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EMF Test Report: Ericsson AIR 6449 B77D NR (FCC)

Document number:	GFTL-20:001076 Uen Rev D	Date of report:	2021-03-26 (Rev D) Added results for configured output power levels of 60, 80, 120, 160 and 240 W.
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Tests performed by:	Fatemeh Ghasemifard	Dates of tests:	2021-03-25 (Rev D) Test was done for configured output power levels of 60, 80, 120, 160 and 240 W.
Manufacturer and market name(s) of device:	Ericsson AIR 6449 B77D		
Testing has been performed in accordance with:	FCC OET Bulletin 65 IEC 62232:2017		
Test results:	RF exposure compliance boundaries (exclusion zones) related to the limits in FCC 47 CFR 1.1310 to be included in the Customer Product Information (CPI) for Ericsson AIR 6449 B77D.		
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Summary of EMF Test Report¹

Equipment under test (EUT)

Product name	AIR 6449 B77D		
Product number	KRD 901 206/11, KRD 901 206/1		
Supported bands, Tx frequency range (MHz) and standards	B77D	3700 – 3980	NR
Duplexing technology and fraction of downlink transmission time to total time	TDD (75%)		
Exposure environment	General public/uncontrolled, Workers/controlled		

Results

RF exposure compliance boundaries, outside of which the exposure is below the general public (GP) and workers (W) exposure limits, are listed below.

Dimensions of the box-shaped compliance boundary for general public (GP) and workers (W) exposure for AIR 6449 applicable in the markets employing the FCC RF exposure limits for maximum output power with power tolerance and TDD downlink duty cycle included.

Mode and output power for AIR 6449						Dimensions of the box-shaped compliance boundary (m)							
						Distance in front of EUT		Width		Height		Distance behind EUT	
Band	Standard	Maximum configured output power from the radio	IEC 62232 installation class	Power tolerance	TDD DL duty cycle	GP	W	GP	W	GP	W	GP	W
B77D	NR	60 W	E+	1.5 dB	75 %	13.5	6.1	15.3	6.9	5.8	2.6	0.2	0.2
B77D	NR	80 W	E+	1.5 dB	75 %	15.6	7.0	17.7	7.9	6.7	3.0	0.2	0.2
B77D	NR	120 W	E+	1.5 dB	75 %	19.1	8.6	21.7	9.7	8.2	3.7	0.2	0.2
B77D	NR	160 W	E+	1.5 dB	75 %	22.1	9.9	25.0	11.2	9.5	4.3	0.2	0.2
B77D	NR	240 W	E+	1.5 dB	75 %	27.0	12.1	30.6	13.7	11.6	5.2	0.2	0.2
B77D	NR	320 W	E+	1.5 dB	75 %	31.2	14.0	35.3	15.8	13.4	6.0	0.2	0.2

For the power levels specified in the table with tolerances added, and the upward rounding of compliance boundary dimensions to the nearest decimeter, the specified results are conservative.

¹ This page contains a summary of the test results. The full report provides a complete description of all test details and results.

1 General information

The test results presented in this report define compliance boundaries for AIR 6449 B77D. Outside of these compliance boundaries, the radio frequency (RF) exposure levels are below the limits specified by the Federal Communications Commission (FCC) [1]. The tests were performed by calculations in accordance with the Ericsson RF exposure calculation procedure for base stations [2], which is in conformity with the FCC OET Bulletin 65 [3] and IEC 62232:2017 [4].

It should be noted that the test results presented in this test report are valid for the frequency range specified in Table 1, for the antenna properties specified in Table 2, and for the power level, the power tolerance and TDD downlink duty cycle specified in Table 3. These data as well as the applied antenna pattern files were supplied by the client and may affect the validity of the results.

Proposed EMF health and safety information for inclusion in the Customer Product Information (CPI) is provided in Appendices A, B and C.

