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EMF Test Report: Ericsson AIR 6472 B77G B77M NR (FCC)

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Testing laboratory:	Ericsson EMF Research Laboratory Ericsson AB SE-164 80 Stockholm Sweden	Company/Client:	Peter Carlsson Ericsson AB Blåfjällsgatan 4 164 80 Stockholm Sweden
Tests performed by:	Carla Di Paola	Dates of tests:	2023-05-04
Manufacturer and market name(s) of device:	Ericsson AIR 6472 B77G B77M		
Testing has been performed in accordance with:	FCC OET Bulletin 65 IEC 62232:2022		
Test results:	RF exposure compliance boundaries (exclusion zones) in conformity with FCC 47 CFR 1.1310 to be included in the Customer Product Information (CPI) for Ericsson AIR 6472 B77G B77M NR.		
Additional information:			
Signature:	Test Engineer  <hr/> Carla Di Paola Experienced Researcher carla.di.paola@ericsson.com Tel: +46 724650873	Quality Manager  <hr/> Christer Törnevik Senior Expert – EMF and Health christer.tornevik@ericsson.com Tel: +46 705863148	

Summary of EMF Test Report¹

Equipment under test (EUT)

Product name	AIR 6472 B77G B77M		
Product number	KRD 901 259/1, KRD 901 259/11		
Supported bands, Tx frequency range (MHz) and standards	B77G B77M	3450 - 3550 3840 - 3980	NR
Duplexing technology and fraction of downlink transmission time to total time	TDD (75%)		

Results

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

Dimensions of the box-shaped compliance boundary for general public (GP) and occupational (O) exposure for AIR 6472 B77G B77M applicable in the USA and markets employing the FCC RF exposure limits. The compliance boundaries are determined for maximum nominal output power with output power tolerance and TDD downlink duty cycle included.

Mode and output power for AIR 6472					Dimensions of the box-shaped compliance boundary (m)							
					Distance in front of EUT		Width		Height		Distance behind EUT	
Band	Standard	Maximum nominal output power from the radio	Power tolerance	TDD DL duty cycle	GP	O	GP	O	GP	O	GP	O
B77M	NR	400 W	1 dB	75 %	40.0	17.9	42.6	19.1	14.4	6.5	0.2	0.2
B77G + B77M		300 W (B77G) + 100 W (B77M)			37.1	16.6	42.6	19.1	14.1	6.3	0.2	0.2
B77G + B77M		200 W (B77G) + 200 W (B77M)			38.1	17.1	42.3	19.0	14.2	6.4	0.2	0.2
B77G + B77M		100 W (B77G) + 300 W (B77M)			39.1	17.5	42.3	19.0	14.3	6.4	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 6472 B77G B77M NR. Outside of these compliance boundaries the radio frequency (RF) exposure levels are below the exposure limits specified 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 62232:2022 [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 nominal output power from the radio unit and the total time-averaged power delivered to the antenna. The total time-averaged power delivered to the antenna includes the 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 6472 B77G B77M	KRD 901 259/1, KRD 901 259/11
Supported bands, Tx frequency range (MHz), and standards	B77G B77M	3450 - 3550 3840 - 3980 NR
Dimensions, H × W × D (mm)	922 × 402 × 188	
Duplexing technology and fraction of downlink transmission time to total time	TDD (75 %)	
Exposure environment	General public/uncontrolled, Occupational/controlled	
IEC 62232 installation class²	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 108 26
Type	Internal AAS
Number of polarizations	2
Gain³ (dBi)	27.3
Antenna configuration (no. of subarray rows, subarray columns and polarizations)	4x8x2
Subarray configuration	4x1
Antenna pattern files	3/15570-KRD901259/11
Maximum scan range in horizontal plane (degrees)	± 60
Maximum scan range in vertical plane (degrees)	87 – 105

Table 3 EUT configurations with the maximum nominal output power level and the total time-averaged power level including the output power tolerance and the TDD downlink duty cycle.

