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Test report

337322-2TRFWL

Date of issue: November 9, 2017

Applicant:

Redline Communications

Product:

Broad-band wireless infrastructure product

Model:

RDL-3000-RMG3

FCC ID:

QC8-RDL3000RMG3

Specifications:

- FCC 47 CFR Part 15 Subpart E, §15.407

  Unlicensed National Information Infrastructure Devises

Test location

Company name	Nemko Canada Inc.
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Website	www.nemko.com
Site number	FCC: CA2041; IC: 2040G-5 (3 m semi anechoic chamber)

Tested by	Yong Huang Wireless/EMC Specialist
Reviewed by	Kevin Rose, Wireless/EMC Specialist
Review date	November 9, 2017
Reviewer signature	

Limits of responsibility

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

Copyright notification

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Redline Communications
Address	302 Town Center Blvd.4th floor
City	Markham
Province/State	Ontario
Postal/Zip code	L3R 0E8
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart E, Clause 15.407	Unlicensed National Information Infrastructure Devises

1.3 Test methods

789033 D02 General UNII Test Procedures New Rules v01r04 (May 2, 2017)	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
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 C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

1.5 Exclusions

None

1.6 Test report revision history

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

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]

Notes: [1]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

[2]The EUT is professionally installed equipment.

2.2 FCC Part 15 Subpart E, test results

Part	Test description	Verdict
§15.403(i)	Emission bandwidth	Not applicable
§15.407(a)(1)	Power and density limits within 5.15–5.25 GHz band	Pass
§15.407(a)(2)	Power and density limits within 5.25–5.35 GHz and 5.47–5.725 GHz bands	Not applicable
§15.407(a)(3)	Power and density limits within 5.725–5.85 GHz band	Not applicable
§15.407(b)(1)	Undesirable emission limits for 5.15–5.25 GHz band	Pass
§15.407(b)(2)	Undesirable emission limits for 5.25–5.35 GHz band	Not applicable
§15.407(b)(3)	Undesirable emission limits for 5.47–5.725 GHz bands	Not applicable
§15.407(b)(4)	Undesirable emission limits for 5.725–5.85 GHz band	Not applicable
§15.407(b)(6)	Conducted limits for U-NII devices using an AC power line	Pass
§15.407(e)	Minimum 6 dB bandwidth of U-NII devices within the 5.725-5.85 GHz band	Not applicable
§15.407(g)	Frequency stability	Pass
§15.407(h)(1)[1]	Transmit power control (TPC)	Not applicable
§15.407(h)(2)[1]	Dynamic Frequency Selection (DFS)	Not applicable

Note: [1]DFS and TPC requirements are only applicable to 5.25–5.35 GHz and 5.47–5.725 GHz bands

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	August 11, 2017
Nemko sample ID number	Item #1

3.2 EUT information

Product name	Broad-band wireless infrastructure product
Model	RDL-3000-RMG3
Serial number	150SC17180002

3.3 Technical information

Frequency band	5150–5250 MHz
Frequency Min (MHz)	5155(5 MHz channel); 5160 (10 MHz channel); 5170 (20 MHz channel)
Frequency Max (MHz)	5247.5(5 MHz channel); 5245 (10 MHz channel); 5240 (20 MHz channel)
Measured BW (MHz) (26 dB)	4.66 (5 MHz channel); 9.21 (10 MHz channel); 18.47 (20 MHz channel)
Type of modulation	OFDM using 256-QAM, 128-QAM, 64-QAM, 16-QAM, QPSK and BPSK modulation for sub-carriers
Emission classification (F1D, G1D, D1D)	W7D
Transmitter spurious, Units @ distance	52.91dBµV/m @3m, average at 5.15 GHz
Power requirements	48 V_{DC} PoE via 120 VAC, 60 Hz
Antenna information	10 dBi Omni-directional Antenna Redline AOD-DB-0512-02 and L-Com HG5158DP-10U 24 dBi Dual Polarization Antenna 4.9–6.1 GHz, Redline 30-00362-00 and Redline 30-00328-50 Dual Polarization Antenna (19dBi) 32 dBi Redline A3FT3204LTPD Parabolic Antenna, 4.9–5.8 GHz, 4 degree, dual polarity The EUT is professionally installed.

3.4 Product description and theory of operation

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

3.5 EUT exercise details

The EUT was controlled to transmit at desired frequency and modulation from laptop using web interface at IP address: 192.168 .25.2

3.6 EUT setup diagram

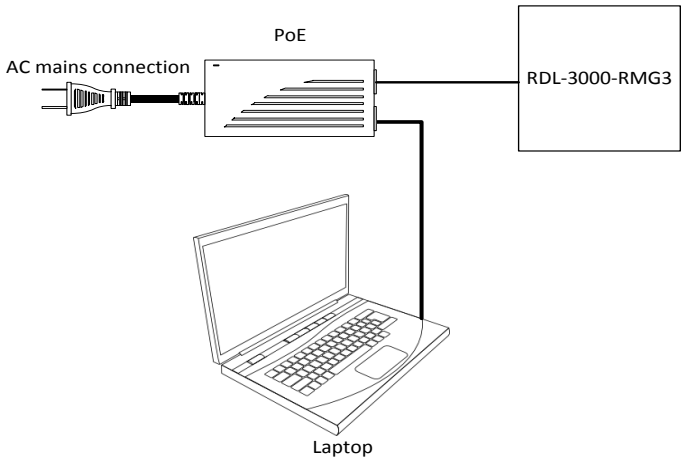


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
PoE	Cincon Electronics Co.	TRG60A-POE-L	004652

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

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

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

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

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

5.2 Power supply range

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

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

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

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

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
Spectrum analyzer	Rohde & Schwarz	FSV 40	FA002731	1 year	July 10/18
50 Ω coax cable	C.C.A.	None	FA002603	—	VOU
50 Ω coax cable	C.C.A.	None	FA002605	—	VOU
50 Ω coax cable	C.C.A.	None	FA002607	—	VOU
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	Oct. 5/17
Horn antenna (1–18 GHz)	EMCO	3115	FA001452	1 year	Oct. 26/17
Horn antenna (18–40 GHz)	EMCO	3116	FA002487	2 year	Aug. 16/18
Pre-amplifier (0.5–18 GHz)	COM-POWER	PAM-118A	FA002561	1 year	May 8/18
Pre-amplifier (18–40 GHz)	COM-POWER	PAM-840	FA002508	1 year	May 8/18
2400-2483 MHz Notch Filter	Microwave Circuits	N0324413	FA002693	—	VOU
50 Ω coax cable	HUBER+SUHNER	SUCOFLEX 100	FA002564	—	VOU
Power source	California Instruments	5001ix	FA001770	1 year	Feb 1/18
Power sensor	Rohde & Schwarz	NRP18S	FA002730	1 year	July 21/18
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	May 3/18
Environmental Chamber	ESPEC	EPX-4H	FA002736	1 year	May 16/18
Multimeter	AMPPROBE	AM-530	FA002536	1 year	May 3/18

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

Section 8. Testing data

8.1 FCC 15.403(i) Emission bandwidth

8.1.1 Definitions and limits

15.403(i) 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.

8.1.2 Test summary

Test date	September 11, 2017	Temperature	24 °C
Test engineer	Yong Huang	Air pressure	1001 mbar
Verdict	Pass	Relative humidity	55 %

8.1.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	approximately 1% of the EBW
Video bandwidth	> RBW
Detector mode	Peak
Trace mode	Max Hold

8.1.4 Test data

Table 8.1-1: *Channel names description*

Channel name	5 MHz channel	10 MHz channel	20 MHz channel
Low	5155	5160	5170
Mid	5200	5200	5200
High	5247.5	5245	5240

Table 8.1-2: *26 dB bandwidth results (in MHz)*

Modulation	Channel	5 MHz channel	10 MHz channel	20 MHz channel
BPSK	Low	4.65	9.17	18.24
	Mid	4.58	9.10	18.23
	High	4.61	9.07	18.20
256-QAM	Low	4.59	9.21	18.17
	Mid	4.66	9.21	18.47
	High	4.62	9.10	18.13

8.1.4 Test data, continued

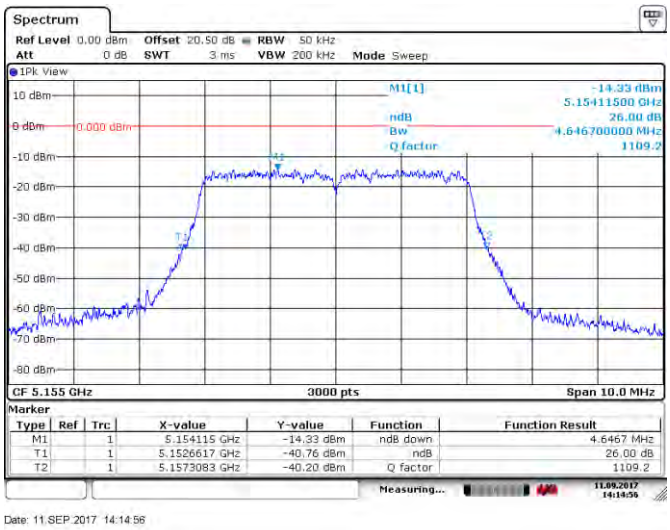


Figure 8.1-1: *26 dB bandwidth of the 5 MHz channel, sample plot*

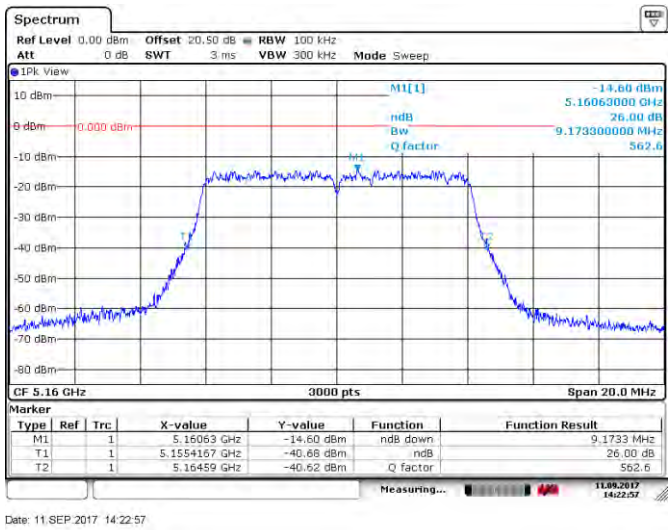


Figure 8.1-2: *26 dB bandwidth of the 10 MHz channel, sample plot*

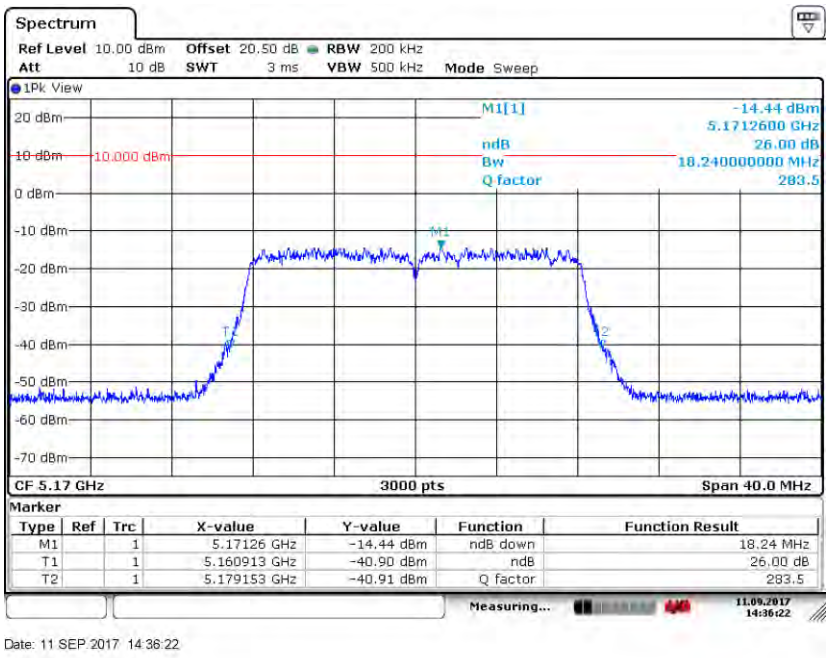


Figure 8.1-3: *26 dB bandwidth of the 20 MHz channel, sample plot*

8.2 FCC 15.407(a)(1) 5.15–5.25 GHz band output power and spectral density limits

8.2.1 Definitions and limits

(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 (30 dBm) 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 megahertz 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 (30 dBm) 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 megahertz 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 (30 dBm). In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. 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 (24 dBm) 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 megahertz 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.

8.2.2 Test summary

Test date:	September 12, 2017 to September 17, 2017	Temperature:	24 °C
Test engineer:	Yong Huang	Air pressure:	1007 mbar
Verdict:	Pass	Relative humidity:	43 %

8.2.3 Observations, settings and special notes

As per manufacturer declaration, when EUT transmits from both antennas, the transmitter output signals are completely uncorrelated.

Output power was tested using RMS power meter.
Spectrum analyzer settings for PSD measurement:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Frequency span	10 MHz (for 5 MHz channel), 50 MHz (for 10 MHz channel), 70 MHz (for 20 MHz channel)
Detector mode	RMS with gated triggering on full power pulses
Trace mode	Power Averaging over 100 sweeps

Combined average output power was calculated as follows: $P_{combined} = 10 \times log_{10}\left(\left(10^{P_{ch0}/10}\right) + \left(10^{P_{ch1}/10}\right)\right)$

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

Combined PPSD was calculated as follows: $PPSD_{combined} = 10 \times log_{10}\left(\left(10^{PSD_{ch0}/10}\right) + \left(10^{PSD_{ch1}/10}\right)\right)$

Note: cable loss is 0.7 dB

Output power limit for 10 dBi antenna was calculated as follows: 30 dBm − (10 dBi – 0.7 dB – 6 dBi) = 26.70 dBm
PPSD limit was calculated as follows: 17 – (10 – 0.7 – 6) = 13.70 dBm/MHz

Output power limit for 24 dBi antenna was calculated as follows: 30 dBm − (24 dBi – 0.7 dB – 6 dBi) = 12.70 dBm
PPSD limit was calculated as follows: 17 – (24 – .07 – 6) = −0.30 dBm/MHz

Output power limit for 32 dBi antenna was calculated as follows: 30 dBm − (32 dBi – 0.7 dB – 6 dBi) = 4.70 dBm
PPSD limit was calculated as follows: 17 – (32 – 0.7 – 6) = −8.30 dBm/MHz

Table 8.2-1: *Elevation vs gain for antennas*

Antenna	Max Antenna Gain above 30° elevation, dBi	Max conducted output power, dBm	e.i.r.p above 30° elevation, dBm	Limit, dBm	Margin, dBm
L-Com HG5158DP-10U, 10 dBi antenna	-8	20.33	12.33	21	8.67
Redline AOD-DB-0512-02, 10 dBi antenna	-8	20.33	12.33	21	8.67
Redline 30-00328-50, 19 dBi antenna	9	5.89	14.89	21	6.11
Redline 30-00362-00, 24 dBi antenna	8	5.89	13.89	21	7.11
Redline A3FT3204LTPD, 32 dBi antenna	0	-2.15	-2.15	21	23.15

8.2.4 Test data

Table 8.2-2: *Output power measurements results for 5 MHz channel, 10 dBi antenna*

Modulation and data rate	Frequency, MHz	Output power on ch0, dBm	Output power on ch1, dBm	Combined power, dBm	Limit, dBm	Margin, dB	Tot. Gain, dBi	EIRP, dBm	Limit, dBm	Margin, dB
BPSK	5155	9.81	9.96	12.90	26.70	13.80	9.3	22.20	36.00	13.80
	5200	16.11	16.22	19.18	26.70	7.52	9.3	28.48	36.00	7.52
	5247.5	15.82	15.77	18.81	26.70	7.89	9.3	28.11	36.00	7.89
256-QAM	5155	9.79	9.82	12.82	26.70	13.88	9.3	22.12	36.00	13.88
	5200	16.01	16.15	19.09	26.70	7.61	9.3	28.39	36.00	7.61
	5247.5	15.82	15.73	18.79	26.70	7.91	9.3	28.09	36.00	7.91

Note: Total antenna gain includes 0.7 dB loss of the cable

Table 8.2-3: *Output power measurements results for 5 MHz channel, 24 dBi antenna*

Modulation and data rate	Frequency, MHz	Output power on ch0, dBm	Output power on ch1, dBm	Combined power, dBm	Limit, dBm	Margin, dB	Tot. Gain, dBi	EIRP, dBm	Limit, dBm	Margin, dB
BPSK	5155	0.41	0.61	3.52	12.70	9.18	23.30	26.82	36.00	9.18
	5200	0.51	0.43	3.48	12.70	9.22	23.30	26.78	36.00	9.22
	5247.5	0.36	0.44	3.41	12.70	9.29	23.30	26.71	36.00	9.29
256-QAM	5155	0.46	0.59	3.54	12.70	9.16	23.30	26.84	36.00	9.16
	5200	0.59	0.39	3.50	12.70	9.20	23.30	26.80	36.00	9.20
	5247.5	0.41	0.42	3.43	12.70	9.27	23.30	26.73	36.00	9.27

Note: Total antenna gain includes 0.7 dB loss of the cable

Table 8.2-4: *Output power measurements results for 5 MHz channel, 32 dBi antenna*

Modulation and data rate	Frequency, MHz	Output power on ch0, dBm	Output power on ch1, dBm	Combined power, dBm	Limit, dBm	Margin, dB	Tot. Gain, dBi	EIRP, dBm	Limit, dBm	Margin, dB
BPSK	5155	-7.12	-7.22	-4.16	4.70	8.86	31.30	27.14	36.00	8.86
	5200	-7.31	-7.55	-4.42	4.70	9.12	31.30	26.88	36.00	9.12
	5247.5	-7.43	-7.62	-4.51	4.70	9.21	31.30	26.79	36.00	9.21
256-QAM	5155	-7.23	-7.51	-4.36	4.70	9.06	31.30	26.94	36.00	9.06
	5200	-7.35	-7.65	-4.49	4.70	9.19	31.30	26.81	36.00	9.19
	5247.5	-7.42	-7.66	-4.53	4.70	9.23	31.30	26.77	36.00	9.23

Note: Total antenna gain includes 0.7 dB loss of the cable

Table 8.2-5: *Output power measurements results for 10 MHz channel, 10 dBi antenna*

Modulation and data rate	Frequency, MHz	Output power on ch0, dBm	Output power on ch1, dBm	Combined power, dBm	Limit, dBm	Margin, dB	Tot. Gain, dBi	EIRP, dBm	Limit, dBm	Margin, dB
BPSK	5160.0	16.87	16.92	19.91	26.70	6.79	9.30	29.21	36.00	6.79
	5200.0	16.89	16.87	19.89	26.70	6.81	9.30	29.19	36.00	6.81
	5245.0	16.59	16.62	19.62	26.70	7.08	9.30	28.92	36.00	7.08
256-QAM	5160.0	16.84	16.89	19.88	26.70	6.82	9.30	29.18	36.00	6.82
	5200.0	16.88	16.75	19.83	26.70	6.87	9.30	29.13	36.00	6.87
	5245.0	16.61	16.71	19.67	26.70	7.03	9.30	28.97	36.00	7.03

Note: Total antenna gain includes 0.7 dB loss of the cable

Table 8.2-6: *Output power measurements results for 10 MHz channel, 24 dBi antenna*

Modulation and data rate	Frequency, MHz	Output power on ch0, dBm	Output power on ch1, dBm	Combined power, dBm	Limit, dBm	Margin, dB	Tot. Gain, dBi	EIRP, dBm	Limit, dBm	Margin, dB
BPSK	5160.0	3.35	3.33	6.35	12.70	6.35	23.30	29.65	36.00	6.35
	5200.0	3.51	3.51	6.52	12.70	6.18	23.30	29.82	36.00	6.18
	5245.0	3.22	3.40	6.32	12.70	6.38	23.30	29.62	36.00	6.38
256-QAM	5160.0	3.61	3.55	6.59	12.70	6.11	23.30	29.89	36.00	6.11
	5200.0	3.58	3.61	6.61	12.70	6.09	23.30	29.91	36.00	6.09
	5245.0	3.18	3.22	6.21	12.70	6.49	23.30	29.51	36.00	6.49

Note: Total antenna gain includes 0.7 dB loss of the cable

Table 8.2-7: *Output power measurements results for 10 MHz channel, 32 dBi antenna*

Modulation and data rate	Frequency, MHz	Output power on ch0, dBm	Output power on ch1, dBm	Combined power, dBm	Limit, dBm	Margin, dB	Tot. Gain, dBi	EIRP, dBm	Limit, dBm	Margin, dB
BPSK	5160.0	-4.64	-4.58	-1.60	4.70	6.30	31.30	29.70	36.00	6.30
	5200.0	-4.72	-4.69	-1.69	4.70	6.39	31.30	29.61	36.00	6.39
	5245.0	-4.81	-4.77	-1.78	4.70	6.48	31.30	29.52	36.00	6.48
256-QAM	5160.0	-4.42	-4.45	-1.42	4.70	6.12	31.30	29.88	36.00	6.12
	5200.0	-4.62	-4.56	-1.58	4.70	6.28	31.30	29.72	36.00	6.28
	5245.0	-4.73	-4.55	-1.63	4.70	6.33	31.30	29.67	36.00	6.33

Note: Total antenna gain includes 0.7 dB loss of the cable

Table 8.2-8: *Output power measurements results for 20 MHz channel, 10 dBi antenna*

Modulation and data rate	Frequency, MHz	Output power on ch0, dBm	Output power on ch1, dBm	Combined power, dBm	Limit, dBm	Margin, dB	Tot. Gain, dBi	EIRP, dBm	Limit, dBm	Margin, dB
BPSK	5170.0	18.22	18.17	21.21	26.70	5.49	9.30	30.51	36.00	5.49
	5200.0	20.14	20.18	23.17	26.70	3.53	9.30	32.47	36.00	3.53
	5240.0	19.81	19.97	22.90	26.70	3.80	9.30	32.20	36.00	3.80
256-QAM	5170.0	18.25	18.23	21.25	26.70	5.45	9.30	30.55	36.00	5.45
	5200.0	20.25	20.33	23.30	26.70	3.40	9.30	32.60	36.00	3.40
	5240.0	19.83	19.90	22.88	26.70	3.82	9.30	32.18	36.00	3.82

Note: Total antenna gain includes 0.7 dB loss of the cable

Table 8.2-9: *Output power measurements results for 20 MHz channel, 24 dBi antenna*

Modulation and data rate	Frequency, MHz	Output power on ch0, dBm	Output power on ch1, dBm	Combined power, dBm	Limit, dBm	Margin, dB	Tot. Gain, dBi	EIRP, dBm	Limit, dBm	Margin, dB
BPSK	5170.0	5.59	5.89	8.75	12.70	3.95	23.30	32.05	36.00	3.95
	5200.0	5.61	5.67	8.65	12.70	4.05	23.30	31.95	36.00	4.05
	5240.0	5.32	5.44	8.39	12.70	4.31	23.30	31.69	36.00	4.31
256-QAM	5170.0	5.55	5.87	8.72	12.70	3.98	23.30	32.02	36.00	3.98
	5200.0	5.63	5.62	8.64	12.70	4.06	23.30	31.94	36.00	4.06
	5240.0	5.35	5.46	8.42	12.70	4.28	23.30	31.72	36.00	4.28

Note: Total antenna gain includes 0.7 dB loss of the cable

Table 8.2-10: *Output power measurements results for 20 MHz channel, 32 dBi antenna*

Modulation and data rate	Frequency, MHz	Output power on ch0, dBm	Output power on ch1, dBm	Combined power, dBm	Limit, dBm	Margin, dB	Tot. Gain, dBi	EIRP, dBm	Limit, dBm	Margin, dB
BPSK	5170.0	-2.42	-2.15	0.73	4.70	3.97	31.30	32.03	36.00	3.97
	5200.0	-2.59	-2.33	0.55	4.70	4.15	31.30	31.85	36.00	4.15
	5240.0	-2.91	-2.60	0.26	4.70	4.44	31.30	31.56	36.00	4.44
256-QAM	5170.0	-2.51	-2.21	0.65	4.70	4.05	31.30	31.95	36.00	4.05
	5200.0	-2.55	-2.36	0.56	4.70	4.14	31.30	31.86	36.00	4.14
	5240.0	-2.89	-2.58	0.28	4.70	4.42	31.30	31.58	36.00	4.42

Note: Total antenna gain includes 0.7 dB loss of the cable

Table 8.2-11: *PSD measurements results for 5 MHz channel, 10 dBi antenna*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	Limit, dBm/MHz	Margin, dB
BPSK	5155	4.98	4.93	7.97	13.7	5.73
	5200	10.74	9.30	13.09	13.7	0.61
	5247.5	9.52	8.95	12.25	13.7	1.45
256-QAM	5155	4.97	4.93	7.96	13.7	5.74
	5200	10.93	9.27	13.19	13.7	0.51
	5247.5	9.62	8.89	12.28	13.7	1.42

Table 8.2-12: *PSD measurements results for 5 MHz channel, 24 dBi antenna*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	Limit, dBm/MHz	Margin, dB
BPSK	5155	-4.24	-3.88	-1.05	-0.3	0.75
	5200	-4.50	-3.84	-1.15	-0.3	0.85
	5247.5	-4.91	-4.12	-1.49	-0.3	1.19
256-QAM	5155	-4.21	-3.99	-1.09	-0.3	0.79
	5200	-4.31	-3.81	-1.04	-0.3	0.74
	5247.5	-4.95	-4.08	-1.48	-0.3	1.18

Table 8.2-13: *PSD measurements results for 5 MHz channel, 32 dBi antenna*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	Limit, dBm/MHz	Margin, dB
BPSK	5155	-12.17	-11.93	-9.04	-8.3	0.74
	5200	-12.78	-11.74	-9.22	-8.3	0.92
	5247.5	-12.33	-12.03	-9.17	-8.3	0.87
256-QAM	5155	-12.05	-11.89	-8.96	-8.3	0.66
	5200	-12.10	-11.75	-8.91	-8.3	0.61
	5247.5	-11.99	-11.98	-8.97	-8.3	0.67

Table 8.2-14: *PSD measurements results for 10 MHz channel, 10 dBi antenna*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	Limit, dBm/MHz	Margin, dB
BPSK	5160.0	9.79	9.76	12.79	13.7	0.91
	5200.0	8.98	10.28	12.69	13.7	1.01
	5245.0	9.31	8.81	12.08	13.7	1.62
256-QAM	5160.0	9.66	9.82	12.75	13.7	0.95
	5200.0	9.08	10.31	12.75	13.7	0.95
	5245.0	9.41	9.04	12.24	13.7	1.46

Table 8.2-15: *PSD measurements results for 10 MHz channel, 24 dBi antenna*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	Limit, dBm/MHz	Margin, dB
BPSK	5160.0	-4.18	-4.03	-1.09	-0.3	0.79
	5200.0	-4.27	-4.05	-1.15	-0.3	0.85
	5245.0	-4.55	-4.92	-1.72	-0.3	1.42
256-QAM	5160.0	-4.15	-4.74	-1.42	-0.3	1.12
	5200.0	-4.22	-3.98	-1.09	-0.3	0.79
	5245.0	-4.61	-4.98	-1.78	-0.3	1.48

Table 8.2-16: *PSD measurements results for 10 MHz channel, 32 dBi antenna*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	Limit, dBm/MHz	Margin, dB
BPSK	5160.0	-11.83	-11.88	-8.84	-8.3	0.54
	5200.0	-12.59	-11.98	-9.26	-8.3	0.96
	5245.0	-12.74	-12.05	-9.37	-8.3	1.07
256-QAM	5160.0	-11.74	-11.91	-8.81	-8.3	0.51
	5200.0	-12.55	-12.06	-9.29	-8.3	0.99
	5245.0	-12.88	-11.99	-9.40	-8.3	1.10

Table 8.2-17: *PSD measurements results for 20 MHz channel, 10 dBi antenna*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	Limit, dBm/MHz	Margin, dB
BPSK	5170.0	7.42	7.71	10.58	13.7	3.12
	5200.0	9.88	9.98	12.94	13.7	0.76
	5240.0	9.11	9.05	12.09	13.7	1.61
256-QAM	5170.0	7.45	7.81	10.64	13.7	3.06
	5200.0	9.89	9.99	12.95	13.7	0.75
	5240.0	9.06	9.11	12.10	13.7	1.60

Table 8.2-18: *PSD measurements results for 20 MHz channel, 24 dBi antenna*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	Limit, dBm/MHz	Margin, dB
BPSK	5170.0	-4.99	-4.70	-1.83	-0.3	1.53
	5200.0	-5.01	-4.98	-1.98	-0.3	1.68
	5240.0	-5.15	-5.22	-2.17	-0.3	1.87
256-QAM	5170.0	-4.95	-4.88	-1.90	-0.3	1.60
	5200.0	-4.99	-4.88	-1.92	-0.3	1.62
	5240.0	-5.16	-5.09	-2.11	-0.3	1.81

Table 8.2-19: *PSD measurements results for 20 MHz channel, 32 dBi antenna*

Modulation and data rate	Frequency, MHz	PSD on ch0, dBm/MHz	PSD on ch1, dBm/MHz	Combined PSD, dBm/MHz	Limit, dBm/MHz	Margin, dB
BPSK	5170.0	-12.72	-12.57	-9.63	-8.3	1.33
	5200.0	-12.88	-12.78	-9.82	-8.3	1.52
	5240.0	-12.95	-13.44	-10.18	-8.3	1.88
256-QAM	5170.0	-12.86	-12.56	-9.70	-8.3	1.40
	5200.0	-12.75	-12.79	-9.76	-8.3	1.46
	5240.0	-12.81	-12.96	-9.87	-8.3	1.57

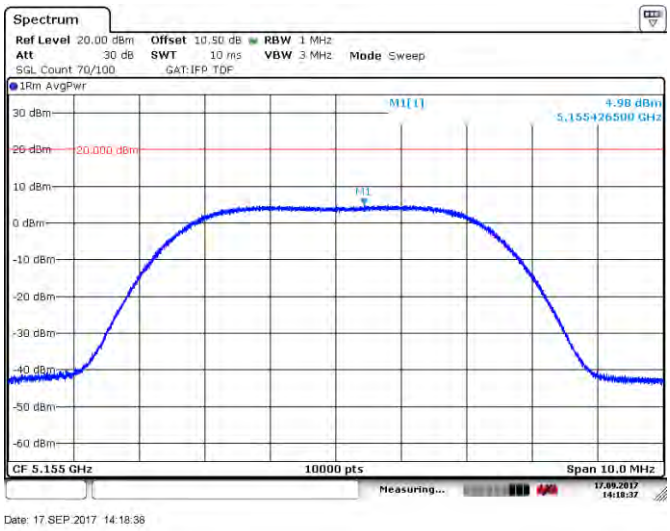


Figure 8.2-1: *Sample plot for PSD on 5 MHz channel*

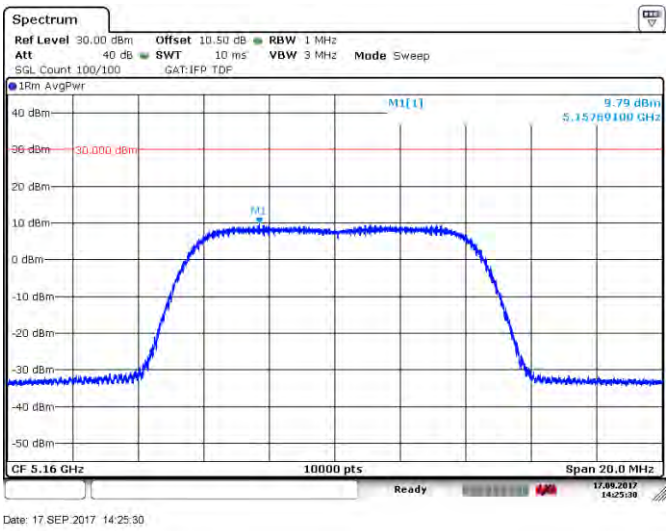


Figure 8.2-2: *Sample plot for PSD on 10 MHz channel*

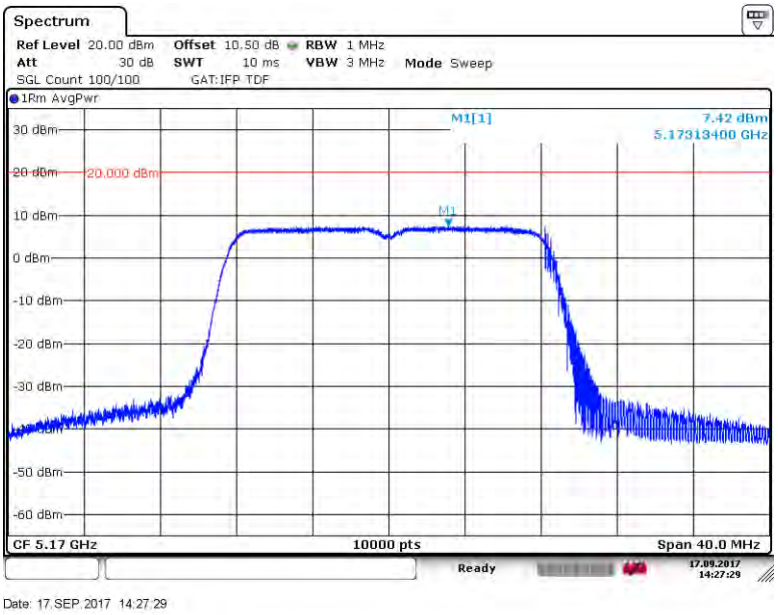


Figure 8.2-3: *Sample plot for PSD on 20 MHz channel*

8.3 FCC 15.407(b) Undesirable (unwanted) emissions

8.3.1 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 8.3-1: *FCC §15.209 Radiated emission limits*

Frequency, MHz	Field strength of emissions µV/m	Field strength of emissions dBµV/m	Measurement distance, m
0.009–0.490	2400/F *(F in kHz)*	$67.6 - 20 \times \log_{10}$(F) *(F in kHz)*	300
0.490–1.705	24000/F *(F in kHz)*	$87.6 - 20 \times \log_{10}$(F) *(F in kHz)*	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

Table 8.3-2: *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			

8.3.2 Test summary

Test date:	September 12, 2017 to September 24, 2017	Temperature:	24 °C
Test engineer:	Yong Huang	Air pressure:	1007 mbar
Verdict:	Pass	Relative humidity:	43 %

8.3.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 40 GHz while the EUT was transmitting on both MIMO chains simultaneously.
As per customer, the transmitter output signals on the two chains are completely uncorrelated.
Conducted measurements were performed on both of the 2 antenna ports, with the highest and the lowest data rate, the worse case is presented.
All conducted plots below have been corrected with antenna gains, RF cable losses and multiple antenna correction factors.
Radiated measurements below 18 GHz were performed at a distance of 3 m.
Radiated measurements above 18 GHz and in the vicinity of the allocated band edges (around 5 GHz) were performed at a distance of 1 m.
Cabinet radiation were performed while both antenna connectors were terminated with 50 Ω load. No emissions related to RF transmitter were detected within 6 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

Spectrum analyser for peak conducted 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 for frequencies where peak results were above the average limit:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	RMS
Trace mode:	Power average
Number of averaging traces:	100

Spectrum analyser for peak conducted measurements outside restricted bands:

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

8.3.4 Test data

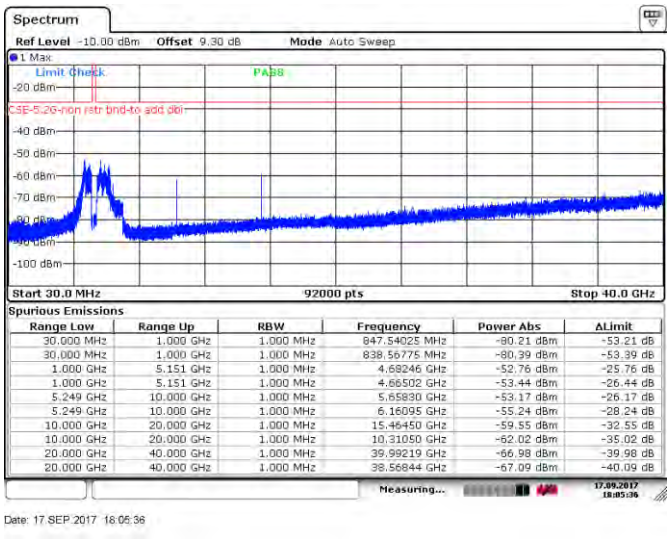


Figure 8.3-1: *Spurious emissions outside restricted bands for 10 dBi antenna, 5 MHz channel, low channel*

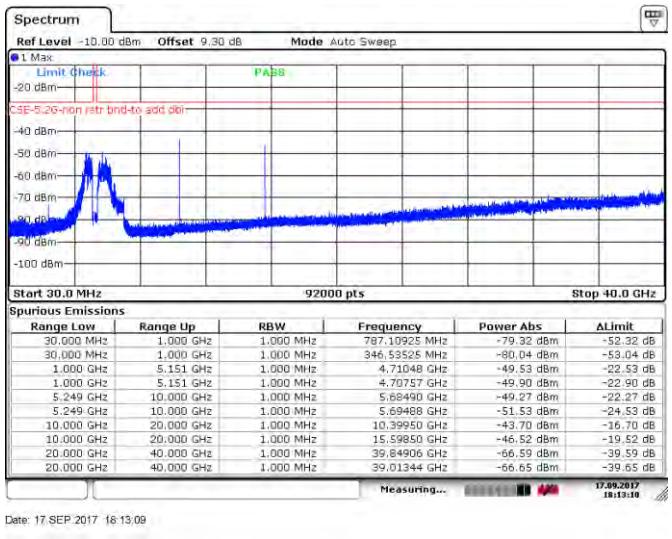


Figure 8.3-2: *Spurious emissions outside restricted bands for 10 dBi antenna, 5 MHz channel, mid channel*

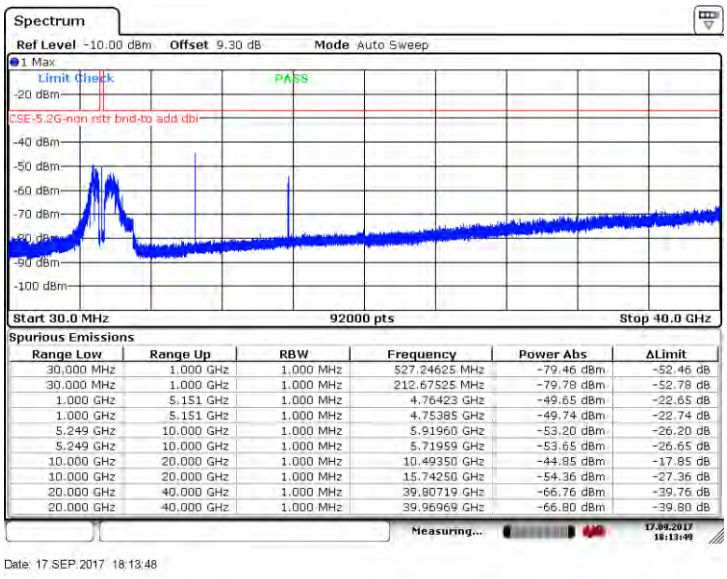


Figure 8.3-3: *Spurious emissions outside restricted bands for 10 dBi antenna, 5 MHz channel, high channel*

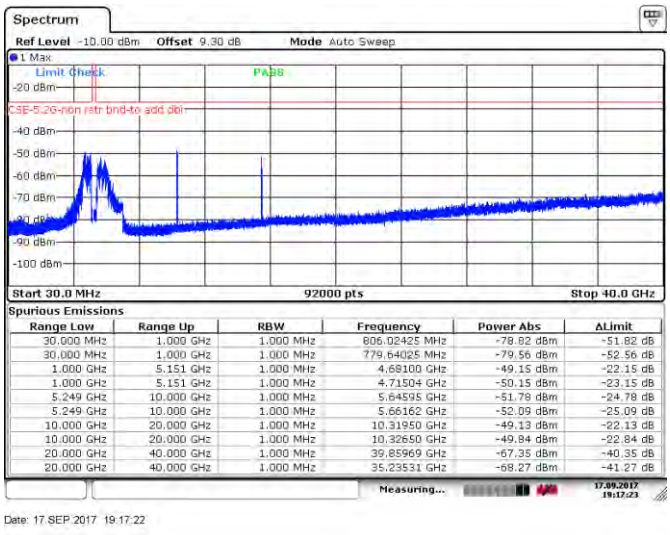


Figure 8.3-4: *Spurious emissions outside restricted bands for 10 dBi antenna, 10 MHz channel, low channel*

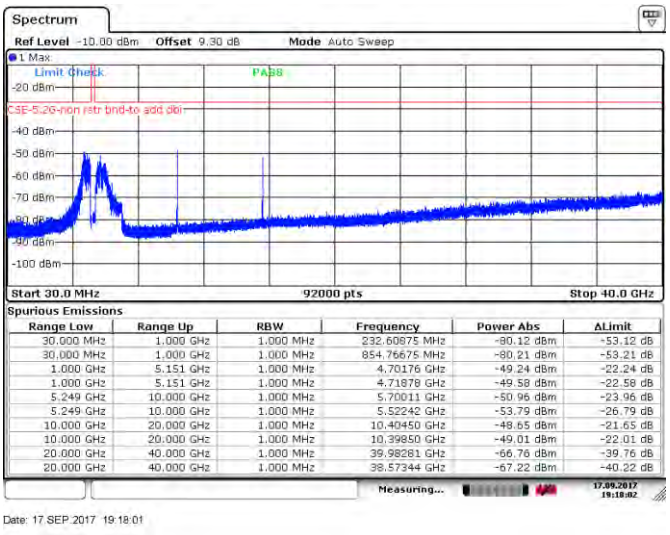


Figure 8.3-5: *Spurious emissions outside restricted bands for 10 dBi antenna, 10 MHz channel, mid channel*

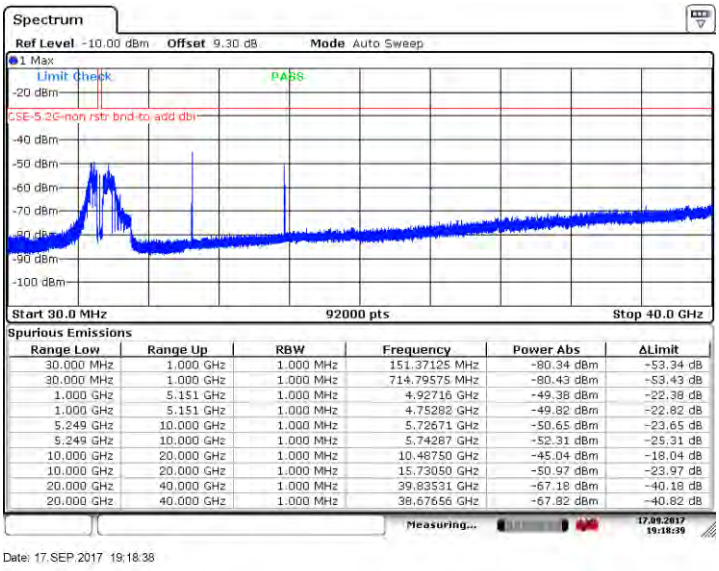


Figure 8.3-6: *Spurious emissions outside restricted bands for 10 dBi antenna, 10 MHz channel, high channel*

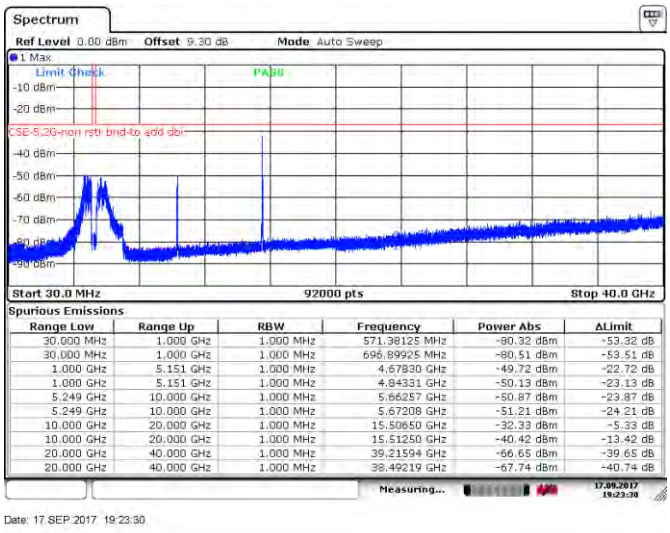


Figure 8.3-7: *Spurious emissions outside restricted bands for 10 dBi antenna, 20 MHz channel, low channel*

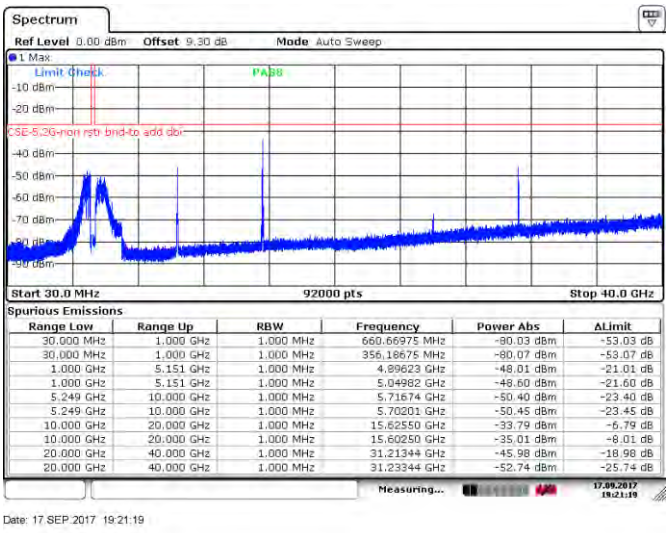


Figure 8.3-8: *Spurious emissions outside restricted bands for 10 dBi antenna, 20 MHz channel, mid channel*

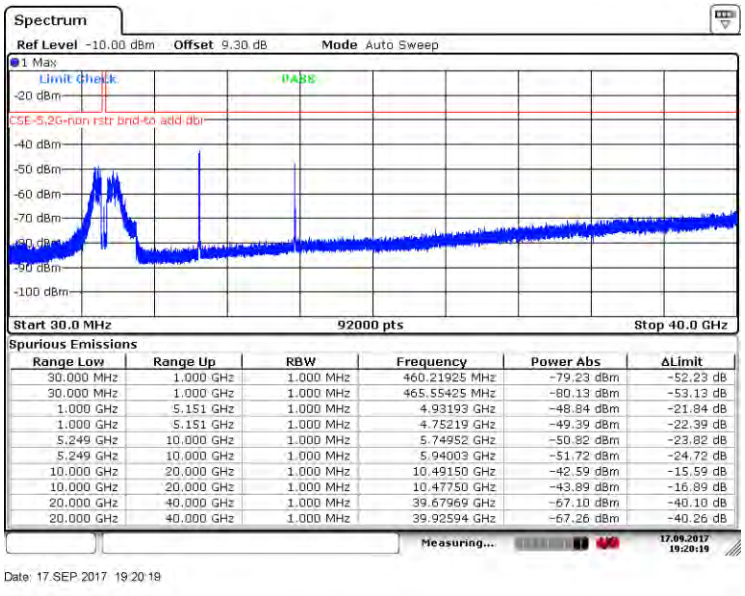


Figure 8.3-9: *Spurious emissions outside restricted bands for 10 dBi antenna, 20 MHz channel, high channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm

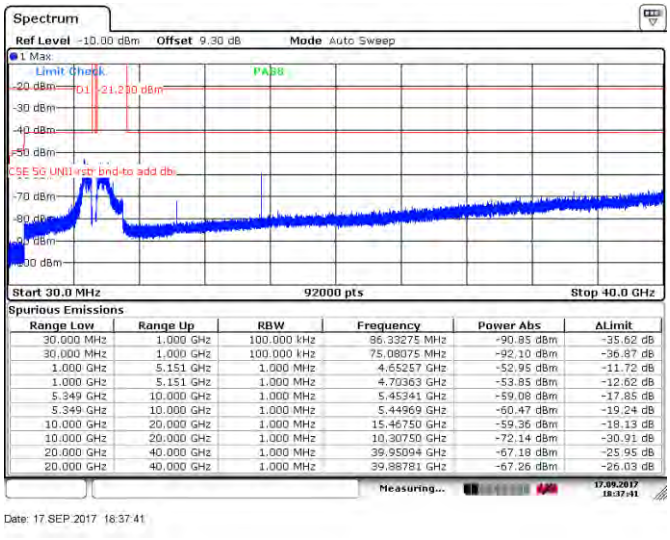


Figure 8.3-10: *Spurious emissions within restricted bands for 10 dBi antenna, 5 MHz channel, low channel*

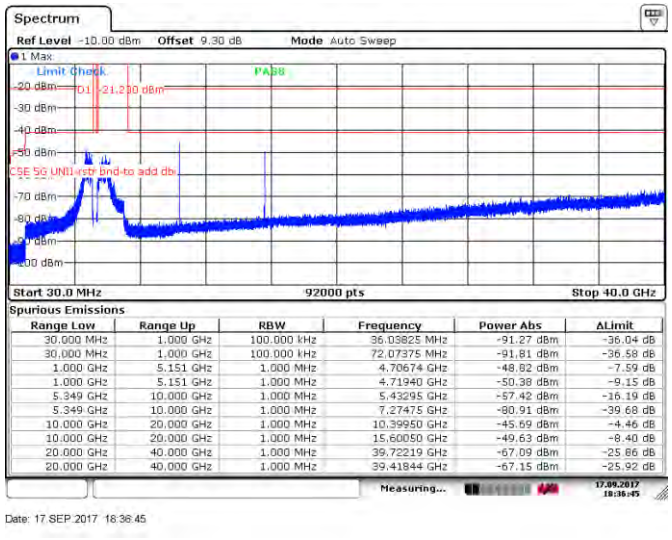


Figure 8.3-11: *Spurious emissions within restricted bands for 10 dBi antenna, 5 MHz channel, mid channel*

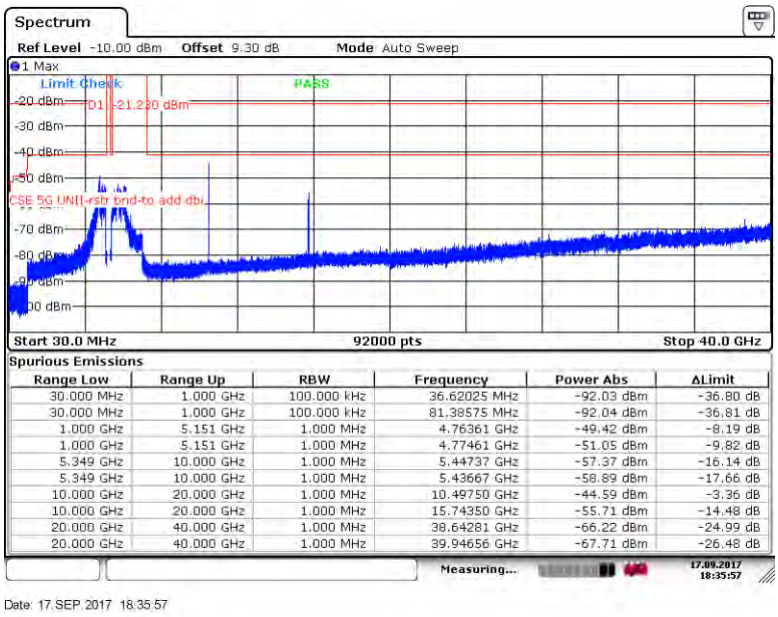


Figure 8.3-12: *Spurious emissions within restricted bands for 10 dBi antenna, 5 MHz channel, high channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm

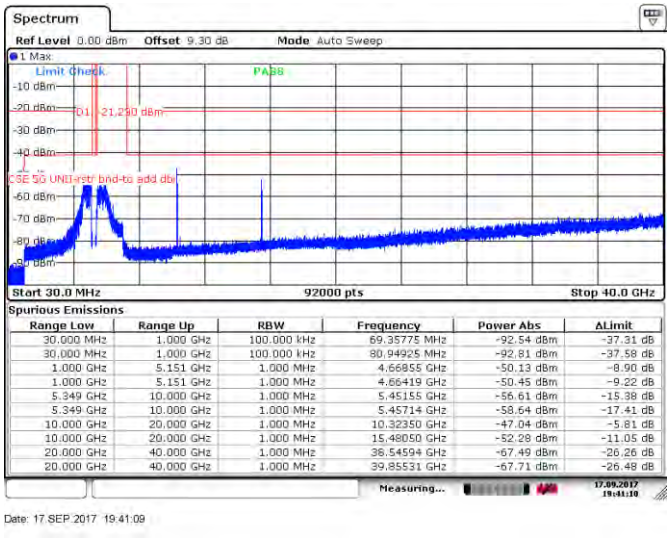


Figure 8.3-13: *Spurious emissions within restricted bands for 10 dBi antenna, 10 MHz channel, low channel*

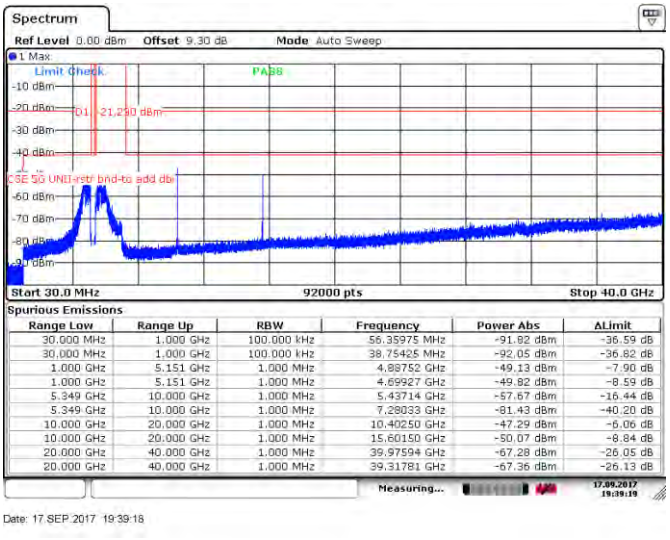


Figure 8.3-14: *Spurious emissions within restricted bands for 10 dBi antenna, 10 MHz channel, mid channel*

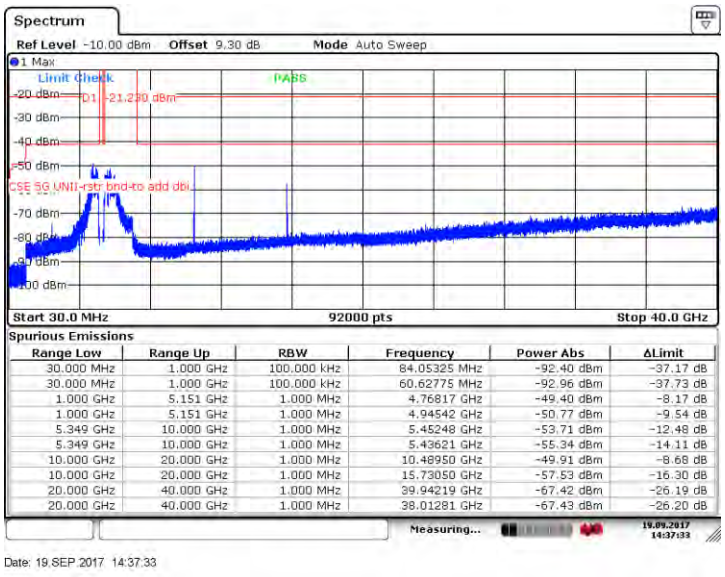


Figure 8.3-15: *Spurious emissions within restricted bands for 10 dBi antenna, 10 MHz channel, high channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm
Plots below show EIRP trace measured using peak detector and compared with average limit. Where peak level of any emission has exceeded average limit line, that emission was then re-measured with RMS detector.

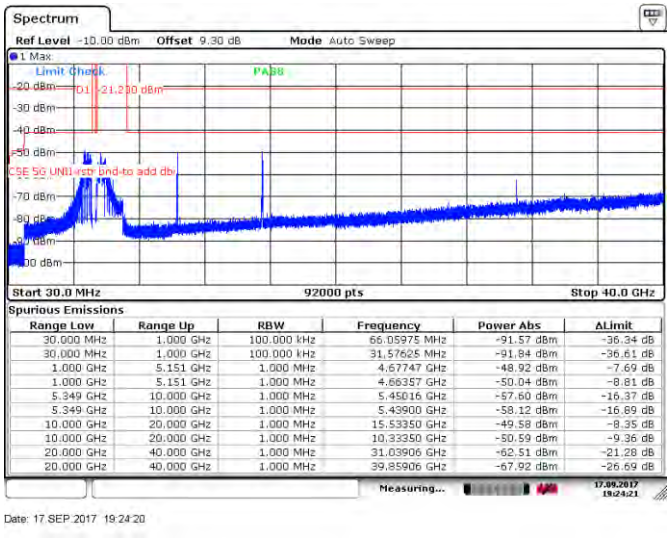


Figure 8.3-16: *Spurious emissions within restricted bands for 10 dBi antenna, 20 MHz channel, low channel*

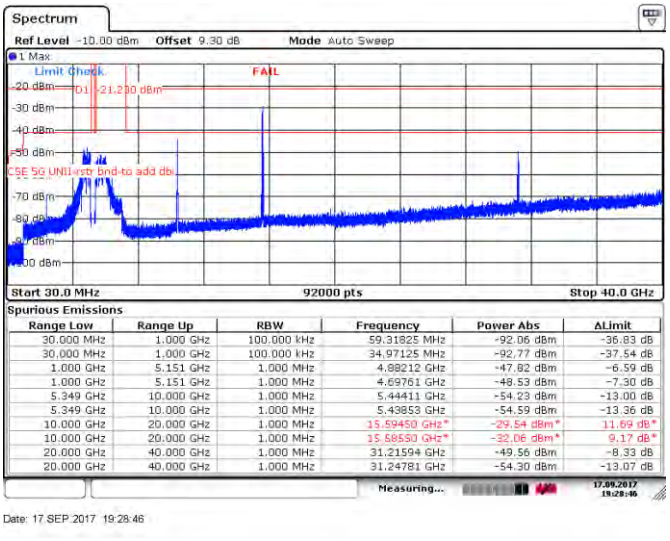


Figure 8.3-17: *Spurious emissions within restricted bands for 10 dBi antenna, 20 MHz channel, mid channel*

Note: Average value of the exceeding emission is −46.62 dBm.

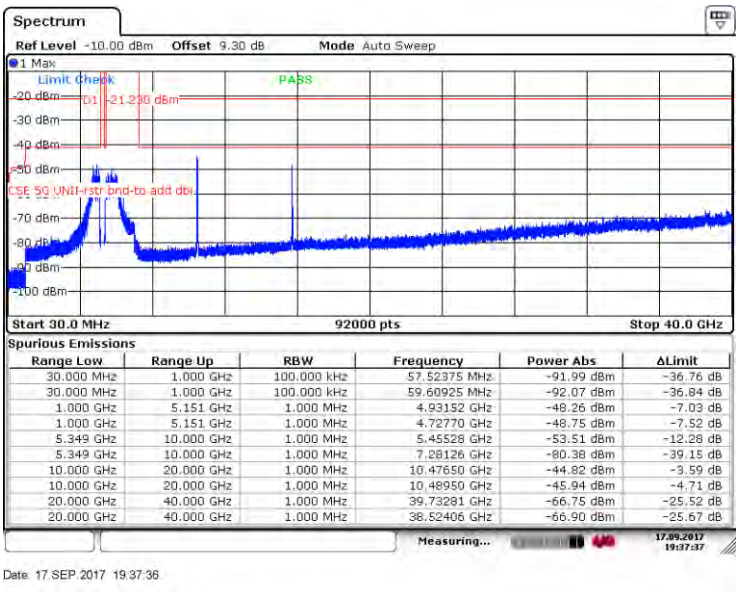


Figure 8.3-18: *Spurious emissions within restricted bands for 10 dBi antenna, 20 MHz channel, high channel*

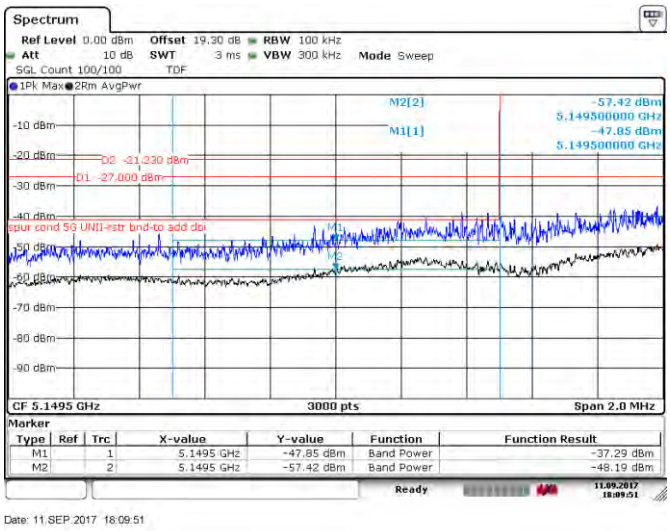


Figure 8.3-19: *Lower band edge for 10 dBi antenna, 5 MHz channel*

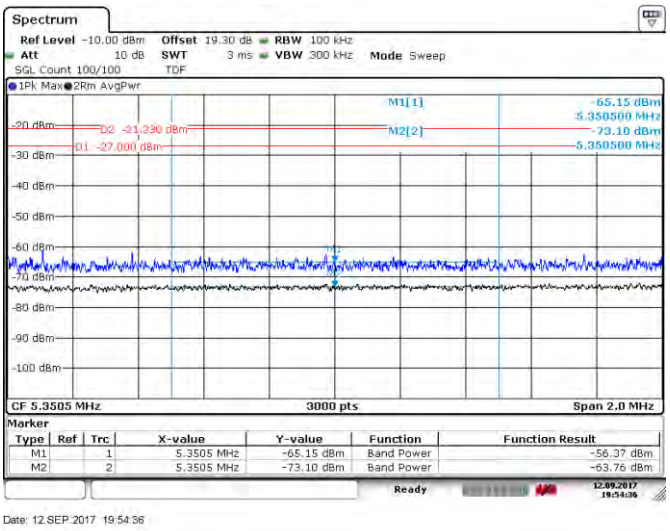


Figure 8.3-20: *Upper band edge for 10 dBi antenna, 5 MHz channel*

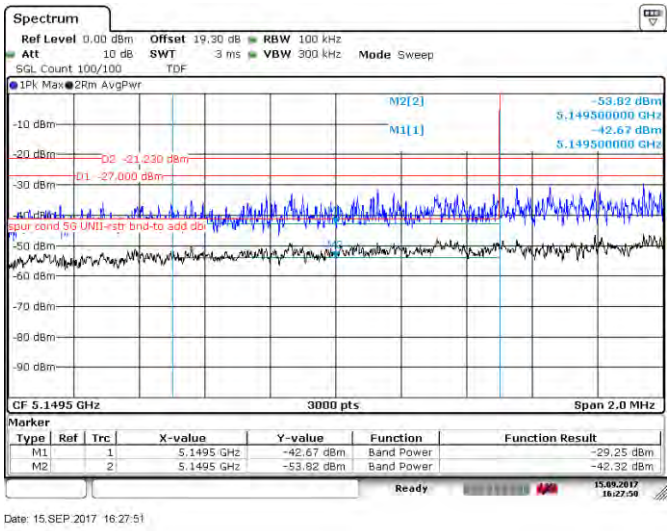


Figure 8.3-21: *Lower band edge for 10 dBi antenna, 10 MHz channel*

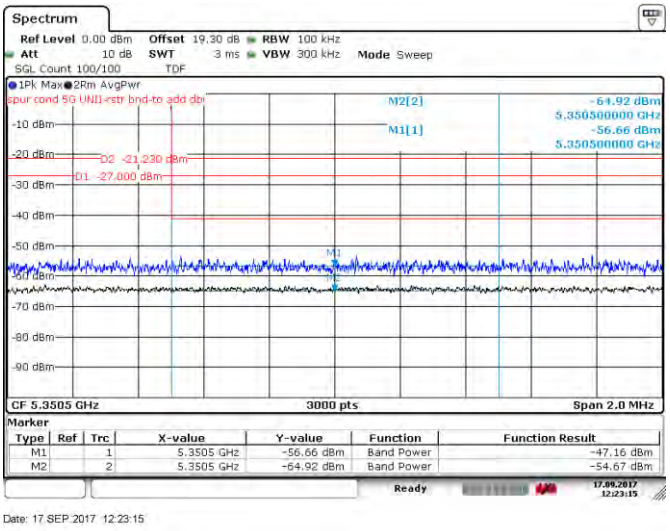


Figure 8.3-22: *Upper band edge for 10 dBi antenna, 10 MHz channel*

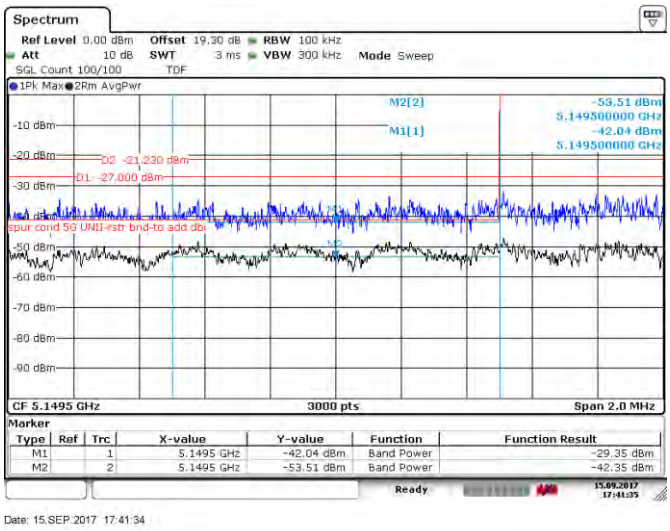


Figure 8.3-23: *Lower band edge for 10 dBi antenna, 20 MHz channel*

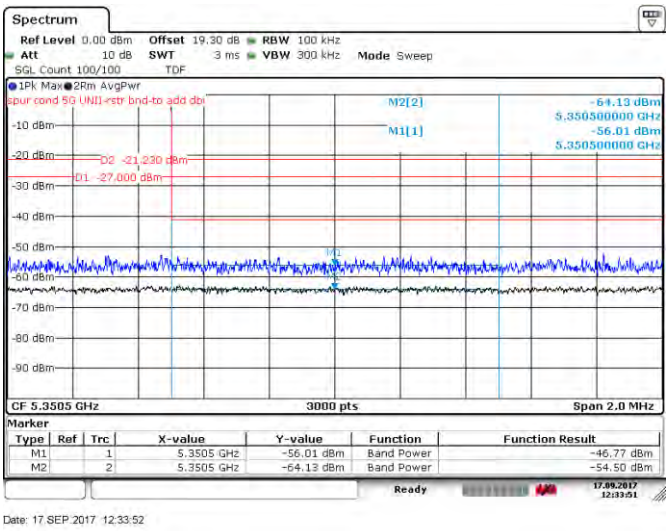


Figure 8.3-24: *Upper band edge for 10 dBi antenna, 20 MHz channel*

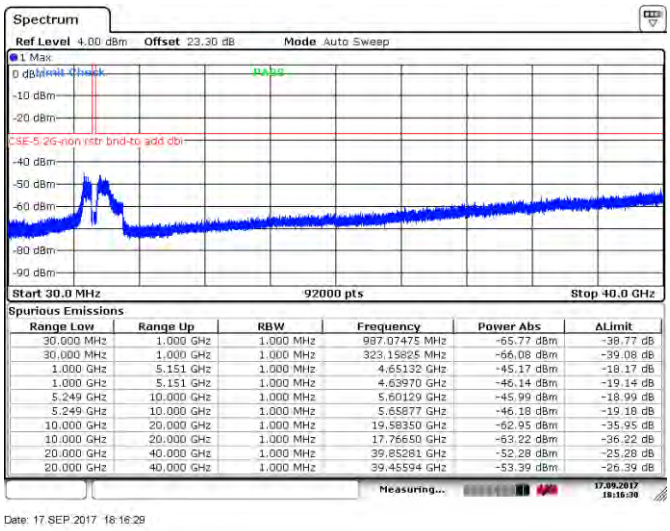


Figure 8.3-25: *Spurious emissions outside restricted bands for 24 dBi antenna, 5 MHz channel, low channel*

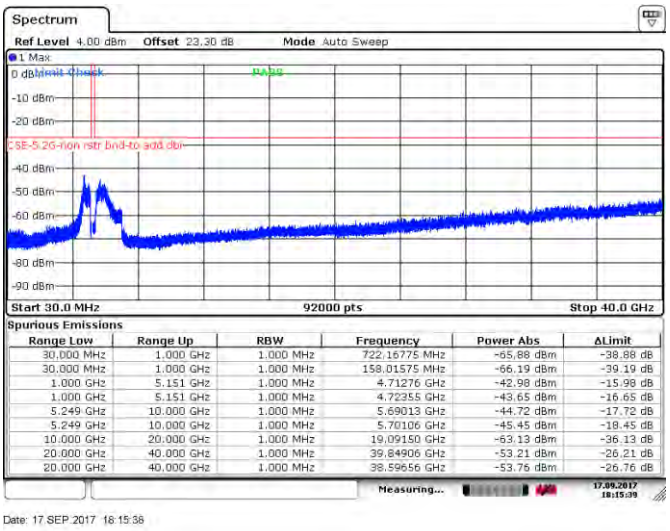


Figure 8.3-26: *Spurious emissions outside restricted bands for 24 dBi antenna, 5 MHz channel, mid channel*

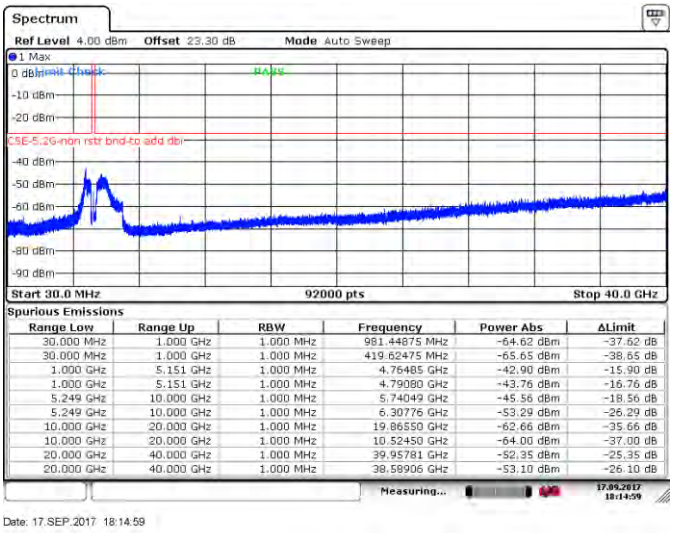


Figure 8.3-27: *Spurious emissions outside restricted bands for 24 dBi antenna, 5 MHz channel, high channel*

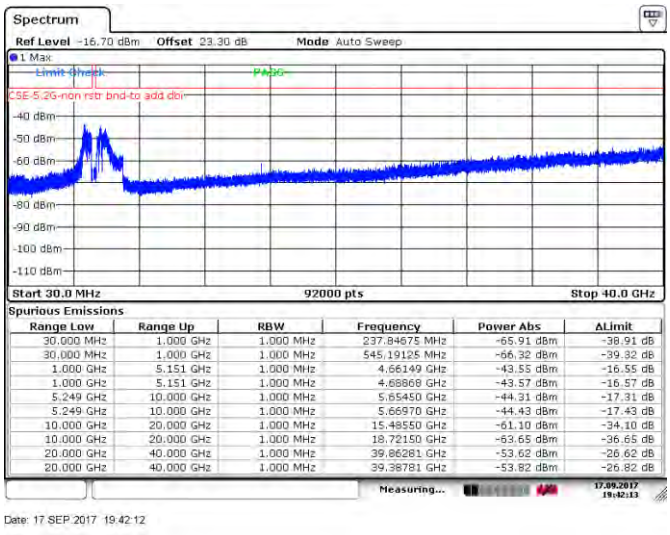


Figure 8.3-28: *Spurious emissions outside restricted bands for 24 dBi antenna, 10 MHz channel, low channel*

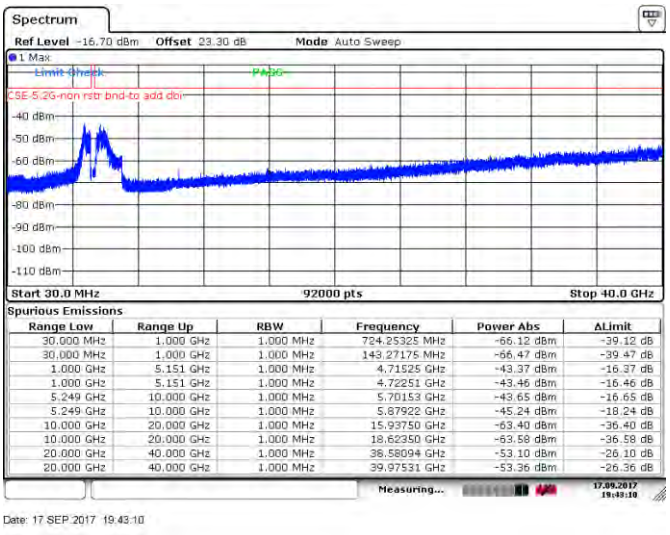


Figure 8.3-29: *Spurious emissions outside restricted bands for 24 dBi antenna, 10 MHz channel, mid channel*

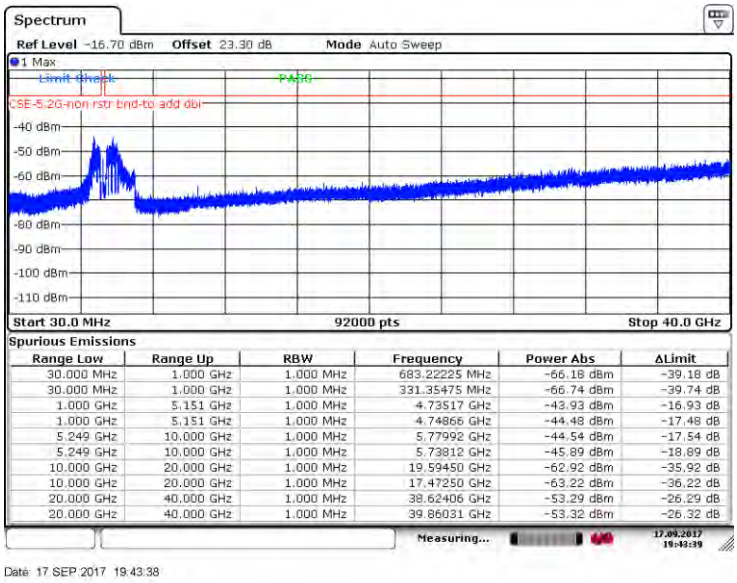


Figure 8.3-30: *Spurious emissions outside restricted bands for 24 dBi antenna, 10 MHz channel, high channel*

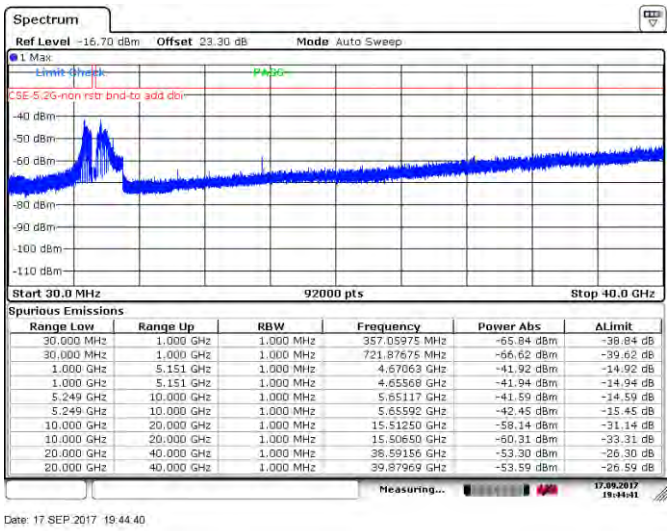


Figure 8.3-31: *Spurious emissions outside restricted bands for 24 dBi antenna, 20 MHz channel, low channel*

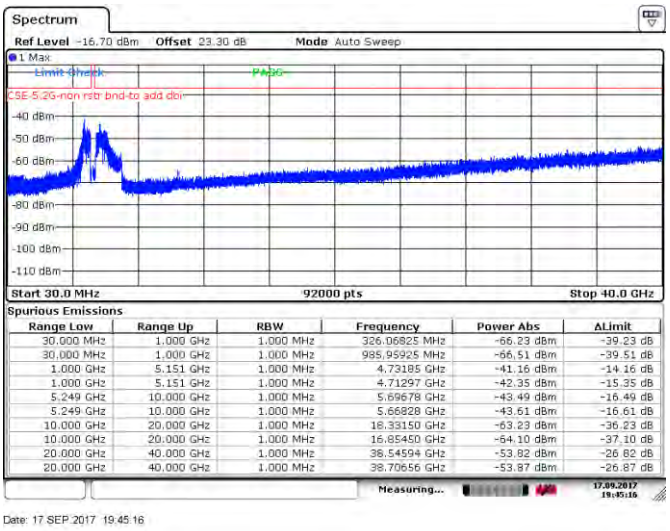


Figure 8.3-32: *Spurious emissions outside restricted bands for 24 dBi antenna, 20 MHz channel, mid channel*

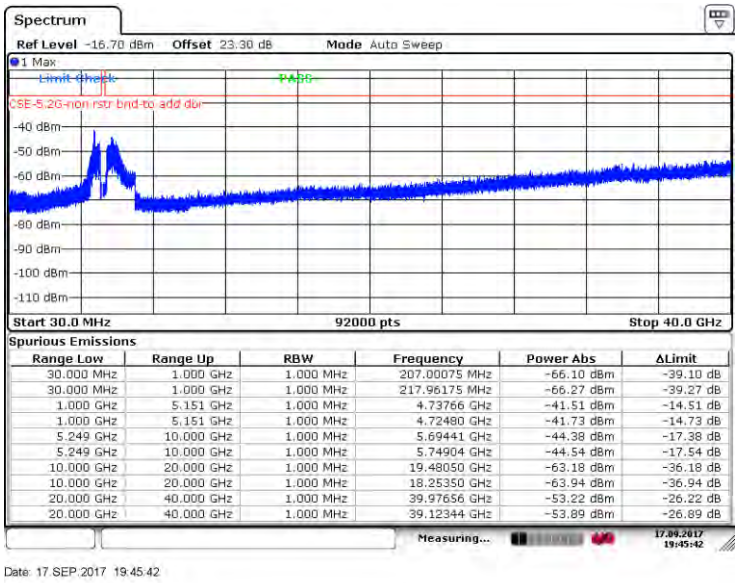


Figure 8.3-33: *Spurious emissions outside restricted bands for 24 dBi antenna, 20 MHz channel, high channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm

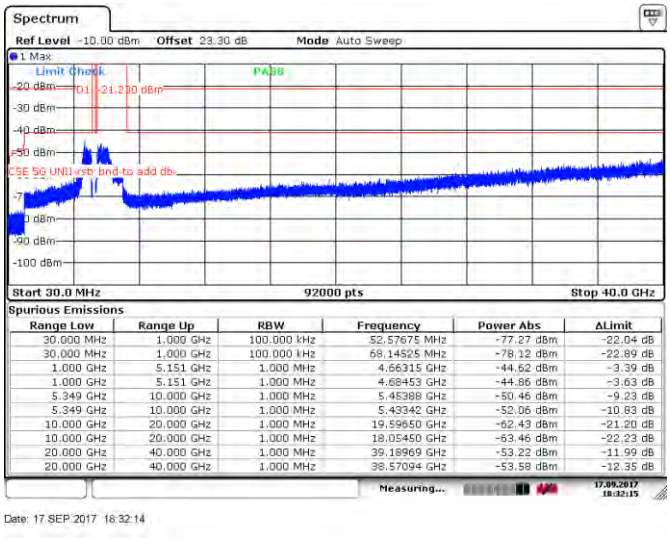


Figure 8.3-34: *Spurious emissions within restricted bands for 24 dBi antenna, 5 MHz channel, low channel*

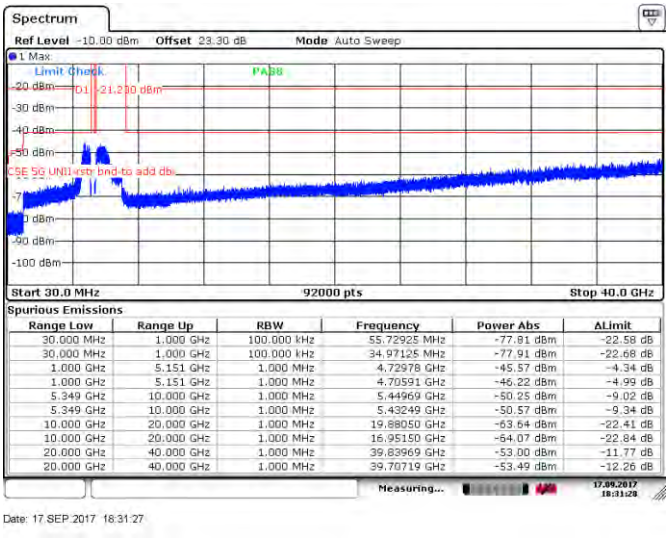


Figure 8.3-35: *Spurious emissions within restricted bands for 24 dBi antenna, 5 MHz channel, mid channel*

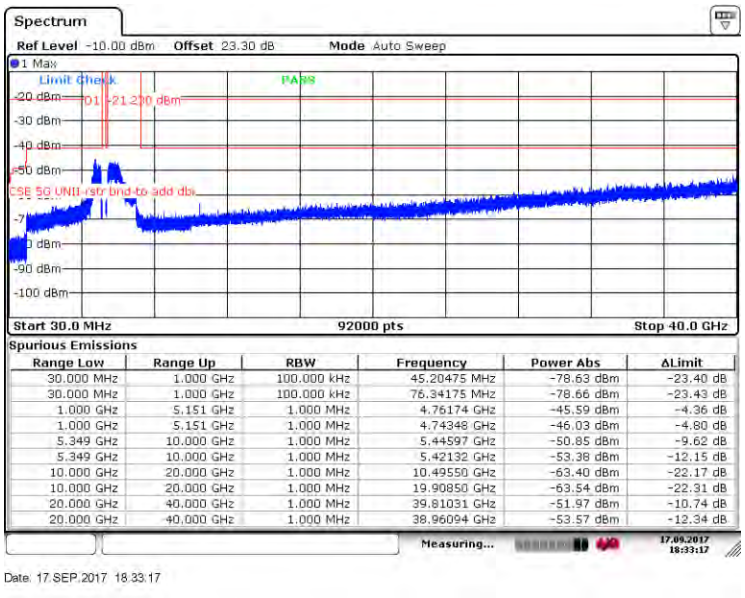


Figure 8.3-36: *Spurious emissions within restricted bands for 24 dBi antenna, 5 MHz channel, high channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm

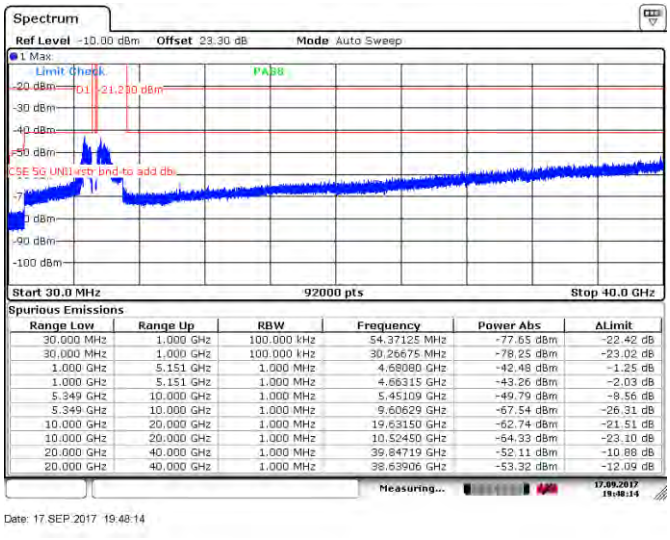


Figure 8.3-37: *Spurious emissions within restricted bands for 24 dBi antenna, 10 MHz channel, low channel*

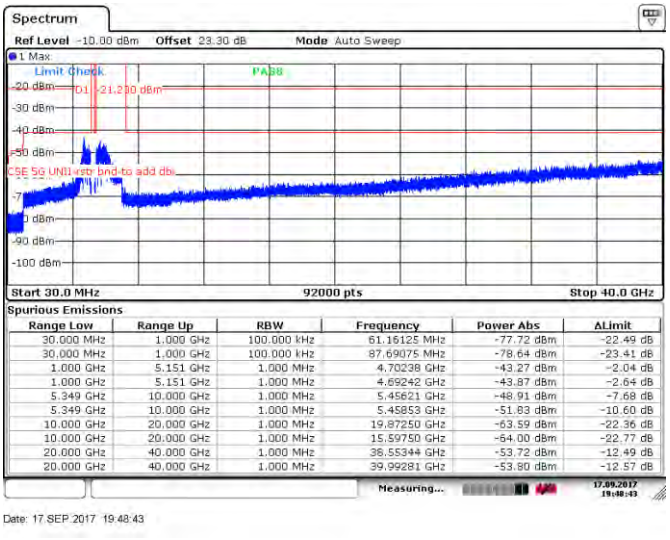


Figure 8.3-38: *Spurious emissions within restricted bands for 24 dBi antenna, 10 MHz channel, mid channel*

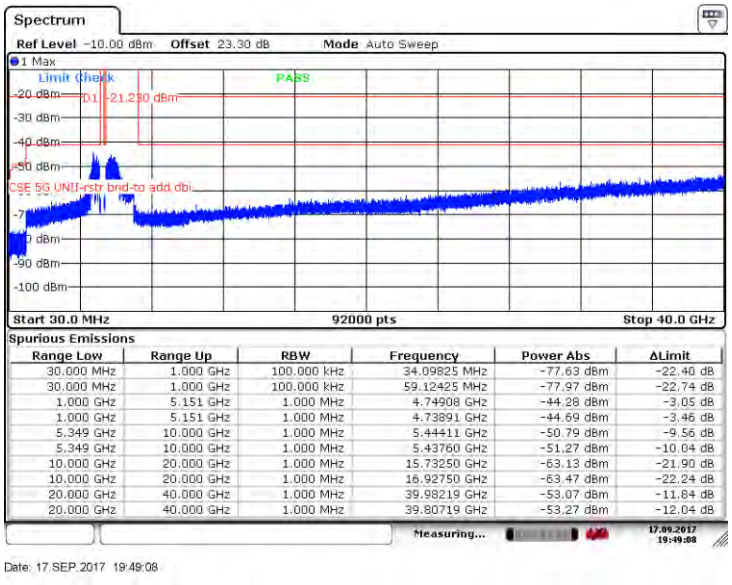


Figure 8.3-39: *Spurious emissions within restricted bands for 24 dBi antenna, 10 MHz channel, high channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm

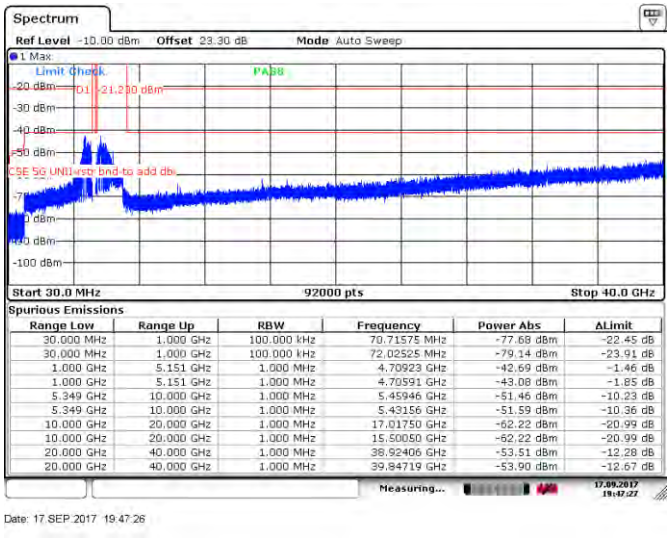


Figure 8.3-40: *Spurious emissions within restricted bands for 24 dBi antenna, 20 MHz channel, low channel*

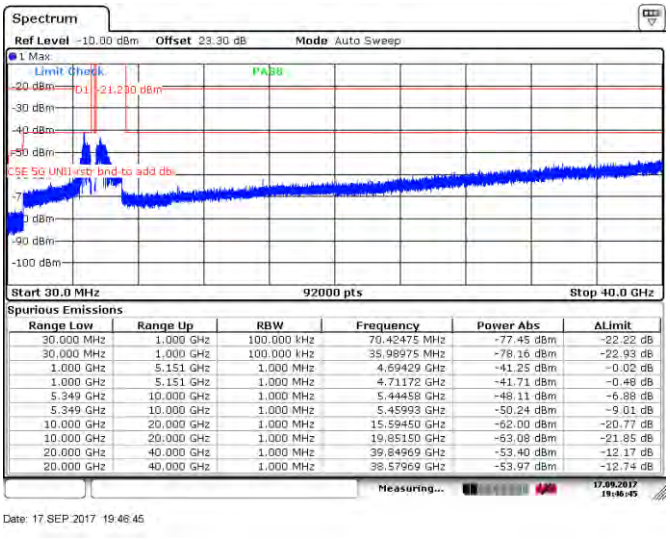


Figure 8.3-41: *Spurious emissions within restricted bands for 24 dBi antenna, 20 MHz channel, mid channel*

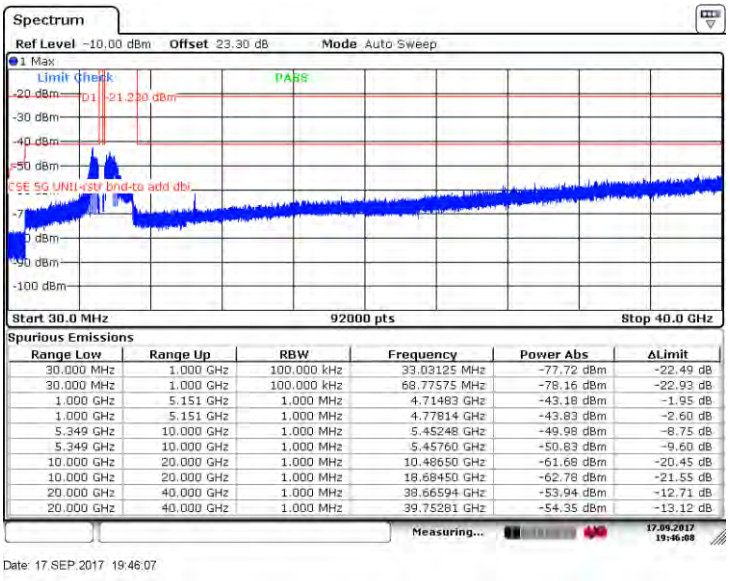


Figure 8.3-42: *Spurious emissions within restricted bands for 24 dBi antenna, 20 MHz channel, high channel*

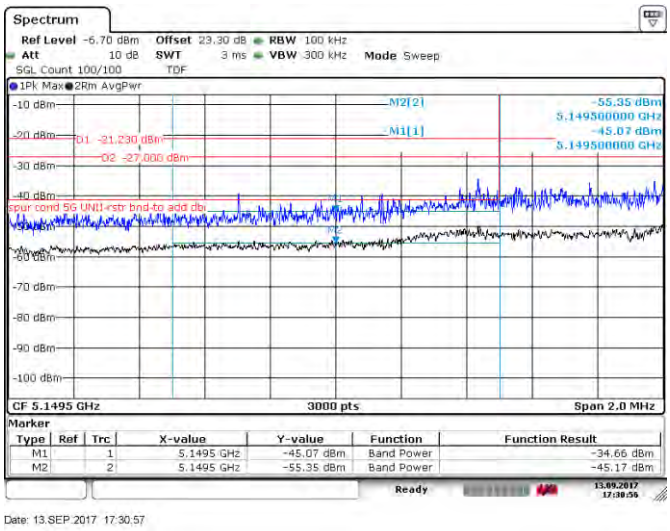


Figure 8.3-43: *Lower band edge for 24 dBi antenna, 5 MHz channel*

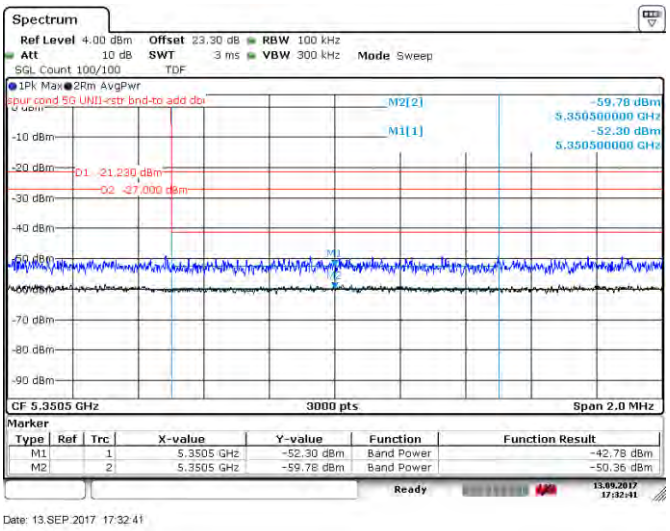


Figure 8.3-44: *Upper band edge for 24 dBi antenna, 5 MHz channel*

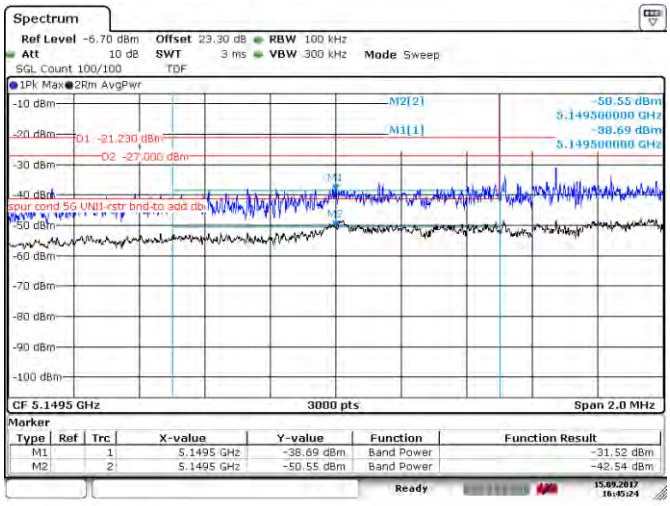


Figure 8.3-45: *Lower band edge for 24 dBi antenna, 10 MHz channel*

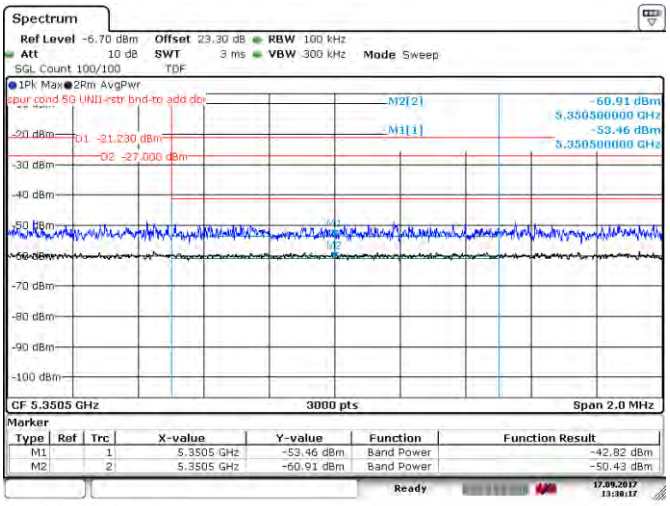


Figure 8.3-46: *Upper band edge for 24 dBi antenna, 10 MHz channel*

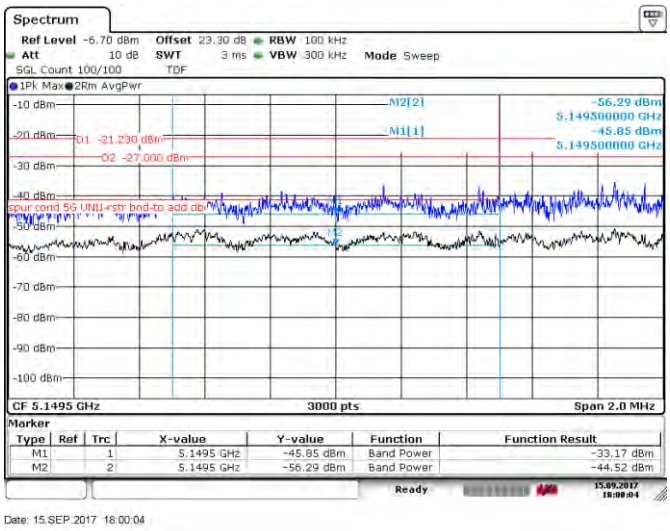


Figure 8.3-47: *Lower band edge for 24 dBi antenna, 20 MHz channel*

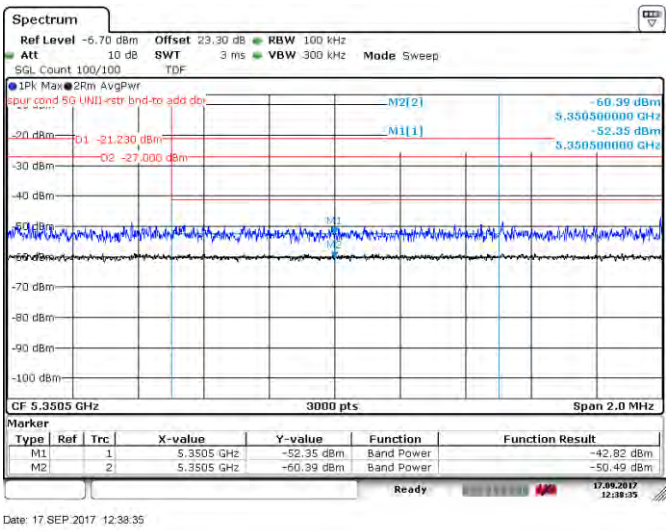


Figure 8.3-48: *Upper band edge for 24 dBi antenna, 20 MHz channel*

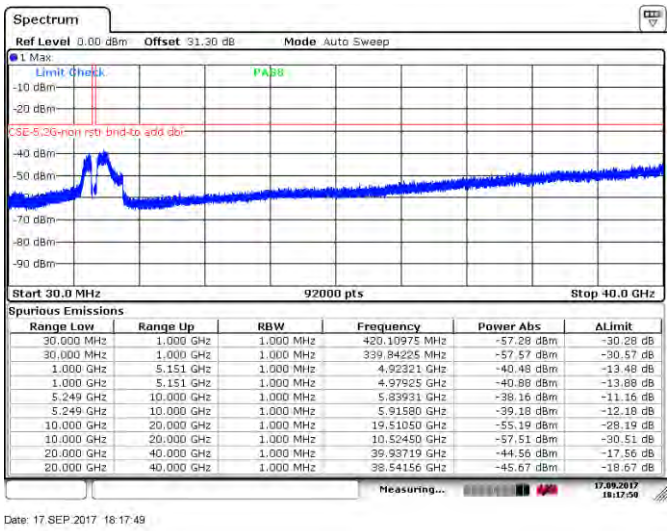


Figure 8.3-49: *Spurious emissions outside restricted bands for 32 dBi antenna, 5 MHz channel, low channel*

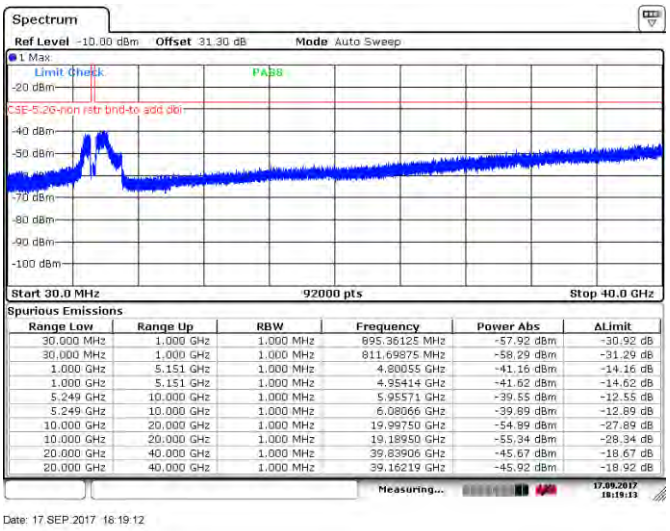


Figure 8.3-50: *Spurious emissions outside restricted bands for 32 dBi antenna, 5 MHz channel, mid channel*

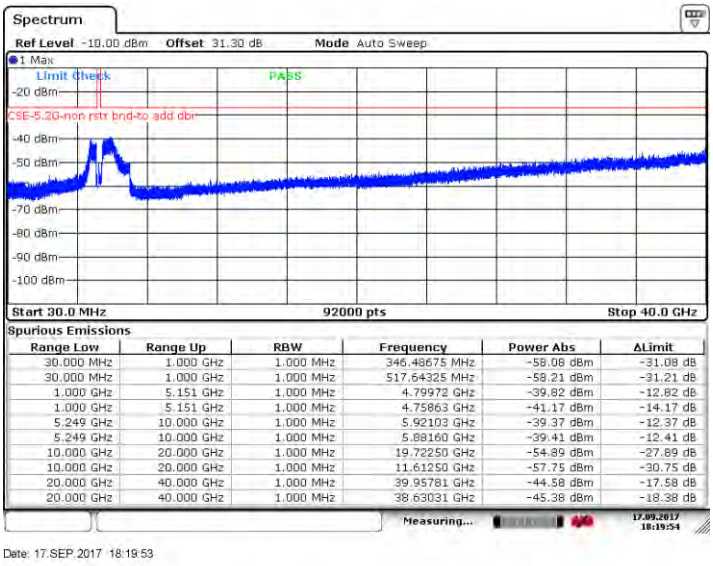


Figure 8.3-51: *Spurious emissions outside restricted bands for 32 dBi antenna, 5 MHz channel, high channel*

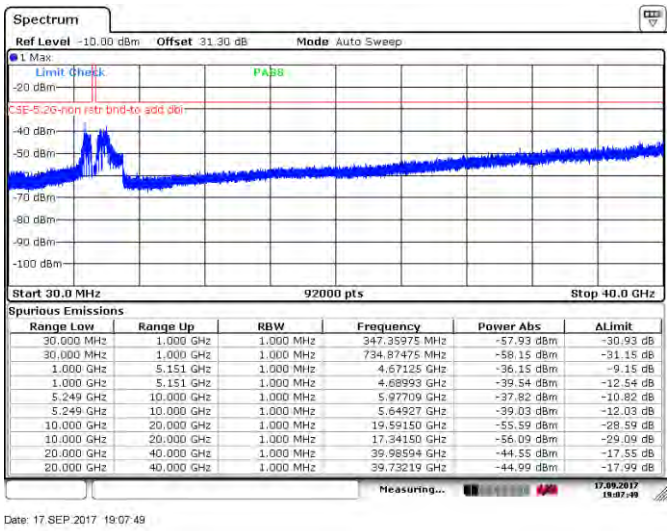


Figure 8.3-52: *Spurious emissions outside restricted bands for 32 dBi antenna, 10 MHz channel, low channel*

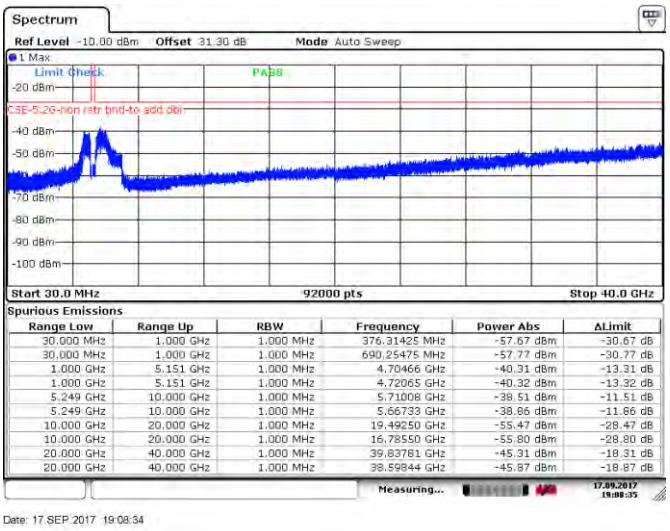


Figure 8.3-53: *Spurious emissions outside restricted bands for 32 dBi antenna, 10 MHz channel, mid channel*

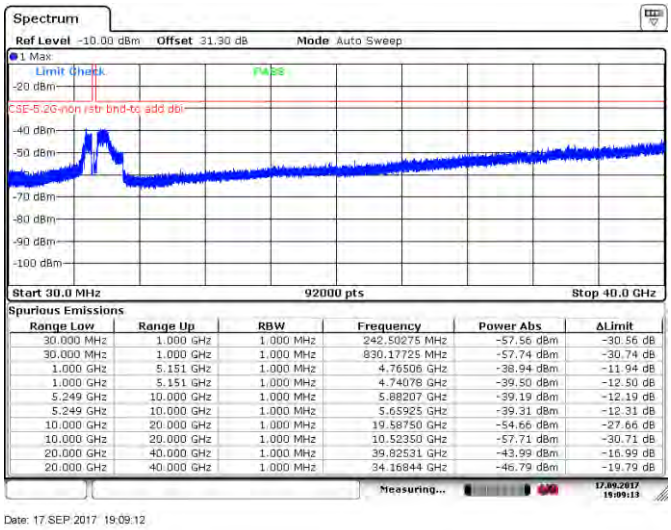


Figure 8.3-54: *Spurious emissions outside restricted bands for 32 dBi antenna, 10 MHz channel, high channel*

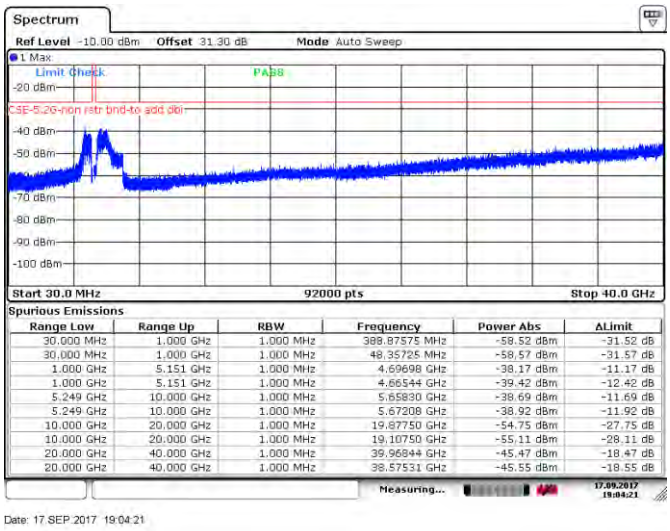


Figure 8.3-55: *Spurious emissions outside restricted bands for 32 dBi antenna, 20 MHz channel, low channel*

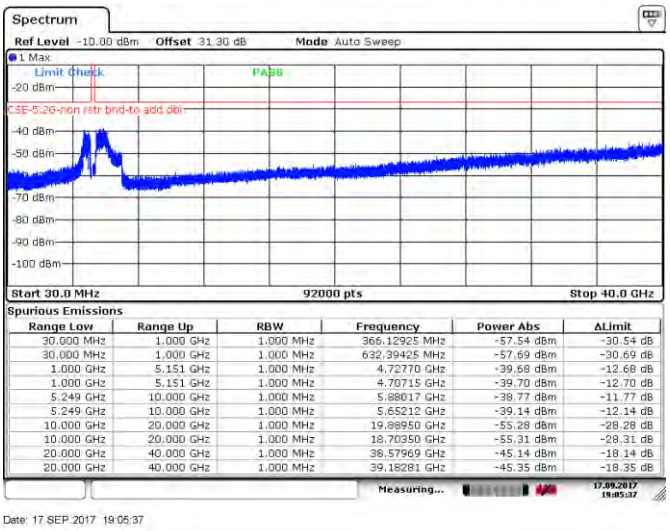


Figure 8.3-56: *Spurious emissions outside restricted bands for 32 dBi antenna, 20 MHz channel, mid channel*

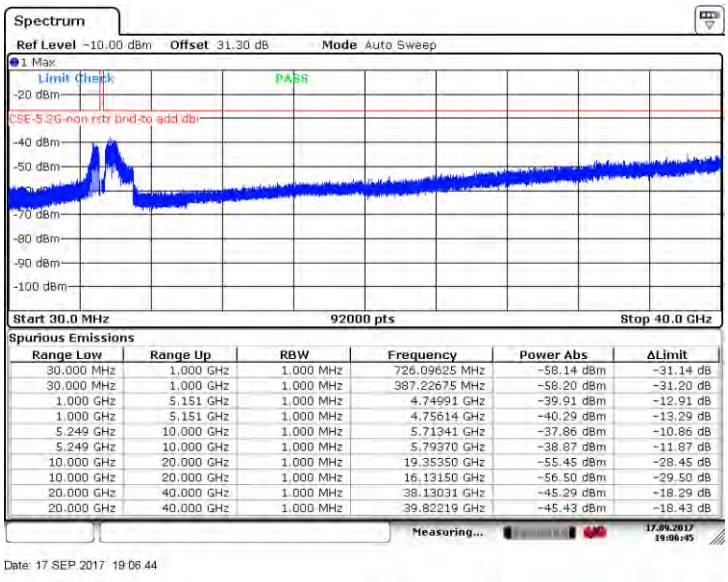


Figure 8.3-57: *Spurious emissions outside restricted bands for 32 dBi antenna, 20 MHz channel, high channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm
Plots below show EIRP trace measured using peak detector and compared with average limit. Where peak level of any emission has exceeded average limit line, that emission was then re-measured with RMS detector.

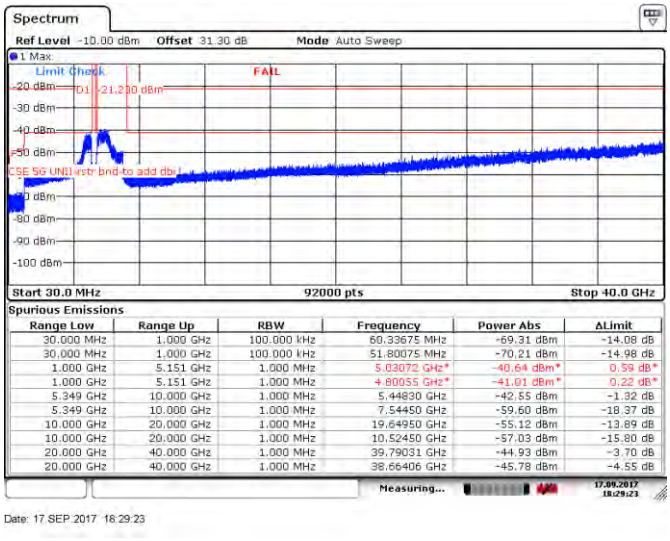


Figure 8.3-58: *Peak Spurious emissions within restricted bands for 32 dBi antenna, 5 MHz channel, low channel*

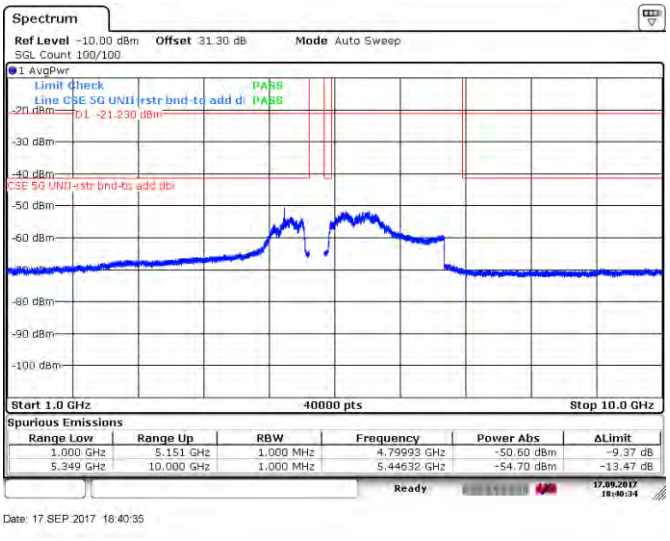
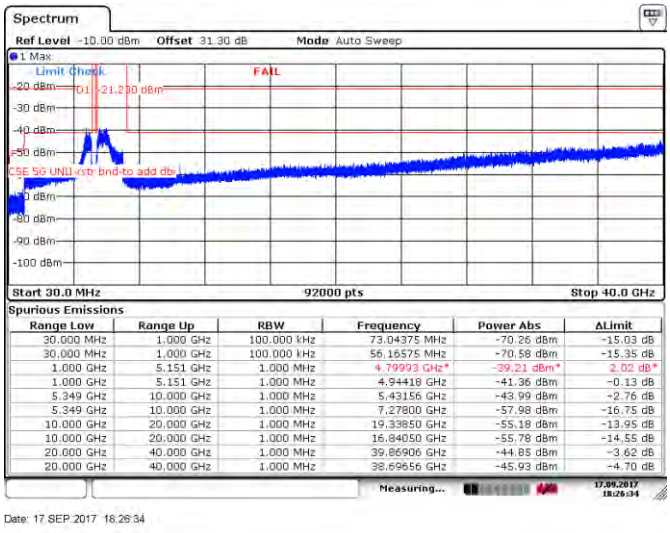


Figure 8.3-59: *Average Spurious emissions within restricted bands for 32 dBi antenna, 5 MHz channel, low channel*



igure 8.3-60: *Peak Spurious emissions within restricted bands for 32 dBi antenna, 5 MHz channel, mid channel*

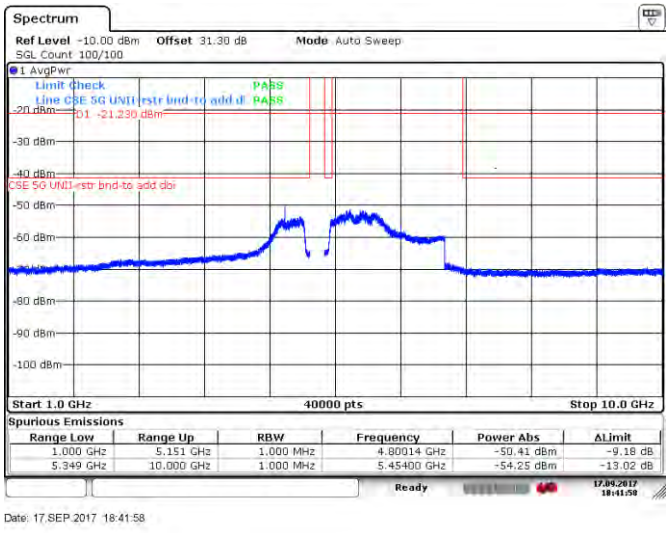


Figure 8.3-61: *Average Spurious emissions within restricted bands for 32 dBi antenna, 5 MHz channel, mid channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm
Plots below show EIRP trace measured using peak detector and compared with average limit. Where peak level of any emission has exceeded average limit line, that emission was then re-measured with RMS detector.

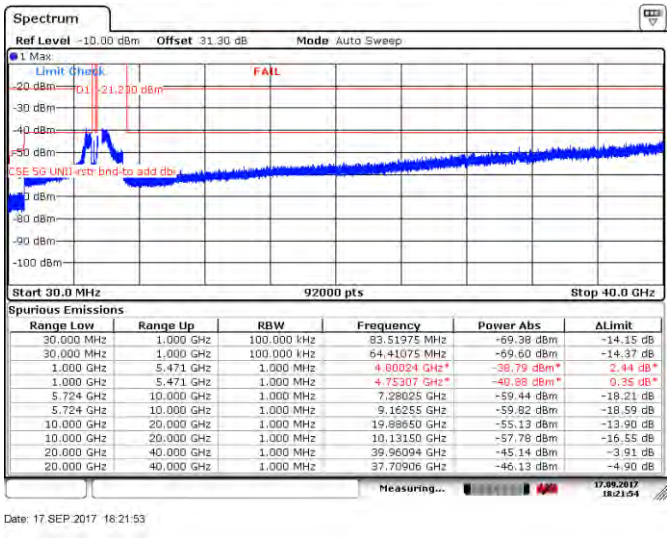


Figure 8.3-62: *Peak Spurious emissions within restricted bands for 32 dBi antenna, 5 MHz channel, high channel*

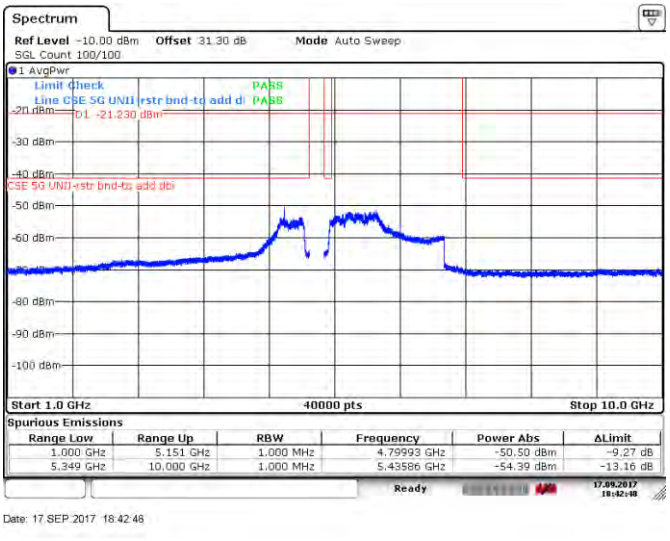


Figure 8.3-63: *Average Spurious emissions within restricted bands for 32 dBi antenna, 5 MHz channel, high channel*

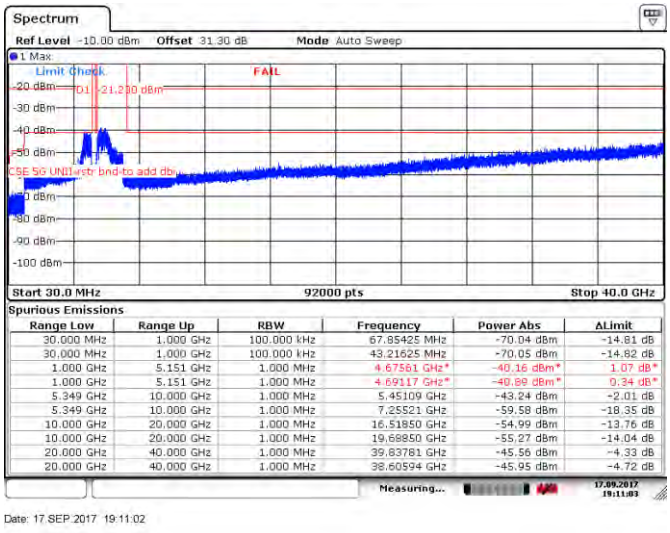


Figure 8.3-64: *Spurious emissions within restricted bands for 32 dBi antenna, 10 MHz channel, low channel*

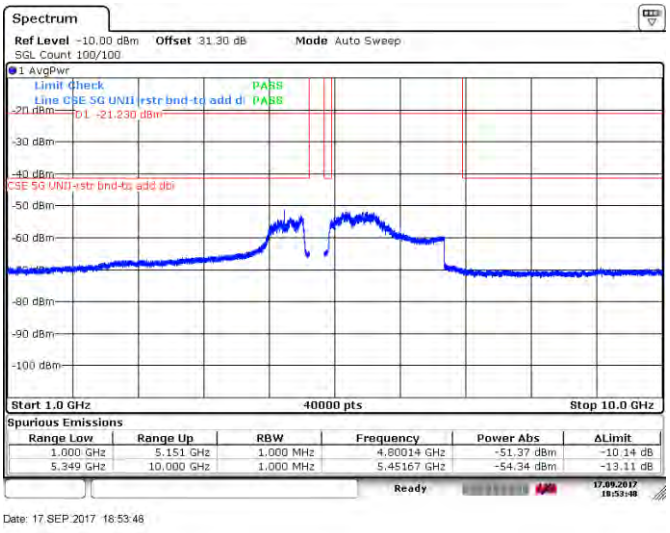


Figure 8.3-65: *Spurious emissions within restricted bands for 32 dBi antenna, 10 MHz channel, mid channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm
Plots below show EIRP trace measured using peak detector and compared with average limit. Where peak level of any emission has exceeded average limit line, that emission was then re-measured with RMS detector.

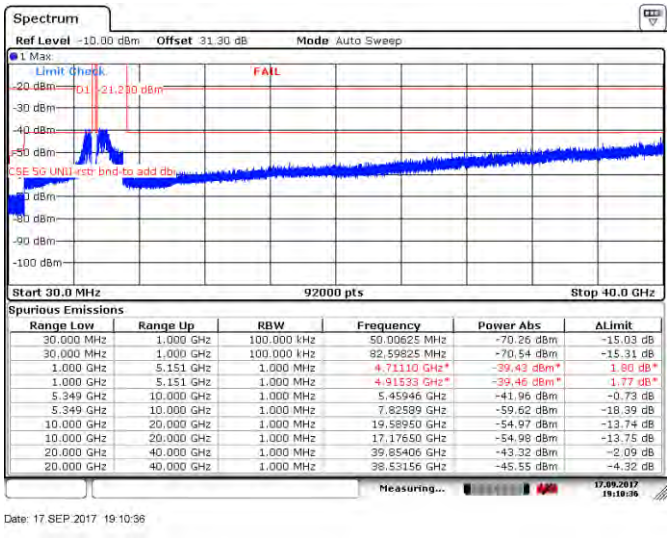


Figure 8.3-66: *Spurious emissions within restricted bands for 32 dBi antenna, 10 MHz channel, mid channel*

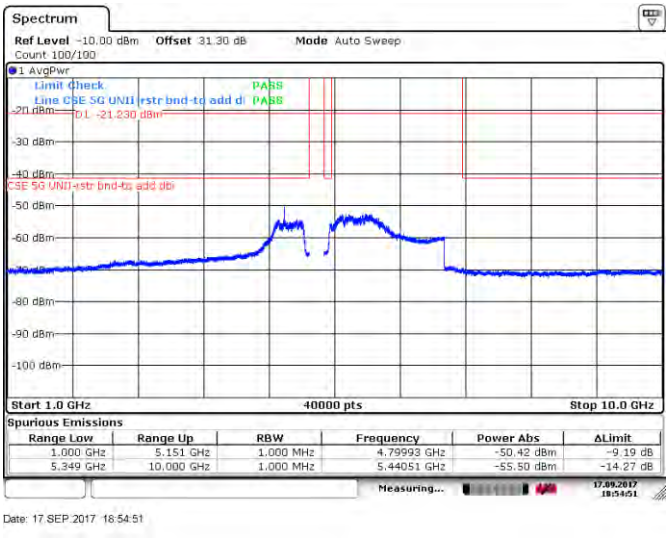


Figure 8.3-67: *Spurious emissions within restricted bands for 32 dBi antenna, 10 MHz channel, mid channel*

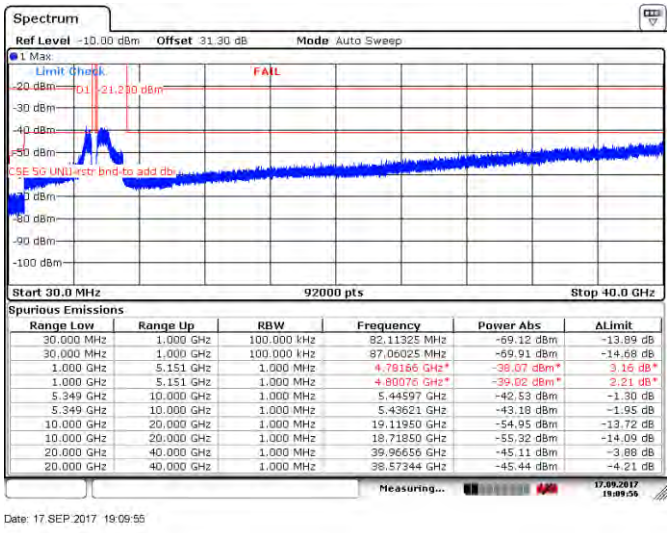


Figure 8.3-68: *Spurious emissions within restricted bands for 32 dBi antenna, 10 MHz channel, high channel*

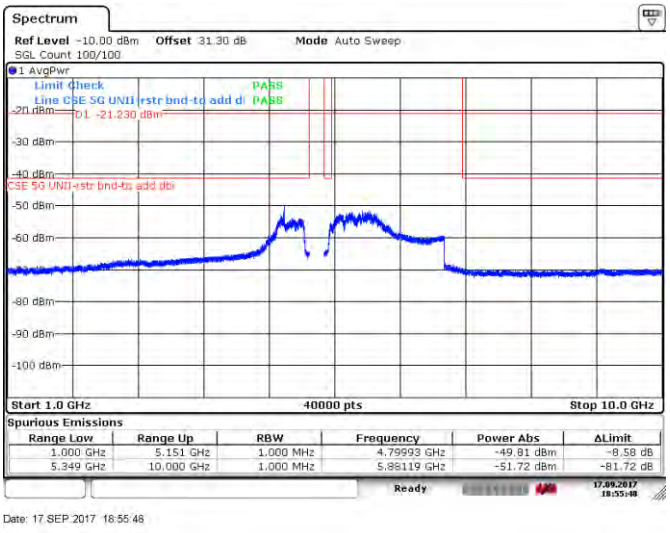


Figure 8.3-69: *Spurious emissions within restricted bands for 32 dBi antenna, 10 MHz channel, high channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm
Plots below show EIRP trace measured using peak detector and compared with average limit. Where peak level of any emission has exceeded average limit line, that emission was then re-measured with RMS detector.

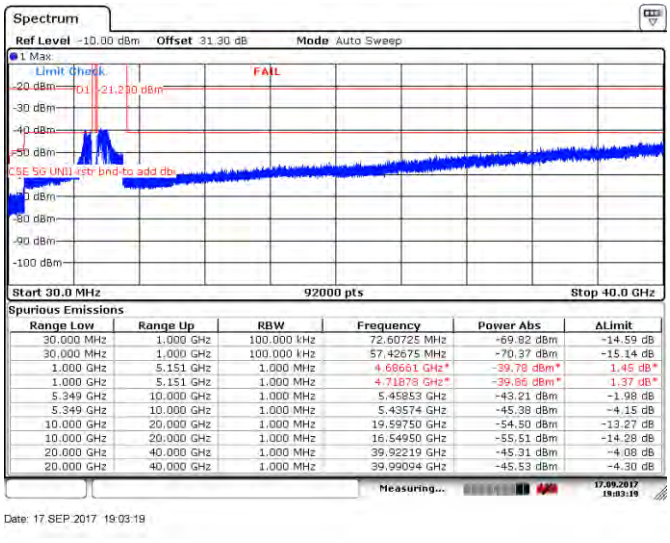


Figure 8.3-70: *Spurious emissions within restricted bands for 32 dBi antenna, 20 MHz channel, low channel*

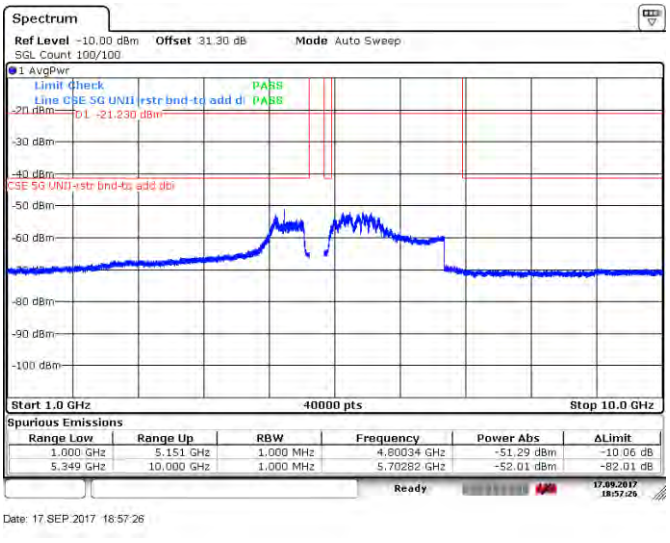


Figure 8.3-71: *Spurious emissions within restricted bands for 32 dBi antenna, 20 MHz channel, low channel*

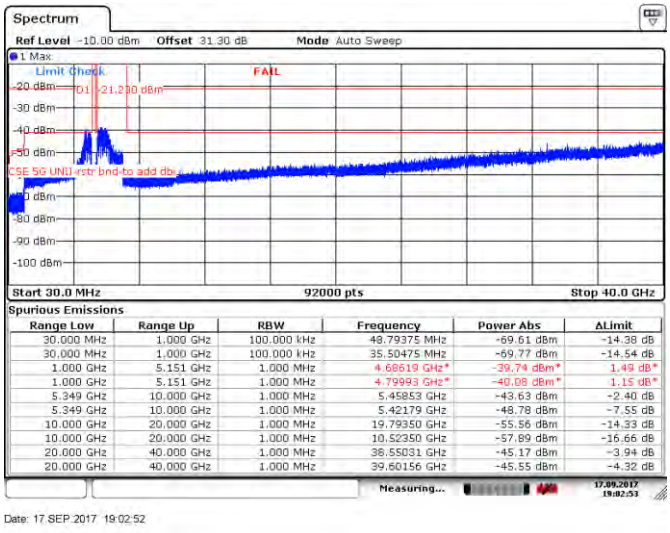


Figure 8.3-72: *Spurious emissions within restricted bands for 32 dBi antenna, 20 MHz channel, mid channel*

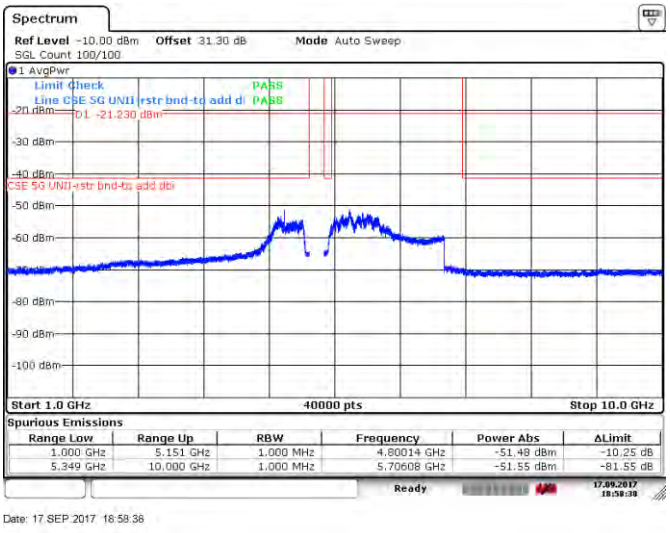


Figure 8.3-73: *Spurious emissions within restricted bands for 32 dBi antenna, 20 MHz channel, mid channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm
Plots below show EIRP trace measured using peak detector and compared with average limit. Where peak level of any emission has exceeded average limit line, that emission was then re-measured with RMS detector.

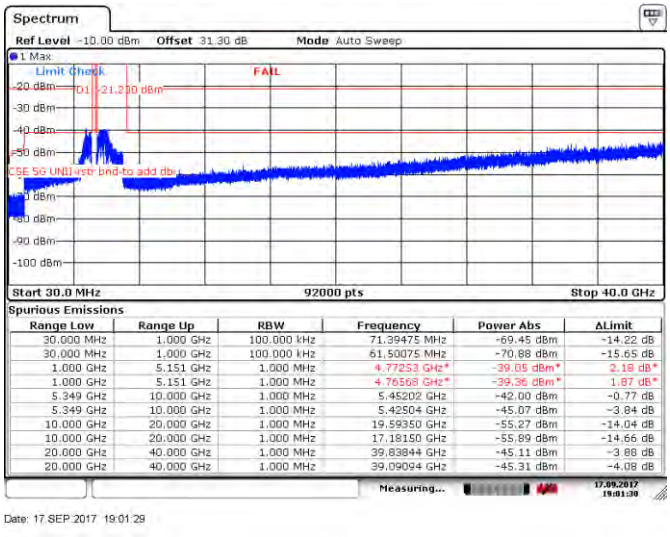


Figure 8.3-74: *Spurious emissions within restricted bands for 32 dBi antenna, 20 MHz channel, high channel*

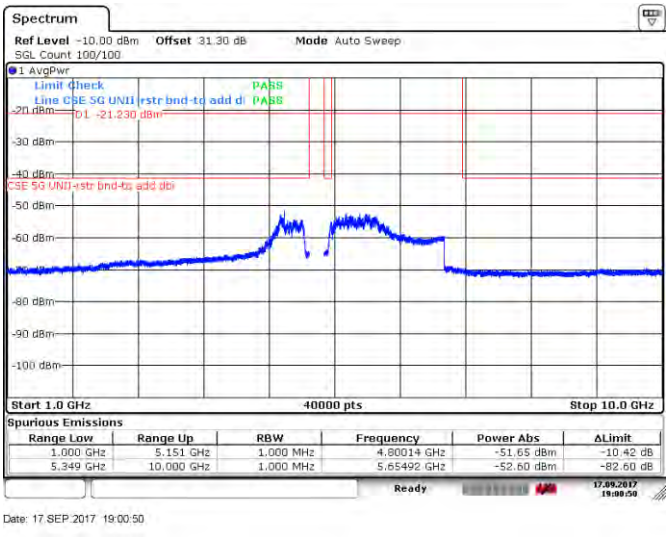


Figure 8.3-75: *Spurious emissions within restricted bands for 32 dBi antenna, 20 MHz channel, high channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm

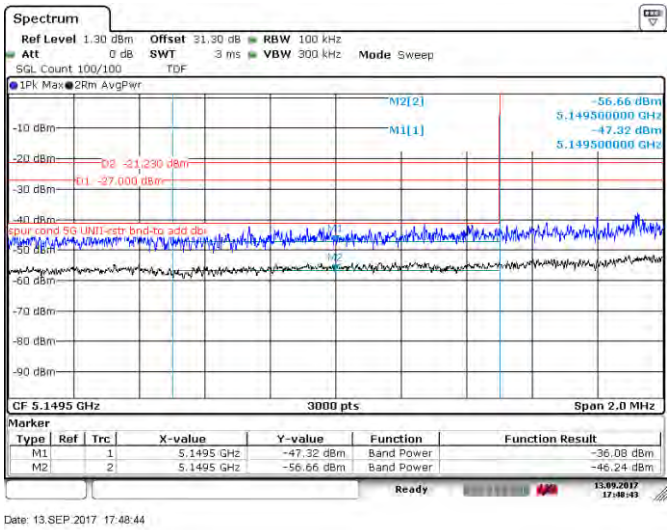


Figure 8.3-76: *Lower band edge for 32 dBi antenna, 5 MHz channel*

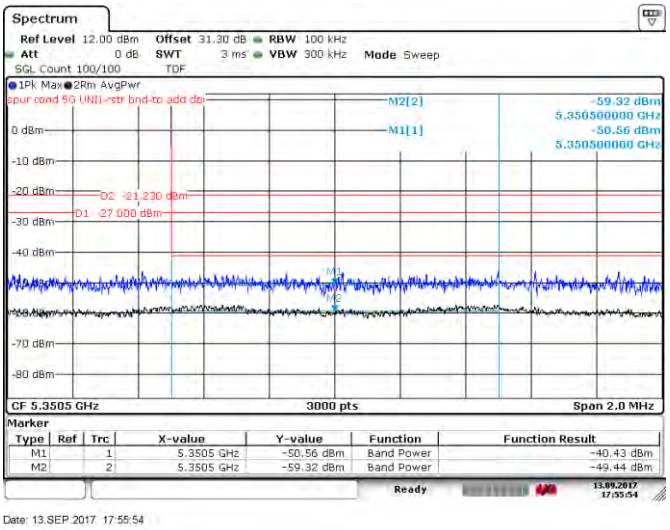


Figure 8.3-77: *Upper band edge for 32 dBi antenna, 5 MHz channel*

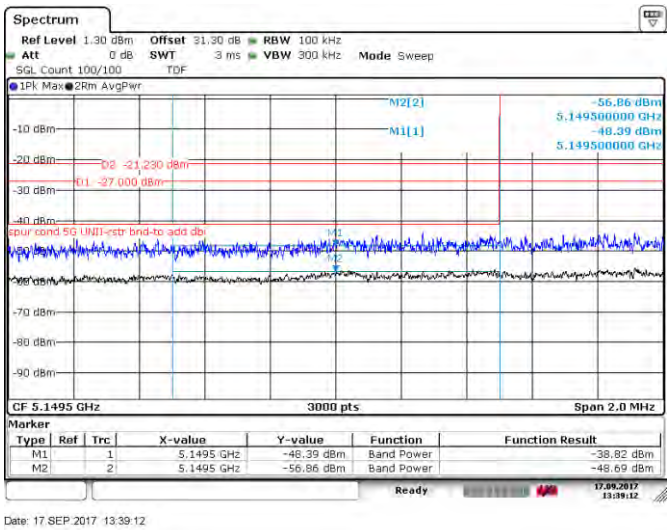


Figure 8.3-78: *Lower band edge for 32 dBi antenna, 10 MHz channel*

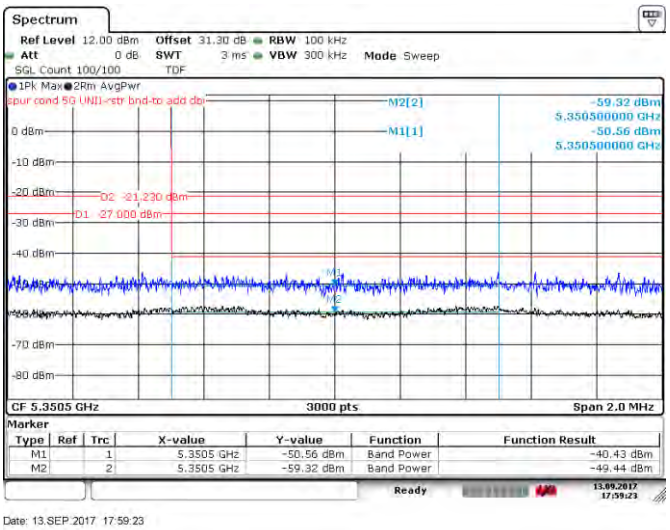


Figure 8.3-79: *Upper band edge for 32 dBi antenna, 10 MHz channel*

Peak limit EIRP equivalent: 74 dBµV/m – 95.23 dB = −21.23 dBm
Average limit EIRP equivalent: 54 dBµV/m – 95.23 dB = −41.23 dBm

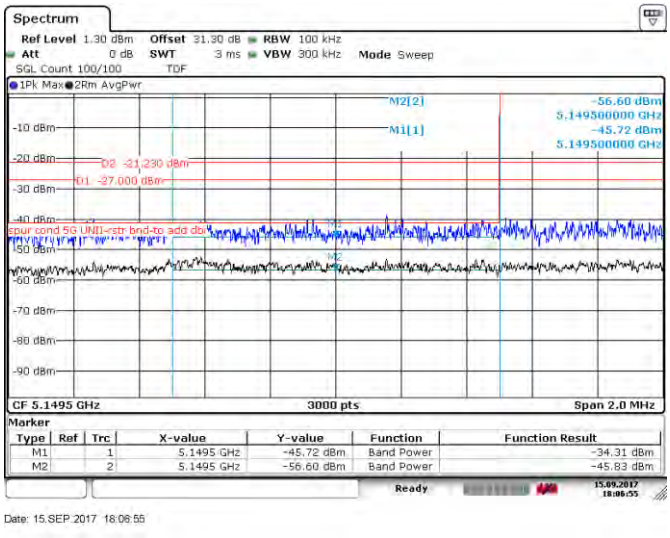


Figure 8.3-80: *Lower band edge for 32 dBi antenna, 20 MHz channel*

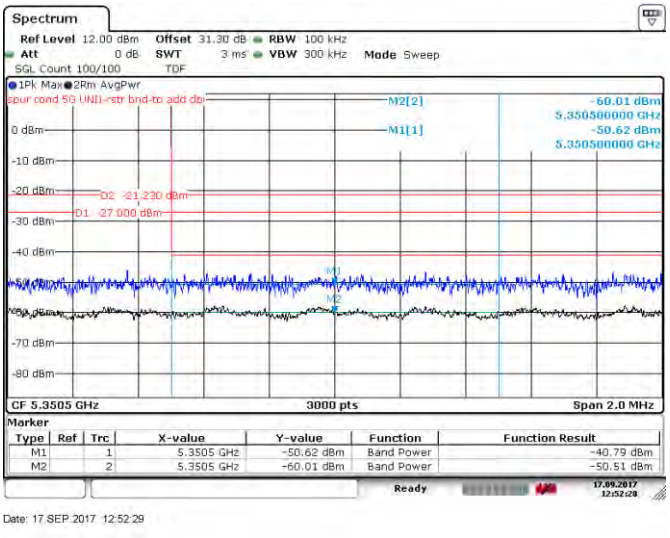


Figure 8.3-81: *Upper band edge for 32 dBi antenna, 20 MHz channel*

8.4 FCC 15.207(a) AC power line conducted emissions limits

8.4.1 Definitions and limits

FCC §15.407(6)(b):

Any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207

FCC §15.207(a):
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 µH/50 Ω 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 8.4-1: *Conducted emissions limit*

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

Note: * - The level decreases linearly with the logarithm of the frequency.
** - A linear average detector is required.

8.4.2 Test summary

Test date:	September 15, 2017	Temperature:	24 °C
Test engineer:	Yong Huang	Air pressure:	1007 mbar
Verdict:	Pass	Relative humidity:	43 %

8.4.3 Observations, settings and special notes

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.

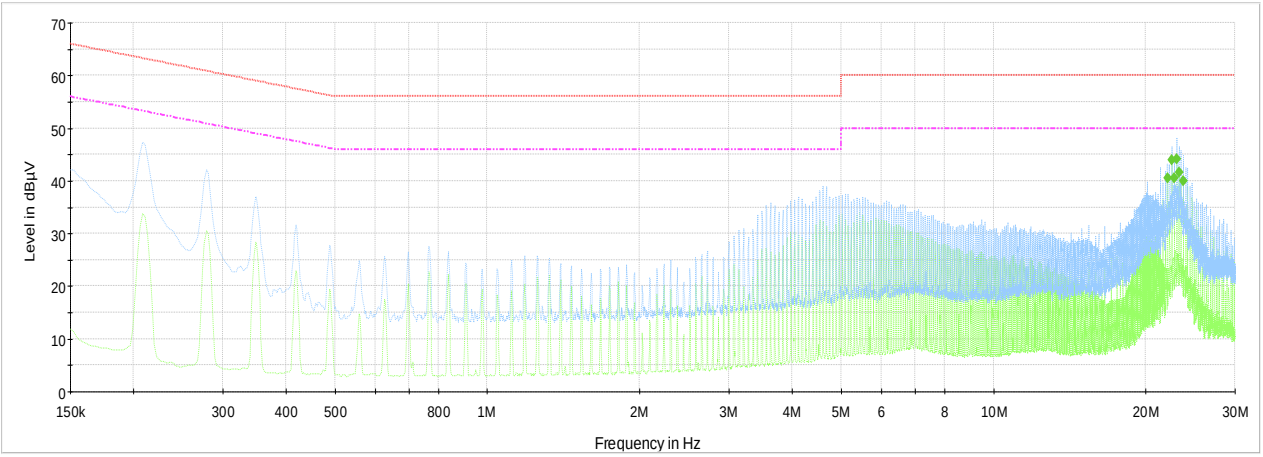
Receiver settings for preview measurements:

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	100 ms

8.4.4 Test data



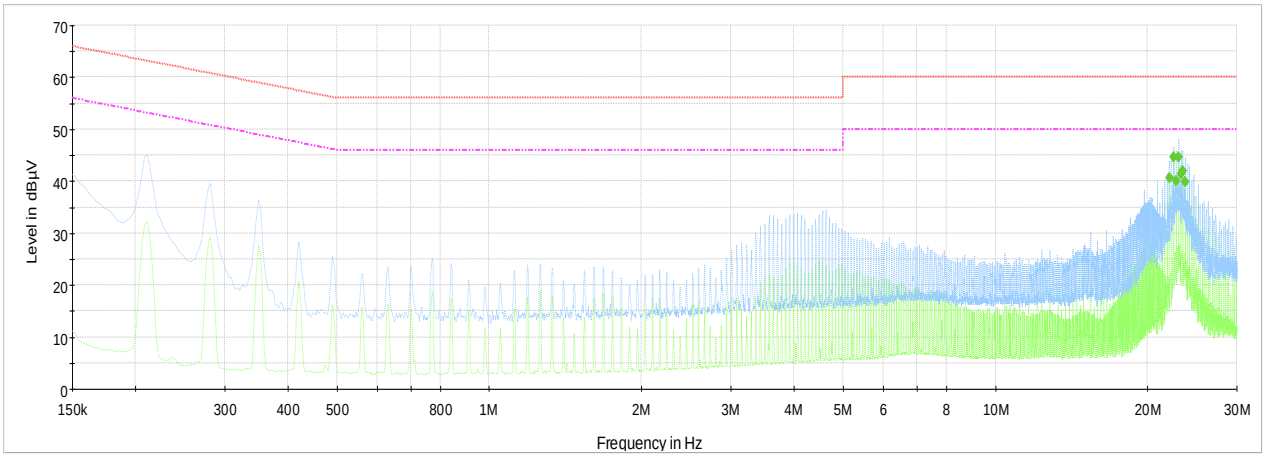
Plot 8.4-1: *Conducted emissions on phase line*

Table 8.4-2: *Average conducted emissions results on phase line*

Frequency, MHz	Average result, dBµV	Limit, dBµV	Margin, dB	Meas. Time, ms	Bandwidth, kHz	Correction, dB
22.053	40.5	50.0	9.6	100	9	10.7
22.528	43.9	50.0	6.1	100	9	10.7
22.764	40.5	50.0	9.5	100	9	10.8
23.001	44.2	50.0	5.9	100	9	10.8
23.239	41.6	50.0	8.4	100	9	10.8
23.712	39.9	50.0	10.1	100	9	10.8

Notes: [1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions have been recorded.

Sample calculation: 40.5 dBµV (result) = 29.8 dBµV (receiver reading) + 10.7 dB (Correction factor)



Plot 8.4-2: *Conducted emissions on neutral line*

Table 8.4-3: *Average conducted emissions results on neutral line*

Frequency, MHz	Average result, dBµV	Limit, dBµV	Margin, dB	Meas. Time, ms	Bandwidth, kHz	Correction, dB
22.056	40.7	50.0	9.3	100	9	10.8
22.530	44.7	50.0	5.3	100	9	10.8
22.767	40.1	50.0	9.9	100	9	10.8
23.003	44.7	50.0	5.3	100	9	10.8
23.241	41.4	50.0	8.6	100	9	10.8
23.478	42.0	50.0	8.0	100	9	10.8
23.714	39.9	50.0	10.1	100	9	10.8

Notes: [1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions have been recorded.

Sample calculation: 40.7 dBµV (result) = 29.9 dBµV (receiver reading) + 10.8 dB (Correction factor)

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:	September 25, 2017	Temperature:	25 °C
Test engineer:	Yong Huang	Air pressure:	1007 mbar
Verdict:	Pass	Relative humidity:	45 %

8.5.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	50 Hz
Video bandwidth:	50 Hz
Detector mode:	Peak
Trace mode:	Max Hold

8.5.4 Test data

Table 8.5-1: *Frequency drift measurement*

Test conditions	Nominal frequency, GHz	Frequency, GHz	Drift, Hz
+50 °C, Nominal	5.2000000	5.2000633	*-21600*
+40 °C, Nominal	5.2000000	5.2000665	*-18400*
+30 °C, Nominal	5.2000000	5.2000775	*-7400*
+20 °C, +15 %	5.2000000	5.2000849	*0*
+20 °C, Nominal	5.2000000	5.2000849	*reference*
+20 °C, −15 %	5.2000000	5.2000849	*0*
+10 °C, Nominal	5.2000000	5.2000989	*14000*
0 °C, Nominal	5.2000000	5.2001071	*22200*
−10 °C, Nominal	5.2000000	5.2001079	*23000*
−20 °C, Nominal	5.2000000	5.2000981	*13200*
−30 °C, Nominal	5.2000000	5.2000845	*-400*

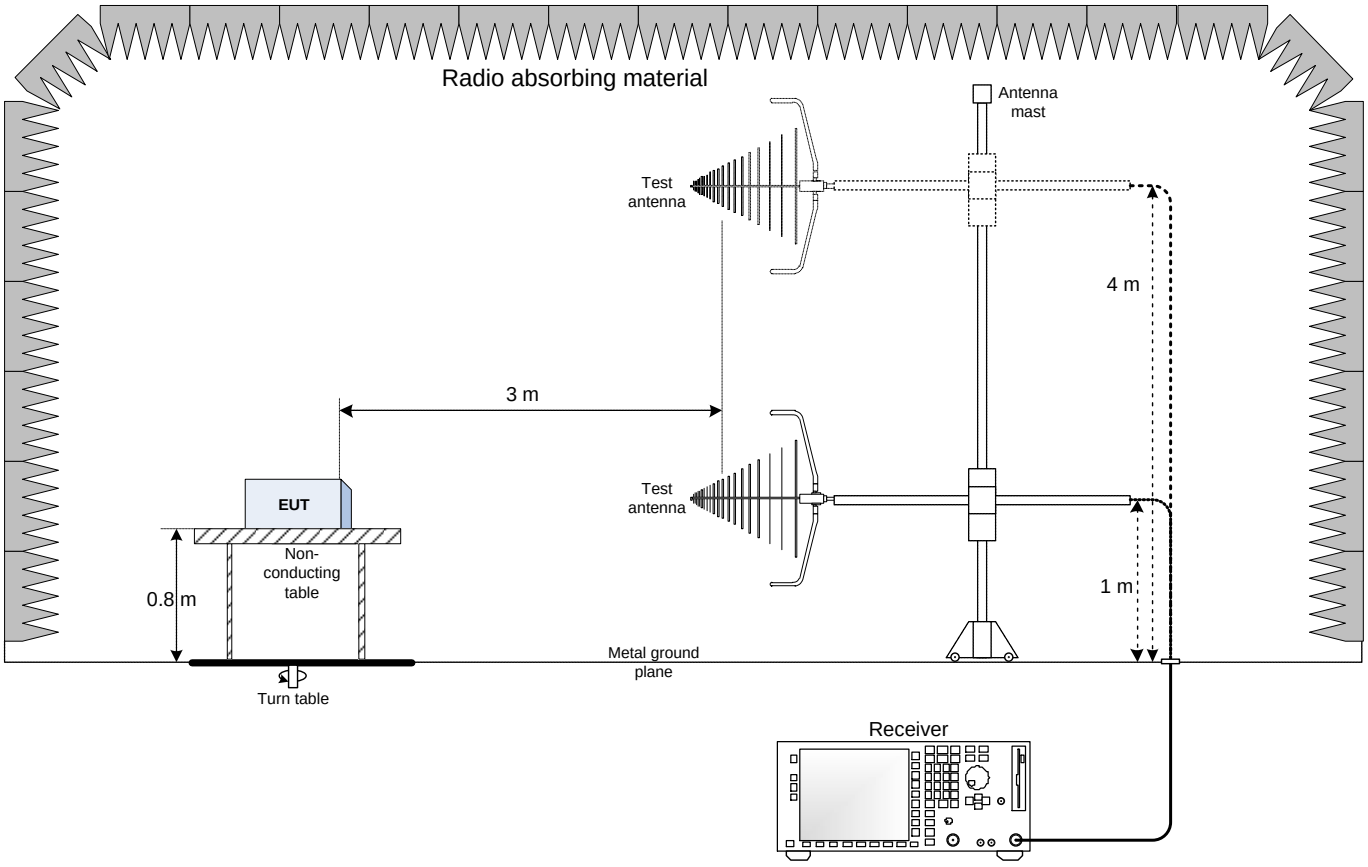
Minimum lower band edge margin is more than 2.6 MHz

Minimum upper band edge margin is more than 175 kHz

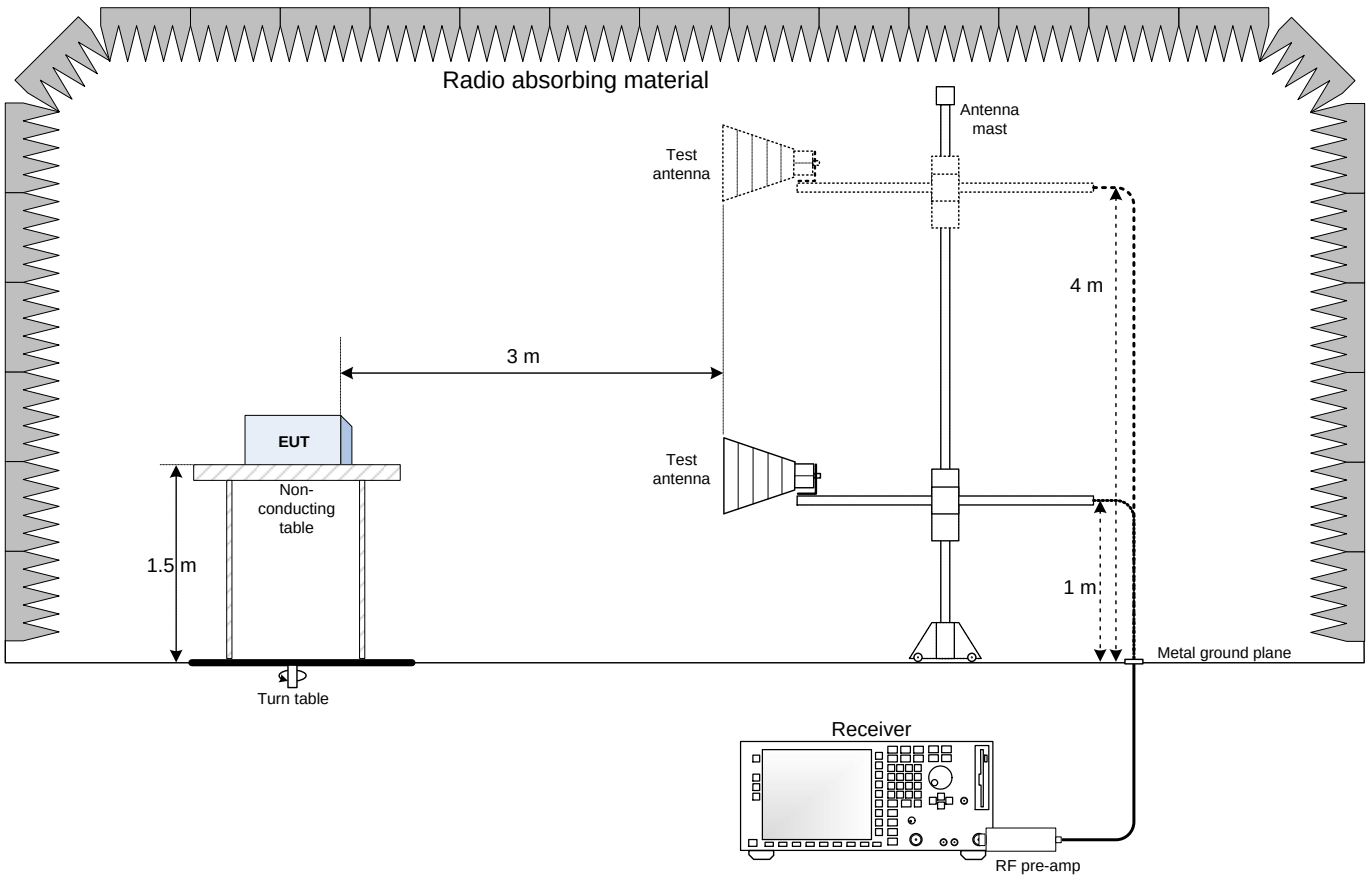
The frequency drifts in above table are within these minimum margins, the emissions are deemed to maintain within the band of operation.

Section 9. Block diagrams of test set-ups

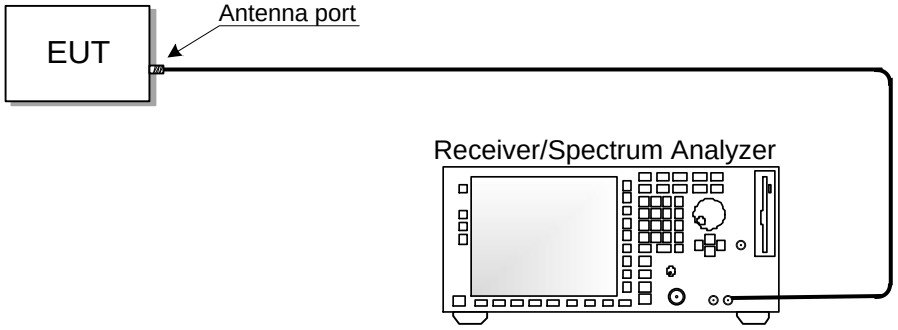
9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted antenna port set-up



9.4 Conducted emissions set-up