2 Equipment under test

Table 1 and Table 2 below summarize the technical data for the equipment under test (EUT) and the properties of the integrated antenna. Table 3 lists the maximum configured output powers from the radio unit (total peak power from all antenna branches), including the rated maximum, and the total time-averaged power delivered to the antenna for the specified configurations. The lower configured power levels can be obtained either by reducing the maximum peak power or by using the Ericsson EMF Power Lock NR feature with an appropriate power threshold and averaging time setting, or with a combination of both. The total time-averaged power delivered to the antenna includes output power tolerance and TDD downlink duty cycle.

The EUT related data in Tables 1-3 were supplied by the client.

Table 1 Technical data for the EUT.

Product name and product number	AIR 6449 B77D	KRD 901 206/11, KRD 901 206/1	
Supported bands, Tx frequency range (MHz), and standards	B77D	3700 – 3980	NR
Antenna	KRE 105 407		
Dimensions, H × W × D (mm)	778 x 403 x 228		
Duplexing technology and fraction of downlink transmission time to total time	TDD (75 %)		
Exposure environment	General public/uncontrolled, Workers/controlled		
IEC 62232 installation class² [4]	E+		

² The stated IEC 62232 installation class was determined based on the total EIRP without power tolerance included and considering the TDD downlink duty cycle. The total EIRP was obtained using the antenna patterns provided by the client.

Table 2 Properties of the antenna.

Product number	KRE 105 407
Type	Internal AAS
Number of polarizations	2
Gain ³ (dBi)	25.65
Horizontal HPBW ⁴ (degrees)	11°
Vertical HPBW ⁴ (degrees)	6°
Number of antenna elements (N_H, N_V)	(8, 12)
Element separation distance (Δ_H, Δ_V) (mm)	(58, 44)
Maximum scan range in horizontal plane (degrees)	±60°
Maximum scan range in vertical plane (degrees)	83° - 109°

Table 3 EUT configurations with nominal peak output power levels and total time-averaged power levels including an output power tolerance and TDD downlink duty cycle.

Band	Standard	Configured output power from the radio (dBm/W)	Power tolerance (dB)	TDD downlink duty cycle	Total time-averaged power delivered to antenna (dBm/W)
B77D	NR	47.8 / 60	1.5	75 %	48.0 / 63.6
B77D	NR	49.0 / 80	1.5	75 %	49.3 / 84.8
B77D	NR	50.8 / 120	1.5	75 %	51.0 / 127.1
B77D	NR	52.0 / 160	1.5	75 %	52.3 / 169.5
B77D	NR	53.8 / 240	1.5	75 %	54.1 / 254.3
B77D	NR	55.1 / 320 (rated maximum)	1.5	75 %	55.3 / 339.0

3 Exposure conditions

The EUT is intended to be installed on roof-tops, masts, walls, poles and similar structures making it possible to ensure that the general public has no access to the EMF compliance boundary. Other installation related exposure conditions are not reasonably foreseeable for the EUT.

Different factors, such as beam scanning in elevation and azimuth, RBS utilization, and scheduling time are reasonably foreseeable and will significantly reduce the time-averaged power and the RF exposure. These factors were, however, not considered in this assessment, which adds to the conservativeness of the obtained compliance boundaries.

4 EMF compliance boundary calculations

The RF exposure was evaluated using calculations performed according to the Ericsson RF Exposure Calculation Procedure for Base Stations [2], which conforms to FCC OET Bulletin 65 [3] and IEC 62232 [4]. The calculations were made using the far-field spherical formula. The first step in calculating the compliance boundary was to use the spherical far-field formula to estimate power density:

$$S_{\text{sph}}(\theta, \phi) = \frac{P_a G(\theta, \phi)}{4\pi r^2},$$

³ The stated gain value is the maximum gain of the antenna within the tested frequency range and obtained from antenna radiation pattern files provided by the client.

⁴ The stated half-power beam widths are for the broadside beam in the reference direction (θ, ϕ) = (96°, 0°).

where S, P_a, G, r, θ , and ϕ denote the power density, the total time-averaged power accepted by antenna, the antenna gain, the distance from the antenna, and the angular variables in a spherical coordinate system, respectively.

The total time-averaged power delivered to the antenna include tolerances and the TDD downlink duty cycle. The envelope of antenna gains for all possible traffic beams was obtained from far-field measurements provided by the client. Such envelope patterns were provided for three different frequencies, specifically 3700 MHz, 3820 MHz, and 3980 MHz within Band 77D. Maximum gain value corresponding to the maximum of all envelope traffic beam patterns was used in the above equation to estimate power density. The maximum gain value of the envelope of traffic beams was found to be 25.65 dBi.

The compliance distance for the spherical model, $CD_{sph}(\theta, \phi)$ was obtained by solving the following equation for r :

$$\frac{S_{total,sph}(r, \theta, \phi)}{S_{gp,w}^{lim}} = 1,$$

where $S_{gp,w}^{lim}$ denotes the FCC power density reference levels [1] for general public and workers exposure. RF EMF exposure limits are given in Table 4.

Table 4 RF EMF exposure limits on power density for the frequency band used by the EUT.

Band	$S_{gp}^{lim} (W/m^2)$	$S_w^{lim} (W/m^2)$
B77D	10	50

Based on the calculated compliance distances, a box-shaped compliance boundary was determined. To comply with the FCC requirement of a minimum test separation distance for a non-portable device of 20 cm, the minimum distance from the EUT to the compliance boundary was set to 20 cm.

5 Results

A box-shaped compliance boundary is used, characterized by its width, height, and the compliance distances behind and in front of the EUT, see Figure 1. Outside of this box, the RF exposure is below the exposure limits.

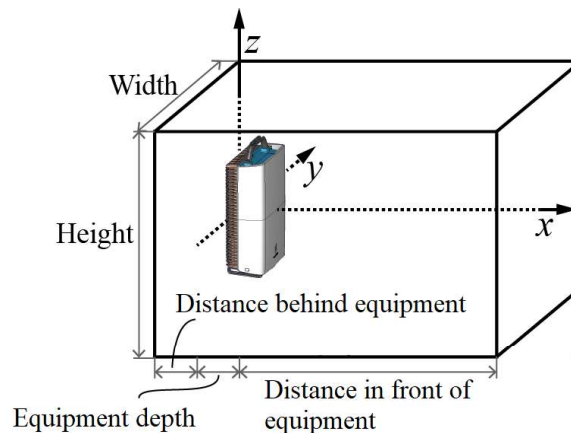


Figure 1 Box-shaped structure specifying the compliance boundary for the tested RBS product.

When applied in the near field, for instance behind the antenna, the spherical far-field formula provides very conservative results. Given the relatively large distance from the antenna array elements to the back of the antenna, it is possible to state that the compliance distance behind the antenna measured from its back plane is less than 0.2 m. From measurements of a typical 3.5 GHz AAS testbed transmitting with nominal total output power of 36 dBm, the maximum power density behind was found to be 0.02 W/m² [5]. For a total output power of 53.3 dBm, this power density value scales to 1.7 W/m², which is far below the general public and workers power density limits listed in Table 4.

In Figure 2-7, the compliance distance results for general public (blue line) and workers (red line) exposure are given for the tested configurations leading to the largest compliance boundary. The results are provided for the FCC exposure limits. Also shown are the resulting compliance boundaries (black lines, solid for general public, dashed for workers exposure). The resulting compliance boundary dimensions are given in Table 5 rounded upwards to the nearest decimeter.

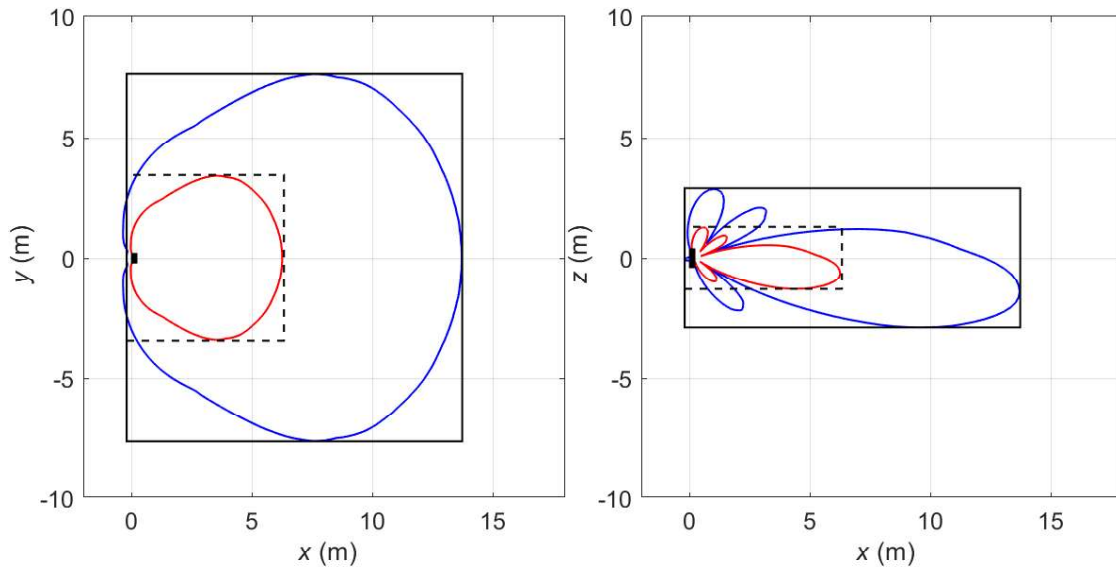


Figure 2 Compliance boundaries for general public (black solid line) and workers (black dashed line) exposure for the markets where the FCC exposure limits apply. The blue and red solid lines correspond to compliance distance results for general public and workers exposure, respectively, obtained using the spherical models. The antenna is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B77D (NR). Total time-averaged power delivered to the antenna: 48.0 dBm.

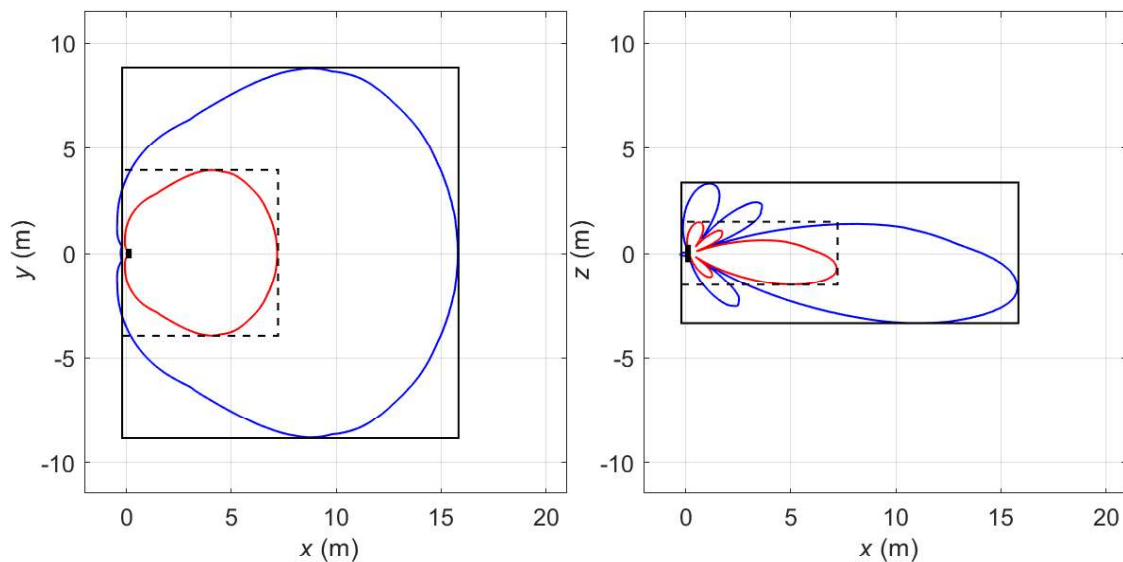


Figure 3 Compliance boundaries for general public (black solid line) and workers (black dashed line) exposure for the markets where the FCC exposure limits apply. The blue and red solid lines correspond to compliance distance results for general public and workers exposure, respectively, obtained using the spherical models. The antenna is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B77D (NR). Total time-averaged power delivered to the antenna: 49.3 dBm.

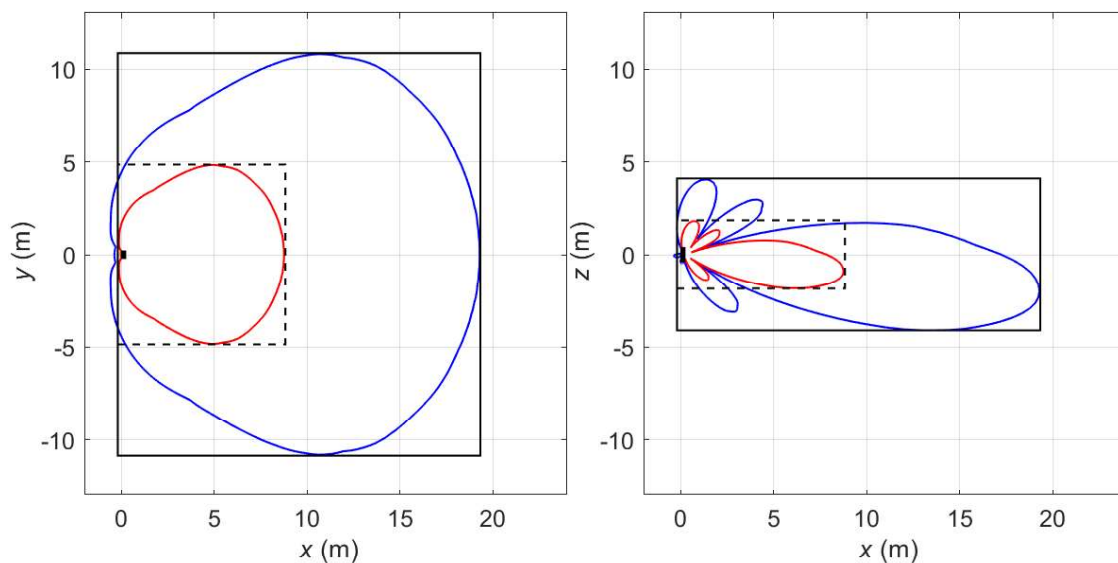


Figure 4 Compliance boundaries for general public (black solid line) and workers (black dashed line) exposure for the markets where the FCC exposure limits apply. The blue and red solid lines correspond to compliance distance results for general public and workers exposure, respectively, obtained using the spherical models. The antenna is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B77D (NR). Total time-averaged power delivered to the antenna: 51.0 dBm.

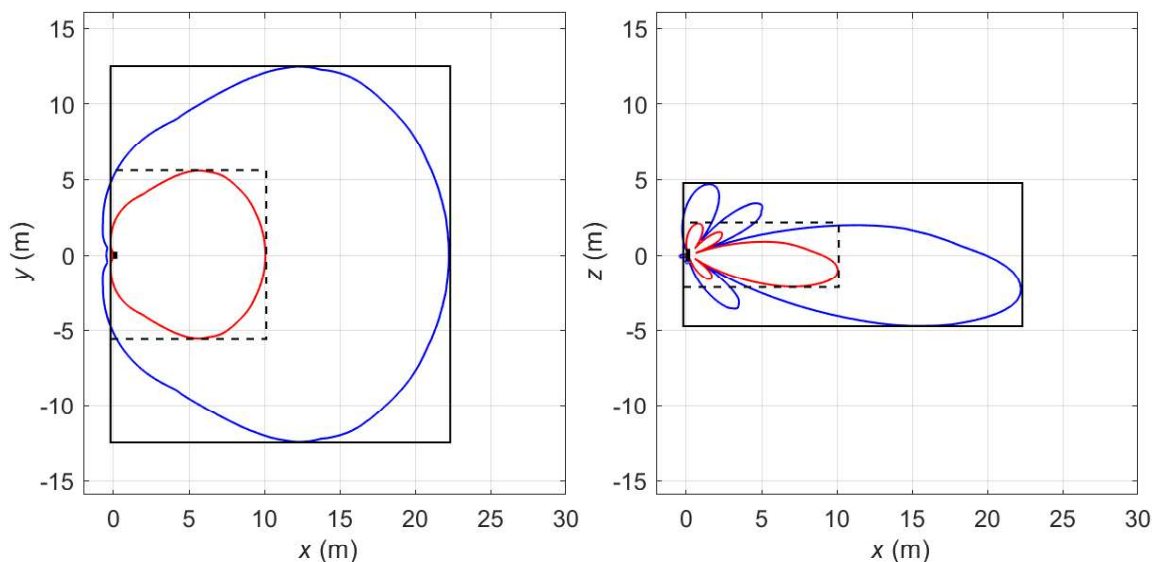


Figure 5 Compliance boundaries for general public (black solid line) and workers (black dashed line) exposure for the markets where the FCC exposure limits apply. The blue and red solid lines correspond to compliance distance results for general public and workers exposure, respectively, obtained using the spherical models. The antenna is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B77D (NR). Total time-averaged power delivered to the antenna: 52.3 dBm.

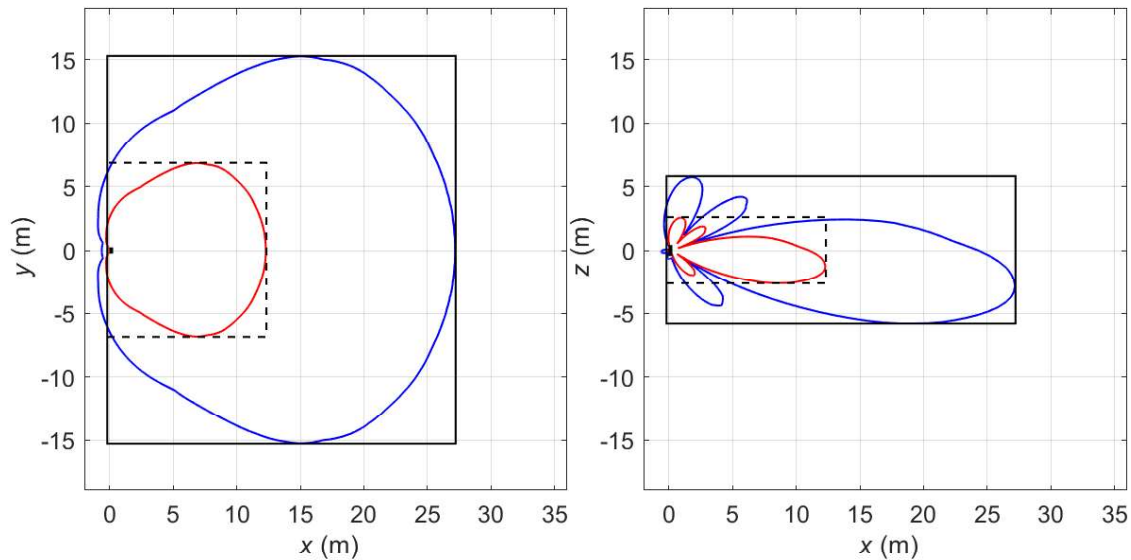


Figure 6 Compliance boundaries for general public (black solid line) and workers (black dashed line) exposure for the markets where the FCC exposure limits apply. The blue and red solid lines correspond to compliance distance results for general public and workers exposure, respectively, obtained using the spherical models. The antenna is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B77D (NR). Total time-averaged power delivered to the antenna: 54.1 dBm.

