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Test report

319271-1TRFWL

Date of issue: February 14, 2017

Applicant:

Redline Communications

Product:

Broad-band wireless infrastructure product

Model:

RDL-3100-RMA

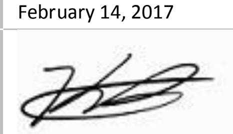
FCC ID:	IC Registration number:
QC8-RDL3100RMA	4310A-RDL3100RMA

Specifications:

- ### FCC Part 90, Subpart Y
  Private Land Mobile Radio Services; Regulations governing licensing and use of frequencies in the 4940–4990 MHz band
- ### RSS-111 Issue 5, September 4, 2014
  Broadband public safety equipment operating in the band 4940–4990 MHz

Test location

Company name:	Nemko Canada Inc.
Address:	303 River Road
City:	Ottawa
Province:	Ontario
Postal code:	K1V 1H2
Country:	Canada
Telephone:	+1 613 737 9680
Facsimile:	+1 613 737 9691
Toll free:	+1 800 563 6336
Website:	www.nemko.com
Site number:	FCC: 176392; IC: 2040A-4 (3 m semi anechoic chamber)

Tested by:	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by:	Kevin Rose, Wireless/EMC Specialist
Date:	February 14, 2017
Signature:	

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.

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Redline Communications
Address	302 Town Center Blvd.
City	Markham
Province/State	Ontario
Postal/Zip code	L3R 0E8
Country	Canada

1.2 Test specifications

FCC Part 90, Subpart Y	Private Land Mobile Radio Services; Regulations governing licensing and use of frequencies in the 4940–4990 MHz band
RSS-111, Issue 5, September 2014	Broadband public safety equipment operating in the band 4940–4990 MHz

1.3 Test methods

971168 D01 Power Meas License Digital Systems v02r02	Measurement guidance for certification of licensed digital transmitters
662911 D01 Multiple Transmitter Output v02r01	Emissions Testing of Transmitters with Multiple Outputs in the Same Band (e.g., MIMO, Smart Antenna, etc)

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. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 RSS-Gen, Issue 4, test results

Clause	Test description	Verdict
6.6	Occupied bandwidth	Pass
7.1.2	Receiver Radiated Limits	Not applicable
7.1.3	Receiver Conducted Limits	Not applicable
8.8	AC power lines conducted emission limits	Pass

Note: According to sections 5.2 and 5.3 of RSS-Gen, Issue 4 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

2.2 RSS-111, Issue 5, tests results

Part	Test description	Verdict
5.1	Types of modulation	Pass[1]
5.2	Transmitter frequency stability	Pass
5.3	Equipment's transmit output power and channel bandwidth	Pass
5.4	Transmitter peak-to-average power ratio	Pass
5.5	Transmitter unwanted emissions	Pass

Notes: [1] The EUT utilizes OFDM method of encoding digital modulations such as BPSK, QPSK, 16-QAM, 64-QAM, 128-QAM, and 256-QAM

2.3 FCC Part 90, tests results

Clause	Test description	Verdict
90.1215(d)	Occupied bandwidth	Pass
90.1215(a)	Peak output power	Pass
90.1215(b)	Peak power spectral density	Pass
90.210(m)	Spurious emissions at the antenna terminals	Pass
90.210(m)(6)	Radiated spurious emissions	Pass
90.213(a)	Frequency stability	Pass

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	September 30, 2013
Nemko sample ID number	133-002803

3.2 EUT information

Product name	Broad-band wireless infrastructure product
Model	RDL-3100
Serial number	318SC16300082

3.3 Technical information

Operating band	4940–4990 MHz
Operating frequency	10 MHz channel: 4945–4985 MHz 20 MHz channel: 4950–4980 MHz
Modulation type	OFDM using 256-QAM, 128-QAM, 64-QAM, 16-QAM, QPSK and BPSK modulation for sub-carriers
Channel bandwidth	10 MHz and 20 MHz
Emission designator	W7D
Power requirements	48 V_{DC} PoE via 120 V_{AC}, 60 Hz
Antenna information	10 dBi Redline AOD-DB-0512-02 omnidirectional antenna 24 dBi Dual Polarization Antenna 4.9–6.1 GHz, Redline 30-00362-00 32 dBi Redline A3FT3204LTPD Parabolic Antenna, 4.9–5.8 GHz, 4 degree, dual polarity

3.4 Product description and theory of operation

The EUT is a 2×2 MIMO point-to-multipoint (PMP) and point-to-point (PTP) carrier grade broadband wireless infrastructure product, designed to operate in the 4940–4990 MHz band.

3.5 EUT exercise details

The EUT was controlled to transmit at desired frequency and modulation from laptop using web interface at IP address: 192.168.25.2

3.6 EUT setup diagram

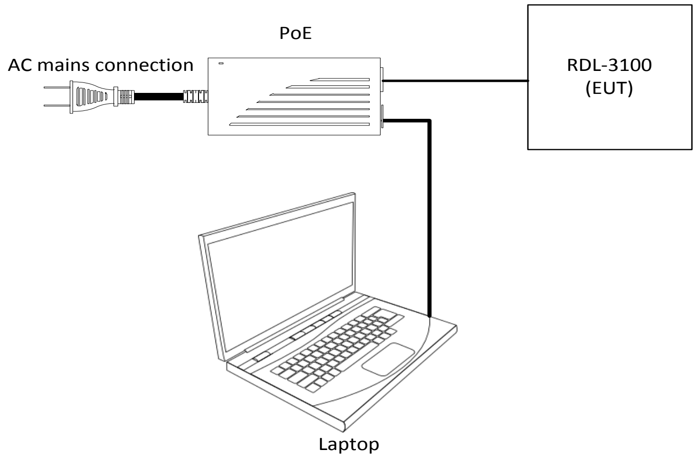


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
PoE	Cincon Electronics Co.	TRG60A-POE-L	1127

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

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. 01/17
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
AC Power source	California Instruments	3001i	FA001021	1 year	Sept. 08/17
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 07/17
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Apr. 15/17
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Apr. 28/17
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Apr. 26/17
Horn antenna 18–40 GHz	EMCO	3116	FA001847	1 year	Apr.15/17
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	April 26/17
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU
Temperature chamber	Espec	EPX-4H	FA002735	1 year	Jan 26/17
Power meter	Agilent	N1911A	FA001946	1 year	Apr. 07/17
Power sensor	Agilent	N1922A	FA001947	1 year	Apr. 08/17
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Mar. 08/17

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

Section 8. Testing data

8.1 FCC 90.1215(d) and RSS-Gen 6.6 Occupied bandwidth

8.1.1 Definitions and limits

FCC

d) The peak power spectral density is measured as conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements are made over a bandwidth of one MHz or the 26 dB emission bandwidth of the device, whichever is less. A resolution bandwidth less than the measurement bandwidth can be used, provided that the measured power is integrated to show total power over the measurement bandwidth. If the resolution bandwidth is approximately equal to the measurement bandwidth, and much less than the emission bandwidth of the equipment under test, the measured results shall be corrected to account for any difference between the resolution bandwidth of the test instrument and its actual noise bandwidth.

ISED:

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 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.

8.1.2 Test summary

Test date:	November 4, 2016	Temperature:	23 °C
Test engineer:	Andrey Adelberg	Air pressure:	1006 mbar
Verdict:	Pass	Relative humidity:	34 %

8.1.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	200 kHz *for 10 MHz channel* 500 kHz *for 20 MHz channel*
Video bandwidth:	≥3 × RBW
Frequency span:	20 MHz *for 10 MHz channel* 50 MHz *for 20 MHz channel*
Detector mode:	Peak
Trace mode:	Max Hold

8.1.4 Test data

Table 8.1-1: *Channel names description*

Channel name	10-MHz channel	20-MHz channel
Low	4945.0	4950.0
Mid	4965.0	4965.0
High	4985.0	4980.0

Table 8.1-2: *26 dB bandwidth results*

Modulation	Channel	10-MHz channel	20-MHz channel
BPSK	Low	9.42	19.39
	Mid	9.45	19.31
	High	9.52	19.23
	Low	9.52	19.39
256-QAM	Mid	9.55	19.31
	High	9.52	19.31
	Low	9.42	19.39
	Mid	9.45	19.31

Table 8.1-3: *99% bandwidth results*

99% bandwidth for 10-MHz channel, MHz	99% bandwidth for 20-MHz channel, MHz
8.33	16.67

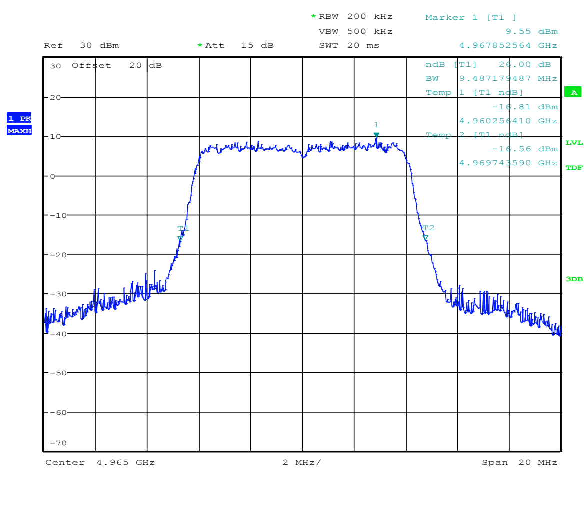


Figure 8.1-1: *26 dB bandwidth for 10 MHz channel, sample plot*

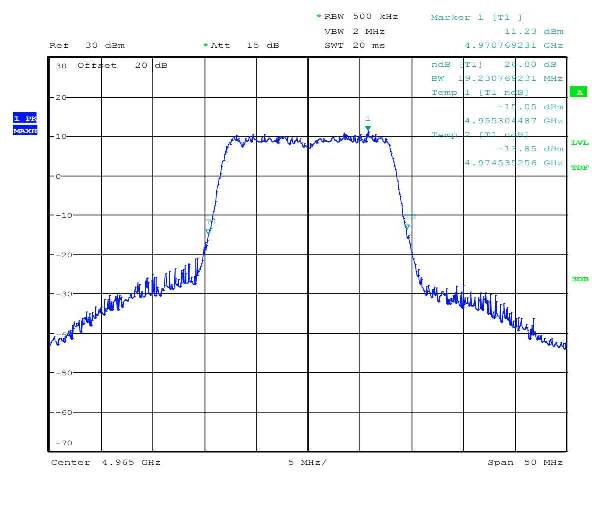


Figure 8.1-2: *26 dB bandwidth for 20 MHz channel, sample plot*

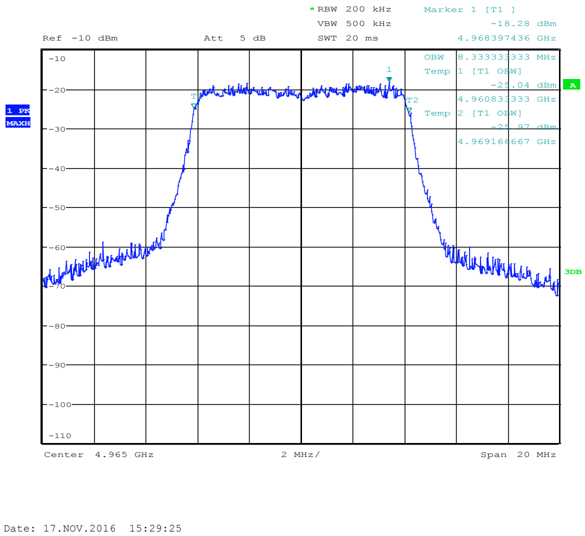


Figure 8.1-3: *99 % occupied bandwidth for 10 MHz channel, sample plot*

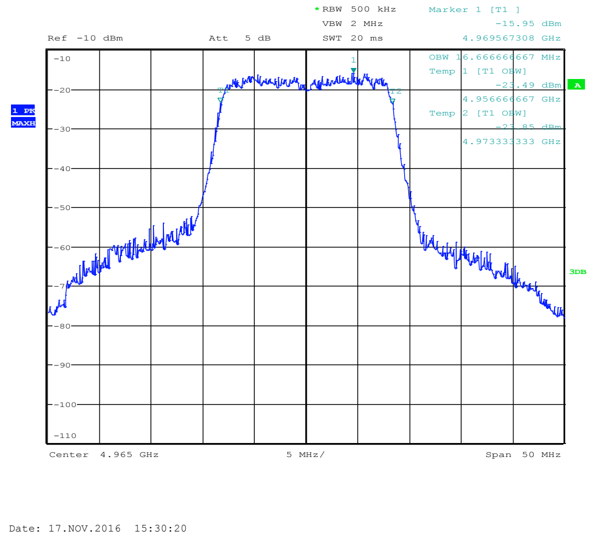


Figure 8.1-4: *99 % occupied bandwidth for 20 MHz channel, sample plot*

8.2 FCC 90.213(a) and RSS-111 Clause 5.2 Transmitter frequency stability

8.2.1 Definitions and limits

FCC:
(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table:

Table 8.2-1: *Minimum frequency stability*

Frequency range (MHz)	Fixed and base stations (±ppm)	Mobile stations (±ppm)	
		Over 2 watts output power	2 watts or less output power
Below 25	100	100	200
25–50	20	20	50
72–76	5		50
150–174	5	5	50
216–220	1.0		1.0
220–222	0.1	1.5	1.5
421–512	2.5	5	5
806–809	1.0	1.5	1.5
809–824	1.5	2.5	2.5
851–854	1.0	1.5	1.5
854–869	1.5	2.5	2.5
896–901	0.1	1.5	1.5
902–928	2.5	2.5	2.5
929–930	1.5		
935–940	0.1	1.5	1.5
1427–1435	300	300	300
Above 2450			

ISED:
The applicant shall ensure frequency stability by showing that the occupied bandwidth is maintained within the band of operation when tested at the temperature and supply voltage variations specified for the frequency stability measurement in RSS-Gen.

8.2.2 Test summary

Test date:	November 17, 2016	Temperature:	22 °C
Test engineer:	Andrey Adelberg	Air pressure:	1010 mbar
Verdict:	Pass	Relative humidity:	32 %

8.2.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	3 kHz
Video bandwidth:	30 kHz
Detector mode:	Peak
Trace mode:	Max Hold

8.2.4 Test data

Table 8.2-2: *Frequency drift measurement*

Temperature, °C	Voltage	Nominal frequency, GHz	Frequency measured, GHz	Offset, Hz
50	Nominal	4.965000000	4.965004121	-102
40	Nominal	4.965000000	4.965004139	-84
30	Nominal	4.965000000	4.965004126	-97
20	Nominal +15 %	4.965000000	4.965004092	-131
20	Nominal	4.965000000	4.965004223	Reference
20	Nominal −15 %	4.965000000	4.965004257	34
10	Nominal	4.965000000	4.965004335	112
0	Nominal	4.965000000	4.965004586	363
−10	Nominal	4.965000000	4.965004396	173
−20	Nominal	4.965000000	4.965004467	244
−30	Nominal	4.965000000	4.965004367	144

8.3 FCC 90.1215(a) and RSS-111 Clause 5.3 Transmit output power and PSD

8.3.1 Definitions and limits

FCC:
(a) The transmitting power of stations operating in the 4940–4990 MHz band must not exceed the maximum limits given in
Table 8.3-1 below
High power devices are also limited to a peak power spectral density of 21 dBm per one MHz. High power devices using channel bandwidths other than those listed above are permitted; however, they are limited to peak power spectral density of 21 dBm/MHz. If transmitting antennas of directional gain greater than 9 dBi are used, both the maximum conducted output power and the peak power spectral density should be reduced by the amount in decibels that the directional gain of the antenna exceeds 9 dBi. However, high power point-to-point and point-to-multipoint operations (both fixed and temporary-fixed rapid deployment) may employ transmitting antennas with directional gain up to 26 dBi without any corresponding reduction in the maximum conducted output power or spectral density. Corresponding reduction in the maximum conducted output power and peak power spectral density should be the amount in decibels that the directional gain of the antenna exceeds 26 dBi.

(b) Low power devices are also limited to a peak power spectral density of 8 dBm per one MHz. Low power devices using channel bandwidths other than those listed above are permitted; however, they are limited to a peak power spectral density of 8 dBm/MHz. If transmitting antennas of directional gain greater than 9 dBi are used, both the maximum conducted output power and the peak power spectral density should be reduced by the amount in decibels that the directional gain of the antenna exceeds 9 dBi.

ISED:
Equipment is classified as either a low-power or high-power device according to its maximum transmitted power and its channel bandwidth as described in the section below. The equipment's occupied bandwidth shall not exceed its channel bandwidth. The transmitted power of low-power and high-power devices shall not exceed the maximum limits corresponding to the equipment type given in
Table 8.3-1 below.

Table 8.3-1: *Channel bandwidth and power limits*

Channel bandwidth, MHz	Output power (P) for low-power device, dBm	Output power (P) for high-power device, dBm
1	P ≤ 7	7 < P ≤ 20
5	P ≤ 14	14 < P ≤ 27
10	P ≤ 17	17 < P ≤ 30
15	P ≤ 18.8	18.8 < P ≤ 31.8
20	P ≤ 20	20 < P ≤ 33

High- and low-power devices are also limited to a maximum power spectral density of 21 dBm/MHz and 8 dBm/MHz respectively. Devices using channel bandwidths other than those listed in Table 1 are permitted; however, the channel bandwidth shall not exceed 20 MHz and the devices shall comply with the maximum power spectral density limits of 21 dBm/MHz for high-power transmitters and 8 dBm/MHz for low-power transmitters.

5.3.1 Equipment with multiple transmitters

For equipment with an antenna system that works with multiple transmitters, with different information transmitted by each transmitter to each receiver, the total power of the device shall be calculated as the sum of the powers from all the transmitters and it shall not be higher than the power limit specified in Table 1 for high-power devices according to the equipment's channel bandwidth.

8.3.2 Test summary

Test date:	November 14, 2016	Temperature:	22 °C
Test engineer:	Andrey Adelberg	Air pressure:	1010 mbar
Verdict:	Pass	Relative humidity:	31 %

8.3.3 Observations settings and special notes

EUT is considered High power device. The transmit power was measured using RMS power meter

The transmitter power spectral density (PSD) was measured over a bandwidth of 1 MHz, with the power measured as per above. A resolution bandwidth less than the measurement bandwidth can be used provided that the measured power is integrated to show total power over the measurement bandwidth. Spectrum analyser settings:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

8.3.4 Test data

Table 8.3-2: *Output power measurements results for 10 MHz channel, 10 dBi and 24 dBi antennas*

Modulation and data rate	Frequency, MHz	Power on ch0, dBm	Power on ch1, dBm	Combined power, dBm	Power limit, dBm	Margin, dB
BPSK 3.3 Mbps	4945.0	20.96	20.60	23.79	30.00	6.21
	4965.0	21.09	20.69	23.90	30.00	6.10
	4985.0	21.22	20.67	23.96	30.00	6.04
256-QAM 93.3 Mbps	4945.0	21.00	20.57	23.80	30.00	6.20
	4965.0	21.05	20.72	23.90	30.00	6.10
	4985.0	20.23	20.65	23.46	30.00	6.54

Table 8.3-3: *Output power measurements results for 10 MHz channel, 32 dBi*

Modulation and data rate	Frequency, MHz	Power on ch0, dBm	Power on ch1, dBm	Combined power, dBm	Power limit, dBm	Margin, dB
BPSK 3.3 Mbps	4945.0	20.10	18.64	22.44	24.70	2.26
	4965.0	19.96	18.79	22.42	24.70	2.28
	4985.0	19.14	19.74	22.46	24.70	2.24
256-QAM 93.3 Mbps	4945.0	20.14	18.65	22.47	24.70	2.23
	4965.0	19.92	18.82	22.42	24.70	2.28
	4985.0	19.08	19.75	22.44	24.70	2.26

Note: for 32 dBi antenna, the power limit was calculated as follows: 30 dBm – (31.3 dBi – 26 dBi) = 24.70 dBm
Total gain = 32 dBi – 0.7 dB (cable loss) = 31.3 dBi

Table 8.3-4: *Output power measurements results for 20 MHz channel, 10 dBi and 24 dBi antennas*

Modulation and data rate	Frequency, MHz	Power on ch0, dBm	Power on ch1, dBm	Combined power, dBm	Power limit, dBm	Margin, dB
BPSK 6.6 Mbps	4950.0	21.38	21.18	24.29	33.00	8.71
	4965.0	21.37	21.16	24.28	33.00	8.72
	4980.0	21.49	21.25	24.38	33.00	8.62
256-QAM 186.6 Mbps	4950.0	21.36	21.16	24.27	33.00	8.73
	4965.0	21.38	21.16	24.28	33.00	8.72
	4980.0	21.47	21.29	24.39	33.00	8.61

Table 8.3-5: *Output power measurements results for 20 MHz channel, 32 dBi*

Modulation and data rate	Frequency, MHz	Power on ch0, dBm	Power on ch1, dBm	Combined power, dBm	Power limit, dBm	Margin, dB
BPSK 6.6 Mbps	4950.0	21.38	21.18	24.29	27.70	3.41
	4965.0	21.37	21.16	24.28	27.70	3.42
	4980.0	21.49	21.25	24.38	27.70	3.32
256-QAM 186.6 Mbps	4950.0	21.36	21.16	24.27	27.70	3.43
	4965.0	21.38	21.16	24.28	27.70	3.42
	4980.0	21.47	21.29	24.39	27.70	3.31

Note: for 32 dBi antenna, the power limit was calculated as follows: 33 dBm – (31.3 dBi – 26 dBi) = 27.70 dBm
Total gain = 32 dBi – 0.7 dB (cable loss) = 31.3 dBi

Table 8.3-6: *Power spectral density measurements results for 10 MHz channel, 10 dBi and 24 dBi antennas*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	PSD limit, dBm/MHz	Margin, dB
BPSK 3.3 Mbps	4945.0	13.65	13.56	16.62	21.00	4.38
	4965.0	13.66	13.83	16.76	21.00	4.24
	4985.0	13.88	13.76	16.83	21.00	4.17
256-QAM 93.3 Mbps	4945.0	13.64	13.58	16.62	21.00	4.38
	4965.0	13.67	13.80	16.75	21.00	4.25
	4985.0	13.91	13.81	16.87	21.00	4.13

Table 8.3-7: *Power spectral density measurements results for 10 MHz channel, 32 dBi antenna*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	PSD limit, dBm/MHz	Margin, dB
BPSK 3.3 Mbps	4945.0	12.91	11.71	15.36	15.70	0.34
	4965.0	12.77	11.86	15.35	15.70	0.35
	4985.0	11.95	12.81	15.41	15.70	0.29
256-QAM 93.3 Mbps	4945.0	12.95	11.72	15.39	15.70	0.31
	4965.0	12.73	11.89	15.34	15.70	0.36
	4985.0	11.89	12.82	15.39	15.70	0.31

Note: for 32 dBi antenna, the PSD limit was calculated as follows: 21 dBm/MHz – (31.3 dBi – 26 dBi) = 15.70 dBm/MHz
Total gain = 32 dBi – 0.7 dB (cable loss) = 31.3 dBi

Table 8.3-8: *Power spectral density measurements results for 20 MHz channel, 10 dBi and 24 dBi antennas*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	PSD limit, dBm/MHz	Margin, dB
BPSK 6.6 Mbps	4950.0	11.30	10.95	14.14	21.00	6.86
	4965.0	11.23	11.14	14.20	21.00	6.80
	4980.0	11.38	11.08	14.24	21.00	6.76
256-QAM 186.6 Mbps	4950.0	11.24	10.98	14.12	21.00	6.88
	4965.0	11.28	11.13	14.22	21.00	6.78
	4980.0	11.34	11.12	14.24	21.00	6.76

Table 8.3-9: *Power spectral density measurements results for 20 MHz channel, 32 dBi antenna*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	PSD limit, dBm/MHz	Margin, dB
BPSK 6.6 Mbps	4950.0	11.30	10.95	14.14	15.70	1.56
	4965.0	11.23	11.14	14.20	15.70	1.50
	4980.0	11.38	11.08	14.24	15.70	1.46
256-QAM 186.6 Mbps	4950.0	11.24	10.98	14.12	15.70	1.58
	4965.0	11.28	11.13	14.22	15.70	1.48
	4980.0	11.34	11.12	14.24	15.70	1.46

Note: for 32 dBi antenna, the PSD limit was calculated as follows: 21 dBm/MHz – (31.3 dBi – 26 dBi) = 15.70 dBm/MHz

Total gain = 32 dBi – 0.7 dB (cable loss) = 31.3 dBi

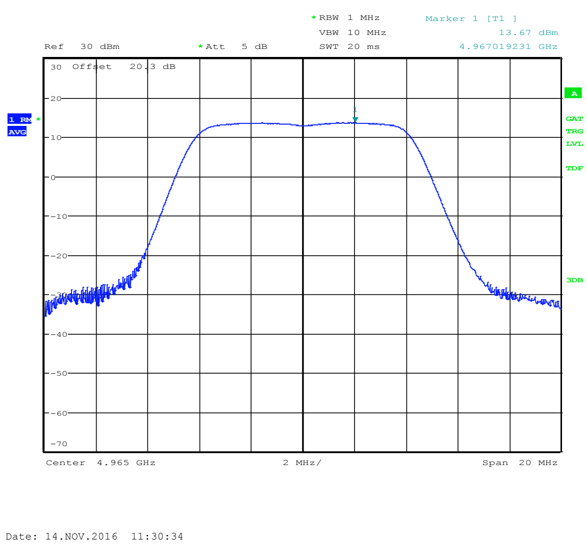


Figure 8.3-1: *PSD for 10 MHz channel, sample plot*

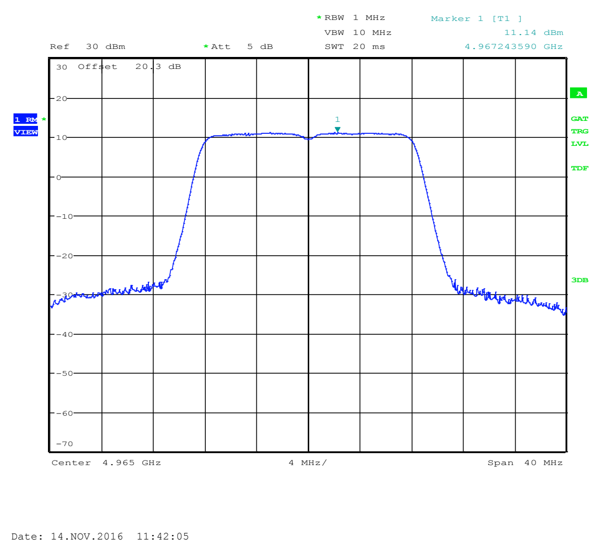


Figure 8.3-2: *26 dB bandwidth for 20 MHz channel, sample plot*

8.4 FCC 90.1215(e) and RSS-111 Clause 5.4 Transmitter Peak to Average Power Ratio (PAPR)

8.4.1 Definitions and limits

FCC:
The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the maximum conducted output power shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

ISED:
The PAPR of the equipment shall not exceed 13 dB for more than 0.1% of the time, using a signal that corresponds to the highest PAPR during periods of continuous transmission.

8.4.2 Test summary

Test date:	November 14, 2016	Temperature:	22 °C
Test engineer:	Andrey Adelberg	Air pressure:	1010 mbar
Verdict:	Pass	Relative humidity:	31 %

8.4.3 Observations settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak and RMS
Trace mode:	Max Hold

8.4.4 Test data

Table 8.4-1: *PAPR measurements results for 10 MHz channel*

Modulation and data rate	Frequency, MHz	Peak power, dBm	Average power, dBm	Ratio, dB	Limit, dB	Margin, dB
BPSK 3.3 Mbps	4945.0	23.79	16.62	7.18	13.00	5.82
	4965.0	23.90	16.76	7.15	13.00	5.85
	4985.0	23.96	16.83	7.13	13.00	5.87
256-QAM 93.3 Mbps	4945.0	23.80	16.62	7.18	13.00	5.82
	4965.0	23.90	16.75	7.15	13.00	5.85
	4985.0	23.46	16.87	6.58	13.00	6.42

Table 8.4-2: *PAPR measurements results for 20 MHz channel*

Modulation and data rate	Frequency, MHz	Peak power, dBm	Average power, dBm	Ratio, dB	Limit, dB	Margin, dB
BPSK 6.6 Mbps	4950.0	24.29	14.14	10.15	13.00	2.85
	4965.0	24.28	14.20	10.08	13.00	2.92
	4980.0	24.38	14.24	10.14	13.00	2.86
256-QAM 186.6 Mbps	4950.0	24.27	14.12	10.15	13.00	2.85
	4965.0	24.28	14.22	10.07	13.00	2.93
	4980.0	24.39	14.24	10.15	13.00	2.85

8.5 FCC 90.210(m) and RSS-111 Clause 5.5 Transmitter unwanted emissions

8.5.1 Definitions and limits

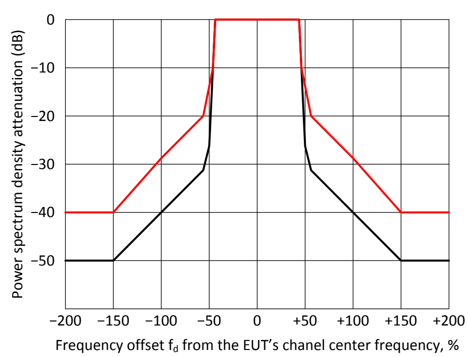
FCC:
Emission Mask M. For high power transmitters (greater than 20 dBm) operating in the 4940–4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as shown in the Table 8.5-1 *Minimum attenuation high-power transmitter*

ISED:
On any frequency f, offset from the channel centre frequency f_c by a separation f_d (expressed as a percentage of the channel bandwidth), the power spectral density of the unwanted emissions for low- and high-power transmitters shall comply with the limits specified in Table 8.5-1. Figure 8.5–1 shows the emission mask for low- and high-power transmitters. For equipment with multiple transmitters, the unwanted emissions of each transmitter shall comply with the emission limits based on the output power of the transmitter regardless of the total output power of the equipment (i.e. total output power from all the transmitters).

Table 8.5-1: *Emission mask for low- and high-power transmitters*

Offset Frequency f_d (% of the equipment's channel bandwidth)	Minimum attenuation low-power transmitter, dB	Minimum attenuation high-power transmitter, dB
$0 < f_d \le 45$	0	0
$45 < f_d \le 50$	$219 \times \log_{10} (f_d / 45)$	$568 \times \log_{10} (f_d / 45)$
$50 < f_d \le 55$	$10 + 242 \times \log_{10} (f_d / 50)$	$26 + 145 \times \log_{10} (f_d / 50)$
$55 < f_d \le 100$	$20 + 31 \times \log_{10} (f_d / 55)$	$32 + 31 \times \log_{10} (f_d / 55)$
$100 < f_d \le 150$	$28 + 68 \times \log_{10} (f_d / 100)$	$40 + 57 \times \log_{10} (f_d / 100)$
$f_d > 150$	40	whichever is less stringent: 50 dBc or −25 dBm

Notes: * - Where: f_d (%) = $((f − f_c) / \text{channel bandwidth}) \times 100$



Note: Red line is for Low-power transmitter, Black line is for High-power transmitter

Figure 8.5-1: *Unwanted emission mask for low- and high-power transmitters*

8.5.2 Test summary

Test date:	November 14, 2016	Temperature:	22 °C
Test engineer:	Andrey Adelberg	Air pressure:	1010 mbar
Verdict:	Pass	Relative humidity:	31 %

8.5.3 Observations settings and special notes

The 0 dB reference level in the unwanted emission mask is the maximum in-band power spectral density measured in terms of average power in the equipment's channel bandwidth, using a resolution bandwidth of as close as possible to, without being less than 1 % of the occupied bandwidth, and a video bandwidth of 30 kHz. The unwanted power spectral density emissions are also measured using the same resolution and video bandwidths used in measuring the reference in-band power spectral density.
Radiated measurements were performed at a distance of 3 m, the EUT was transmitting on both MIMO chains simultaneously. Radiated emissions were performed while both antenna connectors were terminated with 50 Ω load. No spurious emissions were detected above test instrument's noise floor.

Spectrum analyser for peak conducted measurements within restricted bands below 1 GHz:

Resolution bandwidth:	100 kHz (for 10 MHz channel), 200 kHz (for 20 MHz channel)
Video bandwidth:	30 kHz
Detector mode:	RMS
Trace mode:	Max Hold

8.5.4 Test data

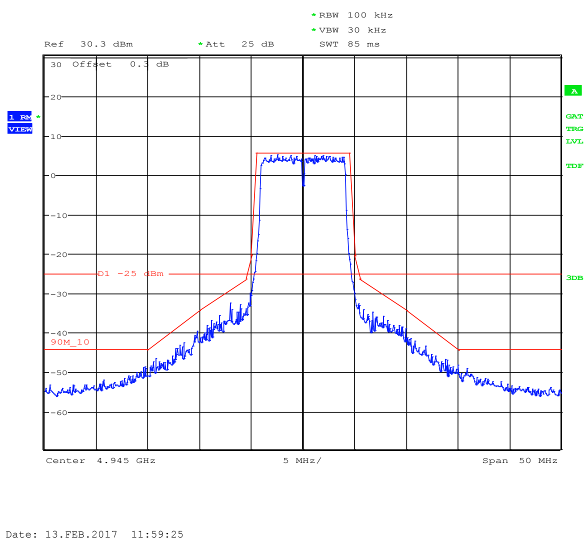


Figure 8.5-2: *Emission mask at low channel, ch0, BPSK, 10 MHz channel*

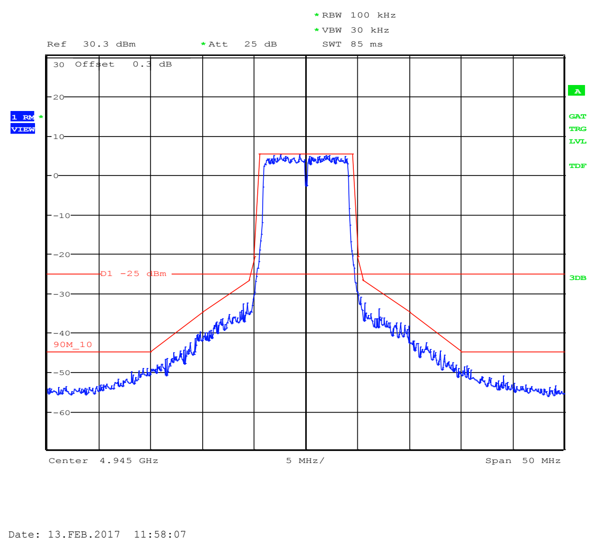


Figure 8.5-3: *Emission mask at low channel, ch0, 256-QAM, 10 MHz channel*

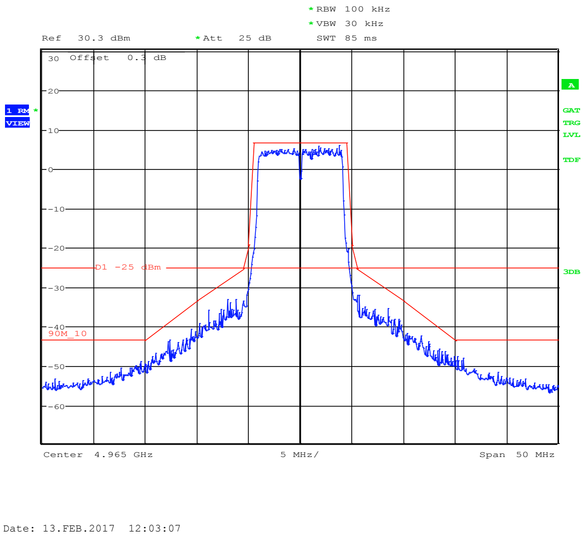


Figure 8.5-4: *Emission mask at mid channel, ch0, BPSK, 10 MHz channel*

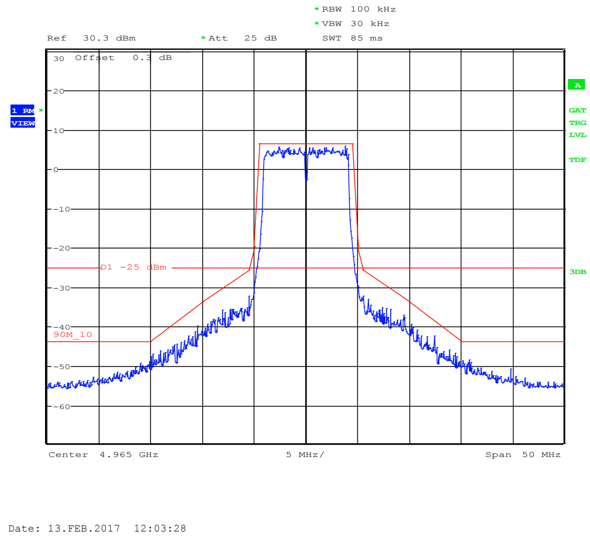


Figure 8.5-5: *Emission mask at mid channel, ch0, 256-QAM, 10 MHz channel*

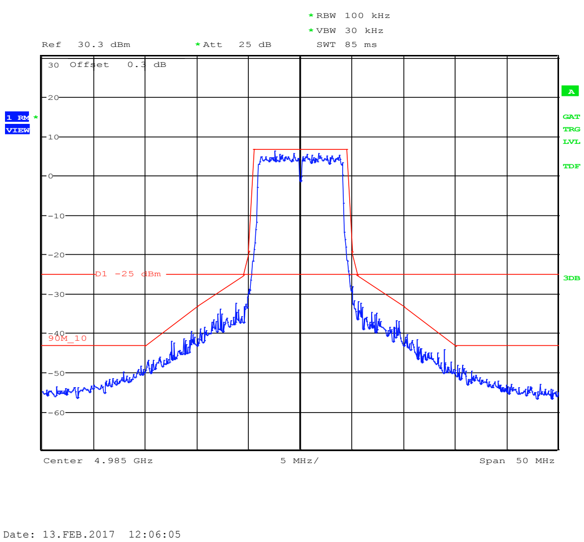


Figure 8.5-6: *Emission mask at high channel, ch0, BPSK, 10 MHz channel*

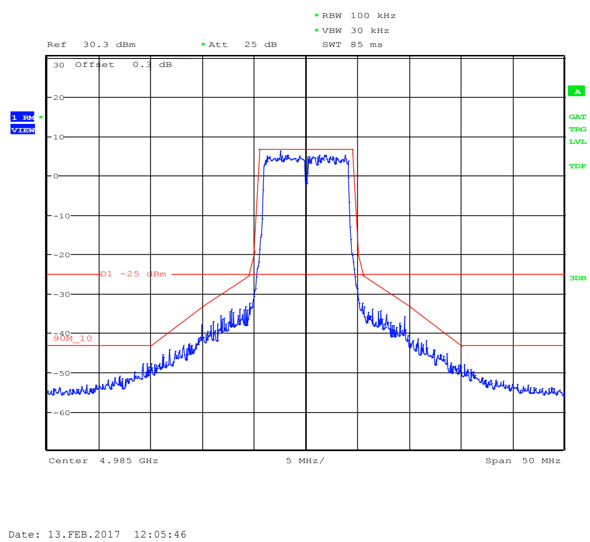


Figure 8.5-7: *Emission mask at high channel, ch0, 256-QAM, 10 MHz channel*

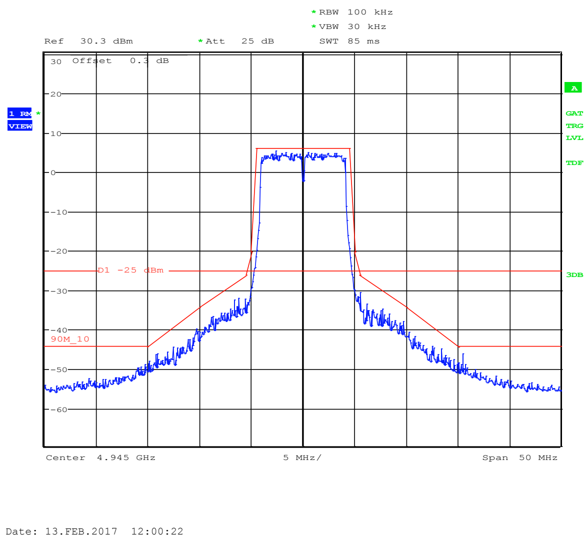


Figure 8.5-8: *Emission mask at low channel, ch1, BPSK, 10 MHz channel*

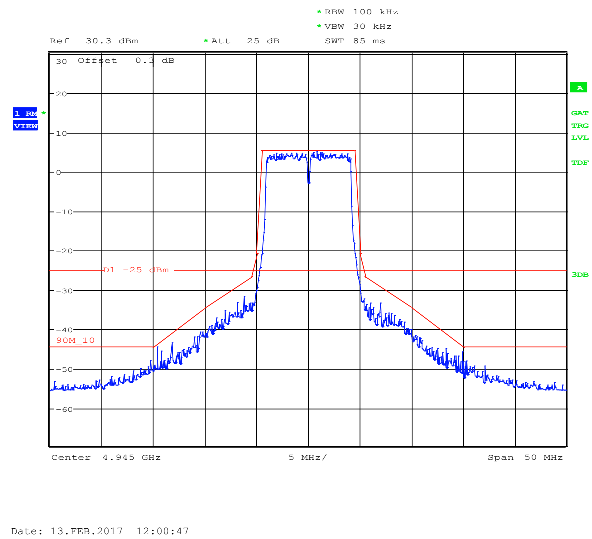


Figure 8.5-9: *Emission mask at low channel, ch1, 256-QAM, 10 MHz channel*

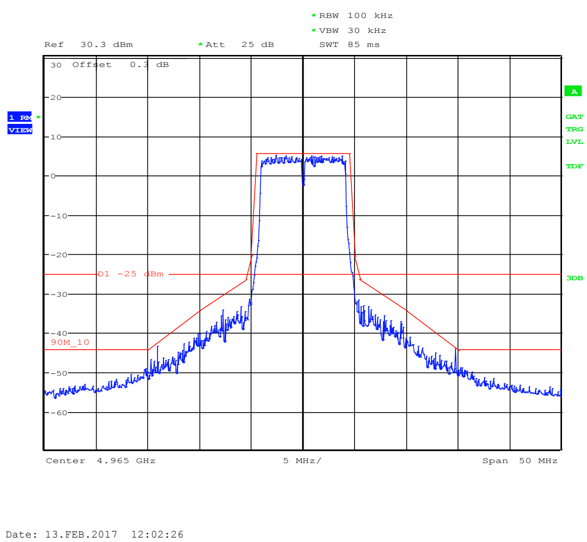


Figure 8.5-10: *Emission mask at mid channel, ch1, BPSK, 10 MHz channel*

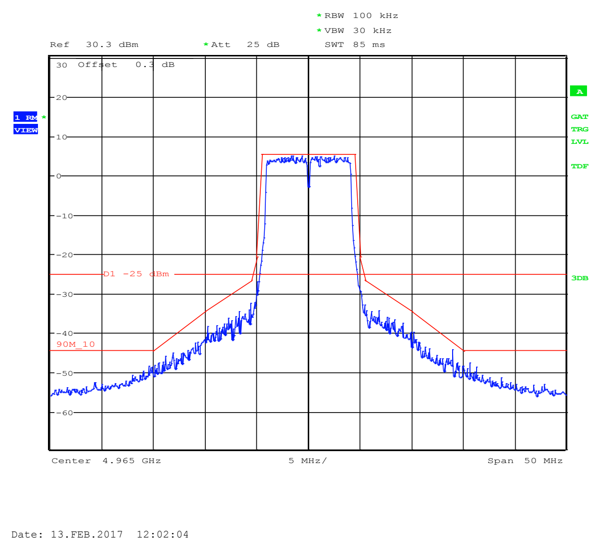


Figure 8.5-11: *Emission mask at mid channel, ch1, 256-QAM, 10 MHz channel*

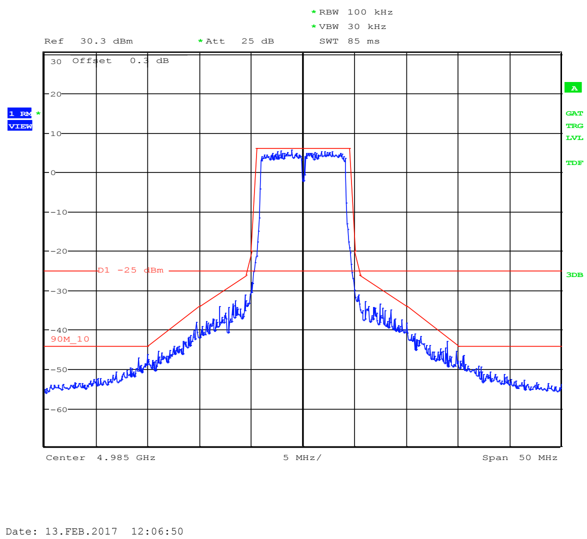


Figure 8.5-12: *Emission mask at high channel, ch1, BPSK, 10 MHz channel*

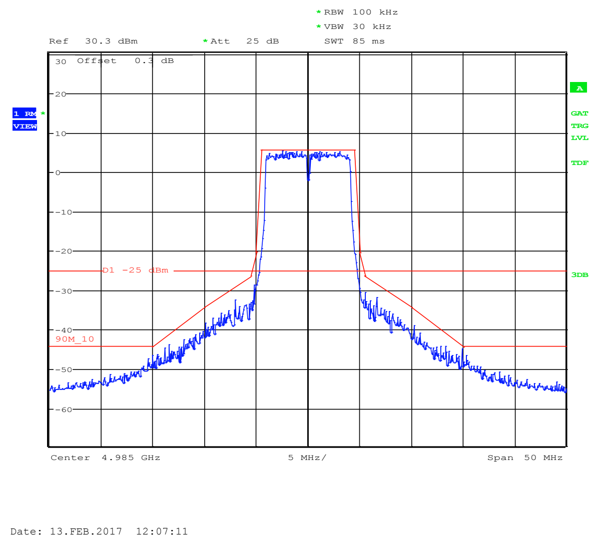


Figure 8.5-13: *Emission mask at high channel, ch1, 256-QAM, 10 MHz channel*

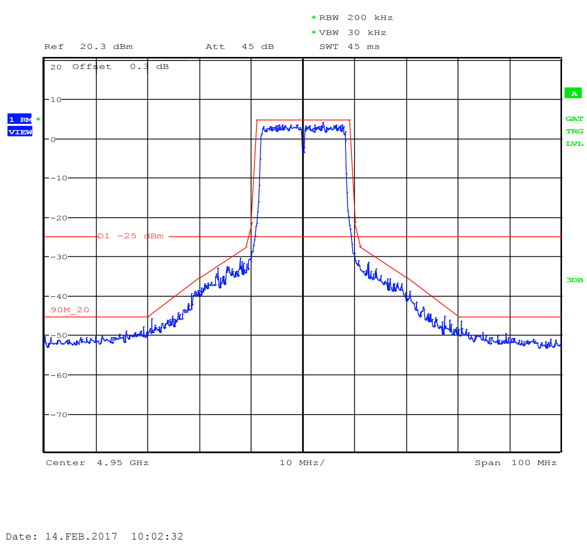


Figure 8.5-14: *Emission mask at low channel, ch0, BPSK, 20 MHz channel*

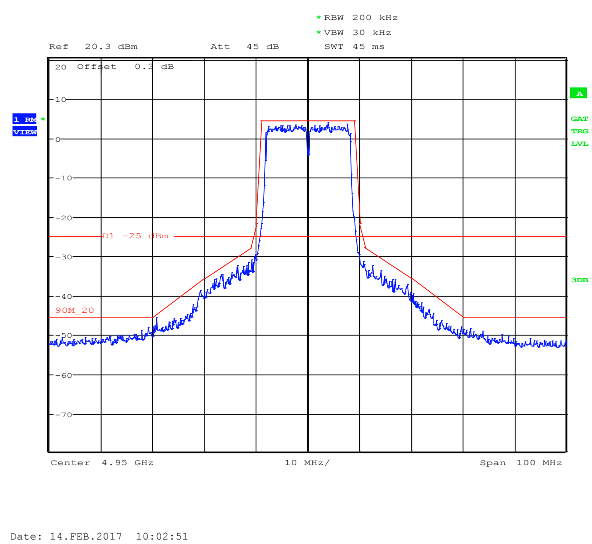


Figure 8.5-15: *Emission mask at low channel, ch0, 256-QAM, 20 MHz channel*

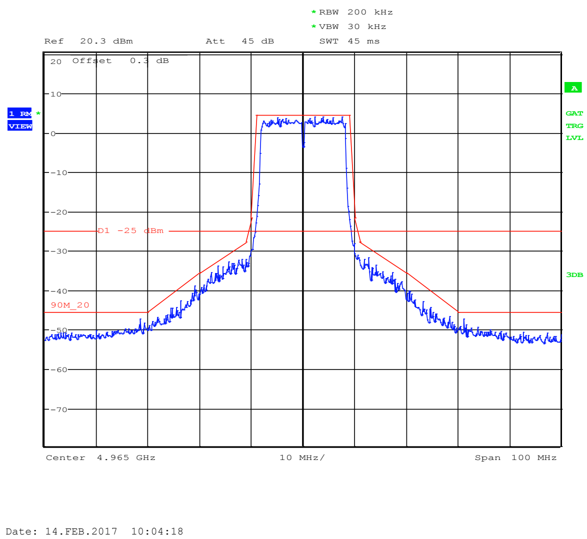


Figure 8.5-16: *Emission mask at mid channel, ch0, BPSK, 20 MHz channel*

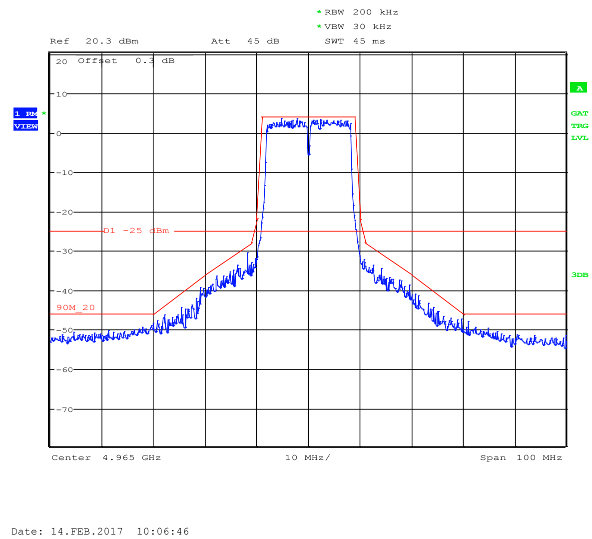


Figure 8.5-17: *Emission mask at mid channel, ch0, 256-QAM, 20 MHz channel*

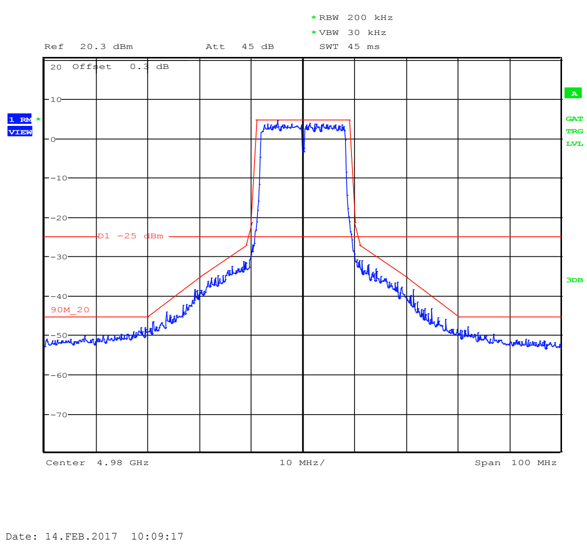


Figure 8.5-18: *Emission mask at high channel, ch0, BPSK, 20 MHz channel*

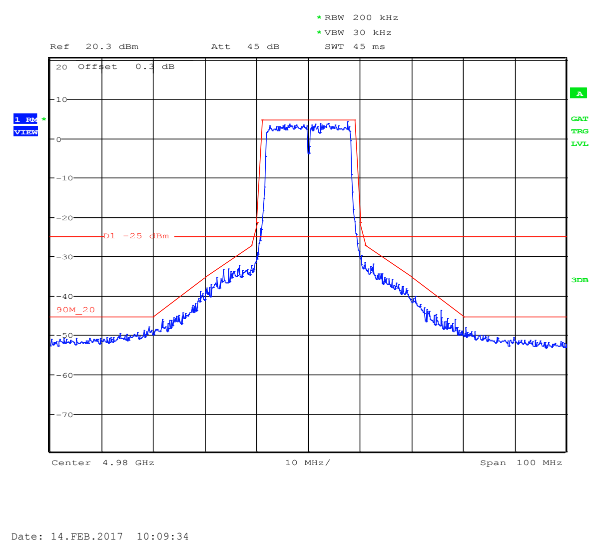


Figure 8.5-19: *Emission mask at high channel, ch0, 256-QAM, 20 MHz channel*

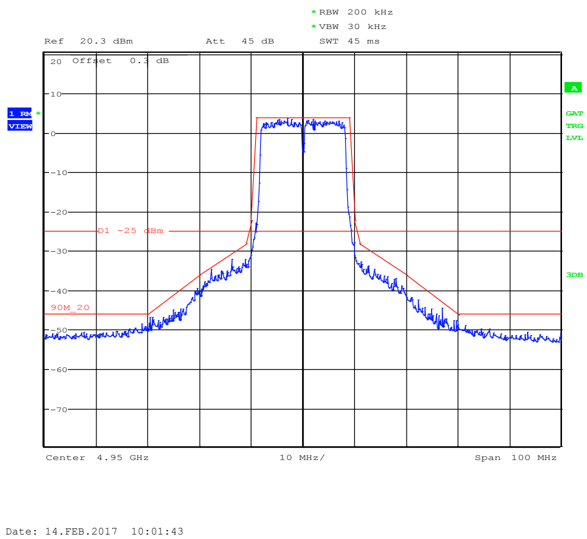


Figure 8.5-20: *Emission mask at low channel, ch1, BPSK, 20 MHz channel*

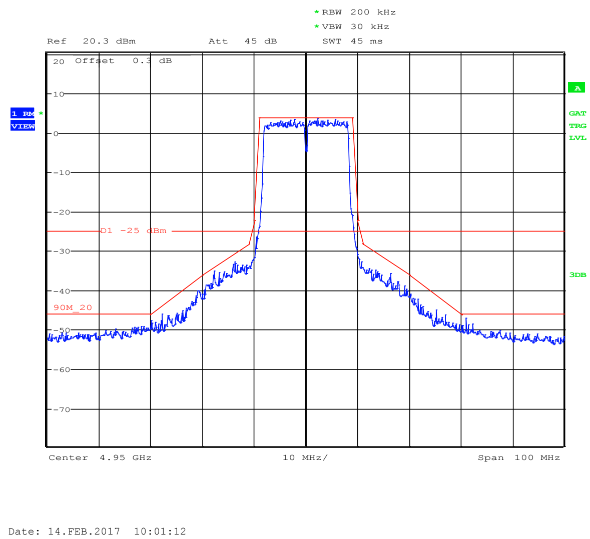


Figure 8.5-21: *Emission mask at low channel, ch1, 256-QAM, 20 MHz channel*

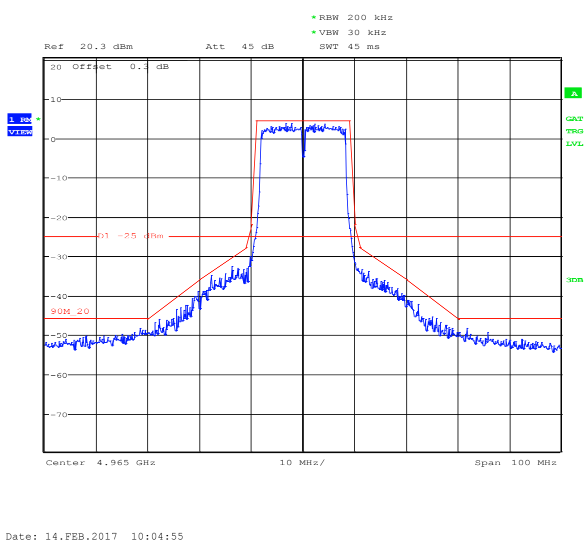


Figure 8.5-22: *Emission mask at mid channel, ch1, BPSK, 20 MHz channel*

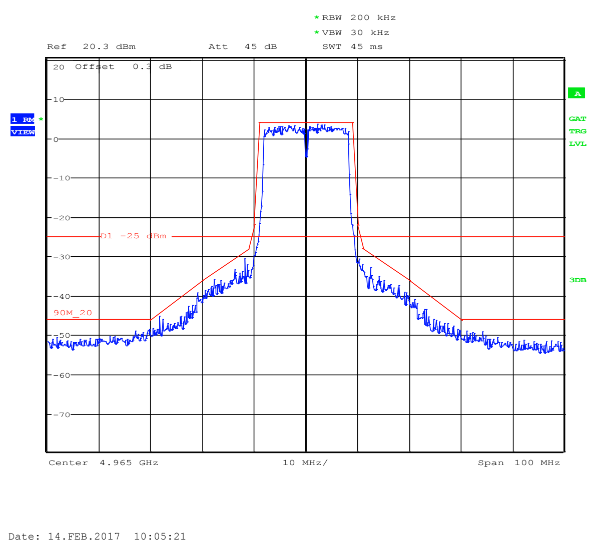


Figure 8.5-23: *Emission mask at mid channel, ch1, 256-QAM, 20 MHz channel*

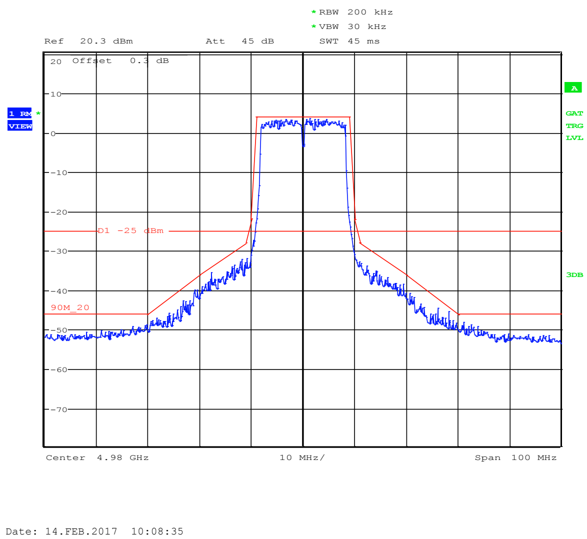


Figure 8.5-24: *Emission mask at high channel, ch1, BPSK, 20 MHz channel*

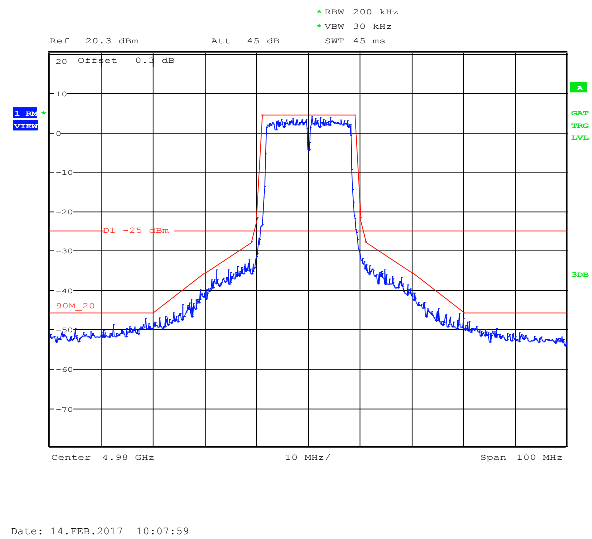


Figure 8.5-25: *Emission mask at high channel, ch1, 256-QAM, 20 MHz channel*

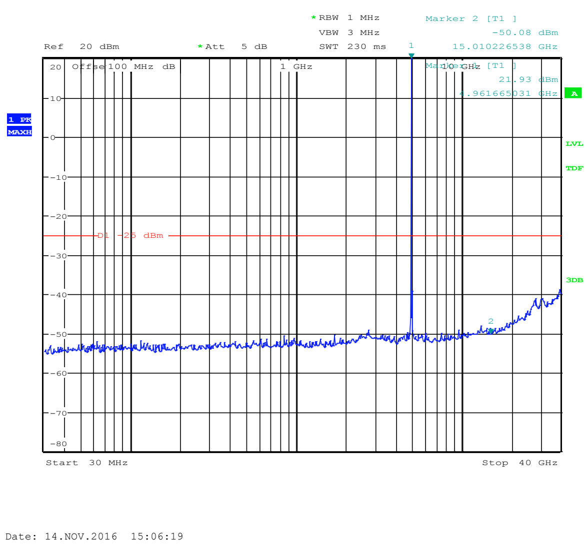


Figure 8.5-26: *Spurious emission at low channel, ch0, 10 MHz channel*

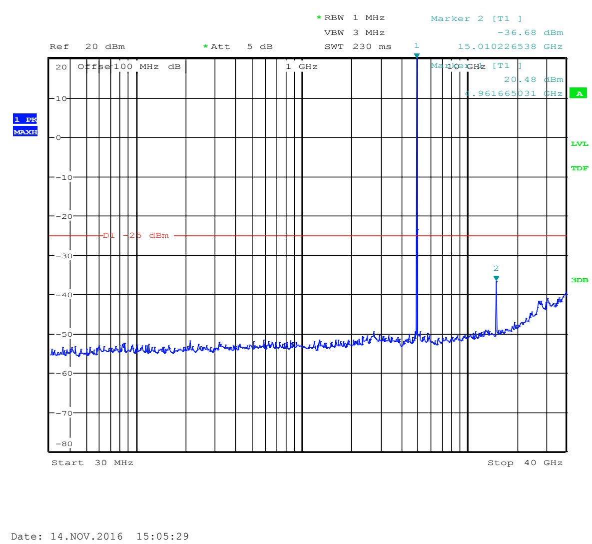


Figure 8.5-27: *Spurious emission at mid channel, ch0, 10 MHz channel*

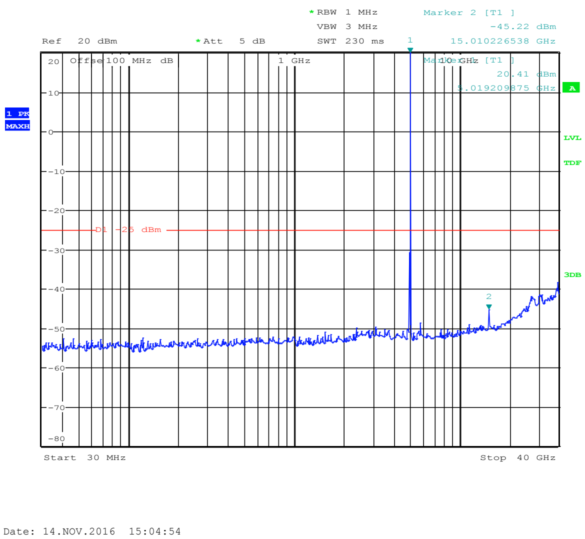


Figure 8.5-28: *Spurious emission at high channel, ch0, 10 MHz channel*

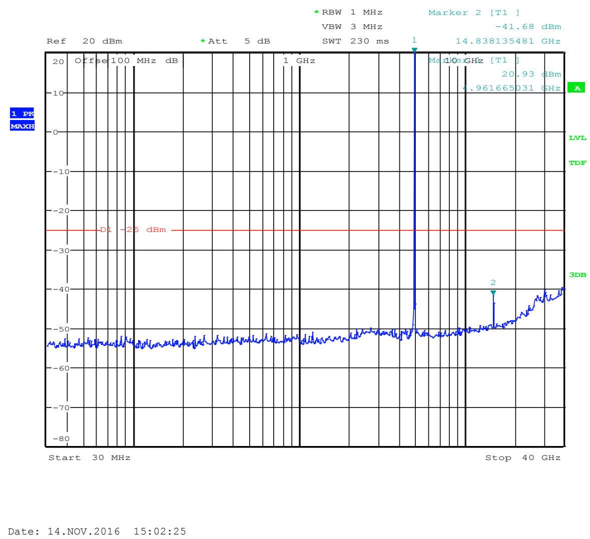


Figure 8.5-29: *Spurious emission at low channel, ch1, 10 MHz channel*

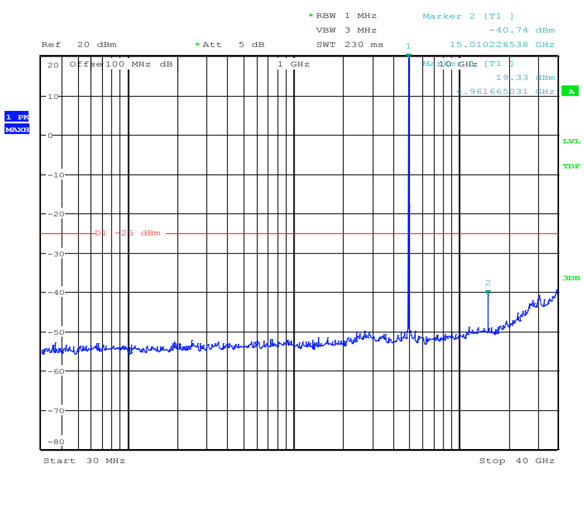


Figure 8.5-30: *Spurious emission at mid channel, ch1, 10 MHz channel*

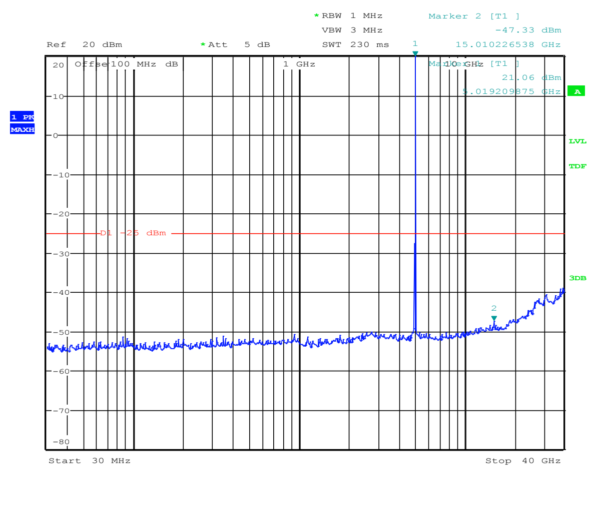


Figure 8.5-31: *Spurious emission at high channel, ch1, 10 MHz channel*

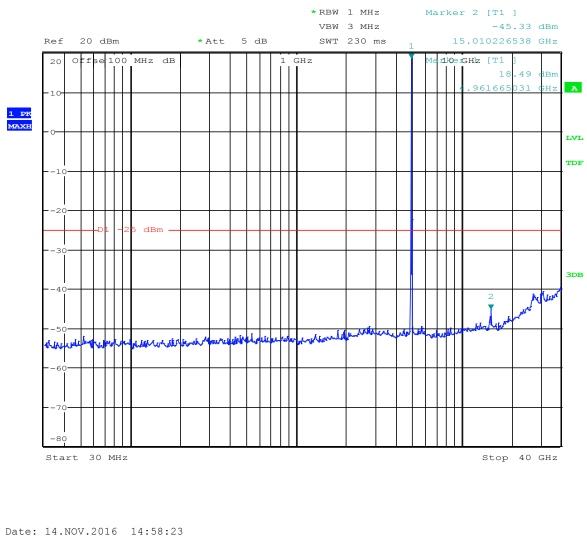


Figure 8.5-32: *Spurious emission at low channel, ch0, 20 MHz channel*

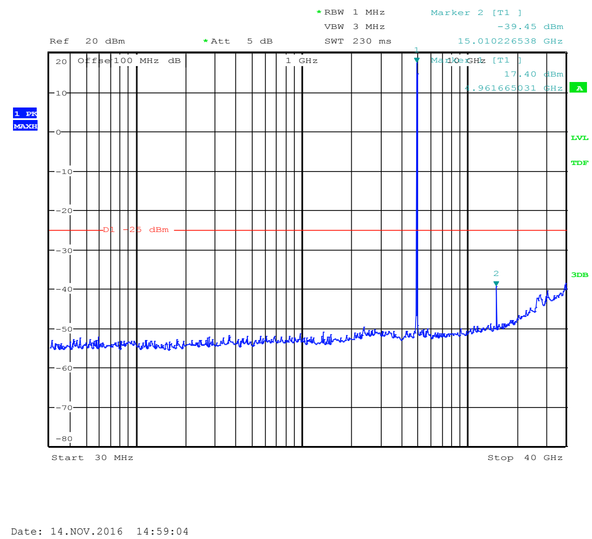


Figure 8.5-33: *Spurious emission at mid channel, ch0, 20 MHz channel*

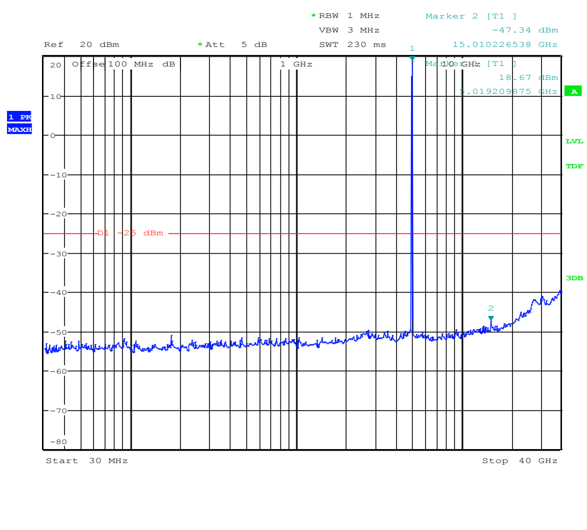


Figure 8.5-34: *Spurious emission at high channel, ch0, 20 MHz channel*

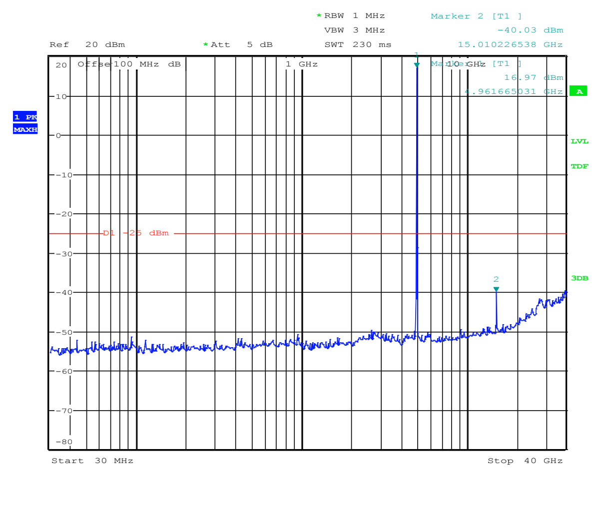


Figure 8.5-35: *Spurious emission at low channel, ch1, 20 MHz channel*

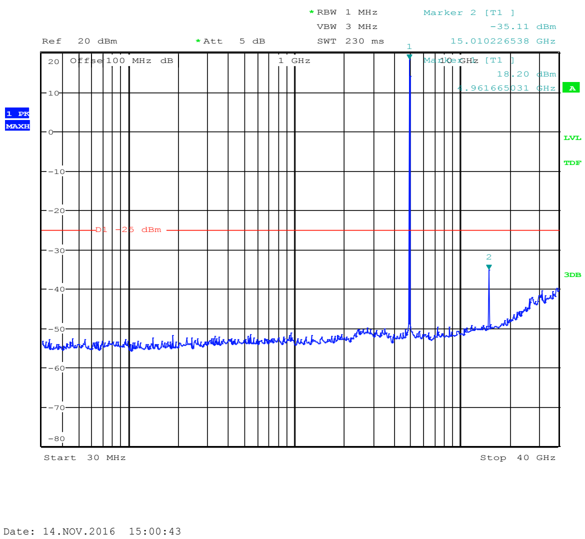


Figure 8.5-36: *Spurious emission at mid channel, ch1, 20 MHz channel*

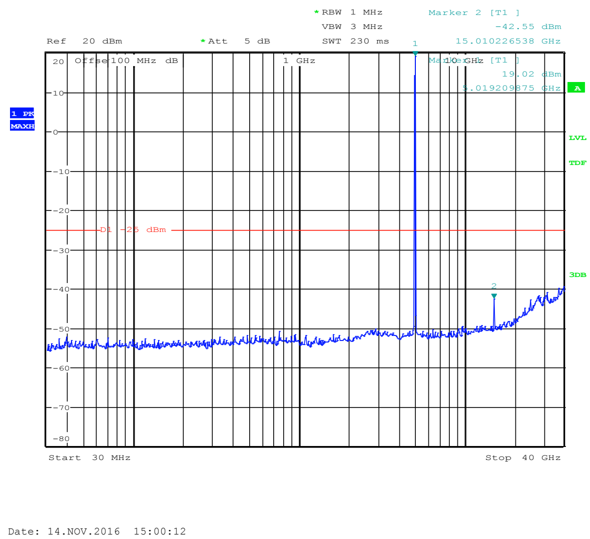


Figure 8.5-37: *Spurious emission at high channel, ch1, 20 MHz channel*

Radiated spurious emissions were assessed from 30 MHz to 40 GHz. Both antenna ports were terminated with 50 Ω loads. No emissions other than those depicted on the plots were detected above the noise floor.

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up