FCC Measurement/Technical Report on

Vehicle immobilizer

A2C93178600

FCC ID: KR5A2C93178600
IC ID: 7812D-93178600

Report Reference: MDE_CONTI_1528_FCCa

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

DAkkS Deutsche Akkreditierungsstelle D-PL-12140-01-01

Note:
The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

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0 Summary

0.1 Technical Report Summary

Type of Authorization
Certification for an intentional radiator: 125 kHz NFC tag reader

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 (10-1-14 Edition) and 15 (10-1-14 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.205 Restricted bands of operation

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.215 Additional provisions to the general radiated emission limitations

Note:
ANSI C63.10-2013 applied

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 0.2 Measurement Summary.

0.2 Measurement Summary

FCC Part 15, Subpart C	**§15.209**		
Radiated Emissions			
The measurement was performed according to ANSI C63.10			
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	Enclosure	passed

FCC Part 15, Subpart C	**§ 15.209**		
Peak Output Power			
The measurement was performed according to ANSI C63.10			
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	Enclosure	passed

FCC Part 15, Subpart C	**§ 15.207**		
Conducted Emissions AC Power line			N/A (1)
The measurement shall be performed according to ANSI C63.10			
OP-Mode	**Setup**	**Port**	**Final Result**
–	–	–	–

FCC Part 15, Subpart C	**§ 15.215**		
Occupied Bandwidth			
The measurement was performed according to ANSI C63.10			
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	Enclosure	passed

Notes:

N/A = Not applicable
(1) The EUT is DC powered and used in vehicles only.

Responsible for Accreditation Scope:	MARCO KULLIK 2016.05.04 16:57:57 +02'00'	Responsible for Test Report:	DOBRIN TODOROV DOBRINOV 2016.05.04 16:49:58 +02'00'

1 Administrative Data

1.1 Testing Laboratory

Company Name:	7Layers GmbH
Address	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716.

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no.:	DAkkS D-PL-12140-01-01
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Andreas Petz Dipl. Ing. Marco Kullik
Report Template Version:	2013-03-14

1.2 Project Data

Responsible for testing and report:	Dipl. Ing. Dobrin Dobrinov
Date of Test(s):	2016-03-17 to 2016-04-25
Date of Report:	2016-04-27

1.3 Applicant Data

Company Name:	Continental Automotive GmbH
Address:	Siemensstrasse 12 93055 Regensburg Germany
Contact Person:	Mr. Sven Kubeil
Phone:	+49 941 790-90292
Fax:	+49 941 79099-90292
E-Mail:	sven.kubeil@continental-corporation.com

1.4 Manufacturer Data

Company Name:	Please see applicants data
Address:	
Contact Person:	

2 Test object Data

2.1 General EUT Description

Equipment under Test Immobilizer
Type Designation: A2C93178600

Kind of Device: 125 kHz RF Transceiver
Voltage Type: DC
Voltage level: 12 V DC powered from vehicle lead acid battery

General product description:

The Immobilizer is a RF Transceiver used for enabling/disabling a car ignition system by bidirectional communication with the Remote key, which contains a passive transponder. The EUT is used in vehicles only.

Specific product description for the EUT:

The EUT operating in 125 kHz frequency range and sends 200 ms interrogation messages, which modulate a LF carrier to ASK output signal.
The tests are performed by using a test box, which modulates the EUT output signal. The test box provided by the applicant, generates a modulation signal with 101010… pattern, instead the real 10100111001 pattern (example), which produces the "worst case" scenario, concerning the radiated emissions spectrum.

The EUT provides the following ports:

- Enclosure
- 4 pin connector connected as is shown in the table below:

Port and interconnecting cables		Cable length	Shielded
EUT to test box:	4 wires with Ø = 0.5 mm^2	1.5 m	no
Test box to DC power supply:	2 wires with Ø = 0.5 mm^2	1.0 m	no

The main components of the EUT are listed and described in Chapter 2.

2.2 EUT Main components

Type, S/N, Short Descriptions etc. used in this Test Report

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status	Date of Receipt
EUT A (Code: DE1024006aa02)	Vehicle immobilizer	A2C93178600	–	A2C93178600	–	2016-03-15
Remarks: EUT A is equipped with an integral coil antenna with typical 0.0 dBi antenna gain. The EUT has no software installed.						

NOTE: The short description is used to simplify the identification of the EUT in this test report.

2.3 Ancillary Equipment

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status	FCC ID
AE 1	Remote key	–	–	–	–	–

2.4 Auxiliary Equipment

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it.
But nevertheless Auxiliary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	Serial no.	HW Status	SW Status	FCC ID
AUX 1	Test box	Immobilizer Tester	–	–	–	–

2.5 EUT Setups

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup No.	Combination of EUTs	Description and Rationale
Setup_01	EUT A + AE 1 + AUX 1	EUT A communicating with Remote key

2.6 Operating Modes

This chapter describes the operating modes of the EUTs used for testing.

Op. Mode	Description of Operating Modes	Remarks
Op-mode 1	continuous modulation	EUT is transmitting a periodic modulated signal, continuously communicating with Remote key.

2.7 Special software used for testing

None.

2.8 Product labelling

2.8.1 FCC ID label

FCC ID: KR5A2C93178600

2.8.2 IC ID label

IC ID: 7812D-93178600

2.8.3 Location of the label on the EUT

Please refer to the documentation of the applicant.

3 Test Results

3.1 Spurious radiated emissions

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

3.1.1. Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The measurement procedure is implemented into the EMI test software EMC32 from R&S. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes. A pre-check is performed while the EUT is powered from a DC power source.

1. Measurement up to 30 MHz
The Loop antenna HFH2-Z2 is used.

Step 1: pre measurement
- Anechoic chamber
- Antenna distance: 3 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 MHz and 0.15 – 30 MHz
- Frequency steps: 0.05 kHz and 2.25 kHz
- IF–Bandwidth: 0.2 kHz and 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: final measurement
For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.
- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 0.2 - 10 kHz
- Measuring time / Frequency step: 1 s

2. Measurement above 30 MHz and up to 1 GHz

Step 1: Preliminary scan
This is a preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Antenna distance: 3 m
- Detector: Peak-Maxhold / Quasipeak (FFT-based)

- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz
- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 ms
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: Adjustment measurement
In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by ± 45° around this value. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by ± 100 cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.
- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: ± 45 ° around the determined value
- Height variation range: ± 100 cm around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with QP detector
With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:
- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

After the measurement a plot will be generated this contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

3.1.2. Test Requirements / Limits

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
0.009 – 0.49	2400/F(kHz)@300m	3	(48.5 – 13.8)@300m
0.49 – 1.705	24000/F(kHz)@30m	3	(33.8 – 23.0)@30m
1.705 – 30	30@30m	3	29.5@30m

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (2).

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (dBµV/m)
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 - 26000	500@3m	3	54.0@3m
26000 - 40000	500@3m	1	54.0@3m

§15.35(b) ..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

Used conversion factor: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

3.1.3. Test Protocol

Temperature: 22 °C
Air Pressure: 1023 hPa
Humidity: 33 %

3.1.1.1 Measurement up to 30 MHz

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
–	–	–	–	–	–	–	–	–	–

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
–	–	–	–	–	–	–	–	–	–

Remark: No relevant spurious emissions in the range 20 dB below the limit found, therefore step 2 was not performed.
Please see annex for the measurement plots.

3.1.2.1 Measurement above 30 MHz

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Delta to limit dB	Delta to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
–	–	–	–	–	–	–	–	–	–

Remarks: No relevant spurious emissions in the range 20 dB below the limit found, therefore step 2 was not performed.
Please see annex for the measurement plots.

3.1.4. Test result: Spurious radiated emissions

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	passed

3.2 Peak power output

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

3.2.1 Test Description

Please refer to sub-clause 3.1.1.

3.2.2 Test Limits

Please refer to sub-clause 3.1.2.

3.2.3 Test Protocol

Temperature: 22 °C
Air Pressure: 1015 hPa
Humidity: 33 %

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

Output power dBµV/m	Frequency kHz	Limit dBµV/m at fundamental frequency for 10 m distance	Remarks
0.03	125.2	84.8	Maximum radiated field strength at fundamental frequency

Note: The EUT transmitted a continuously modulated signal.

Remark: Please see annex for the measurement plot.

3.2.4 Test result: Peak power output

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	passed

3.3 Occupied bandwidth

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

3.3.1. Test Description

The Equipment Under Test (EUT) was setup in a shielded room to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The results recorded were measured with the modulation which produces the worst-case (widest) occupied bandwidth.

3.3.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.215 (c)
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. …

3.3.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1015 hPa
Humidity: 33 %

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

20 dB bandwidth kHz	99% bandwidth kHz	Remarks
31.41	82.64	The carrier is ASK modulated

Remark: Please see annex for the measurement plot.

3.3.4 Test result: Occupied bandwidth

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	Passed

4 Measurement uncertainty

Test Case	Parameter	Uncertainty
Peak power output	Power	± 4.5 dB
Occupied bandwidth	Power Frequency:	± 4.5 dB ± 0.125 kHz
Spurious radiated emissions	Power Frequency:	± 4.5 dB ± 11.2 kHz

5 Test equipment

1 Radiated Emissions

Lab to perform radiated emission tests

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Calibration Due
1.1	Fully Anechoic Room	8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB	
1.2	AM 4.0	Antenna mast	Maturo GmbH	AM4.0/180/11920513	
1.3	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2016-11-13
1.4	Anechoic Chamber	10.58 x 6.38 x 6.00 m³	Frankonia	none	2017-01-09
1.5	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2017-12-08
1.6	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/3790709	
1.7	AS 620 P	Antenna mast	HD GmbH	620/37	
1.8	NRV-Z1	Sensor Head A	Rohde & Schwarz	827753/005	2016-05-11
1.9	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785	
1.10	HL 562	Ultralog new biconicals	Rohde & Schwarz GmbH & Co. KG	830547/003	2018-06-30
1.11	Opus10 THI (8152.00)	ThermoHygro Datalogger 12 (Environ)	Lufft Mess- und Regeltechnik GmbH	12482	2017-03-10
1.12	HFH2-Z2	Loop Antenna	Rohde & Schwarz GmbH & Co. KG	829324/006	2017-11-27
1.13	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2016-11-17
1.14	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936	2017-02-27
1.15	Chroma 6404	AC Power Source	Chroma ATE INC.	64040001304	
1.16	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronik GmbH	00086675	
1.17	HL 562 Ultralog	Log.-per. Antenna	Rohde & Schwarz GmbH & Co. KG	100609	2016-03-18
1.18	HF 907	Double-ridged horn	Rohde & Schwarz GmbH & Co. KG	102444	2018-05-11
1.19	DE 325	Dreheinheit	HD GmbH		

