Evaluation Report 21-1-0165303T01a
EIRP Measurements of Different Antenna Versions when Installed on Car

Number of pages:	14	**Date of Report:**	2023-Jan-18
Testing company:	CETECOM GmbH Im Teelbruch 116 45219 Essen Germany Tel. + 49 (0) 20 54 / 95 19-0 Fax: + 49 (0) 20 54 / 95 19-150	**Applicant:**	Continental Advanced Antenna GmbH Römerring 1, 31137 Hildesheim, Germany
Test Object / Tested Device(s):	**Antennas to be used with RKE223E1 (mounted in car SUV (X254))**		

Frequency Range:	**434 MHz**
EIRP Tests Method Following:	**FCC Regulations: Title 47 CFR, Chapter I, Subchapter A, Subpart C: §15.231(b)** **ISED Regulations: RSS-210, Issue 10, Annex A** **European Regulations: EN 300 220-2 V3.2.1 and EN 300 220-1 V3.1.1**

Signatures:

Dipl.-Ing. Ninovic Perez	**Timo Franke**
Authorization of Test Report	Test Execution and Author of Report

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1 General information

1.1 Disclaimer and Notes

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1.2 Summary of Test Results

The EIRP and field strength data of a reference car, which is installed with RKE module, used in the homologation of the RKE module installed in car has been compared to different scenarios with realistic installations in different cars, which includes combinations of different antenna versions.
There are two different antenna versions for the 434 MHz band (BASE EN, BASE US) being tested.
The car related variant is the SUV (X254).
The tests have been carried out in a test mode (CW mode).
Out of the above mentioned investigation of different variants, a worst case scenario in respect of antenna variant and installation (maximum EIRP) is identified.
For this scenario additional tests at different channels have been conducted in order to identify potential variations over frequency.

For this worst case scenario field strength measurements have been carried out according to the FCC / ISED test standards, and EIRP measurements according to the EN test standards applying the correct modulation and module RF power settings. The results of the field strength and EIRP values used for the homologation based on the reference antenna are summarized below.

Frequency Band	The maximum emission level has been found at
434 MHz	BASE, ANT1 at a measurement antenna height of 4 m

Tab 1: Scenarios creating a maximum emission level

Test	Limit	Reference: Result for homologation using the reference antenna (see [2] and [3])	Measured field strength and EIRP on car	Conclusion
FCC and ISED	80.8 dBµV/m	76.8 dBµV/m	75.83 dBµV/m	Below the reference
Europe	10 dBm	8.1 dBm	7.64 dBm	Below the reference

Tab 2: Overview of the emission level test results

2 Administrative Data

2.1 Identification of Entity Providing the Service

Company address:	CETECOM GmbH / Im Teelbruch 116 / 45219 Essen / Germany
Internet site:	www.cetecom.com
Responsible for laboratory:	Mr. Volker Briddigkeit
Accreditation scope:	DAkkS Webpage
Test location:	CETECOM GmbH / Mündelheimer Weg 35 / 40472 Düsseldorf / Germany

2.2 General Limits for Environmental Conditions

Temperature:	22±2 °C
Humidity:	45 ± 15% rH

2.3 Organizational Items

CETECOM project number:	21-1-0165303T01a
Test Date(s):	01.09.2022
Witness during tests:	n/a
Responsible for test report:	Timo Franke
Date of report:	2023-Jan-18

2.4 Customer Details

Customer address:	Continental Advanced Antenna GmbH / Römerring 1, 31137 Hildesheim, Germany
Customer internet site:	www.continental.com
Contact person:	Thomas Schuhbeck <thomas.schuhbeck@continental-corporation.com>
PO number:	n/a

2.5 Equipment Under Test (EUT): Type and Short Descriptions

Short description	PMT No.	Product / EUT	Mode / Type	S/N	HW status	FW status
EUT 1	21-1-01653S35_C01	RKE Module Base FCC	RKE223E1 / Application sample	000131	13612160B08V00	11.31
EUT 2	21-1-01653S29_C01	RKE Module BASE EN	RKE223E1 / Application sample	003521	13612160B08V00	11.31

Tab 3: EUT details.

