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Wireless test report – 406683-2TRFWL

Applicant:

SECO S.p.A.

Product name:

Enhanced sensor to cloud for IOT

Model:

SYS-D47-IOT-0132-1121-C0

FCC ID:

2ALZB-D47IOT

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.209

  Radiated emission limits; general requirements.

Date of issue: February 9, 2021

Tested by (name, function and signature)	S. Tessa	(project handler)	Signature:	
Reviewed by (name, function and signature)	P. Barbieri	(verifier)	Signature:	

Test location(s)

Company name	Nemko Spa
Address	Via del Carroccio, 4
City	Biassono
Province	MB
Postal code	20853
Country	Italy
Telephone	+39 039 220 12 01
Facsimile	+39 039 220 12 21
Website	www.nemko.com
Site number	FCC: 682159 (10 m semi anechoic chamber)

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 Spa ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	SECO S.p.A.
Address	Via A. Grandi – 52100 Arezzo, Italy

1.2 Test specifications

FCC 47 CFR Part 15 Subpart C, §15.209	Radiated emission limits; general requirements.

1.3 Test methods

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

As per quote, the purpose of this report is verification of transmitters colocation. Only inter-modulation products within restricted bands were assessed, other requirements were excluded from the scope of this report.

1.6 Test report revision history

Revision #	Date of issue	Details of changes made to test report
406683-2TRFWL	February 9, 2021	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.209	Radiated emission limits; general requirements.	Pass

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	December 9, 2020
Nemko sample ID number	4066830004

3.2 EUT information

Product name	Enhanced sensor to cloud for IOT
Model	SYS-D47-IOT-0132-1121-C0
Serial number	-

3.3 Technical information

Frequency band	WiFi: 2400–2483.5 MHz band LTE NB-IOT: Bands 2, 4, 5, 12, 13
Type of modulation	802.11b, BPSK
Emission classification (F1D, G1D, D1D)	F1D, W7D
EUT power requirements	9 - 24 V_{DC}, 1.3-3.5 A
Antenna information	External antenna

3.4 EUT setup diagram

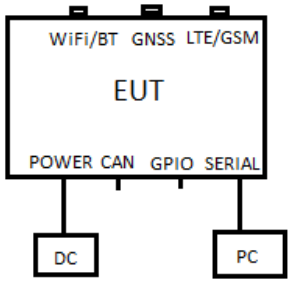


Figure 3.4-1: *Setup diagram*

3.5 Product description and theory of operation

SENSE D47 is a boxed module with a form factor of just 110 x 91 x 31 mm based on a module of Espressif ESP32-WROVER and SIMCOM. This module is suitable both for IoT applications, due to its rich connectivity, and for industrial applications. The EUT features a wide range of connectivity capabilities: it integrates Wi-Fi, Bluetooth, LTE/GPRS and GPS.

3.6 EUT sub assemblies

Table 3.6-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
-	-	-	-

3.7 EUT exercise details

EUT was set to continuously transmit mode during tests. Radio modules were configured in continuous transmission with the ability to adjust modulation, frequency and output power as required.

WiFi/BT – using ESP32 tool provided by client.
Cellular – using radio tester CMW500.

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

No Technical judgment

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

In the laboratory, the following ambient conditions are respected for each test reported below:

Temperature	18 – 33 °C
Relative humidity	25 – 70 %
Air pressure	860 – 1060 mbar

The following instruments are used to monitor the environmental conditions:

Equipment	Manufacturer	Model no.	Asset no.	Cal date	Next cal.
Thermo-hygrometer data loggers	Testo	175-H2	20012380/305	2020-12	2022-12
Thermo-hygrometer data loggers	Testo	175-H2	38203337/703	2020-12	2022-12
Barometer	Castle	GPB 3300	072015	2020-03	2021-03

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

The measurement uncertainty was calculated for each test and quantity listed in this test report, according to CISPR 16-4-2 and other specific test standard and is documented in Nemko Spa working manual WML1002.

The assessment of conformity for each test performed on the equipment is performed not taking into account the measurement uncertainty. The two following possible verdicts are stated in the report:

P (Pass) - The measured values of the equipment respect the specification limit at the points tested. The specific risk of false accept is up to 50% when the measured result is close to the limit.

F (Fail) - One or more measured values of the equipment do not respect the specification limit at the points tested. The specific risk of false reject is up to 50% when the measured result is close to the limit.

Hereafter Nemko's measurement uncertainties are reported:

EUT	Type	Test	Range	Measurement Uncertainty	Notes
Transmitter	Conducted	Frequency error	0.001 MHz ÷ 40 GHz	0.08 ppm	(1)
		Carrier power RF Output Power	0.009 MHz ÷ 30 MHz	1.1 dB	(1)
			30 MHz ÷ 18 GHz	1.5 dB	(1)
			18 MHz ÷ 40 GHz	3.0 dB	(1)
			40 MHz ÷ 140 GHz	5.0 dB	(1)
		Adjacent channel power	1 MHz ÷ 18 GHz	1.4 dB	(1)
		Conducted spurious emissions	0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)
		Intermodulation attenuation	1 MHz ÷ 18 GHz	2.2 dB	(1)
		Attack time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Attack time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Release time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Release time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Transient behaviour of the transmitter– Transient frequency behaviour	1 MHz ÷ 18 GHz	0.2 kHz	(1)
		Transient behaviour of the transmitter – Power level slope	1 MHz ÷ 18 GHz	9%	(1)
		Frequency deviation - Maximum permissible frequency deviation	0.001 MHz ÷ 18 GHz	1.3%	(1)
		Frequency deviation - Response of the transmitter to modulation frequencies above 3 kHz	0.001 MHz ÷ 18 GHz	0.5 dB	(1)
		Dwell time	-	3%	(1)
		Hopping Frequency Separation	0.01 MHz ÷ 18 GHz	1%	(1)
		Occupied Channel Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
		Modulation Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
	Radiated	Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Effective radiated power transmitter	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)

EUT	Type	Test	Range	Measurement Uncertainty	Notes
Receiver	Radiated	Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Sensitivity measurement	1 MHz ÷ 18 GHz	6.0 dB	(1)
	Conducted	Conducted spurious emissions	0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)

NOTES:
(1) The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %

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.
EMI receiver (20 Hz ÷ 8 GHz)	Rohde & Schwarz	ESU8	100202	2020-08	2021-08
EMI receiver (20 Hz ÷ 8 GHz)	Rohde & Schwarz	ESW44	101620	2020-08	2021-08
Trilog Antenna (30 MHz ÷ 7 GHz)	Schwarzbeck	VULB 9162	9162-025	2018-07	2021-07
Bilog antenna (1 ÷ 18 GHz)	Schwarzbeck	STLP 9148	9148-123	2018-07	2021-07
Preamplifier (1 ÷ 18 GHz)	Schwarzbeck	BBV 9718	9718-137	2020-09	2021-09
Horn antenna (18 ÷ 40 GHz)	A.H. System	SAS-574	558	2020-01	2023-01
Preamplifier (18 ÷ 40 GHz)	SAGE	STB-1834034030-KFKF-L1	18490-01	2020-03	2021-03
Controller	Maturo	FCU3.0	10041	NCR	NCR
Tilt antenna mast	Maturo	TAM4.0-E	10042	NCR	NCR
Turntable	Maturo	TT4.0-5T	2.527	NCR	NCR
Semi-anechoic chamber	Nemko	10m semi-anechoic chamber	530	2019-09	2021-09
Shielded room	Siemens	10m control room	1947	NCR	NCR
Shielded room	Siemens	Conducted emission test room	1862	NCR	NCR

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

Section 8. Testing data

8.1 FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements

8.1.1 Definitions and limits

FCC:
(f) In accordance with §15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in §15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in §15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in §15.109 that are applicable to the incorporated digital device.

Table 8.1-1: *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 8.1-2: *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			

8.1.2 Test summary

Test start date	December 14, 2020

8.1.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 40 GHz.
EUT's LTE and WIFI transmitters were set to transmit continuously, different channel setting has been investigated as per provided by client's setup, only the worst-case is presented.
Radiated measurements were performed at a distance of 3 m for frequency rand below 18 GHz, and 1 m for frequency range above 18 GHz. No inter-modulation products emissions were detected above 18 GHz within 6 dB below the limit.

Spectrum analyzer settings for frequencies below 30 MHz:

Detector mode	Quasi-Peak
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Trace mode	Max Hold
Measurement time	100 ms

Spectrum analyser settings for radiated measurements within restricted bands 30 MHz to 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

8.1.4 Test data

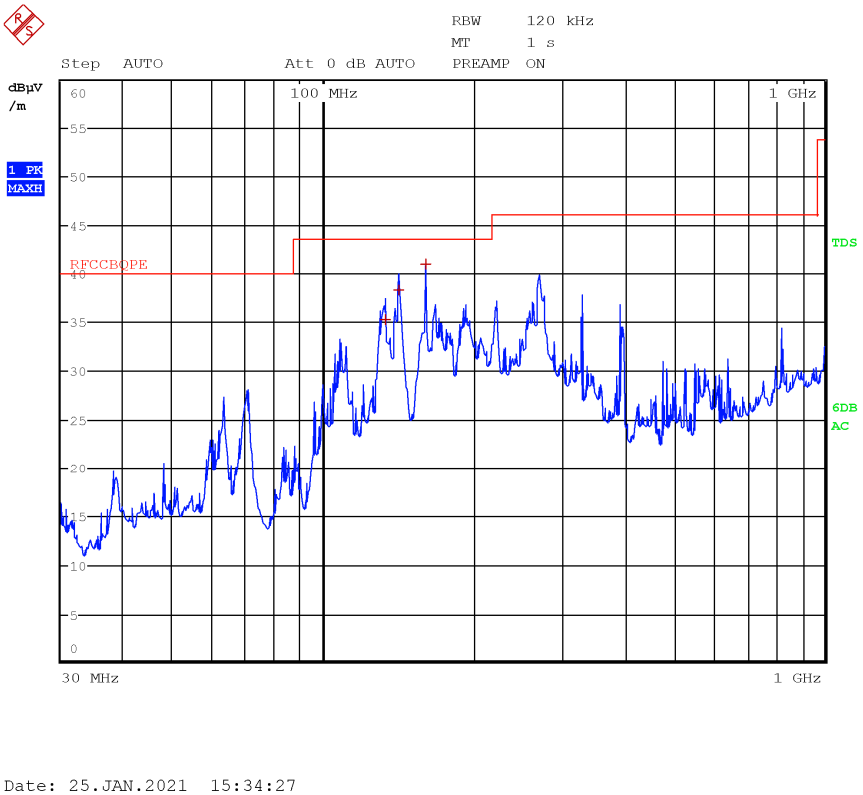


Figure 8.1-1: *Radiated spurious emissions, LTE NB-IOT Band 2, WIFI Tx at 2437 MHz – antenna in horizontal polarization –*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
132.7200	35.3	43.5	-8.2	QP
141.8000	38.4	43.5	-5.1	QP
160.0000	41.0	43.5	-2.5	QP

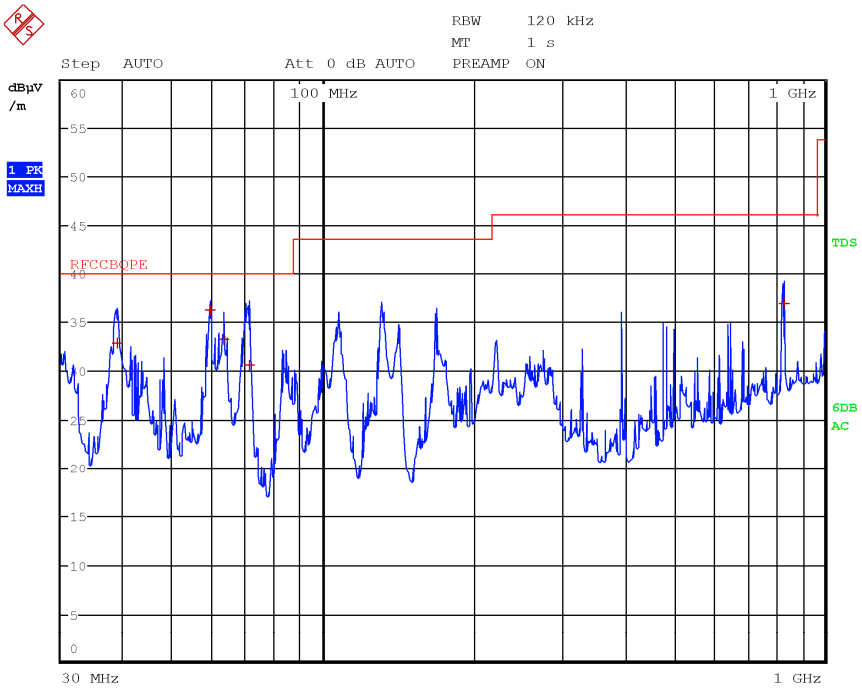


Figure 8.1-2: *Radiated spurious emissions, LTE NB-IOT Band 2, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
38.7200	32.9	40.0	-7.1	QP
59.6400	36.3	40.0	-3.7	QP
63.2000	33.2	40.0	-6.8	QP
71.3200	30.6	40.0	-9.4	QP
828.8400	37.0	46.0	-9.0	QP

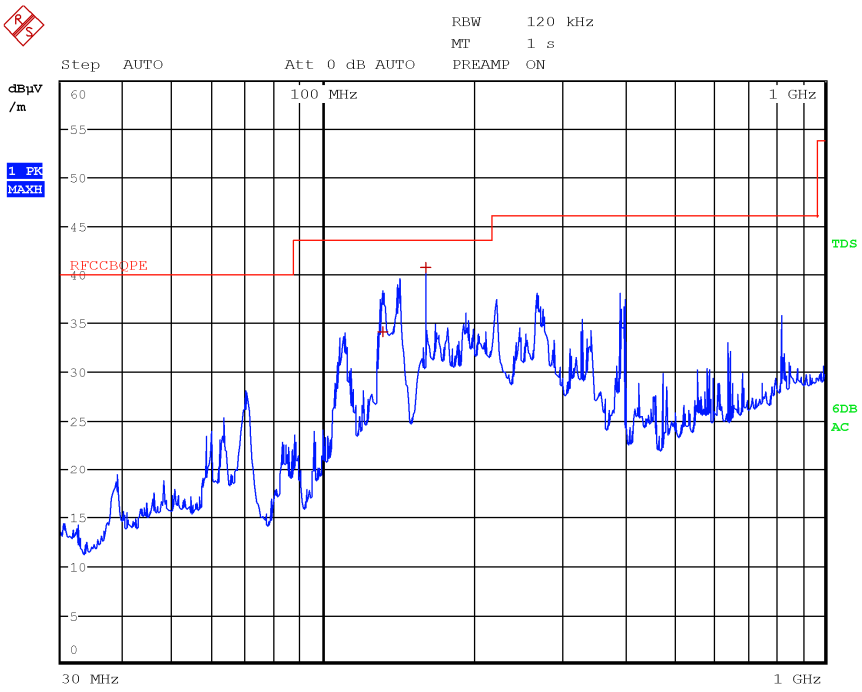


Figure 8.1-3: *Radiated spurious emissions, LTE NB-IOT Band 4, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
131.2000	34.1	43.5	-9.4	QP
160.0000	40.8	43.5	-2.7	QP

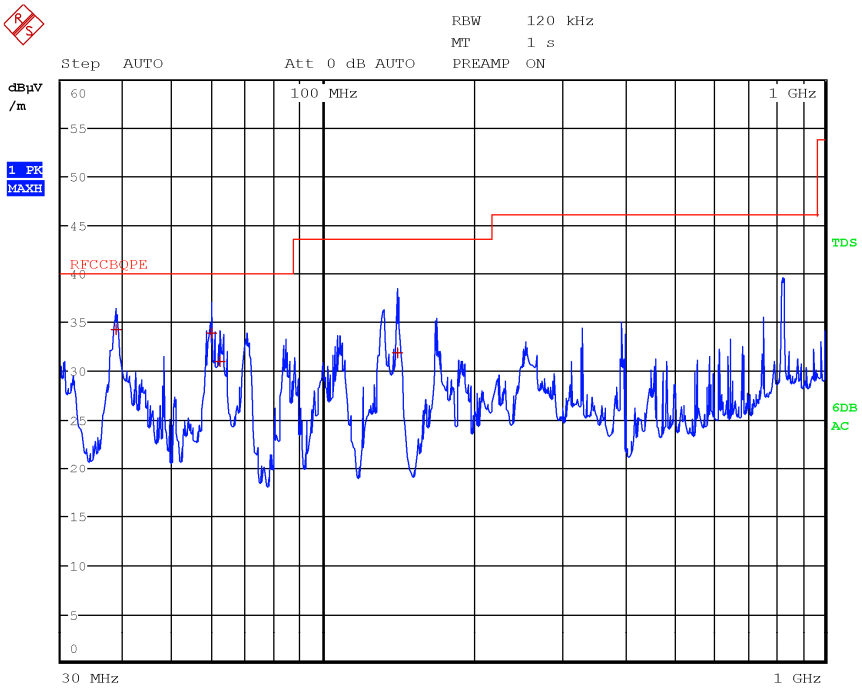


Figure 8.1-4: *Radiated spurious emissions, LTE NB-IOT Band 4, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
38.6800	34.2	40.0	-5.8	QP
59.7200	33.8	40.0	-6.2	QP
62.0800	31.0	40.0	-9.0	QP
140.9200	31.9	43.5	-11.6	QP

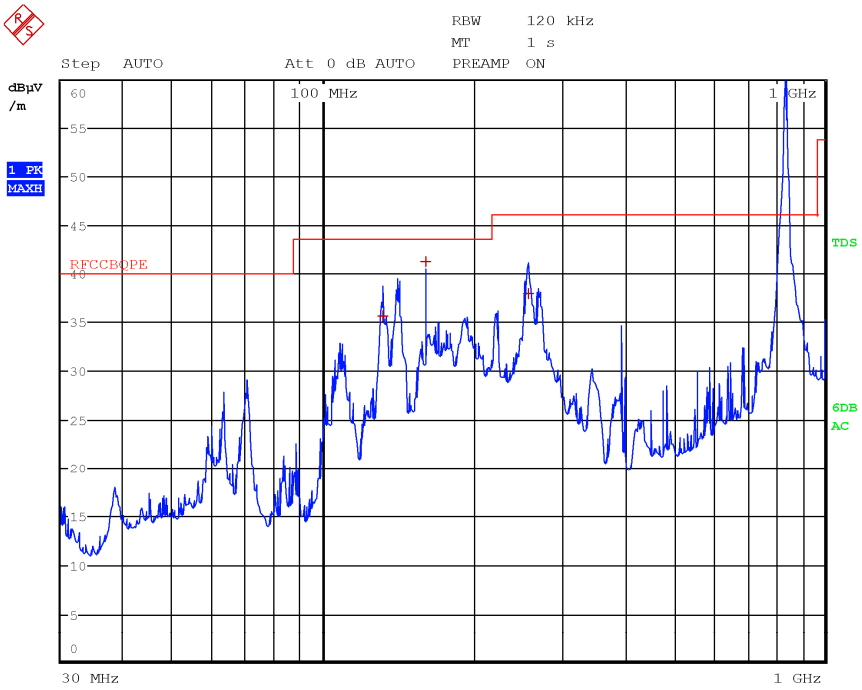


Figure 8.1-5: *Radiated spurious emissions, LTE NB-IOT Band 5, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
131.8400	35.7	43.5	-7.8	QP
160.0000	41.3	43.5	-2.2	QP
256.2400	38.1	46.0	-7.9	QP

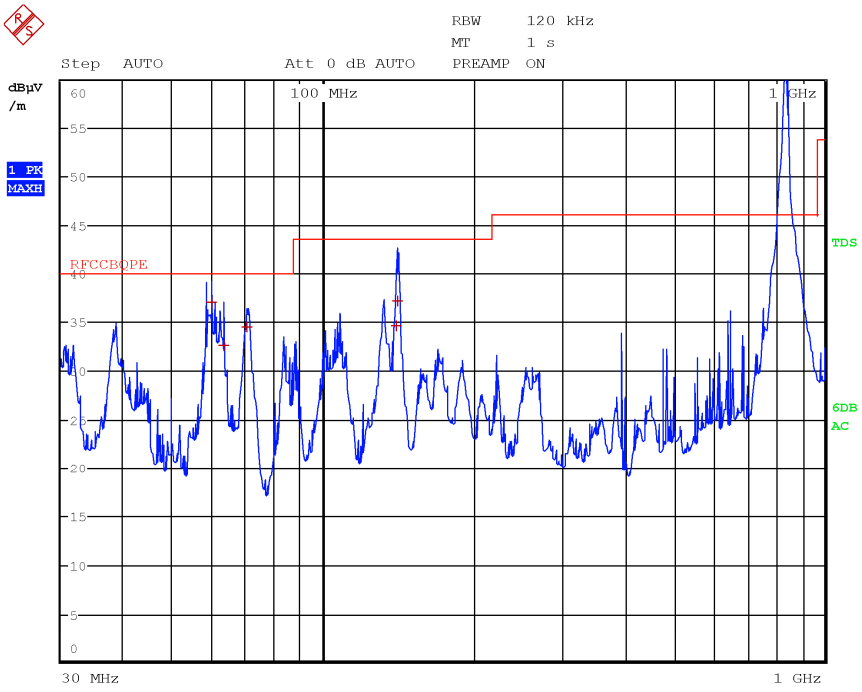


Figure 8.1-6: *Radiated spurious emissions, LTE NB-IOT Band 5, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
59.8000	37.2	40.0	-2.8	QP
63.3200	32.7	40.0	-7.3	QP
70.3600	34.5	40.0	-5.5	QP
139.8400	34.7	43.5	-8.8	QP
141.0400	37.3	43.5	-6.2	QP

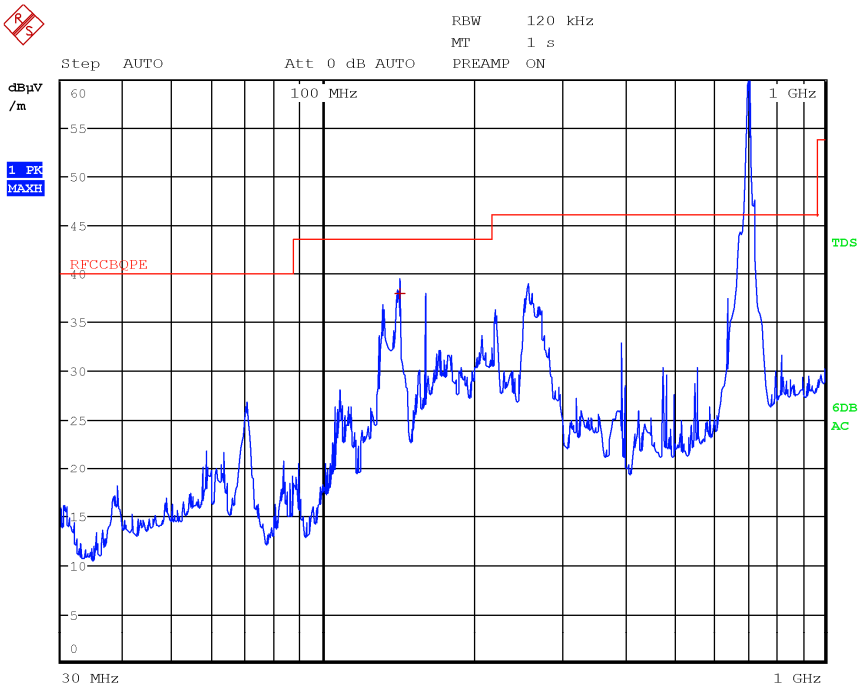


Figure 8.1-7: *Radiated spurious emissions, LTE NB-IOT Band 12, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
141.9600	38.0	43.5	-5.5	QP

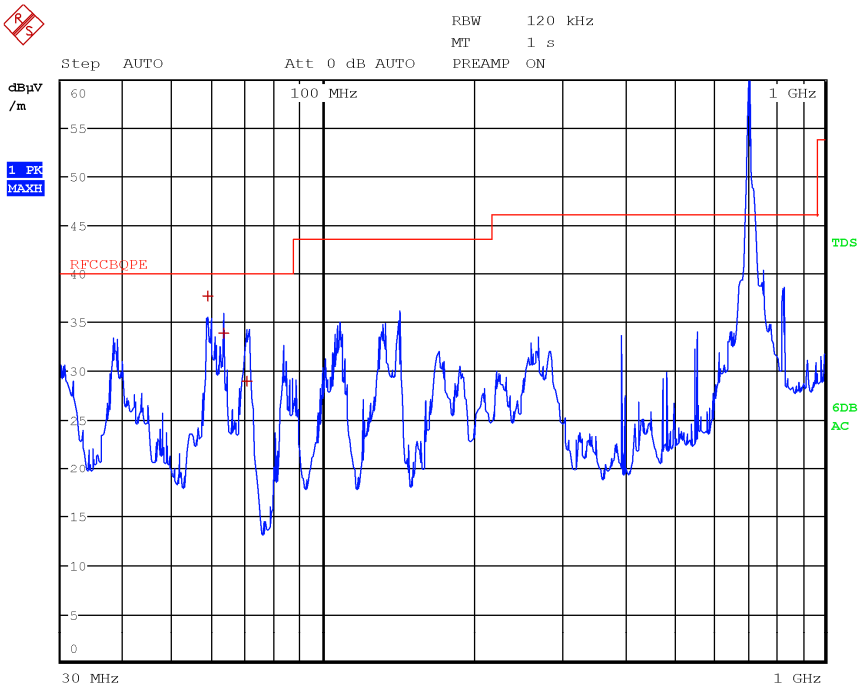


Figure 8.1-8: *Radiated spurious emissions, LTE NB-IOT Band 12, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
58.6800	37.8	40.0	-2.2	QP
63.3600	33.9	40.0	-6.1	QP
70.4000	29.0	40.0	-11.0	QP

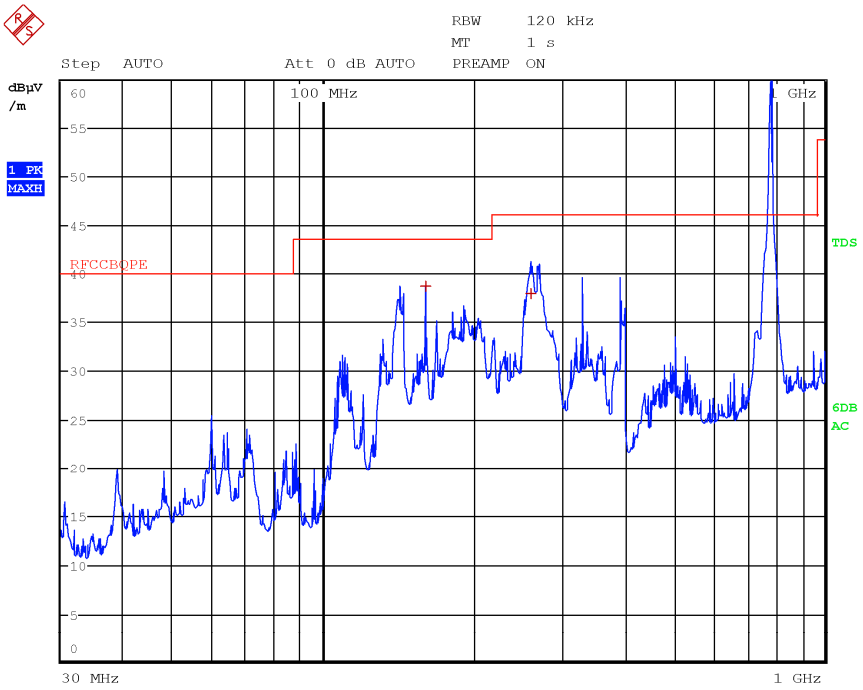


Figure 8.1-9: *Radiated spurious emissions, LTE NB-IOT Band 13, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
160.0000	38.8	43.5	-4.7	QP
259.6000	38.1	46.0	-7.9	QP

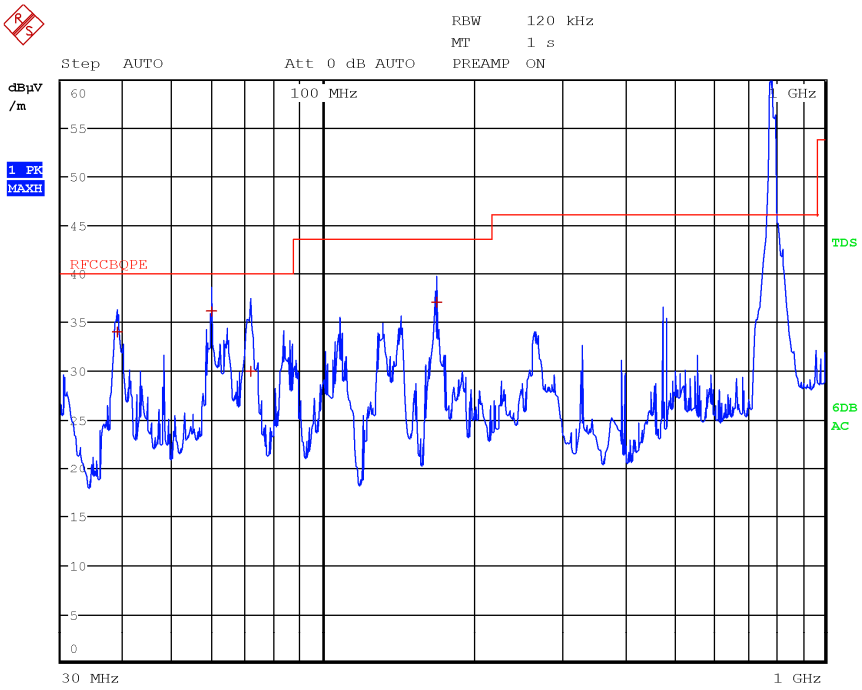


Figure 8.1-10: *Radiated spurious emissions, LTE NB-IOT Band 13, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
38.7200	34.0	40.0	-6.0	QP
59.8000	36.1	40.0	-3.9	QP
71.5600	30.0	40.0	-10.0	QP
167.9200	37.1	43.5	-6.4	QP

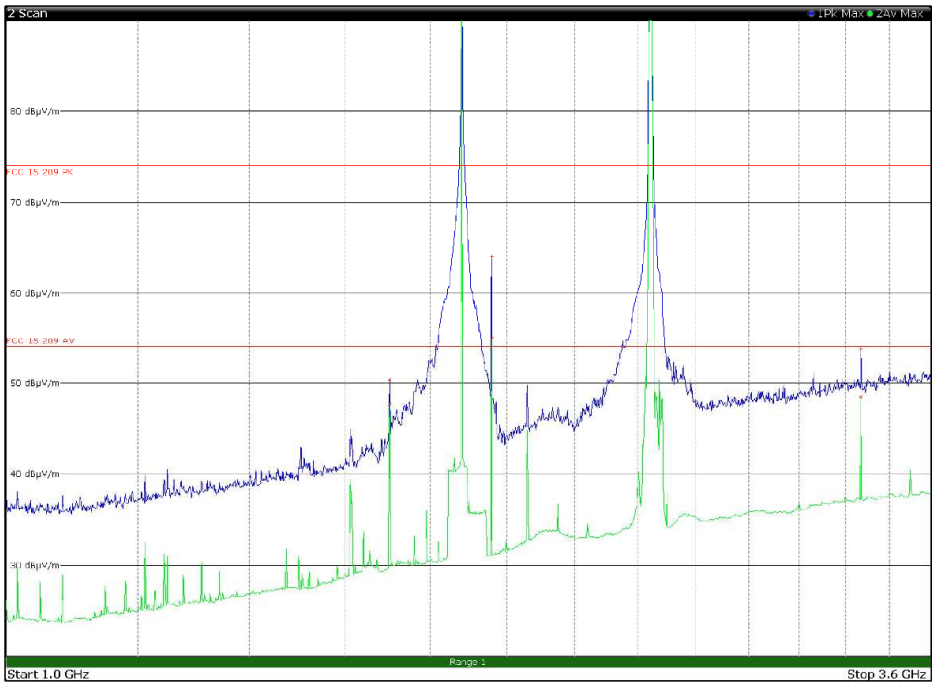


Figure 8.1-11: *Radiated spurious emissions, LTE NB-IOT Band 2, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1700.7500	47.8	54.0	-6.2	Av
1701.0000	50.4	74.0	-23.6	Pk
1960.0000	64.1	82.2	-18.1	Pk
1960.0000	55.1	-	-	Av
3269.2500	48.5	54.0	-5.5	Av
3269.5000	53.8	74.0	-20.2	Pk

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

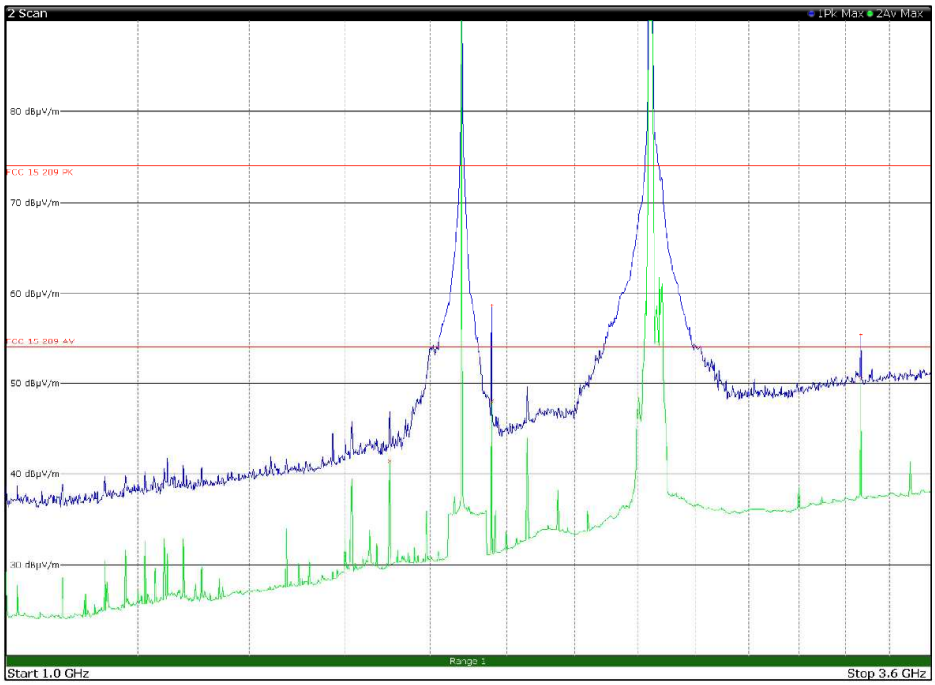


Figure 8.1-12: *Radiated spurious emissions, LTE NB-IOT Band 2, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1701.0000	41.4	54.0	-12.6	Av
1960.0000	58.8	82.2	-23.4	Pk
1960.0000	48.0	-	-	Av
3269.2500	55.5	74.0	-18.5	Pk
3269.2500	50.5	54.0	-3.5	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

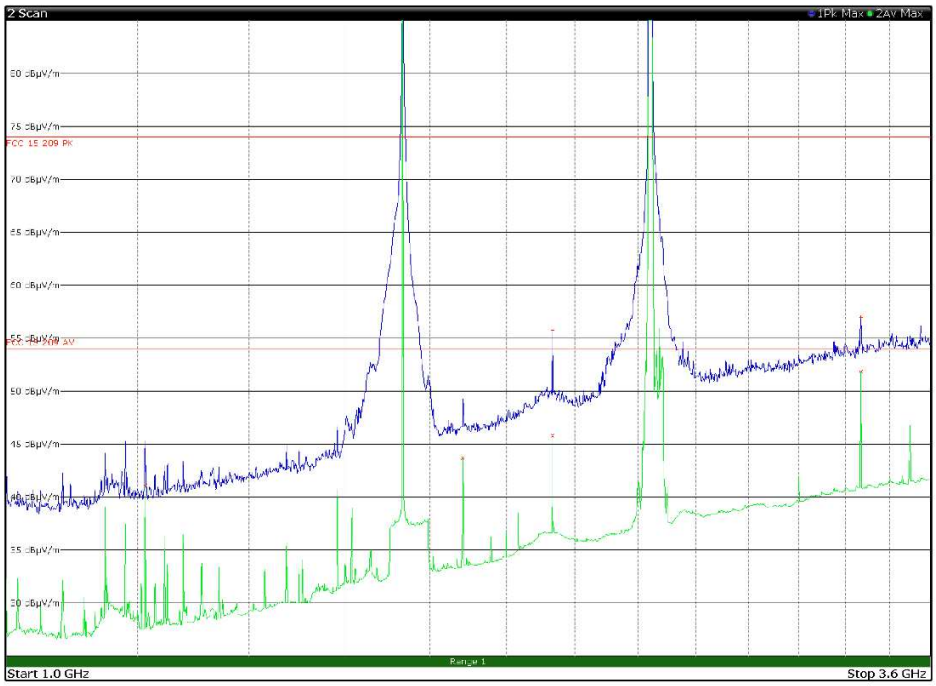


Figure 8.1-13: *Radiated spurious emissions, LTE NB-IOT Band 4, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1212.5000	41.1	54.0	-12.9	Av
2132.5000	55.8	82.2	-26.4	Pk
2132.5000	45.8	-	-	Av
3269.2500	57.0	74.0	-17	Pk
3269.2500	51.9	54.0	-2.1	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

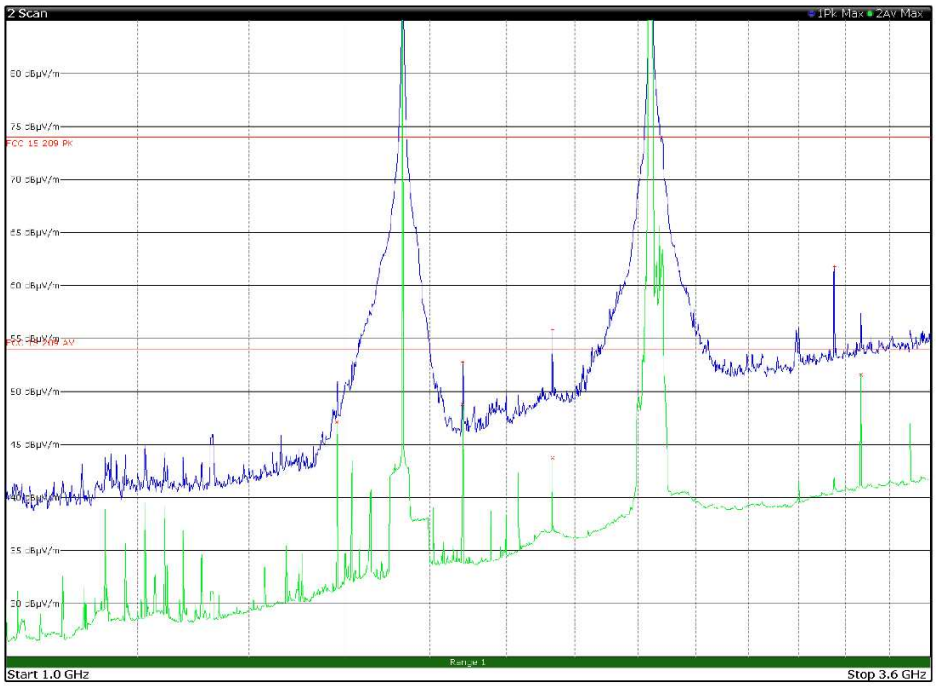


Figure 8.1-14: *Radiated spurious emissions, LTE NB-IOT Band 4, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1581.7500	47.1	54.0	-6.9	Av
1883.0000	52.8	82.2	-29.4	Pk
1883.0000	48.9	-	-	Av
2132.5000	55.9	82.2	-26.3	Pk
2132.5000	43.8	-	-	Av
3150.0000	61.8	82.2	-20.4	Pk
3269.2500	51.7	54.0	-2.3	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

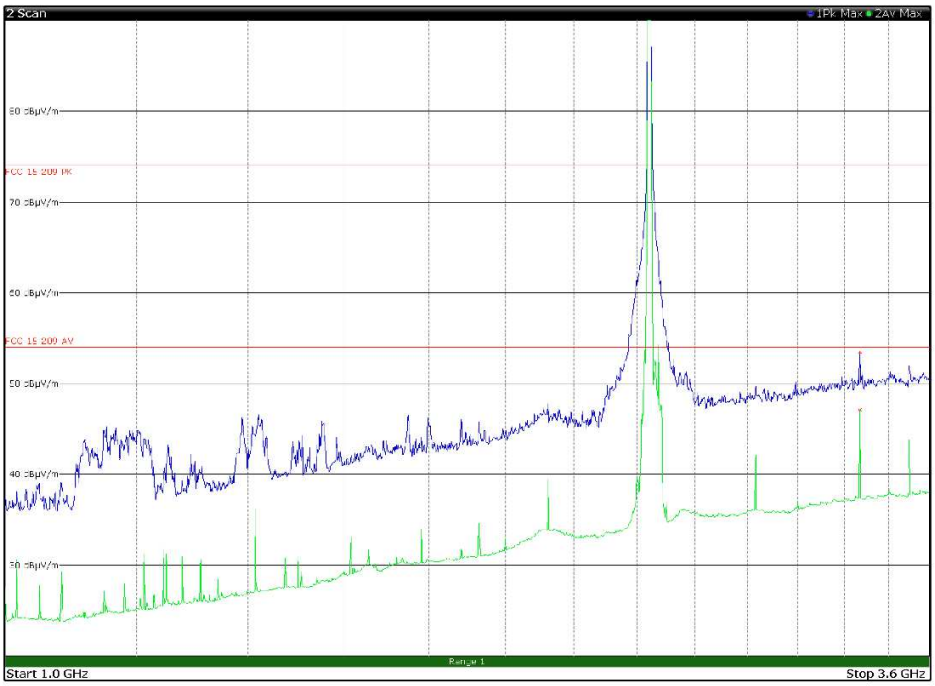


Figure 8.1-15: *Radiated spurious emissions, LTE NB-IOT Band 5, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
3269.2500	47.1	54.0	-6.9	Av
3269.5000	53.4	74.0	-20.6	Pk

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

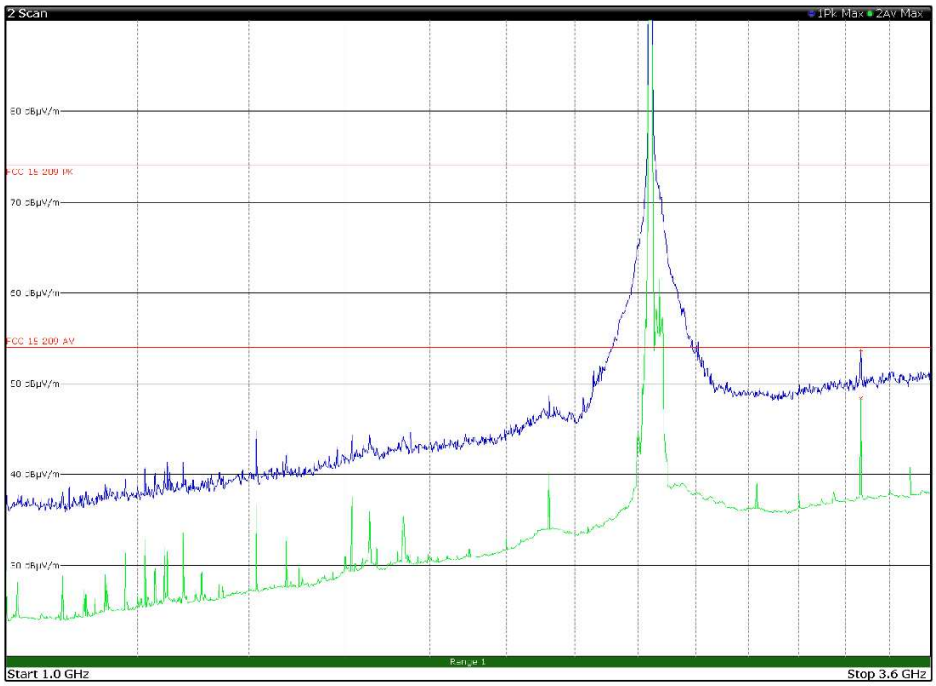


Figure 8.1-16: *Radiated spurious emissions, LTE NB-IOT Band 5, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
3269.2500	48.4	54.0	-5.6	Av
3269.5000	53.7	74.0	-20.3	Pk

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

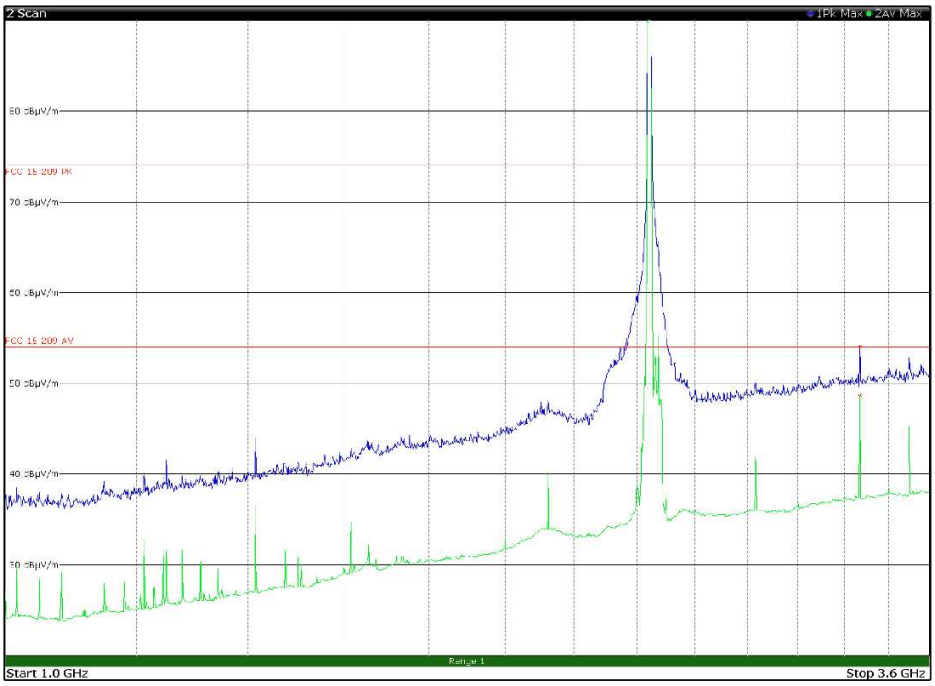


Figure 8.1-17: *Radiated spurious emissions, LTE NB-IOT Band 12, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
3269.2500	54.1	74.0	-19.9	Pk
3269.2500	48.7	54.0	-5.3	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

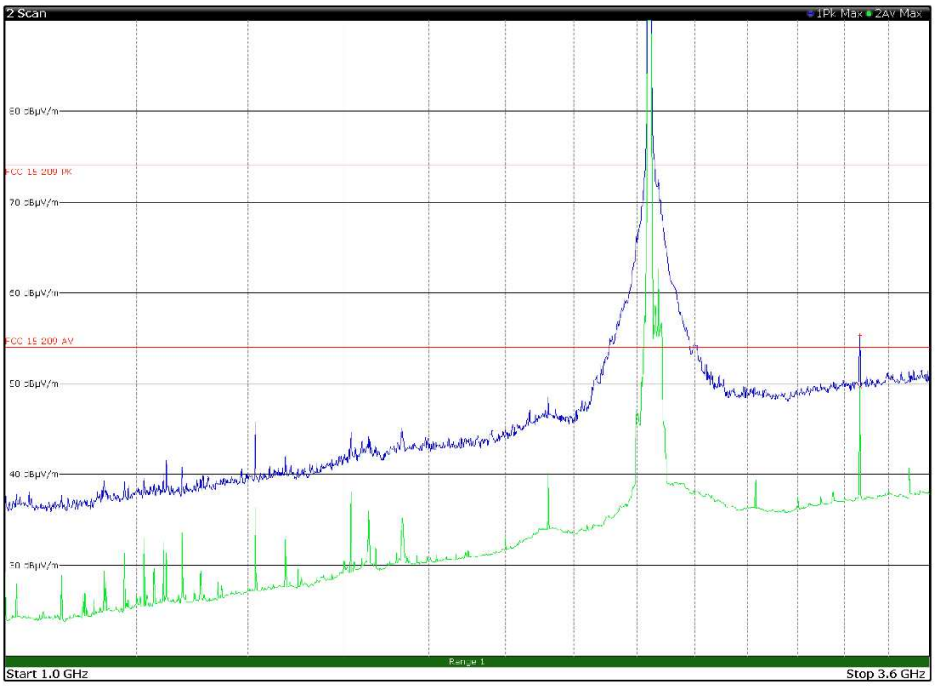


Figure 8.1-18: *Radiated spurious emissions, LTE NB-IOT Band 12, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
3269.2500	55.4	74. 0	-18.6	Pk
3269.2500	49.7	54.0	-4.3	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

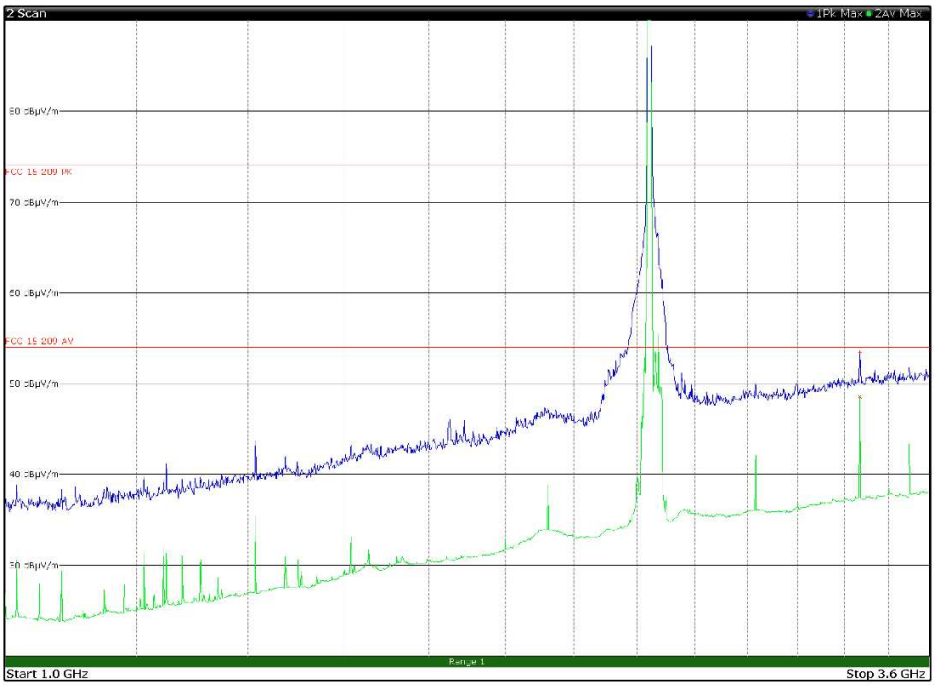


Figure 8.1-19: *Radiated spurious emissions, LTE NB-IOT Band 13, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
3269.2500	53.5	74. 0	-20.5	Pk
3269.2500	48.6	54.0	-5.4	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

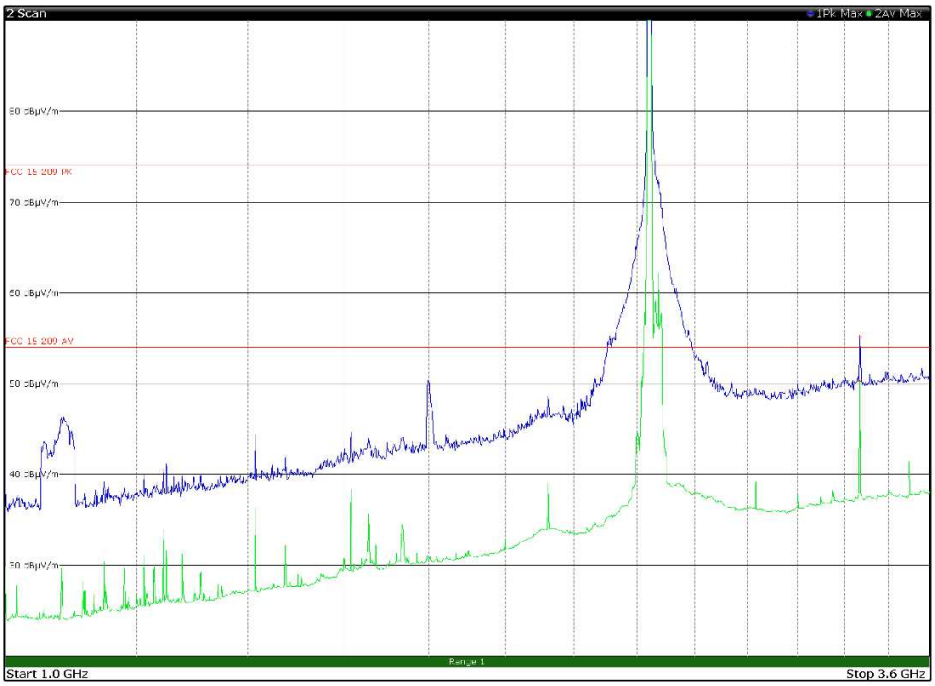


Figure 8.1-20: *Radiated spurious emissions, LTE NB-IOT Band 13, WIFI Tx at 2437 MHz – antenna in verticall polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
3269.2500	55.2	74.0	-18.8	Pk
3269.2500	50.4	54.0	-3.6	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

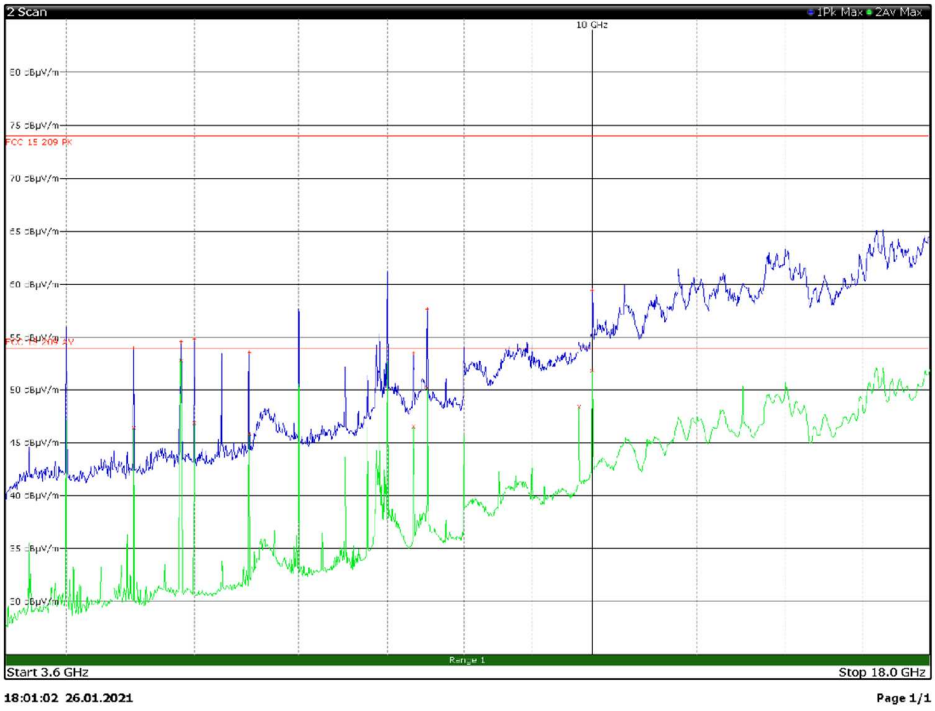


Figure 8.1-21: *Radiated spurious emissions, LTE NB-IOT Band 2, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4500.0000	54.1	74.0	-19.9	Pk
4500.0000	46.4	54.0	-7.6	Av
4884.0000	52.3	54.0	-1.7	Av
4884.2500	54.3	74.0	-19.7	Pk
5000.0000	54.9	74.0	-19.1	Pk
5000.0000	46.9	54.0	-7.1	Av
5500.0000	53.6	82.2	-28.6	Pk
5500.0000	45.9	-	-	Av
7324.5000	53.6	74.0	-20.4	Pk
7325.2500	46.6	54.0	-7.4	Av
7500.0000	57.7	74.0	-16.3	Pk
7500.0000	50.3	54.0	-3.7	Av
10000.2500	59.5	82.0	-22.5	Pk
10000.2500	51.8	-	-	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

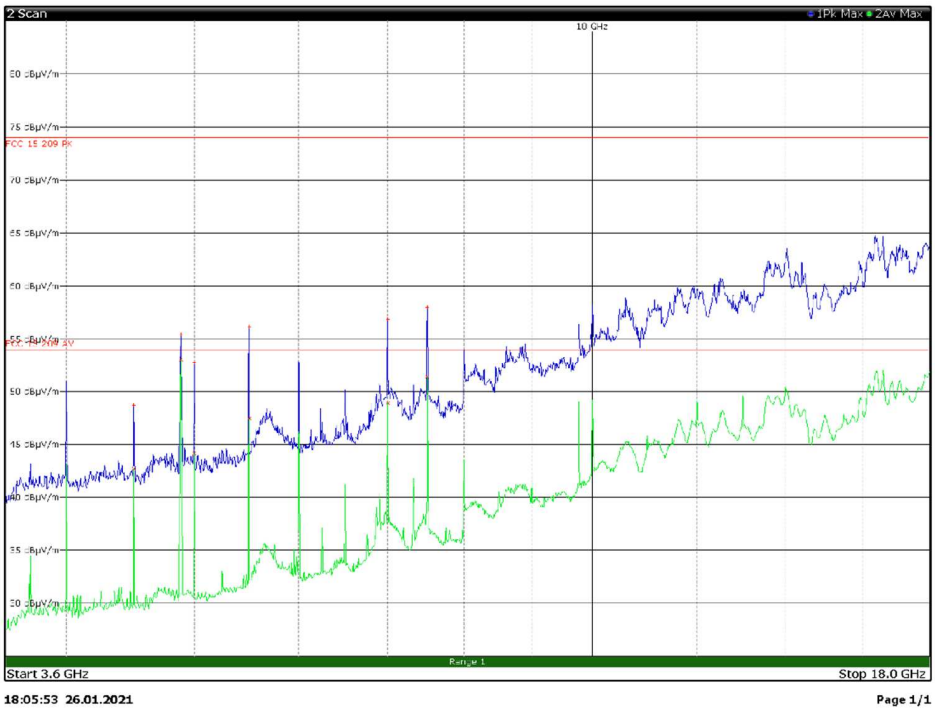


Figure 8.1-22: *Radiated spurious emissions, LTE NB-IOT Band 2, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4500.0000	48.7	74.0	-25.3	Pk
4500.0000	42.7	54.0	-11.3	Av
4884.0000	55.2	74.0	-18.8	Pk
4884.0000	53.8	54.0	-0.2	Av
5000.0000	52.8	74.0	-21.2	Pk
5000.0000	44.2	54.0	-9.8	Av
5500.0000	56.2	82.2	-26.0	Pk
5500.0000	47.5	-		Av
7000.0000	56.9	82.2	-25.3	Pk
7000.0000	48.9	-		Av
7500.0000	58.0	74.0	-16.0	Pk
7500.0000	51.4	54.0	-2.6	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

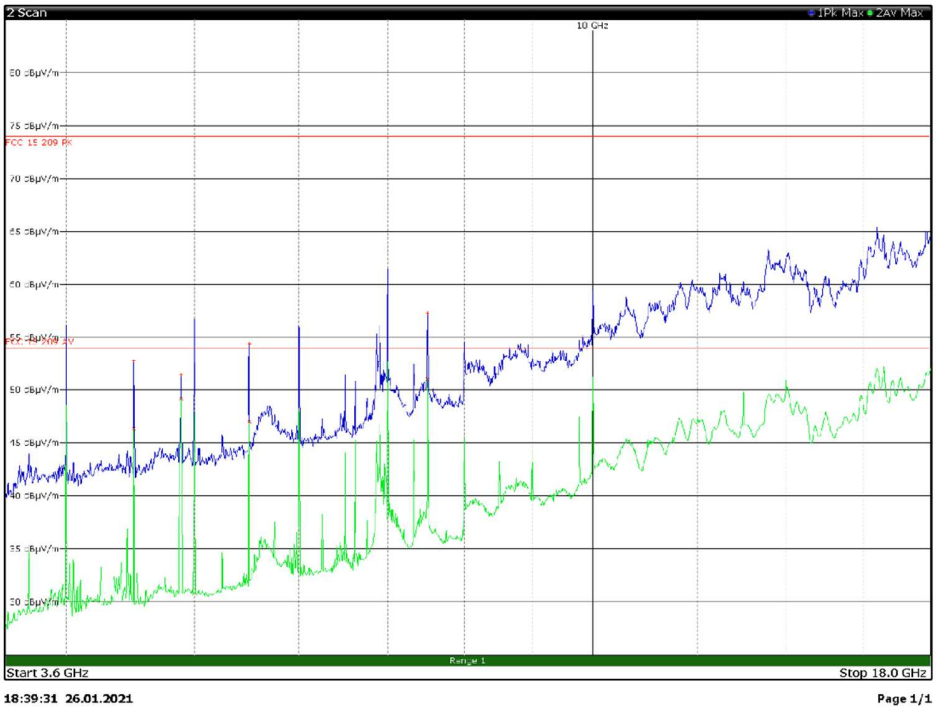


Figure 8.1-23: *Radiated spurious emissions, LTE NB-IOT Band 4, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4500.0000	52.8	74.0	-21.2	Pk
4500.0000	46.4	54.0	-7.6	Av
4884.0000	51.4	74.0	-22.6	Pk
4884.0000	49.2	54.0	-4.8	Av
5500.0000	54.4	82.2	-27.8	Pk
5500.0000	47.0	-	-	Av
7500.0000	57.4	74.0	-16.6	Pk
7500.0000	51.0	54.0	-3.0	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

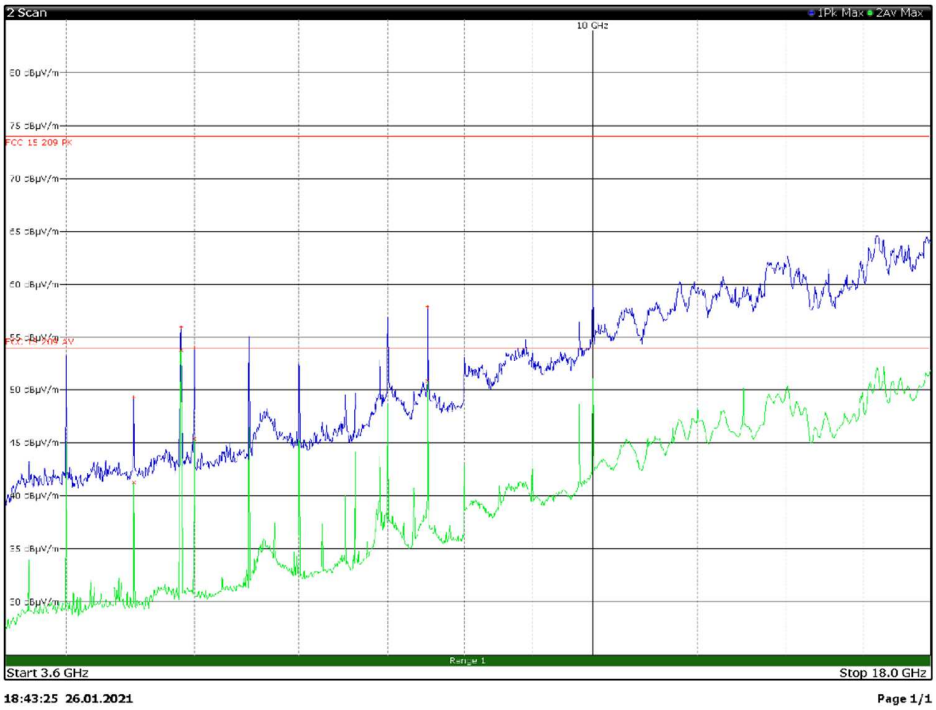


Figure 8.1-24: *Radiated spurious emissions, LTE NB-IOT Band 4, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4500.0000	49.3	74.0	-24.7	Pk
4500.0000	41.3	54.0	-12.7	Av
4884.0000	56.1	74.0	-17.9	Pk
4884.0000	53.0	54.0	-0.1	Av
5000.0000	54.0	74.0	-20.0	Pk
5000.0000	45.4	54.0	-8.6	Av
7500.0000	57.9	74.0	-16.1	Pk
7500.0000	50.9	54.0	-3.1	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

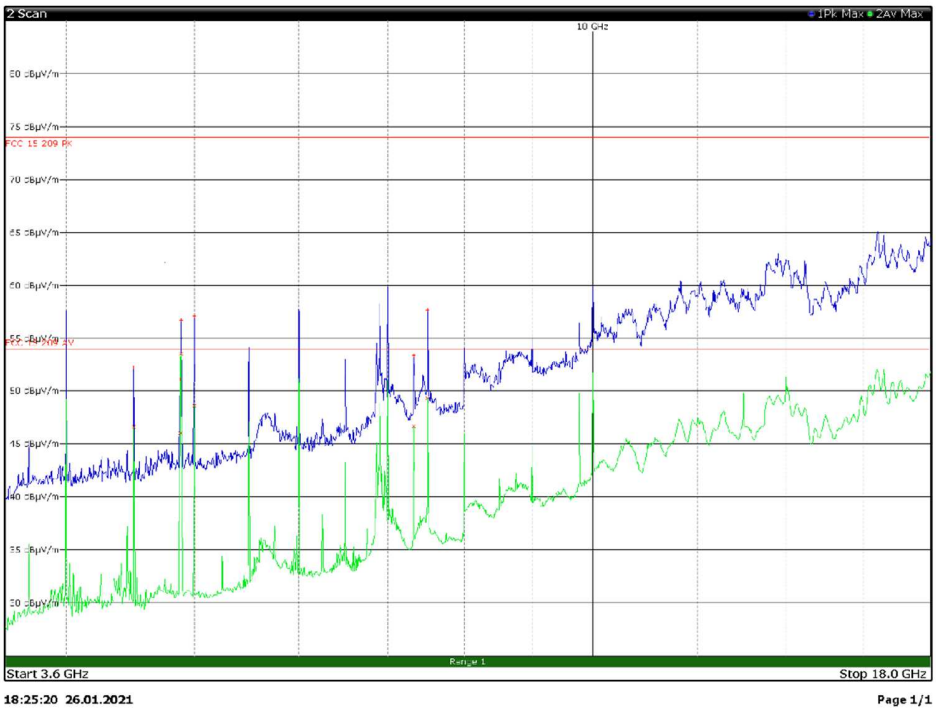


Figure 8.1-25: *Radiated spurious emissions, LTE NB-IOT Band 5, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4500.0000	52.2	74.0	-21.8	Pk
4500.0000	46.6	54.0	-7.4	Av
4881.0000	51.1	74.0	-22.9	Pk
4881.0000	46.0	54.0	-8.0	Av
4884.0000	56.8	74.0	-17.2	Pk
4884.0000	53.8	54.0	-0.2	Av
5000.0000	57.1	74.0	-16.9	Pk
5000.0000	48.6	54.0	-5.4	Av
7325.2500	53.5	74.0	-20.5	Pk
7325.2500	46.7	54.0	-7.3	Av
7500.0000	49.3	54.0	-4.7	Av
7500.2500	57.8	74.0	-16.2	Pk

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

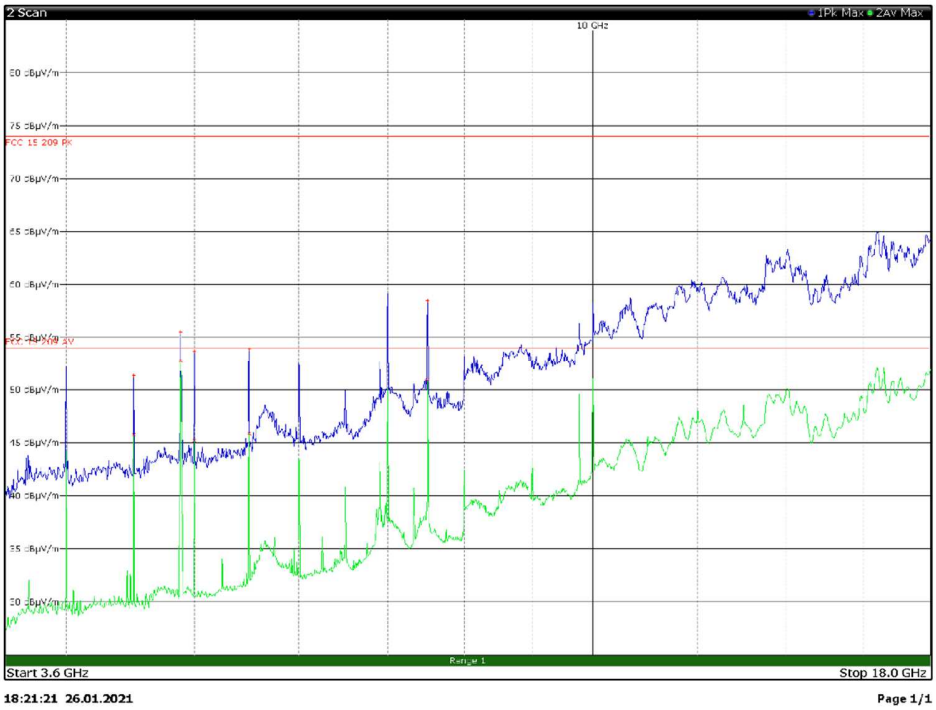


Figure 8.1-26: *Radiated spurious emissions, LTE NB-IOT Band 5, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4500.0000	51.3	74.0	-22.7	Pk
4500.0000	45.8	54.0	-8.2	Av
4884.0000	52.9	54.0	-1.1	Av
4884.2500	55.4	74.0	-18.6	Pk
5000.0000	53.7	74.0	-20.3	Pk
5000.0000	45.2	54.0	-8.8	Av
5500.0000	53.9	82.2	-28.3	Pk
5500.0000	45.9	-	-	Av
7500.0000	58.5	74.0	-15.5	Pk
7500.2500	50.9	54.0	-3.1	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

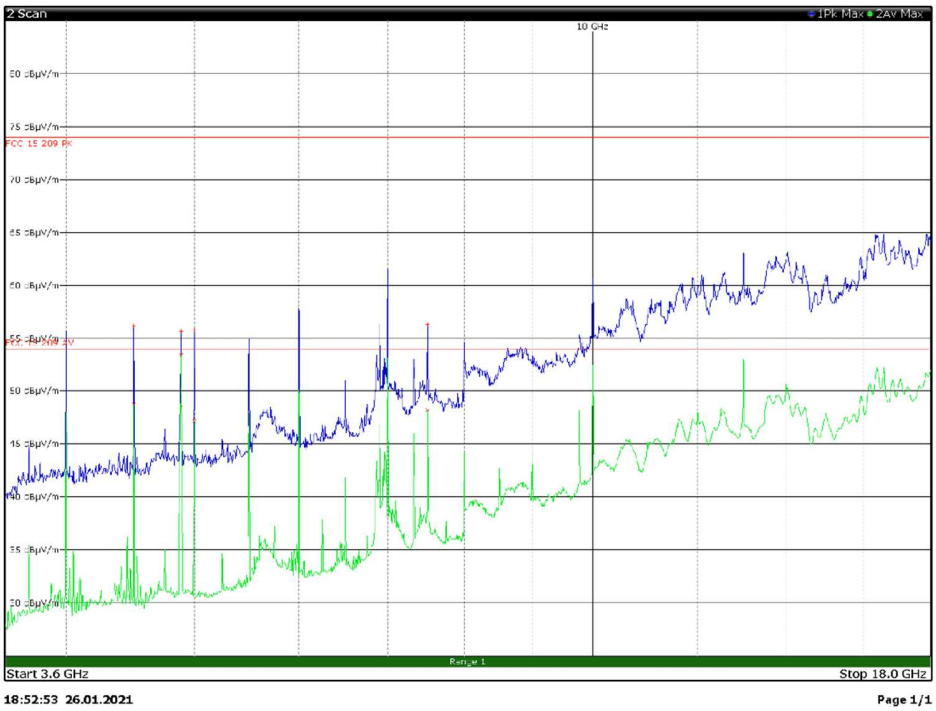


Figure 8.1-27: *Radiated spurious emissions, LTE NB-IOT Band 12, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4500.0000	56.2	74.0	-17.8	Pk
4500.0000	48.7	54.0	-5.3	Av
4884.0000	55.3	74.0	-18.7	Pk
4884.0000	53.6	54.0	-0.4	Av
5000.0000	55.8	74.0	-18.2	Pk
5000.0000	47.2	54.0	-6.8	Av
7500.0000	56.4	74.0	-17.6	Pk
7500.0000	48.2	54.0	-5.8	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

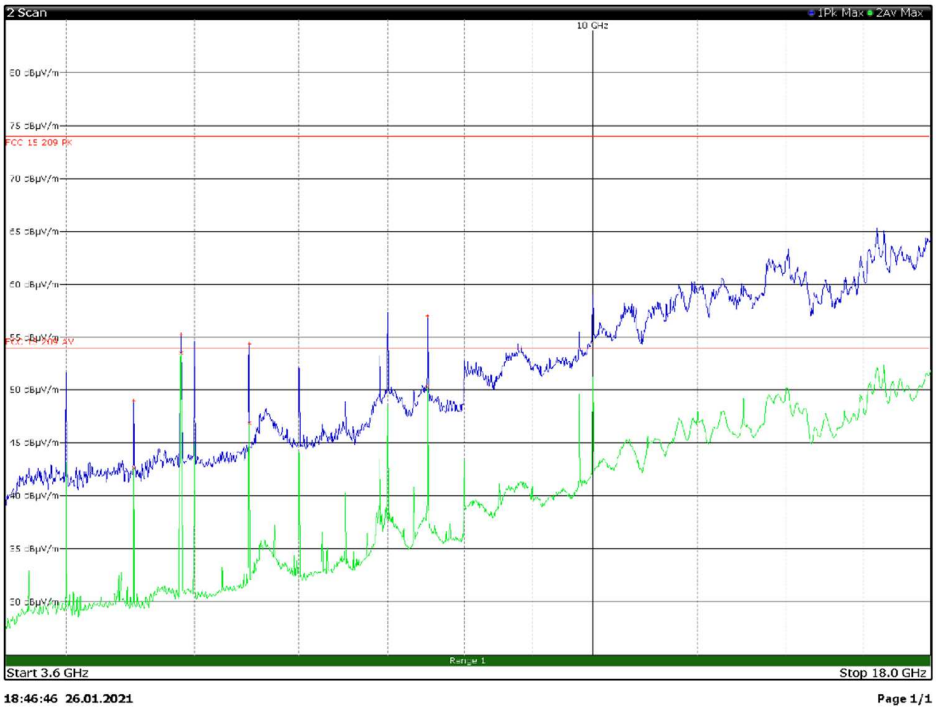


Figure 8.1-28: *Radiated spurious emissions, LTE NB-IOT Band 12, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4500.0000	49.0	74.0	-25.0	Pk
4500.0000	42.7	54.0	-11.3	Av
4884.0000	55.2	74.0	-18.8	Pk
4884.0000	53.6	54.0	-0.4	Av
5500.0000	54.5	82.0	-27.5	Pk
5500.0000	46.9	-	-	Av
7500.0000	50.3	54.0	-3.7	Av
7500.2500	57.1	74.0	-16.9	Pk

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

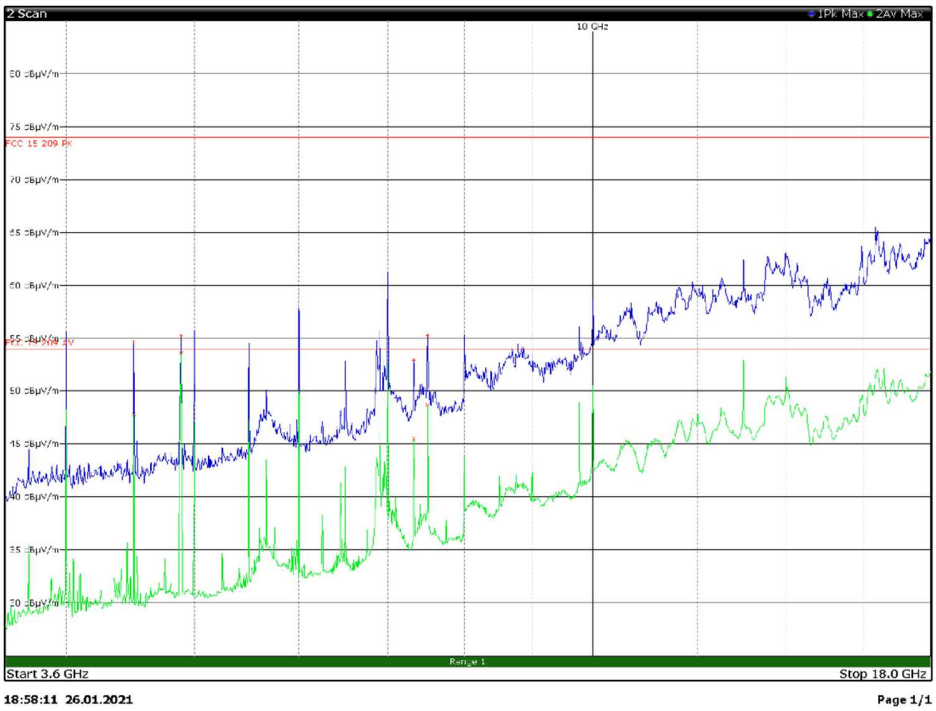


Figure 8.1-29: *Radiated spurious emissions, LTE NB-IOT Band 13, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4500.0000	54.7	74.0	-19.3	Pk
4500.0000	47.8	54.0	-6.2	Av
4884.0000	55.1	74.0	-18.9	Pk
4884.0000	53.8	54.0	-0.2	Av
7325.2500	45.5	54.0	-8.5	Av
7327.2500	53.0	74.0	-21.0	Pk
7500.0000	55.3	74.0	-18.7	Pk
7500.0000	48.7	54.0	-5.3	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

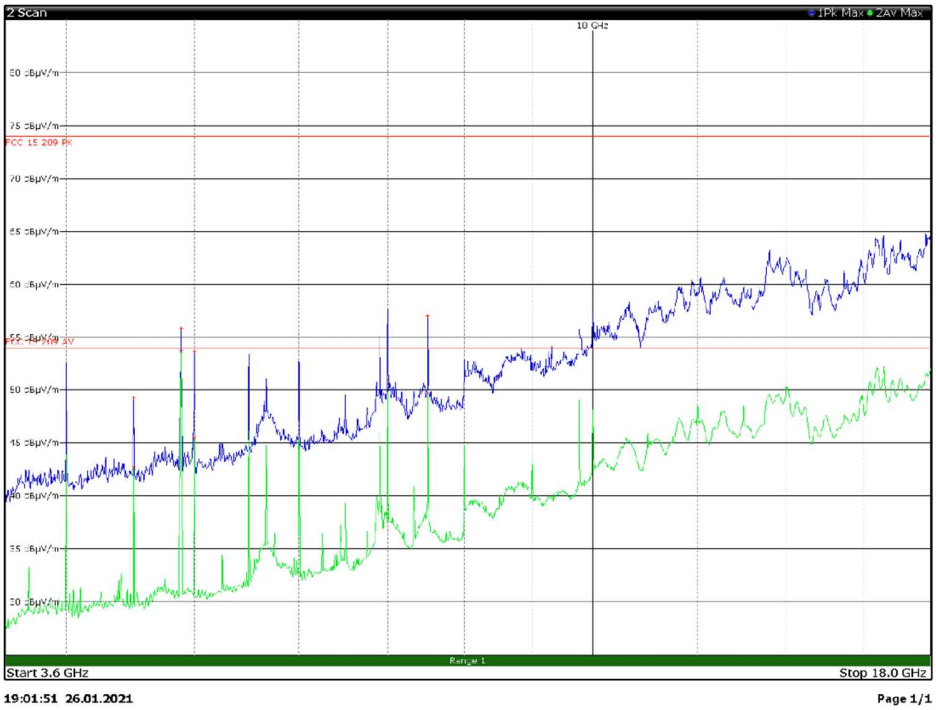


Figure 8.1-30: *Radiated spurious emissions, LTE NB-IOT Band 13, WIFI Tx at 2437 MHz – antenna in verticall polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
4500.0000	49.3	74.0	-24.7	Pk
4500.0000	42.7	54.0	-11.3	Av
4884.0000	56.0	74.0	-18.0	Pk
4884.0000	53.9	54.0	-0.1	Av
5000.0000	53.7	74.0	-20.3	Pk
5000.0000	45.5	54.0	-8.5	Av
7500.0000	57.1	74.0	-16.9	Pk
7500.0000	49.7	54.0	-4.3	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

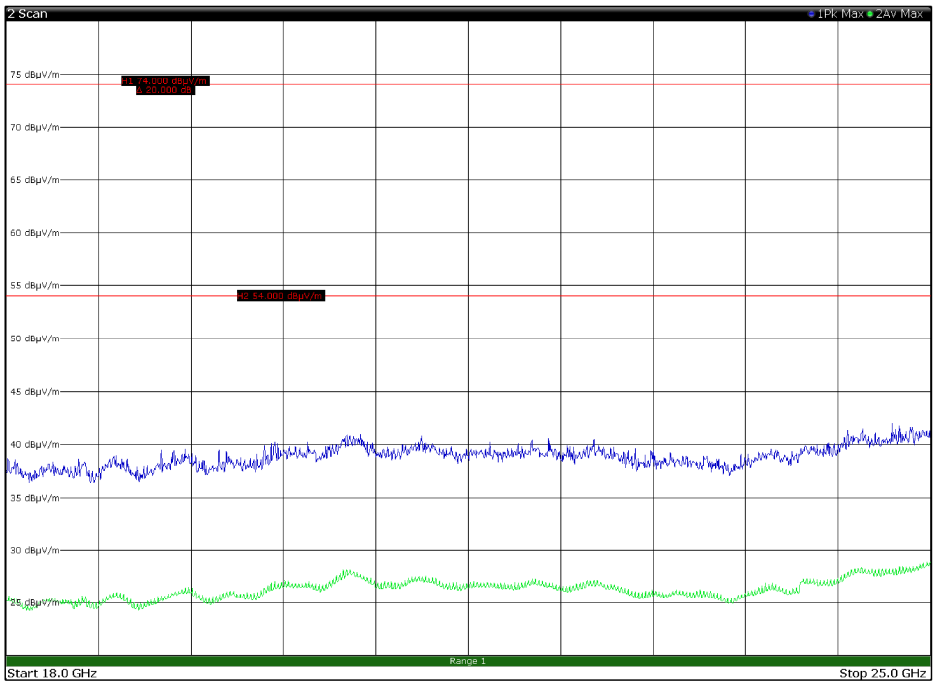


Figure 8.1-31: *Radiated spurious emissions, LTE NB-IOT Band 2, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

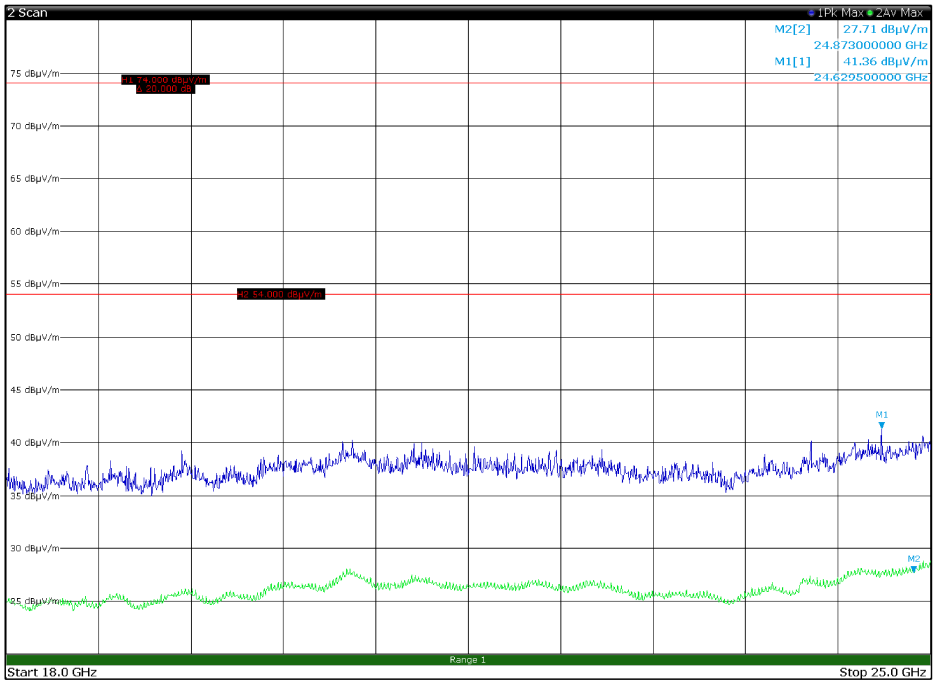


Figure 8.1-32: *Radiated spurious emissions, LTE NB-IOT Band 2, WIFI Tx at 2437 MHz – antenna in vertical polarization*

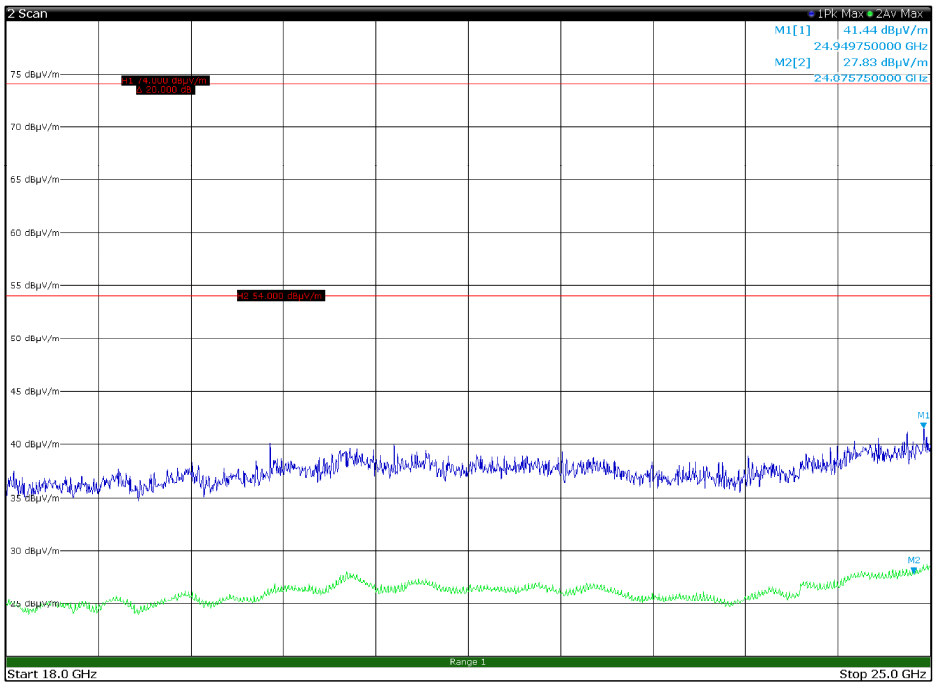


Figure 8.1-33: *Radiated spurious emissions, LTE NB-IOT Band 4, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

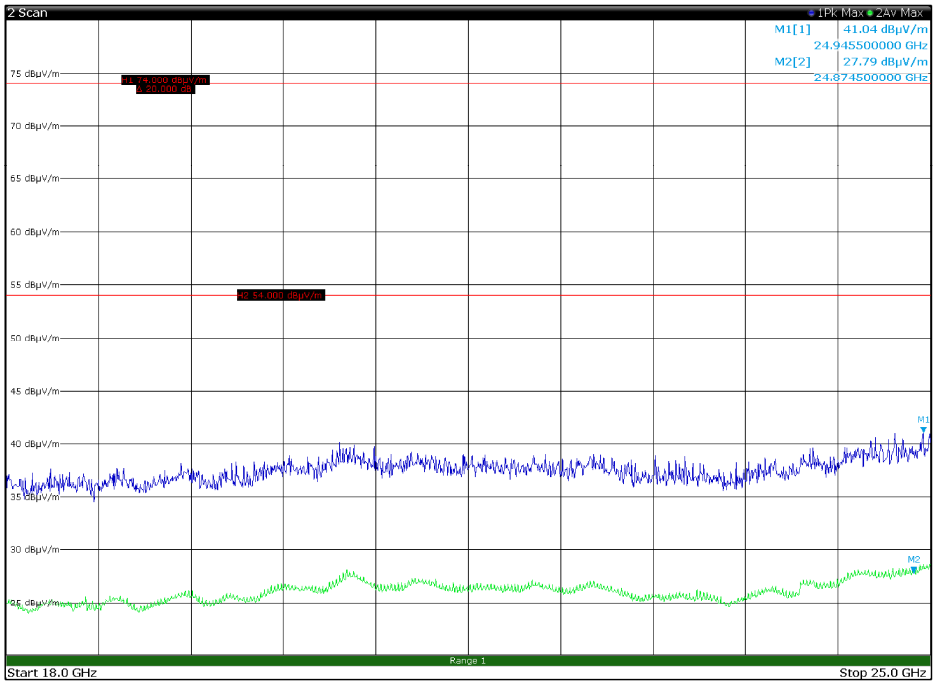


Figure 8.1-34: *Radiated spurious emissions, LTE NB-IOT Band 4, WIFI Tx at 2437 MHz – antenna in vertical polarization*

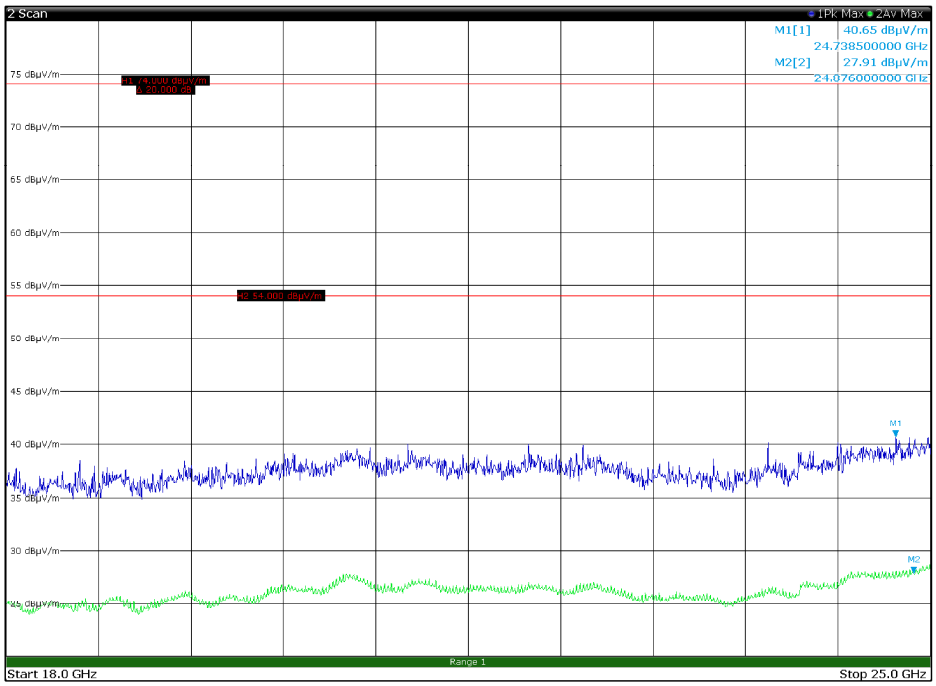


Figure 8.1-35: *Radiated spurious emissions, LTE NB-IOT Band 5, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

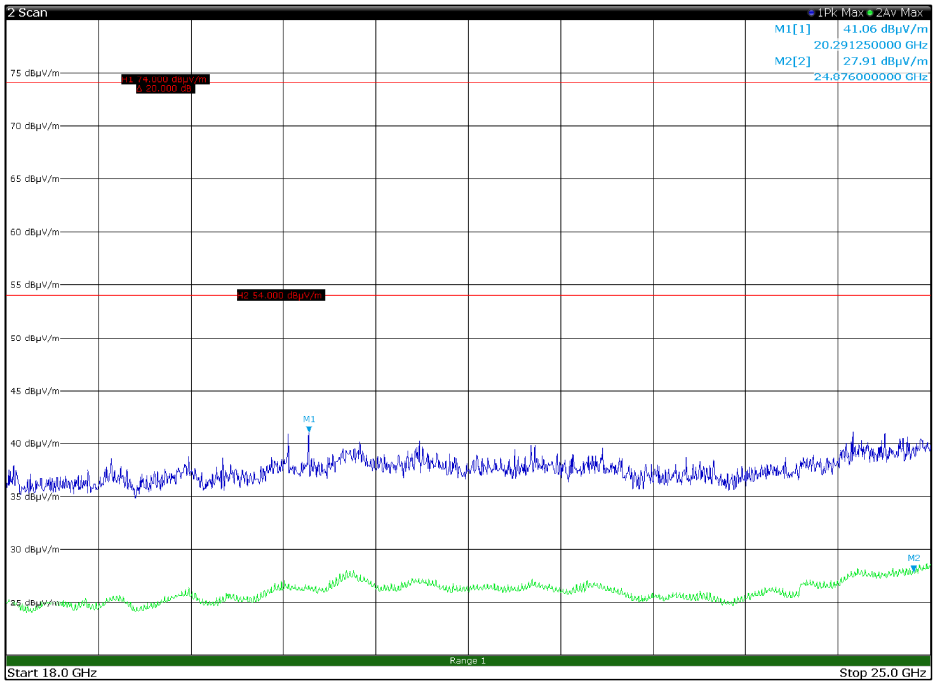


Figure 8.1-36: *Radiated spurious emissions, LTE NB-IOT Band 5, WIFI Tx at 2437 MHz – antenna in vertical polarization*

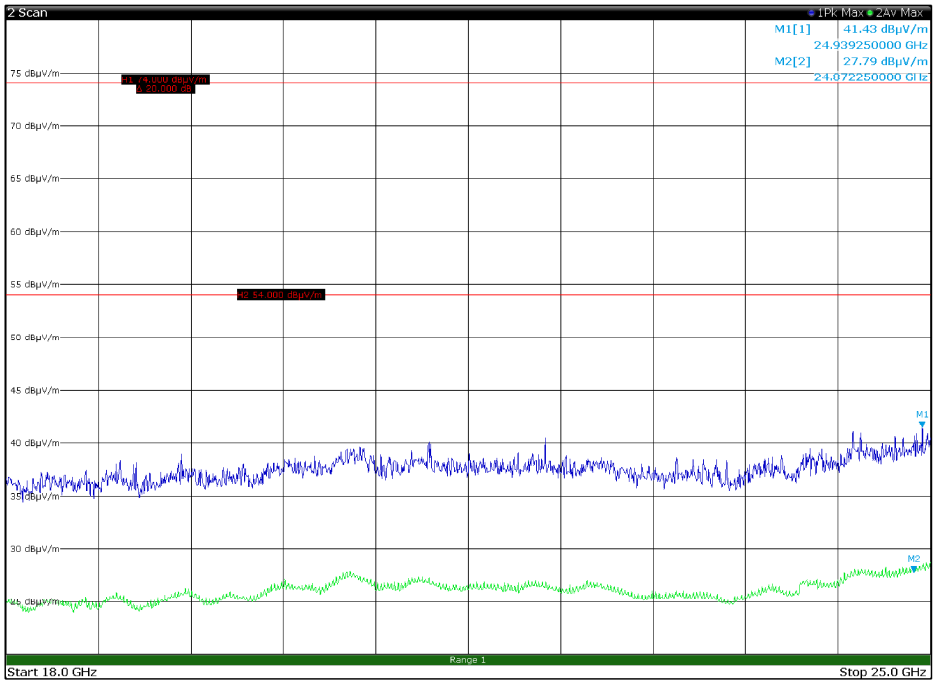


Figure 8.1-37: *Radiated spurious emissions, LTE NB-IOT Band 12, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

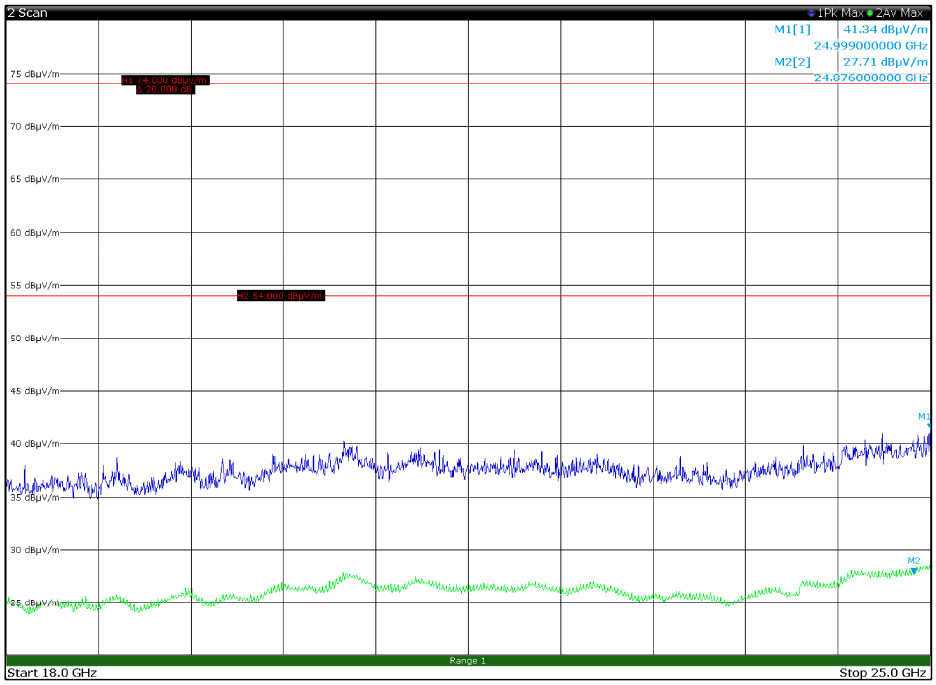


Figure 8.1-38: *Radiated spurious emissions, LTE NB-IOT Band 12, WIFI Tx at 2437 MHz – antenna in vertical polarization*

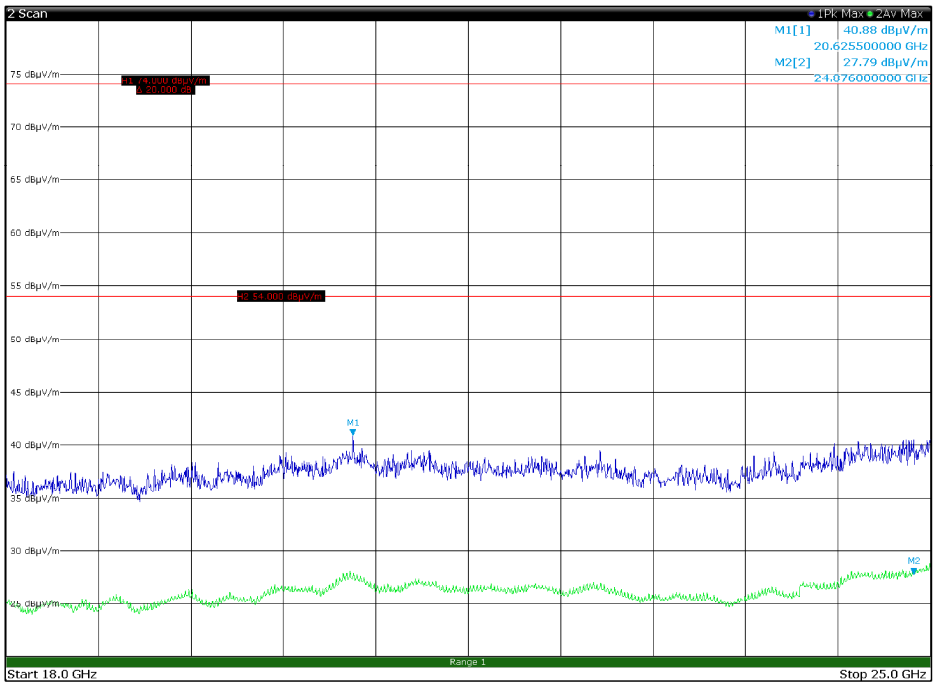


Figure 8.1-39: *Radiated spurious emissions, LTE NB-IOT Band 13, WIFI Tx at 2437 MHz – antenna in horizontal polarization*

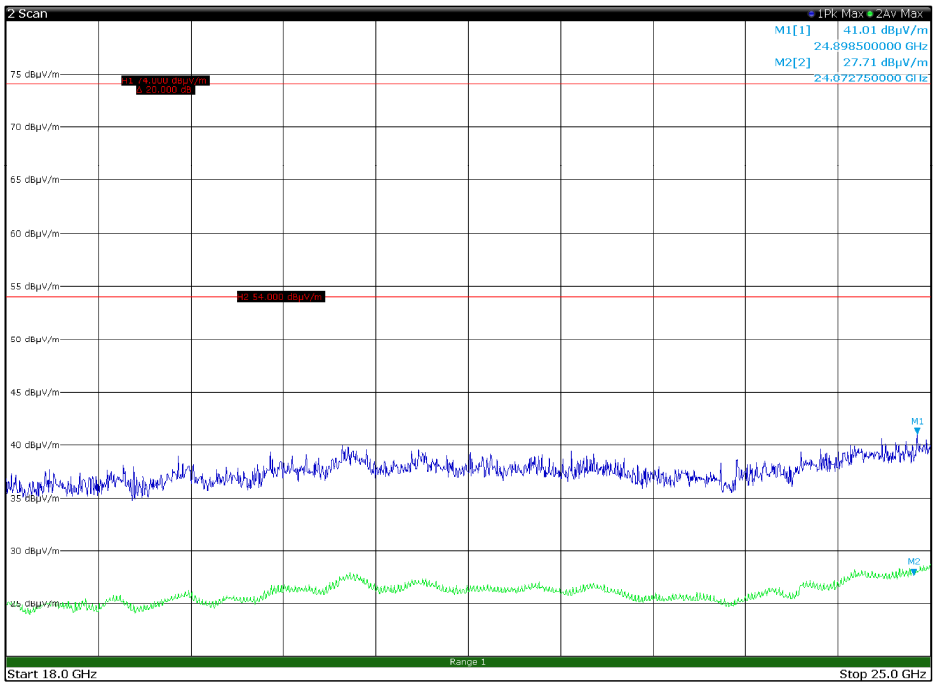
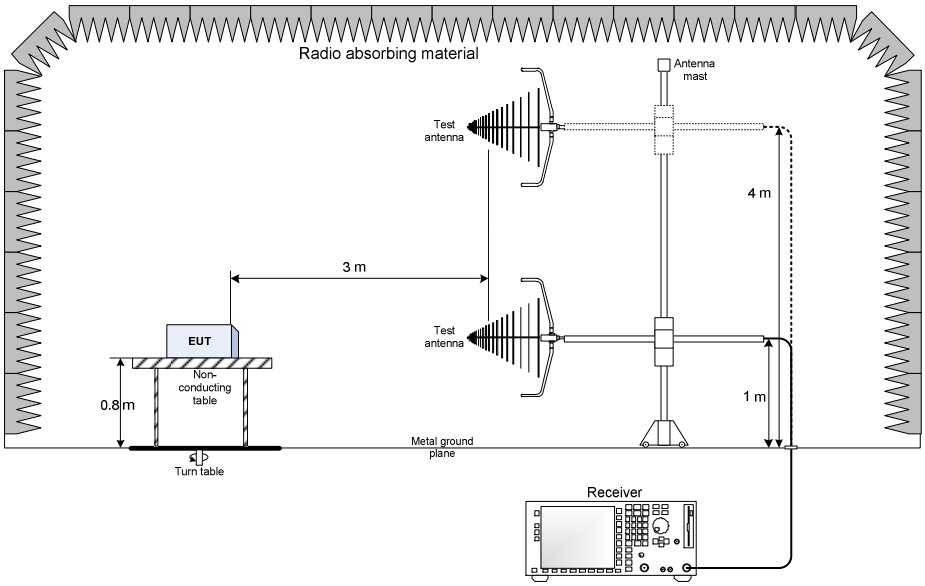


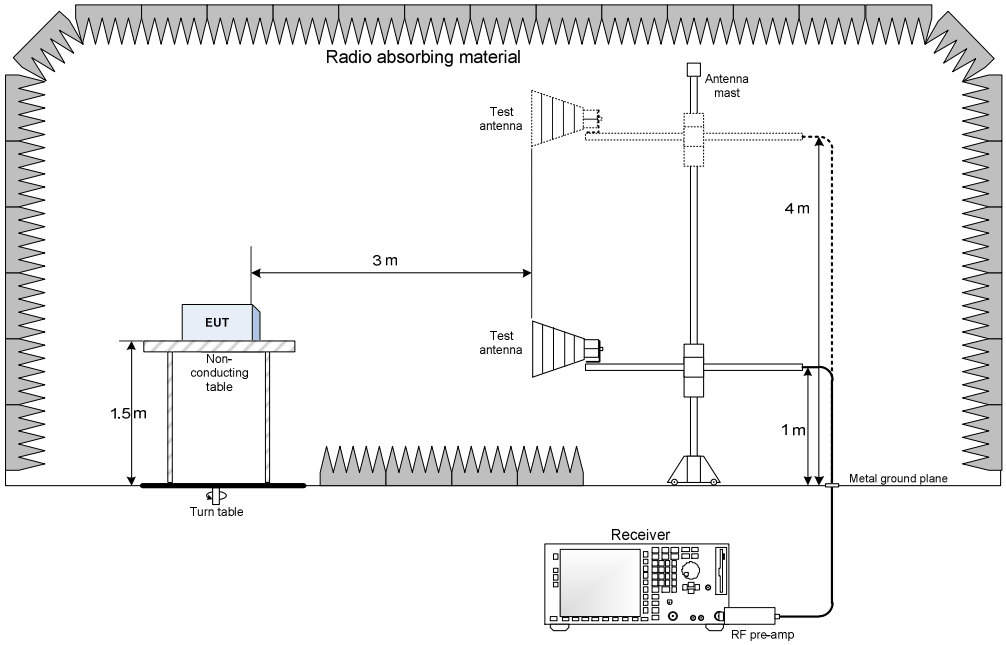
Figure 8.1-40: *Radiated spurious emissions, LTE NB-IOT Band 13, WIFI Tx at 2437 MHz – antenna in vertical polarization*

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



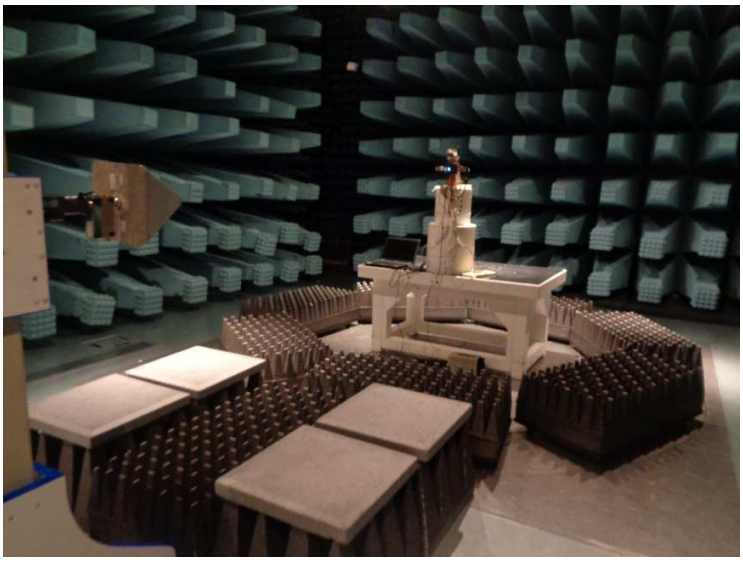
9.2 Radiated emissions set-up for frequencies above 1 GHz



Section 10. Photos

10.1 Photos of the test set-up

Radiated emission below 1 GHz



Radiated emission above 1 GHz

10.2 Photos of the EUT

(End of report)