Evaluation Report 22-1-0146701T001a
EIRP Measurements of Different Antenna Versions when Installed on Car

Number of pages:	14	**Date of Report:**	2023-Apr-03
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):	**Glass antenna to be used with RKE232E1 (mounted in car C192 AMG GT)**		

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:

Dr. Peter Nevermann	**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 is one antenna versions for the 434 MHz band being tested.
The car related variant is the C192 AMG GT.
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	ANT1 at a measurement antenna height of 3.5 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	77.3 dBµV/m	76.16 dBµV/m	Below the reference
Europe	10 dBm	5.2 dBm	4.85 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:	Dipl.-Ing. Ninovic Perez
Accreditation scope:	DAkkS Webpage
Test location:	CETECOM GmbH / Im Teelbruch 116 / 45219 Essen - Kettwig / Germany

2.2 General Limits for Environmental Conditions

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

2.3 Organizational Items

CETECOM project number:	22-1-0146701T001a
Test Date(s):	01.02.2023
Witness during tests:	n/a
Responsible for test report:	Timo Franke
Date of report:	2023-Apr-03

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	22-1-01467S15_C01	RKE Module US	RKE232E1A232 905 1101 / Application sample	n/a	13620028B02V02	V11.31
EUT 2	22-1-01467S24_C01	RKE Module EN	RKE232E1A232 905 1101 / Application sample	n/a	13620028B02V02	V11.31

Tab 3: EUT details.

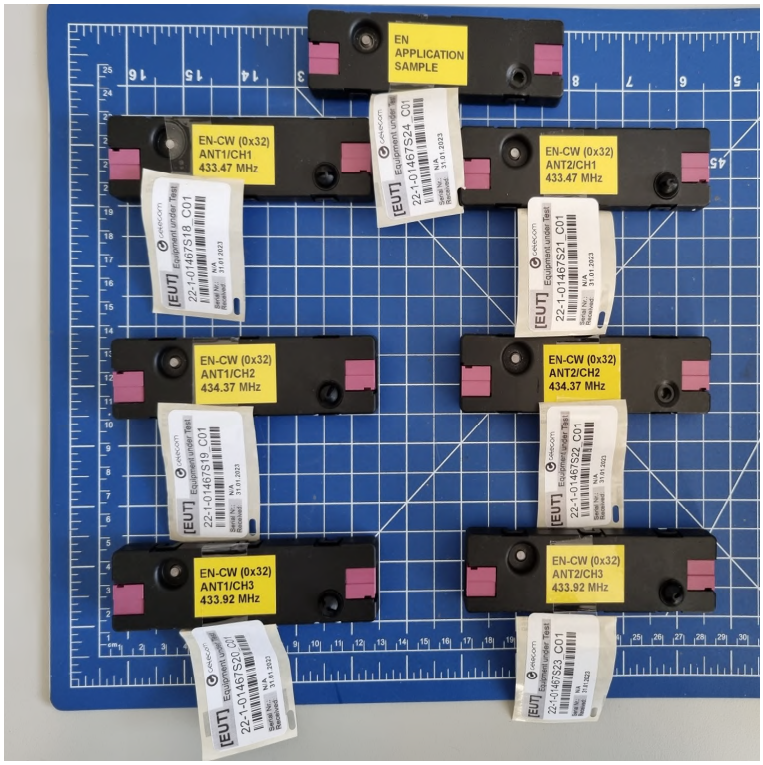
2.6 Auxiliary Equipment: Type and Short Descriptions

Short description	PMT No.	Auxiliary Equipment	Type	S/N	HW status	SW status
AE 1	22-1-01467S25_C01	Testbox RKE232	EN	180401C02	n/a	RKE223_V7.0
AE 2	22-1-01467S17_C01	Testbox RKE232	USA	180401C06	n/a	RKE223_V7.0
AE 3	22-1-01467S26_C01	Car	Mercedes Benz C192 AMG GT	n/a	n/a	n/a

Remark 1: FCC initial testbox power setting was set to 0x2E. For tests value was not changed.

EN initial testbox power setting was set to 0x32. For tests value was not changed.

Tab 4: Auxiliary equipment details.



