Report on the FCC and IC Testing of the ASAP Electronics GmbH
CARSHARING ZUSATZKARTENLESER
In accordance with FCC 47 CFR Part 15 C and ISED RSS-210 and ISED RSS-Gen

Prepared for: ASAP Electronics GmbH
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85080 Geimersheim
Germany

FCC ID: 2AXR3-5A497C0
IC: 27128-5A497C0

Product Service

Add value.
Inspire trust.

COMMERCIAL-IN-CONFIDENCE

Date: 2021-04-19
Document Number: TR-44451-66496-05 | Issue 1

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Mathias Stumpe	2021-04-19	SIGN-ID 495605
Authorised Signatory	Martin Steindl	2021-04-19	SIGN-ID 510957

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

Engineering Statement:
This measurement shown in this report were made in accordance with the procedures described on test pages.
All reporded testing was carried out on a sample equipment to demonstrate limited compilance with with FCC 47 CFR Part 15 C and ISED RSS-210 and RSS-GEN.
The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Matthias Stumpe	2021-04-19	SIGN-ID 495606

Laboratory Accreditation DAkkS Reg. No. D-PL-11321-11-02 DAkkS Reg. No. D-PL-11321-11-03	Laboratory recognition Registration No. BNetzA-CAB-16/21-15	Industry Canada test site registration 3050A-2

Executive Statement:
A sample of this product was tested and found to be compilant with FCC 47 CFR Part 15 C:2019 and ISED RSS-210:2019 and ISED RSS-Gen:2019

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Information pursuant to Section 2(1)
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Product Service

Content

Product Service

1 Report Summary

1.1 Modification Report

Alternations and additions of this report will be issued to the holders of each copy in the form of a complete document.

Issue	*Description of changes*	*Date of Issue*
1	First Issue	2021-04-19

Table 1: Report of Modifications

1.2 Introduction

Applicant	ASAP Electronics GmbH
Manufacturer	ASAP Electronic GmbH
Model Number(s)	---
Serial Number(s)	Nullserie, ab Serie 1001, 1002, 1003, …
Hardware Version(s)	V1.5
Software Version(s)	V1.5
Number of Samples Tested	2
Test Specification(s) / Issue / Date	FCC 47 CFR Part 15 C : 2019 ISED RSS-210, Issue 10, Amd. 1 : 2019 ISED RSS-Gen, Issue 5, Amd. 1 : 2019
Test Plan/Issue/Date	---
Order Number	B15-19-31857
Date	2019-07-29
Date of Receipt of EUT	2020-05-04
Start of Test	2020-05-06
Finish of Test	2020-05-11
Name of Engineer(s)	Matthias Stumpe, Patrick Müller, Agnieszka Hruszcz
Related Document(s)	ANSI C63.10:2013

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1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 15 C and ISED RSS-210 and RSS-Gen is shown below.

Section	*Specification Clause*	*Test Description*	*Result*
Continuously reading RFID Tag - BLE Advertising with RFID Transmitting Continuously – BLE Advertising without RFID			
2.1	15.203	Antenna requirement	Pass
2.2	15.215(c)	Bandwidth of Signal	Pass
---	15.207	Conducted Disturbance at Mains Terminal	N/A*
2.3	15.209, 15.225	Radiated Disturbance	Pass
2.4	15.225(e)	Frequency Tolerance	Pass

Table 2: Results according to FCC 47 CFR Part 15 C

Section	*Specification Clause*	*Test Description*	*Result*
Continuously reading RFID Tag - BLE Advertising with RFID Transmitting Continuously – BLE Advertising without RFID			
2.3	7.3	Radiated Emissions	Pass
---	7.3	AC Power Line Conducted Emissions	N/A*
2.4	B.6 b.	Frequency Tolerance	Pass

Table 3: Results according to ISED RSS-210

Sectio	*Specification Clause*	*Test Description*	*Result*
Continuously reading RFID Tag - BLE Advertising with RFID Transmitting Continuously – BLE Advertising without RFID			
2.2	6.7	Bandwidth of Signal	Pass
---	8.8	AC Power Line Conducted Emissions	N/A*
2.3	8.9, 8.10	Radiated Emissions	Pass
2.4	6.11	Frequency Tolerance	Pass

Table 4: Results according to ISED RSS-Gen

Note:
*N/A – Not Applicable, EUT battery supplied

Product Service

1.4 Product Information

1.4.1 Technical Description

CARSHARING ZUSATZKARTENLESER is a BLE Advertising device with / without RFID function.

Operating frequency: 13.56 MHZ RFID
2.4 GHz BLE

Frequency Band	13.110 – 14.010 MHz
Number of frequency channels:	1
Emission designator:	1K64A1D
Supply Voltage:	3.0 V battery supplied
Supply Frequency:	---
Highest clock frequency (radio part):	2.4 GHz
Highest clock frequency (non-radio part):	32.0 MHz

1.4.2 List of Antennas

Manufacturer	*Model*	*Antenna impedance*	*Antenna Type*	*Antenna gain*
STMicroelectronics	AN3359	50 Ohm	PCB antenna	1.95 dBi

Table 5: List of antennas

1.4.3 EUT Ports / Cables identification

Port	Max Cable Length specified	Usage	Type	Screened
Continuously reading RFID Tag - BLE Advertising with RFID Normal operation mode – BLE Advertising without RFID				
---	---	---	---	---

Table 6

Product Service

1.5 Test Configuration

Continuously reading RFID Tag - BLE Advertising with RFID
Normal operation mode – BLE Advertising without RFID

1.6 Modes of Operation

Continuously reading RFID Tag - BLE Advertising with RFID
Normal operation mode – BLE Advertising without RFID

1.7 Deviations from Standard

None

1.8 EUT Modifications Record

The table below details modifications made to the EUT during the test program.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Continuously reading RFID Tag - BLE Advertising with RFID, 80:E1:26:08:49:2F			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 7

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Normal operation mode – BLE Advertising without RFID, 80:E1:26:08:44:84			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 8

Product Service

1.9 Test Location

TÜV SÜD Product Service conducted the following tests at our Straubing test laboratory:

Test Name	Name of Engineer(s)
Continuously reading RFID Tag - BLE Advertising with RFID	
Bandwidth of Signal	Matthias Stumpe, Agnieszka Hruszcz
Frequency Tolerance	Matthias Stumpe, Agnieszka Hruszcz
Continuously reading RFID Tag - BLE Advertising with RFID Normal operation mode – BLE Advertising without RFID	
Radiated Disturbance	Matthias Stumpe, Patrick Müller

Office Address:
Äußere Frühlingstraße 45
94315 Straubing
Germany

Product Service

2 Test Details

2.1 Antenna requirement

2.1.1 Specification Reference

FCC 47 CFR Part 15 C, Clauses 15.203

2.1.2 Equipment under Test and Modification State

CARSHARING ZUSATZKARTENLESER, Continuously reading RFID Tag - BLE Advertising with RFID, 80:E1:26:08:49:2F, Modification State: 0

CARSHARING ZUSATZKARTENLESER, Normal operation mode – BLE Advertising without RFID, 80:E1:26:08:44:84, Modification State: 0

2.1.3 Date of Test

2020-05-13

2.1.4 Specification Limits

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some fields disturbance sensors, or to other intentional radiators which must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits are not exceeded.

2.1.5 Test Results

Antenna connector type: PCB Antenna
Antenna connector impedance: 50 Ω

Manufacturer	*Model*	*Antenna gain*	*Result*
STMicroelectronics	AN3359	1.95 dBi	Pass

Product Service

2.2 Bandwidth of Signal

2.2.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.215(c)
ISED RSS-Gen, Clause 6.7

2.2.2 Equipment under Test and Modification State

CARSHARING ZUSATZKARTENLESER, Continuously reading RFID Tag - BLE Advertising with RFID, 80:E1:26:08:49:2F, Modification State: 0

2.2.3 Date of Test

2020-05-11

2.2.4 Environmental Conditions

Ambient Temperature	21.0 °C
Relative Humidity	32.0 %

2.2.5 Specification Limits

No limitation – Bandwidth noted

2.2.6 Test Method

The test was performed according to ANSI C63.10, clauses 6.9
See section 2.3 of this test report for details.

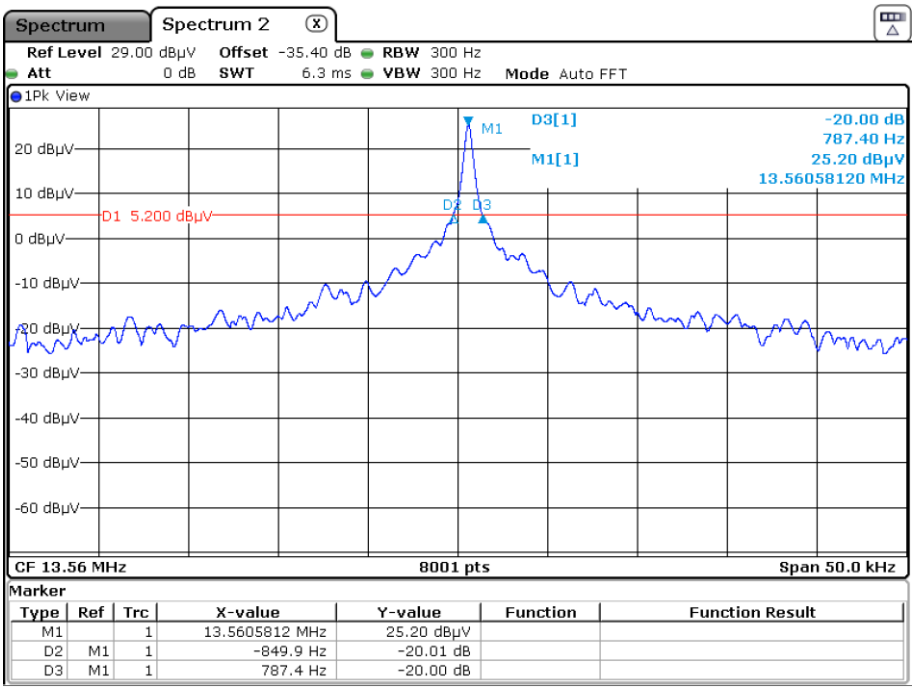
Product Service

2.2.7 Test Results

20 dB Bandwidth:

Center frequency (MHz)	*20 dB Bandwidth (kHz)*
13.5606	1.637

Table 9: 20 dB bandwidth



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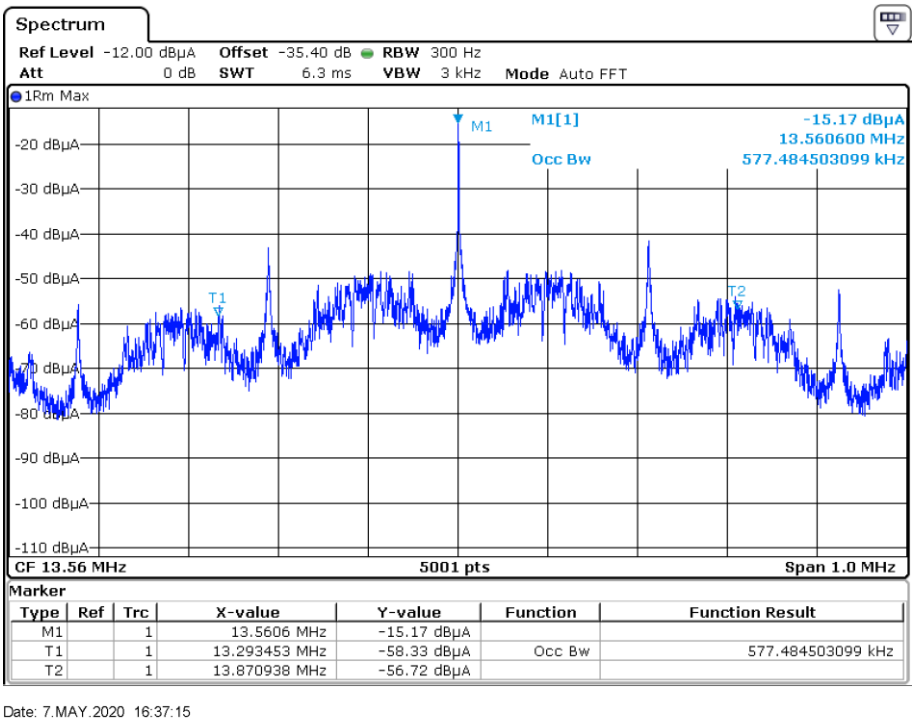
99% Bandwidth:

Centre Frequency (MHz)	*99% Bandwidth (kHz)*
13.5606	577.485

Table 10: 99% bandwidth



Product Service

2.2.8 Test Location and Test Equipment

The test was carried out in Non shielded room.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rhode & schwarz	FSV40	20219	12	2021-01-31

Table 11

Product Service

2.3 Radiated Emissions

2.3.1 Specification Reference

FCC 47 CFR Part 15 C, Clauses 15.205, 15.209 and 15.225
ISED RSS-210, Clause 7.7 and B.6
ISED RSS-Gen, Clause 8.9 and 8.10

2.3.2 Equipment under Test and Modification State

CARSHARING ZUSATZKARTENLESER, Continuously reading RFID Tag - BLE Advertising with RFID, 80:E1:26:08:49:2F, Modification State: 0

CARSHARING ZUSATZKARTENLESER, Normal operation mode – BLE Advertising without RFID, 80:E1:26:08:44:84, Modification State: 0

2.3.3 Date of Test

2020-05-06

2.3.4 Environmental Conditions

Ambient Temperature	22.0 °C
Relative Humidity	26.0 %

Product Service

2.3.5 Specification Limits

Radiated emission limits:					
Frequency Range (MHz)	*Test distance (m)*	*Field strength*		*Field strength*	
		(µA/m)	*(dBµA/m)*	*(µV/m)*	*(dBµV/m)*
0.009 – 0.49	300	6.37 / *f*	20*lg(6.37 / *f*)	2400 / *f*	20*lg(2400 / *f*)
0.49 – 1.705	30	63.7 / *f*	20*lg(63.7 / *f*)	24000 / *f*	20*lg(24000 / *f*)
1.705 – 13.110	30	0.08	-21.94	30	29.54
13.110 – 13.410	30	0.283	-11.0	106	40.5
13.410 – 13.553	30	0.891	-1.0	334	50.5
13.553 – 13.567	30	42.26	32.5	15848	84
13.567 – 13.710	30	0.891	-1.0	334	50.5
13.710 – 14.010	30	0.283	-11.0	106	40.5
14.010 - 30	30	0.08	-21.94	30	29.54
30 – 88	3	---	---	100	40
88 – 216	3	--	---	150	43.5
126 – 960	3	--	---	200	46
above 960	3	--	---	500	54
Note 1: *f* in kHz					

Table 12 Radiated emission limits

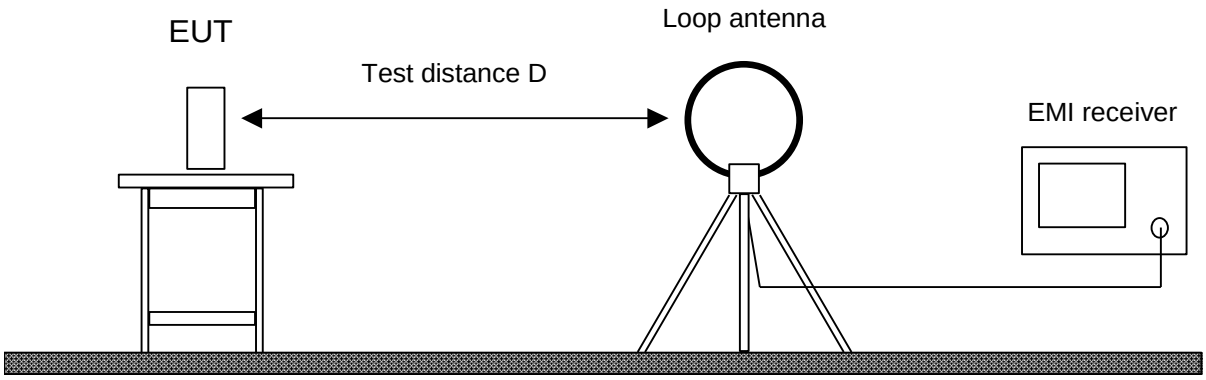
Product Service

2.3.6 Test Method

The test was performed according to ANSI C63.10, sections 11.11 and 11.12

Prescans are performed in six positions of the EUT to get the full spectrum of emission caused by the EUT with the measuring antenna raised and lowered from 1 m to 4 m with vertical and horizontal polarisation to find the combination of table position, antenna height and antenna polarisation for the maximum emission levels.
Data reduction is applied to these results to select those levels having less margin than 10 dB or exceeding the limit using subranges and limited number of maximums.
Further maximisation for adjusting the maximum position is following.
Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

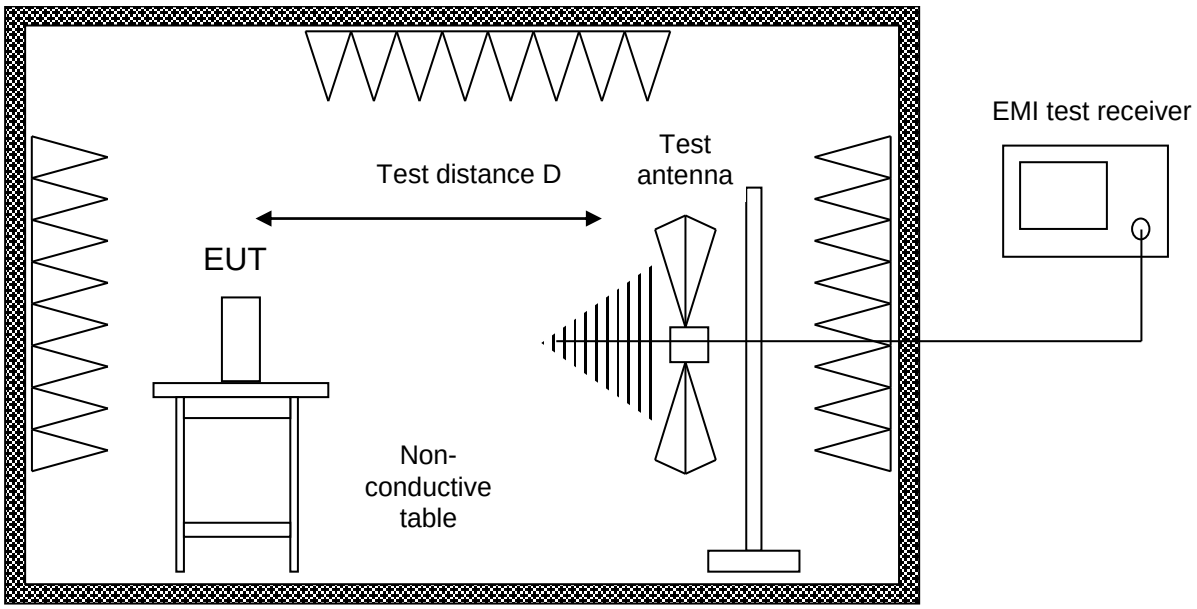
2.3.6.1 Frequency range 9 kHz – 30 MHz



The EUT was placed on a non-conductive table, 0.8 m above the ground.
Radiated emissions in the frequency 9 kHz – 30 MHz is measured within a semi-anechoic room with an active loop antenna with the measurement detector set to peak. In addition in the frequency range 9 kHz to 490 kHz also an average detector was used. The measurement bandwidth of the receiver was set to 300 Hz in the frequency range 9 kHz to 150 kHz and 10 kHz in the frequency range 150 kHz to 30 MHz. Prescans were performed in six positions of the EUT.
For final measurements the detector was set to CISPR quasi-peak and in addition to CISPR average in the frequency range 9 kHz to 490 kHz with a resolution bandwidth 200 Hz in the frequency range 9 kHz to 150 kHz and 9 kHz in the frequency range 150 kHz to 30 MHz. Final tests were performed immediately after a final frequency and zoom (for drifting disturbances) and maximum adjustment.

Product Service

2.3.6.2 Frequency range 30 MHz – 1 GHz

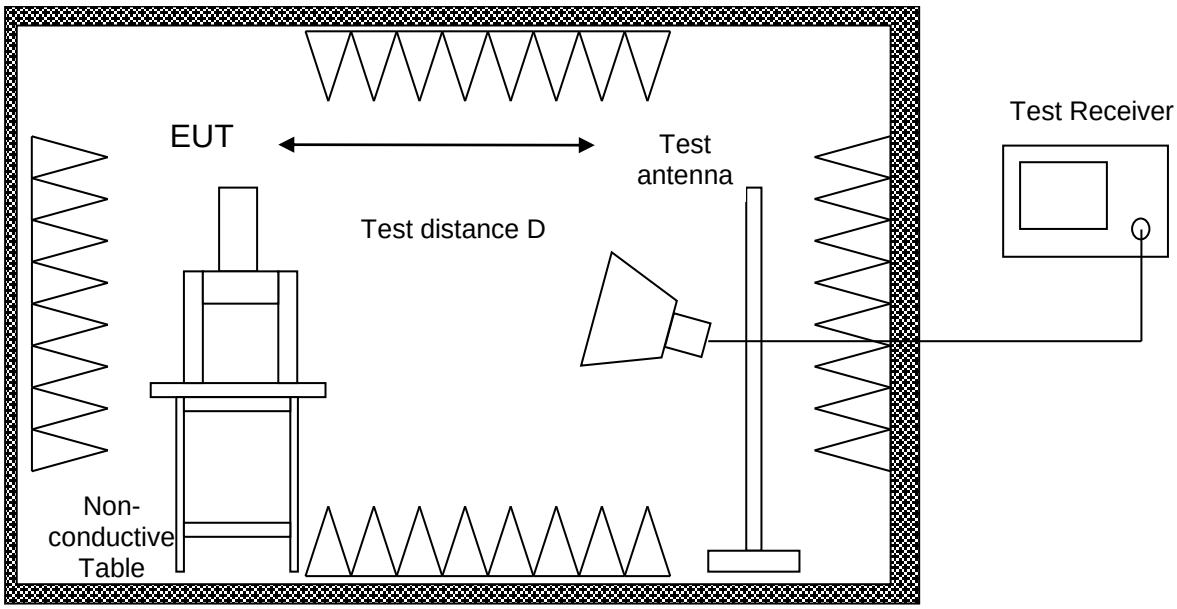


Alternate test site (semi anechoic room)

The EUT was placed on a non-conductive table, 0.8 m above the ground plane
Radiated emissions in the frequency range 30 MHz – 1 GHz is measured within a semi-anechoic room with groundplane complying with the NSA requirements of ANSI C63.4. for alternative test sites. A linear polarised logarithmic periodic antenna combined with a 4:1 broadband dipole (“Trilog broadband antenna”) is used.
For prescan tests the test receiver is set to peak-detector with a bandwidth of 120 kHz.
With the measurement bandwidth of the test receiver set to 120 kHz CISPR quasi-peak detector is selected for final measurements following immediately after a final frequency zoom (for drifting disturbances) and maximum adjustment.

Product Service

2.3.6.3 Frequency range above 1 GHz



Fully anechoic room

The EUT was placed on a non-conductive table, 1.5 m above the ground plane
Radiated emission tests above 1 GHz are performed in a fully anechoic room with the S_{VSWR} requirements of ANSI C63.4. Measurements are performed both in the horizontal and vertical planes of polarisation using a test receiver with the detector function set to peak and average and the resolution bandwidth set to 1 MHz. Testing above 1 GHz is performed with horn antennas with the EUT in boresight of the antenna.
For prescan tests the test receiver is set to peak- and average-detector with a bandwidth of 1 MHz. With the measurement bandwidth of the test receiver set to 1 MHz and peak- and CISPR average-detector is selected for final measurements following immediately after a final frequency zoom (for drifting disturbances) and maximum adjustment.

Product Service

2.3.7 Test Results

Frequency range	*Limit applied*	*Test distance*
9 kHz - 30 MHz	FCC Part 15.225	3 m
30 MHz – 1 GHz	FCC Part 15 C	3 m
1 GHz – 18 GHz	FCC Part 15 C	3 m
18 GHz – 25 GHz	FCC Part 15 C	3 m

Table 13

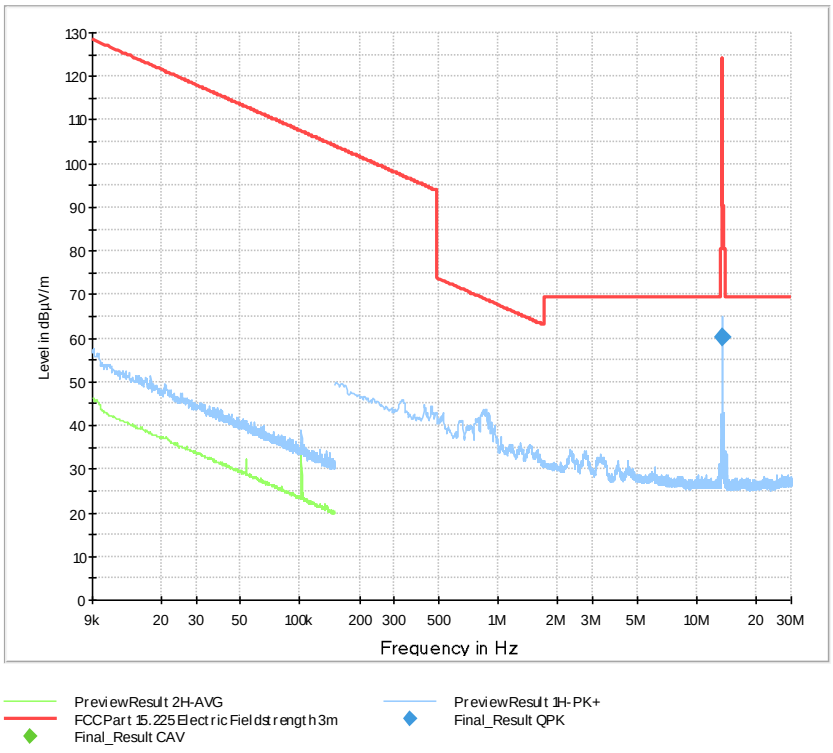
Sample calculation:

Final Value (dBµV/m) = Reading Value (dBµV) + (Cable attenuation (dB) + Antenna Transducer (dB(1/m)))

Product Service

Frequency range 9 kHz – 30 MHz

CARSHARING ZUSATZKARTENLESER, continuously reading RFID Tag - BLE Advertising with RFID



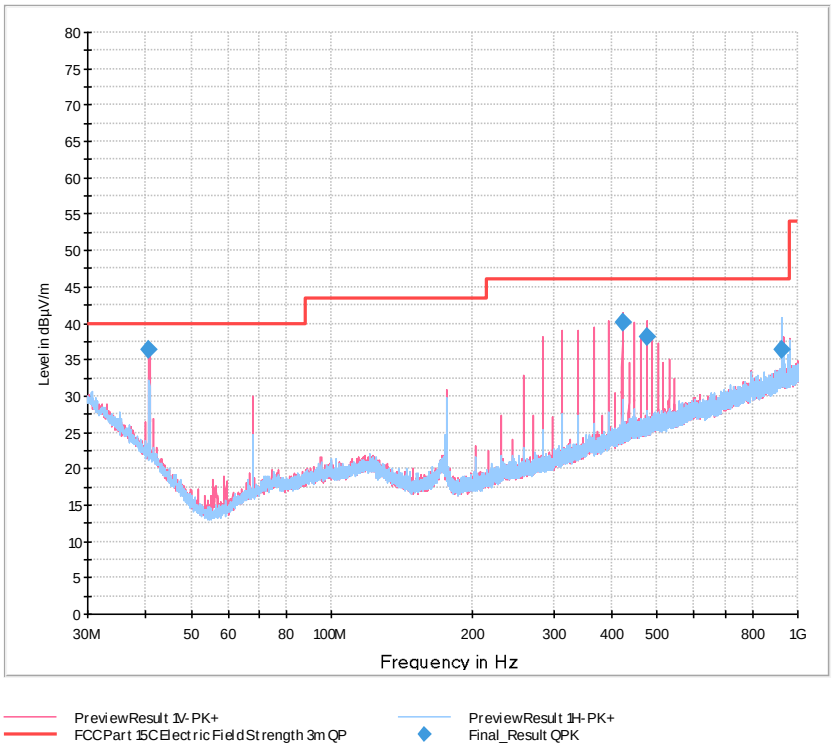
Final Results:

Frequency MHz	*QuasiPeak dBµV/m*	*CAverage dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB/m*
13.560000	60.08	---	124.00	63.92	1000.0	9.000	100.0	H	189.0	18.8

Product Service

Frequency range 30 MHz – 1 GHz

CARSHARING ZUSATZKARTENLESER, continuously reading RFID Tag - BLE Advertising with RFID



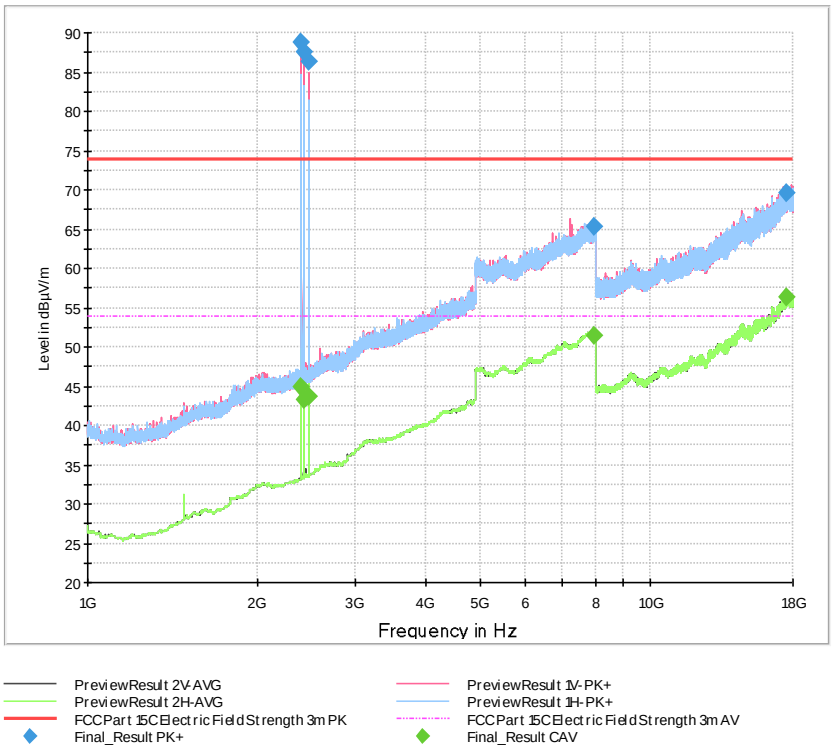
Final Results:

Frequency MHz	*QuasiPeak dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Bandwidth kHz*	*Height cm*	*Pol*	*Azimuth deg*	*Corr. dB/m*
40.680000	36.28	40.00	3.72	1000.0	120.000	157.0	V	-85.0	19.9
420.390000	40.10	46.02	5.92	1000.0	120.000	120.0	V	70.0	22.0
474.630000	38.13	46.02	7.89	1000.0	120.000	109.0	V	-18.0	23.3
927.270000	36.44	46.02	9.58	1000.0	120.000	163.0	H	-111.0	29.1

Product Service

Frequency range 1 GHz – 18 GHz

CARSHARING ZUSATZKARTENLESER, Normal operation mode – BLE Advertising without RFID



Final Results:

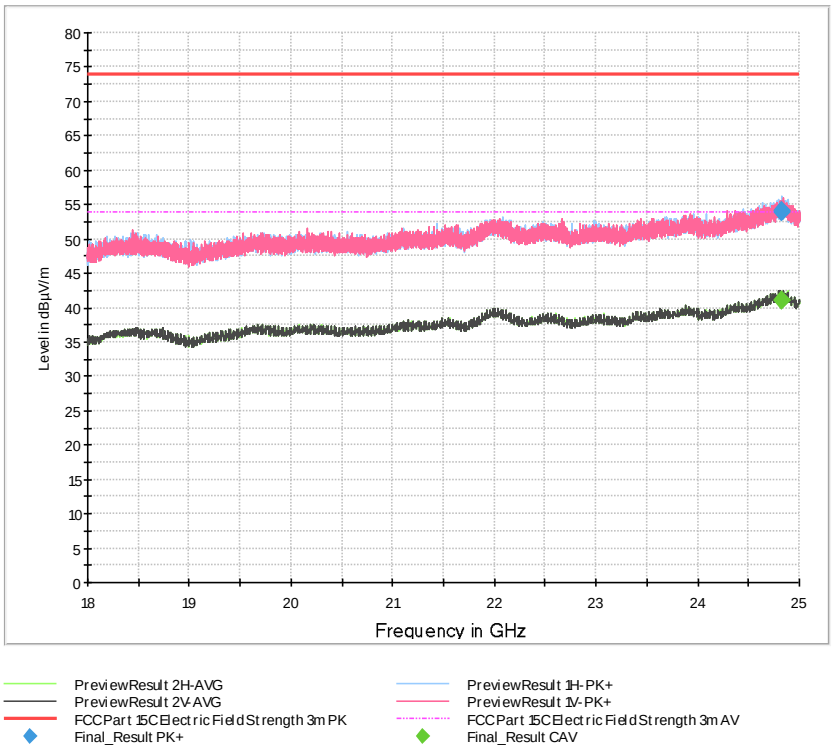
Frequency MHz	*Max-Peak dBµV/m*	*CAver-age dBµV/m*	*Limit dBµV/m*	*Margin dB*	*Meas. Time ms*	*Band-width kHz*	*Height cm*	*Pol*	*Azi-muth deg*	*Corr. dB/m*
2402.250	88.71	---	73.98	#1	1000.0	1000.000	100.0	V	21.0	32.3
2402.250	---	44.92	53.98	9.06	1000.0	1000.000	100.0	V	21.0	32.3
2425.750	---	43.18	53.98	10.80	1000.0	1000.000	283.0	V	112.0	32.5
2425.750	87.53	---	73.98	#1	1000.0	1000.000	283.0	V	112.0	32.5
2480.000	86.36	---	73.98	#1	1000.0	1000.000	209.0	V	137.0	32.9
2480.000	---	43.74	53.98	10.24	1000.0	1000.000	209.0	V	137.0	32.9
7948.000	---	51.37	53.98	2.61	1000.0	1000.000	204.0	H	-122.0	43.4
7948.000	65.31	---	73.98	8.67	1000.0	1000.000	204.0	H	-122.0	43.4
17567.250	---	56.34	53.98	#1	1000.0	1000.000	110.0	V	-114.0	54.4
17567.250	69.65	---	73.98	4.33	1000.0	1000.000	110.0	V	-114.0	54.4

Note:
#1 Intentional Radiation

Product Service

Frequency range 18 GHz – 25 GHz

CARSHARING ZUSATZKARTENLESER, Normal operation mode – BLE Advertising without RFID



Final Results:

Frequency MHz	*Max-Peak dBµV/m*	*CAver-age dBµV/m*	*Limit dBµV/m*	*Mar-gin dB*	*Meas. Time ms*	*Band-width kHz*	*Height cm*	*Pol*	*Azi-muth deg*	*Corr. dB/m*
24820.750	---	41.07	53.98	12.91	1000.0	1000.000	122.0	V	-127.0	21.3
24820.750	53.94	---	73.98	20.04	1000.0	1000.000	122.0	V	-127.0	21.3
24834.250	---	41.06	53.98	12.92	1000.0	1000.000	213.0	H	-144.0	21.3
24834.250	54.09	---	73.98	19.89	1000.0	1000.000	213.0	H	-144.0	21.3

Product Service

2.3.8 Test Location and Test Equipment

The test was carried out in FAR No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rhode & Schwarz	ESW44	39897	12	2021-03-31
Double ridged horn antenna	Rhode & Schwarz	HF907	40089	24	2021-02-28
Loop antenna	Schwarzbeck	FMZB 1519B	44334	36	2023-01-31
ULTRALOG Antenna	Rhode & Schwarz	HL562E	39969	36	2022-11-30
Horn Antenna with preamplifier	Rhode & Schwarz	A-INFOMW LB-180400H-KF+ TS-	43661	12	2020-10-31
EMC measurement software	Rhode & Schwarz	EMC32 Emission K11 – V10.50.10	42986	---	---
Semi Anechoic Room	Frankonia	Cabin No. 11	42961	36	2022-08-31

Table 14

Product Service

2.4 Temperature Stability

2.4.1 Specification Reference

FCC 47 CFR Part 15 E, Clause 15.225(e)
ISSED RSS-210, Clause B.6 b.
ISED RSS-Gen, Clause 6.11

2.4.2 Equipment under Test and Modification State

CARSHARING ZUSATZKARTENLESER, Continuously reading RFID Tag - BLE Advertising with RFID, 80:E1:26:08:49:2F, Modification State: 0

2.4.3 Date of Test

2020-05-07 and 2020-05-11

2.4.4 Environmental Conditions

Ambient Temperature	21.0 °C
Relative Humidity	32.0 %

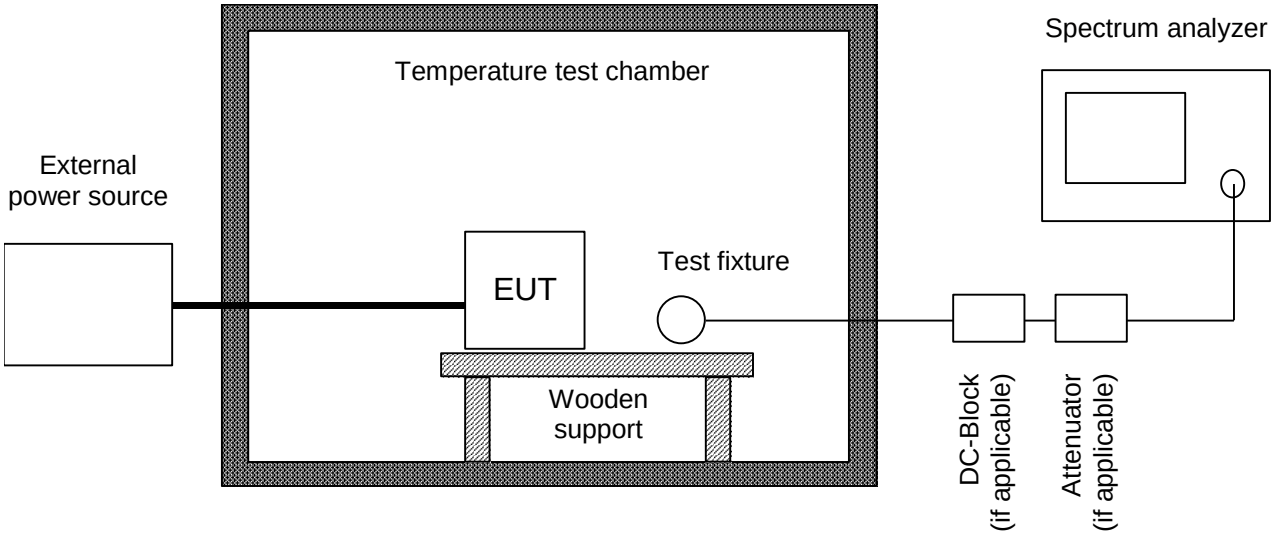
2.4.5 Specification Limits

The frequency tolerance of the carrier signal shall be maintained within ±0.01 % of the operating frequency over a temperature variation of -20 °C to +50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20 “C. For battery operated equipment, the equipment tests shall be performed using a new battery.

Product Service

2.4.6 Test Method

The test was performed according to ANSI C63.10, section 6.8.



The frequency tolerance of the carrier signal is measured over a temperature variation of -20 °C to +50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rates supply voltage at a temperature of 20 °C. Temperature and voltage range may vary if the manufacturer states another temperature or voltage range.
If the EUT provides an antenna connector the spectrum analyzer is connected to this port. If required, a resistive matching network equal to the impedance specified or employed for the antenna is used as well as a DC block and appropriate (50 Ω) attenuators. In case where the EUT does not provide an antenna connector or a test fixture is used.
For battery operated equipment, the test is performed using a new battery. Alternatively, an external supply voltage can be used and is at least set to:

- The maximum battery voltage as delivered by a new battery or 115 % of the battery nominal voltage;
- The battery nominal voltage
- 85 % of the battery nominal voltage
- The battery operating end point voltage which shall be specified by the equipment manufacturer.

The EUT is operating providing an unmodulated carrier for frequency error tests. The peak detector of the spectrum analyzer is selected and resolution as well as video bandwidth are set to values appropriate to shape of the spectrum of the EUT. The frequency counter mode of the spectrum analyzer is used to maximize the accuracy of the measured frequency tolerance.
If an unmodulated carrier is not available a significant and stable point of the spectrum is selected and the span is reduced to a value that delivers an accuracy which shall be better than 1 % of the maximum frequency tolerance allowed for the carrier signal. This method may be performed as long as the margin to the frequency tolerance is larger than the uncertainty of the measured frequency tolerance.

Product Service

2.4.7 Test Results

Temperature	*Supply Voltage*	*Frequency (MHz)*	*Frequency drift (ppm)*	*Result*
-20.0 °C	3 V dc	13,560500	0,0000	pass
-10.0 °C	3 V dc	13,560500	0,0000	pass
0.0 °C	3 V dc	13,560625	+0,92	pass
+10.0 °C	3 V dc	13,560500	0,0000	pass
+20.0 °C	1.8 V dc	13,560750	+1,84	pass
+20.0 °C	3 V dc	13,560500	0,0000	pass
+30.0 °C	3 V dc	13,560500	0,0000	pass
+40.0 °C	3 V dc	13,560500	0,0000	pass
+50.0 °C	3 V dc	13,560500	0,0000	pass

Table 15

2.4.8 Test Location and Test Equipment

The test was carried out in Non shielded room.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
Spectrum Analyzer	Rhode & Schwarz	FSV40	20219	12	2021-01-31
Climatic test chamber	Feutron	KPK200-2	19868	36	2021-08-31

Table 16

Product Service

2.5 RF Exposure

2.5.1 Specification Reference

FCC 47 CFR Part 2 J, Clause 2.1093
KDB 447498 D01 V06, section 4.3.1

2.5.2 Equipment under Test and Modification State

CARSHARING ZUSATZKARTENLESER, Continuously reading RFID Tag - BLE Advertising with RFID, 80:E1:26:08:49:2F, Modification State: 0

2.5.3 Date of Test

2020-05-08

2.5.4 Environmental Conditions

Ambient Temperature	21.0 °C
Relative Humidity	32.0 %

2.5.5 Test Method

Estimation is based on output power test.
For details please refer to section 2.3 of this test report.

Product Service

2.5.6 Specification Limits

KDB 447498
Systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy levels in excess of the Comission's guideline. Acc. to KDB 447498:

a) The 1 g and 10 g SAR test exclusion thresholds for frequencies below100 MHz to 6 GHz at test separations distances ≤ 50 mm are determined by:

$$\frac{max.\ power\ of\ channel, incl.\ tune-up\ tol., mW}{min. test\ separation\ distance, mm} \cdot \sqrt{f, GHz} \leq \begin{Bmatrix} 3.0\ \ for\ 1\ g \\ 7.5\ for\ 10\ g \end{Bmatrix} extremity\ SAR$$

- *f* (GHz) is the RF channel frequency in GHz;
- Power and distance are rounded to the nearest mW and mm before calculation;
- The result is rounded to one decimal place for comparison;
- 3.0 and 7.5 are referred to as the numeric thresholds

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm, and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied.

b) For 100 MHz to 6 GHz and test separation distances > 50 mm, the 1 g and 10 g SAR test exclusion threshold are determined by the following:
   1. *{[Power allowed at numeric threshold for 50 mm in step a)]*
      + [(test separation distance – 50 mm)(f_{MHz}/150)]} mW for 100 MHz to 1500 MHz
   2. *{[Power allowed at numeric threshold for 50 mm in step a)]*
      + [10 (test separation distance – 50 mm)]} mW for > 1500 MHz to 6 GHz

c) For frequencies below 100 MHz the following may be considered for SAR test exclusion:
   1. For test separation distance > 50 mm and < 200 mm, the power threshold at the corresponding test separation distance at 100 MHz in step b) is multiplied by *[1+*log*(100/ f_{MHz})]*
   2. For test separation distance ≤ 50 mm, the power threshold determined by the equation in c)1) for 50 mm and 100 MHz is multiplied by ½.
   3. SAR measurement procedures are not established below 100 MHz.

Product Service

ISED RSS-102, Clause 2.5.1

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in the table.

For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in the table, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

For medical implants devices, the exemption limit for routine evaluation is set at 1 mW. The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.:

Frequency (MHz)	Exemption limits (mW)[1] at separation distance of									
	≤5 mm	10 mm	15 mm	20 mm	25 mm	30 mm	35 mm	40 mm	45 mm	≥50 mm
≤300 [2]	71	101	132	162	193	223	254	284	315	345
450	52	70	88	106	123	141	159	177	195	213
835	17	30	42	55	67	80	92	105	117	130
1900	7	10	18	34	60	99	153	225	316	431
2450	4	7	15	30	52	83	123	173	235	309
3500	2	6	16	32	55	86	124	170	225	290
5800	1	6	15	27	41	56	71	85	97	106

[1] The excemption limit in the table are based on measurements and simulations on half-wave dipole antennas at separaton distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from alinear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from athird order polynomial fit.

[2] Transmitters operating between 3 kHz and 10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in IC RSS-102, issue 5, section 4.

Product Service

2.5.7 Test Results

acc. to KDB 447498 D01:

Maximum Radiated Power (EIRP) Pmax:	-35.15 dBm = 305 nW (see section 2.3 for measurement)
Compliance Boundary d:	5 mm
Frequency f:	13.56 MHz

Calculation according to Section 4.3.1

1. $\frac{1}{2}\left[1+\log\left(\frac{100}{100}\right)\right]*\left[\left((Power\ allowed\ at\ numeric\ threshold\ for\ 50\ mm\ in\ step\ a)\right)+(50mm-50mm)*\left(\frac{100}{150}\right)\right]$
2. $\frac{1}{2}[1+0]*\left[\left((Power\ allowed\ at\ numeric\ threshold\ for\ 50\ mm\ in\ step\ a)\right)+0*\left(\frac{100}{150}\right)\right]$
3. $\frac{1}{2}[Power\ allowed\ at\ numeric\ threshold\ for\ 50\ mm\ in\ step\ a]$
4. $\frac{\max power}{\min distance}*\sqrt{f}\leq 3.0$
5. $\max power\leq\frac{3.0*\min distance}{\sqrt{f}}$
6. $\max power\leq\frac{3.0*50\ mm}{\sqrt{0{,}1GHz}}=474\ mW$
7. $\frac{1}{2}*474\ mW=237\ mW$ → maximal allowed Power
8. 305 nW < 237 mW → criteria fulfilled

Product Service

IC RSS-GEN Issue 5, section 3.2 and IC RSS-102, Issue 5, section 2.5

Exposure of Humans to RF Fields	Applicable	Declared by applicant	Measured	Exemption
The antenna is				
☐ detachable				
The conducted output power (CP in watts) is measured at the antenna connector: CP =			☐	
The effective isotropic radiated power (EIRP in watts) is calculated using				
☐ the numerical antenna gain: G = $EIRP = G \cdot CP \Rightarrow EIRP$ =		☐		
☐ the field strength[3] in V/m: FS = ... V/m			☐	
$EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP$ = mW				
with:				
Distance between the antennas in m: D = mm		☐		
☒ not detachable				
A field strength measurement is used to determine the effective isotropic radiated power (EIRP in watts) given by: $EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP$ = 0.305 µW				
with:				
Field strength in V/m: FS = 60.08 dBµV/m			☒	
Distance between the two antennas in m: D = 3 m			☒	
Selection of output power				
The output power TP is the higher of the conducted or effective isotropic radiated power (e.i.r.p.): TP = 0.305 µW				

[3] The conversion formula is valid only for properly matched antennas. In other cases the transmitter output power may have to be measured by a terminated measurement when applying the exemption clauses.
If an open area test site is used for field strength measurement, the effect due to the metal ground reflecting plane should be subtracted from the maximum field strength value in order to reference it to free space, before calculating TP.

Product Service

Exposure of Humans to RF Fields (continued)		Applicable	Declared by applicant	Measured	Exemption
Separation distance between the user and the transmitting device is					
☒ less than or equal to 20 cm	☐ greater than 20 cm		☒		
Transmitting device is					
☐ in the vicinity of the human head	☐ body-worn		☐		

Product Service

SAR evaluation				
SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in the table. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in the table, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required. For medical implants devices, the exemption limit for routine evaluation is set at 1 mW. The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.				

Frequency (MHz)	Exemption limits (mW)[4] at separation distance of									
	≤5 mm	10 mm	15 mm	20 mm	25 mm	30 mm	35 mm	40 mm	45 mm	≥50 mm
450	52	70	88	106	123	141	159	177	195	213
835	17	30	42	55	67	80	92	105	117	130
1900	7	10	18	34	60	99	153	225	316	431
2450	4	7	15	30	52	83	123	173	235	309
3500	2	6	16	32	55	86	124	170	225	290
5800	1	6	15	27	41	56	71	85	97	106

Carrier frequency:	f	=	13.56 MHz	
Distance:	d	=	5 mm	☒
Transmitter output power:	TP	=	305 nW	
Limit:	TP_{limit}	=	52 mW	☒

[4] The exemption limit in the table are based on measurements and simulations on half-wave dipole antennas at separaton distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.

Product Service

3 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

The measurement uncertainty in the laboratory is less than or equal to the maximum measurement uncertainty according to CISPR16-4-2: 2011 + A1 + A2 + Cor1 (U_{CISPR}). This normative regulation means that the measured value is also the value to be assessed in relation to the limit value.

Radio Interference Emission Testing		
Test Name	*kp*	*Expanded Uncertainty*
Conducted Voltage Emission		
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB
100 kHz to 200 MHz (50Ω/5µH AMN)	2	± 3.6 dB
Discontinuous Conducted Emission		
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB
Conducted Current Emission		
9 kHz to 200 MHz	2	± 3.5 dB
Magnetic Fieldstrength		
9 kHz to 30 MHz (with loop antenna)	2	± 3.9 dB
9 kHz to 30 MHz (large-loop antenna 2 m)	2	± 3.5 dB
Radiated Emission		
30 MHz to 300 MHz	2	± 4.9 dB
300 MHz to 1 GHz	2	± 5.0 dB
1 GHz to 6 GHz	2	± 4.6 dB
Test distance 10 m		
30 MHz to 300 MHz	2	± 4.9 dB
300 MHz to 1 GHz	2	± 4.9 dB
The expanded uncertainty reported according to to CISPR16-4-2: 2011 + A1 + A2 + Cor1 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%		

Table 17 Measurement uncertainty based on CISPR 16-4-2

Product Service

Radio Interference Emission Testing		
Test Name	*kp*	*Expanded Uncertainty*
Occupied Bandwdith	2	± 5 %
Conducted Power		
9 kHz ≤ f < 30 MHz	2	± 1.0 dB
30 MHz ≤ f < 1 GHz	2	± 1.5 dB
1 GHz ≤ f ≤ 40 GHz	2	± 2.5 dB
1 MS/s power sensor (TS8997)	2	± 1.5 dB
Occupied Bandwidth	2	± 5 %
Power Spectral Density	2	± 3.0 dB
Radiated Power		
9 kHz ≤ f < 26.5 GHz	2	± 6.5 dB
26.5 GHz ≤ f < 60 GHz	2	± 8.0 dB
60 GHz ≤ f < 325 GHz	2	± 10 dB
Conducted Spurious Emissions	2	± 3.0 dB
Radiated Spurious Emissions	2	± 6.0 dB
Voltage		
DC	2	± 1.0 %
AC	2	± 2.0 %
Time (automatic)	2	± 5 %
Frequency	2	± 10^{-7}
The expanded uncertainty reported according to to ETSI TR 100 028:2001 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%		

Table 18 Measurement uncertainty based on ETSI TR 100 028