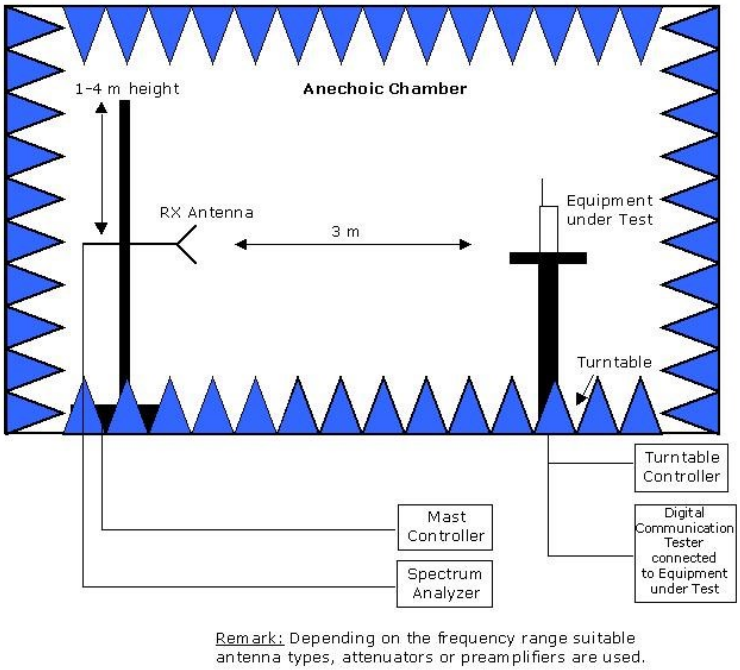
2 Radio Lab

2.1	Signal Analyzer	FSV30	Rohde & Schwarz	103005
2.2	10 dB attenuator	Weinschel 56-10	Weinschel	W3711
2.3	10 dB attenuator	Weinschel 4T-10	Weinschel	F9401
2.4	6 dB coupler	WA1515	Weinschel	A855
2.5	20 dB coupler	A8455-4 Rev.0	-	07-00
2.6	Coaxial cable (RLC-1)	ST18/SMAm/SMAm/36	-	Batch No. 12424
2.7	Coaxial cable (RLC-2)	ST18/SMAm/SMAm/36	-	Batch No. 625905
2.8	Coaxial cable (RL-RX spuri cable)	ST18/SMAm/Nm/48	-	Batch No. 625626
2.9	DC blocker	7006-1	Weinschel	W0026
2.10	DC power supply	NGSM 32/10	Rohde & Schwarz	3992
2.11	Thermo-Hydrometer	OPUS 10	Lufft	12482
2.12	Digital Voltmeter	177	Fluke	86670383
2.13	Temperature Chamber	VT4002	Vötsch	58566002150010

6 Photo Report

Photos are included in an external report.

7 Setup Drawings



Drawing 1: Setup in the Anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting ground plane.

8 FCC and IC Correlation of measurement requirements for General Radio Equipment from FCC and IC

General radio equipment

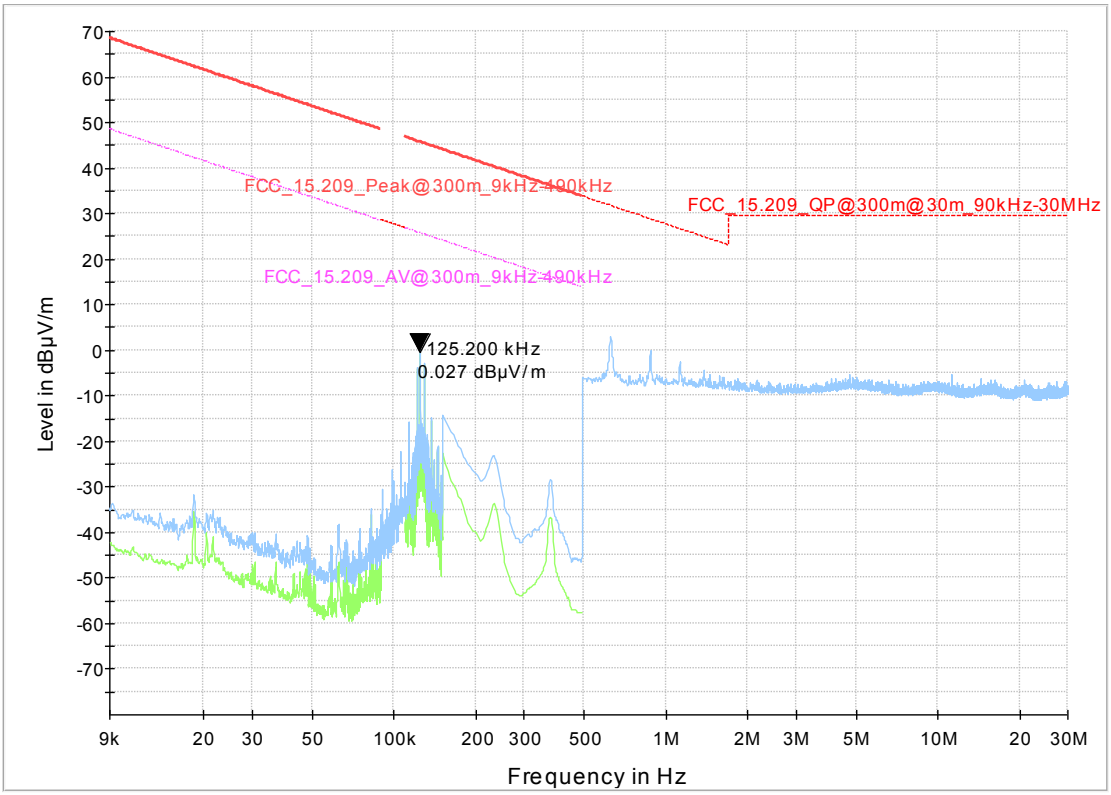
Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 4: 8.8
Transmitter spurious radiated emissions	§ 15.209	RSS-Gen Issue 4: 6.13/8.9/8.10; RSS-210 Issue 8: 2.5
Spurious radiated emissions below 490 kHz and restricted to emission level	§ 15.201, CFR47, Part 2, Subpart J; if all emissions ≤ 40 dB below the limit listed in §15.209	RSS-Gen Issue 4: 8.9/8.10; RSS-210 Issue 8: 2.5.1; RSS-310 Issue 3; if all emissions ≤ 40 dB below the limit listed in RSS-Gen
Wanted Emission (Carrier)	§ 15.209	RSS-210 Issue 8: 2.5.1 RSS-Gen Issue 4: 6.12, 8.9
Other requirements, e.g. Transmitter frequency stability	§15.215	RSS- Gen, Issue 4: 6.11/8.11
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	–	RSS-210 Issue 8: 2.3; RSS Gen Issue 4: 5/7 *)

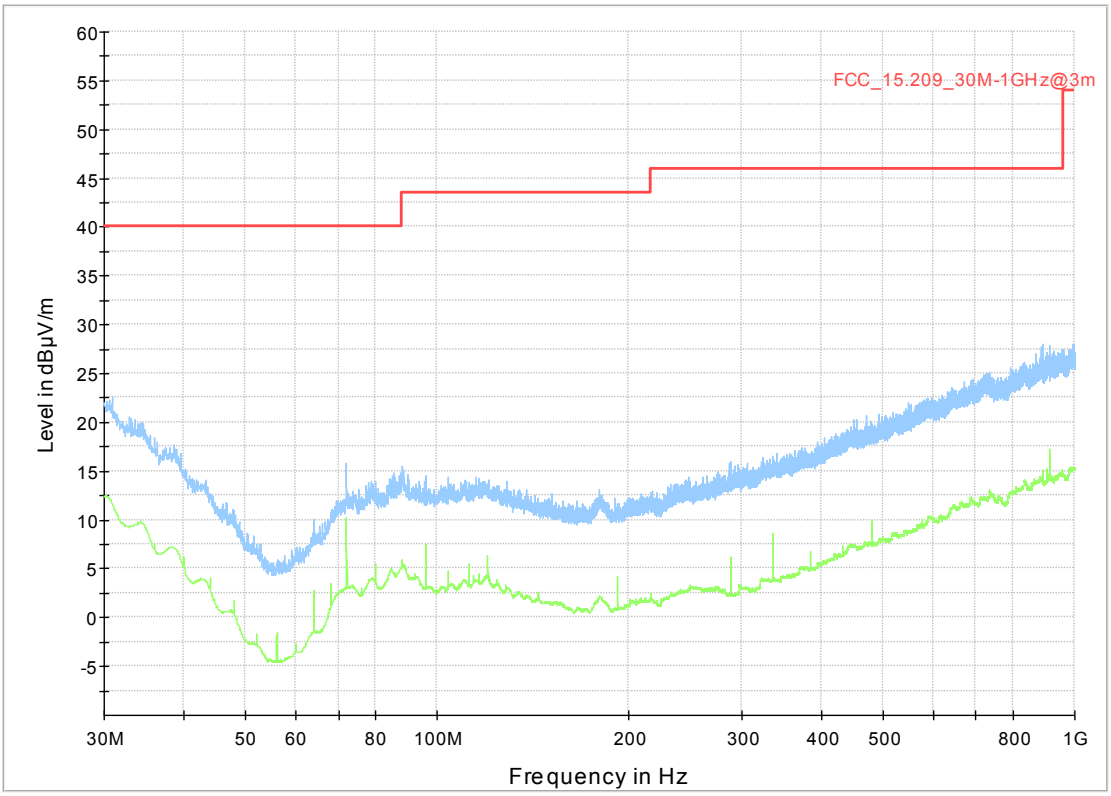
*) Receivers are exempted from certification besides if operating in stand-alone mode in the frequency range 30–960 MHz or if these are scanner receivers.

9 Annex measurement plots

9.1 Radiated emissions and peak output power

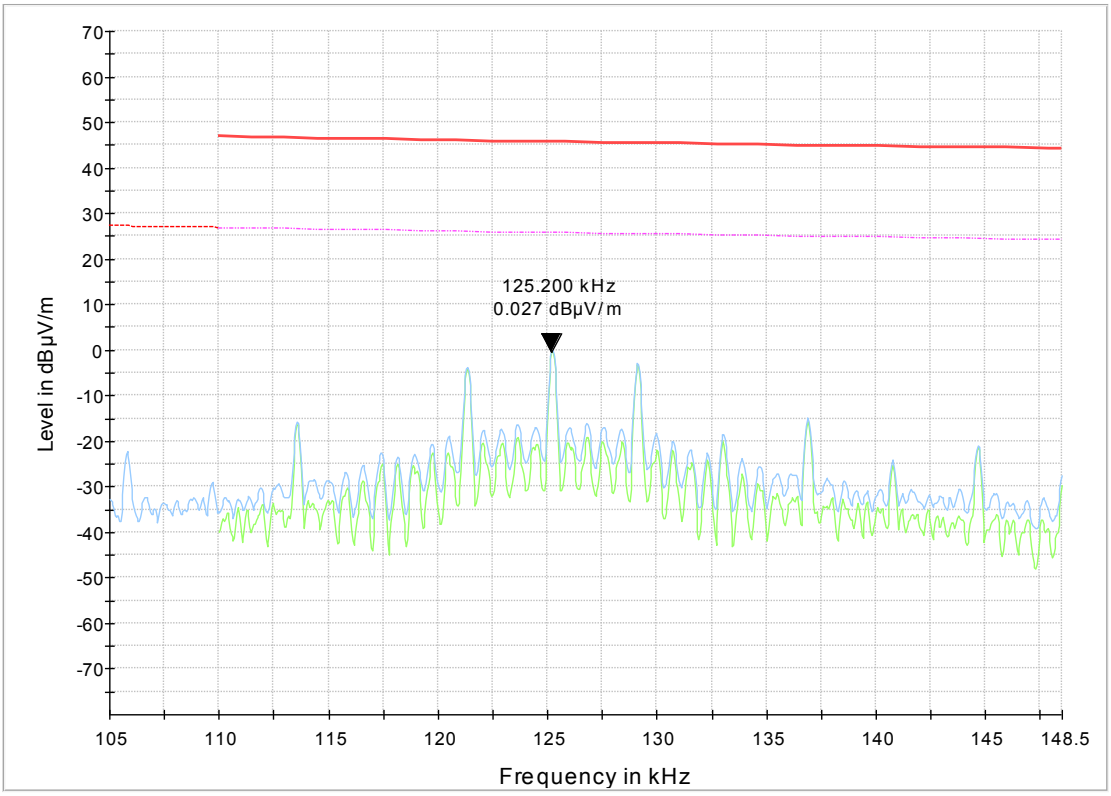
9.1.1 Spurious radiated emissions up to 30 MHz – Op-Mode 1



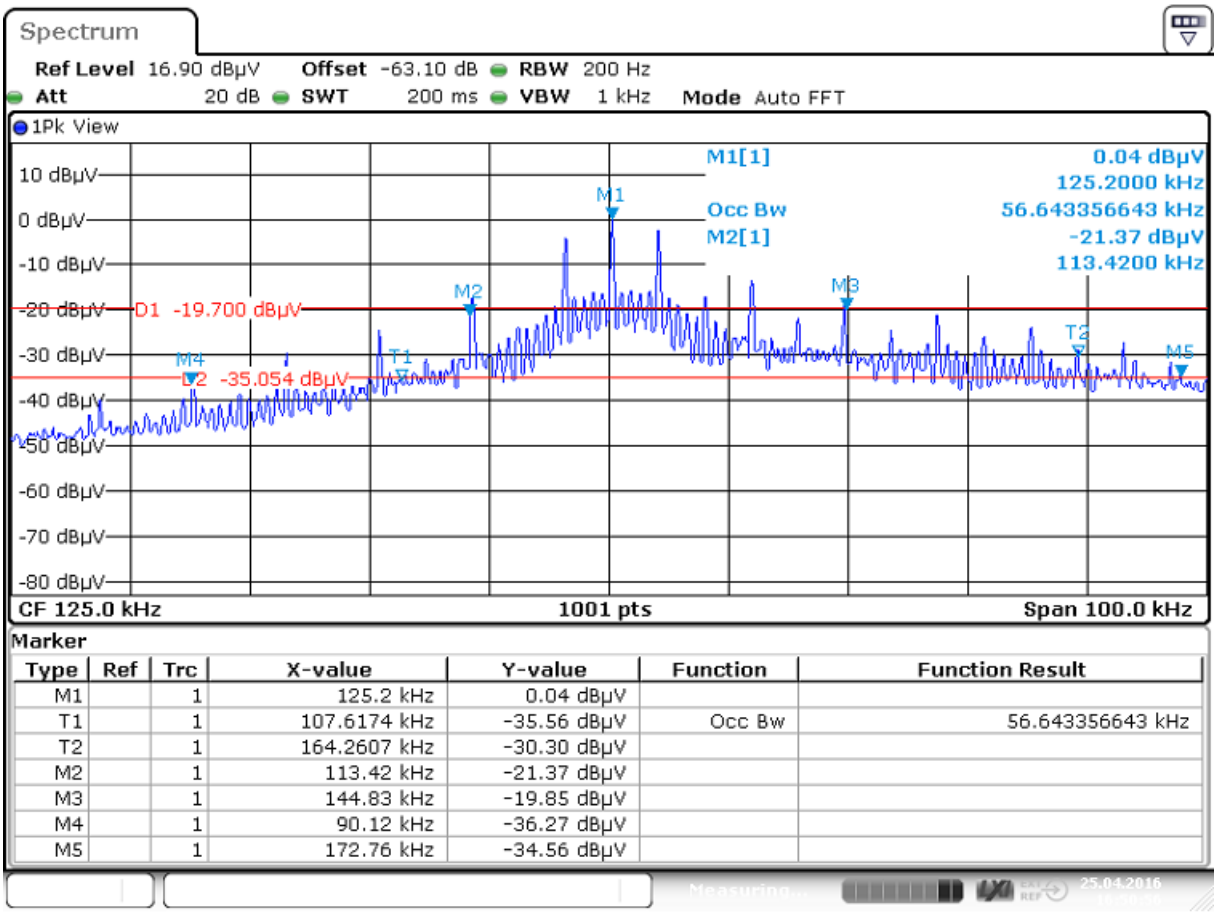


9.1.2 Spurious radiated emissions above 30 MHz – Op_Mode 1

9.1.3 Peak output power



9.2 Occupied Bandwidth



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Notes: 20 dB occupied bandwidth = 31.41 kHz (M3 – M2)
99% occupied power bandwidth = 82.64 kHz (M5 –M4)