

**Rapport utfärdad av ackrediterat provningslaboratorium**
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EMF Test Report: Ericsson AIR 5121

Document number:	GFTB-17:001589 Uen Rev C	Date of report:	2018-10-10
Testing laboratory:	Ericsson EMF Research Laboratory Ericsson AB SE-164 80 Stockholm Sweden	Company/Client:	Göran Berglund Ericsson AB SE-164 80 Stockholm Sweden
Tests performed by:	Elif Degirmenci	Dates of tests:	2018-10-10 (Rev C) This document replaces the GFTB- 17:001589 Uen, Rev B
Manufacturer and market name(s) of device:	Ericsson AIR 5121		
Testing has been performed in accordance with:	European standards: EN 50385:2017, IEC/EN 62232:2017 FCC OET Bulletin 65		
Test results:	The tested equipment complies with the requirements in respect of all parameters subject to the test.		
Additional information:	By inclusion of the test report summary and the content of Appendices B and C in the product documentation, the tested equipment complies with the requirements of EN 50385.		
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1 Summary of EMF Test Report¹

Equipment under test (EUT)

Product name	AIR 5121		
Product number	KRD 901 059/1, KRD 901 059/4		
Supported Tx frequency range (GHz) and standards	27.5 - 28.35	NR, VTF (pre-NR)	
Duplexing technology and fraction of downlink transmission time to total time	TDD (89 %)		
Exposure environment	General public/uncontrolled, Workers/controlled		
EIRP ² (dBm) and IEC 62232 installation class [9]	55	E+	

1.1 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 maximum output power including 1.5 dB power tolerance and TDD ratio.

Mode and output power for AIR 5121		Dimensions of the box-shaped compliance boundary (m)							
		Distance in front of antenna		Width		Height		Distance behind antenna	
Standard	Nominal EIRP per beam	GP	W	GP	W	GP	W	GP	W
NR, VTF ³ (pre-NR)	46 dBm	1.8	0.8	2.3	1.0	1.0	0.5	0	0

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

² The stated EIRP value is the total EIRP without power tolerance included.

³ The abbreviation stands for Verizon technical forum.

2 General information

The test results presented in this report define compliance boundaries for maximum power configurations for AIR 5121. Outside of these compliance boundaries the radio frequency (RF) exposure levels are below the limits specified by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) [3]-[5] and the Federal Communications Commission (FCC) [6][7].

The tests were performed by calculations in accordance with the Ericsson RF exposure calculation procedure for base stations [8], which is in conformity with the European standards IEC/EN 62232 [9], EN 50385 [2], and FCC OET Bulletin 65 [7].

Recommended product specific EMF health and safety information for Ericsson radio products is found in [1]. By inclusion of the test report summary in [1] and the content of Appendices B and C in the product documentation of the tested equipment, it complies with the documentation requirements listed in clause 8 of EN 50385 [2].

3 Equipment under test

Tables 1 and 2 below summarize the technical data for the equipment under test (EUT) and the antenna properties for the tested antennas.

Table 1 Technical data for the EUT.

Product name and product number	AIR 5121	KRD 901 059/1, KRD 901 059/4
Supported Tx frequency range (GHz), and standards	27.5 - 28.35	NR, VTF (pre-NR)
Antennas	PAAM (Phased Array Antenna Module)	
Dimensions, H x W x D (mm)	600 x 300 x 90	
Duplexing technology and fraction of downlink transmission time to total time	TDD (89 %)	
Exposure environment	General public, Workers	
EIRP ⁴ (dBm) and IEC 62232 installation class [9]	55	E+

Table 2. EUT antenna properties.

Type	Internal AAS
Number of antenna panels	4
Number of beams	8
Gain ⁵ (dBi)	24
EIRP ⁶ (dBm) per beam	46
Horizontal HPBW ⁷ (degrees)	12°±2°
Vertical HPBW ⁷ (degrees)	12°±2°
Number of antenna elements (N_H, N_V)	(8,8) (2 polarizations)
Element separation distance (Δ_H, Δ_V) (mm)	(5.9, 5.9)
Maximum scan range in horizontal plane (degrees)	±60°
Maximum scan range in vertical plane (degrees)	±15°

⁴ The stated EIRP value is the total EIRP without power tolerance included.

⁵ The stated gain value is the peak beam gain.

⁶ The stated EIRP value is the peak beam EIRP without power tolerance included.

⁷ The stated half-power beam widths are for the reference direction $(\theta, \phi) = (90^\circ, 0^\circ)$.

Table 3 lists the nominal output power from the radio unit (total power from all antenna branches) and the total power delivered to the antenna panels. The total power antenna includes an output power tolerance of 1.5 dB and TDD ratio.

Table 3. Nominal output power level and total power level including a tolerance of 1.5 dB and TDD ratio for the EUT.