2.6 Auxiliary Equipment: Type and Short Descriptions

Short description	PMT No.	Auxiliary Equipment	Type	S/N	HW status	SW status
AE 1	21-1-01653S38_C01	Testbox	Testbox programmable (USB)	180401C24	n/a	RKE223_V7.0
AE 2	21-1-01653S39_C01	Testbox	Testbox programmable (USB)	180401C21	n/a	RKE223_V7.0
AE 3	21-1-01653S40_C01	Testbox	Testbox programmable (USB)	180401B35	n/a	RKE223_V7.0
AE 4	21-1-01653S46_C01	Car	Mercedes Benz SUV (X254)	n/a	n/a	n/a

Remark 1: 3 different testboxes are just used to simplify the search for the valid power setting.

Remark 2: FCC initial testbox power setting was set to 0x34. For tests value was reduced to 0x2C.

EN initial testbox power setting was set to 0x37. For tests value was reduced to 0x36.

Tab 4: Auxiliary equipment details.

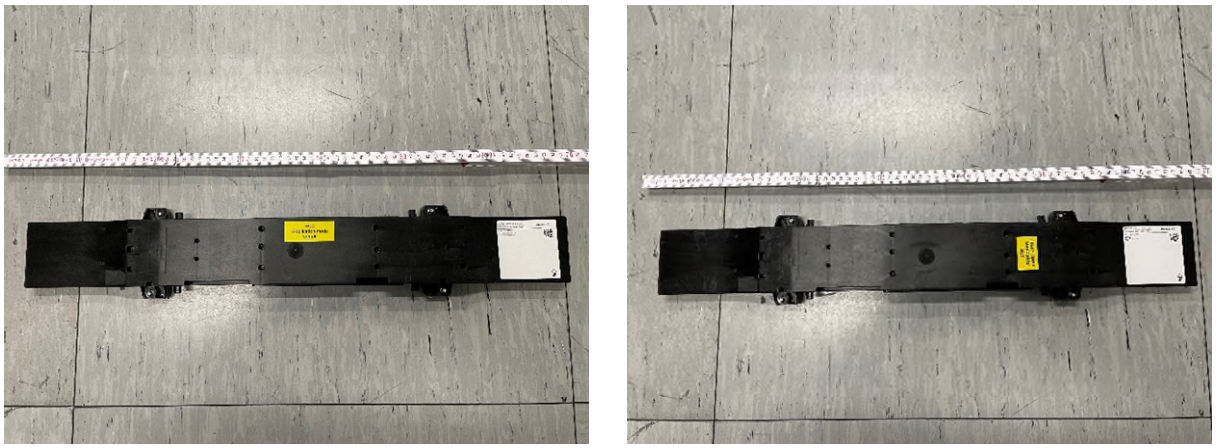

Fig 1: Photos of the antennas

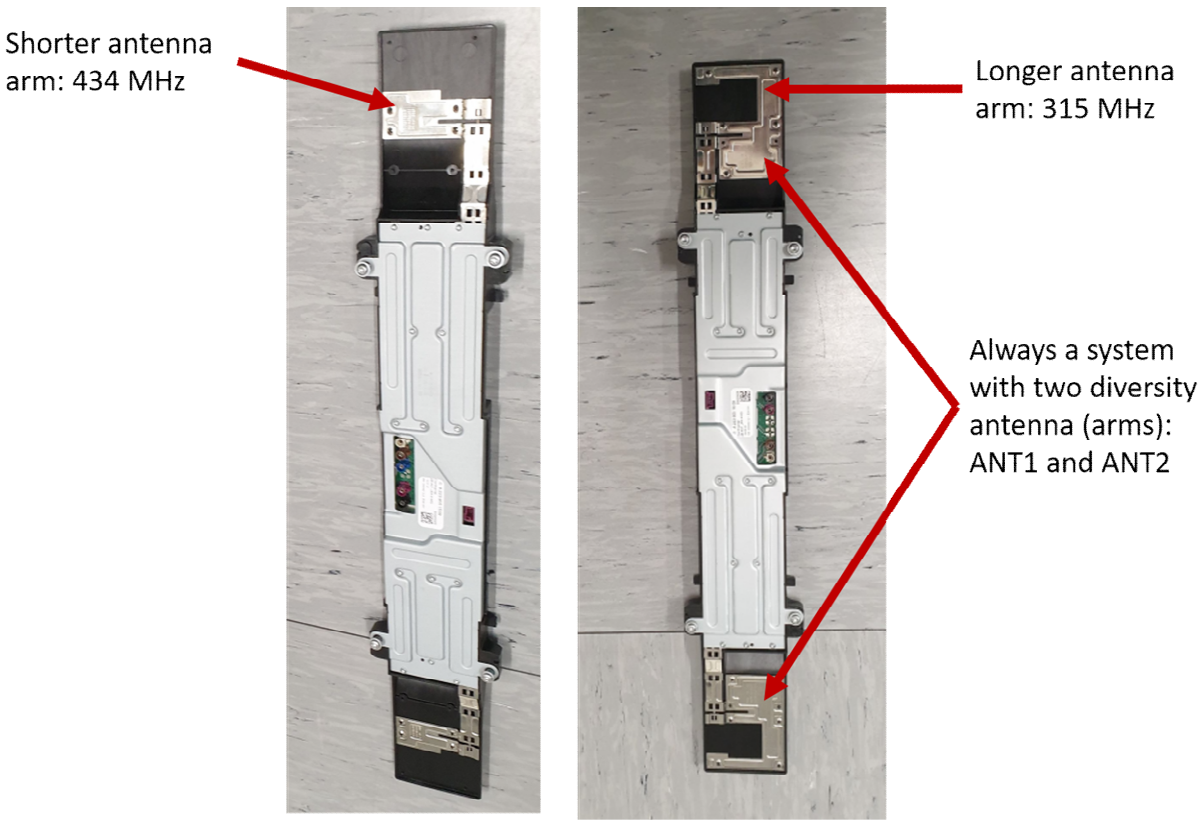

Fig. 2: Photos covering the differences of the antenna versions

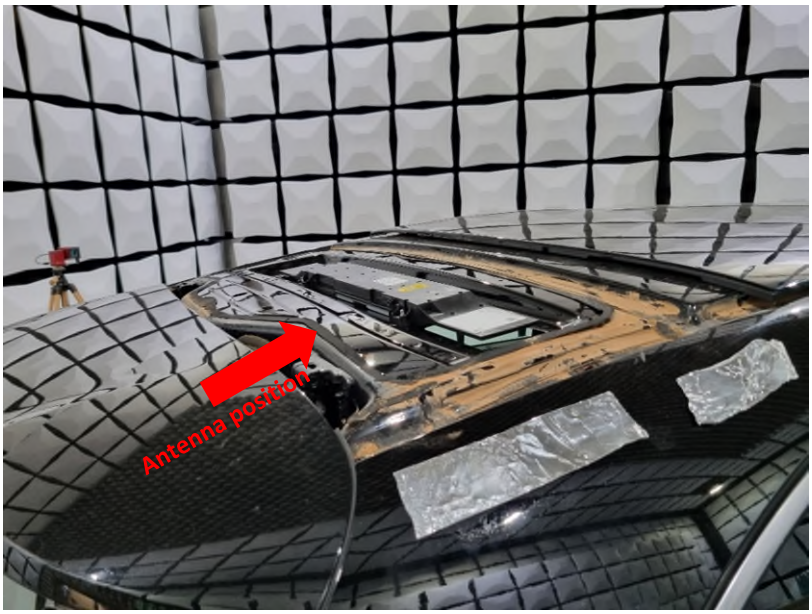

Fig. 3: Photo and indication of antenna position

3 General Test Setup and Test Method

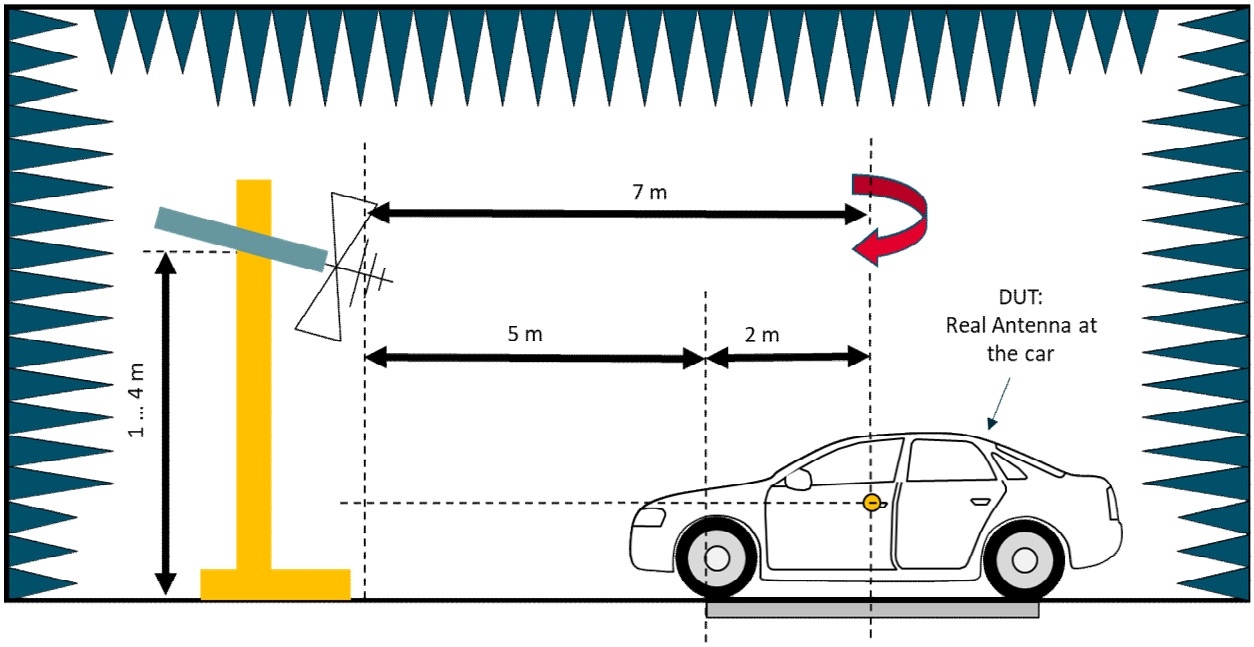

Fig. 4: Measurement set up using a movable antenna mast with tilt boresight (tilt) function

Antenna measurements at cars with the need for greater measurement distance are carried out in the CETECOM SAC5 chamber in Düsseldorf as shown in Fig. 4 and Fig. 5. A movable mast with an antenna tilt function is used.

The following test procedure related parameter has been used:

- The module was set to a fixed frequency in CW mode
- The turn table rotated between 0 and 360° and readings where gathered with an angular resolution of 5°
- Both polarization are taken into account
- The antenna height was varied between 1 and 4 m in steps of 0.5 m (7 levels) representing an angular resolution in elevation of approximately also 4°
- Out of the power measurements the antenna pattern was determined and the maximum EIRP values estimated.

This procedure has been used to test first the reference antenna and repeated for different antenna versions (see Fig. 2) at a car.

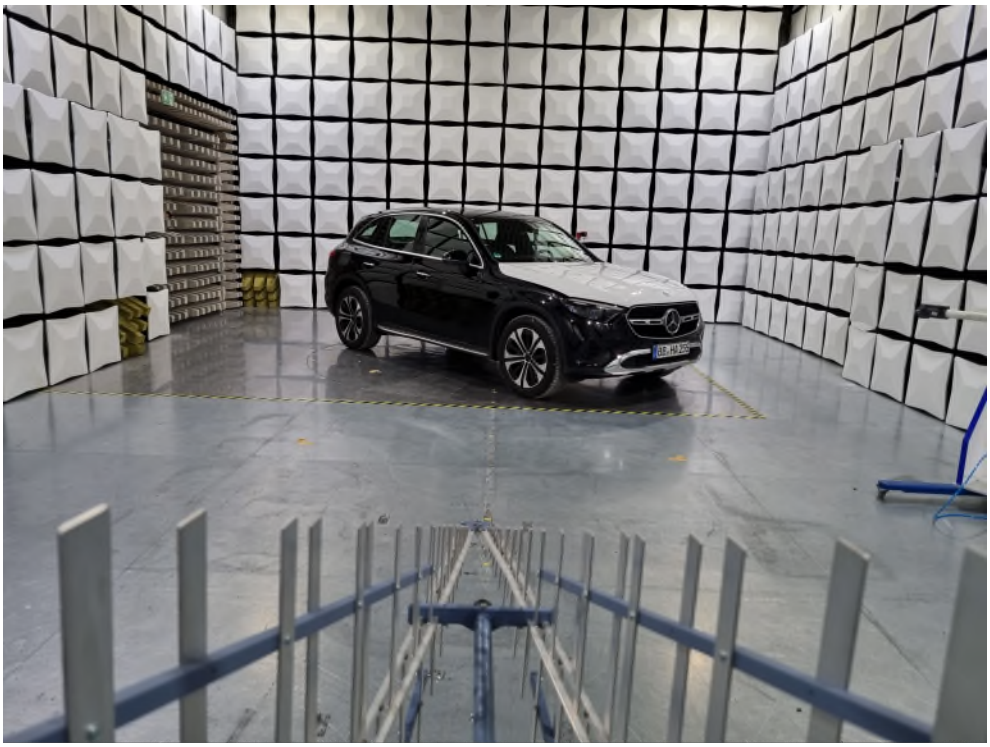

Fig. 5: Set up with EUT for test without absorbers at a car (SUV (X254))

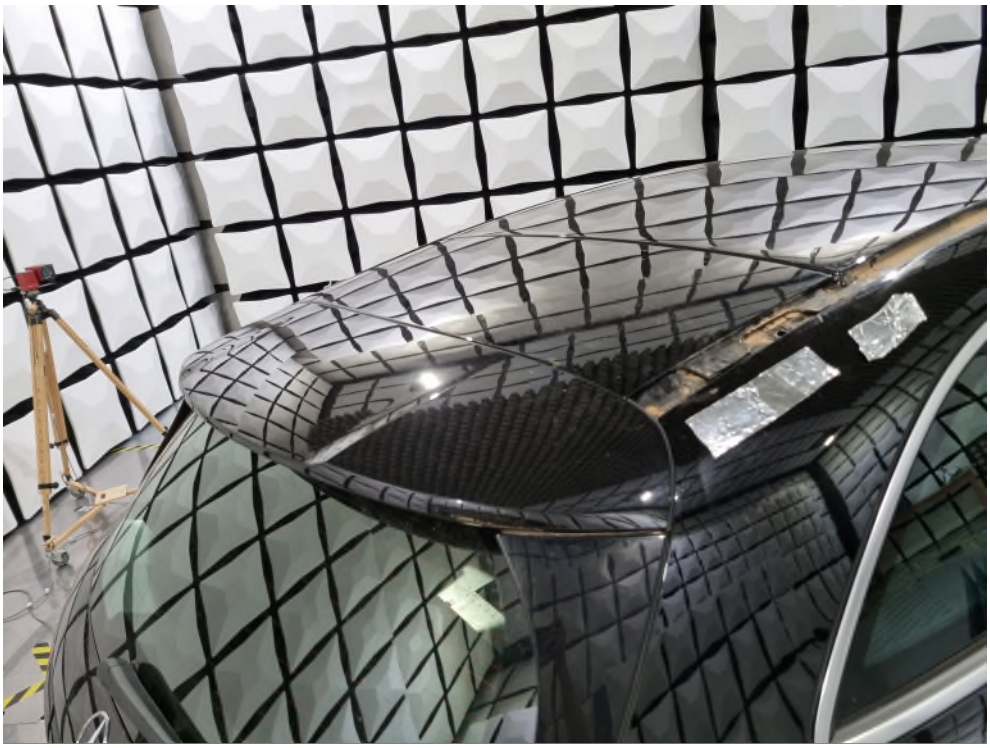

Fig. 6: EUT support details: set up when measuring the real antenna installed at the car (with cover)

4 Measurement Results

4.1 Searching for the Worst Case Scenario

The following relative results have been found for:

- Set up as shown in Fig. 5
- Test procedure as described in chapter 3: Resolution 5° in azimuth and 4° in elevation.
- Car: SUV (X254)
- Antenna system variant “BASE”
- CW source

433.92 MHz	ANT1	ANT2
BASE	0.0 dB	-1.98 dB

Tab 5: Relative EIRP values found for 434 MHz antenna version.

In result the maximum EIRP values where found for:

- The 434 MHz antenna for: BASE, ANT1 at a measurement antenna height of 4 m.

At those positions the impact for frequency (channels) has been measured in terms of the whole antenna pattern at one plane (measurement antenna height). Those tests has been executed using the final set up, and using a modulated signal at the above mentioned worst case setups. The results are summarized in Tab 6. It was found a variation over frequency to be less than 0.5 dB. This is lower than the (heuristically determined) uncertainty for the relative measurement uncertainty of about ±0.4 dB.

	Low (channel 1)	Mid (channel 3)	High (channel 2)
434 MHz band	433.47 MHz	433.92 MHz	434.37 MHz
BASE	0 dB	-0.17 dB	-0.28 dB

Tab 6: Relative values to the highest value found for different frequencies

4.2 Field Strength and EIRP Measurements with actual settings for Power and Modulation build in at a typical car

For measuring the final maximum field strength and EIRP value the set up for the worst case scenario as determined by the measurements as reported in chapter has been used and the for the 434 MHz the channel 3 = 433.92 MHz. The measurement was done using a peak detector with a resolution bandwidth of 300 kHz. For calculating the right average field strength the timing results out of the report CETECOM_TR18_1_0257101T93a.pdf and CETECOM_TR18_1_0257101T97a.pdf has been used:

- For the FCC version at 434 MHz band: -17.35 dB

4.2.1 FCC and ISED Canada related Test Result

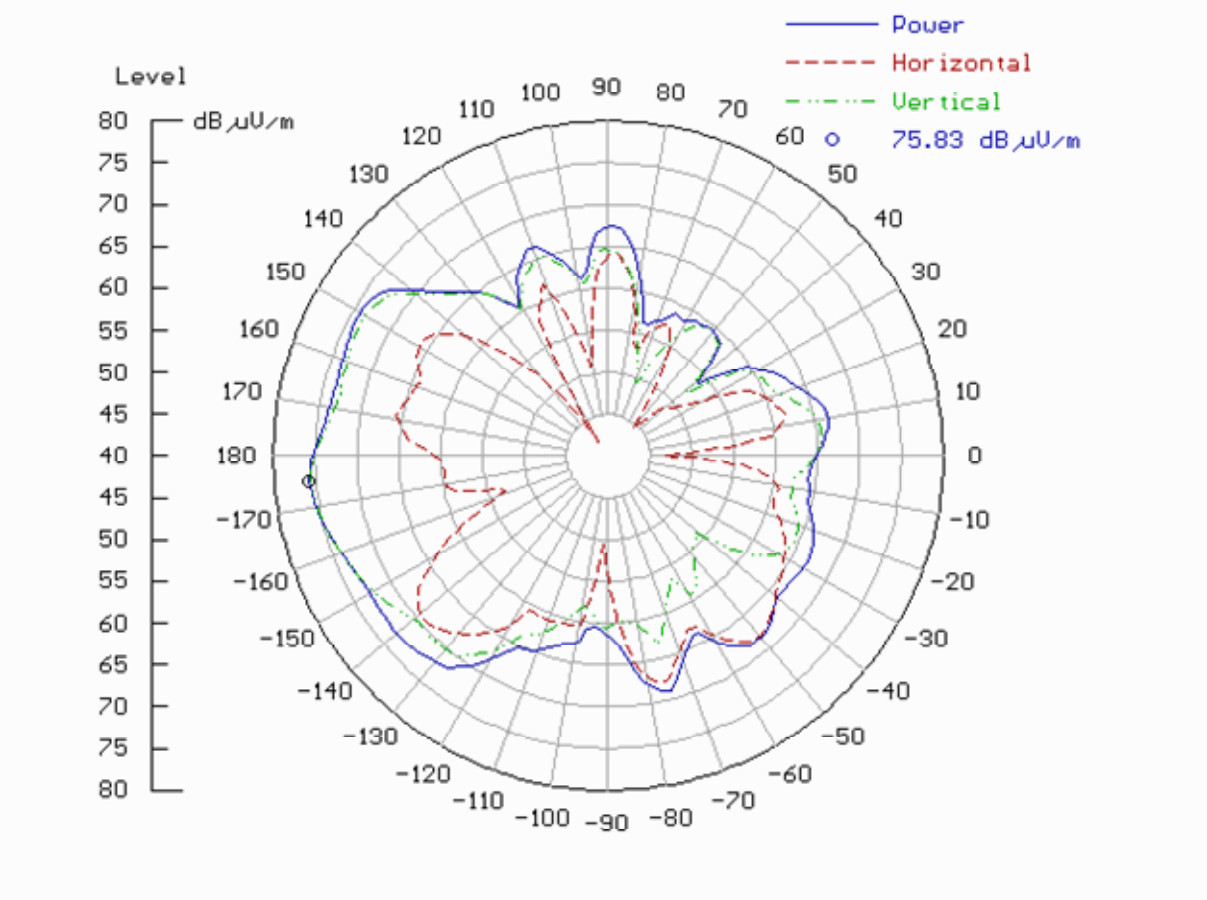

Fig. 7: Maximum EIRP value found for 434 MHz antenna when attached to real car in worst case scenario and when set to appropriate modulation, timing and power value 0x2C.

4.2.2 EN Related Test Result

For assessment in respect of European norm no timing information is taken into account, because the limits and measured values are maximum peak data.

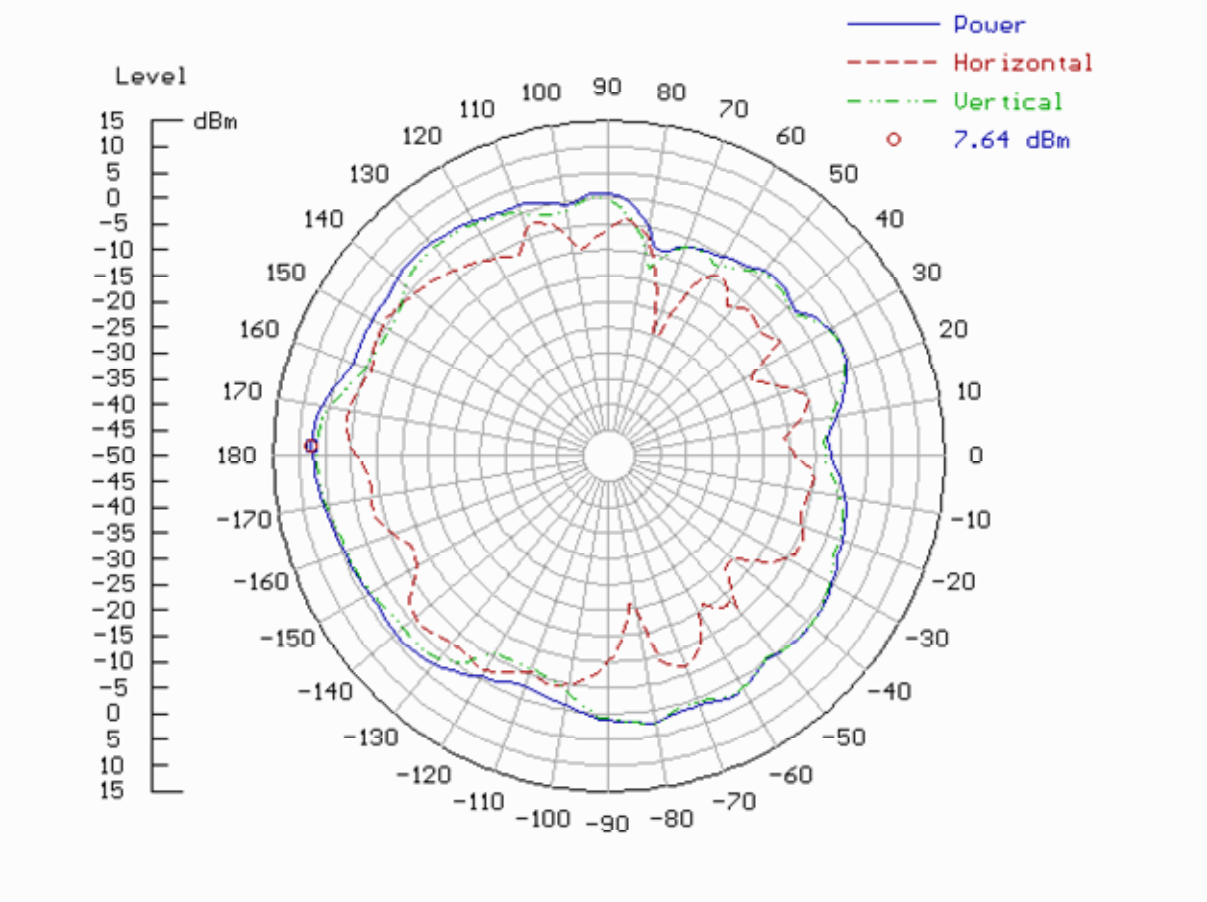

Fig. 8: Maxim EIRP value found for 434 MHz antenna when attached to real car in a worst case scenario and when set to appropriate modulation, and power value 0x36.

5 Equipment lists

ID	Description	Manufacturer / Type	Serial Number	Calibration Due Date
25358	Anechoic Chamber	Albatross Projects GmbH / SAC5	P27281-016	2026
25360	Antennenmast BAM 4.5-P	maturo GmbH / BAM 4.5	P/091/17791115	--
25361	Controller	maturo GmbH / NCD	202/17791115	--
25348	EMI Test Receiver	Rohde & Schwarz / ESR7	101600	09.08.2023
25352	Switch and control Platform	Rohde & Schwarz / OSP120	101542-rV	--
25357	Measurement Antenna	R&S HL562E (30 MHz – 6 GHz)	100824	09.10.2023

Tab. 1: Test equipment list.

6 Measurement Uncertainty

The measurement uncertainty has been calculated and reported in a separate document [1]. The absolute uncertainty for the antenna gain is in the range: < ± 4.2 dB.
The uncertainty applicable for relative measurements over frequency was determined heuristically (and refers mainly to the measurement antenna gain over frequency ripple) is in range of ±0.4 dB.

7 References

[1] CETECOM: “Working Instruction WI_EMC-DUS_10_MESSUNSICHERHEIT V03, CTECOM GmbH EMC Testlab Branch Düsseldorf”, January 2019.
[2] CETECOM Testreport 18-1-0257110T05a (EU), 03/2021.
[3] CETECOM Testreport 18-1-0257110T02a (FCC and ISED), 03/2021.

8 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2023-Jan-18
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End of Test Report