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Test report

Invention Planet Smart Display 341567B-TRFWL

Date of issue: February 6, 2018

Applicant: Invention Planet, LLC

Product: Wireless Smart Display Sign

Model	Variants
SD2010	N/A

FCC ID: WZK-PR-1003

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247

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

Test location

Company name	Nemko USA, Inc.
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City	Carlsbad
Province	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com
Site number	FCC: US5058; IC: 2040B

Tested by	Nikolay Shtin, Senior Wireless Engineer
Reviewed by	Juan Manuel Gonzalez, Business Development Manager EMC/Wireless Division
Review date	February 6, 2018
Reviewer signature	

Limits of responsibility

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

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Invention Planet, LLC
Address	3535 Industrial Ave., Suite A4
City	Santa Rosa
Province/State	California
Postal/Zip code	95403
Country	USA

1.2 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, 5725–5850 MHz
RSS-247, Issue 1	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.3 Test methods

ANSI C64.3-2014	American National Standard for Methods of Measurement of Radio- Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

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

See “Summary of test results” for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
	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	Not applicanle[1]
§15.31(e)	Variation of power source	Pass
§15.203	Antenna requirement	Pass[2]
§15.205	Restricted bands of operation	Pass

Notes: [1] EUT is powered through USB/batteries and has no direct connection to the AC mains.

[2] The EUT uses trace antenna on PCB.

2.2 FCC Part 15 Subpart C, intentional radiators test results

Part	Test description	Verdict
§15.247(a)(1)	20 dB bandwidth of the hopping channel	Not applicable
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Pass
§15.247(b)(1)	Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	Not applicable
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(b)(3)	Maximum peak output power of systems using digital modulation 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	Not applicable
§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 for digitally modulated devices	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	December 11, 2017 and January 4, 2018
Nemko sample ID number	51211 and 20104

3.2 EUT information

Product name	Wireless Smart Display Sign
Model	SD2010
Model variant	N/A
Serial number	N/A
FCC ID	WZK-PR-1003
IC Registration Number	N/A

3.3 Technical information

Frequency band	2400-2483.5 MHz
Frequency Min (MHz)	2402
Frequency Max (MHz)	2480
RF power Min (W), Conducted/ERP/EIRP	N/A
RF power Max (W), Conducted/ERP/EIRP	0.00163 (Conducted)
Field strength, Units @ distance	N/A
Measured BW (kHz) (6 dB)	709.3
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	GFSK
Emission classification (F1D, G1D, D1D)	W7D
Transmitter spurious, Units @ distance	56.11 dBµV/m @ 3m Peak / 49.37 dBµV/m @ 3m Average
Power requirements	5 VDC through USB interface
Antenna information	Folded Dipole Antenna, peak gain is 7.4 dBi. The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

The Equipment Under Test (EUT) was an Invention Planet, LLC Wireless Smart Display Sign. The EUT incorporates a low power radio operating in the 2400-2483.5 MHz ISM band.

3.5 EUT exercise details

A test software was used that allows the change of different RF modes/channels. EUT is set to fixed channel test mode with modulation.

RF conducted test was performed on unit with a temporary RF output port (50Ω SMA before antennas).

3.6 EUT setup diagram

Setup Photo in separate exhibit

Figure 3.6-1: *Radiated Emissions Test Setup – below 1GHz*

Setup Photo in separate exhibit

Figure 3.6-2: *Radiated Emissions Test Setup – above 1GHz*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
AC/DC USB Adapter	Phihong	PSA10F-050Q	N/A
Shielded high-speed USB cable	Copartner	N/A	N/A

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.
120VAC 60Hz

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

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

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

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMC Test Receiver	Rohde & Schwarz	ESU 40	E1121	1 yr.	7/28/2018
Antenna, Bilog	Schaffner-Chase	CBL6111C	1480	1 yr.	7/21/2018
Antenna, Horn	EMCO	3115	1033	1 yr.	7/27/2018
Spectrum Analyzer	Rohde & Schwarz	FSV40	E1120	1 yr.	7-27-2018
Signal Generator	Rohde & Schwarz	SMB 100A	E1128	1 yr.	9-13-2018
High-pass filter	Wainwright Instruments GMBH	WHKX12-2493-2770-18000-60SS	N/A	N/A	Verified with FSV40
Band reject filter	Wainwright Instruments GMBH	WRCGV10-2363.5-2400-2483.5-2520-60SS	N/A	N/A	Verified with FSV40

Section 8. Test Data

8.1 FCC 15.247(a) (2) Minimum 6 dB bandwidth

8.1.1 Definitions and limits

FCC 15.247:
(a) (2) 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.

8.1.2 Test summary

Test date	December 12, 2017	Temperature	19 °C
Test engineer	Nikolay Shtin	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	31.5 %

8.1.3 Observations, settings and special notes

Spectrum analyzer settings:

Resolution bandwidth	100 kHz
Video bandwidth	≥3 × RBW
Frequency span	5 MHz
Detector mode	Peak
Trace mode	Max Hold

8.1.4 Test data

Table 8.1-1: *6 dB bandwidth results*

Modulation	Frequency, MHz	6dB bandwidth, kHz	Limit, kHz	Margin, kHz
GFSK	2402	709.3	500	209.3
	2442	709.3	500	209.3
	2480	709.3	500	209.3

Date: 12.DEC.2017 11:37:47

Figure 8.1-1: *6 dB bandwidth, Low CH*

Date: 12.DEC.2017 12:00:00

Figure 8.1-2: *6 dB bandwidth, Mid CH*

Date: 12.DEC.2017 11:55:13

Figure 8.1-3: *6 dB bandwidth, High CH*

8.2 FCC 15.247(b) and RSS-247 5.4 (d) Transmitter output power and e.i.r.p. requirements

8.2.1 Definitions and limits

FCC 15.247:

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

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. 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.

8.2.2 Test summary

Test date	December 12, 2017	Temperature	20 °C
Test engineer	Nikolay Shtin	Air pressure	1008 mbar
Verdict	Pass	Relative humidity	56 %

8.2.3 Observations, settings and special notes

Peak Conducted Power Measured, Maximum declared antenna gain is 7.4dBi (folded dipole). Since conducted power is less than 3dBm and EUT complies with EIRP limits for more than 26dB the reduction of conducted power is not necessary.

Spectrum analyser settings:

Resolution bandwidth	≥ Channel BW (1MHz)
Video bandwidth	≥ 3 × RBW (3MHz)
Frequency span	≥ 3 x RBW (3MHz)
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: *Output power measurements results*

Modulation	Frequency, MHz	Conducted output power, dBm		Margin, dB	Max Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
		Measured	Limit					
GFSK	2402	2.11	30	27.89	7.4	9.51	36	26.49
	2440	1.70	30	28.30	7.4	9.10	36	26.90
	2480	1.35	30	28.65	7.4	8.75	36	27.25

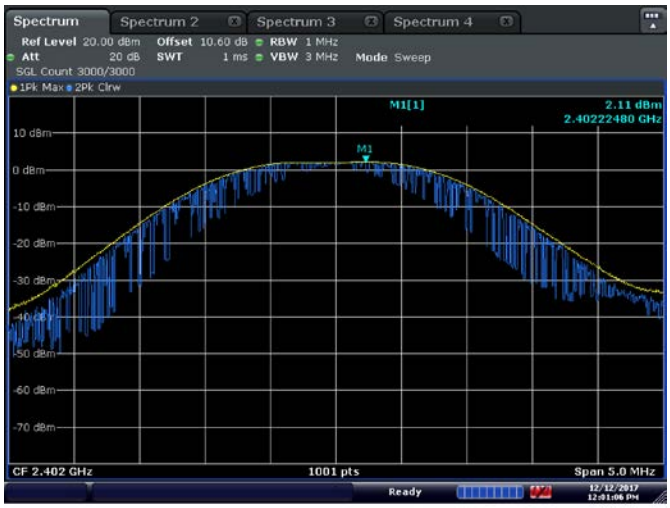

Figure 8.2-1: *Output Power, Low CH*

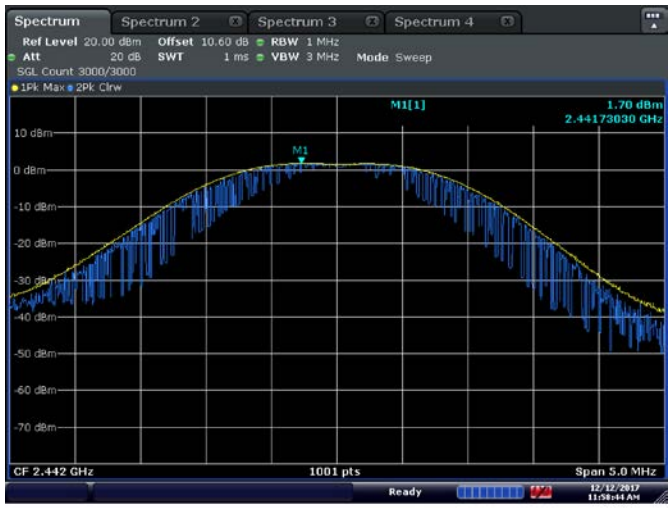

Figure 8.2-2: *Output Power, Mid CH*

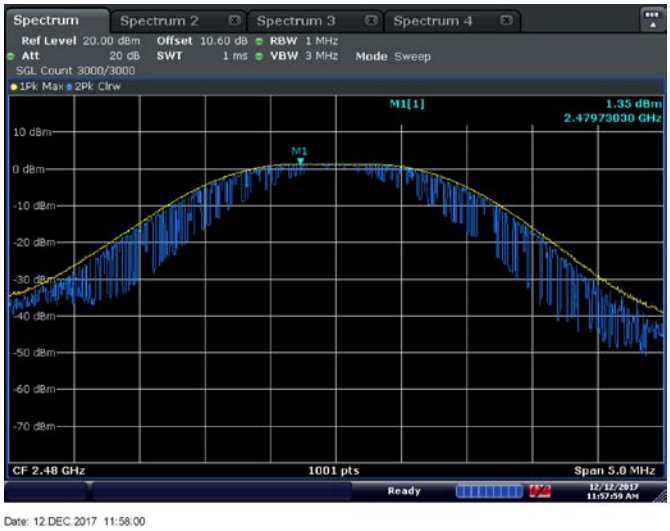

Figure 8.2-3: *Output Power, High CH*

8.3 FCC 15.247(d) Spurious (out-of-band) emissions

8.3.1 Definitions and limits

FCC 15.247:
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 8.3-1: *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 8.3-2: *FCC restricted frequency bands*

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

8.3.2 Test summary

Test date	December 12, 2016	Temperature	20 °C
Test engineer	Nikolay Shtin	Air pressure	1008 mbar
Verdict	Pass	Relative humidity	55 %

8.3.3 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.
Antenna 0 path was selected for most radiated test cases as worst case.

Spectrum analyzer settings for conducted spurious emissions measurements:

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

Spectrum analyzer 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 analyzer 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:	3 MHz
Detector mode:	AVG
Trace mode:	Max Hold

8.3.4 Test data

Figure 8.3.1: *Band-edge Measurement, low channel*

Figure 8.3.2: *Band-edge Measurement, high channel*

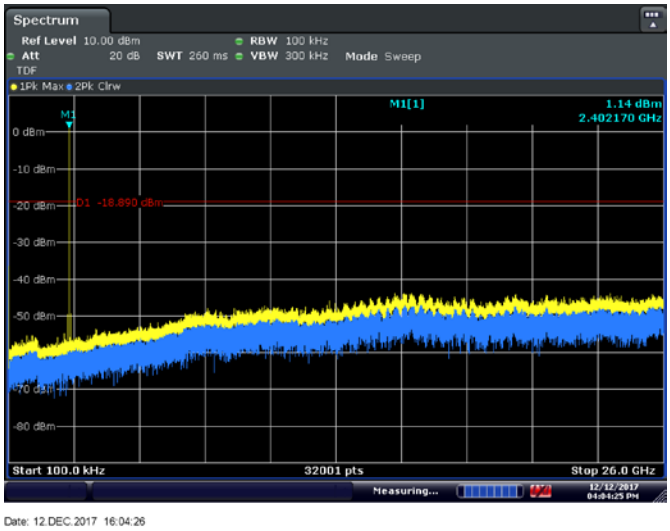

Figure 8.3.3: *Conducted spurious emissions, low channel*

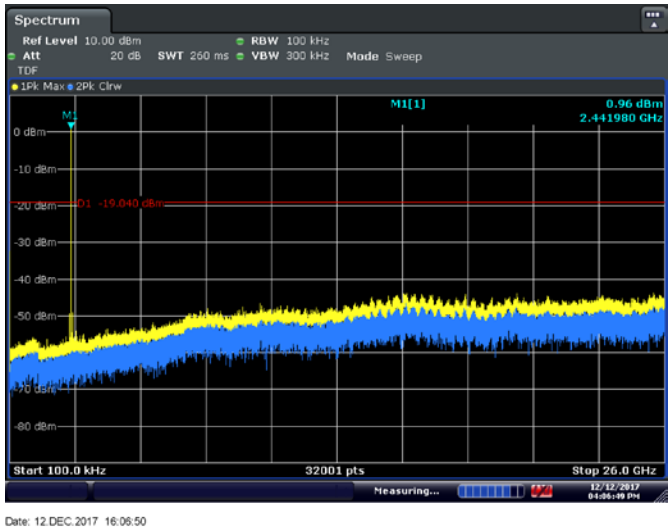

Figure 8.3.4: *Conducted spurious emissions, mid channel*

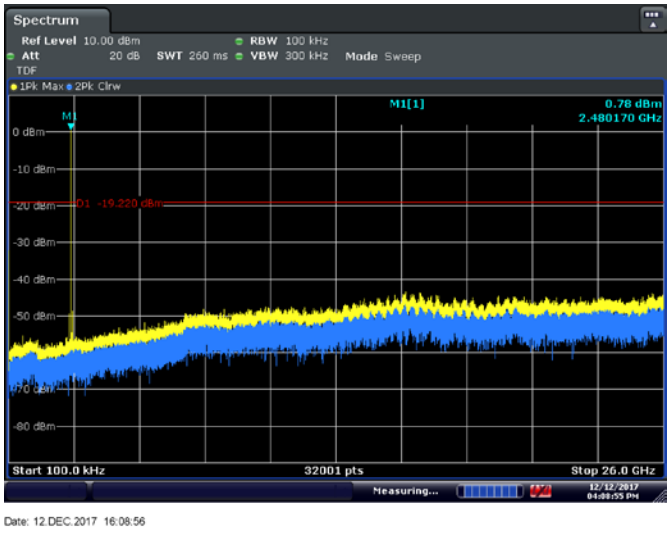

Figure 8.3.5: *Conducted spurious emissions, high channel*

Note: Peaks within 2400-2483.5MHz are transmitter fundamentals.

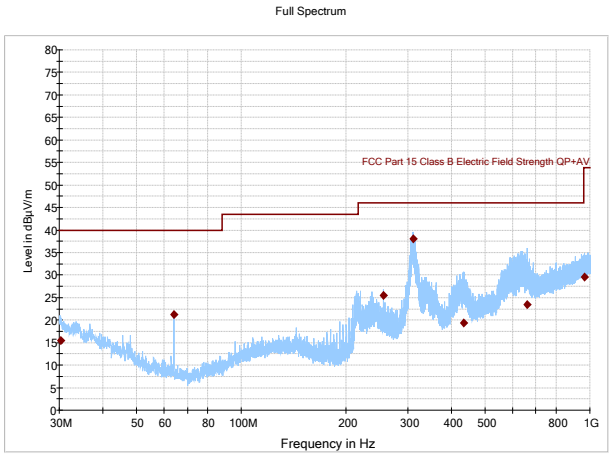

Figure 8.3.6: *Radiated spurious emissions, low channel, 30-1000MHz*

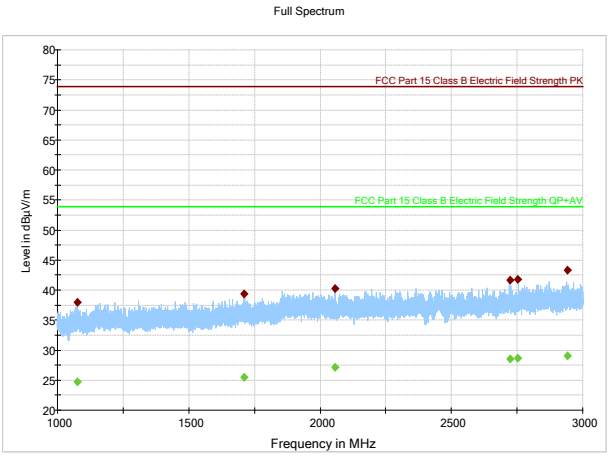

Figure 8.3.7: *Radiated spurious emissions, low channel, 1-3GHz*

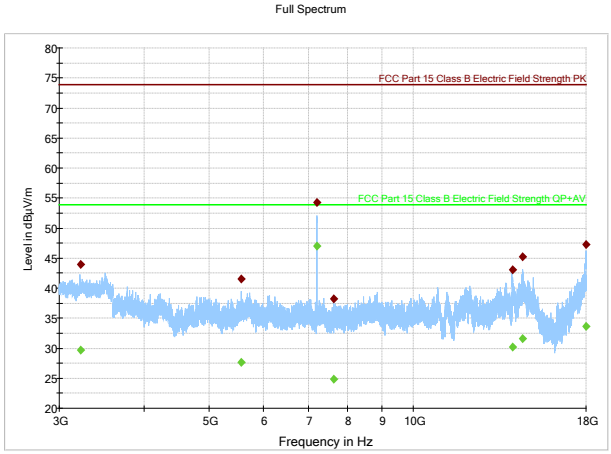

Figure 8.3.8: *Radiated spurious emissions, low channel, 3-18GHz*

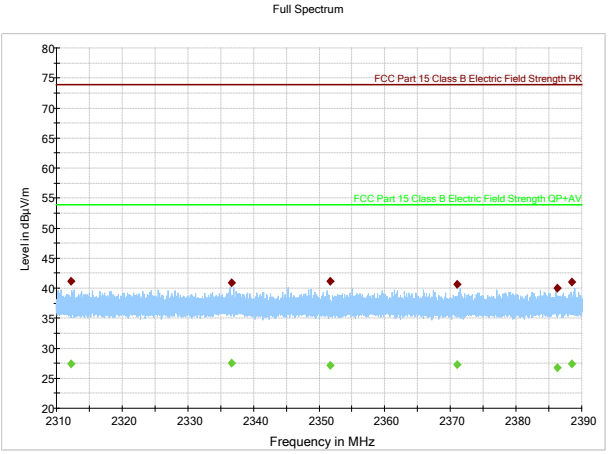

Figure 8.3.9: *Radiated spurious emissions in the 2.31-2.39GHz Restricted Band, low channel*

Table 8.3-3: *Radiated field strength measurement results for low channel 2402MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.240000	15.45	40.00	24.55	5000.0	120.000	197.6	V	93.0
63.998500	21.16	40.00	18.84	5000.0	120.000	144.7	V	184.0
256.010000	25.42	46.00	20.58	5000.0	120.000	118.3	H	93.0
310.755500	38.08	46.00	7.92	5000.0	120.000	100.0	H	72.0
433.551500	19.40	46.00	26.60	5000.0	120.000	182.4	V	180.0
659.604000	23.37	46.00	22.63	5000.0	120.000	292.7	H	154.0
964.938000	29.48	53.90	24.42	5000.0	120.000	279.8	H	235.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1074.53333	38.00	---	73.90	35.90	5000.0	1000.000	291.2	H	274.0
1074.53333	---	24.72	53.90	29.18	5000.0	1000.000	291.2	H	274.0
1710.46666	---	25.46	53.90	28.44	5000.0	1000.000	111.7	V	0.0
1710.46666	39.35	---	73.90	34.55	5000.0	1000.000	111.7	V	0.0
2057.60000	40.32	---	73.90	33.58	5000.0	1000.000	401.9	V	103.0
2057.60000	---	27.12	53.90	26.78	5000.0	1000.000	401.9	V	103.0
2722.60000	41.66	---	73.90	32.24	5000.0	1000.000	391.7	V	236.0
2722.60000	---	28.56	53.90	25.34	5000.0	1000.000	391.7	V	236.0
2752.33333	---	28.67	53.90	25.23	5000.0	1000.000	399.3	H	0.0
2752.33333	41.77	---	73.90	32.13	5000.0	1000.000	399.3	H	0.0
2940.33333	43.32	---	73.90	30.58	5000.0	1000.000	404.9	V	42.0
2940.33333	---	29.10	53.90	24.80	5000.0	1000.000	404.9	V	42.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
3222.50000	43.89	---	73.90	30.01	5000.0	1000.000	404.8	V	276.0
3222.50000	---	29.64	53.90	24.26	5000.0	1000.000	404.8	V	276.0
5569.40000	---	27.65	53.90	26.25	5000.0	1000.000	404.8	V	305.0
5569.40000	41.50	---	73.90	32.40	5000.0	1000.000	404.8	V	305.0
7205.20000	---	47.01	53.90	6.89	5000.0	1000.000	134.8	V	292.0
7205.20000	54.29	---	73.90	19.61	5000.0	1000.000	134.8	V	292.0
7634.70000	---	24.83	53.90	29.07	5000.0	1000.000	107.3	V	85.0
7634.70000	38.19	---	73.90	35.71	5000.0	1000.000	107.3	V	85.0
14008.5000	43.10	---	73.90	30.80	5000.0	1000.000	178.5	H	283.0
14008.5000	---	30.13	53.90	23.77	5000.0	1000.000	178.5	H	283.0
14523.9000	45.18	---	73.90	28.72	5000.0	1000.000	404.8	V	343.0
14523.9000	---	31.64	53.90	22.26	5000.0	1000.000	404.8	V	343.0
17999.1000	47.28	---	73.90	26.62	5000.0	1000.000	146.3	V	0.0
17999.1000	---	33.69	53.90	20.21	5000.0	1000.000	146.3	V	0.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2312.19333	41.18	---	73.90	32.72	5000.0	1000.000	410.0	H	102.0
2312.19333	---	27.44	53.90	26.46	5000.0	1000.000	410.0	H	102.0
2336.68933	40.84	---	73.90	33.06	5000.0	1000.000	410.0	H	17.0
2336.68933	---	27.57	53.90	26.33	5000.0	1000.000	410.0	H	17.0
2351.67066	---	27.19	53.90	26.71	5000.0	1000.000	410.0	H	72.0
2351.67066	41.13	---	73.90	32.77	5000.0	1000.000	410.0	H	72.0
2371.00666	---	27.30	53.90	26.60	5000.0	1000.000	410.0	H	42.0
2371.00666	40.67	---	73.90	33.23	5000.0	1000.000	410.0	H	42.0
2386.30800	39.94	---	73.90	33.96	5000.0	1000.000	293.3	H	234.0
2386.30800	---	26.74	53.90	27.16	5000.0	1000.000	293.3	H	234.0
2388.49733	41.00	---	73.90	32.90	5000.0	1000.000	410.0	H	55.0
2388.49733	---	27.34	53.90	26.56	5000.0	1000.000	410.0	H	55.0

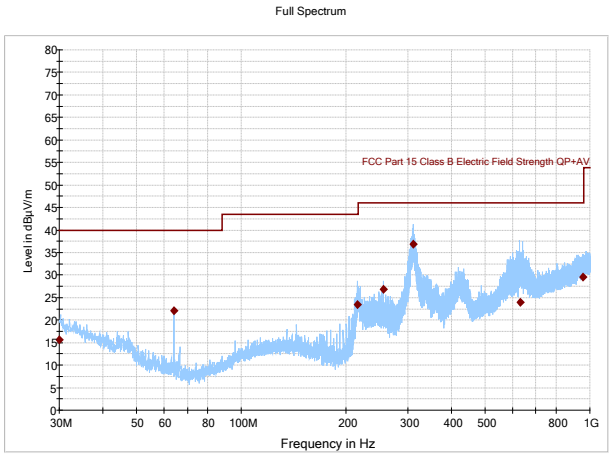

Figure 8.3.10: *Radiated spurious emissions, mid channel, 30-1000MHz*

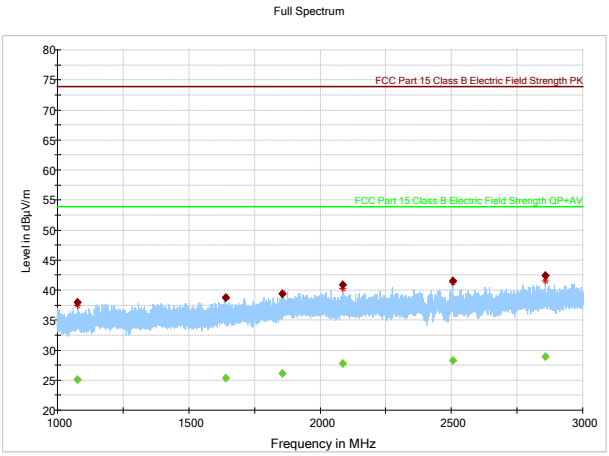

Figure 8.3.11: *Radiated spurious emissions, mid channel, 1-3GHz*

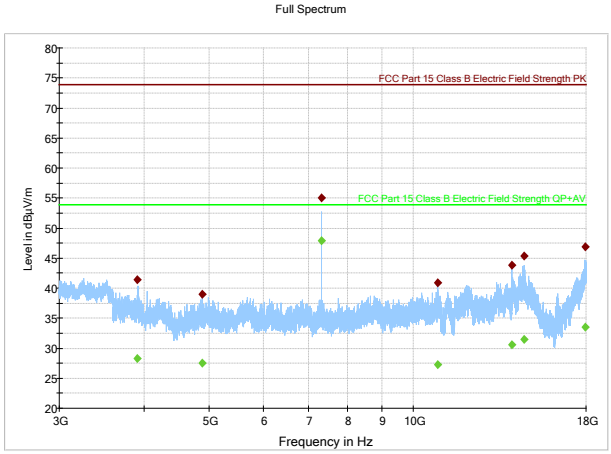

Figure 8.3.12: *Radiated spurious emissions, mid channel, 3-18GHz*

Table 8.3-4: *Radiated field strength measurement results for mid channel 2442 MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.040000	15.59	40.00	24.41	5000.0	120.000	348.4	H	332.0
63.990000	22.16	40.00	17.84	5000.0	120.000	109.4	V	162.0
215.658000	23.51	43.50	19.99	5000.0	120.000	133.5	H	115.0
256.010000	26.89	46.00	19.11	5000.0	120.000	110.7	H	94.0
311.620000	36.86	46.00	9.14	5000.0	120.000	110.7	H	72.0
629.917000	23.95	46.00	22.05	5000.0	120.000	410.0	H	294.0
954.604000	29.50	46.00	16.50	5000.0	120.000	403.7	V	122.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1076.13333	---	25.03	53.90	28.87	5000.0	1000.000	248.3	H	264.0
1076.13333	37.93	---	73.90	35.97	5000.0	1000.000	248.3	H	264.0
1641.80000	38.69	---	73.90	35.21	5000.0	1000.000	237.5	V	350.0
1641.80000	---	25.41	53.90	28.49	5000.0	1000.000	237.5	V	350.0
1855.26666	---	26.08	53.90	27.82	5000.0	1000.000	110.9	V	271.0
1855.26666	39.35	---	73.90	34.55	5000.0	1000.000	110.9	V	271.0
2087.20000	---	27.83	53.90	26.07	5000.0	1000.000	400.9	H	0.0
2087.20000	40.93	---	73.90	32.97	5000.0	1000.000	400.9	H	0.0
2504.40000	---	28.34	53.90	25.56	5000.0	1000.000	404.8	V	72.0
2504.40000	41.55	---	73.90	32.35	5000.0	1000.000	404.8	V	72.0
2856.06666	42.42	---	73.90	31.48	5000.0	1000.000	404.8	V	206.0
2856.06666	---	28.95	53.90	24.95	5000.0	1000.000	404.8	V	206.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
3914.90000	41.45	---	73.90	32.45	5000.0	1000.000	404.8	V	223.0
3914.90000	---	28.28	53.90	25.62	5000.0	1000.000	404.8	V	223.0
4882.50000	---	27.56	53.90	26.34	5000.0	1000.000	177.9	V	133.0
4882.50000	38.95	---	73.90	34.95	5000.0	1000.000	177.9	V	133.0
7325.20000	---	47.88	53.90	6.02	5000.0	1000.000	138.6	V	297.0
7325.20000	55.03	---	73.90	18.87	5000.0	1000.000	138.6	V	297.0
10866.5000	40.83	---	73.90	33.07	5000.0	1000.000	219.3	V	0.0
10866.5000	---	27.28	53.90	26.62	5000.0	1000.000	219.3	V	0.0
14001.6000	43.78	---	73.90	30.12	5000.0	1000.000	123.4	V	0.0
14001.6000	---	30.55	53.90	23.35	5000.0	1000.000	123.4	V	0.0
14565.3000	---	31.46	53.90	22.44	5000.0	1000.000	401.7	V	192.0
14565.3000	45.29	---	73.90	28.61	5000.0	1000.000	401.7	V	192.0
17973.3000	46.85	---	73.90	27.05	5000.0	1000.000	128.4	H	92.0
17973.3000	---	33.46	53.90	20.44	5000.0	1000.000	128.4	H	92.0

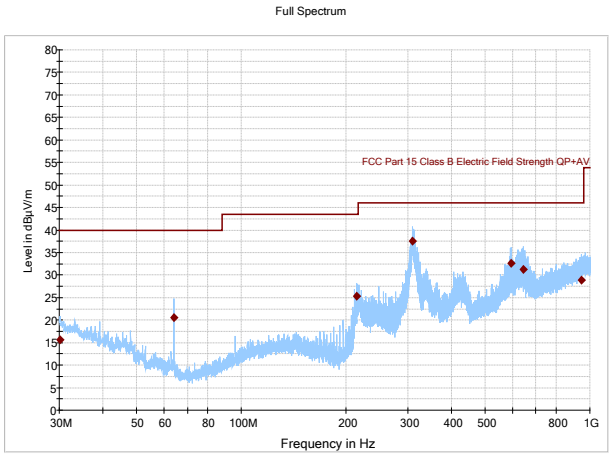

Figure 8.3.13: *Radiated spurious emissions, high channel, 30-1000MHz*

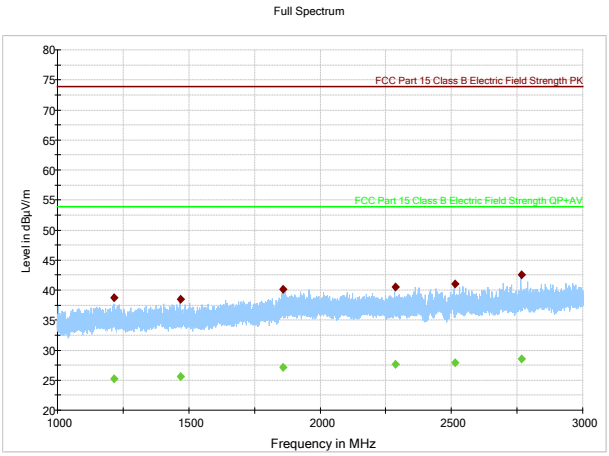

Figure 8.3.14: *Radiated spurious emissions, high channel, 1-3GHz*

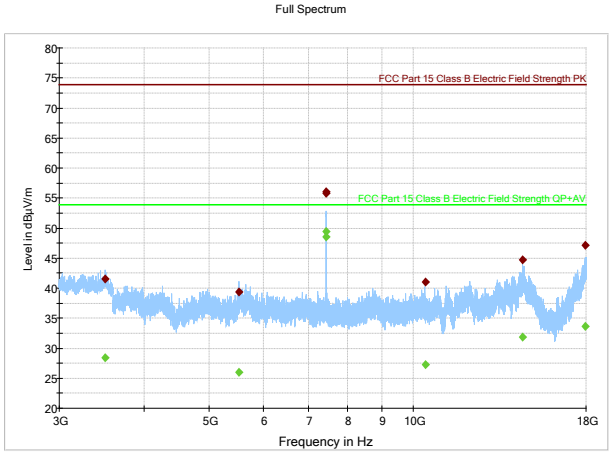

Figure 8.3.15: *Radiated spurious emissions, high channel, 3-18GHz*

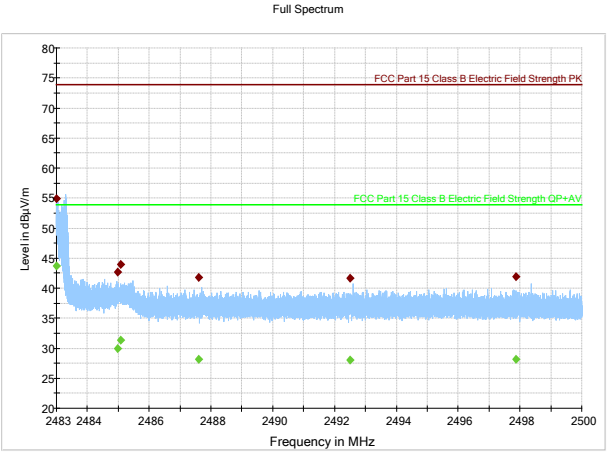

Figure 8.3.16: *Radiated spurious emissions in the 2.4835-2.5GHz Restricted Band, high channel*

Table 8.3-5: *Radiated field strength measurement results for high channel 2480MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
30.120000	15.58	40.00	24.42	5000.0	120.000	289.3	V	0.0
63.990000	20.55	40.00	19.45	5000.0	120.000	126.0	V	325.0
213.903500	25.36	43.50	18.14	5000.0	120.000	143.3	H	86.0
310.393000	37.58	46.00	8.42	5000.0	120.000	110.8	H	263.0
593.013500	32.66	46.00	13.34	5000.0	120.000	125.3	H	72.0
643.543000	31.24	46.00	14.76	5000.0	120.000	113.6	H	101.0
944.455500	28.95	46.00	17.05	5000.0	120.000	365.5	H	222.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1215.46666	38.75	---	73.90	35.15	5000.0	1000.000	245.5	V	124.0
1215.46666	---	25.20	53.90	28.70	5000.0	1000.000	245.5	V	124.0
1468.20000	---	25.64	53.90	28.26	5000.0	1000.000	406.7	H	-1.0
1468.20000	38.52	---	73.90	35.38	5000.0	1000.000	406.7	H	-1.0
1858.06666	---	27.16	53.90	26.74	5000.0	1000.000	405.0	V	222.0
1858.06666	40.19	---	73.90	33.71	5000.0	1000.000	405.0	V	222.0
2287.66666	40.47	---	73.90	33.43	5000.0	1000.000	404.8	V	325.0
2287.66666	---	27.61	53.90	26.29	5000.0	1000.000	404.8	V	325.0
2512.40000	41.00	---	73.90	32.90	5000.0	1000.000	248.3	V	280.0
2512.40000	---	27.94	53.90	25.96	5000.0	1000.000	248.3	V	280.0
2767.06666	42.52	---	73.90	31.38	5000.0	1000.000	404.8	V	222.0
2767.06666	---	28.55	53.90	25.35	5000.0	1000.000	404.8	V	222.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
3504.40000	41.52	---	73.90	32.38	5000.0	1000.000	107.3	H	220.0
3504.40000	---	28.43	53.90	25.47	5000.0	1000.000	107.3	H	220.0
5529.40000	---	26.03	53.90	27.87	5000.0	1000.000	109.1	H	162.0
5529.40000	39.41	---	73.90	34.49	5000.0	1000.000	109.1	H	162.0
7439.30000	---	49.37	53.90	4.53	5000.0	1000.000	100.0	V	294.0
7439.30000	56.11	---	73.90	17.79	5000.0	1000.000	100.0	V	294.0
7440.70000	---	48.50	53.90	5.40	5000.0	1000.000	116.5	V	292.0
7440.70000	55.83	---	73.90	18.07	5000.0	1000.000	116.5	V	292.0
10412.2000	---	27.31	53.90	26.59	5000.0	1000.000	229.3	H	305.0
10412.2000	41.07	---	73.90	32.83	5000.0	1000.000	229.3	H	305.0
14500.9000	44.70	---	73.90	29.20	5000.0	1000.000	410.0	H	353.0
14500.9000	---	31.80	53.90	22.10	5000.0	1000.000	410.0	H	353.0
17969.7000	---	33.66	53.90	20.24	5000.0	1000.000	286.5	V	55.0
17969.7000	47.17	---	73.90	26.74	5000.0	1000.000	286.5	V	55.0

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
2483.00206	54.93	---	73.90	18.97	5000.0	1000.000	114.7	V	64.0
2483.00206	---	43.65	53.90	10.25	5000.0	1000.000	114.7	V	64.0
2484.96840	---	29.97	53.90	23.93	5000.0	1000.000	135.2	V	312.0
2484.96840	42.66	---	73.90	31.24	5000.0	1000.000	135.2	V	312.0
2485.06853	---	31.30	53.90	22.60	5000.0	1000.000	203.5	V	0.0
2485.06853	43.94	---	73.90	29.96	5000.0	1000.000	203.5	V	0.0
2487.59596	41.74	---	73.90	32.16	5000.0	1000.000	402.8	H	154.0
2487.59596	---	28.19	53.90	25.71	5000.0	1000.000	402.8	H	154.0
2492.50386	41.61	---	73.90	32.29	5000.0	1000.000	404.9	V	192.0
2492.50386	---	28.00	53.90	25.90	5000.0	1000.000	404.9	V	192.0
2497.86913	---	28.10	53.90	25.80	5000.0	1000.000	410.0	H	30.0
2497.86913	41.85	---	73.90	32.05	5000.0	1000.000	410.0	H	30.0

8.4 FCC 15.247(e) Power Spectrum Density

8.4.1 Definitions and limits

FCC 15.247:
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.

8.4.2 Test summary

Test date	December 12, 2016	Temperature	20 °C
Test engineer	Nikolay Shtin	Air pressure	1008 mbar
Verdict	Pass	Relative humidity	55 %

8.4.3 Observations, settings and special notes

50kHz RBW

8.4.4 Test data

Table 8.4-1: *Power Spectrum Density*

Modulation	Frequency, MHz	Conducted PSD@50kHz, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
		Measured	Limit					
GFSK	2402	1.25	8	6.75	5.3	6.55	14	7.45
	2440	0.33	8	7.67	5.3	5.63	14	8.37
	2480	0.73	8	5.30	5.3	6.03	14	7.97

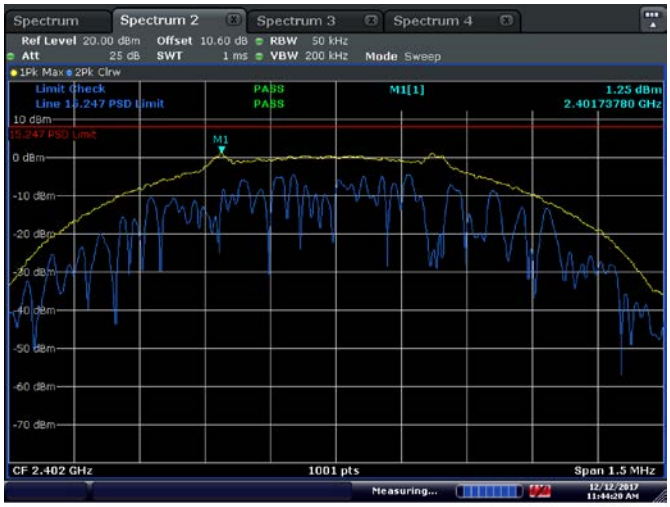

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Figure 8.4-1: *PSD, Low CH*

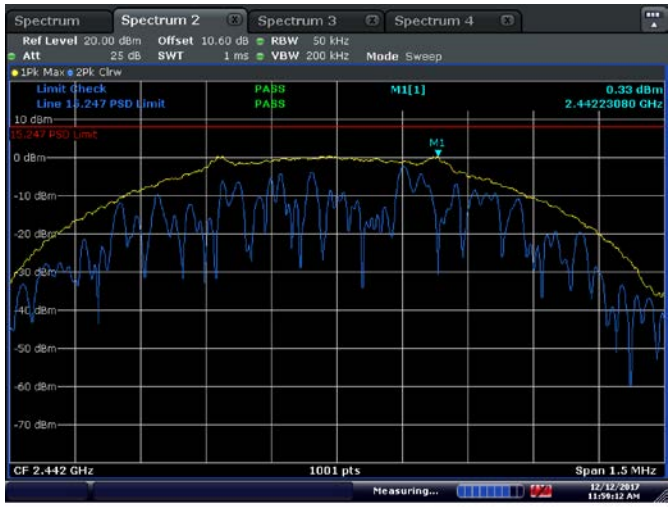

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Figure 8.4-2: *PSD, Mid CH*

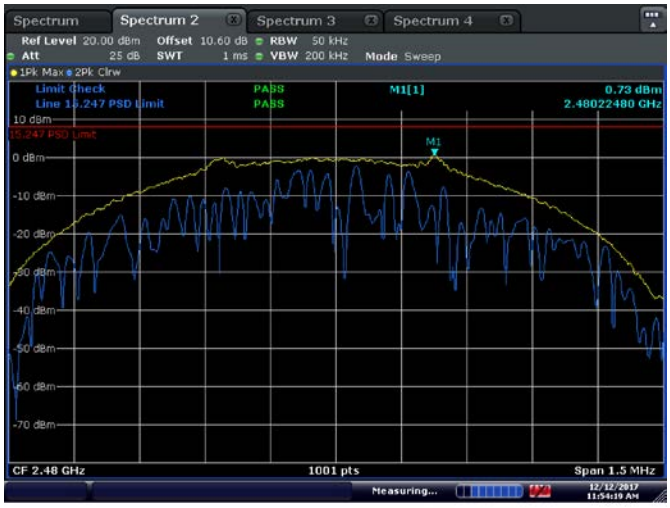

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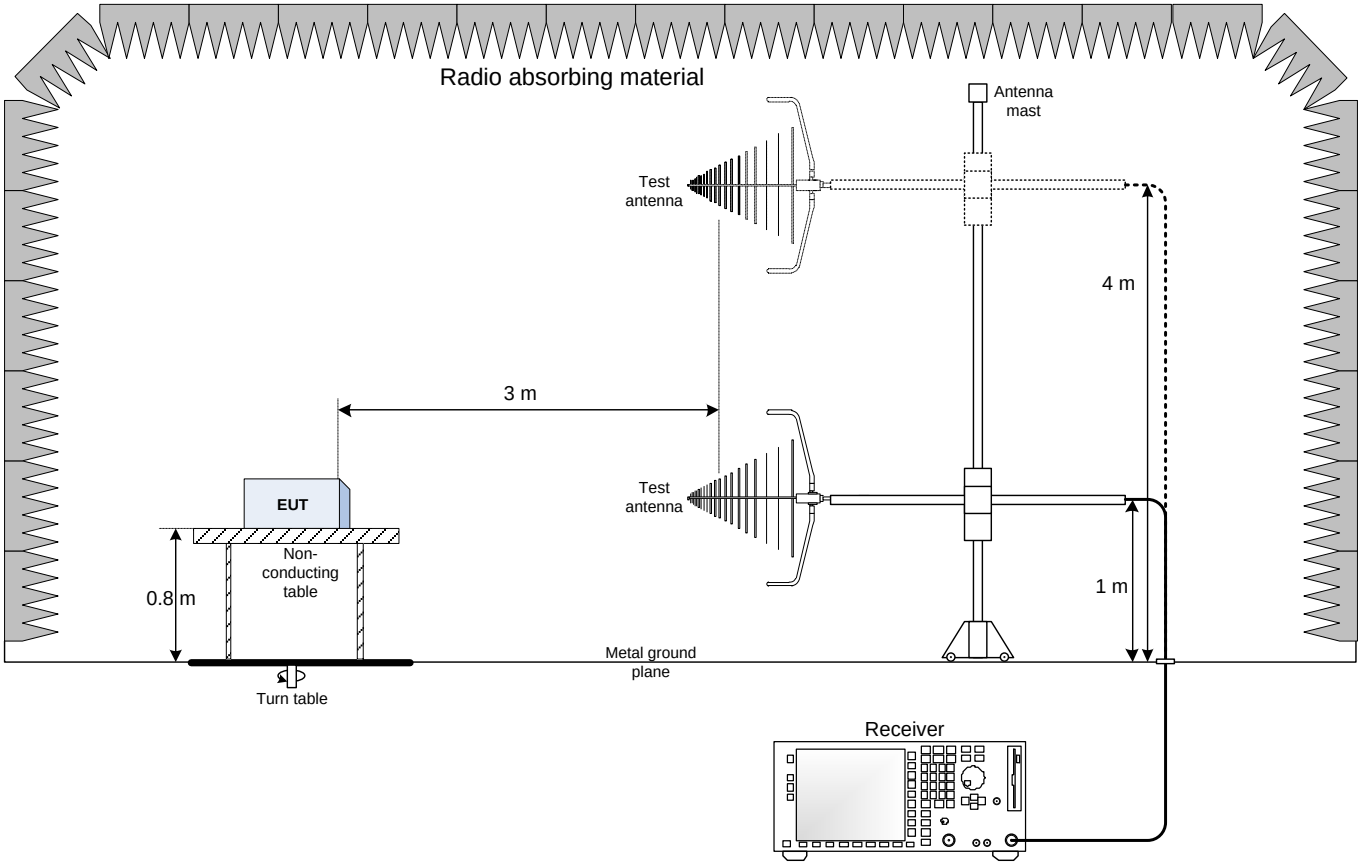
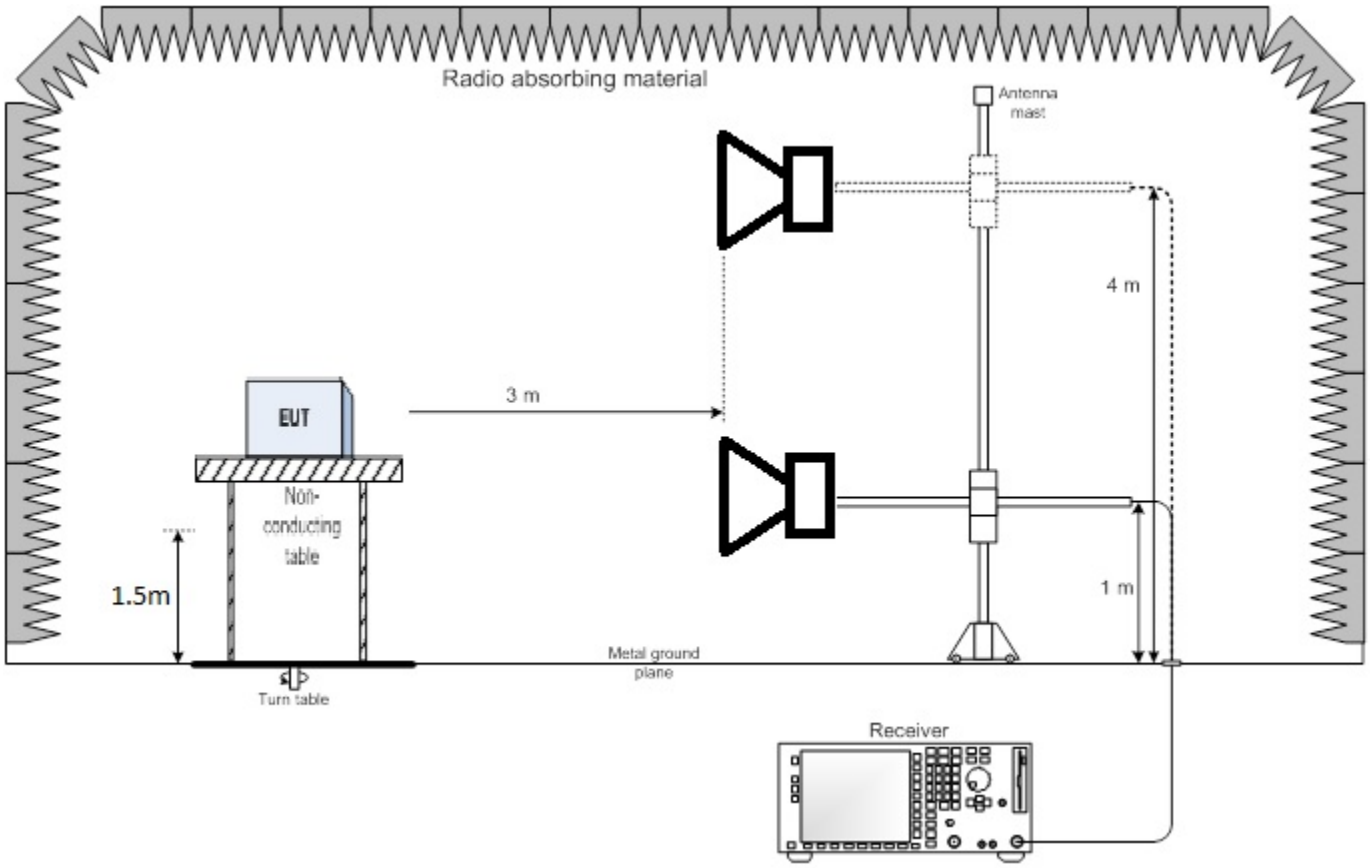
Figure 8.4-3: *PSD, High CH*

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up – Below 1GHz



9.2 Radiated emissions set-up – Above 1GHz