DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29507456

ISED CABid: ES1909

Test Report No:
NIE: 68001RRF.005

Partial Test Report

USA FCC 15.31(h), 22, 24
CANADA RSS-132, RSS-133

(*) 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 15.31(h) (10-1-20 Edition): Measurement standard. USA FCC Part 22 (10-1-20 Edition): Public Mobile Services. USA FCC Part 24 (10-1-20 Edition): Personal Communications Services. CANADA RSS-132 Issue 3, Jan. 2013. CANADA RSS-133 Issue 6, Jan. 2018. -Transmitter out of band radiated emissions with simultaneous transmissions. KDB 971168 D01 Power Meas License Digital Systems v03r01, April 2018. ANSI C63.26-2015.
Approved by (name / position & signature)	Rafael López Martín EMC Consumer & RF Lab. Manager 2022.01.11 16:41:07 +01'00'
Date of issue	2022-01-11
Report template No	FDT08_23 (*) "Data provided by the client"

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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.

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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-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-GOERING-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

i. V. Alexandru Neacsu

By: Alexandru Costin Neacsu
Title: Regulatory Product Compliance Expert
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i. V.

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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 Nº	Description	Model	Serial Nº	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 Nº	Description	Model	Serial Nº	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(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	
	☒	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 ..... :	☐	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)	2021-10-06
Date (finish)	2021-10-07

Document history

Report number	Date	Description
68001RRF.005	2022-01-11	First release.

Environmental conditions

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

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

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

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

Remarks and comments

The tests have been performed by the technical personnel: Alfonso Gutiérrez, José Manuel Jiménez and Miguel Manuel López.

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.	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	2020/12	2021/12
6.	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2021/10	2023/10
7.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	N/A	N/A
8.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/11	2021/11

Testing verdicts

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

Summary

FCC Parts 15, 22, 24 / RSS-132, RSS-133 PARAGRAPH		
Requirement – Test case	**Verdict**	**Remark**
FCC 15.31(h), FCC 22.917 / RSS-132 5.5. Emission limitations radiated (Transmitter)	P	(1)
FCC 15.31(h), FCC 24.238 / RSS-133 6.5. Emission limitations radiated (Transmitter)	P	(1)
Supplementary information and remarks: (1) Only Co-Location radiated spurious emission test requested.		

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

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TEST CONDITIONS

(*): Data provided by the Applicant.

POWER SUPPLY (*):

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

TEST FREQUENCIES (*):

Based on preliminary testing that identified the worst-cases, in terms of the highest E.I.R.P.

	CELLULAR 2G + 3G		
Band:	2G Band GSM-850		
Frequency Range:	824 – 849 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD1	Middle: 190	836.6
Band:	3G Band V		
Frequency Range:	824 – 849 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD2	Adjacent channel to Middle: 4207	841.4

	CELLULAR 2G + LTE		
Band:	2G Band GSM-850		
Frequency Range:	824 – 849 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD1	Middle: 190	836.6
Band:	LTE Band 5		
Frequency Range:	824 – 849 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD2	Adjacent channel to Middle: 20575	841.5

	CELLULAR 3G + LTE		
Band:	3G Band V		
Frequency Range:	824 – 849 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD1	Middle: 4182	836.4
Band:	LTE Band 5		
Frequency Range:	824 – 849 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD2	Adjacent channel to Middle: 20575	841.5

The test set-up was made in accordance to the general provisions of the KDB 971168 D01 Power Meas License Digital Systems v03r01, April 2018.

Selected Transmission Modes for each Radio:

The following configurations were selected based on preliminary testing that identified those corresponding to the worst-cases:

- **Module NAD1:**

* Cellular 2G Band GSM-850: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in:
Cellular 2G Band GSM-850 / Middle Channel in EDGE mode configuration.

* Cellular 3G Band V: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in:
Cellular 3G Band V / Middle Channel in HSUPA mode configuration.

- **Module NAD2:**

* Cellular 3G Band V: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in:
Cellular 3G Band V / Adjacent channel to Middle Channel in HSUPA mode configuration.

* Cellular LTE Band 5: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in:
Cellular LTE Band 5 / Adjacent channel to Middle Channel in QPSK mode configuration.

TESTED SIMULTANEOUS TRANSMISSION MODES:

*** Co-Location mode 2G Band GSM-850, 3G Band V**, with the EUT configured to simultaneously transmit two signals at maximum output power:

CO-LOCATION	2G Band GSM-850		3G Band V	
	Module	Channel	Module	Channel
MULTI-TRANSMITTER MODE 1	NAD1	Middle	NAD2	Adjacent channel to Middle

*** Co-Location mode 2G Band GSM-850, LTE Band 5**, with the EUT configured to simultaneously transmit two signals at maximum output power:

CO-LOCATION	2G Band GSM-850		LTE Band 5	
	Module	Channel	Module	Channel
MULTI-TRANSMITTER MODE 2	NAD1	Middle	NAD2	Adjacent channel to Middle

*** Co-Location mode 3G Band V, LTE Band 5**, with the EUT configured to simultaneously transmit two signals at maximum output power:

CO-LOCATION	3G Band V		LTE Band 5	
	Module	Channel	Module	Channel
MULTI-TRANSMITTER MODE 3	NAD1	Middle	NAD2	Adjacent channel to Middle

Radiated Emissions

SPECIFICATION:

1. 2G Band GSM-850, 3G Band V, LTE Band 5. FCC §2.1053 & §22.917 / RSS-132 Issue 3 Clause 5.5.:

FCC §22.917:

> (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

RSS-132 Clause 5.5:

> i. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts).
>
> ii. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

Measurement Limit:

According to the 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 Po transmitting power the specified minimum attenuation becomes 43+10log (Po) and the level in dBm relative Po becomes:

$$Po\ (dBm) – [43 + 10 \log (Po\ in\ mWatts) - 30] = -13\ dBm$$

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 highest frequency of the co-located radios.

The EUT was placed on a 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 meter reading was recorded. The maximum field strength (dBµV/m) is measured and recorded.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

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:

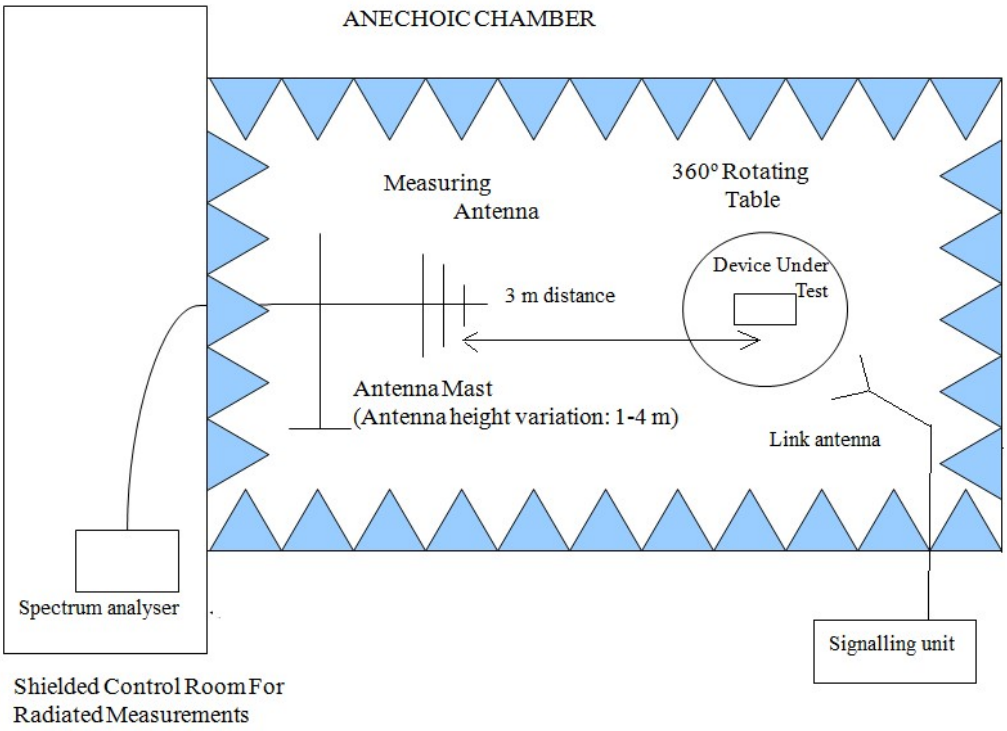
EIRP (dBm) = E (dBµV/m) + 20 log(D) - 104.8; where D is the measurement distance (in the far field region) in m.
D = 3 m

These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces that can transmit simultaneously.

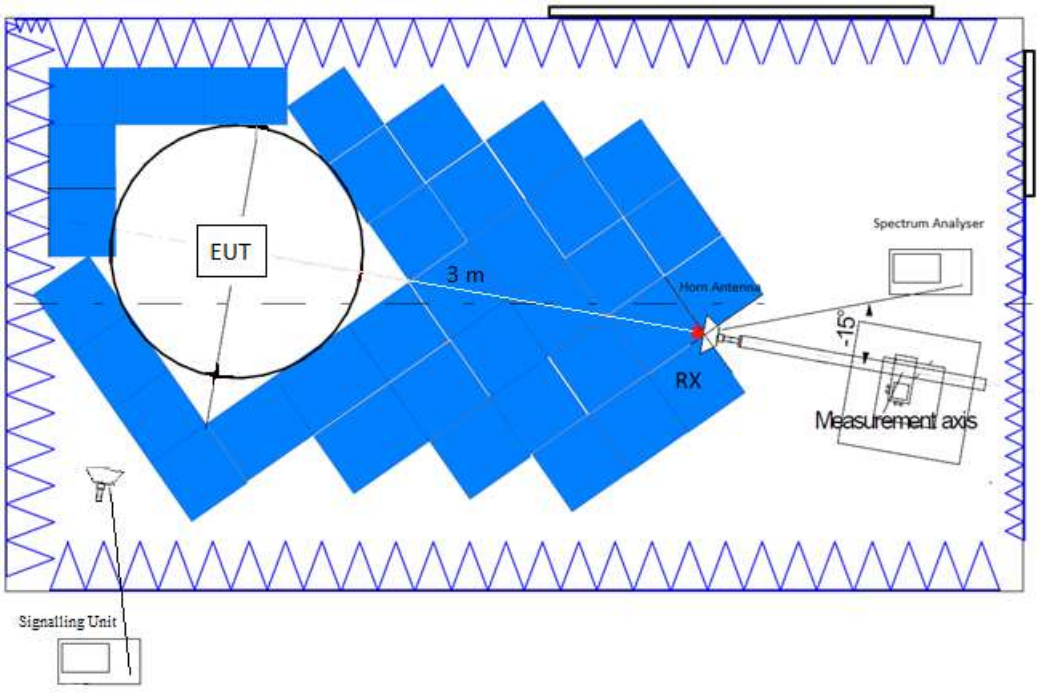
A resolution bandwidth / video bandwidth of 100 kHz / 300 kHz or higher were used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

TEST SETUP:

Radiated measurements below 1 GHz:



Radiated measurements above 1 GHz up to 8.5 GHz:



RESULTS:

- **Co-Location mode 2G Band GSM-850, 3G Band V:**

MULTI-TRANSMITTER MODE 1: A preliminary scan determined the module NAD1, 2G Band GSM-850, Middle Channel, EDGE modulation and the module NAD2, 3G Band V, Middle Channel, HSUPA modulation as the worst-case. The following results are the ones of the worst-case.

2G Band GSM-850: Module NAD1. Middle Channel (836.6 MHz). EDGE.
3G Band V: Module NAD2. Adjacent channel to Middle Channel (841.4 MHz). HSUPA.

LIMIT: The spurious frequencies were measured at 3 meter. The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBm)
30 MHz to 8.5 GHz	PK	43 + 10 log (P) dB = -13 dBm

MULTI-TRANSMITTER MODE 1:

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 8.5 GHz:

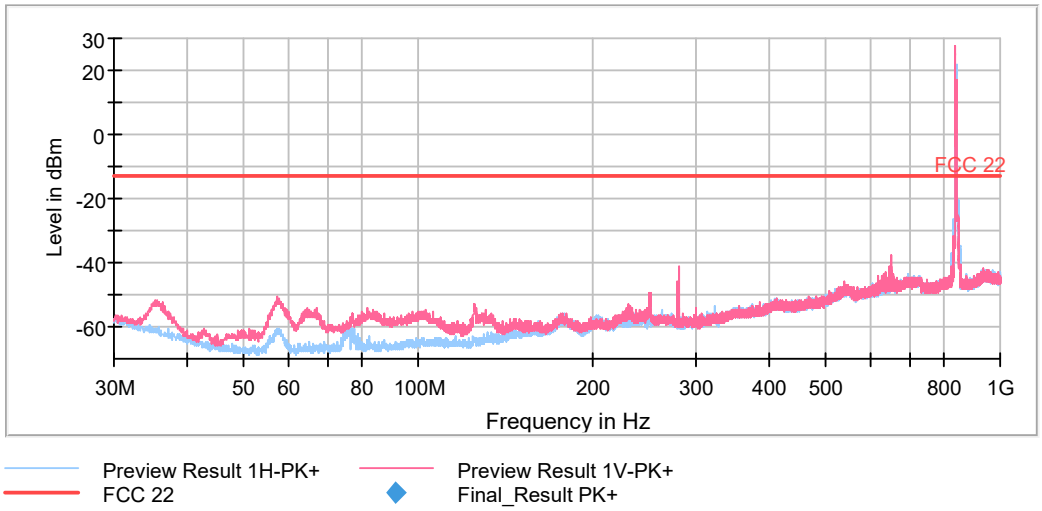
No spurious frequencies at less than 20 dB below the limit.

Measurement Uncertainty (dB)	<±5.08 for f < 1 GHz <±5.13 for f ≥ 1 GHz up to 8.5 GHz

Verdict: PASS

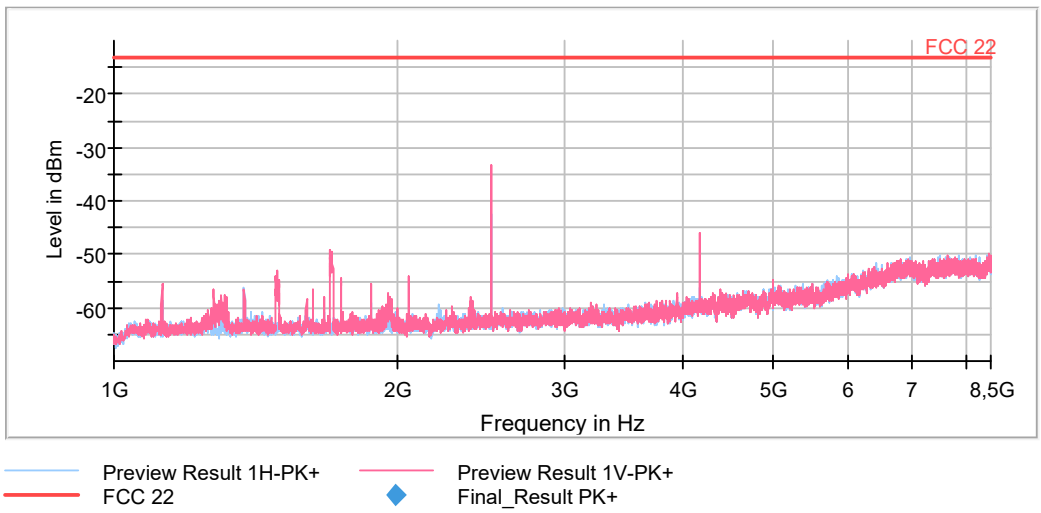
MULTI-TRANSMITTER MODE 1:

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



The peaks above the limit are the carriers frequencies of the 2G Band GSM-850 and the 3G Band V.

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



- **Co-Location mode 2G Band GSM-850, LTE Band 5:**

MULTI-TRANSMITTER MODE 2: A preliminary scan determined the module NAD1, 2G Band GSM-850, Middle Channel, EDGE modulation and the module NAD2, LTE Band 5, Middle Channel, QPSK modulation as the worst-case. The following results are the ones of the worst-case.

2G Band GSM-850: Module NAD1. Middle Channel (836.6 MHz). EDGE.
LTE Band 5: Module NAD2. Adjacent channel to Middle Channel (841.5 MHz). QPSK. BW=5 MHz. RB Size=1. RB Offset=0.

LIMIT: The spurious frequencies were measured at 3 meter. The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBm)
30 MHz to 8.5 GHz	PK	43 + 10 log (P) dB = -13 dBm

MULTI-TRANSMITTER MODE 2:

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 8.5 GHz:

Spurious frequencies at less than 20 dB below the limit:

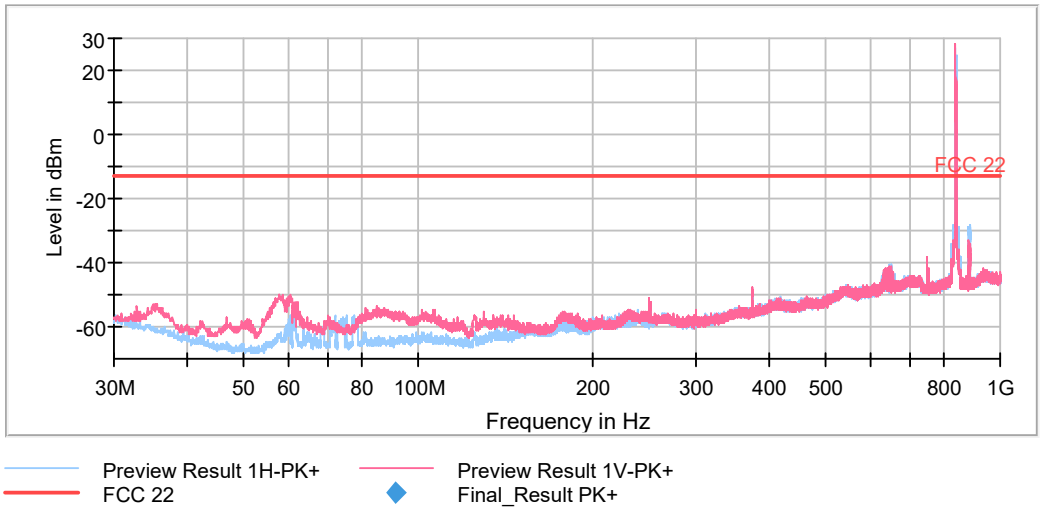
Spurious frequency (MHz)	E.I.R.P (dBm)	Polarization	Detector
2509.375000	-32.74	V	Peak

Measurement Uncertainty (dB) <±5.08 for f < 1 GHz
<±5.13 for f ≥ 1 GHz up to 8.5 GHz

Verdict: PASS

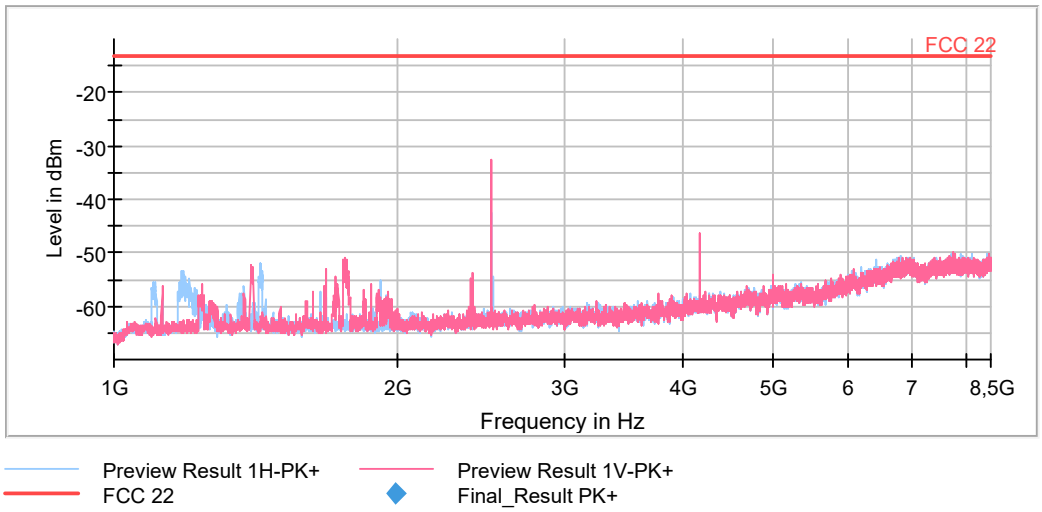
MULTI-TRANSMITTER MODE 2:

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



The peaks above the limit are the Carriers frequencies of the 2G Band GSM-850 and the LTE Band 5.

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



- **Co-Location mode 3G Band V, LTE Band 5:**

MULTI-TRANSMITTER MODE 3: A preliminary scan determined the module NAD1, 3G Band V, Middle Channel, WCDMA modulation and the module NAD2, LTE Band 5, Middle Channel, QPSK modulation as the worst-case. The following results are the ones of the worst-case.

3G Band V:	Module NAD1. Middle Channel (836.4 MHz). WCDMA.
LTE Band 5:	Module NAD2. Adjacent channel to Middle Channel (841.5 MHz). QPSK. BW=5 MHz. RB Size=1. RB Offset=0.

LIMIT: The spurious frequencies were measured at 3 meter. The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBm)
30 MHz to 8.5 GHz	PK	43 + 10 log (P) dB = -13 dBm

MULTI-TRANSMITTER MODE 3:

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 8.5 GHz:

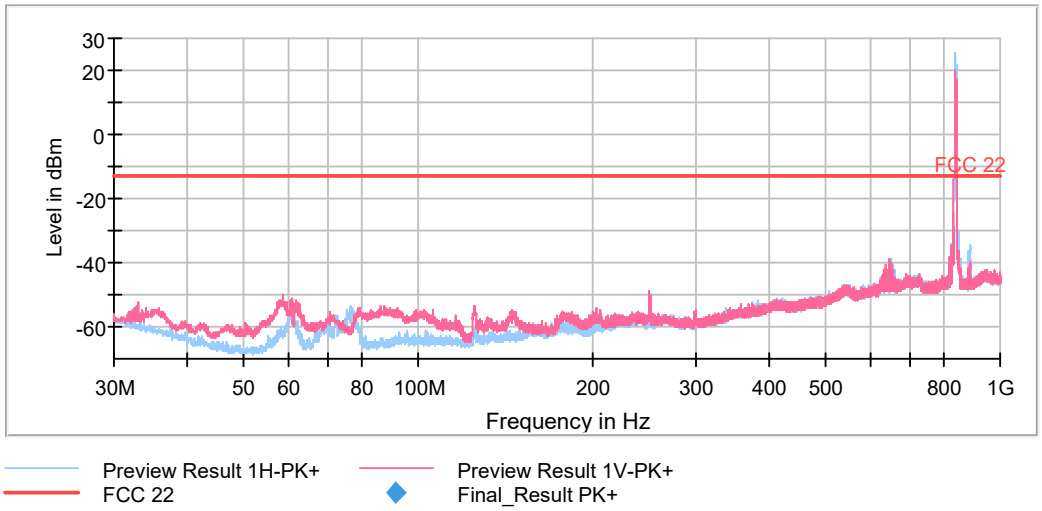
No spurious frequencies at less than 20 dB below the limit.

Measurement Uncertainty (dB)	<±5.08 for f < 1 GHz <±5.13 for f ≥ 1 GHz up to 8.5 GHz

Verdict: PASS

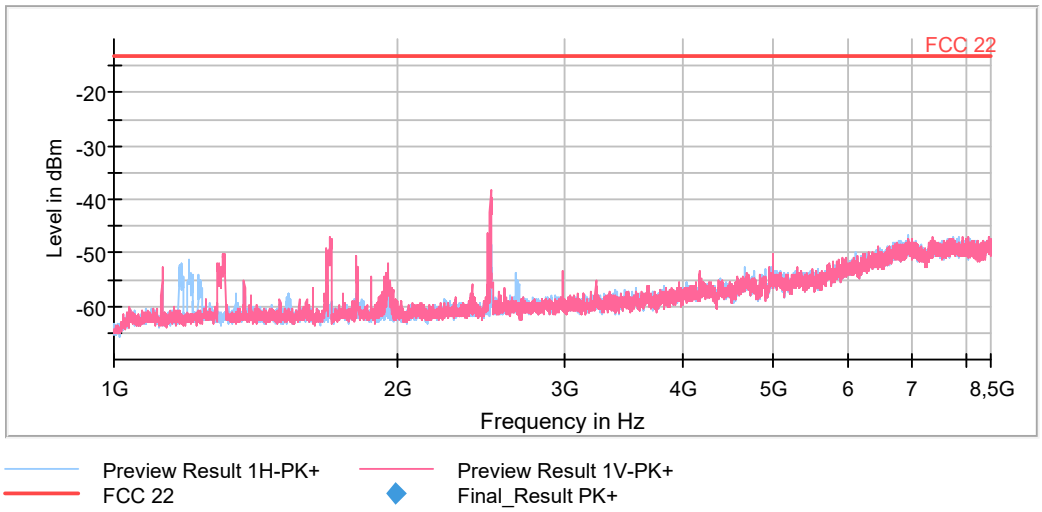
MULTI-TRANSMITTER MODE 3:

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



The peaks above the limit are the Carriers frequencies of the 3G Band V and LTE Band 5.

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



Appendix B: Test results FCC Part 24 / RSS-133

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TEST CONDITIONS

(*): Data provided by the Applicant.

POWER SUPPLY (*):

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

TEST FREQUENCIES (*):

Based on preliminary testing that identified the worst-cases, in terms of the highest E.I.R.P.

	CELLULAR 2G + 3G		
Band:	2G Band GSM-1900		
Frequency Range:	1850 – 1910 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD1	662	1880.2
Band:	3G Band II		
Frequency Range:	1850 – 1910 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD2	Adjacent channel to Middle: 9425	1885

	CELLULAR 2G + LTE		
Band:	2G Band GSM-1900		
Frequency Range:	1850 – 1910 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD1	662	1880.2
Band:	LTE Band 25		
Frequency Range:	1850 – 1915 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD2	Adjacent channel to Middle: 26515	1897.5

	CELLULAR 3G + LTE		
Band:	3G Band II		
Frequency Range:	1850 – 1910 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD1	Middle: 9400	1880
Band:	LTE Band 25		
Frequency Range:	1850 – 1915 MHz		
Transmit Channel:	Module	Channel	Channel Frequency (MHz)
	NAD2	Adjacent channel to Middle: 26515	1897.5

The test set-up was made in accordance to the general provisions of the KDB 971168 D01 Power Meas License Digital Systems v03r01, April 2018.

Selected Transmission Modes for each Radio:

The following configurations were selected based on preliminary testing that identified those corresponding to the worst-cases:

- **Module NAD1:**

* Cellular 2G Band PCS-1900: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in:
Cellular 2G Band PCS-1900 / Middle Channel in EDGE mode configuration.

* Cellular 3G Band II: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in:
Cellular 3G Band II / Middle Channel in HSUPA mode configuration.

- **Module NAD2:**

* Cellular 3G Band II: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in:
Cellular 3G Band II / Adjacent channel to Middle Channel in HSUPA mode configuration.

* Cellular LTE Band 25: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in:
Cellular LTE Band 25 / Adjacent channel to Middle Channel in QPSK mode configuration.

TESTED SIMULTANEOUS TRANSMISSION MODES:

*** Co-Location mode 2G Band PCS-1900, 3G Band II**, with the EUT configured to simultaneously transmit two signals at maximum output power:

CO-LOCATION	2G Band PCS-1900		3G Band II	
	Module	Channel	Module	Channel
MULTI-TRANSMITTER MODE 1	NAD1	Middle	NAD2	Adjacent channel to Middle

*** Co-Location mode 2G Band PCS-1900, LTE Band 25**, with the EUT configured to simultaneously transmit two signals at maximum output power:

CO-LOCATION	2G Band PCS-1900		LTE Band 25	
	Module	Channel	Module	Channel
MULTI-TRANSMITTER MODE 2	NAD1	Middle	NAD2	Adjacent channel to Middle

*** Co-Location mode 3G Band II, LTE Band 25**, with the EUT configured to simultaneously transmit two signals at maximum output power:

CO-LOCATION	3G Band II		LTE Band 25	
	Module	Channel	Module	Channel
MULTI-TRANSMITTER MODE 3	NAD1	Middle	NAD2	Adjacent channel to Middle

Radiated Emissions

SPECIFICATION:

1. 2G PCS-1900, 3G Band II, LTE Band 25. FCC §2.1053 & §24.238 / RSS-133 Issue 6 Clause 6.5.:

FCC §24.238:

> (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

RSS-133 Issue 6 Clause 6.5:

> i. In the 1.0 MHz bands immediately outside and adjacent to the equipment's operating frequency block, the emission power per any 1% of the emission bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts).
>
> ii. After the first 1.0 MHz, the emission power in any 1 MHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts). If the measurement is performed using 1% of the emission bandwidth, power integration over 1.0 MHz is required.

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 highest frequency generated within the equipment.

The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 18 GHz and at 1 m distance for measurements above 18 GHz.
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 field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

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:

EIRP (dBm) = E (dBµV/m) + 20 log(D) - 104.8; where D is the measurement distance (in the far field region) in m.
D = 3 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 Po transmitting power, the specified minimum attenuation becomes 43+10log (Po), and the level in dBm relative Po becomes:

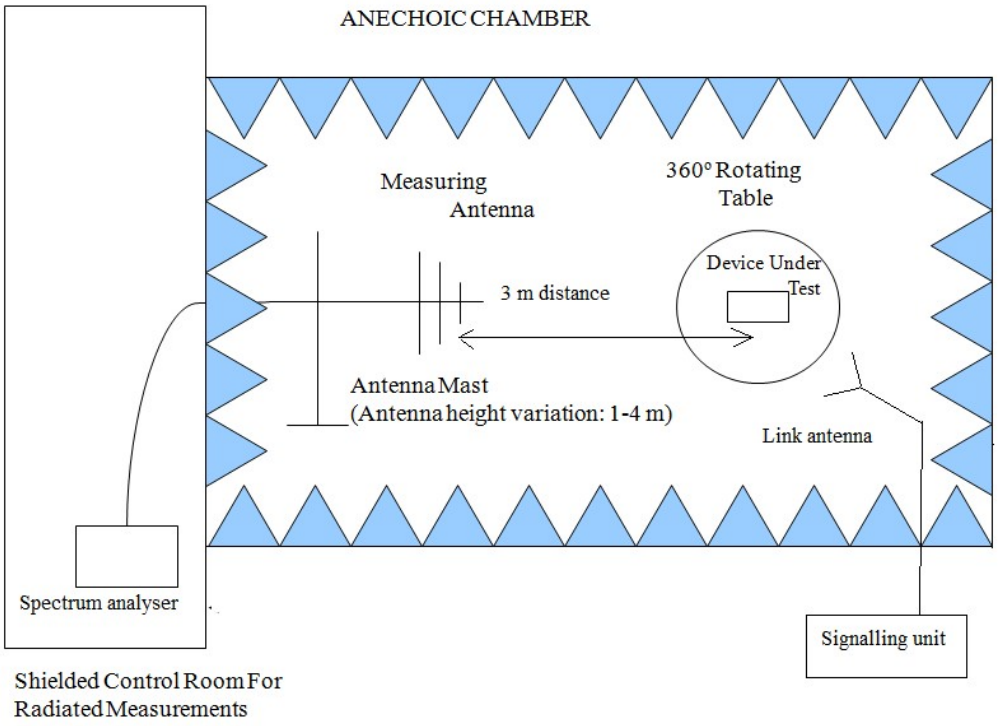
Po (dBm) – [43 + 10 log (Po in mwatts) - 30] = - 13 dBm

These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces that can transmit simultaneously.

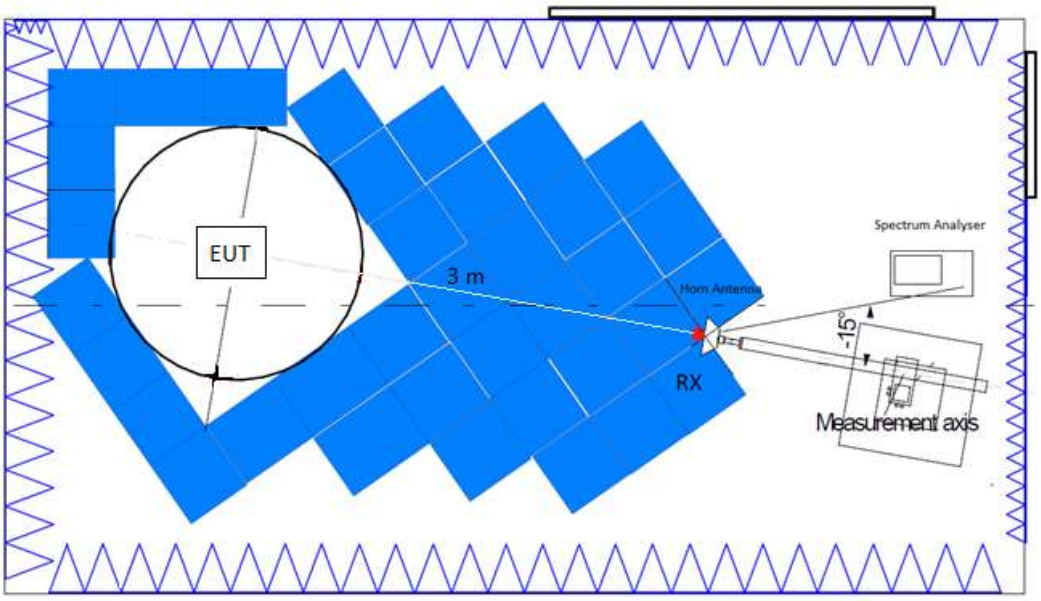
A resolution bandwidth / video bandwidth of 100 kHz / 300 kHz or higher were used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

TEST SETUP:

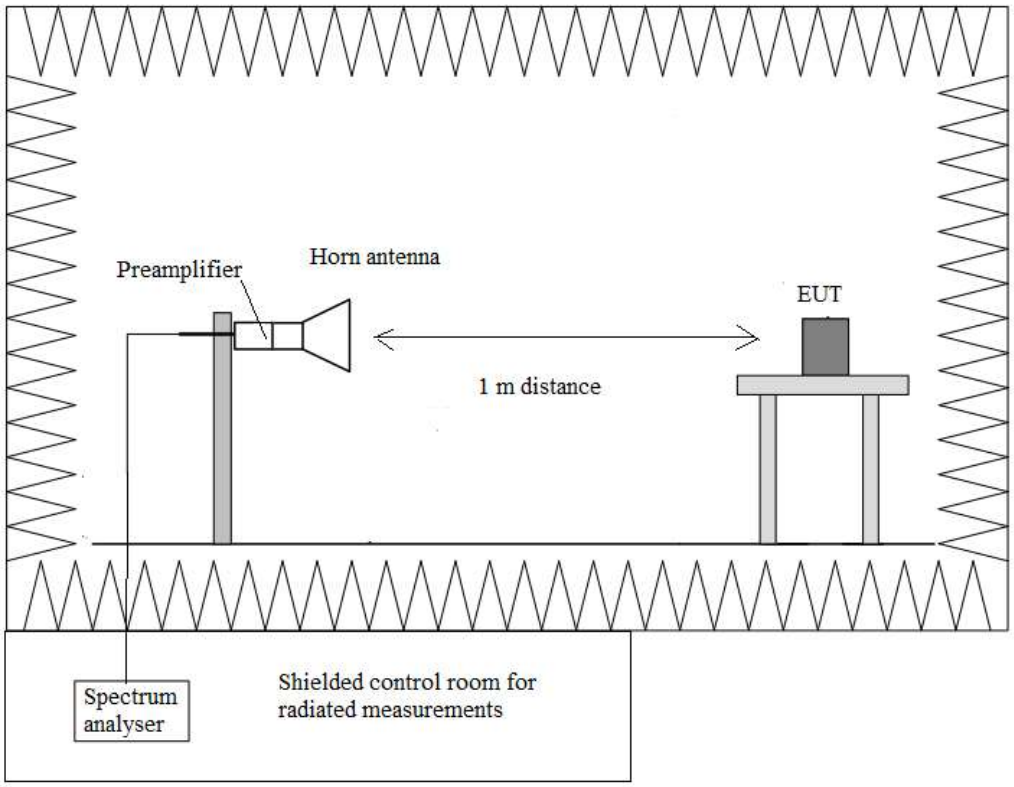
Radiated measurements below 1 GHz:



Radiated measurements setup from 1 GHz to 18 GHz:



Radiated measurements setup f > 18 GHz:



RESULTS:

- **Co-Location mode 2G PCS-1900, 3G Band II:**

MULTI-TRANSMITTER MODE 1: A preliminary scan determined the module NAD1, 2G Band PCS-1900, Middle Channel, EDGE modulation and the module NAD2, 3G Band II, Middle Channel, HSUPA modulation as the worst-case. The following results are the ones of the worst-case.

2G Band PCS-1900: Module NAD1. Channel (1880.2 MHz). EDGE.
3G Band II: Module NAD2. Adjacent channel to Middle Channel (1885 MHz). HSUPA.

LIMIT: The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBm)
30 MHz to 20 GHz	PK	43 + 10 log (P) dB = -13 dBm

MULTI-TRANSMITTER MODE 1:

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 20 GHz:

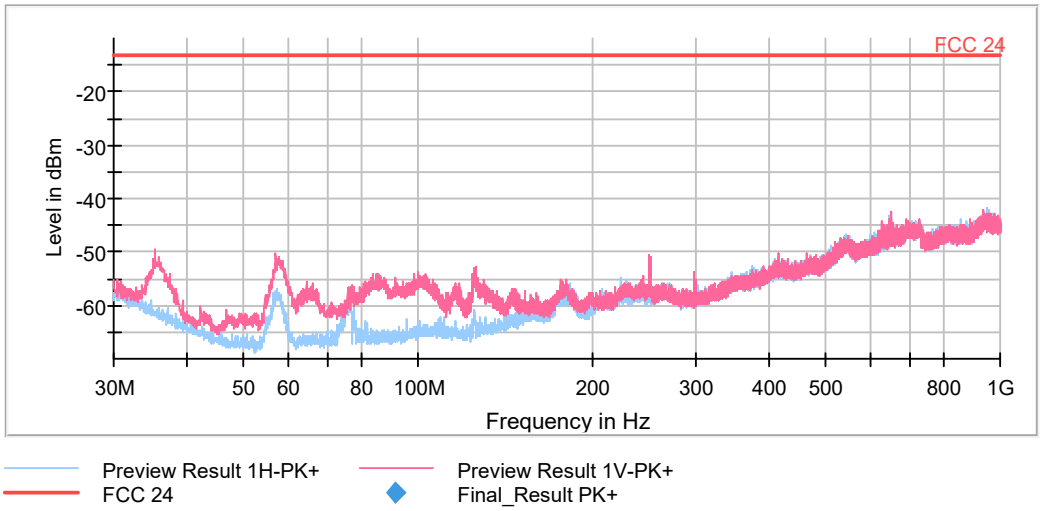
No spurious frequencies at less than 20 dB below the limit.

Measurement Uncertainty (dB)	<±5.08 for f < 1 GHz <±5.13 for f ≥ 1 GHz up to 17 GHz <±4.82 for f ≥ 17 GHz up to 20 GHz

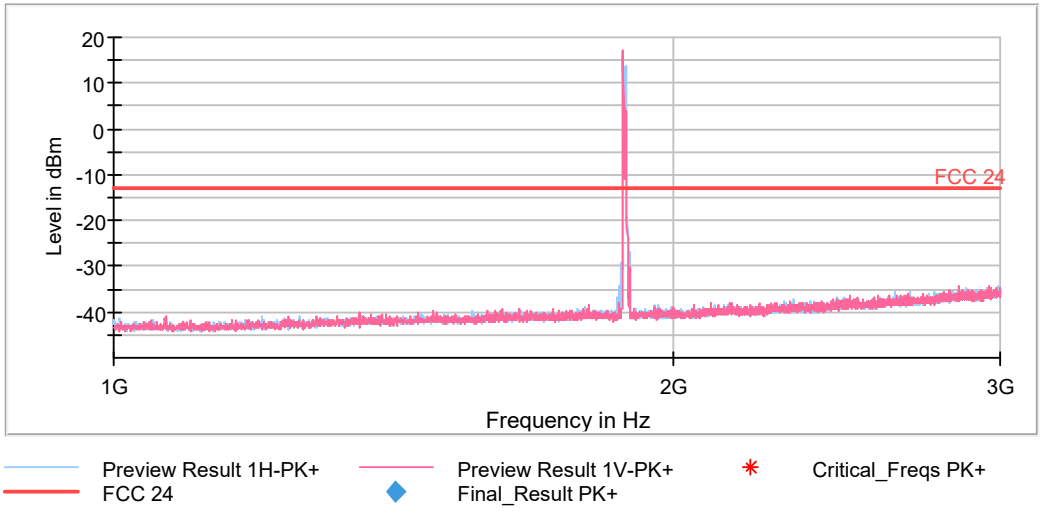
Verdict: PASS

MULTI-TRANSMITTER MODE 1:

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

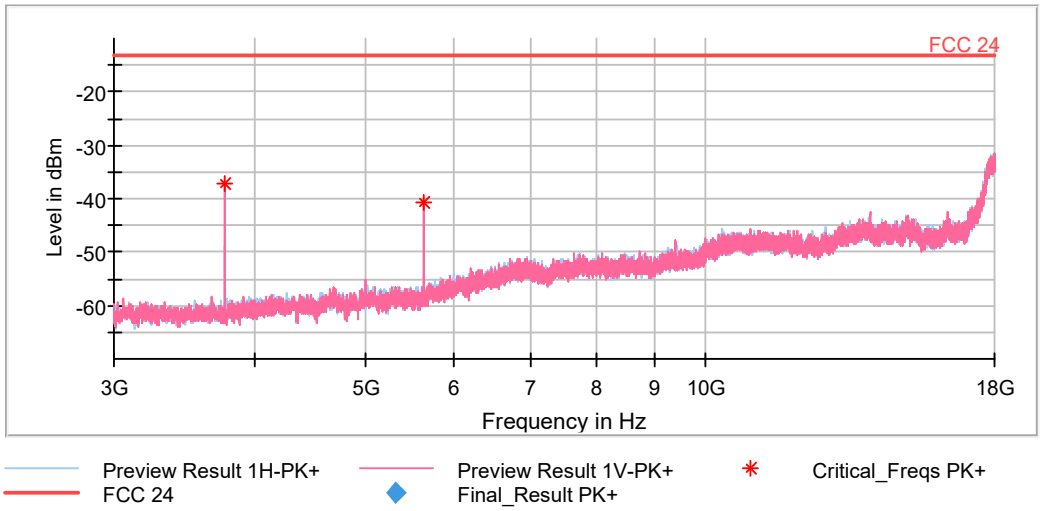


FREQUENCY RANGE 1 - 3 GHz (worst-case):

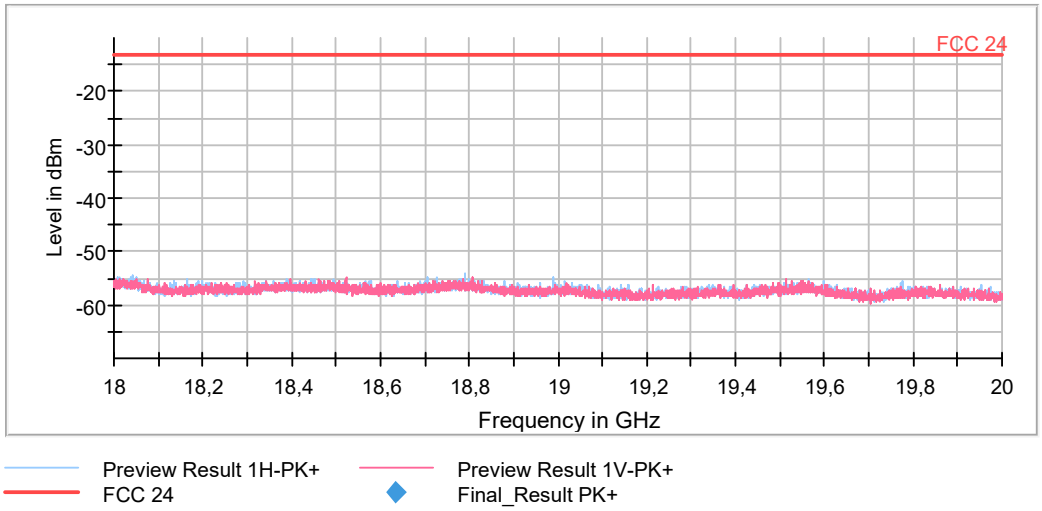


The peaks above the limit are the Carriers frequencies of the 2G Band PCS-1900 and the 3G Band II.

FREQUENCY RANGE 3 - 18 GHz (worst-case):



FREQUENCY RANGE 18 - 20 GHz (worst-case):



- **Co-Location mode 2G PCS-1900, LTE Band 25:**

MULTI-TRANSMITTER MODE 2: A preliminary scan determined the module NAD1, 2G Band PCS-1900, Middle Channel, EDGE modulation and the module NAD2, LTE Band 25, Middle Channel, QPSK modulation as the worst-case. The following results are the ones of the worst-case.

2G Band PCS-1900: Module NAD1. Channel (1880.2 MHz). EDGE.
LTE Band 25: Module NAD2. Adjacent channel to Middle Channel (1897.5 MHz). BW=15 MHz. QPSK. RB Size=1. RB Offset=0.

LIMIT: The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBm)
30 MHz to 20 GHz	PK	43 + 10 log (P) dB = -13 dBm

MULTI-TRANSMITTER MODE 2:

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 20 GHz:

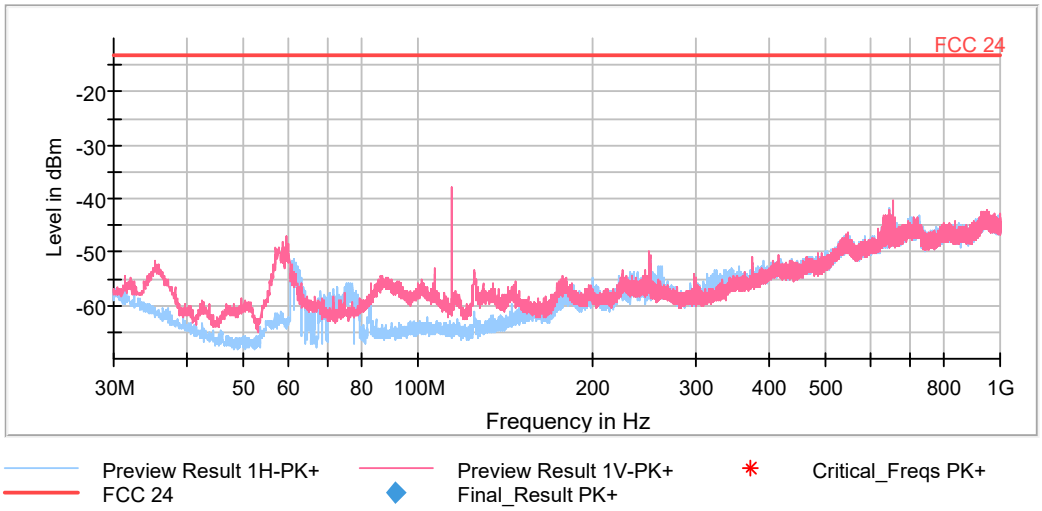
No spurious frequencies at less than 20 dB below the limit.

Measurement Uncertainty (dB)	<±5.08 for f < 1 GHz <±5.13 for f ≥ 1 GHz up to 17 GHz <±4.82 for f ≥ 17 GHz up to 20 GHz

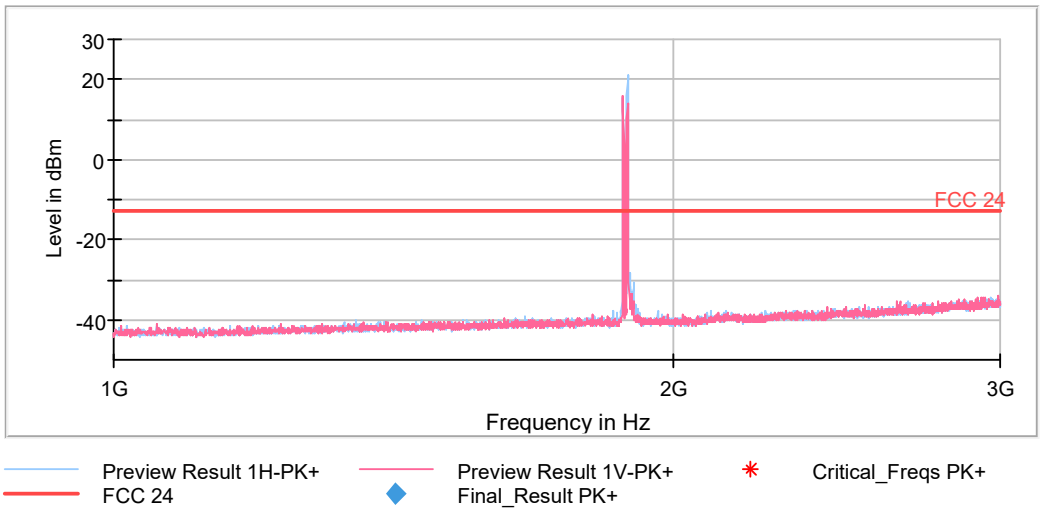
Verdict: PASS

MULTI-TRANSMITTER MODE 2:

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

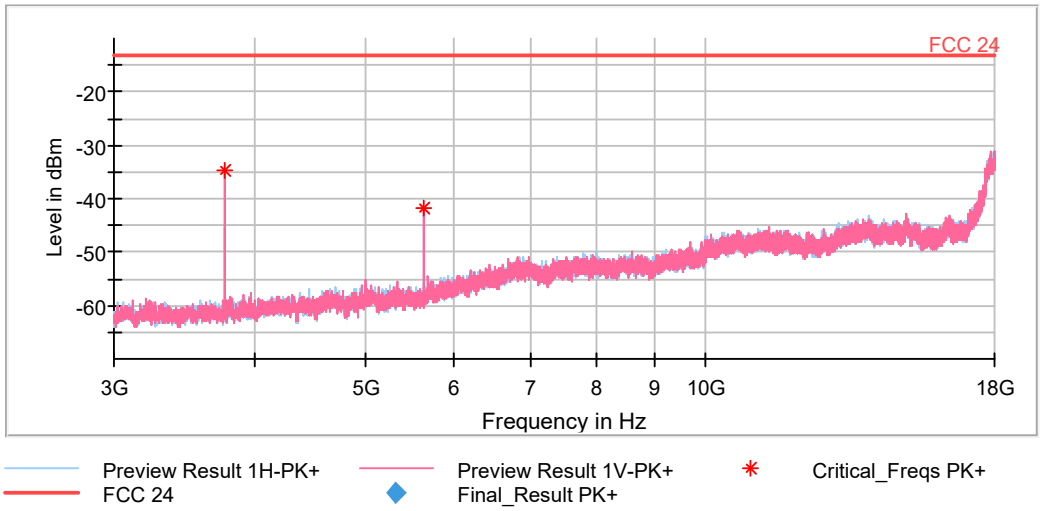


FREQUENCY RANGE 1 - 3 GHz (worst-case):

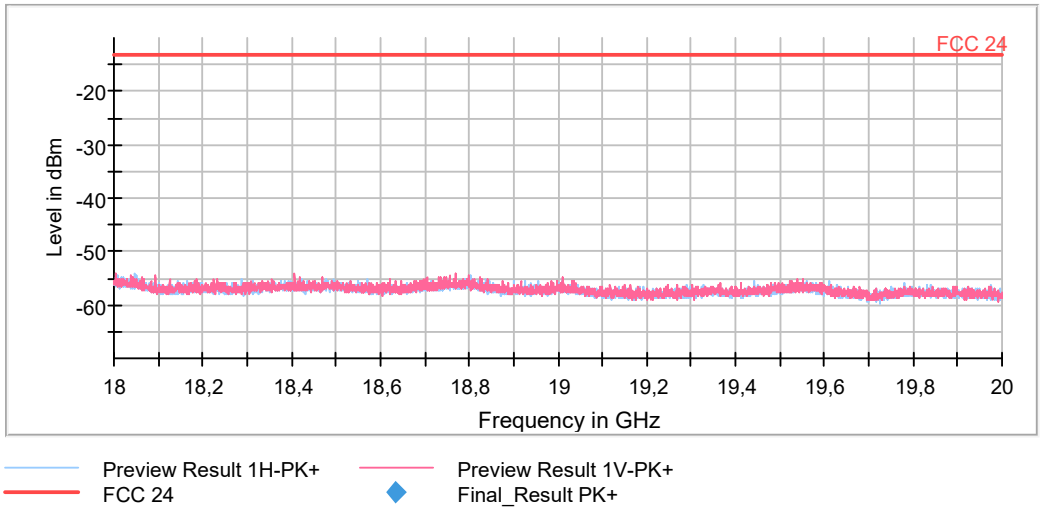


The peaks above the limit are the Carriers frequencies of the 2G Band PCS-1900 and LTE Band 25.

FREQUENCY RANGE 3 - 18 GHz (worst-case):



FREQUENCY RANGE 18 - 20 GHz (worst-case):



- **Co-Location mode 3G Band II, LTE Band 25:**

MULTI-TRANSMITTER MODE 3: A preliminary scan determined the module NAD1, 3G Band II, Middle Channel, HSUPA modulation and the module NAD2, LTE Band 25, Middle Channel, QPSK modulation as the worst-case. The following results are the ones of the worst-case.

3G Band II: Module NAD1. Middle Channel (1880 MHz). HSUPA.
LTE Band 25: Module NAD2. Adjacent channel to Middle Channel (1897.5 MHz). QPSK. BW=15 MHz. RB Size=1. RB Offset=0.

LIMIT: The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBm)
30 MHz to 20 GHz	PK	43 + 10 log (P) dB = -13 dBm

MULTI-TRANSMITTER MODE 3:

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 20 GHz:

Spurious frequencies at less than 20 dB below the limit:

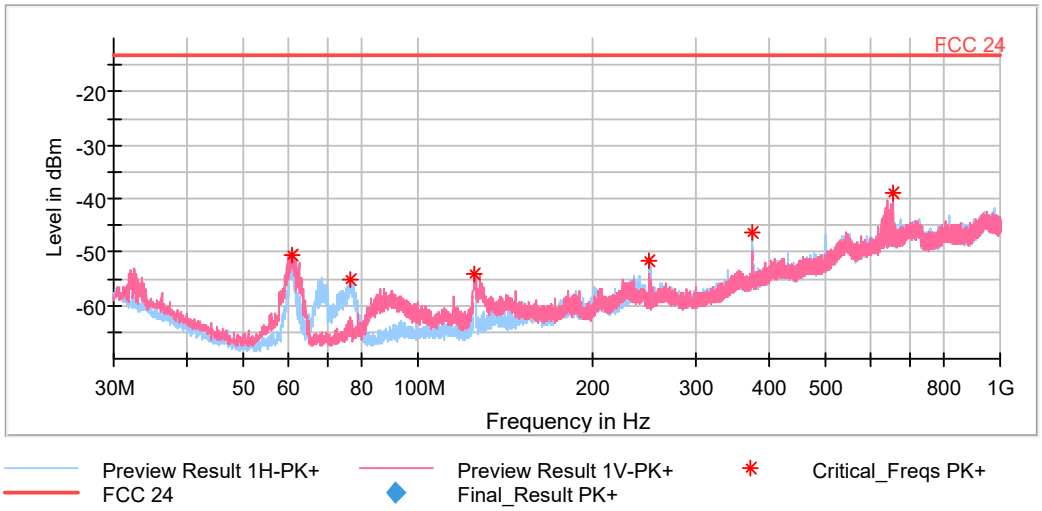
Spurious frequency (GHz)	E.I.R.P. (dBm)	Polarization	Detector
1844.000000	-28.64	V	Peak
1915.500000	-30.18	V	Peak

Measurement Uncertainty (dB) <±5.08 for f < 1 GHz
<±5.13 for f ≥ 1 GHz up to 17 GHz
<±4.82 for f ≥ 17 GHz up to 20 GHz

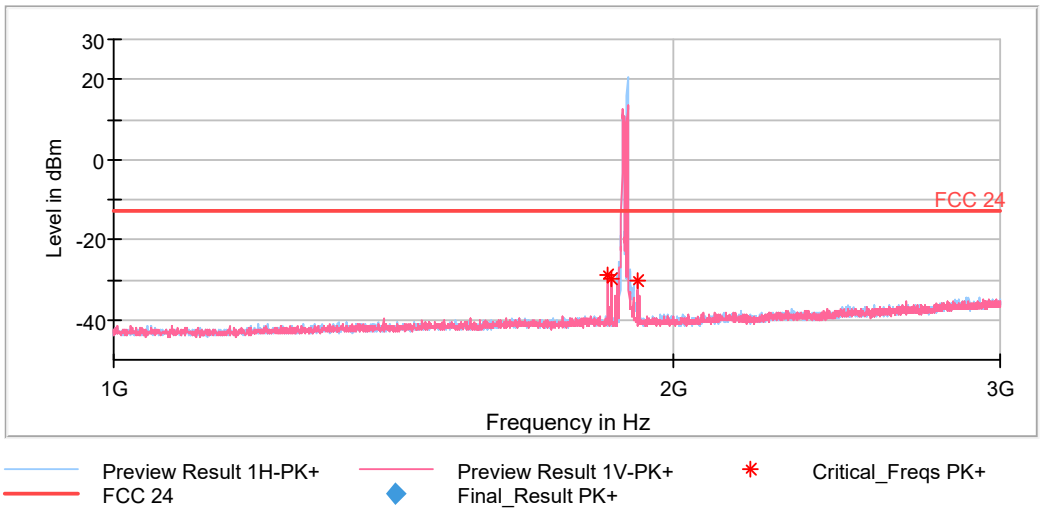
Verdict: PASS

MULTI-TRANSMITTER MODE 1:

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

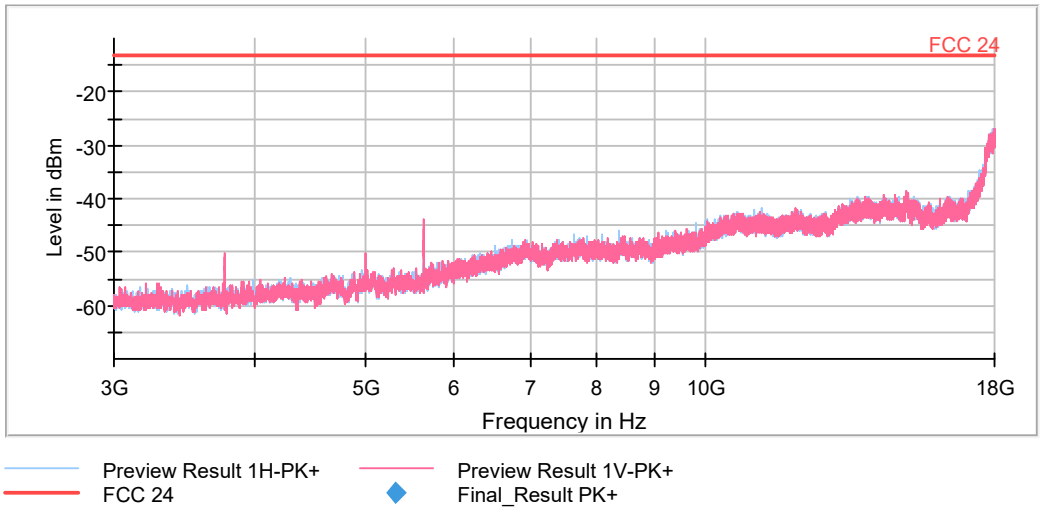


FREQUENCY RANGE 1 - 3 GHz (worst-case):



The peaks above the limit are the Carriers frequencies of the 3G Band II and LTE Band 25.

FREQUENCY RANGE 3 - 18 GHz (worst-case):



FREQUENCY RANGE 18 - 20 GHz (worst-case):