

	Test report issued by an Accredited Testing Laboratory
Accred. no. 1761 Testing ISO/IEC 17025	

EMF Test Report: Ericsson Radio 4480 B71 B85A (FCC)

Document number:	GFTL-21:000201 Uen Rev C	Date of report:	2021-07-05
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Tests performed by:	Davide Colombi	Dates of tests:	2021-02-18 (Rev A) 2021-06-02 (Rev B) 2021-07-02 (Rev C)
Manufacturer and market name(s) of device:	Ericsson Radio 4480 B71 B85A		
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 Radio 4480 B71 B85A.		
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Summary of EMF Test Report¹

Equipment under test (EUT)

Product name	Radio 4480 B71 B85A		
Product number	KRC 161 922/1		
Supported bands, Tx frequency range (MHz) and standards	Band 71	617 – 652	LTE, NR, NB-IoT
	Band 85A	728 – 745	LTE, NB-IoT
Duplexing technology	FDD		

Antennas

Product number	RFS APXVAARR18_43-U-NA20
Tested mode(s)	Band 71 (L/N/I) ² + Band 85A (L/I)

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 Radio 4480 applicable in the markets employing the FCC RF exposure limits. The compliance boundaries are determined for maximum output power with 0.5 dB transmission loss and 0.6 dB output power tolerance included.

Mode and output power for Radio 4480				Dimensions of the box-shaped compliance boundary (m)							
				Distance in front of antenna		Width		Height		Distance behind the antenna	
Band	Standard ²	Maximum nominal output power from the radio	IEC 62232 installation class	GP	W	GP	W	GP	W	GP	W
B71 + B85A	L/N/I + L/I	4 × 60 W (B71) + 4 × 40 W (B85A)	E+	20.2	9.0	16.0	7.2	3.8	2.3	0.6	0.3

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.

² The standards are abbreviated in this report according to: L for LTE, N for NR and I for NB-IoT.

1 General information

The test results presented in this report define compliance boundaries for Radio 4480 B71 B85A. Outside 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 levels, power tolerance and transmission loss 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

Tables 1 and 2 below summarize the technical data for the equipment under test (EUT) and the properties of antenna. Table 3 lists the maximum nominal output power from the radio unit (total peak power from all antenna branches) and the total time-averaged power delivered to the antenna for the specified configurations. The total time-averaged power delivered to the antenna includes transmission loss and output power tolerance.

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	Radio 4480 B71 B85A		KRC 161 922/1
Supported bands, Tx frequency range (MHz) and standards.	Band 71	617 – 652	LTE, NR, NB-IoT
	Band 85A	728 – 745	LTE, NB-IoT
Duplexing technology	FDD		
Exposure environment	General public, Workers		
IEC 62232 installation class [4]³	E+		

Table 2 Properties of the antenna.

Product number	RFS APXVAARR18_43-U-NA20
Type	Macro cell, directional, 4 Tx (2 columns, X polarized)
Frequency range (MHz)	617 – 2200
Tested band and frequency range (MHz)	B71: 617 – 652
	B85A: 728 – 745
Maximum gain⁴ (dBi) per antenna port	14.5 (B71)
	14.9 (B85A)
Electrical tilt (degrees)	0
Dimensions, H × W × D (mm)	1829 × 609 × 215

³ The stated IEC 62232 installation class was determined based on the total EIRP without power tolerance included and considering the transmission loss. The total EIRP was obtained using the antenna patterns provided by the client.

⁴ Maximum gain among the antenna ports obtained using the antenna patterns provided by the antenna manufacturer.

Table 3 EUT configurations with maximum nominal output power levels and total time-averaged power levels including transmission loss and output power tolerance.

Band	Standard	Maximum nominal output power from the radio	Transmission loss (dB)	Power tolerance (dB)	Total time-averaged power delivered to the antenna (dBm/W)
B71 + B85A	L/N/I + L/I	4 × 60 W (B71) + 4 × 40 W (B85A)	0.5	0.6	56.1 / 409.3

3 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 assessments were conducted for maximum power configurations, i.e. by assuming 100% utilization without taking time-averaging into account. A reduced RBS utilization compared with the theoretical maximum is reasonably foreseeable and will significantly reduce the time-averaged power and the RF exposure. This was, however, not considered in the assessment, which adds to the conservativeness of the obtained compliance boundaries.

4 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 62232:2017 [4]. The calculations were made using the far-field spherical formula and the cylindrical wave model. 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, θ , and ϕ denote the power density, the power accepted by each antenna port, the antenna gain per port, the distance from the antenna, and the angular variables in a spherical coordinate system, respectively. Antenna far-field measurement data were provided by the client for three frequencies, specifically 617 MHz, 632 MHz, and 647 MHz within Band 71, and for two frequencies, specifically 728 MHz and 737 MHz within Band 85A. The procedure described in this section was applied to each of these, and the compliance boundaries were determined as the maximum values for the tested frequencies. Power density was evaluated for the lowest applicable electrical down tilt of the antenna (0°). The maximum gain values among the 4 ports was found to be 14.5 dBi considering all the tested frequencies in B71. The corresponding values considering all the tested frequencies in B85A was found to be 14.9 dBi.

The tested configurations are characterized by a total of 4 transmitters (4 TX per band), and the RF exposure was determined for both bands operating simultaneously (each antenna port serving both B71 and B85A).

The accepted power per port was taken as the total power delivered to the antenna, including tolerances, divided by the number of ports. In the frontal hemisphere ($\phi \in [-\frac{\pi}{2}, \frac{\pi}{2}]$), the exposure from antenna ports with the same nominal polarizations (denoted ± 45) were summed in a correlated way to consider beamforming while the exposure from antenna ports with different nominal polarizations were summed in an uncorrelated manner. Also, in the rear hemisphere ($\phi \notin [-\frac{\pi}{2}, \frac{\pi}{2}]$), uncorrelated exposure was assumed [2]. With the two antenna columns denoted 1 and 2, the total power density as estimated by the spherical far-field formula is thus given by

$$S_{\text{total,sph,B71}} = \begin{cases} \left(\sqrt{S_{\text{sph},1,+45,\text{B71}}} + \sqrt{S_{\text{sph},2,+45,\text{B71}}} \right)^2 + \left(\sqrt{S_{\text{sph},1,-45,\text{B71}}} + \sqrt{S_{\text{sph},2,-45,\text{B71}}} \right)^2 & , \phi \in \left[-\frac{\pi}{2}, \frac{\pi}{2} \right] \\ S_{\text{sph},1,+45,\text{B71}} + S_{\text{sph},2,+45,\text{B71}} + S_{\text{sph},1,-45,\text{B71}} + S_{\text{sph},2,-45,\text{B71}} & , \phi \notin \left[-\frac{\pi}{2}, \frac{\pi}{2} \right] \end{cases}$$

$$S_{\text{total,sph,B85A}} = \begin{cases} \left(\sqrt{S_{\text{sph},1,+45,\text{B85A}}} + \sqrt{S_{\text{sph},2,+45,\text{B85A}}} \right)^2 + \left(\sqrt{S_{\text{sph},1,-45,\text{B85A}}} + \sqrt{S_{\text{sph},2,-45,\text{B85A}}} \right)^2 & , \phi \in \left[-\frac{\pi}{2}, \frac{\pi}{2} \right] \\ S_{\text{sph},1,+45,\text{B85A}} + S_{\text{sph},2,+45,\text{B85A}} + S_{\text{sph},1,-45,\text{B85A}} + S_{\text{sph},2,-45,\text{B85A}} & , \phi \notin \left[-\frac{\pi}{2}, \frac{\pi}{2} \right] \end{cases}$$

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

$$\frac{S_{\text{total,sph,B71}}(r, \theta, \phi)}{S_{\text{gp,w,B71}}^{\text{lim}}} + \frac{S_{\text{total,sph,B85A}}(r, \theta, \phi)}{S_{\text{gp,w,B85A}}^{\text{lim}}} = 1,$$

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

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

Band	$S_{\text{gp}}^{\text{lim}}$ (W/m ²)	$S_{\text{w}}^{\text{lim}}$ (W/m ²)
B71	4.1	20.6
B85A	4.9	24.3

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

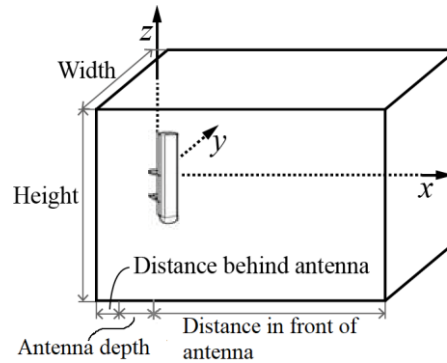


Figure 1 Box-shaped structure specifying the compliance boundary for the antenna.

In Figure 2, compliance distance results for general public (blue line) and workers (red line) exposure are given for the tested configuration leading to the largest compliance boundary. The solid colored lines represent the result obtained with the spherical model. 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.

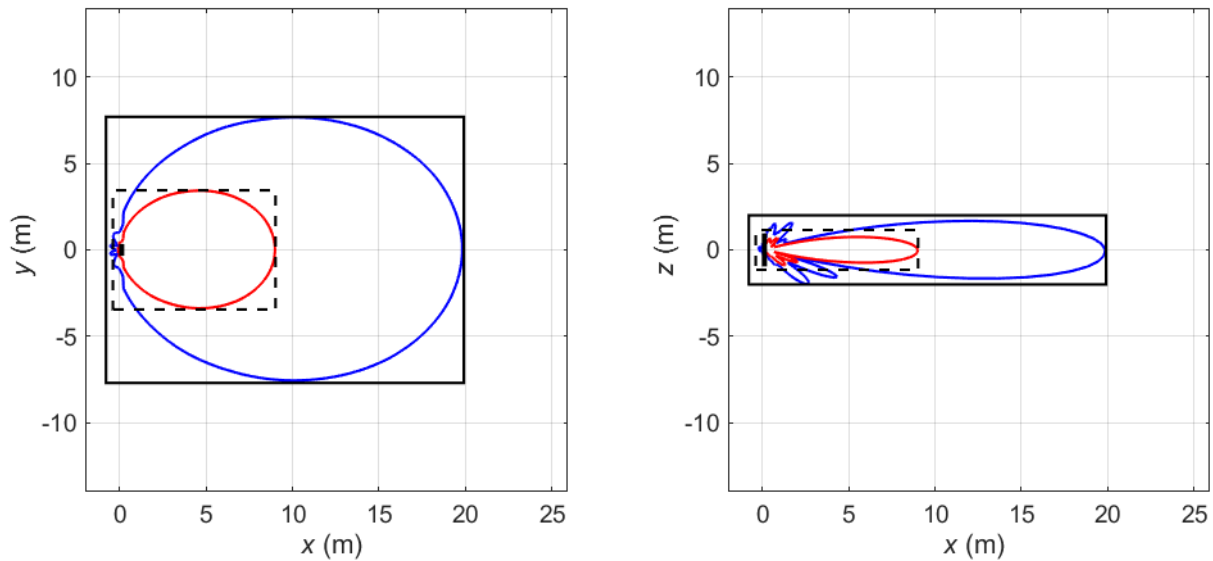


Figure 2 Compliance boundary for general public (black solid line) and workers (black dashed line) exposure. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical model. The red solid lines correspond to compliance distance results for workers exposure obtained using the spherical model. The antenna is shown from above (left figure) and from the side (right figure) with its back plane located at $x = 0$ m. Mode: B71 (L/N/I) and B85A (L/I). Total power delivered to the antenna: 409.3 W divided as 60 % for B71 and 40 % for B85A.

Table 5 Dimensions of the box-shaped compliance boundary for general public (GP) and workers (W) exposure for Radio 4480 applicable in the markets employing the FCC RF exposure limits. The compliance boundaries are determined for maximum output power with 0.5 dB transmission loss and 0.6 dB output power tolerance included.

Mode and output power for Radio 4480			Dimensions of the box-shaped compliance boundary (m)							
			Distance in front of antenna		Width		Height		Distance behind the antenna	
Band	Standard ²	Maximum nominal output power from the radio	GP	W	GP	W	GP	W	GP	W
B71 + B85A	L/N/I + L/I	4 × 60 W (B71) + 4 × 40 W (B85A)	20.2	9.0	16.0	7.2	3.8	2.3	0.6	0.3

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 Conclusions

The Ericsson Radio 4480 B71 B85A 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 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, LME-12:001904 Uen, “Exposure to radio frequency electromagnetic fields”.

9 Revision History

Rev.	Date	Description
A	2021-02-19	First revision.
B	2021-06-02	NR configuration for B71 added.
C	2021-07-05	Corrected typo in the specified frequency range for B71.

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 Radio 4480 is below the limits applicable in:

- USA (47 CFR 1.1310).

Table A.1 Dimensions of the box-shaped compliance boundary for general public (GP) and occupational (O) exposure for Radio 4480 applicable in the markets employing the FCC RF exposure limits. The compliance boundaries are determined for maximum output power with 0.5 dB transmission loss and 0.6 dB output power tolerance included.

Mode and output power				Dimensions of the box-shaped compliance boundary ⁽¹⁾ (m)							
				Distance in front of antenna		Width		Height		Distance behind the antenna	
Product	Standard ⁽²⁾	Maximum nominal output power from the radio	IEC 62232 Installation class	GP	O	GP	O	GP	O	GP	O
Radio 4480 B71 B85A	L/N/I (B71) + L/I (B85A)	4 × 60 W (B71) + 4 × 40 W (B85A)	E+	20.2	9.0	16.0	7.2	3.8	2.3	0.6	0.3

- (1) The compliance boundaries are determined for maximum output power with transmission loss and power tolerance included using the antenna RFS APXVAARR18_43-U-NA20 and 0 degrees of electrical down tilt.
- (2) The standards are abbreviated according to: L for LTE, N for NR and I for NB-IoT.

Appendix B. Guidelines on how to install the product

The antenna connected to Radio 4480 B71 B85A (KRC 161 922/1) 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 antenna connected to the Radio 4480 (KRC 161 922/1), 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 [5].