Standard	Nominal output power from the radio (dBm/W)	Maximum TDD downlink/uplink ratio [8]	Total time-averaged power delivered to antenna panels (dBm/W)
NR, VTF (pre-NR)	31 / 1.26	89:11	32 / 1.58

4 Exposure conditions

The EUT is intended to be installed on roof-tops, masts, towers, buildings, 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/uplink ratio 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. These factors were however not considered in this assessment, which adds to the conservativeness of the obtained compliance boundaries.

5 Exposure limits

Table 4 presents the FCC [6] and ICNIRP [3] limits on power density for general public/uncontrolled and workers/controlled exposure in the frequency range used by the EUT.

Table 4 RF EMF exposure limits applicable for the frequency range used by the EUT.

Quantity	General public / Uncontrolled exposure limit	Workers / Controlled exposure limit
Power density S (W/m ²)	10	50

6 EMF compliance boundary calculations

Compliance boundary calculations were conducted according to the Ericsson RF exposure calculation procedure for base stations using large array antennas [8] which is based on the far-field formula assuming a cosine scan loss and a Gaussian beam shape [9],[11]. For convenience, the used formulas taken from [8] are included in Appendix A.

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

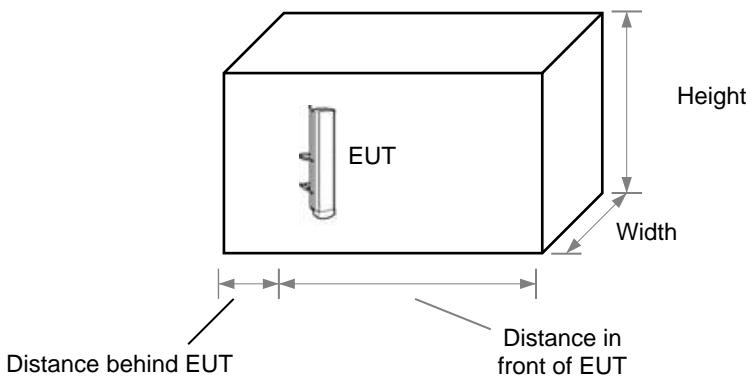


Figure 1. Box-shaped structure specifying the compliance boundary for the EUT.

The compliance distance behind the EUT is determined using the SAR estimation formula [8],[9]. With the number of elements and the total power level given in Table 2 and Table 3, and the ICNIRP/FCC localized SAR limits for general public and workers, the compliance distance behind the antenna ground plane was found to be less than 1 cm for both general public and workers exposure. Since this distance is much shorter than the thickness of the radio located behind the antenna, the EUT is compliant for touch conditions in the back direction.

The obtained compliance boundary dimensions are given in Table 5.

Table 5 Dimensions of the box-shaped compliance boundary for general public (GP) and workers (W) exposure for maximum output power with an assumed 1.5 dB power tolerance and TDD ratio.

Mode and output power for AIR 5121		Dimensions of the box-shaped compliance boundary (m)							
		Distance in front of EUT		Width		Height		Distance behind EUT	
Standard	Nominal EIRP per beam	GP	W	GP	W	GP	W	GP	W
NR, VTF (pre-NR)	46 dBm	1.8	0.8	2.3	1.0	1.0	0.5	0	0

7 Uncertainty

The input parameters were chosen within their range so as to maximize the calculated compliance boundary dimensions. Consequently, the approach described in Section 6 results in an exposure assessment which is conservative.

8 References

- [1] Ericsson, 5/124 46-LZA 701 6001, “Radio Frequency Electromagnetic Exposure, CDMA/GSM/LTE/WCDMA”.
- [2] EN 50385, “Product standard to demonstrate the compliance of base station equipment with radio frequency electromagnetic field exposure limits (110 MHz – 100 GHz), when placed on the market”, European Committee for Electrotechnical Standardization (CENELEC), 2017.
- [3] ICNIRP, “Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)”, International Commission on Non-Ionizing Radiation Protection (ICNIRP), Health Physics, vol. 74, pp 494-522, April 1998.
- [4] 1999/519/EC, “Council Recommendation on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)”, July 1999.
- [5] 2013/35/EU, “Directive of the European Parliament and of the Council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents

(electromagnetic fields) (20th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) and repealing Directive 2004/40/EC", June 2013.

- [6] FCC, Code of Federal Regulations CFR title 47, part 1.1310 "Radiofrequency radiation exposure limits", Federal Communications Commission (FCC), August 1997.
- [7] 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.
- [8] GFTE-16:001718 Uen, "Ericsson RF exposure calculation procedure for base stations", Instruction.
- [9] EN/IEC 62232:2017, Determination of RF field strength, power density and SAR in the vicinity of radio communication base stations for the purpose of evaluating human exposure, 2017
- [10] 3GPP TS 36:211, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation", 2017
- [11] Mailloux, "Phased array antenna handbook", Artech House, 2005.
- [12] Ericsson, LME-12:001904 Uen, "Exposure to radio frequency electromagnetic fields".

9 Revision history

Rev.	Date	Description
A	2017-10-24	First revision
B	2018-01-16	Corrected nominal power per beam and updated results
C	2018-10-10	Removed bands, updated standard and product numbers

Appendix A. Formulas used to estimate the compliance boundary dimensions

The compliance distances in front of, to the left/right and above/below the EUT are determined using the equations below [8]

$$CD_{\text{front}} = \sqrt{\frac{PA}{\lambda^2 S_{\text{lim}}}}$$

$$CD_{\text{left/right}} = \max_{\alpha \leq \alpha_{\text{max,H}}} \left(CD_{\text{front}} \sqrt{\cos \alpha} \sqrt{2 - \left[\frac{2(\alpha_{\text{GS,H}} - \alpha)}{HHPBW(\alpha)} \right]^2} \sin(\alpha_{\text{GS,H}}) \right)$$

$$CD_{\text{up/down}} = \max_{\alpha \leq \alpha_{\text{max,V}}} \left(CD_{\text{front}} \sqrt{\cos \alpha} \sqrt{2 - \left[\frac{2(\alpha_{\text{GS,V}} - \alpha)}{VHPBW(\alpha)} \right]^2} \sin(\alpha_{\text{GS,V}}) \right)$$

where $\alpha_{\text{max,H}}$, $\alpha_{\text{max,V}}$, $HHPBW$, and $VHPBW$ denote the maximum scan angles and the half power beam widths in the horizontal and vertical planes, respectively, and A denotes the antenna aperture area given by

$$A = N_y \Delta_y N_z \Delta_z$$

Furthermore, with λ denoting the free space wavelength

$$\alpha_{\text{GS,H}} = \frac{\tilde{A}_H \alpha + \sqrt{\tilde{A}_H^2 \alpha^2 + 4\tilde{A}_H + \frac{4}{3}}}{2\left(\tilde{A}_H + \frac{1}{3}\right)}$$

$$\alpha_{\text{GS,V}} = \frac{\tilde{A}_V \alpha + \sqrt{\tilde{A}_V^2 \alpha^2 + 4\tilde{A}_V + \frac{4}{3}}}{2\left(\tilde{A}_V + \frac{1}{3}\right)}$$

$$\tilde{A}_H^2 = \frac{4 \ln 2}{[HHPBW(\alpha)]^2}$$

$$\tilde{A}_V^2 = \frac{4 \ln 2}{[VHPBW(\alpha)]^2}$$

$$HHPBW(\alpha) = \frac{0.886\lambda}{N_y \Delta_y \cos \alpha}$$

$$VHPBW(\alpha) = \frac{0.886\lambda}{N_z \Delta_z \cos \alpha}$$

The compliance distance in the back direction is given by [9]

$$CD_{\text{back}}^{\text{gp,occ}} = \frac{D_{10g}^{\text{B}} P_t}{N_e SAR_{\text{lim}}^{\text{gp,occ}}}$$

where $D_{10g}^B = 0.005 \text{ m} \cdot \text{kg}^{-1}$, N_e is the number of antenna elements for all panels, and $SAR_{\text{lim}}^{\text{gp,occ}}$ denotes the SAR limits for general public and workers exposure, respectively.

Appendix B. Guidelines on how to install the product

The AIR 5121 product (KRD 901 059/1, KRD 901 059/4) 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. To consider possible contributions from ambient sources (e.g. other radio products already present on site) or the influence from any reflecting or scattering objects in the vicinity of the product installation, procedures in IEC 62232 [9] apply.

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

For AIR 5121 (KRD 901 059/1, KRD 901 059/4), it is possible to work behind the radio without any restrictions related to RF EMF exposure if the product is installed so that contributions from other ambient sources (e.g. other radio products) are not significant and may be neglected. 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. To consider possible contributions from ambient sources (e.g. other radio products already present on site) or the influence from any reflecting or scattering objects in the vicinity of the product installation, procedures in IEC 62232 [9] apply.

If work is conducted on behalf of Ericsson, minimum EMF related requirements are provided in [12].

Appendix D. Photograph of the EUT

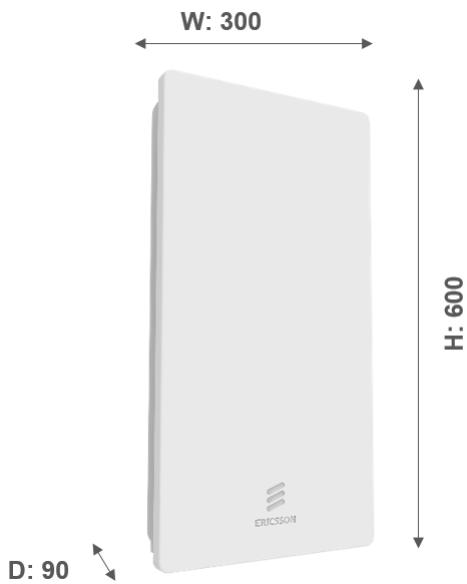


Figure D.1 Front view of the AIR 5121 with dimensions.