

Evaluation Report 21-1-0165308T01a

EIRP Measurements of Different Antenna Versions when Installed on Car

| | | | |
|-------------------------|---|------------------------|---|
| Number of pages: | 14 | Date of Report: | 2022-Dec-28 |
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| | |
|--|---|
| Test Object / Tested Device(s): | Antennas to be used with RKE223E1 (mounted in car C-Class (C254)) |
|--|---|



| | |
|-------------------------------------|--|
| 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 Authorization of Test Report Timo Franke 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 C-Class (C254).

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 3 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 ISSED | 80.8 dB μ V/m | 76.8 dB μ V/m | 76.42 dB μ V/m | Below the reference |
| Europe | 10 dBm | 8.1 dBm | 6.88 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: | 21-1-0165308T01a |
| Test Date(s): | 19.12.2022 |
| Witness during tests: | n/a |
| Responsible for test report: | Timo Franke |
| Date of report: | 2022-Dec-28 |

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 | 21-1-01653S48_C01 | Car | Mercedes Benz C-Class (C254) | 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 0x34.

Tab 4: Auxiliary equipment details.

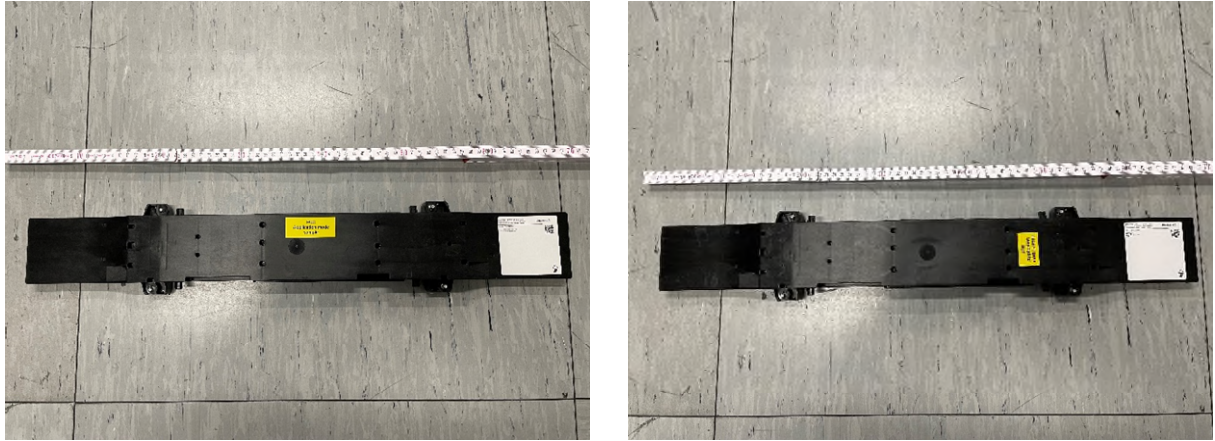


Fig 1: Photos of the antennas

Shorter antenna
arm: 434 MHz



Longer antenna
arm: 315 MHz



Always a system
with two diversity
antenna (arms):
ANT1 and ANT2

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

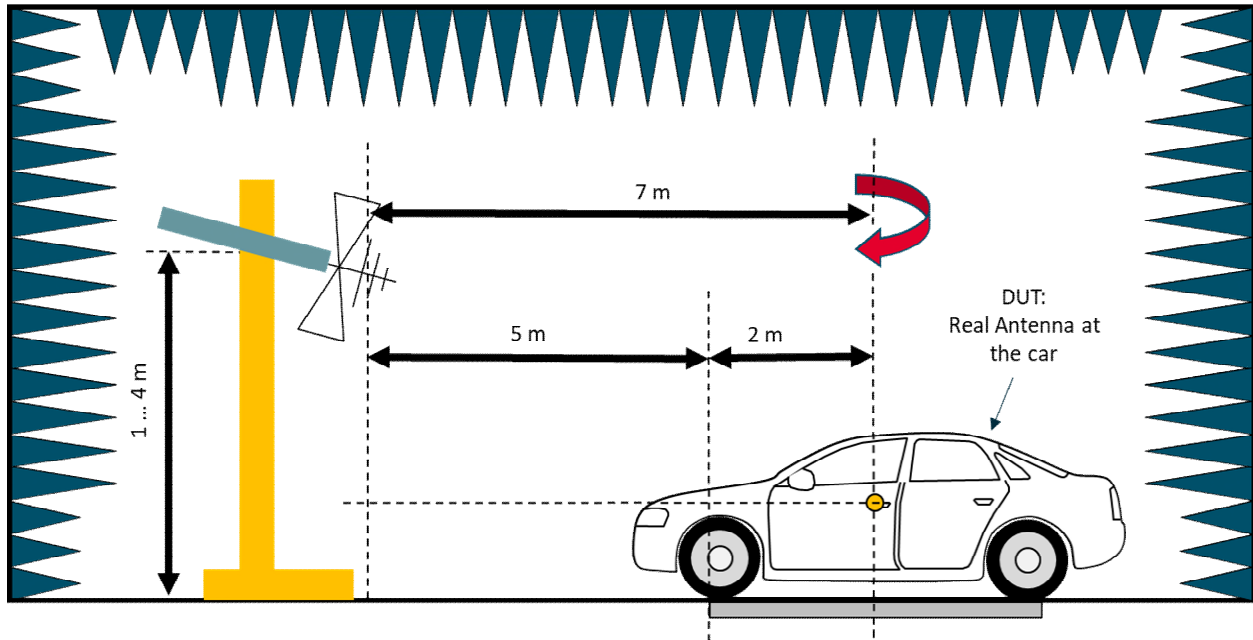


Fig. 4: Measurement set up using a movable antenna mast with tilt boresight (tilt) function

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 were 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 (C-Class (C254))



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

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: C-Class (C254)
- Antenna system variant "BASE"
- CW source

| 433.92 MHz | ANT1 | ANT2 |
|------------|------|----------|
| BASE | 0 dB | -2.35 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 3 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 | -0.12 dB | -0.27 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

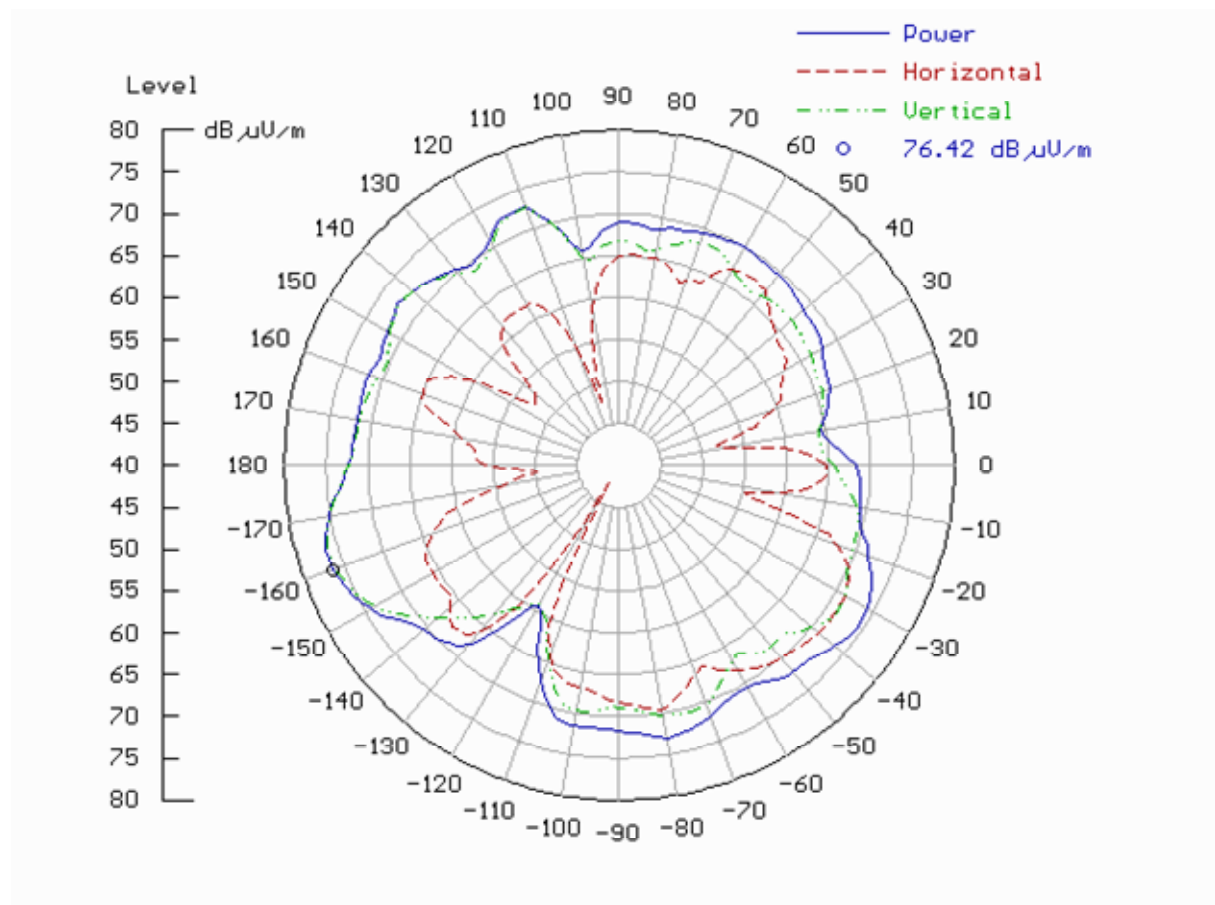


Fig. 7: Maximum EIRP value found for 434 MHz antenna when attached to real car in worst case scenario and when set to appropriate modulation, timing and power value 0x2C.

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.

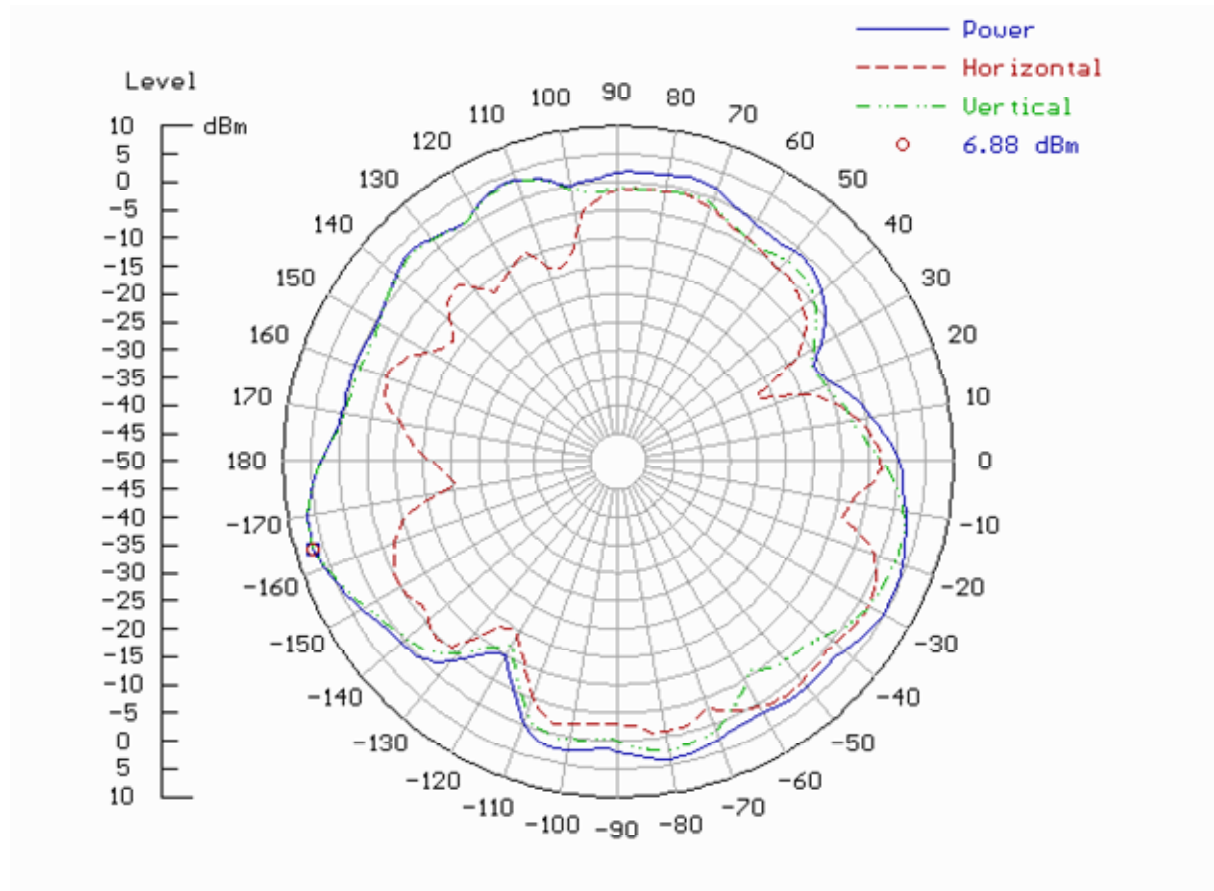


Fig. 8: Maxim EIRP value found for 434 MHz antenna when attached to real car in a worst case scenario and when set to appropriate modulation, and power value 0x34.

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 | maturro GmbH / BAM 4.5 | P/091/17791115 | -- |
| 25361 | Controller | maturro 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: $< \pm 4.2$ 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, CETECOM GmbH EMC Testlab Branch Düsseldorf", January 2019.
- [2] CETECOM Testreport 18-1-0257110T05a (EU), 03/2021.
- [3] CETECOM Testreport 18-1-0257110T02a (FCC and ISSED), 03/2021.

8 Versions of test reports (change history)

| Version | Applied changes | Date of release |
|---------|-----------------|-----------------|
| -- | Initial release | 2022-Dec-28 |
| -- | -- | -- |

End of Test Report
