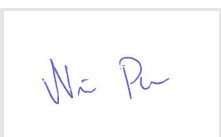
Evaluation Report 21-1-0165301T02a
EIRP Measurements of Different Antenna Versions when Installed on Car

Number of pages:	14	**Date of Report:**	2022-Mar-01
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 EQS (V297))**		

Frequency Range:	**434 MHz**
EIRP Test 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
Authorization of Test Report

Guangcheng Huang
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 data of a reference antenna used in the basic homologation of the RKE module has been compared to different scenarios with realistic installations, which includes combinations of different antenna versions and different car related variants.
There are four different antenna versions for the 434 MHz band (BASE EN, HAF EN, BASE US & HAF US) being tested.
The car related variant is the EQS (V297) with rear windshield made of IR coated glass nearby the antenna.
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 EIRP measurements have been carried out according the FCC / ISED and EN Test standards applying the correct modulation and module RF power settings. The results of the EIRP and field strength values used for the homologation based on the reference antenna are summarized below.

Frequency Band	The maximum EIRP has been found at
434 MHz	HAF, ANT2 at a measurement antenna height of 3.5 m

Tab. 1: Scenarios creating a maximum EIRP value.

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	79.1 dBµV/m	78.5 dBµV/m	Below the reference
Europe	10 dBm	8.5 dBm	8.0 dBm	Below the reference

Tab. 2: Overview test results of EIRP and field strength.

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:	21-1-0165301T02a
Test Date(s):	24.01.2022
Witness during tests:	Christian Magg <christian.magg@continental-corporation.com>
Responsible for test report:	Guangcheng Huang
Date of report:	2022-Mar-01

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:	-

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 A	S10	RKE Module HAF FCC	RKE223E1 / Application sample (50020030)	000170	13612160B08V00	11.31
EUT B	S07	RKE Module BASE FCC	RKE223E1 / Application sample (50020025)	000131	13612160B08V00	11.31
EUT C	S16	RKE Module HAF EN	RKE223E1 / Application sample (50020041)	000052	13612160B08V00	11.31
EUT D	S13	RKE Module BASE EN	RKE223E1 / Application sample (50020038)	003521	13612160B08V00	11.31

Tab. 1: EUT details.

2.6 Auxiliary Equipment: Type and Short Descriptions

Short description	PMT No.	Auxiliary Equipment	Type	S/N	HW status	SW status
AE 01	S24	Testbox FCC	Testbox	180401B35	--	RKE223_V7.0
AE 02	S23	Testbox EN & JPN	Testbox	180401B12	--	RKE223_V6.2
AE 03	S21	Mercedes-Benz EQS sedan (V297)	Car	--	--	--

Tab. 2: Auxiliary equipment details.

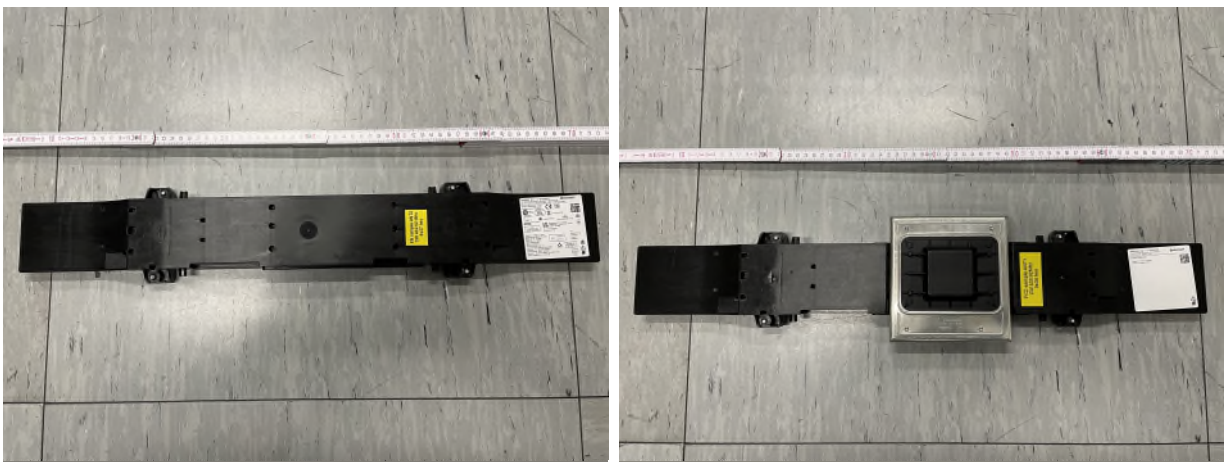

Fig. 1: Photos of the EUT front side: Module BASE EN programmed with CW signal (left), and module HAF US programmed with modulated signal (right)

