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Wireless test report – 346210-1TRFWL

Applicant:

Redline Communications

Product name:

Broad-band wireless infrastructure product

Model:

RDL-3000-RME

FCC ID:

QC8-RDL3000RME2

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

  Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz

Date of issue: July 17, 2018

Test engineer(s):	Andrey Adelberg, Senior Wireless/EMC Specialist	Signature:	Andrey Adelberg
Reviewed by:	Kevin Rose, Wireless/EMC Specialist	Signature:	

Test location(s)

Company name	Nemko Canada Inc.
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Province	Ontario
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Country	Canada
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Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: CA2040; IC: 2040A-4 (3 m SAC)

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.
City	Markham
Province/State	Ontario
Postal/Zip code	L3R 0E8
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–585 MHz
RSS-247, Issue 2, Feb 2017, Section 5	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.3 Test methods

558074 D01 DTS Meas Guidance v04 (April 5, 2017)	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
662911 D01 Multiple Transmitter Output v02r01 (October 31, 2013)	Emissions Testing of Transmitters with Multiple Outputs in the Same Band
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 performed against all relevant requirements of the test standard except as noted in section 1.5 below. 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 #	Date of issue	Details of changes made to test report
TRF	July 17, 2018	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[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 utilizes a unique antenna connector and EUT is a professionally installed device.

2.2 FCC Part 15 Subpart C, intentional radiators test results for digital transmission systems (DTS)

Part	Test description	Verdict
§15.247(a)(2)	Minimum 6 dB bandwidth	Pass
§15.247(b)(3)	Maximum peak output power in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Pass
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Pass
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density	Pass
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	February 1, 2018
Nemko sample ID number	1

3.2 EUT information

Product name	Broad-band wireless infrastructure product
Model	RDL-3000-RME
Serial number	153PC13200072

3.3 Technical information

Frequency band	2400–2483.5 MHz
Frequency Min (MHz)	2402.5 (for 5 MHz channel); 2405 (for 10 MHz channel); 2410 (for 20 MHz channel)
Frequency Max (MHz)	2476.0 (for 5 MHz channel); 2473.5 (for 10 MHz channel); 2463.5 (for 20 MHz channel)
Channel bandwidth	5 MHz, 10 MHz and 20 MHz
Type of modulation	BPSK, 256-QAM
Emission classification (F1D, G1D, D1D)	W7D
Power requirements	120 V_{AC} 60 Hz via PoE
Antenna information	Redline AOD-DB-0212-02 Antenna Omni 2.3–2.7 GHz 10 dBi 25 in (640 mm) 12deg dual-pol Redline AFS-DBG-0290-01 Antenna Sectoral 2.3–2.7 GHz 14.5 dBi 3 ft. (90 cm) 90-deg dual-pol Redline 30-00366-00 Antenna Panel Integrated 2.3–2.7 GHz 19 dBi 14 in Dual-Pol 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 module, designed to operate in the 2.4 GHz ISM band. The EUT can be used as a base station as well as a user station.

3.5 EUT exercise details

The EUT was controlled to transmit at desired frequency and modulation from laptop using web GUI interface.

3.6 EUT setup diagram

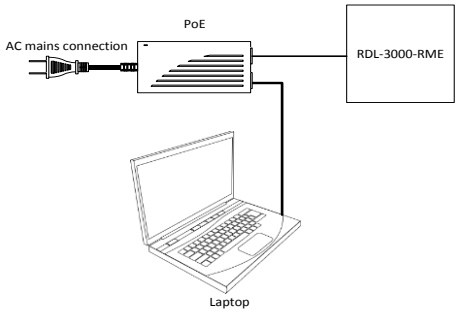


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
PoE	Microsemi	PD-9001GR/AT/AC	–

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

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

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

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

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Dec. 09/18
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
AC Power source	Chenwa	2700M-10k	FA002716	—	VOU
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	March 26/19
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	July 18/18
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	June 27/18
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	June 21/18
Preamp (1–18 GHz)	ETS-Lindgren	124334	FA002877	1 year	Nov. 14/18
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	1 year	June 27/18
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002514	1 year	Dec. 15/18

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

Section 8. Testing data

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

8.1.1 Definitions and limits

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 8.1-1: *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.

8.1.2 Test date

Start date	May 28, 2018

8.1.3 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.

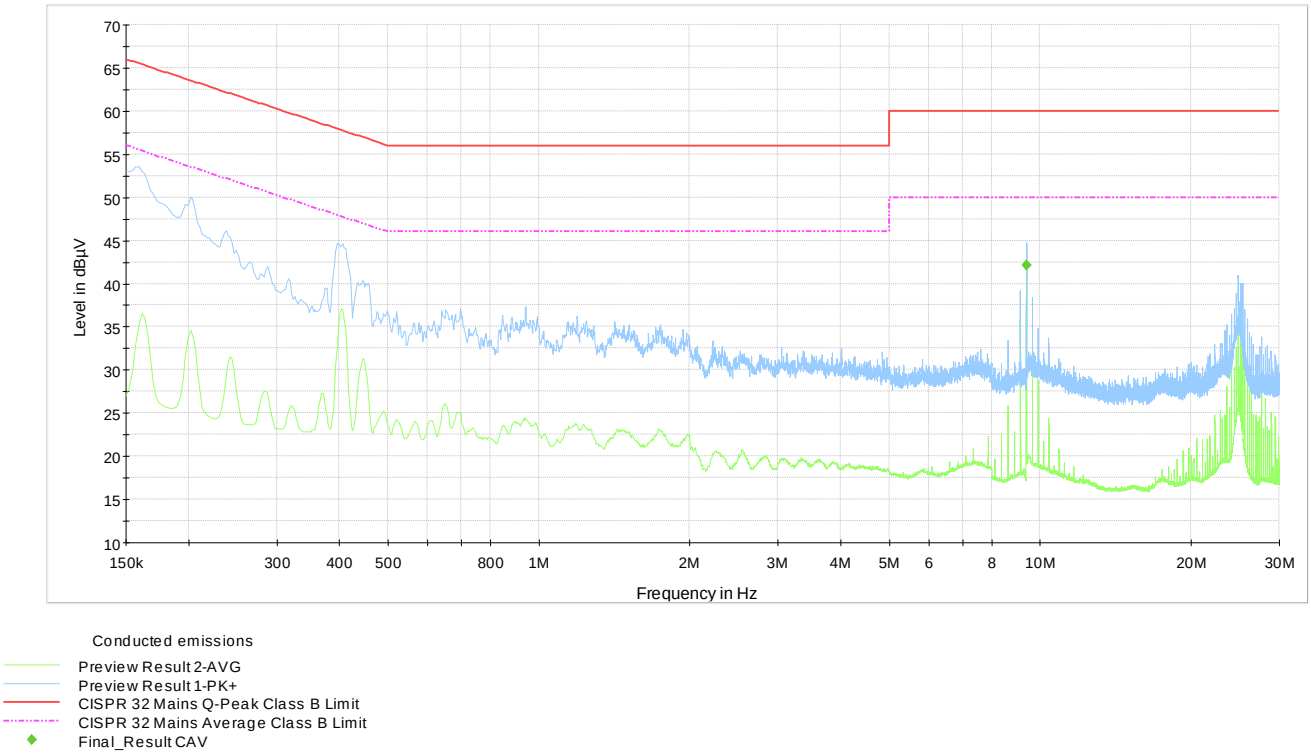
Receiver settings for preview measurements:

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

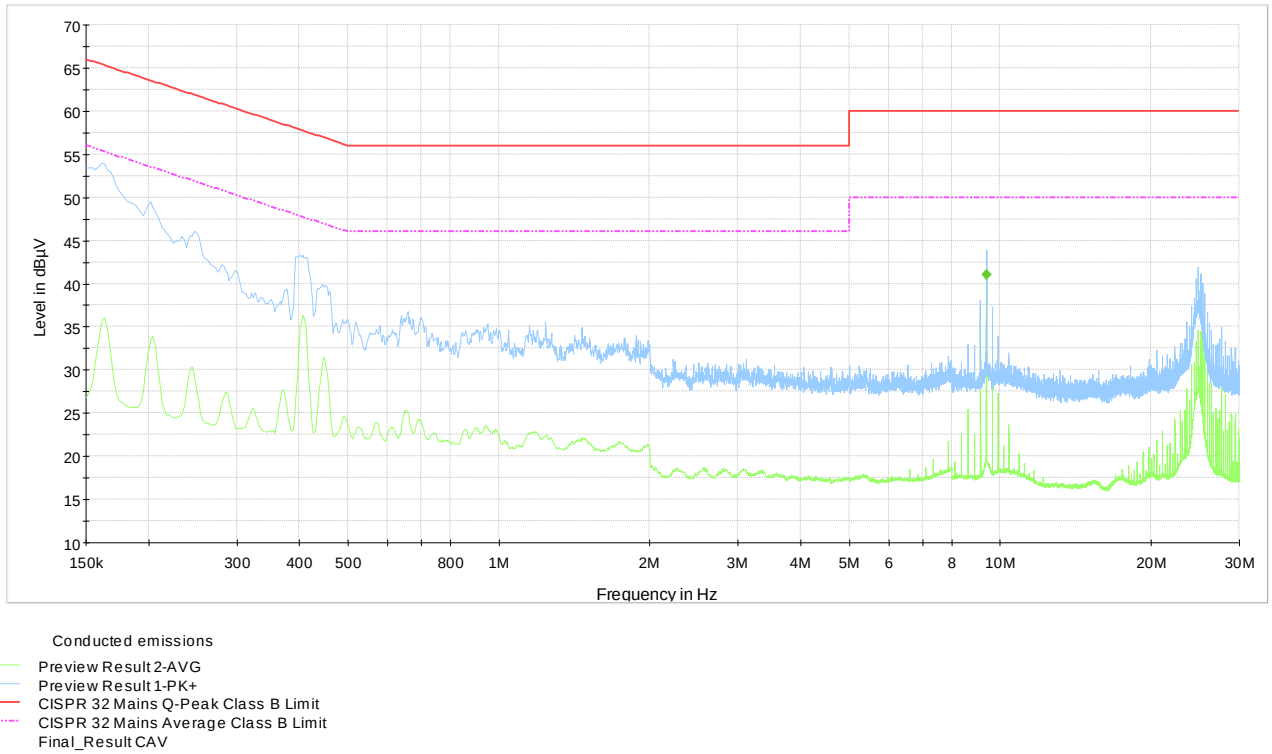
8.1.4 Test data



Plot 8.1-1: *Conducted emissions on phase line*

Table 8.1-2: *Quasi-Peak conducted emissions results on phase line*

Frequency, MHz	Average result, dBµV	Limit, dBµV	Margin, dB	Meas. Time, ms	Bandwidth, kHz	Correction, dB
9.386250	42.17	50.00	7.83	100	9	9.9



Plot 8.1-2: *Conducted emissions on neutral line*

Table 8.1-3: *Quasi-Peak conducted emissions results on neutral line*

Frequency, MHz	Average result, dBµV	Limit, dBµV	Margin, dB	Meas. Time, ms	Bandwidth, kHz	Correction, dB
9.386250	41.05	50.00	8.95	100	9	9.9

8.2 FCC 15.247(a)(2) Minimum 6 dB bandwidth for DTS systems

8.2.1 Definitions and limits

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.2.1 Test date

Start date	January 11, 2018

8.2.2 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	100 kHz
Video bandwidth	≥3 × RBW
Frequency span	10 MHz for 5-MHz channel. 20 MHz for 10-MHz channel and 30 MHz for 20-MHz channel;
Detector mode	Peak
Trace mode	Max Hold

8.2.3 Test data

Table 8.2-1: *6 dB bandwidth results for antenna port 1, BPSK*

Channel bandwidth, MHz	Frequency, MHz	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
5	2402.5	4.071	0.500	3.571
	2440.0	4.087	0.500	3.587
	2476.0	4.103	0.500	3.603
10	2405.0	8.276	0.500	7.776
	2440.0	8.269	0.500	7.769
	2473.5	8.213	0.500	7.713
20	2410.0	16.538	0.500	16.038
	2440.0	16.474	0.500	15.974
	2463.5	16.385	0.500	15.885

Table 8.2-2: *6 dB bandwidth results for antenna port 2, BPSK*

Channel bandwidth, MHz	Frequency, MHz	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
5	2402.5	4.103	0.500	3.603
	2440.0	4.103	0.500	3.603
	2476.0	4.103	0.500	3.603
10	2405.0	8.205	0.500	7.705
	2440.0	8.199	0.500	7.699
	2473.5	8.212	0.500	7.712
20	2410.0	16.474	0.500	15.974
	2440.0	16.538	0.500	16.038
	2463.5	16.385	0.500	15.885

Table 8.2-3: *6 dB bandwidth results for antenna port 1, 256QAM*

Channel bandwidth, MHz	Frequency, MHz	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
5	2402.5	4.103	0.500	3.603
	2440.0	4.087	0.500	3.587
	2476.0	4.103	0.500	3.603
10	2405.0	8.276	0.500	7.776
	2440.0	8.201	0.500	7.701
	2473.5	8.212	0.500	7.712
20	2410.0	16.474	0.500	15.974
	2440.0	16.474	0.500	15.974
	2463.5	16.385	0.500	15.885

Table 8.2-4: *6 dB bandwidth results for antenna port 2, 256QAM*

Channel bandwidth, MHz	Frequency, MHz	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
5	2402.5	4.103	0.500	3.603
	2440.0	4.103	0.500	3.603
	2476.0	4.103	0.500	3.603
10	2405.0	8.205	0.500	7.705
	2440.0	8.198	0.500	7.698
	2473.5	8.212	0.500	7.712
20	2410.0	16.551	0.500	16.051
	2440.0	16.487	0.500	15.987
	2463.5	16.384	0.500	15.884

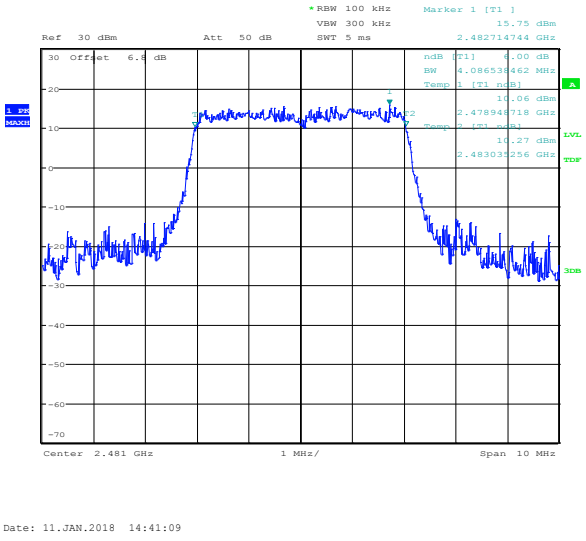


Figure 8.2-1: *6 dB bandwidth on 5 MHz channel, sample plot*

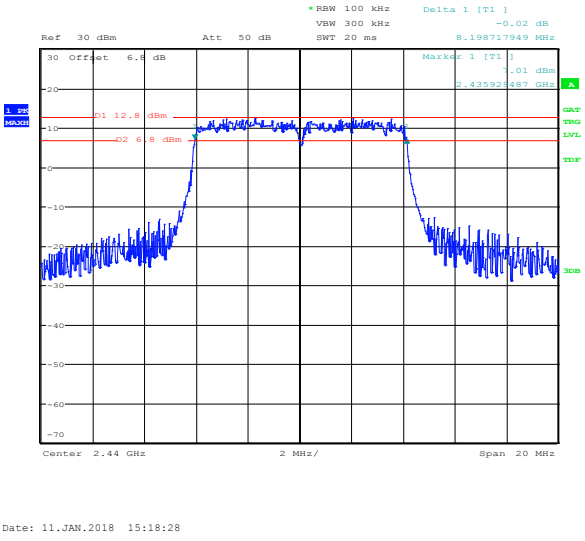


Figure 8.2-2: *6 dB bandwidth on 10 MHz channel, sample plot*

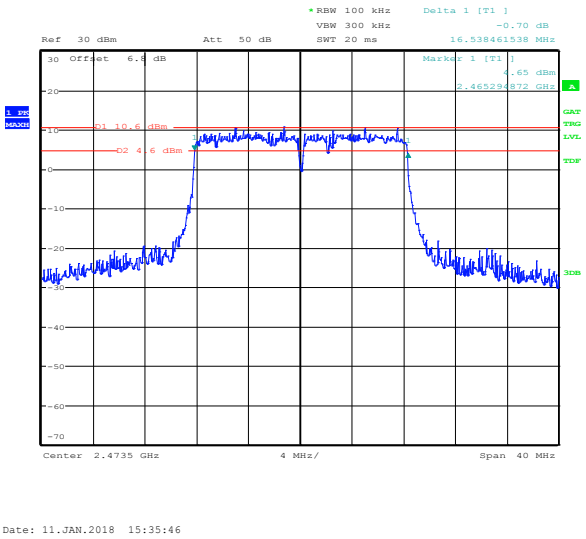


Figure 8.2-3: *6 dB bandwidth on 20 MHz channel, sample plot*

8.3 FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and e.i.r.p. requirements for DTS in 2.4 GHz

8.3.1 Definitions and limits

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(3) For systems using digital modulation in the 2400–2483.5 MHz band: 1 W (30 dBm). As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(c) Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

(i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(iii) Fixed, point-to-point operation, as used in paragraphs (c)(1)(i) and (c)(1)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

(iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

(iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

8.3.1 Test date

Start date	January 11, 2018

8.3.2 Observations, settings and special notes

The test was performed using RMS power meter technique.
Combined average output power for MIMO 2 × 2 application was calculated as follows: $P_{combined} = 10 \times log_{10}\left(\left(10^{P_{ch0}/10}\right) + \left(10^{P_{ch1}/10}\right)\right)$

Note: in the following calculations 0.7 dB of a cable loss was added to the antenna path.
Point-to-multipoint operation.
Output power limit for 10 dBi antenna was calculated as follows: 30 – (9.3 – 6) = 26.7 dBm
Output power limit for 14.5 dBi antenna was calculated as follows: 30 – (13.8 – 6) = 22.2 dBm
Output power limit for 19 dBi antenna was calculated as follows: 30 – (18.3 – 6) = 17.7 dBm
Fixed Point-to-point operation.
Output power limit for 10 dBi antenna was calculated as follows: 30 – (9.3 – 6)/3 = 28.9 dBm
Output power limit for 14.5 dBi antenna was calculated as follows: 30 – (13.8 – 6)/3 = 27.4 dBm
Output power limit for 19 dBi antenna was calculated as follows: 30 – (18.3 – 6)/3 = 25.9 dBm

8.3.3 Test data

Table 8.3-1: *Output power measurements results for BPSK, 10 dBi antenna, Point-to-multipoint operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
5	2402.5	22.98	23.24	26.12	26.70	0.58	9.30	35.42	36.00	0.58
5	2440.0	23.03	22.91	25.98	26.70	0.72	9.30	35.28	36.00	0.72
5	2476.0	15.31	15.20	18.27	26.70	8.43	9.30	27.57	36.00	8.43
10	2405.0	22.86	22.94	25.91	26.70	0.79	9.30	35.21	36.00	0.79
10	2440.0	22.89	22.83	25.87	26.70	0.83	9.30	35.17	36.00	0.83
10	2473.5	11.40	12.41	14.94	26.70	11.76	9.30	24.24	36.00	11.76
20	2410.0	23.09	23.10	26.11	26.70	0.59	9.30	35.41	36.00	0.59
20	2440.0	23.16	23.08	26.13	26.70	0.57	9.30	35.43	36.00	0.57
20	2463.5	11.73	12.73	15.27	26.70	11.43	9.30	24.57	36.00	11.43

Table 8.3-2: *Output power measurements results for 256QAM, 10 dBi antenna, Point-to-multipoint operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
5	2402.5	22.97	23.25	26.12	26.70	0.58	9.30	35.42	36.00	0.58
5	2440.0	23.00	23.17	26.10	26.70	0.60	9.30	35.40	36.00	0.60
5	2476.0	15.30	15.22	18.27	26.70	8.43	9.30	27.57	36.00	8.43
10	2405.0	22.83	22.99	25.92	26.70	0.78	9.30	35.22	36.00	0.78
10	2440.0	22.89	22.80	25.86	26.70	0.84	9.30	35.16	36.00	0.84
10	2473.5	11.42	12.37	14.93	26.70	11.77	9.30	24.23	36.00	11.77
20	2410.0	23.14	23.10	26.13	26.70	0.57	9.30	35.43	36.00	0.57
20	2440.0	23.16	23.08	26.13	26.70	0.57	9.30	35.43	36.00	0.57
20	2463.5	11.72	12.73	15.26	26.70	11.44	9.30	24.56	36.00	11.44

Table 8.3-3: *Output power measurements results for BPSK, 14.5 dBi antenna, Point-to-multipoint operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
5	2402.5	18.46	18.9	21.70	22.20	0.50	13.80	35.50	36.00	0.50
5	2440.0	18.37	18.83	21.62	22.20	0.58	13.80	35.42	36.00	0.58
5	2476.0	14.19	14.38	17.30	22.20	4.90	13.80	31.10	36.00	4.90
10	2405.0	19.25	19.02	22.15	22.20	0.05	13.80	35.95	36.00	0.05
10	2440.0	19.25	18.96	22.12	22.20	0.08	13.80	35.92	36.00	0.08
10	2473.5	9.31	10.19	12.78	22.20	9.42	13.80	26.58	36.00	9.42
20	2410.0	18.46	19.03	21.76	22.20	0.44	13.80	35.56	36.00	0.44
20	2440.0	18.42	19.15	21.81	22.20	0.39	13.80	35.61	36.00	0.39
20	2463.5	9.47	9.28	12.39	22.20	9.81	13.80	26.19	36.00	9.81

Table 8.3-4: *Output power measurements results for 256QAM, 14.5 dBi antenna, Point-to-multipoint operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
5	2402.5	18.41	19.08	21.77	22.20	0.43	13.80	35.57	36.00	0.43
5	2440.0	18.36	18.83	21.61	22.20	0.59	13.80	35.41	36.00	0.59
5	2476.0	14.20	14.36	17.29	22.20	4.91	13.80	31.09	36.00	4.91
10	2405.0	19.26	19.01	22.15	22.20	0.05	13.80	35.95	36.00	0.05
10	2440.0	19.24	18.72	22.00	22.20	0.20	13.80	35.80	36.00	0.20
10	2473.5	9.31	10.49	12.95	22.20	9.25	13.80	26.75	36.00	9.25
20	2410.0	18.45	18.97	21.73	22.20	0.47	13.80	35.53	36.00	0.47
20	2440.0	18.42	19.14	21.81	22.20	0.39	13.80	35.61	36.00	0.39
20	2463.5	9.49	9.29	12.40	22.20	9.80	13.80	26.20	36.00	9.80

Table 8.3-5: *Output power measurements results for BPSK, 19 dBi antenna, Point-to-multipoint operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
5	2402.5	14.53	14.29	17.42	17.70	0.28	18.30	35.72	36.00	0.28
5	2440.0	14.53	14.17	17.36	17.70	0.34	18.30	35.66	36.00	0.34
5	2476.0	12.30	12.45	15.39	17.70	2.31	18.30	33.69	36.00	2.31
10	2405.0	14.28	14.05	17.18	17.70	0.52	18.30	35.48	36.00	0.52
10	2440.0	14.38	14.07	17.24	17.70	0.46	18.30	35.54	36.00	0.46
10	2473.5	6.32	8.33	10.45	17.70	7.25	18.30	28.75	36.00	7.25
20	2410.0	14.61	14.28	17.46	17.70	0.24	18.30	35.76	36.00	0.24
20	2440.0	14.60	14.26	17.44	17.70	0.26	18.30	35.74	36.00	0.26
20	2463.5	8.66	8.55	11.62	17.70	6.08	18.30	29.92	36.00	6.08

Table 8.3-6: *Output power measurements results for 256QAM, 19 dBi antenna, Point-to-multipoint operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
5	2402.5	14.54	14.09	17.33	17.70	0.37	18.30	35.63	36.00	0.37
5	2440.0	14.54	14.19	17.38	17.70	0.32	18.30	35.68	36.00	0.32
5	2476.0	12.31	12.46	15.40	17.70	2.30	18.30	33.70	36.00	2.30
10	2405.0	14.34	14.07	17.22	17.70	0.48	18.30	35.52	36.00	0.48
10	2440.0	14.23	15.05	17.67	17.70	0.03	18.30	35.97	36.00	0.03
10	2473.5	6.31	8.56	10.59	17.70	7.11	18.30	28.89	36.00	7.11
20	2410.0	14.31	14.34	17.34	17.70	0.36	18.30	35.64	36.00	0.36
20	2440.0	14.59	14.26	17.44	17.70	0.26	18.30	35.74	36.00	0.26
20	2463.5	8.69	8.45	11.58	17.70	6.12	18.30	29.88	36.00	6.12

Table 8.3-7: *Output power measurements results for BPSK, 10 dBi antenna, fixed Point-to-point operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm
5	2402.5	22.98	23.24	26.12	28.90	2.78	9.30	35.42
5	2440.0	23.03	22.91	25.98	28.90	2.92	9.30	35.28
5	2476.0	15.31	15.20	18.27	28.90	10.63	9.30	27.57
10	2405.0	22.86	22.94	25.91	28.90	2.99	9.30	35.21
10	2440.0	22.89	22.83	25.87	28.90	3.03	9.30	35.17
10	2473.5	11.40	12.41	14.94	28.90	13.96	9.30	24.24
20	2410.0	23.09	23.10	26.11	28.90	2.79	9.30	35.41
20	2440.0	23.16	23.08	26.13	28.90	2.77	9.30	35.43
20	2463.5	11.73	12.73	15.27	28.90	13.63	9.30	24.57

Table 8.3-8: *Output power measurements results for 256QAM, 10 dBi antenna, fixed Point-to-point operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm
5	2402.5	22.97	23.25	26.12	28.90	2.78	9.30	35.42
5	2440.0	23.00	23.17	26.10	28.90	2.80	9.30	35.40
5	2476.0	15.30	15.22	18.27	28.90	10.63	9.30	27.57
10	2405.0	22.83	22.99	25.92	28.90	2.98	9.30	35.22
10	2440.0	22.89	22.80	25.86	28.90	3.04	9.30	35.16
10	2473.5	11.42	12.37	14.93	28.90	13.97	9.30	24.23
20	2410.0	23.14	23.10	26.13	28.90	2.77	9.30	35.43
20	2440.0	23.16	23.08	26.13	28.90	2.77	9.30	35.43
20	2463.5	11.72	12.73	15.26	28.90	13.64	9.30	24.56

Table 8.3-9: *Output power measurements results for BPSK, 14.5 dBi antenna, fixed Point-to-point operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm
5	2402.5	22.98	23.24	26.12	27.40	1.28	13.80	39.92
5	2440.0	23.03	22.91	25.98	27.40	1.42	13.80	39.78
5	2476.0	14.19	14.38	17.30	27.40	10.10	13.80	31.10
10	2405.0	22.86	22.94	25.91	27.40	1.49	13.80	39.71
10	2440.0	22.89	22.83	25.87	27.40	1.53	13.80	39.67
10	2473.5	9.31	10.19	12.78	27.40	14.62	13.80	26.58
20	2410.0	23.09	23.10	26.11	27.40	1.29	13.80	39.91
20	2440.0	23.16	23.08	26.13	27.40	1.27	13.80	39.93
20	2463.5	9.47	9.28	12.39	27.40	15.01	13.80	26.19

Table 8.3-10: *Output power measurements results for 256QAM, 14.5 dBi antenna, fixed Point-to-point operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm
5	2402.5	22.97	23.25	26.12	27.40	1.28	13.80	39.92
5	2440.0	23.00	23.17	26.10	27.40	1.30	13.80	39.90
5	2476.0	14.20	14.36	17.29	27.40	10.11	13.80	31.09
10	2405.0	22.83	22.99	25.92	27.40	1.48	13.80	39.72
10	2440.0	22.89	22.80	25.86	27.40	1.54	13.80	39.66
10	2473.5	9.31	10.49	12.95	27.40	14.45	13.80	26.75
20	2410.0	23.14	23.10	26.13	27.40	1.27	13.80	39.93
20	2440.0	23.16	23.08	26.13	27.40	1.27	13.80	39.93
20	2463.5	9.49	9.29	12.40	27.40	15.00	13.80	26.20

Table 8.3-11: *Output power measurements results for BPSK, 19 dBi antenna, fixed Point-to-point operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm
5	2402.5	22.98	21.96	25.51	25.90	0.39	18.30	43.81
5	2440.0	23.03	21.82	25.48	25.90	0.42	18.30	43.78
5	2476.0	12.30	12.45	15.39	25.90	10.51	18.30	33.69
10	2405.0	22.86	21.73	25.34	25.90	0.56	18.30	43.64
10	2440.0	22.89	22.83	25.87	25.90	0.03	18.30	44.17
10	2473.5	6.32	8.33	10.45	25.90	15.45	18.30	28.75
20	2410.0	22.21	23.10	25.69	25.90	0.21	18.30	43.99
20	2440.0	22.15	23.08	25.65	25.90	0.25	18.30	43.95
20	2463.5	8.66	8.55	11.62	25.90	14.28	18.30	29.92

Table 8.3-12: *Output power measurements results for 256QAM, 19 dBi antenna, fixed Point-to-point operation*

Channel bandwidth, MHz	Frequency, MHz	Conducted output power, ant 1, dBm	Conducted output power, ant 2, dBm	Total output power, dBm	Power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm
5	2402.5	22.97	21.94	25.50	25.90	0.40	18.30	43.80
5	2440.0	23.00	21.83	25.46	25.90	0.44	18.30	43.76
5	2476.0	12.31	12.46	15.40	25.90	10.50	18.30	33.70
10	2405.0	22.83	21.77	25.34	25.90	0.56	18.30	43.64
10	2440.0	22.89	22.80	25.86	25.90	0.04	18.30	44.16
10	2473.5	6.31	8.56	10.59	25.90	15.31	18.30	28.89
20	2410.0	22.21	23.10	25.69	25.90	0.21	18.30	43.99
20	2440.0	22.14	23.08	25.65	25.90	0.25	18.30	43.95
20	2463.5	8.69	8.45	11.58	25.90	14.32	18.30	29.88

8.4 FCC 15.247(d) Spurious (out-of-band) unwanted emissions

8.4.1 Definitions and limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

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	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	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

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			

8.4.1 Test date

Start date	February 12, 2018

8.4.2 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
EUT was set to transmit with 100 % duty cycle.
Radiated measurements were performed at a distance of 3 m, the EUT was transmitting on both MIMO chains simultaneously.
Both antenna ports were terminated with matching loads during cabinet radiation testing.
Since fundamental power was tested using average method, the spurious emissions limit is −30 dBc/100 kHz.
Conducted spurious emissions (within restricted bands) test was performed with the maximum point-to-point power settings with spectral plots' offsets that include the highest antenna gain. EIRP limits were calculated using the following formula: EIRP limit (dBm) = Field Strength limit (dBµV/m) – 95.23 (dB).

Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

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

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

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

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

Resolution bandwidth:	1 MHz
Video bandwidth:	10 Hz
Detector mode:	Peak
Trace mode:	Max Hold

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

Resolution bandwidth:	1 MHz
Video bandwidth:	10 MHz
Detector mode:	RMS
Trace mode:	Power averaging over 100 sweeps

Spectrum analyser settings for conducted spurious emissions measurements outside restricted bands:

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

8.4.4 Test data

Table 8.4-3: *Radiated restricted bands field strength measurement results for 5 MHz channel*

Channel	Frequency, MHz	Peak Field strength, dBµV/m		Margin, dB	Average Field strength, dBµV/m		Margin, dB
		Measured	Limit		Measured	Limit	
Low	2390.0	52.04	74.00	21.96	52.04	54.00	1.96
Low	4806.5	53.45	74.00	20.55	53.45	54.00	0.55
Mid	4880.0	66.03	74.00	7.97	50.46	54.00	3.54
High	2483.5	52.93	74.00	21.07	52.93	54.00	1.07
High	4951.5	48.29	74.00	25.71	48.29	54.00	5.71

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.4-4: *Radiated restricted bands field strength measurement results for 10 MHz channel*

Channel	Frequency, MHz	Peak Field strength, dBµV/m		Margin, dB	Average Field strength, dBµV/m		Margin, dB
		Measured	Limit		Measured	Limit	
Low	2390.0	52.93	74.00	21.07	52.93	54.00	1.07
Low	4810.5	52.31	74.00	21.69	52.31	54.00	1.69
Mid	4885.0	53.75	74.00	20.25	53.75	54.00	0.25
High	2483.5	53.64	74.00	20.36	53.64	54.00	0.36

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.4-5: *Radiated restricted bands field strength measurement results for 20 MHz channel*

Channel	Frequency, MHz	Peak Field strength, dBµV/m		Margin, dB	Average Field strength, dBµV/m		Margin, dB
		Measured	Limit		Measured	Limit	
Low	2390.0	53.03	74.00	20.97	53.03	54.00	0.97
Low	4829.5	50.42	74.00	23.58	50.42	54.00	3.58
Mid	4878.5	52.31	74.00	21.69	52.31	54.00	1.69
High	2483.5	52.98	74.00	21.02	52.98	54.00	1.02

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.4-6: *Conducted restricted bands field strength to EIRP equivalent measurement results for 5 MHz channel with 10 dBi antenna*

Channel, antenna	Frequency, MHz	Peak EIRP, dBm		Margin, dB	Average EIRP, dBm		Margin, dB
		Measured	Limit		Measured	Limit	
Low, Ant 1	2390.0	-32.59	-21.23	11.36	-42.64	-41.23	1.41
Low, Ant 2	2390.0	-34.77	-21.23	13.54	-42.20	-41.23	0.97
High, Ant 1	2483.5	-43.10	-21.23	21.87	-55.57	-41.23	14.34
High, Ant 2	2483.5	-43.77	-21.23	22.54	-55.96	-41.23	14.73

Notes: EIRP includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.4-7: *Conducted restricted bands field strength to EIRP equivalent measurement results for 10 MHz channel with 10 dBi antenna*

Channel, antenna	Frequency, MHz	Peak EIRP, dBm		Margin, dB	Average EIRP, dBm		Margin, dB
		Measured	Limit		Measured	Limit	
Low, Ant 1	2390.0	-32.64	-21.23	11.41	-43.80	-41.23	2.57
Low, Ant 2	2390.0	-31.62	-21.23	10.39	-43.06	-41.23	1.83
High, Ant 1	2483.5	-43.36	-21.23	22.13	-54.19	-41.23	12.96
High, Ant 2	2483.5	-44.04	-21.23	22.81	-54.05	-41.23	12.82

Notes: EIRP includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.4-8: *Conducted restricted bands field strength to EIRP equivalent measurement results for 20 MHz channel with 10 dBi antenna*

Channel, antenna	Frequency, MHz	Peak EIRP, dBm		Margin, dB	Average EIRP, dBm		Margin, dB
		Measured	Limit		Measured	Limit	
Low, Ant 1	2390.0	-32.68	-21.23	11.45	-41.36	-41.23	0.13
Low, Ant 2	2390.0	-33.17	-21.23	11.94	-41.66	-41.23	0.43
High, Ant 1	2483.5	-45.22	-21.23	23.99	-55.36	-41.23	14.13
High, Ant 2	2483.5	-44.13	-21.23	22.90	-53.59	-41.23	12.36

Notes: EIRP includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.4-9: *Conducted restricted bands field strength to EIRP equivalent measurement results for 5 MHz channel with 14.5 dBi antenna*

Channel, antenna	Frequency, MHz	Peak EIRP, dBm		Margin, dB	Average EIRP, dBm		Margin, dB
		Measured	Limit		Measured	Limit	
Low, Ant 1	2390.0	-29.18	-21.23	7.95	-41.89	-41.23	0.66
Low, Ant 2	2390.0	-30.11	-21.23	8.88	-41.81	-41.23	0.58
High, Ant 1	2483.5	-45.60	-21.23	24.37	-58.20	-41.23	16.97
High, Ant 2	2483.5	-46.26	-21.23	25.03	-58.60	-41.23	17.37

Notes: EIRP includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.4-10: *Conducted restricted bands field strength to EIRP equivalent measurement results for 10 MHz channel with 14.5 dBi antenna*

Channel, antenna	Frequency, MHz	Peak EIRP, dBm		Margin, dB	Average EIRP, dBm		Margin, dB
		Measured	Limit		Measured	Limit	
Low, Ant 1	2390.0	-31.84	-21.23	10.61	-42.33	-41.23	1.10
Low, Ant 2	2390.0	-26.24	-21.23	5.01	-41.86	-41.23	0.63
High, Ant 1	2483.5	-47.97	-21.23	26.74	-58.93	-41.23	17.70
High, Ant 2	2483.5	-47.90	-21.23	26.67	-58.23	-41.23	17.00

Notes: EIRP includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.4-11: *Conducted restricted bands field strength to EIRP equivalent measurement results for 20 MHz channel with 14.5 dBi antenna*

Channel, antenna	Frequency, MHz	Peak EIRP, dBm		Margin, dB	Average EIRP, dBm		Margin, dB
		Measured	Limit		Measured	Limit	
Low, Ant 1	2390.0	-34.07	-21.23	12.84	-42.24	-41.23	1.01
Low, Ant 2	2390.0	-33.74	-21.23	12.51	-41.94	-41.23	0.71
High, Ant 1	2483.5	-49.98	-21.23	28.75	-60.31	-41.23	19.08
High, Ant 2	2483.5	-51.15	-21.23	29.92	-60.84	-41.23	19.61

Notes: EIRP includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.4-12: *Conducted restricted bands field strength to EIRP equivalent measurement results for 5 MHz channel with 19 dBi antenna*

Channel, antenna	Frequency, MHz	Peak EIRP, dBm		Margin, dB	Average EIRP, dBm		Margin, dB
		Measured	Limit		Measured	Limit	
Low, Ant 1	2390.0	-29.67	-21.23	8.44	-42.69	-41.23	1.46
Low, Ant 2	2390.0	-25.79	-21.23	4.56	-42.27	-41.23	1.04
High, Ant 1	2483.5	-50.87	-21.23	29.64	-62.85	-41.23	21.62
High, Ant 2	2483.5	-52.04	-21.23	30.81	-63.17	-41.23	21.94

Notes: EIRP includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.4-13: *Conducted restricted bands field strength to EIRP equivalent measurement results for 10 MHz channel with 19 dBi antenna*

Channel, antenna	Frequency, MHz	Peak EIRP, dBm		Margin, dB	Average EIRP, dBm		Margin, dB
		Measured	Limit		Measured	Limit	
Low, Ant 1	2390.0	-33.22	-21.23	11.99	-42.30	-41.23	1.07
Low, Ant 2	2390.0	-32.87	-21.23	11.64	-42.07	-41.23	0.84
High, Ant 1	2483.5	-55.30	-21.23	34.07	-65.52	-41.23	24.29
High, Ant 2	2483.5	-52.33	-21.23	31.10	-62.60	-41.23	21.37

Notes: EIRP includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Table 8.4-14: *Conducted restricted bands field strength to EIRP equivalent measurement results for 20 MHz channel with 19 dBi antenna*

Channel, antenna	Frequency, MHz	Peak EIRP, dBm		Margin, dB	Average EIRP, dBm		Margin, dB
		Measured	Limit		Measured	Limit	
Low, Ant 1	2390.0	-33.50	-21.23	12.27	-41.64	-41.23	0.41
Low, Ant 2	2390.0	-33.05	-21.23	11.82	-41.48	-41.23	0.25
High, Ant 1	2483.5	-52.14	-21.23	30.91	-62.57	-41.23	21.34
High, Ant 2	2483.5	-53.10	-21.23	31.87	-63.02	-41.23	21.79

Notes: EIRP includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Sample plots of the worst-case emissions are provided below.

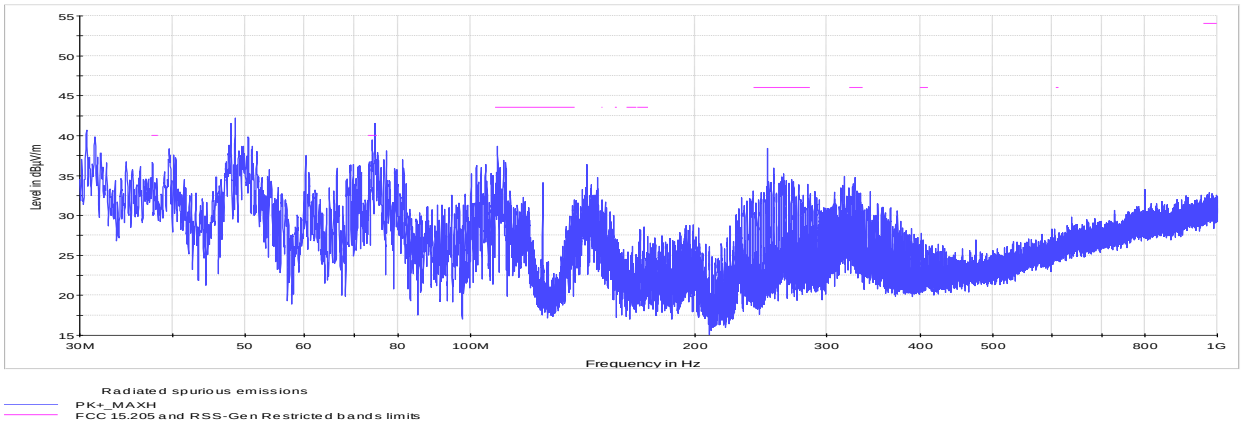


Figure 8.4-1: *Radiated spurious emissions for 5 MHz, low channel*

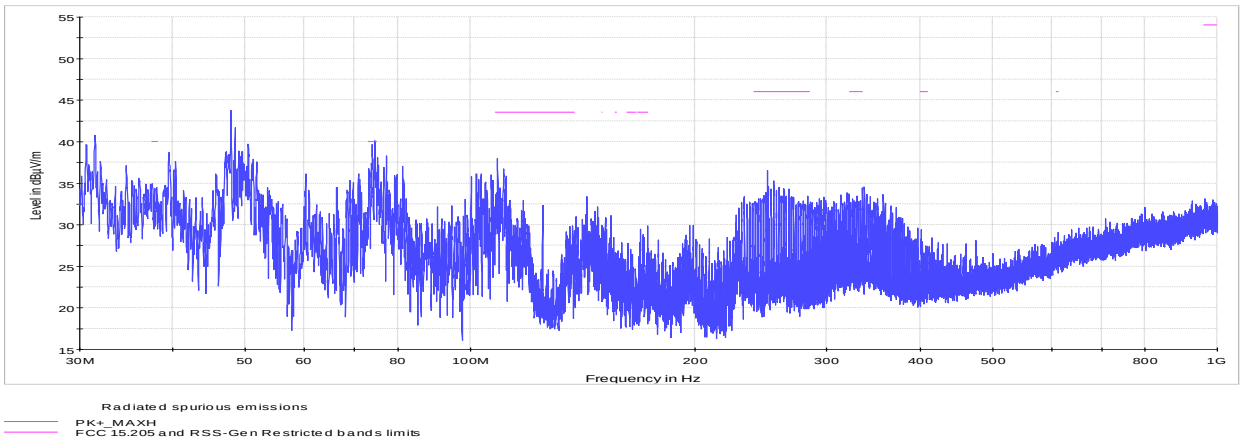


Figure 8.4-2: *Radiated spurious emissions for 5 MHz, mid channel*

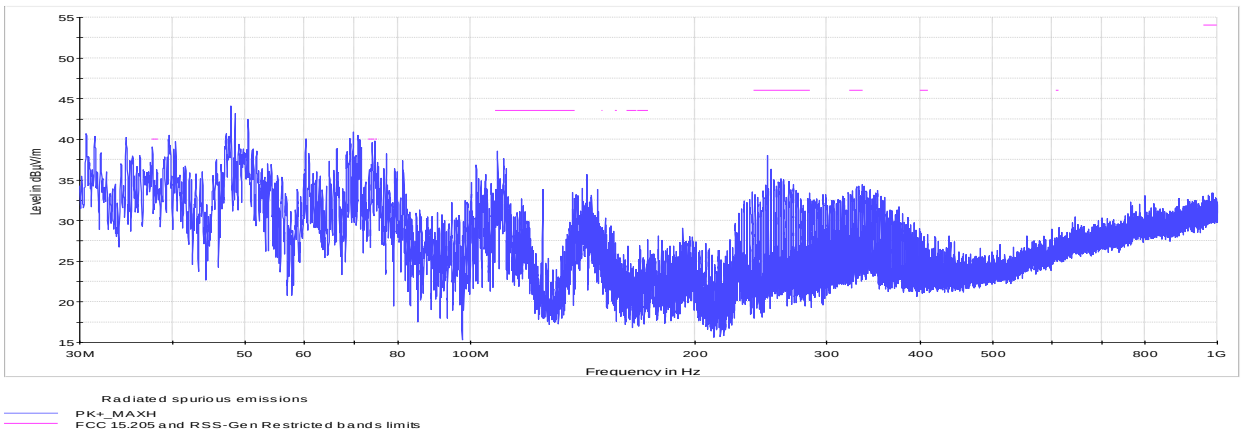


Figure 8.4-3: *Radiated spurious emissions for 5 MHz, high channel*

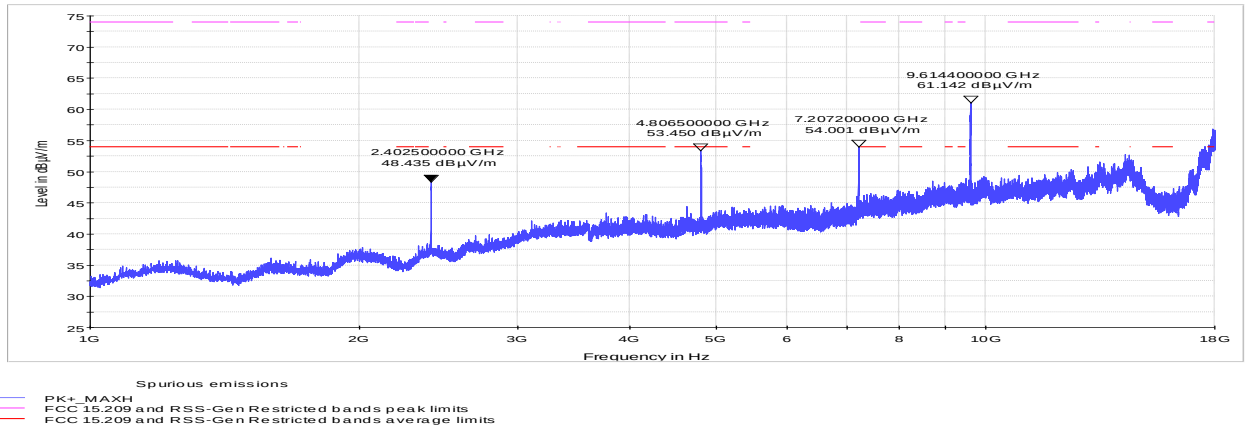


Figure 8.4-4: *Radiated spurious emissions for 5 MHz, low channel*

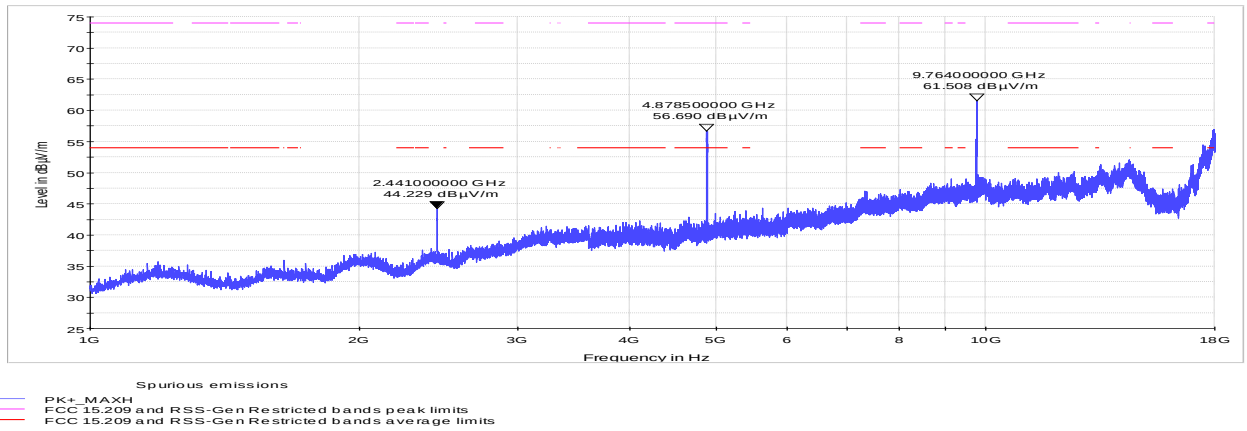


Figure 8.4-5: *Radiated spurious emissions for 5 MHz, mid channel*

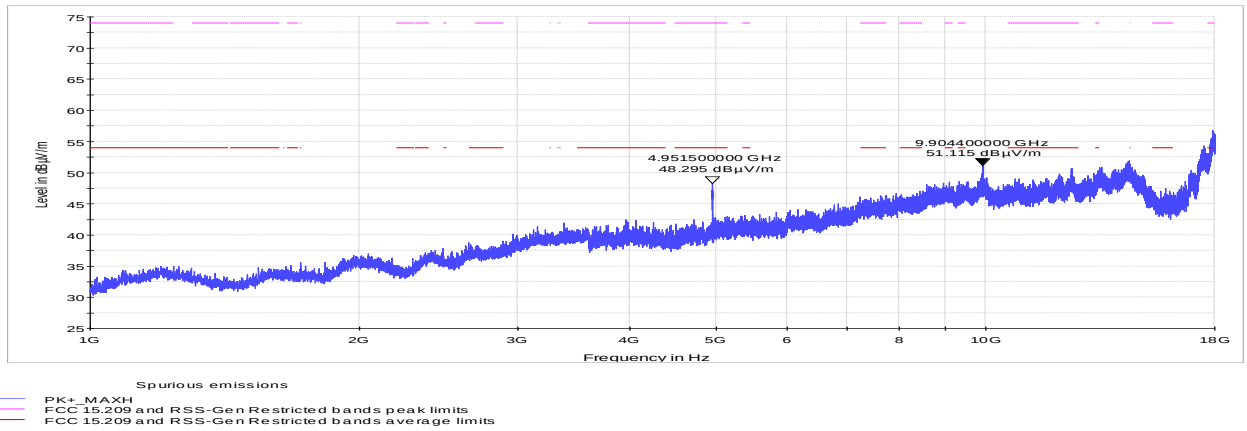


Figure 8.4-6: *Radiated spurious emissions for 5 MHz, high channel*

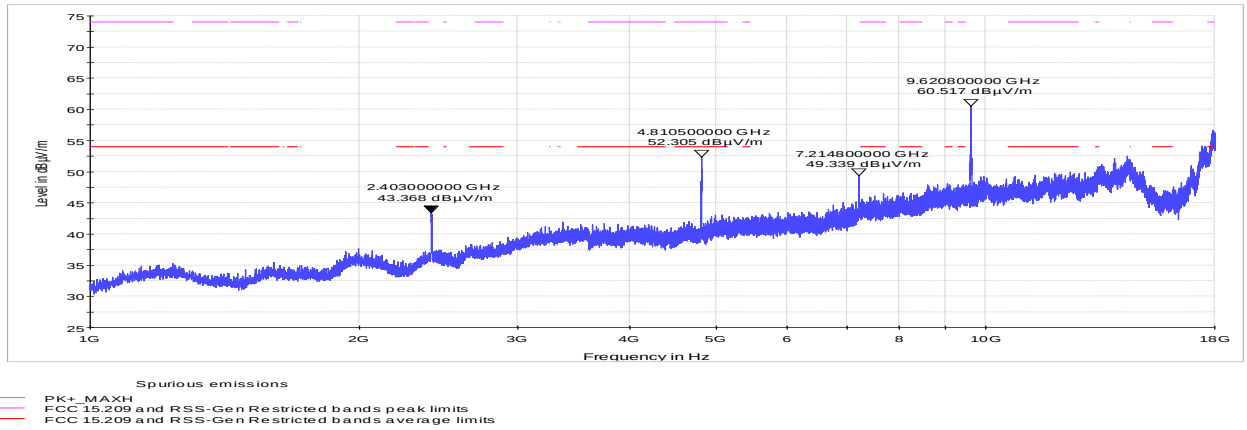


Figure 8.4-7: *Radiated spurious emissions for 10 MHz, low channel*

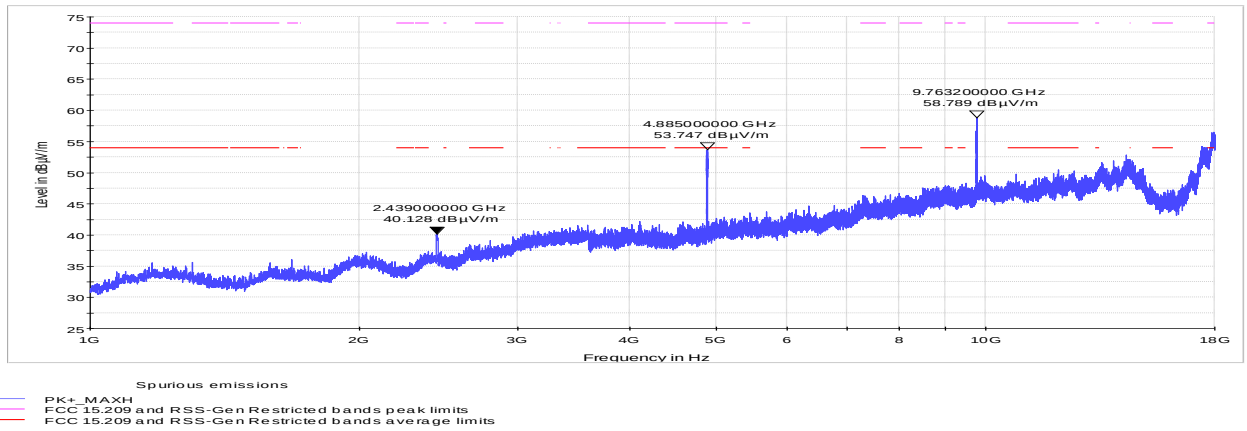


Figure 8.4-8: *Radiated spurious emissions for 10 MHz, mid channel*

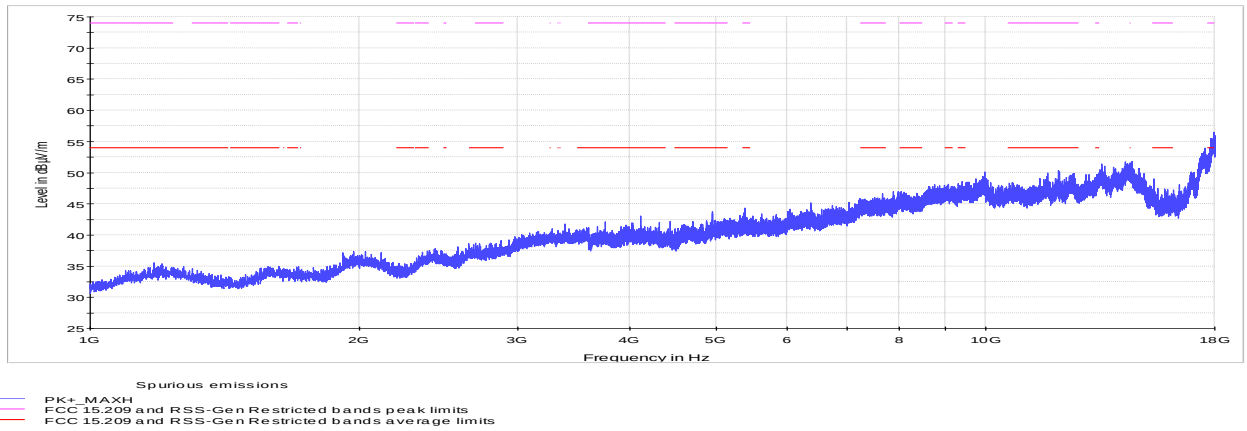


Figure 8.4-9: *Radiated spurious emissions for 10 MHz, high channel*

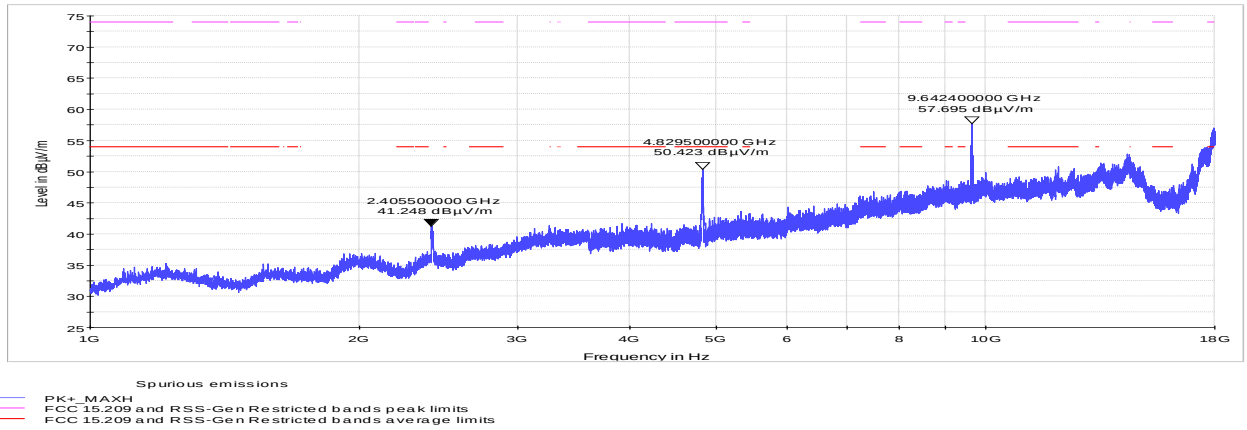


Figure 8.4-10: *Radiated spurious emissions for 20 MHz, low channel*

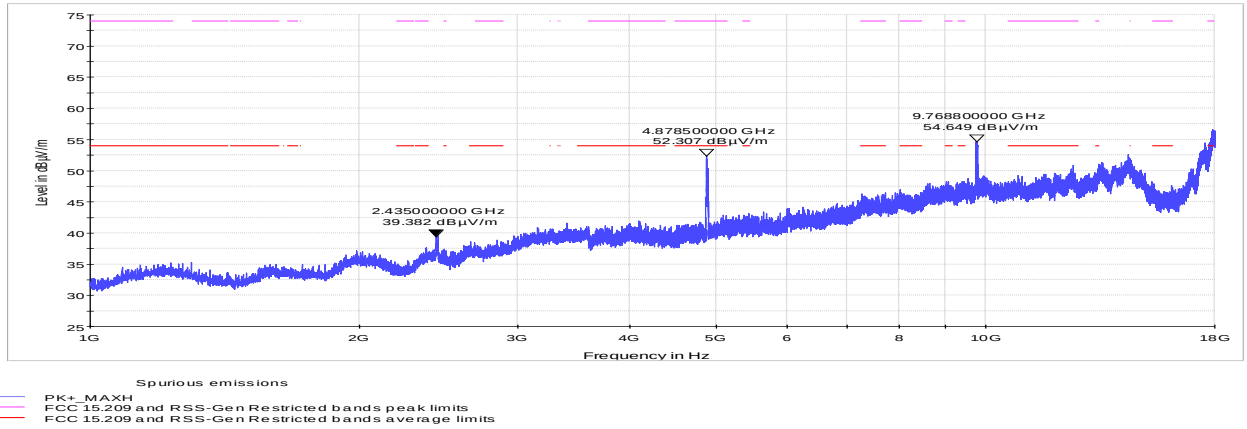


Figure 8.4-11: *Radiated spurious emissions for 20 MHz, mid channel*

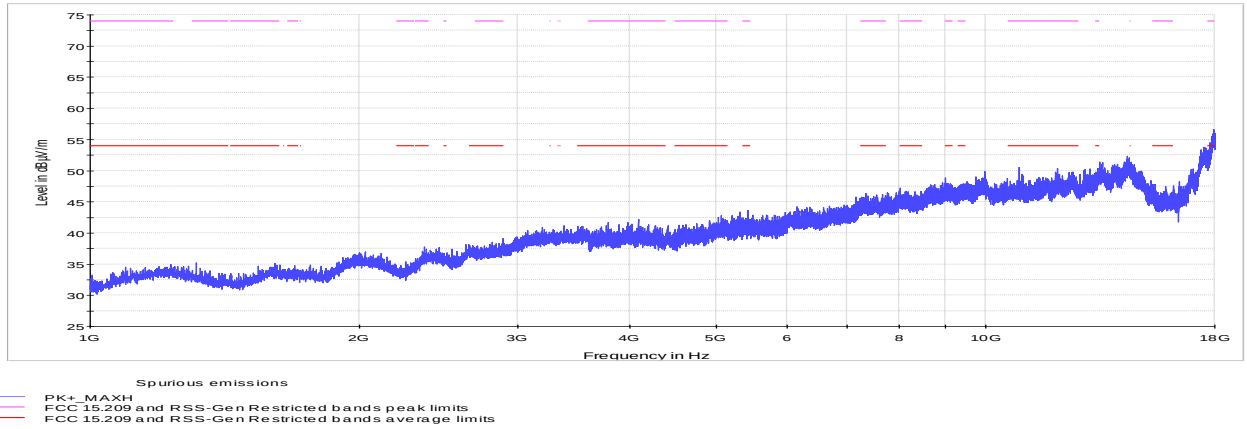


Figure 8.4-12: *Radiated spurious emissions for 20 MHz, high channel*

Sample plots of the worst-case emissions are provided below.

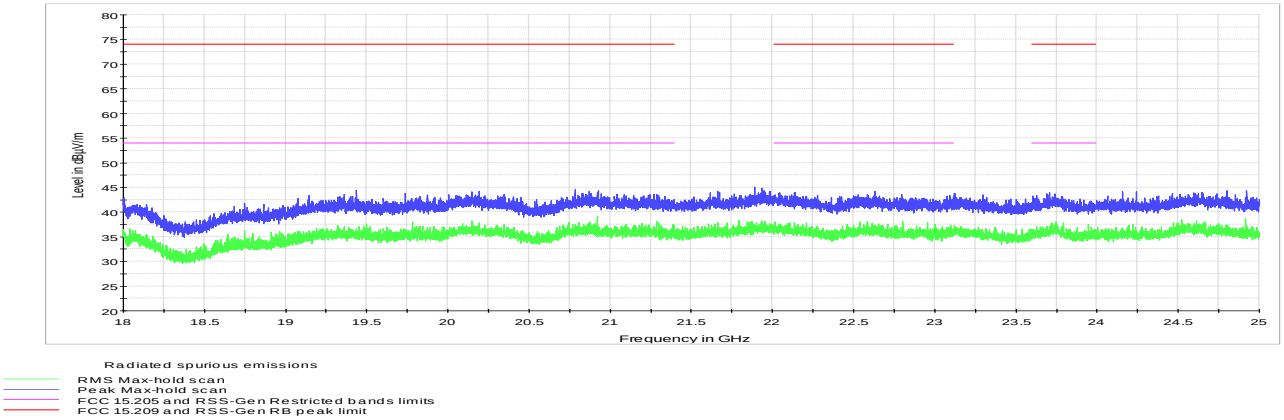


Figure 8.4-13: *Radiated spurious emissions for 5 MHz, low channel*

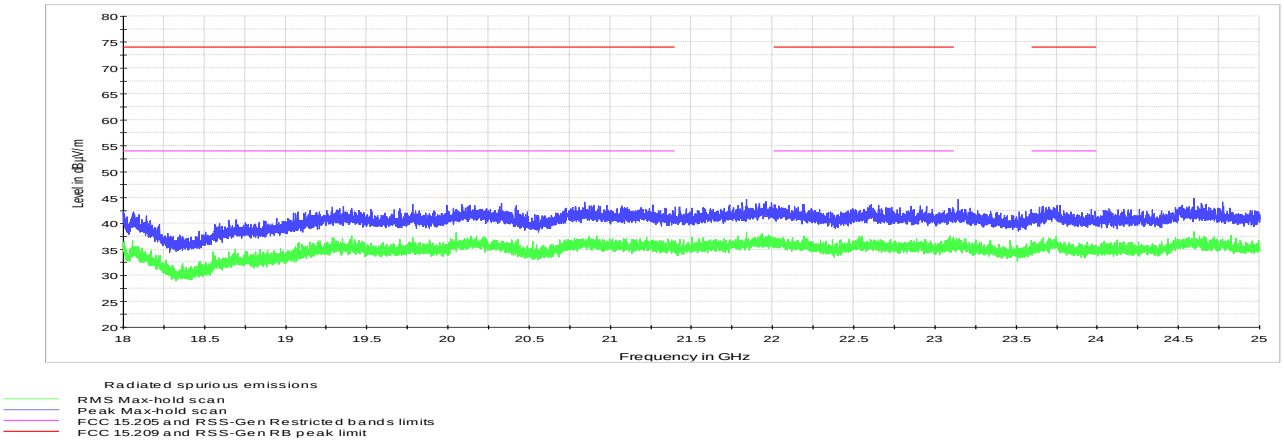


Figure 8.4-14: *Radiated spurious emissions for 5 MHz, mid channel*

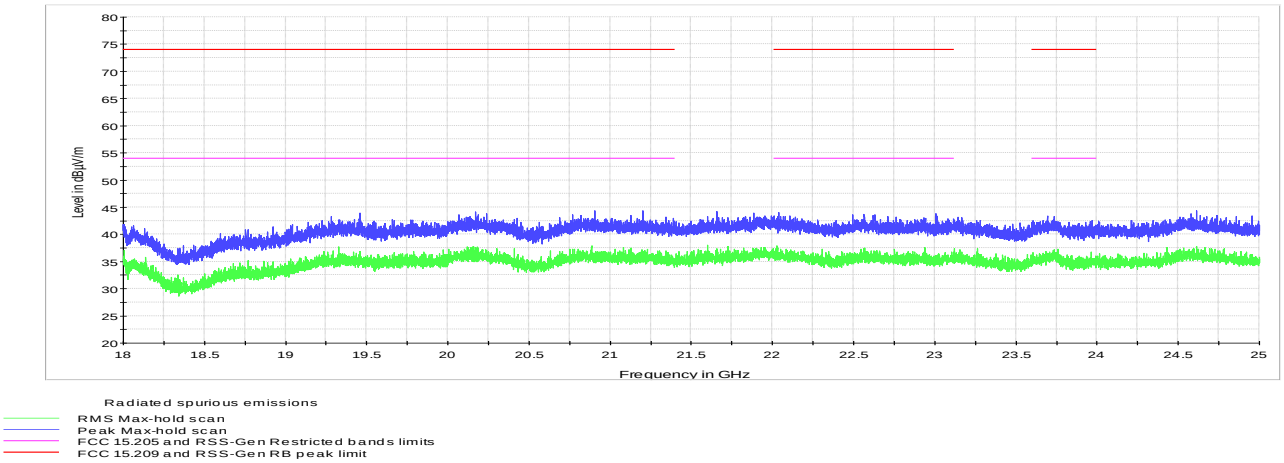


Figure 8.4-15: *Radiated spurious emissions for 5 MHz, high channel*

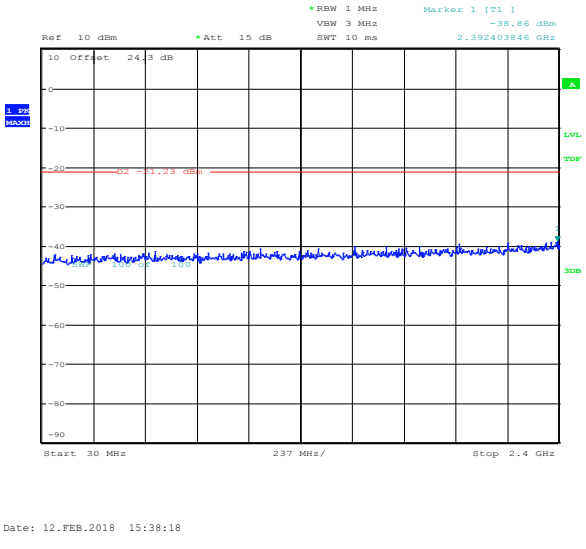


Figure 8.4-16: *Conducted spurious emissions below operation band, 5 MHz low channel, Ant 1, peak*

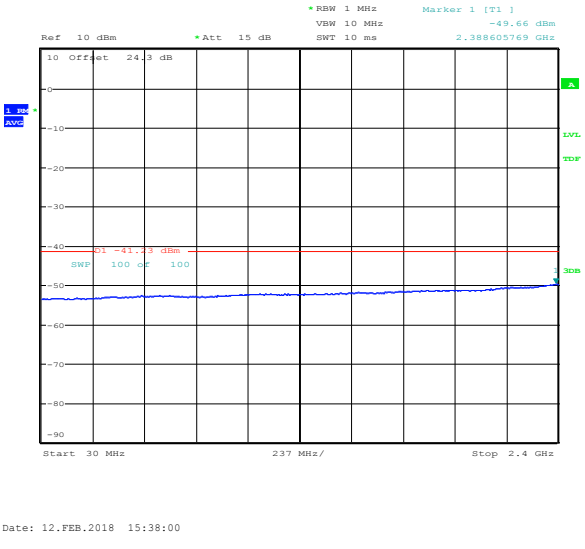


Figure 8.4-17: *Conducted spurious emissions below operation band, 5 MHz low channel, Ant 1, average*

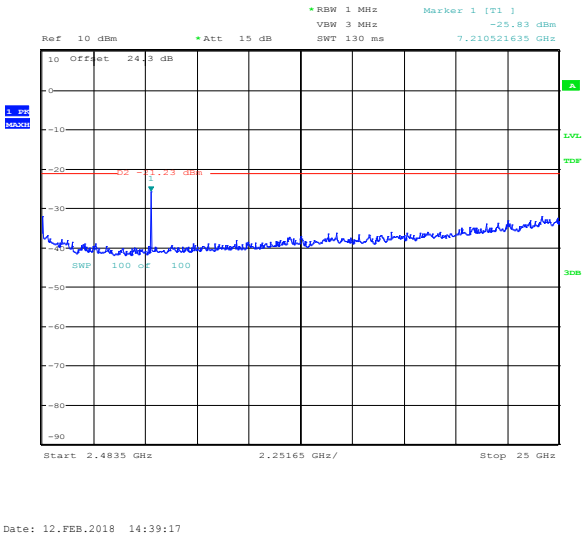


Figure 8.4-18: *Conducted spurious emissions above operation band, 5 MHz low channel, Ant 1, peak*

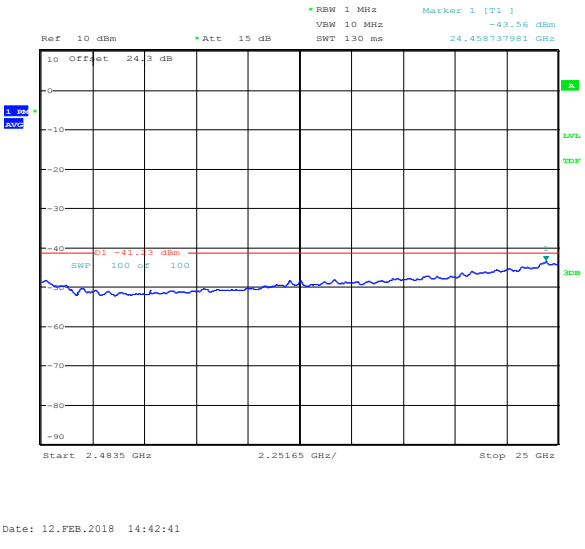


Figure 8.4-19: *Conducted spurious emissions above operation band, 5 MHz low channel, Ant 1, average*

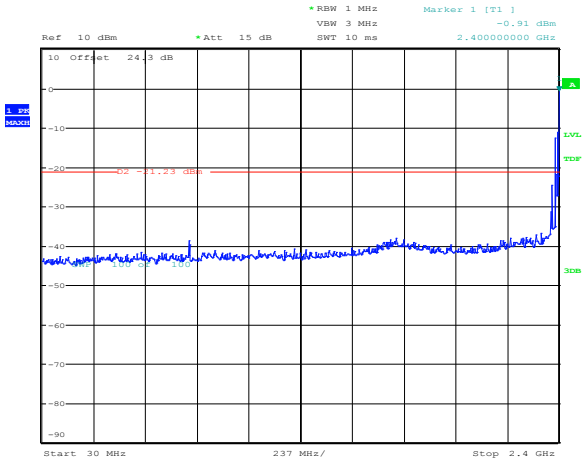


Figure 8.4-20: *Conducted spurious emissions below operation band, 5 MHz low channel, Ant 2, peak*

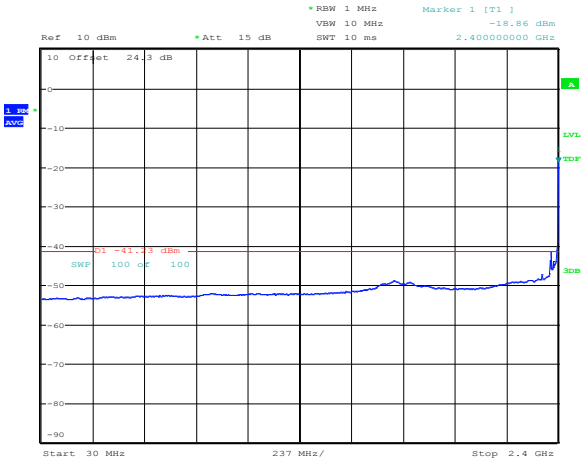


Figure 8.4-21: *Conducted spurious emissions below operation band, 5 MHz low channel, Ant 2, average*

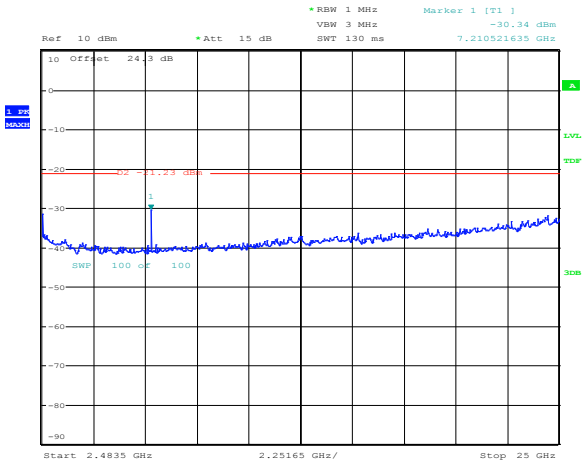


Figure 8.4-22: *Conducted spurious emissions above operation band, 5 MHz low channel, Ant 2, peak*

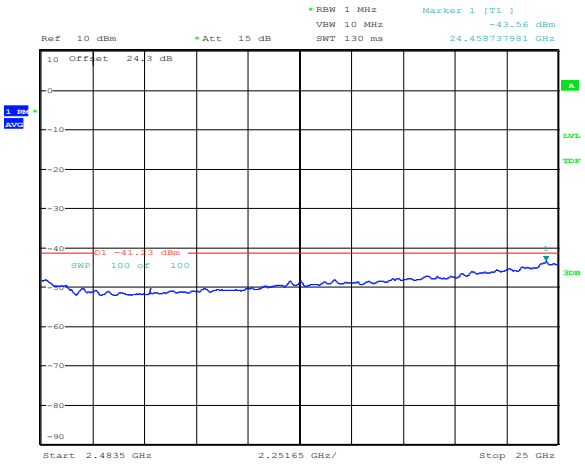


Figure 8.4-23: *Conducted spurious emissions above operation band, 5 MHz low channel, Ant 2, average*

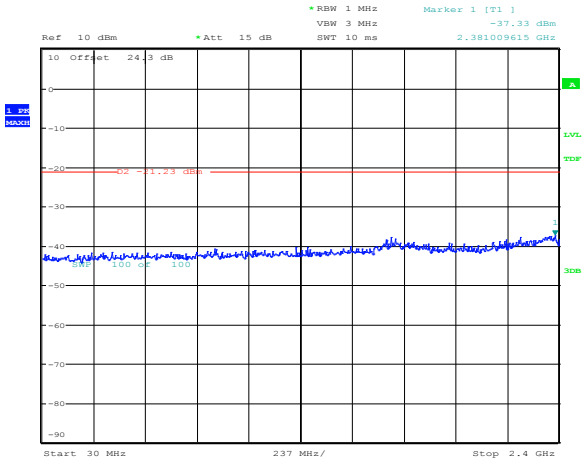


Figure 8.4-24: *Conducted spurious emissions below operation band, 5 MHz mid channel, Ant 1, peak*

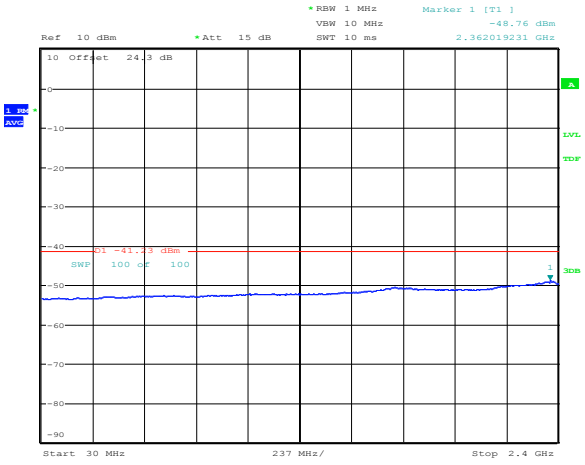


Figure 8.4-25: *Conducted spurious emissions below operation band, 5 MHz mid channel, Ant 1, average*

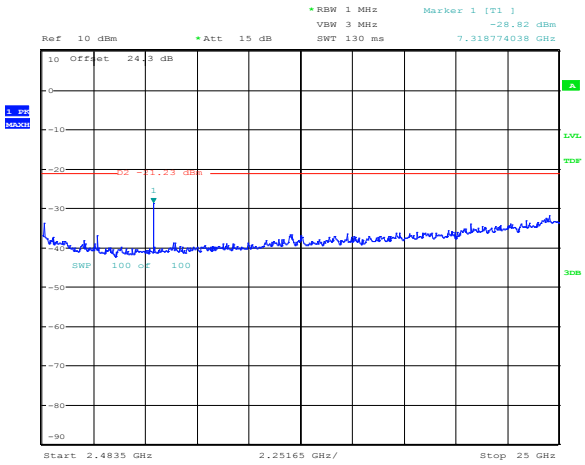


Figure 8.4-26: *Conducted spurious emissions above operation band, 5 MHz mid channel, Ant 1, peak*

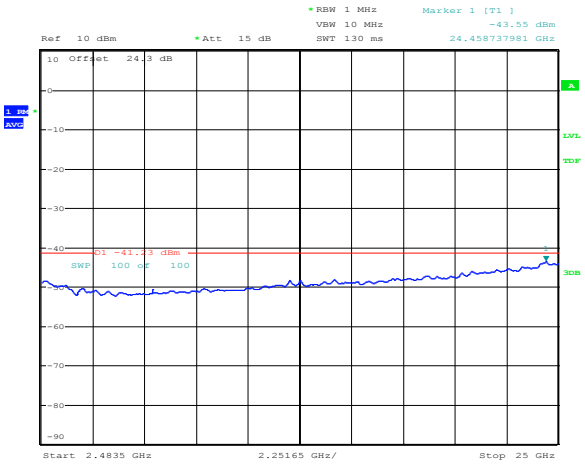


Figure 8.4-27: *Conducted spurious emissions above operation band, 5 MHz mid channel, Ant 1, average*

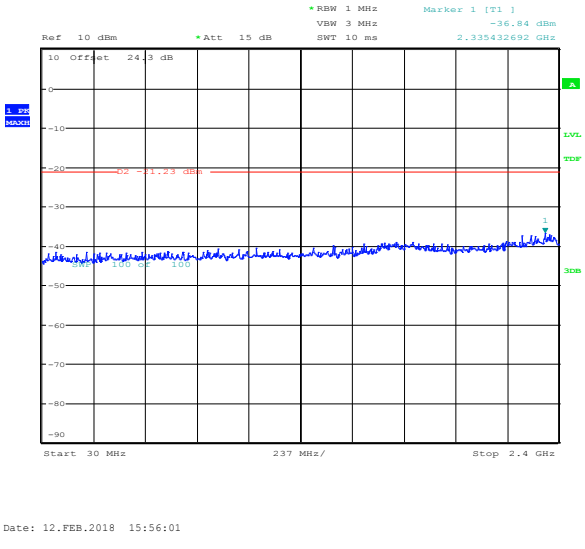


Figure 8.4-28: *Conducted spurious emissions below operation band, 5 MHz mid channel, Ant 2, peak*

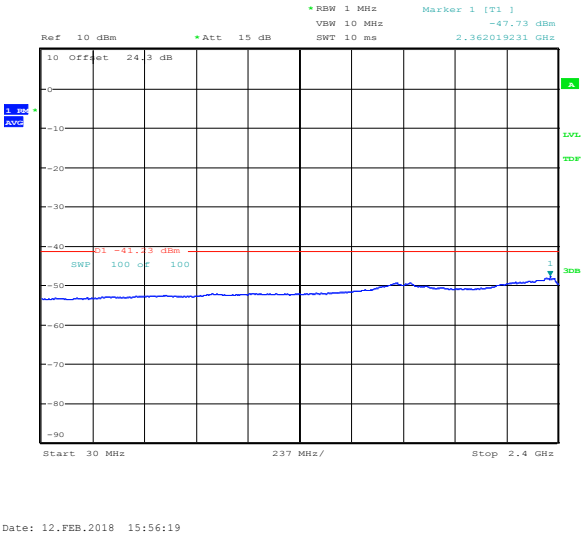


Figure 8.4-29: *Conducted spurious emissions below operation band, 5 MHz mid channel, Ant 2, average*

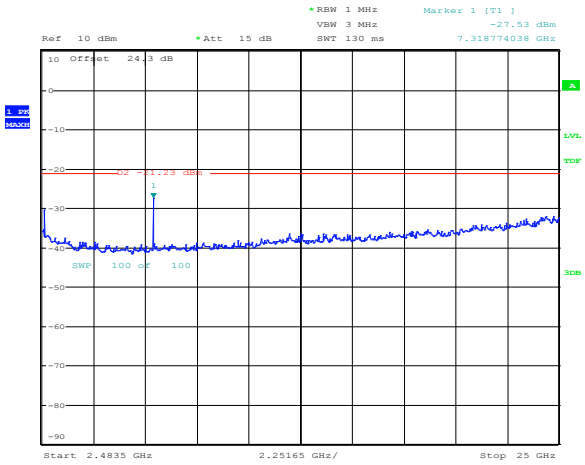


Figure 8.4-30: *Conducted spurious emissions above operation band, 5 MHz mid channel, Ant 2, peak*

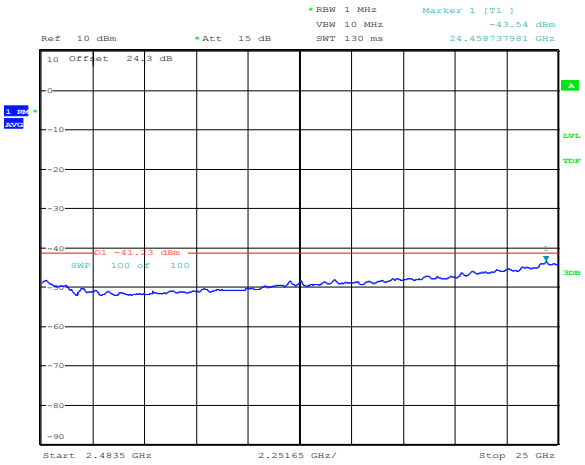


Figure 8.4-31: *Conducted spurious emissions above operation band, 5 MHz mid channel, Ant 2, average*

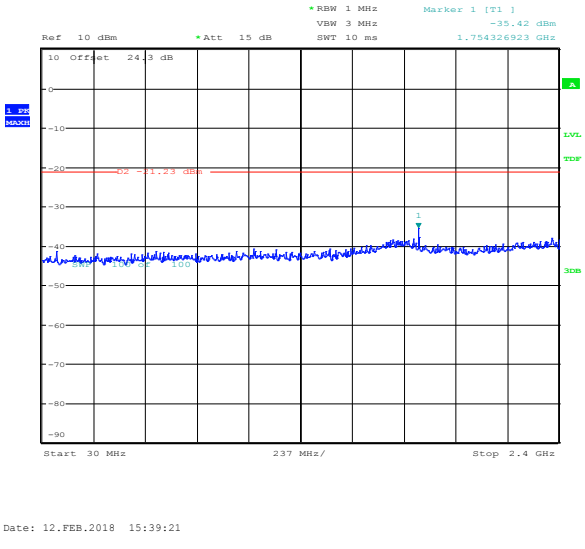


Figure 8.4-32: *Conducted spurious emissions below operation band, 5 MHz high channel, Ant 1, peak*

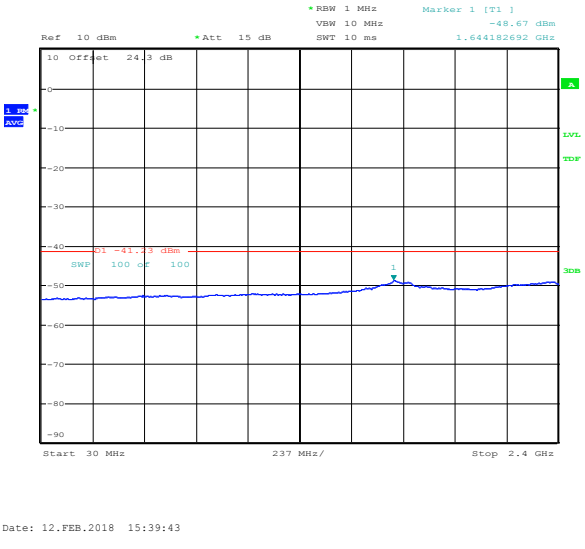


Figure 8.4-33: *Conducted spurious emissions below operation band, 5 MHz high channel, Ant 1, average*

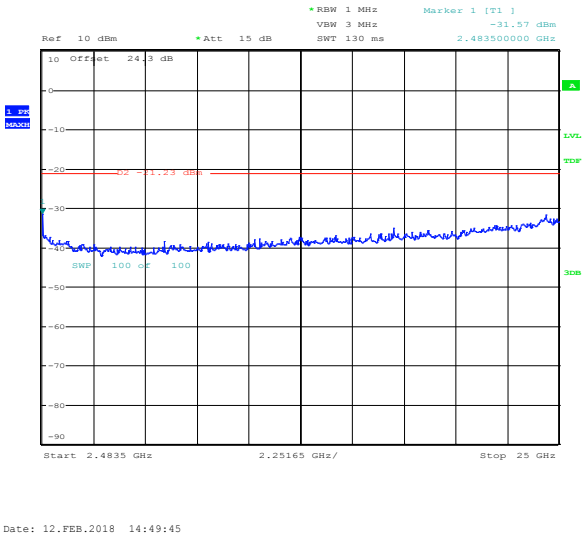


Figure 8.4-34: *Conducted spurious emissions above operation band, 5 MHz high channel, Ant 1, peak*

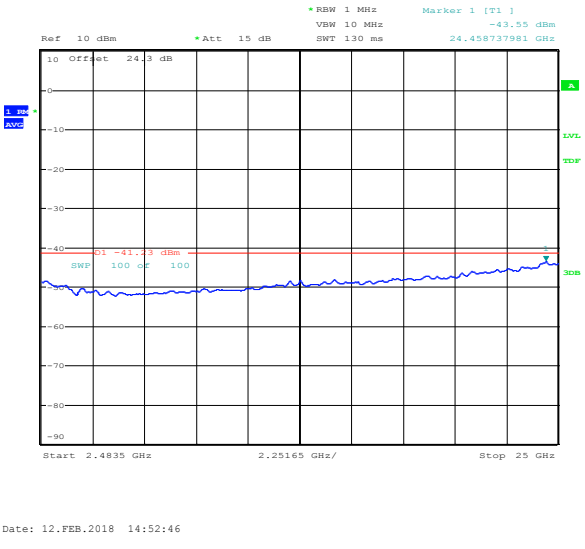


Figure 8.4-35: *Conducted spurious emissions above operation band, 5 MHz high channel, Ant 1, average*

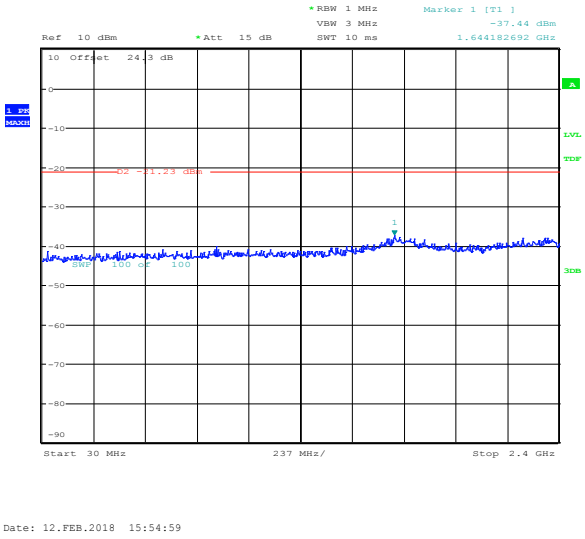


Figure 8.4-36: *Conducted spurious emissions below operation band, 5 MHz high channel, Ant 2, peak*

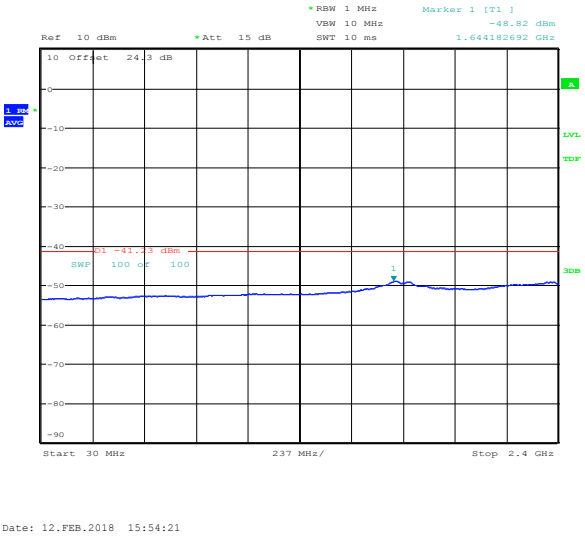


Figure 8.4-37: *Conducted spurious emissions below operation band, 5 MHz high channel, Ant 2, average*

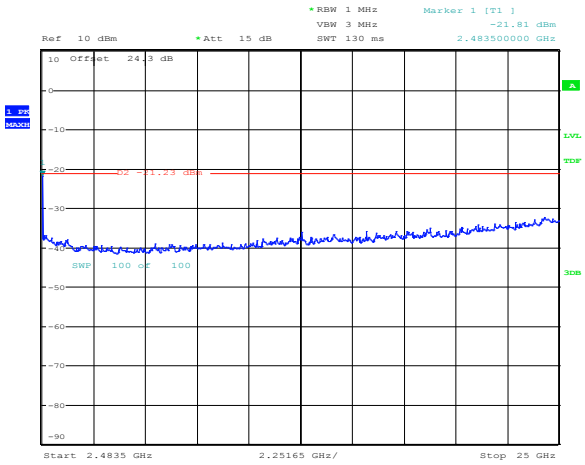


Figure 8.4-38: *Conducted spurious emissions above operation band, 5 MHz high channel, Ant 2, peak*

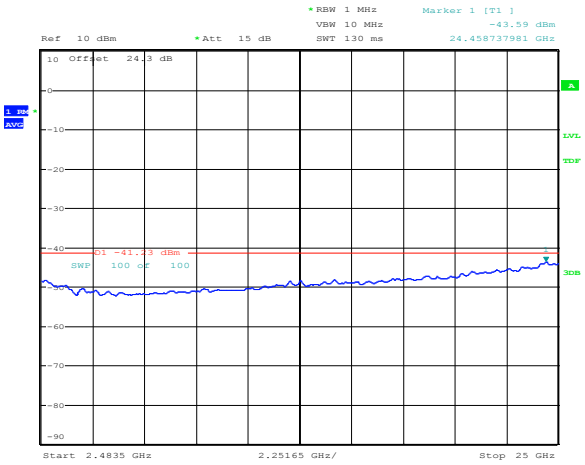


Figure 8.4-39: *Conducted spurious emissions above operation band, 5 MHz high channel, Ant 2, average*

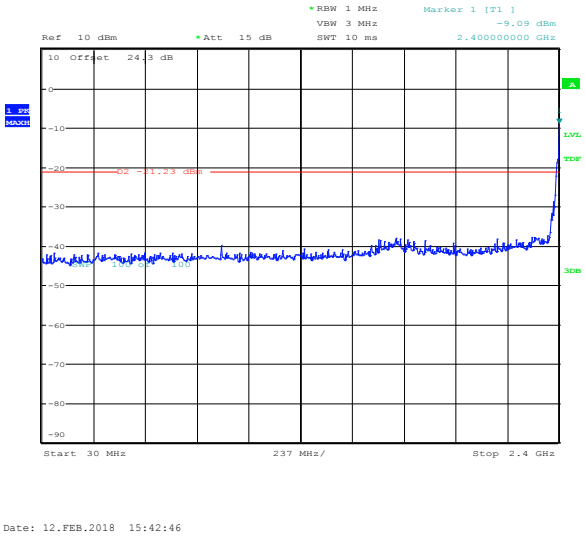


Figure 8.4-40: *Conducted spurious emissions below operation band, 10 MHz low channel, Ant 1, peak*

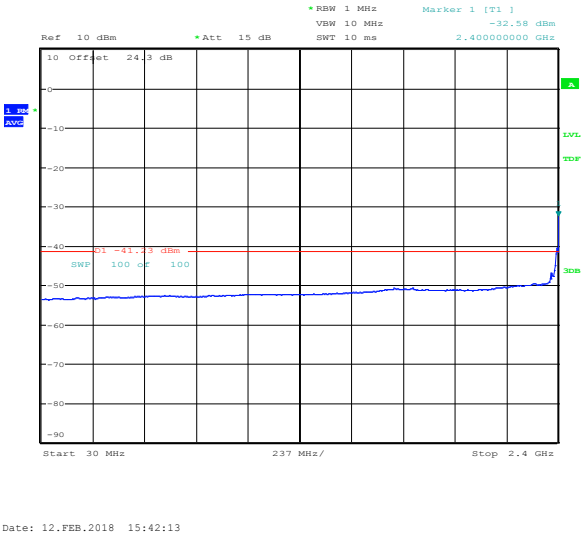


Figure 8.4-41: *Conducted spurious emissions below operation band, 10 MHz low channel, Ant 1, average*

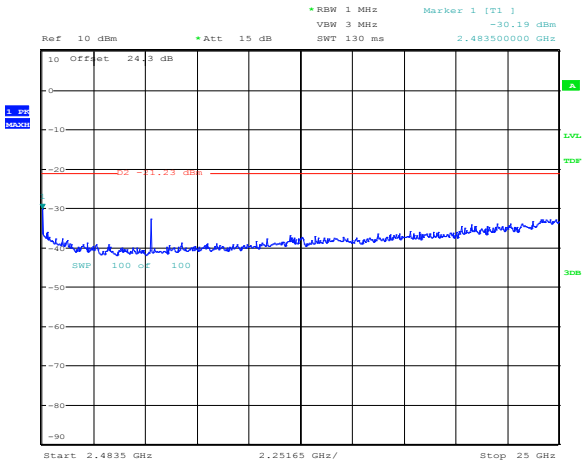


Figure 8.4-42: *Conducted spurious emissions above operation band, 10 MHz low channel, Ant 1, peak*

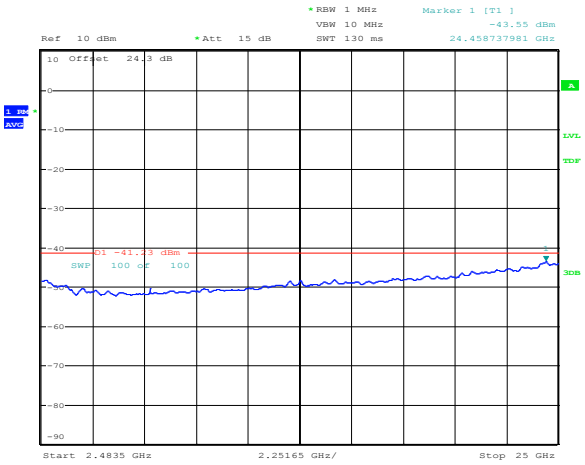


Figure 8.4-43: *Conducted spurious emissions above operation band, 10 MHz low channel, Ant 1, average*

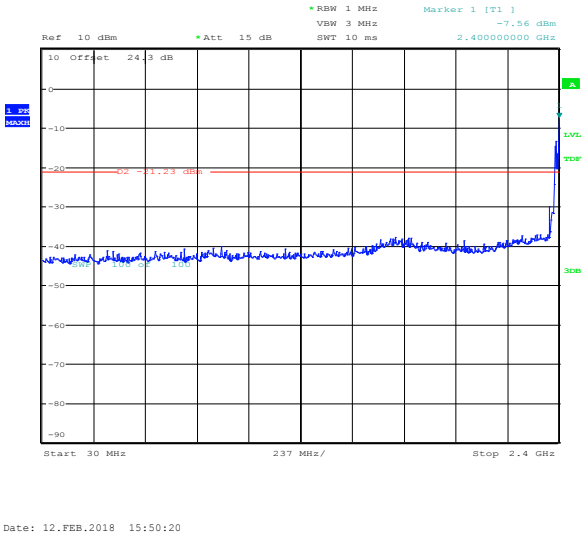


Figure 8.4-44: *Conducted spurious emissions below operation band, 10 MHz low channel, Ant 2, peak*

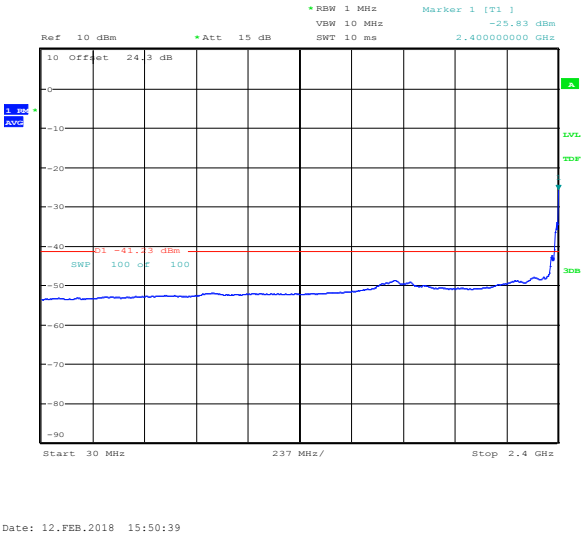


Figure 8.4-45: *Conducted spurious emissions below operation band, 10 MHz low channel, Ant 2, average*

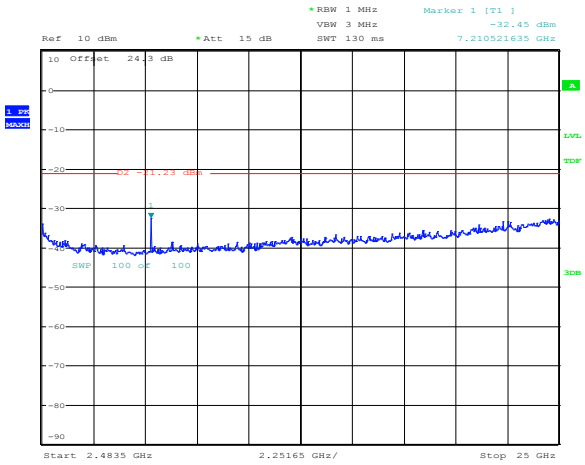


Figure 8.4-46: *Conducted spurious emissions above operation band, 10 MHz low channel, Ant 2, peak*

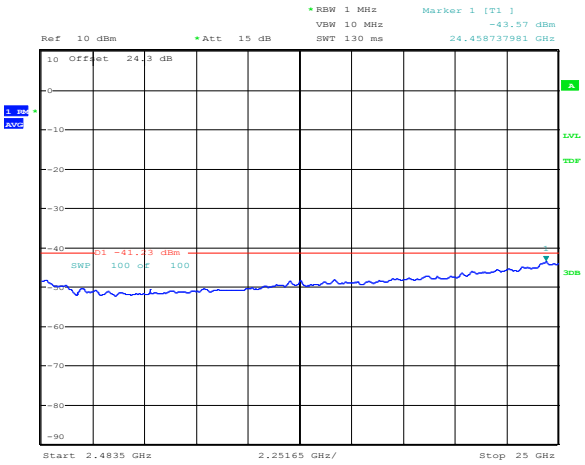


Figure 8.4-47: *Conducted spurious emissions above operation band, 10 MHz low channel, Ant 2, average*

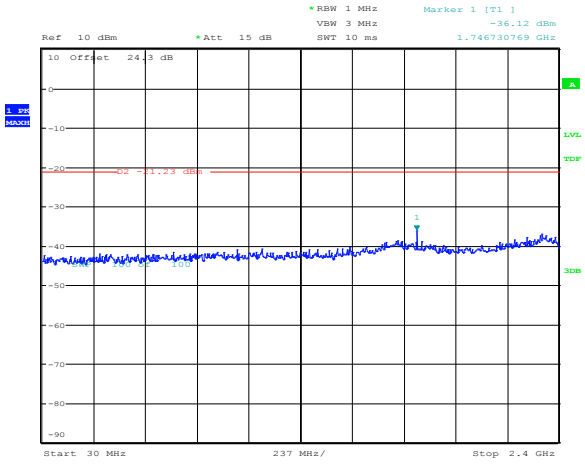


Figure 8.4-48: *Conducted spurious emissions below operation band, 10 MHz mid channel, Ant 1, peak*

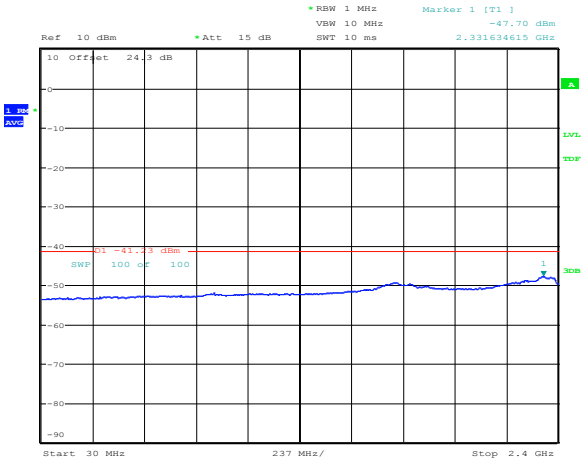


Figure 8.4-49: *Conducted spurious emissions below operation band, 10 MHz mid channel, Ant 1, average*

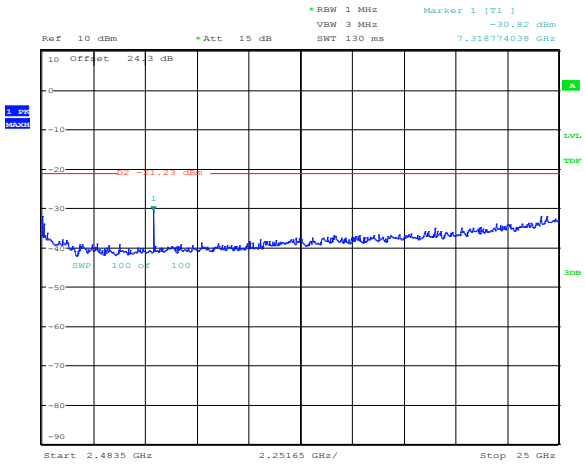


Figure 8.4-50: *Conducted spurious emissions above operation band, 10 MHz mid channel, Ant 1, peak*

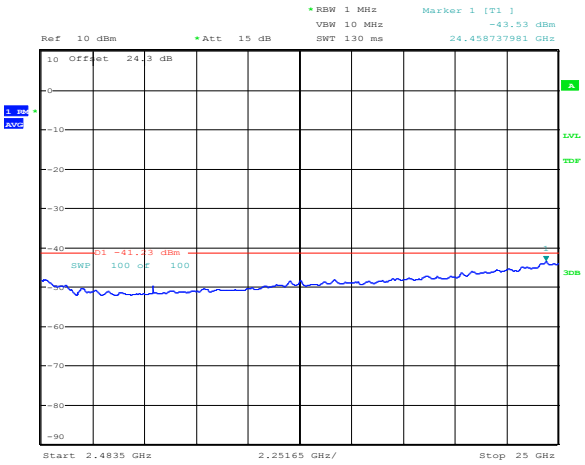


Figure 8.4-51: *Conducted spurious emissions above operation band, 10 MHz mid channel, Ant 1, average*

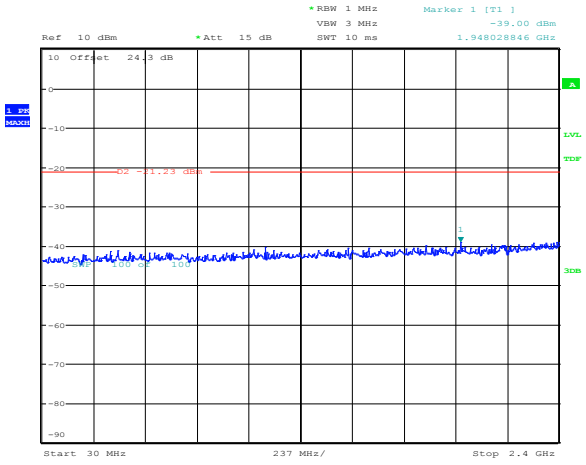


Figure 8.4-52: *Conducted spurious emissions below operation band, 10 MHz mid channel, Ant 2, peak*

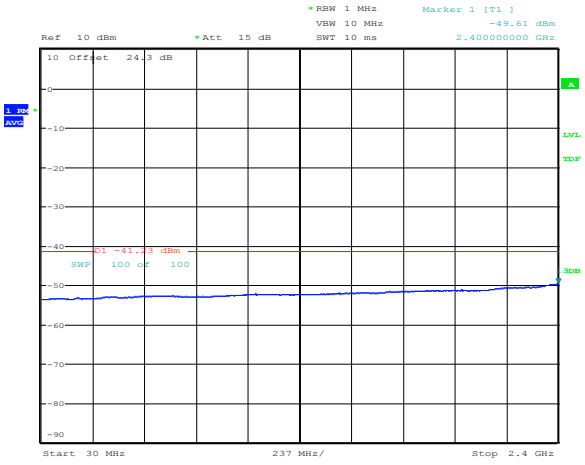


Figure 8.4-53: *Conducted spurious emissions below operation band, 10 MHz mid channel, Ant 2, average*

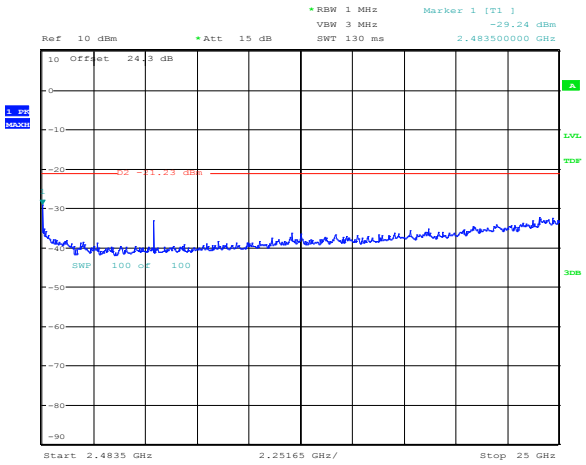


Figure 8.4-54: *Conducted spurious emissions above operation band, 10 MHz mid channel, Ant 2, peak*

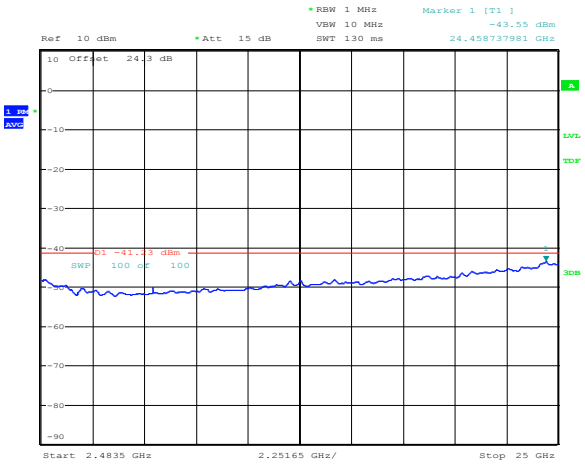


Figure 8.4-55: *Conducted spurious emissions above operation band, 10 MHz mid channel, Ant 2, average*

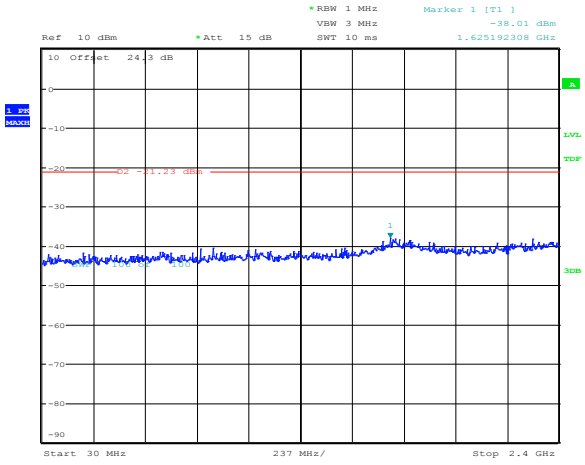


Figure 8.4-56: *Conducted spurious emissions below operation band, 10 MHz high channel, Ant 1, peak*

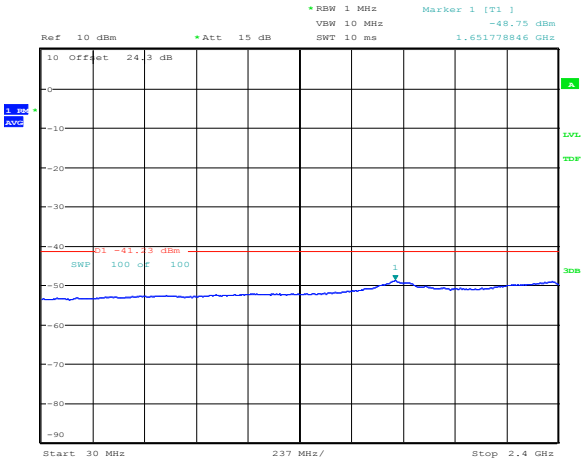


Figure 8.4-57: *Conducted spurious emissions below operation band, 10 MHz high channel, Ant 1, average*

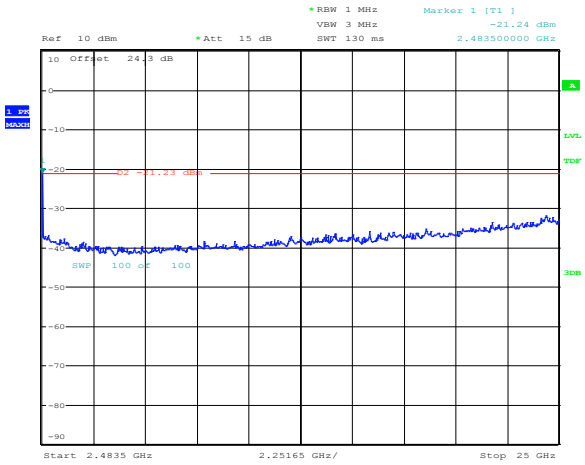


Figure 8.4-58: *Conducted spurious emissions above operation band, 10 MHz high channel, Ant 1, peak*

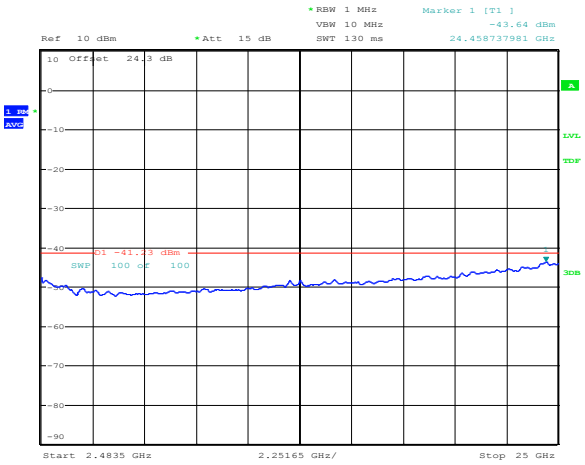


Figure 8.4-59: *Conducted spurious emissions above operation band, 10 MHz high channel, Ant 1, average*

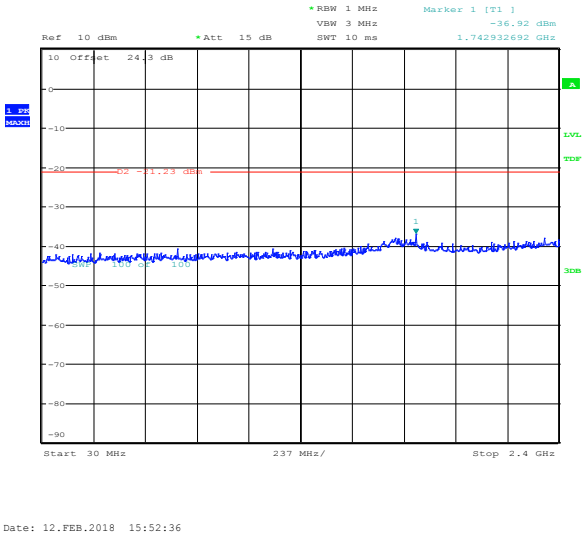


Figure 8.4-60: *Conducted spurious emissions below operation band, 10 MHz high channel, Ant 2, peak*

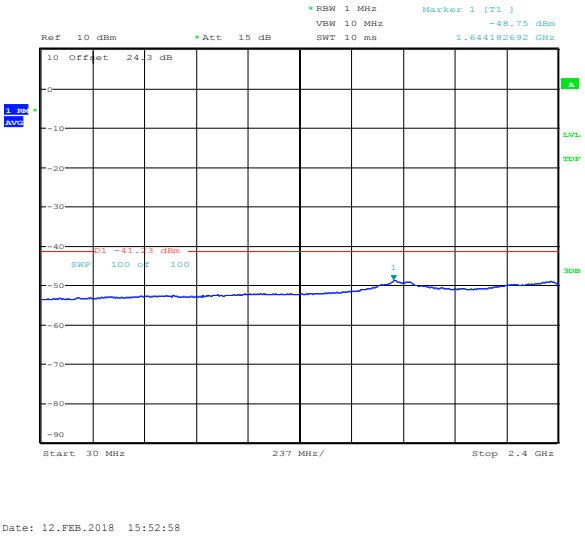


Figure 8.4-61: *Conducted spurious emissions below operation band, 10 MHz high channel, Ant 2, average*

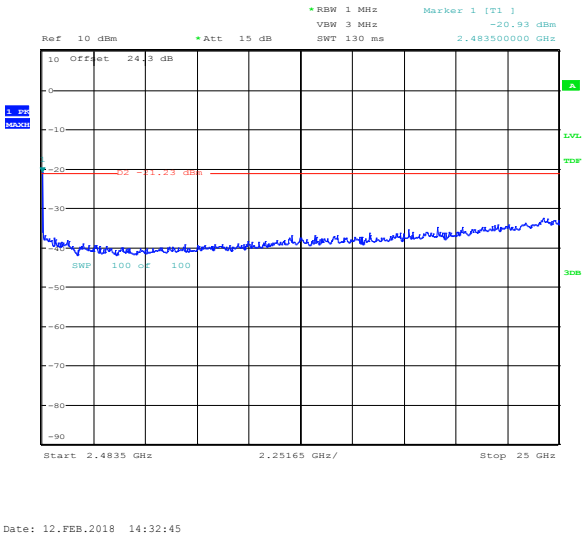


Figure 8.4-62: *Conducted spurious emissions above operation band, 10 MHz high channel, Ant 2, peak*

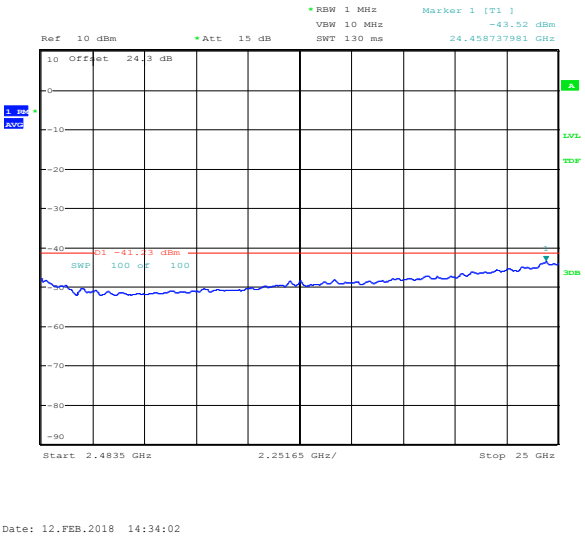


Figure 8.4-63: *Conducted spurious emissions above operation band, 10 MHz high channel, Ant 2, average*

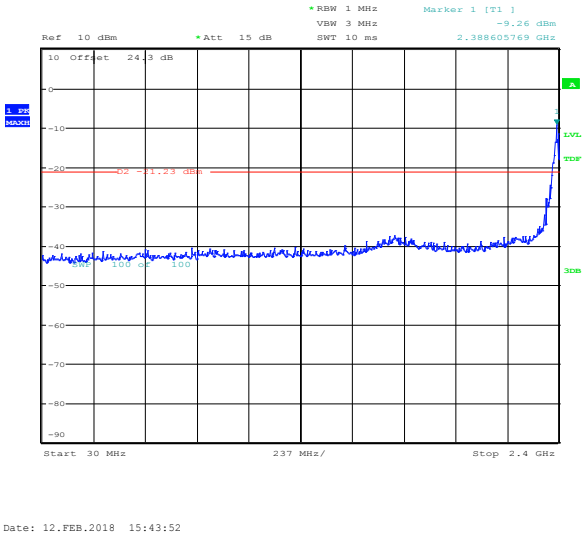


Figure 8.4-64: *Conducted spurious emissions below operation band, 20 MHz low channel, Ant 1, peak*

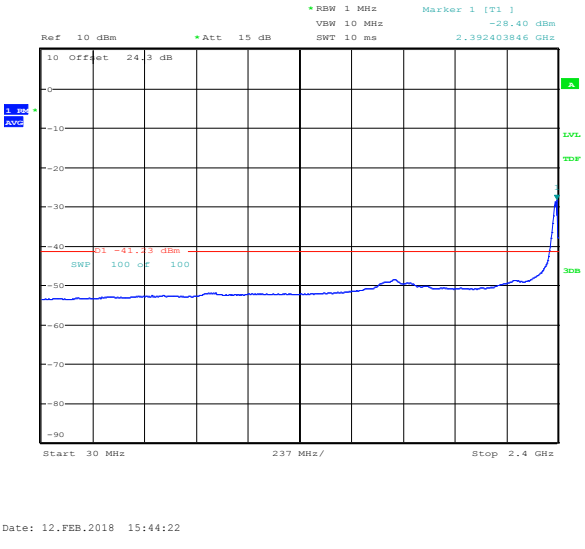


Figure 8.4-65: *Conducted spurious emissions below operation band, 20 MHz low channel, Ant 1, average*

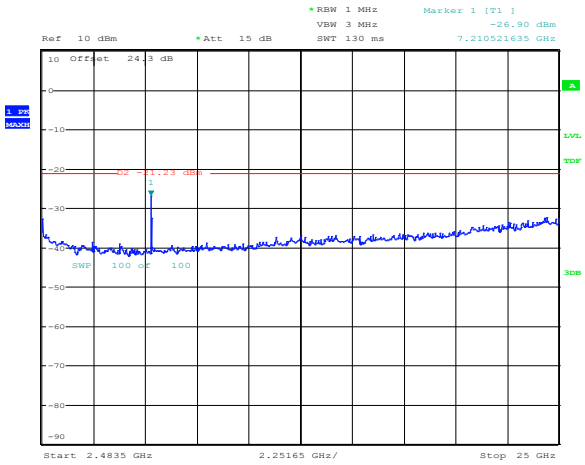


Figure 8.4-66: *Conducted spurious emissions above operation band, 20 MHz low channel, Ant 1, peak*

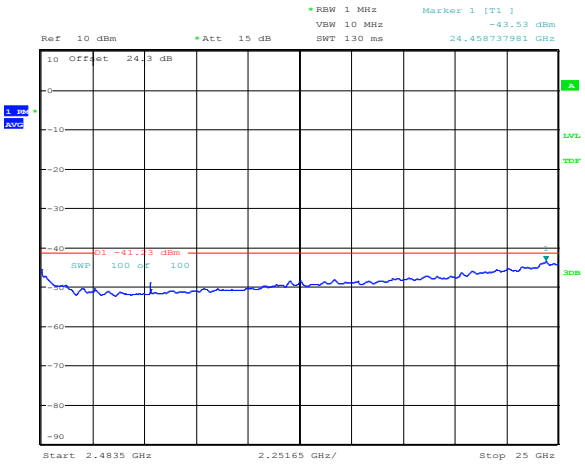


Figure 8.4-67: *Conducted spurious emissions above operation band, 20 MHz low channel, Ant 1, average*

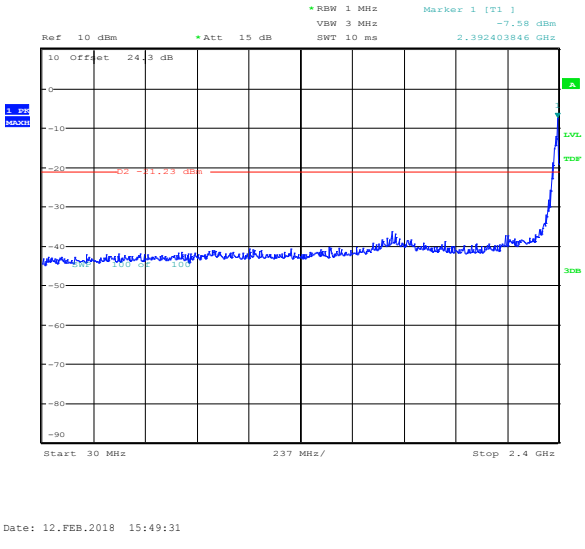


Figure 8.4-68: *Conducted spurious emissions below operation band, 20 MHz low channel, Ant 2, peak*

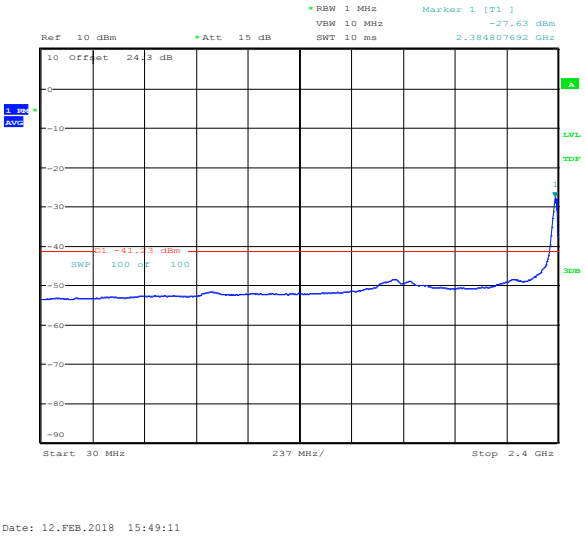


Figure 8.4-69: *Conducted spurious emissions below operation band, 20 MHz low channel, Ant 2, average*

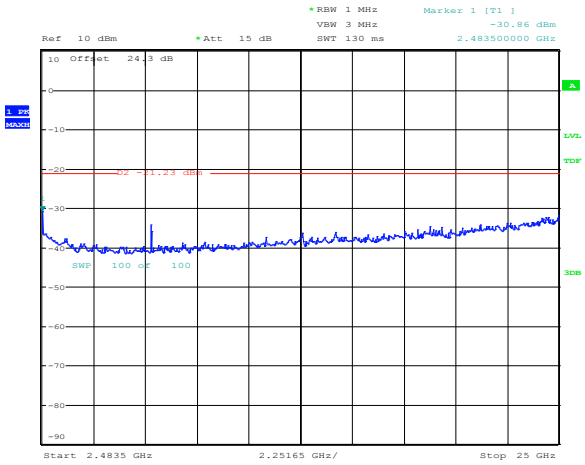


Figure 8.4-70: *Conducted spurious emissions above operation band, 20 MHz low channel, Ant 2, peak*

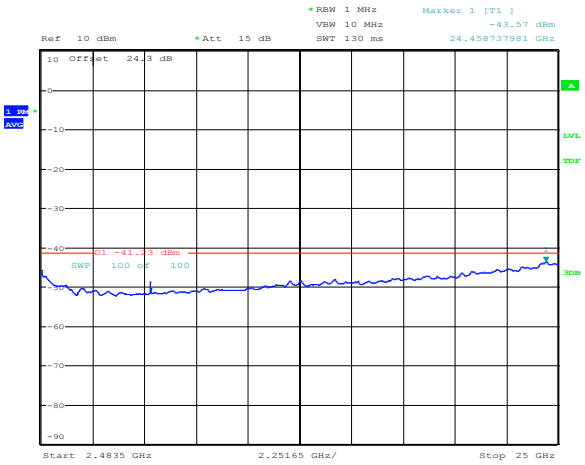


Figure 8.4-71: *Conducted spurious emissions above operation band, 20 MHz low channel, Ant 2, average*

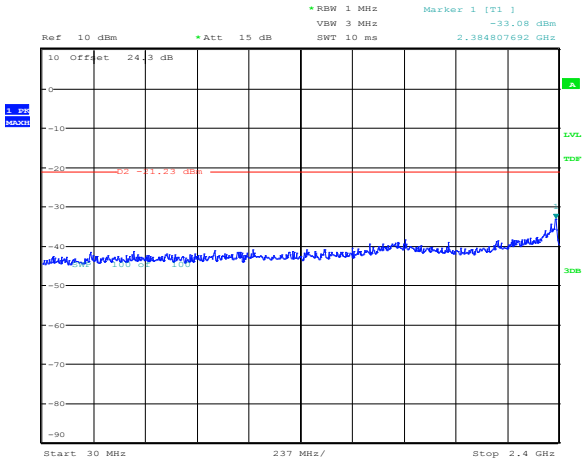


Figure 8.4-72: *Conducted spurious emissions below operation band, 20 MHz mid channel, Ant 1, peak*

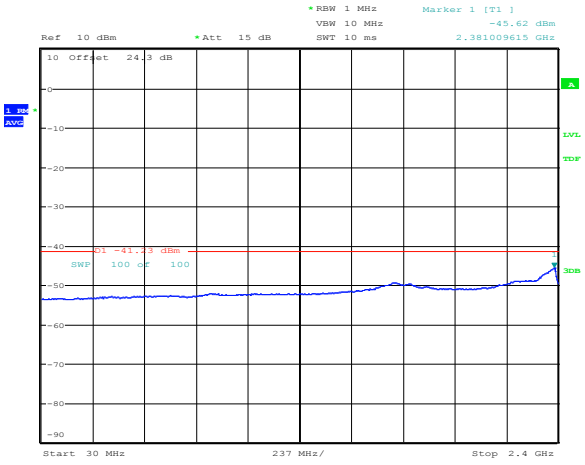


Figure 8.4-73: *Conducted spurious emissions below operation band, 20 MHz mid channel, Ant 1, average*

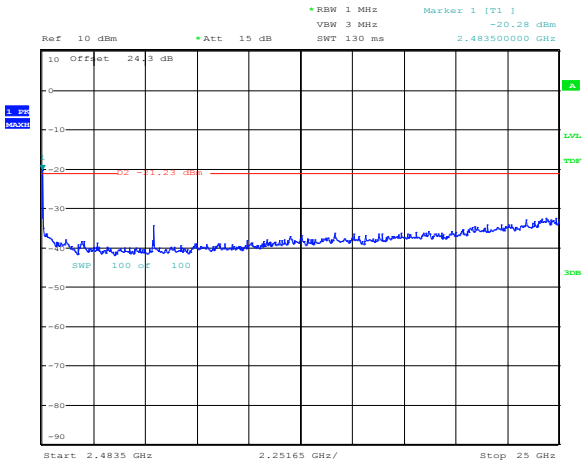


Figure 8.4-74: *Conducted spurious emissions above operation band, 20 MHz mid channel, Ant 1, peak*

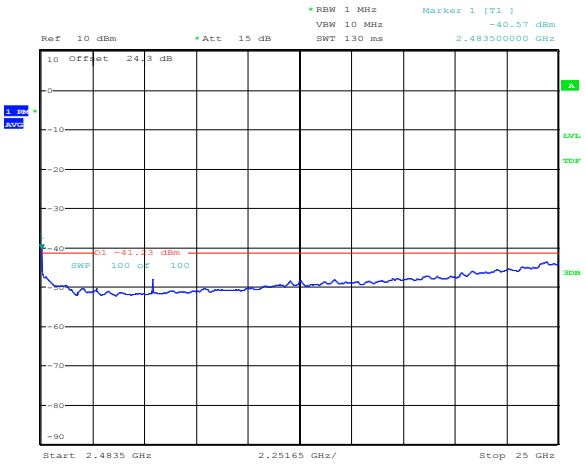


Figure 8.4-75: *Conducted spurious emissions above operation band, 20 MHz mid channel, Ant 1, average*

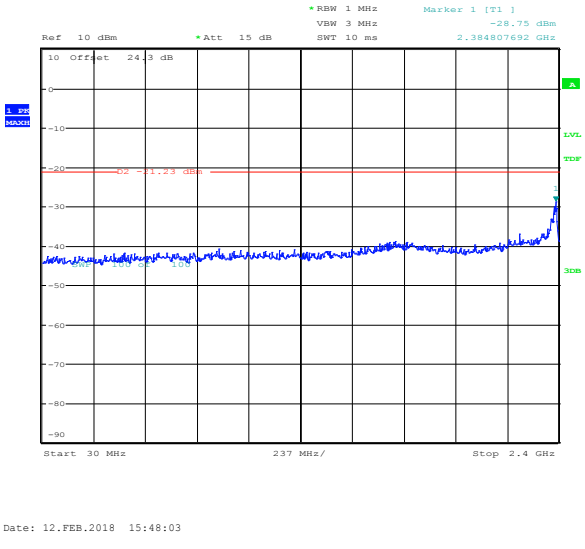


Figure 8.4-76: *Conducted spurious emissions below operation band, 20 MHz mid channel, Ant 2, peak*

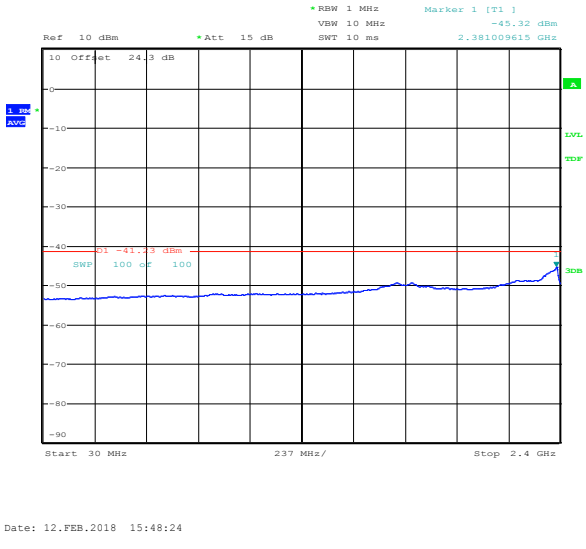


Figure 8.4-77: *Conducted spurious emissions below operation band, 20 MHz mid channel, Ant 2, average*

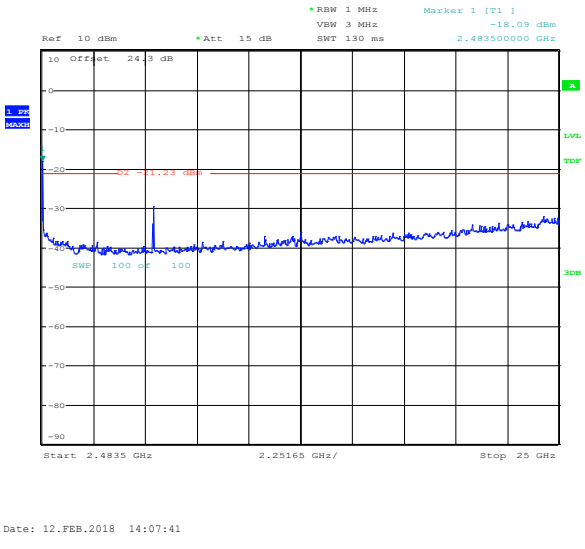


Figure 8.4-78: *Conducted spurious emissions above operation band, 20 MHz mid channel, Ant 2, peak*

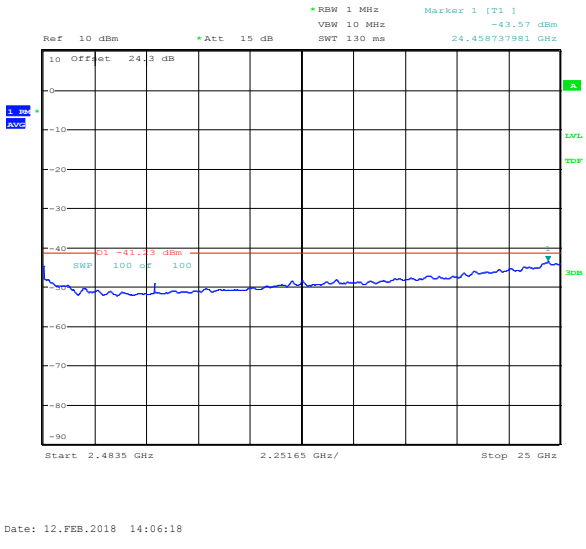


Figure 8.4-79: *Conducted spurious emissions above operation band, 20 MHz mid channel, Ant 2, average*

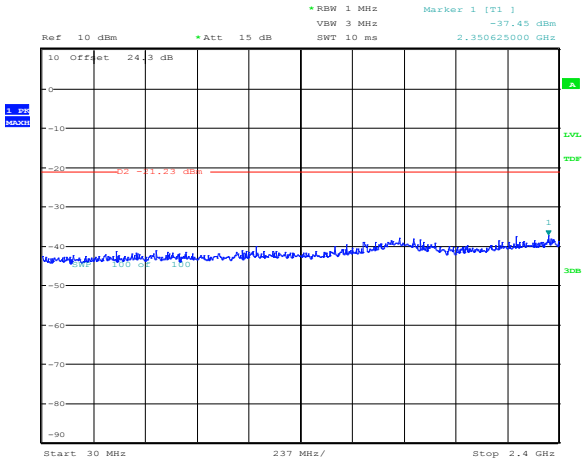


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Figure 8.4-80: *Conducted spurious emissions below operation band, 20 MHz high channel, Ant 1, peak*

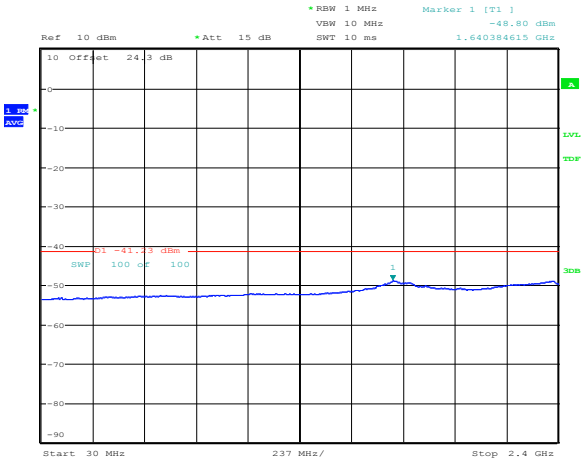

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Figure 8.4-81: *Conducted spurious emissions below operation band, 20 MHz high channel, Ant 1, average*

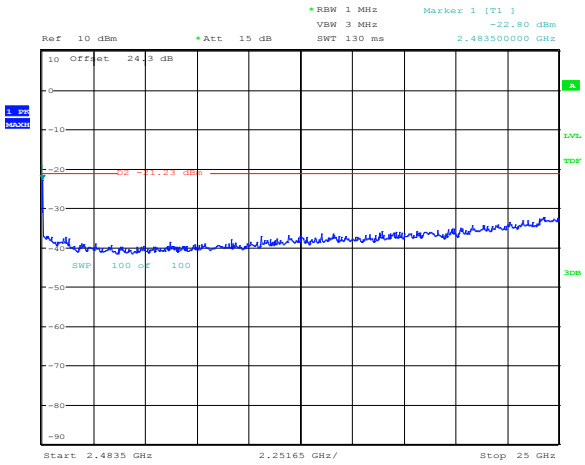

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Figure 8.4-82: *Conducted spurious emissions above operation band, 20 MHz high channel, Ant 1, peak*

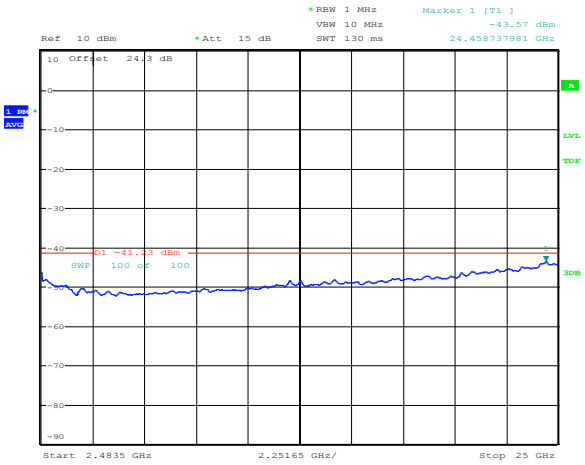

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Figure 8.4-83: *Conducted spurious emissions above operation band, 20 MHz high channel, Ant 1, average*

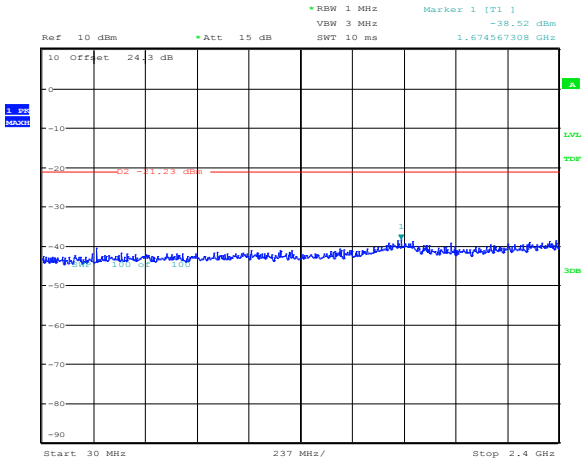


Figure 8.4-84: *Conducted spurious emissions below operation band, 20 MHz high channel, Ant 2, peak*

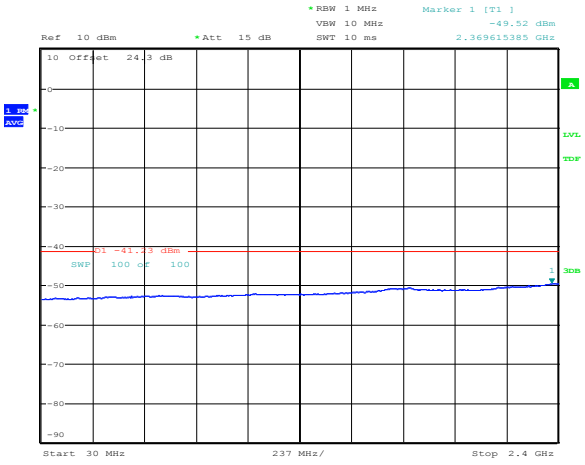


Figure 8.4-85: *Conducted spurious emissions below operation band, 20 MHz high channel, Ant 2, average*

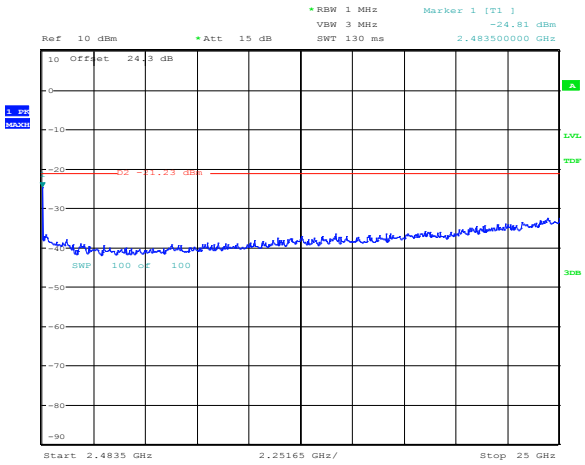


Figure 8.4-86: *Conducted spurious emissions above operation band, 20 MHz high channel, Ant 2, peak*

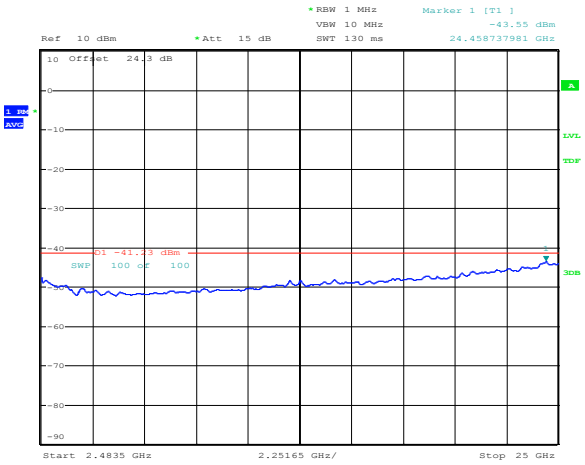


Figure 8.4-87: *Conducted spurious emissions above operation band, 20 MHz high channel, Ant 2, average*

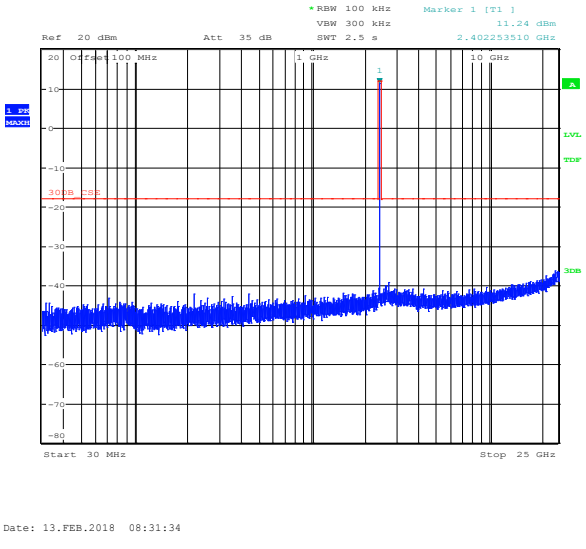


Figure 8.4-88: *Conducted spurious emissions outside restricted bands, 5 MHz low channel, Ant 1*

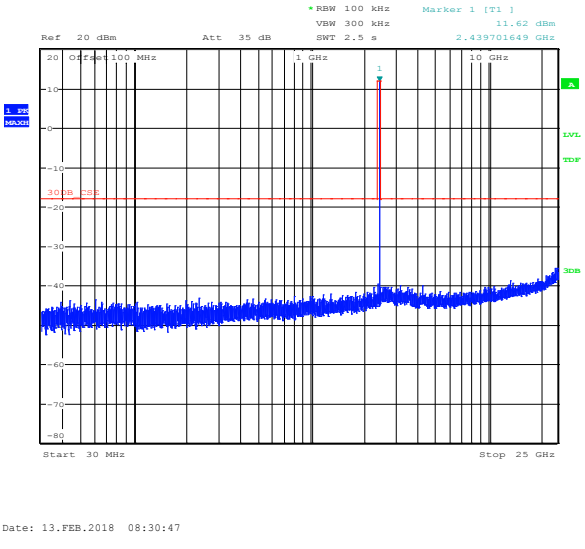


Figure 8.4-89: *Conducted spurious emissions outside restricted bands, 5 MHz mid channel, Ant 1*

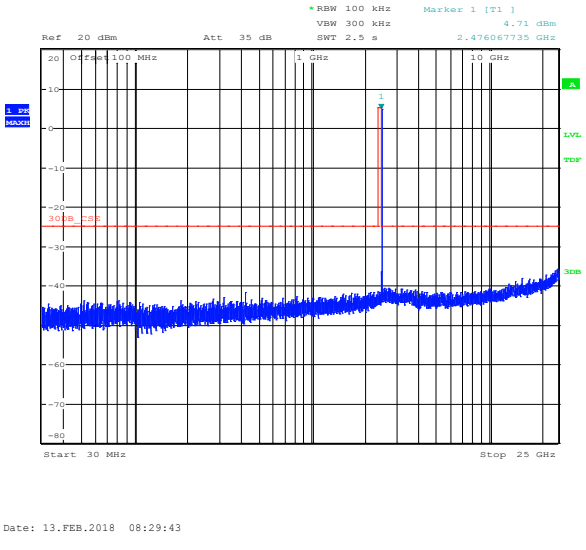


Figure 8.4-90: *Conducted spurious emissions outside restricted bands, 5 MHz high channel, Ant 1*

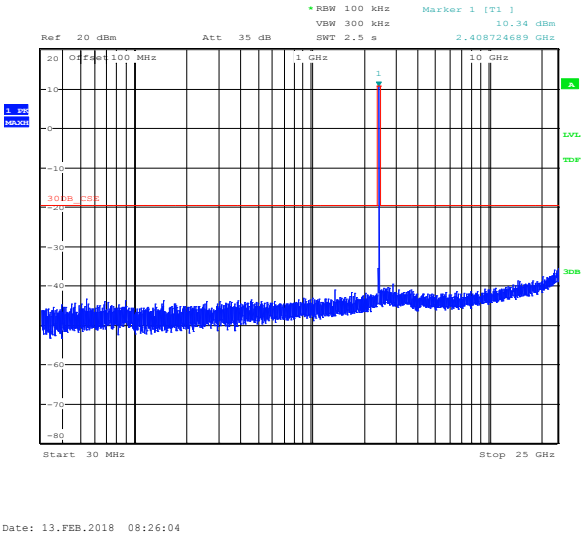


Figure 8.4-91: *Conducted spurious emissions outside restricted bands, 10 MHz low channel, Ant 1*

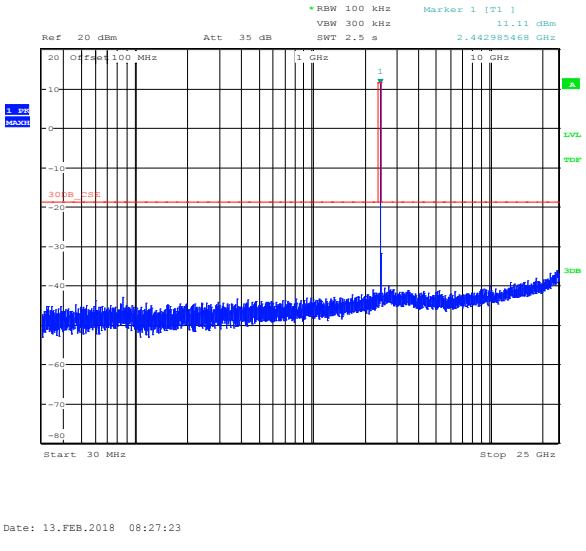


Figure 8.4-92: *Conducted spurious emissions outside restricted bands, 10 MHz mid channel, Ant 1*

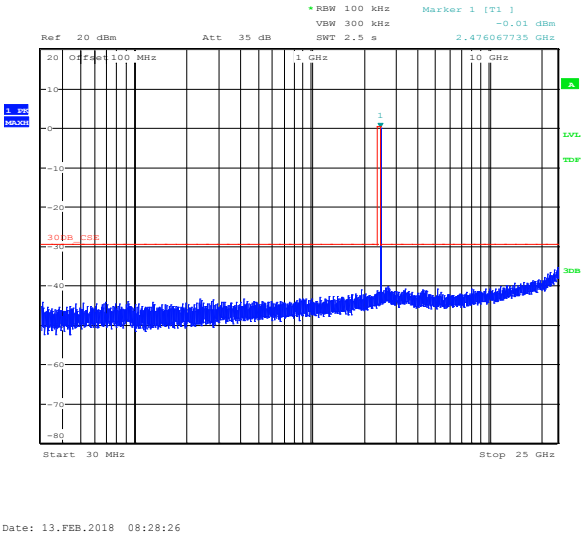


Figure 8.4-93: *Conducted spurious emissions outside restricted bands, 10 MHz high channel, Ant 1*

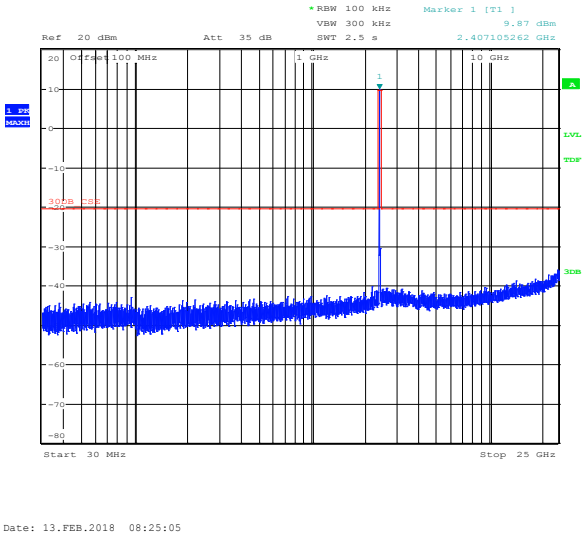


Figure 8.4-94: *Conducted spurious emissions outside restricted bands, 20 MHz low channel, Ant 1*

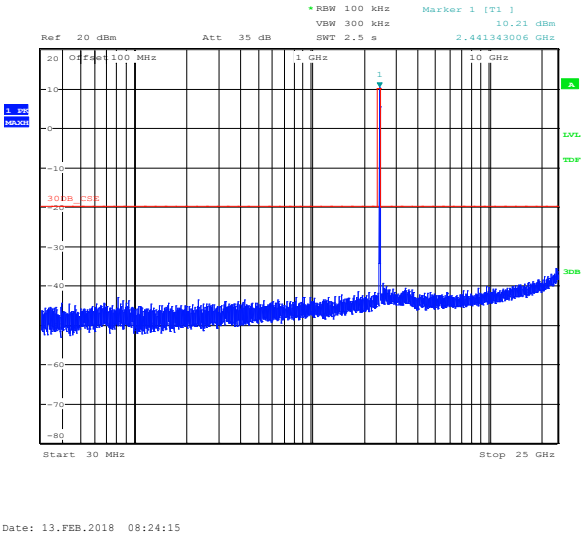


Figure 8.4-95: *Conducted spurious emissions outside restricted bands, 20 MHz mid channel, Ant 1*

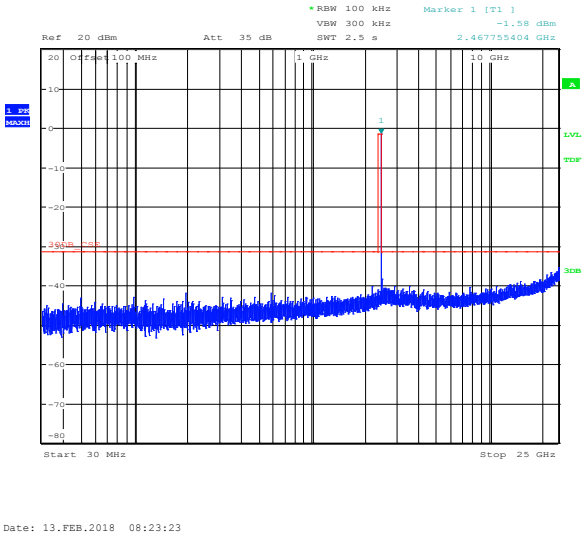


Figure 8.4-96: *Conducted spurious emissions outside restricted bands, 20 MHz high channel, Ant 1*

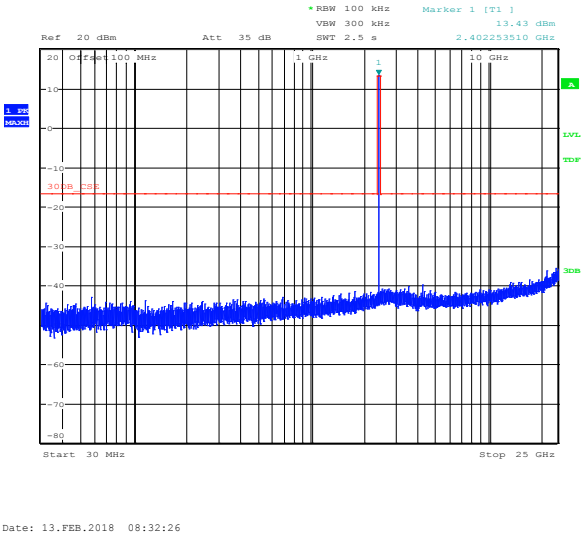


Figure 8.4-97: *Conducted spurious emissions outside restricted bands, 5 MHz low channel, Ant 2*

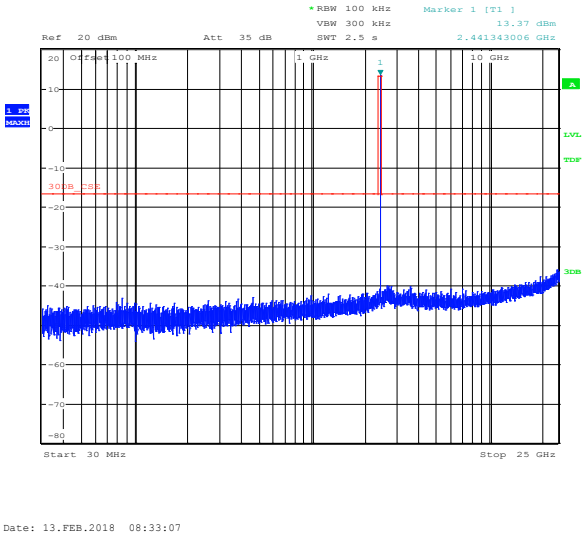


Figure 8.4-98: *Conducted spurious emissions outside restricted bands, 5 MHz mid channel, Ant 2*

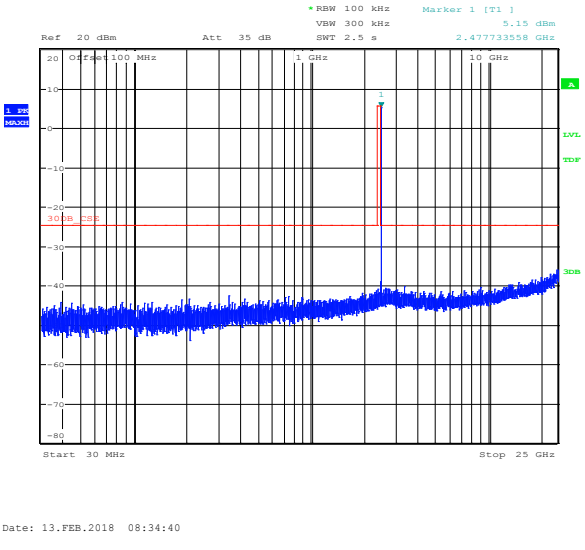


Figure 8.4-99: *Conducted spurious emissions outside restricted bands, 5 MHz high channel, Ant 2*

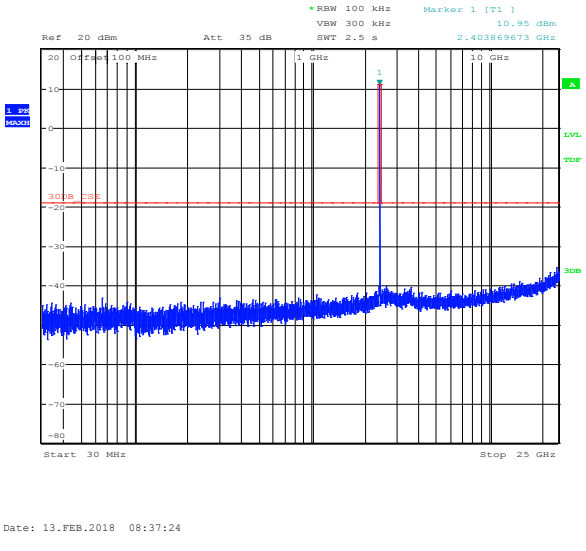


Figure 8.4-100: *Conducted spurious emissions outside restricted bands, 10 MHz low channel, Ant 2*

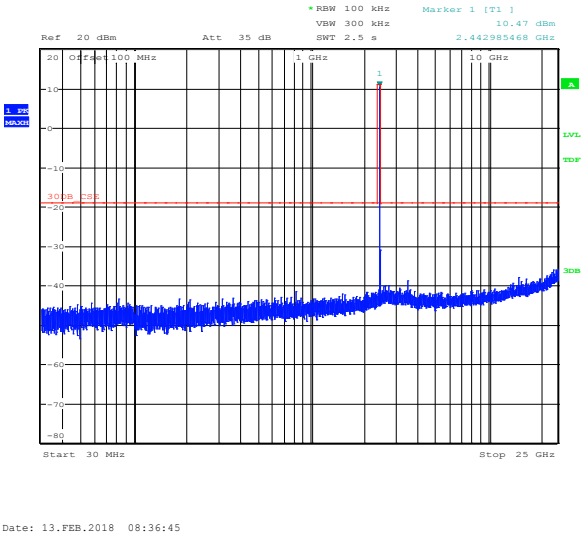


Figure 8.4-101: *Conducted spurious emissions outside restricted bands, 10 MHz mid channel, Ant 2*

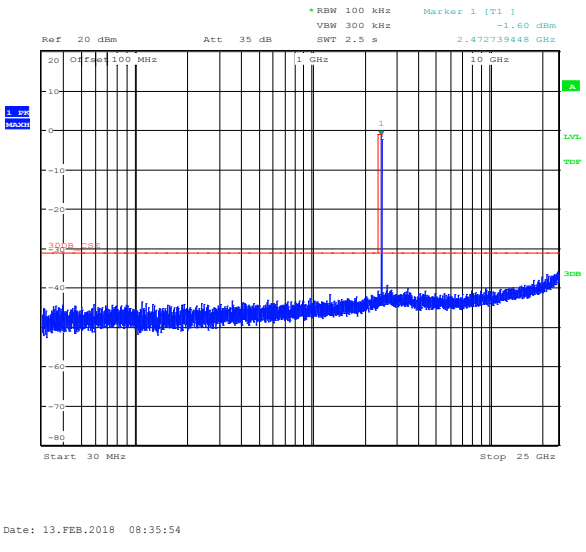


Figure 8.4-102: *Conducted spurious emissions outside restricted bands, 10 MHz high channel, Ant 2*

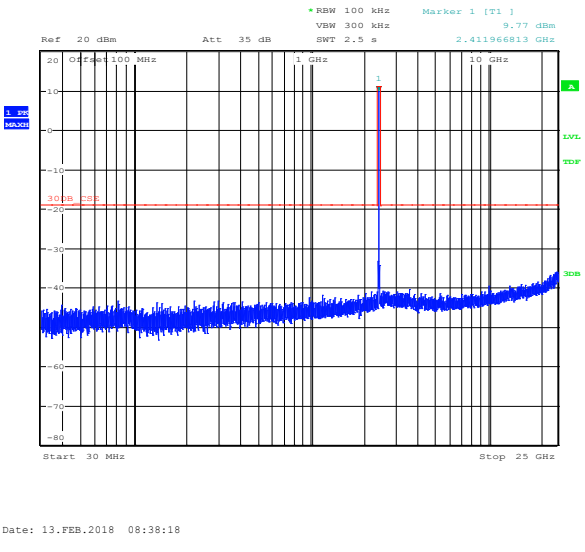


Figure 8.4-103: *Conducted spurious emissions outside restricted bands, 20 MHz low channel, Ant 2*

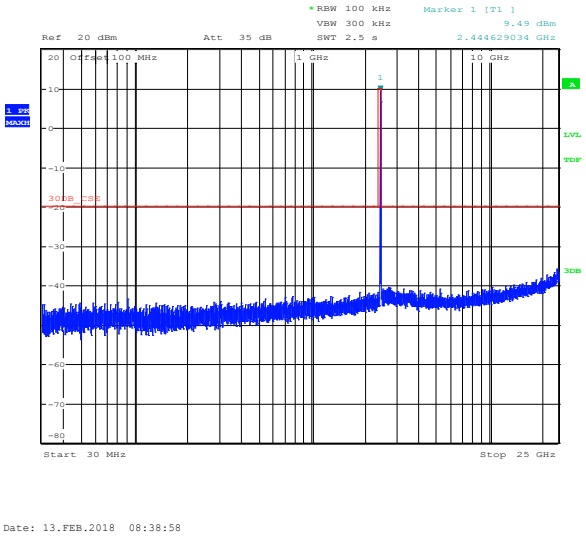


Figure 8.4-104: *Conducted spurious emissions outside restricted bands, 20 MHz mid channel, Ant 2*

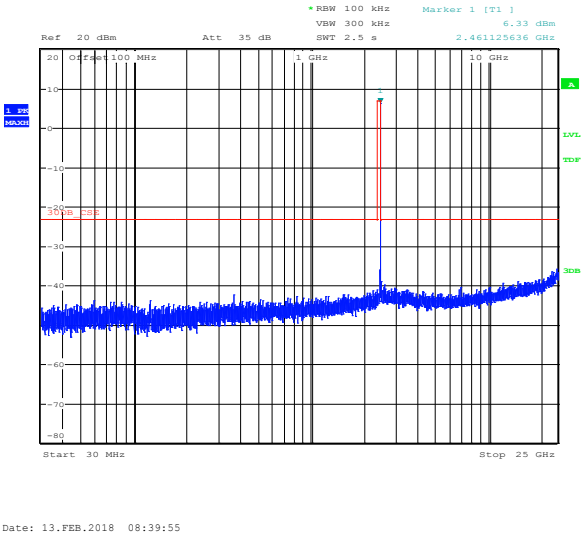


Figure 8.4-105: *Conducted spurious emissions outside restricted bands, 20 MHz high channel, Ant 2*

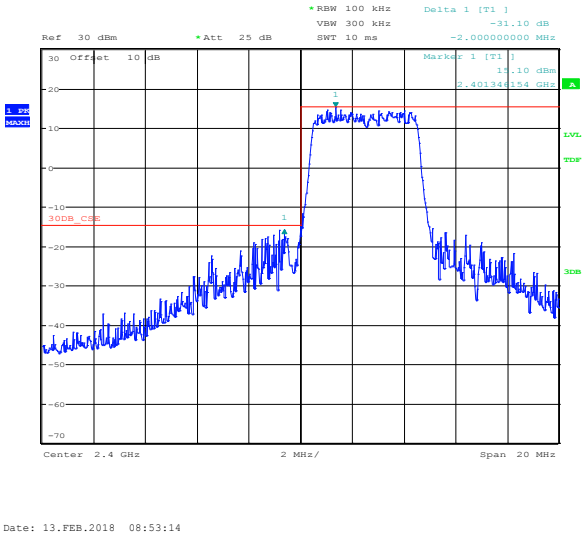


Figure 8.4-106: *Conducted spurious emissions outside restricted bands at the lower band edge, 5 MHz low channel, Ant 1*

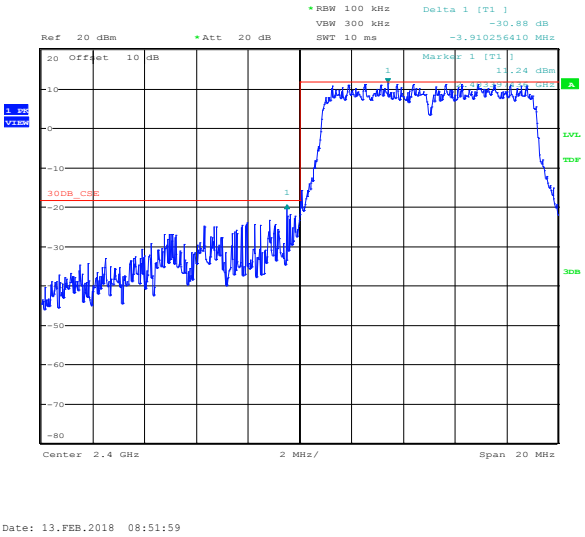


Figure 8.4-107: *Conducted spurious emissions outside restricted bands at the lower band edge, 10 MHz low channel, Ant 1*

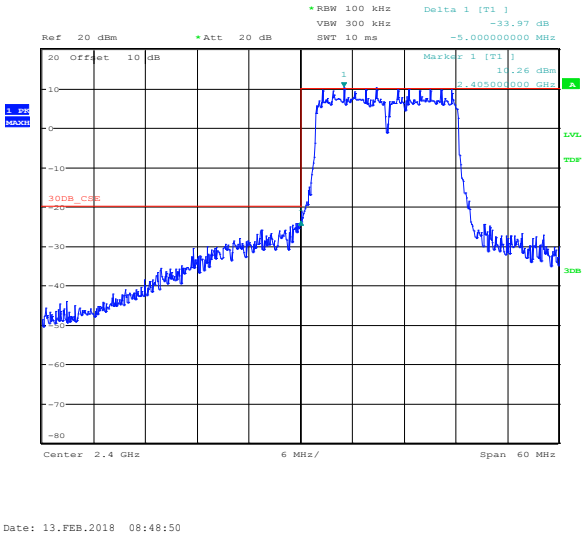


Figure 8.4-108: *Conducted spurious emissions outside restricted bands at the lower band edge, 20 MHz low channel, Ant 1*

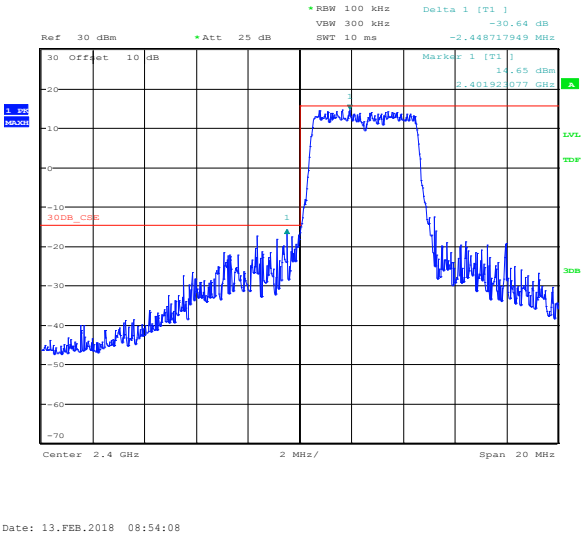


Figure 8.4-109: *Conducted spurious emissions outside restricted bands at the lower band edge, 5 MHz low channel, Ant 2*

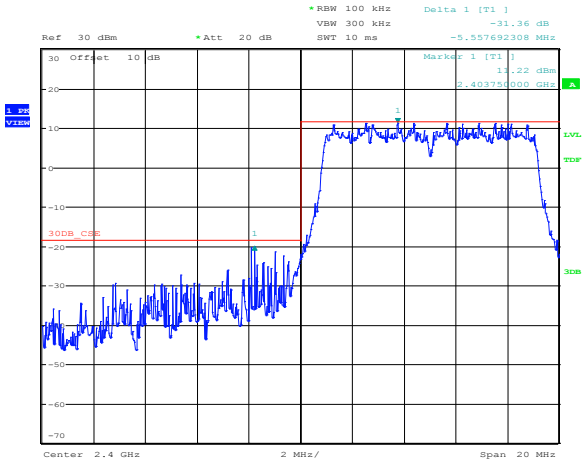


Figure 8.4-110: *Conducted spurious emissions outside restricted bands at the lower band edge, 10 MHz low channel, Ant 2*

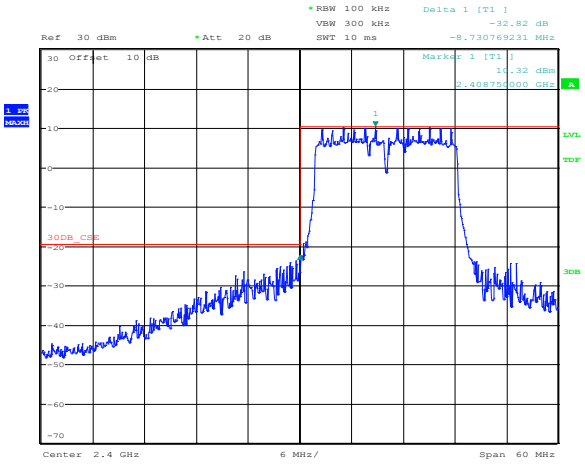


Figure 8.4-111: *Conducted spurious emissions outside restricted bands at the lower band edge, 20 MHz low channel, Ant 2*

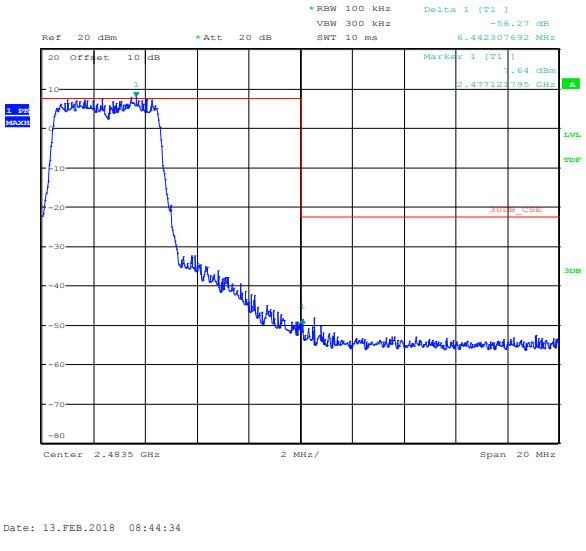


Figure 8.4-112: *Conducted spurious emissions outside restricted bands at the upper band edge, 5 MHz high channel, Ant 1*

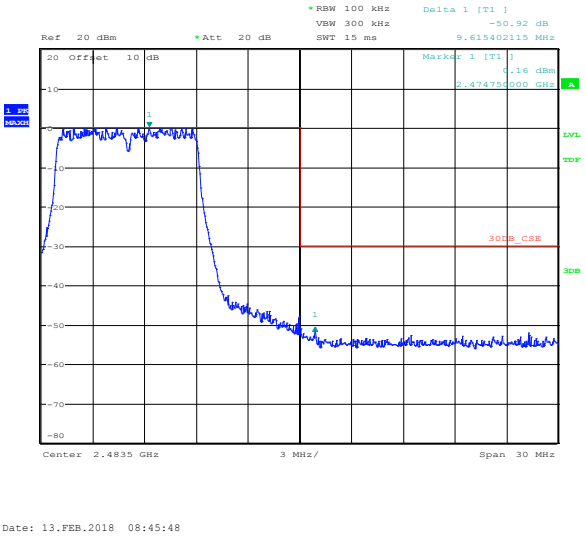


Figure 8.4-113: *Conducted spurious emissions outside restricted bands at the upper band edge, 10 MHz high channel, Ant 1*

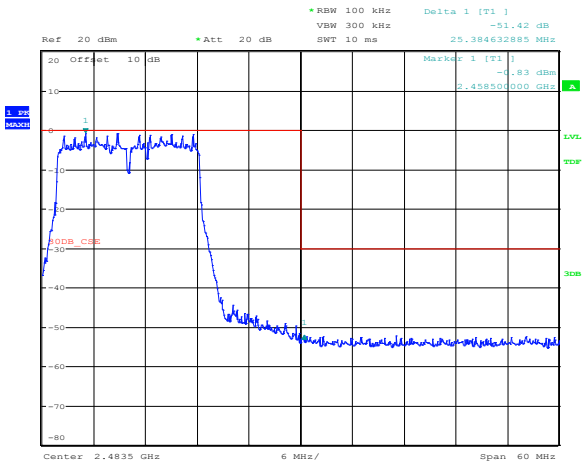


Figure 8.4-114: *Conducted spurious emissions outside restricted bands at the upper band edge, 20 MHz high channel, Ant 1*

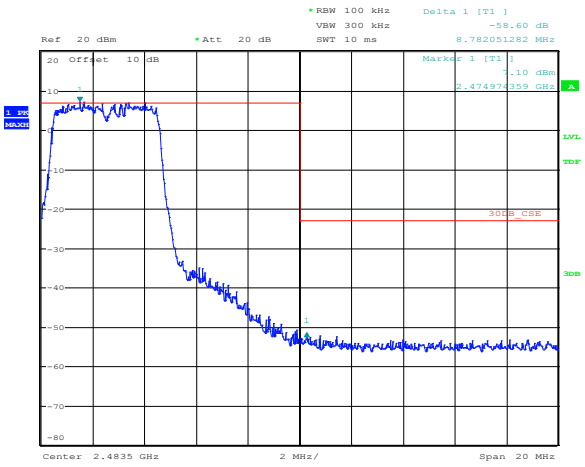


Figure 8.4-115: *Conducted spurious emissions outside restricted bands at the upper band edge, 5 MHz high channel, Ant 2*

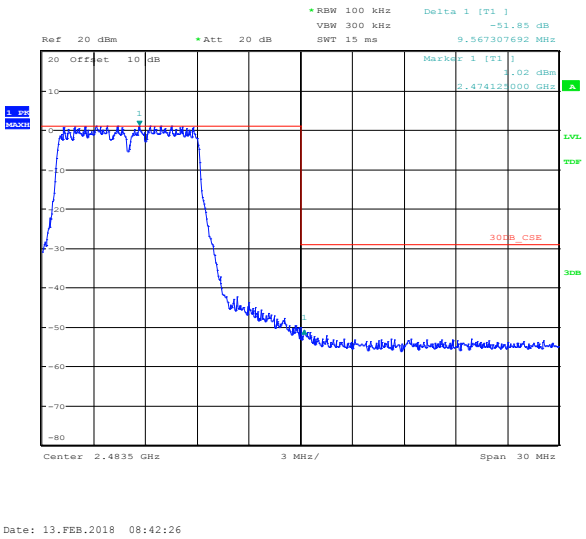


Figure 8.4-116: *Conducted spurious emissions outside restricted bands at the upper band edge, 10 MHz high channel, Ant 2*

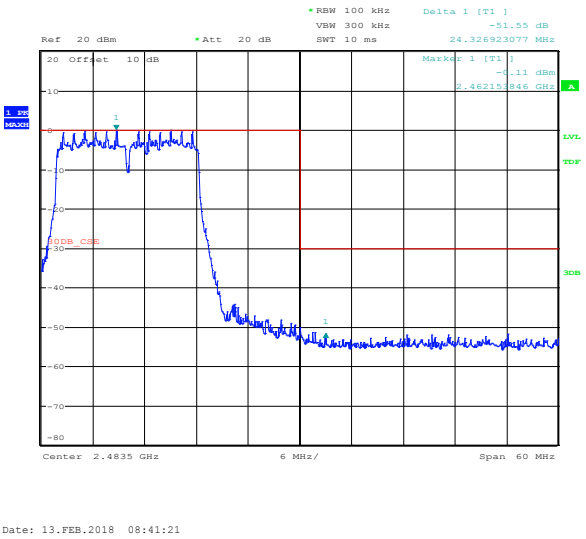


Figure 8.4-117: *Conducted spurious emissions outside restricted bands at the upper band edge, 20 MHz high channel, Ant 2*

8.5 FCC 15.247(e) Power spectral density for digitally modulated devices

8.5.1 Definitions and limits

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

8.5.1 Test date

Start date	January 12, 2018

8.5.2 Observations, settings and special notes

The test was performed using method AVGPSD-1 (trace averaging with EUT transmitting at full power throughout each sweep). Spectrum analyser settings:

Resolution bandwidth:	3 kHz
Video bandwidth:	≥3 × RBW
Frequency span:	1.5 times the OBW
Detector mode:	RMS
Trace mode:	Power average
Averaging sweeps number:	100

Combined PSD for MIMO 2 × 2 application was calculated as follows: $PSD_{combined} = 10 \times log_{10}\left(\left(10^{PSD_{ch0}/10}\right) + \left(10^{PSD_{ch1}/10}\right)\right)$

8.5.3 Test data

Table 8.5-1: *PSD measurements results for BPSK*

Channel bandwidth, MHz	Frequency, MHz	Peak power spectral density, ant 1, dBm/3 kHz	Peak power spectral density, ant 2, dBm/3 kHz	Total Peak power spectral density, dBm/3 kHz	PSD limit, dBm/3 kHz	Margin, dB
5	2402.5	0.11	0.11	3.12	8.00	4.88
5	2440.0	0.22	0.12	3.18	8.00	4.82
5	2476.0	-10.95	-10.89	-7.91	8.00	15.91
10	2405.0	1.32	1.56	4.45	8.00	3.55
10	2440.0	-0.16	0.03	2.95	8.00	5.05
10	2473.5	-11.9	-10.71	-8.25	8.00	16.25
20	2410.0	2.11	2.16	5.15	8.00	2.85
20	2440.0	2.86	2.53	5.71	8.00	2.29
20	2463.5	-10.25	-8.83	-6.47	8.00	14.47

Table 8.5-2: *PSD measurements results for 256QAM*

Channel bandwidth, MHz	Frequency, MHz	Peak power spectral density, ant 1, dBm/3 kHz	Peak power spectral density, ant 2, dBm/3 kHz	Total Peak power spectral density, dBm/3 kHz	PSD limit, dBm/3 kHz	Margin, dB
5	2402.5	0.33	0.25	3.30	8.00	4.70
5	2440.0	0.22	0.08	3.16	8.00	4.84
5	2476.0	-11.03	-11.03	-8.02	8.00	16.02
10	2405.0	1.27	1.36	4.33	8.00	3.67
10	2440.0	-0.49	-0.08	2.73	8.00	5.27
10	2473.5	-11.83	-10.67	-8.20	8.00	16.20
20	2410.0	2.10	2.18	5.15	8.00	2.85
20	2440.0	2.96	2.47	5.73	8.00	2.27
20	2463.5	-10.22	-8.83	-6.46	8.00	14.46

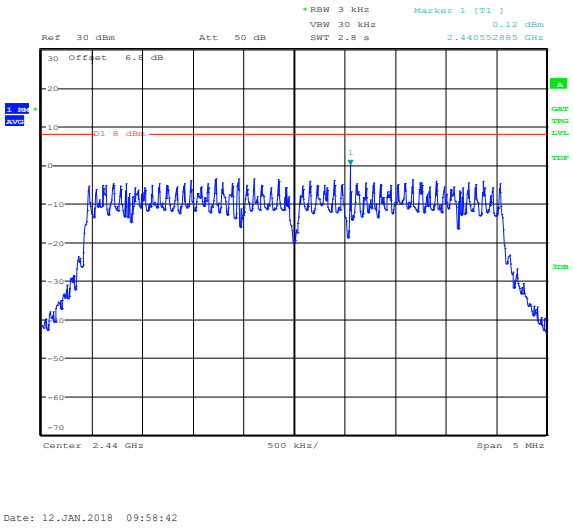


Figure 8.5-1: *PSD sample plot for 5 MHz channel*

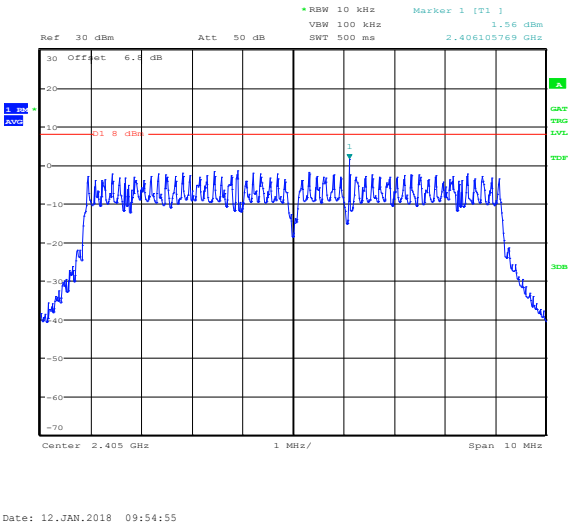


Figure 8.5-2: *PSD sample plot for 10 MHz channel*

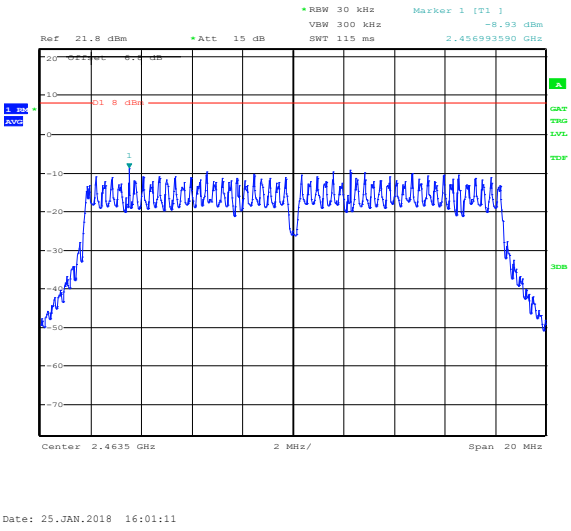
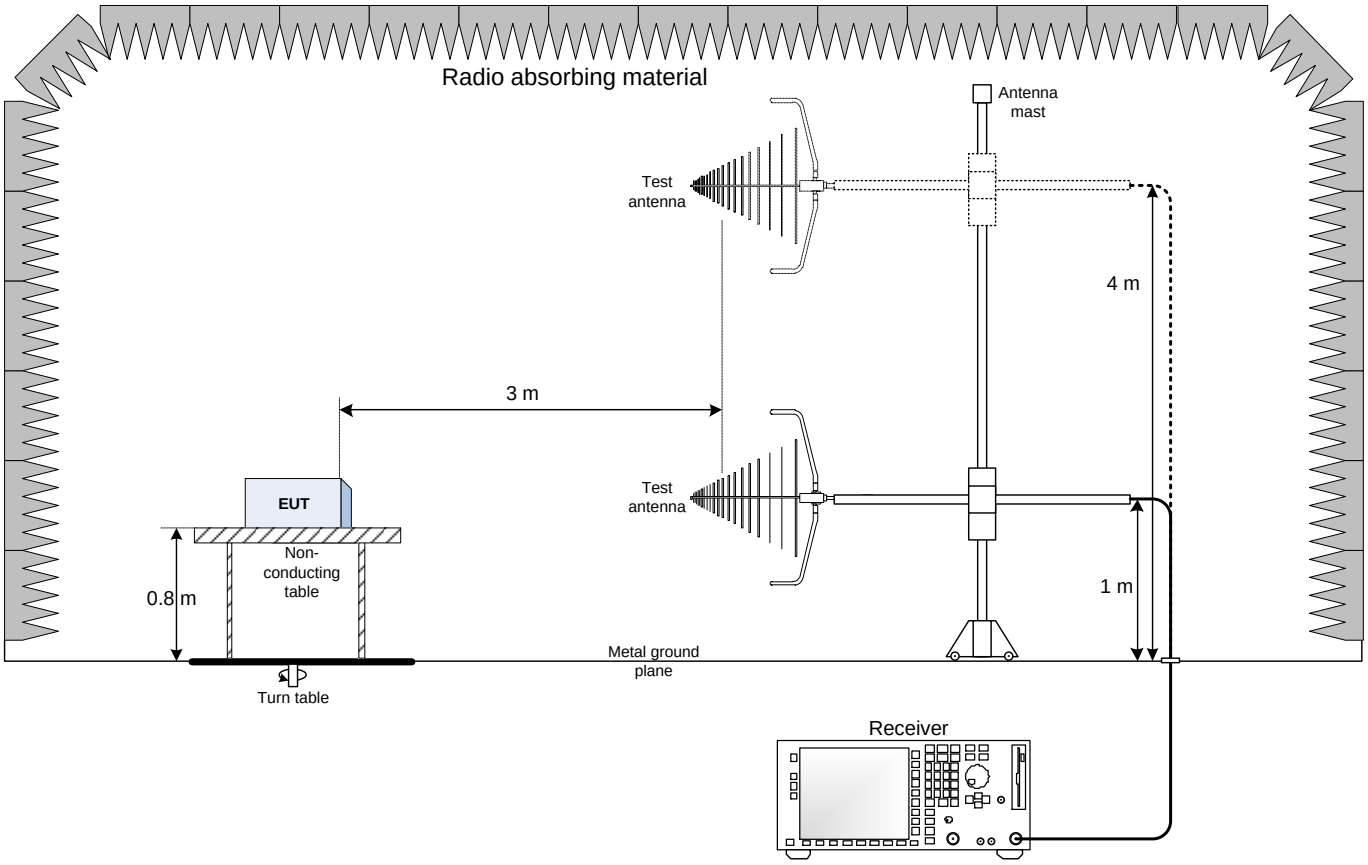


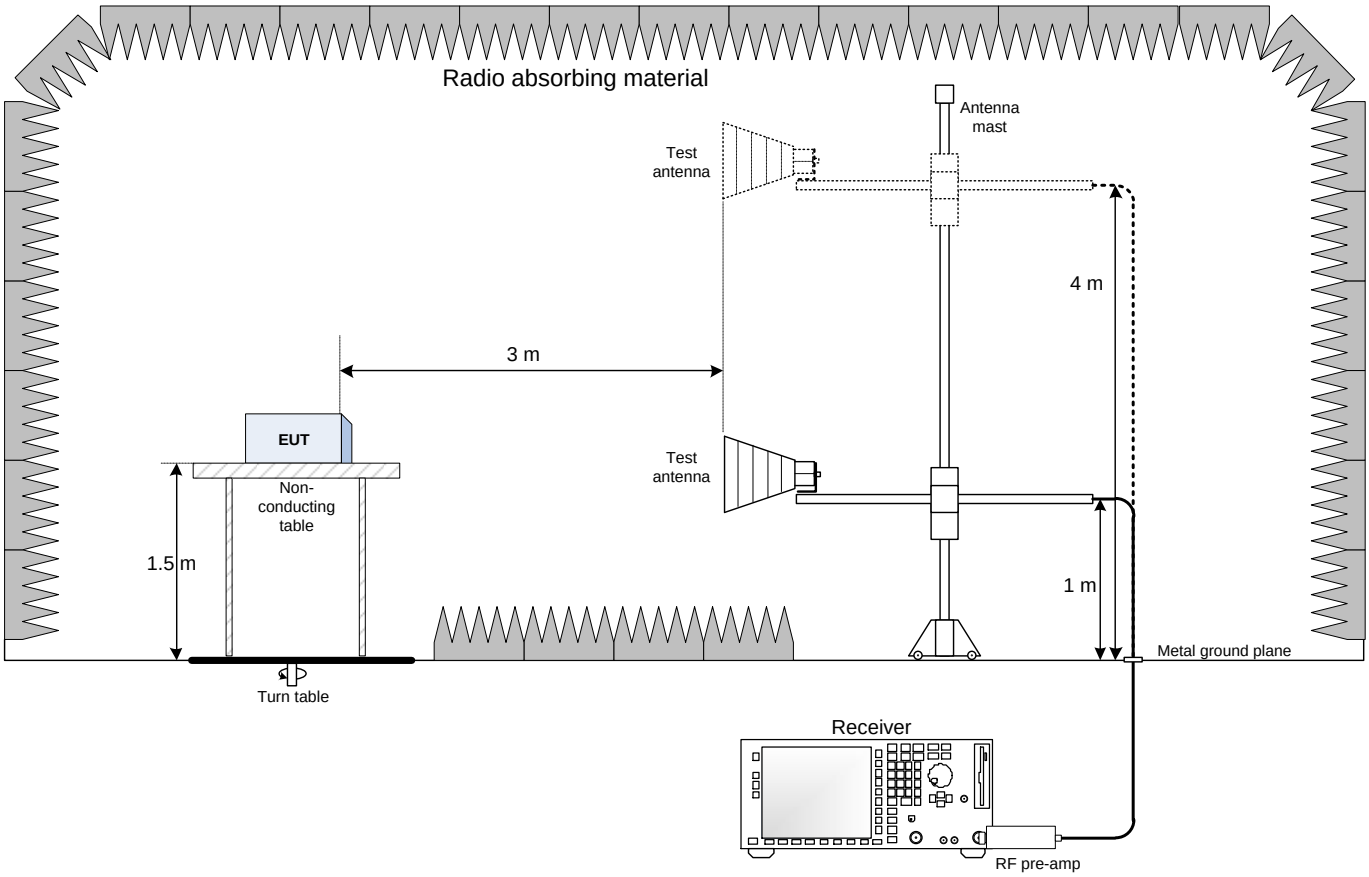
Figure 8.5-3: *PSD sample plot for 20 MHz channel*

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up