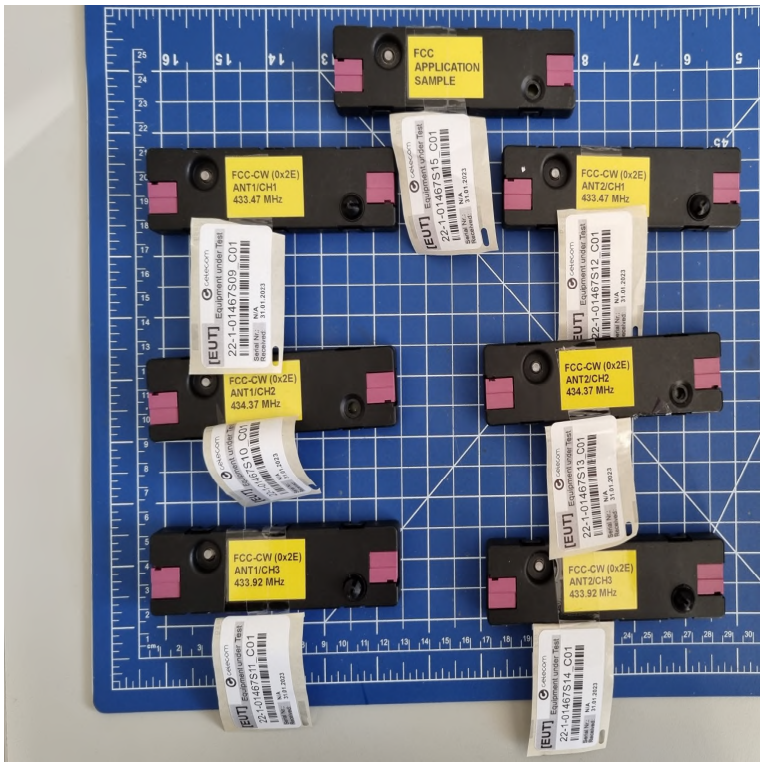


Fig 1: Photos of the antennas

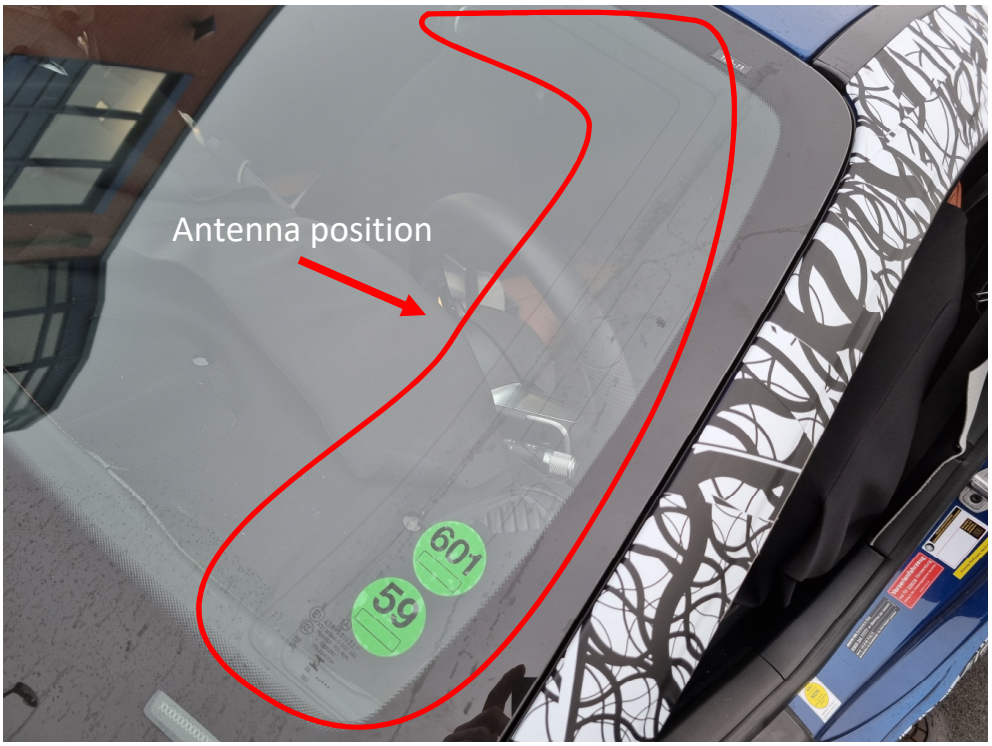


Fig. 2: Photos covering the antenna position embedded in windshield glass

Fig. 3: Photo and indication of antenna module

3 General Test Setup and Test Method

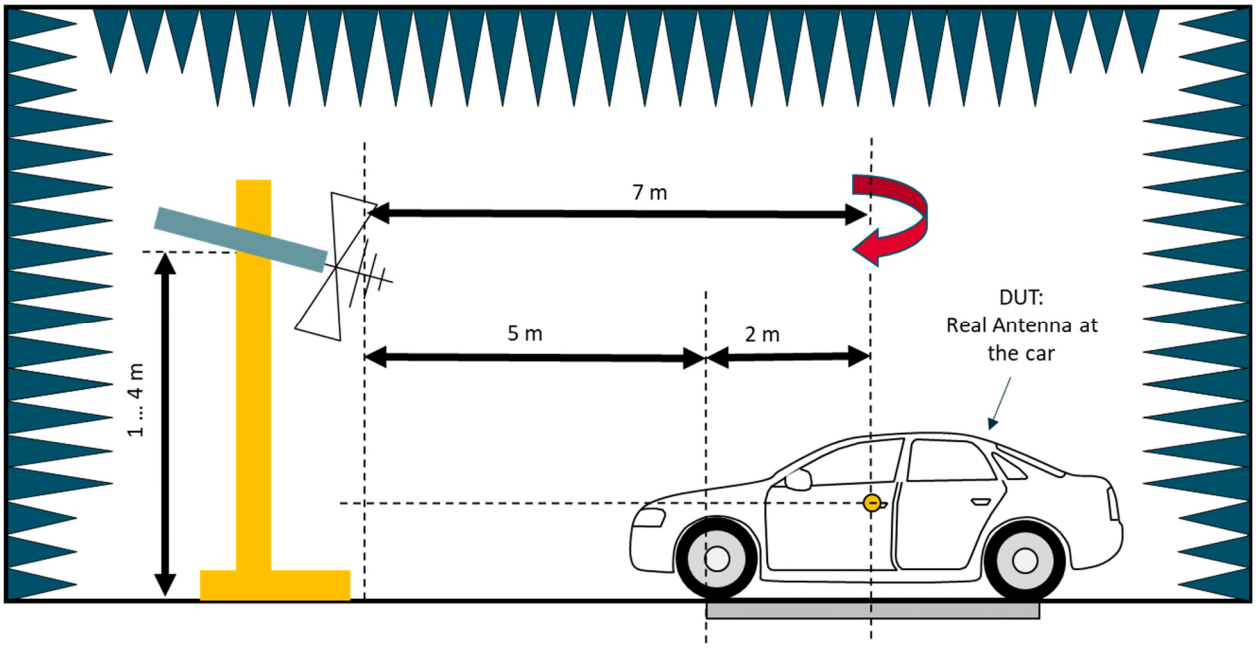


Fig. 4: Measurement set up using a movable antenna mast with tilt boresight (tilt) function

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 (C192 AMG GT)

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: C192 AMG GT
- CW source

434.37 MHz	ANT1	ANT2
Relative EIRP	0 dB	-2.96 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: ANT1 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 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
Relative EIRP	-3.01 dB	-0.84 dB	0 dB

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

At worst case configuration of EUT position, antenna and channel a manual check has been performed to take the deviation from CW and modulated sample into account. Only raw values were compared.

434 MHz band	Δ mod/CW
EN	+0.40 dB
FCC	-0.35 dB

Tab 7: Level deviation from modulated sample and CW sample

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 4.1 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 CETECOM_TR19-1-0173601T06a_C1.pdf has been used:

- For the FCC version at 434 MHz band: -17.33 dB

4.2.1 FCC and ISED Canada related Test Result

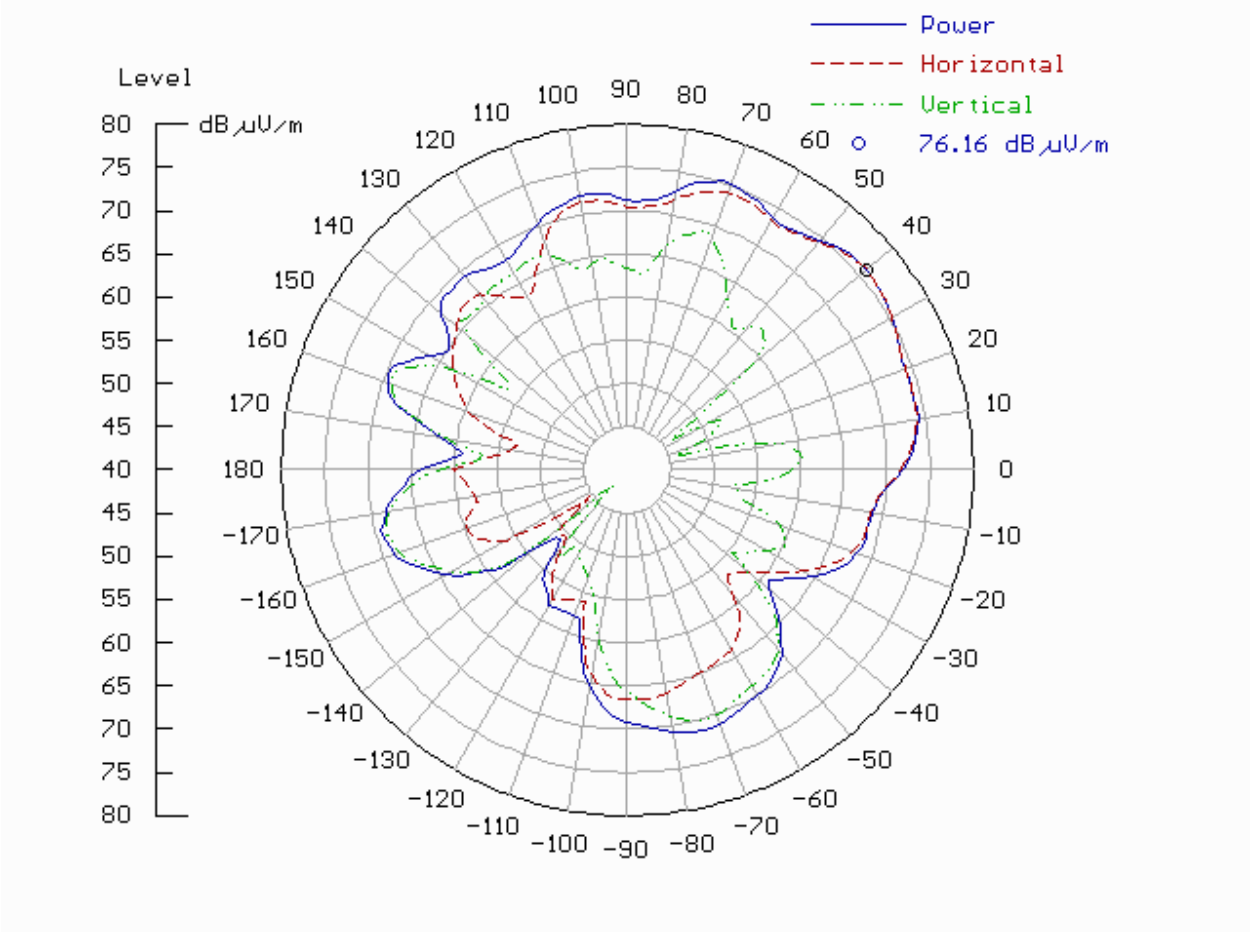


Fig. 6: Maximum EIRP value found for 434 MHz antenna when attached to real car in worst case scenario and when set to appropriate modulation, timing and power value 0x2E.

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.

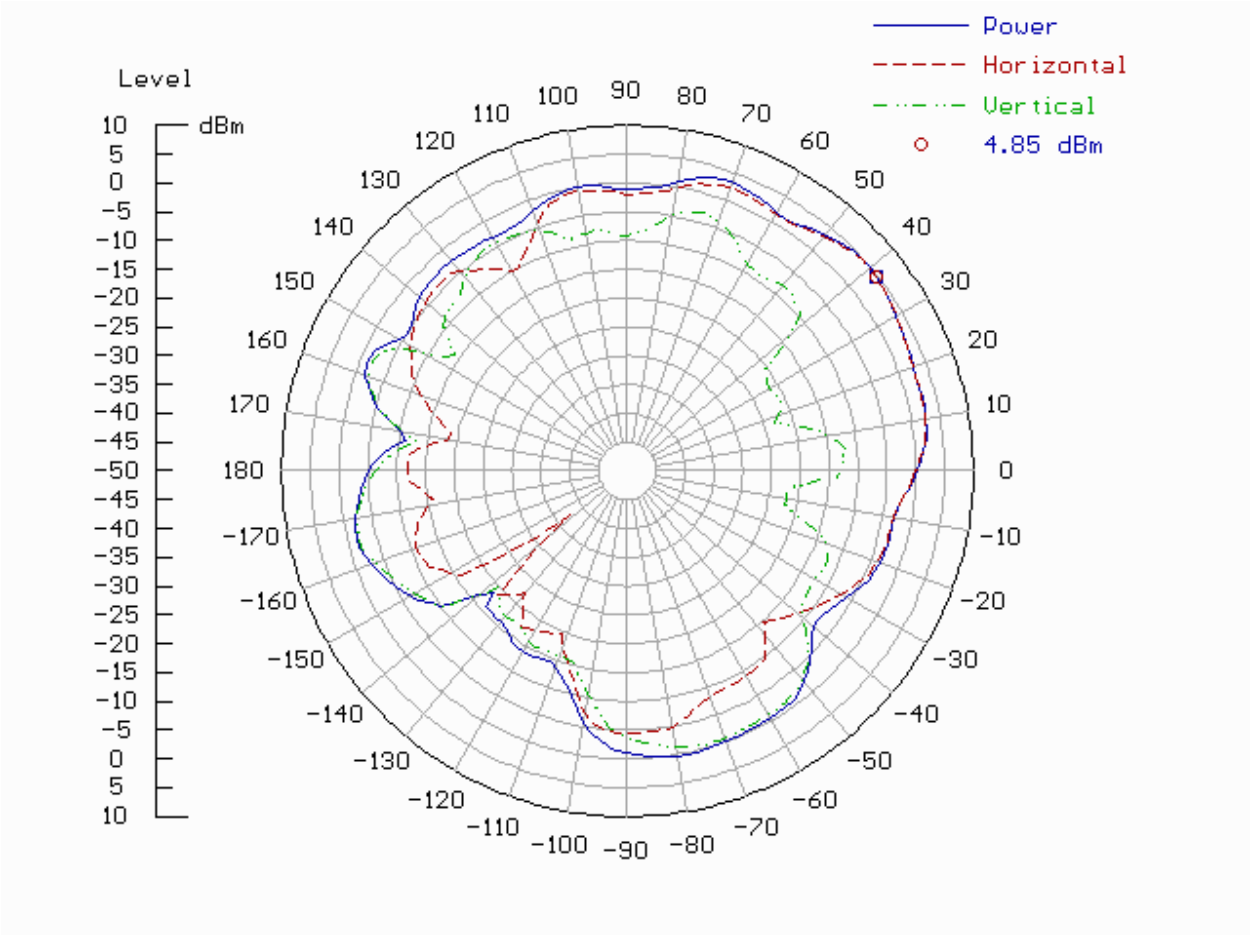


Fig. 7: Maxim EIRP value found for 434 MHz antenna when attached to real car in a worst case scenario and when set to appropriate modulation, and power value 0x32.

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. 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 19-1-0173601T02a_C2 (EU), 01/2021.
[3] CETECOM Testreport 19-1-0173601T06a_C1 (FCC and ISED), 01/2021.

8 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2023-Apr-03
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End of Test Report