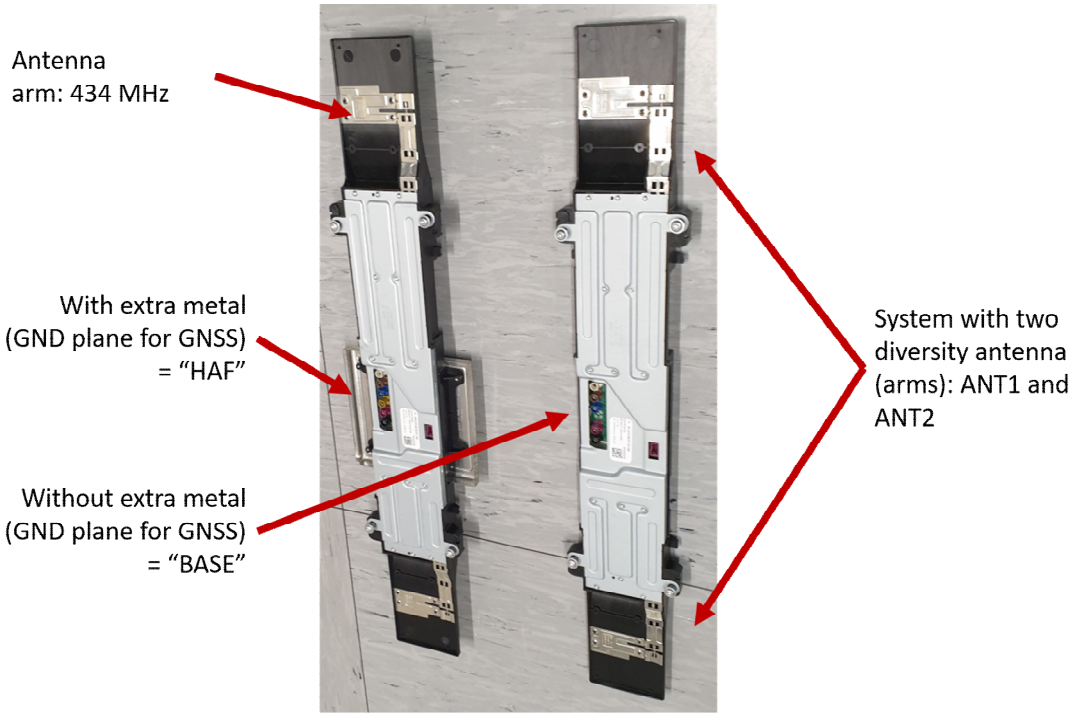

Fig. 2: Photos of EUT backside: the antenna (arms) and the connections.

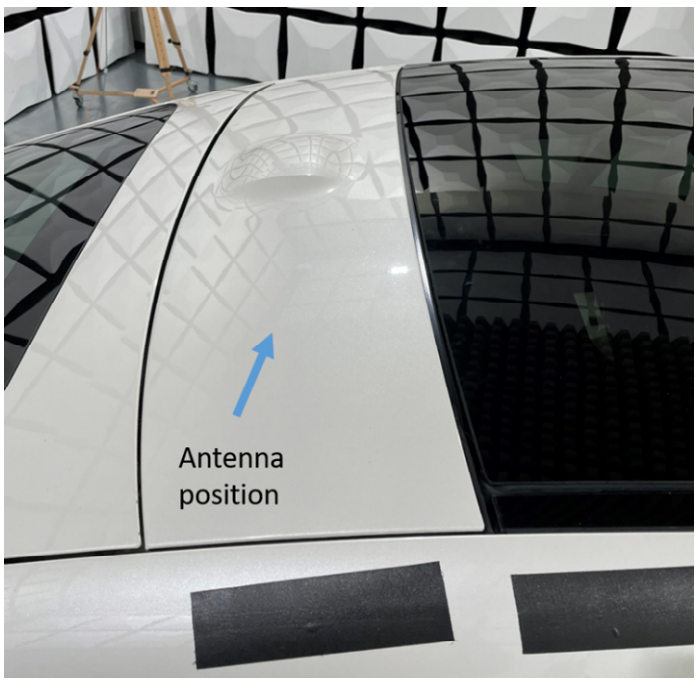

Fig. 3: Photo and indication of antenna position.

3 General Test Setup and Test Method

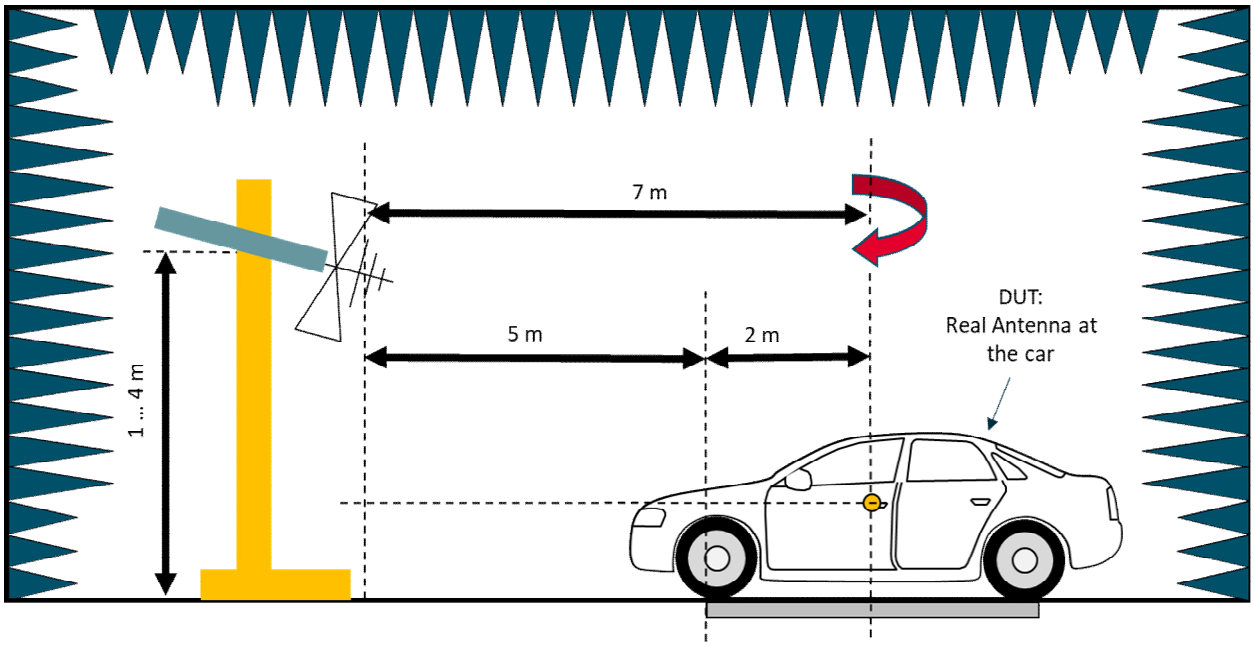

Fig. 4: Measurement set up using a movable antenna mast with tilt boresight (tilt) function.

Antenna measurements at cars with the need for higher 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 was 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 repeated for different antenna versions (see Fig. 2) at a car.

Fig. 5: Set up with EUT for test without absorbers at a car (EQS (V297)).

