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RADIO TEST REPORT – 339241-1TRFWL

Applicant:

Redline Communications

Product:

LTE Base Station – Bands 12 and 17

Model:

Ellipse 4G HP

FCC ID:

QC8-B12B17

ISED Reg. Number

4310A-B12B17

Requirements/Summary:

Standard	Environmental phenomenon	Compliance
FCC 47 CFR Part 27	Miscellaneous wireless communications services	Yes
RSS-130 Issue 1, October 2013	Mobile Broadband Services (MBS) Equipment Operating in the Frequency Bands 698–756 MHz and 777–787 MHz	Yes

Date of issue: November 20, 2017

Test engineer(s): Andrey Adelberg, Senior EMC/Wireless Specialist Signature:

Reviewed by: David Duchesne, Senior EMC/Wireless Specialist Signature:

Lab and test locations

Company name	Nemko Canada Inc.		
Facilities	Ottawa site: 303 River Road, Ottawa, ON, Canada, K1V 1H2 Tel: +1 613 737 9680 Fax: +1 613 737 9691	Montreal site: 292 Labrosse Avenue, Pointe-Claire, QC, Canada, H9R 5L8 Tel: +1 514 694 2684 Fax: +1 514 694 3528	Almonte site: 1500 Peter Robinson Road, West Carleton, ON, Canada, K0A 1L0 Tel: +1 613 256-9117 Fax: +1 613 256-8848

Test site registration	**Organization**	**Recognition numbers and location**
	FCC	CA2040 (Ottawa); CA2041 (Montreal)
	ISED	CA2040A-4 (Ottawa); CA2040G-5 (Montreal); CA2040A-3 (Almonte)
Website	www.nemko.com	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Redline Communications
Address	302 Town Center Blvd., Markham, ON, Canada, L3R 0E8

1.2 Test specifications

FCC 47 CFR Part 27	Miscellaneous wireless communications services
FCC 47 CFR Part 2	Frequency Allocations and Radio Treaty Maters; General Rules and Regulations
RSS-130 Issue 1, October 2013	Mobile Broadband Services (MBS) Equipment Operating in the Frequency Bands 698–756 MHz and 777–787 MHz
RSS-Gen Issue 4, November 2014	General Requirements for Compliance of Radio Apparatus
SRSP-518 Issue 1, October 2013	Technical Requirements for Mobile Broadband Services (MBS) in the Bands 698–756 MHz and 777–787 MHz

1.3 Test method

ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested.

See “Summary of test results” for full details.

1.5 Exclusions

None

1.6 Test report revision history

Table 1.6-1: *Test report revision history*

Revision #	Date of issue	Details of changes made to test report
TRF	November 20, 2017	Original report issued

Section 2. Summary of test results

2.1 FCC Part 27 test results for Band 17

Part	Test description	Verdict
§27.50(c)	Maximum output power at RF antenna connector	Pass
§27.53(g)	Spurious emissions at RF antenna connector	Pass
§27.53(g)	Radiated spurious emissions	Pass
§27.54	Frequency stability	Pass
§2.1049	Occupied bandwidth	Pass

Notes: None

2.2 FCC Part 27 test results for Band 12

Part	Test description	Verdict
§27.50(c)	Maximum output power at RF antenna connector	Pass
§27.53(g)	Spurious emissions at RF antenna connector	Pass
§27.53(g)	Radiated spurious emissions	Pass
§27.54	Frequency stability	Pass
§2.1049	Occupied bandwidth	Pass

Notes: None

2.3 RSS-130 test results for band 17

Part	Test description	Verdict
4.4	Transmitter output power and Equivalent Isotropic Radiated Power (e.i.r.p.)	Pass
4.6.1	Spurious emissions at RF antenna connector	Pass
4.6.1	Radiated spurious emissions	Pass
4.3	Transmitter frequency stability	Pass
RSS-Gen, 6.6	Occupied bandwidth	Pass

Notes: None

2.4 RSS-130 test results for band 12

Part	Test description	Verdict
4.4	Transmitter output power and Equivalent Isotropic Radiated Power (e.i.r.p.)	Pass
4.6.1	Spurious emissions at RF antenna connector	Pass
4.6.1	Radiated spurious emissions	Pass
4.3	Transmitter frequency stability	Pass
RSS-Gen, 6.6	Occupied bandwidth	Pass

Notes: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	September 21, 2017
Nemko sample ID number	1

3.2 EUT information

Product name	LTE Base Station – Bands 12 and 17
Model	Ellipse 4G HP
Serial number	Band 12: 319RM17350001; Band 17: 322RM17360001
Antenna ports	2 TX/RX Ports
Frequency	Band 12: 729–746 MHz; Band 17: 734–746 MHz
Operating Frequencies:	Band 12: 731.5–743.5 MHz (5 MHz channel); 734–741 MHz (10 MHz channel) Band 17: 736.5–743.5 MHz (5 MHz channel); 739–741 MHz (10 MHz channel)
Nominal voltage	48 V_{DC} via 120 V_{AC}/ 60 Hz power supply
Modulation	LTE: QPSK, 16 QAM, 64 QAM
Channel bandwidth	LTE: 5, 10 MHz
Emission Designator:	5M00-W7D, 10M0-W7D

3.3 Product description and theory of operation

Ellipse 4G HP is an all outdoor LTE eNodeB (E-UTRAN Node B) single band base station operating in LTE Band 12 (729–746 MHz) or 17 (734–746 MHz)

3.4 EUT setup diagram

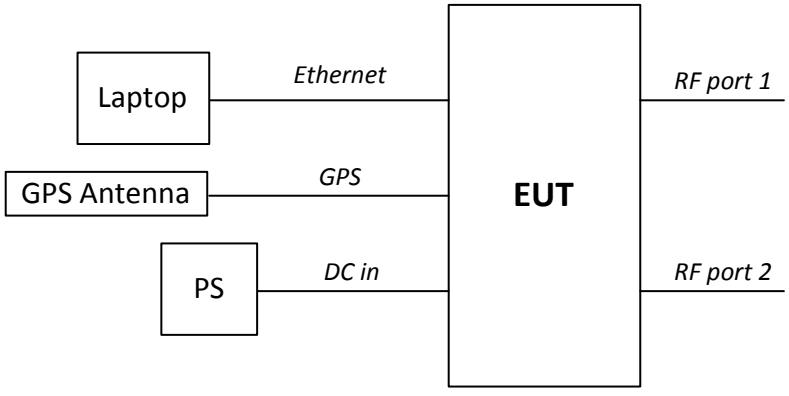

Figure 3.4-1: *Setup diagram*

3.5 Setup photographs

Figure 3.5-1: *Test / Measurement Equipment - Set up for Radio Compliance Testing – below 1 GHz*

Figure 3.5-2: *EUT Set-up for Radio Compliance Testing – above 1 GHz*

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Dec. 1/17
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
AC Power source	Chenwa	2700M-10k	FA002716	—	VOU
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 31/18
Horn with Preamp (1–18 GHz)	ETS-Lindgren	3117-PA	FA002840	1 year	Nov. 11/17
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	June 27/18
Spectrum analyzer	Rohde & Schwarz	FSP	FA001920	1 year	Aug. 08/18
Temperature chamber	Thermotron	SM-16C	FA001030	1 year	NCR

Note: NCR - no calibration required, VOU - verify on use

Section 8. Testing data

8.1 FCC 27.50(c) and RSS-130, 4.4 Maximum output power at RF antenna connector (Band 12)

8.1.1 Definitions and limits

§ 27.50(c) Operation in the 600 MHz band and the 698–746 MHz band.

(3) Fixed and base stations transmitting a signal with an emission bandwidth greater than 1 MHz must not exceed an ERP of 1000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts/MHz ERP in accordance with Table 3 of this section;

(4) Fixed and base stations located in a county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, and transmitting a signal with an emission bandwidth greater than 1 MHz must not exceed an ERP of 2000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 2000 watts/MHz ERP in accordance with Table 4 of this section;

RSS-130, Section 4.4

- The transmitter output power shall be measured in terms of average power.
- For base and fixed equipment, refer to SRSP-518 for power limits.
- The e.i.r.p. shall not exceed 50 watts for mobile equipment or for outdoor fixed subscriber equipment, nor shall it exceed 5 watts for portable equipment or for indoor fixed subscriber equipment.
- In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time and shall use a signal corresponding to the highest PAPR during periods of continuous transmission.

SRSP-518, Section 5.1

5.1.1 Fixed and base stations

5.1.1.1 For fixed and base stations transmitting in accordance with sections 4.1.1 to 4.1.3 within the frequency range 716–756 MHz with a channel bandwidth equal to or less than 1 MHz, the maximum permissible equivalent isotropically radiated power (e.i.r.p.) is 1640 watts with an antenna height above average terrain (HAAT) up to 305 metres. The same e.i.r.p. limit also applies to fixed and base stations operating at any frequency in the 700 MHz band in accordance with Section 4.1.4.

5.1.1.2 For fixed and base stations transmitting in accordance with sections 4.1.1 to 4.1.3 within the frequency range 716–756 MHz with a channel bandwidth greater than 1 MHz, the maximum permissible e.i.r.p. is 1640 watts/MHz (i.e. no more than 1640 watts e.i.r.p. in any 1 MHz band segment) with a HAAT up to 305 metres. The same e.i.r.p. limit also applies to fixed and base stations operating at any frequency in the 700 MHz band in accordance with Section 4.1.4.

5.1.1.3 Fixed and base stations located in geographical areas at a distance greater than 26 km from large or medium population centres and transmitting in accordance with sections 4.1.1 to 4.1.3 within the frequency range 716–756 MHz, may increase their e.i.r.p. up to a maximum of 3280 watts/MHz (i.e. no more than 3280 watts e.i.r.p. in any 1 MHz band segment), with an antenna HAAT up to 305 metres.

This provision also applies for fixed and base stations with a channel bandwidth equal to or less than 1 MHz (i.e. e.i.r.p. may be increased up to a maximum of 3280 watts).

5.1.1.4 For all installations with an antenna HAAT in excess of 305 metres, a corresponding reduction in e.i.r.p. according to the following formula shall be applied:

$$EIRP_{reduction} = 20 \log_{10}(HAAT / 305)\ dB$$

8.1.2 Test summary

Test date	October 11, 2017 - October 16, 2017
Test engineer	Andrey Adelberg
Verdict	Pass

8.1.3 Observations, settings and special notes

Note: ERP limit is 1000 W/MHz (60 dBm/MHz), EIRP limit is 1640 W/MHz (62.1484 dBm/MHz)
Based on the RF margins noted in this report, considerations pertaining to the maximum allowed EIRP and antenna type should be considered for each installation.
Test receiver settings:

Detector mode	RMS
Resolution bandwidth	Output power: 100 kHz; PSD: 1 MHz
Video bandwidth	>RBW
Measurement mode	Power over emission bandwidth
Trace mode	Power Averaging over 100 traces
Measurement time	Auto

8.1.4 Test data

Table 8.1-1: *Output power measurement results for 5 MHz channel, SISO operation*

Remarks	Frequency, MHz	Total RF output power, dBm	Total RF output power, W	RF output power (PSD), dBm/MHz	ERP limit, dBm/MHz	Margin, dB
QPSK, antenna port 1	731.5	39.36	8.630	33.72	60.00	26.28
QPSK, antenna port 1	737.5	39.73	9.397	34.12	60.00	25.88
QPSK, antenna port 1	743.5	39.83	9.616	34.11	60.00	25.89
QPSK, antenna port 2	731.5	39.90	9.772	33.20	60.00	26.80
QPSK, antenna port 2	737.5	39.28	8.472	33.55	60.00	26.45
QPSK, antenna port 2	743.5	39.46	8.831	33.76	60.00	26.24
16-QAM, antenna port 1	731.5	39.32	8.551	33.98	60.00	26.02
16-QAM, antenna port 1	737.5	39.72	9.376	34.20	60.00	25.80
16-QAM, antenna port 1	743.5	39.90	9.772	34.41	60.00	25.59
16-QAM, antenna port 2	731.5	38.81	7.603	33.49	60.00	26.51
16-QAM, antenna port 2	737.5	39.18	8.279	33.67	60.00	26.33
16-QAM, antenna port 2	743.5	39.39	8.690	34.07	60.00	25.93
64-QAM, antenna port 1	731.5	39.32	8.551	33.74	60.00	26.26
64-QAM, antenna port 1	737.5	39.72	9.376	34.01	60.00	25.99
64-QAM, antenna port 1	743.5	39.90	9.772	34.28	60.00	25.72
64-QAM, antenna port 2	731.5	38.97	7.889	33.25	60.00	26.75
64-QAM, antenna port 2	737.5	39.17	8.260	33.57	60.00	26.43
64-QAM, antenna port 2	743.5	39.55	9.016	33.83	60.00	26.17

Table 8.1-2: *Output power measurement results for 10 MHz channel, SISO operation*

Remarks	Frequency, MHz	Total RF output power, dBm	Total RF output power, W	RF output power (PSD), dBm/MHz	ERP limit, dBm/MHz	Margin, dB
QPSK, antenna port 1	734.0	39.41	8.730	30.84	60.00	29.16
QPSK, antenna port 1	737.5	39.63	9.183	31.01	60.00	28.99
QPSK, antenna port 1	741.0	39.71	9.354	31.09	60.00	28.91
QPSK, antenna port 2	734.0	39.06	8.054	30.43	60.00	29.57
QPSK, antenna port 2	737.5	39.29	8.492	30.69	60.00	29.31
QPSK, antenna port 2	741.0	39.37	8.650	30.65	60.00	29.35
16-QAM, antenna port 1	734.0	39.42	8.750	31.03	60.00	28.97
16-QAM, antenna port 1	737.5	39.50	8.913	31.10	60.00	28.90
16-QAM, antenna port 1	741.0	39.64	9.204	31.22	60.00	28.78
16-QAM, antenna port 2	734.0	38.93	7.816	30.71	60.00	29.29
16-QAM, antenna port 2	737.5	39.03	7.998	30.86	60.00	29.14
16-QAM, antenna port 2	741.0	39.21	8.337	30.81	60.00	29.19
64-QAM, antenna port 1	734.0	39.42	8.750	30.82	60.00	29.18
64-QAM, antenna port 1	737.5	39.55	9.016	30.99	60.00	29.01
64-QAM, antenna port 1	741.0	39.77	9.484	31.06	60.00	28.94
64-QAM, antenna port 2	734.0	39.07	8.072	30.44	60.00	29.56
64-QAM, antenna port 2	737.5	39.23	8.375	30.59	60.00	29.41
64-QAM, antenna port 2	741.0	39.41	8.730	30.74	60.00	29.26

Table 8.1-3: *Output power measurement results for 5 MHz, MIMO operation*

Remarks	Frequency, MHz	RF output power Antenna 1, dBm/MHz	RF output power Antenna 2, dBm/MHz	Total output power, dBm/MHz	ERP limit, dBm/MHz	Margin, dB
QPSK modulation	731.5	33.72	33.20	36.48	60.00	23.52
QPSK modulation	737.5	34.12	33.55	36.85	60.00	23.15
QPSK modulation	743.5	34.11	33.76	36.95	60.00	23.05
16-QAM modulation	731.5	33.98	33.49	36.75	60.00	23.25
16-QAM modulation	737.5	34.20	33.67	36.95	60.00	23.05
16-QAM modulation	743.5	34.41	34.07	37.25	60.00	22.75
64-QAM modulation	731.5	33.74	33.25	36.51	60.00	23.49
64-QAM modulation	737.5	34.01	33.57	36.81	60.00	23.19
64-QAM modulation	743.5	34.28	33.83	37.07	60.00	22.93

Table 8.1-4: *Output power measurement results for 10 MHz, MIMO operation*

Remarks	Frequency, MHz	RF output power Antenna 1, dBm/MHz	RF output power Antenna 2, dBm/MHz	Total output power, dBm/MHz	ERP limit, dBm/MHz	Margin, dB
QPSK modulation	734.0	30.84	30.43	33.65	60.00	26.35
QPSK modulation	737.5	31.01	30.69	33.86	60.00	26.14
QPSK modulation	741.0	31.09	30.65	33.89	60.00	26.11
16-QAM modulation	734.0	31.03	30.71	33.88	60.00	26.12
16-QAM modulation	737.5	31.10	30.86	33.99	60.00	26.01
16-QAM modulation	741.0	31.22	30.81	34.03	60.00	25.97
64-QAM modulation	734.0	30.82	30.44	33.64	60.00	26.36
64-QAM modulation	737.5	30.99	30.59	33.80	60.00	26.20
64-QAM modulation	741.0	31.06	30.74	33.91	60.00	26.09

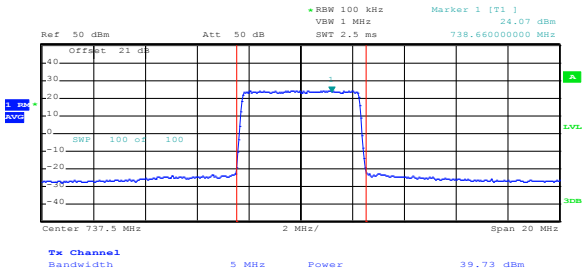

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Figure 8.1-1: *Output power sample plot, QPSK, 5 MHz*

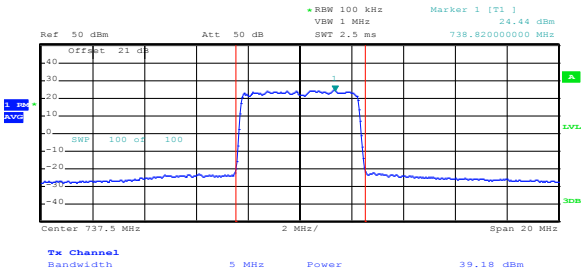

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Figure 8.1-2: *Output power sample plot, 16-QAM, 5 MHz*

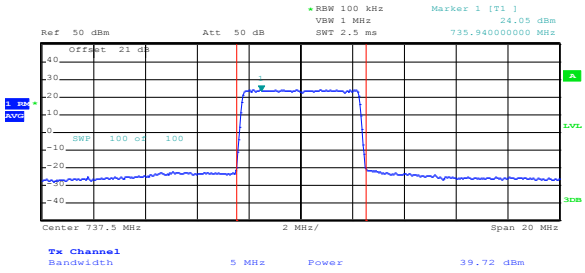

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Figure 8.1-3: *Output power sample plot, 64-QAM, 5 MHz*

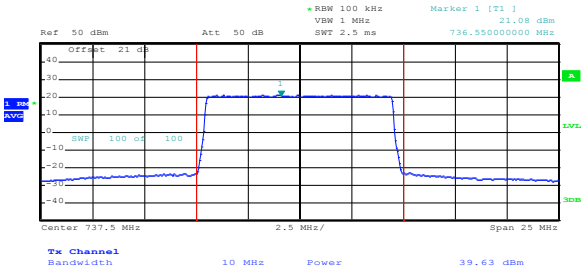

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Figure 8.1-4: *Output power sample plot, QPSK, 10 MHz*

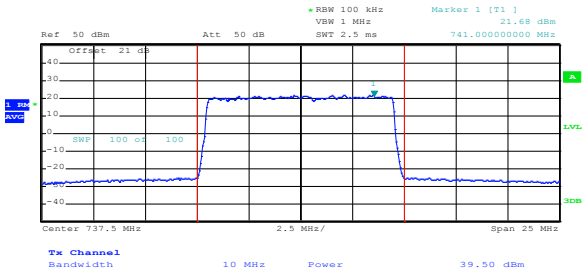

Figure 8.1-5: *Output power sample plot, 16-QAM, 10 MHz*

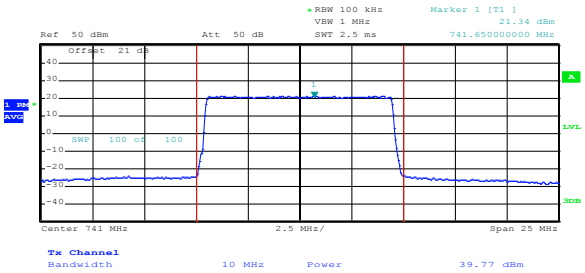

Figure 8.1-6: *Output power sample plot, 64-QAM, 10 MHz*

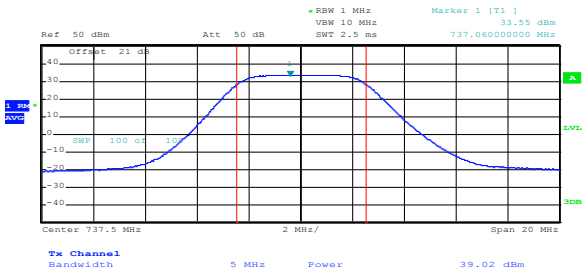

Figure 8.1-7: *PSD sample plot, QPSK, 5 MHz*

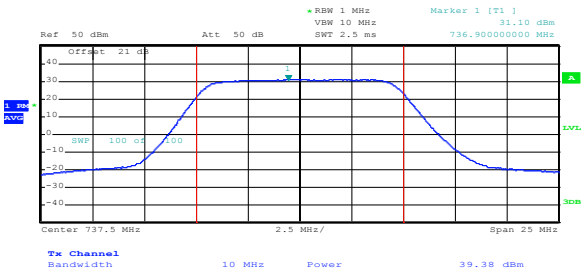

Figure 8.1-8: *PSD sample plot, 16-QAM, 5 MHz*

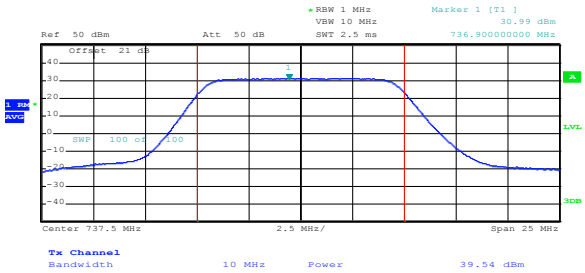

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Figure 8.1-9: *PSD sample plot, 64-QAM, 5 MHz*

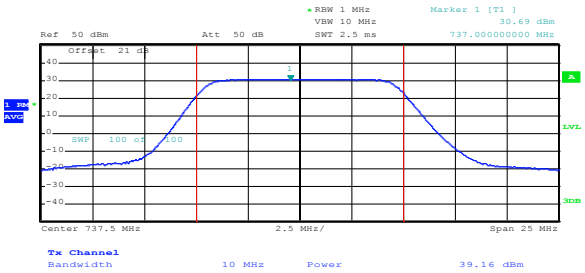

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Figure 8.1-10: *PSD sample plot, QPSK, 10 MHz*

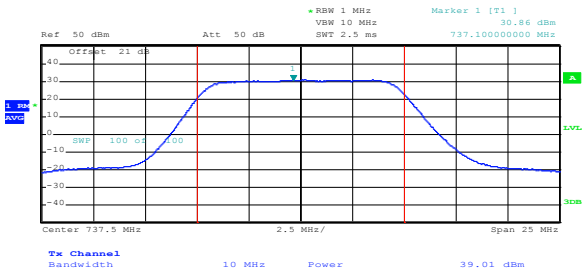

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Figure 8.1-11: *PSD sample plot, 16-QAM, 10 MHz*

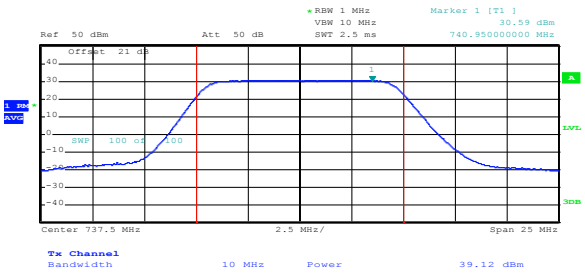

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Figure 8.1-12: *PSD sample plot, 64-QAM, 10 MHz*

Table 8.1-5: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results*

Remarks	0.1% CCDF, dB	PAPR reduction limit, dB	Margin, dB
QPSK, 5 MHz	7.28	13.00	5.72
16-QAM, 5 MHz	7.32	13.00	5.68
64-QAM, 5 MHz	7.44	13.00	5.56
QPSK, 10 MHz	7.60	13.00	5.40
16-QAM, 10 MHz	7.72	13.00	5.28
64-QAM, 10 MHz	7.72	13.00	5.28

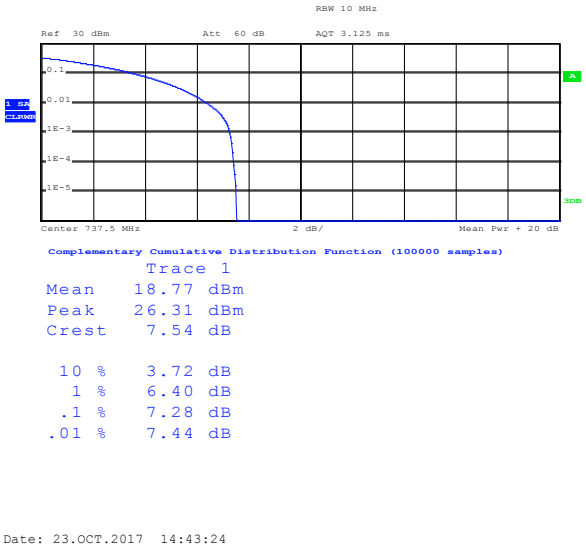


Figure 8.1-13: *CCDF, 5 MHz, QPSK*

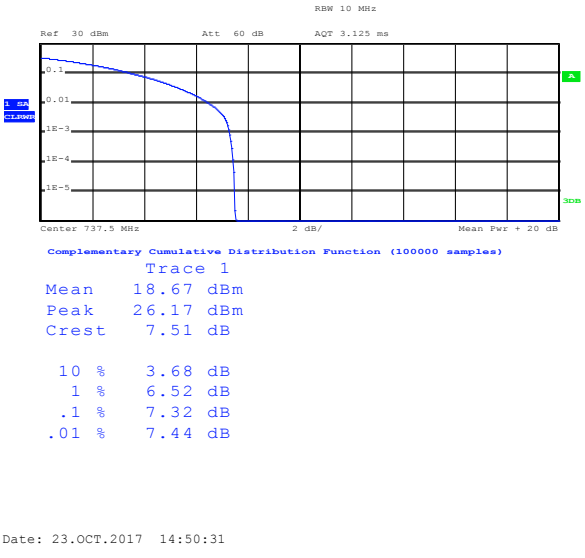


Figure 8.1-14: *CCDF, 5 MHz, 16-QAM*

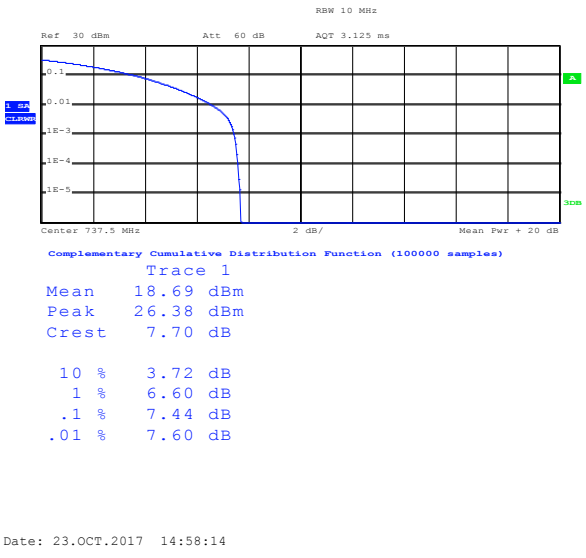


Figure 8.1-15: *CCDF, 5 MHz, 64-QAM*

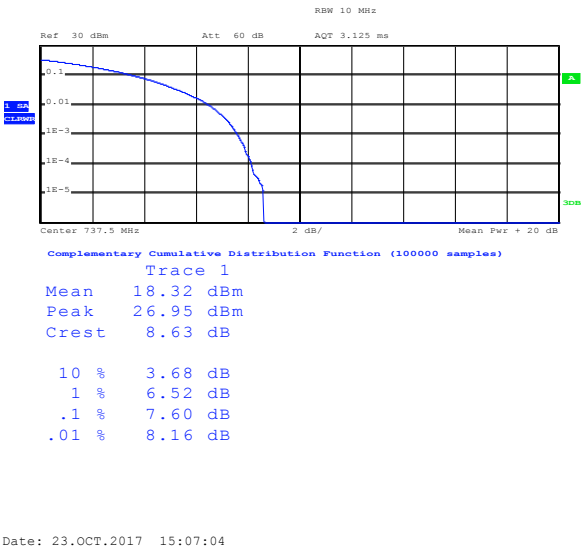


Figure 8.1-16: *CCDF, 10 MHz, QPSK*

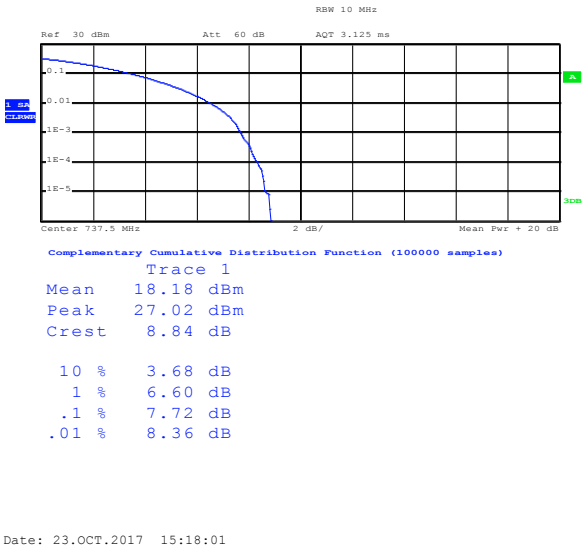


Figure 8.1-17: *CCDF, 10 MHz, 16-QAM*

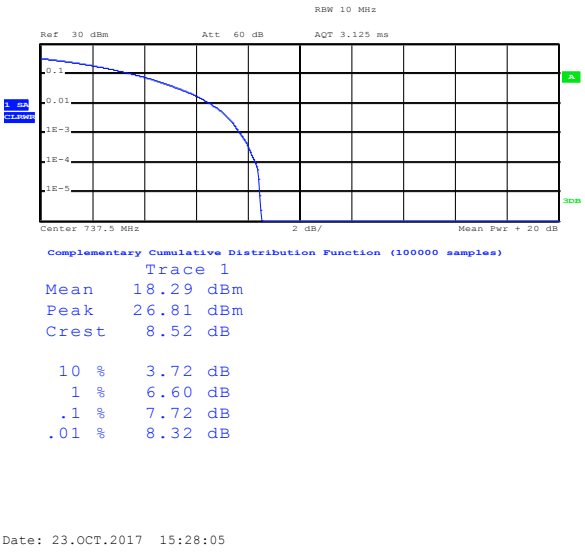


Figure 8.1-18: *CCDF, 10 MHz, 64-QAM*

8.2 FCC 27.53(g) and RSS-130, 4.6.1 Spurious emissions at RF antenna connector (Band 12)

8.2.1 Definitions and limits

FCC:
(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 (−13 dBm). 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:
4.6.1 The power of any unwanted emissions in any 100 kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 $\log_{10}$ p (watts), dB (−13 dBm). However, in the 100 kHz band immediately outside the equipment's operating frequency range, a resolution bandwidth of 30 kHz may be employed.

8.2.2 Test summary

Test date	October 18, 2017
Test engineer	Andrey Adelberg
Verdict	Pass

8.2.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
All measurements were performed using a peak detector.
For MIMO applications all marker values on the plots below should be increased by 3 dB (10 × Log_{10}(2))
RBW within 30–1000 MHz was 100 kHz and 1 MHz above 1 GHz. VBW was wider than RBW.

8.2.4 Test data

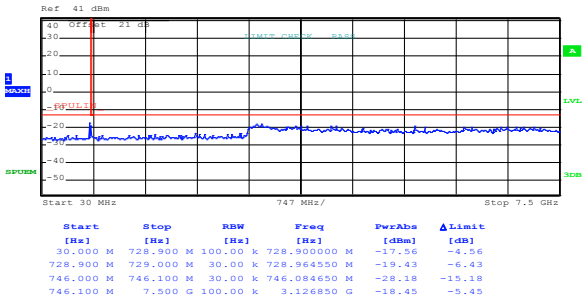


Figure 8.2-1: *Conducted spurious emissions, antenna 1, 5 MHz, low channel, QPSK*

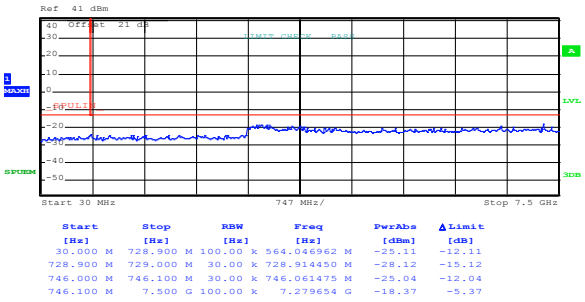


Figure 8.2-2: *Conducted spurious emissions, antenna 1, 5 MHz, mid channel, QPSK*

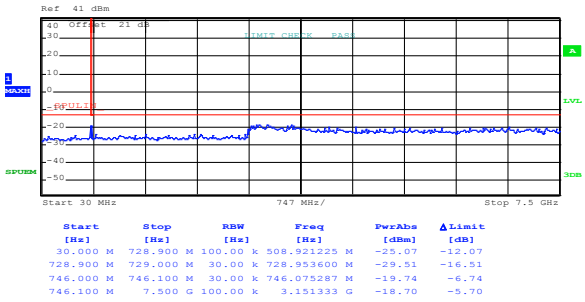


Figure 8.2-3: *Conducted spurious emissions, antenna 1, 5 MHz, high channel, QPSK*

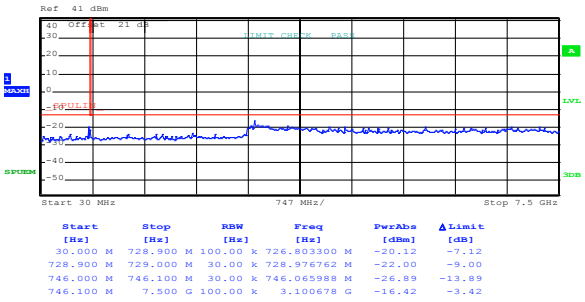


Figure 8.2-4: *Conducted spurious emissions, antenna 2, 5 MHz, low channel, QPSK*

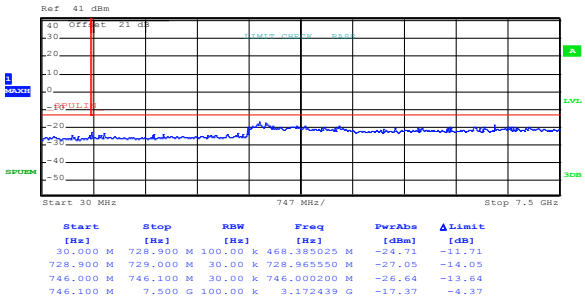


Figure 8.2-5: *Conducted spurious emissions, antenna 2, 5 MHz, mid channel, QPSK*

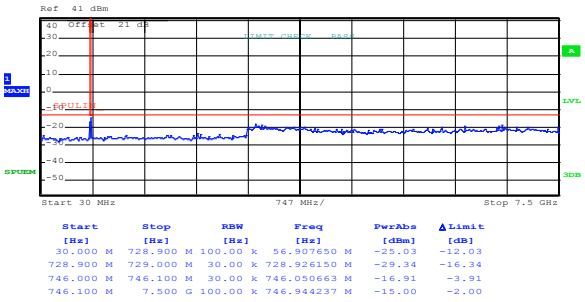


Figure 8.2-6: *Conducted spurious emissions, antenna 2, 5 MHz, high channel, QPSK*

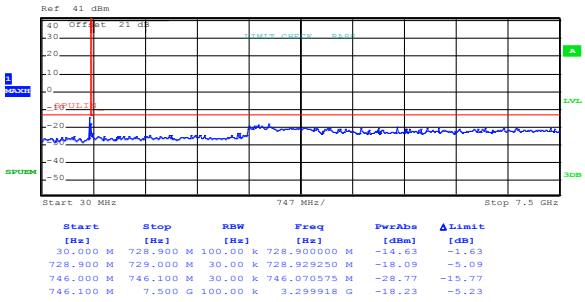


Figure 8.2-7: *Conducted spurious emissions, antenna 1, 5 MHz, low channel, 16-QAM*

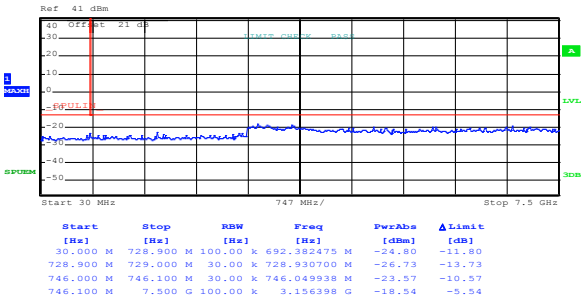


Figure 8.2-8: *Conducted spurious emissions, antenna 1, 5 MHz, mid channel, 16-QAM*

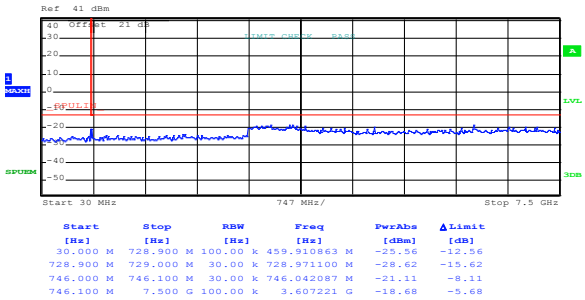


Figure 8.2-9: *Conducted spurious emissions, antenna 1, 5 MHz, high channel, 16-QAM*

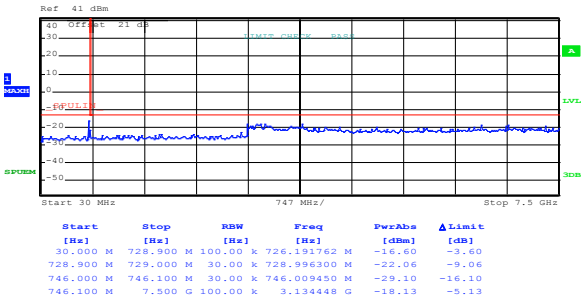


Figure 8.2-10: *Conducted spurious emissions, antenna 2, 5 MHz, low channel, 16-QAM*

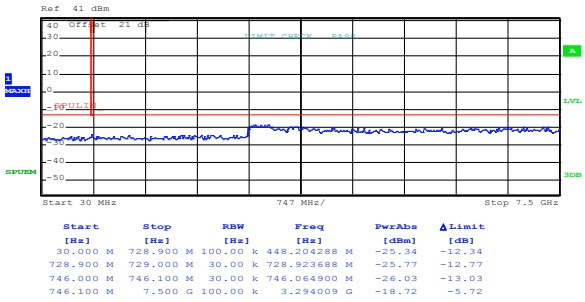


Figure 8.2-11: *Conducted spurious emissions, antenna 2, 5 MHz, mid channel, 16-QAM*

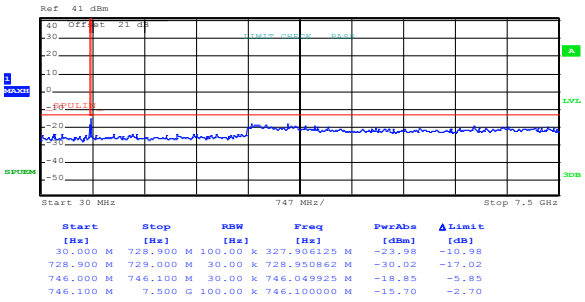


Figure 8.2-12: *Conducted spurious emissions, antenna 2, 5 MHz, high channel, 16-QAM*

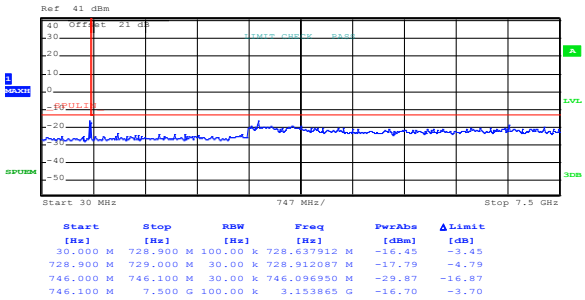


Figure 8.2-13: *Conducted spurious emissions, antenna 1, 5 MHz, low channel, 64-QAM*

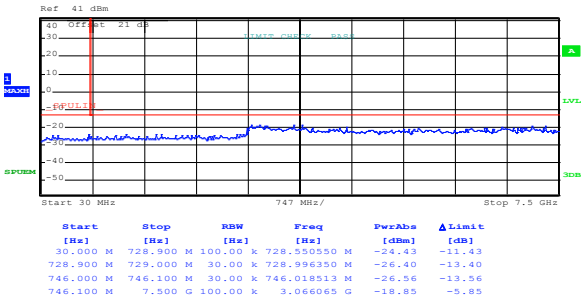


Figure 8.2-14: *Conducted spurious emissions, antenna 1, 5 MHz, mid channel, 64-QAM*

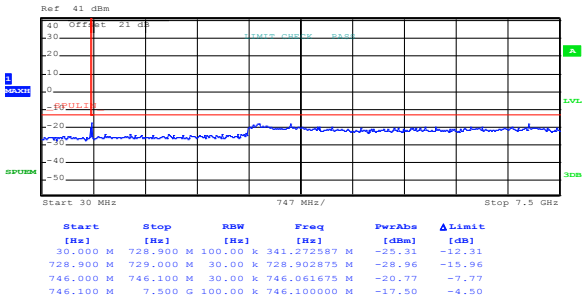


Figure 8.2-15: *Conducted spurious emissions, antenna 1, 5 MHz, high channel, 64-QAM*

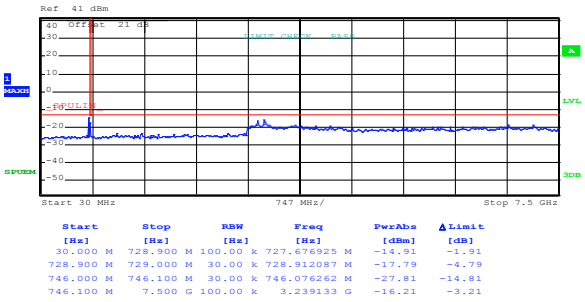


Figure 8.2-16: *Conducted spurious emissions, antenna 2, 5 MHz, low channel, 64-QAM*

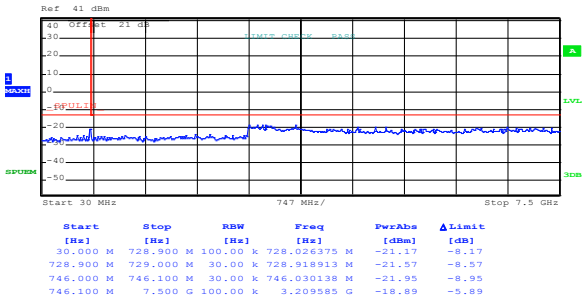


Figure 8.2-17: *Conducted spurious emissions, antenna 2, 5 MHz, mid channel, 64-QAM*

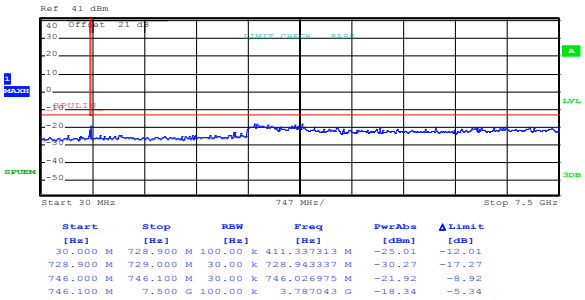


Figure 8.2-18: *Conducted spurious emissions, antenna 2, 5 MHz, high channel, 64-QAM*

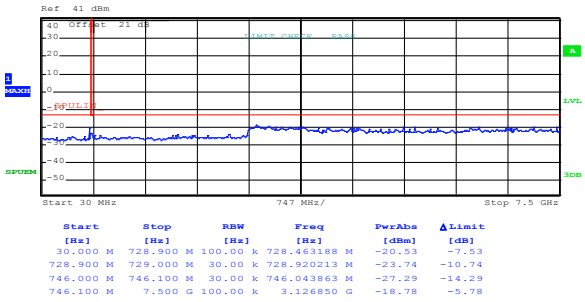


Figure 8.2-19: *Conducted spurious emissions, antenna 1, 10 MHz, low channel, QPSK*

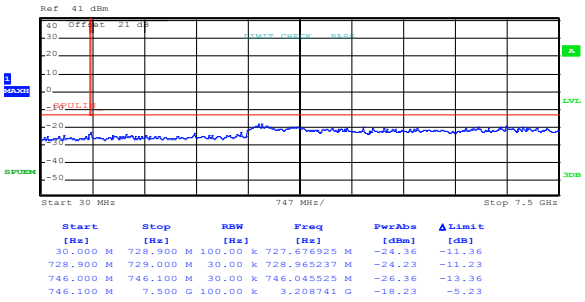


Figure 8.2-20: *Conducted spurious emissions, antenna 1, 10 MHz, mid channel, QPSK*

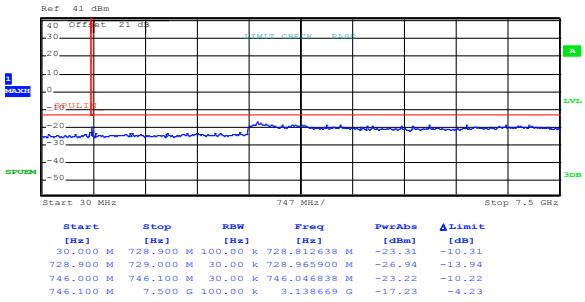


Figure 8.2-21: *Conducted spurious emissions, antenna 1, 10 MHz, high channel, QPSK*

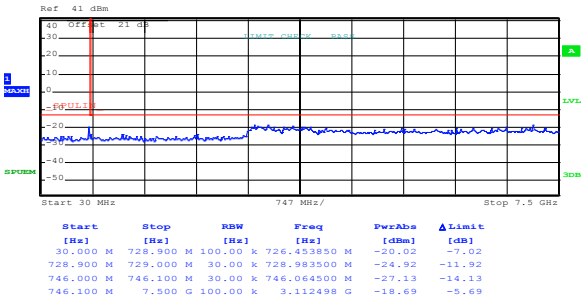


Figure 8.2-22: *Conducted spurious emissions, antenna 2, 10 MHz, low channel, QPSK*

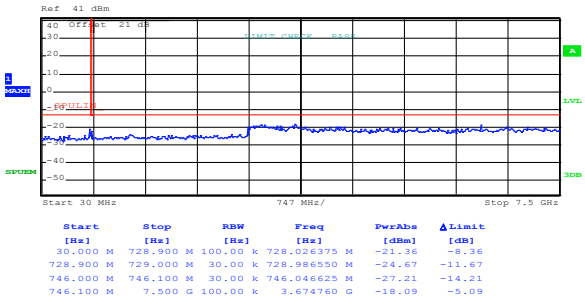


Figure 8.2-23: *Conducted spurious emissions, antenna 2, 10 MHz, mid channel, QPSK*

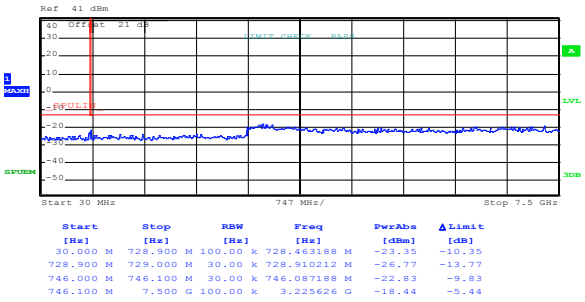
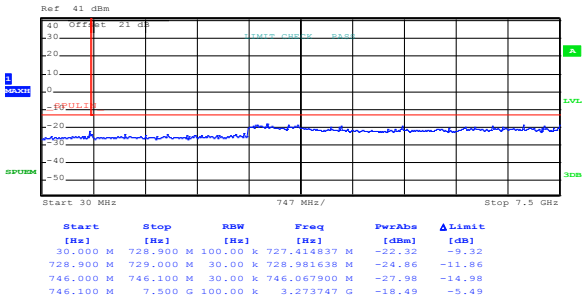


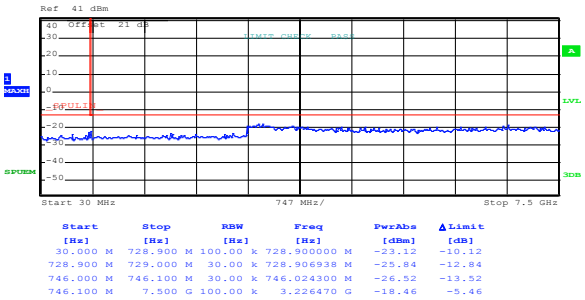
Figure 8.2-24: *Conducted spurious emissions, antenna 2, 10 MHz, high channel, QPSK*



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
30.000 M	728.900 M	100.00 k	727.414837 M	-22.32	-9.32
728.900 M	729.000 M	30.00 k	728.981638 M	-24.86	-11.86
746.000 M	746.100 M	30.00 k	746.067900 M	-27.98	-14.98
746.100 M	7.500 G	100.00 k	3.273747 G	-18.49	-5.49

Date: 18.OCT.2017 15:39:00

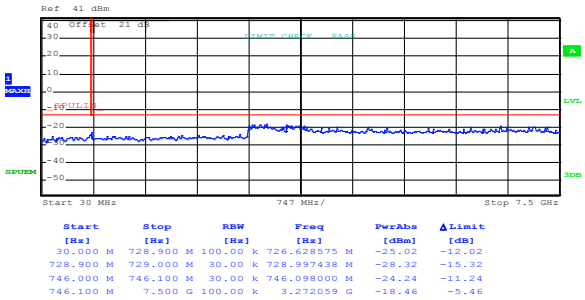
Figure 8.2-25: *Conducted spurious emissions, antenna 1, 10 MHz, low channel, 16-QAM*



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
30.000 M	728.900 M	100.00 k	728.900000 M	-23.12	-10.12
728.900 M	729.000 M	30.00 k	728.906938 M	-25.84	-12.84
746.000 M	746.100 M	30.00 k	746.024300 M	-26.52	-13.52
746.100 M	7.500 G	100.00 k	3.226470 G	-18.46	-5.46

Date: 18.OCT.2017 15:43:39

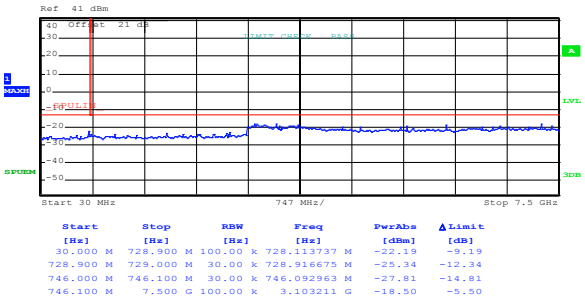
Figure 8.2-26: *Conducted spurious emissions, antenna 1, 10 MHz, mid channel, 16-QAM*



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
30.000 M	728.900 M	100.00 k	726.628575 M	-25.02	-12.02
728.900 M	729.000 M	30.00 k	728.997438 M	-28.32	-15.32
746.000 M	746.100 M	30.00 k	746.098000 M	-24.24	-11.24
746.100 M	7.500 G	100.00 k	3.272059 G	-18.46	-5.46

Date: 18.OCT.2017 15:47:03

Figure 8.2-27: *Conducted spurious emissions, antenna 1, 10 MHz, high channel, 16-QAM*



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	ΔLimit [dB]
30.000 M	728.900 M	100.00 k	728.113737 M	-22.19	-9.19
728.900 M	729.000 M	30.00 k	728.916675 M	-25.34	-12.34
746.000 M	746.100 M	30.00 k	746.092963 M	-27.81	-14.81
746.100 M	7.500 G	100.00 k	3.103211 G	-18.50	-5.50

Date: 18.OCT.2017 15:39:57

Figure 8.2-28: *Conducted spurious emissions, antenna 2, 10 MHz, low channel, 16-QAM*

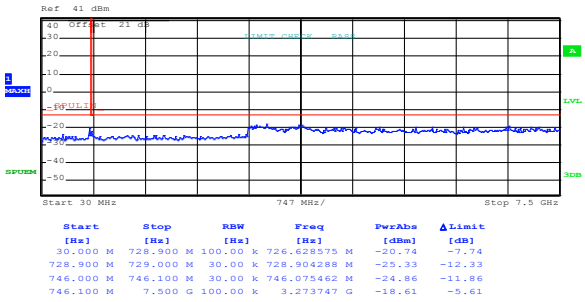


Figure 8.2-29: *Conducted spurious emissions, antenna 2, 10 MHz, mid channel, 16-QAM*

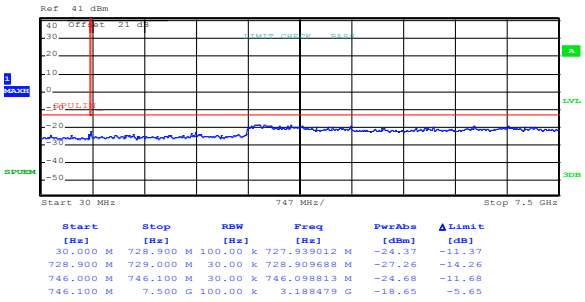


Figure 8.2-30: *Conducted spurious emissions, antenna 2, 10 MHz, high channel, 16-QAM*

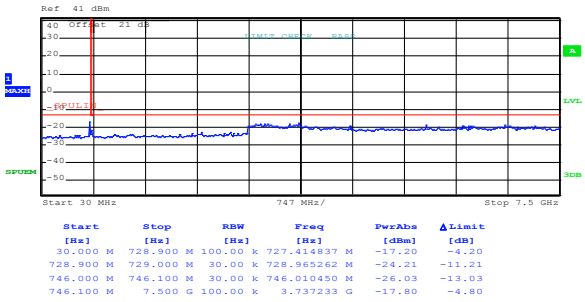


Figure 8.2-31: *Conducted spurious emissions, antenna 1, 10 MHz, low channel, 64-QAM*

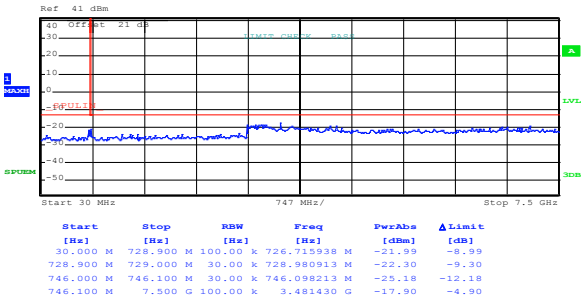


Figure 8.2-32: *Conducted spurious emissions, antenna 1, 10 MHz, mid channel, 64-QAM*

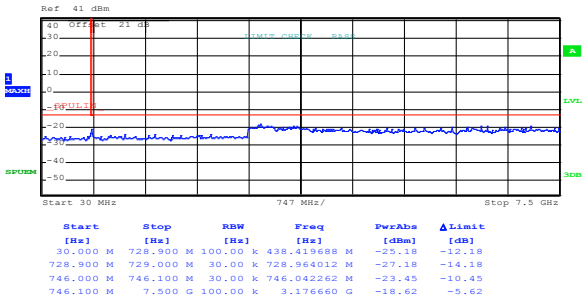


Figure 8.2-33: *Conducted spurious emissions, antenna 1, 10 MHz, high channel, 64-QAM*

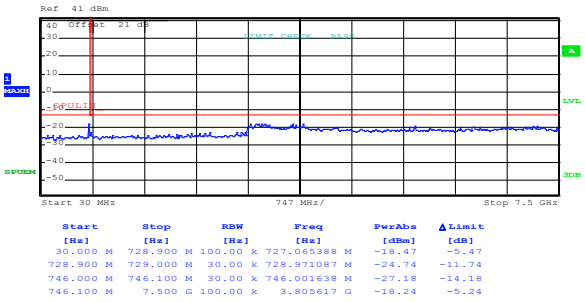


Figure 8.2-34: *Conducted spurious emissions, antenna 2, 10 MHz, low channel, 64-QAM*

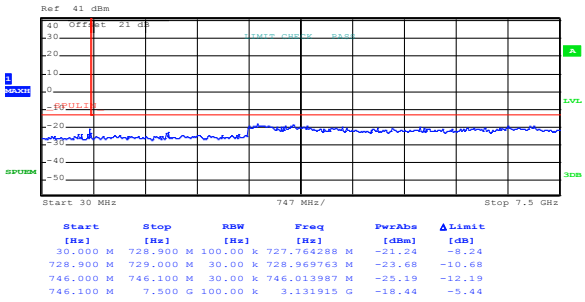


Figure 8.2-35: *Conducted spurious emissions, antenna 2, 10 MHz, mid channel, 64-QAM*

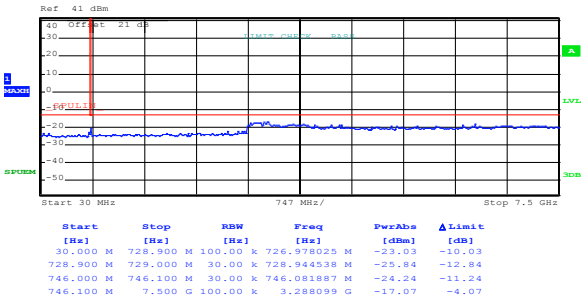


Figure 8.2-36: *Conducted spurious emissions, antenna 2, 10 MHz, high channel, 64-QAM*

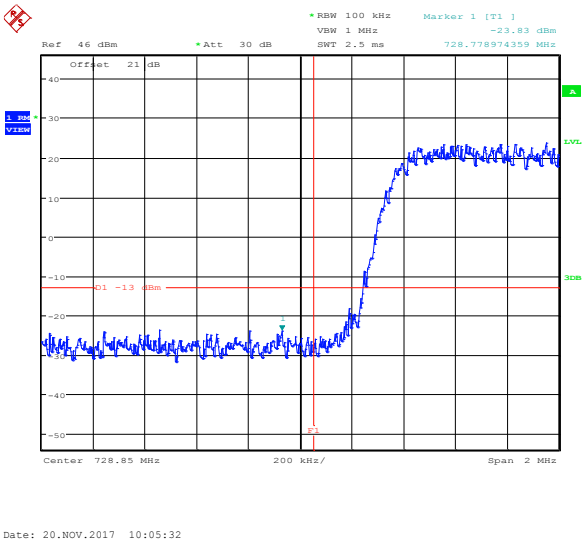


Figure 8.2-37: *Lower band edge emission, 5 MHz channel, antenna 1*

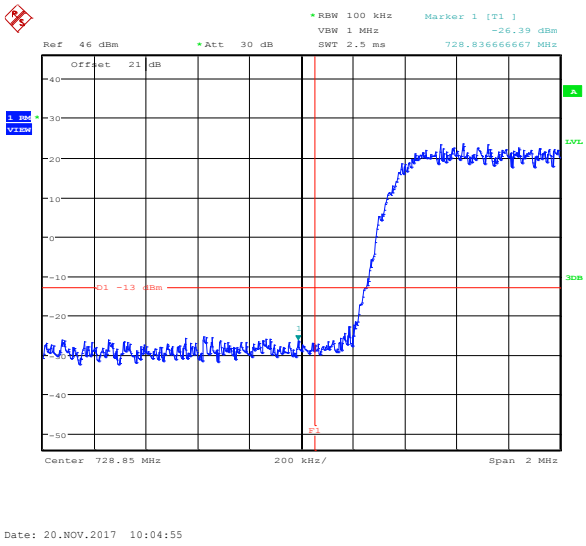


Figure 8.2-38: *Lower band edge emission, 5 MHz channel, antenna 2*

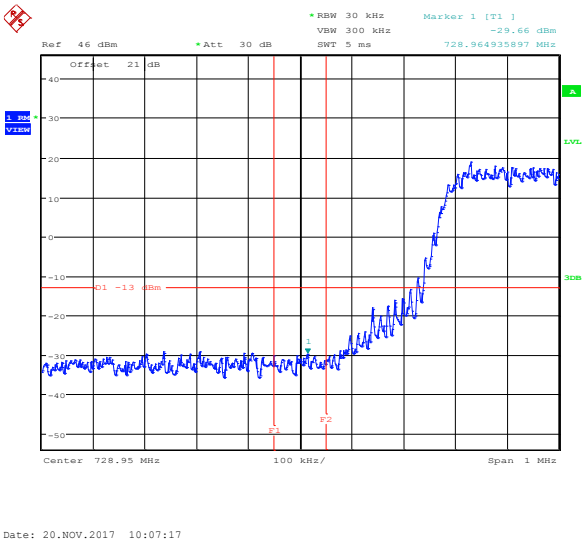


Figure 8.2-39: *Lower band edge Out-of-band emission, 5 MHz channel, antenna 1*

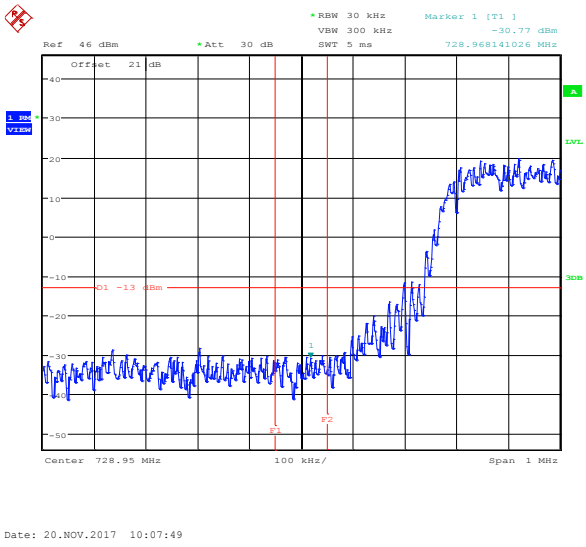


Figure 8.2-40: *Lower band edge Out-of-band emission, 5 MHz channel, antenna 2*

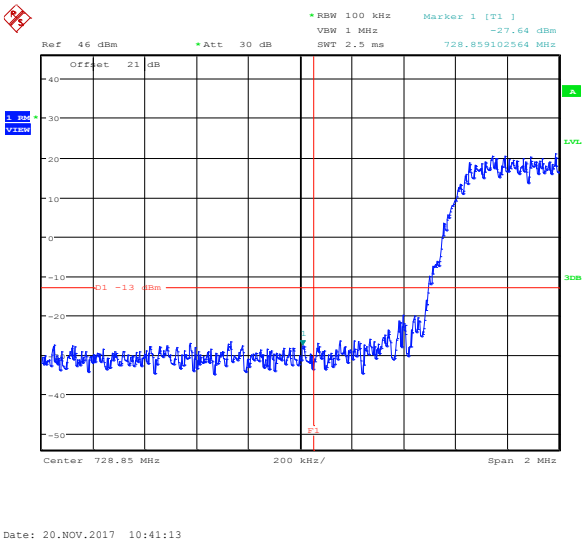


Figure 8.2-41: *Lower band edge emission, 10 MHz channel, antenna 1*

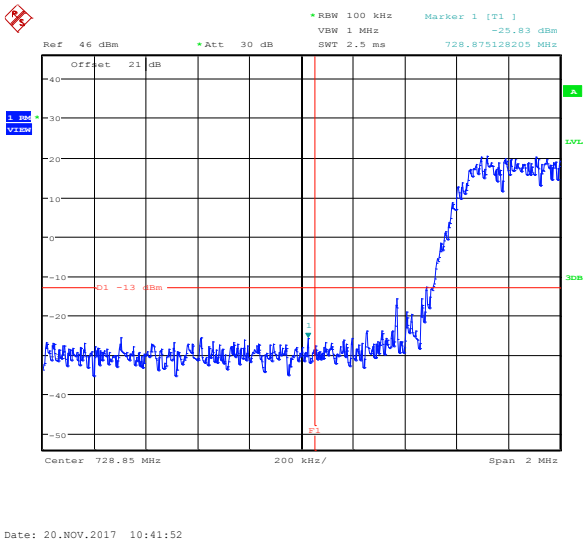


Figure 8.2-42: *Lower band edge emission, 10 MHz channel, antenna 2*

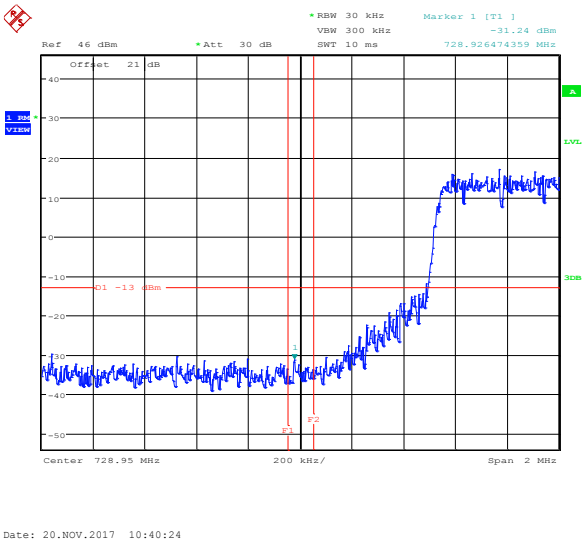


Figure 8.2-43: *Lower band edge Out-of-band emission, 10 MHz channel, antenna 1*

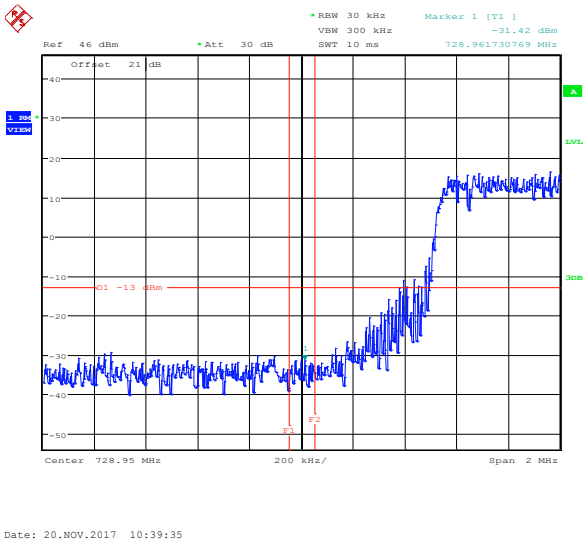


Figure 8.2-44: *Lower band edge Out-of-band emission, 10 MHz channel, antenna 2*

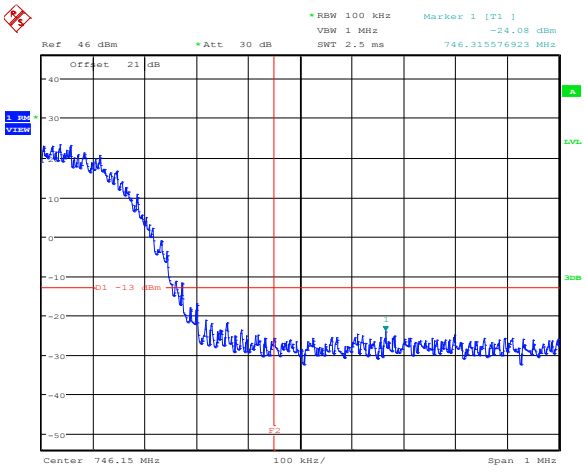


Figure 8.2-45: *Upper band edge emission, 5 MHz channel, antenna 1*

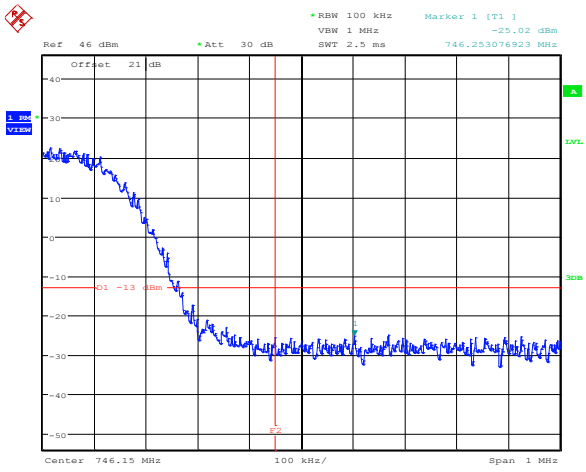


Figure 8.2-46: *Upper band edge emission, 5 MHz channel, antenna 2*

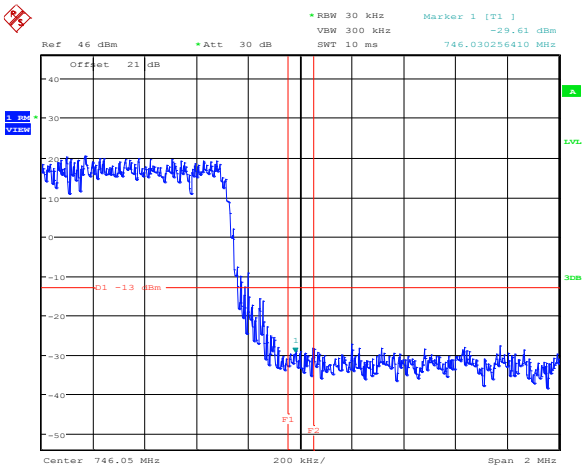


Figure 8.2-47: *Upper band edge Out-of-band emission, 5 MHz channel, antenna 1*

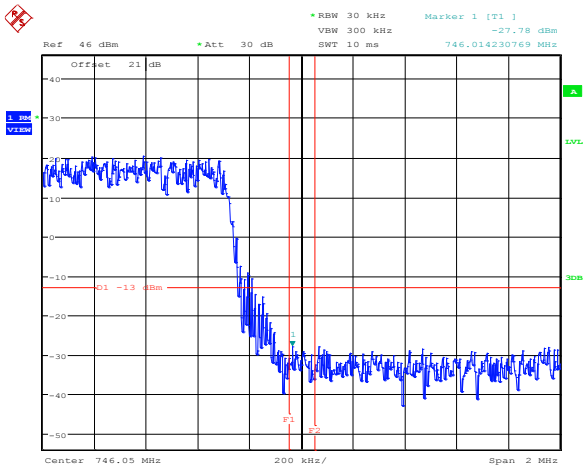


Figure 8.2-48: *Upper band edge Out-of-band emission, 5 MHz channel, antenna 2*

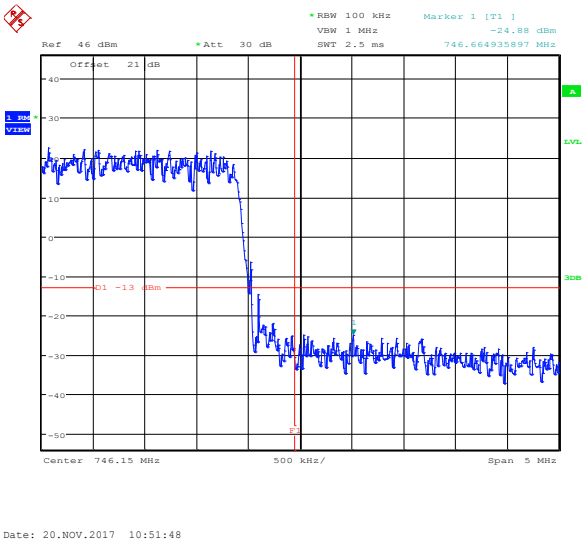


Figure 8.2-49: *Upper band edge emission, 10 MHz channel, antenna 1*

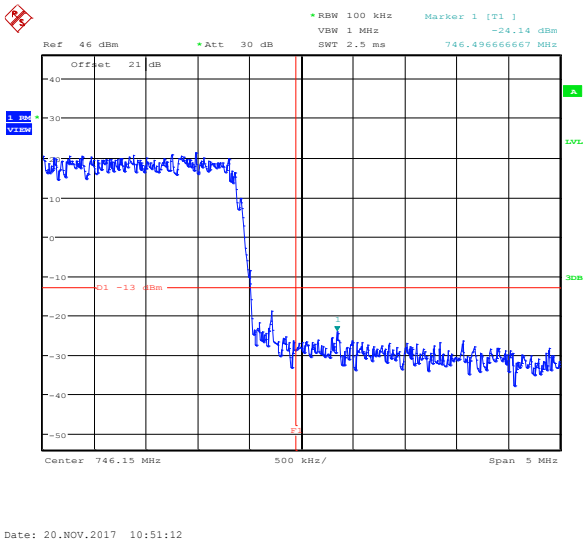


Figure 8.2-50: *Upper band edge emission, 10 MHz channel, antenna 2*

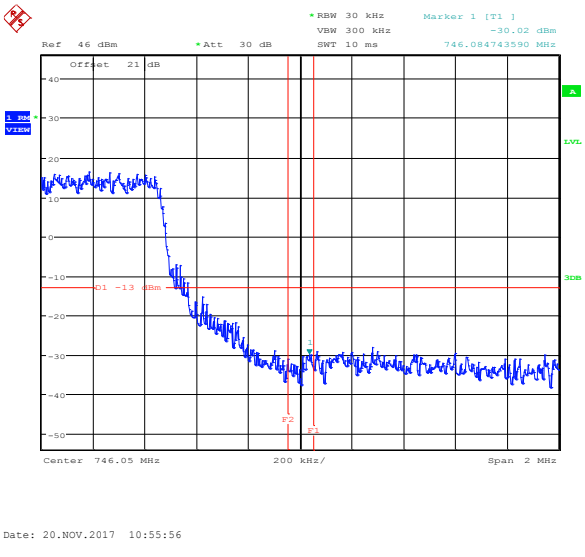


Figure 8.2-51: *Upper band edge Out-of-band emission, 10 MHz channel, antenna 1*

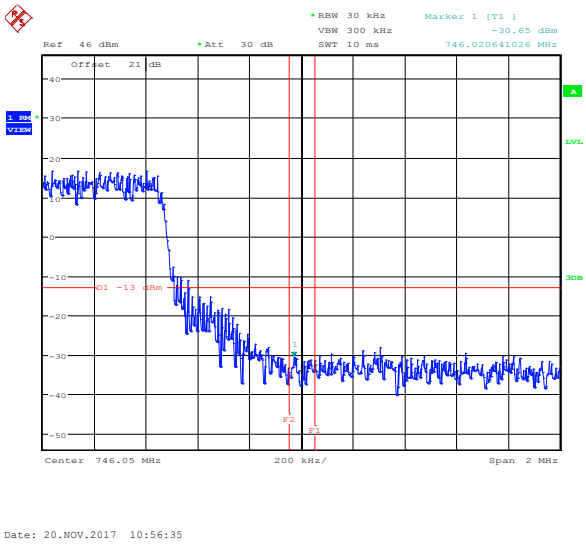


Figure 8.2-52: *Upper band edge Out-of-band emission, 10 MHz channel, antenna 2*

8.3 FCC 27.53(g) and RSS-130, 4.6.1 Radiated spurious emissions (Band 12)

8.3.1 Definitions and limits

FCC:
(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 (−13 dBm). 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:
4.6.1 The power of any unwanted emissions in any 100 kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 $\log_{10}$ p (watts), dB (−13 dBm). However, in the 100 kHz band immediately outside the equipment's operating frequency range, a resolution bandwidth of 30 kHz may be employed.

8.3.2 Test summary

Test date	October 12, 2017
Test engineer	Andrey Adelberg
Verdict	Pass

8.3.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
All measurements were performed using a peak detector.
RBW within 30–1000 MHz was 100 kHz and 1 MHz above 1 GHz. VBW was wider than RBW.
Testing was performed with RF ports terminated with 50 Ohm load.

8.3.4 Test data

Table 8.3-1: *Radiated spurious emissions, worst case*

Remarks	Frequency, MHz	Emission power level, dBm	Limit, dBm	Margin, dB
5 MHz channel	1463.0	-37	-13	24
10 MHz channel	1468.0	-41	-13	28

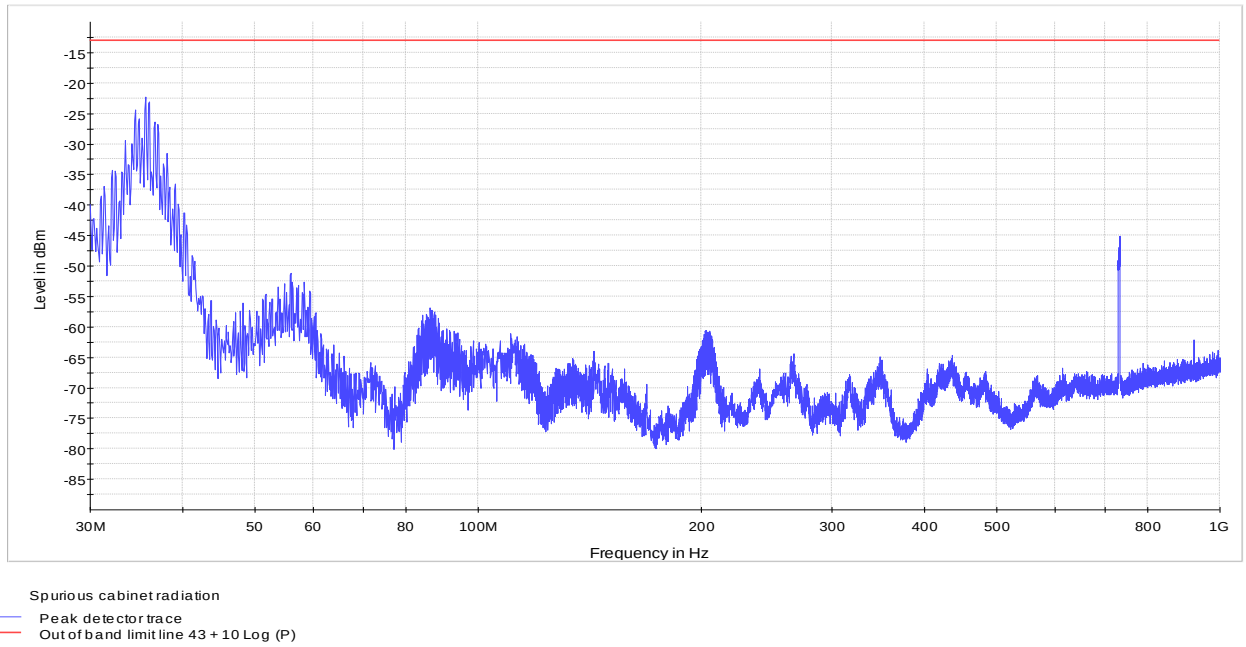


Figure 8.3-1: *Radiated spurious emission below 1 GHz, 5 MHz channel*

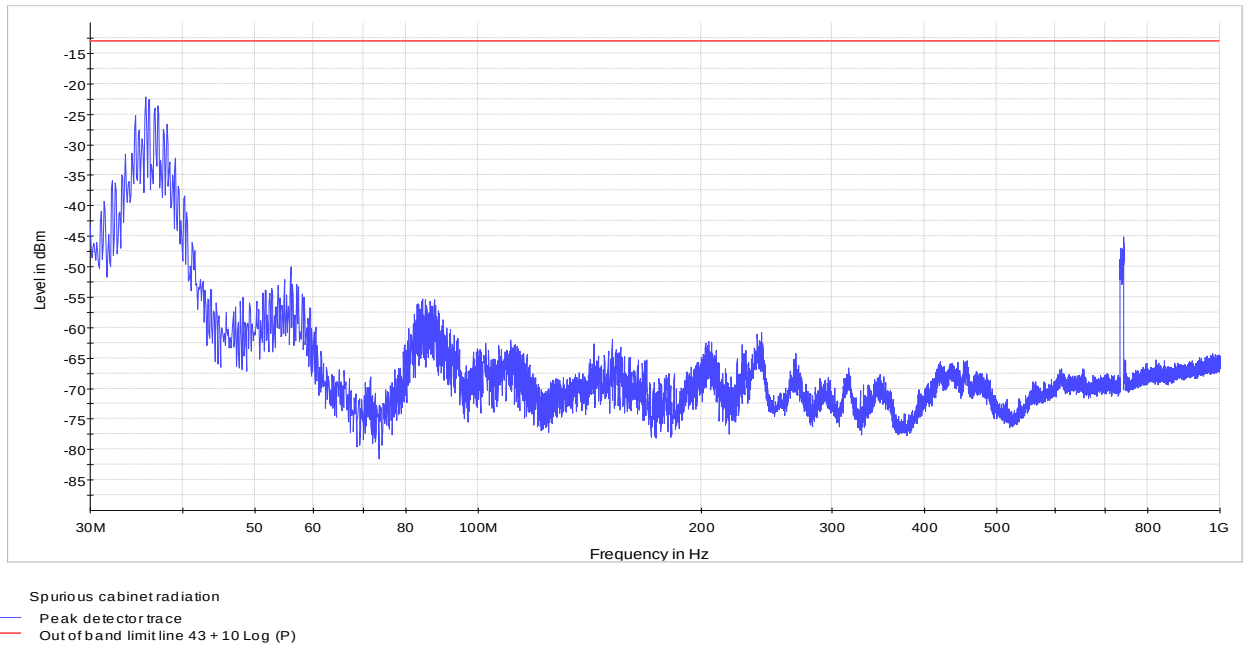


Figure 8.3-2: *Radiated spurious emission below 1 GHz, 10 MHz channel*

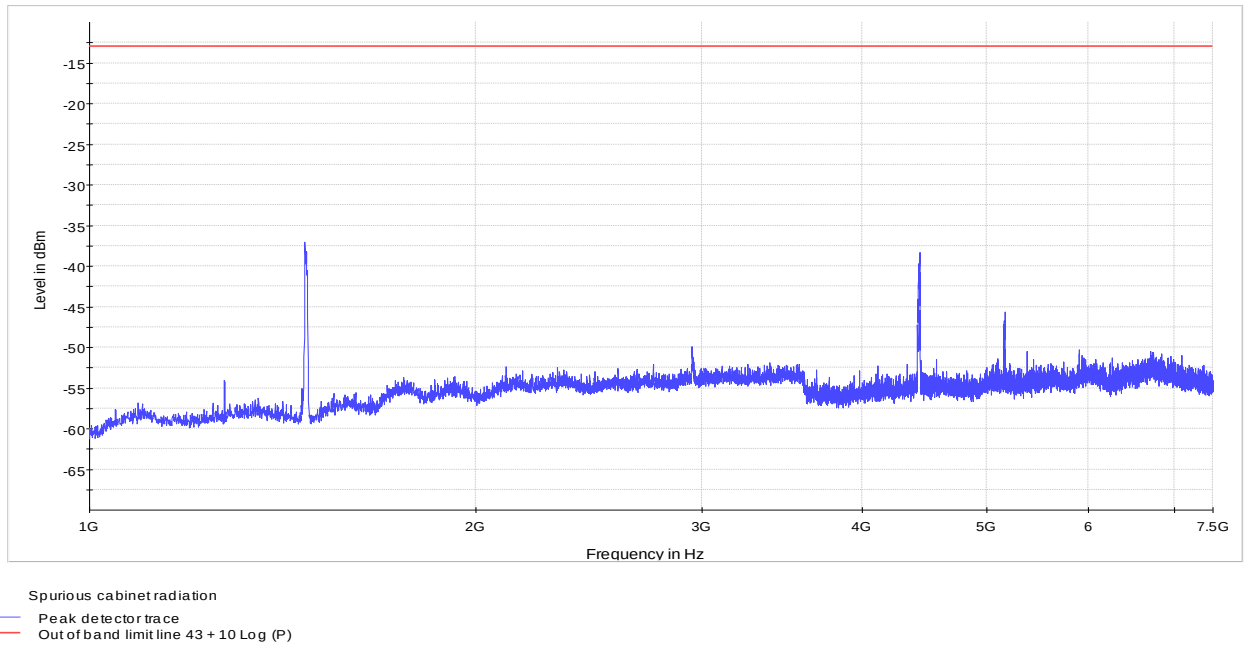


Figure 8.3-3: *Radiated spurious emission above 1 GHz, 5 MHz channel*

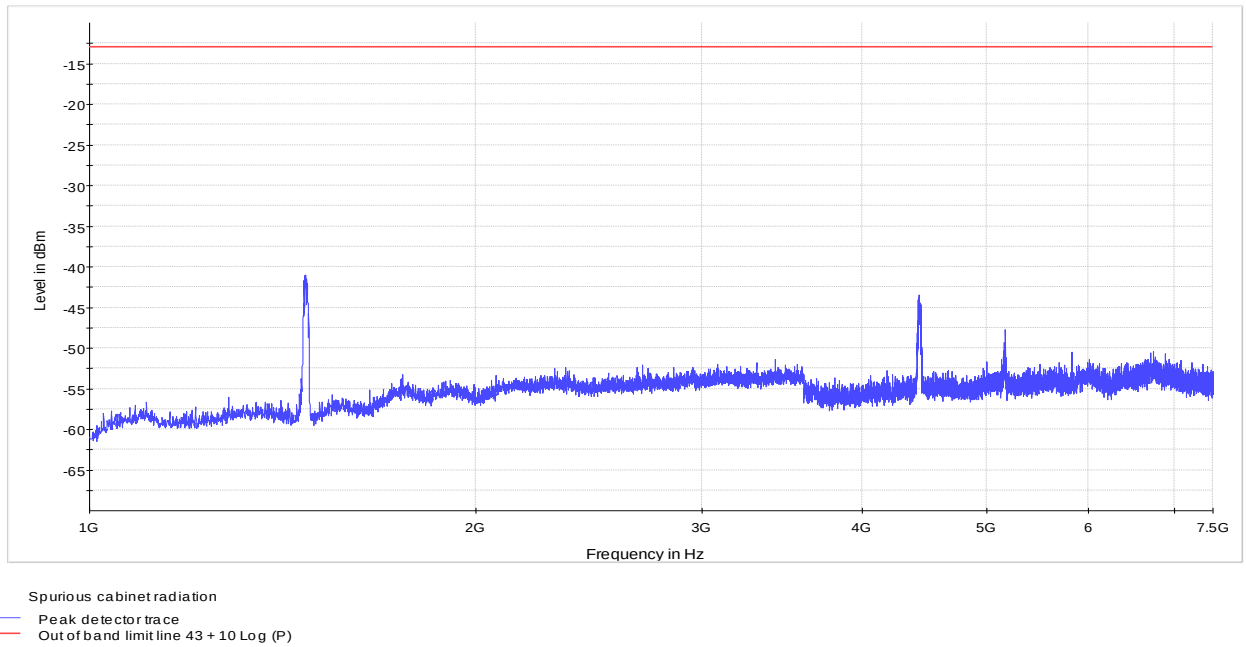


Figure 8.3-4: *Radiated spurious emission above 1 GHz, 10 MHz channel*

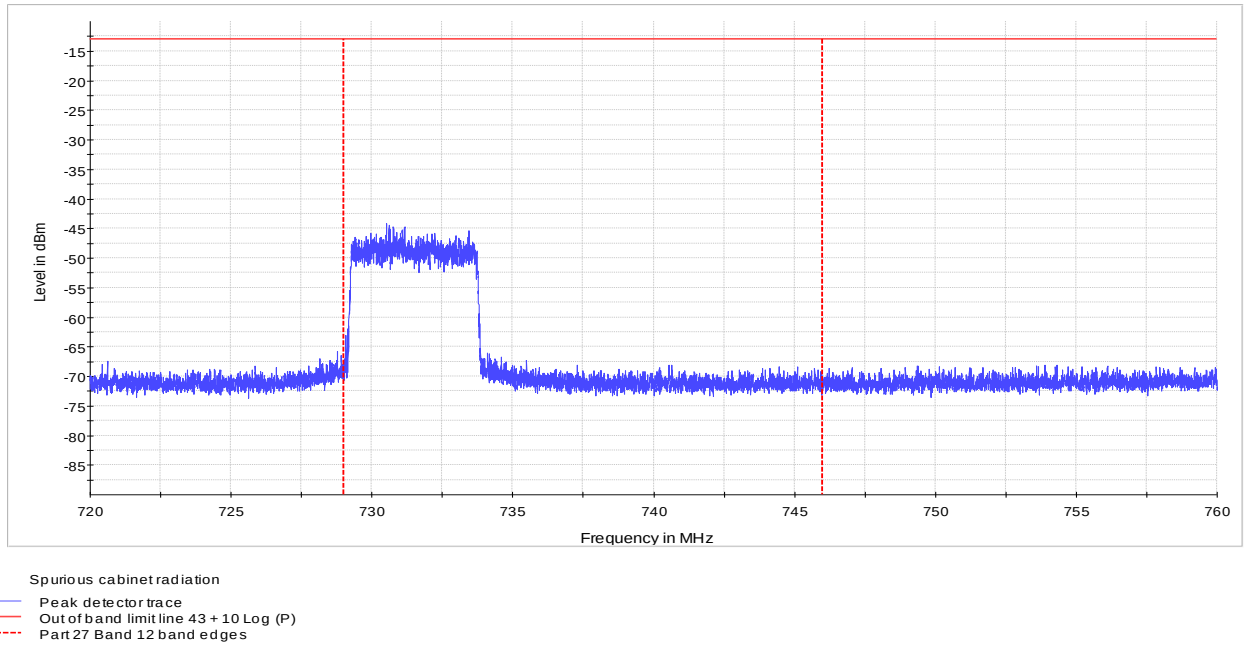


Figure 8.3-5: *Radiated spurious emission at the lower band edge, 5 MHz channel, QPSK*

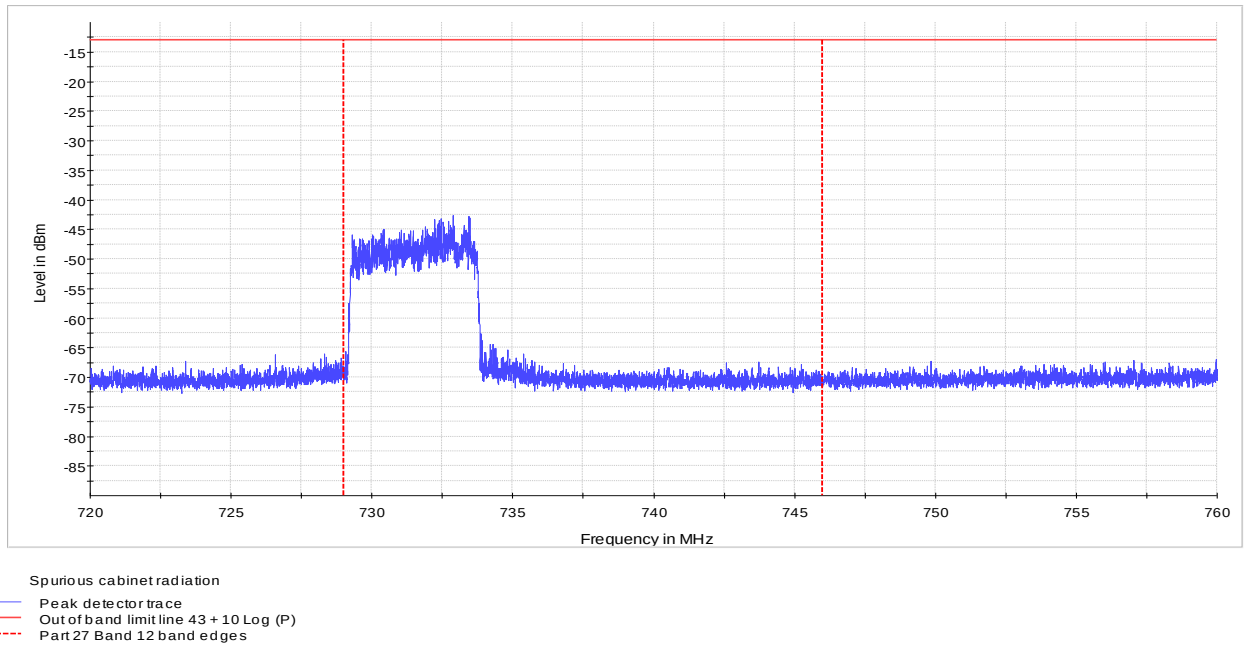


Figure 8.3-6: *Radiated spurious emission at the lower band edge, 5 MHz channel, 16-QAM*

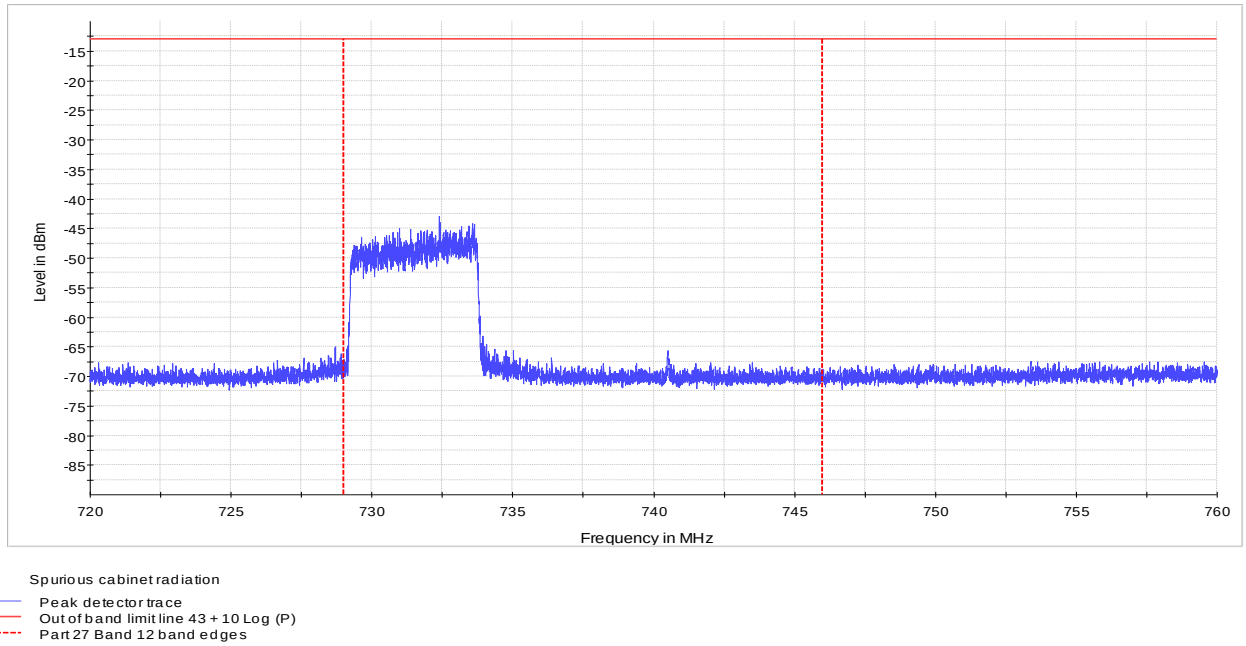


Figure 8.3-7: *Radiated spurious emission at the lower band edge, 5 MHz channel, 64-QAM*

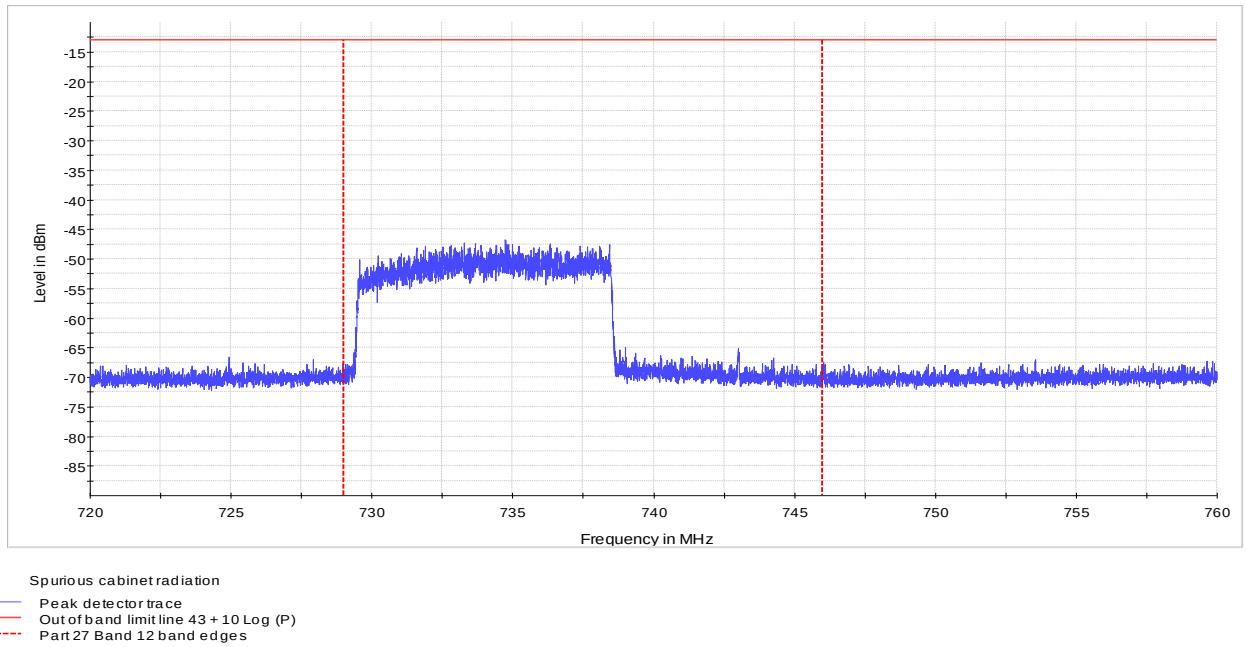


Figure 8.3-8: *Radiated spurious emission at the lower band edge, 10 MHz channel, QPSK*

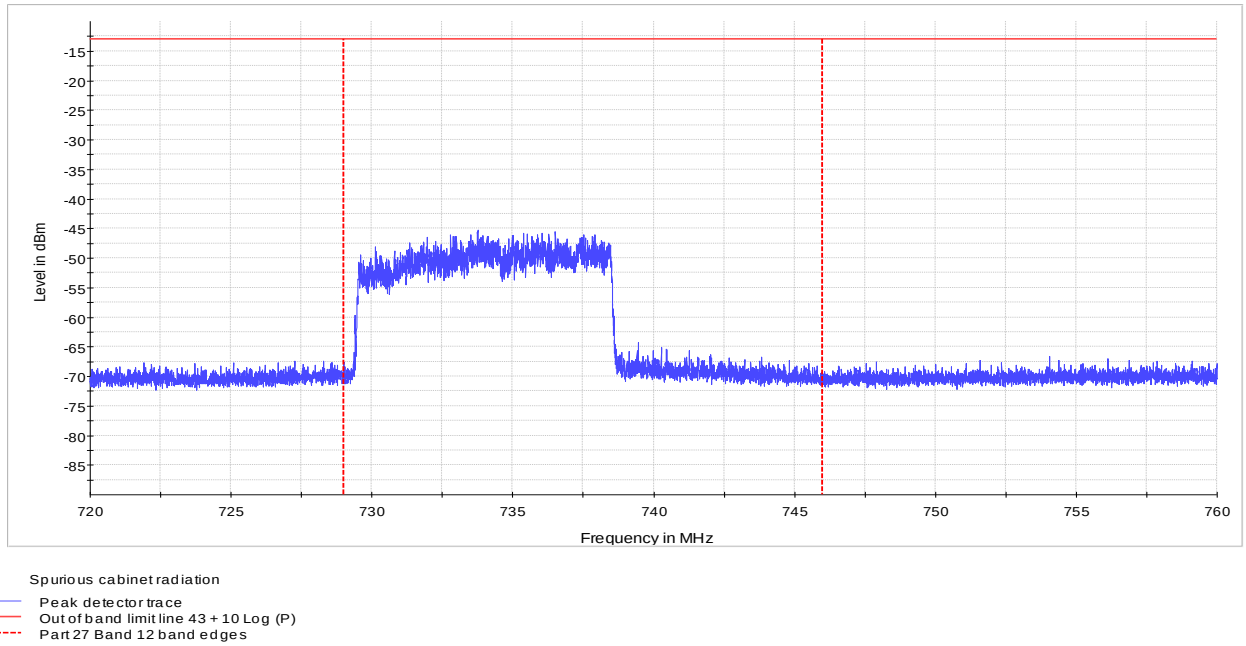


Figure 8.3-9: *Radiated spurious emission at the lower band edge, 10 MHz channel, 16-QAM*

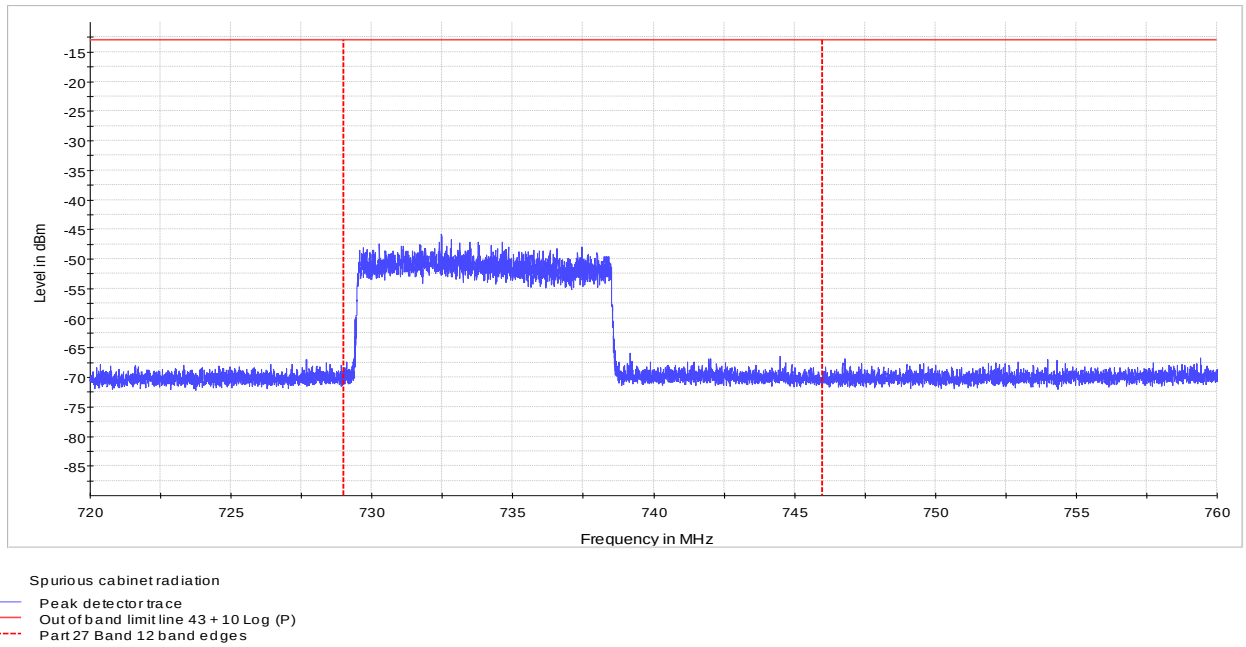


Figure 8.3-10: *Radiated spurious emission at the lower band edge, 10 MHz channel, 64-QAM*

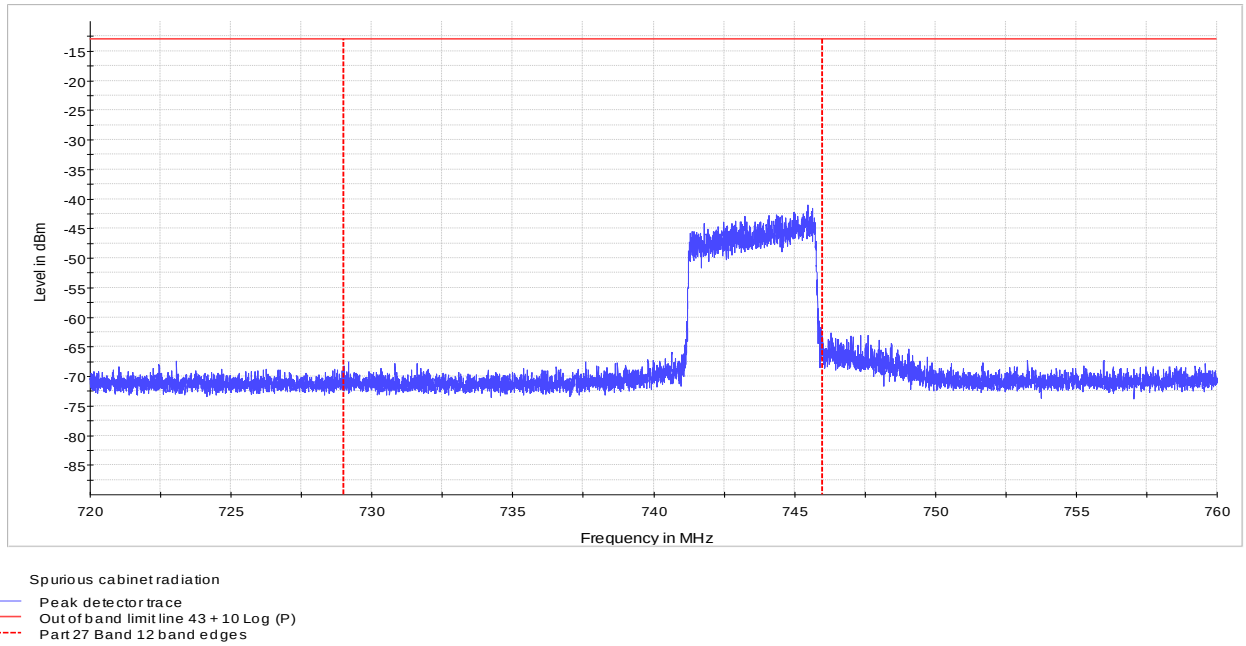


Figure 8.3-11: *Radiated spurious emission at the upper band edge, 5 MHz channel, QPSK*

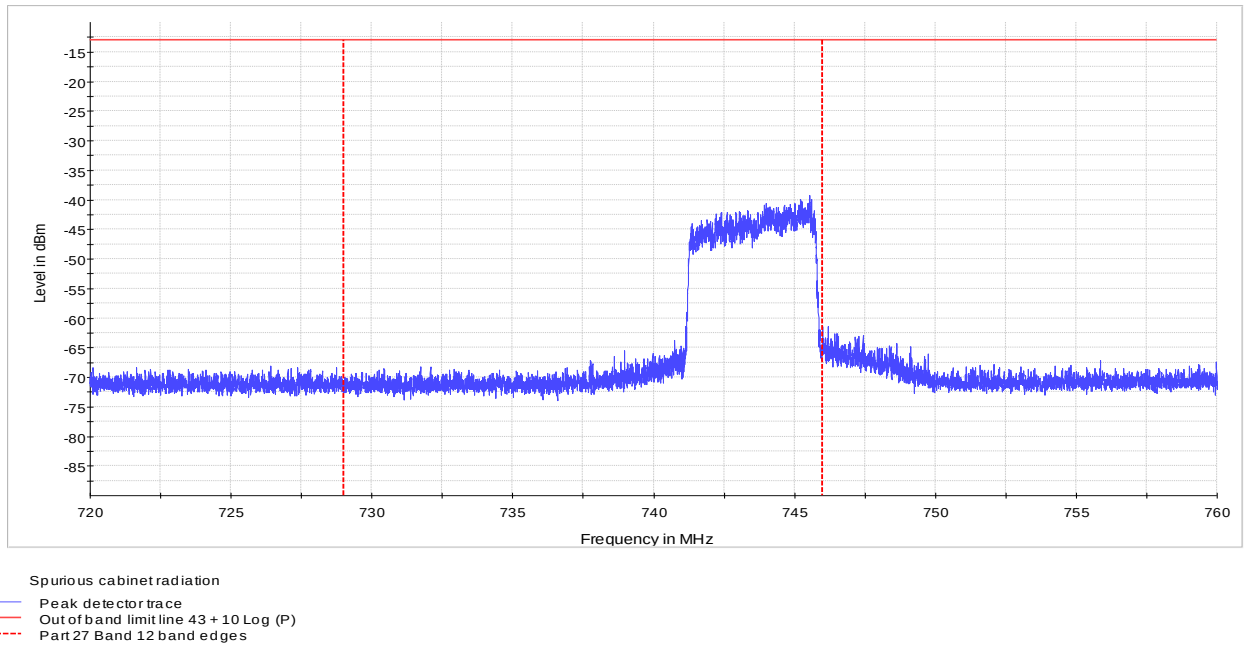


Figure 8.3-12: *Radiated spurious emission at the upper band edge, 5 MHz channel, 16-QAM*

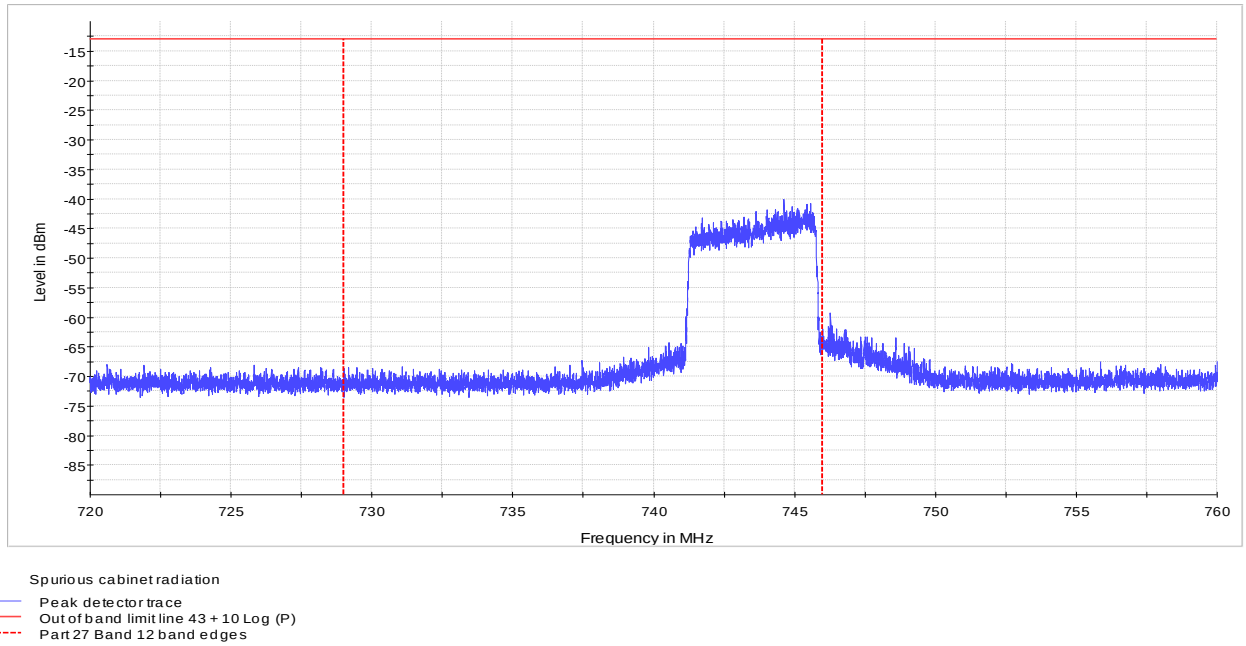


Figure 8.3-13: *Radiated spurious emission at the upper band edge, 5 MHz channel, 64-QAM*

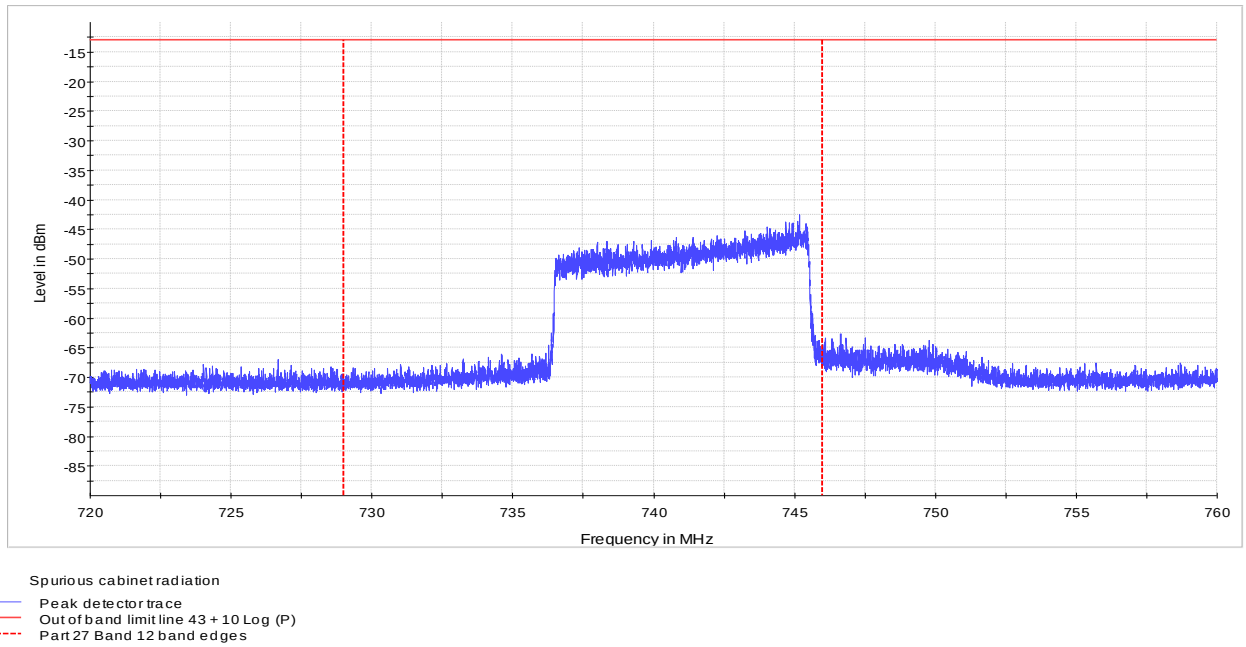


Figure 8.3-14: *Radiated spurious emission at the upper band edge, 10 MHz channel, QPSK*

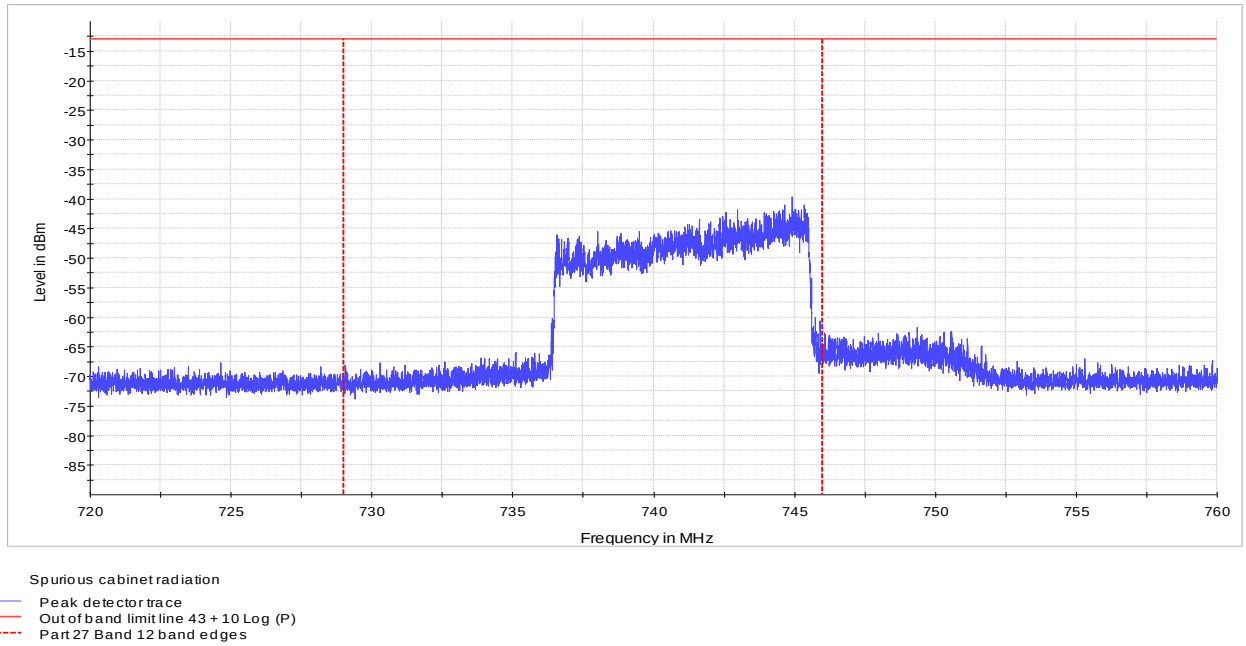


Figure 8.3-15: *Radiated spurious emission at the upper band edge, 10 MHz channel, 16-QAM*

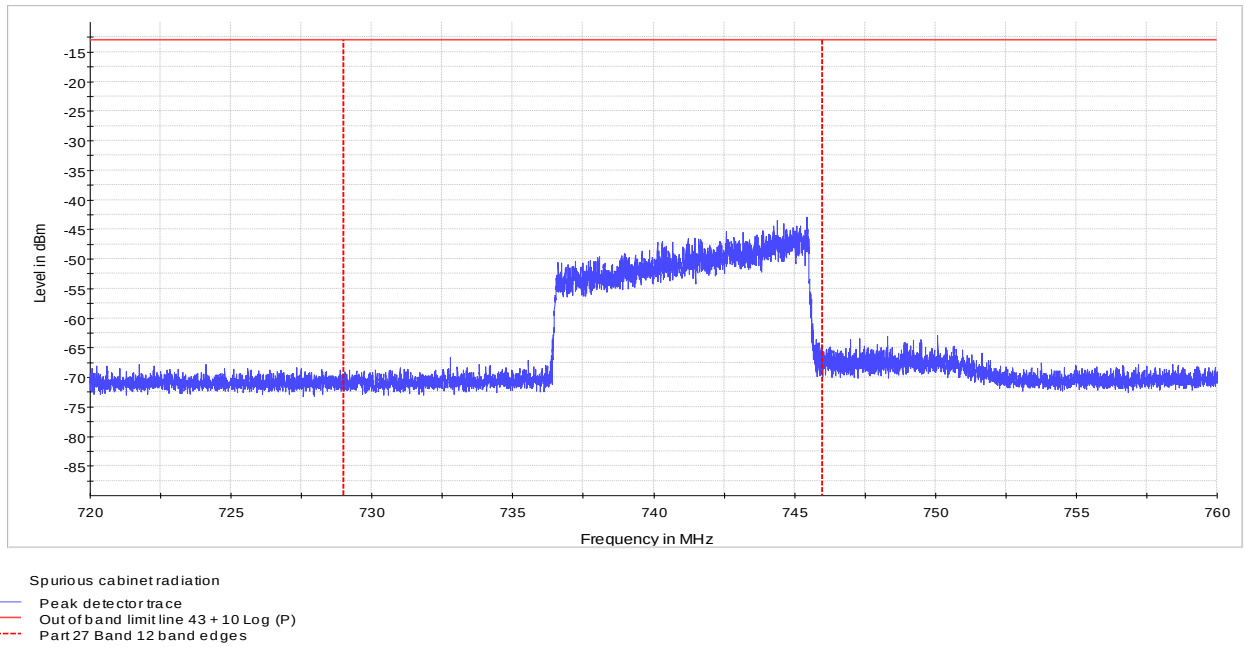


Figure 8.3-16: *Radiated spurious emission at the upper band edge, 10 MHz channel, 64-QAM*

8.4 FCC Part 2.1049 and RSS-Gen, 6.6 Occupied bandwidth (Band 12)

8.4.1 Definitions and limits

FCC:
The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

RSS-Gen, 6.6
The emission bandwidth (×dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated × dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3× the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3×RBW.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

8.4.2 Test summary

Test date	October 17, 2017	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	33 %

8.4.3 Observations, settings and special notes

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	≥1 % of span
Video bandwidth	RBW × 3
Trace mode	Max Hold

8.4.4 Test data

Table 8.4-1: *Occupied bandwidth results*

Remarks	99% OBW, MHz	26 dB BW, MHz
5 MHz, QPSK, antenna 1	4.520	4.860
5 MHz, QPSK, antenna 2	4.500	4.860
5 MHz, 16-QAM, antenna 1	4.480	4.820
5 MHz, 16-QAM, antenna 2	4.500	4.820
5 MHz, 64-QAM, antenna 1	4.480	4.840
5 MHz, 64-QAM, antenna 2	4.500	4.860
10 MHz, QPSK, antenna 1	9.100	10.000
10 MHz, QPSK, antenna 2	9.100	9.950
10 MHz, 16-QAM, antenna 1	9.150	10.000
10 MHz, 16-QAM, antenna 2	9.100	9.900
10 MHz, 64-QAM, antenna 1	9.100	10.000
10 MHz, 64-QAM, antenna 2	9.150	10.050

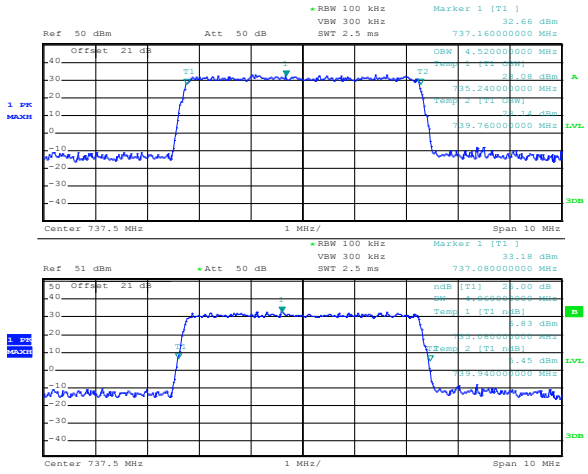


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Figure 8.4-1: *Occupied bandwidth, 5 MHz channel, QPSK, antenna 1*

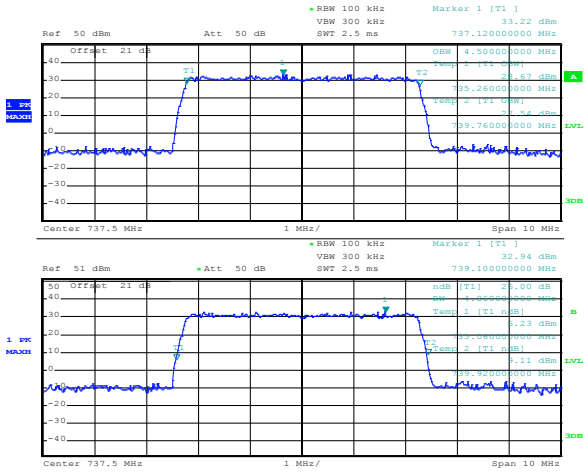

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Figure 8.4-2: *Occupied bandwidth, 5 MHz channel, QPSK, antenna 2*

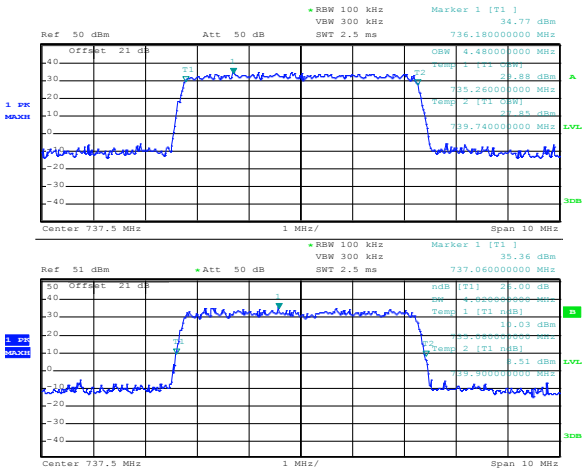

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Figure 8.4-3: *Occupied bandwidth, 5 MHz channel, 16-QAM, antenna 1*

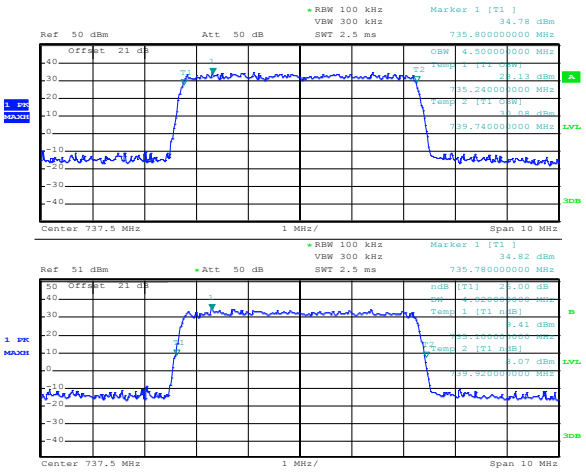

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Figure 8.4-4: *Occupied bandwidth, 5 MHz channel, 16-QAM, antenna 2*

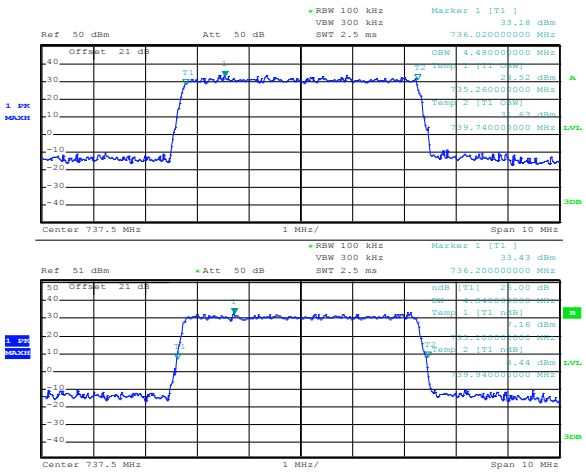

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Figure 8.4-5: *Occupied bandwidth, 5 MHz channel, 64-QAM, antenna 1*

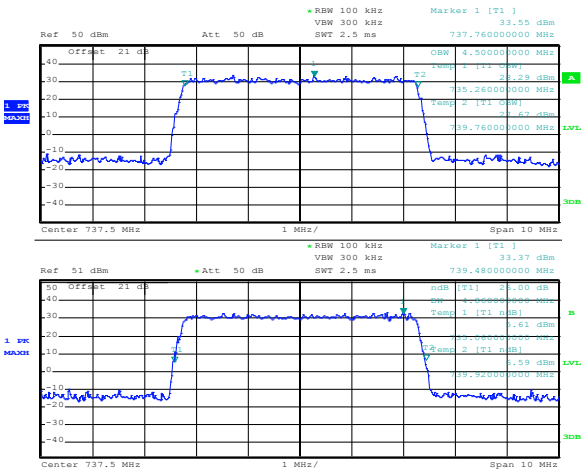

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Figure 8.4-6: *Occupied bandwidth, 5 MHz channel, 64-QAM, antenna 2*

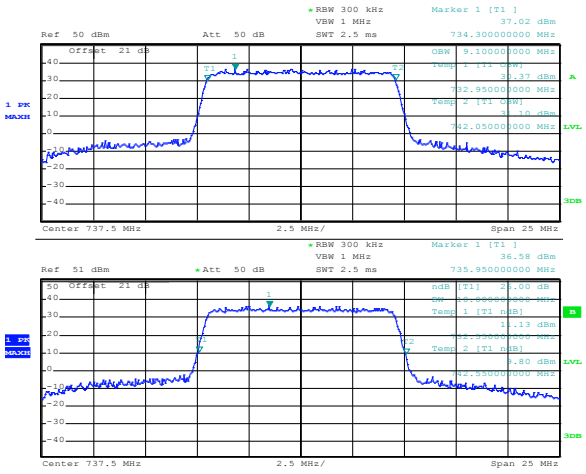


Figure 8.4-7: *Occupied bandwidth, 10 MHz channel, QPSK, antenna 1*

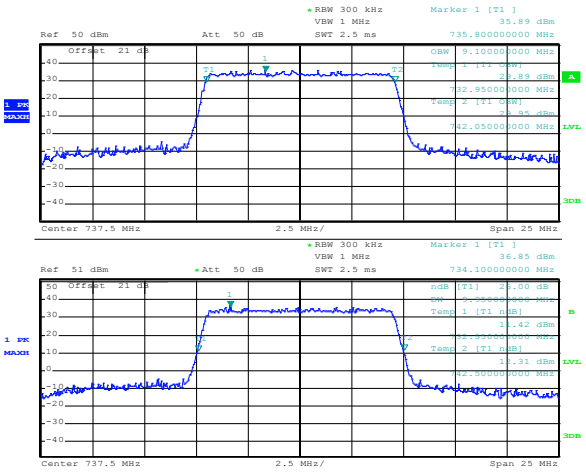


Figure 8.4-8: *Occupied bandwidth, 10 MHz channel, QPSK, antenna 2*

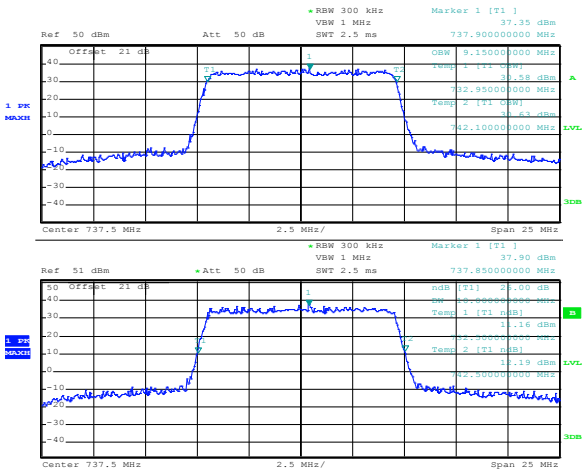


Figure 8.4-9: *Occupied bandwidth, 10 MHz channel, 16-QAM, antenna 1*

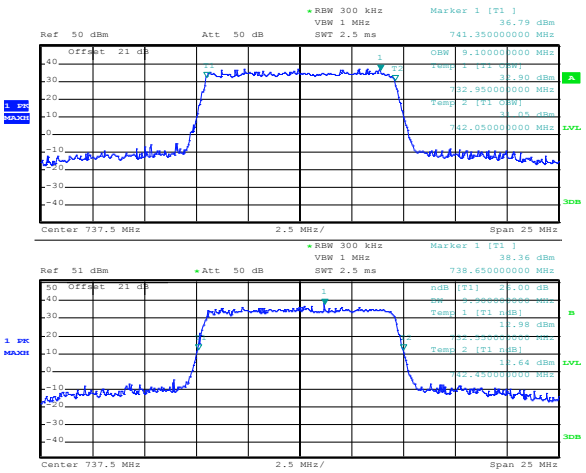


Figure 8.4-10: *Occupied bandwidth, 10 MHz channel, 16-QAM, antenna 2*

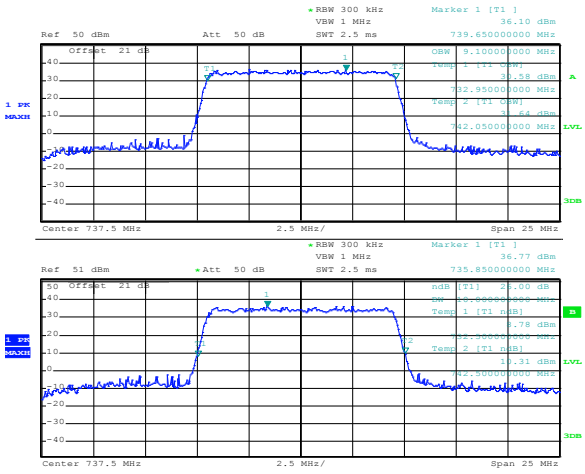


Figure 8.4-11: *Occupied bandwidth, 10 MHz channel, 64-QAM, antenna 1*

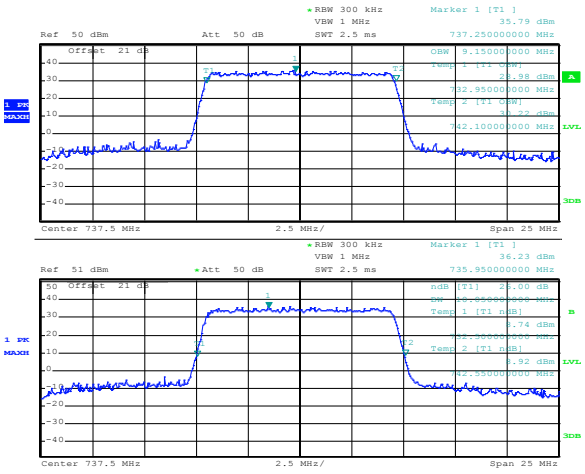


Figure 8.4-12: *Occupied bandwidth, 10 MHz channel, 64-QAM, antenna 2*

8.5 FCC 27.50(c) and RSS-130, 4.4 Maximum output power at RF antenna connector (Band 17)

8.5.1 Definitions and limits

§ 27.50(c) Operation in the 600 MHz band and the 698–746 MHz band.

(3) Fixed and base stations transmitting a signal with an emission bandwidth greater than 1 MHz must not exceed an ERP of 1000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 1000 watts/MHz ERP in accordance with Table 3 of this section;

(4) Fixed and base stations located in a county with population density of 100 or fewer persons per square mile, based upon the most recently available population statistics from the Bureau of the Census, and transmitting a signal with an emission bandwidth greater than 1 MHz must not exceed an ERP of 2000 watts/MHz and an antenna height of 305 m HAAT, except that antenna heights greater than 305 m HAAT are permitted if power levels are reduced below 2000 watts/MHz ERP in accordance with Table 4 of this section;

RSS-130, Section 4.4

- The transmitter output power shall be measured in terms of average power.
- For base and fixed equipment, refer to SRSP-518 for power limits.
- The e.i.r.p. shall not exceed 50 watts for mobile equipment or for outdoor fixed subscriber equipment, nor shall it exceed 5 watts for portable equipment or for indoor fixed subscriber equipment.
- In addition, the peak-to-average power ratio (PAPR) of the transmitter shall not exceed 13 dB for more than 0.1% of the time and shall use a signal corresponding to the highest PAPR during periods of continuous transmission.

SRSP-518, Section 5.1

5.1.1 Fixed and base stations

5.1.1.1 For fixed and base stations transmitting in accordance with sections 4.1.1 to 4.1.3 within the frequency range 716–756 MHz with a channel bandwidth equal to or less than 1 MHz, the maximum permissible equivalent isotropically radiated power (e.i.r.p.) is 1640 watts with an antenna height above average terrain (HAAT) up to 305 metres. The same e.i.r.p. limit also applies to fixed and base stations operating at any frequency in the 700 MHz band in accordance with Section 4.1.4.

5.1.1.2 For fixed and base stations transmitting in accordance with sections 4.1.1 to 4.1.3 within the frequency range 716–756 MHz with a channel bandwidth greater than 1 MHz, the maximum permissible e.i.r.p. is 1640 watts/MHz (i.e. no more than 1640 watts e.i.r.p. in any 1 MHz band segment) with a HAAT up to 305 metres. The same e.i.r.p. limit also applies to fixed and base stations operating at any frequency in the 700 MHz band in accordance with Section 4.1.4.

5.1.1.3 Fixed and base stations located in geographical areas at a distance greater than 26 km from large or medium population centres and transmitting in accordance with sections 4.1.1 to 4.1.3 within the frequency range 716–756 MHz, may increase their e.i.r.p. up to a maximum of 3280 watts/MHz (i.e. no more than 3280 watts e.i.r.p. in any 1 MHz band segment), with an antenna HAAT up to 305 metres.

This provision also applies for fixed and base stations with a channel bandwidth equal to or less than 1 MHz (i.e. e.i.r.p. may be increased up to a maximum of 3280 watts).

5.1.1.4 For all installations with an antenna HAAT in excess of 305 metres, a corresponding reduction in e.i.r.p. according to the following formula shall be applied:

$$EIRP_{reduction} = 20 \log_{10}(HAAT / 305)\ dB$$

8.5.2 Test summary

Test date	October 16, 2017
Test engineer	Andrey Adelberg
Verdict	Pass

8.5.3 Observations, settings and special notes

Note: ERP limit is 1000 W/MHz (60 dBm/MHz), EIRP limit is 1640 W/MHz (62.1484 dBm/MHz)
Based on the RF margins noted in this report, considerations pertaining to the maximum allowed EIRP and antenna type should be considered for each installation.
Test receiver settings:

Detector mode	RMS
Resolution bandwidth	Output power: 100 kHz; PSD: 1 MHz
Video bandwidth	>RBW
Measurement mode	Power over emission bandwidth
Trace mode	Power Averaging over 100 traces
Measurement time	Auto

8.5.4 Test data

Table 8.5-1: *Output power measurement results for 5 MHz channel, SISO operation*

Remarks	Frequency, MHz	Total RF output power, dBm	Total RF output power, W	RF output power (PSD), dBm/MHz	ERP limit, dBm/MHz	Margin, dB
QPSK, antenna port 1	736.5	39.85	9.661	34.17	60.00	25.83
QPSK, antenna port 1	740.0	40.02	10.046	34.90	60.00	25.10
QPSK, antenna port 1	743.5	39.97	9.931	34.29	60.00	25.71
QPSK, antenna port 2	736.5	39.5	8.913	33.90	60.00	26.10
QPSK, antenna port 2	740.0	39.66	9.247	34.02	60.00	25.98
QPSK, antenna port 2	743.5	39.65	9.226	34.00	60.00	26.00
16-QAM, antenna port 1	736.5	39.58	9.078	34.18	60.00	25.82
16-QAM, antenna port 1	740.0	39.73	9.397	34.38	60.00	25.62
16-QAM, antenna port 1	743.5	39.82	9.594	34.32	60.00	25.68
16-QAM, antenna port 2	736.5	39.42	8.750	34.07	60.00	25.93
16-QAM, antenna port 2	740.0	39.56	9.036	34.23	60.00	25.77
16-QAM, antenna port 2	743.5	39.78	9.506	33.59	60.00	26.41
64-QAM, antenna port 1	736.5	39.56	9.036	33.95	60.00	26.05
64-QAM, antenna port 1	740.0	39.64	9.204	33.89	60.00	26.11
64-QAM, antenna port 1	743.5	39.69	9.311	34.00	60.00	26.00
64-QAM, antenna port 2	736.5	39.23	8.375	33.59	60.00	26.41
64-QAM, antenna port 2	740.0	39.32	8.551	33.78	60.00	26.22
64-QAM, antenna port 2	743.5	39.36	8.630	33.62	60.00	26.38

Table 8.5-2: *Output power measurement results for 10 MHz channel, SISO operation*

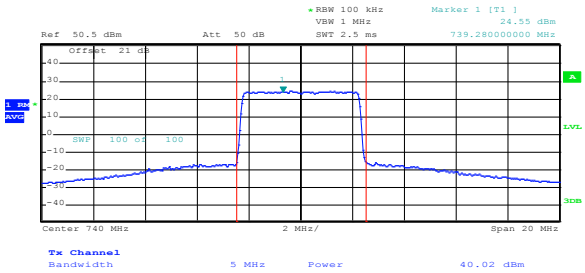
Remarks	Frequency, MHz	Total RF output power, dBm	Total RF output power, W	RF output power (PSD), dBm/MHz	ERP limit, dBm/MHz	Margin, dB
QPSK, antenna port 1	739.0	39.77	9.484	31.22	60.00	28.78
QPSK, antenna port 1	740.0	39.84	9.638	32.21	60.00	27.79
QPSK, antenna port 1	741.0	39.75	9.441	31.20	60.00	28.80
QPSK, antenna port 2	739.0	39.51	8.933	30.80	60.00	29.20
QPSK, antenna port 2	740.0	39.55	9.016	30.93	60.00	29.07
QPSK, antenna port 2	741.0	39.5	8.913	30.79	60.00	29.21
16-QAM, antenna port 1	739.0	39.57	9.057	31.25	60.00	28.75
16-QAM, antenna port 1	740.0	39.56	9.036	31.27	60.00	28.73
16-QAM, antenna port 1	741.0	39.63	9.183	31.26	60.00	28.74
16-QAM, antenna port 2	739.0	39.45	8.810	30.98	60.00	29.02
16-QAM, antenna port 2	740.0	39.26	8.433	30.87	60.00	29.13
16-QAM, antenna port 2	741.0	39.48	8.872	31.05	60.00	28.95
64-QAM, antenna port 1	739.0	39.74	9.419	31.06	60.00	28.94
64-QAM, antenna port 1	740.0	39.64	9.204	31.01	60.00	28.99
64-QAM, antenna port 1	741.0	39.71	9.354	31.03	60.00	28.97
64-QAM, antenna port 2	739.0	39.49	8.892	30.63	60.00	29.37
64-QAM, antenna port 2	740.0	39.49	8.892	30.86	60.00	29.14
64-QAM, antenna port 2	741.0	39.43	8.770	30.59	60.00	29.41

Table 8.5-3: *Output power measurement results for 5 MHz, MIMO operation*

Remarks	Frequency, MHz	RF output power Antenna 1, dBm/MHz	RF output power Antenna 2, dBm/MHz	Total output power, dBm/MHz	ERP limit, dBm/MHz	Margin, dB
QPSK modulation	736.5	34.17	33.90	37.05	60.00	22.95
QPSK modulation	740.0	34.90	34.02	37.49	60.00	22.51
QPSK modulation	743.5	34.29	34.00	37.16	60.00	22.84
16-QAM modulation	736.5	34.18	34.07	37.14	60.00	22.86
16-QAM modulation	740.0	34.38	34.23	37.32	60.00	22.68
16-QAM modulation	743.5	34.32	33.59	36.98	60.00	23.02
64-QAM modulation	736.5	33.95	33.59	36.78	60.00	23.22
64-QAM modulation	740.0	33.89	33.78	36.85	60.00	23.15
64-QAM modulation	743.5	34.00	33.62	36.82	60.00	23.18

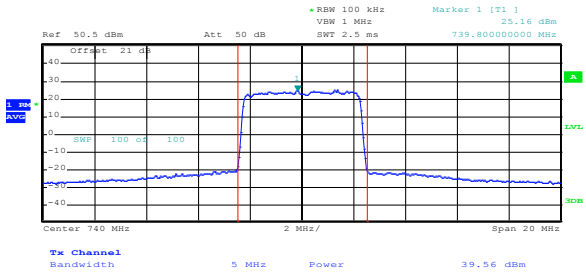
Table 8.5-4: *Output power measurement results for 10 MHz, MIMO operation*

Remarks	Frequency, MHz	RF output power Antenna 1, dBm/MHz	RF output power Antenna 2, dBm/MHz	Total output power, dBm/MHz	ERP limit, dBm/MHz	Margin, dB
QPSK modulation	739.0	31.22	30.80	34.03	60.00	25.97
QPSK modulation	740.0	32.21	30.93	34.63	60.00	25.37
QPSK modulation	741.0	31.20	30.79	34.01	60.00	25.99
16-QAM modulation	739.0	31.25	30.98	34.13	60.00	25.87
16-QAM modulation	740.0	31.27	30.87	34.08	60.00	25.92
16-QAM modulation	741.0	31.26	31.05	34.17	60.00	25.83
64-QAM modulation	739.0	31.06	30.63	33.86	60.00	26.14
64-QAM modulation	740.0	31.01	30.86	33.95	60.00	26.05
64-QAM modulation	741.0	31.03	30.59	33.83	60.00	26.17



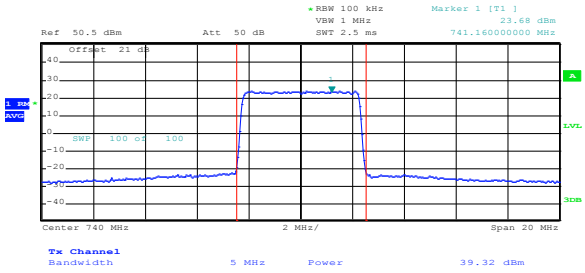
Date: 17.OCT.2017 10:49:01

Figure 8.5-1: *Output power sample plot, QPSK, 5 MHz*



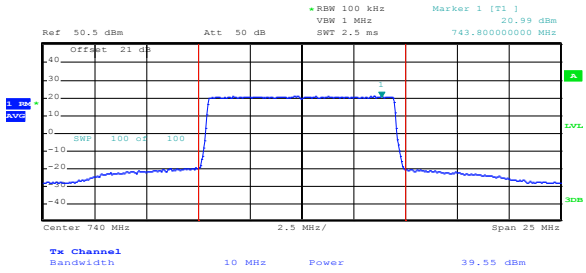
Date: 17.OCT.2017 11:33:55

Figure 8.5-2: *Output power sample plot, 16-QAM, 5 MHz*



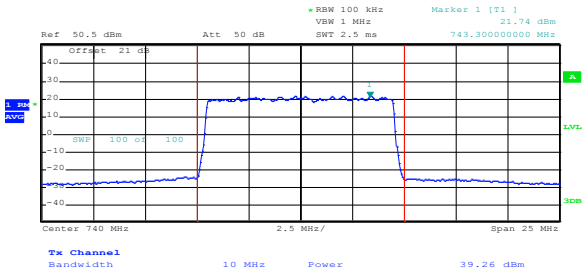
Date: 17.OCT.2017 12:02:29

Figure 8.5-3: *Output power sample plot, 64-QAM, 5 MHz*



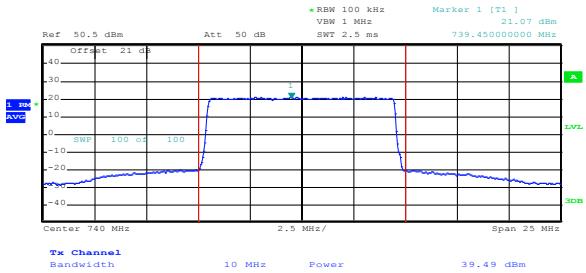
Date: 17.OCT.2017 14:32:18

Figure 8.5-4: *Output power sample plot, QPSK, 10 MHz*



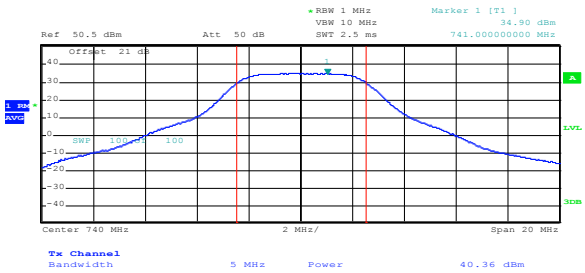
Date: 17.OCT.2017 15:06:52

Figure 8.5-5: *Output power sample plot, 16-QAM, 10 MHz*



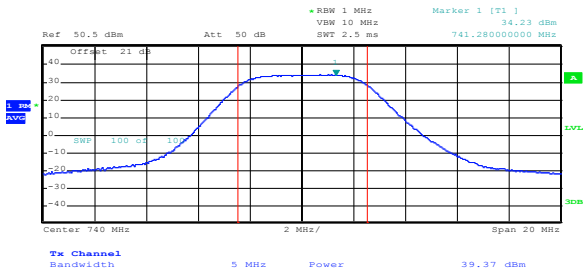
Date: 17.OCT.2017 15:23:07

Figure 8.5-6: *Output power sample plot, 64-QAM, 10 MHz*



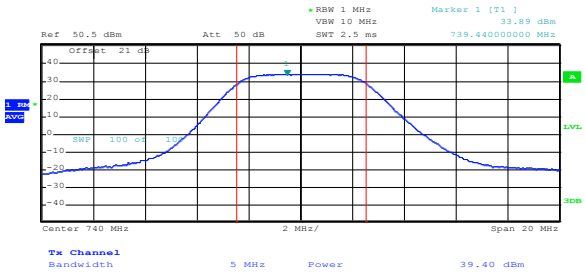
Date: 17.OCT.2017 10:48:18

Figure 8.5-7: *PSD sample plot, QPSK, 5 MHz*



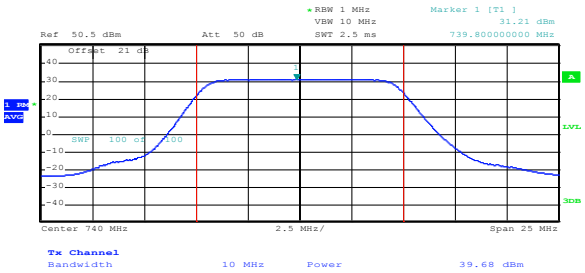
Date: 17.OCT.2017 11:34:40

Figure 8.5-8: *PSD sample plot, 16-QAM, 5 MHz*



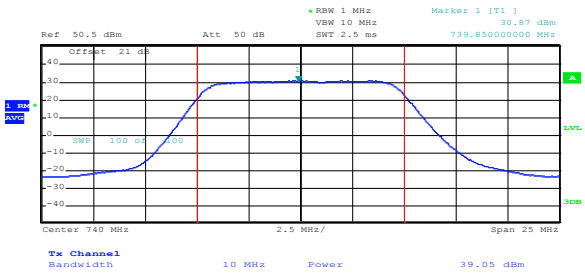
Date: 17.OCT.2017 12:01:47

Figure 8.5-9: *PSD sample plot, 64-QAM, 5 MHz*



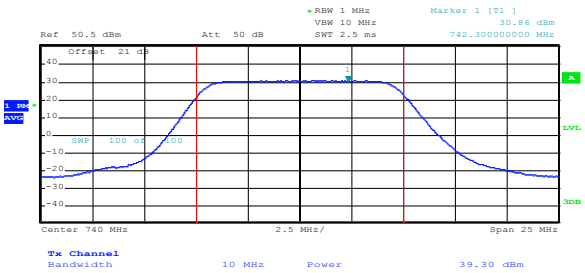
Date: 17.OCT.2017 14:33:14

Figure 8.5-10: *PSD sample plot, QPSK, 10 MHz*



Date: 17.OCT.2017 15:06:38

Figure 8.5-11: *PSD sample plot, 16-QAM, 10 MHz*



Date: 17.OCT.2017 15:23:23

Figure 8.5-12: *PSD sample plot, 64-QAM, 10 MHz*

Table 8.5-5: *Complementary Cumulative Distribution Function (CCDF) of the PAPR reduction measurement results*

Remarks	0.1% CCDF, dB	PAPR reduction limit, dB	Margin, dB
QPSK, 5 MHz	7.56	13.00	5.44
16-QAM, 5 MHz	7.56	13.00	5.44
64-QAM, 5 MHz	7.52	13.00	5.48
QPSK, 10 MHz	7.60	13.00	5.40
16-QAM, 10 MHz	7.64	13.00	5.36
64-QAM, 10 MHz	7.64	13.00	5.36

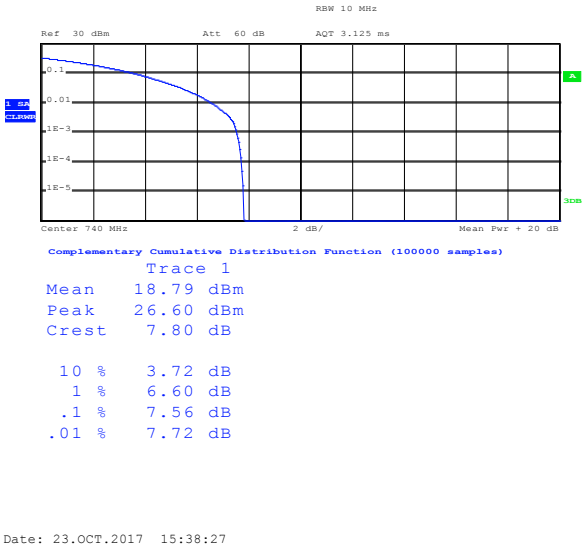


Figure 8.5-13: *CCDF, 5 MHz, QPSK*

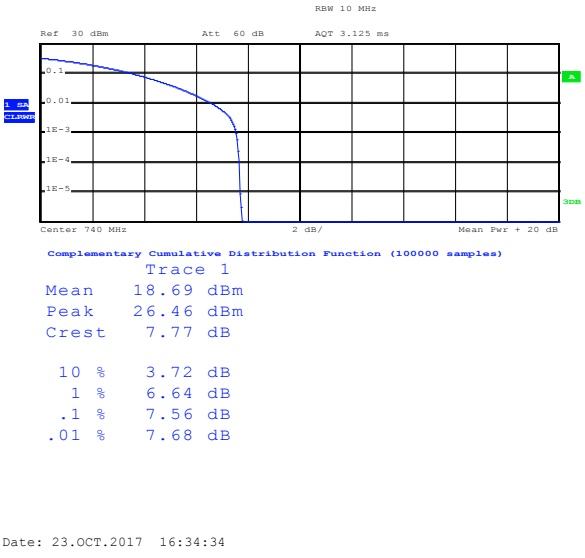


Figure 8.5-14: *CCDF, 5 MHz, 16-QAM*

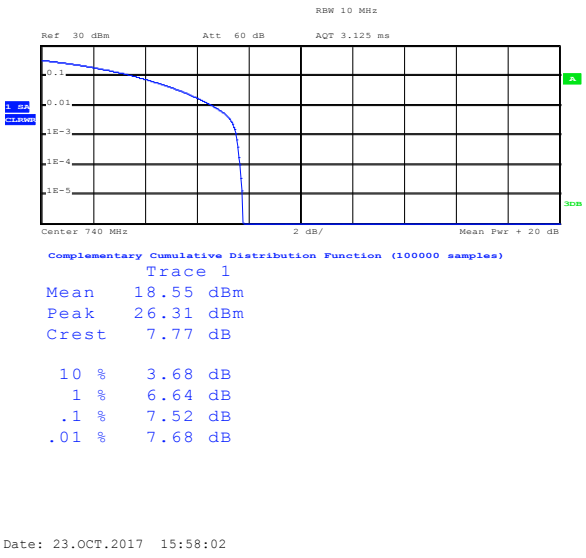


Figure 8.5-15: *CCDF, 5 MHz, 64-QAM*

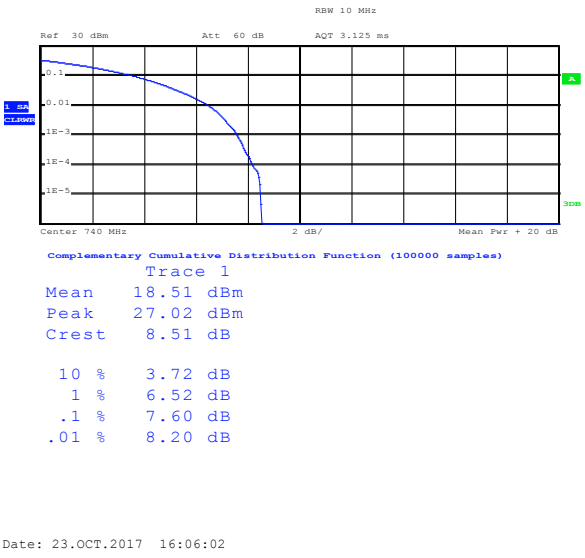


Figure 8.5-16: *CCDF, 10 MHz, QPSK*

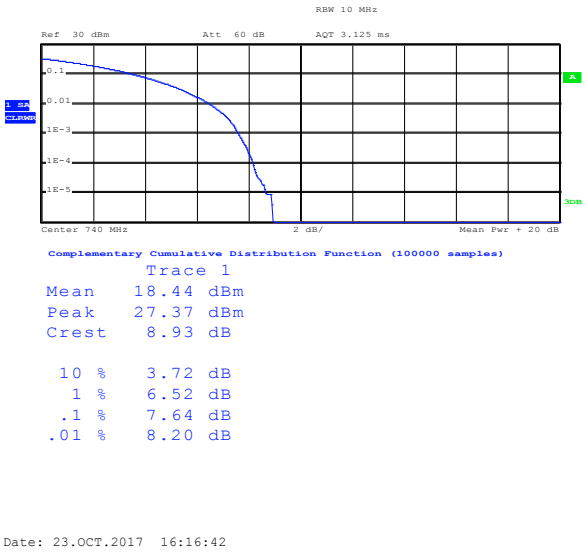


Figure 8.5-17: *CCDF, 10 MHz, 16-QAM*

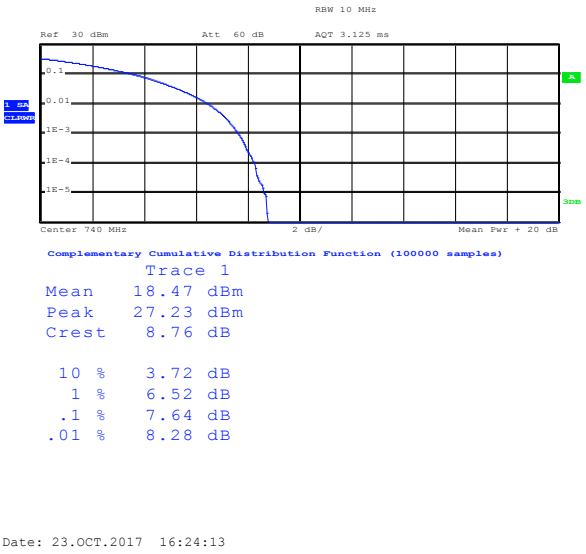


Figure 8.5-18: *CCDF, 10 MHz, 64-QAM*

8.6 FCC 27.53(g) and RSS-130, 4.6.1 Spurious emissions at RF antenna connector (Band 17)

8.6.1 Definitions and limits

FCC:
(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 (−13 dBm). 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:
4.6.1 The power of any unwanted emissions in any 100 kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 $\log_{10}$ p (watts), dB (−13 dBm). However, in the 100 kHz band immediately outside the equipment's operating frequency range, a resolution bandwidth of 30 kHz may be employed.

8.6.2 Test summary

Test date	October 18, 2017
Test engineer	Andrey Adelberg
Verdict	Pass

8.6.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
All measurements were performed using a peak detector.
For MIMO applications all marker values on the plots below should be increased by 3 dB (10 × Log_{10}(2))
RBW within 30–1000 MHz was 100 kHz and 1 MHz above 1 GHz. VBW was wider than RBW.

8.6.4 Test data

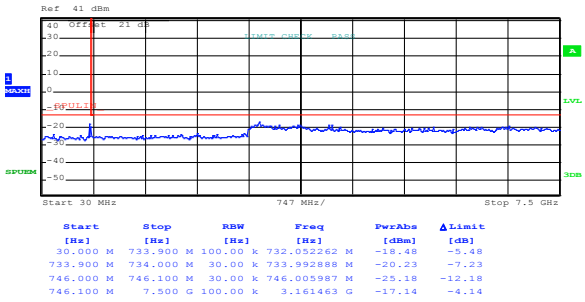


Figure 8.6-1: *Conducted spurious emissions, antenna 1, 5 MHz, low channel, QPSK*

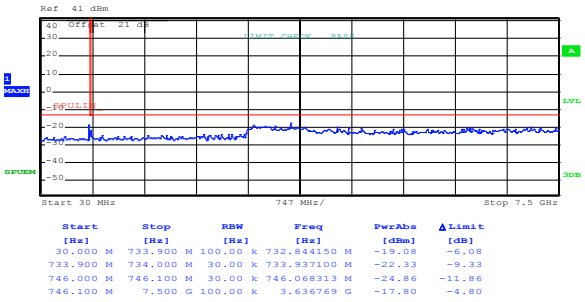


Figure 8.6-2: *Conducted spurious emissions, antenna 1, 5 MHz, mid channel, QPSK*

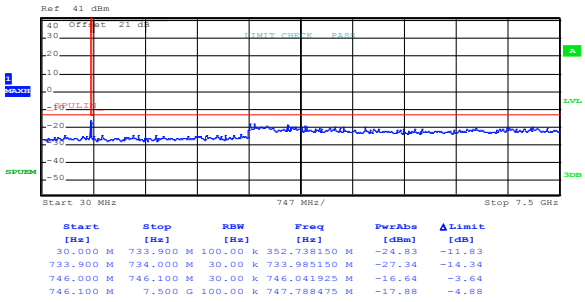


Figure 8.6-3: *Conducted spurious emissions, antenna 1, 5 MHz, high channel, QPSK*

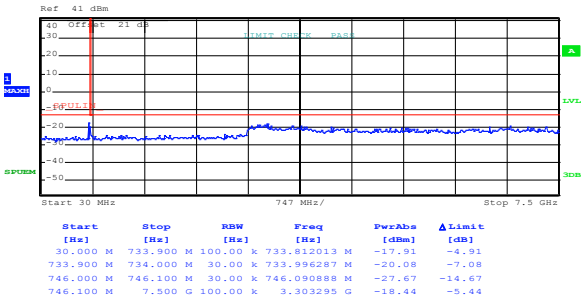


Figure 8.6-4: *Conducted spurious emissions, antenna 2, 5 MHz, low channel, QPSK*

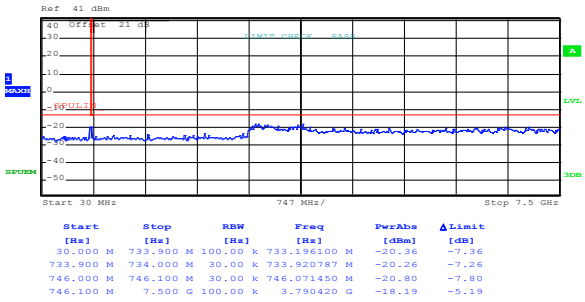


Figure 8.6-5: *Conducted spurious emissions, antenna 2, 5 MHz, mid channel, QPSK*

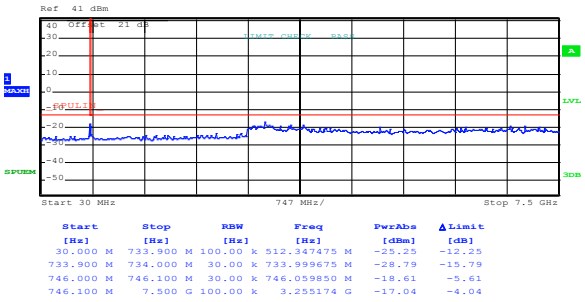


Figure 8.6-6: *Conducted spurious emissions, antenna 2, 5 MHz, high channel, QPSK*

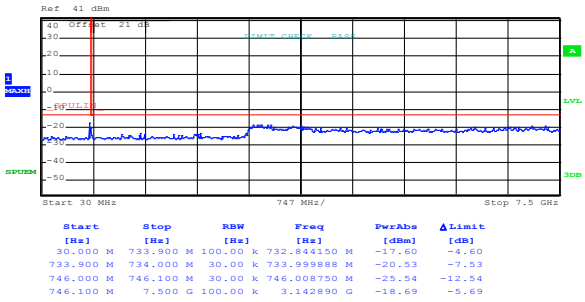


Figure 8.6-7: *Conducted spurious emissions, antenna 1, 5 MHz, low channel, 16-QAM*

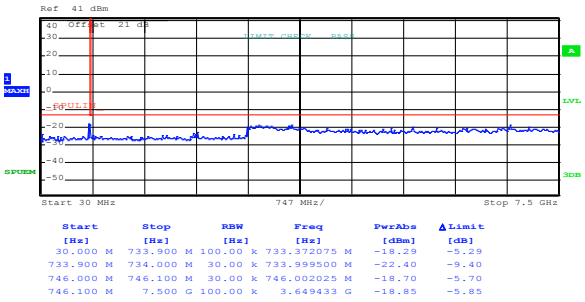


Figure 8.6-8: *Conducted spurious emissions, antenna 1, 5 MHz, mid channel, 16-QAM*

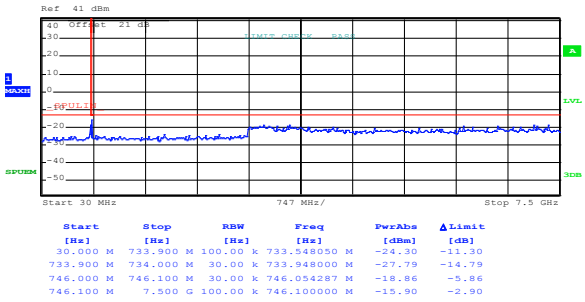


Figure 8.6-9: *Conducted spurious emissions, antenna 1, 5 MHz, high channel, 16-QAM*

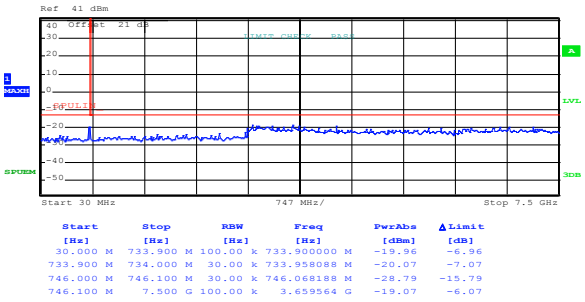


Figure 8.6-10: *Conducted spurious emissions, antenna 2, 5 MHz, low channel, 16-QAM*

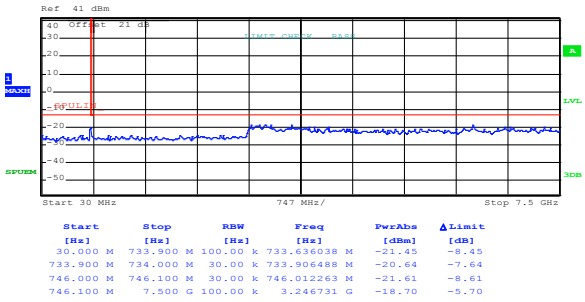


Figure 8.6-11: *Conducted spurious emissions, antenna 2, 5 MHz, mid channel, 16-QAM*

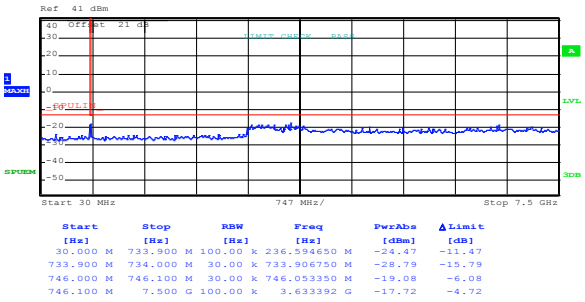


Figure 8.6-12: *Conducted spurious emissions, antenna 2, 5 MHz, high channel, 16-QAM*

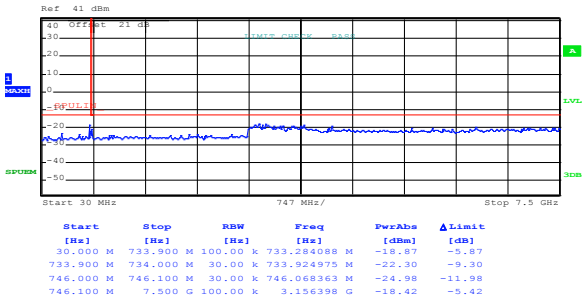


Figure 8.6-13: *Conducted spurious emissions, antenna 1, 5 MHz, low channel, 64-QAM*

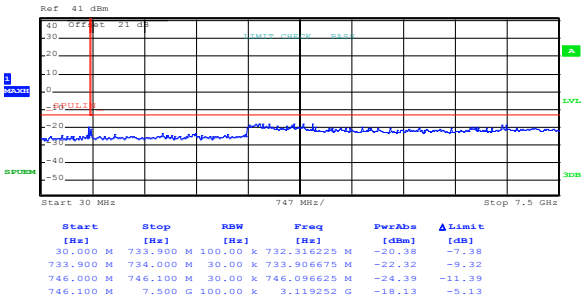


Figure 8.6-14: *Conducted spurious emissions, antenna 1, 5 MHz, mid channel, 64-QAM*

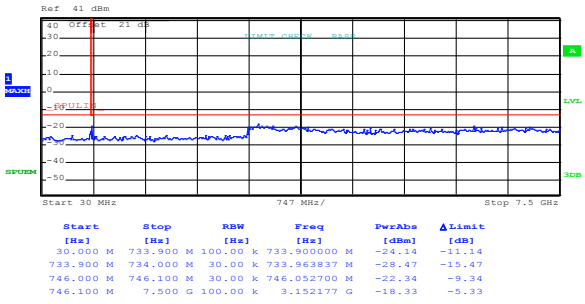


Figure 8.6-15: *Conducted spurious emissions, antenna 1, 5 MHz, high channel, 64-QAM*

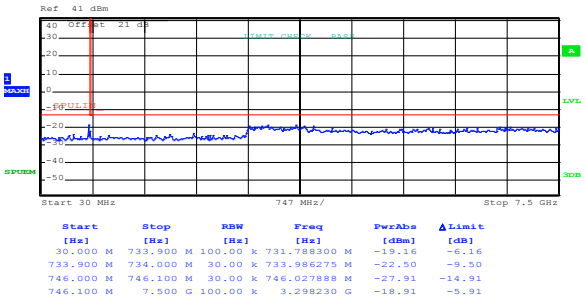


Figure 8.6-16: *Conducted spurious emissions, antenna 2, 5 MHz, low channel, 64-QAM*

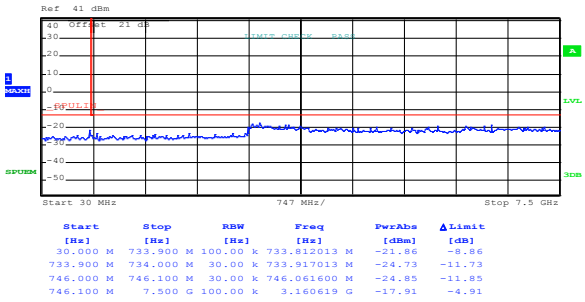


Figure 8.6-17: *Conducted spurious emissions, antenna 2, 5 MHz, mid channel, 64-QAM*

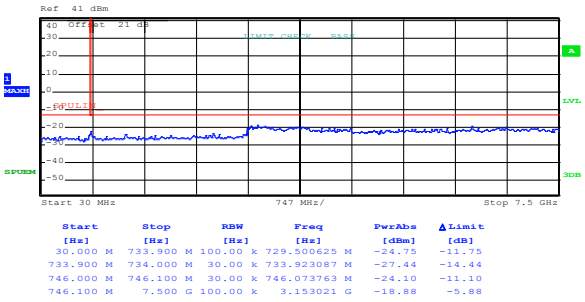


Figure 8.6-18: *Conducted spurious emissions, antenna 2, 5 MHz, high channel, 64-QAM*

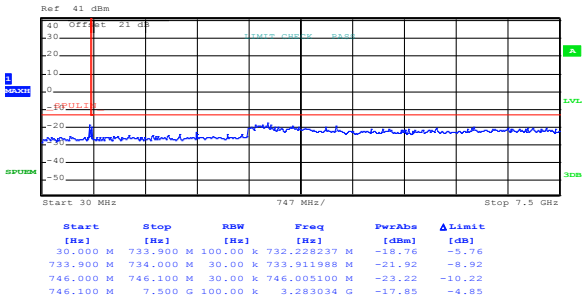


Figure 8.6-19: *Conducted spurious emissions, antenna 1, 10 MHz, low channel, QPSK*

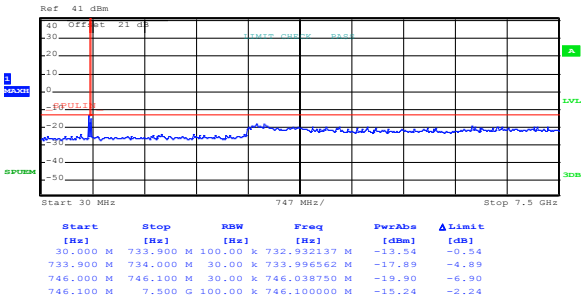


Figure 8.6-20: *Conducted spurious emissions, antenna 1, 10 MHz, mid channel, QPSK*

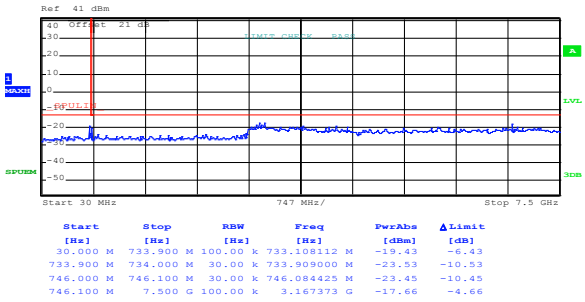


Figure 8.6-21: *Conducted spurious emissions, antenna 1, 10 MHz, high channel, QPSK*

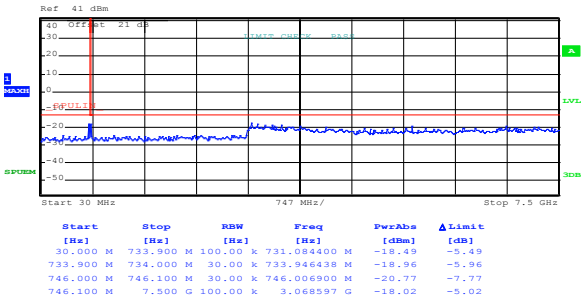


Figure 8.6-22: *Conducted spurious emissions, antenna 2, 10 MHz, low channel, QPSK*

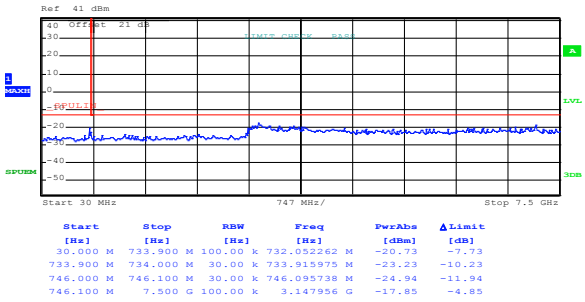


Figure 8.6-23: *Conducted spurious emissions, antenna 2, 10 MHz, mid channel, QPSK*

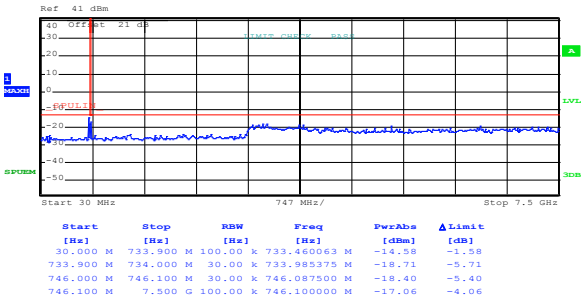


Figure 8.6-24: *Conducted spurious emissions, antenna 2, 10 MHz, high channel, QPSK*

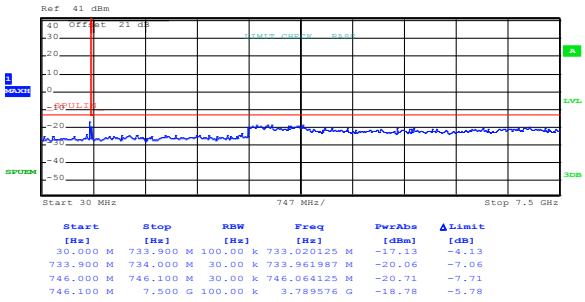


Figure 8.6-25: *Conducted spurious emissions, antenna 1, 10 MHz, low channel, 16-QAM*

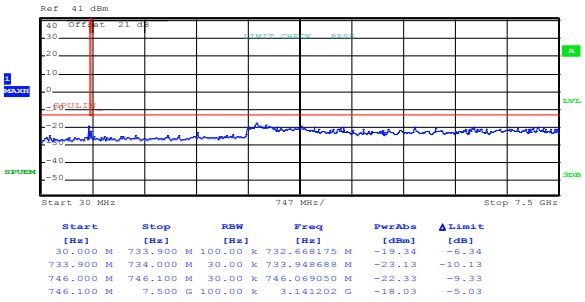


Figure 8.6-26: *Conducted spurious emissions, antenna 1, 10 MHz, mid channel, 16-QAM*

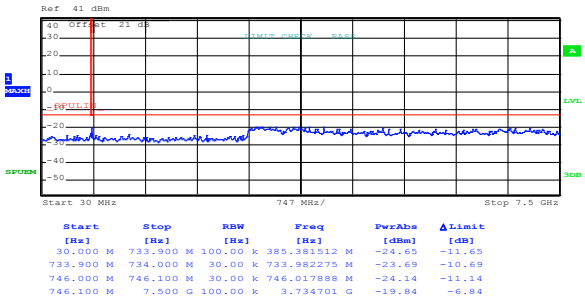


Figure 8.6-27: *Conducted spurious emissions, antenna 1, 10 MHz, high channel, 16-QAM*

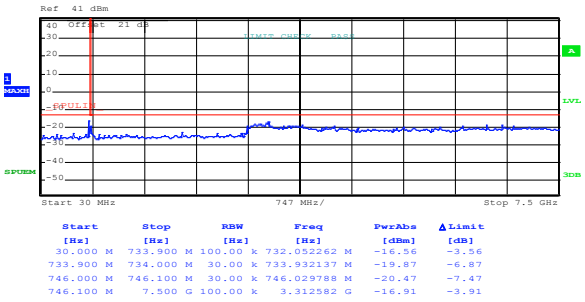


Figure 8.6-28: *Conducted spurious emissions, antenna 2, 10 MHz, low channel, 16-QAM*

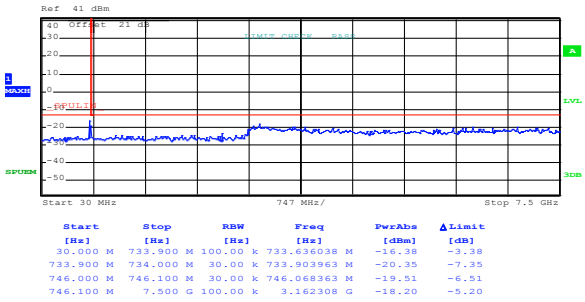


Figure 8.6-29: *Conducted spurious emissions, antenna 2, 10 MHz, mid channel, 16-QAM*

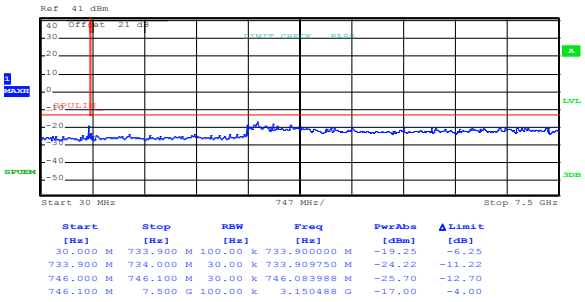


Figure 8.6-30: *Conducted spurious emissions, antenna 2, 10 MHz, high channel, 16-QAM*

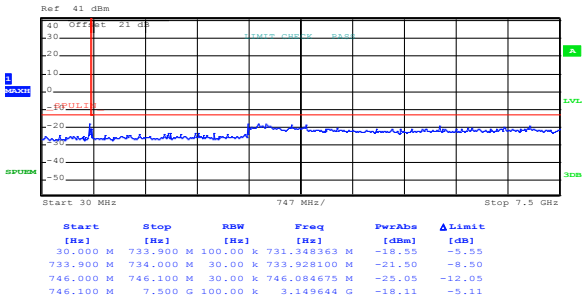


Figure 8.6-31: *Conducted spurious emissions, antenna 1, 10 MHz, low channel, 64-QAM*

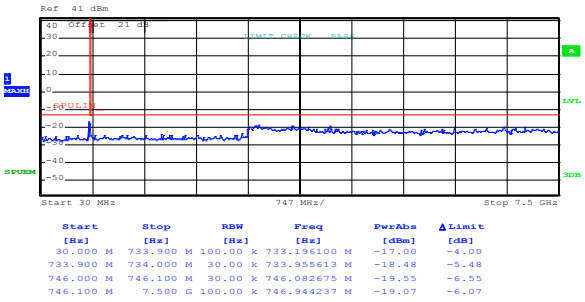


Figure 8.6-32: *Conducted spurious emissions, antenna 1, 10 MHz, mid channel, 64-QAM*

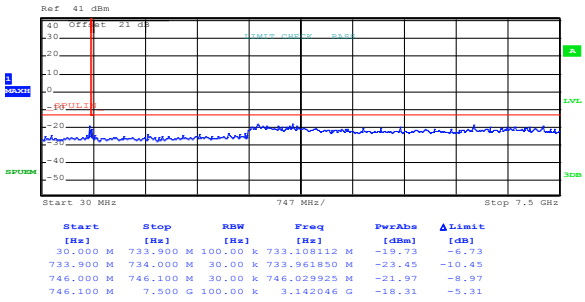


Figure 8.6-33: *Conducted spurious emissions, antenna 1, 10 MHz, high channel, 64-QAM*

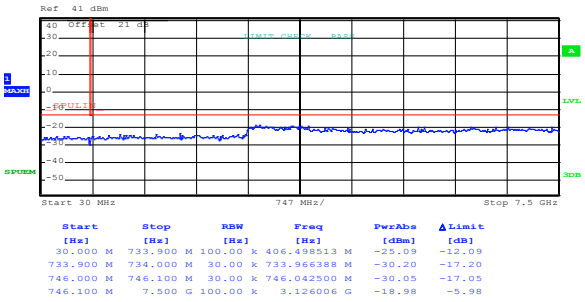


Figure 8.6-34: *Conducted spurious emissions, antenna 2, 10 MHz, low channel, 64-QAM*

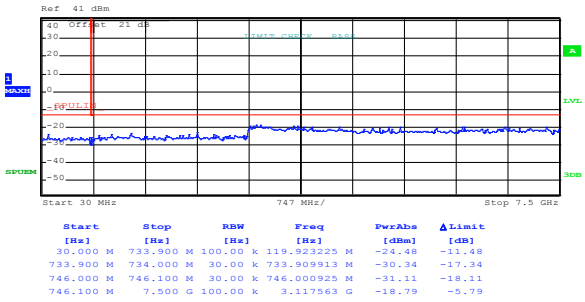


Figure 8.6-35: *Conducted spurious emissions, antenna 2, 10 MHz, mid channel, 64-QAM*

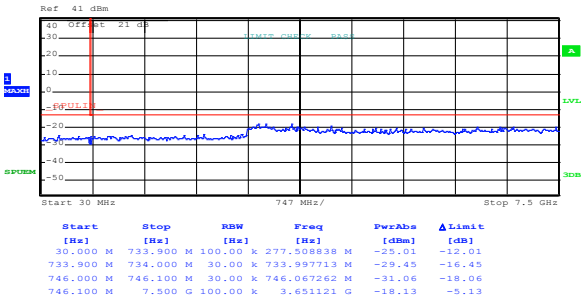


Figure 8.6-36: *Conducted spurious emissions, antenna 2, 10 MHz, high channel, 64-QAM*

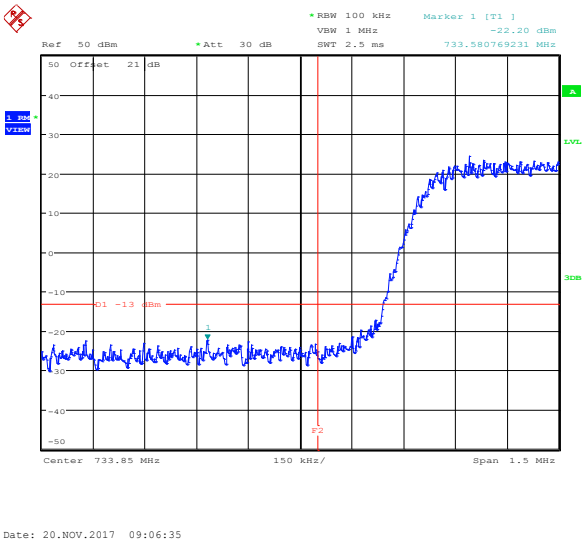


Figure 8.6-37: *Lower band edge emission, 5 MHz channel, antenna 1*

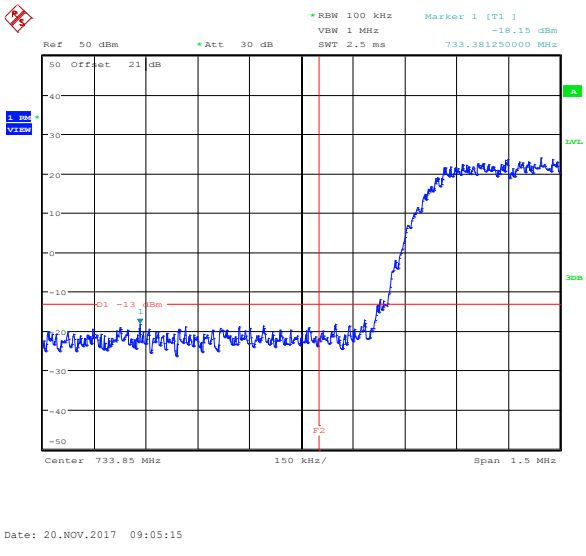


Figure 8.6-38: *Lower band edge emission, 5 MHz channel, antenna 2*

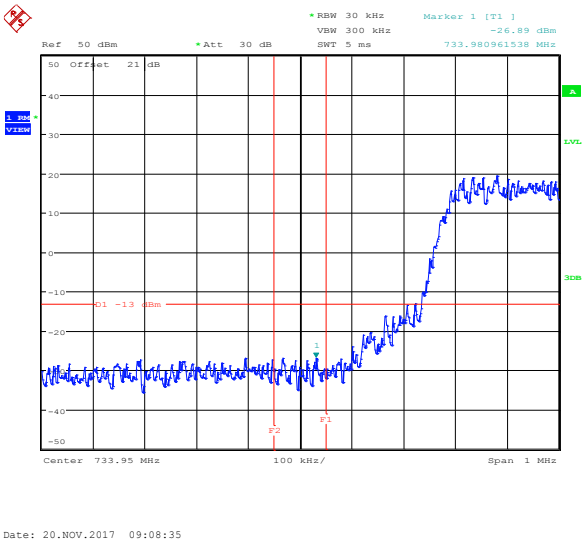


Figure 8.6-39: *Lower band edge Out-of-band emission, 5 MHz channel, antenna 1*

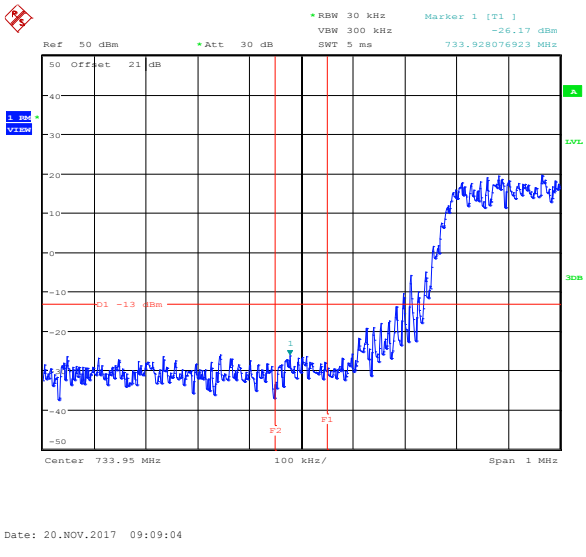


Figure 8.6-40: *Lower band edge Out-of-band emission, 5 MHz channel, antenna 2*

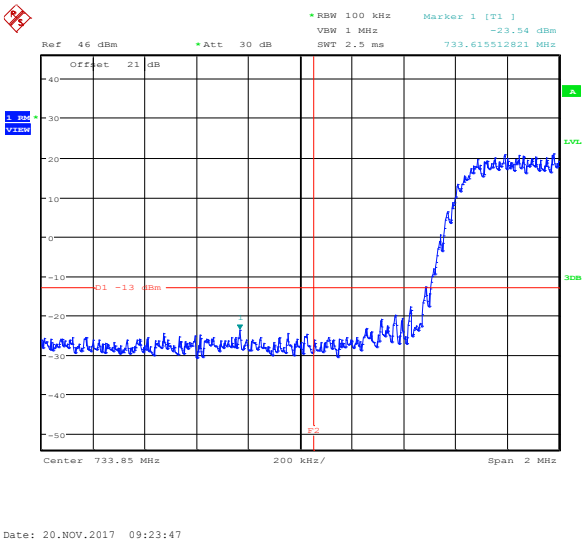


Figure 8.6-41: *Lower band edge emission, 10 MHz channel, antenna 1*

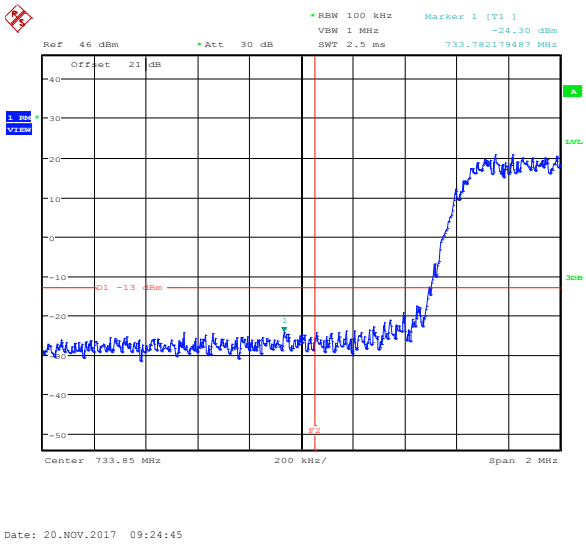


Figure 8.6-42: *Lower band edge emission, 10 MHz channel, antenna 2*

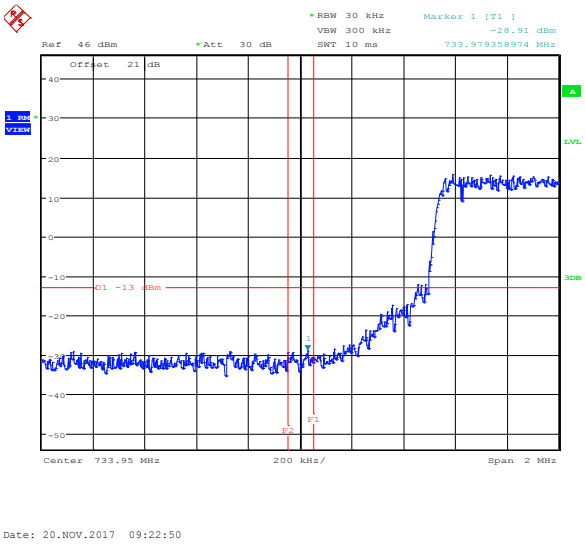


Figure 8.6-43: *Lower band edge Out-of-band emission, 10 MHz channel, antenna 1*

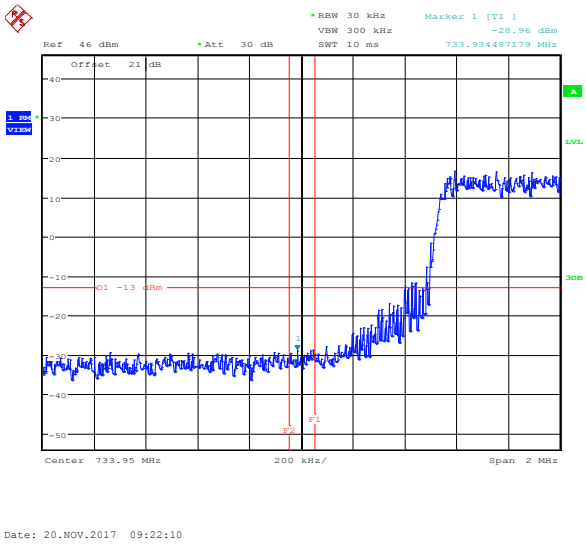


Figure 8.6-44: *Lower band edge Out-of-band emission, 10 MHz channel, antenna 2*

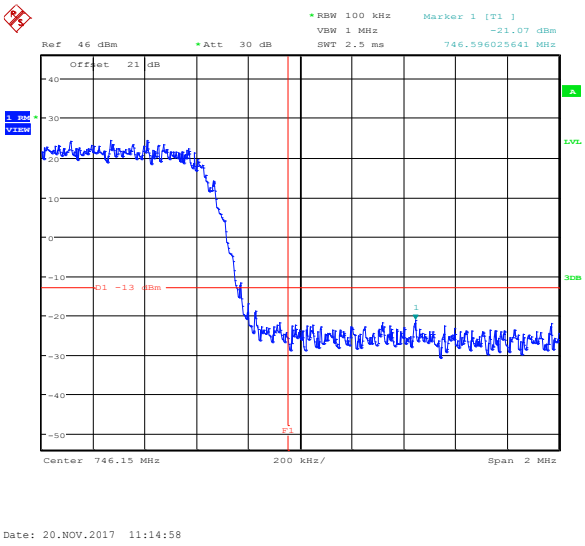


Figure 8.6-45: *Upper band edge emission, 5 MHz channel, antenna 1*

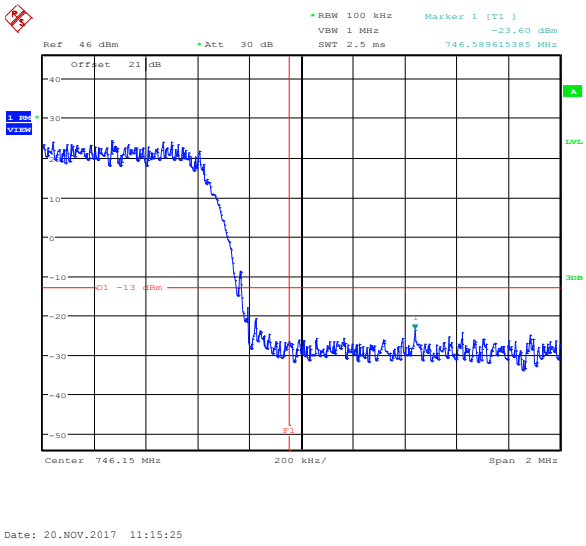


Figure 8.6-46: *Upper band edge emission, 5 MHz channel, antenna 2*

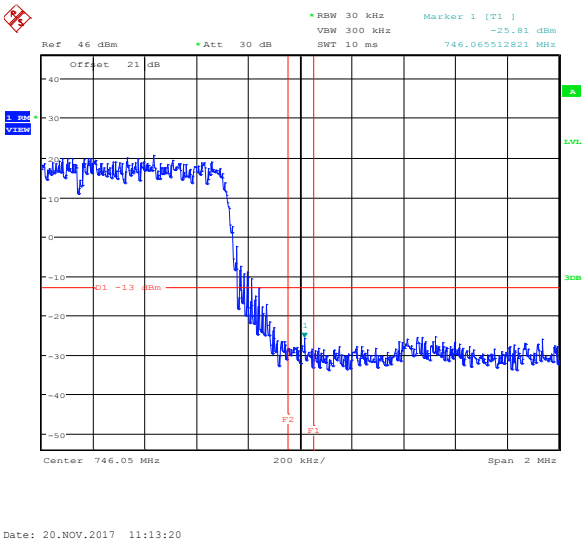


Figure 8.6-47: *Upper band edge Out-of-band emission, 5 MHz channel, antenna 1*

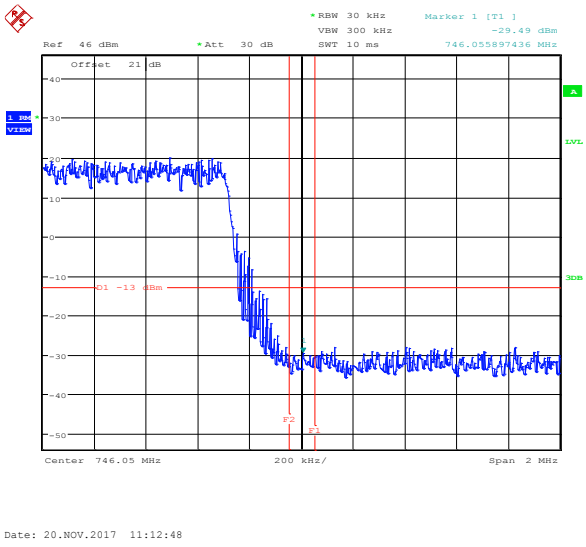


Figure 8.6-48: *Upper band edge Out-of-band emission, 5 MHz channel, antenna 2*

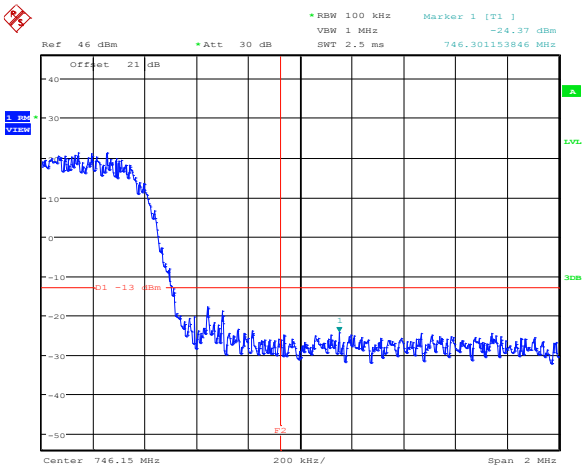


Figure 8.6-49: *Upper band edge emission, 10 MHz channel, antenna 1*

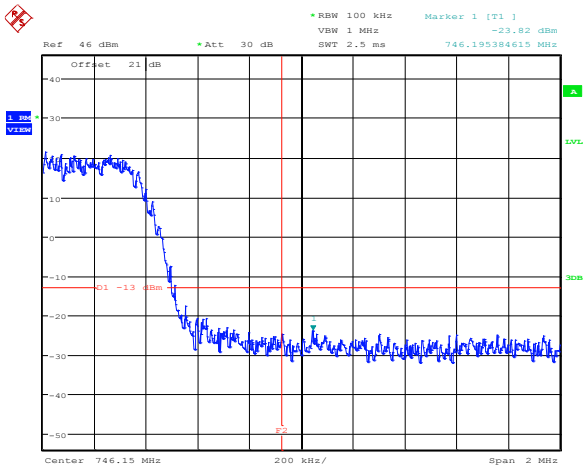


Figure 8.6-50: *Upper band edge emission, 10 MHz channel, antenna 2*

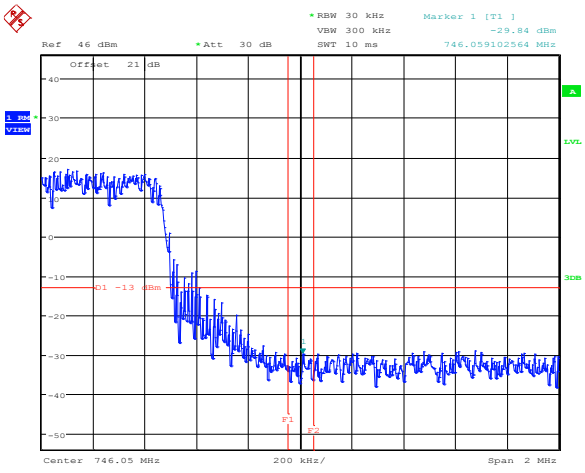


Figure 8.6-51: *Upper band edge Out-of-band emission, 10 MHz channel, antenna 1*

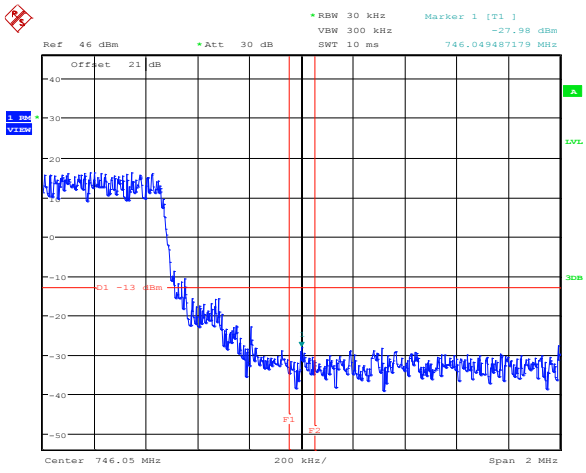


Figure 8.6-52: *Upper band edge Out-of-band emission, 10 MHz channel, antenna 2*

8.7 FCC 27.53(g) and RSS-130, 4.6.1 Radiated spurious emissions (Band 17)

8.7.1 Definitions and limits

FCC:
(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 (−13 dBm). 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:
4.6.1 The power of any unwanted emissions in any 100 kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 $\log_{10}$ p (watts), dB (−13 dBm). However, in the 100 kHz band immediately outside the equipment's operating frequency range, a resolution bandwidth of 30 kHz may be employed.

8.7.2 Test summary

Test date	October 12, 2017
Test engineer	Andrey Adelberg
Verdict	Pass

8.7.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
All measurements were performed using a peak detector.
RBW within 30–1000 MHz was 100 kHz and 1 MHz above 1 GHz. VBW was wider than RBW.
Testing was performed with RF ports terminated with 50 Ohm load.

8.7.4 Test data

Table 8.7-1: *Radiated spurious emissions, worst case*

Remarks	Frequency, MHz	Emission power level, dBm	Limit, dBm	Margin, dB
5 MHz channel	4442.0	-34	-13	21
10 MHz channel	4434.0	-38	-13	25

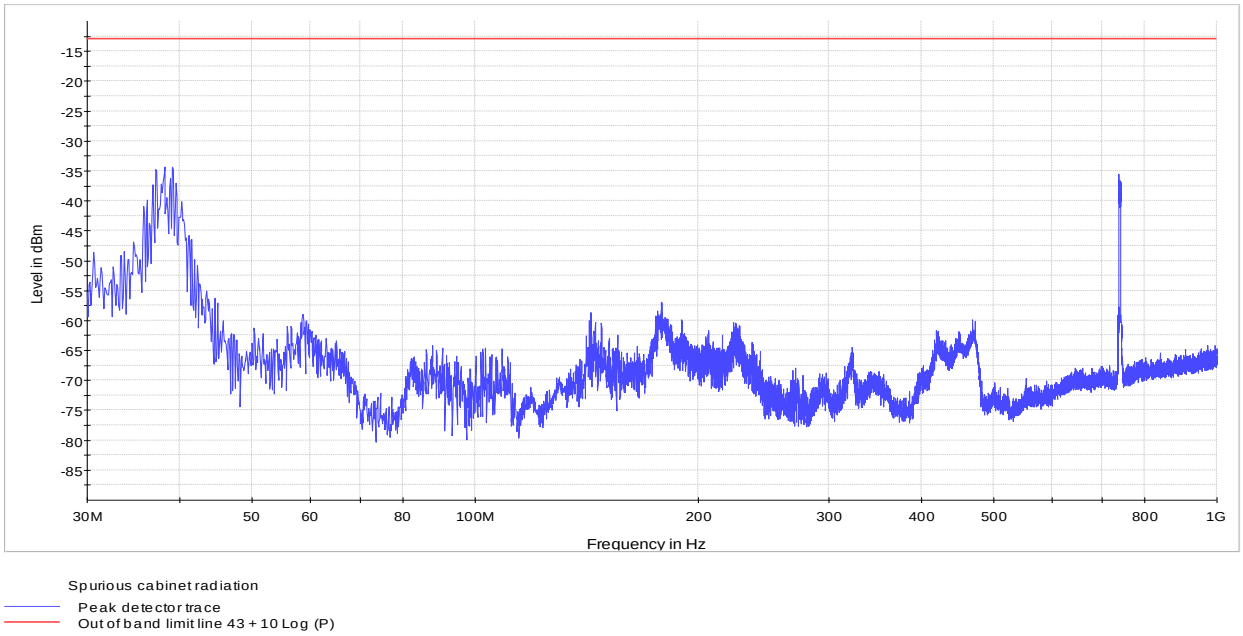


Figure 8.7-1: *Radiated spurious emission below 1 GHz, 5 MHz channel*

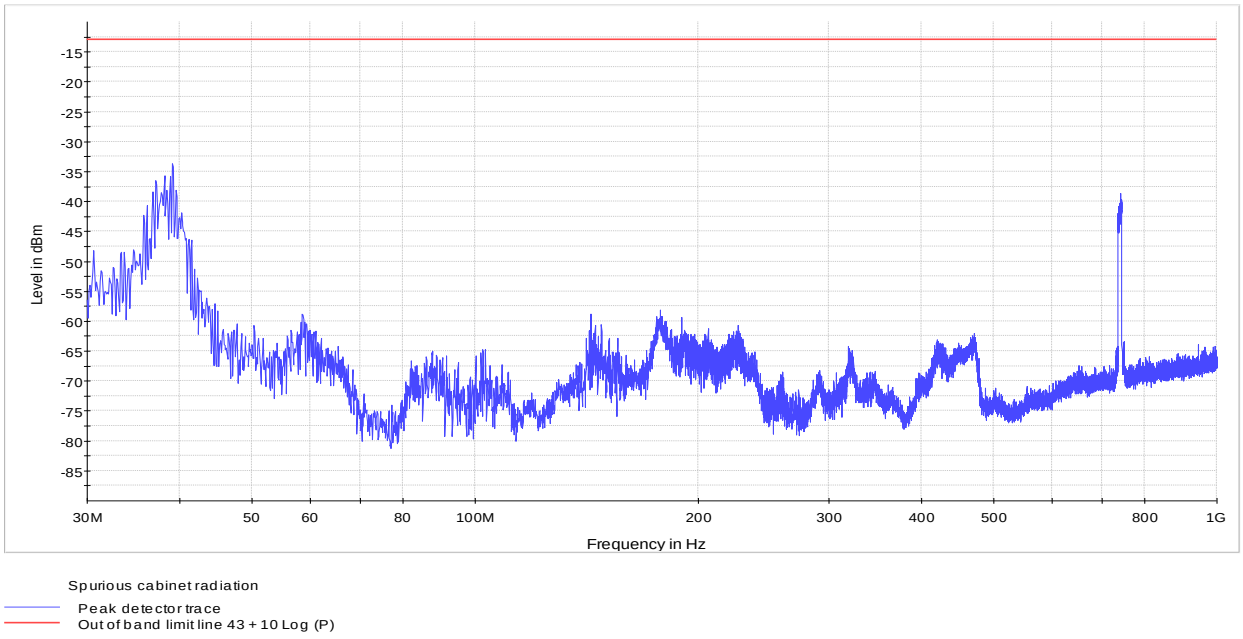


Figure 8.7-2: *Radiated spurious emission below 1 GHz, 10 MHz channel*

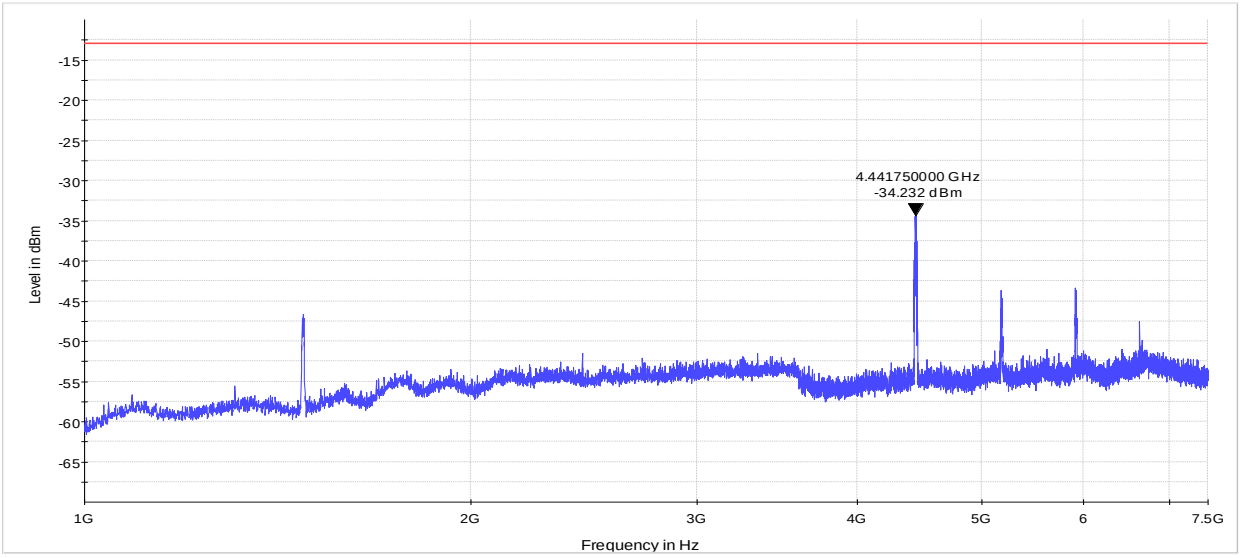


Figure 8.7-3: *Radiated spurious emission above 1 GHz, 5 MHz channel*

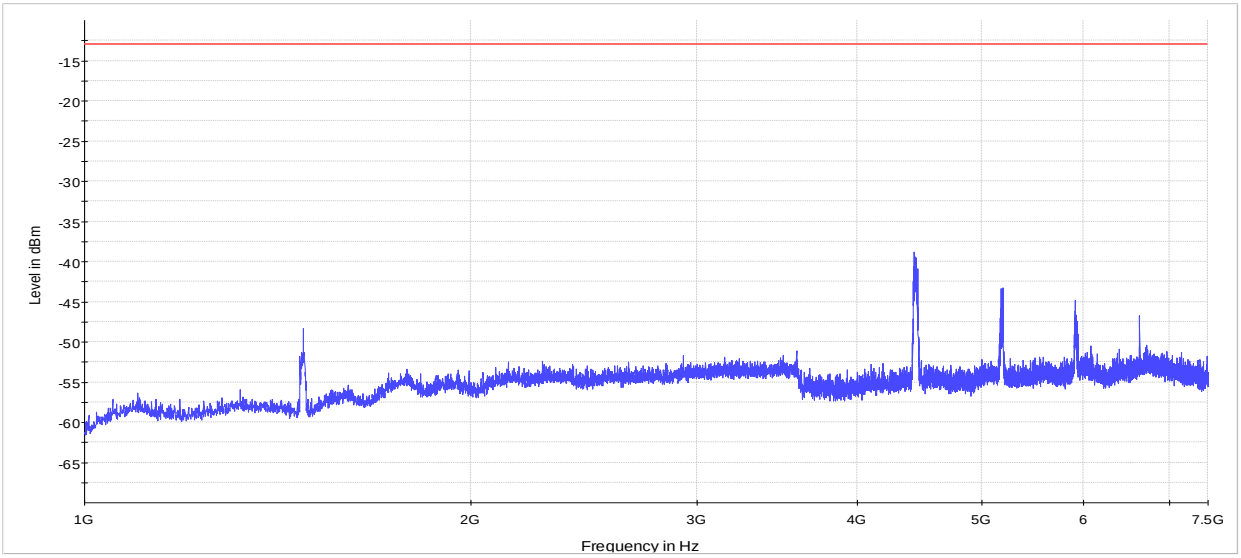


Figure 8.7-4: *Radiated spurious emission above 1 GHz, 10 MHz channel*

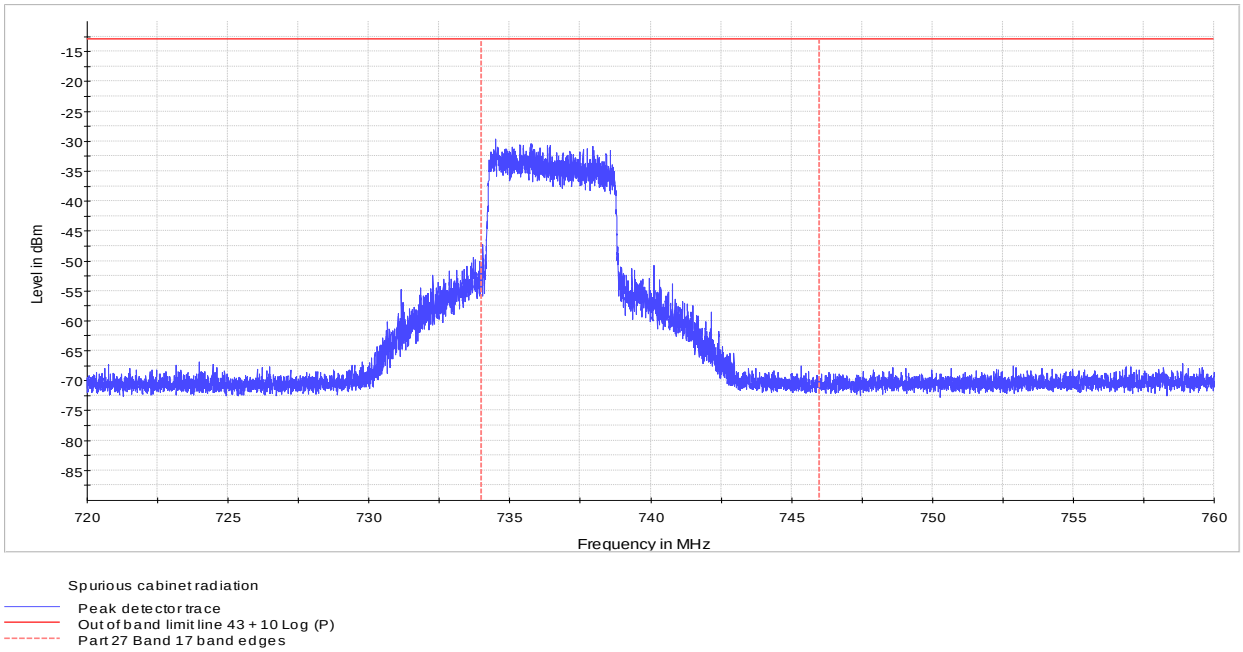


Figure 8.7-5: *Radiated spurious emission at the lower band edge, 5 MHz channel, QPSK*

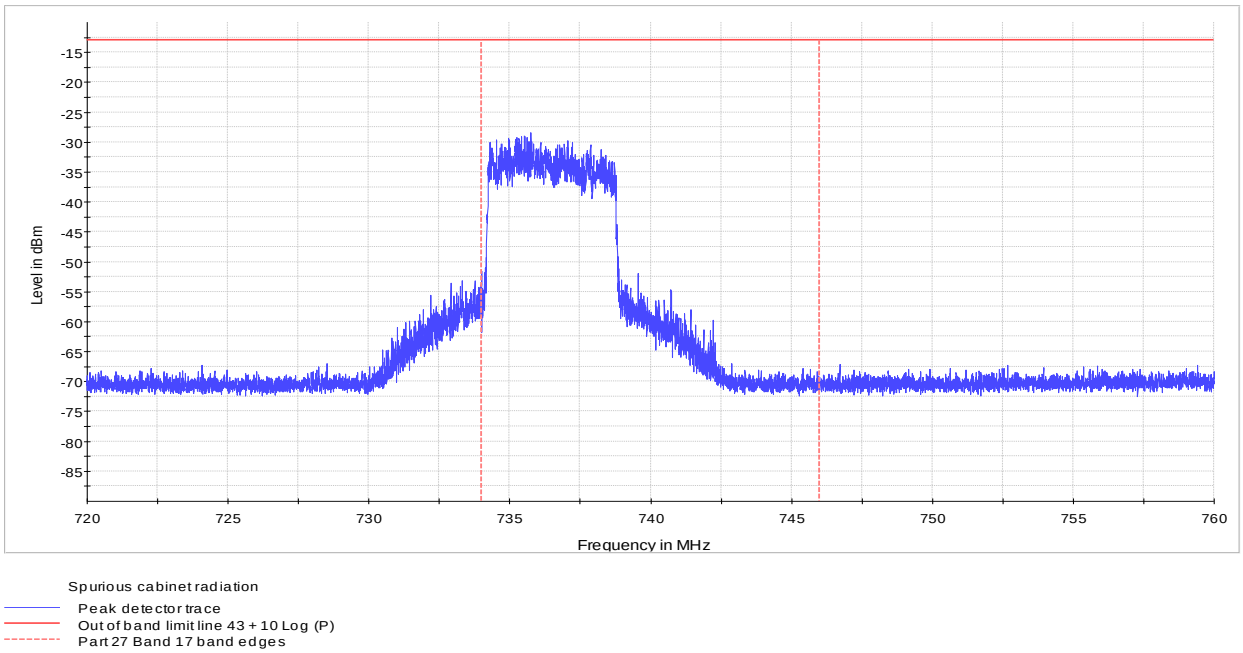


Figure 8.7-6: *Radiated spurious emission at the lower band edge, 5 MHz channel, 16-QAM*

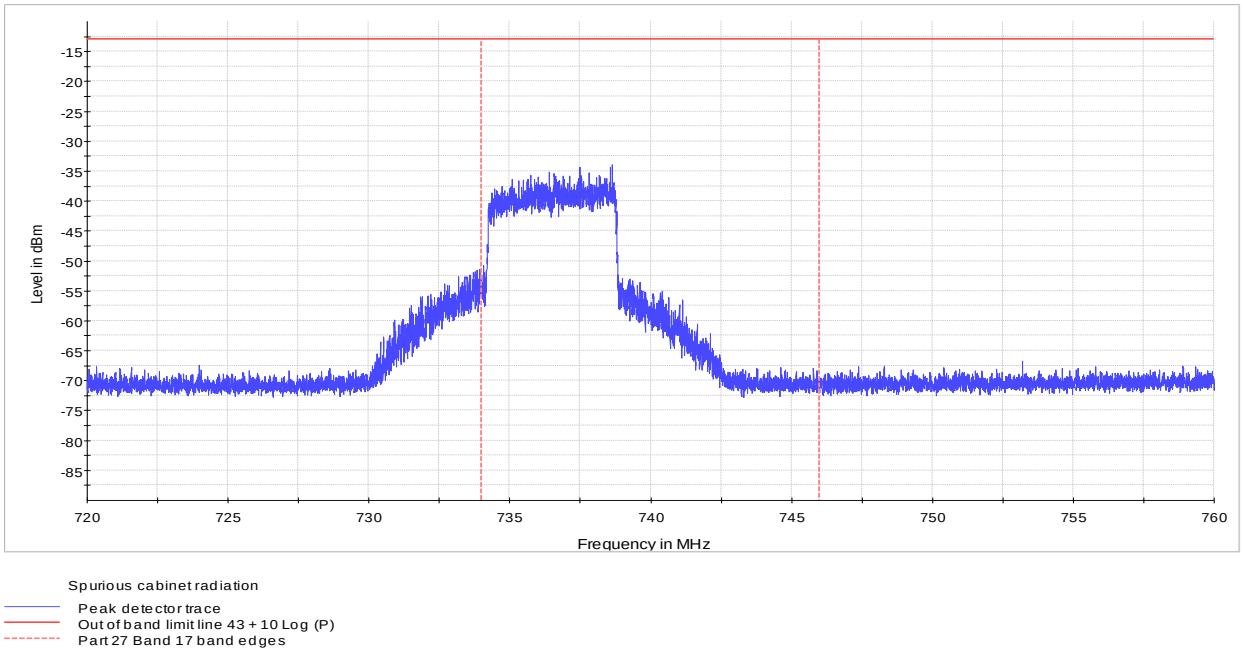


Figure 8.7-7: *Radiated spurious emission at the lower band edge, 5 MHz channel, 64-QAM*

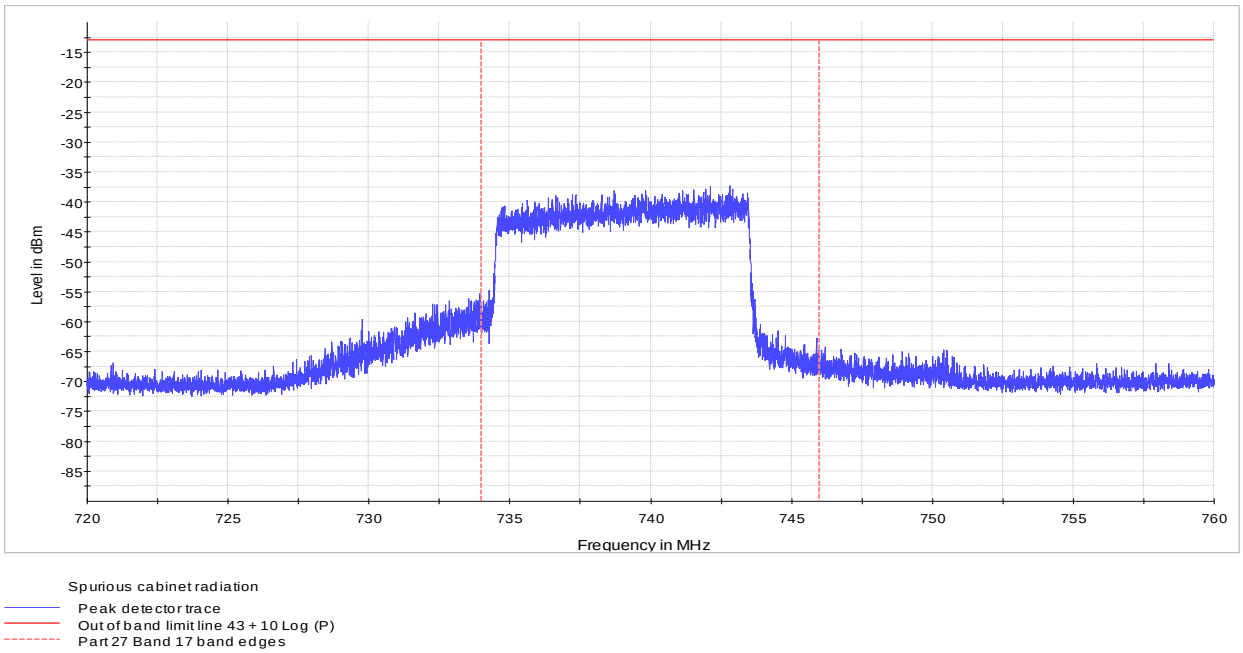


Figure 8.7-8: *Radiated spurious emission at the lower band edge, 10 MHz channel, QPSK*

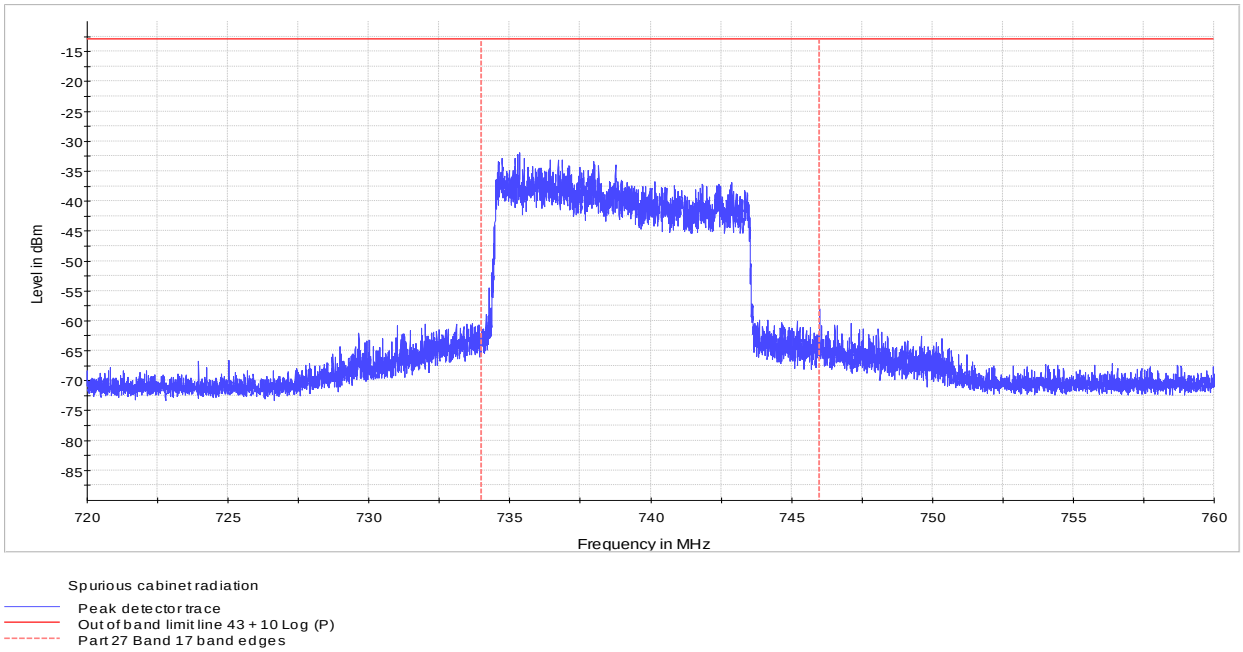


Figure 8.7-9: *Radiated spurious emission at the lower band edge, 10 MHz channel, 16-QAM*

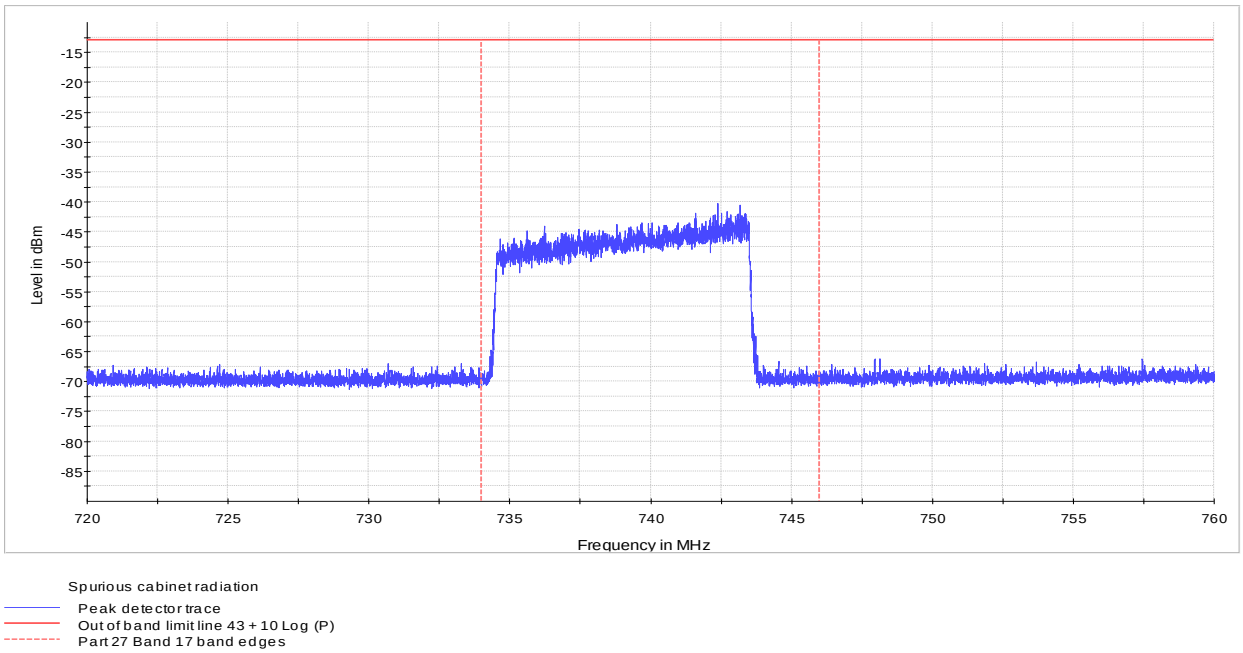


Figure 8.7-10: *Radiated spurious emission at the lower band edge, 10 MHz channel, 64-QAM*

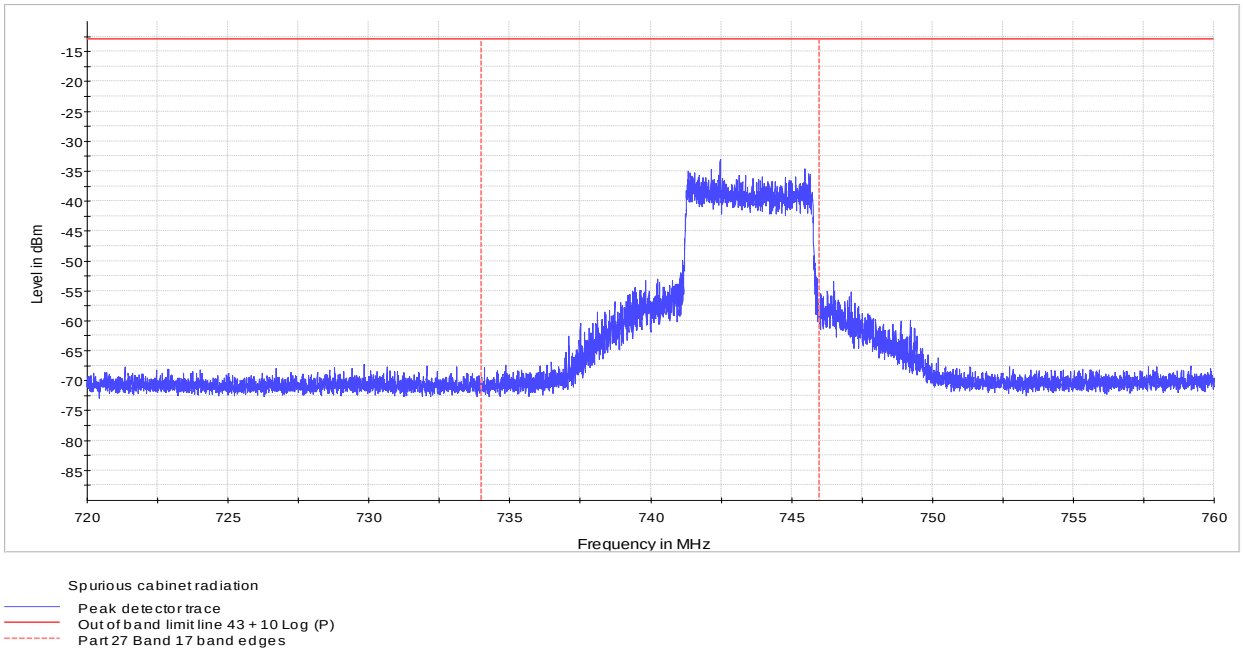


Figure 8.7-11: *Radiated spurious emission at the upper band edge, 5 MHz channel, QPSK*

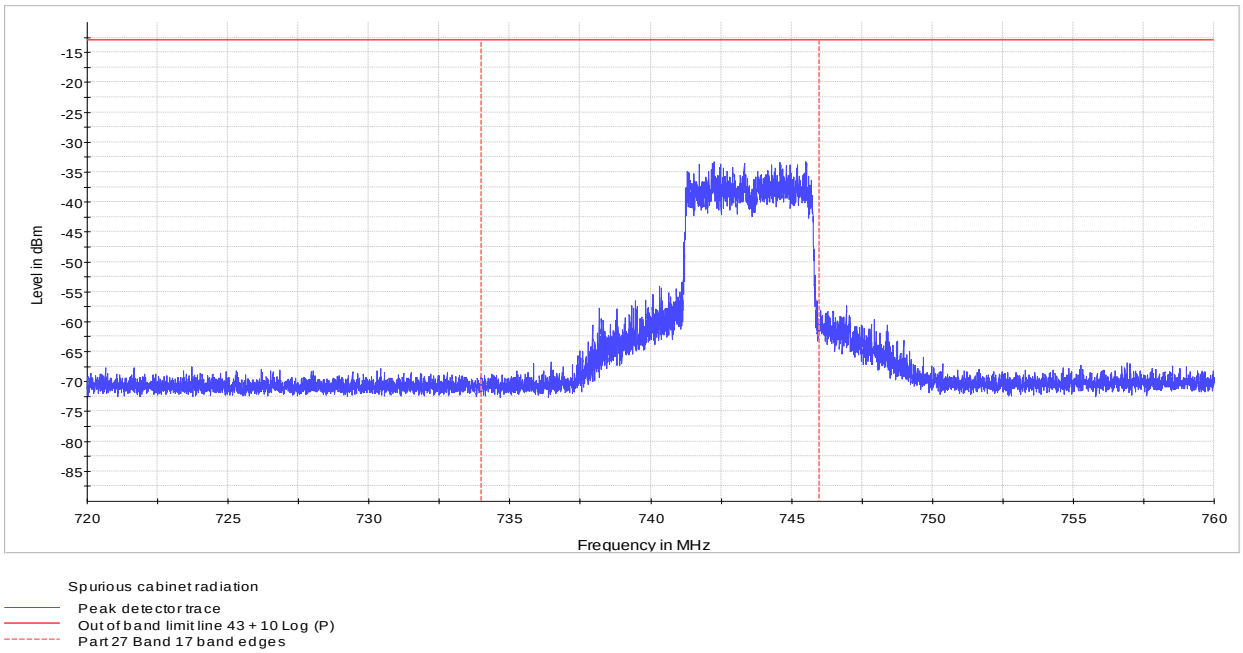


Figure 8.7-12: *Radiated spurious emission at the upper band edge, 5 MHz channel, 16-QAM*

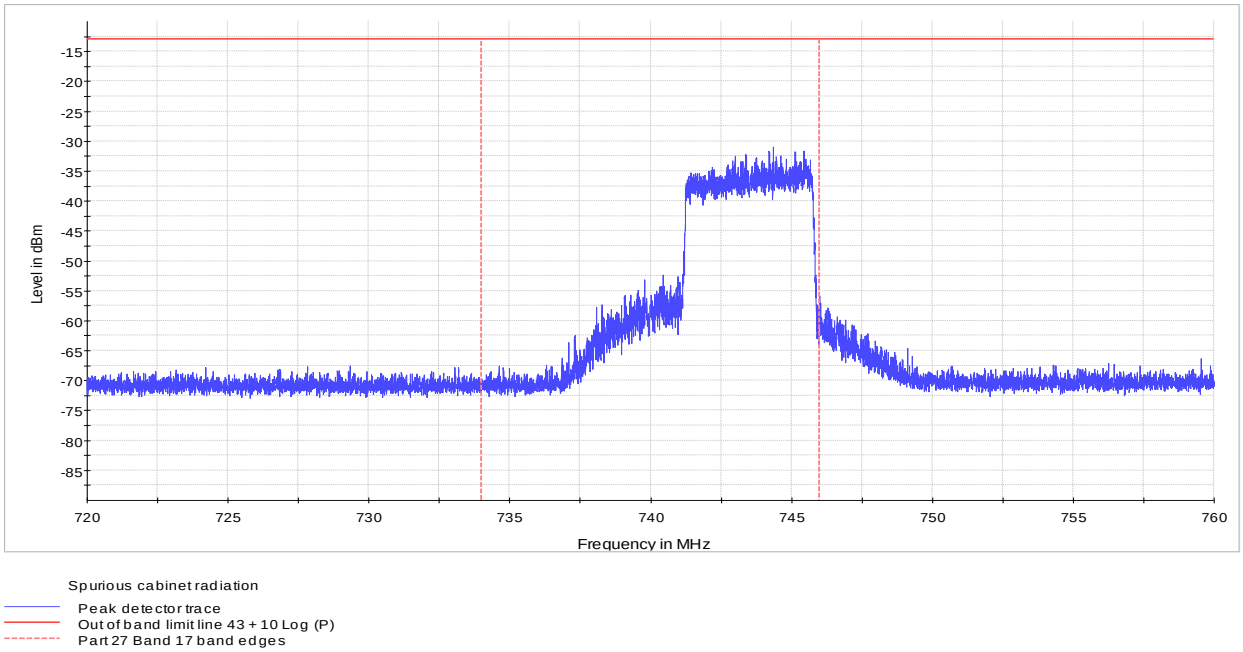


Figure 8.7-13: *Radiated spurious emission at the upper band edge, 5 MHz channel, 64-QAM*

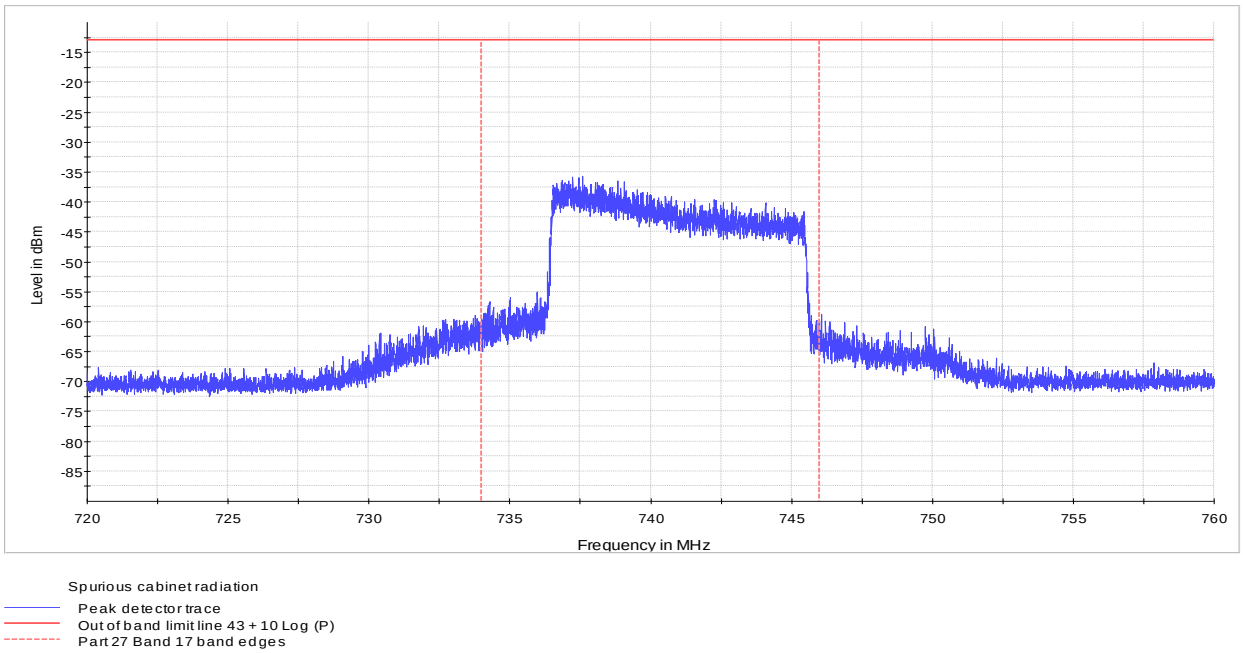


Figure 8.7-14: *Radiated spurious emission at the upper band edge, 10 MHz channel, QPSK*

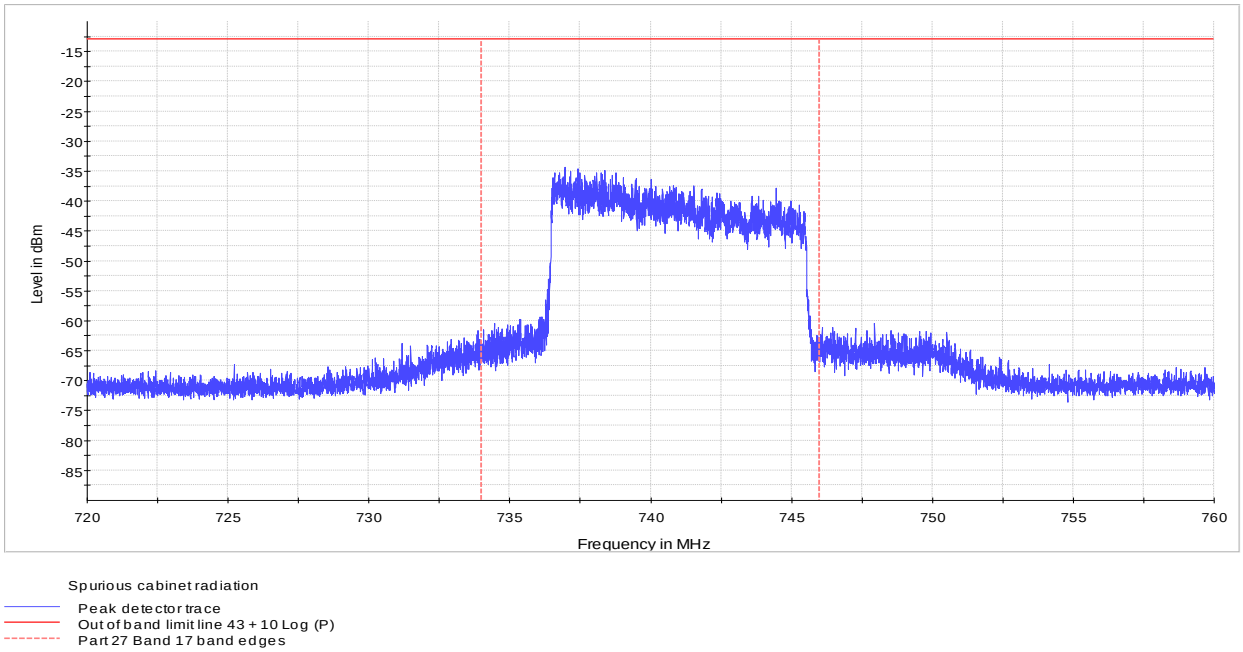


Figure 8.7-15: *Radiated spurious emission at the upper band edge, 10 MHz channel, 16-QAM*

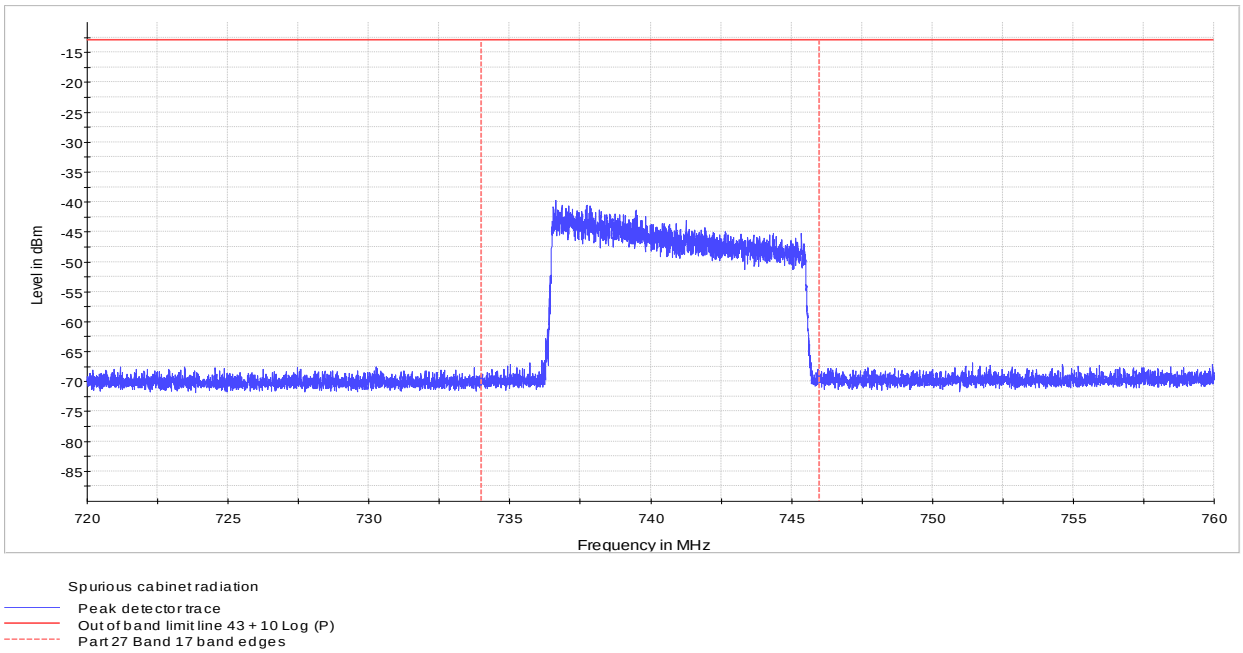


Figure 8.7-16: *Radiated spurious emission at the upper band edge, 10 MHz channel, 64-QAM*

8.8 FCC Part 2.1049 and RSS-Gen, 6.6 Occupied bandwidth (Band 17)

8.8.1 Definitions and limits

FCC:
The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

RSS-Gen, 6.6
The emission bandwidth (×dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated × dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3× the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3×RBW.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

8.8.2 Test summary

Test date	October 17, 2017
Test engineer	Andrey Adelberg
Verdict	Pass

8.8.3 Observations, settings and special notes

Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	≥1 % of span
Video bandwidth	RBW × 3
Trace mode	Max Hold

8.8.4 Test data

Table 8.8-1: *Occupied bandwidth results*

Remarks	99% OBW, MHz	26 dB BW, MHz
5 MHz, QPSK, antenna 1	4.540	5.100
5 MHz, QPSK, antenna 2	4.500	4.840
5 MHz, 16-QAM, antenna 1	4.500	4.860
5 MHz, 16-QAM, antenna 2	4.480	4.780
5 MHz, 64-QAM, antenna 1	4.500	4.840
5 MHz, 64-QAM, antenna 2	4.520	4.840
10 MHz, QPSK, antenna 1	9.100	10.050
10 MHz, QPSK, antenna 2	9.100	10.000
10 MHz, 16-QAM, antenna 1	9.150	10.000
10 MHz, 16-QAM, antenna 2	9.050	10.000
10 MHz, 64-QAM, antenna 1	9.100	10.050
10 MHz, 64-QAM, antenna 2	9.050	10.050

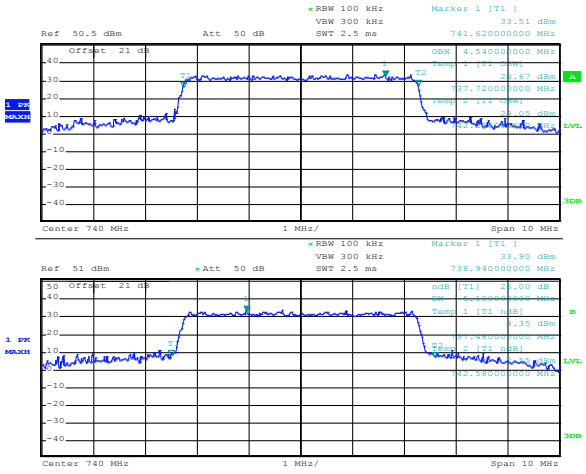


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Figure 8.8-1: *Occupied bandwidth, 5 MHz channel, QPSK, antenna 1*

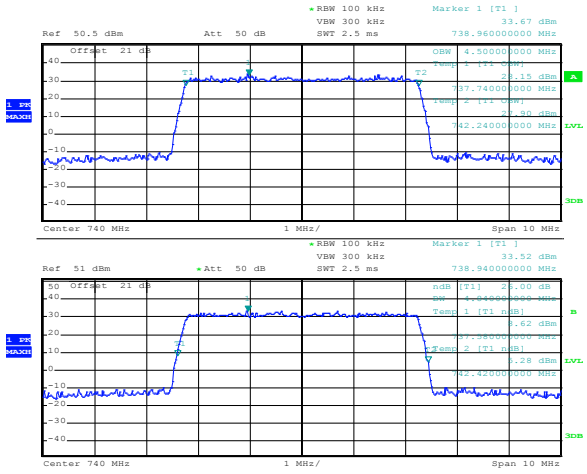

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Figure 8.8-2: *Occupied bandwidth, 5 MHz channel, QPSK, antenna 2*

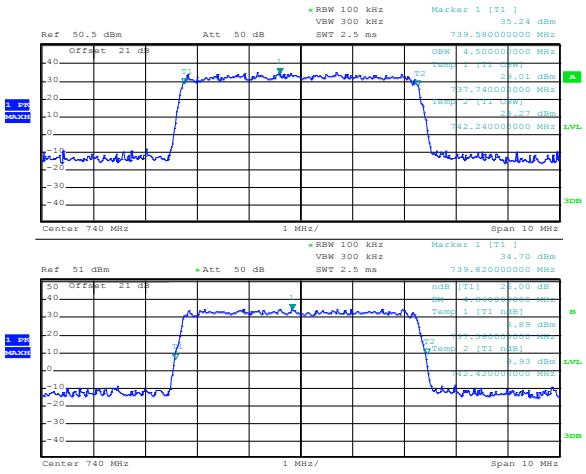

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Figure 8.8-3: *Occupied bandwidth, 5 MHz channel, 16-QAM, antenna 1*

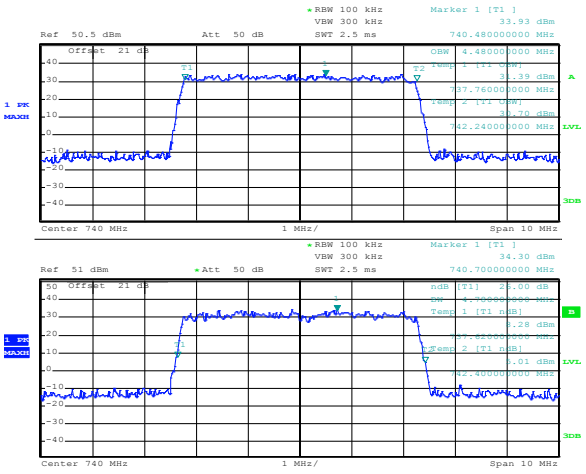

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Figure 8.8-4: *Occupied bandwidth, 5 MHz channel, 16-QAM, antenna*

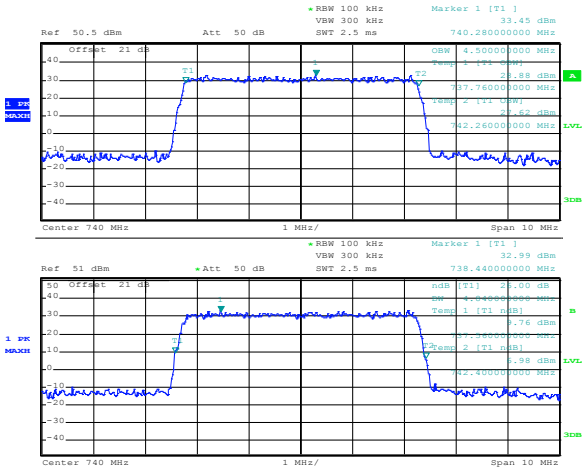

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Figure 8.8-5: *Occupied bandwidth, 5 MHz channel, 64-QAM, antenna 1*

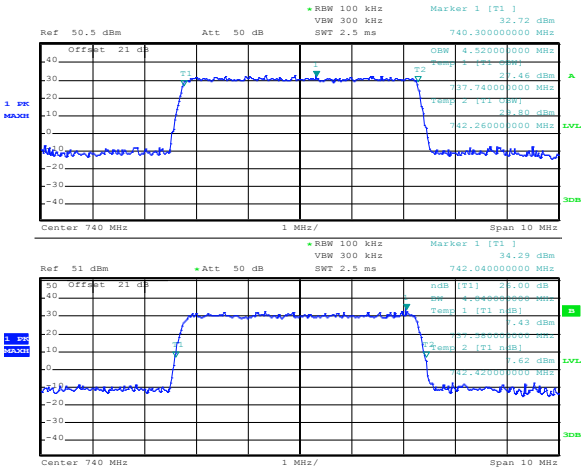

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Figure 8.8-6: *Occupied bandwidth, 5 MHz channel, 64-QAM, antenna 2*

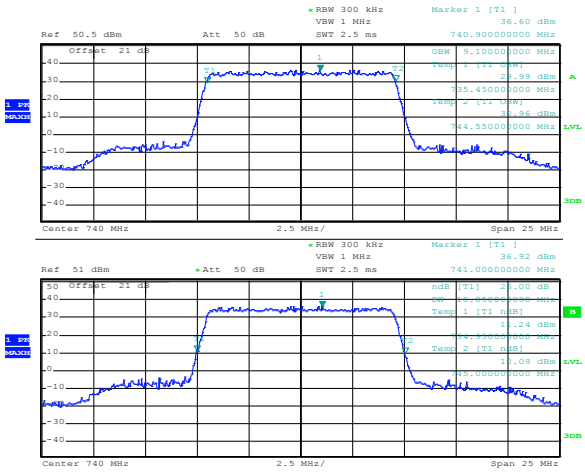

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Figure 8.8-7: *Occupied bandwidth, 10 MHz channel, QPSK, antenna 1*

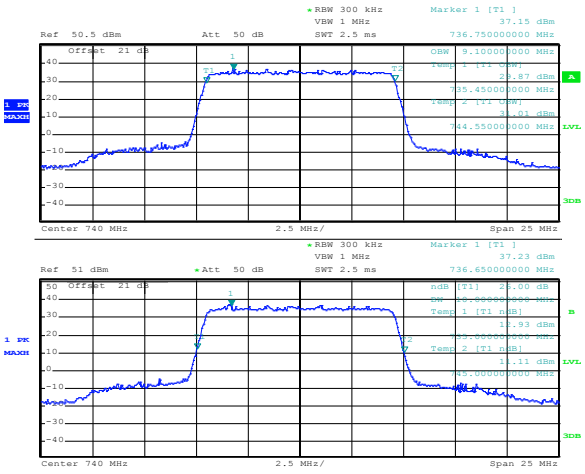

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Figure 8.8-8: *Occupied bandwidth, 10 MHz channel, QPSK, antenna 2*

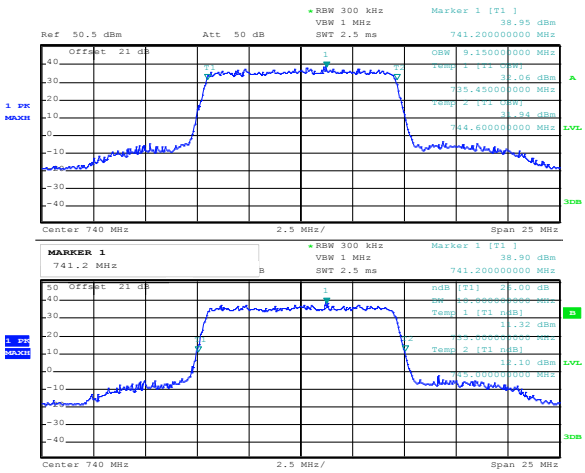

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Figure 8.8-9: *Occupied bandwidth, 10 MHz channel, 16-QAM, antenna 1*

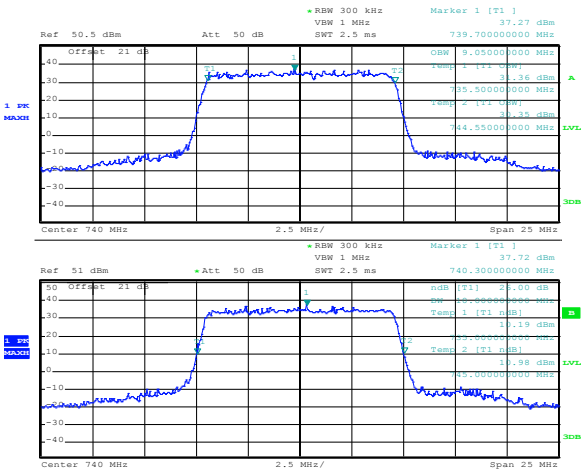

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Figure 8.8-10: *Occupied bandwidth, 10 MHz channel, 16-QAM, antenna 2*

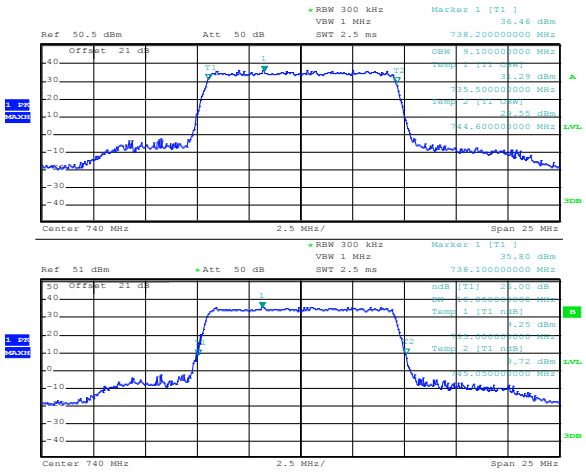

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Figure 8.8-11: *Occupied bandwidth, 10 MHz channel, 64-QAM, antenna 1*

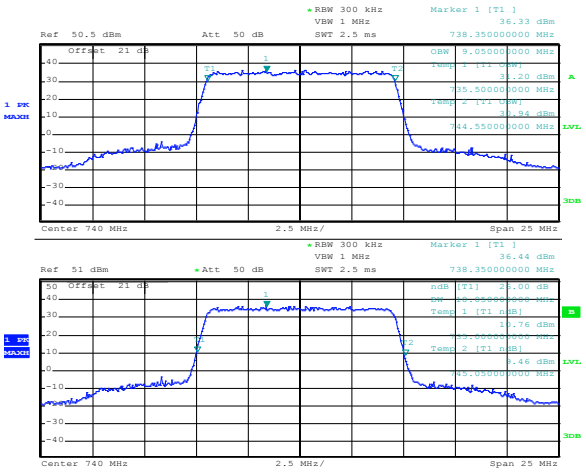

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Figure 8.8-12: *Occupied bandwidth, 10 MHz channel, 64-QAM, antenna 2*

8.9 FCC 27.54 and RSS-130, 4.3 Frequency stability

8.9.1 Definitions and limits

FCC:
The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

RSS-130, 4.6:
The transmitter frequency stability limit shall be determined as follows:

(a) The frequency offset shall be measured according to the procedure described in RSS-Gen and recorded;
(b) Using a resolution bandwidth of 1% of the occupied bandwidth, a reference point at the unwanted emission level which complies with the attenuation of 43 + 10 $\log_{10}$ p (watts) on the emission mask of the lowest and highest channel shall be selected, and the frequency at these points shall be recorded as f_L and f_H respectively.

The applicant shall ensure frequency stability by showing that f_L minus the frequency offset and f_H plus the frequency offset shall be within the frequency range in which the equipment is designed to operate.

8.9.2 Test summary

Test date	October 20, 2017
Test engineer	Andrey Adelberg
Verdict	Pass

8.9.3 Observations, settings and special notes

26 dBc points including frequency tolerance were assessed to remain within assigned band.
Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	30 Hz
Video bandwidth	RBW × 3
Trace mode	Max Hold

8.9.4 Test data

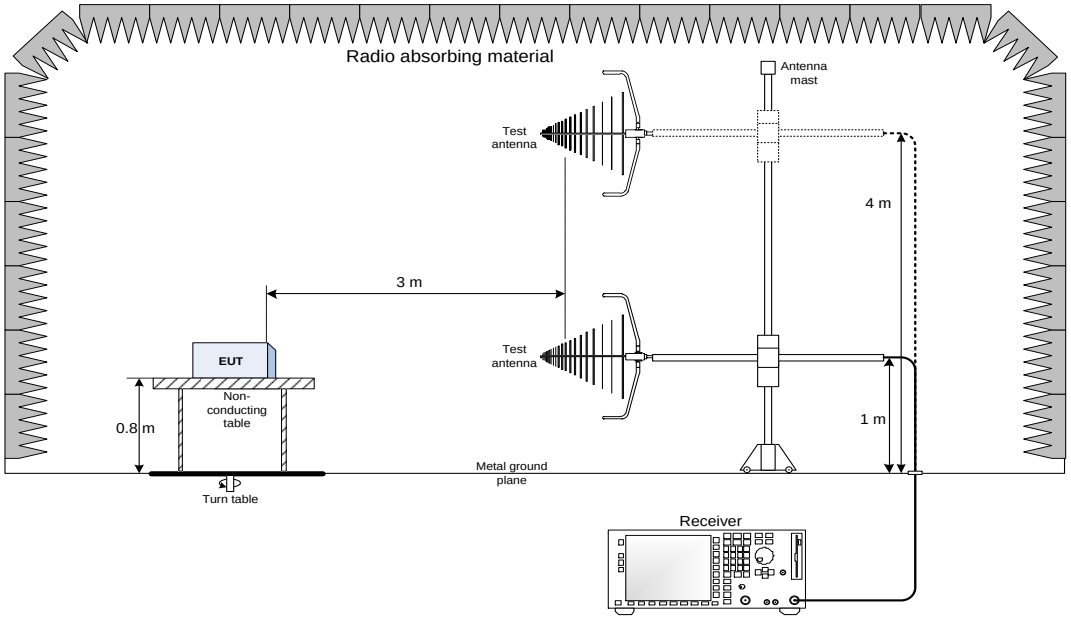
Table 8.9-1: *Frequency error results*

Temperature, °C	Voltage, V_{AC}	Measured frequency, Hz	Frequency drift, Hz
+50	120	733999954	54
+40	120	733999954	54
+30	120	733999954	54
+20	138	733999954	54
+20	120	733999954	54
+20	102	733999954	54
+10	120	733999954	54
0	120	733999954	54
−10	120	733999954	54
−20	120	733999954	54
−30	120	733999954	54

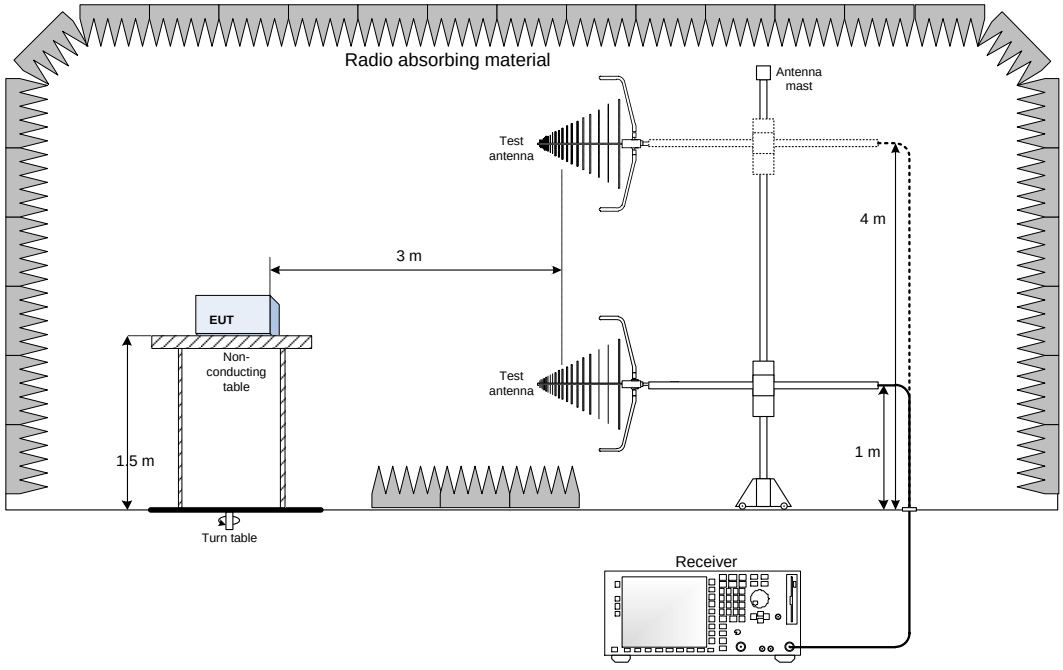
Note: nominal frequency is 734 MHz.

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up