Test report

399868-2TRFWL

Date of issue: June 12, 2020

Applicant:

RecoverX

Product:

RecoverX Contrast Knee

Model:

104-0001

FCC ID: 2AWOM-1040001 IC ID: 26209-1040001

Specifications:

- FCC 47 CFR Part 15, Subpart C – §15.247
- Industry Canada RSS-247, Issue 2

Lab and test locations

Company name	Nemko USA Inc.
Address	2210 Faraday Ave, Suite 150
City	Carlsbad
State	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com
FCC Site Number	Test Firm Registration Number: 392943 Designation Number: US5058
ISED Test Site	2040B-3

Tested by	James Cunningham, Wireless Supervisor
Reviewed by	Juan M Gonzalez, EMC & Wireless Divisions Manager
Review date	June 12, 2020
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.
This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

Copyright notification

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Section 1 Report summary

1.1 Applicant

Company name	RecoverX
Address	3636 Camino Del Rio North
City	Suite 240
Province/State	San Diego
Postal/Zip code	CA
Country	92108

1.2 Manufacturer

Company name	RecoverX
Address	3636 Camino Del Rio North
City	Suite 240
Province/State	San Diego
Postal/Zip code	CA
Country	92108

1.3 Test specifications

FCC 47 CFR Part 15, Subpart C – §15.247 IC RSS-247 Issue 2	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.4 Test methods

ANSI C64.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.5 Exclusions

None

1.6 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed 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.

1.7 Test report revision history

Table 1.7-1: Test report revision history

Revision #	Details of changes made to test report
399868-2TRFWL	Original report issued

Notes:

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
§15.203	Antenna requirement	Pass[1]
§15.205	Restricted bands of operation	Pass

Notes: [1] The EUT uses trace antennas 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

Notes: None

2.4 IC RSS-GEN, Issue 5, test results

Part	Test description	Verdict
7.3	Receiver radiated emission limits	Pass
7.4	Receiver conducted emission limits	Not applicable
8.8	Power Line Conducted Emissions Limits for License-Exempt Radio Apparatus	Pass

Notes: None

2.4 IC RSS-247, Issue 2, test results

Part	Test description	Verdict
5.1 (1)	Bandwidth of a frequency hopping channel	Not applicable
5.1 (2)	Minimum channel spacing for frequency hopping systems	Not applicable
5.1 (3)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.1 (4)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
5.1 (5)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
5.2 (1)	Minimum 6 dB bandwidth	Pass
5.2 (2)	Maximum power spectral density	Pass
5.3 (1)	Digital modulation turned off	Not applicable
5.3 (2)	Frequency hopping turned off	Not applicable
5.4 (1)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.4 (2)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
5.4 (3)	Frequency hopping systems operating in the 5725–5850 MHz	Not applicable
5.4 (4)	Systems employing digital modulation techniques	Pass
5.4 (5)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
5.4 (6)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Not applicable
5.5	Out-of-band emissions	Pass

Notes: None

Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	May 27, 2020
Nemko sample ID number	NEx: 399868

3.2 EUT information

Product name	RecoverX Contrast Knee
Model	104-0001
Serial number	172018000003
Part number	104-0001

3.3 EUT technical information

Frequency band	2400-2483.5 MHz
Minimum frequency (MHz)	2402
Maximum frequency (MHz)	2480
Minimum RF power (W)	N/A
Maximum RF power (W) Conducted	0.00275
Field strength, Units @ distance	N/A
Measured occupied bandwidth (6 dB) (kHz)	689.6
Measured occupied bandwidth (99%) (kHz)	1071
Type of modulation	GFSK
Emission classification (F1D, G1D, D1D)	F1D
Transmitter spurious, Units @ distance	43.54 dBµV/m @ 3m Quasi-Peak
Power requirements	8.4 VDC via AC wall adaptor
Antenna information	Antenna printed onto PCBA. Peak gain is 3.54 dBi. The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

Electric heat and cold therapy knee brace for rehabilitation. Controlled via Bluetooth Low Energy (BLE) connection to smartphone app.

3.5 EUT exercise and monitoring details

For AC mains conducted emissions, the full EUT was tested while powered via its AC adaptor. For radiated emissions and all conducted testing, the PCBA with the Bluetooth Low Energy transmitter was tested with a temporary antenna connector. The PCBA was powered via battery. The BLE transmitter was configured to the required operating modes via test software on a laptop which connected to the PCBA via a debug connector. The laptop was disconnected during all testing.
Software version at time of testing was EngineerX Version 7.3. Which was run from a smartphone app.

Table 3.5-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number	Rev.
None				

Table 3.5-2: EUT interface ports

Description	Qty.
None	

Table 3.5-3: Support equipment

Description	Brand name	Model/Part number	Serial number	Rev.
None				

Table 3.5-4: Inter-connection cables

Cable description	From	To	Length (ft)
None	USB port	Controller laptop	3

3.6 EUT setup diagram

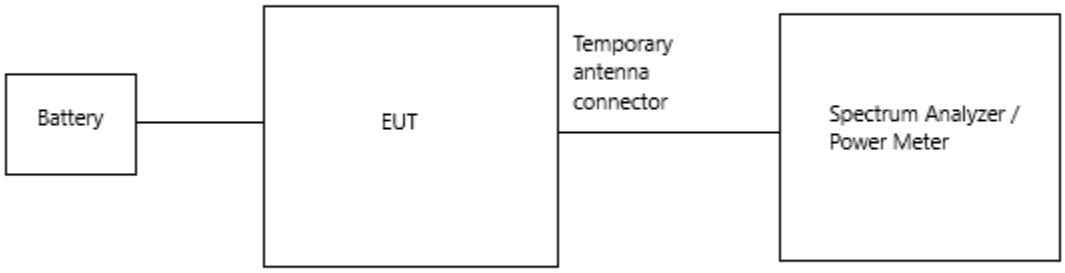


Figure 3.6-1: Test setup – conducted testing

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	86–106 kPa

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

5.2 Power supply range

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

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

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

Test name	Measurement uncertainty, dB
Radiated spurious emissions	3.78
Powerline conducted emissions	1.38
All antenna port measurements	0.55
Conducted spurious emissions	1.13

Section 7 Test equipment

Table 6.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Spectrum analyzer	Rohde & Schwarz	FSW43	E1302	1 year	10 Jan 2021
Signal generator	Rohde & Schwarz	SMW200A	E1157	1 year	10 Oct 2020
20 dB attenuator	Centric RF	C407-20	E1201	*	*
RF power meter	ETS Lindgren	7002-006	E1062	1 year	31 May 2021
EMC Test Receiver	Rohde & Schwarz	ESIB26	1767	18 months	25-Sep-2020
Antenna, Bilog	Schaffner-Chase	CBL 6111D	1763	1 year	18-Feb-2021
DRG Horn	ETS-Lindgren	3117-PA	E1139	2 years	21 Mar 2021
Pre-Amp as part of DRG Horn	ETS-Lindgren	3117-PA	Part of E1139	2 years	21 Mar 2021
System Controller	Sunol Sciences	SC104V	E1191	NCR	NCR
EMI Test Receiver	Rohde & Schwarz	ESCI7	E0126	2 years	29-May-2021
Transient Limiter	Hewlett Packard	11947A	E1159	NCR	NCR
Two Line V-Network	Rohde & Schwarz	ENV216	E1019	1 year	12-Jul-2020
2.4 GHz Notch Filter	Micro-Tonics	HPM50110-01	E1142	VBU	VBU

Notes: NCR – no calibration required
* -Verified with Asset E1302
VBU – verified before use

Section 8 Testing data

8.1 FCC 15.207(a) and IC RSS-GEN, Issue 5 8.8 AC power line conducted emissions

8.1.1 Definitions and limits

FCC 15.207:

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms 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: * - Decreases with the logarithm of the frequency.

8.1.2 Test summary

Test date	May 27, 2020	Temperature	21 °C
Test engineer	James Cunningham	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	62 %

8.1.3 Observations, settings, and special notes

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

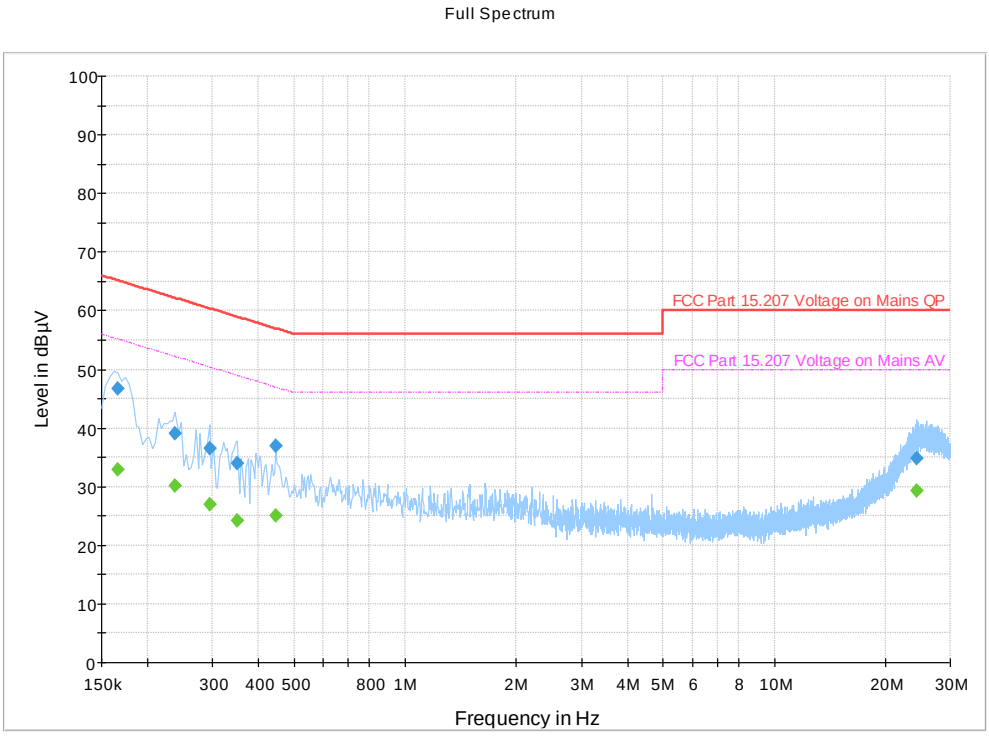
Measurements were performed on the full product with the BLE transmitter operating at full power.

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.
Spectrum analyzer settings:

Receiver settings for AC conducted emissions:

Frequency span:	150 kHz – 30 MHz
Resolution bandwidth:	9 kHz
Video bandwidth:	30 kHz
Detector mode:	Peak (preview mode); Quasi-Peak and Average (final measurements)
Measurement time:	1000 ms

8.1.4 Test data



The spectral plot has been corrected with transducer factors (i.e. cable loss, LISN factors, and transient limiter).

Figure 8.1-1: Conducted disturbance at mains port spectral plot (transmitter full power)

Table 8.1-2: Conducted disturbance at mains port (Quasi-Peak and CAverage) results (transmitter full power)

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.166000	---	32.81	55.16	22.35	5000.0	9.000	N	ON	19.6
0.166000	46.74	---	65.16	18.42	5000.0	9.000	N	ON	19.6
0.238000	39.01	---	62.17	23.15	5000.0	9.000	L1	ON	19.5
0.238000	---	30.14	52.17	22.03	5000.0	9.000	L1	ON	19.5
0.294000	---	27.01	50.41	23.40	5000.0	9.000	L1	ON	19.5
0.294000	36.52	---	60.41	23.89	5000.0	9.000	L1	ON	19.5
0.350000	---	24.15	48.96	24.81	5000.0	9.000	N	ON	19.4
0.350000	33.92	---	58.96	25.05	5000.0	9.000	N	ON	19.4
0.446000	---	25.06	46.95	21.89	5000.0	9.000	N	ON	19.4
0.446000	36.89	---	56.95	20.06	5000.0	9.000	N	ON	19.4
24.402000	34.81	---	60.00	25.19	5000.0	9.000	L1	ON	20.0
24.402000	---	29.35	50.00	20.65	5000.0	9.000	L1	ON	20.0

Notes: [1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.

8.2 FCC 15.247(a)(2) minimum 6 dB bandwidth

8.2.1 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.

ISED RSS-247:
5.2 Digital transmission systems
DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz:

a. The minimum 6 dB bandwidth shall be 500 kHz.

ISED RSS-GEN:
6.7 Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth
The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

8.2.2 Test summary

Test date	May 27, 2020	Temperature	21 °C
Test engineer	James Cunningham	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	62 %

8.2.3 Observations, settings, and special notes

Spectrum analyzer settings:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz (≥3 × RBW)
Frequency span	4 MHz
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: 6 dB bandwidth results

Modulation	Frequency, MHz	6dB bandwidth, kHz	Limit, kHz	Margin, kHz
GFSK	2402	686.48	500	186.48
	2440	685.10	500	185.10
	2480	689.60	500	189.60

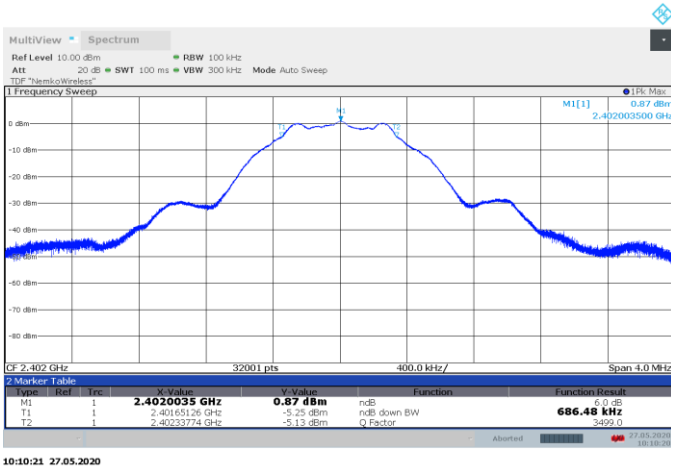


Figure 8.2-1: 6 dB bandwidth, LOW channel

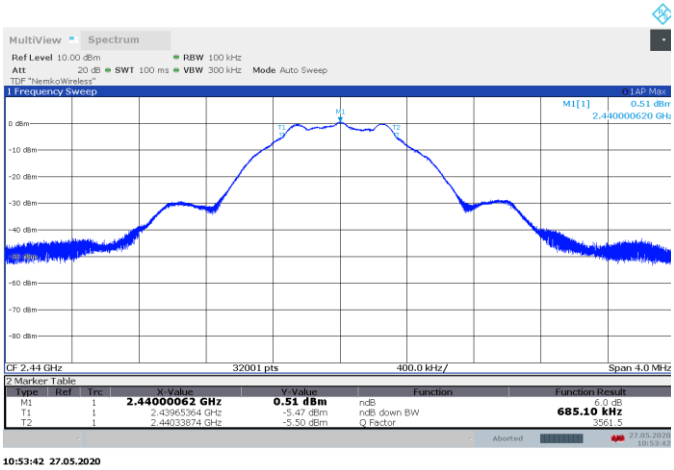


Figure 8.2-2: 6 dB bandwidth, MID channel

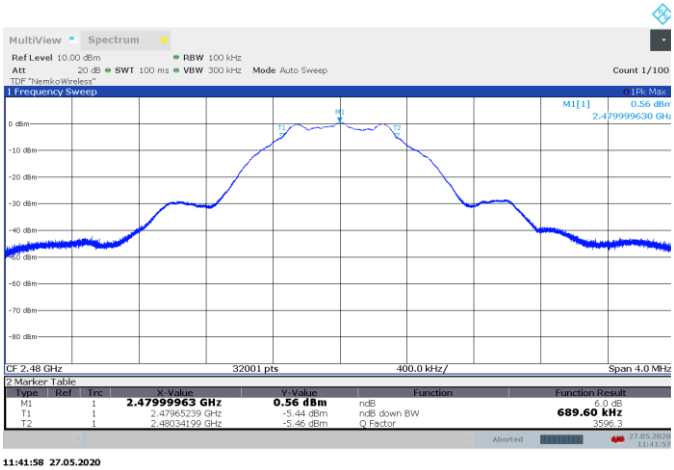


Figure 8.2-3: 6 dB bandwidth, HIGH channel

Table 8.2-2: 99% bandwidth results

Modulation	Frequency, MHz	99% bandwidth, MHz
GFSK	2402	1.062
	2440	1.066
	2480	1.071

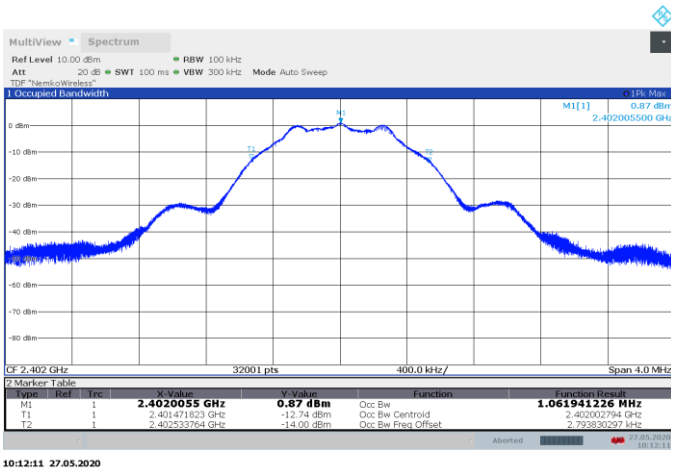


Figure 8.2-4: 99% bandwidth, LOW channel

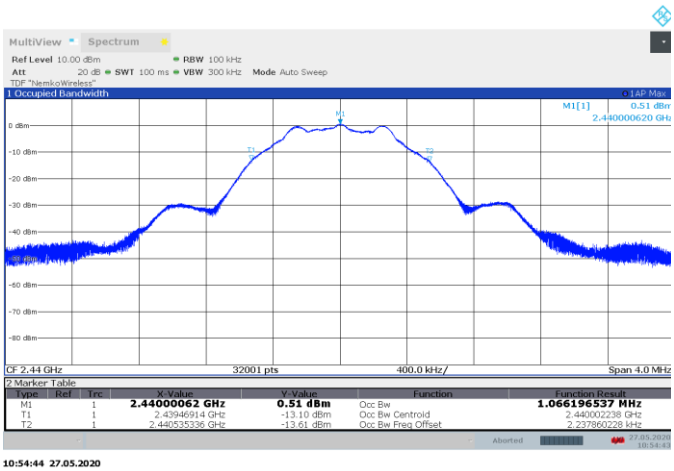


Figure 8.2-5: 99% bandwidth, MID channel

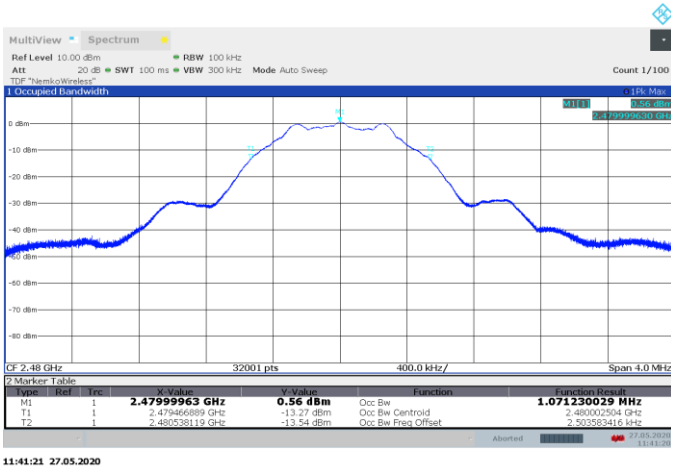


Figure 8.2-6: 99% bandwidth, HIGH channel

8.3 FCC 15.247(b) transmitter output power and e.i.r.p. requirements

8.3.1 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.

8.3.2 Test summary

Test date	May 27, 2020	Temperature	21 °C
Test engineer	James Cunningham	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	62 %

8.3.3 Observations, settings, and special notes

The RF power meter was directly connected to the temporary antenna connector of the EUT. The declared antenna gain was input as a correction factor.

8.3.4 Test data

Table 8.3-1: Peak output power results

Modulation	Frequency (MHz)	Conducted output power			Maximum Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		Measured (dBm)	Limit (dBm)	Margin (dB)				
GFSK	2402	0.85	30	29.15	3.54	4.39	36	PASS
	2440	0.70	30	29.3	3.54	4.24	36	PASS
	2480	0.50	30	30.5	3.54	4.04	36	PASS

8.4 FCC 15.247(d) spurious out-of-band emissions

8.4.1 Definitions and limits

FCC 15.247:

(d) 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 µV/m	Field strength of emissions dBµV/m	Measurement distance, 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			

8.4.2 Test summary

Test date	May 27, 2020	Temperature	21 °C
Test engineer	James Cunningham	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	62 %

8.4.3 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.

Spectrum analyzer settings for conducted (band-edge) spurious measurements:

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

Spectrum analyzer settings for radiated spurious measurements < 1 GHz:

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

Spectrum analyzer settings for radiated spurious measurements > 1 GHz:

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

8.4.4 Test data

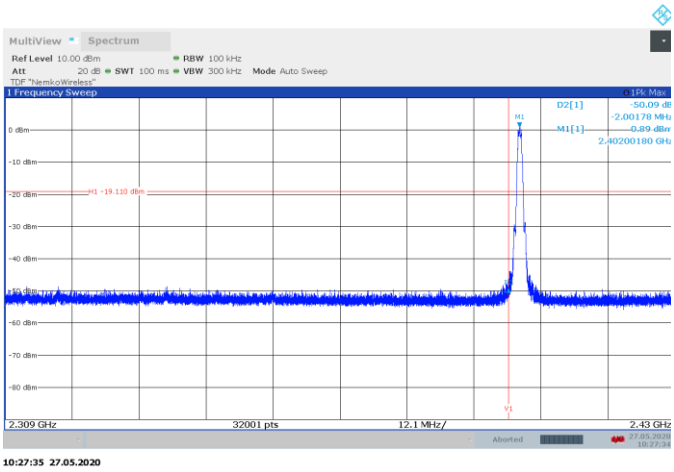


Figure 8.4-1: Band-edge, LOW channel

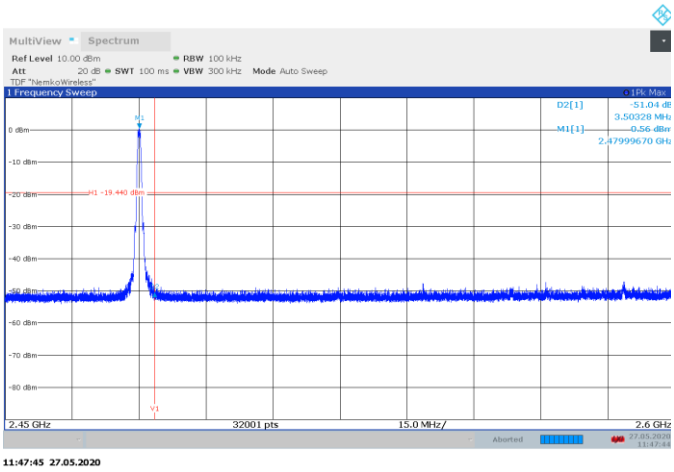


Figure 8.4-2: Band edge, MID channel

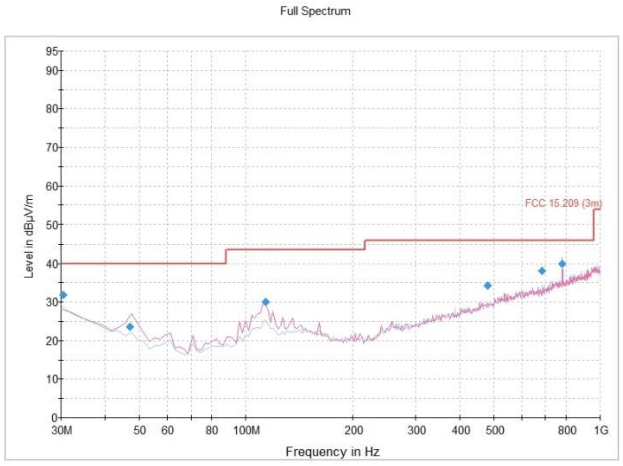


Figure 8.4-3: Radiated spurious emissions, 30-1000 MHz, LOW channel

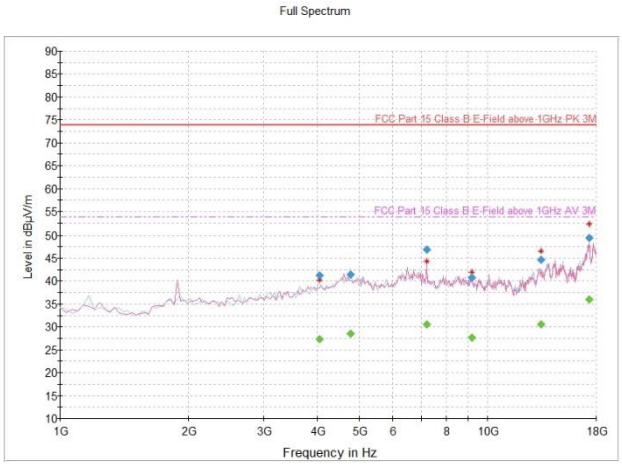


Figure 8.4-4: Radiated spurious emissions, 1-18 GHz, LOW channel

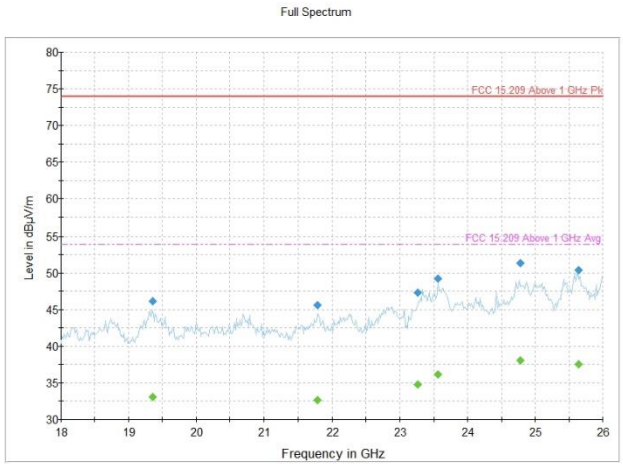


Figure 8.4-5: Radiated spurious emissions, 18-26 GHz, LOW channel

Radiated Emissions Notes:

[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB) − amplifier gain (dB)
[3] The maximum measured value observed over a period of 3 seconds was recorded.

Table 8.4-3: 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)	Corr. (dB/m)
30.520000	31.89	40.00	8.11	3000.0	120.000	108.0	H	351.0	26.2
47.134990	23.53	40.00	16.47	3000.0	120.000	372.0	V	38.0	17.2
113.627174	29.98	43.50	13.52	3000.0	120.000	370.0	V	166.0	18.8
480.781964	34.33	46.00	11.67	3000.0	120.000	108.0	V	0.0	26.3
685.570180	38.14	46.00	7.86	3000.0	120.000	407.0	H	260.0	29.6
781.964569	39.94	46.00	6.06	3000.0	120.000	258.0	V	300.0	31.1

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4034.464128	41.17	---	73.90	32.73	3000.0	1000.000	303.0	H	40.0	-4.4
4034.464128	---	27.38	53.90	26.52	3000.0	1000.000	303.0	H	40.0	-4.4
4781.163126	---	28.53	53.90	25.37	3000.0	1000.000	265.0	H	109.0	-2.6
4781.163126	41.48	---	73.90	32.42	3000.0	1000.000	265.0	H	109.0	-2.6
7206.400802	---	30.51	53.90	23.39	3000.0	1000.000	111.0	V	122.0	-1.0
7206.400802	46.85	---	73.90	27.05	3000.0	1000.000	111.0	V	122.0	-1.0
9210.020842	40.68	---	73.90	33.22	3000.0	1000.000	369.0	V	-1.0	1.8
9210.020842	---	27.61	53.90	26.29	3000.0	1000.000	369.0	V	-1.0	1.8
13374.333467	44.57	---	73.90	29.33	3000.0	1000.000	405.0	H	201.0	7.5
13374.333467	---	30.63	53.90	23.27	3000.0	1000.000	405.0	H	201.0	7.5
17351.505411	49.32	---	73.90	24.58	3000.0	1000.000	159.0	H	60.0	12.1
17351.505411	---	35.94	53.90	17.96	3000.0	1000.000	159.0	H	60.0	12.1

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19354.493387	---	33.07	53.90	20.83	3000.0	1000.000	218.0	H	0.0	15.0
19354.493387	46.13	---	73.90	27.77	3000.0	1000.000	218.0	H	0.0	15.0
21784.167134	45.63	---	73.90	28.27	3000.0	1000.000	143.0	H	36.0	16.2
21784.167134	---	32.67	53.90	21.23	3000.0	1000.000	143.0	H	36.0	16.2
23268.349098	---	34.79	53.90	19.11	3000.0	1000.000	235.0	V	0.0	18.5
23268.349098	47.31	---	73.90	26.59	3000.0	1000.000	235.0	V	0.0	18.5
23558.526252	---	36.14	53.90	17.76	3000.0	1000.000	286.0	H	116.0	20.6
23558.526252	49.26	---	73.90	24.64	3000.0	1000.000	286.0	H	116.0	20.6
24776.931062	---	38.10	53.90	15.80	3000.0	1000.000	398.0	V	166.0	18.4
24776.931062	51.30	---	73.90	22.60	3000.0	1000.000	398.0	V	166.0	18.4
25642.662525	50.43	---	73.90	23.47	3000.0	1000.000	374.0	H	113.0	19.3
25642.662525	---	37.55	53.90	16.35	3000.0	1000.000	374.0	H	113.0	19.3

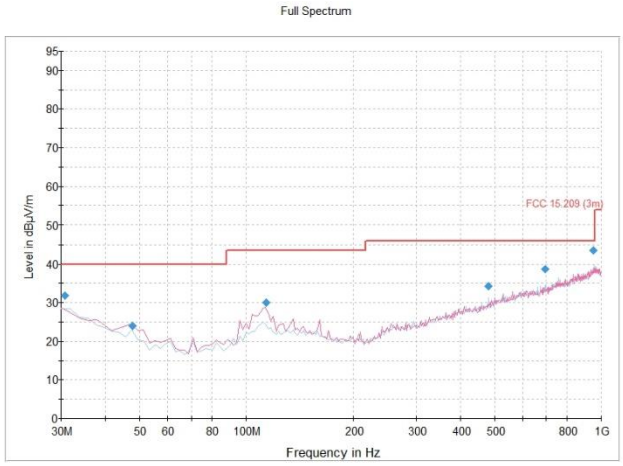


Figure 8.4-6: Radiated spurious emissions, 30-1000 MHz, MID channel

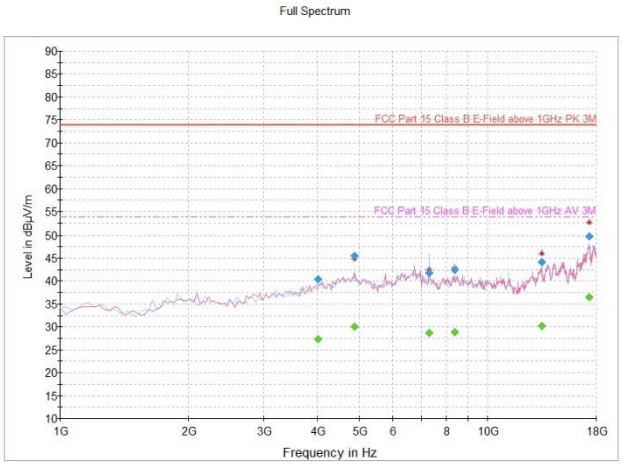


Figure 8.4-7: Radiated spurious emissions, 1-18 GHz, MID channel

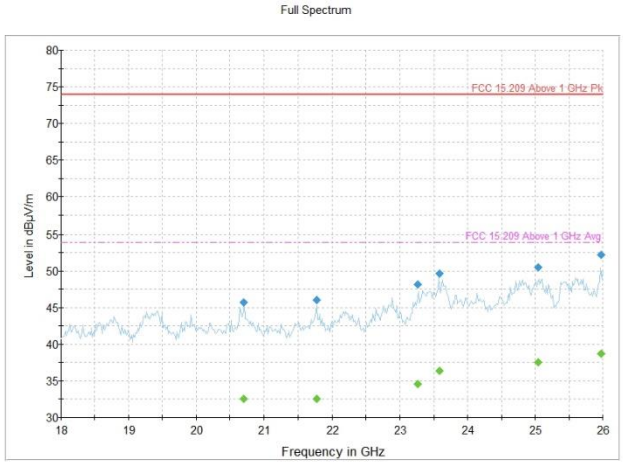


Figure 8.4-8: Radiated spurious emissions, 18-26 GHz, MID channel

Table 8.4-4: Radiated field strength measurement results for mid channel 2440 MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.760000	31.82	40.00	8.18	3000.0	120.000	125.0	V	160.0	26.0
47.654990	23.95	40.00	16.05	3000.0	120.000	110.0	V	269.0	16.9
113.627174	30.10	43.50	13.40	3000.0	120.000	385.0	V	104.0	18.8
481.421964	34.32	46.00	11.68	3000.0	120.000	172.0	H	147.0	26.3
696.353507	38.72	46.00	7.28	3000.0	120.000	398.0	H	146.0	30.1
952.866693	43.53	46.00	2.47	3000.0	120.000	325.0	H	46.0	34.0

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4000.795992	40.41	---	73.90	33.49	3000.0	1000.000	290.0	H	241.0	-4.6
4000.795992	---	27.40	53.90	26.50	3000.0	1000.000	290.0	H	241.0	-4.6
4879.367535	---	30.05	53.90	23.85	3000.0	1000.000	111.0	V	237.0	-2.7
4879.367535	45.50	---	73.90	28.40	3000.0	1000.000	111.0	V	237.0	-2.7
7308.205210	---	28.70	53.90	25.20	3000.0	1000.000	289.0	H	84.0	-0.7
7308.205210	41.84	---	73.90	32.06	3000.0	1000.000	289.0	H	84.0	-0.7
8400.785571	---	28.77	53.90	25.13	3000.0	1000.000	163.0	V	108.0	1.0
8400.785571	42.39	---	73.90	31.51	3000.0	1000.000	163.0	V	108.0	1.0
13400.001603	---	30.28	53.90	23.62	3000.0	1000.000	313.0	V	44.0	7.5
13400.001603	44.11	---	73.90	29.79	3000.0	1000.000	313.0	V	44.0	7.5
17312.237274	49.74	---	73.90	24.16	3000.0	1000.000	317.0	H	330.0	12.6
17312.237274	---	36.45	53.90	17.45	3000.0	1000.000	317.0	H	330.0	12.6

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
20701.218838	45.73	---	73.90	28.17	3000.0	1000.000	167.0	H	142.0	16.0
20701.218838	---	32.52	53.90	21.38	3000.0	1000.000	167.0	H	142.0	16.0
21767.735070	---	32.55	53.90	21.35	3000.0	1000.000	306.0	V	91.0	16.3
21767.735070	45.98	---	73.90	27.92	3000.0	1000.000	306.0	V	91.0	16.3
23266.749098	---	34.53	53.90	19.37	3000.0	1000.000	407.0	H	194.0	18.5
23266.749098	48.19	---	73.90	25.71	3000.0	1000.000	407.0	H	194.0	18.5
23581.358317	---	36.42	53.90	17.48	3000.0	1000.000	101.0	V	182.0	20.6
23581.358317	49.66	---	73.90	24.24	3000.0	1000.000	101.0	V	182.0	20.6
25041.908216	50.48	---	73.90	23.42	3000.0	1000.000	289.0	V	264.0	19.1
25041.908216	---	37.49	53.90	16.41	3000.0	1000.000	289.0	V	264.0	19.1
25973.735872	---	38.67	53.90	15.23	3000.0	1000.000	245.0	V	215.0	20.4
25973.735872	52.21	---	73.90	21.69	3000.0	1000.000	245.0	V	215.0	20.4

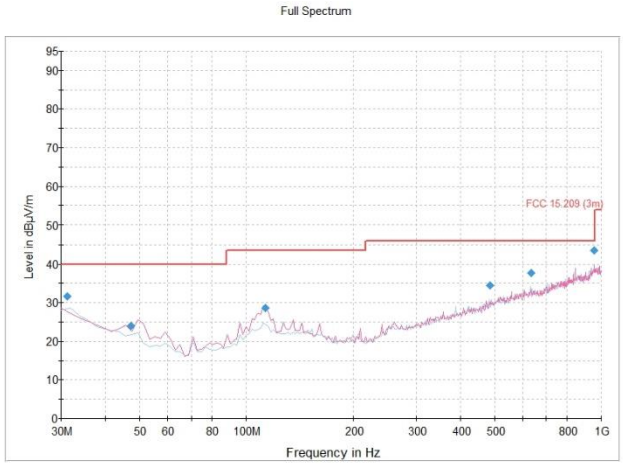


Figure 8.4-9: Radiated spurious emissions, 30-1000 MHz, HIGH channel

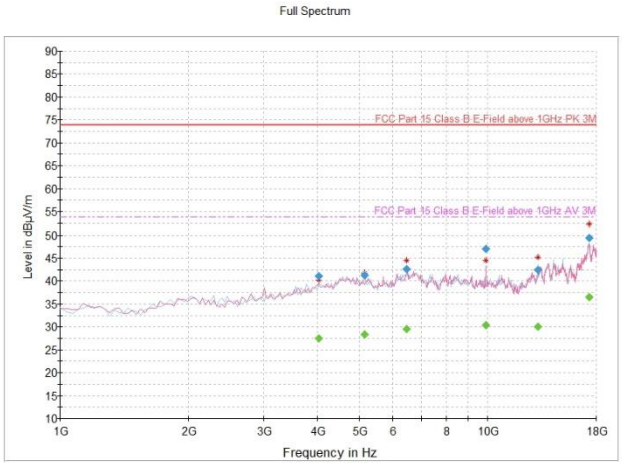


Figure 8.4-10: Radiated spurious emissions, 1-18 GHz, HIGH channel

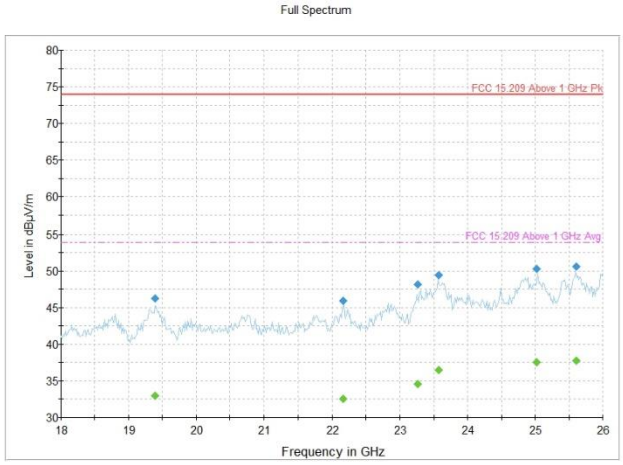


Figure 8.4-11: Radiated spurious emissions, 18-26 GHz, HIGH channel

Table 8.4-5: Radiated field strength measurement results for high channel 2480 MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.223888	31.62	40.00	8.38	3000.0	120.000	204.0	H	133.0	25.7
47.238878	24.08	40.00	15.92	3000.0	120.000	115.0	V	232.0	17.1
113.123287	28.69	43.50	14.81	3000.0	120.000	399.0	V	130.0	18.8
484.405852	34.49	46.00	11.51	3000.0	120.000	247.0	H	119.0	26.4
634.005210	37.71	46.00	8.29	3000.0	120.000	231.0	H	66.0	29.2
956.314469	43.54	46.00	2.46	3000.0	120.000	122.0	V	92.0	34.1

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
4027.264128	---	27.49	53.90	26.41	3000.0	1000.000	197.0	H	268.0	-4.4
4027.264128	41.13	---	73.90	32.77	3000.0	1000.000	197.0	H	268.0	-4.4
5157.512625	---	28.27	53.90	25.63	3000.0	1000.000	236.0	H	80.0	-3.0
5157.512625	41.33	---	73.90	32.57	3000.0	1000.000	236.0	H	80.0	-3.0
6479.769940	42.59	---	73.90	31.31	3000.0	1000.000	101.0	V	216.0	-0.7
6479.769940	---	29.61	53.90	24.29	3000.0	1000.000	101.0	V	216.0	-0.7
9919.051703	---	30.39	53.90	23.51	3000.0	1000.000	101.0	V	121.0	2.0
9919.051703	47.05	---	73.90	26.85	3000.0	1000.000	101.0	V	121.0	2.0
13132.656513	---	30.01	53.90	23.89	3000.0	1000.000	188.0	H	46.0	6.5
13132.656513	42.47	---	73.90	31.43	3000.0	1000.000	188.0	H	46.0	6.5
17313.837274	49.47	---	73.90	24.43	3000.0	1000.000	266.0	V	21.0	12.5
17313.837274	---	36.53	53.90	17.37	3000.0	1000.000	266.0	V	21.0	12.5

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19389.789579	46.27	---	73.90	27.63	3000.0	1000.000	133.0	V	44.0	14.9
19389.789579	---	32.93	53.90	20.97	3000.0	1000.000	133.0	V	44.0	14.9
22163.336673	45.92	---	73.90	27.98	3000.0	1000.000	150.0	H	276.0	15.9
22163.336673	---	32.56	53.90	21.34	3000.0	1000.000	150.0	H	276.0	15.9
23266.717034	48.19	---	73.90	25.71	3000.0	1000.000	297.0	H	276.0	18.5
23266.717034	---	34.53	53.90	19.37	3000.0	1000.000	297.0	H	276.0	18.5
23570.126252	49.44	---	73.90	24.46	3000.0	1000.000	389.0	V	247.0	20.7
23570.126252	---	36.46	53.90	17.44	3000.0	1000.000	389.0	V	247.0	20.7
25023.476152	50.23	---	73.90	23.67	3000.0	1000.000	157.0	V	12.0	19.1
25023.476152	---	37.52	53.90	16.38	3000.0	1000.000	157.0	V	12.0	19.1
25609.398397	50.59	---	73.90	23.31	3000.0	1000.000	147.0	V	182.0	19.3
25609.398397	---	37.72	53.90	16.18	3000.0	1000.000	147.0	V	182.0	19.3

8.5 FCC 15.247(e) power spectrum density

8.5.1 Definitions and limits

FCC 15.247:

(e) 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.

8.5.2 Test summary

Test date	May 27, 2020	Temperature	21 °C
Test engineer	James Cunningham	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	62 %

8.5.3 Observations, settings, and special notes

The test was performed as per ANSI C63.10 §11.10.2 (Method PKPSD).

8.5.4 Test data

Table 8.5-1: power spectral density results

Modulation	Frequency (MHz)	Conducted power spectral density			Maximum Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Result
		Measured	Limit	Margin (dB)				
GFSK	2402	0.88	8	7.12	3.54	4.42	14	Pass
	2440	0.53	8	7.47	3.54	4.07	14	Pass
	2480	0.56	8	7.44	3.54	4.1	14	Pass

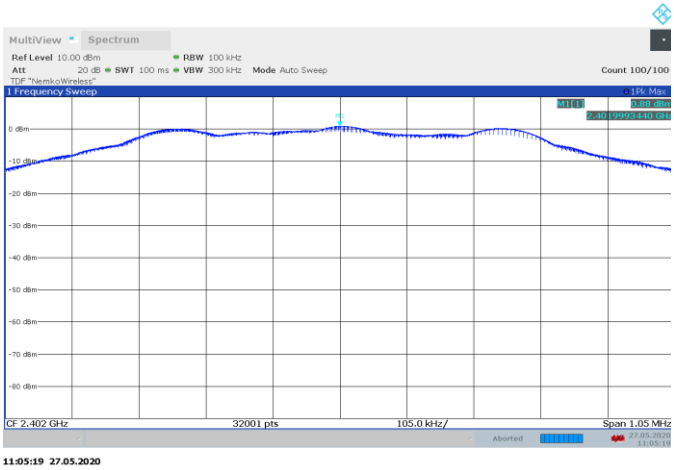


Figure 8.5-1: Power spectral density, LOW channel

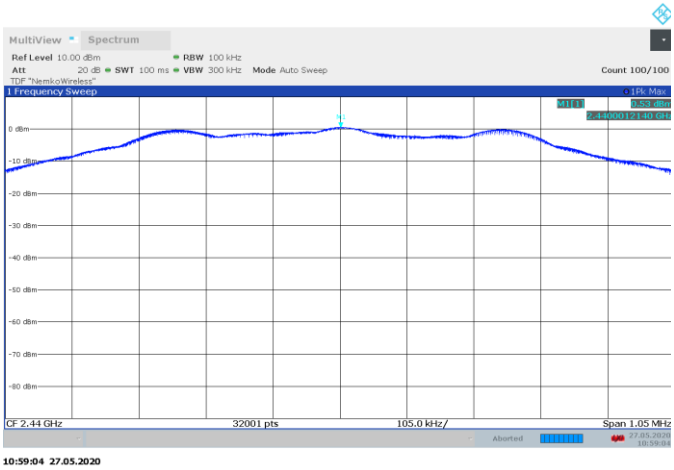


Figure 8.5-2: Power spectral density, MID channel

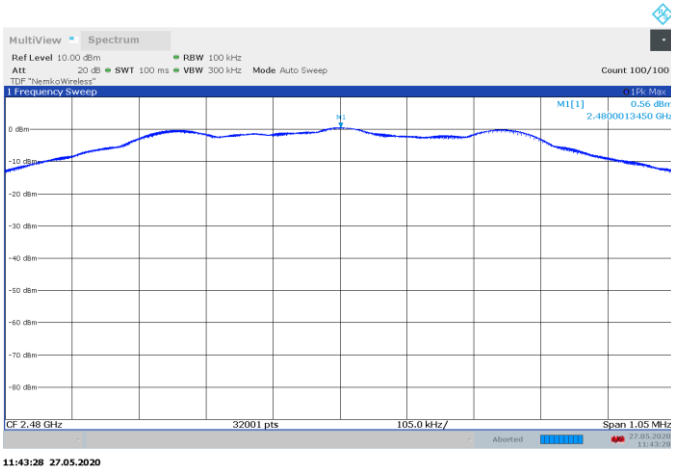


Figure 8.5-3: Power spectral density, HIGH channel

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up

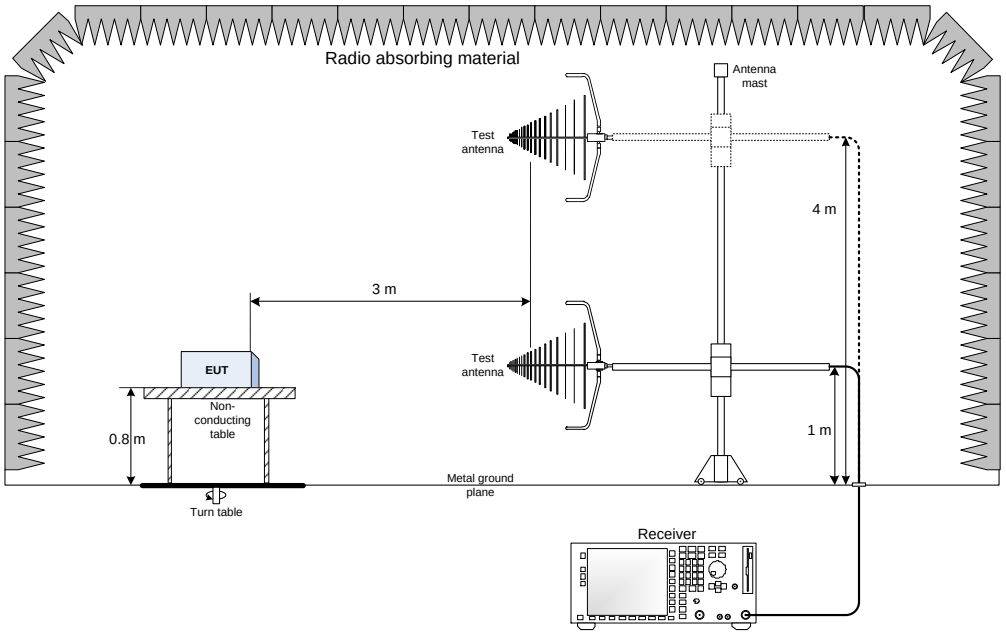


Figure 9.1-1 30 MHz - 1000 MHz Setup

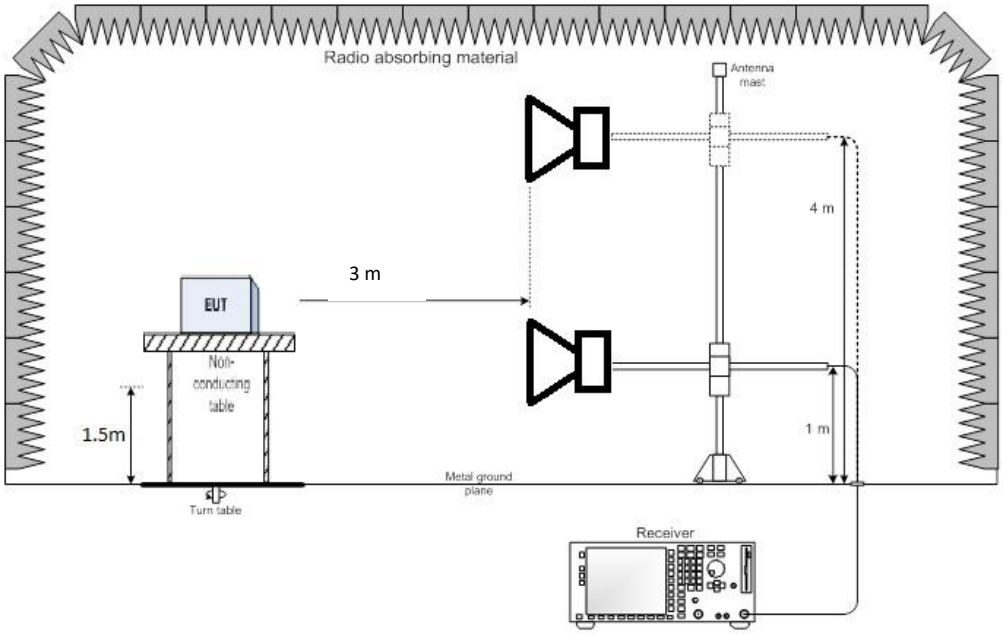


Figure 9.1-2 1 GHz - 26 GHz Setup

Thank you for choosing