

# Test report

**267135-1TRFWL**

Date of issue: September 12, 2014

Applicant:

**Redline Communications**

Product:

**Broad-band wireless infrastructure product**

Model:

**RDL-3000-RMG**

FCC ID:

**QC8-RDL3000RMG**

IC Registration number:

**4310A-RDL3000RMG**


Specifications:

- ◆ **FCC 47 CFR Part 15 Subpart E, §15.407**  
Unlicensed National Information Infrastructure Devices

Test location

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Website	www.nemko.com
Site number	FCC: 176392 (3 m semi anechoic chamber)

Tested by	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by	Kevin Rose, Wireless/EMC Specialist
Date	September 12, 2014
Signature of the reviewer	

Limits of responsibility

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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.

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## Table of contents

<b>Table of contents</b> .....	<b>3</b>
<b>Section 1. Report summary</b> .....	<b>4</b>
1.1 Applicant and manufacturer .....	4
1.2 Test specifications .....	4
1.3 Test methods.....	4
1.4 Statement of compliance .....	4
1.5 Exclusions.....	4
1.6 Test report revision history .....	4
<b>Section 2. Summary of test results</b> .....	<b>5</b>
2.1 FCC Part 15 Subpart C, general requirements test results.....	5
2.2 FCC Part 15 Subpart E, test results .....	5
<b>Section 3. Equipment under test (EUT) details</b> .....	<b>6</b>
3.1 Sample information.....	6
3.2 EUT information .....	6
3.3 Technical information .....	6
3.4 Product description and theory of operation .....	6
3.5 EUT exercise details.....	7
3.6 EUT setup diagram .....	7
3.7 EUT sub assemblies .....	7
<b>Section 4. Engineering considerations</b> .....	<b>8</b>
4.1 Modifications incorporated in the EUT.....	8
4.2 Technical judgment .....	8
4.3 Deviations from laboratory tests procedures .....	8
<b>Section 5. Test conditions</b> .....	<b>9</b>
5.1 Atmospheric conditions .....	9
5.2 Power supply range.....	9
<b>Section 6. Measurement uncertainty</b> .....	<b>10</b>
6.1 Uncertainty of measurement .....	10
<b>Section 7. Test equipment</b> .....	<b>11</b>
7.1 Test equipment list.....	11
<b>Section 8. Testing data</b> .....	<b>12</b>
8.1 FCC 15.207(a) AC power line conducted emissions limits .....	12
8.2 FCC 15.403(i) Emission bandwidth .....	16
8.3 FCC 15.407(a)(1) 5.15–5.25 GHz band output power, EIRP and spectral density limits .....	18
8.4 FCC 15.407(b) Spurious (out-of-band) emissions .....	25
8.5 FCC 15.407(g) Frequency stability .....	42
<b>Section 9. Block diagrams of test set-ups</b> .....	<b>44</b>
9.1 Radiated emissions set-up.....	44
9.2 Conducted emissions set-up .....	44

## Section 1. Report summary

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### 1.1 Applicant and manufacturer

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

### 1.2 Test specifications

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FCC 47 CFR Part 15, Subpart E, Clause 15.407	Unlicensed National Information Infrastructure Devices
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### 1.3 Test methods

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789033 D02 General UNII Test Procedures New Rules v01 (June 6, 2014)	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E
662911 D01 Multiple Transmitter Output v02r01 (October 31, 2013)	Emissions testing of transmitters with multiple outputs in the same band (MIMO)
662911 D02 MIMO with Cross Polarized Antenna v01 (October 25, 2011)	Emissions testing of transmitters with multiple outputs in the same band (MIMO) with Cross Polarized Antenna
ANSI C64.3 v 2003	American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

### 1.4 Statement of compliance

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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

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None

### 1.6 Test report revision history

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

## Section 2. Summary of test results

### 2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass <sup>1</sup>
§15.203	Antenna requirement	Pass <sup>2</sup>

Notes: <sup>1</sup>Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

<sup>2</sup>The Antennas are located within the enclosure of EUT and not user accessible.

### 2.2 FCC Part 15 Subpart E, test results

Part	Test description	Verdict
§15.403(i)	Emission bandwidth	Not applicable
§15.407(a)(1)	5.15–5.25 GHz band power and density limits	Pass
§15.407(a)(2)	5.25–5.35 GHz and 5.47–5.725 GHz bands power and density limits	Not applicable
§15.407(a)(3)	5.725–5.850 GHz band power and density limits	Not applicable
§15.407(b)(1)	5.15–5.25 GHz band undesired emission limits	Pass
§15.407(b)(2)	5.25–5.35 GHz band undesired emission limits	Not applicable
§15.407(b)(3)	5.47–5.725 GHz band undesired emission limits	Not applicable
§15.407(b)(4)	5.725–5.850 GHz band undesired emission limits	Not applicable
§15.407(b)(6)	Unwanted emissions below 1 GHz	Pass
§15.407(b)(7)	Radiated emissions within restricted bands	Pass
§15.407(e)	6 dB bandwidth for 5.725–5.850 GHz band	Not applicable
§15.407(g)	Frequency stability	Pass
§15.407(h)(1)	Transmit power control (TPC) <sup>1</sup>	Not applicable
§15.407(h)(2)	Dynamic Frequency Selection (DFS) <sup>1</sup>	Not applicable

Note: <sup>1</sup>Not applicable for devices operating within 5.15–5.25 GHz U-NII band.

## Section 3. Equipment under test (EUT) details

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### 3.1 Sample information

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Receipt date	August 6, 2014
Nemko sample ID number	1

### 3.2 EUT information

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Product name	Broad-band wireless infrastructure product
Model	RDL-3000-RMG
Serial number	149PC12480006

### 3.3 Technical information

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Operating band	5150–5250 MHz
Operating frequency	5155–5247.5 MHz (5 MHz channel), 5160–5245 MHz (10 MHz channel) and 5170–5240 MHz (20 MHz channel)
Modulation type	OFDM using 64-QAM, 16-QAM, QPSK and BPSK modulation for sub-carriers
Occupied bandwidth (99 %)	4.1 MHz (5 MHz channel), 8.17 MHz (10 MHz channel), 16.41 MHz (20 MHz channel)
Emission designator	W7D
Power requirements	48 V <sub>DC</sub> PoE via 120 V <sub>AC</sub> , 60 Hz
Antenna information	19 dBi Dual Polarization/ Dual Slant Subscriber Antenna 4.9–6.1 GHz, Redline 30-00328-50 10 dBi L-COM HG5158DP-10U, L-COM 29 dBi Redline APD-DB05-2ft-RAD-01 Parabolic Antenna, 4.9–5.9 GHz, 2-ft, dual polarity The EUT is professionally installed.

### 3.4 Product description and theory of operation

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The EUT is a 2x2 MIMO point-to-multipoint (PMP) carrier grade broadband wireless infrastructure product, designed to operate in the 5150–5250 MHz band.

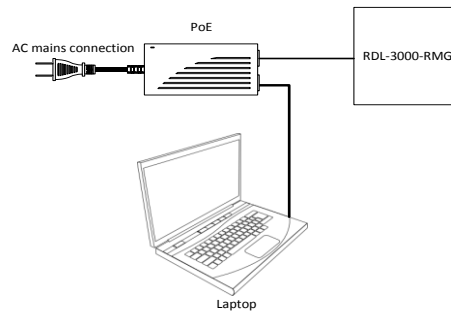
### 3.5 EUT exercise details

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The EUT was controlled to transmit at desired frequency and modulation from laptop using Art GUI software and telnet session.

### 3.6 EUT setup diagram

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**Figure 3.6-1:** Setup diagram

### 3.7 EUT sub assemblies

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**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

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### 4.1 Modifications incorporated in the EUT

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

### 4.2 Technical judgment

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None

### 4.3 Deviations from laboratory tests procedures

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No deviations were made from laboratory procedures.



## Section 5. Test conditions

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### 5.1 Atmospheric conditions

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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

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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  $\pm 5\%$ , for which the equipment was designed.

## Section 6. Measurement uncertainty

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### 6.1 Uncertainty of measurement

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Nemko Canada Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 "Uncertainty in EMC measurements." Measurement uncertainty was calculated using the methods described in CISPR 16-4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements; as well as described in UKAS LAB34: The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of  $K=2$  with 95% certainty.

## 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	Mar. 18/15
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Power source	California Instruments	5001ix	FA002494	1 year	Oct. 22/14
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Oct. 24/14
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Jan. 27/15
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Mar. 12/15
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Mar. 10/15
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	2 year	Sept. 06/14
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	June 21/15
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	Oct. 28/14
Power meter	Agilent	N1911A	FA001946	1 year	Mar. 04/15
Power sensor	Agilent	N1922A	FA001947	1 year	Mar. 04/15
Temperature chamber	Thermotron	SM-16C	FA001030	1 year	NCR
Multimeter	Fluke	16	FA001831	1 year	Feb. 04/15

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

## Section 8. Testing data

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### 8.1 FCC 15.207(a) AC power line conducted emissions limits

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#### 8.1.1 Definitions and limits

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Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50  $\Omega$  line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

**Table 8.1-1: Conducted emissions limit**

Frequency of emission (MHz)	Conducted limit (dB $\mu$ V)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: \* - Decreases with the logarithm of the frequency.

#### 8.1.2 Test summary

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Test date	August 6, 2014	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	32 %

### 8.1.3 Observations, settings and special notes

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The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

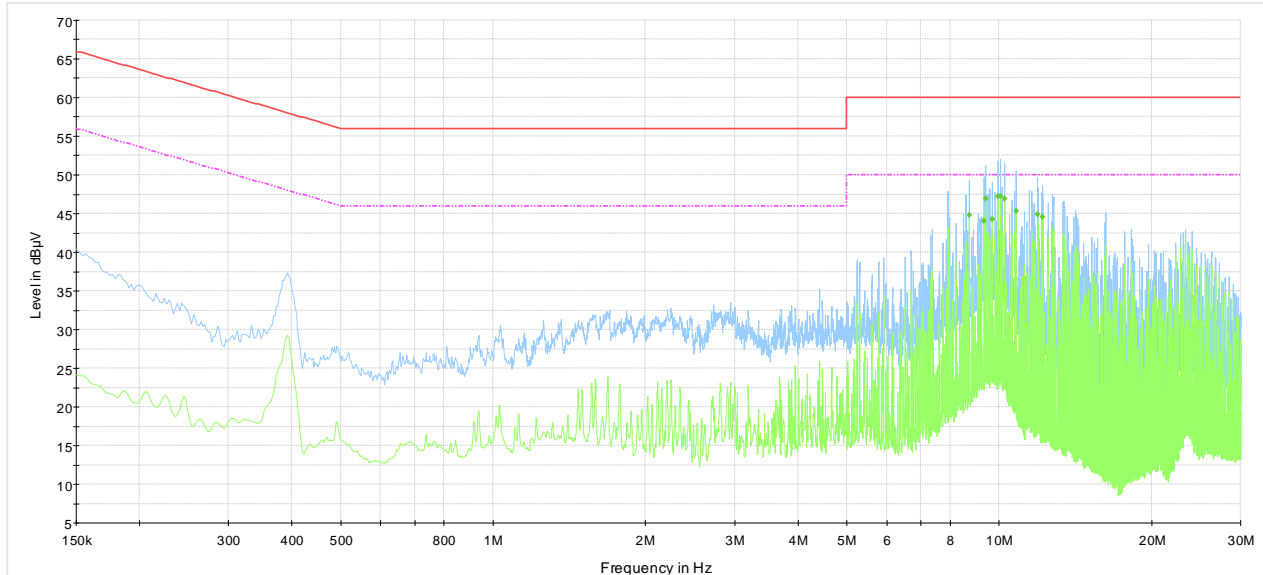
Receiver settings for preview measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time:	100 ms

Receiver settings for final measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Quasi-Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

8.1.4 Test data



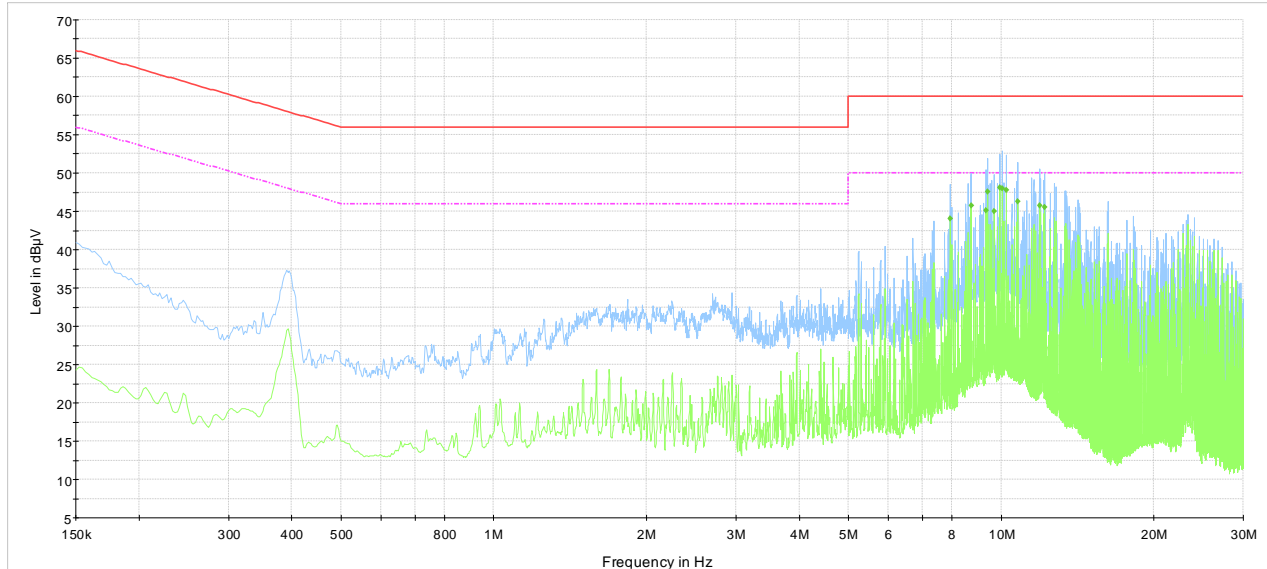
Conducted emissions on phase line  
 — CISPR 22 Mains QP Class B  
 - - - CISPR 22 Mains AV Class B  
 — Preview Result 1-PK+  
 — Preview Result 2-AVG  
 ◆ Final Result 2-AVG

Plot 8.1-1: Conducted emissions on phase line

Table 8.1-2: Average conducted emissions results on phase line

Frequency, MHz	Average result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Conductor	Correction, dB	Margin, dB	Limit, dBµV
8.718000	44.8	100	9	On	Phase	10.2	5.2	50.0
9.327750	44.1	100	9	On	Phase	10.2	5.9	50.0
9.388500	46.9	100	9	On	Phase	10.2	3.1	50.0
9.694500	44.3	100	9	On	Phase	10.2	5.7	50.0
9.937500	47.2	100	9	On	Phase	10.3	2.8	50.0
10.060750	47.3	100	9	On	Phase	10.3	2.7	50.0
10.243000	46.9	100	9	On	Phase	10.3	3.1	50.0
10.794250	45.3	100	9	On	Phase	10.3	4.7	50.0
11.892250	44.9	100	9	On	Phase	10.4	5.1	50.0
12.198250	44.6	100	9	On	Phase	10.4	5.4	50.0

8.1.4 Test data, continued



Conducted emissions on neutral line  
 — CISPR 22 Mains QP Class B  
 - - - CISPR 22 Mains AV Class B  
 — Preview Result 1-PK+  
 — Preview Result 2-AVG  
 ◆ Final Result 2-AVG

Plot 8.1-2: Conducted emissions on neutral line

Table 8.1-3: Average conducted emissions results on neutral line

Frequency, MHz	Average result, dBµV	Meas. Time, ms	Bandwidth, kHz	Filter	Conductor	Correction, dB	Margin, dB	Limit, dBµV
7.923750	44.0	100	9	On	Neutral	10.2	6.0	50.0
8.718000	45.8	100	9	On	Neutral	10.3	4.2	50.0
9.327750	45.2	100	9	On	Neutral	10.3	4.8	50.0
9.388500	47.5	100	9	On	Neutral	10.3	2.5	50.0
9.694500	45.0	100	9	On	Neutral	10.3	5.0	50.0
9.937500	48.1	100	9	On	Neutral	10.3	1.9	50.0
10.060750	48.0	100	9	On	Neutral	10.3	2.0	50.0
10.243000	47.8	100	9	On	Neutral	10.3	2.2	50.0
10.794250	46.3	100	9	On	Neutral	10.4	3.7	50.0
11.892250	45.8	100	9	On	Neutral	10.4	4.2	50.0
12.198250	45.5	100	9	On	Neutral	10.5	4.5	50.0

## 8.2 FCC 15.403(i) Emission bandwidth

### 8.2.1 Definitions and limits

For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

### 8.2.2 Test summary

Test date	August 11, 2014	Temperature	23 °C
Test engineer	Andrey Adelberg	Air pressure	1002 mbar
Verdict	Pass	Relative humidity	31 %

### 8.2.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	≥ 1 % of emission BW
Video bandwidth	≥3 × RBW
Frequency span	10 MHz for 5 MHz channel; 20 MHz for 10 MHz channel and 40 MHz for 20 MHz channel
Detector mode	Peak
Trace mode	Max Hold

### 8.2.4 Test data

**Table 8.2-1:** 26 dB and 99 % occupied bandwidth results for 5 MHz channel

Frequency, MHz	26 dB bandwidth, MHz	99 % bandwidth, MHz
5155.0	4.55	4.10
5200.0	4.42	4.06
5247.5	4.57	4.10

**Table 8.2-2:** 26 dB and 99 % occupied bandwidth results for 10 MHz channel

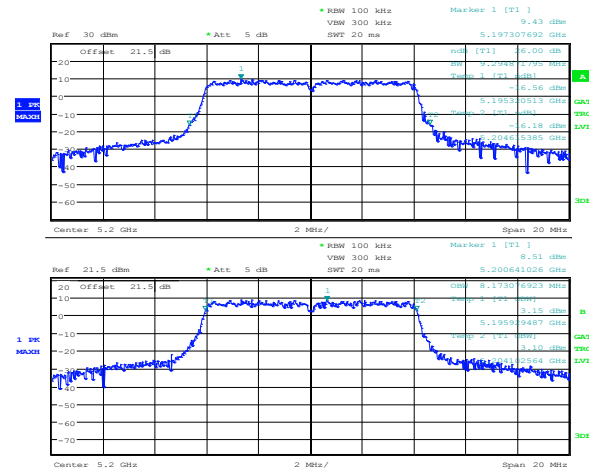
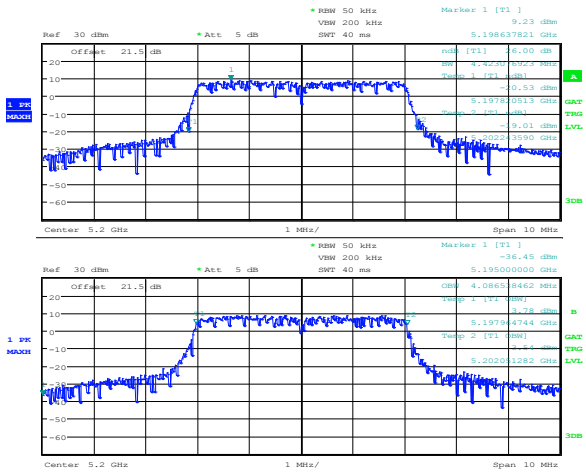
Frequency, MHz	26 dB bandwidth, MHz	99 % bandwidth, MHz
5160.0	9.26	8.17
5200.0	9.30	8.17
5245.0	9.30	8.17

**Table 8.2-3:** 26 dB and 99 % occupied bandwidth results for 20 MHz channel

Frequency, MHz	26 dB bandwidth, MHz	99 % bandwidth, MHz
5170.0	18.53	16.41
5200.0	18.60	16.41
5240.0	18.59	16.41



8.2.4 Test data, continued

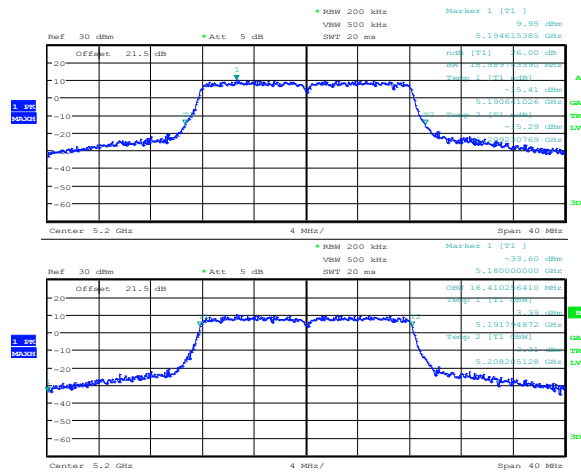


Date: 11.AUG.2014 10:41:30

Date: 11.AUG.2014 10:35:47

Figure 8.2-1: 26 dB and 99 % occupied bandwidth on 5 MHz channel, sample plot

Figure 8.2-2: 26 dB and 99 % occupied bandwidth on 10 MHz channel, sample plot



Date: 11.AUG.2014 10:39:15

Figure 8.2-3: 26 dB and 99 % occupied bandwidth on 20 MHz channel, sample plot

## 8.3 FCC 15.407(a)(1) 5.15–5.25 GHz band output power, EIRP and spectral density limits

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### 8.3.1 Definitions and limits

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- (i) For an outdoor access point operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).
- (ii) For an indoor access point operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
- (iii) For fixed point-to-point access points operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.
- (iv) For mobile and portable client devices in the 5.15–5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
- (4) The maximum conducted output power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage.
- (5) The maximum power spectral density is measured as a 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 in the 5.15–5.25 GHz, 5.25–5.35 GHz, and the 5.47–5.725 GHz bands are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full reference bandwidth.

### 8.3.2 Test summary

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Test date	August 15, 2014	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	32 %

### 8.3.3 Observations, settings and special notes

The output power test was performed according to 789033 D02 General UNII Test Procedures New Rules, section E) 2) b) Method SA-1: trace averaging with the EUT transmitting at full power throughout each sweep. The PPSD test was performed according to 789033 D01 General UNII Test Procedures New Rules, section F. As per manufacturer declaration, radio module RDL-3000-RM, FCC ID: QC8-RDL3000RM, when operates in MIMO A (STBC/STC) mode or MIMO B (spatial multiplexing) modes, the only modes in which it transmits from both antennas, the transmitter output signals are completely uncorrelated.

Spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	≥3 MHz
Frequency span	≥99% of the occupied bandwidth
Detector mode	RMS with video triggering on full power pulses
Trace mode	Power Averaging over 100 sweeps

Combined average output power was calculated as follows:  $P_{combined} = 10 \times \log_{10} \left( (10^{P_{cho}/10}) + (10^{P_{ch1}/10}) \right)$

EIRP was calculated as follows:  $EIRP = P_{combined} + \text{antenna gain}$

Combined PPSD was calculated as follows:  $PPSD_{combined} = 10 \times \log_{10} \left( (10^{PSD_{cho}/10}) + (10^{PSD_{ch1}/10}) \right)$

**Table 8.3-1: Elevation vs gain for L-COM HG5158DP-10U, 10 dBi antenna**

Angle, deg	Antenna gain, dBi
<30	+10
>30	-15

Note: cable loss is 1 dB

Output power limit for 10 dBi antenna was calculated as follows:  $30 \text{ dBm} - (10 \text{ dBi} - 1 \text{ dB} - 6 \text{ dBi}) = 27.00 \text{ dBm}$

PPSD limit was calculated as follows:  $17 - (10 - 1 - 6) = 14.00 \text{ dBm/MHz}$

**Table 8.3-2: Elevation vs gain for Redline 30-00328-50, 19 dBi antenna**

Angle, deg	Antenna gain, dBi
<30	+19
>30	-10

Note: no cable loss

Output power limit for 19 dBi antenna was calculated as follows:  $30 \text{ dBm} - (19 \text{ dBi} - 6 \text{ dBi}) = 17.00 \text{ dBm}$

PPSD limit was calculated as follows:  $17 - (19 - 6) = 4.00 \text{ dBm/MHz}$

**Table 8.3-3: Elevation vs gain for Redline APD-DB-05-2ft-RAD-01, 29 dBi antenna**

Angle, deg	Antenna gain, dBi
<30	+29
>30	-28

Note: cable loss is 1.5 dB

Output power limit for 29 dBi antenna was calculated as follows:  $30 \text{ dBm} - (29 \text{ dBi} - 1.5 \text{ dB} - 6 \text{ dBi}) = 8.50 \text{ dBm}$

PPSD limit was calculated as follows:  $17 - (29 - 1.5 - 6) = -4.50 \text{ dBm/MHz}$

8.3.4 Test data

**Table 8.3-4:** Output power and EIRP measurements results with 10 dBi antenna, 5 MHz channel

Modulation (Rate)	Frequency, MHz	P <sub>ch0r</sub> , dBm	P <sub>ch1r</sub> , dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain*, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
QPSK (1.5 Mbps)	5155.0	10.31	10.10	13.22	27.00	13.78	9.00	22.22	36.00	13.78
	5200.0	15.95	16.43	19.21	27.00	7.79	9.00	28.21	36.00	7.79
	5247.5	15.94	16.12	19.04	27.00	7.96	9.00	28.04	36.00	7.96
64-QAM (13.5 Mbps)	5155.0	10.31	9.94	13.14	27.00	13.86	9.00	22.14	36.00	13.86
	5200.0	15.94	16.45	19.21	27.00	7.79	9.00	28.21	36.00	7.79
	5247.5	15.97	16.11	19.05	27.00	7.95	9.00	28.05	36.00	7.95

Note: including 1 dB cable loss

**Table 8.3-5:** Output power and EIRP measurements results with 19 dBi antenna, 5 MHz channel

Modulation (Rate)	Frequency, MHz	P <sub>ch0r</sub> , dBm	P <sub>ch1r</sub> , dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
QPSK (1.5 Mbps)	5155.0	3.77	3.37	6.58	17.00	10.42	19.00	25.58	36.00	10.42
	5200.0	6.11	6.46	9.30	17.00	7.70	19.00	28.30	36.00	7.70
	5247.5	6.06	6.20	9.14	17.00	7.86	19.00	28.14	36.00	7.86
64-QAM (13.5 Mbps)	5155.0	3.76	3.37	6.58	17.00	10.42	19.00	25.58	36.00	10.42
	5200.0	6.12	6.45	9.30	17.00	7.70	19.00	28.30	36.00	7.70
	5247.5	6.06	6.16	9.12	17.00	7.88	19.00	28.12	36.00	7.88

**Table 8.3-6:** Output power and EIRP measurements results with 29 dBi antenna, 5 MHz channel

Modulation (Rate)	Frequency, MHz	P <sub>ch0r</sub> , dBm	P <sub>ch1r</sub> , dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain*, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
QPSK (1.5 Mbps)	5155.0	-12.32	-13.45	-9.84	8.50	18.34	27.50	17.66	36.00	18.34
	5200.0	-2.38	-3.03	0.32	8.50	8.18	27.50	27.82	36.00	8.18
	5247.5	-2.50	-3.15	0.20	8.50	8.30	27.50	27.70	36.00	8.30
64-QAM (13.5 Mbps)	5155.0	-12.26	-13.50	-9.83	8.50	18.33	27.50	17.67	36.00	18.33
	5200.0	-2.34	-3.16	0.28	8.50	8.22	27.50	27.78	36.00	8.22
	5247.5	-2.53	-4.12	-0.24	8.50	8.74	27.50	27.26	36.00	8.74

Note: including 1.5 dB cable loss

**Table 8.3-7:** Output power and EIRP measurements results with 10 dBi antenna, 10 MHz channel

Modulation (Rate)	Frequency, MHz	P <sub>ch0r</sub> , dBm	P <sub>ch1r</sub> , dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain*, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
QPSK (3 Mbps)	5160.0	12.71	13.51	16.14	27.00	10.86	9.00	25.14	36.00	10.86
	5200.0	19.26	18.50	21.91	27.00	5.09	9.00	30.91	36.00	5.09
	5245.0	19.10	19.06	22.09	27.00	4.91	9.00	31.09	36.00	4.91
64-QAM (27 Mbps)	5160.0	12.71	13.51	16.14	27.00	10.86	9.00	25.14	36.00	10.86
	5200.0	19.38	18.52	21.98	27.00	5.02	9.00	30.98	36.00	5.02
	5245.0	19.08	19.03	22.07	27.00	4.93	9.00	31.07	36.00	4.93

Note: including 1 dB cable loss

8.3.4 Test data, continued

**Table 8.3-8:** Output power and EIRP measurements results with 19 dBi antenna, 10 MHz channel

Modulation (Rate)	Frequency, MHz	P <sub>ch0</sub> , dBm	P <sub>ch1</sub> , dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
QPSK (3 Mbps)	5160.0	8.68	8.31	11.51	17.00	5.49	19.00	30.51	36.00	5.49
	5200.0	9.08	8.53	11.82	17.00	5.18	19.00	30.82	36.00	5.18
	5245.0	9.16	8.96	12.07	17.00	4.93	19.00	31.07	36.00	4.93
64-QAM (27 Mbps)	5160.0	8.70	8.30	11.51	17.00	5.49	19.00	30.51	36.00	5.49
	5200.0	9.18	8.48	11.85	17.00	5.15	19.00	30.85	36.00	5.15
	5245.0	9.10	8.96	12.04	17.00	4.96	19.00	31.04	36.00	4.96

**Table 8.3-9:** Output power and EIRP measurements results with 29 dBi antenna, 10 MHz channel

Modulation (Rate)	Frequency, MHz	P <sub>ch0</sub> , dBm	P <sub>ch1</sub> , dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain*, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
QPSK (3 Mbps)	5160.0	-7.87	-8.43	-5.13	8.50	13.63	27.50	22.37	36.00	13.63
	5200.0	0.69	0.27	3.50	8.50	5.00	27.50	31.00	36.00	5.00
	5245.0	0.48	0.20	3.35	8.50	5.15	27.50	30.85	36.00	5.15
64-QAM (27 Mbps)	5160.0	-7.87	-8.41	-5.12	8.50	13.62	27.50	22.38	36.00	13.62
	5200.0	0.67	0.28	3.49	8.50	5.01	27.50	30.99	36.00	5.01
	5245.0	0.44	0.32	3.39	8.50	5.11	27.50	30.89	36.00	5.11

Note: including 1.5 dB cable loss

**Table 8.3-10:** Output power and EIRP measurements results with 10 dBi antenna, 20 MHz channel

Modulation (Rate)	Frequency, MHz	P <sub>ch0</sub> , dBm	P <sub>ch1</sub> , dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain*, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
QPSK (6 Mbps)	5170.0	14.10	14.77	17.46	27.00	9.54	9.00	26.46	36.00	9.54
	5200.0	21.85	21.66	24.77	27.00	2.23	9.00	33.77	36.00	2.23
	5240.0	21.92	21.34	24.65	27.00	2.35	9.00	33.65	36.00	2.35
64-QAM (54 Mbps)	5170.0	14.13	15.09	17.65	27.00	9.35	9.00	26.65	36.00	9.35
	5200.0	21.95	21.55	24.76	27.00	2.24	9.00	33.76	36.00	2.24
	5240.0	21.88	21.49	24.70	27.00	2.30	9.00	33.70	36.00	2.30

Note: including 1 dB cable loss

**Table 8.3-11:** Output power and EIRP measurements results with 19 dBi antenna, 20 MHz channel

Modulation (Rate)	Frequency, MHz	P <sub>ch0</sub> , dBm	P <sub>ch1</sub> , dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
QPSK (6 Mbps)	5170.0	11.90	11.29	14.62	17.00	2.38	19.00	33.62	36.00	2.38
	5200.0	11.40	11.78	14.60	17.00	2.40	19.00	33.60	36.00	2.40
	5240.0	12.14	11.57	14.87	17.00	2.13	19.00	33.87	36.00	2.13
64-QAM (54 Mbps)	5170.0	11.93	11.29	14.63	17.00	2.37	19.00	33.63	36.00	2.37
	5200.0	11.30	11.86	14.60	17.00	2.40	19.00	33.60	36.00	2.40
	5240.0	12.20	11.48	14.87	17.00	2.13	19.00	33.87	36.00	2.13



8.3.4 Test data, continued

Table 8.3-12: Output power and EIRP measurements results with 29 dBi antenna, 20 MHz channel

Modulation (Rate)	Frequency, MHz	P <sub>ch0</sub> , dBm	P <sub>ch1</sub> , dBm	Aggregated power, dBm	Power limit, dBm	Power margin, dBm	Antenna gain*, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
QPSK (6 Mbps)	5170.0	-6.09	-6.14	-3.10	8.50	11.60	27.50	24.40	36.00	11.60
	5200.0	2.93	2.39	5.68	8.50	2.82	27.50	33.18	36.00	2.82
	5240.0	3.71	3.24	6.49	8.50	2.01	27.50	33.99	36.00	2.01
64-QAM (54 Mbps)	5170.0	-6.14	-6.14	-3.13	8.50	11.63	27.50	24.37	36.00	11.63
	5200.0	3.05	2.38	5.74	8.50	2.76	27.50	33.24	36.00	2.76
	5240.0	3.67	3.21	6.46	8.50	2.04	27.50	33.96	36.00	2.04

Note: including 1.5 dB cable loss

Table 8.3-13: PSD measurements results with 10 dBi antenna, 5 MHz channel

Modulation (Rate)	Frequency, MHz	PSD <sub>ch0</sub> , dBm/MHz	PSD <sub>ch1</sub> , dBm/MHz	Aggregated PSD, dBm/MHz	PSD limit, dBm/MHz	PSD margin, dB
QPSK (1.5 Mbps)	5155.0	5.26	5.20	8.24	14.00	5.76
	5200.0	10.65	11.10	13.89	14.00	0.11
	5247.5	10.70	10.96	13.84	14.00	0.16
64-QAM (13.5 Mbps)	5155.0	5.29	5.03	8.17	14.00	5.83
	5200.0	10.65	11.29	13.99	14.00	0.01
	5247.5	10.73	10.94	13.85	14.00	0.15

Table 8.3-14: PSD measurements results with 19 dBi antenna, 5 MHz channel

Modulation (Rate)	Frequency, MHz	PSD <sub>ch0</sub> , dBm/MHz	PSD <sub>ch1</sub> , dBm/MHz	Aggregated PSD, dBm/MHz	PSD limit, dBm/MHz	PSD margin, dB
QPSK (1.5 Mbps)	5155.0	-1.28	-1.62	1.56	4.00	2.44
	5200.0	0.80	1.09	3.96	4.00	0.04
	5247.5	0.80	0.93	3.88	4.00	0.12
64-QAM (13.5 Mbps)	5155.0	-1.29	-1.62	1.56	4.00	2.44
	5200.0	0.81	1.13	3.98	4.00	0.02
	5247.5	0.72	0.95	3.85	4.00	0.15

Table 8.3-15: PSD measurements results with 29 dBi antenna, 5 MHz channel

Modulation (Rate)	Frequency, MHz	PSD <sub>ch0</sub> , dBm/MHz	PSD <sub>ch1</sub> , dBm/MHz	Aggregated PSD, dBm/MHz	PSD limit, dBm/MHz	PSD margin, dB
QPSK (1.5 Mbps)	5155.0	-17.33	-18.55	-14.89	-4.50	10.39
	5200.0	-7.31	-7.94	-4.60	-4.50	0.10
	5247.5	-7.57	-8.21	-4.87	-4.50	0.37
64-QAM (13.5 Mbps)	5155.0	-17.27	-18.54	-14.85	-4.50	10.35
	5200.0	-7.27	-7.92	-4.57	-4.50	0.07
	5247.5	-7.55	-8.22	-4.86	-4.50	0.36

Table 8.3-16: PSD measurements results with 10 dBi antenna, 10 MHz channel

Modulation (Rate)	Frequency, MHz	PSD <sub>ch0</sub> , dBm/MHz	PSD <sub>ch1</sub> , dBm/MHz	Aggregated PSD, dBm/MHz	PSD limit, dBm/MHz	PSD margin, dB
QPSK (3 Mbps)	5160.0	4.67	5.56	8.15	14.00	5.85
	5200.0	11.22	10.39	13.84	14.00	0.16
	5245.0	10.90	10.85	13.89	14.00	0.11
64-QAM (27 Mbps)	5160.0	4.65	5.58	8.15	14.00	5.85
	5200.0	11.38	10.44	13.95	14.00	0.05
	5245.0	10.89	10.83	13.87	14.00	0.13

8.3.4 Test data, continued

Table 8.3-17: PSD measurements results with 19 dBi antenna, 10 MHz channel

Modulation (Rate)	Frequency, MHz	PSD <sub>ch0</sub> , dBm/MHz	PSD <sub>ch1</sub> , dBm/MHz	Aggregated PSD, dBm/MHz	PSD limit, dBm/MHz	PSD margin, dB
QPSK (3 Mbps)	5160.0	0.62	0.36	3.50	4.00	0.50
	5200.0	1.03	0.39	3.73	4.00	0.27
	5245.0	0.95	0.76	3.87	4.00	0.13
64-QAM (27 Mbps)	5160.0	0.67	0.35	3.52	4.00	0.48
	5200.0	1.08	0.35	3.74	4.00	0.26
	5245.0	0.79	0.76	3.79	4.00	0.21

Table 8.3-18: PSD measurements results with 29 dBi antenna, 10 MHz channel

Modulation (Rate)	Frequency, MHz	PSD <sub>ch0</sub> , dBm/MHz	PSD <sub>ch1</sub> , dBm/MHz	Aggregated PSD, dBm/MHz	PSD limit, dBm/MHz	PSD margin, dB
QPSK (3 Mbps)	5160.0	-14.77	-16.43	-12.51	-4.50	8.01
	5200.0	-7.32	-7.72	-4.51	-4.50	0.01
	5245.0	-7.60	-7.89	-4.73	-4.50	0.23
64-QAM (27 Mbps)	5160.0	-14.82	-16.39	-12.52	-4.50	8.02
	5200.0	-7.35	-7.69	-4.51	-4.50	0.01
	5245.0	-7.75	-7.83	-4.78	-4.50	0.28

Table 8.3-19: PSD measurements results with 10 dBi antenna, 20 MHz channel

Modulation (Rate)	Frequency, MHz	PSD <sub>ch0</sub> , dBm/MHz	PSD <sub>ch1</sub> , dBm/MHz	Aggregated PSD, dBm/MHz	PSD limit, dBm/MHz	PSD margin, dB
QPSK (6 Mbps)	5170.0	3.53	4.23	6.90	14.00	7.10
	5200.0	10.94	10.74	13.85	14.00	0.15
	5240.0	11.10	10.46	13.80	14.00	0.20
64-QAM (54 Mbps)	5170.0	3.55	4.65	7.15	14.00	6.85
	5200.0	10.99	10.66	13.84	14.00	0.16
	5240.0	11.06	10.77	13.93	14.00	0.07

Table 8.3-20: PSD measurements results with 19 dBi antenna, 10 MHz channel

Modulation (Rate)	Frequency, MHz	PSD <sub>ch0</sub> , dBm/MHz	PSD <sub>ch1</sub> , dBm/MHz	Aggregated PSD, dBm/MHz	PSD limit, dBm/MHz	PSD margin, dB
QPSK (6 Mbps)	5170.0	1.29	0.31	3.84	4.00	0.16
	5200.0	0.44	0.82	3.64	4.00	0.36
	5240.0	1.26	0.67	3.99	4.00	0.01
64-QAM (54 Mbps)	5170.0	1.31	0.30	3.84	4.00	0.16
	5200.0	0.36	0.97	3.69	4.00	0.31
	5240.0	1.34	0.59	3.99	4.00	0.01

Table 8.3-21: PSD measurements results with 29 dBi antenna, 20 MHz channel

Modulation (Rate)	Frequency, MHz	PSD <sub>ch0</sub> , dBm/MHz	PSD <sub>ch1</sub> , dBm/MHz	Aggregated PSD, dBm/MHz	PSD limit, dBm/MHz	PSD margin, dB
QPSK (6 Mbps)	5170.0	-16.79	-16.75	-13.76	-4.50	9.26
	5200.0	-7.72	-8.21	-4.95	-4.50	0.45
	5240.0	-7.35	-7.76	-4.54	-4.50	0.04
64-QAM (54 Mbps)	5170.0	-16.80	-16.75	-13.76	-4.50	9.26
	5200.0	-7.52	-8.24	-4.85	-4.50	0.35
	5240.0	-7.30	-7.77	-4.52	-4.50	0.02

8.3.4 Test data, continued

Table 8.3-22: EIRP calculation results with 10 dBi antenna for elevation angles above 30°

Channel bandwidth, MHz	Maximum aggregated power, dBm	Antenna gain*, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
5	19.21	-16.00	3.21	21.00	17.79
10	22.09	-16.00	6.09	21.00	14.91
20	24.77	-16.00	8.77	21.00	12.23

Note: including cable loss of 1 dB

Table 8.3-23: EIRP calculation results with 19 dBi antenna for elevation angles above 30°

Channel bandwidth, MHz	Maximum aggregated power, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
5	9.30	-10.00	-0.70	21.00	21.70
10	12.07	-10.00	2.07	21.00	18.93
20	14.87	-10.00	4.87	21.00	16.13

Table 8.3-24: EIRP calculation results with 29 dBi antenna for elevation angles above 30°

Channel bandwidth, MHz	Maximum aggregated power, dBm	Antenna gain*, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
5	0.32	-29.50	-29.18	21.00	50.18
10	3.50	-29.50	-26.00	21.00	47.00
20	6.49	-29.50	-23.01	21.00	44.01

Note: including cable loss of 1.5 dB

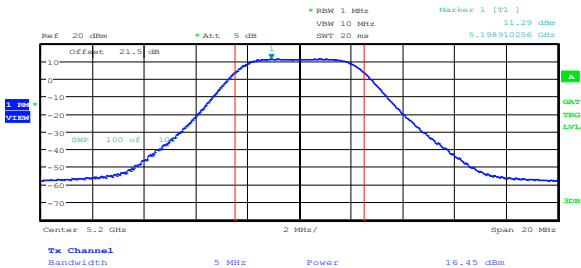


Figure 8.3-1: Power and PSD on 5 MHz channel, sample plot

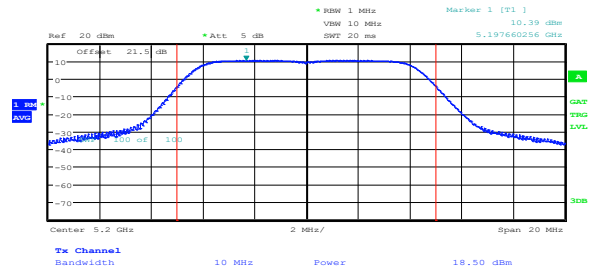


Figure 8.3-2: Power and PSD on 10 MHz channel, sample plot

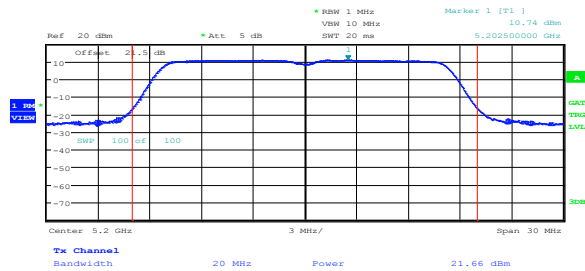


Figure 8.3-3: Power and PSD on 20 MHz channel, sample plot



## 8.4 FCC 15.407(b) Spurious (out-of-band) emissions

### 8.4.1 Definitions and limits

- (1) For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz.  
 (5) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.  
 (6) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in § 15.209.  
 (7) The provisions of § 15.205 apply to intentional radiators operating under this section.  
 (8) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency block edges as the design of the equipment permits.

**Table 8.4-1: FCC §15.209 – Radiated emission limits**

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/m	
0.009–0.490*	2400/F	67.6 – 20 × log <sub>10</sub> (F)	300
0.490–1.705*	24000/F	87.6 – 20 × log <sub>10</sub> (F)	30
1.705–30.0*	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.

For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

### 8.4.1 Definitions and limits, continued

**Table 8.4-2: FCC restricted frequency bands**

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

### 8.4.2 Test summary

Test date	August 15, 2014	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	32 %

### 8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 40 GHz.

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 within 10 dB below the limit.

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

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold

Average limit line was calculated as follows:

For 10 dBi antenna:  $54 \text{ dB}\mu\text{V}/\text{m} - 95.23 \text{ dB} - 10 \times \log_{10}(2) \text{ dB} - (10 \text{ dBi} - 1 \text{ dB}) - 4.7 \text{ dB} = -57.93 \text{ dBm}$

For 19 dBi antenna:  $54 \text{ dB}\mu\text{V}/\text{m} - 95.23 \text{ dB} - 10 \times \log_{10}(2) \text{ dB} - 19 \text{ dBi} - 4.7 \text{ dB} = -67.93 \text{ dBm}$

For 29 dBi antenna:  $54 \text{ dB}\mu\text{V}/\text{m} - 95.23 \text{ dB} - 10 \times \log_{10}(2) \text{ dB} - (29 \text{ dBi} - 1.5 \text{ dB}) - 4.7 \text{ dB} = -76.43 \text{ dBm}$

Spectrum analyser for peak measurements within restricted bands above 1 GHz:

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

Spectrum analyser for average conducted measurements within restricted bands above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	10 MHz
Detector mode	RMS
Trace mode	Power average
Number of averaging traces	$100 \times (1 / \text{duty cycle})$ : 370 (5 MHz), 385 (10 MHz) and 455 (20 MHz)

If all peak measurements satisfy the average limit, then average measurements are not required. Average limit line was calculated as follows:

For 10 dBi antenna:  $54 \text{ dB}\mu\text{V}/\text{m} - 95.23 \text{ dB} - 10 \times \log_{10}(2) \text{ dB} - (10 \text{ dBi} - 1 \text{ dB}) = -53.23 \text{ dBm}$

For 19 dBi antenna:  $54 \text{ dB}\mu\text{V}/\text{m} - 95.23 \text{ dB} - 10 \times \log_{10}(2) \text{ dB} - 19 \text{ dBi} = -63.23 \text{ dBm}$

For 29 dBi antenna:  $54 \text{ dB}\mu\text{V}/\text{m} - 95.23 \text{ dB} - 10 \times \log_{10}(2) \text{ dB} - (29 \text{ dBi} - 1.5 \text{ dB}) = -71.73 \text{ dBm}$

Peak limit is 20 dB higher than the average limit.

Spectrum analyser for peak conducted measurements outside restricted bands:

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

The limit line was calculated as follows:

For 10 dBi antenna:  $-27 \text{ dBm}/\text{MHz} - 10 \times \log_{10}(2) - (10 \text{ dBi} - 1 \text{ dB}) = -39.00 \text{ dBm}/\text{MHz}$

For 19 dBi antenna:  $-27 \text{ dBm}/\text{MHz} - 10 \times \log_{10}(2) - 19 \text{ dBi} = -49.00 \text{ dBm}/\text{MHz}$

For 29 dBi antenna:  $-27 \text{ dBm}/\text{MHz} - 10 \times \log_{10}(2) - (29 \text{ dBi} - 1.5 \text{ dB}) = -57.50 \text{ dBm}/\text{MHz}$

Note: an out-of-band emission that complies with both the peak and average limits of § 15.209 is not required to satisfy the  $-27 \text{ dBm}/\text{MHz}$  maximum emission limit.

8.4.4 Test data

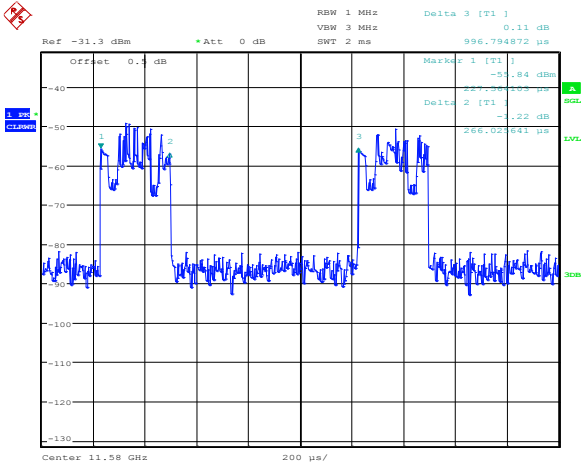


Figure 8.4-1: Duty cycle for 5 MHz channel

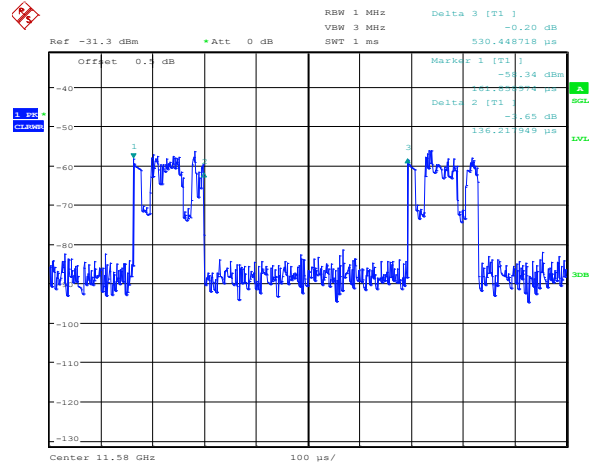


Figure 8.4-2: Duty cycle for 10 MHz channel

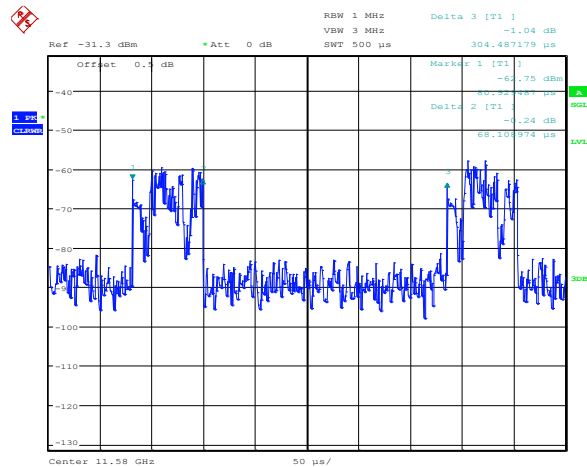


Figure 8.4-3: Duty cycle for 20 MHz channel

Duty cycle correction factor calculations:

For 5 MHz channel

$T_{XON}$  is 266.03 µs;  $T_{XPERIOD}$  is 996.80 µs; Duty cycle = 0.27; Correction Factor =  $10 \times \text{Log}_{10}(1 / 0.27) = 5.69$  dB

For 10 MHz channel

$T_{XON}$  is 136.20 µs;  $T_{XPERIOD}$  is 530.45 µs; Duty cycle = 0.26; Correction Factor =  $10 \times \text{Log}_{10}(1 / 0.26) = 5.85$  dB

For 20 MHz channel

$T_{XON}$  is 68.11 µs;  $T_{XPERIOD}$  is 304.49 µs; Duty cycle = 0.22; Correction Factor =  $10 \times \text{Log}_{10}(1 / 0.22) = 6.58$  dB



8.4.4 Test data, continued

Table 8.4-3: Lower band edge (5150 MHz) emissions average results

Antenna gain, dBi	Channel bandwidth, MHz	Chain	Band edge level, dBm/MHz	Duty cycle factor, dB	Corrected band edge level, dBm/MHz	Band edge limit, dBm/MHz	Margin, dB
10	5	0	-59.13	5.69	-53.44	-53.23	0.21
		1	-59.03	5.69	-53.34	-53.23	0.11
	10	0	-60.04	5.69	-54.35	-53.23	1.12
		1	-59.11	5.69	-53.42	-53.23	0.19
	20	0	-61.65	5.69	-55.96	-53.23	2.73
		1	-59.92	5.69	-54.23	-53.23	1.00
19	5	0	-69.50	5.85	-63.65	-63.23	0.42
		1	-69.59	5.85	-63.74	-63.23	0.51
	10	0	-69.47	5.85	-63.62	-63.23	0.39
		1	-69.44	5.85	-63.59	-63.23	0.36
	20	0	-69.82	5.85	-63.97	-63.23	0.74
		1	-69.16	5.85	-63.31	-63.23	0.08
29	5	0	-78.50	6.58	-71.92	-71.23	0.69
		1	-78.44	6.58	-71.86	-71.23	0.63
	10	0	-78.63	6.58	-72.05	-71.23	0.82
		1	-78.59	6.58	-72.01	-71.23	0.78
	20	0	-78.35	6.58	-71.77	-71.23	0.54
		1	-78.36	6.58	-71.78	-71.23	0.55

Table 8.4-4: Lower band edge (5150 MHz) emissions peak results

Antenna gain, dBi	Channel bandwidth, MHz	Chain	Band edge level, dBm/MHz	Band edge limit, dBm/MHz	Margin, dB
10	5	0	-45.16	-33.23	11.93
		1	-46.19	-33.23	12.96
	10	0	-48.97	-33.23	15.74
		1	-46.43	-33.23	13.20
	20	0	-47.59	-33.23	14.36
		1	-47.29	-33.23	14.06
19	5	0	-58.61	-43.23	15.38
		1	-58.54	-43.23	15.31
	10	0	-57.95	-43.23	14.72
		1	-57.88	-43.23	14.65
	20	0	-56.28	-43.23	13.05
		1	-57.53	-43.23	14.30
29	5	0	-66.34	-51.23	15.11
		1	-66.13	-51.23	14.90
	10	0	-66.41	-51.23	15.18
		1	-66.90	-51.23	15.67
	20	0	-66.12	-51.23	14.89
		1	-66.14	-51.23	14.91

8.4.4 Test data, continued

Table 8.4-5: Upper band edge (5350 MHz) emissions average results

Antenna gain, dBi	Channel bandwidth, MHz	Chain	Band edge level, dBm/MHz	Duty cycle factor, dB	Corrected band edge level, dBm/MHz	Band edge limit, dBm/MHz	Margin, dB
10	5	0	-70.32	5.69	-64.63	-53.23	11.40
		1	-70.14	5.69	-64.45	-53.23	11.22
	10	0	-68.89	5.69	-63.20	-53.23	9.97
		1	-69.68	5.69	-63.99	-53.23	10.76
	20	0	-77.55	5.69	-71.86	-53.23	18.63
		1	-77.73	5.69	-72.04	-53.23	18.81
19	5	0	-78.03	5.85	-72.18	-63.23	8.95
		1	-77.68	5.85	-71.83	-63.23	8.60
	10	0	-71.70	5.85	-65.85	-63.23	2.62
		1	-72.69	5.85	-66.84	-63.23	3.61
	20	0	-77.59	5.85	-71.74	-63.23	8.51
		1	-76.47	5.85	-70.62	-63.23	7.39
29	5	0	-77.85	6.58	-71.27	-71.23	0.04
		1	-78.22	6.58	-71.64	-71.23	0.41
	10	0	-77.98	6.58	-71.40	-71.23	0.17
		1	-78.47	6.58	-71.89	-71.23	0.66
	20	0	-78.37	6.58	-71.79	-71.23	0.56
		1	-78.81	6.58	-72.23	-71.23	1.00

Table 8.4-6: Upper band edge (5350 MHz) emissions peak results

Antenna gain, dBi	Channel bandwidth, MHz	Chain	Band edge level, dBm/MHz	Band edge limit, dBm/MHz	Margin, dB
10	5	0	-59.09	-33.23	25.86
		1	-59.19	-33.23	25.96
	10	0	-57.17	-33.23	23.94
		1	-58.58	-33.23	25.35
	20	0	-61.12	-33.23	27.89
		1	-61.67	-33.23	28.44
19	5	0	-61.50	-43.23	18.27
		1	-60.71	-43.23	17.48
	10	0	-59.47	-43.23	16.24
		1	-60.42	-43.23	17.19
	20	0	-60.50	-43.23	17.27
		1	-59.58	-43.23	16.35
29	5	0	-66.62	-51.23	15.39
		1	-67.27	-51.23	16.04
	10	0	-66.26	-51.23	15.03
		1	-67.37	-51.23	16.14
	20	0	-66.53	-51.23	15.30
		1	-67.40	-51.23	16.17

8.4.5 Test data, continued

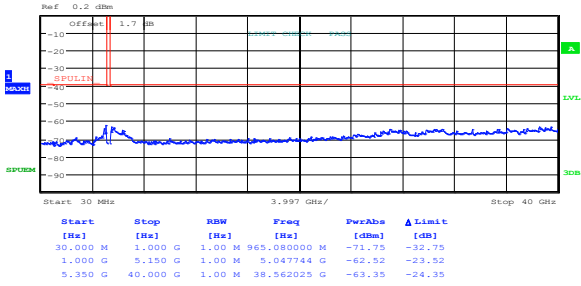


Figure 8.4-4: Conducted spurious emissions outside restricted bands, cho, 10 dBi antenna, 5 MHz channel, low

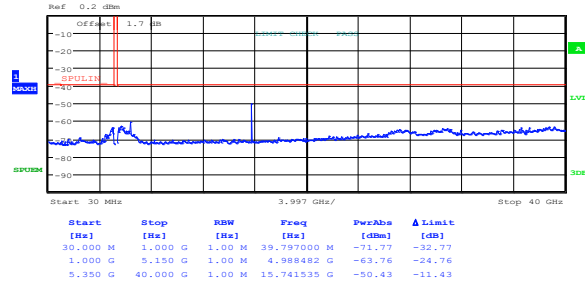


Figure 8.4-5: Conducted spurious emissions outside restricted bands, cho, 10 dBi antenna, 5 MHz channel, high

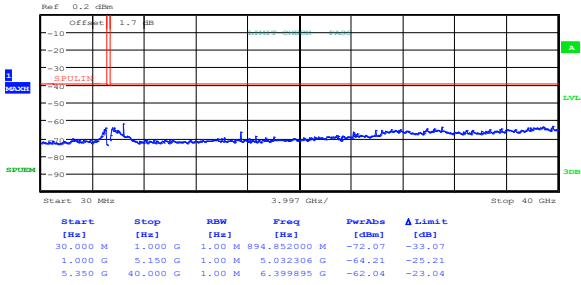


Figure 8.4-6: Conducted spurious emissions outside restricted bands, cho, 10 dBi antenna, 10 MHz channel, low

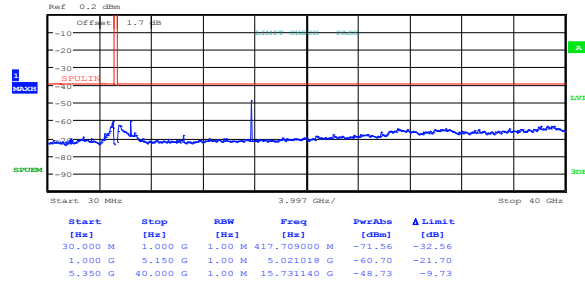


Figure 8.4-7: Conducted spurious emissions outside restricted bands, cho, 10 dBi antenna, 10 MHz channel, high

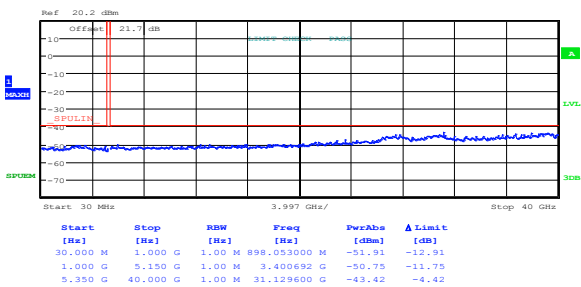


Figure 8.4-8: Conducted spurious emissions outside restricted bands, cho, 10 dBi antenna, 20 MHz channel, low

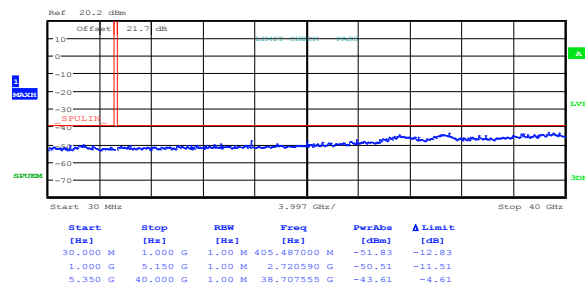


Figure 8.4-9: Conducted spurious emissions outside restricted bands, cho, 10 dBi antenna, 20 MHz channel, high

8.4.4 Test data, continued

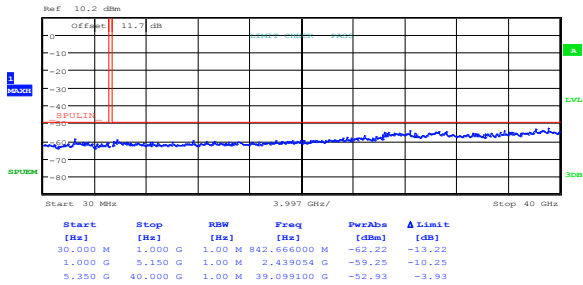


Figure 8.4-10: Conducted spurious emissions outside restricted bands, cho, 19 dBm antenna, 5 MHz channel, low

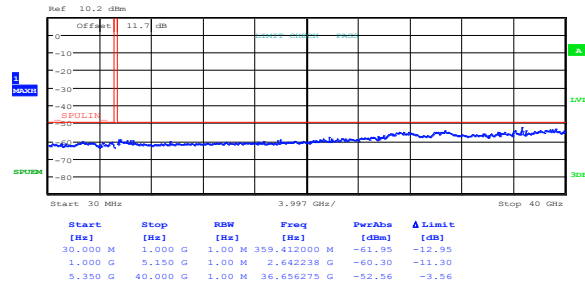


Figure 8.4-11: Conducted spurious emissions outside restricted bands, cho, 19 dBm antenna, 5 MHz channel, high

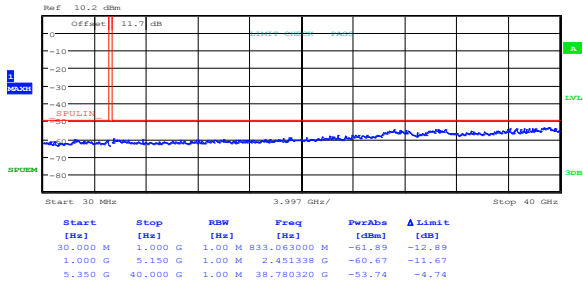


Figure 8.4-12: Conducted spurious emissions outside restricted bands, cho, 19 dBm antenna, 10 MHz channel, low

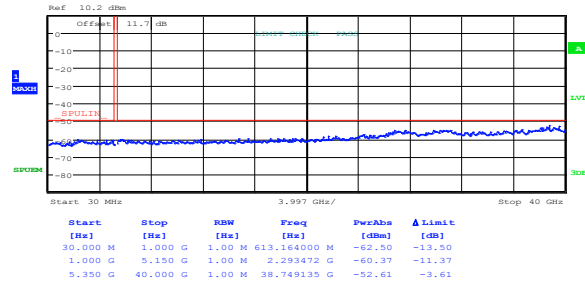


Figure 8.4-13: Conducted spurious emissions outside restricted bands, cho, 19 dBm antenna, 10 MHz channel, high

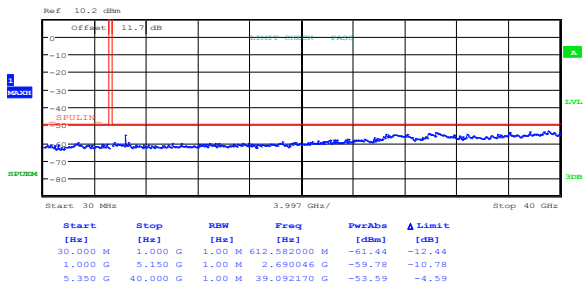


Figure 8.4-14: Conducted spurious emissions outside restricted bands, cho, 19 dBm antenna, 20 MHz channel, low

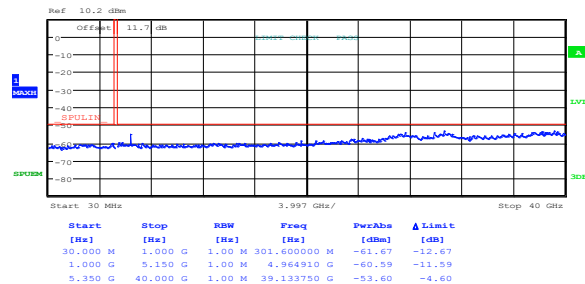


Figure 8.4-15: Conducted spurious emissions outside restricted bands, cho, 19 dBm antenna, 20 MHz channel, high

8.4.4 Test data, continued

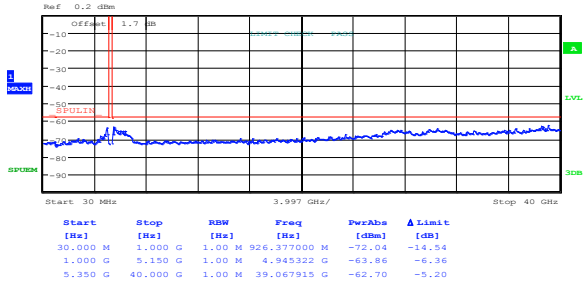


Figure 8.4-16: Conducted spurious emissions outside restricted bands, cho, 29 dBi antenna, 5 MHz channel, low

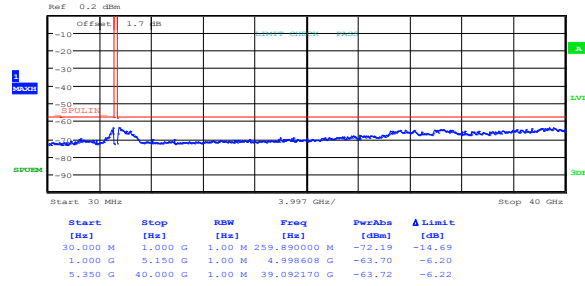


Figure 8.4-17: Conducted spurious emissions outside restricted bands, cho, 29 dBi antenna, 5 MHz channel, high

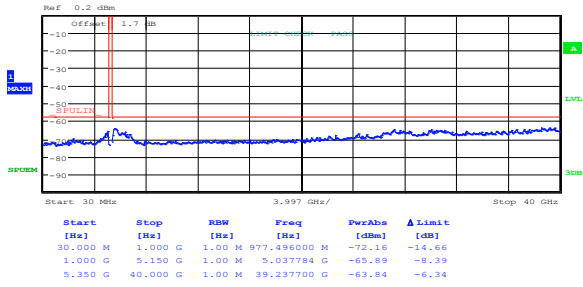


Figure 8.4-18: Conducted spurious emissions outside restricted bands, cho, 29 dBi antenna, 10 MHz channel, low

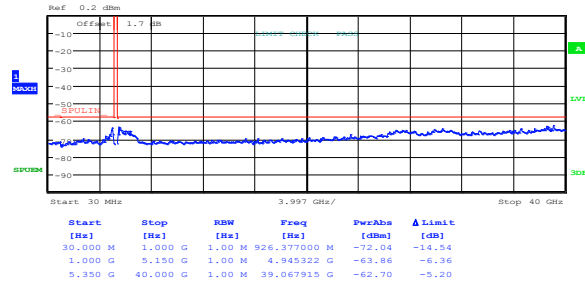


Figure 8.4-19: Conducted spurious emissions outside restricted bands, cho, 29 dBi antenna, 10 MHz channel, high

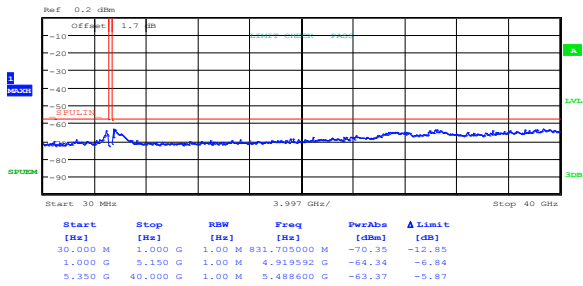


Figure 8.4-20: Conducted spurious emissions outside restricted bands, cho, 29 dBi antenna, 20 MHz channel, low

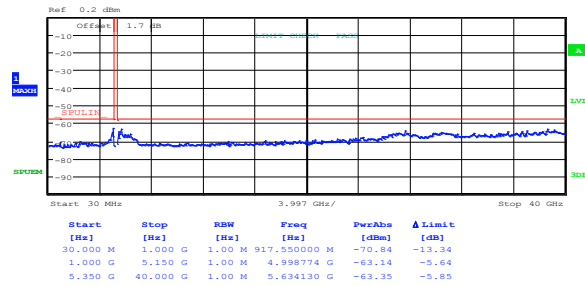


Figure 8.4-21: Conducted spurious emissions outside restricted bands, cho, 29 dBi antenna, 20 MHz channel, high



8.4.4 Test data, continued

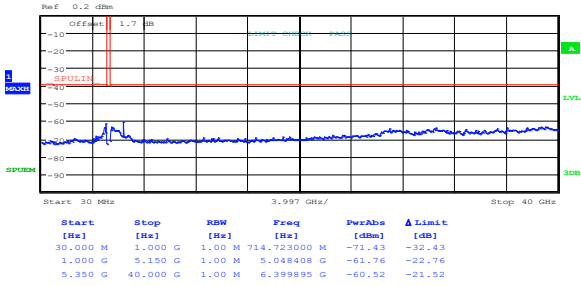


Figure 8.4-22: Conducted spurious emissions outside restricted bands, ch1, 10 dBi antenna, 5 MHz channel, low

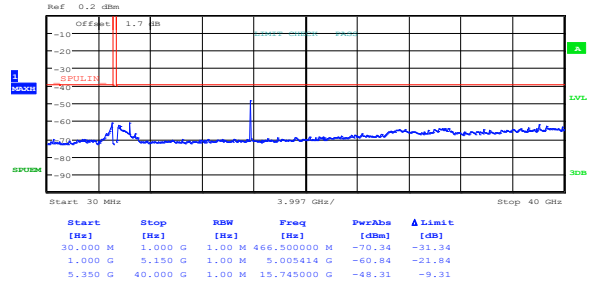


Figure 8.4-23: Conducted spurious emissions outside restricted bands, ch1, 10 dBi antenna, 5 MHz channel, high

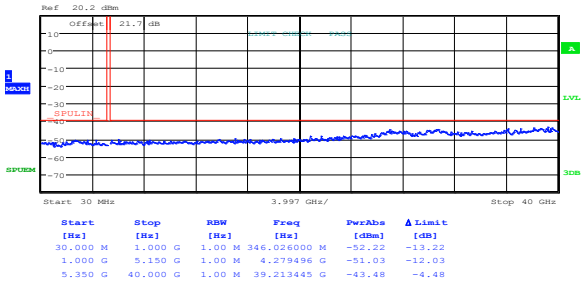


Figure 8.4-24: Conducted spurious emissions outside restricted bands, ch1, 10 dBi antenna, 10 MHz channel, low

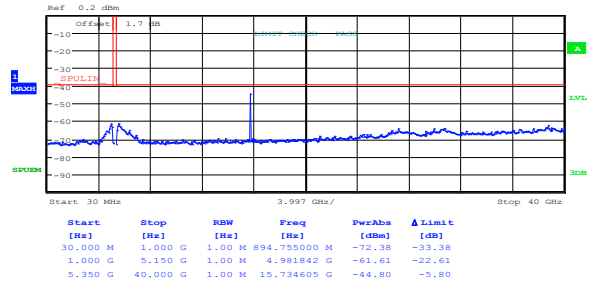


Figure 8.4-25: Conducted spurious emissions outside restricted bands, ch1, 10 dBi antenna, 10 MHz channel, high

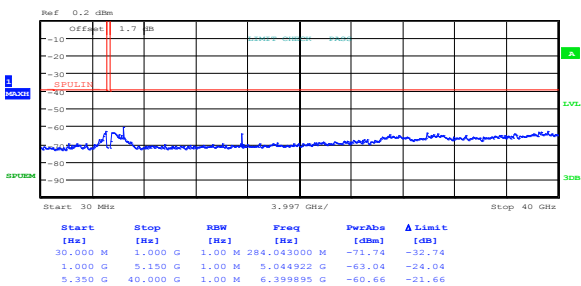


Figure 8.4-26: Conducted spurious emissions outside restricted bands, ch1, 10 dBi antenna, 20 MHz channel, low

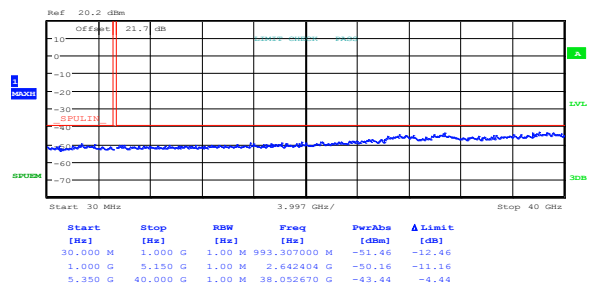


Figure 8.4-27: Conducted spurious emissions outside restricted bands, ch1, 10 dBi antenna, 20 MHz channel, high

8.4.4 Test data, continued

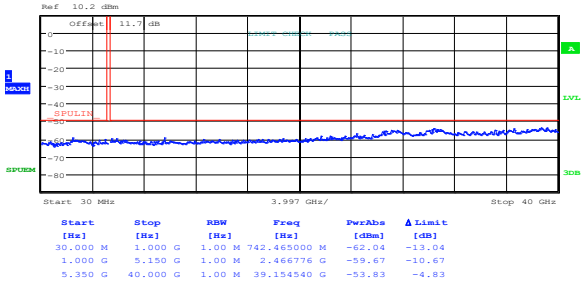


Figure 8.4-28: Conducted spurious emissions outside restricted bands, ch1, 19 dBi antenna, 5 MHz channel, low

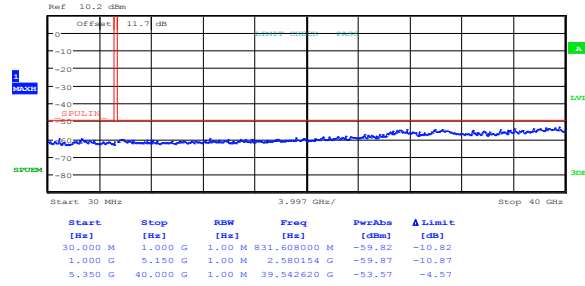


Figure 8.4-29: Conducted spurious emissions outside restricted bands, ch1, 19 dBi antenna, 5 MHz channel, high

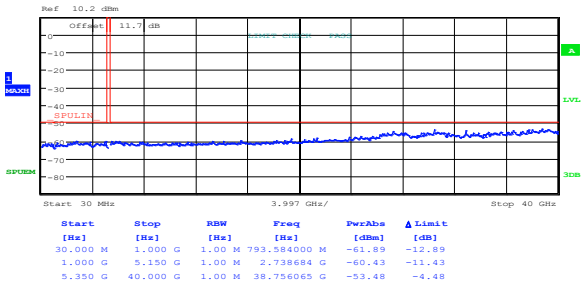


Figure 8.4-30: Conducted spurious emissions outside restricted bands, ch1, 19 dBi antenna, 10 MHz channel, low

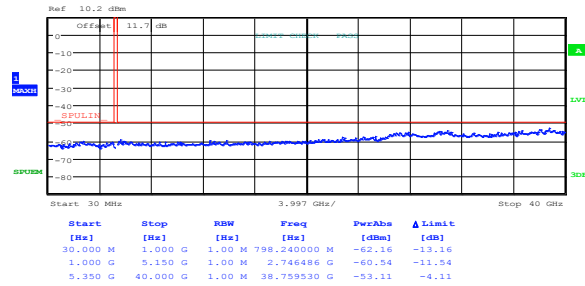


Figure 8.4-31: Conducted spurious emissions outside restricted bands, ch1, 19 dBi antenna, 10 MHz channel, high

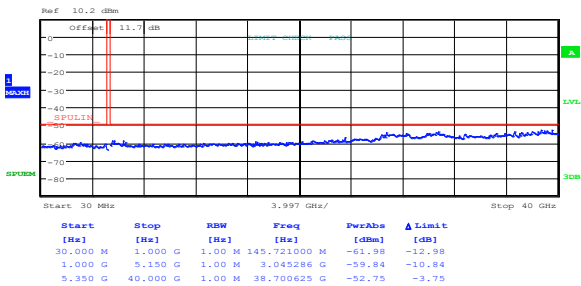


Figure 8.4-32: Conducted spurious emissions outside restricted bands, ch1, 19 dBi antenna, 20 MHz channel, low

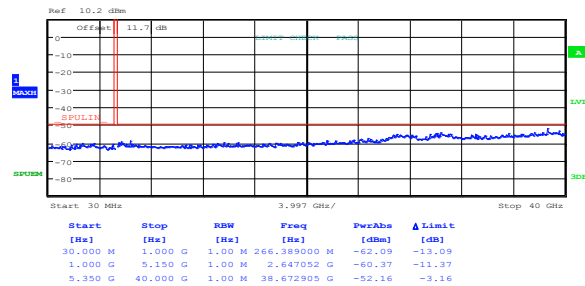


Figure 8.4-33: Conducted spurious emissions outside restricted bands, ch1, 19 dBi antenna, 20 MHz channel, high

8.4.4 Test data, continued

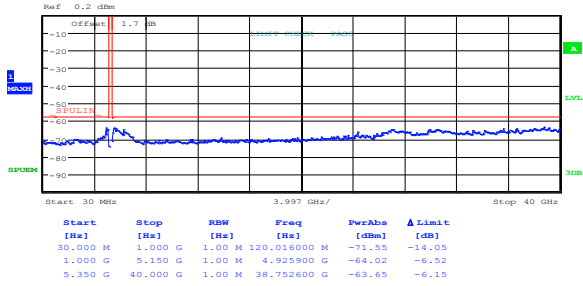


Figure 8.4-34: Conducted spurious emissions outside restricted bands, ch1, 29 dBi antenna, 5 MHz channel, low

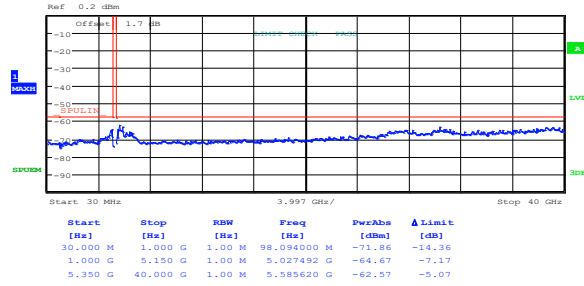


Figure 8.4-35: Conducted spurious emissions outside restricted bands, ch1, 29 dBi antenna, 5 MHz channel, high

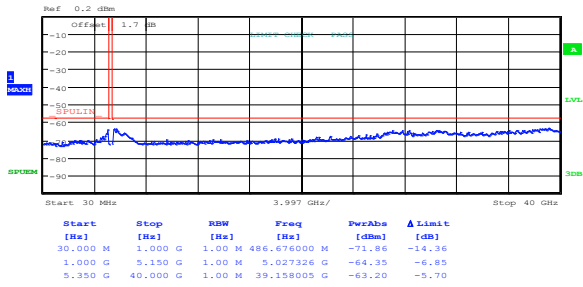


Figure 8.4-36: Conducted spurious emissions outside restricted bands, ch1, 29 dBi antenna, 10 MHz channel, low

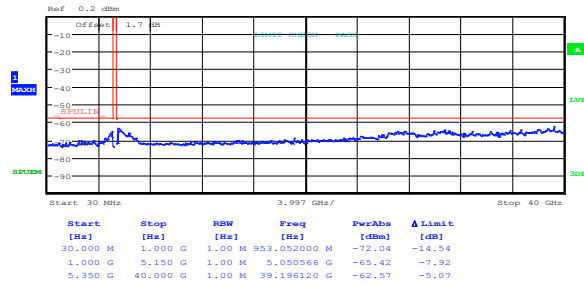


Figure 8.4-37: Conducted spurious emissions outside restricted bands, ch1, 29 dBi antenna, 10 MHz channel, high

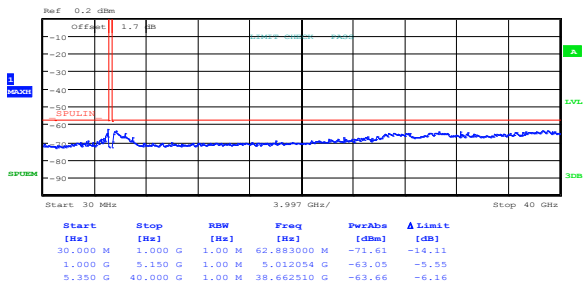


Figure 8.4-38: Conducted spurious emissions outside restricted bands, ch1, 29 dBi antenna, 20 MHz channel, low

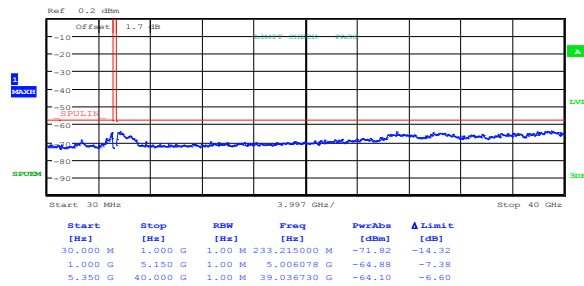


Figure 8.4-39: Conducted spurious emissions outside restricted bands, ch1, 29 dBi antenna, 20 MHz channel, high

8.4.5 Test data, continued

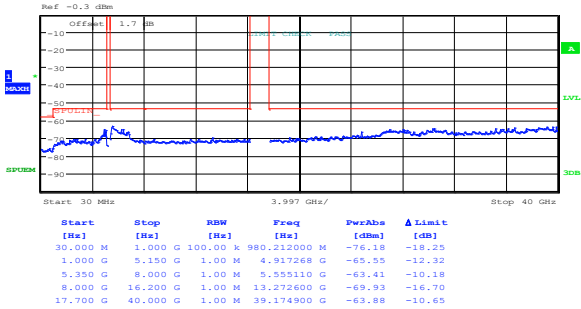


Figure 8.4-40: Conducted spurious emissions within restricted bands, cho, 10 dBi antenna, 5 MHz channel, low

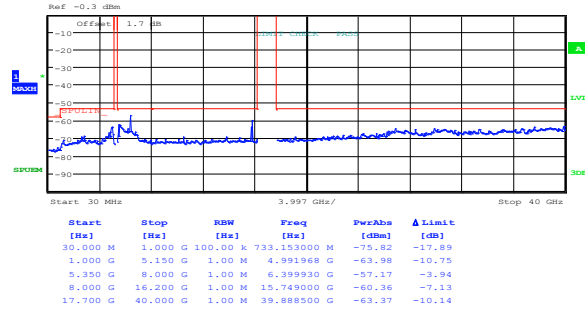


Figure 8.4-41: Conducted spurious emissions within restricted bands, cho, 10 dBi antenna, 5 MHz channel, high

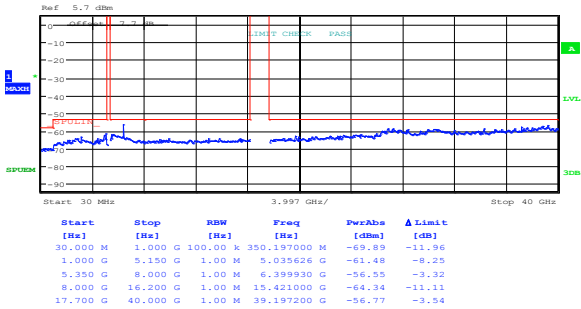


Figure 8.4-42: Conducted spurious emissions within restricted bands, cho, 10 dBi antenna, 10 MHz channel, low

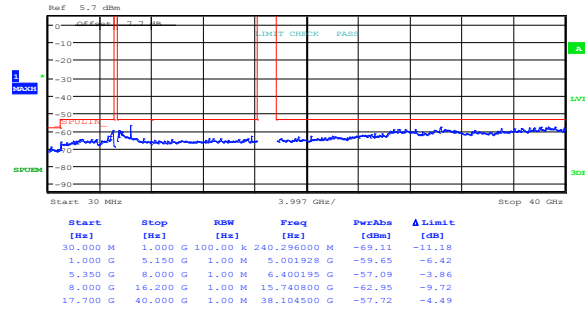


Figure 8.4-43: Conducted spurious emissions within restricted bands, cho, 10 dBi antenna, 10 MHz channel, high

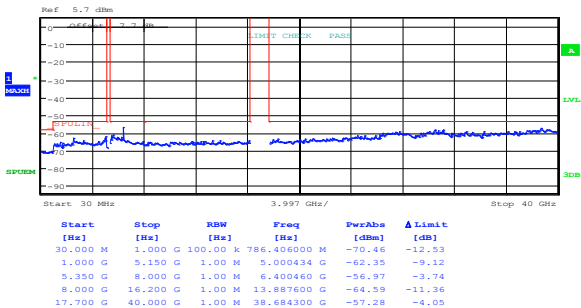


Figure 8.4-44: Conducted spurious emissions within restricted bands, cho, 10 dBi antenna, 20 MHz channel, low

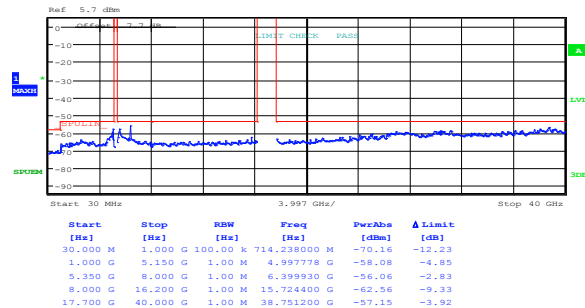


Figure 8.4-45: Conducted spurious emissions within restricted bands, cho, 10 dBi antenna, 20 MHz channel, high

8.4.4 Test data, continued

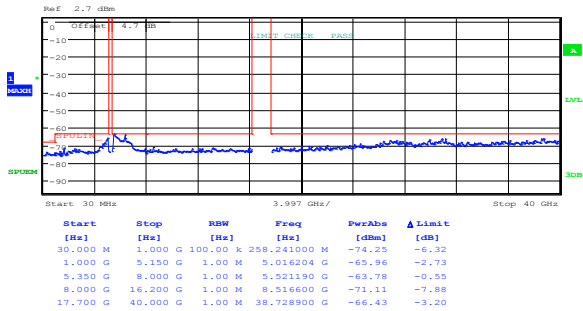


Figure 8.4-46: Conducted spurious emissions within restricted bands, cho, 19 dBi antenna, 5 MHz channel, low

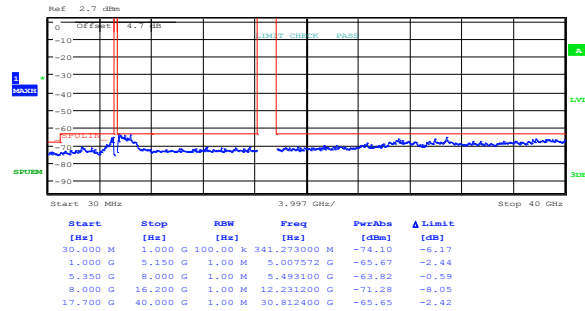


Figure 8.4-47: Conducted spurious emissions within restricted bands, cho, 19 dBi antenna, 5 MHz channel, high

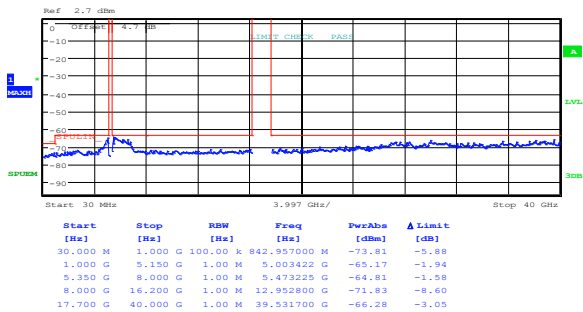


Figure 8.4-48: Conducted spurious emissions within restricted bands, cho, 19 dBi antenna, 10 MHz channel, low

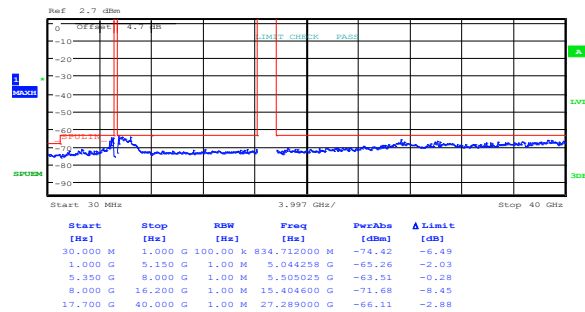


Figure 8.4-49: Conducted spurious emissions within restricted bands, cho, 19 dBi antenna, 10 MHz channel, high

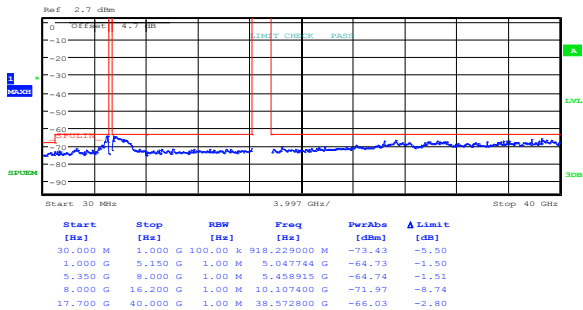


Figure 8.4-50: Conducted spurious emissions within restricted bands, cho, 19 dBi antenna, 20 MHz channel, low

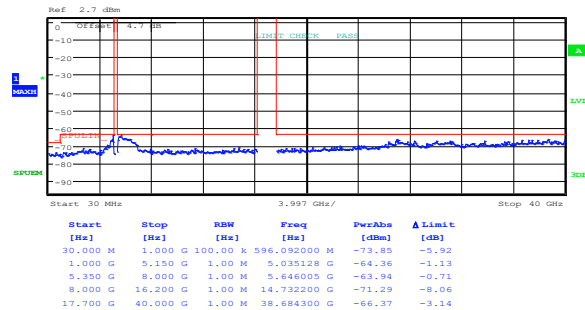


Figure 8.4-51: Conducted spurious emissions within restricted bands, cho, 19 dBi antenna, 20 MHz channel, high

8.4.4 Test data, continued

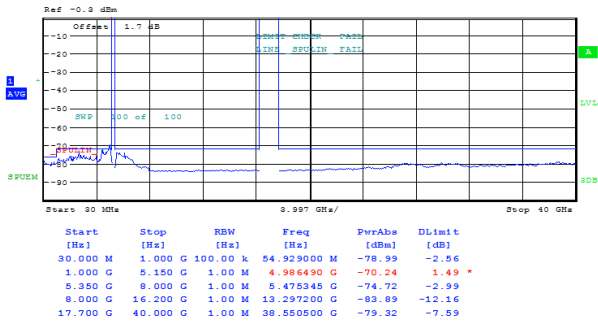


Figure 8.4-52: Conducted spurious emissions within restricted bands, cho, 29 dBi antenna, 5 MHz channel, low

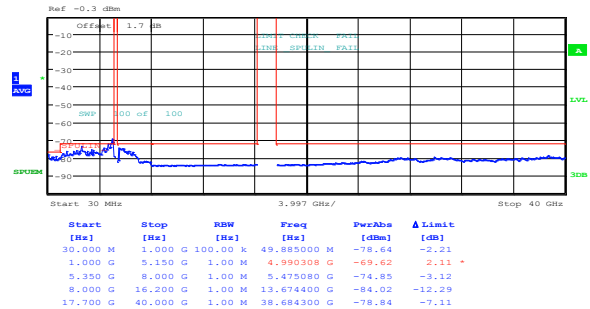


Figure 8.4-53: Conducted spurious emissions within restricted bands, cho, 29 dBi antenna, 5 MHz channel, high

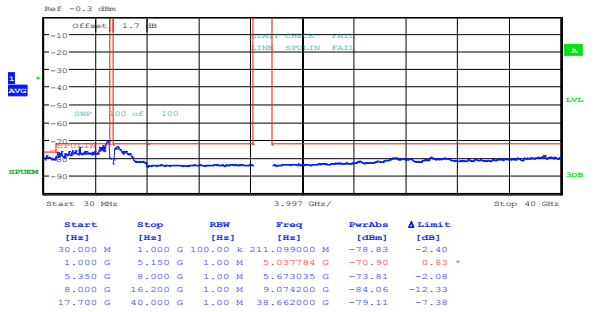


Figure 8.4-54: Conducted spurious emissions within restricted bands, cho, 29 dBi antenna, 10 MHz channel, low

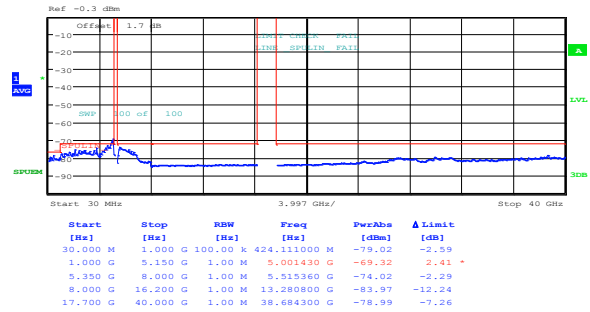


Figure 8.4-55: Conducted spurious emissions within restricted bands, cho, 29 dBi antenna, 10 MHz channel, high

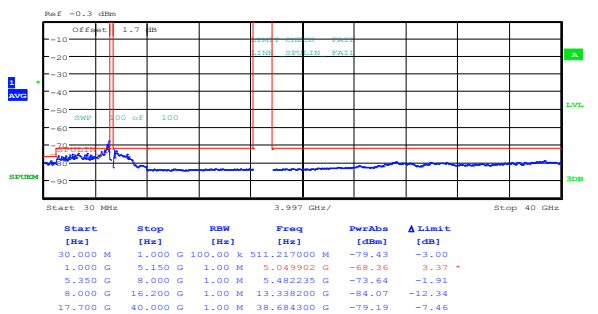


Figure 8.4-56: Conducted spurious emissions within restricted bands, cho, 29 dBi antenna, 20 MHz channel, low

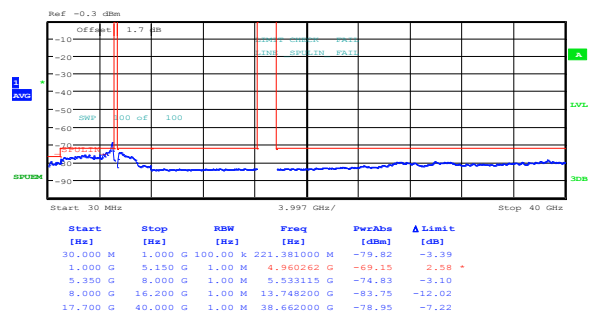


Figure 8.4-57: Conducted spurious emissions within restricted bands, cho, 29 dBi antenna, 20 MHz channel, high

Note: For lower bandage accurate measurement results please refer to the tables 8.4-3 and 8.4-4.

8.4.4 Test data, continued

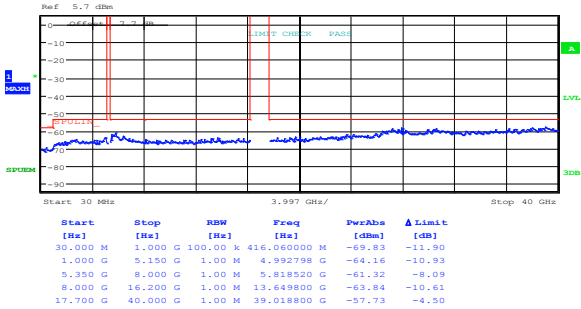


Figure 8.4-58: Conducted spurious emissions within restricted bands, ch1, 10 dBi antenna, 5 MHz channel, low

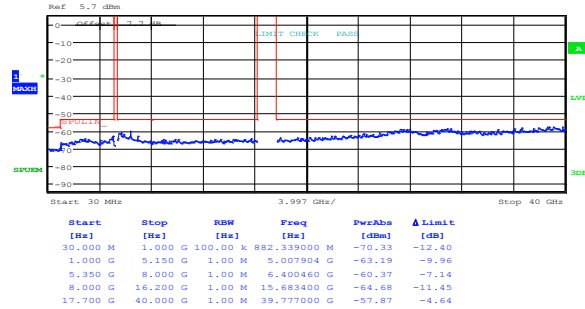


Figure 8.4-59: Conducted spurious emissions within restricted bands, ch1, 10 dBi antenna, 5 MHz channel, high

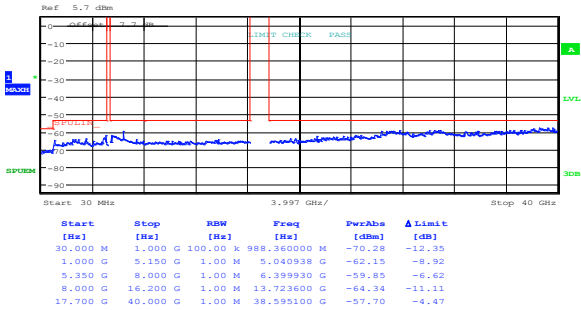


Figure 8.4-60: Conducted spurious emissions within restricted bands, ch1, 10 dBi antenna, 10 MHz channel, low

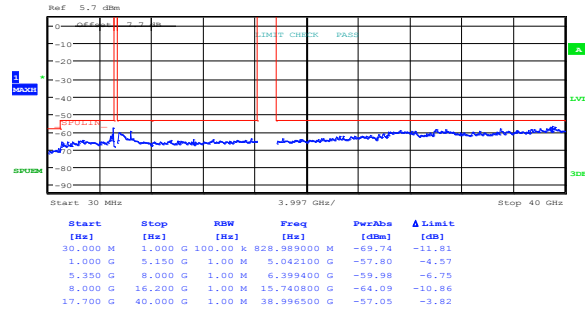


Figure 8.4-61: Conducted spurious emissions within restricted bands, ch1, 10 dBi antenna, 10 MHz channel, high

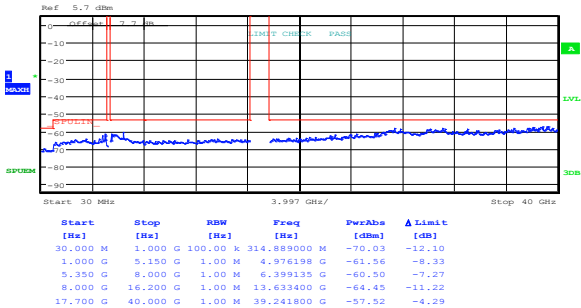


Figure 8.4-62: Conducted spurious emissions within restricted bands, ch1, 10 dBi antenna, 20 MHz channel, low

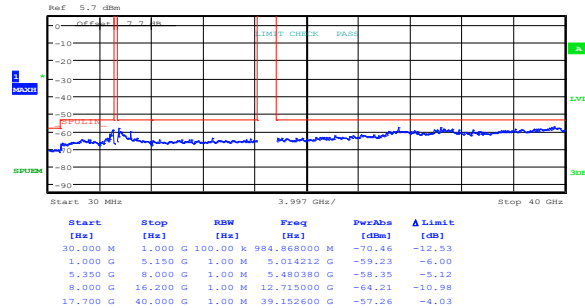


Figure 8.4-63: Conducted spurious emissions within restricted bands, ch1, 10 dBi antenna, 20 MHz channel, high

8.4.4 Test data, continued

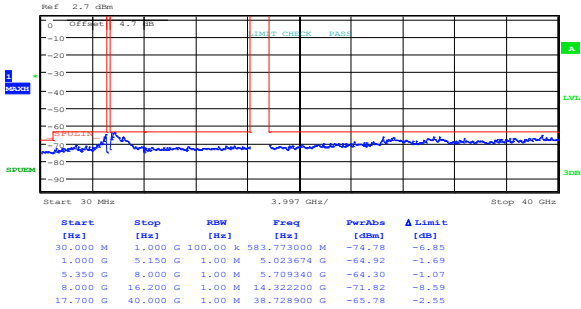


Figure 8.4-64: Conducted spurious emissions within restricted bands, ch1, 19 dBi antenna, 5 MHz channel, low

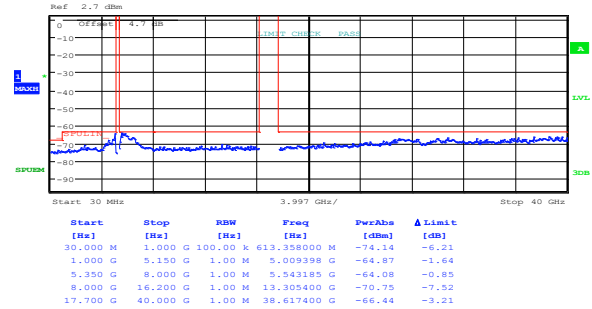


Figure 8.4-65: Conducted spurious emissions within restricted bands, ch1, 19 dBi antenna, 5 MHz channel, high

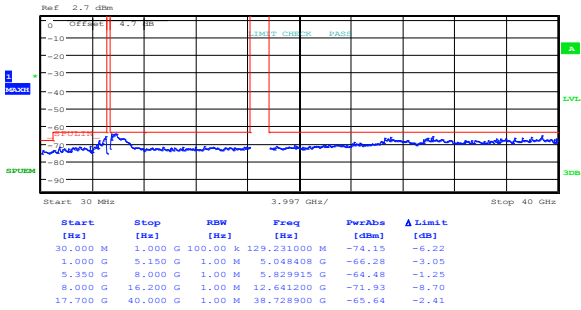


Figure 8.4-66: Conducted spurious emissions within restricted bands, ch1, 19 dBi antenna, 10 MHz channel, low

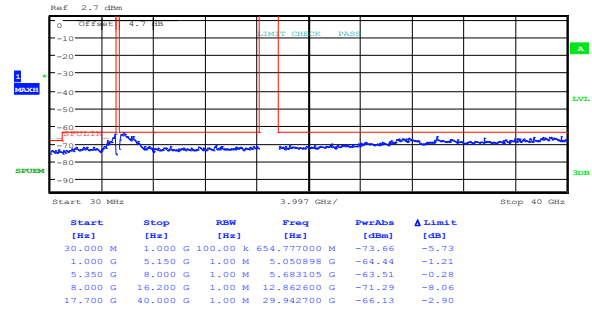


Figure 8.4-67: Conducted spurious emissions within restricted bands, ch1, 19 dBi antenna, 10 MHz channel, high

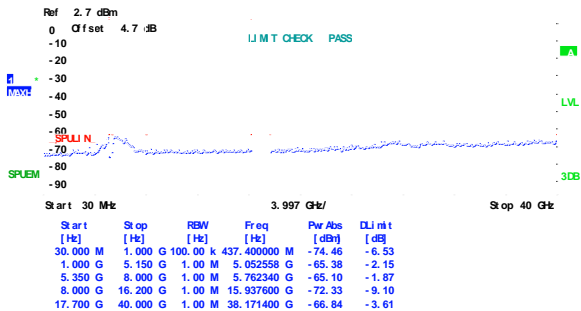


Figure 8.4-68: Conducted spurious emissions within restricted bands, ch1, 19 dBi antenna, 20 MHz channel, low

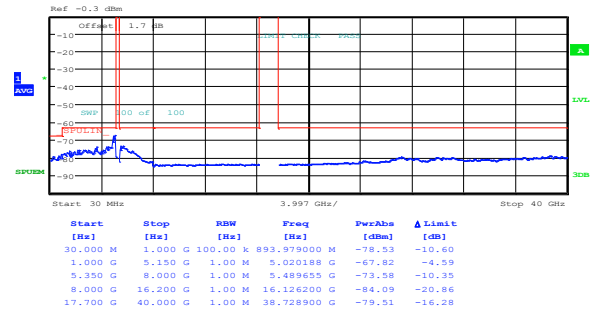


Figure 8.4-69: Conducted spurious emissions within restricted bands, ch1, 19 dBi antenna, 20 MHz channel, high



8.4.4 Test data, continued

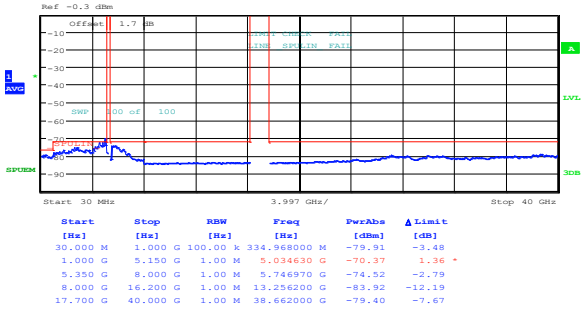


Figure 8.4-70: Conducted spurious emissions within restricted bands, ch1, 29 dBi antenna, 5 MHz channel, low

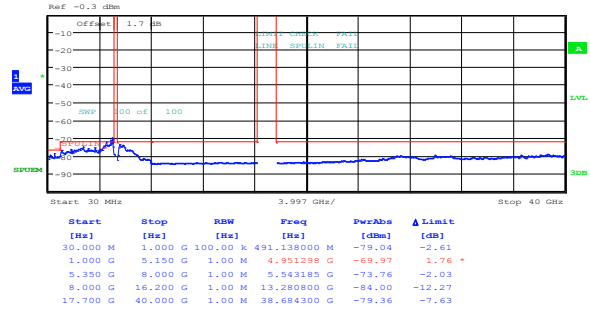


Figure 8.4-71: Conducted spurious emissions within restricted bands, ch1, 29 dBi antenna, 5 MHz channel, high

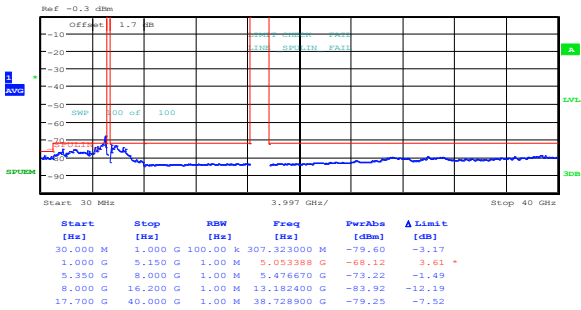


Figure 8.4-72: Conducted spurious emissions within restricted bands, ch1, 29 dBi antenna, 10 MHz channel, low

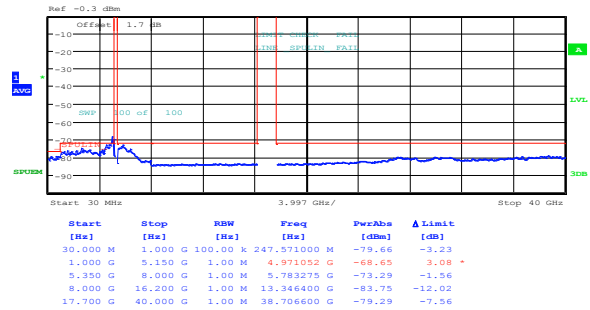


Figure 8.4-73: Conducted spurious emissions within restricted bands, ch1, 29 dBi antenna, 10 MHz channel, high

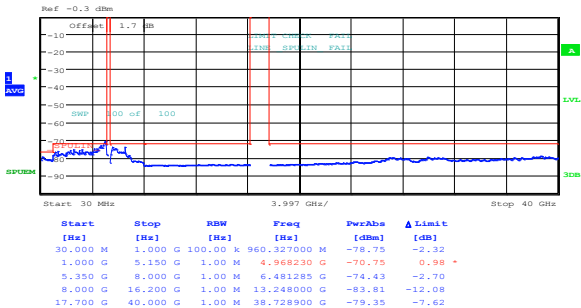


Figure 8.4-74: Conducted spurious emissions within restricted bands, ch1, 29 dBi antenna, 20 MHz channel, low

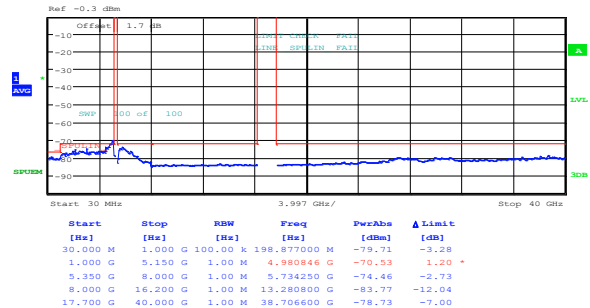


Figure 8.4-75: Conducted spurious emissions within restricted bands, ch1, 29 dBi antenna, 20 MHz channel, high

Note: For lower bandage accurate measurement results please refer to the tables 8.4-3 and 8.4-4.

## 8.5 FCC 15.407(g) Frequency stability

### 8.5.1 Definitions and limits

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

### 8.5.2 Test summary

Test date	August 18, 2014	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1006 mbar
Verdict	Pass	Relative humidity	35 %

### 8.5.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	10 kHz
Video bandwidth	30 kHz
Detector mode	Peak
Trace mode	Max Hold

### 8.5.4 Test data

**Table 8.5-1: Frequency drift measurement for 5 MHz channel**

Test conditions	Frequency, GHz	Drift, Hz
+50 °C, Nominal	5.199945349	-131
+40 °C, Nominal	5.199945234	-246
+30 °C, Nominal	5.199945361	-119
+20 °C, +15 %	5.199945168	-312
+20 °C, Nominal	5.199945480	<i>Reference</i>
+20 °C, -15 %	5.199945483	3
+10 °C, Nominal	5.199945559	79
0 °C, Nominal	5.199945604	124
-10 °C, Nominal	5.199945651	171
-20 °C, Nominal	5.199945701	221
-30 °C, Nominal	5.199945528	48

**Table 8.5-2: Frequency drift measurement for 10 MHz channel**

Test conditions	Frequency, GHz	Drift, Hz
+50 °C, Nominal	5.199945884	-76
+40 °C, Nominal	5.199945670	-290
+30 °C, Nominal	5.199945778	-182
+20 °C, +15 %	5.199945772	-188
+20 °C, Nominal	5.199945960	<i>Reference</i>
+20 °C, -15 %	5.199945962	2
+10 °C, Nominal	5.199946008	48
0 °C, Nominal	5.199946015	55
-10 °C, Nominal	5.199946118	158
-20 °C, Nominal	5.199946108	148
-30 °C, Nominal	5.199946040	80

8.5.4 Test data, continued

**Table 8.5-3:** Frequency drift measurement for 20 MHz channel

Test conditions	Frequency, GHz	Drift, Hz
+50 °C, Nominal	5.199945366	-114
+40 °C, Nominal	5.199944901	-579
+30 °C, Nominal	5.199945323	-157
+20 °C, +15 %	5.199945376	-104
+20 °C, Nominal	5.199945480	Reference
+20 °C, -15 %	5.199945481	1
+10 °C, Nominal	5.199945570	90
0 °C, Nominal	5.199945573	93
-10 °C, Nominal	5.199945546	66
-20 °C, Nominal	5.199945695	215
-30 °C, Nominal	5.199945625	145

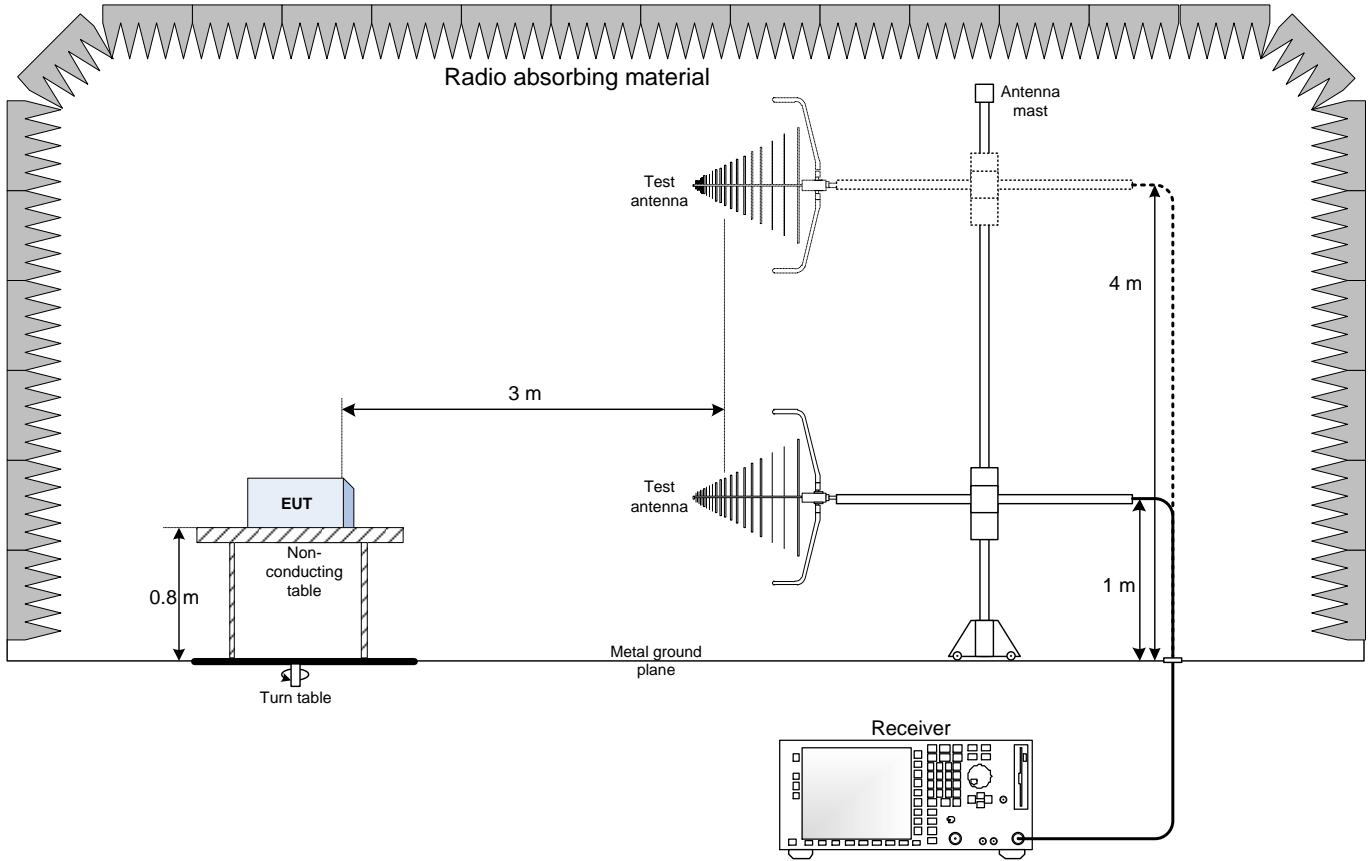
**Table 8.5-4:** Band edge drift calculation

Channel bandwidth, MHz	-26 dBc lower cross point, GHz	Max negative drift, Hz	Drifted lower cross point, GHz	Band edge, GHz	Margin, MHz
5	5.15278846	312	5.152788150	5.15	2.788
10	5.15535256	290	5.155352274	5.15	5.352
20	5.16070513	579	5.160704550	5.15	10.705
Channel bandwidth, MHz	-26 dBc upper cross point, GHz	Max positive drift, Hz	Drifted upper cross point, GHz	Band edge, GHz	Margin, MHz
5	5.24971154	221	5.249711760	5.25	0.288
10	5.24964744	158	5.249647594	5.25	0.352
20	5.24929487	215	5.249295087	5.25	0.705

Notes: Drifted lower cross point = -26 dBc lower cross point - max negative drift. Drifted upper cross point = -26 dBc upper cross point + max positive drift.

## Section 9. Block diagrams of test set-ups

### 9.1 Radiated emissions set-up



### 9.2 Conducted emissions set-up

