to 2470	1200 to 1600	1200 to 1600 or 2400 to 3200	1500 to 2000 or 3000 to 4000
Transmit duty cycle, %	10.8	8 to 11	8 to 11	8 to 11

TABLE 3-2

SAR antenna gain equations (spotlight)

Pattern	Gain $G(\theta)$ (dBi) as a function of off-axis angle θ (degrees)	Angle range
Vertical (elevation)	$G_v(\theta_v) = 0.0 - 0.38(\theta_v)^2$ $G_v(\theta_v) = 0.0 - 0.544\|\theta_v\| - 8.5$ $G_v(\theta_v) = -22.0$	$0° < \|\theta_v\| < 5.5°$ $5.5° \le \|\theta_v\| < 24.75°$ $\|\theta_v\| \ge 24.75°$
Horizontal (azimuth)	$G_h(\theta_h) = 35.6 - 1.3(\theta_h)^2$ $G_h(\theta_h) = 35.6 - 0.62\|\theta_h\| - 5.62$ $G_h(\theta_h) = 35.6 - 23.0$ $G_h(\theta_h) = 35.6 - 23.0 - 35\log(\|\theta_h\|/38)$ $G_h(\theta_h) = 35.6 - 36.1$	$0° < \|\theta_h\| < 2.17°$ $2.17° \le \|\theta_h\| < 13.0°$ $13.0° \le \|\theta_h\| < 38.0°$ $38.0° \le \|\theta_h\| < 90.0°$ $\|\theta_h\| \ge 90.0°$
Beam pattern	$G(\theta) = G_v(\theta_v) + G_h(\theta_h)$	-
Note	These equations cover the worst case envelope patterns with the maximum electric beam steering angle range in both elevation and azimuth directions. As the result, these equations contain some margins against actual antenna patterns. Therefore, the –3 dB beamwidth derived from these equations can be slightly different from the beamwidth (-3dB) specified in Table 1.	

TABLE 3-3

SAR antenna gain equations (Ultra-fine, High-Sensitive, Fine, ScanSAR)

Pattern	Gain $G(\theta)$ (dBi) as a function of off-axis angle θ (degrees)	Angle range
Vertical (elevation)	$G_v(\theta_v) = 0.0 - 0.20(\theta_v)^2$ $G_v(\theta_v) = 0.0 - 0.69\lvert\theta_v\rvert - 3.9$ $G_v(\theta_v) = -23.0$	$0° < \lvert\theta_v\rvert < 6.20°$ $6.20° \le \lvert\theta_v\rvert < 27.00°$ $\lvert\theta_v\rvert \ge 27.00°$
Horizontal (azimuth)	$G_h(\theta_h) = 34.5 - 6.0(\theta_h)^2$ $G_h(\theta_h) = 34.5 - 1.43\lvert\theta_h\rvert - 10.8$ $G_h(\theta_h) = 34.5 - 25.0$ $G_h(\theta_h) = 34.5 - 25.0 - 34\log(\lvert\theta_h\rvert/40)$ $G_h(\theta_h) = 0$	$0° < \lvert\theta_h\rvert < 1.46°$ $1.46° \le \lvert\theta_h\rvert < 8.47°$ $8.47° \le \lvert\theta_h\rvert < 40.0°$ $40.0° \le \lvert\theta_h\rvert < 90.0°$ $\lvert\theta_h\rvert \ge 90.0°$
Beam pattern	$G(\theta) = G_{max} + G_v(\theta_v) + G_h(\theta_h)$	$G_{max} = 36.6$
Note	These equations cover the worst case envelope patterns with the maximum electric beam steering angle range in both elevation and azimuth directions. As the result, these equations contain some margins against actual antenna patterns. Therefore, the –3 dB beamwidth derived from these equations can be slightly different from the beamwidth (-3 dB) specified in Table 1.	

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TABLE 4-1

NISAR L-band EESS (active) sensor parameters

GENERAL EESS SENSOR PARAMETERS	Split-Spectrum (5 +20 MHz)		40 MHz	77 MHz
Sensor type	SAR		SAR	SAR
Orbit Parameters:				
Type of orbit	Sun-synchronous			
Altitude, km	747			
Inclination, deg	98.4			
Ascending/Descending Node LST	18:00, ascending node			
Eccentricity	0 (circular)			
Repeat period, days	22 days			
Sensor Antenna Parameters:				
Polarization	Dual pol H and V		Quad pol, H, V	Dual pol, H and V
Azimuth scan rate, rpm (Scatterometers)	Not Applicable			
Antenna beam look angle, deg	30			
Antenna beam azimuth angle, deg	0			
Sensor antenna pattern	See Table 2			
Transmit Pulse Parameters:				
RF Center Frequency, MHz	1229.0	1293.5	1239.0	1257.5
RF Bandwidth, MHz (chirp-width)	20	5	40	77
Transmit Pk pwr, W	1440			
Pulsewidth, µsec	20	5	40	40
Pulse Repetition Frequency (PRF), Hz	1910		3200	1910
Transmit duty cycle, %	3.82	0.955	12.8	7.64

TABLE 4-2

NISAR L-band antenna gain equations

Pattern	Gain $G(\theta)$ (dBi) as a function of off-axis angle θ (degrees)	Angle range
Vertical (elevation)	$G_v(\theta_v) = -20$	$(\theta_v - 37.0°) < -40.0°$
	$G_v(\theta_v) = 3.04 + 0.576\,\theta_v$	$-40.0° \leq (\theta_v - 37.0°) < -8.75°$
	$G_v(\theta_v) = -58.99 - 35.314\,\theta_v - 3.2994\,\theta_v^2$	$-8.75° \leq (\theta_v - 37.0°) < -4.0°$
	$G_v(\theta_v) = -34$	$-4.0° \leq (\theta_v - 37.0°) < 4.0°$
	$G_v(\theta_v) = = -58.99 + 35.314\,\theta_v - 3.2994\,\theta_v^2$	$4.0° \leq (\theta_v - 37.0°) < 9.0°$
	$G_v(\theta_v) = 3.75 - 0.6575\,\theta_v$	$9.0° \leq (\theta_v - 37.0°) < 27.0°$
	$G_v(\theta_v) = -14$	$(\theta_v - 37.0°) \geq 27°$
Horizontal (azimuth)	$G_h(\theta_h) = 0.0 - 15.0\,(\theta_h)^2$	$\lvert\theta_h\rvert < 1.1°$
	$G_h(\theta_h) = -18.0$	$1.1° \leq \lvert\theta_h\rvert < 1.7°$
	$G_h(\theta_h) = -13.55 - 23 \log \lvert\theta_h\rvert$	$1.7° \leq \lvert\theta_h\rvert < 20.0°$
	$G_h(\theta_h) = -43.47$	$\lvert\theta_h\rvert \geq 20.0°$
Beam pattern	$G(\theta) = \{G_v(\theta_v) + G_h(\theta_h)\}$	