

Test report No:
NIE: 62486RRF.008

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, January 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  Firmado digitalmente por 74841983Y JOSE CARLOS LUQUE (C:A29507456) Fecha: 2021.02.02 13:21:48 +01'00'
Date of issue	2021-02-02
Report template No	FDT08_23 (*) "Data provided by the client"

Index

Competences and guarantees3

General conditions3

Uncertainty3

Data provided by the client.....3

Usage of samples4

Test sample description4

Identification of the client.....6

Testing period and place.....6

Document history6

Environmental conditions7

Remarks and comments7

Testing verdicts.....8

Summary8

Appendix A: Test results for FCC Part 22 / RSS-1329

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.

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 with appropriate scope of accreditation that include testing performed in this test report.

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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

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

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/264	Telematic Control Unit	WAVE-11-HIGH-R1	B393140L4902514	2020/09/30
62486E/014	Antenna (DA WAVE HIGH 5G US)	DA05DI20	--	2020/09/22
62486E/024	Antenna Box	AB01-I20-01	--	2020/09/22
62486E/025	Antenna Box	AB01-I20-01	--	2020/09/22
62486E/026	Antenna Box	AB01-I20-01	--	2020/09/22
62486E/027	Antenna Box	AB01-I20-01	--	2020/09/22
62486E/124	Harness 20 pol	--	--	2020/09/28
62486E/061	Harness 20 pol	--	--	2020/09/22

Auxiliary elements used with the Sample S/01:

Control N°	Description	Model	Serial N°	Date of reception
62486E/269	Battery Li-ion	11FR1580-2	--	2020/09/30
62486E/044	Antenna ground planes for roof	--	--	2020/09/22
62486E/048	RF Cable for 4-Fakra	--	--	2020/09/22
62486E/145	OABR Cable	--	--	2020/09/28
62486E/167	OABR 1000 BaseT Converter	--	--	2020/09/28
62486E/156	Cable OABR Adapter	--	--	2020/09/28
62486E/072	Ethernet Cable	--	--	2020/09/22
62486E/090	Speaker	FR7	--	2020/09/28
62486E/101	SOS Pulser (E-Call)	9385	11221	2020/09/28

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)	2021-01-18
Date (finish)	2021-01-21

Document history

Report number	Date	Description
62486RRF.008	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, Verónica García.

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	2019/11	2022/11
4. Biconical/Log Antenna 30 MHz - 6 GHz ETS LINDGREN 3142E	2020/04	2023/04
5. RF Preamplifier, 40 dB, 1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2020/05	2021/05
6. Spectrum Analyzer ROHDE AND SCHWARZ FSW50	2020/07	2022/07
7. EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
8. Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2020/04	2021/04
9. Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2020/07	2021/07
10. UXM 5G RF Test Platform KEYSIGHT TECHNOLOGIES E7515B	2020/01	2022/01
11. DC Power Supply, 30V/5A KEYSIGHT TECHNOLOGIES U8002A	---	---
12. Digital Multimeter FLUKE 175	2020/11	2021/11
13. High Pass Filter 3 - 18 GHz TEMSTRON / TEMWELL ST-3GA2833-HS	2020/05	2021/05

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 report 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

INDEX

TEST CONDITIONS11

Radiated emissions12

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 for Dual connectivity. And the other module has been tested using an adjacent channel to the 5G with LTE band with a setting that would allow communication in the same band to both modules simultaneously.

This report cover the worst case between DC_2A_n5A and DC_66A_n5A.

TEST FREQUENCIES:

E-UTRA New Radio Dual Connectivity & MIMO 2x2:

EN-DC configuration DC_2A_n5A + LTE Band 5. (antenna configuration 3):

Table 4.3.1.1.5-1: Test frequencies for NR operating band n5 and SCS 15 kHz

CBW [MHz]	carrier Bandw idth [PRBs]	Range		Carrier centre [MHz]	Carrier centre [ARFCN]	point A [MHz]	absolute Frequen cyPoint A [ARFCN]	offsetTo Carrier [Carrier PRBs]	SS block SCS [kHz]	GSCN	absolute Frequen cySSB [ARFCN]	K_{SSB}	Offset Carrier CORE SET#0 [RBs] Note 2	CORE SET#0 Index (Offset [RBs]) Note 1	offsetTo PointA (SIB1) [PRBs] Note 1
5	25	Downlink	Low	871.5	174300	869.25	173850	0	15	2178	174270	8	1	0 (0)	1
			Mid	881.5	176300	860.89	172178	102		2203	176210	0	0	0 (0)	102
			High	891.5	178300	798.53	159706	504		2228	178330	4	1	1 (2)	507
		Uplink	Low	826.5	165300	824.25	164850	0	-	-	-	-	-	-	-
			Mid	836.5	167300	743.53	148706	504		-	-	-	-	-	-
			High	846.5	169300	843.17	168634	6		-	-	-	-	-	-
10	52	Downlink	Low	874	174800	869.32	173864	0	15	2179	174290	10	1	0 (0)	1
			Mid	881.5	176300	858.46	171692	102		2197	175730	2	0	0 (0)	102
			High	889	177800	793.6	158720	504		2218	177410	2	1	2 (4)	509
		Uplink	Low	829	165800	824.32	164864	0	-	-	-	-	-	-	-
			Mid	836.5	167300	741.1	148220	504		-	-	-	-	-	-
			High	844	168800	838.24	167648	6		-	-	-	-	-	-
15	79	Downlink	Low	876.5	175300	869.39	173878	0	15	2177	174250	4	0	0 (0)	0
			Mid	881.5	176300	856.03	171206	102		2191	175250	4	0	0 (0)	102
			High	886.5	177300	788.67	157734	504		2205	176430	4	1	2 (4)	509
		Uplink	Low	831.5	166300	824.39	164878	0	-	-	-	-	-	-	-
			Mid	836.5	167300	738.67	147734	504		-	-	-	-	-	-
			High	841.5	168300	833.31	166662	6		-	-	-	-	-	-
20	106	Downlink	Low	879	175800	869.46	173892	0	15	2178	174270	6	0	0 (0)	0
			Mid	881.5	176300	853.6	170720	102		2185	174770	6	0	0 (0)	102
			High	884	176800	783.74	156748	504		2192	175450	6	1	2 (4)	509
		Uplink	Low	834	166800	824.46	164892	0	-	-	-	-	-	-	-
			Mid	836.5	167300	736.24	147248	504		-	-	-	-	-	-
			High	839	167800	828.38	165676	6		-	-	-	-	-	-
Note 1: The CORESET#0 Index and the associated CORESET#0 Offset refers to Table 13-1 in TS 38.213 [22]. The value of CORESET#0 Index is signalled in controlResourceSetZero (pdcch-ConfigSIB1) in the MIB. The offsetToPointA IE is expressed in units of resource blocks assuming 15 kHz subcarrier spacing for FR1 and 60 kHz subcarrier spacing for FR2.															
Note 2: The parameter Offset Carrier CORESET#0 specifies the offset from the lowest subcarrier of the carrier and the lowest subcarrier of CORESET#0. It corresponds to the parameter $\Delta F_{\text{OffsetCORESET-0-Carrier}}$ in Annex C expressed in number of common RBs.															

Module NAD2								Module NAD1			
DC 2A_n5A								LTE Band 5			
Inter-band. Test frequencies for DC 2A_n5A.											
Inter-band DC with a LTE Carrier in Band 2 and a 5G Carrier in Band n5.											
Channel	2A			n5A				Channel	BW (MHz)	Freq. (MHz)	EARFCN
	BW (MHz)	Freq. (MHz)	EARFCN	SCS (kHz)	BW (MHz)	Freq. (MHz)	EARFCN				
Low	20	1860	18700	15	20	834	166800	Adjacent channel to Low	5	846.5	20625
Middle	20	1880	18900	15	20	836.5	167300	Adjacent channel to Middle	1.4	848	20640
High	20	1900	19100	15	20	839	167800	Adjacent channel to High	5	826.5	26815

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:

$EIRP (dBm) = E (dB\mu V/m) + 20 \log(D) - 104.8$; 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.