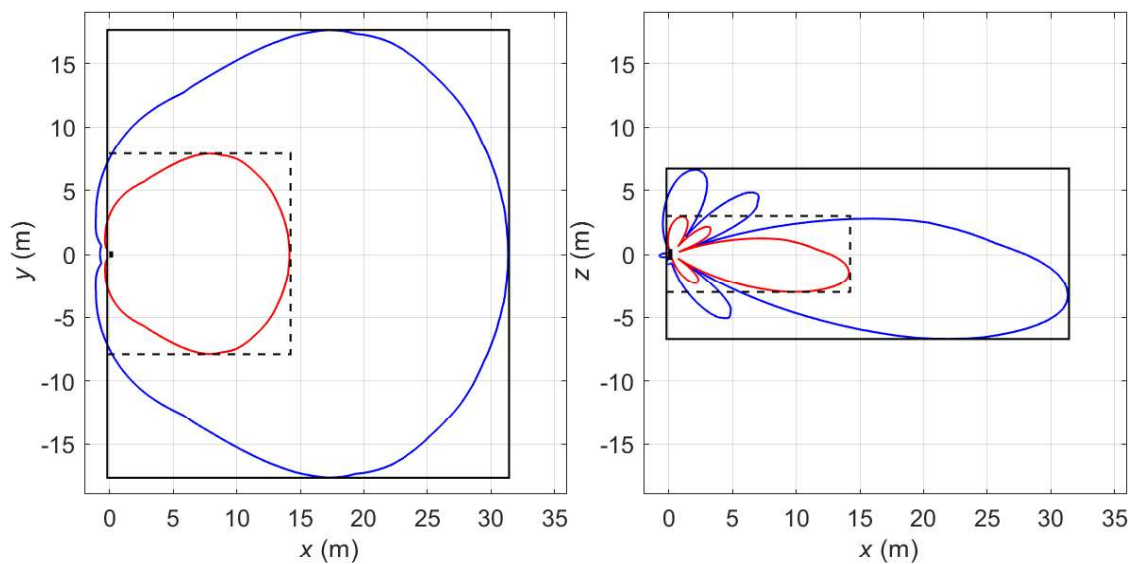


Figure 7 Compliance boundaries for general public (black solid line) and workers (black dashed line) exposure for the markets where the FCC exposure limits apply. The blue and red solid lines correspond to compliance distance results for general public and workers exposure, respectively, obtained using the spherical models. The antenna is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B77D (NR). Total time-averaged power delivered to the antenna: 55.3 dBm.

Table 5 Dimensions of the box-shaped compliance boundary for general public (GP) and workers (W) exposure for AIR 6449 applicable in the markets employing the FCC exposure limits for maximum output power with power tolerance and TDD downlink duty cycle included.

Mode and output power for AIR 6449					Dimensions of the box-shaped compliance boundary (m)							
					Distance in front of EUT		Width		Height		Distance behind EUT	
Band	Standard	Maximum configured output power from the radio	Power tolerance	TDD DL duty cycle	GP	W	GP	W	GP	W	GP	W
B77D	NR	60 W	1.5 dB	75 %	13.5	6.1	15.3	6.9	5.8	2.6	0.2	0.2
B77D	NR	80 W	1.5 dB	75 %	15.6	7.0	17.7	7.9	6.7	3.0	0.2	0.2
B77D	NR	120 W	1.5 dB	75 %	19.1	8.6	21.7	9.7	8.2	3.7	0.2	0.2
B77D	NR	160 W	1.5 dB	75 %	22.1	9.9	25.0	11.2	9.5	4.3	0.2	0.2
B77D	NR	240 W	1.5 dB	75 %	27.0	12.1	30.6	13.7	11.6	5.2	0.2	0.2
B77D	NR	320 W	1.5 dB	75 %	31.2	14.0	35.3	15.8	13.4	6.0	0.2	0.2

For the power levels specified in the table with tolerances added, and the upward rounding of compliance boundary dimensions to the nearest decimeter, the specified results are conservative.

6 Uncertainty

For the input parameters defined in the test report, the calculated compliance boundary dimensions determined according the approach described in Section 4 results in an exposure assessment which is conservative. The compliance boundary dimensions were determined by comparing the evaluated RF exposure directly with the limits.

7 Conclusion

The Ericsson AIR 6449 B77D has been tested using methods and procedures specified in FCC OET Bulletin 65 [3] and IEC 62232:2017 [4]. The results in Section 5 show the compliance boundary dimensions for the considered configurations of the product. Outside of these compliance boundaries, the RF exposure is below the limits specified in [1].

8 References

- [1] FCC, Code of Federal Regulations CFR title 47, part 1.1310 "Radiofrequency radiation exposure limits", Federal Communications Commission (FCC), August 1997.
- [2] Ericsson, GFTE-16:001718 Uen, "Ericsson RF exposure calculation procedure for base stations".
- [3] FCC, "Evaluating compliance with FCC guidelines for human exposure to radiofrequency electromagnetic fields. OET Bulletin 65. Edition 97-01." Federal Communications Commission (FCC), Office of Engineering and Technology, August 1997.
- [4] IEC 62232:2017, "Determination of RF field strength, power density and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure", June 2017.
- [5] Ericsson, GFTB-18:001016 Uen, "EMF assessments of the Ericsson 5G Testbed V1.0 RRU 3.5 GHz".
- [6] Ericsson, LME-12:001904 Uen, "Exposure to radio frequency electromagnetic fields".

9 Revision history

Rev.	Date	Description
A	2020-09-08	First revision.
B	2021-02-11	Second revision. Update of test results with the new antenna radiation pattern files and update of the report according to the latest test report template.
C	2021-02-15	Third revision. Correct the antenna gain in Table 2
D	2021-03-26	Added results for configured output power levels of 60, 80, 120, 160 and 240 W.

Appendix A. Information to be included in the CPI

Table A.1 below lists the compliance boundaries (exclusion zones), outside of which the RF EMF exposure from AIR 6449 is below the limits applicable in:

- USA (47 CFR 1.1310)

Information is provided for the theoretical maximum exposure condition.

Table A.1 Dimensions of the box-shaped compliance boundary for general public (GP) and occupational (O) exposure for AIR 6449 applicable in the markets employing the FCC exposure limits.

Mode and output power for AIR 6449						Dimensions of the box-shaped compliance boundary ⁽¹⁾ (m)							
						Distance in front of equipment		Width		Height		Distance behind equipment	
Band	Standard	Maximum configured output power from the radio	IEC 62232 Installation class	Power tolerance	TDD DL duty cycle	GP	O	GP	O	GP	O	GP	O
B77D	NR	60 W	E+	1.5 dB	75 %	13.5	6.1	15.3	6.9	5.8	2.6	0.2	0.2
B77D	NR	80 W	E+	1.5 dB	75 %	15.6	7.0	17.7	7.9	6.7	3.0	0.2	0.2
B77D	NR	120 W	E+	1.5 dB	75 %	19.1	8.6	21.7	9.7	8.2	3.7	0.2	0.2
B77D	NR	160 W	E+	1.5 dB	75 %	22.1	9.9	25.0	11.2	9.5	4.3	0.2	0.2
B77D	NR	240 W	E+	1.5 dB	75 %	27.0	12.1	30.6	13.7	11.6	5.2	0.2	0.2
B77D	NR	320 W	E+	1.5 dB	75 %	31.2	14.0	35.3	15.8	13.4	6.0	0.2	0.2

(1) The compliance boundaries are determined for maximum output power with power tolerance and TDD downlink duty cycle included.

Appendix B. Guidelines on how to install the product

The Ericsson AIR 6449 B77D product (KRD 901 206/11, KRD 901 206/1) shall be installed to make sure that the general public does not have access to the applicable RF EMF compliance boundary. The compliance boundary dimensions were determined for the product transmitting in free space.

Appendix C. Guidelines for workers during installation, maintenance, and repair of the product

For the Ericsson AIR 6449 B77D product (KRD 901 206/11, KRD 901 206/1), if work needs to be performed within the compliance boundary applicable for workers, the radio equipment shall be powered off, or the power be reduced to a level ensuring that the RF EMF exposure is below the relevant exposure limit for workers.

If work is conducted on behalf of Ericsson, minimum EMF related requirements are provided in [6].