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

4 Measurement Results

4.1 Typical Antenna Pattern

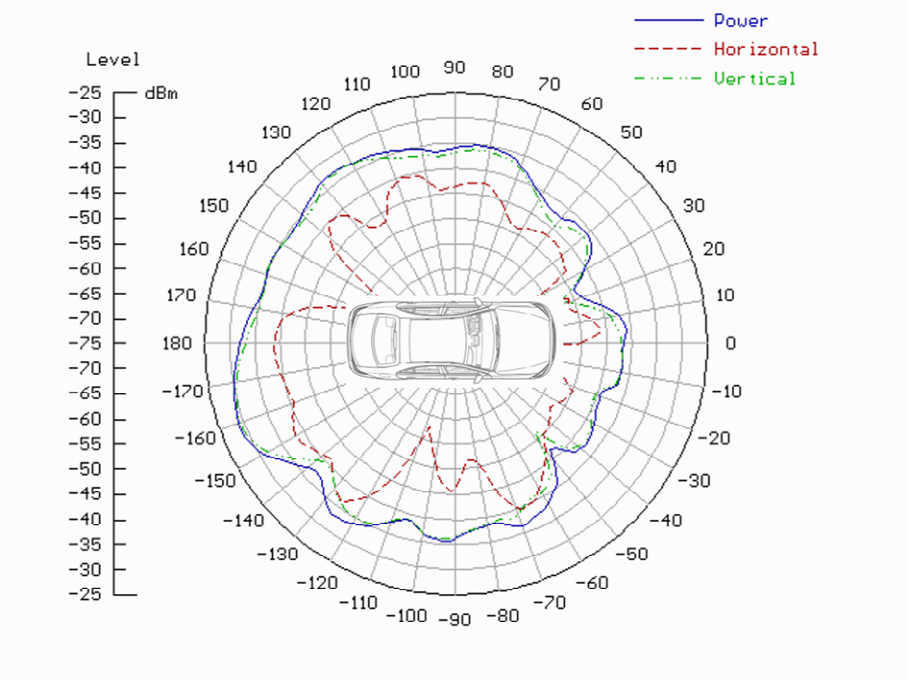

Fig. 7: Example pattern measured at 434 MHz from ANT1 with the installed module BASE (raw data for measurement antenna at 3.5 m height).

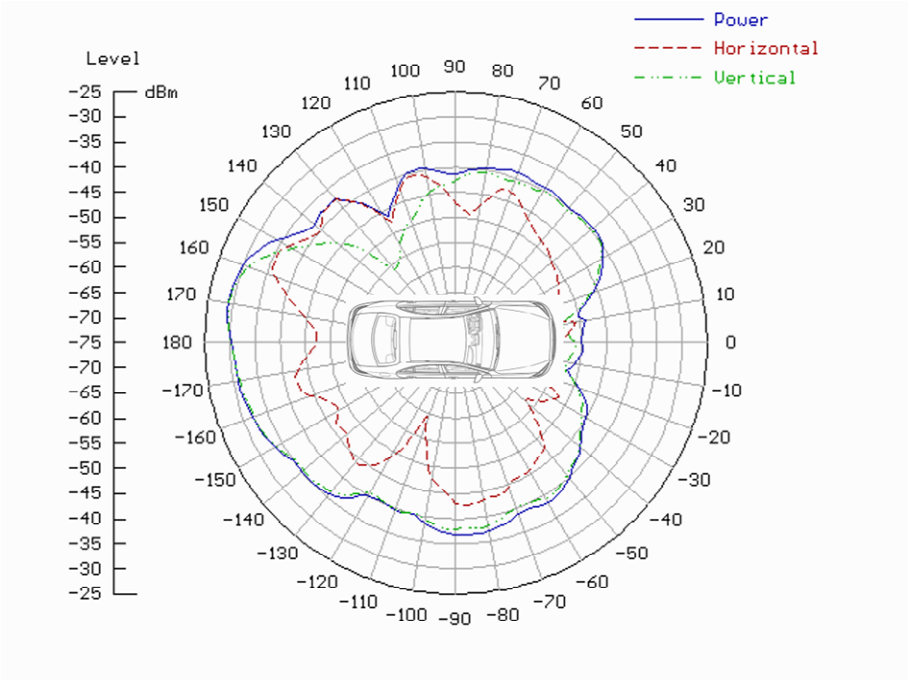

Fig. 8: Example pattern measured at 434 MHz from ANT2 with the installed module HAF (raw data for measurement antenna at 2.5 m height).

4.2 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: EQS (V297) with IR glass
- antenna system with two antennas (“BASE”) and with additional metal (“HAF”)
- CW source

433.92 MHz	IR Glass	
	ANT1	ANT2
HAF	-1.3 dB	0.0 dB
BASE	-1.5 dB	-0.7 dB

Tab. 3: Relative EIRP values found for 434 MHz antenna version.

In result the maximum EIRP values where found for:

- The 434 MHz antenna for: HAF, ANT2 and IR glass at a measurement antenna height of 3.5 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. 4. 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. The same low variation of less than 0.5 dB was found in the variant for Europe with a higher power setting when testing at one selected position.

	Low (channel 1)	Mid (channel 3)	High (channel 2)
434 MHz band	433.37 MHz	433.92 MHz	434.37 MHz
Field strength	-0.08 dB	-0.05 dB	0.00 dB

Tab. 4: Relative values to the highest value found for different frequencies.

4.3 EIRP and Field Strength Measurements for Actual Setting for Power and Modulation and Usage at a Typical Car

For measuring the final maximum 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 2 = 434.37 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 [3] has been used:

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

4.3.1 FCC and ISED Canada related Test Result

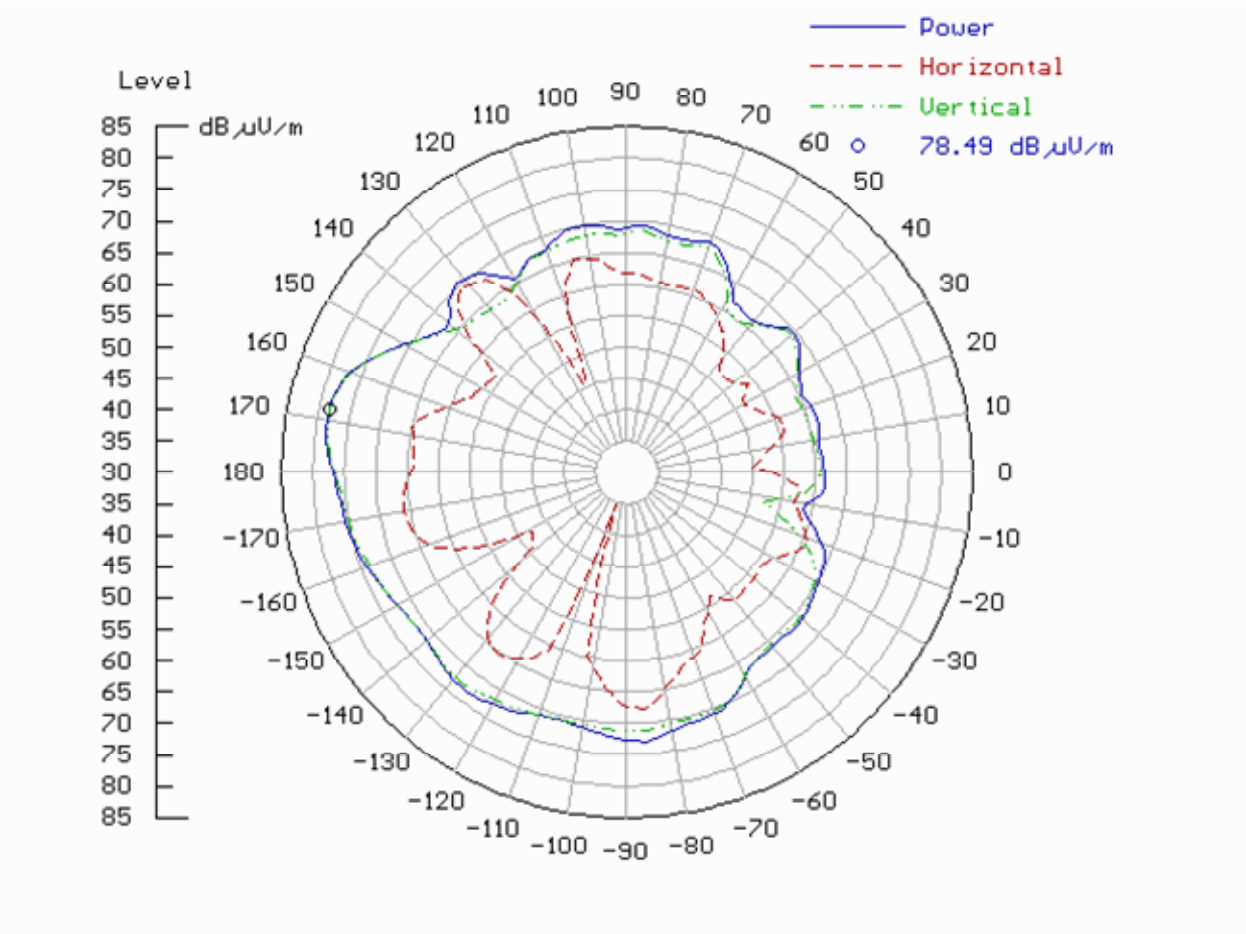

Fig. 9: Maximum field strength value found for 434 MHz antenna when attached to real car in worst case scenario and when set to appropriate modulation, timing and power value (Hex 0x2B).

4.3.2 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.

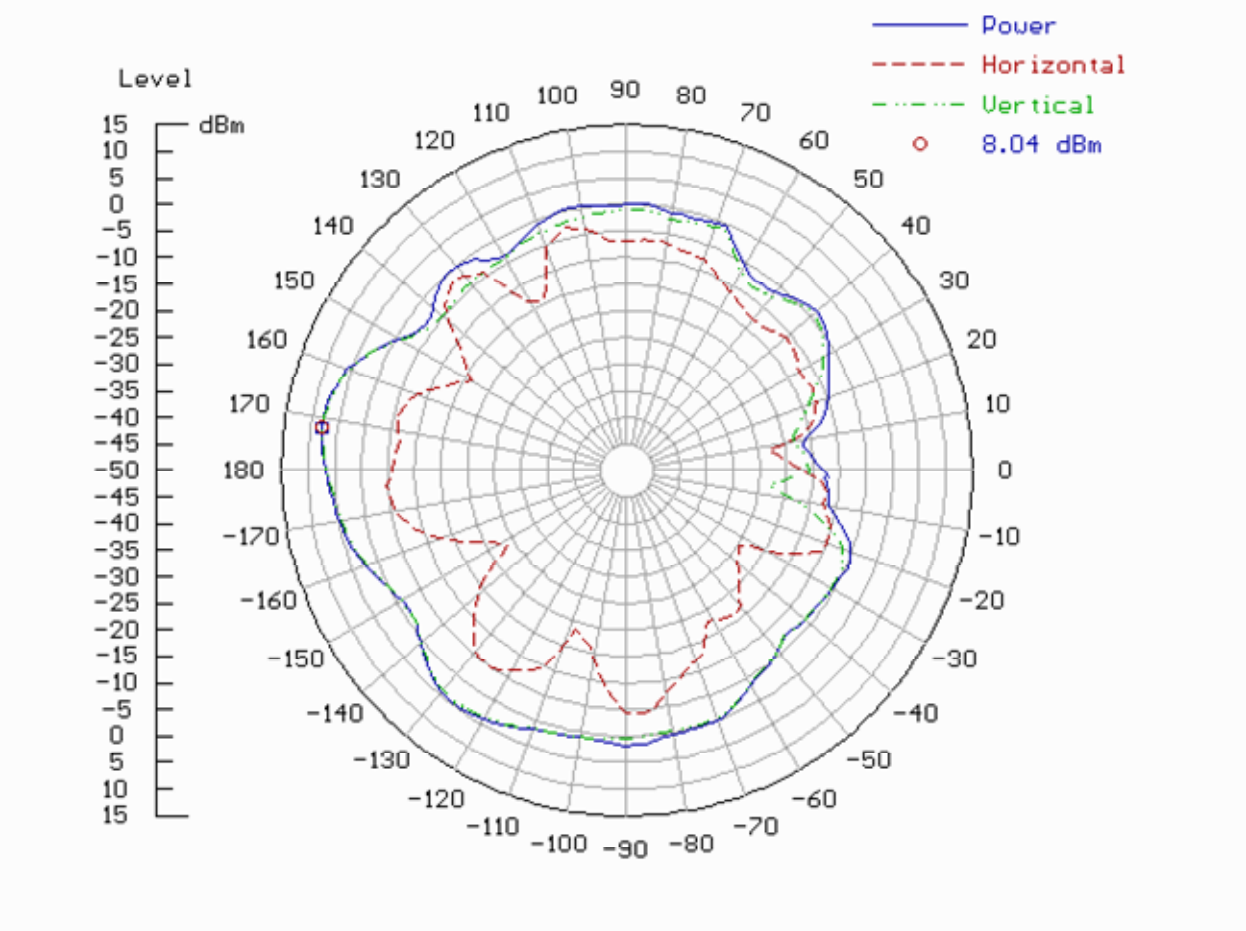

Fig. 10: Maxim EIRP value found for 434 MHz antenna when attached to real car in a worst case scenario and when set to appropriate modulation, and power value (Hex 0x32).

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. 5: 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 18-1-0257101T86a (EU), 08/2019.
[3] CETECOM Testreport 18-1-0257101T93a (FCC and ISED), 09/2019.

8 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2022-Mar-01
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End of Test Report