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EMF Test Report: Ericsson Radio 4402 B2/B25 (FCC)

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Manufacturer and market name(s) of device:	Ericsson Radio 4402 B2/25		
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 4402 B2/25.		
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Summary of EMF Test Report¹

Equipment under test (EUT)

Product name	Radio 4402 B2/25		
Product number	KRC 161 737/1		
Supported bands, Tx frequency range (MHz) and standards	B2/25 (1900)	1930 – 1995	LTE
Duplexing technology	FDD		
Exposure environment	General public/uncontrolled, Workers/controlled		
EIRP ² (dBm) and IEC 62232:2017 installation class [4]	55.0 (Single Radio), 58.0 (Dual Radio)	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 Radio 4402 B2/25 applicable in the markets employing the FCC exposure limits for maximum output power with output power tolerance included.

Mode and output power for Radio 4402 B2/25					Dimensions of the box-shaped compliance boundary (m)							
					Distance in front of EUT		Width		Height		Distance behind EUT	
Band	Standard	Single/Dual Radio version	Nominal output power from the radio	Power tolerance	GP	W	GP	W	GP	W	GP	W
B2/25	LTE	Single	4 × 5 W	0.6 dB	1.7	0.8	1.6	0.7	1.5	0.7	0.2	0.2
B2/25	LTE	Dual	4 × 5 W + 4 × 5 W	0.6 dB	2.4	1.1	2.2	1.0	2.3	1.2	0.2	0.2

For the power levels specified in the table which include 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 values are the maximum EIRP without power tolerance included and are obtained using the antenna patterns provided by the antenna manufacturers.

1 General information

The test results presented in this report define compliance boundaries for Radio 4402 B2/25. 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 levels and the power tolerance 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 nominal peak output power from the radio unit (total peak power from all antenna branches) and the total power delivered to the antenna for the specified configuration. The total power delivered to the antenna includes output power tolerance.

The EUT was tested for both Single Radio and Dual Radio versions shown in Appendix D. In the Single Radio version, each radio unit has its own power supply unit, while in the Dual Radio version one power supply unit can support two radios.

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 4402 B2/25		KRC 161 737/1
Supported bands, Tx frequency range (MHz), and standards	B2/25 (1900)	1930 – 1995	LTE
Antenna	KRE 105 280/1		
Duplexing technology	FDD		
Dimensions, $H \times W \times D$ (mm)	213.5 × 200 × 125 (Single radio including power supply and antenna) 449 × 200 × 130 (Dual radio including power supply and antennas)		
Exposure environment	General public/uncontrolled, Workers/controlled		
EIRP² (dBm) and IEC 62232:2017 installation class [4]	55.0 (Single Radio), 58.0 (Dual Radio)		E+

Table 2 Properties of the antenna.

Product number	KRE 105 280/1		
Type	Internal antenna, directional, 4 Tx		
Tested band and frequency range (MHz)	1930 – 1995		
Gain (dBi)³	9.2		
Electrical downtilt angle (degree)	8		
Number of dual-polarized elements per column, element separation distance per column (mm)	2, 2		83, 83
Dimensions, $H \times W \times D$ (mm)	200 × 200 × 25		

³ Maximum gain per antenna port obtained from the antenna pattern files provided by the client.

Table 3 EUT configurations with nominal output power levels and total power levels including output power tolerance.

Band	Standard ^{Erro} rf Bookmark not defined.	Single/Dual Radio version	Nominal total output power (dBm/W)	Power tolerance (dB)	Total power delivered to antennas (dBm/W)
B2/25	LTE	Single	43.0 / 20	0.6	43.6 / 22.9
B2/25	LTE	Dual	46.0 / 40	0.6	46.6 / 45.7

3 Exposure conditions

The EUT is intended to be installed on walls, poles, ceilings, 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. Effects of real RBS utilization (time-averaged) is reasonably foreseeable and will significantly reduce the time-averaged power and the RF exposure. This factor was 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 62232:2017 [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:

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

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 four frequencies, specifically 1930 MHz, 1960 MHz, 1980 MHz, and 1995 MHz within Band 2/25. The procedure described in this session was applied to each of these, and the compliance boundaries were determined as the maximum values for the tested frequencies. The maximum gain values were found to be 9.0 dBi (port A, pol. +45), 9.1 dBi (port B, pol. -45), 9.2 dBi (port C, pol. +45), and 8.8 dBi (port D, pol. -45), considering all the tested frequencies.

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 spatial multiplexing 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

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

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

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

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

Table 4 RF EMF exposure limits on power density for the frequency band used by the EUT [1].

Band	S_{gp}^{lim} (W/m ²)	S_w^{lim} (W/m ²)
B2/25 (1900)	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.

Since antenna far-field data provided by the client correspond to the Single Radio version, compliance boundaries for the Dual Radio version were obtained in a conservative way by doubling the RF exposure for the Single Radio version. To take into consideration the actual placement of radios in the Dual Radio version (see Appendix D), the distance between the centers of the two radios was added in the obtained compliance boundary height.

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.

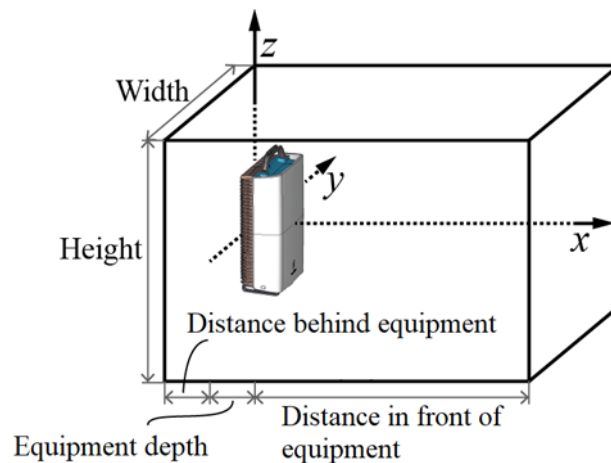


Figure 1 Box-shaped structure specifying the compliance boundary for the tested RBS product.

In Figure 2 and Figure 3, the compliance distance results for general public (blue line) and workers (red line) exposure are given for the Single Radio and the Dual Radio versions, respectively. Also shown are the resulting compliance boundaries (black lines, solid for general public, dashed for workers). The resulting compliance boundary dimensions are given in Table 5 rounded upwards to the nearest decimeter.

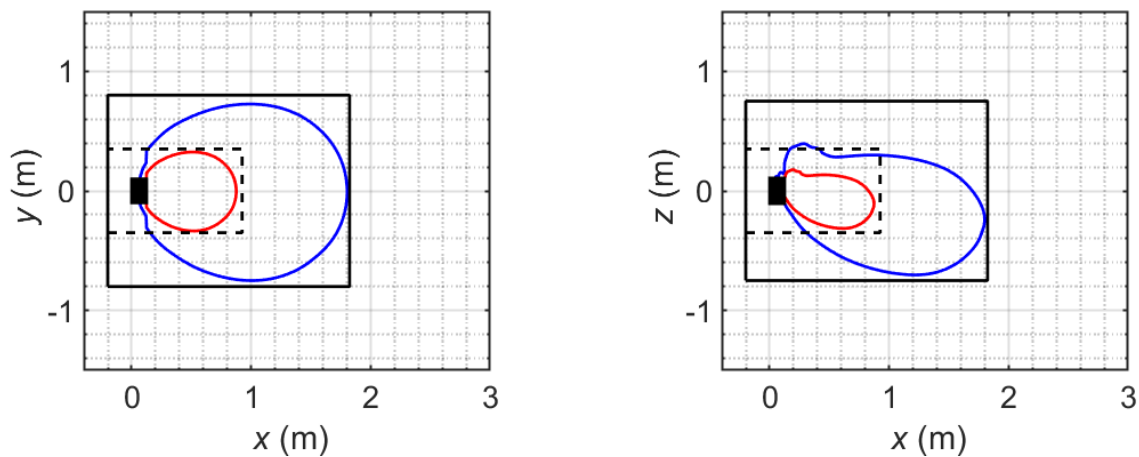


Figure 2 Compliance boundary for general public (black solid line) and workers (black dashed line) exposure for Single Radio. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical model. The solid red lines indicate the corresponding compliance distance results for workers exposure. The EUT is shown from above (left) and from the side (right) with its back plane located at $x = 0$ m. Mode: B2/25 (1900) (LTE). Total power delivered to the antenna: 22.9 W.

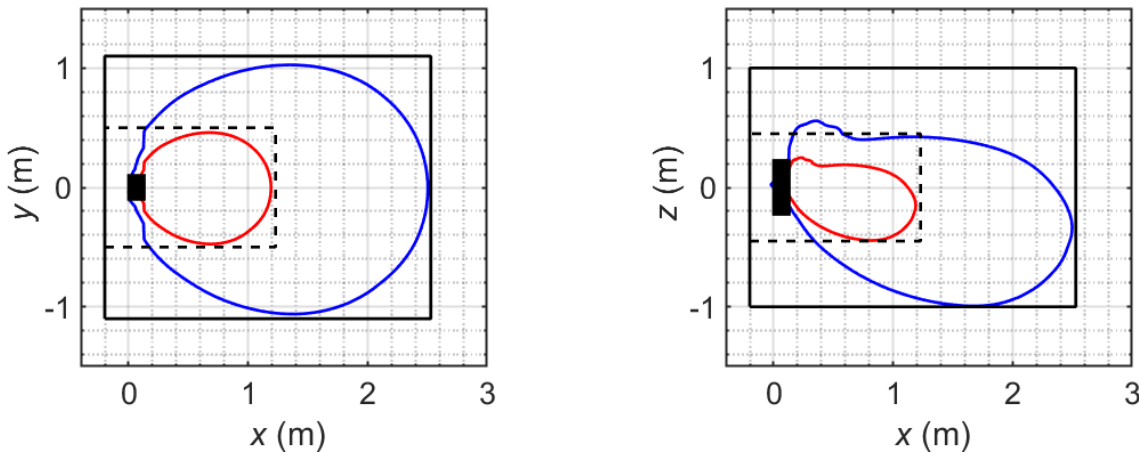


Figure 3 Compliance boundary for general public (black solid line) and workers (black dashed line) exposure for Dual Radio. The blue solid lines correspond to compliance distance results for general public exposure obtained using the spherical model. The solid red lines indicate the corresponding compliance distance results for workers exposure. The EUT is shown from above (left) and from the side (right) with its back plane located at $x = 0$ m. Mode: B2/25 (1900) (LTE). Total power delivered to the antenna: 45.7 W.

Table 5 Dimensions of the box-shaped compliance boundary for general public (GP) and workers (W) exposure for Radio 4402 B2/25 applicable in the markets employing the FCC exposure limits for maximum output power with output power tolerance included.

Mode and output power for Radio 4402 B2/25					Dimensions of the box-shaped compliance boundary (m)							
					Distance in front of EUT		Width		Height		Distance behind EUT	
Band	Standard ⁴	Single/Dual Radio version	Nominal output power from the radio	Power tolerance	GP	W	GP	W	GP	W	GP	W
B2/25	LTE	Single	4 × 5 W	0.6 dB	1.7	0.8	1.6	0.7	1.5	0.7	0.2	0.2
B2/25	LTE	Dual	4 × 5 W + 4 × 5 W	0.6 dB	2.4	1.1	2.2	1.0	2.3	1.2	0.2	0.2

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

⁴ The standards are abbreviated in this report according to: W for WCDMA and L for LTE.

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 Radio 4402 B2/25 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, LME-12:001904 Uen, "Exposure to radio frequency electromagnetic fields".

9 Revision history

Rev.	Date	Description
A	2019-11-13	First revision.

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 4402 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 4402 applicable in the markets employing the FCC exposure limits (including 0.6 dB output power tolerance).

Mode and output power for Radio 4402				Dimensions of the box-shaped compliance boundary ⁽¹⁾ (m)							
				Distance in front of radio		Width		Height		Distance behind radio	
Band	Single/Dual Radio version	Nominal output power from the radio	IEC 62232 Installation class	GP	O	GP	O	GP	O	GP	O
B2/25 ⁽²⁾	Single	4 × 5 W	E+	1.7	0.8	1.6	0.7	1.5	0.7	0.2	0.2
B2/25 ⁽²⁾	Dual	4 × 5 W + 4 × 5 W	E+	2.4	1.1	2.2	1.0	2.3	1.2	0.2	0.2

(1) The compliance boundaries are determined for maximum output power with power tolerance.

(2) With integrated directional antenna KRE 105 280/1.

Appendix B. Guidelines on how to install the product

The Radio 4402 B2/25 product (KRC 161 737/1) 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

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].

Appendix D. Pictures of Radio 4402 B2/25

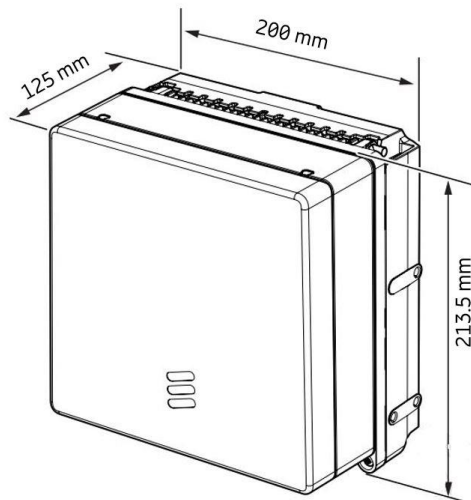


Figure D.1 Picture of Single Radio version of Radio 4402 B2/25.

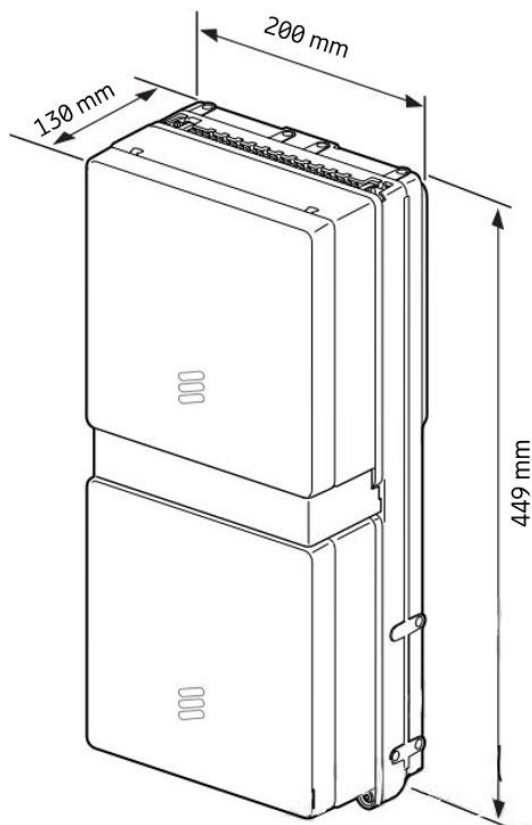


Figure D.2 Picture of Dual Radio version of Radio 4402 B2/25.