Band⁴	Standard	Maximum nominal output power from the radio	Power tolerance (dB)	TDD downlink duty cycle	Total time-averaged power delivered to antenna (dBm/W)
B77M	NR	400 W	1 dB	75 %	55.8 / 377.7
B77G + B77M		300 W (B77G) + 100 W (B77M)			55.8 / 377.7 (54.5 / 283.3 (B77G) + 49.8 / 94.4 (B77M))
B77G + B77M		200 W (B77G) + 200 W (B77M)			55.8 / 377.7 (52.8 / 188.8 (B77G) + 52.8 / 188.8 (B77M))
B77G + B77M		100 W (B77G) + 300 W (B77M)			55.8 / 377.7 (49.8 / 94.4 (B77G) + 54.5 / 283.3 (B77M))

3 Exposure conditions

The EUT is intended to be used outdoor and installed on poles, walls, masts, towers, 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.

The maximum TDD downlink duty cycle was considered to obtain the maximum time-averaged power delivered to the antenna.

Other 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. A theoretical maximum exposure condition assessment was conducted, in which these factors were not considered, which makes the obtained compliance boundaries very conservative.

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 Ericsson in-house MATLAB-based tool called MSI compliance analyzer

³ The stated gain value is the maximum gain of the antenna within the frequency band(s) supported by the product and obtained using the antenna patterns provided by the client. The patterns used are based on theoretical modelling of the antenna and may differ slightly from the measured ones.
⁴ AIR 6472 B77G single band mode is not allowed due to regulatory requirements.

(release 2022-02) [5]. The first step in calculating the compliance boundary was to use the spherical far-field formula to estimate power density:

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

where $S, P_a, G, r, \theta,$ and ϕ denote the power density, the total time-averaged power accepted by the 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 includes the output power tolerance and the TDD downlink duty cycle.

The envelope of antenna gains for all possible traffic beams as well as antenna gain patterns for broadcast beams were provided by the client based on theoretical modelling of the antenna. Only the traffic beam envelope was used in the calculation of the compliance boundary as the contribution from the broadcast beams is negligible for NR and thus the overestimation of the RF exposure by applying the total power to the higher gain traffic beams is insignificant. The use of these antenna gain patterns, together with the applied tolerance, provides an upper bound for the compliance boundary. Such envelope patterns were provided for six frequencies, specifically 3450 MHz, 3500 MHz, and 3550MHz (B77G), and 3840 MHz, 3910 MHz, and 3980MHz (B77M). Maximum gain values, corresponding to the maximum of all the envelope patterns, were used in the above equation to estimate power density. The maximum gain value of the antenna considering all possible scan directions was found to be 26.4 dBi for B77G and 27.3 dBi for B77M.

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

$$\sum_{j=1}^2 \frac{S_{\text{total,sph,Band}_j}(r, \theta, \phi)}{S_{\text{gp,o,Band}_j}^{\text{lim}}} = 1,$$

Where $\text{Band}_j \in \{\text{B77G}, \text{B77M}\}$ and $S_{\text{gp,o}}^{\text{lim}}$ denotes the FCC power density limits for general public and occupational exposure. The limits for the frequency bands of interest are given in Table 4.

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

Band	$S_{\text{gp}}^{\text{lim}}$ (W/m ²)	$S_{\text{o}}^{\text{lim}}$ (W/m ²)
B77G	10.0	50.0
B77M	10.0	50.0

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 antenna 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.

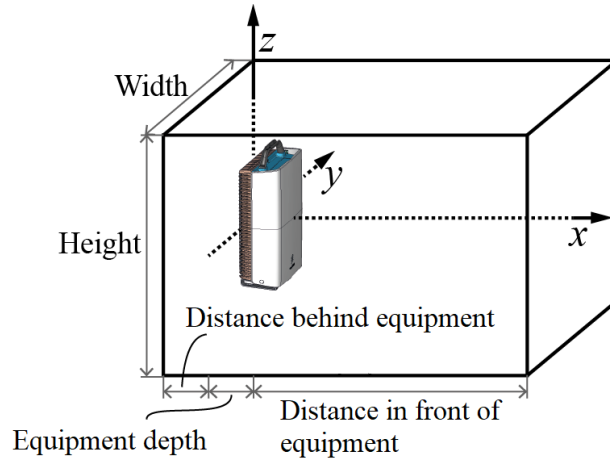


Figure 1 Box-shaped structure specifying the compliance boundary for the tested RBS product.

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, and based on extensive experience from a large set of numerical EMF tests for products and antennas with similar geometrical configurations and power levels, it is possible to state that the compliance distance behind the antenna measured from its back plane is 0 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 [6]. For a total output power of 55.8 dBm, this power density value scales to 1.9 W/m² which is far below the general public and occupational power density limits listed in Table 4.

From Figure 2 to Figure 6, compliance distance results for general public exposure (blue line) and occupational exposure (red line) are given for the tested configurations leading to the largest compliance boundary for theoretical and actual maximum exposure conditions, respectively. Also shown are the resulting compliance boundaries (black lines, solid for general public, dashed for occupational exposure). The resulting compliance boundary dimensions are given in Table 5 rounded upwards to the nearest decimeter.

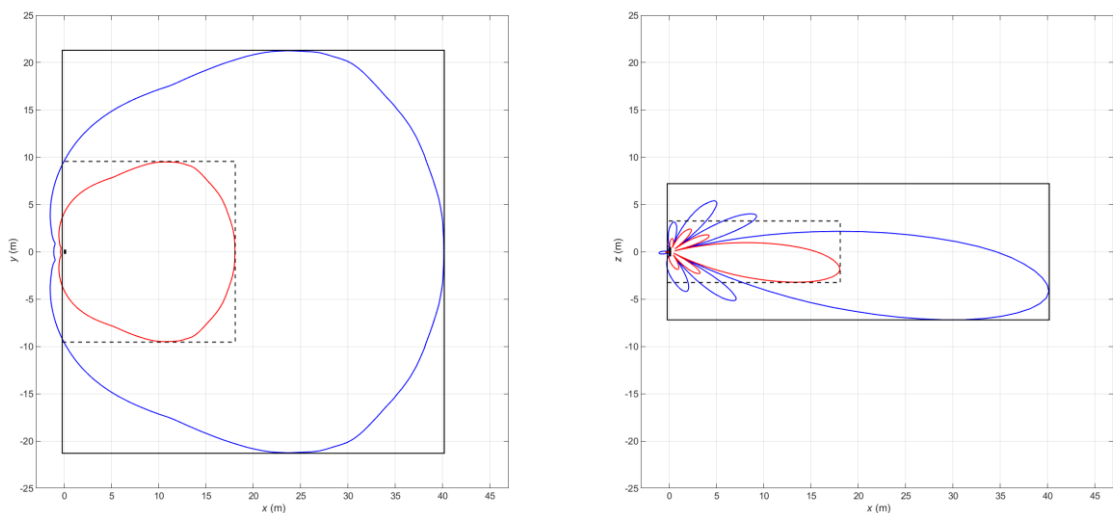


Figure 2 Compliance boundaries for general public exposure (black solid line) and occupational exposure (black dashed line) for the markets where the FCC limits apply. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical models. The red solid lines indicate the corresponding compliance distance results for occupational exposure. The EUT is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B77G B77M (NR). Total time-averaged power delivered to the antenna: 55.8 dBm / 377.7 W (B77M).

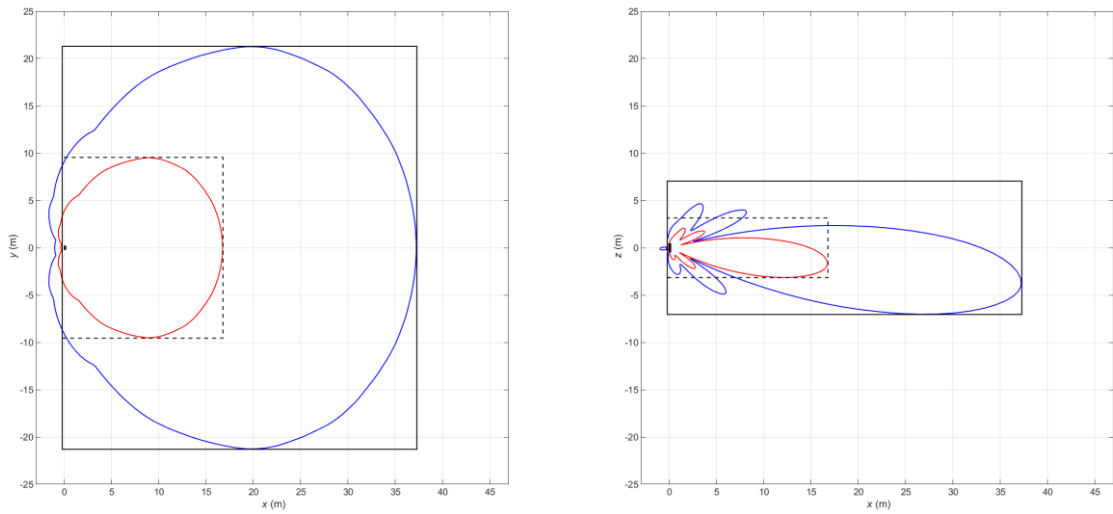


Figure 3 Compliance boundaries for general public exposure (black solid line) and occupational exposure (black dashed line) for the markets where the FCC limits apply. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical models. The red solid lines indicate the corresponding compliance distance results for occupational exposure. The EUT is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B77G B77M (NR). Total time-averaged power delivered to the antenna: 55.8 dBm / 377.7 W (283.3 W (B77G) + 94.4 W (B77M)).

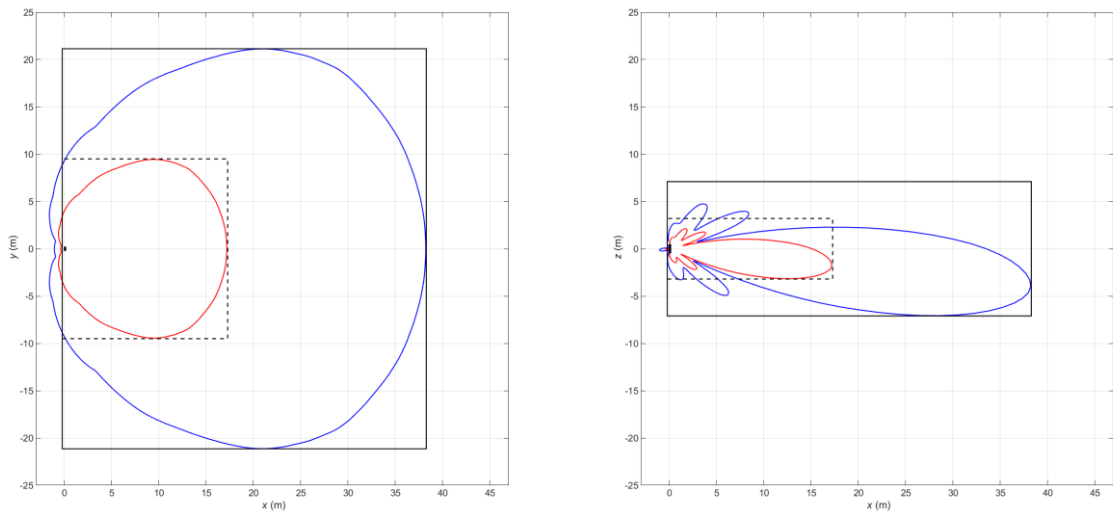


Figure 4 Compliance boundaries for general public exposure (black solid line) and occupational exposure (black dashed line) for the markets where the FCC limits apply. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical models. The red solid lines indicate the corresponding compliance distance results for occupational exposure. The EUT is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B77G B77M (NR). Total time-averaged power delivered to the antenna: 55.8 dBm / 377.7 W (188.8 W (B77G) + 188.8 W (B77M)).

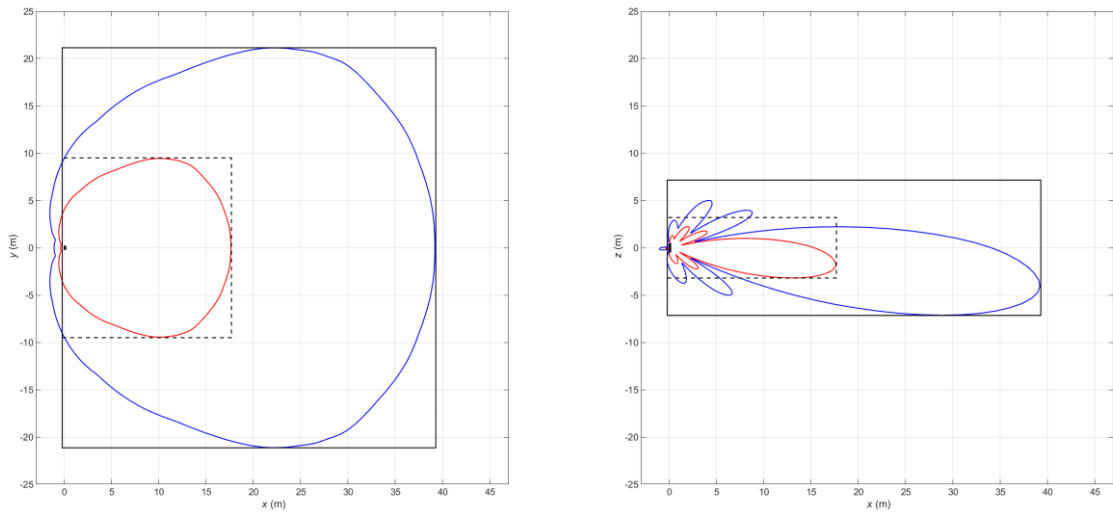


Figure 5 Compliance boundaries for general public exposure (black solid line) and occupational exposure (black dashed line) for the markets where the FCC limits apply. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical models. The red solid lines indicate the corresponding compliance distance results for occupational exposure. The EUT is shown from above (left) and from the side (right) with its backplane located at $x = 0$ m. Mode: B77G B77M (NR). Total time-averaged power delivered to the antenna: 55.8 dBm / 377.7 W (94.4 W (B77G) + 283.3 W (B77M)).

Table 5 Dimensions of the box-shaped compliance boundary for general public (GP) and occupational (O) exposure for AIR 6472 B77G B77M applicable in the USA and markets employing the FCC RF exposure limits. The compliance boundaries are determined for maximum nominal output power with output power tolerance and TDD downlink duty cycle included.

Mode and output power AIR 6472					Dimensions of the box-shaped compliance boundary (m)							
					Distance in front of EUT		Width		Height		Distance behind EUT	
Band	Standard	Maximum nominal output power from the radio	Power tolerance	TDD DL duty cycle	GP	O	GP	O	GP	O	GP	O
B77M	NR	400 W	1 dB	75 %	40.0	17.9	42.6	19.1	14.4	6.5	0.2	0.2
B77G + B77M		300 W (B77G) + 100 W (B77M)			37.1	16.6	42.6	19.1	14.1	6.3	0.2	0.2
B77G + B77M		200 W (B77G) + 200 W (B77M)			38.1	17.1	42.3	19.0	14.2	6.4	0.2	0.2
B77G + B77M		100 W (B77G) + 300 W (B77M)			39.1	17.5	42.3	19.0	14.3	6.4	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 to 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 6472 B77G B77M has been tested using methods and procedures specified in FCC OET Bulletin 65 [3] and IEC 62232:2022 [4]. The results in Section 5 show the compliance boundary dimensions of the product to be included in the Customer Product Information (CPI). 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), April 2020.
- [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 Edition 3.0, "Determination of RF field strength, power density and SAR in the vicinity of base stations for the purpose of evaluating human exposure", October 2022.
- [5] Ericsson, GFTL-19:000424 Uen, "User manual of MSI compliance analyzer".
- [6] Ericsson, GFTB-18:001016 Uen, "EMF assessments of the Ericsson 5G Testbed V1.0 RRU 3.5 GHz".
- [7] Ericsson, LME-12:001904 Uen, "Exposure to radio frequency electromagnetic fields".

9 Revision history

Rev.	Date	Description
A	2023-05-05	First revision.
B	2024-02-27	Second revision. B77G single band specific results removed as B77G single band mode is not allowed due to regulatory requirements.

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 6472 is below the limits specified by the FCC, and the limits applicable in:

- USA (47 CFR 1.1310)

Information is provided for the theoretical maximum

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

Mode and output power						Dimensions of the box-shaped compliance boundary ⁽¹⁾ (m)							
						Distance in front of AIR		Width		Height		Distance behind AIR	
Product	Standard	Maximum nominal output power from the radio	IEC 62232 installation class	Power tolerance	TDD DL duty cycle	GP	O	GP	O	GP	O	GP	O
AIR 6472 B77G B77M	NR	400 W (B77M)	E+	1 dB	75 %	40.0	17.9	42.6	19.1	14.4	6.5	0.2	0.2
		300 W (B77G) + 100 W (B77M)				37.1	16.6	42.6	19.1	14.1	6.3	0.2	0.2
		200 W (B77G) + 200 W (B77M)				38.1	17.1	42.3	19.0	14.2	6.4	0.2	0.2
		100 W (B77G) + 300 W (B77M)				39.1	17.5	42.3	19.0	14.3	6.4	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 AIR 6472 B77G B77M product (KRD 901 259/1, KRD 901 259/11) 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 AIR 6472 B77G B77M product (KRD 901 259/1, KRD 901 259/11), 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 [7].

Appendix D. Photograph/Sketch of the EUT

