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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.

DEKRA Testing and Certification is a FCC-recognized accredited testing laboratory with appropriate scope of accreditation that covers the performed tests in this 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

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.
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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 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 ⁽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)	2021-09-27
Date (finish)	2021-10-05

Document history

Report number	Date	Description
68001RRF.004	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: Alfonso Gutiérrez, Miguel Manuel López, Javier Miguel Nadales.

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.	Horn Antenna 18-40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2020/05	2023/05
6.	RF Preamplifier G>30dB, 1-18GHz BONN ELEKTRONIK BLMA 0118-3A	2020/10	2021/10
7.	Pre-Amplifier G>30dB 17-40GHz BONN ELEKTRONIK BLMA 1840-4A	2021/09	2022/09
8.	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2019/10	2021/10
9.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
10.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2020/07	2021/07
11.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2020/12	2022/12
12.	Attenuator 3 dB 2W, DC-6GHz, JFW 50HN-03	2020/10	2021/10
13.	RF Preamplifier 40 dB, 10 MHz - 6 GHz BONN ELEKTRONIK BLNA 0160-01N	2021/03	2022/03

Testing verdicts

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

Summary

FCC PART 27 / RSS-130, RSS-139, RSS-199 PARAGRAPH		
Requirement – Test case	Verdict	Remark
FCC 27.50 / RSS-130 4.6., RSS-139 6.5., RSS-199 4.4.: RF output power	N/M	(1)
FCC 2.1047 / RSS-130 4.2., RSS-139 6.2., RSS-199 4.1.: Modulation characteristics	N/M	(1)
FCC 27.54 / RSS-130 4.3., RSS-139 6.4., RSS-199 4.3.: Frequency stability	N/M	(1)
FCC 2.1049 / RSS-Gen 6.7., RSS-139 6.4., RSS-199 4.3.: Occupied Bandwidth	N/M	(1)
FCC 27.53 / RSS-130 4.7., RSS-139 6.6., RSS-199 4.5.: Spurious emissions at antenna terminals	N/M	(1)
FCC 27.53 / RSS-130 4.7., RSS-139 6.6., RSS-199 4.5.: Radiated emissions	P	
Supplementary information and remarks:		
(1) Test not requested.		

Appendix A: Test results for FCC Part 27 / RSS-130, RSS-139, RSS-199

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TEST CONDITIONS

The module with the highest antenna gain has been tested using the worst-case obtained for conducted output power. 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.

(*): Data provided by the Applicant.

POWER SUPPLY (*):

Vnominal: 12 Vdc
Type of Power Supply: External DC (Vehicle Battery).

TEST FREQUENCIES (*):

3G Band IV. WCDMA and HSUPA modulations. MIMO 2x2:

Module NAD1		Module NAD2	
Low Channel (1312)	1712.4 MHz	Adjacent channel to Low Channel (1337)	1717.4 MHz
Middle Channel (1762)	1732.5 MHz	Adjacent channel to Middle Channel (1787)	1737.5 MHz
High Channel (1513)	1752.6 MHz	Adjacent channel to High Channel (1488)	1747.6 MHz

Note: Tested channels due to the characteristics of the simultaneous transmission of both modules.

LTE Band 4. QPSK and QAM modulations. MIMO 2x2:

	Channel (Frequency)					
	BW = 1.4 MHz	BW = 3 MHz	BW = 5 MHz	BW = 10 MHz	BW = 15 MHz	BW = 20 MHz
Low	19957 (1710.7 MHz)	19965 (1711.5 MHz)	19975 (1712.5 MHz)	20000 (1715.0 MHz)	20025 (1717.5 MHz)	20050 (1720.0 MHz)
Middle	20175 (1732.5 MHz)	20175 (1732.5 MHz)	20175 (1732.5 MHz)	20175 (1732.5 MHz)	20175 (1732.5 MHz)	20175 (1732.5 MHz)
High	20393 (1754.3 MHz)	20385 (1753.5 MHz)	20375 (1752.5 MHz)	20350 (1750.0 MHz)	20325 (1747.5 MHz)	20300 (1745.0 MHz)

NOTE: This band is completely included in the LTE Band 66, so the channels of the LTE Band 66 were tested to give conformity to the assigned block.

LTE Band 7. QPSK and QAM modulations. MIMO 2x2:

Channel (Frequency)				
	BW = 5 MHz	BW = 10 MHz	BW = 15 MHz	BW = 20 MHz
Low	20775 (2502.5 MHz)	20800 (2505.0 MHz)	20825 (2507.5 MHz)	20850 (2510.0 MHz)
Middle	21100 (2535.0 MHz)	21100 (2535.0 MHz)	21100 (2535.0 MHz)	21100 (2535.0 MHz)
High	21425 (2567.5 MHz)	21400 (2565.0 MHz)	21375 (2562.5 MHz)	21350 (2560.0 MHz)

Note: Common used channels.

Module NAD1		Module NAD2	
Low Channel (20800)	2505 MHz	Adjacent channel to Low Channel (20950)	2520 MHz
Middle Channel (21100)	2535 MHz	Adjacent channel to Middle Channel (21250)	2550 MHz
High Channel (21400)	2565 MHz	Adjacent channel to High Channel (21250)	2550 MHz

Note: Tested channels due to the characteristics of the simultaneous transmission of both modules.

LTE Band 12. QPSK and QAM modulations. MIMO 2x2:

Channel (Frequency)				
	BW = 1.4 MHz	BW = 3 MHz	BW = 5 MHz	BW = 10 MHz
Low	23017 (699.7 MHz)	23025 (700.5 MHz)	23035 (701.5 MHz)	23060 (704.0 MHz)
Middle	23095 (707.5 MHz)	23095 (707.5 MHz)	23095 (707.5 MHz)	23095 (707.5 MHz)
High	23173 (715.3 MHz)	23165 (714.5 MHz)	23155 (713.5 MHz)	23130 (711.0 MHz)

Note: Common used channels.

Module NAD1 (BW=3MHz)		Module NAD2(BW=10MHz)	
Low Channel (23030)	701 MHz	Middle channel (23095)	707.5 MHz
No combination without overlapping the carriers with BW=10MHz and BW=3MHz.			
High Channel (23160)	714 MHz	Middle channel (23095)	707.5 MHz

Note: Tested channels due to the characteristics of the simultaneous transmission of both modules.

LTE Band 13. QPSK and QAM modulations. MIMO 2x2:

	Channel (Frequency)	
	BW = 5 MHz	BW = 10 MHz
Low	23205 (779.5 MHz)	N/A
Middle	23230 (782.0 MHz)	23230 (782.0 MHz)
High	23255 (784.5 MHz)	N/A

Note: Common used channels.

Module NAD1		Module NAD2	
Low Channel (23205)	779.5 MHz	Adjacent channel to Low Channel (23255)	784.5 MHz
No combination without overlapping the carriers.			
High Channel (23255)	784.5 MHz	Adjacent channel to High Channel (23205)	779.5 MHz

Note: Tested channels due to the characteristics of the simultaneous transmission of both modules.

LTE Band 17. QPSK and QAM modulations. MIMO 2x2:

	Channel (Frequency)	
	BW = 5 MHz	BW = 10 MHz
Low	23755 (706.5 MHz)	23780 (709 MHz)
Middle	23790 (710 MHz)	23790 (710 MHz)
High	23825 (713.5 MHz)	23800 (711 MHz)

NOTE: This band is completely included in the LTE Band 12, so the channels of the LTE Band 12 were tested to give conformity to the assigned block.

LTE Band 29. NOTE: Downlink only.

LTE Band 30. NOTE: Downlink only.

LTE Band 41. QPSK and QAM modulations. MIMO 2x2 (configuration 3):

	Channel (Frequency)			
	BW = 5 MHz	BW = 10 MHz	BW = 15 MHz	BW = 20 MHz
Low	39675 (2498.50 MHz)	39700 (2501.00 MHz)	39725 (2503.50 MHz)	39750 (2506.00 MHz)
Middle	40620 (2593.00 MHz)	40620 (2593.00 MHz)	40620 (2593.00 MHz)	40620 (2593.00 MHz)
High	41565 (2687.50 MHz)	41540 (2685.00 MHz)	41515 (2682.50 MHz)	41490 (2680.00 MHz)

Note: Common used channels.

Module NAD1		Module NAD2	
Low Channel (39750)	2506 MHz	Adjacent channel to Low Channel (39950)	2526 MHz
Middle Channel (40620)	2593 MHz	Adjacent channel to Middle Channel (40820)	2613 MHz
High Channel (41490)	2680 MHz	Adjacent channel to High Channel (41290)	2660 MHz

Note: Tested channels due to the characteristics of the simultaneous transmission of both modules.

LTE Band 66. QPSK and QAM modulations. MIMO 2x2 (configuration 3):

	Channel (Frequency)					
	BW = 1.4 MHz	BW = 3 MHz	BW = 5 MHz	BW = 10 MHz	BW = 15 MHz	BW = 20 MHz
Low	131979 (1710.7 MHz)	131987 (1711.5 MHz)	131997 (1712.5 MHz)	132022 (1715.0 MHz)	132047 (1717.5 MHz)	132072 (1720.0 MHz)
Middle	132322 (1745.0 MHz)	132322 (1745.0 MHz)	132322 (1745.0 MHz)	132322 (1745.0 MHz)	132322 (1745.0 MHz)	132322 (1745.0 MHz)
High	132665 (1779.3 MHz)	132657 (1778.5 MHz)	132647 (1777.5 MHz)	132622 (1775.0 MHz)	132597 (1772.5 MHz)	132572 (1770.0 MHz)

Module NAD1		Module NAD2	
Low Channel (131987)	1711.5 MHz	Adjacent channel to Low Channel (132017)	1714.5 MHz
Middle Channel (132322)	1745 MHz	Adjacent channel to Middle Channel (132352)	1748 MHz
High Channel (132657)	1778.5 MHz	Adjacent channel to High Channel (132627)	1775.5 MHz

Note: Tested channels due to the characteristics of the simultaneous transmission of both modules.

LTE Band 71. QPSK and 16QAM modulations. MIMO 2x2 (configuration 3):

Channel (Frequency)				
	BW = 5 MHz	BW = 10 MHz	BW = 15 MHz	BW = 20 MHz
Low	133147 (665.50 MHz)	133172 (668.00 MHz)	133197 (670.50 MHz)	133222 (673.00 MHz)
Middle	133297 (680.50 MHz)	133297 (680.50 MHz)	133297 (680.50 MHz)	133297 (680.50 MHz)
High	133447 (695.50 MHz)	133422 (693.00 MHz)	133397 (690.50 MHz)	133372 (688.00 MHz)

Note: Common used channels.

Module NAD1		Module NAD2	
Low Channel (133197)	670.5 MHz	Adjacent channel to Low Channel (133322)	683 MHz
Middle Channel (133297)	680.5 MHz	Adjacent channel to Middle Channel (133422)	693 MHz
High Channel (133397)	690.5 MHz	Adjacent channel to High Channel (133271)	677.9 MHz

Note: Tested channels due to the characteristics of the simultaneous transmission of both modules.

Radiated Emissions

SPECIFICATION:

1. 3G Band IV and LTE Band 66. FCC §2.1053 & §27.53 (h) / RSS-139 Issue 3 Clause 6.6.

FCC §27.53 (h):

(h) Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 MHz, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10} (P)$ dB.

RSS-139 Issue 3 Clause 6.6:

i. In the first 1.0 MHz bands immediately outside and adjacent to the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power per any 1% of the emission bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least $43 + 10 \log_{10} p$ (watts) dB.

ii. After the first 1.0 MHz outside the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power in any 1 MHz bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least $43 + 10 \log_{10} P$ (watts) dB.

2. LTE Band 7 and LTE Band 41. FCC §2.1053 & §27.53 (m) (4) / RSS-199 Issue 3 Clause 4.5 (b).

FCC §27.53 (m) (4):

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(4) For mobile digital stations, the attenuation factor shall be not less than $40 + 10 \log (P)$ dB on all frequencies between the channel edge and 5 megahertz from the channel edge, $43 + 10 \log (P)$ dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and $55 + 10 \log (P)$ dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less than $43 + 10 \log (P)$ dB on all frequencies between 2490.5 MHz and 2496 MHz and $55 + 10 \log (P)$ dB at or below 2490.5 MHz. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

RSS-199 Issue 3 Clause 4.5 (b):

4.5. In the 1 MHz band immediately outside and adjacent to the channel edge, the unwanted emission power shall be measured with a resolution bandwidth of at least 1% of the occupied bandwidth for base station and fixed subscriber equipment, and 2% for mobile subscriber equipment. Beyond the 1 MHz band, a resolution bandwidth of 1 MHz shall be used. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz, or 1% or 2% of the occupied bandwidth, as applicable.

Equipment shall comply with the following unwanted emission limits:

(b) for mobile subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least:

- i. $40 + 10 \log_{10} p$ from the channel edges to 5 MHz away
- ii. $43 + 10 \log_{10} p$ between 5 MHz and X MHz from the channel edges, and
- iii. $55 + 10 \log_{10} p$ at X MHz and beyond from the channel edges

In addition, the attenuation shall not be less than $43 + 10 \log_{10} p$ on all frequencies between 2490.5 MHz and 2496 MHz, and $55 + 10 \log_{10} p$ at or below 2490.5 MHz.

In (b), p is the transmitter power measured in watts and X is 6 MHz or the equipment occupied bandwidth, whichever is greater.

LTE Band 7 and LTE Band 41 MEASUREMENT LIMIT:

On all frequencies between the channel edge and 5 megahertz from the channel edge:

At P_o transmitting power, the specified minimum attenuation becomes $40 + 10 \log(P_o)$, and the level in dBm relative P_o becomes:

$$P_o \text{ (dBm)} - [40 + 10 \log(P_o \text{ in mwatts}) - 30] = -10 \text{ dBm}$$

On all frequencies between 5 megahertz and X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section; and between 2490.5 MHz and 2496 MHz:

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

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

On all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section; and below 2490.5 MHz:

At P_o transmitting power, the specified minimum attenuation becomes $55 + 10 \log(P_o)$, and the level in dBm relative P_o becomes:

$$P_o \text{ (dBm)} - [55 + 10 \log(P_o \text{ in mwatts}) - 30] = -25 \text{ dBm}$$

3. LTE Band 12 and LTE Band 71. FCC §2.1053 & §27.53 (g) / RSS-130 Issue 2 Clause 4.7.

FCC §27.53 (g):

(g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least $43 + 10 \log(P)$ dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

RSS-130 Issue 2 Clause 4.7:

4.7.1. The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least $43 + 10 \log_{10} p$ (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

LTE Band 12 and LTE Band 71 MEASUREMENT LIMIT:

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

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

4. LTE Band 13. FCC §2.1053 & §27.53 (c) (2) (4) & (f) / RSS-130 Issue 2 Clause 4.7.

FCC §27.53 (c) (2) (4) & (f):

(c) (2) On any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least $43 + 10 \log (P)$ dB.

(c) (4) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than $65 + 10 \log (P)$ dB in a 6.25 kHz band segment, for mobile and portable stations.

(f) For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to -70 dBW (-40 dBm)/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW (-50 dBm) EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

RSS-130 Issue 2 Clause 4.7:

4.7.1. The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power, P (dBW), by at least $43 + 10 \log_{10} p$ (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

4.7.2. In addition to the limit outlined in section 4.7.1 above, equipment operating in the frequency bands 746-756 MHz and 777-787 MHz shall also comply with the following restrictions:

a. the power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power, P (dBW), by at least:

- i. $76 + 10 \log_{10} p$ (watts), dB, for base and fixed equipment and
- ii. $65 + 10 \log_{10} p$ (watts), dB, for mobile and portable equipment

b. the e.i.r.p. in the band 1559-1610 MHz shall not exceed -70 dBW/MHz for wideband signal and -80 dBW for discrete emission with bandwidth less than 700 Hz.

LTE Band 13 MEASUREMENT LIMIT:

On any frequency outside the 776-788 MHz at least:

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

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

On all frequencies between 763-775 MHz and 793-806 MHz not less than:

At P_o transmitting power, the specified minimum attenuation becomes $65 + 10 \log (P_o)$, and the level in dBm relative P_o becomes:

$$P_o \text{ (dBm)} - [65 + 10 \log (P_o \text{ in mwatts}) - 30] = -35 \text{ dBm}$$

Emissions in the band 1559-1610 MHz for wideband signal:

At P_o transmitting power, shall be limited to -70 dBW (-40 dBm)/MHz equivalent isotropically radiated power (EIRP), and the level in dBm relative P_o becomes:

$$P_o \text{ (dBm)} = -40 \text{ dBm}$$

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 High 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 meter reading was recorded.

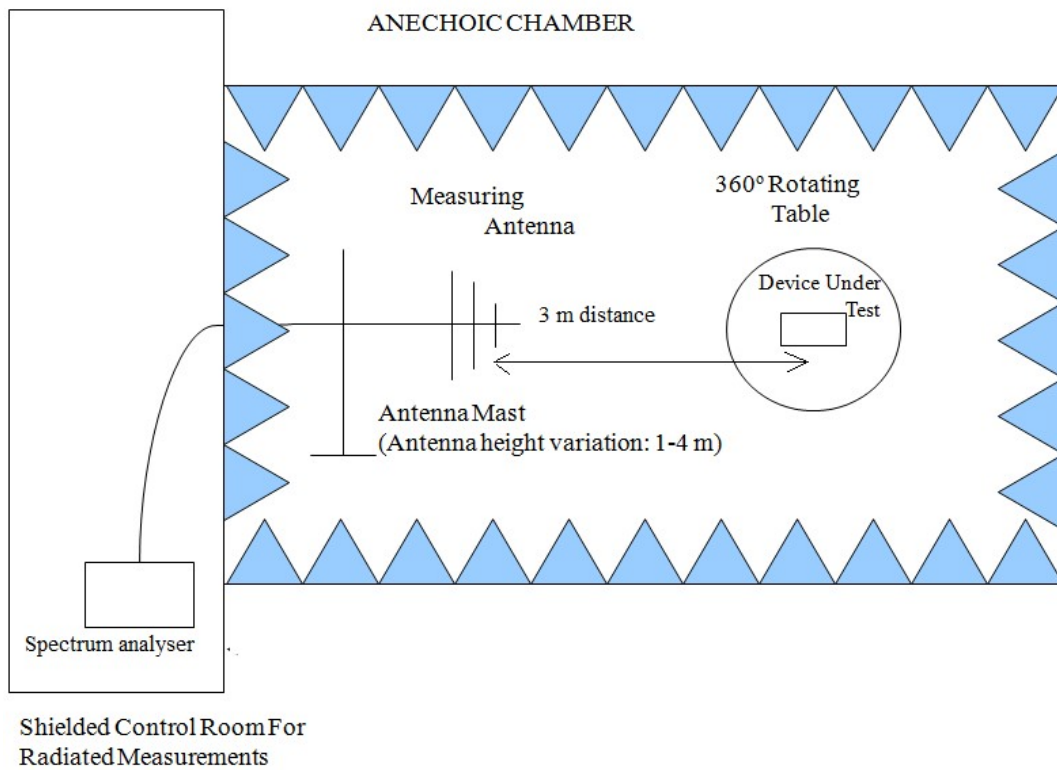
The maximum field strength (dBμV/m) of each detected emission at less than 20 dB respect to the limit is converted to an equivalent EIRP level (dBm) according to ANSI C63.26 with the formula:

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

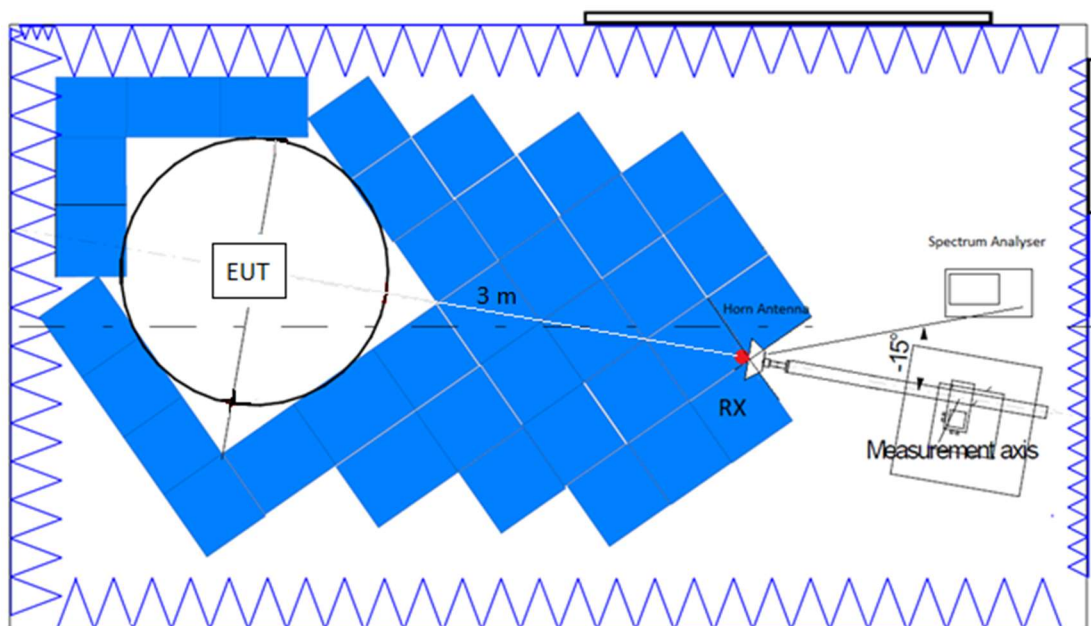
A resolution bandwidth / video bandwidth of 100 kHz / 300 kHz or higher were used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

TEST SETUP:

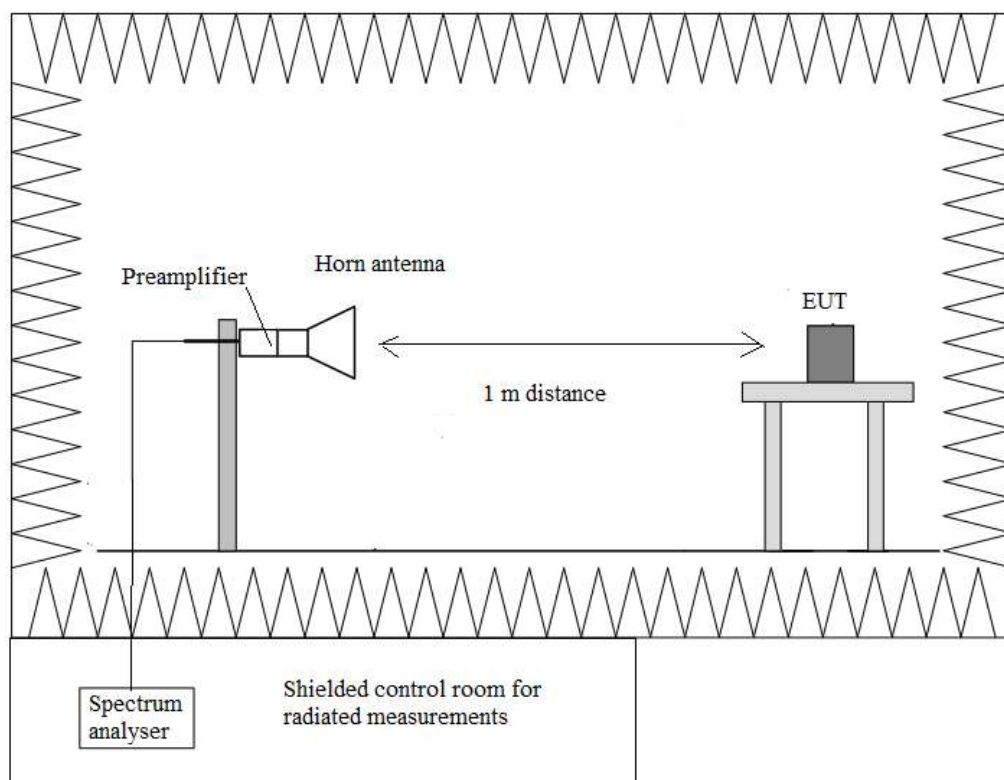
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 18 GHz:



Radiated measurements setup $f > 18$ GHz:



RESULTS:

3G Band IV:

WCDMA and HSUPA modulations: A preliminary scan determined the HSUPA modulation, modules NAD1 and NAD2, as the worst-case.

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 - 18 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 - 18 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 - 18 GHz:

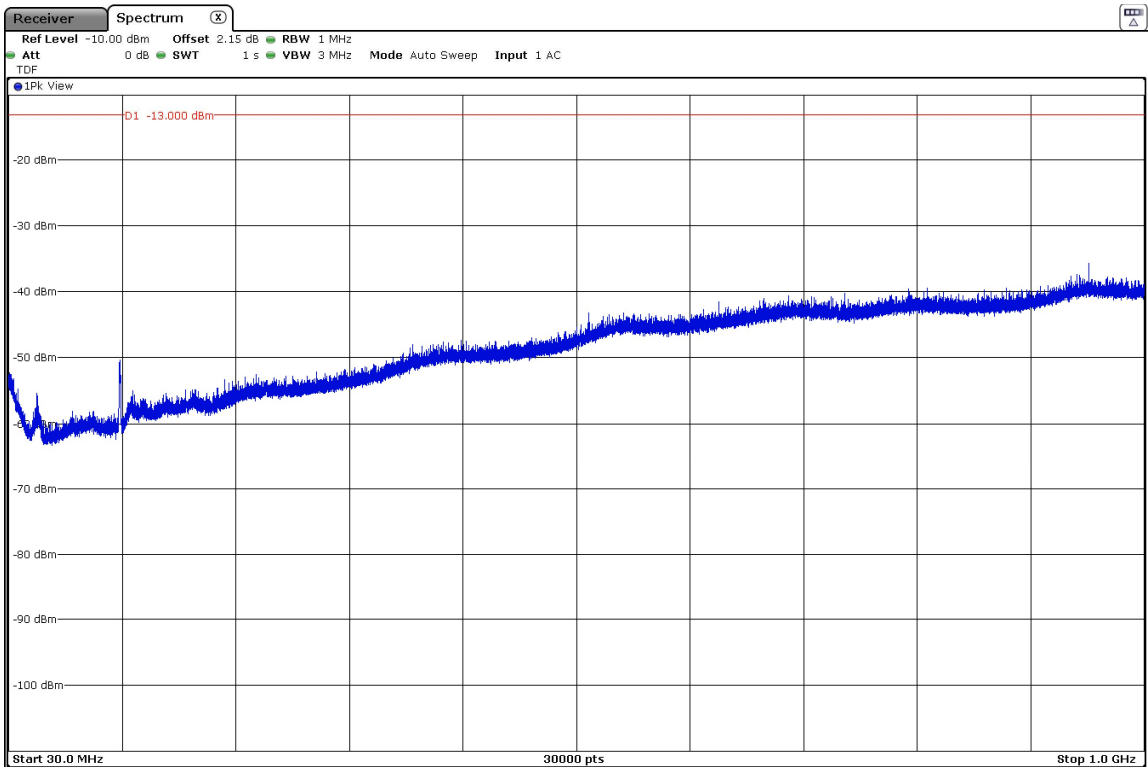
No spurious frequencies at less than 20 dB below the limit.

Measurement Uncertainty (dB)	<± 4.99 for f < 1 GHz <± 4.98 for f ≥ 1 GHz up to 17 GHz <± 5.08 for f ≥ 17 GHz up to 18 GHz
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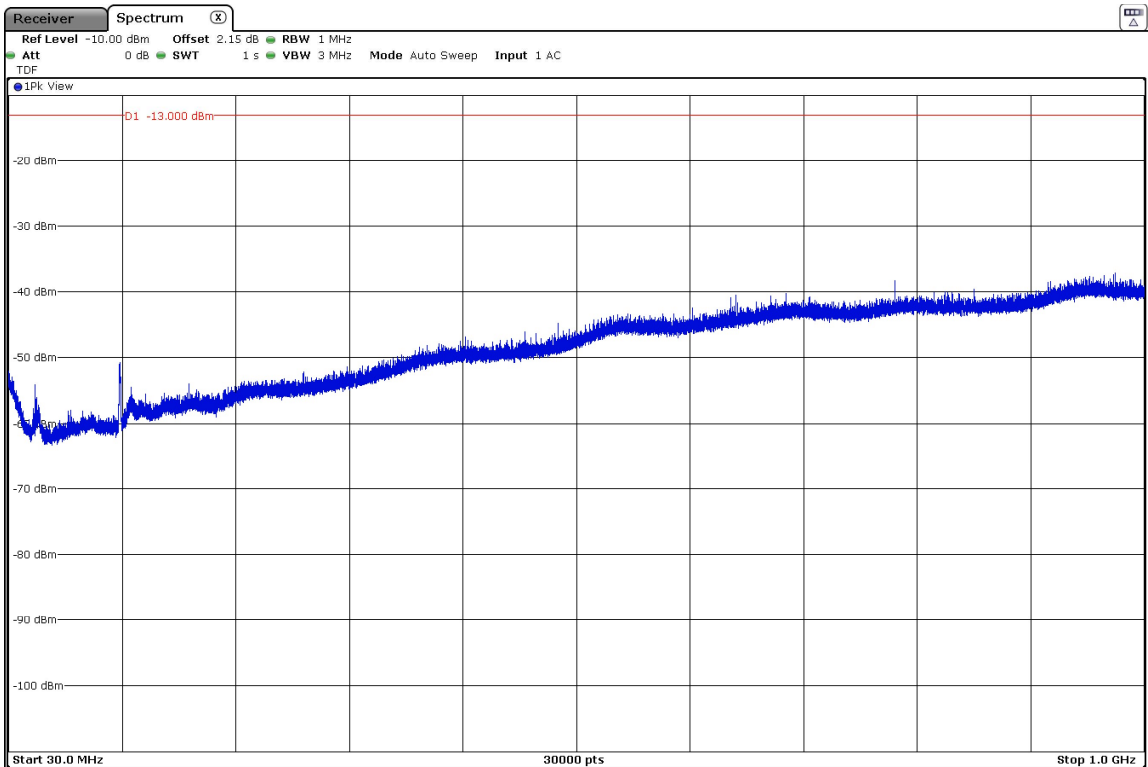
Verdict: PASS

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

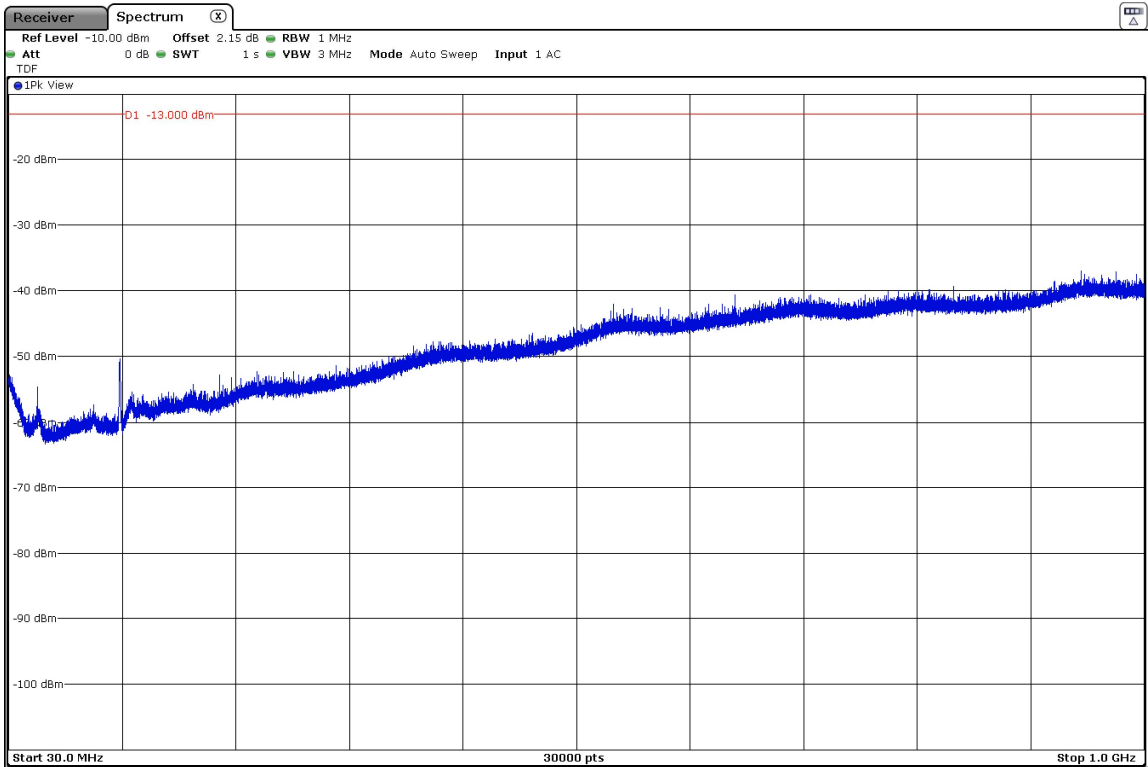
- Low Channel:



- Middle Channel:

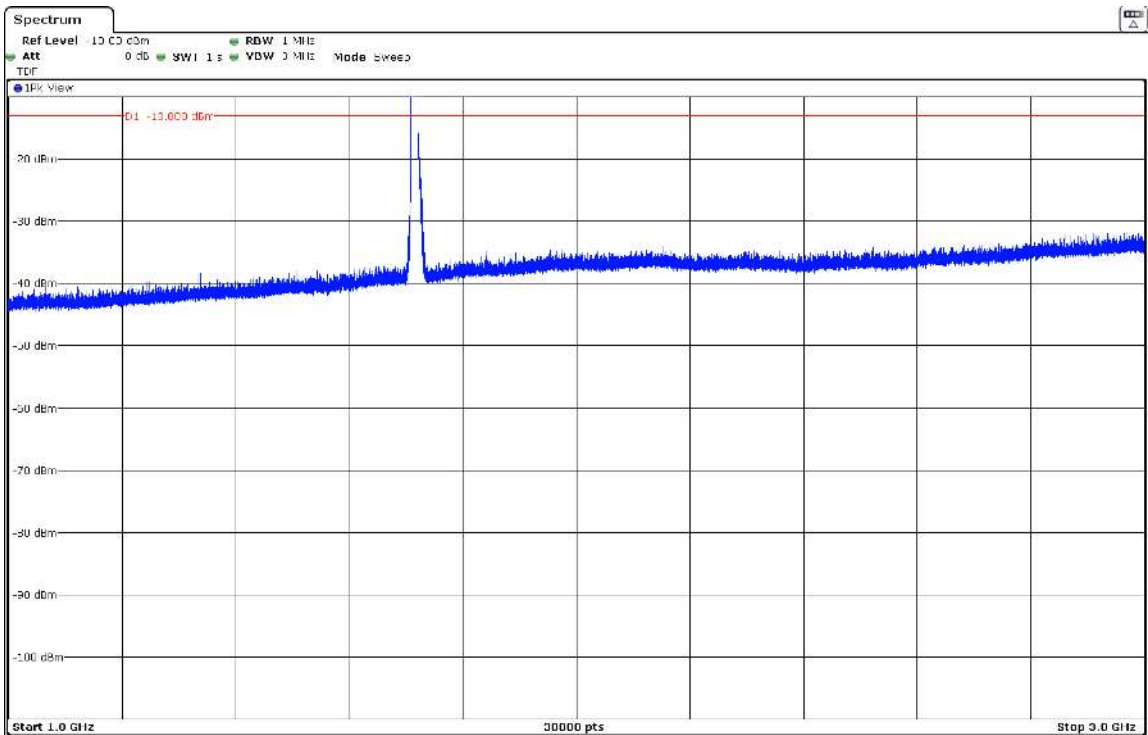


- High Channel:



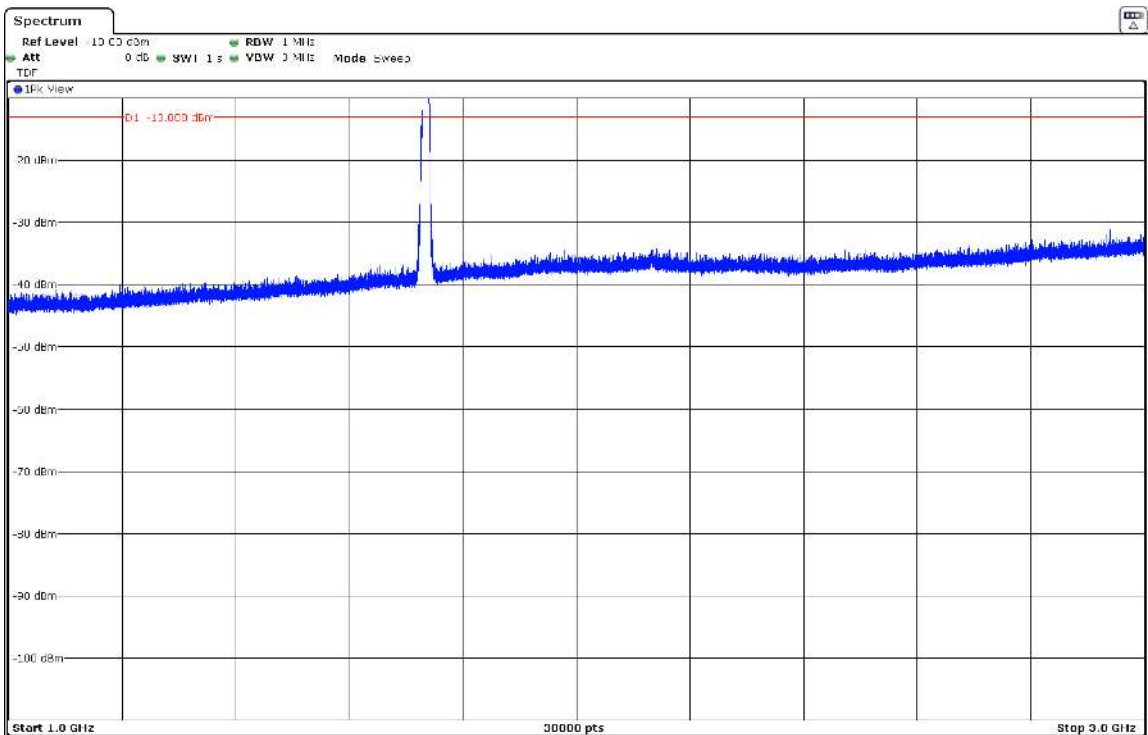
FREQUENCY RANGE 1 - 3 GHz (worst-case):

- Low Channel:



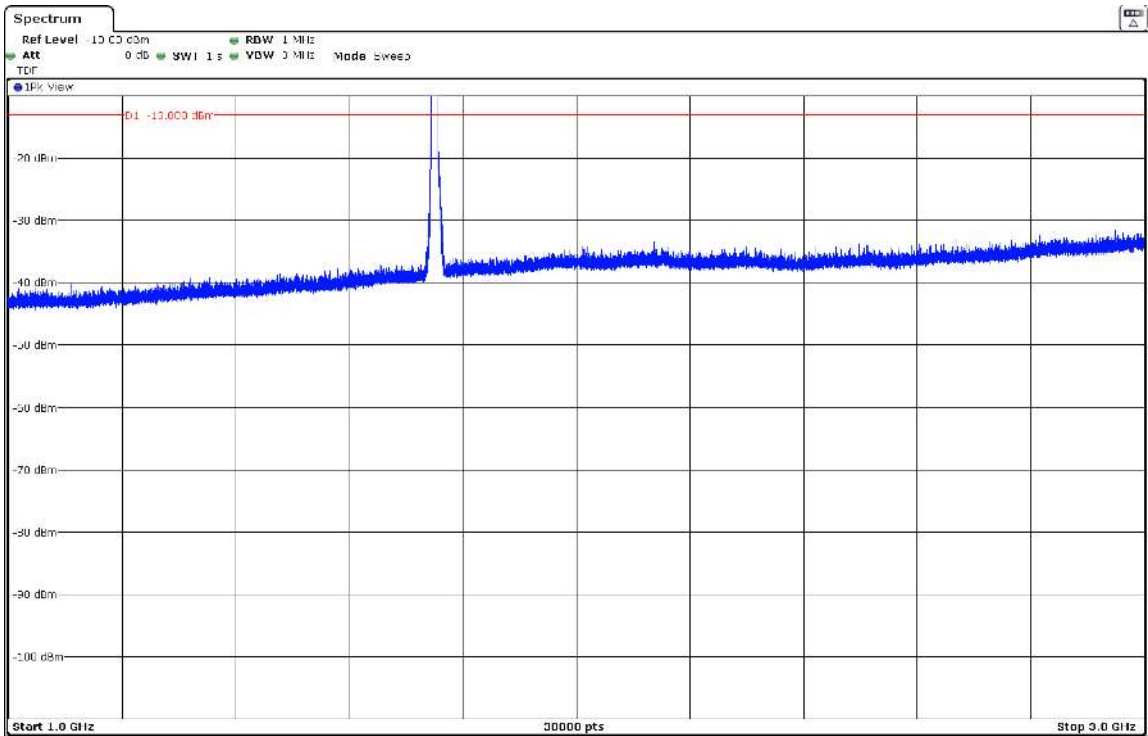
The peaks above the limit are the carrier frequencies.

- Middle Channel:



The peaks above the limit are the carrier frequencies.

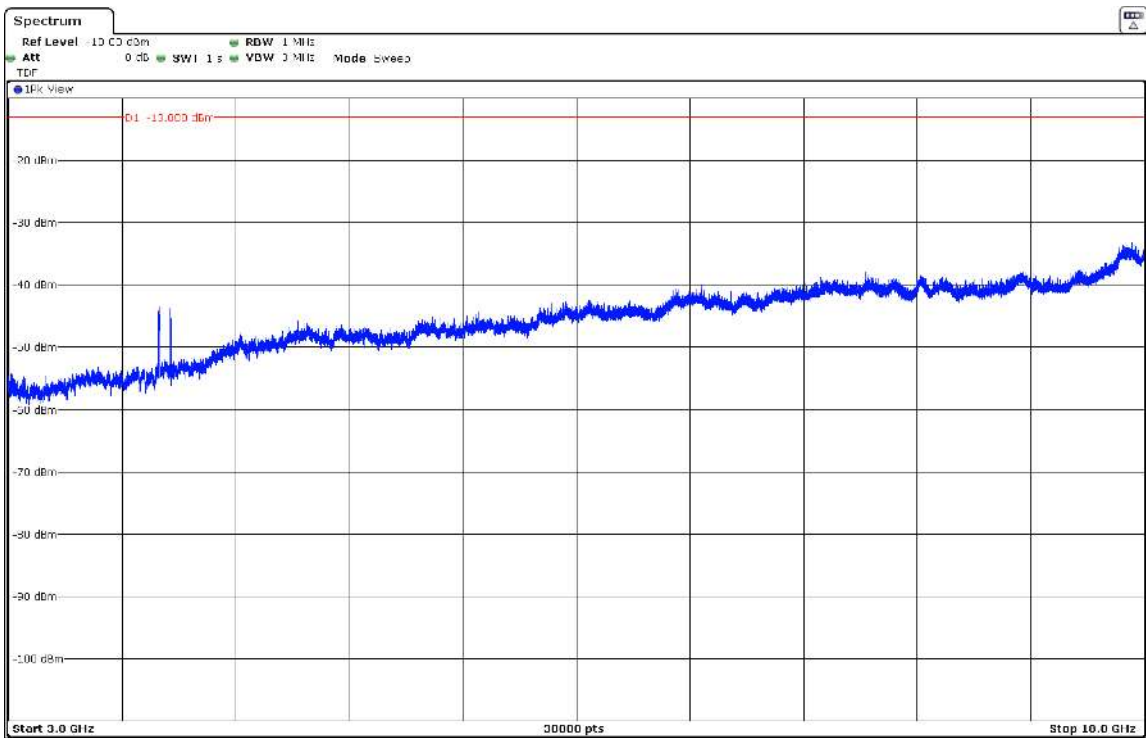
- High Channel:



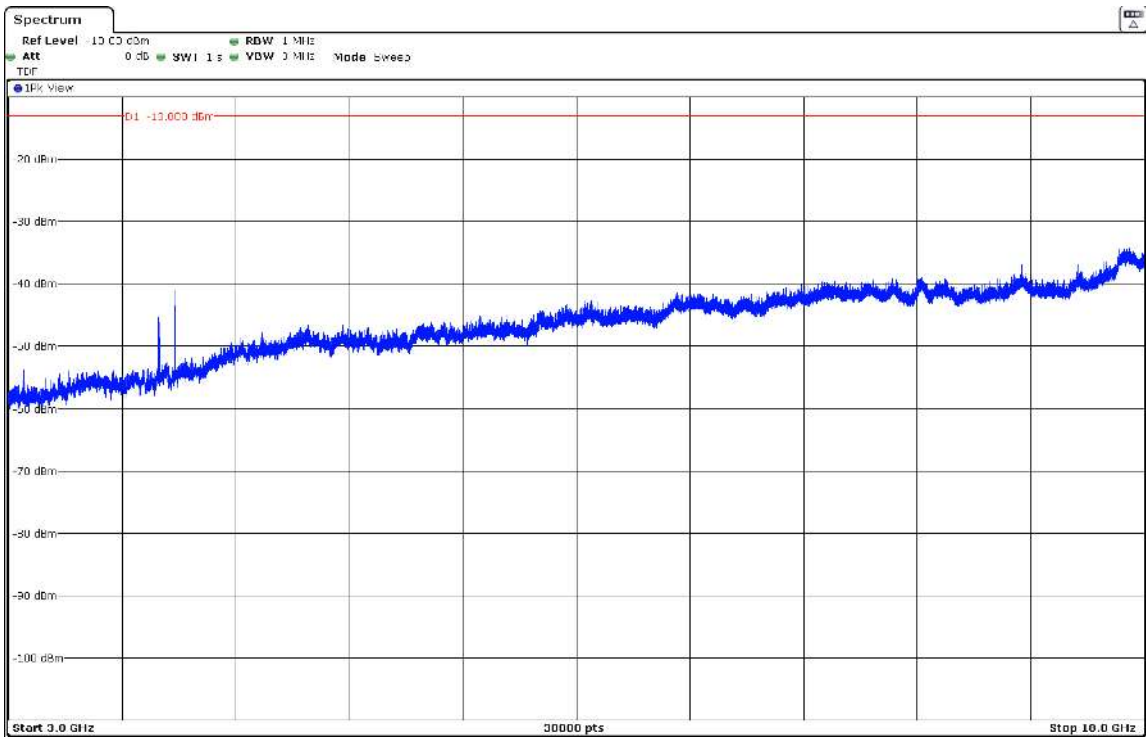
The peaks above the limit are the carrier frequencies.

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

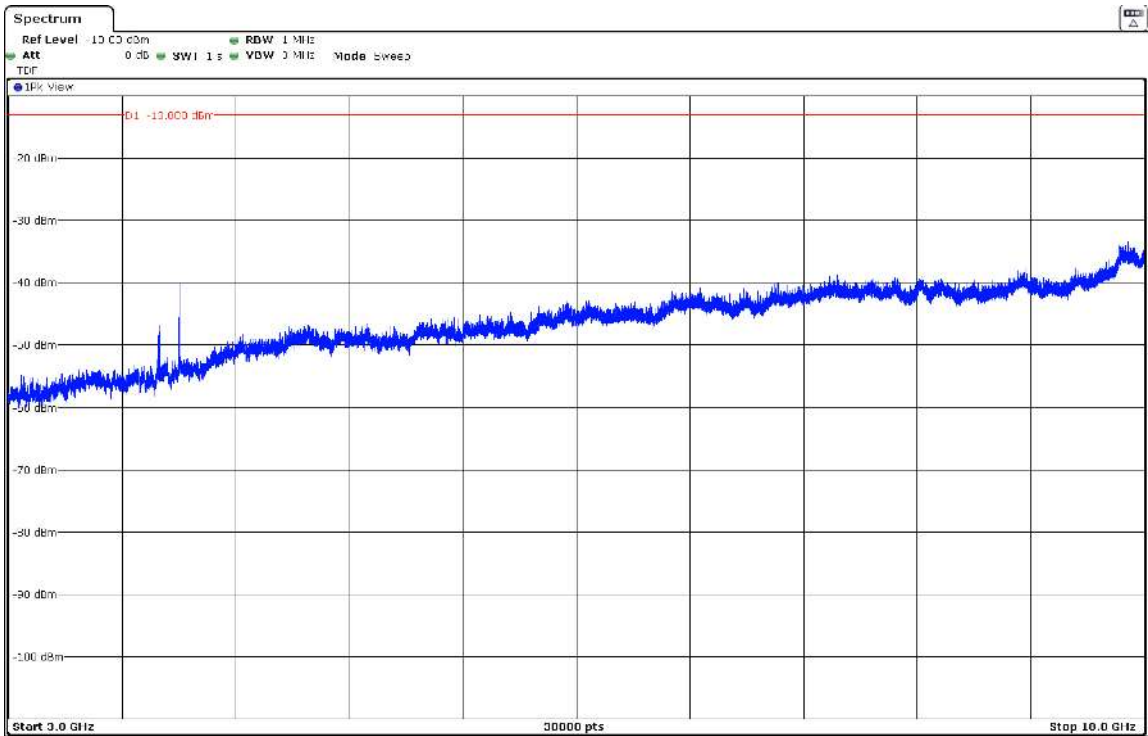
- Low Channel:



- Middle Channel:



- High Channel:



LTE Band 7:

QPSK and QAM modulations: A preliminary scan determined the QPSK modulation, modules NAD1 and NAD2
Nominal Bandwidth 10 MHz, Resource Block Size 1, Resource Block Offset 0 as the worst-case.
The following results are the ones of the worst-case.

- LOW CHANEL:

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 26 GHz:

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	E.I.R.P (dBm)	Polarization	Detector
17.61525	-40.79	V	RMS

Frequency range 2490.5 - 2496 MHz:

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 - 26 GHz:

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	E.I.R.P (dBm)	Polarization	Detector
17.81925	-35.94	V	RMS

Frequency range 2490.5 - 2496 MHz:

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 - 26 GHz:

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	E.I.R.P (dBm)	Polarization	Detector
15.27375	-44.49	V	RMS
17.81925	-35.38	V	RMS

Frequency range 2490.5 - 2496 MHz:

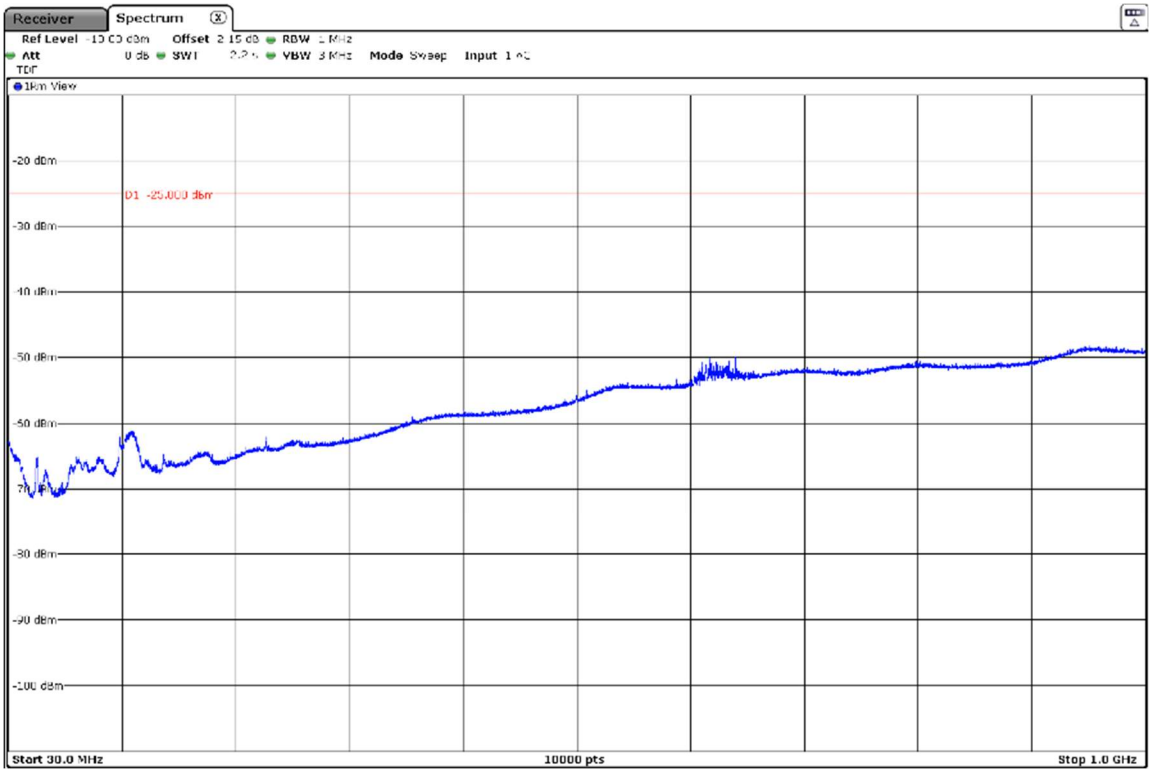
No spurious frequencies at less than 20 dB below the limit.

Measurement Uncertainty (dB)	$<\pm 4.99$ for $f < 1$ GHz $<\pm 4.98$ for $f \geq 1$ GHz up to 17 GHz $<\pm 5.08$ for $f \geq 17$ GHz up to 26 GHz
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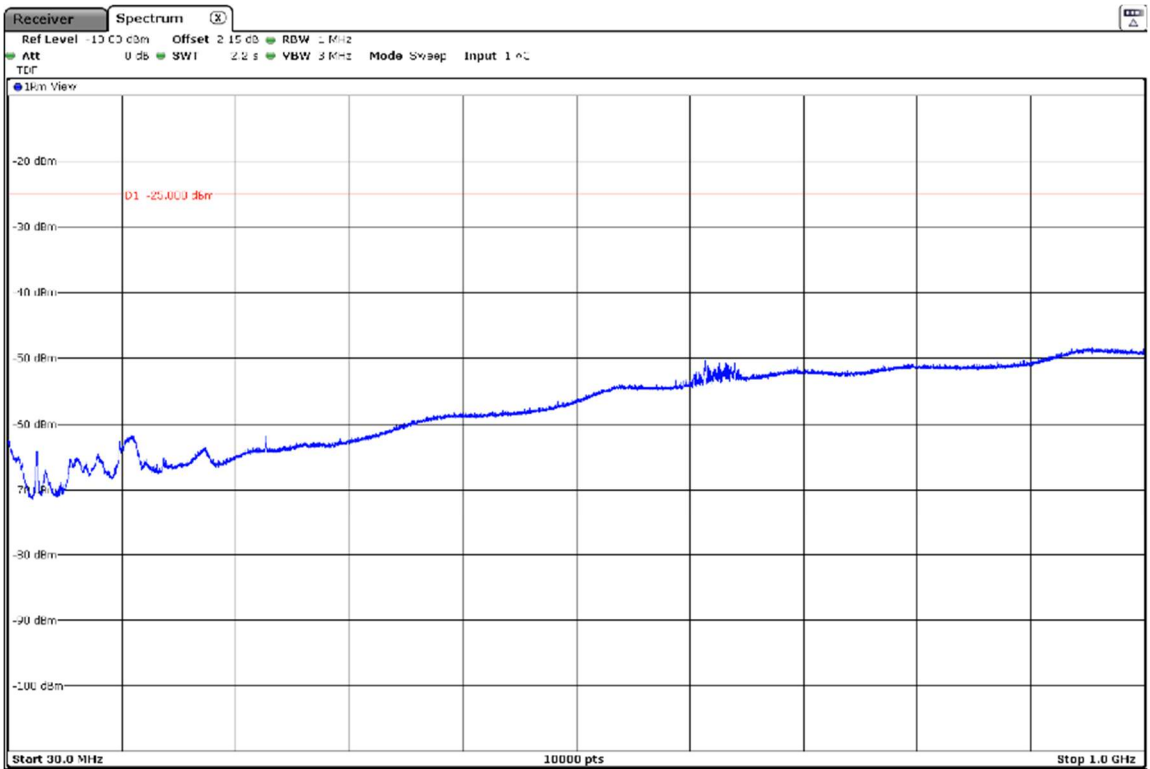
Verdict: PASS

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

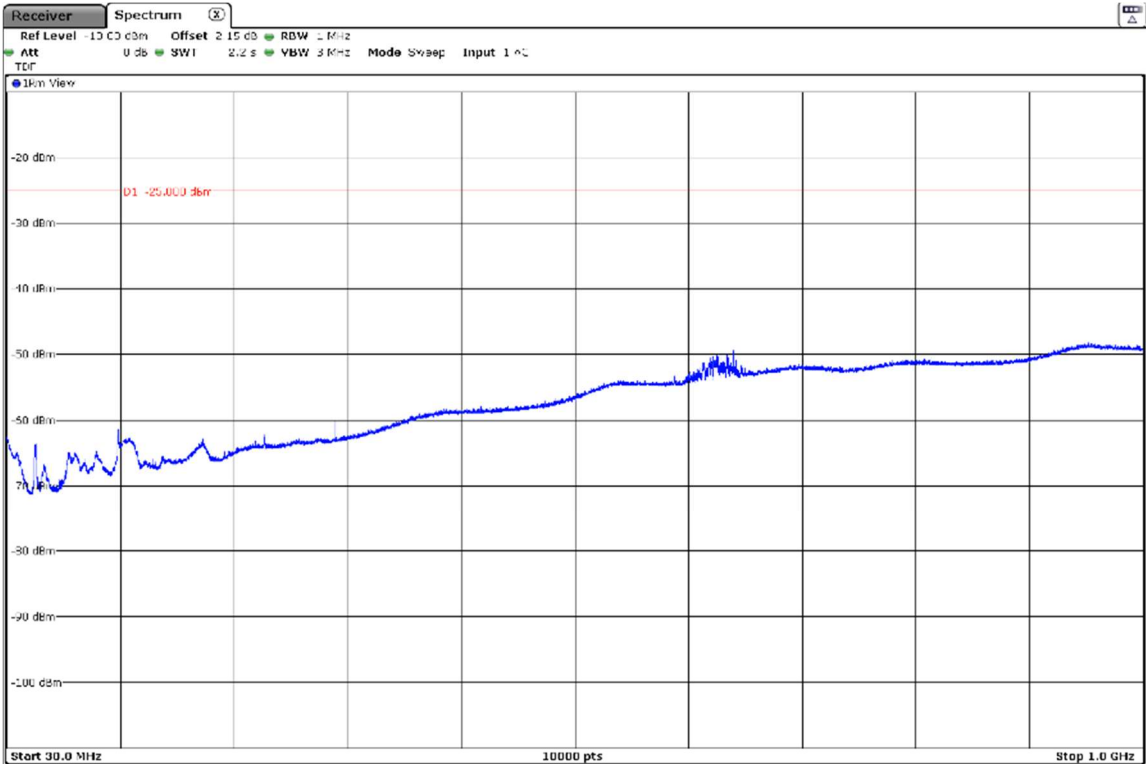
- Low Channel:



- Middle Channel:

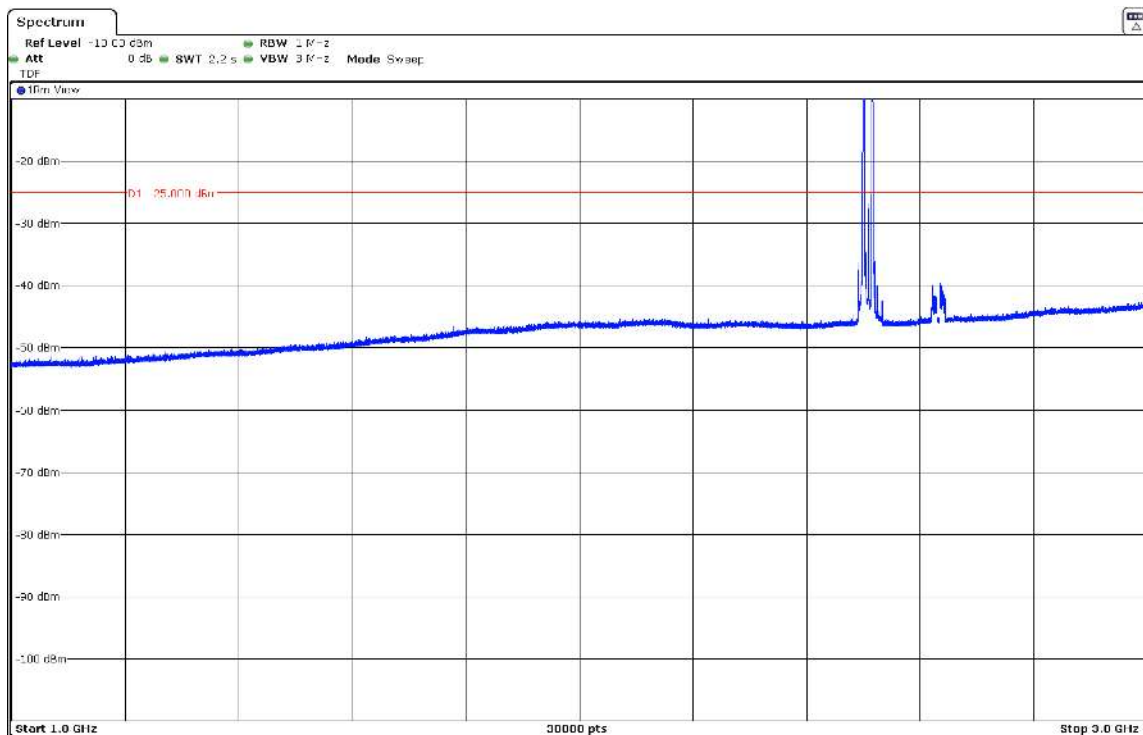


- High Channel:



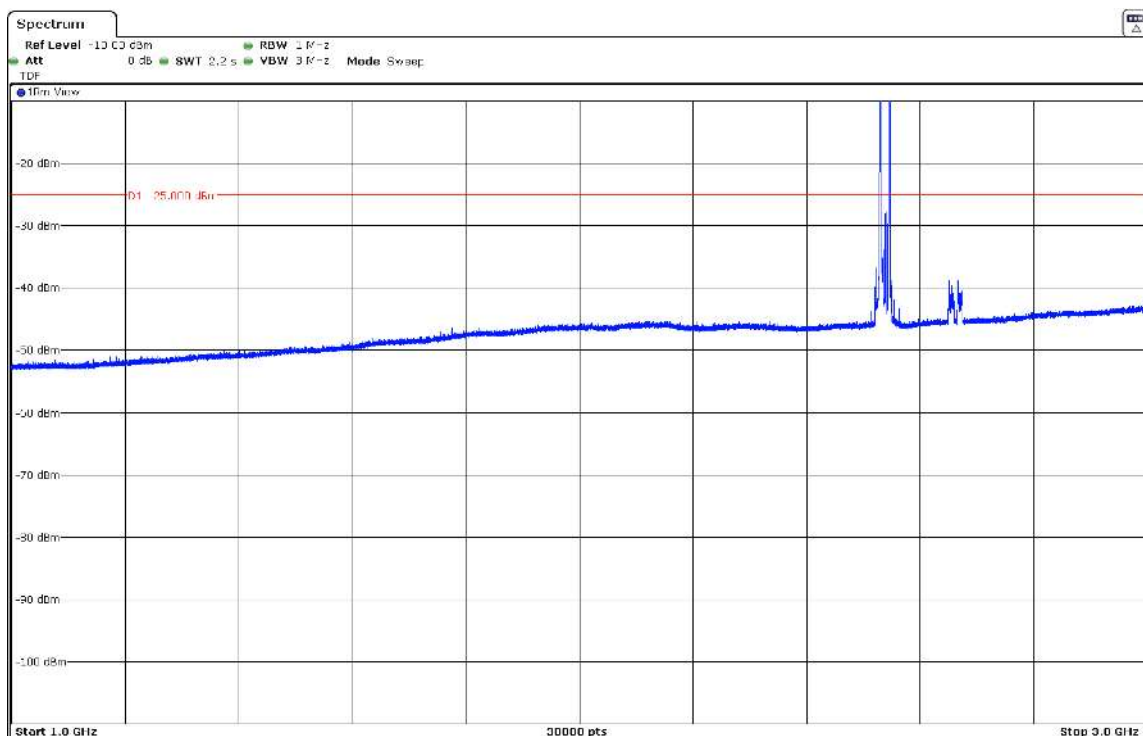
FREQUENCY RANGE 1 - 3 GHz (worst-case):

- Low Channel:



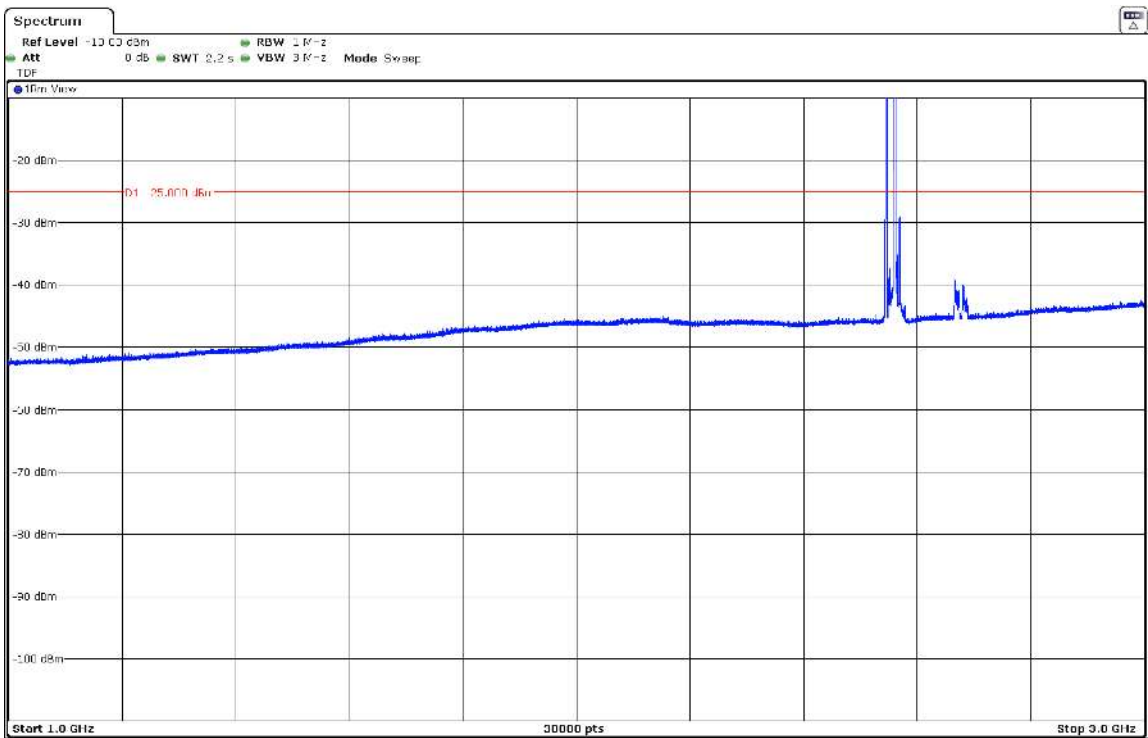
The peaks above the limit are the carrier frequencies. The peaks at 2625 MHz and 2640 MHz correspond to the downlink signals.

- Middle Channel:



The peaks above the limit are the carrier frequencies. The peaks at 2655 MHz and 2670 MHz correspond to the downlink signals.

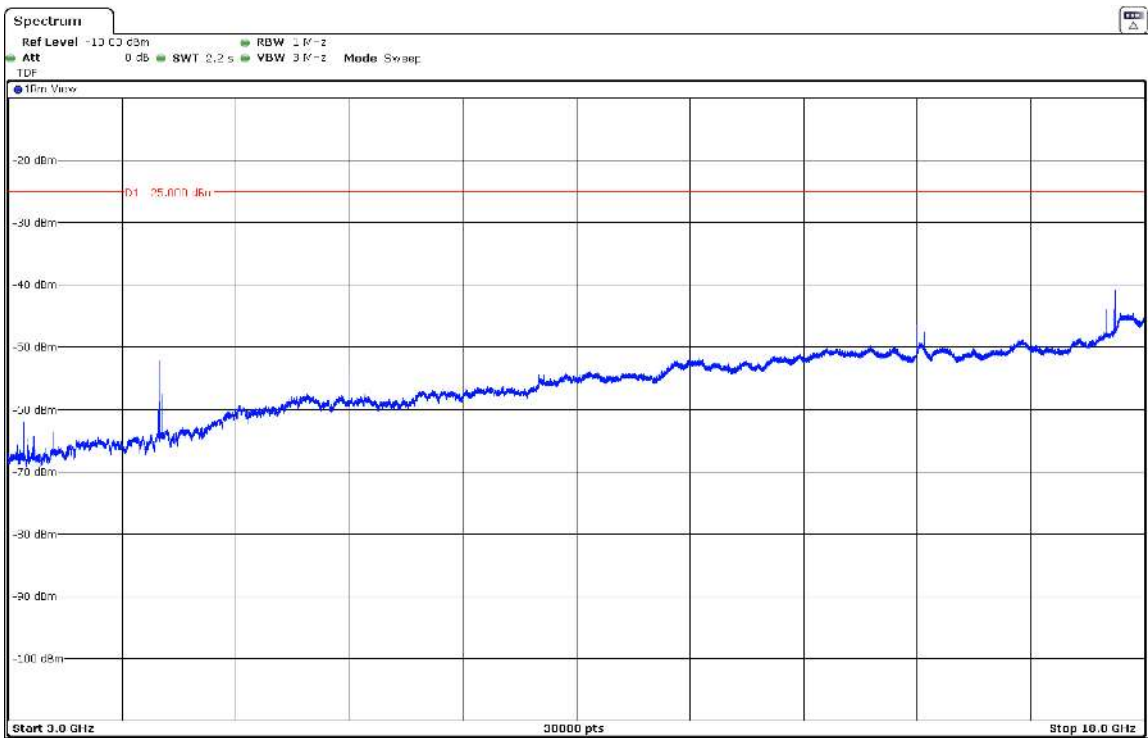
- High Channel:



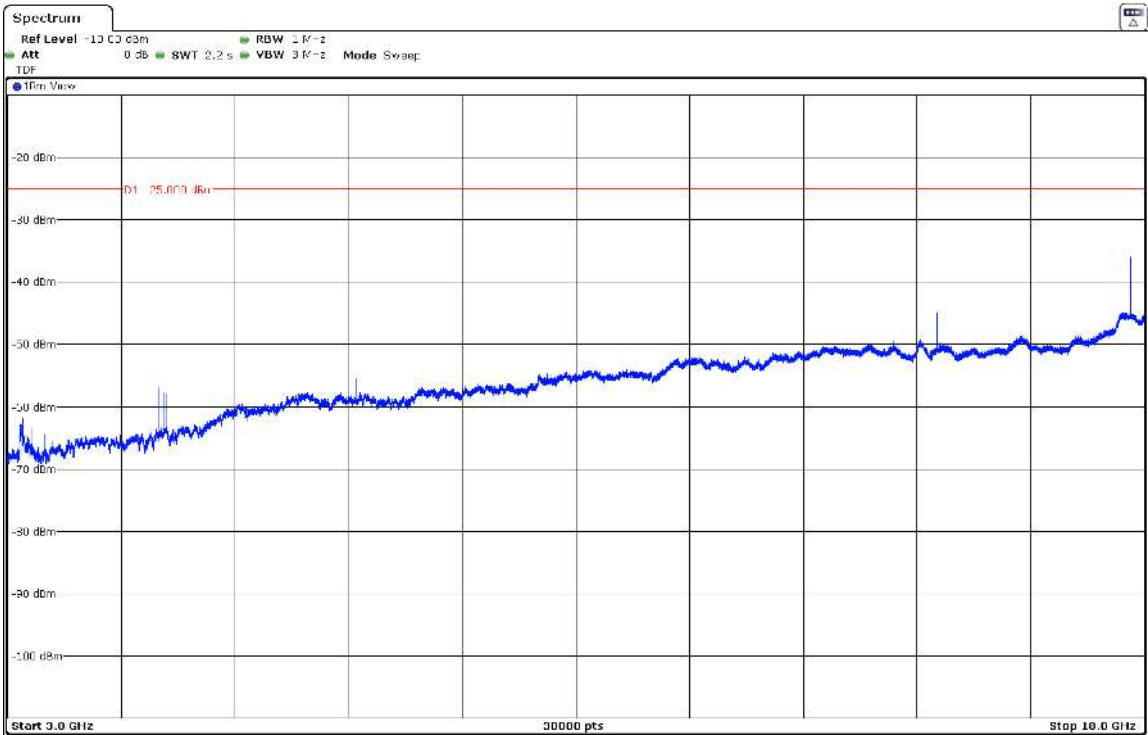
The peaks above the limit are the carrier frequencies. The peaks at 2685 MHz and 2670 MHz correspond to the downlink signals.

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

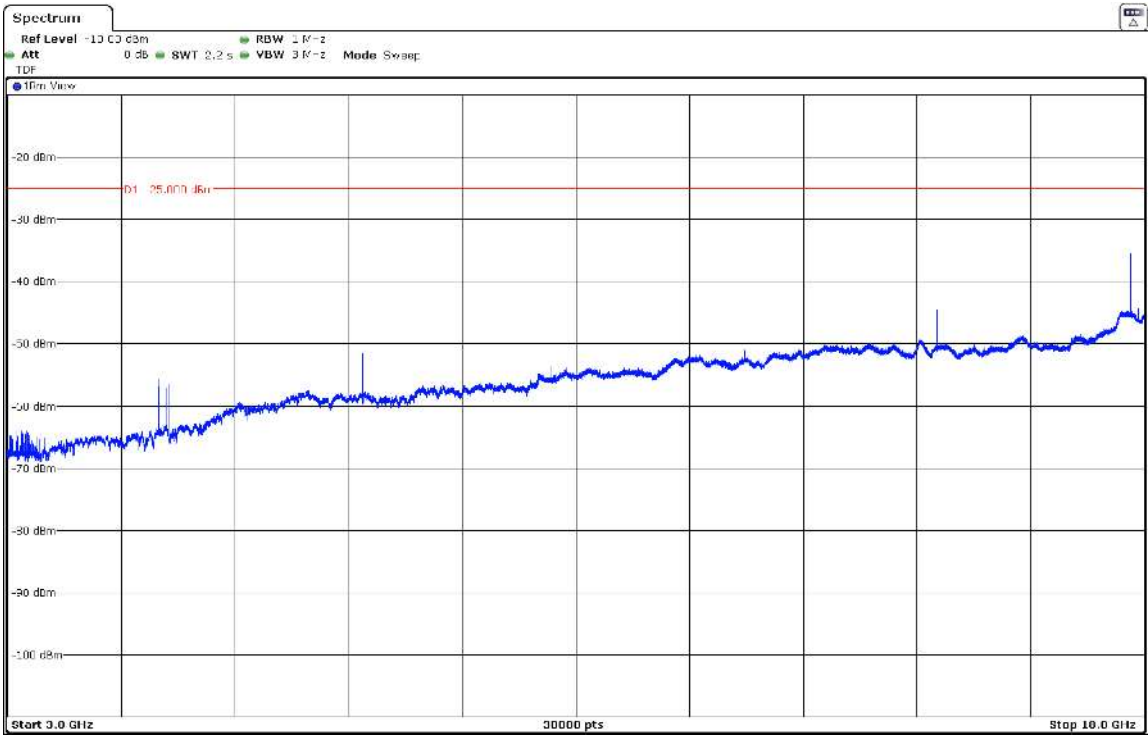
- Low Channel:



- Middle Channel:

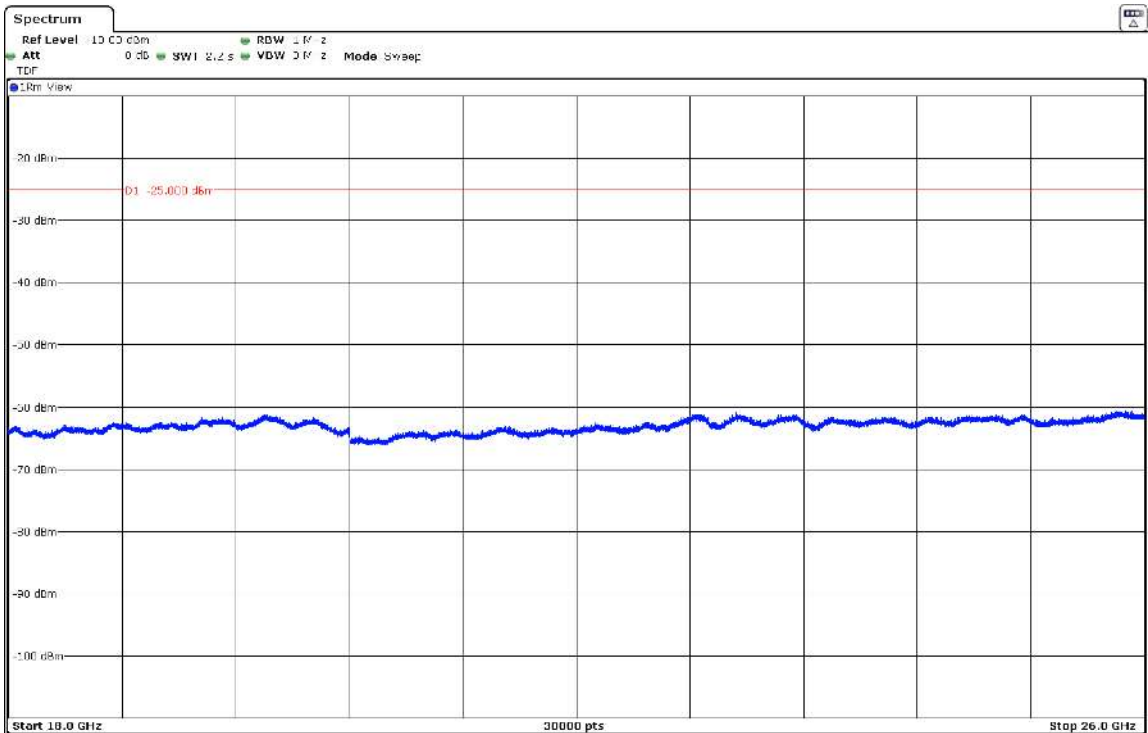


- High Channel:

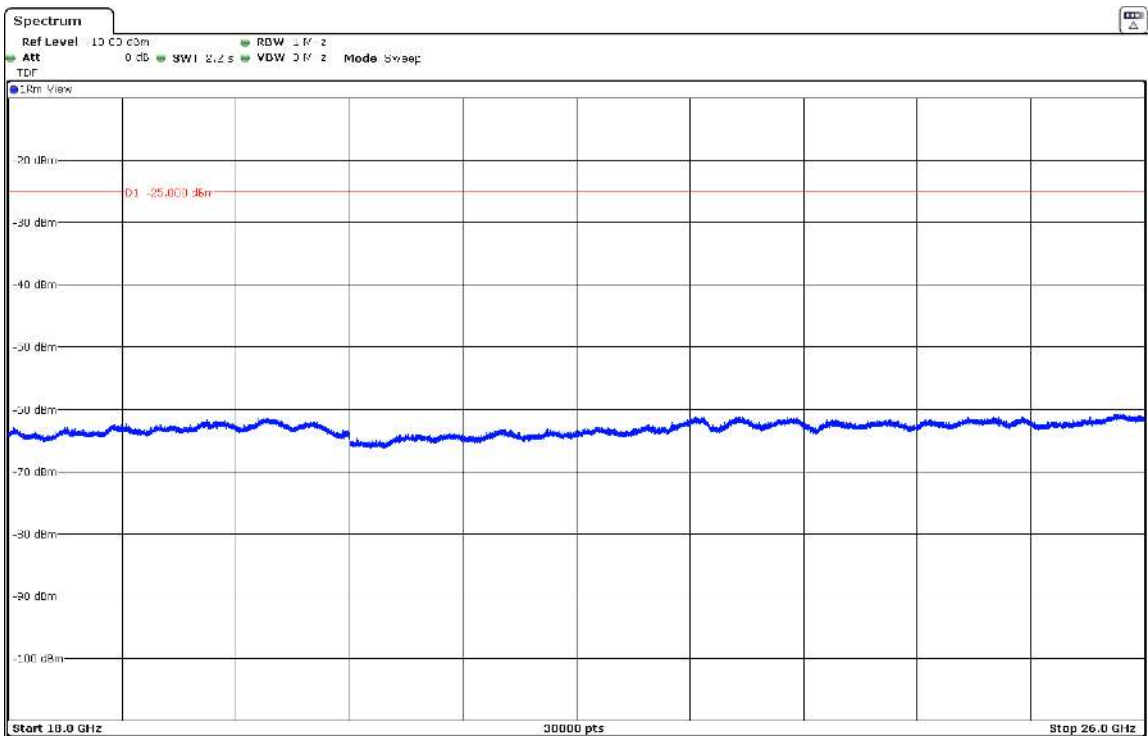


FREQUENCY RANGE 18 - 26 GHz (worst-case):

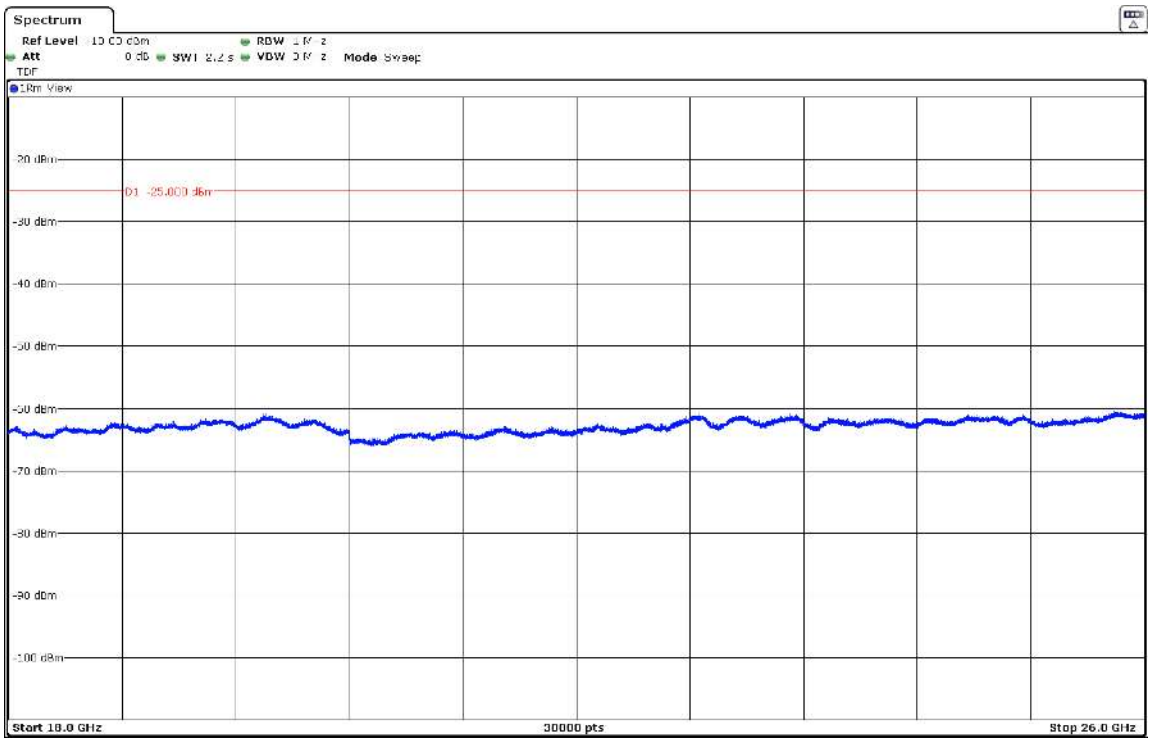
- Low Channel:



- Middle Channel:

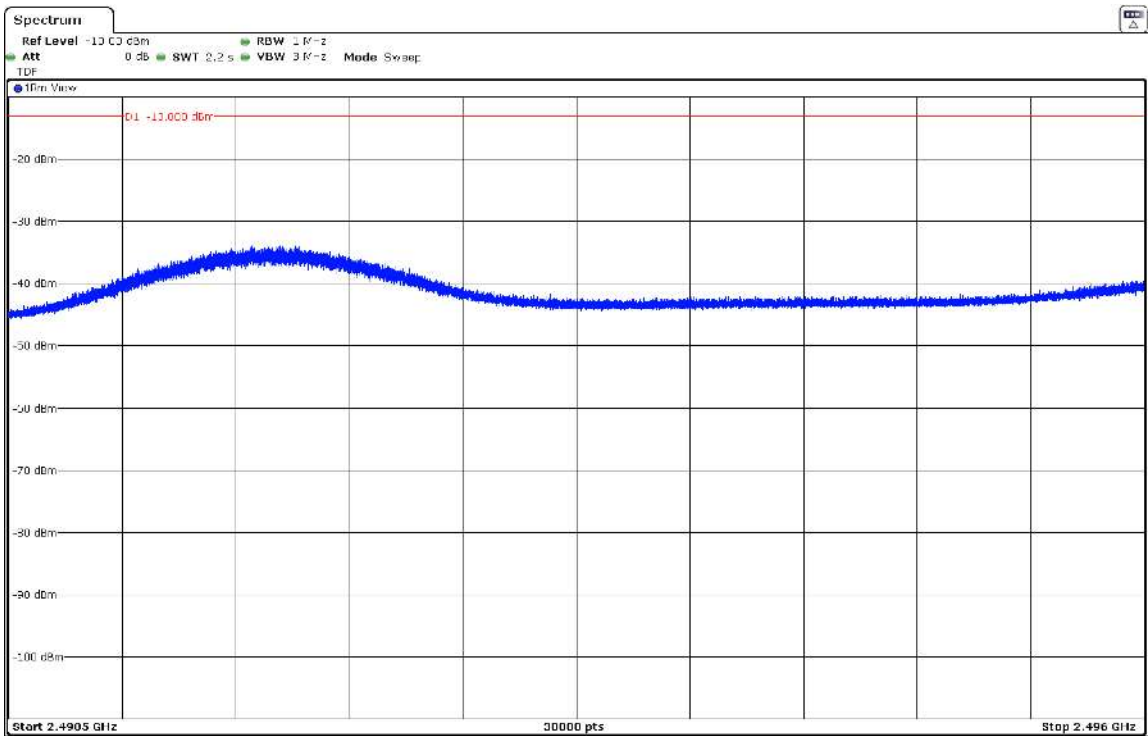


- High Channel:

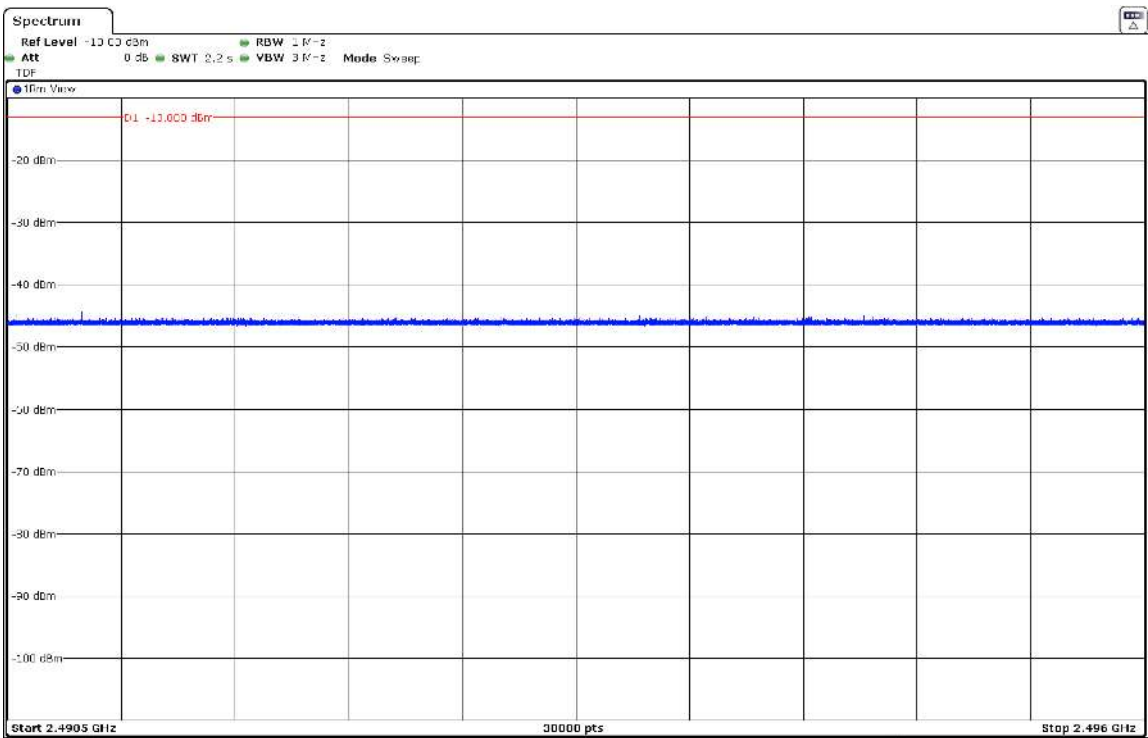


FREQUENCY RANGE 2490.5 - 2496 MHz (worst-case):

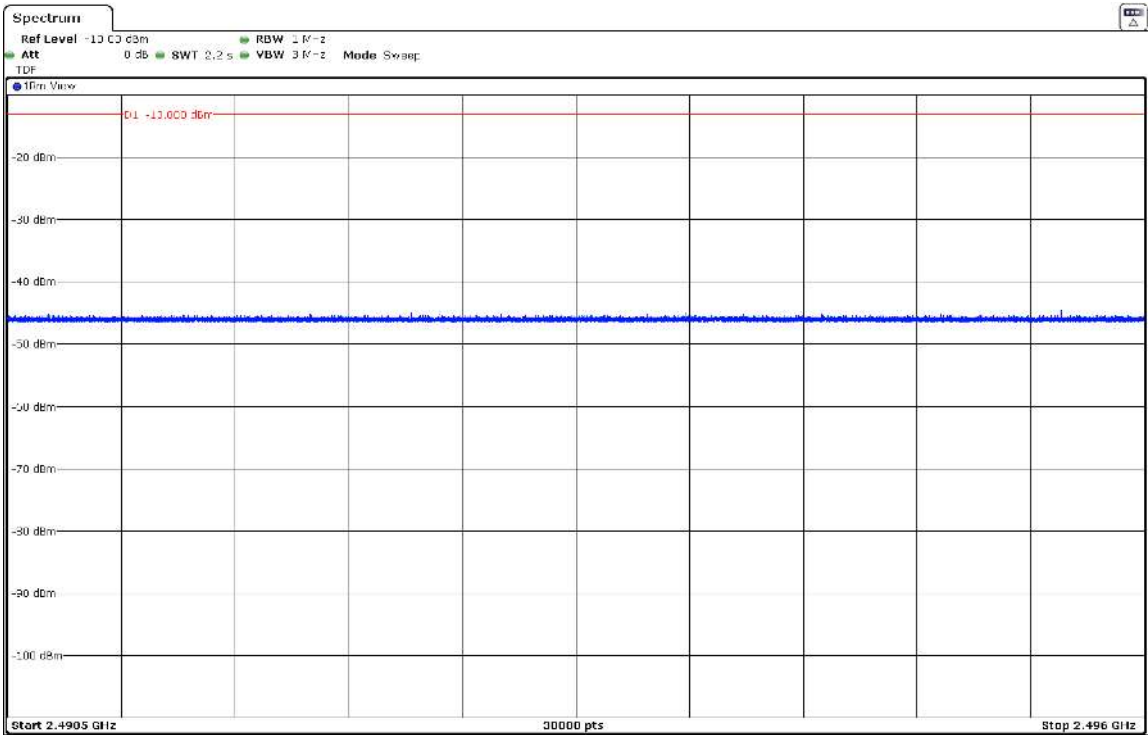
- Low Channel:



- Middle Channel:



- High Channel:



LTE Band 12:

QPSK and QAM modulations: A preliminary scan determined the QPSK modulation, module NAD1 Nominal Bandwidth 3 MHz and module NAD2 Nominal Bandwidth 10 MHz, Resource Block Size 1, Resource Block Offset 0 as the worst-case.

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:

No combination without overlapping the carriers with NAD1 Nominal Bandwidth 3 MHz and module NAD2 Nominal Bandwidth 10 MHz.

- 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:

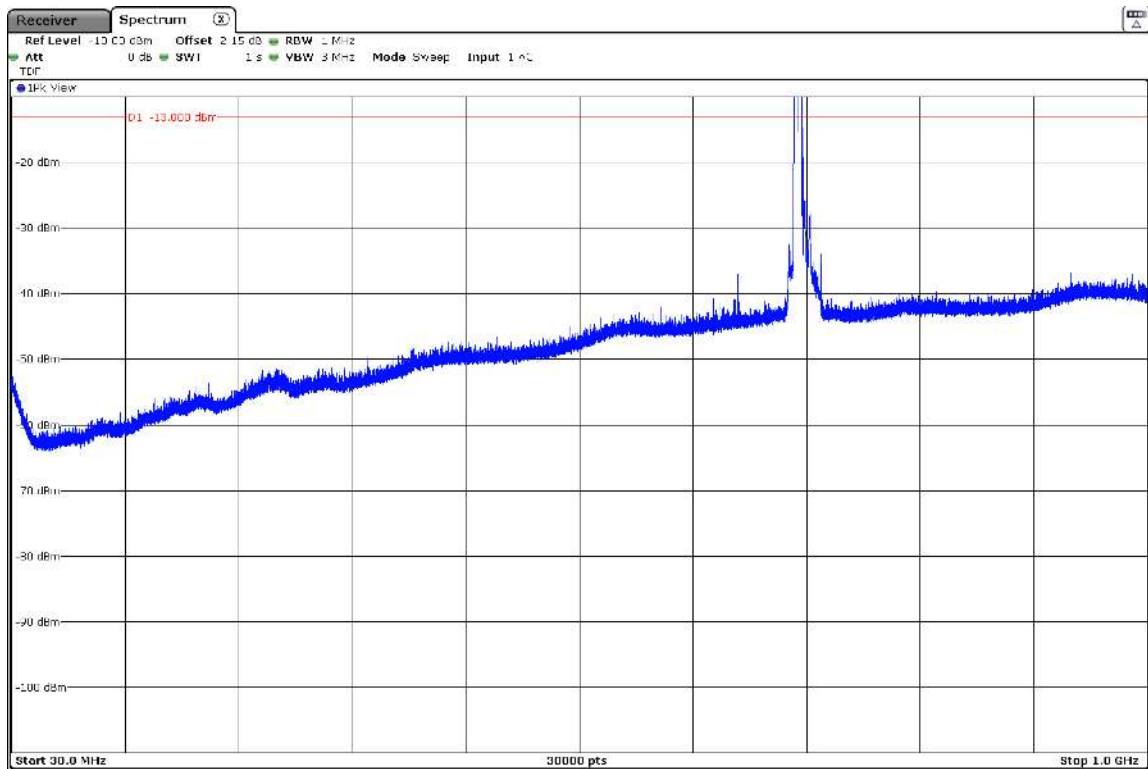
No spurious frequencies at less than 20 dB below the limit.

Measurement Uncertainty (dB)	<± 4.99 for f < 1 GHz <± 4.98 for f ≥ 1 GHz up to 8 GHz
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Verdict: PASS

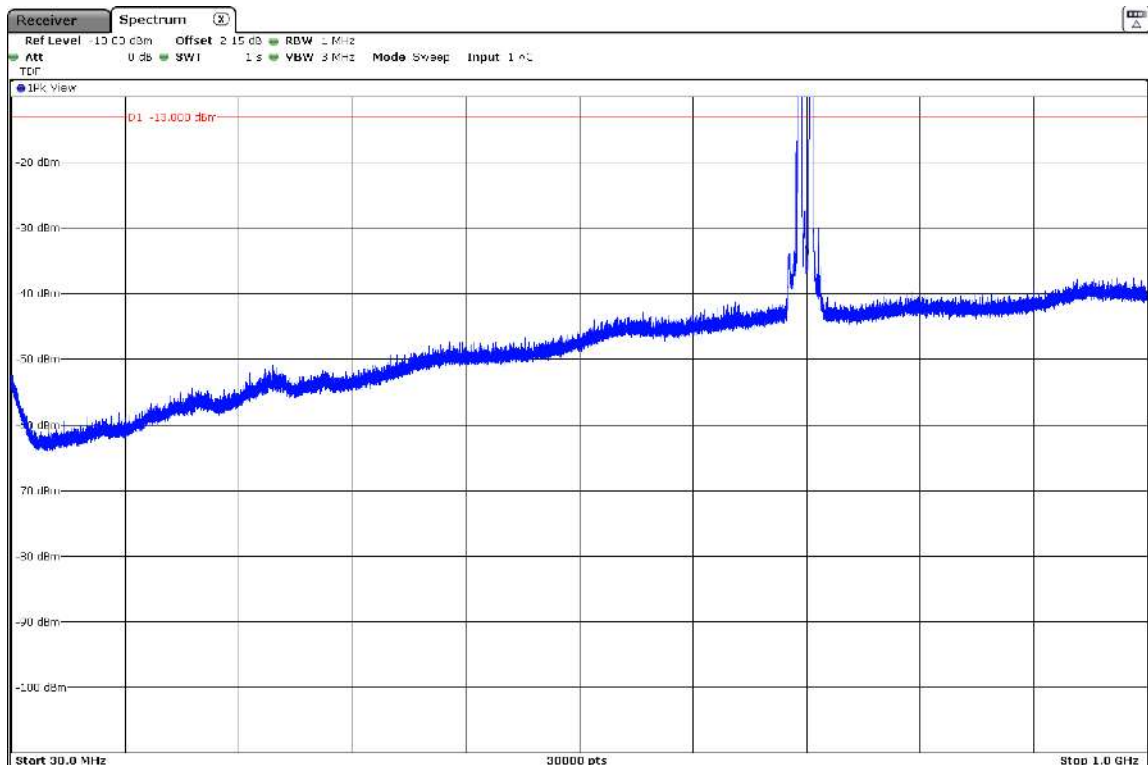
FREQUENCY RANGE 30 MHz - 1 GHz (worst-case):

- Low Channel:



The peaks above the limit are the carrier frequencies. The other peaks at 731 MHz and 737.5 MHz correspond to the downlink signals.

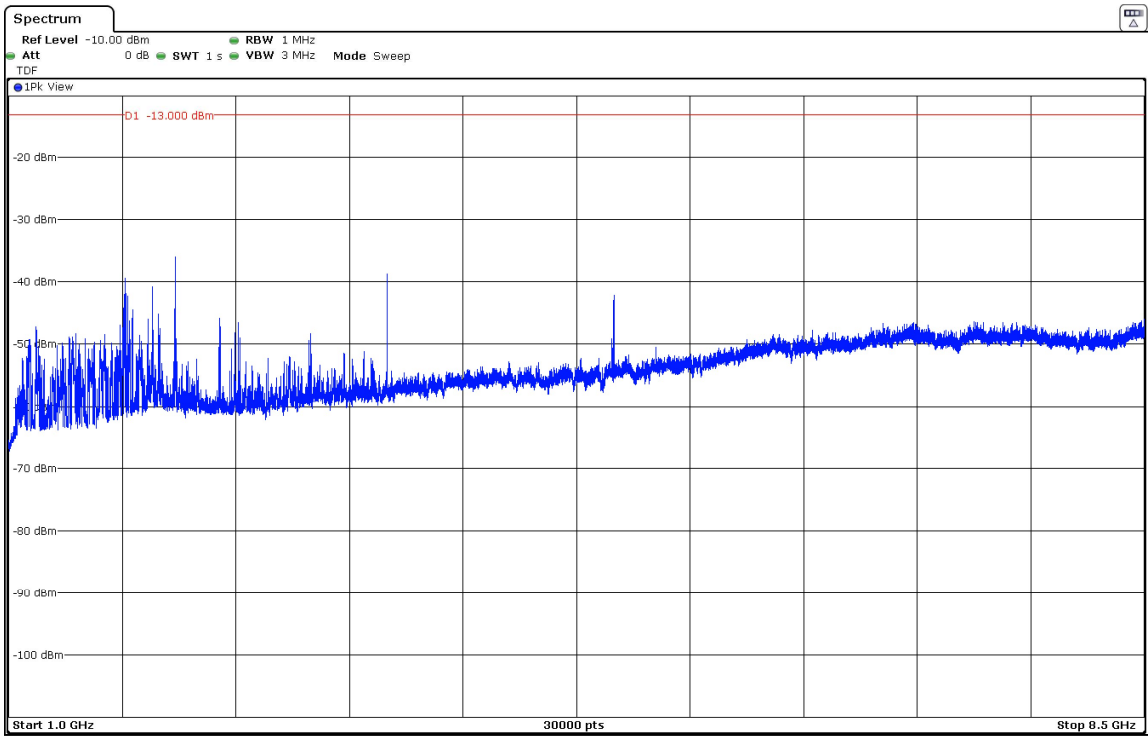
- High Channel:



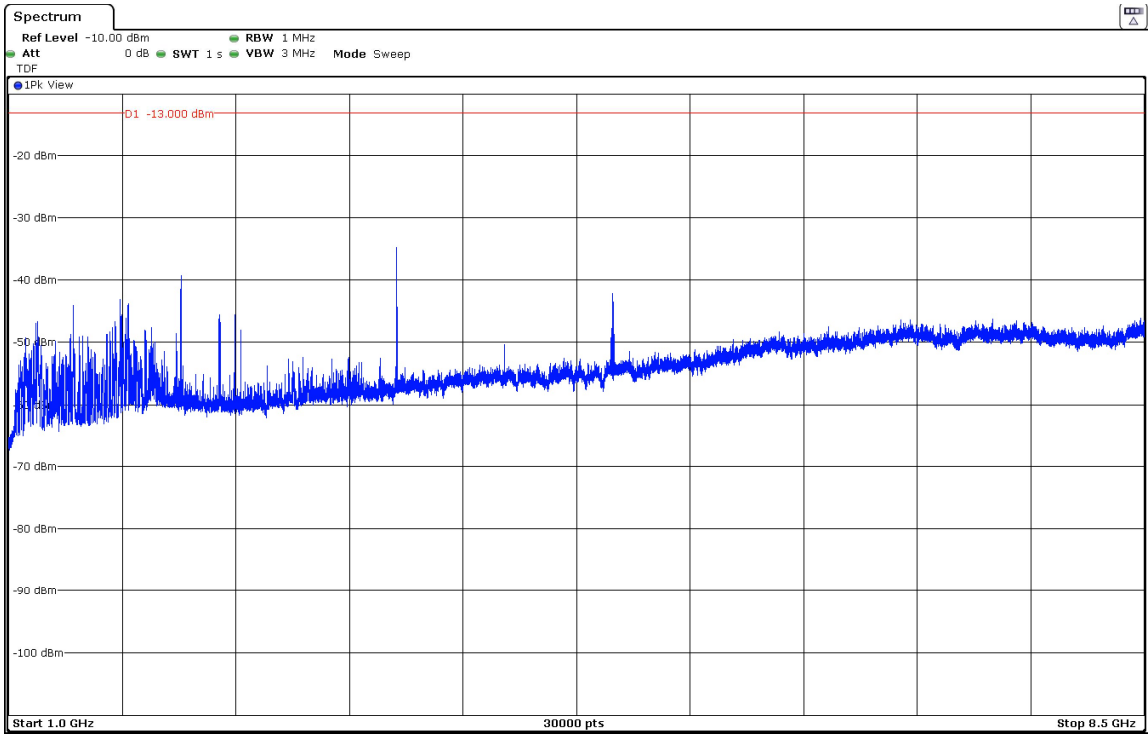
The peaks above the limit are the carrier frequencies. The other peaks at 744 MHz and 737.5 MHz correspond to the downlink signals.

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

- Low Channel:



- High Channel:



LTE Band 13:

QPSK and QAM modulations: A preliminary scan determined the QPSK modulation, modules NAD1 and NAD2
Nominal Bandwidth 5 MHz, Resource Block Size 1, Resource Block Offset 0 as the worst-case.
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 GHz:

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

Frequency range 763 - 775 MHz:

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

Frequency range 793 - 806 MHz:

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

Frequency range 1559 - 1610 MHz:

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	E.I.R.P (dBm)	Polarization	Detector
1.5648931	-45.96	V	Peak
1.5906651	-50.56	V	Peak
1.6001052	-53.1	V	Peak

- HIGH CHANNEL:

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 8 GHz:

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	E.I.R.P (dBm)	Polarization	Detector
3.91188	-29.72	V	Peak

Frequency range 763 - 775 MHz:

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

Frequency range 793 - 806 MHz:

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

Frequency range 1559 - 1610 MHz:

Spurious frequencies at less than 20 dB below the limit:

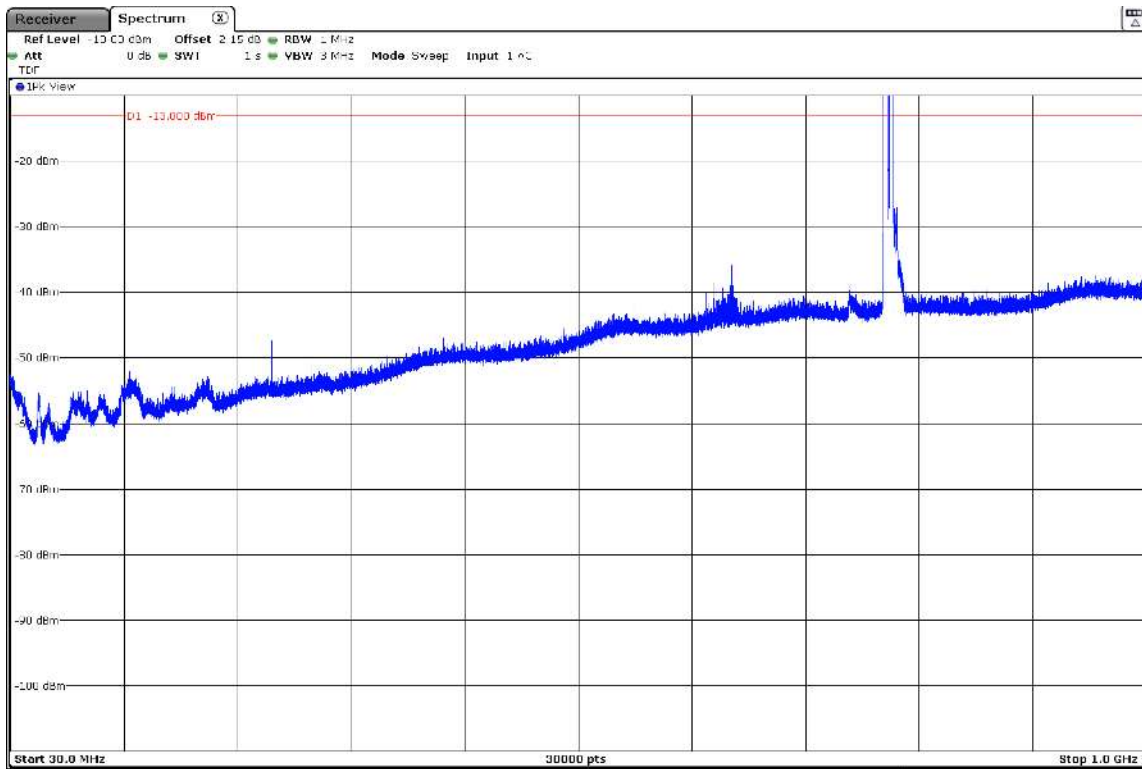
Spurious frequency (GHz)	E.I.R.P (dBm)	Polarization	Detector
1.5653776	-55.9	V	Peak
1.5732928	-54.17	V	Peak
1.6002531	-54.21	V	Peak

Measurement Uncertainty (dB)	<±4.99 for f < 1 GHz <±4.98 for f ≥ 1 GHz up to 18 GHz
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Verdict: PASS

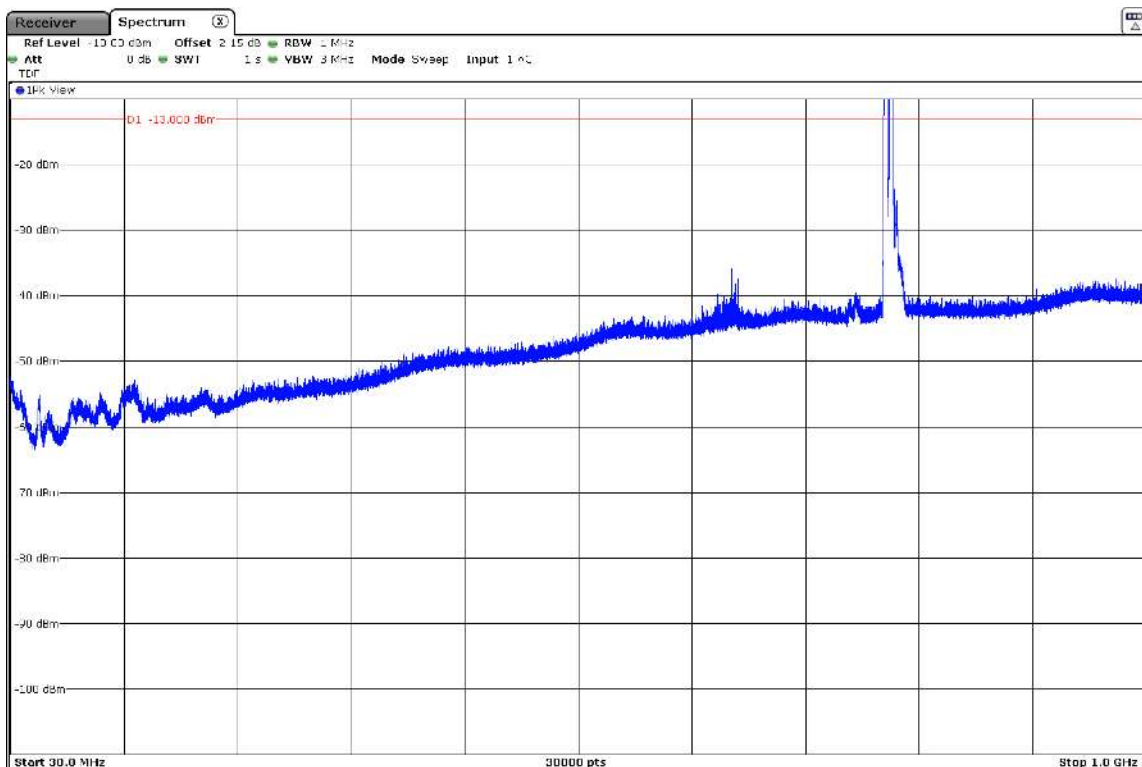
FREQUENCY RANGE 30 MHz - 1 GHz (worst-case):

- Low Channel:



The peaks above the limit are the carrier frequencies. The peaks at 748.5 MHz and 753.5 MHz correspond to the downlink signals.

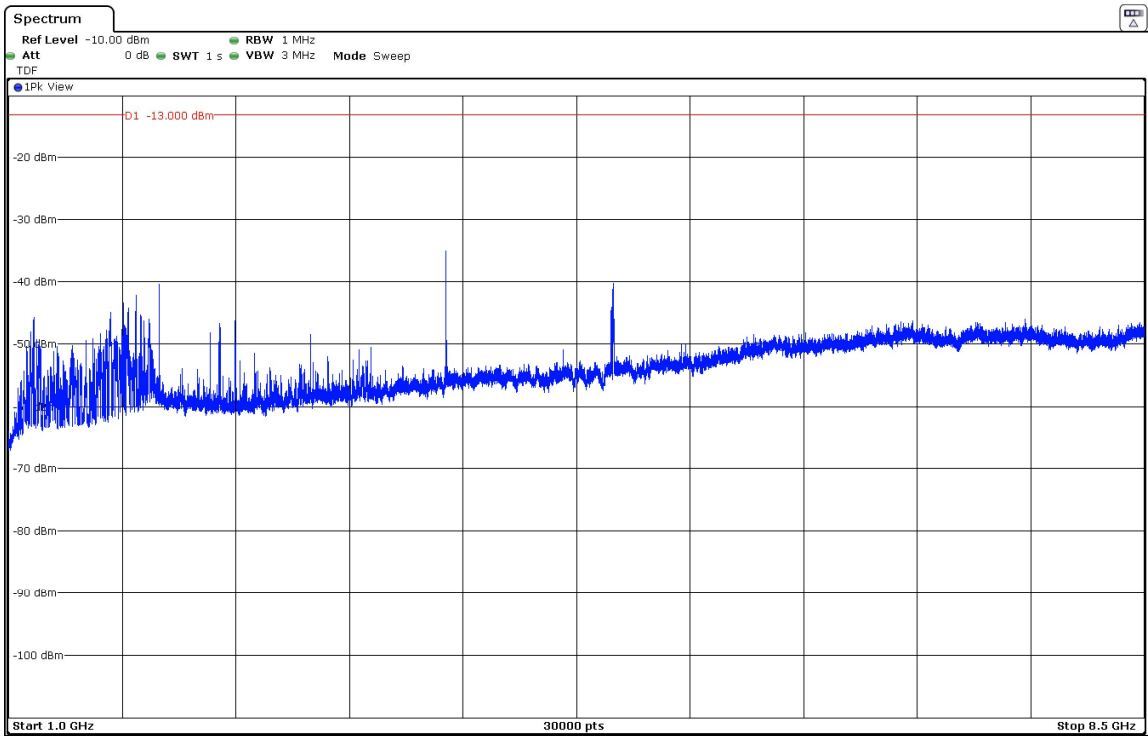
- High Channel:



The peaks above the limit are the carrier frequencies. The peaks at 753.5 MHz and 748.5 MHz correspond to the downlink signals.

FREQUENCY RANGE 1 - 8 GHz (worst-case):

- Low Channel:



- High Channel:

