Nemko

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RADIO TEST REPORT – 400316-1R1TRFWL

Type of assessment:

Class II Permissive Change

Applicant:

Redline Communications

Product:

Broad-band wireless infrastructure product

Model:

RDL-3100-RMA

FCC ID:

QC8-RDL3100RMA

IC Registration number:

4310A-RDL3100RMA

Specifications:

- FCC 47 CFR Part 90, Subpart Y
- RSS-111 Issue 5, September 2014

Date of issue: July 29, 2020

Andrey Adelberg, Senior EMC/RF Specialist

Tested by

Signature

David Duchesne, EMC/RF Lab Manager

Reviewed by

Signature

Nemko Canada Inc., a testing laboratory, is accredited by the Standards Council of Canada.
The tests included in this report are within the scope of this accreditation

SCC Accredited LAB

LAB Accrédité CCN

Lab locations

Company name	Nemko Canada Inc.
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	Almonte site: 1500 Peter Robinson Road West Carleton, Ontario Canada K0A 1L0 Tel: +1 613 256-9117 Fax: +1 613 256-8848
Website	www.nemko.com

Test site identifier

Organization	Ottawa/Almonte	Montreal	Cambridge
FCC:	CA2040	CA2041	CA0101
ISED:	2040A-4	2040G-5	24676

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 contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of Contents

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 90, Subpart Y	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

1.2 Test methods

ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
RSS-102, Issue 5, March 19, 2015	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
SP-4940, June 2006	Spectrum Utilization Policy, Technical and Licensing Requirements for Broadband Public Safety in the Band 4940–4990 MHz
FCC 47 CFR Part 2, Subpart J	Equipment authorization procedures
RSS-Gen Issue 5, March 2019	General Requirements for Compliance of Radio Apparatus

1.3 Exclusions

Since this application is an addition of two channel bandwidths to the existing certification, only limited subset of testing has been assessed.

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.3 above. 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 Test report revision history

Table 1.5-1: *Test report revision history*

Revision #	Date of issue	Details of changes made to test report
TRF	July 9, 2020	Original report issued
R1TRF	July 29, 2020	Internal photographs were removed

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

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

2.2 Technical judgment

It was verified that the worst-case results were observed when EUT was operating with BPSK modulation, therefore all the measurement results in this report are based on this modulation.

2.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Atmospheric conditions

Temperature	15 °C – 35 °C
Relative humidity	20 % – 75 %
Air pressure	86 kPa (860 mbar) – 106 kPa (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.

3.2 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 4 Measurement uncertainty

4.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

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

Table 4.1-1: *Measurement uncertainty calculations for Radio*

Test name	Measurement uncertainty, ±dB
All antenna port measurements	0.55
Occupied bandwidth	4.45
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78

Section 5 Information provided by the applicant

5.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

5.2 Applicant/Manufacture

Applicant name	Redline Communications
Applicant address	302 Town Center Blvd., Markham, Ontario L3R 0E8, Canada
Manufacture name	Same as applicant
Manufacture address	Same as applicant

5.3 EUT information

Product name	Broad-band wireless infrastructure product
Model	RDL-3100-RMA
Serial number	318SC16300082
Power supply requirements	48 V_{DC} PoE via 120 V_{AC}, 60 Hz
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.

5.4 Technical information

Frequency band	4940–4990 MHz
Channel sizes*	0.875 MHz and 5 MHz
Type of modulation	OFDM using 256-QAM, 128-QAM, 64-QAM, 16-QAM, QPSK and BPSK modulation for sub-carriers
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

Note: * This test report only covers two supported channel sizes.

Channel sizes:	0.875 MHz	5 MHz
Frequency Min (MHz)	4940.5	4942.5
Frequency Max (MHz)	4989.5	4987.5
RF power Max (W), Conducted	0.095 (19.80 dBm)	0.301 (24.78 dBm)
Measured BW (kHz), 99% OBW	729	4663
Emission classification	729KW7D	4M66W7D
Transmitter spurious, dBµV/m @ 3 m	66.49 at 9.882 GHz	66.81 at 15.989 GHz

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	Software version used: 3.12.6
Transmitter state	The EUT was controlled to transmit at desired frequency and modulation from laptop using web interface at IP address: 192.168.25.2. In addition, Telnet session was used to force 95% duty cycle with the following command: *dbg txloop 1 0 95*

5.5.2 EUT setup configuration

Table 5.5-1: *Support equipment*

Description	Brand name	Model, Part number, Serial number, Revision level
Power over Ethernet adapter	Microsemi	PN: PD-9001GR/AT/AC

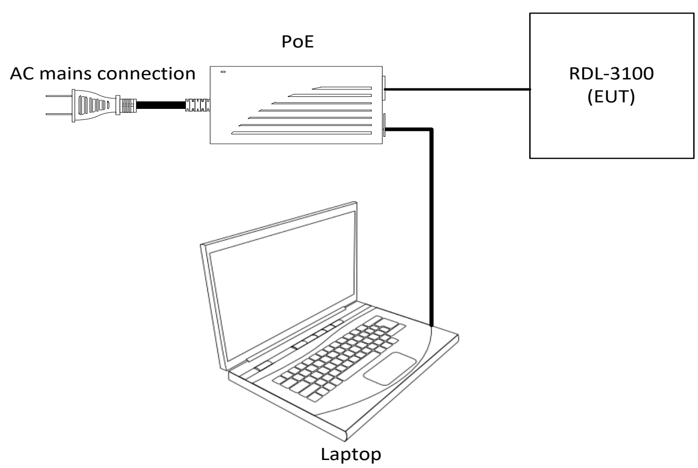


Figure 5.5-1: *Setup block diagram*

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Ottawa

6.2 Testing period

Test start date	June 15, 2020	Test end date	June 19, 2020

6.3 Sample information

Receipt date	June 12, 2020	Nemko sample ID number(s)	1

6.4 FCC Part 2 and 90 Subpart Y test requirements results

Table 6.4-1: *FCC requirements results*

Paragraph	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	Not tested

Note: Frequency stability was assessed during the original application.

6.5 ISED RSS-111, Issue 5 and RSS-Gen, Issue 5 test requirements results

Table 6.5-1: *ISED requirements results*

Section	Test description	Verdict
RSS-111, 5.1	Types of modulation	Pass[1]
RSS-111, 5.2	Transmitter frequency stability	Not tested[2]
RSS-111, 5.3	Equipment's transmit output power and channel bandwidth	Pass
RSS-111, 5.4	Transmitter peak-to-average power ratio	Pass
RSS-111, 5.5	Transmitter unwanted emissions	Pass
RSS-Gen, 6.6	Occupied bandwidth	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]Frequency stability was assessed during the original application.

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	January 24, 2021
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	November 8, 2020
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	October 31, 2020
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	October 31, 2020
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002873	1 year	November 4, 2020
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	1 year	November 7, 2020
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU

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

Section 8 Testing data

8.1 Number of frequencies

8.1.1 References, definitions and limits

ANSI C63.26, Clause 5.1.2:

Measurements of transmitters shall be performed and, if required, reported for each frequency band in which the EUT can be operated with the device transmitting at the number of frequencies in each band specified in table below.

RSS-Gen, Clause 6.9:

Except where otherwise specified, measurements shall be performed for each frequency band of operation for which the radio apparatus is to be certified, with the device operating at the frequencies in each band of operation shown in table below. The frequencies selected for measurements shall be reported in the test report.

Table 8.1-1: *Frequency Range of Operation*

Frequency range over which the device operates (in each band)	Number of test frequencies required	Location of measurement frequency inside the operating frequency range
1 MHz or less	1	Center (middle of the band)
1–10 MHz	2	1 near high end, 1 near low end
Greater than 10 MHz	3	1 near high end, 1 near center and 1 near low end

Notes: “near” means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

8.1.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	June 15, 2020

8.1.3 Observations, settings and special notes

None

8.1.4 Test data

Table 8.1-2: *Test channels selection*

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Channel size, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
4940	4990	50	0.875	4940.5	4965.0	4989.5
			5.000	4942.5	4965.0	4987.5

8.2 Transmitter Output Power

8.2.1 References, definitions and limits

FCC §90.1215:

The transmitting power of stations operating in the 4940–4990 MHz band must not exceed the maximum limits in this section.

(a)(1) The maximum conducted output power should not exceed limits in the table below

(2) 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.

RSS-111, Clause 5.3:

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 below

Table 8.2-1: *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. See SP 4940 MHz for antenna gain limits and operational restrictions for the device.

For low-power devices, if a directional antenna is used and its gain exceeds 9 dBi, the transmit power shall be reduced by the same amount that the antenna gain is exceeded.

For high-power fixed point-to-point and point-to-multipoint operations, if the directional antenna gain exceeds 26 dBi, the transmit power shall be reduced by same amount that the antenna gain is exceeded.

SP-4940, Clause 7:

7.1 Radiated Power Limits

The following section specifies the technical requirements for the authorization of public safety systems operating in the band 4940–4990 MHz.

7.1.1 Mobile and Fixed Operations

The transmitting power of stations operating in the band 4940–4990 MHz must not exceed the maximum limits specified below. However all systems should be limited to the power necessary to provide adequate coverage.

References, definitions and limits, continued

7.1.2 Limits for Operation of High-power Devices

Table 8.2-2: *Channel bandwidth and power limits for High-power Devices*

Channel bandwidth, MHz	High power peak transmit power, dBm
1	20
5	27
10	30
15	31.8
20	33

Devices may use other channel bandwidths, however high-power devices are limited to a peak power spectral density of 21 dBm per 1 MHz. If a directional gain greater than 9 dBi is used, both the peak transmit power and the peak power spectral density should be reduced by the equivalent amount.

For high-power fixed point-to-point and point-to-multipoint operation, a directional gain up to 26 dBi may be used, however if it exceeds 26 dBi, both the peak transmit power and the peak power spectral density should be reduced by the equivalent amount.

7.1.3 Limits for Operation of Low-power Devices

Table 8.2-3: *Channel bandwidth and power limits for Low-power Devices*

Channel bandwidth, MHz	High power peak transmit power, dBm
1	7
5	14
10	17
15	18.8
20	20

Devices may use other channel bandwidths, however low-power devices are limited to a peak power spectral density of 8 dBm per 1 MHz. If a directional gain greater than 9 dBi is used, both the peak transmit power and the peak power spectral density should be reduced by the equivalent amount.

8.2.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	June 18, 2020

8.2.3 Observations, settings and special notes

EUT is a high power device, therefore higher limits apply.
Measurement of output power and PSD was performed with the following spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	≥ 3 × RBW
Frequency span	≥ 2 × OBW
Detector mode	RMS
Trace mode	Averaging over 100 sweeps
Power integration	Over the channel BW

8.2.4 Test data

Table 8.2-4: *Transmitter power results for 0.875 MHz channel with 10 dBi and 24 dBi antenna gains*

Frequency, MHz	Power on ch0, dBm	Power on ch1, dBm	Combined power, dBm	Power limit, dBm	Margin, dB
4940.5	16.52	17.04	19.80	20.00	0.20
4965.0	16.73	16.50	19.63	20.00	0.37
4989.5	16.55	16.40	19.49	20.00	0.51

Table 8.2-5: *Transmitter power results for 0.875 MHz channel with 32 dBi antenna gain*

Frequency, MHz	Power on ch0, dBm	Power on ch1, dBm	Combined power, dBm	Power limit[1], dBm	Margin, dB
4940.5	11.59	11.29	14.45	14.70	0.25
4965.0	11.54	11.42	14.49	14.70	0.21
4989.5	11.62	11.66	14.65	14.70	0.05

Notes: [1]For 32 dBi antenna, the power limit was calculated as follows: 20 dBm – ([2]31.3 dBi – 26 dBi) = 14.70 dBm
[2]Total gain = 32 dBi – 0.7 dB (cable loss) = 31.3 dBi

Table 8.2-6: *Transmitter power results for 5 MHz channel with 10 dBi and 24 dBi antenna gains*

Frequency, MHz	Power on ch0, dBm	Power on ch1, dBm	Combined power, dBm	Power limit, dBm	Margin, dB
4942.5	21.08	21.40	24.25	27.00	2.75
4965.0	21.81	21.66	24.75	27.00	2.25
4987.5	21.86	21.68	24.78	27.00	2.22

Table 8.2-7: *Transmitter power results for 5 MHz channel with 32 dBi antenna gain*

Frequency, MHz	Power on ch0, dBm	Power on ch1, dBm	Combined power, dBm	Power limit[1], dBm	Margin, dB
4942.5	17.16	17.97	20.59	21.70	1.11
4965.0	18.04	17.86	20.96	21.70	0.74
4987.5	18.04	18.03	21.05	21.70	0.65

Notes: [1]For 32 dBi antenna, the power limit was calculated as follows: 27 dBm – ([2]31.3 dBi – 26 dBi) = 21.70 dBm
[2]Total gain = 32 dBi – 0.7 dB (cable loss) = 31.3 dBi

Test data, continued

Table 8.2-8: *Transmitter power spectral density results for 0.875 MHz channel with 10 dBi and 24 dBi antenna gains*

Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	PSD limit, dBm/MHz	Margin, dB
4940.5	16.52	17.04	19.80	21.00	1.20
4965.0	16.73	16.50	19.63	21.00	1.37
4989.5	16.55	16.40	19.49	21.00	1.51

Table 8.2-9: *Transmitter power spectral density results for 0.875 MHz channel with 32 dBi antenna gain*

Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	PSD limit[1], dBm/MHz	Margin, dB
4940.5	11.59	11.29	14.45	15.70	1.25
4965.0	11.54	11.42	14.49	15.70	1.21
4989.5	11.62	11.66	14.65	15.70	1.05

Notes: [1]For 32 dBi antenna, the PSD limit was calculated as follows: 21 dBm/MHz – ([2]31.3 dBi – 26 dBi) = 15.70 dBm/MHz
[2]Total gain = 32 dBi – 0.7 dB (cable loss) = 31.3 dBi

Table 8.2-10: *Transmitter power spectral density results for 5 MHz channel with 10 dBi and 24 dBi antenna gains*

Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	PSD limit, dBm/MHz	Margin, dB
4942.5	16.51	16.15	19.34	21.00	1.66
4965.0	16.51	16.36	19.45	21.00	1.55
4987.5	16.53	16.32	19.44	21.00	1.56

Table 8.2-11: *Transmitter power spectral density results for 5 MHz channel with 32 dBi antenna gain*

Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	PSD limit[1], dBm/MHz	Margin, dB
4942.5	11.84	12.67	15.29	15.70	0.41
4965.0	12.74	12.53	15.65	15.70	0.05
4987.5	12.69	12.67	15.69	15.70	0.01

Notes: [1]For 32 dBi antenna, the PSD limit was calculated as follows: 21 dBm/MHz – ([2]31.3 dBi – 26 dBi) = 15.70 dBm/MHz
[2]Total gain = 32 dBi – 0.7 dB (cable loss) = 31.3 dBi

Test data, continued

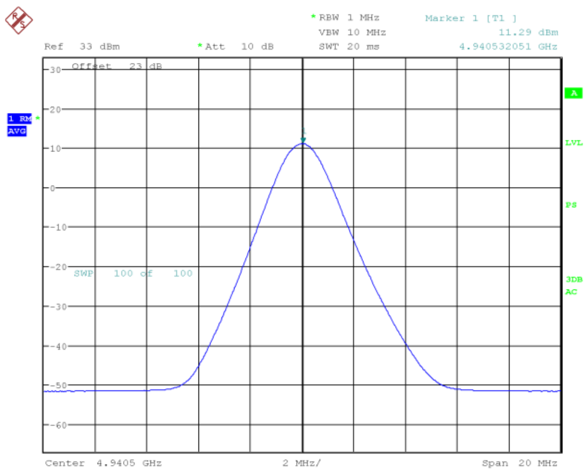


Figure 8.2-1: *Output power/PSD on 0.875 MHz channel, sample plot*

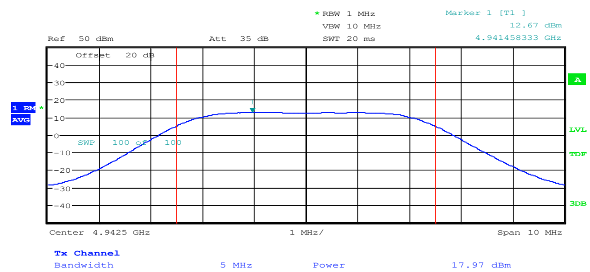


Figure 8.2-2: *Output power/PSD on 5 MHz channel, sample plot*

8.3 Transmitter Peak to Average Power Ratio (PAPR)

8.3.1 References, definitions and limits

FCC §90.1215:

The transmitting power of stations operating in the 4940–4990 MHz band must not exceed the maximum limits in this section.

(e) 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.

RSS-111, Clause 5.4:

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.

8.3.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	June 18, 2020

8.3.3 Observations, settings and special notes

Measurement of peak and RMS output power was performed with the following spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	≥ 3 × RBW
Frequency span	≥ 2 × OBW
Detector mode	Peak and RMS
Trace mode	Averaging over 100 sweeps

8.3.4 Test data

Table 8.3-1: *PAPR measurements results for 0.875 MHz channel*

Frequency, MHz	Antenna port	Ratio, dB	Limit, dB	Margin, dB
4940.5	Ch0	10.81	13.00	2.19
4965.0	Ch0	10.74	13.00	2.26
4989.5	Ch0	10.73	13.00	2.27
4940.5	Ch1	10.62	13.00	2.38
4965.0	Ch1	10.56	13.00	2.44
4989.5	Ch1	10.75	13.00	2.25

Table 8.3-2: *PAPR measurements results for 5 MHz channel*

Frequency, MHz	Antenna port	Ratio, dB	Limit, dB	Margin, dB
4942.5	Ch0	10.66	13.00	2.34
4965.0	Ch0	11.16	13.00	1.84
4987.5	Ch0	11.34	13.00	1.66
4942.5	Ch1	10.72	13.00	2.28
4965.0	Ch1	11.74	13.00	1.26
4987.5	Ch1	11.62	13.00	1.38

Test data, continued

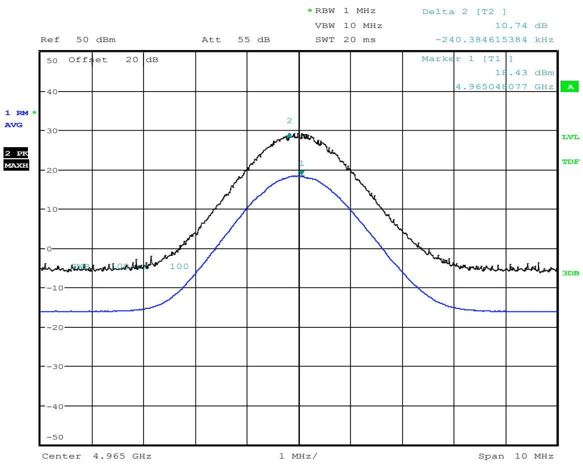


Figure 8.3-1: *PAPR on 0.875 MHz channel, sample plot*

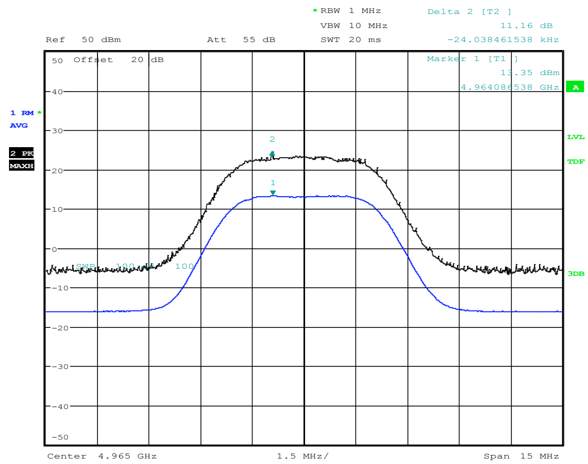


Figure 8.3-2: *PAPR on 5 MHz channel, sample plot*

8.4 Occupied bandwidth

8.4.1 References, definitions and limits

FCC §90.1215:

(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.

RSS-Gen, Clause 6.7:

For the 99% emission bandwidth, the trace data points are recovered and 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 occupied bandwidth (or the 99% emission bandwidth).

8.4.2 Test summary

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	June 18, 2020

8.4.3 Observations, settings and special notes

The test was performed as per ANSI C63.26, subclause 5.4.4.
Spectrum analyser settings:

Resolution bandwidth	10 kHz for 1 MHz channel 50 kHz for 5 MHz channel
Video bandwidth	≥3 × RBW
Frequency span	~1.5 × OBW
Detector mode	Peak
Trace mode	Max Hold

8.4.4 Test data

Table 8.4-1: *Occupied bandwidth results for 0.875 MHz channel*

Antenna port	Frequency, MHz	99% occupied bandwidth, kHz	26 dB bandwidth, kHz
Ch0	4940.5	729	825
Ch0	4965.0	729	825
Ch0	4989.5	721	817
Ch1	4940.5	729	817
Ch1	4965.0	721	817
Ch1	4989.5	721	825

Table 8.4-2: *Occupied bandwidth results for 5 MHz channel*

Antenna port	Frequency, MHz	99% occupied bandwidth, MHz	26 dB bandwidth, MHz
Ch0	4942.5	4.111	4.688
Ch0	4965.0	4.086	4.663
Ch0	4987.5	4.663	4.639
Ch1	4942.5	4.111	4.663
Ch1	4965.0	4.086	4.712
Ch1	4987.5	4.086	4.712

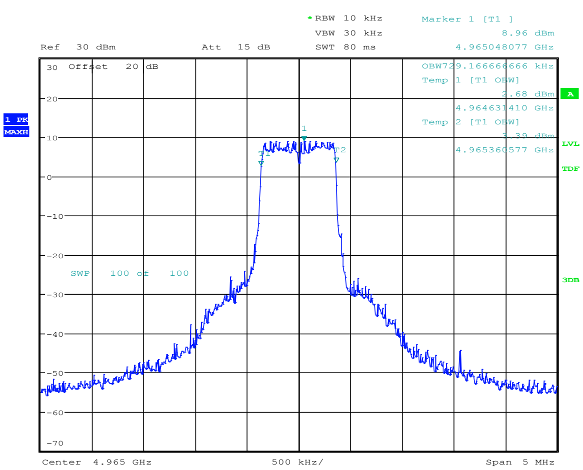


Figure 8.4-1: *99% occupied bandwidth on 0.875 MHz channel, sample plot*

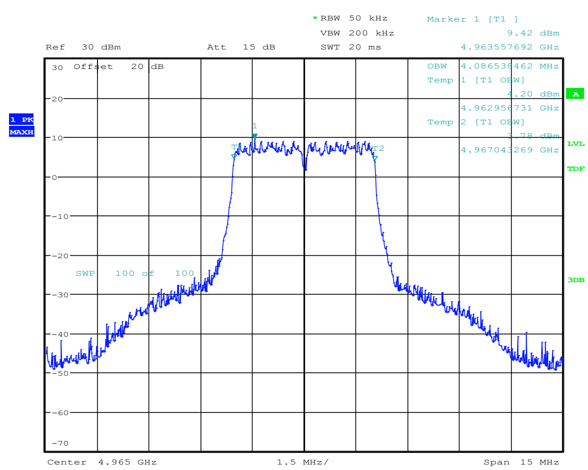


Figure 8.4-2: *99% occupied bandwidth on 5 MHz channel, sample plot*

Test data, continued

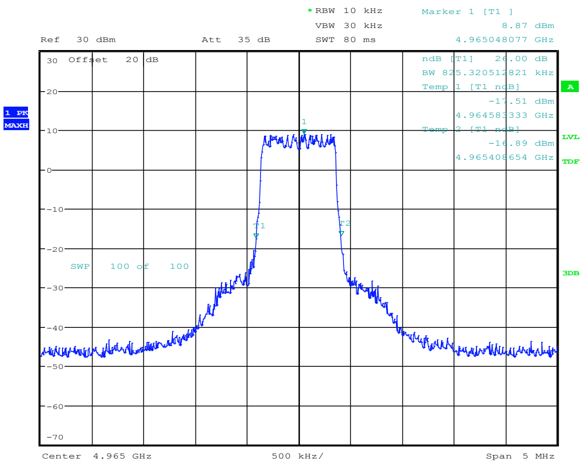


Figure 8.4-3: *26 dB bandwidth on 0.875 MHz channel, sample plot*

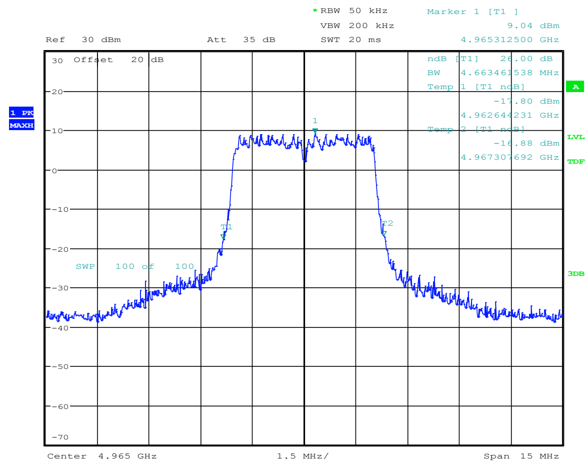


Figure 8.4-4: *26 dB bandwidth on 5 MHz channel, sample plot*

8.5 Spectrum mask and spurious emissions

8.5.1 References, definitions and limits

FCC §90.210:

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (o) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth. Unless indicated elsewhere in this part, the table in this section specifies the emission masks for equipment operating under this part.

Table 8.5-1: *Applicable Emission Masks*

Frequency band, MHz	Mask for equipment with audio low pass filter	Mask for equipment with audio low pass filter
4940–4990	L or M	L or M

(m) **Emission Mask M.** For high power transmitters (greater that 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 follows:

(1) On any frequency removed from the assigned frequency between 0–45% of the authorized bandwidth (BW): 0 dB.

(2) On any frequency removed from the assigned frequency between 45–50% of the authorized bandwidth: 568 log (% of (BW)/45) dB.

(3) On any frequency removed from the assigned frequency between 50–55% of the authorized bandwidth: 26 + 145 log (% of BW/50) dB.

(4) On any frequency removed from the assigned frequency between 55–100% of the authorized bandwidth: 32 + 31 log (% of (BW)/55) dB.

(5) On any frequency removed from the assigned frequency between 100–150% of the authorized bandwidth: 40 + 57 log (% of (BW)/100) dB.

(6) On any frequency removed from the assigned frequency between above 150% of the authorized bandwidth: 50 dB or 55 + 10 log (P) dB, whichever is the lesser attenuation.

(7) The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz. The power spectral density is the power measured within the resolution bandwidth of the measurement device divided by the resolution bandwidth of the measurement device. Emission levels are also based on the use of measurement instrumentation employing a resolution bandwidth of at least one percent of the occupied bandwidth.

RSS-119, Clause 5.5:

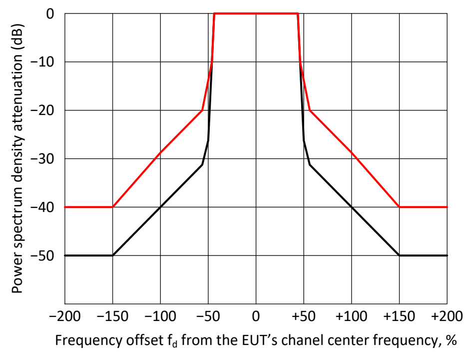
On any frequency f, offset from the channel centre frequency fc by a separation fd (expressed as a percentage of the channel bandwidth), the power spectral density of the unwanted emissions for low- and high-power transmitters shall comply with the limits specified in Table 8.5 2. Figure 8.5–1 shows 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 8.5-2: *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
$0 < f_d \leq 45$	0	0
$45 < f_d \leq 50$	$219 \times \log_{10} (f_d / 45)$	$568 \times \log_{10} (f_d / 45)$
$50 < f_d \leq 55$	$10 + 242 \times \log_{10} (f_d / 50)$	$26 + 145 \times \log_{10} (f_d / 50)$
$55 < f_d \leq 100$	$20 + 31 \times \log_{10} (f_d / 55)$	$32 + 31 \times \log_{10} (f_d / 55)$
$100 < f_d \leq 150$	$28 + 68 \times \log_{10} (f_d / 100)$	$40 + 57 \times \log_{10} (f_d / 100)$
$f_d > 150$	40	whichever is less stringent: 50 dBc or −25 dBm

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

References, definitions and limits, continued



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

Verdict	Pass		
Tested by	Andrey Adelberg	Test date	June 19, 2020

8.5.3 Observations, settings and special notes

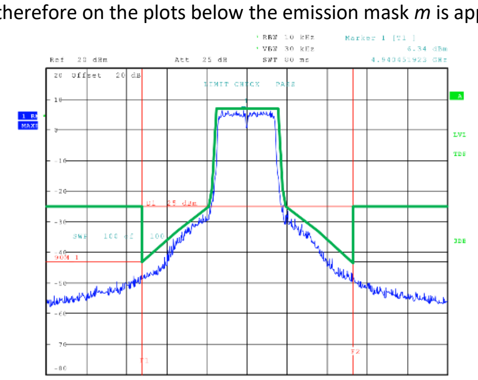
Spectrum analyser settings for spectrum mask:

Resolution bandwidth:	10 kHz (for 0.875 MHz channel) / 50 kHz (for 5 MHz channel)
Video bandwidth:	30 kHz
Detector mode:	RMS
Trace mode:	Max Hold

Spectrum analyser settings for spurious emissions:

Resolution bandwidth:	100k Hz (below 1 GHz); 1 MHz (above 1 GHz)
Video bandwidth:	> RBW
Detector mode:	Peak
Trace mode:	Max Hold

−50 dBc is much stringent limit than −25 dBm, therefore on the plots below the emission mask *m* is applicable up to ±150% of channel bandwidth:



8.5.4 Test data

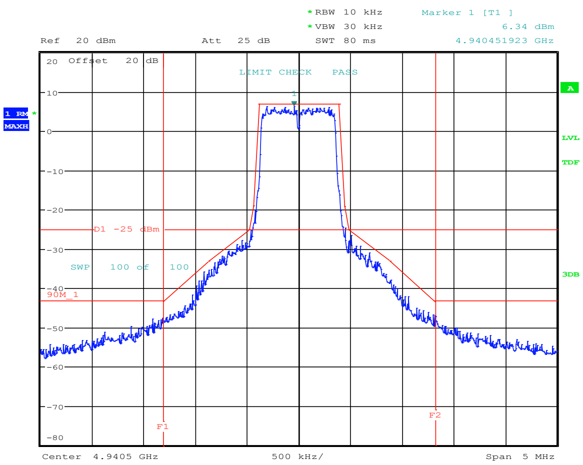


Figure 8.5-2: *Emission mask for 0.875 MHz low channel at ch0 for 10 dBi and 24 dBi antennas*

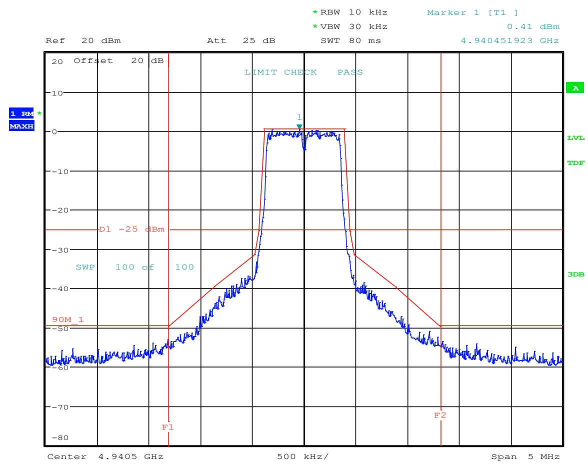


Figure 8.5-3: *Emission mask for 0.875 MHz low channel at ch0 for 32 dBi antenna*

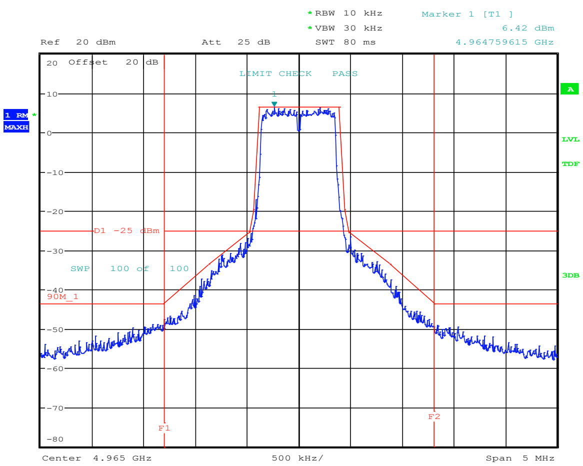


Figure 8.5-4: *Emission mask for 0.875 MHz mid channel at ch0 for 10 dBi and 24 dBi antennas*

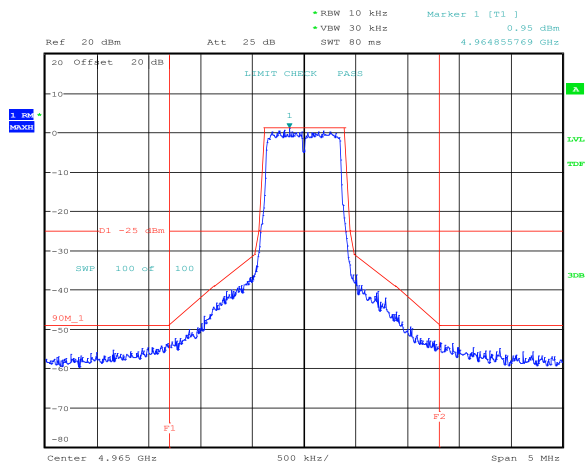


Figure 8.5-5: *Emission mask for 0.875 MHz mid channel at ch0 for 32 dBi antenna*

Test data, continued

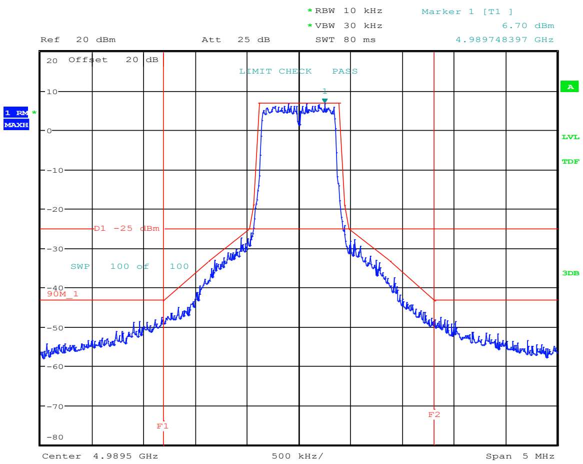


Figure 8.5-6: *Emission mask for 0.875 MHz high channel at ch0 for 10 dBi and 24 dBi antennas*

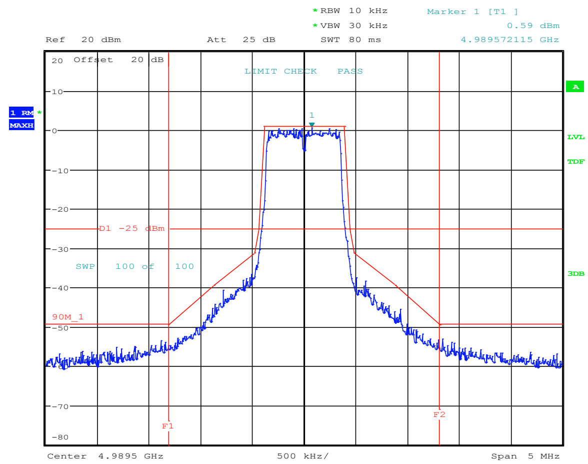


Figure 8.5-7: *Emission mask for 0.875 MHz high channel at ch0 for 32 dBi antenna*

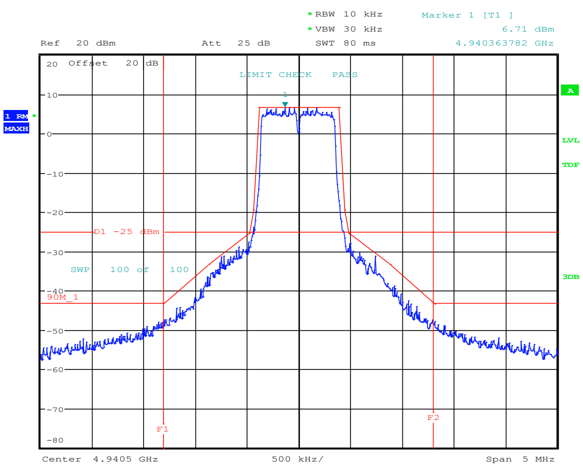


Figure 8.5-8: *Emission mask for 0.875 MHz low channel at ch1 for 10 dBi and 24 dBi antennas*

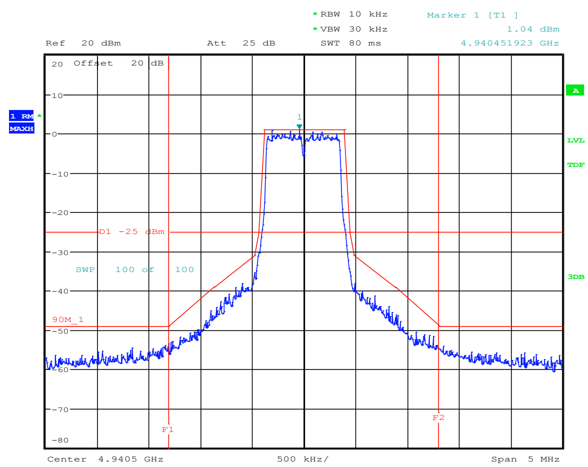


Figure 8.5-9: *Emission mask for 0.875 MHz low channel at ch1 for 32 dBi antenna*

Test data, continued

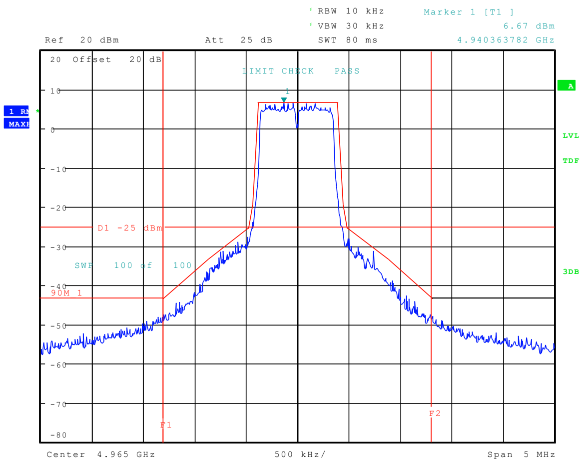


Figure 8.5-10: *Emission mask for 0.875 MHz mid channel at ch1 for 10 dBi and 24 dBi antennas*

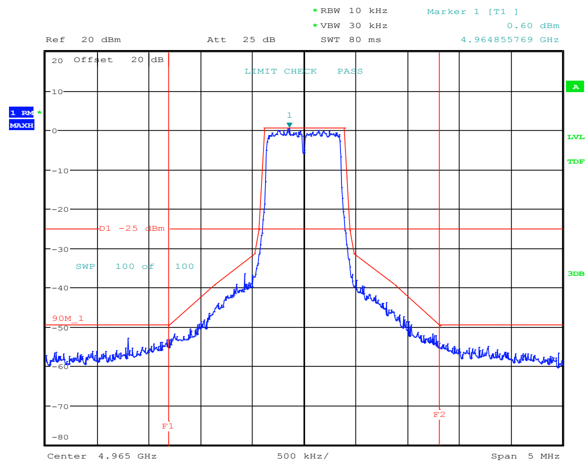


Figure 8.5-11: *Emission mask for 0.875 MHz mid channel at ch1 for 32 dBi antenna*

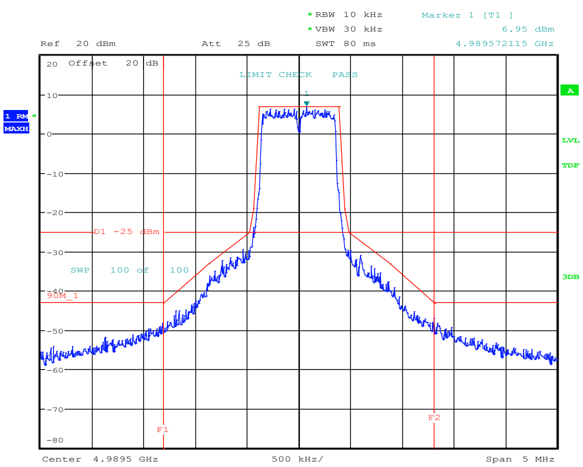


Figure 8.5-12: *Emission mask for 0.875 MHz high channel at ch1 for 10 dBi and 24 dBi antennas*

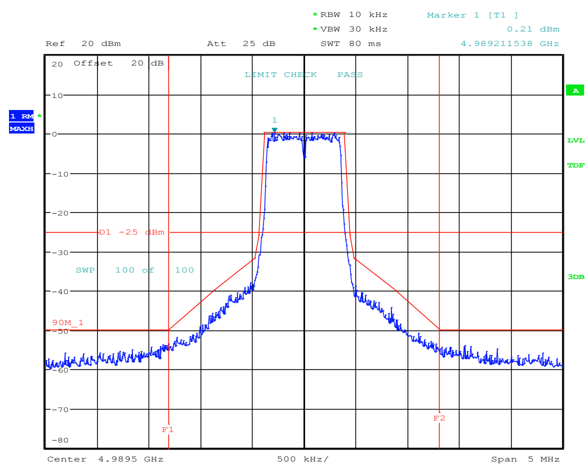


Figure 8.5-13: *Emission mask for 0.875 MHz high channel at ch1 for 32 dBi antenna*

Test data, continued

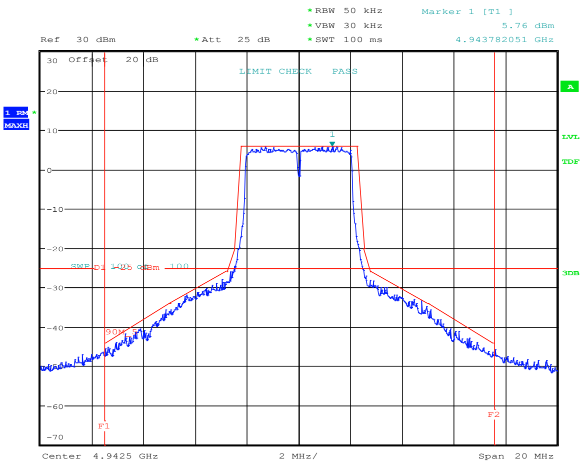


Figure 8.5-14: *Emission mask for 5 MHz low channel at ch0 for 10 dBi and 24 dBi antennas*

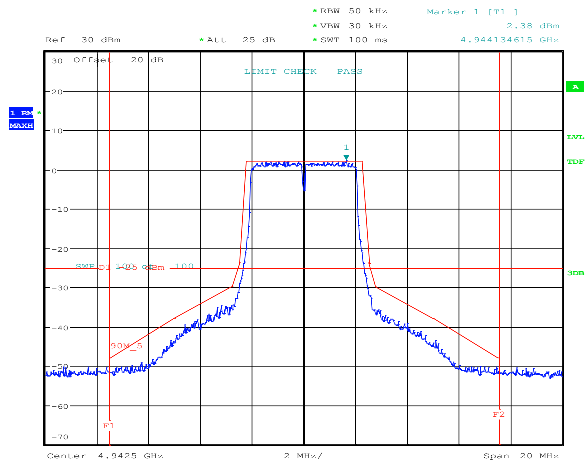


Figure 8.5-15: *Emission mask for 5 MHz low channel at ch0 for 32 dBi antenna*

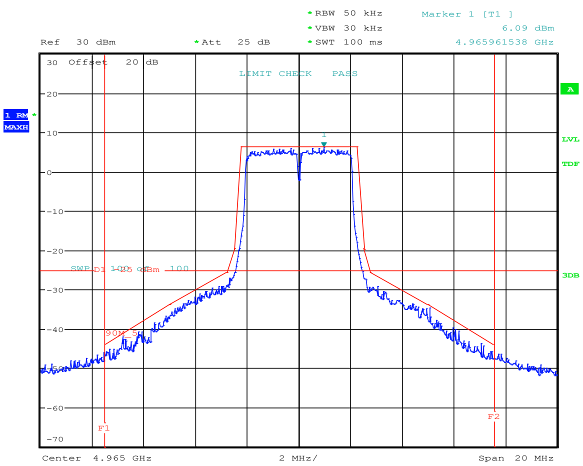


Figure 8.5-16: *Emission mask for 5 MHz mid channel at ch0 for 10 dBi and 24 dBi antennas*

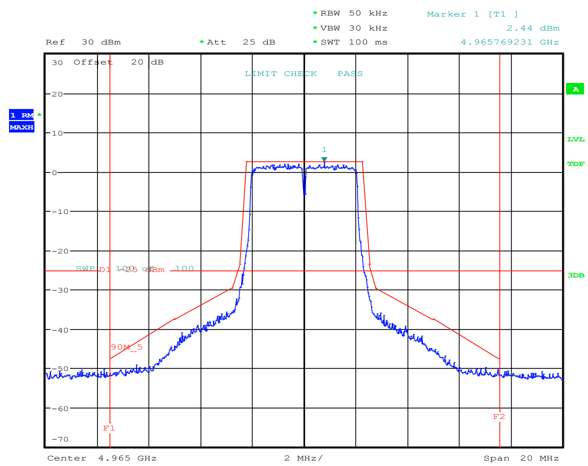


Figure 8.5-17: *Emission mask for 5 MHz mid channel at ch0 for 32 dBi antenna*

Test data, continued

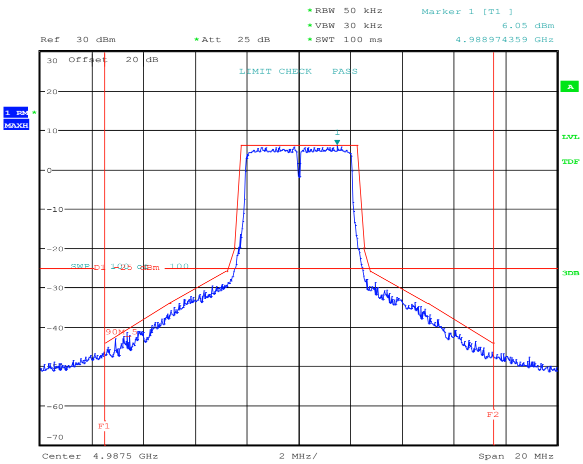


Figure 8.5-18: *Emission mask for 5 MHz high channel at ch0 for 10 dBi and 24 dBi antennas*

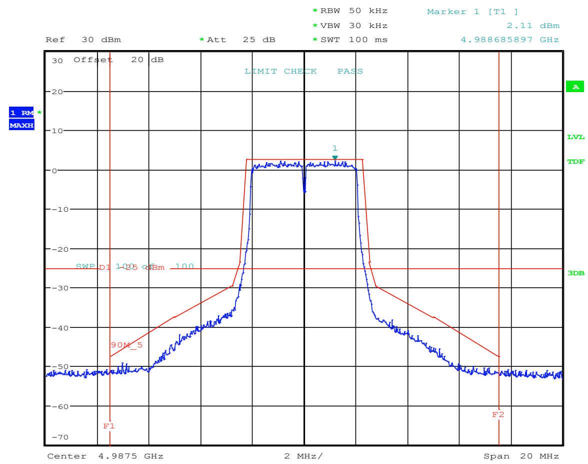


Figure 8.5-19: *Emission mask for 5 MHz high channel at ch0 for 32 dBi antenna*

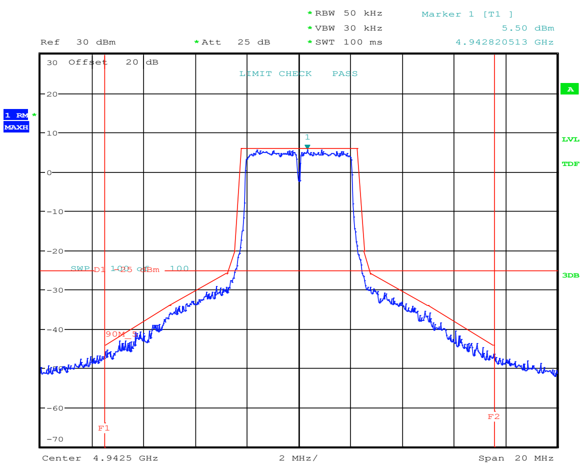


Figure 8.5-20: *Emission mask for 5 MHz low channel at ch1 for 10 dBi and 24 dBi antennas*

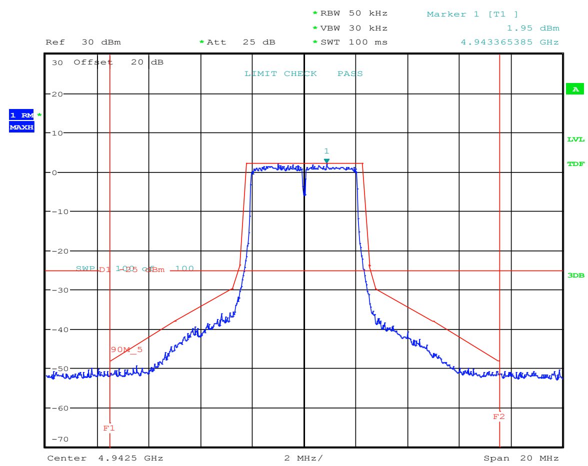


Figure 8.5-21: *Emission mask for 5 MHz low channel at ch1 for 32 dBi antenna*

Test data, continued

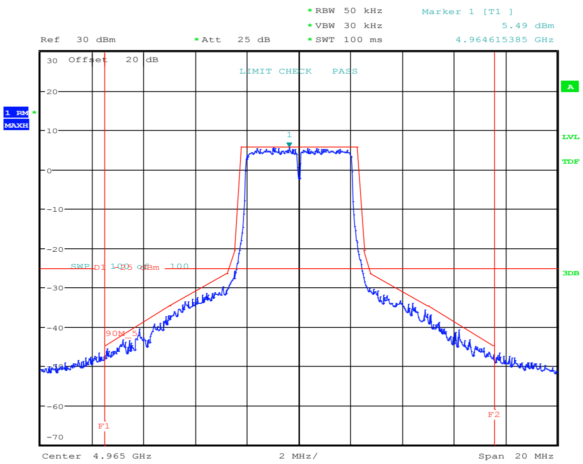


Figure 8.5-22: *Emission mask for 5 MHz mid channel at ch1 for 10 dBi and 24 dBi antennas*

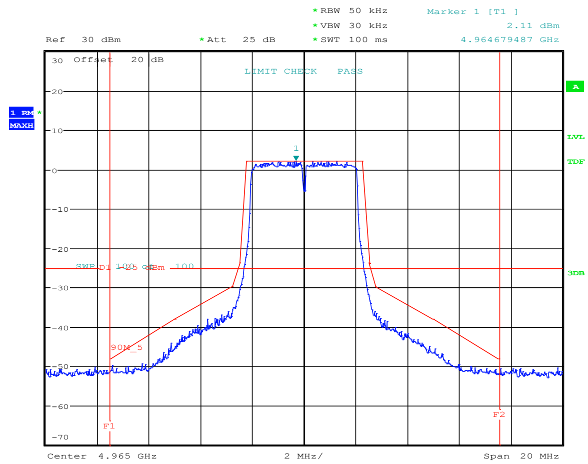


Figure 8.5-23: *Emission mask for 5 MHz mid channel at ch1 for 32 dBi antenna*

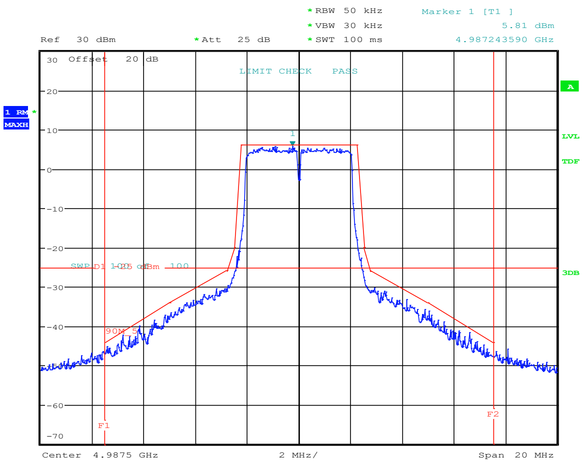


Figure 8.5-24: *Emission mask for 5 MHz high channel at ch1 for 10 dBi and 24 dBi antennas*

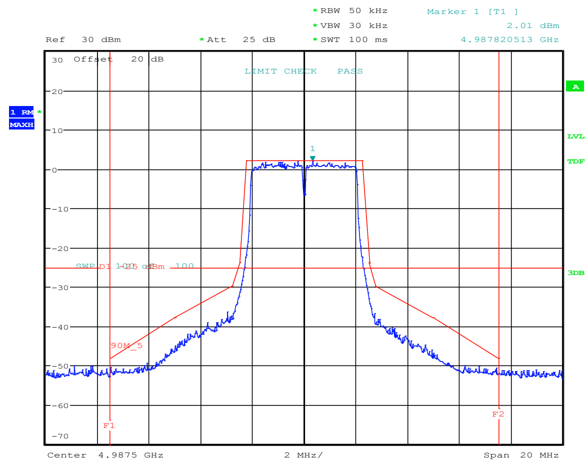


Figure 8.5-25: *Emission mask for 5 MHz high channel at ch1 for 32 dBi antenna*

Test data, continued

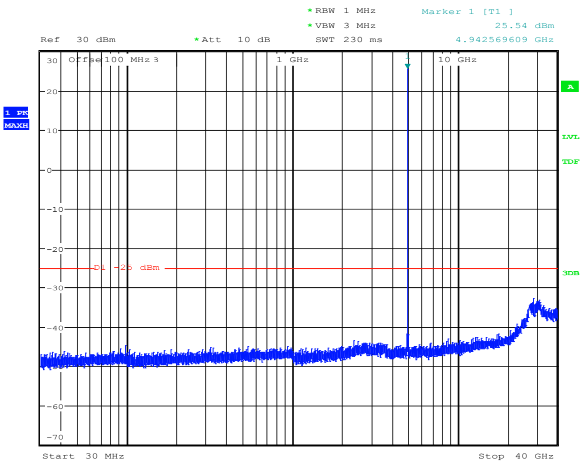


Figure 8.5-26: *Conducted spurious emissions for 0.875 MHz low channel at ch0*

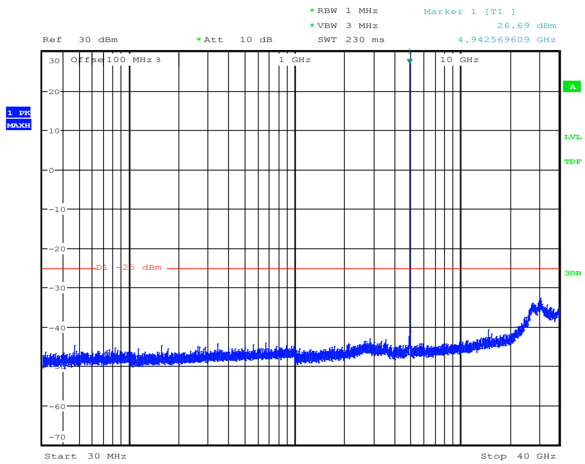


Figure 8.5-27: *Conducted spurious emissions for 0.875 MHz low channel at ch1*

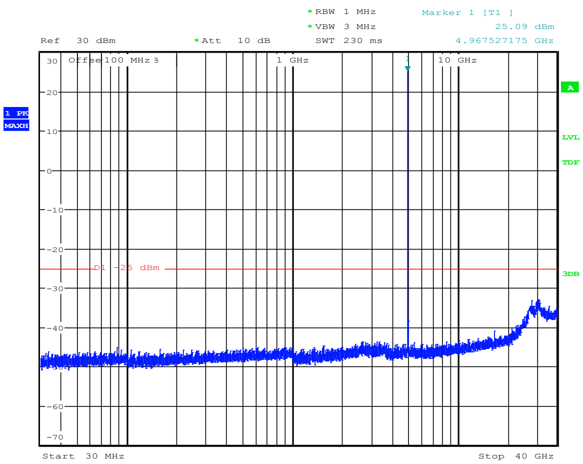


Figure 8.5-28: *Conducted spurious emissions for 0.875 MHz mid channel at ch0*

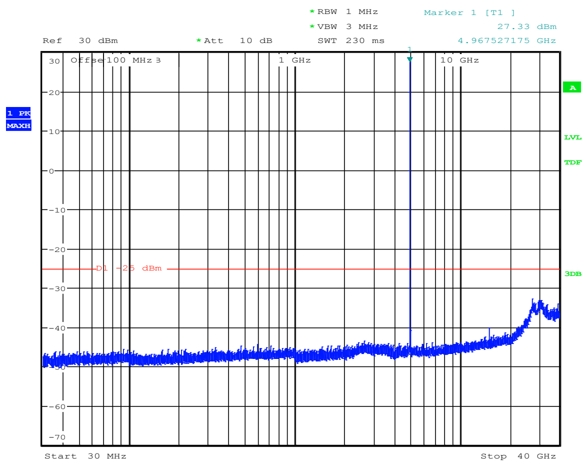


Figure 8.5-29: *Conducted spurious emissions for 0.875 MHz mid channel at ch1*

Test data, continued

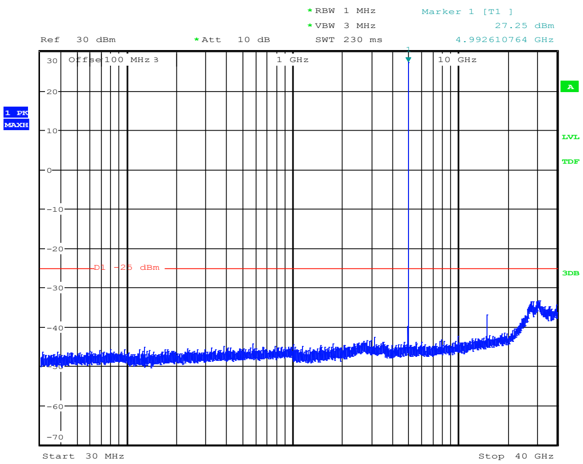


Figure 8.5-30: *Conducted spurious emissions for 0.875 MHz high channel at ch0*

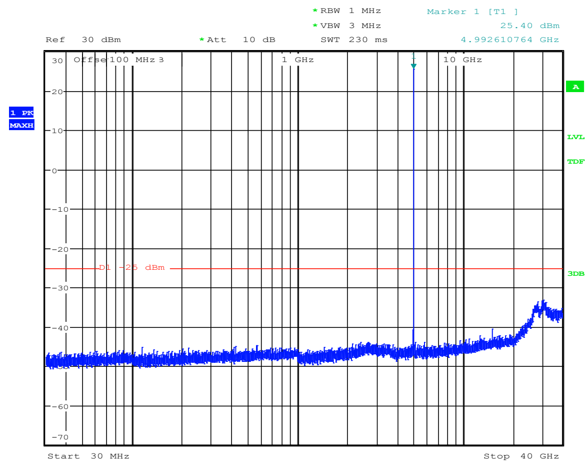


Figure 8.5-31: *Conducted spurious emissions for 0.875 MHz high channel at ch1*

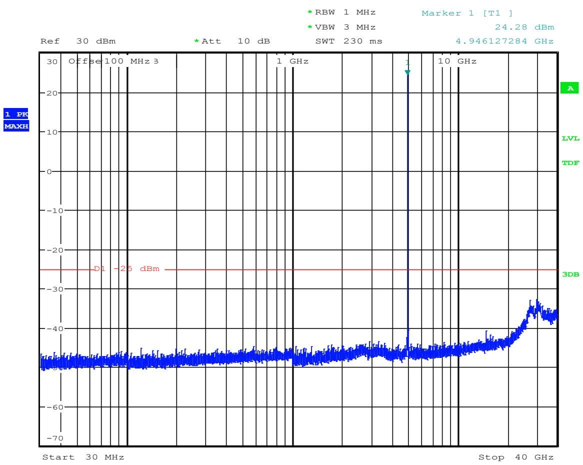


Figure 8.5-32: *Conducted spurious emissions for 5 MHz low channel at ch0*

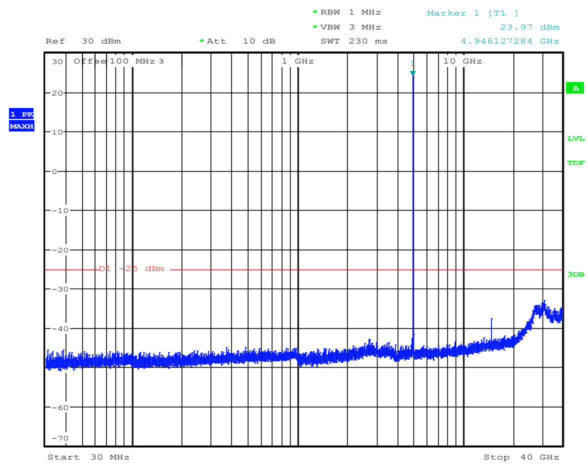


Figure 8.5-33: *Conducted spurious emissions for 5 MHz low channel at ch1*

Test data, continued

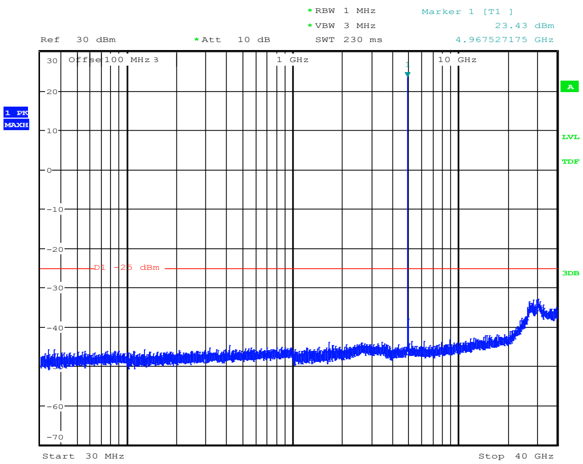


Figure 8.5-34: *Conducted spurious emissions for 5 MHz mid channel at ch0*

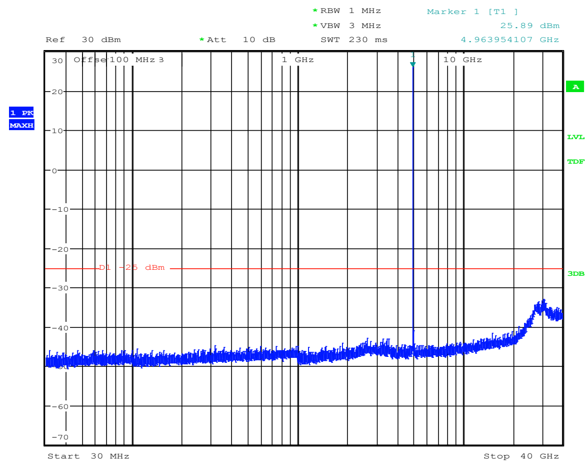


Figure 8.5-35: *Conducted spurious emissions for 5 MHz mid channel at ch1*

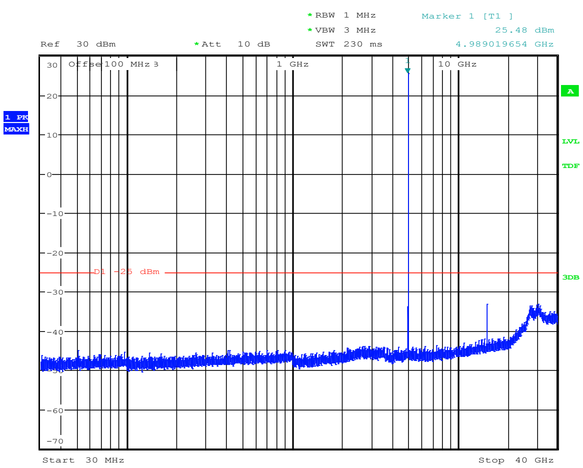


Figure 8.5-36: *Conducted spurious emissions for 5 MHz high channel at ch0*

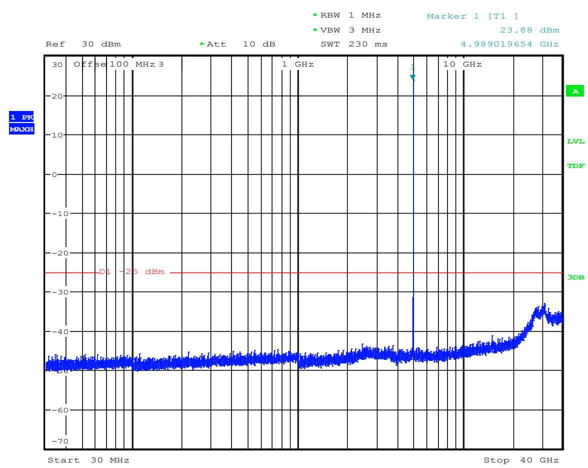


Figure 8.5-37: *Conducted spurious emissions for 5 MHz high channel at ch1*

Test data, continued

Table 8.5-3: *Radiated spurious emissions measurements results*

Channel	Frequency, GHz	Emission power, dBm	Limit, dB	Margin, dB
0.875 MHz low	9.882	-28.74	-25.00	3.74
	14.822	-38.68	-25.00	13.68
	19.762	-31.17	-25.00	6.17
	24.703	-38.17	-25.00	13.17
0.875 MHz mid	9.931	-29.87	-25.00	4.87
	14.897	-36.78	-25.00	11.78
	19.842	-32.67	-25.00	7.67
	24.803	-36.57	-25.00	11.57
0.875 MHz high	9.979	-32.14	-25.00	7.14
	14.969	-30.96	-25.00	5.96
	19.958	-33.67	-25.00	8.67
	24.948	-37.97	-25.00	12.97
5 MHz low	9.885	-35.76	-25.00	10.76
	15.989	-28.52	-25.00	3.52
	19.770	-32.77	-25.00	7.77
	24.712	-40.07	-25.00	15.07
5 MHz mid	9.931	-31.57	-25.00	6.57
	14.895	-39.56	-25.00	14.56
	19.842	-34.87	-25.00	9.87
	35.547	-37.87	-25.00	12.87
5 MHz high	9.975	-35.94	-25.00	10.94
	14.965	-38.76	-25.00	13.76
	19.947	-43.17	-25.00	18.17

Test data, continued

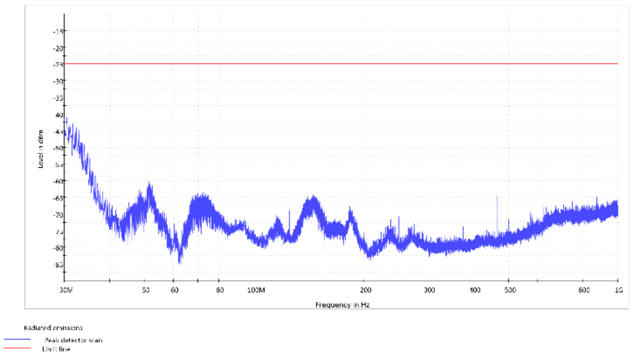


Figure 8.5-38: _Radiated spurious emissions for 0.875 MHz low channel below 1 GHz_

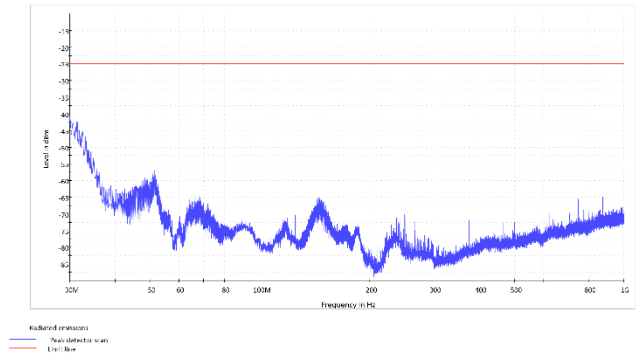


Figure 8.5-39: _Radiated spurious emissions for 0.875 MHz mid channel below 1 GHz_

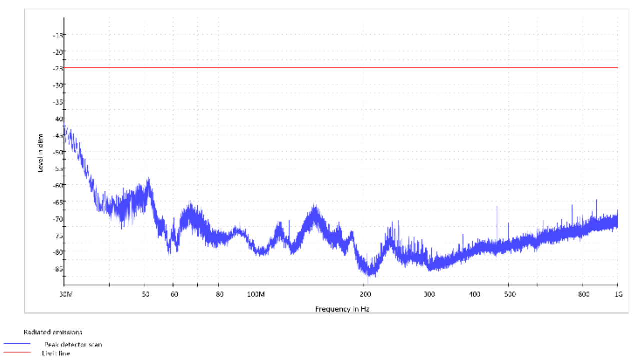


Figure 8.5-40: _Radiated spurious emissions for 0.875 MHz high channel below 1 GHz_

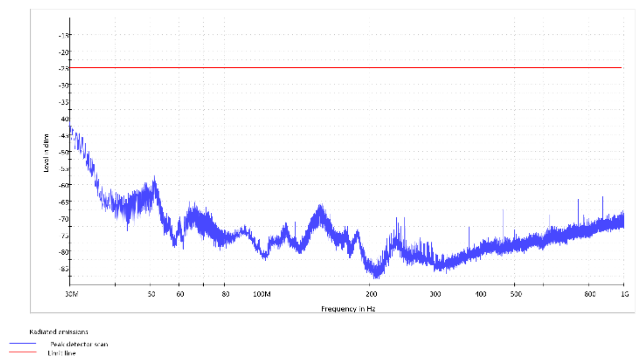


Figure 8.5-41: _Radiated spurious emissions for 5 MHz low channel below 1 GHz_

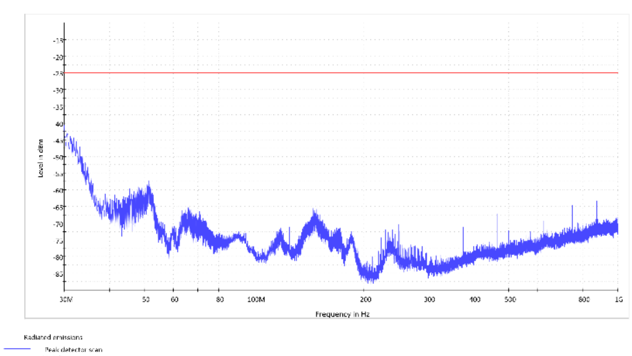


Figure 8.5-42: _Radiated spurious emissions for 5 MHz mid channel below 1 GHz_

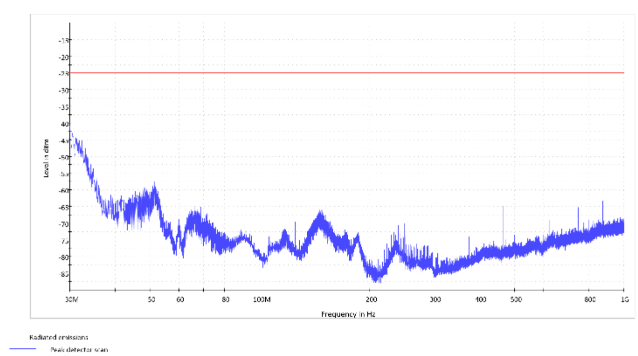


Figure 8.5-43: _Radiated spurious emissions for 5 MHz high channel below 1 GHz_

Test data, continued

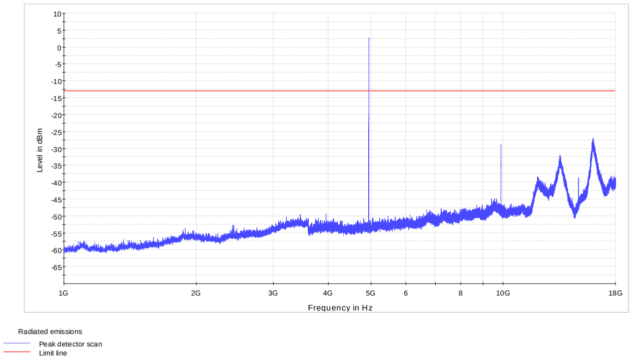


Figure 8.5-44: *Radiated spurious emissions for 0.875 MHz low channel within 1–18 GHz*

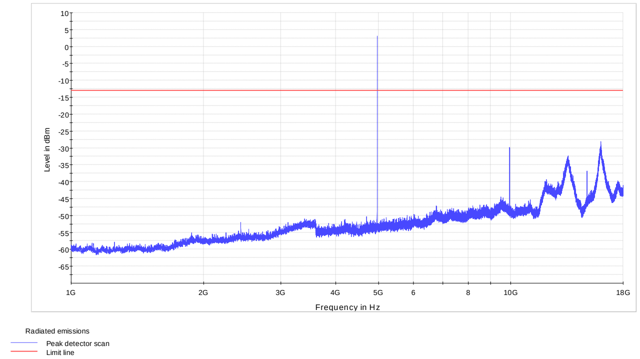


Figure 8.5-45: *Radiated spurious emissions for 0.875 MHz mid channel within 1–18 GHz*

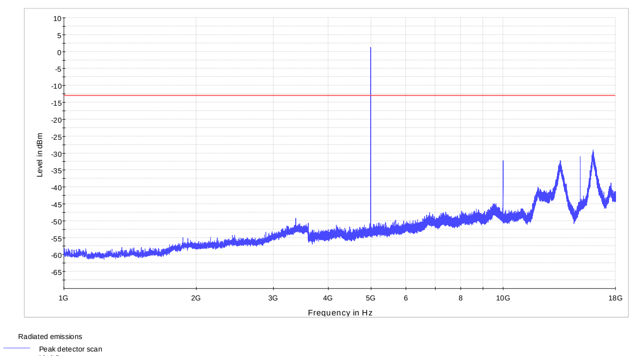


Figure 8.5-46: *Radiated spurious emissions for 0.875 MHz high channel within 1–18 GHz*

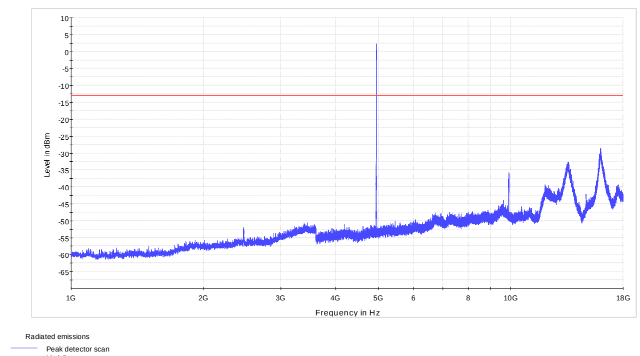


Figure 8.5-47: *Radiated spurious emissions for 5 MHz low channel within 1–18 GHz*

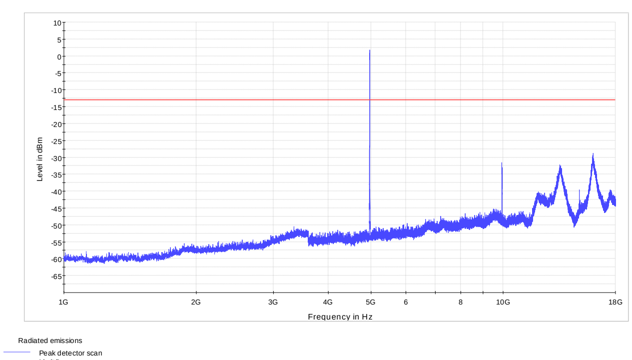


Figure 8.5-48: *Radiated spurious emissions for 5 MHz mid channel within 1–18 GHz*

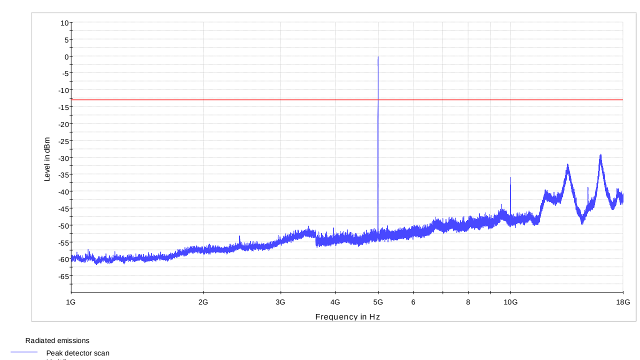


Figure 8.5-49: *Radiated spurious emissions for 5 MHz high channel within 1–18 GHz*

Test data, continued

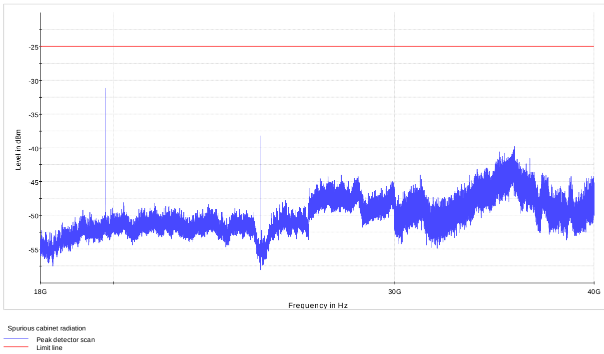


Figure 8.5-50: *Radiated spurious emissions for 0.875 MHz low channel within 18–40 GHz*

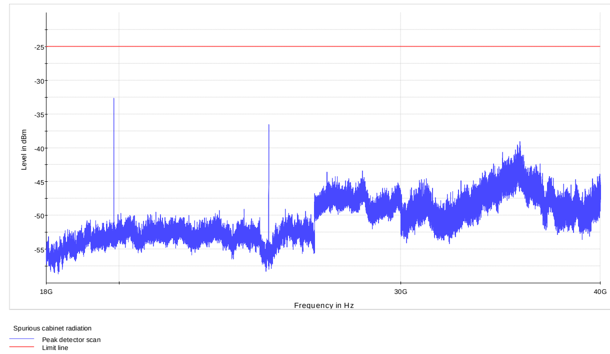


Figure 8.5-51: *Radiated spurious emissions for 0.875 MHz mid channel within 18–40 GHz*

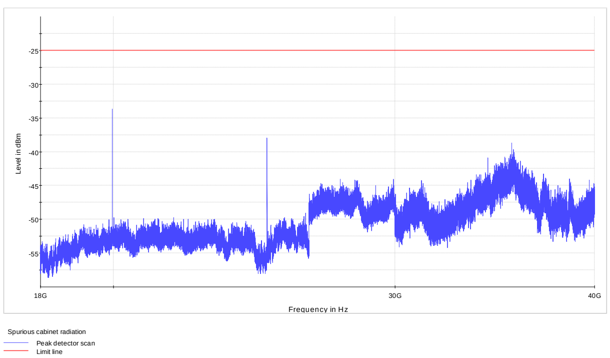


Figure 8.5-52: *Radiated spurious emissions for 0.875 MHz high channel within 18–40 GHz*

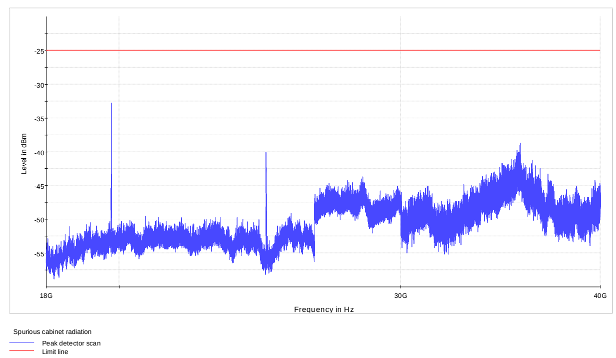


Figure 8.5-53: *Radiated spurious emissions for 5 MHz low channel within 18–40 GHz*

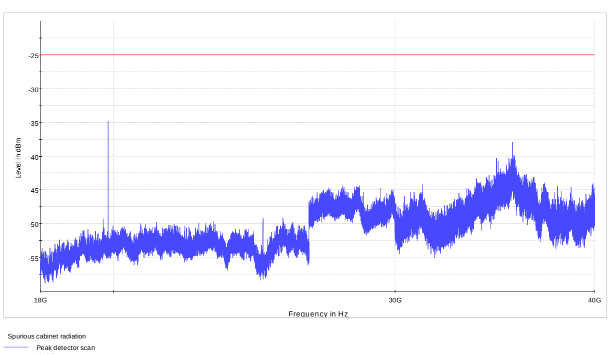


Figure 8.5-54: *Radiated spurious emissions for 5 MHz mid channel within 18–40 GHz*

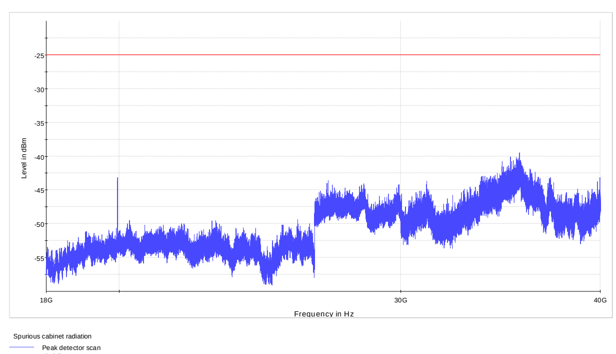


Figure 8.5-55: *Radiated spurious emissions for 5 MHz high channel within 18–40 GHz*

End of the test report