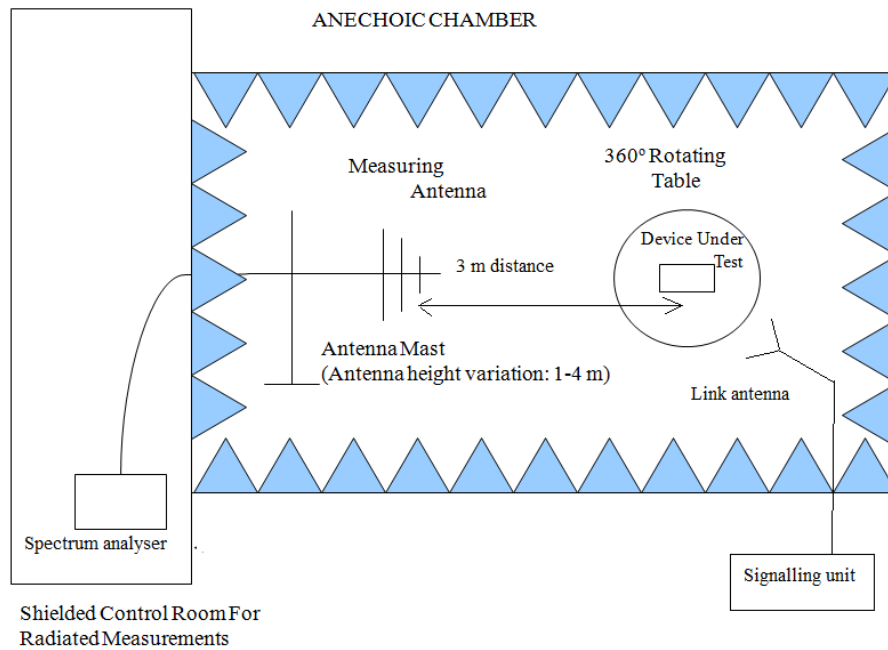
At P_o transmitting power. the specified minimum attenuation becomes $43+10\log (P_o)$. and the level in dBm relative P_o becomes:

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

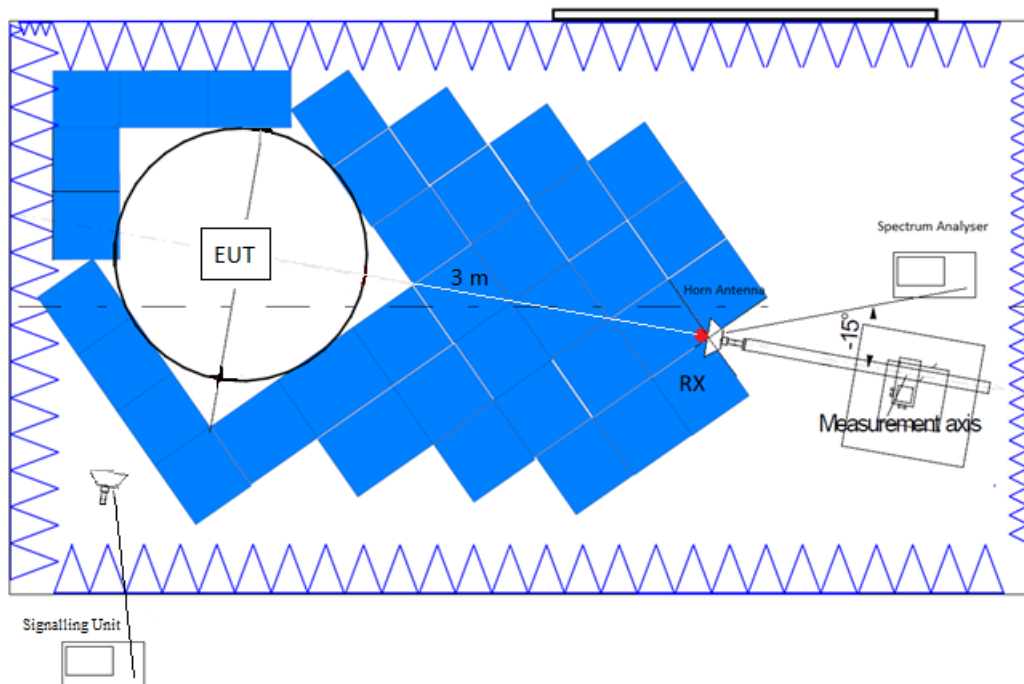
A resolution bandwidth / video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

TEST SETUP:

Radiated measurements below 1 GHz:



Radiated measurements above 1 GHz up to 8.5 GHz:



RESULTS:

• DC_2A_n5A + LTE Band 5:

A preliminary scan determined the worst case:

1) DC_2A_n5A (Module NAD2):

2A: QPSK, BW=20 MHz, RB=1, Offset=0.

n5A: Pi/2 BPSK, BW=20 MHz, SCS=15 kHz, RB=1, Offset=53.

2) LTE Band 5 (Module NAD1):

5: QPSK, BW=5 MHz (for Low and High Channels), BW=1.4 MHz (for Middle Channel), RB=1, Offset=0.

The following results are the ones of the worst case.

- LOW CHANNEL:

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.

- MIDDLE CHANNEL:

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.

- HIGH CHANNEL:

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 8.5 GHz:

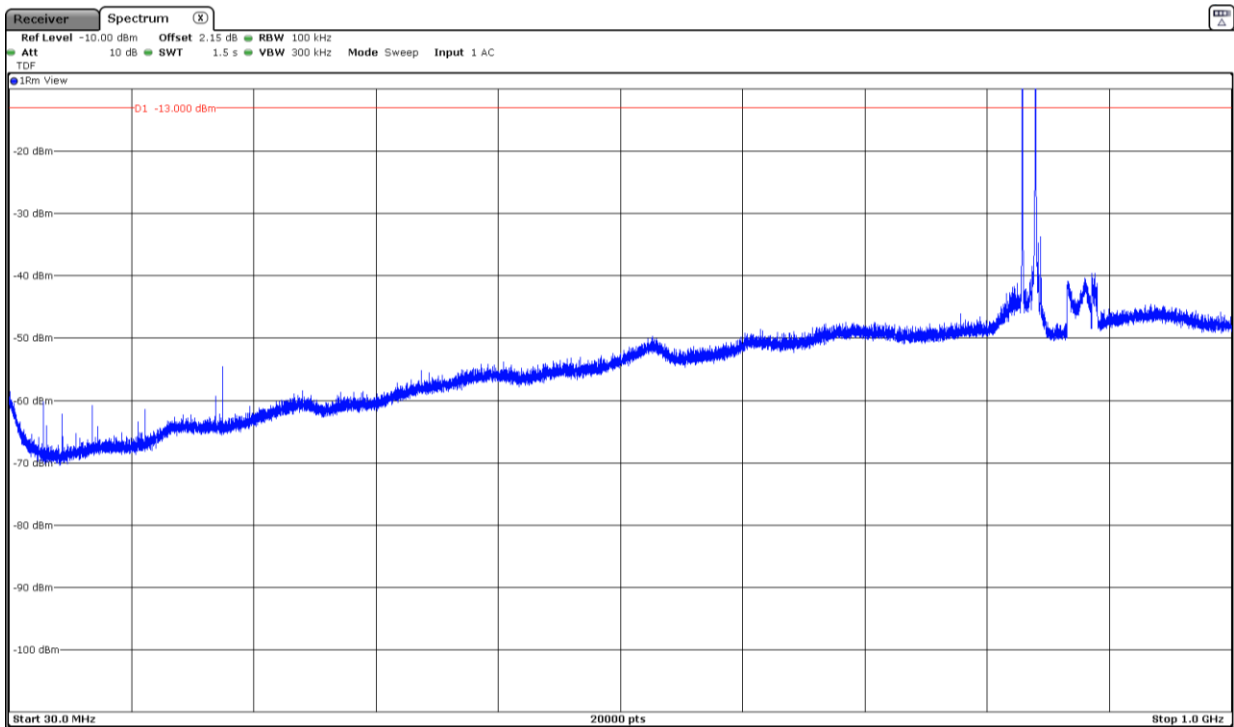
No spurious frequencies at less than 20 dB below the limit.

Measurement Uncertainty (dB): $\leq \pm 4.99$ for $f \geq 30$ MHz up to 1 GHz
 $\leq \pm 4.98$ for $f \geq 1$ GHz up to 8.5 GHz

Verdict: PASS

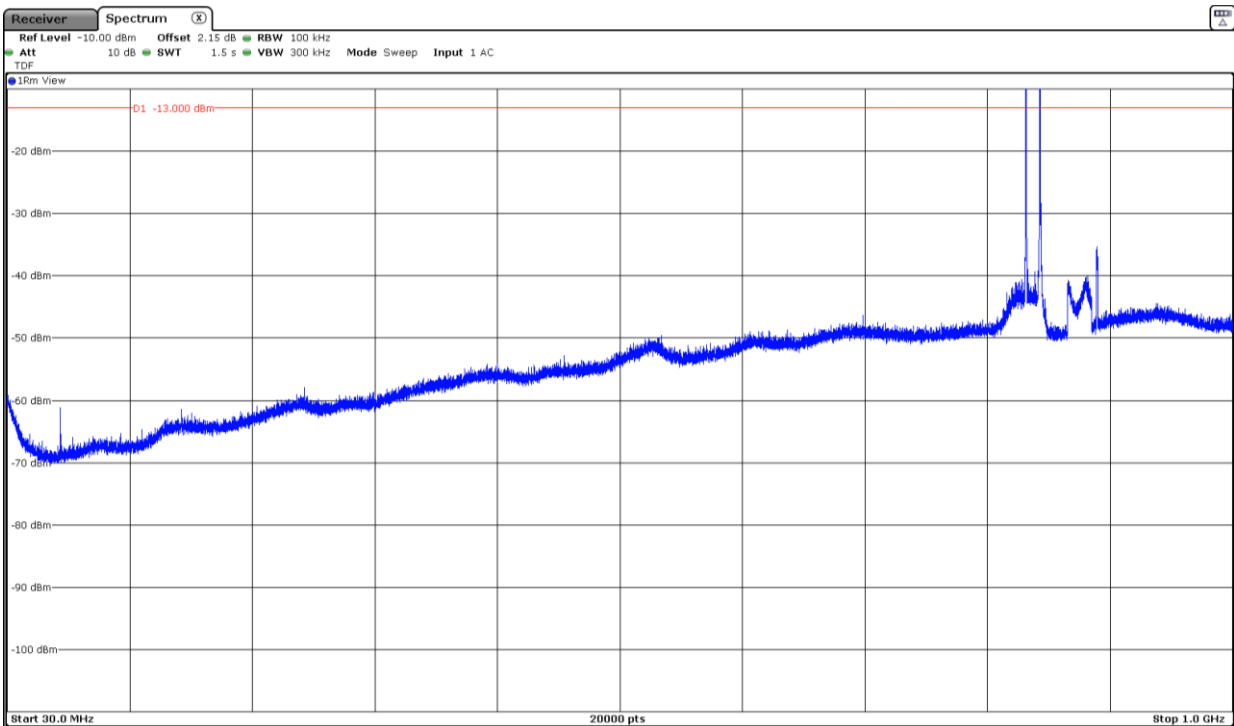
FREQUENCY RANGE 30 MHz - 1 GHz (worst case):

- Low Channel:



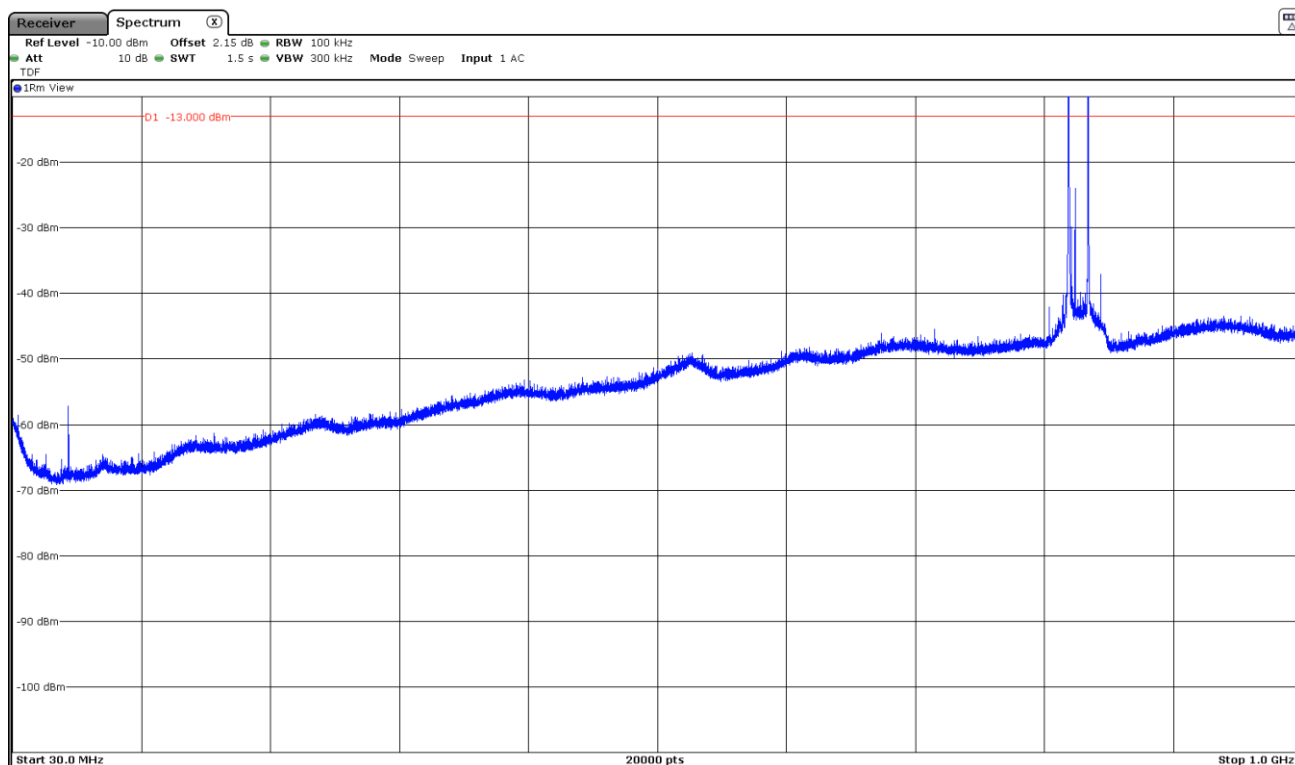
The peaks above the limit are the carrier frequencies.

- Middle Channel:



The peaks above the limit are the carrier frequencies.

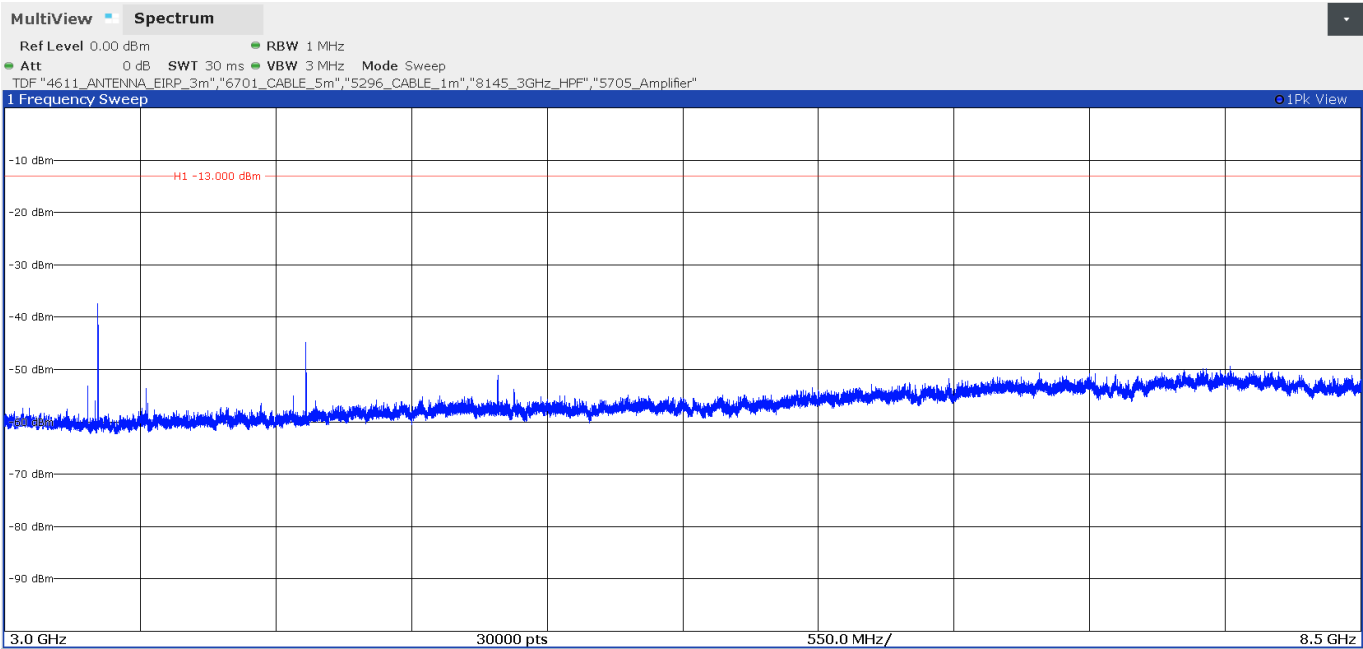
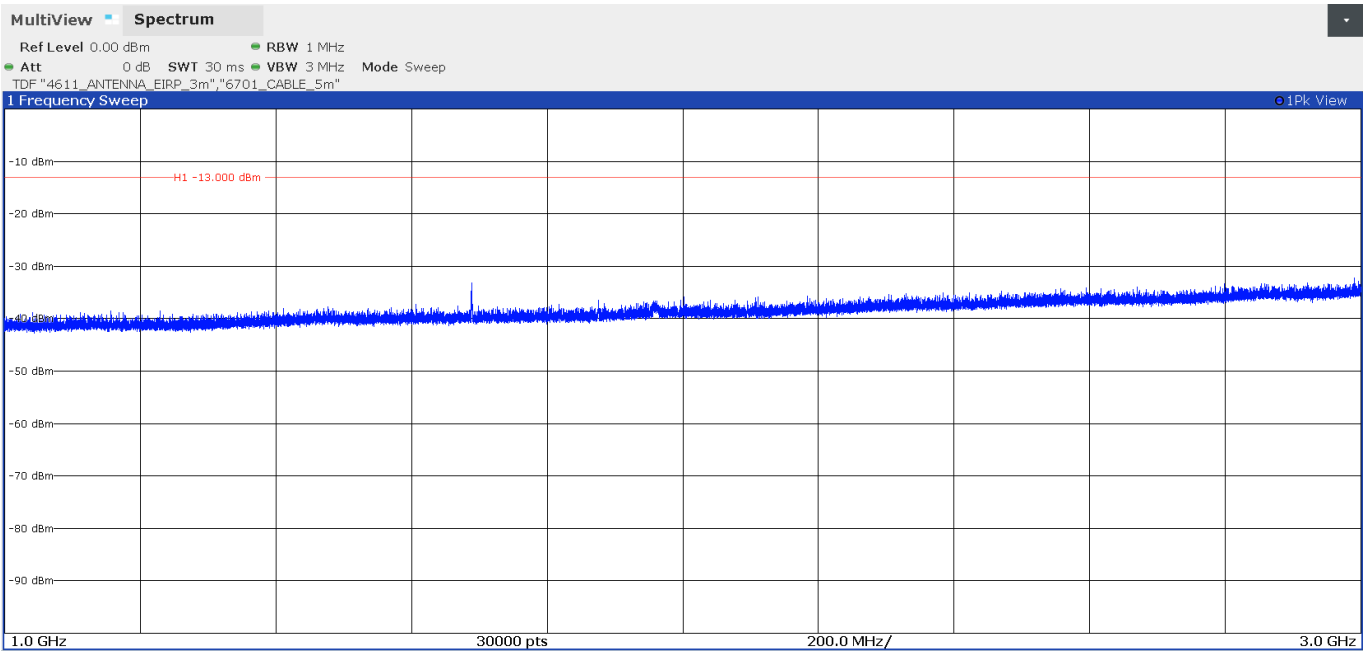
- High Channel:



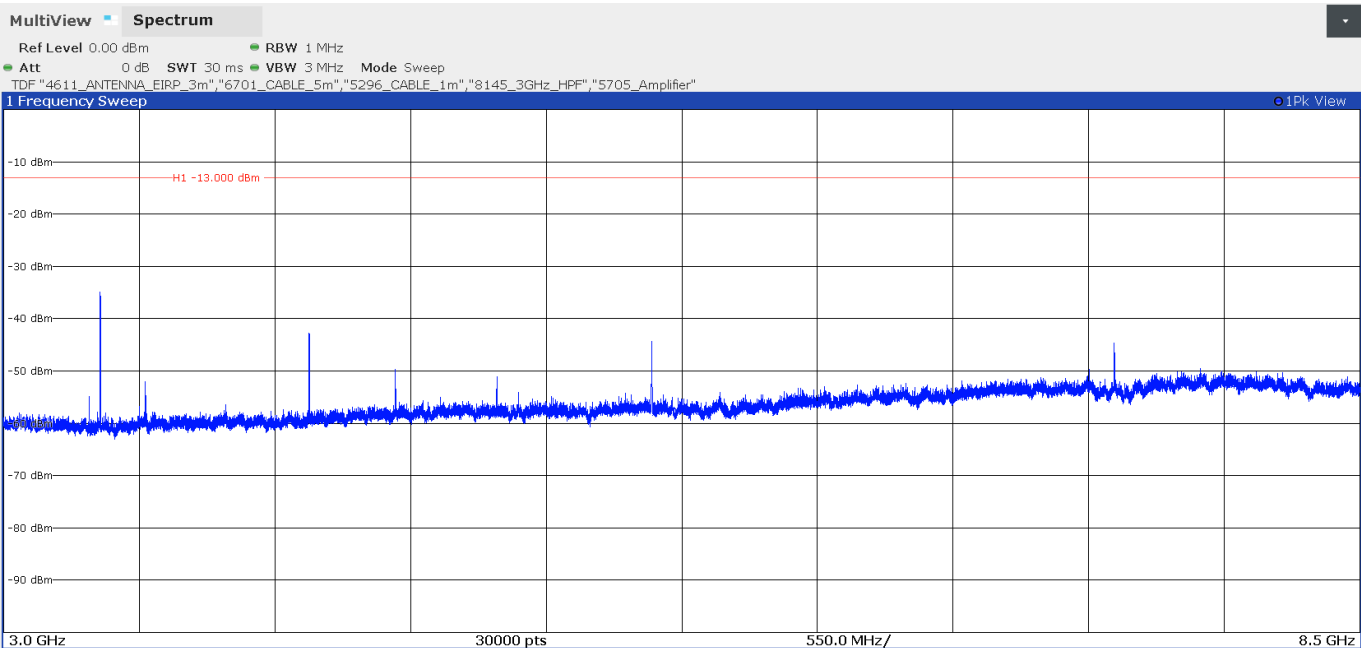
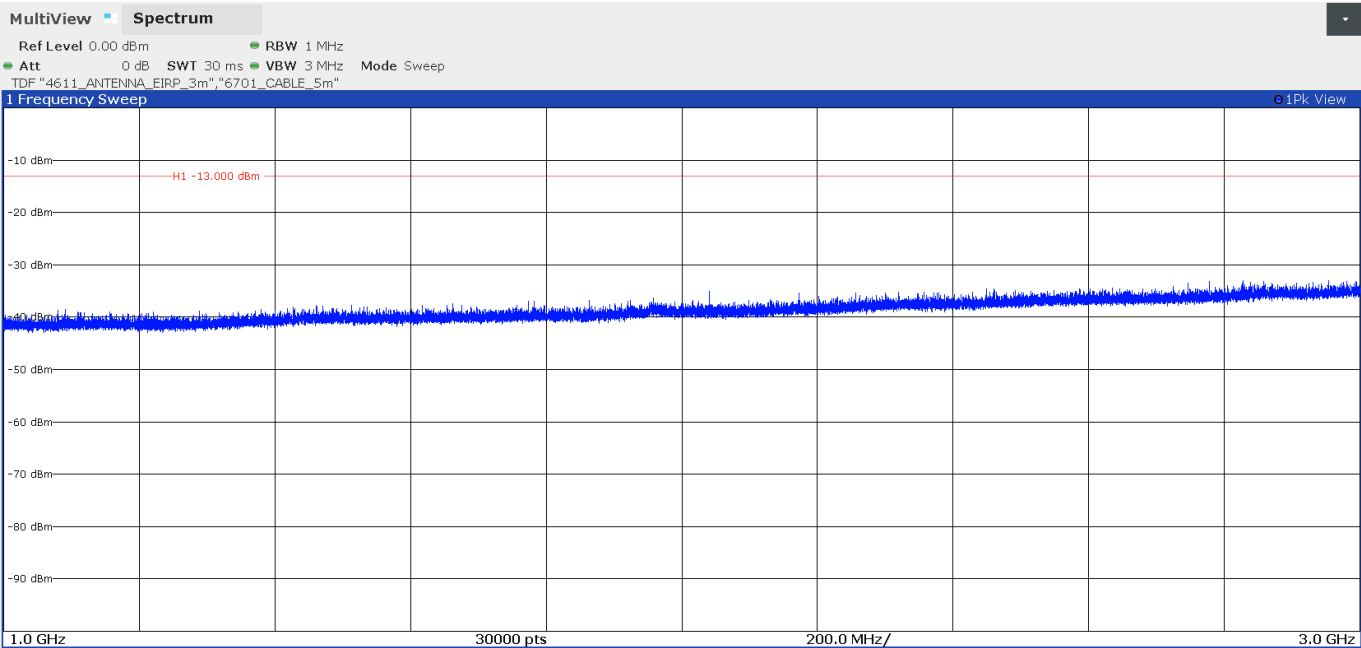
The peaks above the limit are the carrier frequencies.

FREQUENCY RANGE 1 - 8.5 GHz (worst case):

- Low Channel:



- Middle Channel:



- High Channel:

