

Test report No:
NIE: 62486RRF.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-HIGH-R1
Other identification of the product	HW version: D3 SW version: 20512H.001_047_009 FCC ID: T8GWAVE11HIGH-R1 IC: 6434A-WAVE11HIGH-R1
(*) 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 (10-1-19 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)	José Carlos Luque RF Lab. Supervisor 
Date of issue	2021-02-02
Report template No	FDT08_23 (*) "Data provided by the client"

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Competences and guarantees

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.

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1. This report is only referred to the item that has undergone the test.
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Uncertainty

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

Data provided by the client

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-HIGH-R1 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.

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
62486E/106	Telematic Control Unit	WAVE-11-HIGH-R1	B392160L4900519	2020/09/28
62486E/012	Antenna DA wave HIGH 5G US	DA05DI20	--	2020/09/22
62486E/036	Antenna Box	AB01-I20-01	--	2020/09/22
62486E/037	Antenna Box	AB01-I20-01	--	2020/09/22
62486E/038	Antenna Box	AB01-I20-01	--	2020/09/22
62486E/039	Antenna Box	AB01-I20-01	--	2020/09/22
62486E/060	Harness 20 pol	--	--	2020/09/22

Auxiliary elements used with the Sample S/01:

Control N°	Description	Model	Serial N°	Date of reception
62486E/109	Battery Li-ion	11FR1580-2	--	2020/09/28
62486E/042	Antenna ground planes for roof	--	--	2020/09/22
62486E/045	RF Cable for 4-Fakra	--	--	2020/09/22
62486E/056	OABR Cable	--	--	2020/09/22
62486E/064	OABR 1000 BaseT Converter	--	--	2020/09/22
62486E/067	I-Box OABR Adapter	--	--	2020/09/22
62486E/071	Ethernet Cable	--	--	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 ⁽³⁾		
	RF connector –code D violet trunk/roof)	Port not used for SOP2021 (it has V2X interfaces and gateway for SDARS signal towards another ECU)	☐	☒	☐		
	RF connector – code C blue (trunk/roof)	>5m	☒	☒	☐		
	NanoMQS 20pol	>5m	☒	☐	☐		
	NanoMQS 10pol	>8m	☒	☐	☐		
	HDBT MATenet 2-Pol (Roof/Trunk)	>5m	☒	☐	☐		
	Antenna Connector grey (Roof)	<0.5m	☒	☒	☐		
Supplementary information to the ports..... :							
Rated power supply	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐
	☐	AC:	☐	☐	☐	☐	☐
	☒	DC: 12V car battery / attenuator (4,5 V ≤ UB ≤ 18 V; UB typical: 12 V)					
☐	DC:						
Rated Power	12V DC						
Clock frequencies.....	25MHz;26MHz;32,768kHz;49,58MHz;						
Other parameters	See Technical description						
Software version	D3						
Hardware version	20512H.001_047_009						

Dimensions in cm (W x H x D)	160x18x112 mm		
Mounting position	☐	Table top equipment	
	☐	Wall/Ceiling mounted equipment	
	☐	Floor standing equipment	
	☐	Hand-held equipment	
	☒	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		

⁽³⁾ 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)	2020-10-30
Date (finish)	2020-11-04

Document history

Report number	Date	Description
62486RRF.006	2021-02-02	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: Nicolás Salguero, Cristina Calle, Miguel Manuel López and Pablo Redondo.

Used instrumentation:

Radiated Measurements:

	Last Calibration	Due Calibration
1. Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N.A.	N.A.
2. Shielded Room ETS LINDGREN S101	N.A.	N.A.
3. Multi-device Controller EMCO 2090	N.A.	N.A.
4. Antenna Mast ETS LINDGREN 2175 MiniMast	N.A.	N.A.
5. Field Probe Positioner MATURO FPP 2.3-M	N.A.	N.A.
6. Biconical/Log Antenna 30 MHz - 6 GHz ETS LINDGREN 3142E	2020/04	2023/04
7. Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2019/11	2022/11
8. RF Preamplifier, 40 dB ,1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2020/05	2021/05
9. Spectrum Analyzer ROHDE AND SCHWARZ FSW50	2020/07	2022/07
10. EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
11. Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2020/04	2021/04
12. Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2020/07	2021/07
13. High Pass Filter 1.1 - 8 GHz, WAINWRIGHT INSTRUMENTS WHK10-990-1100-8000-40SS	2019/06	2021/06
14. DC Power Supply, 30V/5A KEYSIGHT TECHNOLOGIES U8002A	N.A.	N.A.
15. Digital Multimeter FLUKE 175	2020/11	2021/11

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	(2)
<u>Supplementary information and remarks:</u> (1) Test not requested. Radiated emissions test only requested. (2) The 62486RRF.001 contains the results of the pre-testing to determine the worst case of the setting of the antennas. · Conf #1: MIMO1 Port -> Int BuA Antenna / MIMO2 Port -> MIMO2 Antenna / Antennenbox for NAD#2. · Conf #2: MIMO1 Port -> Int BuA Antenna / MIMO2 Port -> MIMO2 Antenna / FSA antenna for NAD#2. · Conf #3: MIMO1 Port -> MIMO1 Antenna / MIMO2 Port -> MIMO2 Antenna / Antennenbox for NAD#2. · Conf #4: MIMO1 Port -> MIMO2 Antenna / MIMO2 Port -> MIMO2 Antenna / FSA antenna for NAD#2.		

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 (configuration 3):

LTE Band 5:

	Channel (Frequency)			
	BW = 1.4 MHz	BW = 3 MHz	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 _{RB_agg} [RB]	CC1 Note1					CC2 Note1				
		BW [RB]	N _{UL}	f _{UL} [MHz]	N _{DL}	f _{DL} [MHz]	BW [RB]	N _{UL}	f _{UL} [MHz]	N _{DL}	f _{DL} [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
	50+50	50	20450	829	2450	874	50	20549	838.9	2549	883.9
Mid	15+25	15	20501	834.1	2501	879.1	25	20540	838.0	2540	883.0
		25	20510	835.0	2510	880.0	15	20549	838.9	2549	883.9
	25+50	25	20478	831.8	2478	876.8	50	20550	839	2550	884
High	50+25	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
	15+25	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
	25+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 NAD1								Module NAD2		
Carrier Aggregation Intra-band. Test frequencies for CA 5B.								LTE Band 5		
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	5	Adjacent channel to SCC1 (20625)	846.5
Middle	50+25	10	20500	834	5	20572	841.2	5	Adjacent channel to SCC1 (20625)	846.5
High	50+25	10	20550	839	5	20622	846.2	5	Adjacent channel to PCC (20425)	826.5

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 (dBμV/m) is measured and recorded.

The maximum field strength (dBμV/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.

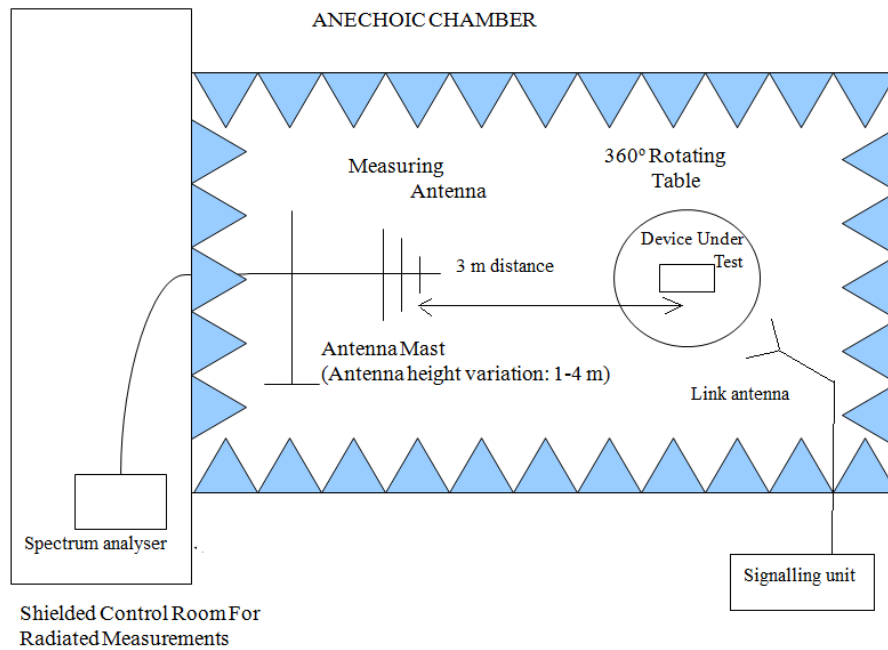
At P_o transmitting power. the specified minimum attenuation becomes $43+10\log (P_o)$. and the level in dBm relative P_o becomes:

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

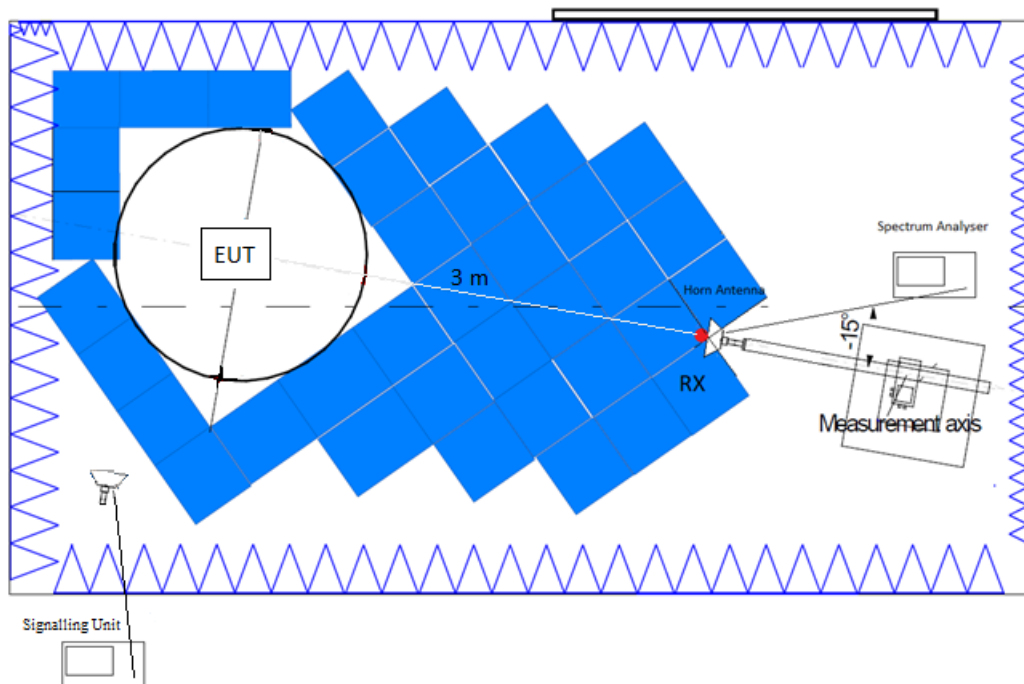
A resolution bandwidth / video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

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=5 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)
814.827	-15.71	V	Peak	<± 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)
819.871	-21.32	H	Peak	<± 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)
853.433	-30.03	V	Peak	<± 4.99

Frequency range 1 - 8.5 GHz:

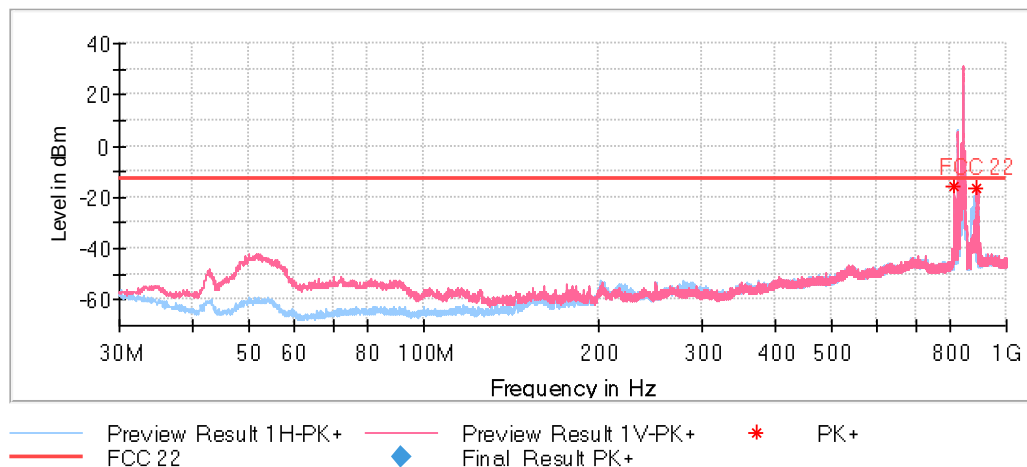
No spurious frequencies at less than 20 dB below the limit.

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

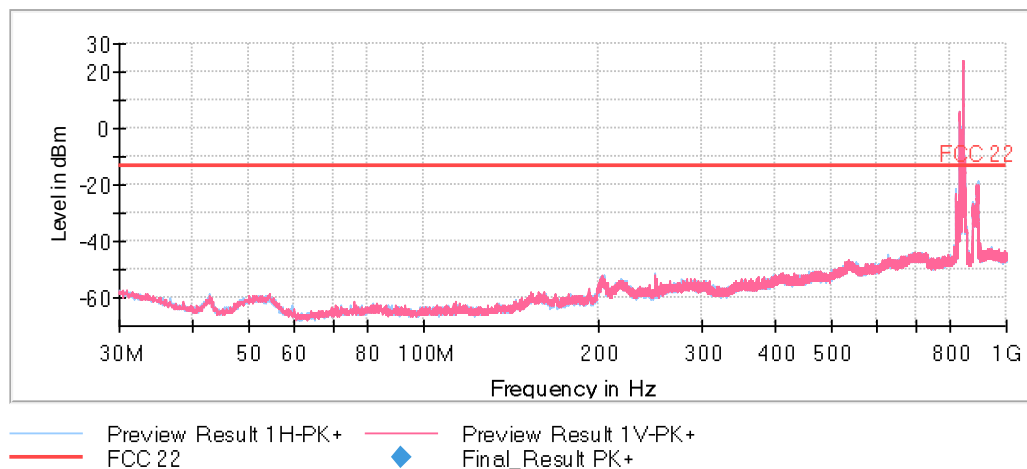
FREQUENCY RANGE 30 MHz - 1 GHz (worst case):

- Low Channel:



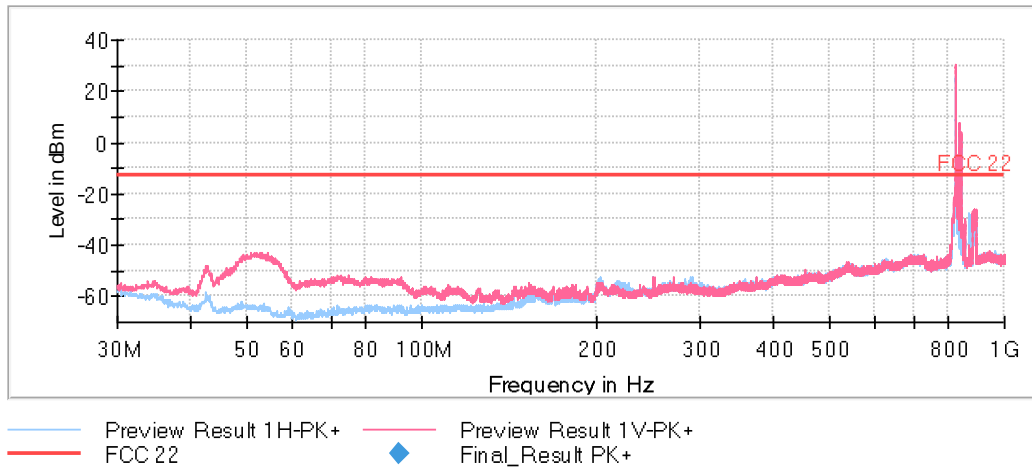
The peaks above the limit are the carrier frequencies. The peak at 891.5MHz corresponds to the downlink signal.

- Middle Channel:



The peaks above the limit are the carrier frequencies. The peak at 891.5MHz corresponds to the downlink signal.

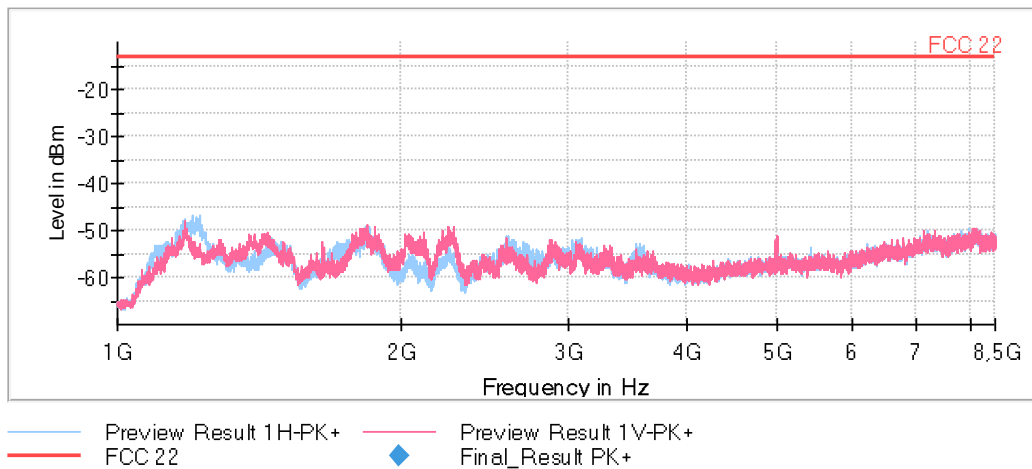
- High Channel:



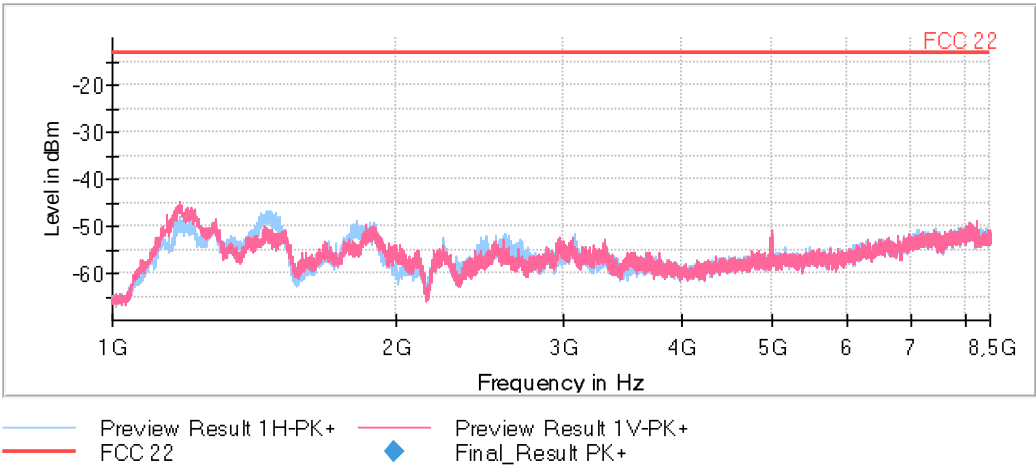
The peaks above the limit are the carrier frequencies. The peak at 871.5MHz and 891.2 correspond to the downlink signals.

FREQUENCY RANGE 1 - 8.5 GHz (worst case):

- Low Channel:



- Middle Channel:



- High Channel:

