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EMF Test Report: Ericsson AIR 5331 B260 (FCC)

Document number:	GFTL-18:000263 Uen Rev B	**Date of report:**	2019-01-25
Testing laboratory:	Ericsson EMF Research Laboratory Ericsson AB SE-164 80 Stockholm Sweden	**Company/Client:**	Henrik Börjeson Ericsson AB Mobilvägen 12 22 362, Lund Sweden
Tests performed by:	Elif Degirmenci	**Dates of tests:**	2018-12-13 (Rev A) 2019-01-25 (Rev B)
Manufacturer and market name(s) of device:	Ericsson AIR 5331		
Testing has been performed in accordance with:	FCC OET Bulletin 65 IEC 62232:2017		
Test results:	The tested equipment complies with the requirements in respect of all parameters subject to the test.		
Additional information:			

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Summary of EMF Test Report[1]

Equipment under test (EUT)

Product name	AIR 5331		
Product number	KRD 901 079/1 KRD 901 079/4		
Supported bands, Tx frequency range (GHz) and standards	B260	37– 40	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 [5]	59.5 (maximum power configuration) 53.5 (close-in area power configuration)	E+	

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 5331 applicable in markets employing the FCC RF exposure limits for maximum output power configuration and close-in area power configuration with power tolerance and TDD downlink/uplink ratio included.

Mode and output power for AIR 5331					**Dimensions of the box-shaped compliance boundary (m)**							
					Distance in front of EUT		**Width**		**Height**		**Distance behind EUT**	
Band	**Standard**	**Nominal total EIRP**	**Power tolerance**	**TDD DL duty cycle**	**GP**	**W**	**GP**	**W**	**GP**	**W**	**GP**	**W**
B260	NR	60 dBm	1.5 dB	89 %	3.2	1.5	4.0	1.8	1.3	0.6	0	0
B260	NR	54 dBm	1.5 dB	89 %	1.6	0.8	2.0	0.9	0.7	0.3	0	0

With the accepted power taken as the total power delivered to the antenna including tolerances, 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.
[2] The stated EIRP value is the total EIRP with the TDD duty cycle and without power tolerance included.

1 General information

The test results presented in this report define compliance boundaries for maximum power configurations for AIR 5331. Outside of these compliance boundaries the radio frequency (RF) exposure levels are below the exposure limits specified by the Federal Communications Commission (FCC) [1], and International Commission on Non-Ionizing Radiation Protection (ICNIRP) [2].

The tests were performed by calculations in accordance with the Ericsson RF exposure calculation procedure for base stations [3], which is in conformity with the FCC OET Bulletin 65 [4] and IEC 62232 [5].

Recommended product specific EMF health and safety information for Ericsson radio products is found in [6]. The test report summary and the content of Appendices A and B in the product documentation of the tested equipment should be included in [6].

2 Equipment under test

Tables 1 and 2 below summarize the technical data for the equipment under test (EUT) and the antenna properties for the integrated antennas. Table 3 lists the nominal total output power from the radio unit and the total time-averaged output power including output power tolerance and the TDD downlink/uplink ratio. In addition to the maximum power configuration, a lower power configuration (6 dB below maximum) intended for close-in areas where maximum power will not be necessary was also considered.

Table 1 Technical data for the EUT.

Product name and product number	AIR 5331		KRD 901 079/1 KRD 901 079/4
Supported bands, Tx frequency range (GHz), and standards	B260 (39 GHz)	37 – 40	NR
Dimensions[3], H x W x D (mm)	600 × 303 × 110		
Duplexing technology and fraction of downlink transmission time to total time	TDD (89 %)		
Exposure environment	General public/uncontrolled, Workers/controlled		
EIRP[4] (dBm) and IEC 62232 installation class [9]	59.5 (maximum power configuration) 53.5 (close-in area power configuration)		E+

[3] The dimensions of the EUT exclude mounting brackets.
[4] The stated EIRP value is the total EIRP with the TDD duty cycle without power tolerance included.

Table 2 Properties of the integrated antennas.

Type	Phased Array Antenna Module (PAAM)
Number of antenna panels	4
Number of beams	8
Gain[5] (dBi)	29
EIRP[6] (dBm) per beam	51 (maximum power configuration) 45 (close-in area power configuration)
Horizontal HPBW[7] (degrees)	4°±1°
Vertical HPBW[7] (degrees)	10°±2°
Number of antenna elements (N_H, N_V) per antenna panel	(24, 8) (2 polarizations)
Element separation distance (Δ_H, Δ_V) (mm)	(3.9, 4.725)
Maximum scan range in horizontal plane (degrees)	±60°
Maximum scan range in vertical plane (degrees)	±15°

Table 3 EUT configurations with nominal output power levels and total power levels including output power tolerance and TDD downlink/uplink ratio.

Band	Standard	Nominal total output power (dBm/W)	TDD downlink duty cycle	Power tolerance (dB)	Total time-averaged output power (dBm/W)
B260	NR	31 / 1.3	89 %	1.5	32 / 1.6
B260	NR	25 / 0.3	89 %	1.5	26 / 0.4

3 Exposure conditions

The EUT is intended to be installed on walls, poles, roof-tops, masts, 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 output power. 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.

4 EMF compliance boundary calculations

Compliance boundary calculations were conducted according to the Ericsson RF exposure calculation procedure for base stations using large array antennas [3] which is based on the far-field formula assuming a cosine scan loss and a Gaussian beam shape [5], [8]. For convenience, the used formulas taken from [3] are included in Appendix A.

Table 4 presents the FCC [1] 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 [1].

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

[5] The stated gain value is the maximum gain of antenna per panel.
[6] The stated EIRP value is without power tolerance included.
[7] The stated half-power beam widths are for broadside beam in the reference direction $(\theta, \phi) = (90°, 0°)$.

5 Results

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 antenna, see Figure 1. Outside of this box, the RF exposure is below the exposure limits.

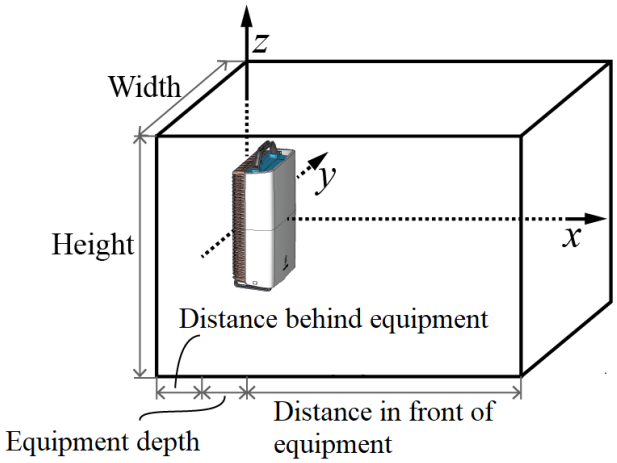

Figure 1 Box-shaped structure specifying the compliance boundary for the tested RBS product.

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 [6], it is possible to state that the compliance distance behind the antenna measured from its back plane is 0 m. Furthermore, from measurements of a similar mmW AAS testbed radio (28 GHz) transmitting with total output power of 47.3 dBm, the maximum power density behind was found to be 0.1 W/m^2 [7]. Scaling of this result to 60 dBm output power, gives a power density of around 2 W/m^2 which is below the general public and workers power density limits listed in Table 4.

The resulting compliance boundary dimensions are given in Table 5 rounded upwards to the nearest decimeter.

Table 5 Dimensions of the box-shaped compliance boundary for general public (GP) and workers (W) exposure for AIR 5331 applicable in markets employing the FCC RF exposure limits for maximum output power configuration and close-in area power configuration with power tolerance and TDD downlink/uplink ratio included.

Mode and output power for AIR 5331					Dimensions of the box-shaped compliance boundary (m)							
					Distance in front of EUT		Width		Height		Distance behind EUT	
Band	**Standard**	**Nominal total EIRP**	**Power tolerance**	**TDD DL duty cycle**	**GP**	**W**	**GP**	**W**	**GP**	**W**	**GP**	**W**
B260	NR	60 dBm	1.5 dB	89 %	3.2	1.5	4.0	1.8	1.3	0.6	0	0
B260	NR	54 dBm	1.5 dB	89 %	1.6	0.8	2.0	0.9	0.7	0.3	0	0

With the accepted power taken as the total power delivered to the antenna including tolerances, and the upward rounding of compliance boundary dimensions to the nearest decimeter, the specified results are conservative

6 Uncertainty

The input parameters were chosen within their range so as to maximize the calculated compliance boundary dimensions. Consequently, the approach described in Section 4 results in an exposure assessment which is conservative.

7 Conclusion

The results in Section 5 show the compliance boundary dimensions for the considered configurations of the Ericsson AIR 5331 B260 radio products when tested according to US Federal Communications Commission (FCC) requirements [1],[4] and IEC 62232 [5]. Outside of this compliance boundary, the exposure is below the exposure limits [1].

The tested equipment complies with the requirements in respect of all parameters subject to the test.

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] 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.

[3] GFTE-16:001718 Uen, “Ericsson RF exposure calculation procedure for base stations”.

[4] 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.

[5] 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.

[6] Ericsson, 5/124 46-LZA 701 6001, “Radio Frequency Electromagnetic Exposure, CDMA/GSM/LTE/WCDMA”.

[7] Ericsson, GFTL-18:000263 Uen GFTE-17:000189 Uen, “EMF measurements of the Ericsson 28 GHz PAAM 5G test bed radio unit”.

[8] Mailloux, “Phased array antenna handbook”, Artech House, 2005.

[9] Ericsson, LME-12:001904 Uen, “Exposure to radio frequency electromagnetic fields”.

9 Revision history

Rev.	Date	Description
A	2018-12-13	First revision
B	2019-01-25	Corrected EIRP value given in the summary table and correponding footnote.

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 [7]

$$CD_{\text{front}} = \sqrt{\frac{PG}{4\pi S_{\text{lim}}}}$$

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

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

where P, G and S_{lim} denote the power accepted by the antenna, the antenna gain, the power density limit, and $\alpha_{\text{max,H}}$, $\alpha_{\text{max,V}}$, $HHPBW$,and $VHPBW$ denote the maximum scan angles and the half power beam widths in the horizontal and vertical planes, respectively.

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

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

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

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

$$HHPBW(\alpha) = \frac{0.886\lambda}{N_H \Delta_H \cos\alpha}$$

$$VHPBW(\alpha) = \frac{0.886\lambda}{N_V \Delta_V \cos\alpha}$$

where N_H , N_V, Δ_H and Δ_V denote the number of elements and the inter-element distances in the horizontal and the vertical planes, respectively. Furthermore, λ denoting the free space wavelength.

Appendix B. Guidelines on how to install the product

The AIR 5331 product (KRD 901 079/1, KRD 901 079/4) 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.

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

For AIR 5331 (KRD 901 079/1, KRD 901 79/4), it is possible to work behind the RBS without any restrictions related to RF EMF exposure if the product is installed so that contributions from other ambient sources (e.g. other RBS 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.

If work is conducted on behalf of Ericsson, minimum EMF related requirements are provided in [9].

Appendix D. Photograph of the AIR 5331

Figure D.1 Photograph of AIR 5331