

ISED CABid: ES1909

Test report No:  
 NIE: 68001RRF.006

## Partial Test Report

Reference Standard:  
 USA FCC Part 22  
 CANADA RSS-132

(*) Identification of item tested	Telematic control unit with wireless technologies, used in automotive industry
(*) Trademark	BMW
(*) Model and /or type reference	WAVE-11-HAF-R2
(*) Derived model not tested	WAVE-11-HIGH-R2
Other identification of the product	Type: B424 HW version: D5 SW version: 21411A.004_045_017 IMEI TAC: 35011736 (OEM modem), 35894272 (CUS modem) Contains FCC ID: T8GSAN9000 Contains FCC ID: T8GSAN9001 Contains IC: 6434A-SAN9000 Contains IC: 6434A-SAN9001
(*) Features	GSM, UMTS, LTE, 5G, GNSS
Applicant	HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH BECKER-GOERING-STR. 16; 76307 KARLSBAD, GERMANY
Test method requested, standard	USA FCC Part 22 (10-1-20 Edition). CANADA RSS-132 Issue 3, Jan. 2013. - Radiated Emissions. ANSI C63.26 - 2015. KDB 971168 D01 Power Meas License Digital Systems v03r01, April. 2018.
Approved by (name / position & signature)	Rafael López Martín EMC Consumer & RF Lab. Manager
Date of issue	2022-01-11
Report template No	FDT08_23 (*) "Data provided by the client"

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## Competences and guarantees

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DEKRA Testing and Certification S.A.U. is a testing laboratory accredited by the National Accreditation Body (ENAC -Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification is a FCC-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory, CABid: ES1909, with the appropriate scope of accreditation that covers the performed tests in this report.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification S.A.U. has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification S.A.U. at the time of performance of the test.

DEKRA Testing and Certification S.A.U. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document. **IMPORTANT:** No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of DEKRA Testing and Certification S.A.U.

## General conditions

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1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification S.A.U. and the Accreditation Bodies.

## Uncertainty

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Uncertainty (factor  $k=2$ ) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

## Data provided by the client

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The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample of the model WAVE-11-HAF-R2 is a Telematics control unit with wireless technologies, used in automotive, equipped with 2 modems, OEM and customer. The project name WAVE has the meaning "Wireless Access in Vehicular Environment" and thus describes the key features of this device as Communication and Data Interface. This unit was designed for automotive usage and contains the following features: GSM, UMTS, LTE, 5G, and GNSS.

3. Derived model not tested. These models have been declared by the supplier of the sample as being the same as the model under test.

**HARMAN AUTOMOTIVE DIVISION**  
HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH  
BECKER-GÖRING-STRASSE 16  
76307 KARLSBAD, GERMANY



### Declaration of similarity

To whom it may concern,

We, **Harman Becker Automotive Systems GmbH**, located in  
**Becker-Goering-Str. 16; 76307 Karlsbad, Germany**

Hereby declare that the following units: **WAVE-11-HIGH-R2** and **WAVE-11-HAF-R2** have integrated the same NAD modules, are using same schematic and same PCB layout.

The only difference between the two models is that **WAVE-11-HIGH-R2** is equipped with chipset U-Blox UBX-F9940, where **WAVE-11-HAF-R2** is equipped with chipset ST-Micro STA9100MGA & STA5635S.

Where only one of the aforementioned variants has been used as DUT, shall remain valid and applicable for these two models described.

This declaration is intended to be included in the test reports where applies

Regards



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DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

## Usage of samples

Samples undergoing test have been selected by: The client.

- Sample S/01 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
68001/009	Telematic control unit with wireless technologies, used in automotive industry (Type B424)	WAVE-11-HAF-R2	B4250S0M4907002	2021/08/10
68000C/083	Antenna (DA WAVE HIGH US 5G ROW)	DA05DI20	--	2021/08/27
62486/024	Antenna Box	AB01-I20-01	--	2020/09/22
62486/027	Antenna Box	AB01-I20-01	--	2020/09/22
68000C/065	Spoiler Antenna (FSA-WAVE-5G Links)	FS01DI20	--	2021/10/28
62486/026	Antenna Box	AB01-I20-01	--	2020/09/22
62486/062	RF Harness	--	--	2020/09/22

Auxiliary elements used with the Sample S/01:

Control N°	Description	Model	Serial N°	Date of reception
68000C/009	Battery	607492	--	2021/07/29
62486/048	RF Cable for 4-Fakra	--	--	2020/09/22
62486/055	OABR Cable	--	--	2020/09/22
62486/047	RF Cable for 4-Fakra	--	--	2020/09/22
62486/162	OABR 1000 BaseT Converter	--	--	2020/09/28
62486/070	I-Box OABR Adapter	--	--	2020/09/22
62486/101	SOS Button (E-Call)	9385	11221	2020/09/28
62486/042	Antenna ground planes for roof	--	--	2020/09/22

Sample S/01 has undergone the following test(s): The Radiated tests indicated in the Appendix A.

## Test sample description

Ports.....:	Port name and description	Cable			
		Specified max length [m]	Attached during test	Shielded	Coupled to patient <sup>(3)</sup>
	RF connector –code D violet trunk/roof)	Port not used for SOP2021 (it has V2X interfaces and gateway for SDARS signal towards another ECU)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	RF connector – code C blue (trunk/roof)	>5m	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	NanoMQS 20pol	>5m	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	NanoMQS 10pol	>8m	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	HDBT MATENet 2-Pol (Roof/Trunk)	>5m	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Antenna Connector grey (Roof)	<0.5m	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Supplementary information to the ports.....:	-				
Rated power supply .....	Voltage and Frequency				
	<input checked="" type="checkbox"/>	DC: 12V car battery / attenuator (4,5 V ≤ UB ≤ 18 V; UB typical: 12 V)			
Rated Power..... :	12V DC				
Clock frequencies..... :	25MHz;26MHz;32,768kHz;49,58MHz;				
Other parameters .....	See Technical description				
Software version..... :	21411A.004_045_017				
Hardware version .....	D5				
Dimensions in cm (W x H x D) ... :	160x18x112 mm				
Mounting position .....	<input type="checkbox"/>	Table top equipment			
	<input type="checkbox"/>	Wall/Ceiling mounted equipment			
	<input type="checkbox"/>	Floor standing equipment			
	<input type="checkbox"/>	Hand-held equipment			
	<input checked="" type="checkbox"/>	Other: automotive telematics control unit			
Modules/parts..... :	Module/parts of test item		Type	Manufacturer	
	-				
Accessories (not part of the test item) .....	Description		Type	Manufacturer	
	Cable Harness		-		
	2G/3G4G/5G Antenna		-	Hirschmann/ Molex	
	E-CALL button/LED		-		
	SOS Loudspeaker		-		

	Wake-up unit Box	-	
Documents as provided by the applicant..... :	Description	File name	Issue date
	Technical Description		

<sup>(3)</sup> Only for Medical Equipment

## Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH  
 BECKER-GOERING-STR. 16, 76307 KARLSBAD, GERMANY

## Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2021-10-05
Date (finish)	2021-10-05

## Document history

Report number	Date	Description
68001RRF.006	2022-01-11	First release.

## Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

In the semianechoic chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

## Remarks and comments

The tests have been performed by the technical personnel: Miguel Manuel López.

Used instrumentation:

### Radiated Measurements:

		Last Calibration	Due Calibration
1.	Semianecoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N/A	N/A
2.	Shielded Room ETS LINDGREN S101	N/A	N/A
3.	Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2020/08	2023/08
4.	Biconical/Log Antenna 30MHz - 6 GHz ETS LINDGREN 3142E	2020/10	2023/10
5.	RF Preamplifier G>30dB, 1-18GHz BONN ELEKTRONIK BLMA 0118-3A	2020/10	2021/10
6.	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2021/10	2023/10
7.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
8.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	N/A	N/A
10.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2020/12	2022/12

## Testing verdicts

Not applicable:	N/A
Pass:	P
Fail:	F
Not measured:	N/M



## Summary

FCC PART 22 / RSS-132 PARAGRAPH		
Requirement – Test case	Verdict	Remark
FCC 22.913 / RSS-132 5.4: RF output power	N/M	(1)
FCC 2.1047 / RSS-132 5.2: Modulation characteristics	N/M	(1)
FCC 22.355 / RSS-132 5.3: Frequency stability	N/M	(1)
FCC 2.1049: Occupied Bandwidth	N/M	(1)
FCC 22.917 / RSS-132 5.5: Spurious emissions at antenna terminals	N/M	(1)
FCC 22.917 / RSS-132 5.5: Radiated emissions	P	
<u>Supplementary information and remarks:</u> (1) Test not requested. Radiated emissions test only requested.		

## Appendix A: Test results for FCC Part 22 / RSS-132

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## TEST CONDITIONS

### POWER SUPPLY (V):

Vnominal: 12 Vdc  
 Type of Power Supply: External DC (vehicle battery).

The module with the highest antenna gain has been tested using the worst case obtained for conducted output power with LTE carrier aggregation. And the other module has been tested using an adjacent channel with a setting that would allow communication in the same band to both modules simultaneously with LTE.

LTE Band CA\_5B + LTE Band 5. QPSK and QAM modulations. CARRIER AGGREGATION & MIMO 2x2:

LTE Band 5:

	Channel (Frequency)			
	BW = 1.4 MHz	<b>BW = 3 MHz</b>	BW=5 MHz	BW=10 MHz
Low	20407 (824.70 MHz)	20415 (825.50 MHz)	20425 (826.50 MHz)	20450 (829.00 MHz)
Middle	20525 (836.50 MHz)	20525 (836.50 MHz)	20525 (836.50 MHz)	20525 (836.50 MHz)
High	20643 (848.30 MHz)	20635 (847.50 MHz)	20625 (846.50 MHz)	20600 (844.00 MHz)

LTE Band CA\_5B:

Range	CC-Combo / N <sub>RB_agg</sub> [RB]	CC1 Note1					CC2 Note1					
		BW [RB]	N <sub>UL</sub>	f <sub>UL</sub> [MHz]	N <sub>DL</sub>	f <sub>DL</sub> [MHz]	BW [RB]	N <sub>UL</sub>	f <sub>UL</sub> [MHz]	N <sub>DL</sub>	f <sub>DL</sub> [MHz]	
Low	15+25	15	20416	825.6	2416	870.6	25	20455	829.5	2455	874.5	
		25	20425	826.5	2425	871.5	15	20464	830.4	2464	875.4	
	25+50	25	20428	826.8	2428	871.8	50	20500	834	2500	879	
		50+25	50	20450	829	2450	874	25	20522	836.2	2522	881.2
Mid	15+25	50+50	50	20450	829	2450	874	50	20549	838.9	2549	883.9
		15+25	15	20501	834.1	2501	879.1	25	20540	838.0	2540	883.0
	25+50	25	20510	835.0	2510	880.0	15	20549	838.9	2549	883.9	
		50+25	25	20478	831.8	2478	876.8	50	20550	839	2550	884
High	15+25	50+50	50	20500	834	2500	879	25	20572	841.2	2572	886.2
		50+50	50	20476	831.6	2476	876.6	50	20575	841.5	2575	886.5
	25+50	15	20586	842.6	2586	887.6	25	20625	846.5	2625	891.5	
		25	20595	843.5	2595	888.5	15	20634	847.4	2634	892.4	
50+50	25	20528	836.8	2528	881.8	50	20600	844	2600	889		
	50+25	50	20550	839	2550	884	25	20622	846.2	2622	891.2	
	50+50	50	20501	834.1	2501	879.1	50	20600	844	2600	889	

Note 1: Carriers in increasing frequency order.

TEST FREQUENCIES:

Module NAD2								Module NAD1		
Carrier Aggregation Intra-band. Test frequencies for CA 5B.										
CA 5B: Band 5 with 2 contiguous intra-band CC (PCC+SCC), 1 RBlock.										
Channel	NRB	PCC			SCC1			BW (MHz)	EARFCN	BW (MHz)
		BW (MHz)	EARFCN	Freq. (MHz)	BW (MHz)	EARFCN	Freq. (MHz)			
Low	50+25	10	20450	829	5	20522	836.2	3	Adjacent channel to SCC1 (20562)	840.2
Middle	50+25	10	20500	834	5	20572	841.2	3	Adjacent channel to SCC1 (20612)	845.2
High	50+25	10	20550	839	5	20622	846.2	3	Adjacent channel to PCC (20485)	832.5

## Radiated emissions

### SPECIFICATION:

FCC §22.917 and RSS-132 Issue 3 Clause 5.5:

The power of emissions shall be attenuated below the transmitter power (P) by a factor of at least  $43 + 10 \log (P)$  dB. P in watts.

### METHOD:

The measurement was performed with the EUT inside an anechoic chamber. The spectrum was scanned from 30 MHz to at least the 10th harmonic of the High frequency generated within the equipment.

The EUT was placed on a 1 meter high non-conductive stand at a 3 meter distance from the measuring antenna.

Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum field strength (dB $\mu$ V/m) is measured and recorded.

The maximum field strength (dB $\mu$ V/m) of each detected emission at less than 20 dB respect to the limit is converted to an equivalent EIRP level (dBm) according to ANSI C63.26 with the formula:

$$\text{EIRP (dBm)} = E \text{ (dB}\mu\text{V/m)} + 20 \log(D) - 104.8; \text{ where } D \text{ is the measurement distance (in the far field region) in m.}$$
$$D = 3 \text{ m}$$

### Measurement Limit:

According to specification. the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least  $43 + 10 \log (P)$  dB. P in Watts.

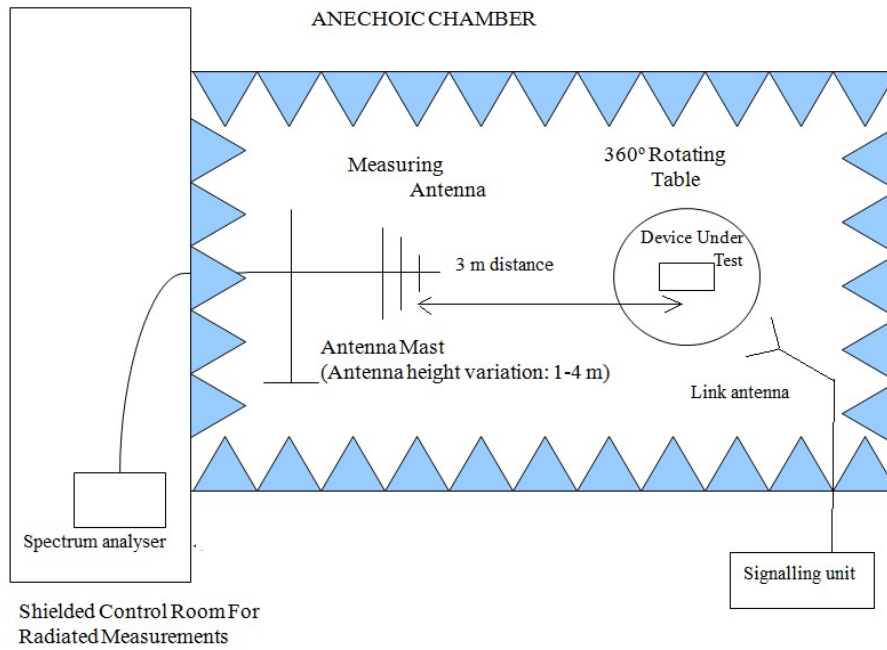
At  $P_o$  transmitting power. the specified minimum attenuation becomes  $43+10\log (P_o)$ . and the level in dBm relative  $P_o$  becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log (P_o \text{ in mWatts}) - 30] = -13 \text{ dBm}$$

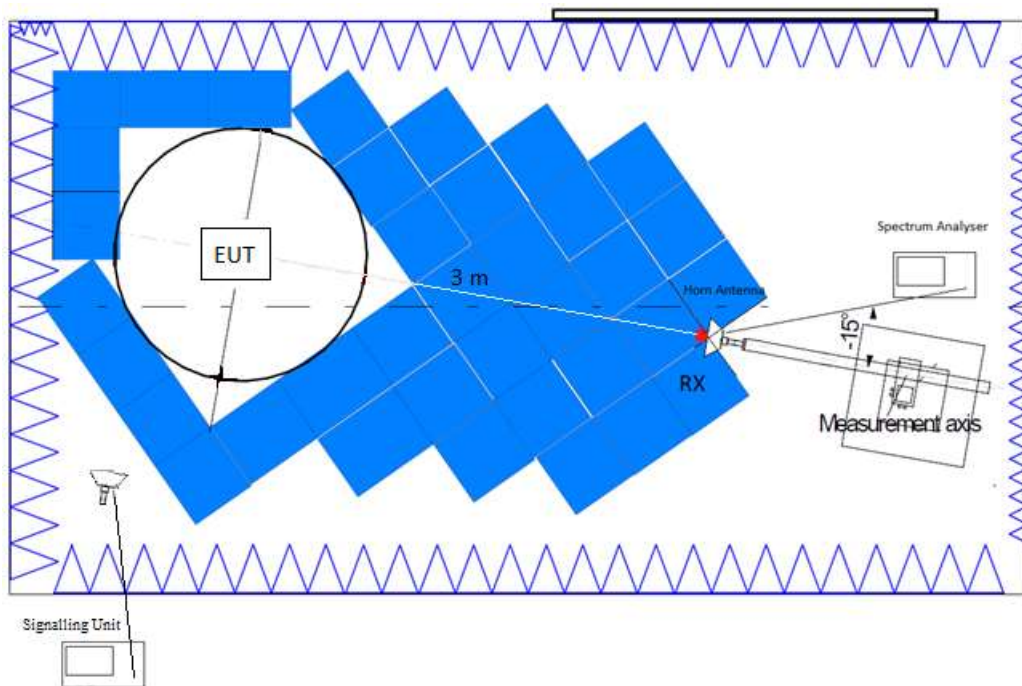
A resolution bandwidth / video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

**TEST SETUP:**

Radiated measurements below 1 GHz:



Radiated measurements above 1 GHz up to 10 GHz:



**RESULTS:**

**LTE Band CA 5B + LTE Band 5:**

QPSK and modulations: A preliminary scan determined the worst case:

- 1) LTE CA\_5B: For the PCC: QPSK modulation, BW=10 MHz, RB=1, Offset=0.  
 For the SCC1: QPSK modulation, BW=5 MHz, RB=1, Offset=0.
- 2) LTE Band 5: QPSK modulation, BW=3 MHz, RB=1, Offset=0.

The following results are the ones of the worst case.

**- LOW CHANNEL:**

**Frequency range 30 MHz - 1 GHz:**

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (MHz)	E.I.R.P (dBm)	Polarization	Detector	Measurement Uncertainty (dB)
814.924	-24.3	H	RMS	<± 4.99

**Frequency range 1 - 8.5 GHz:**

No spurious frequencies at less than 20 dB below the limit.

**- MIDDLE CHANNEL:**

**Frequency range 30 MHz - 1 GHz:**

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (MHz)	E.I.R.P (dBm)	Polarization	Detector	Measurement Uncertainty (dB)
820.259	-28.99	H	RMS	<± 4.99

**Frequency range 1 - 8.5 GHz:**

No spurious frequencies at less than 20 dB below the limit.

**- HIGH CHANNEL:**

**Frequency range 30 MHz - 1 GHz:**

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (MHz)	E.I.R.P (dBm)	Polarization	Detector	Measurement Uncertainty (dB)
852.754	-34.79	V	RMS	<± 4.99

**Frequency range 1 - 8.5 GHz:**

No spurious frequencies at less than 20 dB below the limit.

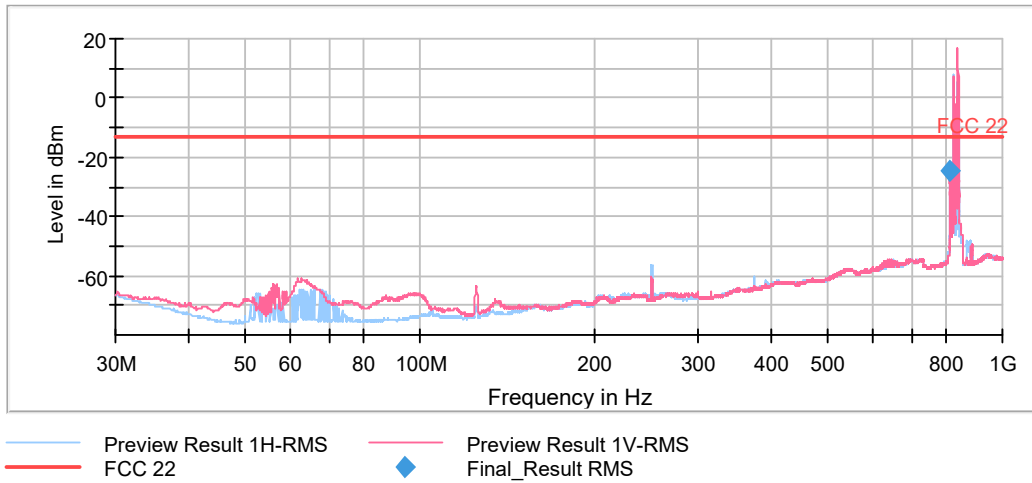
Measurement Uncertainty (dB): <± 4.99 for f ≥ 30 MHz up to 1 GHz  
 <± 4.98 for f ≥ 1 GHz up to 10 GHz

Verdict: PASS



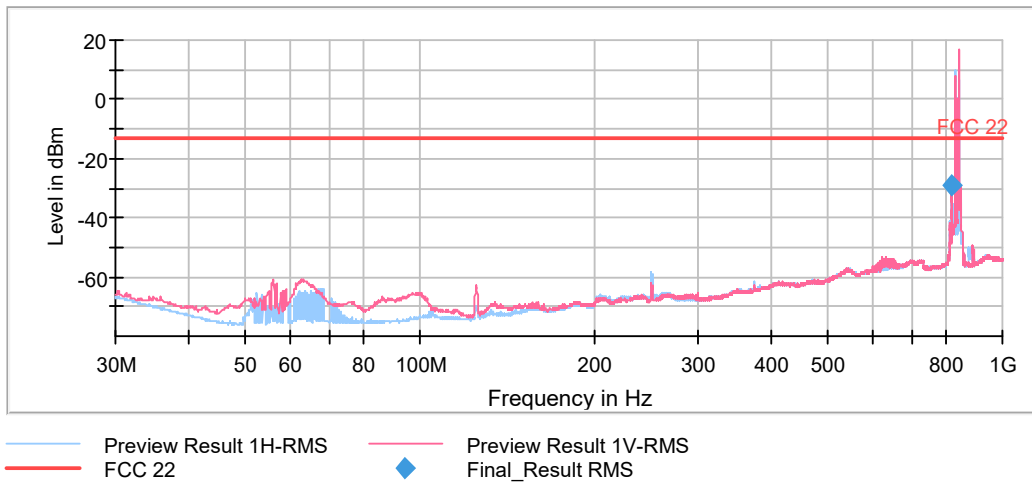
### FREQUENCY RANGE 30 MHz - 1 GHz (worst case):

- Low Channel:



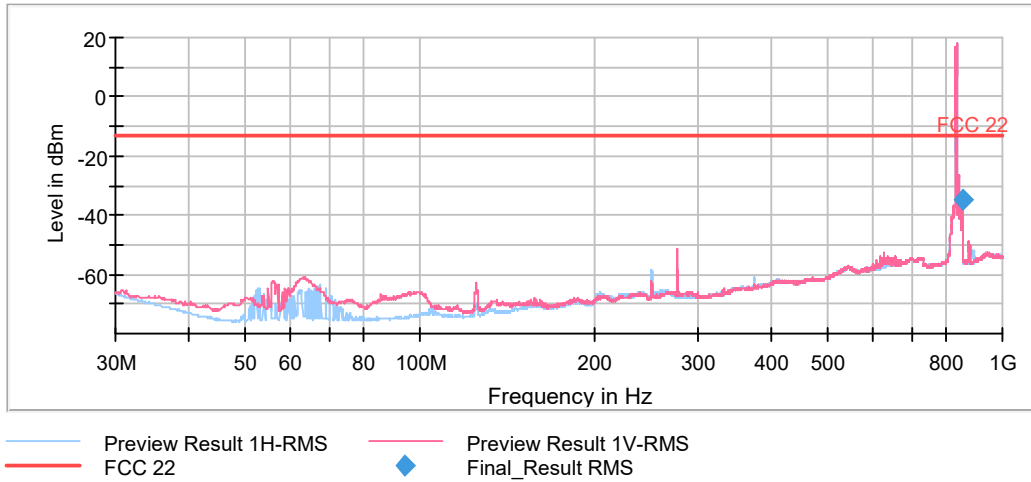
The peaks above the limit are the carrier frequencies.

- Middle Channel:



The peaks above the limit are the carrier frequencies.

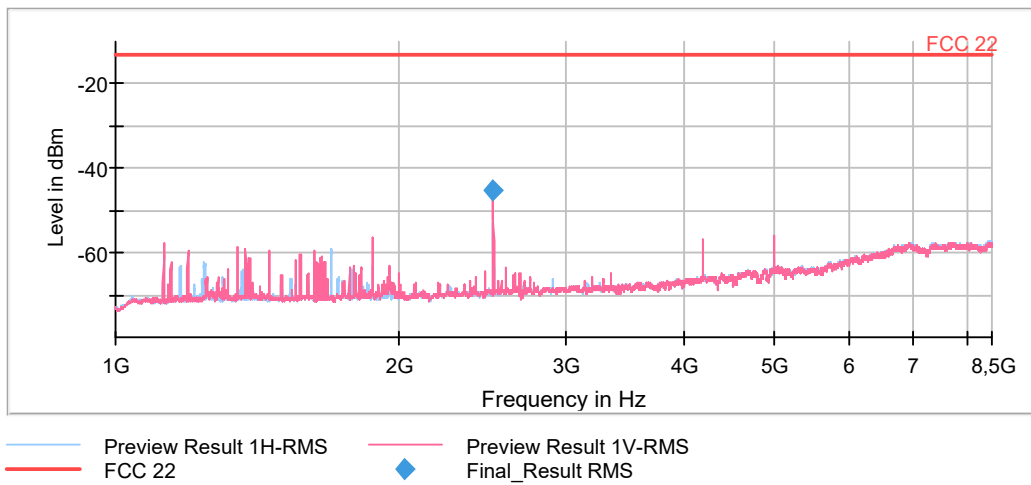
- High Channel:



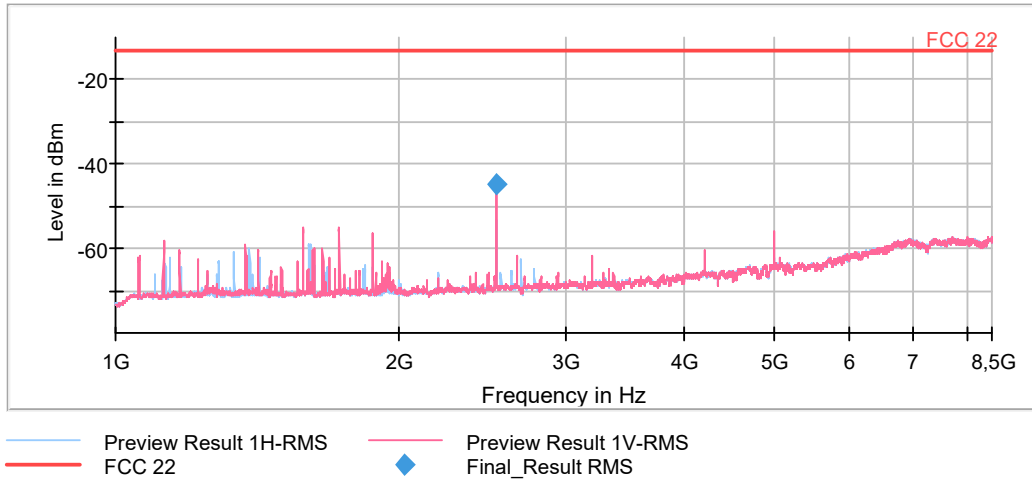
The peaks above the limit are the carrier frequencies.

**FREQUENCY RANGE 1 - 8.5 GHz (worst case):**

- Low Channel:



- Middle Channel:



- High Channel:

