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Test report

408117-4TRFWL

Date of issue: April 6, 2021

Applicant:

Clear-Com LLC

Product:

Arcadia Main Station

Model:

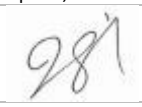
1410

Specifications:

- FCC 47 CFR Part 15, Subpart C – §15.247
  Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, 5727 – 5850 MHz
- Industry Canada RSS-247, Issue 2
  Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

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	David Hewitt, EMC Specialist
Reviewed by	James Cunningham, EMC/MIL/WL Supervisor
Review date	April 6, 2021
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	Clear-Com LLC
Address	1301 Marina Village Parkway Suite 105
City	Alameda
Province/State	CA
Postal/Zip code	94501
Country	USA

1.2 Manufacturer

Company name	Clear-Com LLC
Address	1301 Marina Village Parkway Suite 105
City	Alameda
Province/State	CA
Postal/Zip code	94501
Country	USA

1.3 Test specifications

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

1.4 Test methods

ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
558074 D01 DTS Measurement Guidance v03r02 (June 5, 2014)	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

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 Choose an item. 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
408117-4TRFWL	Original report issued

Notes:

Section 2 Summary of test results

2.1 FCC Part 15 Subpart C, general requirements

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31(e)	Variation of power source	Pass
§15.203	Antenna requirement	Pass

Notes: EUT is AC powered
The antenna is located within the protective cover of EUT on PCB

2.2 FCC Part 15.247

Part	Test description	Verdict
§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(b)(4)	Transmitting antennas of directional gain greater than 6 dBi	Not applicable
§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

2.3 IC RSS-247, Issue 2

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

2.4 IC RSS-GEN, Issue 5

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

Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	October 14, 2020
Nemko sample ID number	NEx: 408177

3.2 EUT information

Product name	Arcadia Main Station
Model	1410
Serial number	F35ZC050 F34ZC037
Part number	No Part Number

3.3 Technical information

Used IC test site(s) reg. number	2040A
RSS number and issue	RSS-247 issue 2 (February 2017)
Frequency band	2400 – 2483.5 MHz
Minimum frequency (MHz)	2402
Maximum frequency (MHz)	2480
Minimum output power (dBm)	8.41 dBm (e.i.r.p.)
Maximum output power (dBm)	9.50 dBm (e.i.r.p.)
Measured 6 dB bandwidth	2402 MHz: 695.30 kHz 2440 MHz: 691.30 kHz 2480 MHz: 691.30 kHz
Type of modulation	GFSK
Emission classification	F1D
Power requirements	100-240 V_{AC}; 50 / 60 Hz
Antenna information	3 dBi gain antenna on PCB

3.4 EUT exercise and monitoring details

The EUT was controlled via test software and commanded to transmit at full power on the required frequencies. Measurements were taken with EUT set to transmit in its one modulation scheme.

Table 3.4-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number	Rev.
Arcadia Main Station	Clear-Com	1410	F35ZC050 F34ZC037	-- --
AC/DC Adapter	eUrasia Power	uA161-1012-1 ATS160T-P120	--	--

Table 3.4-2: *EUT interface ports*

Description	Qty.
Ethernet	14
3-pin XLR	4
4-pin XLR	1
9-pin GPIO	2
USB	1
Fiber optic	4
½ in TRS (Mic-In)	1

Table 3.4-3: *Support equipment*

Description	Brand name	Model/Part number	Serial number	Rev.
Headset (x5)	Clear-Com	CC-300	--	--
Beltpack 1	Clear-Com	RS-703	42VC0222	B
Beltpack (x3)	Clear-Com	RS-701	P19RC007 24YC2522 24YC2523	A E E
Ethernet switch (ethernet termination point only)	Trendnet	TE100-S5/A	RA1321S506515	2.0R
Support Laptop	Lenovo	Yoga 2 Pro	YE08387738	--
Support Laptop	ASUS	Q301L	E2N0CX587859094	--

Table 3.4-4: *Inter-connection cables*

Cable description	From	To	Length (m)
Ethernet	EUT	Ethernet Switch	3
3-pin XLR	EUT	Beltpack	3
4-pin XLR	EUT	Headset	1

3.5 EUT setup diagram

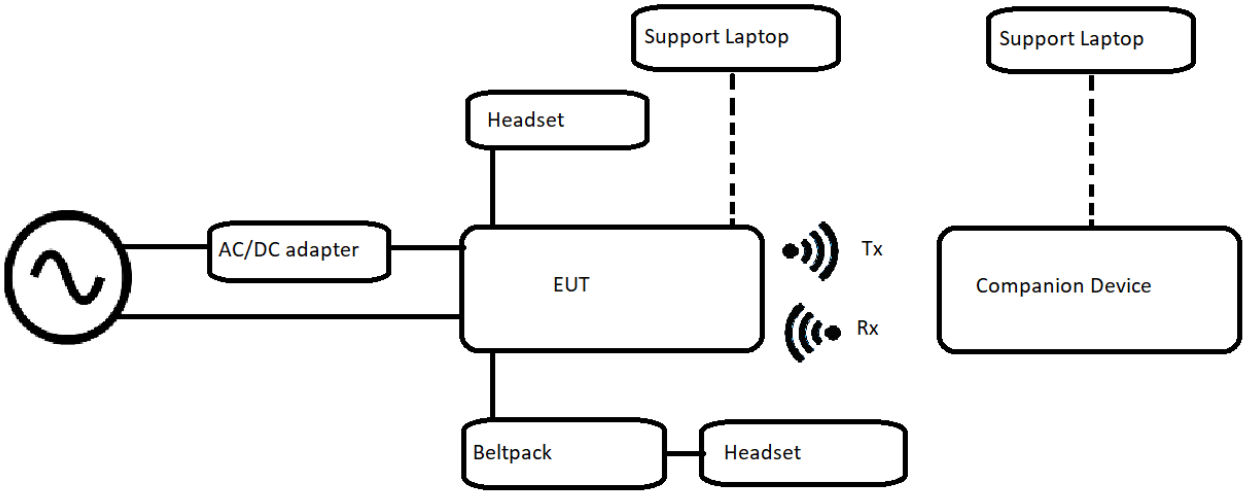

Figure 3.5-1: *Setup diagram*

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: *Test Equipment List*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Test Receiver	Rohde & Schwarz	ESCI 7	E1026	2 yr	29 May 2021
Transient Limiter	Hewlett-Packard	11947A	681	1 yr	20 Jan 2021
Two Line V-Network	Rohde & Schwarz	ENV216	E1019	1 yr	4 Aug 2021
LISN	Solar	9348-50-R-24-BNC	384	1 yr	17 Aug 2021
Signal and spectrum analyzer	Rohde & Schwarz	FSW 43	E1302	1 yr	18 Sep 2021
Power sensor	ETS Lindgren	7002-006	E1062	1 yr	14 Oct 2021
EMI Test Receiver	Rohde & Schwarz	ESU40	E1121	1 yr	1 Dec 2021
System Controller	Sunol Sciences	SC104V	E1129	NCR	NCR
Bilog Antenna (30-1000 MHz)	Schaffner	CBL6111C	1480	1 yr	28 Oct 2021
DRG Horn antenna (1-18 GHz)	ETS-Lindgren	3117-PA	E1139	2 yr	21 Mar 2021
2.4 GHz notch filter	Micro-Tonics	HPM50110-01	E1142	NCR	NCR
Horn antenna (18-26 GHz)	Sage Millimeter, Inc.	SAR-2309-42-S2	E1143	2 yr	13 Nov 2022
System controller	Sunol Sciences	SC104V	E1191	NCR	NCR
Low Noise Amplifier	Sage Millimeter, Inc.	SBL-1834034030-KFKF	E1228	VOU	VOU
Variac	Shanghai China	TDGC	S1043	NCR	NCR
Multimeter	Fluke	175	4041	1 yr	4 Sep 2021

Notes: NCR - no calibration required
VOU - verify on use

Table 6.1-2: *Test Software*

Manufacturer of Software	Details
Rohde & Schwarz	EMC 32 V10.60.10 (AC conducted emissions)
Rohde & Schwarz	EMC 32 V10.60.15 (radiated emissions, 3m chamber)
	EMC 32 V10.00.00 (radiated emissions, 10m chamber)

Notes: None

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 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.207(a)
RSS-Gen → §8.8

For Low-power radio-frequency devices that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Ω line impedance stabilization network (LISN). 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

Verdict	Pass		
Test date	January 20, 2021	Temperature	23 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1004 mbar
Test location	Ground Plane	Relative humidity	33 %

8.1.1 Notes

Testing was performed with the transmitter operating on a fixed center channel at full power.

Testing was performed according to ANSI C63.10 §6.2.

8.1.2 Setup details

Port under test	AC mains supply only, AC/DC adapter only, AC mains with AC/DC adapter supplement, AC/DC adapter with AC mains supplement
EUT setup configuration	Table top
Measurement details	A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver settings:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	– Peak and Average (Preview measurement) – Quasi-peak and CAverage (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak and Average preview measurement) – 5000 ms (Quasi-peak final measurement) – 5000 ms (CAverage final measurement)

8.1.3 Test data

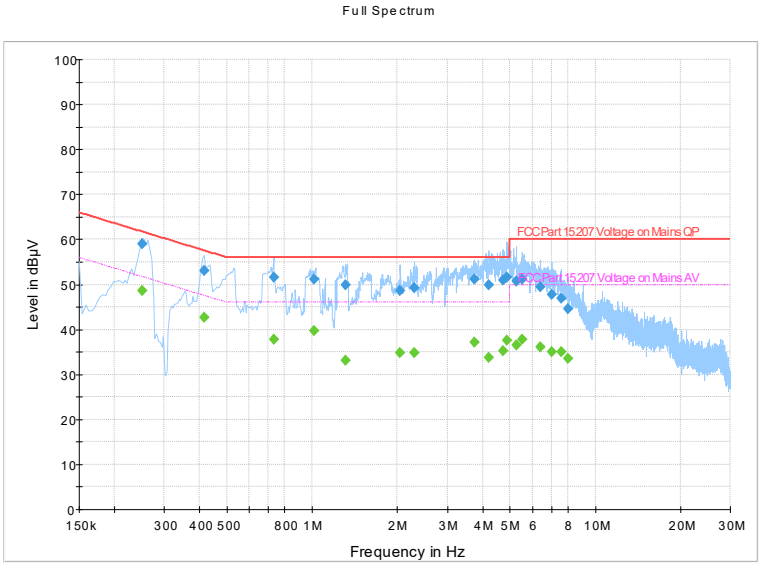

Figure 8.1-1: *AC conducted emissions, AC mains supply only*

Table 8.1-2: *AC conducted emissions, 150 kHz – 30 MHz, AC mains supply only*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.250000	---	48.56	51.76	3.20	5000.0	9.000	N	ON	19.5
0.250000	58.95	---	61.76	2.81	5000.0	9.000	N	ON	19.5
0.414000	---	42.73	47.57	4.84	5000.0	9.000	N	ON	19.4
0.414000	53.07	---	57.57	4.50	5000.0	9.000	N	ON	19.4
0.730000	---	37.89	46.00	8.11	5000.0	9.000	N	ON	19.4
0.730000	51.53	---	56.00	4.47	5000.0	9.000	N	ON	19.4
1.014000	---	39.70	46.00	6.30	5000.0	9.000	L1	ON	19.4
1.014000	51.10	---	56.00	4.90	5000.0	9.000	L1	ON	19.4
1.314000	---	33.06	46.00	12.95	5000.0	9.000	N	ON	19.4
1.314000	49.99	---	56.00	6.01	5000.0	9.000	N	ON	19.4
2.042000	48.66	---	56.00	7.34	5000.0	9.000	L1	ON	19.4
2.042000	---	34.89	46.00	11.11	5000.0	9.000	L1	ON	19.4
2.298000	---	34.89	46.00	11.11	5000.0	9.000	L1	ON	19.4
2.298000	49.18	---	56.00	6.82	5000.0	9.000	L1	ON	19.4
3.750000	51.07	---	56.00	4.93	5000.0	9.000	L1	ON	19.3
3.750000	---	37.19	46.00	8.81	5000.0	9.000	L1	ON	19.3
4.218000	49.96	---	56.00	6.04	5000.0	9.000	L1	ON	19.3
4.218000	---	33.68	46.00	12.32	5000.0	9.000	L1	ON	19.3
4.734000	---	35.29	46.00	10.71	5000.0	9.000	L1	ON	19.3
4.734000	50.99	---	56.00	5.01	5000.0	9.000	L1	ON	19.3
4.878000	51.63	---	56.00	4.37	5000.0	9.000	L1	ON	19.3
4.878000	---	37.59	46.00	8.41	5000.0	9.000	L1	ON	19.3
5.278000	---	36.46	50.00	13.54	5000.0	9.000	L1	ON	19.3
5.278000	50.73	---	60.00	9.27	5000.0	9.000	L1	ON	19.3
5.526000	---	37.70	50.00	12.30	5000.0	9.000	L1	ON	19.3
5.526000	51.24	---	60.00	8.76	5000.0	9.000	L1	ON	19.3
6.386000	---	36.02	50.00	13.98	5000.0	9.000	L1	ON	19.3
6.386000	49.45	---	60.00	10.55	5000.0	9.000	L1	ON	19.3
7.034000	47.83	---	60.00	12.17	5000.0	9.000	L1	ON	19.3
7.034000	---	35.13	50.00	14.87	5000.0	9.000	L1	ON	19.3
7.610000	---	34.99	50.00	15.01	5000.0	9.000	L1	ON	19.3
7.610000	46.95	---	60.00	13.05	5000.0	9.000	L1	ON	19.3
7.990000	44.64	---	60.00	15.36	5000.0	9.000	L1	ON	19.3
7.990000	---	33.48	50.00	16.52	5000.0	9.000	L1	ON	19.3

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

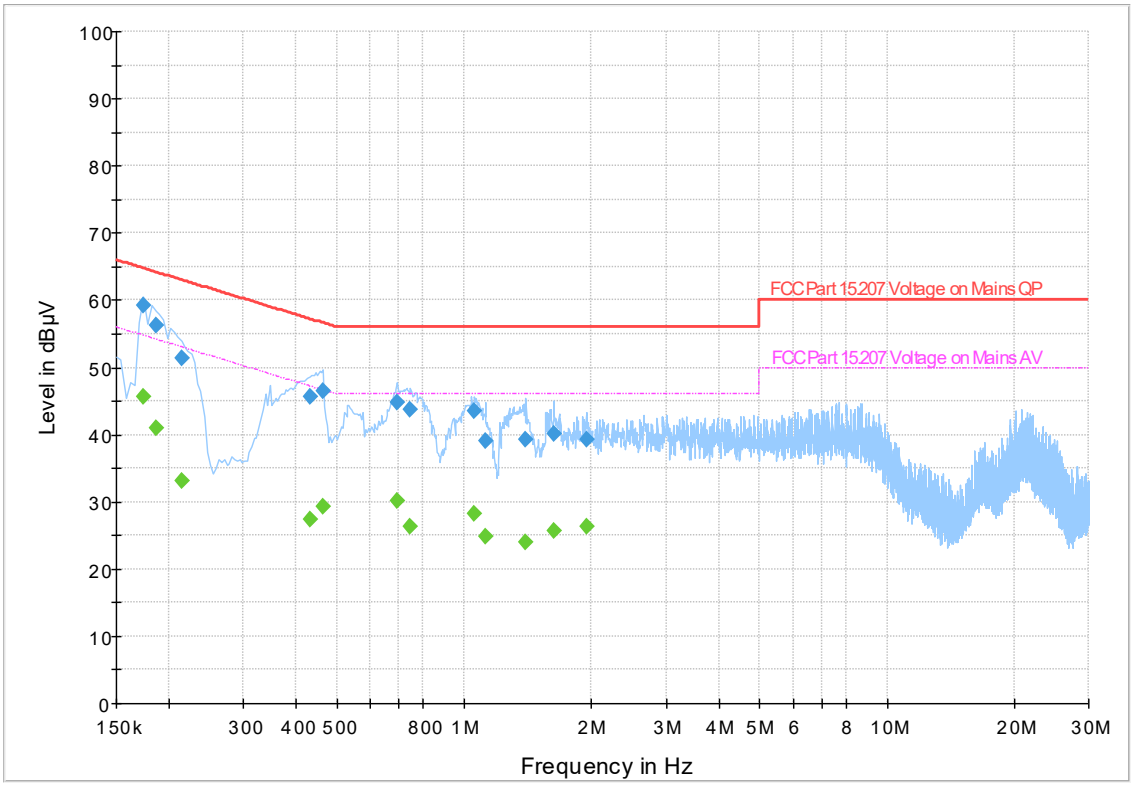

Figure 8.1-2: *AC conducted emissions, AC/DC adapter only*

Table 8.1-3: *AC conducted emissions, 150 kHz – 30 MHz, AC/DC adapter only*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.174000	---	45.55	54.77	9.22	5000.0	9.000	N	ON	19.5
0.174000	59.33	---	64.77	5.44	5000.0	9.000	N	ON	19.5
0.186000	---	40.89	54.21	13.32	5000.0	9.000	N	ON	19.5
0.186000	56.22	---	64.21	7.99	5000.0	9.000	N	ON	19.5
0.214000	51.47	---	63.05	11.58	5000.0	9.000	N	ON	19.5
0.214000	---	33.05	53.05	20.00	5000.0	9.000	N	ON	19.5
0.430000	---	27.34	47.25	19.91	5000.0	9.000	L1	ON	19.4
0.430000	45.55	---	57.25	11.70	5000.0	9.000	L1	ON	19.4
0.462000	46.47	---	56.66	10.19	5000.0	9.000	L1	ON	19.4
0.462000	---	29.34	46.66	17.32	5000.0	9.000	L1	ON	19.4
0.694000	---	30.24	46.00	15.76	5000.0	9.000	L1	ON	19.4
0.694000	44.81	---	56.00	11.19	5000.0	9.000	L1	ON	19.4
0.746000	---	26.28	46.00	19.72	5000.0	9.000	L1	ON	19.4
0.746000	43.66	---	56.00	12.34	5000.0	9.000	L1	ON	19.4
1.058000	43.54	---	56.00	12.46	5000.0	9.000	L1	ON	19.4
1.058000	---	28.30	46.00	17.70	5000.0	9.000	L1	ON	19.4
1.122000	---	24.92	46.00	21.08	5000.0	9.000	L1	ON	19.4
1.122000	39.02	---	56.00	16.98	5000.0	9.000	L1	ON	19.4
1.398000	39.18	---	56.00	16.82	5000.0	9.000	L1	ON	19.4
1.398000	---	24.07	46.00	21.93	5000.0	9.000	L1	ON	19.4
1.630000	---	25.66	46.00	20.34	5000.0	9.000	L1	ON	19.4
1.630000	40.10	---	56.00	15.91	5000.0	9.000	L1	ON	19.4
1.942000	---	26.30	46.00	19.70	5000.0	9.000	L1	ON	19.4
1.942000	39.35	---	56.00	16.65	5000.0	9.000	L1	ON	19.4

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

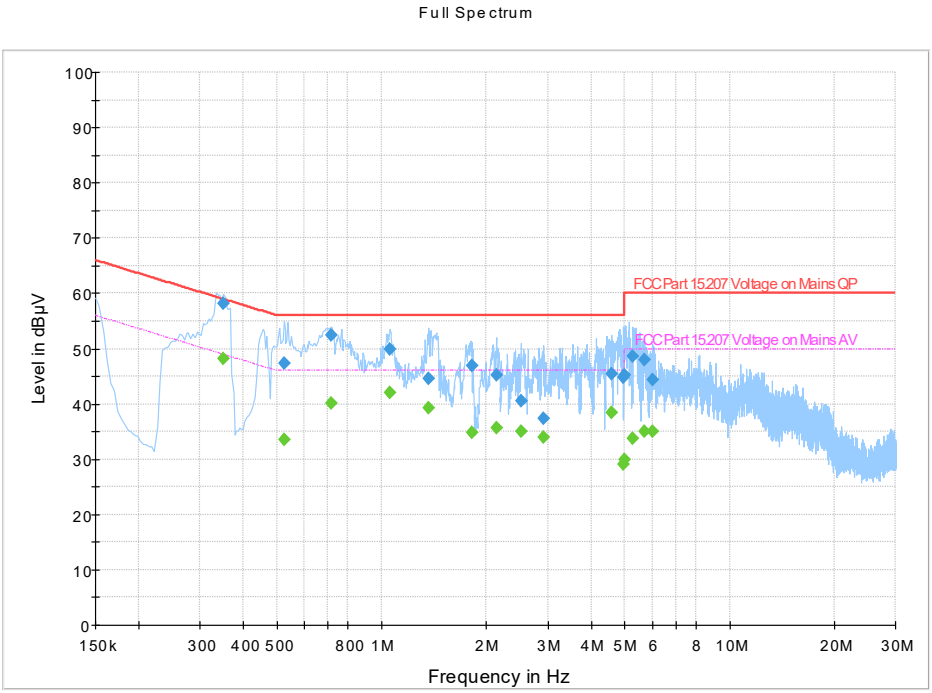

Figure 8.1-3: *AC conducted emissions, AC mains with AC/DC adapter supplement*

Table 8.1-4: *AC conducted emissions, 150 kHz – 30 MHz, AC mains with AC/DC adapter supplement*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.350000	---	48.21	48.96	0.75	5000.0	9.000	N	ON	19.4
0.350000	58.16	---	58.96	0.80	5000.0	9.000	N	ON	19.4
0.522000	47.25	---	56.00	8.75	5000.0	9.000	L1	ON	19.4
0.522000	---	33.51	46.00	12.49	5000.0	9.000	L1	ON	19.4
0.714000	---	40.19	46.00	5.81	5000.0	9.000	L1	ON	19.4
0.714000	52.39	---	56.00	3.61	5000.0	9.000	L1	ON	19.4
1.058000	49.80	---	56.00	6.20	5000.0	9.000	L1	ON	19.4
1.058000	---	42.09	46.00	3.91	5000.0	9.000	L1	ON	19.4
1.362000	44.62	---	56.00	11.38	5000.0	9.000	L1	ON	19.4
1.362000	---	39.26	46.00	6.74	5000.0	9.000	L1	ON	19.4
1.814000	46.87	---	56.00	9.13	5000.0	9.000	L1	ON	19.4
1.814000	---	34.80	46.00	11.20	5000.0	9.000	L1	ON	19.4
2.130000	---	35.71	46.00	10.29	5000.0	9.000	L1	ON	19.4
2.130000	45.13	---	56.00	10.87	5000.0	9.000	L1	ON	19.4
2.514000	40.52	---	56.00	15.48	5000.0	9.000	L1	ON	19.4
2.514000	---	34.94	46.00	11.06	5000.0	9.000	L1	ON	19.4
2.910000	---	33.87	46.00	12.13	5000.0	9.000	L1	ON	19.4
2.910000	37.39	---	56.00	18.61	5000.0	9.000	L1	ON	19.4
4.574000	45.48	---	56.00	10.52	5000.0	9.000	L1	ON	19.3
4.574000	---	38.39	46.00	7.61	5000.0	9.000	L1	ON	19.3
4.962000	---	28.99	46.00	17.01	5000.0	9.000	L1	ON	19.3
4.962000	44.87	---	56.00	11.13	5000.0	9.000	L1	ON	19.3
4.974000	45.28	---	56.00	10.72	5000.0	9.000	L1	ON	19.3
4.974000	---	29.99	46.00	16.01	5000.0	9.000	L1	ON	19.3
5.282000	48.64	---	60.00	11.36	5000.0	9.000	L1	ON	19.3
5.282000	---	33.85	50.00	16.15	5000.0	9.000	L1	ON	19.3
5.674000	47.89	---	60.00	12.11	5000.0	9.000	L1	ON	19.3
5.674000	---	35.08	50.00	14.92	5000.0	9.000	L1	ON	19.3
6.026000	44.48	---	60.00	15.52	5000.0	9.000	L1	ON	19.3
6.026000	---	35.12	50.00	14.88	5000.0	9.000	L1	ON	19.3

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

Full Spectrum

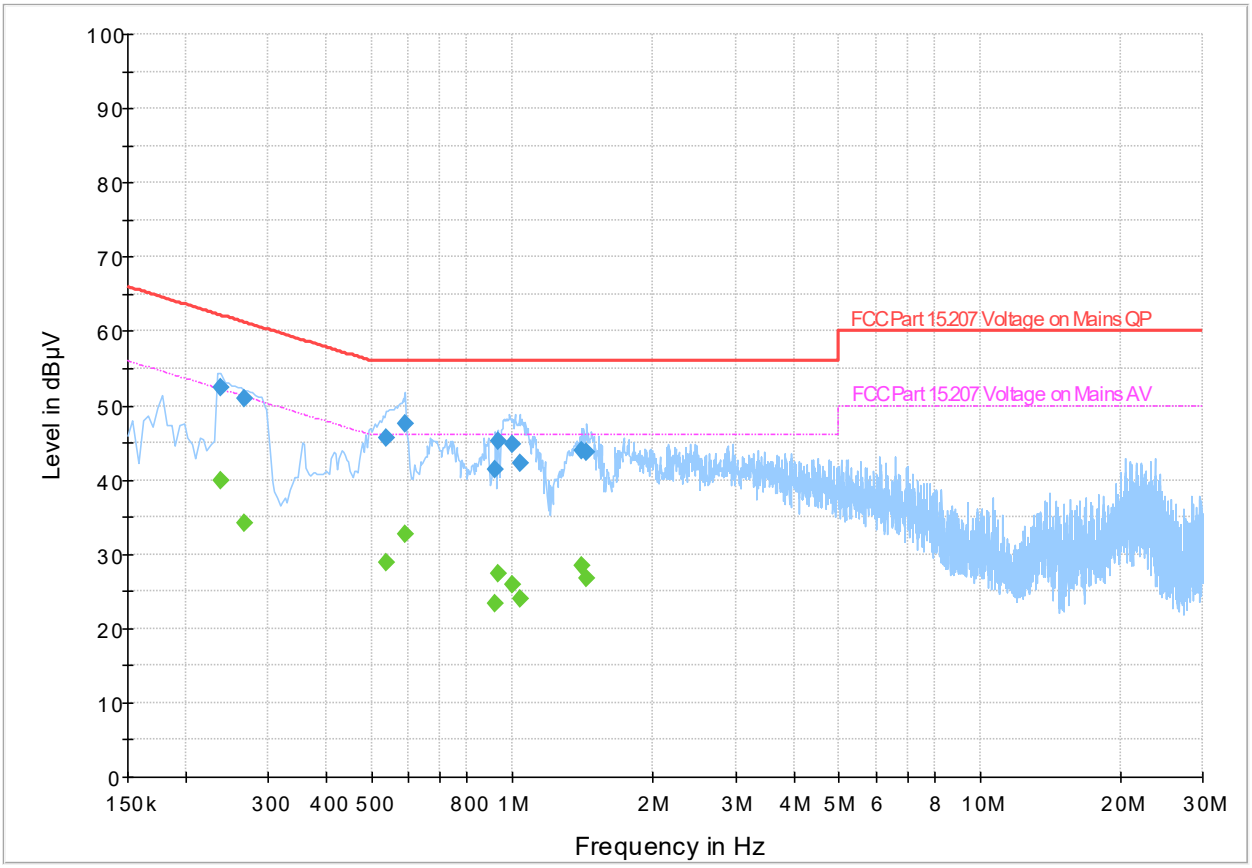

Figure 8.1-4: *AC conducted emissions, AC/DC adapter with AC mains supplement*

Table 8.1-5: *AC conducted emissions, 150 kHz – 30 MHz, AC/DC adapter with AC mains supplement*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.238000	---	39.95	52.17	12.21	5000.0	9.000	N	ON	19.5
0.238000	52.42	---	62.17	9.75	5000.0	9.000	N	ON	19.5
0.266000	50.88	---	61.24	10.36	5000.0	9.000	L1	ON	19.5
0.266000	---	34.27	51.24	16.97	5000.0	9.000	L1	ON	19.5
0.538000	45.68	---	56.00	10.32	5000.0	9.000	L1	ON	19.4
0.538000	---	28.78	46.00	17.22	5000.0	9.000	L1	ON	19.4
0.590000	---	32.67	46.00	13.33	5000.0	9.000	L1	ON	19.4
0.590000	47.49	---	56.00	8.51	5000.0	9.000	L1	ON	19.4
0.918000	41.34	---	56.00	14.66	5000.0	9.000	L1	ON	19.4
0.918000	---	23.41	46.00	22.59	5000.0	9.000	L1	ON	19.4
0.934000	---	27.29	46.00	18.71	5000.0	9.000	L1	ON	19.4
0.934000	45.30	---	56.00	10.70	5000.0	9.000	L1	ON	19.4
1.002000	44.75	---	56.00	11.25	5000.0	9.000	L1	ON	19.4
1.002000	---	25.90	46.00	20.10	5000.0	9.000	L1	ON	19.4
1.038000	42.24	---	56.00	13.76	5000.0	9.000	L1	ON	19.4
1.038000	---	24.03	46.00	21.97	5000.0	9.000	L1	ON	19.4
1.406000	---	28.38	46.00	17.62	5000.0	9.000	L1	ON	19.4
1.406000	43.90	---	56.00	12.10	5000.0	9.000	L1	ON	19.4
1.442000	43.71	---	56.00	12.29	5000.0	9.000	L1	ON	19.4
1.442000	---	26.84	46.00	19.16	5000.0	9.000	L1	ON	19.4

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

8.2 FCC 15.247(a)(2) and RSS-247 5.2(1) Minimum 6 dB bandwidth for systems using digital modulation techniques References

8.2.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(a)(2)
RSS-247 → §5.2(a)

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(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.

8.2.2 Test summary

Verdict	Pass		
Test date	January 19, 2021	Temperature	25 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	997 mbar
Test location	Wireless bench	Relative humidity	31 %

8.2.1 Notes

None

8.2.2 Setup details

EUT setup configuration	Table top
Test facility	Nemko San Diego
Measurement method	558074 D01 DTS Measurement Guidance §8.2 ANSI C63.10 §11.8.1 using built-in marker function of the spectrum analyzer

Receiver/spectrum analyzer settings:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.2.3 Test data

Table 8.2-1: *6 dB occupied bandwidth test data*

Test Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Margin (kHz)
2402	695.30	> 500	195.30
2440	691.30	> 500	191.30
2480	691.30	> 500	191.30

8.2.5 Test data, continued

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Figure 8.2-1: *6 dB occupied bandwidth, 2402 MHz*

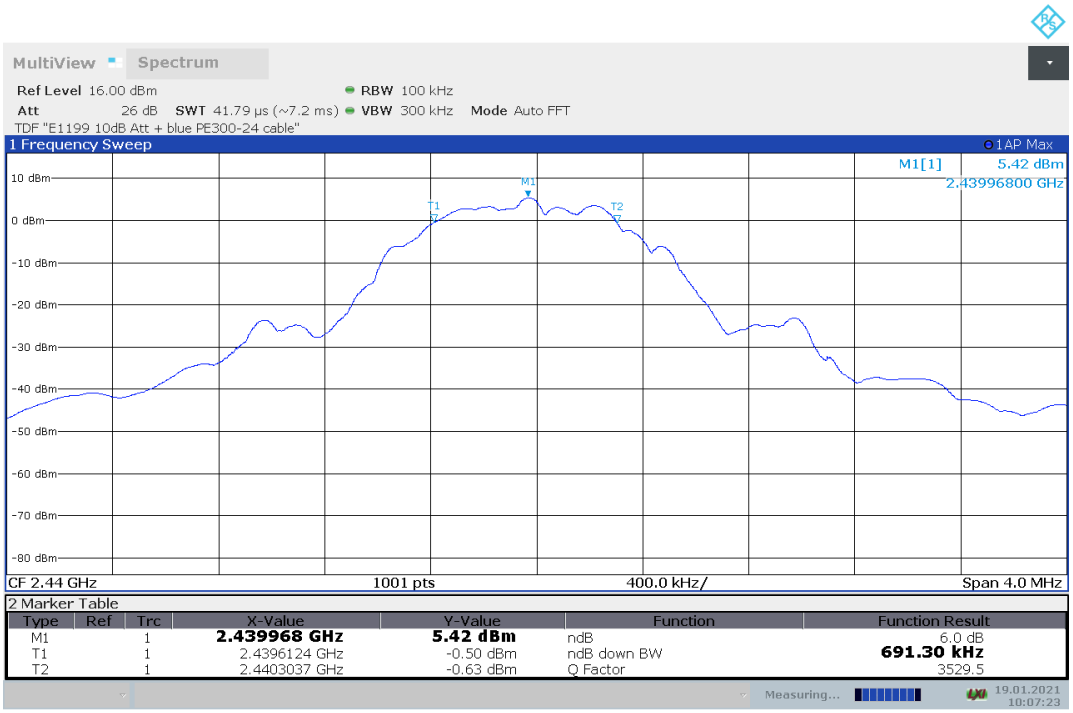

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Figure 8.2-2: *6 dB occupied bandwidth, 2440 MHz*

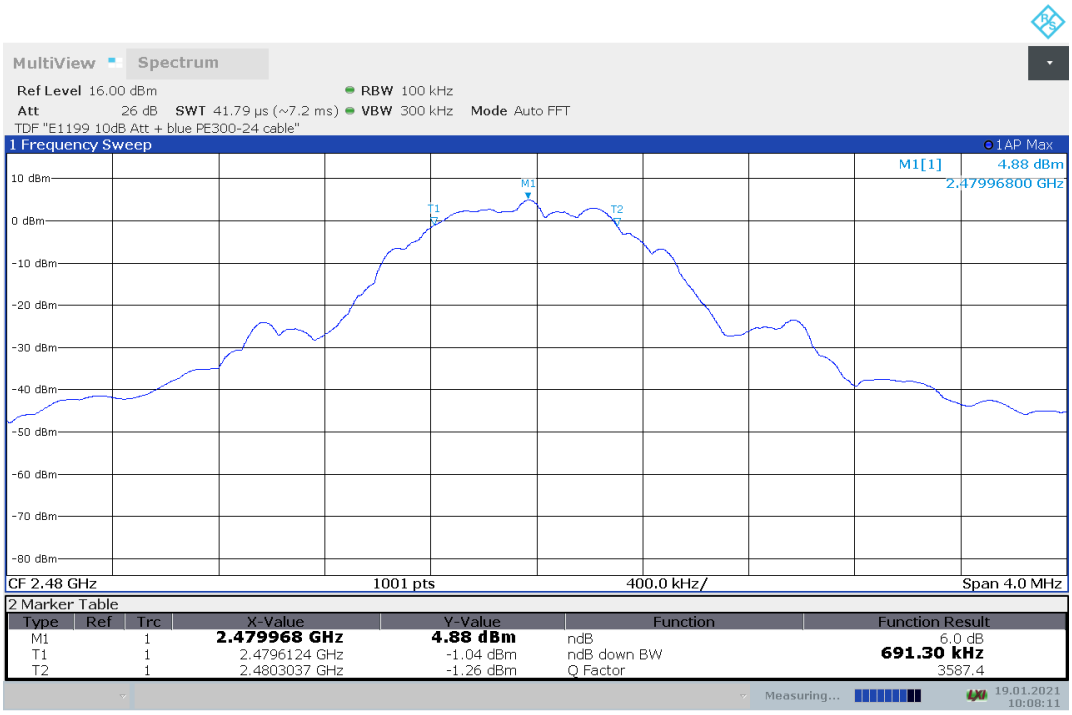

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Figure 8.2-3: *6 dB occupied bandwidth, 2480 MHz*

8.3 FCC 15.247(b) and RSS-247 5.4 (4) Transmitter output power and e.i.r.p. requirements

8.3.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(b)(2) / (3)

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

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

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

RSS-247 → §5.4(d)

(d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling 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 transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

8.3.2 Test summary

Verdict	Pass		
Test date	January 19, 2021	Temperature	25 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	997 mbar
Test location	Wireless bench	Relative humidity	31 %

8.3.3 Notes

Testing was performed in Tx mode and the EUT transmitting on a fixed channel at full power.

The attenuation of the interconnecting cable was included in the power meter software as a correction factor.

The antenna gain is 3 dBi per client declaration.

Conducted Power = Power Meter Measurement + Duty Cycle Correction Factor
EIRP = Conducted Power + Declared Antenna Gain

8.3.4 Setup details

EUT setup configuration	Table top
Test facility	Nemko San Diego
Measurement method	ANSI C63.10 §11.9.2.3.1 Method AVGPM

8.3.5 Test data

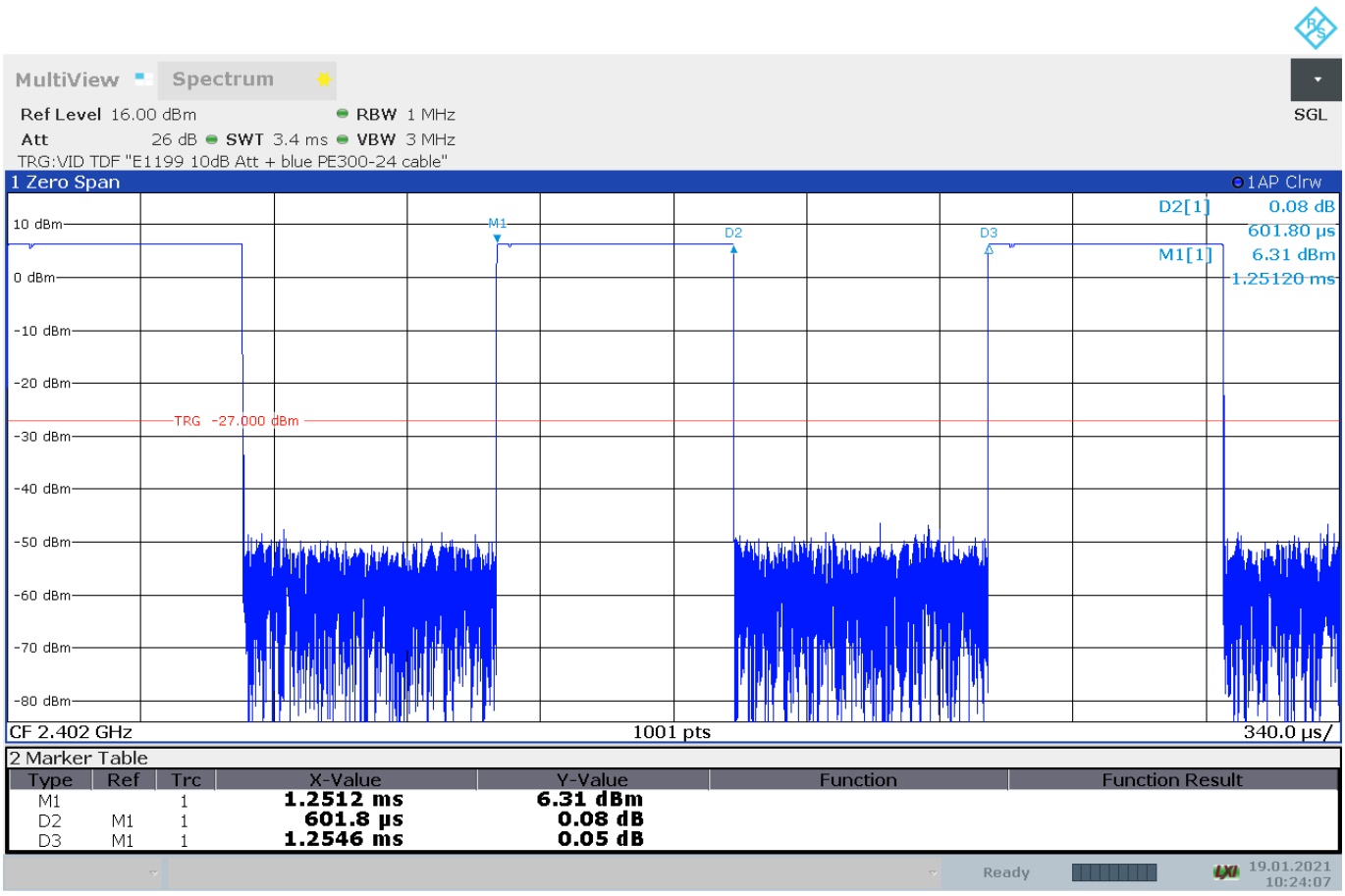

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Figure 8.3-1: *Duty cycle*

Duty Cycle Correction Factor calculation:

Transmitter "ON" time: 601.8 µs
Transmitter pulse repetition time: 1254.6 µs
Duty cycle D ("ON" time / repetition time): 601.8 / 1254.6 = 48.0 %
Duty Cycle Correction Factor: $10 \times \log_{10}(1/D) = 10 \times \log_{10}(1/0.480) = 3.19$ dB

Table 8.3-1: *Output power*

Test Frequency (MHz)	Measured Average Conducted Power (dBm)	Duty Cycle Correction Factor (dBm)	Maximum Conducted Power (dBm)	Conducted Limit (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)
2402	3.31	3.19	6.50	30.0	3.00	9.50	36.0
2440	2.99	3.19	6.18	30.0	3.00	9.18	36.0
2480	2.22	3.19	5.41	30.0	3.00	8.41	36.0

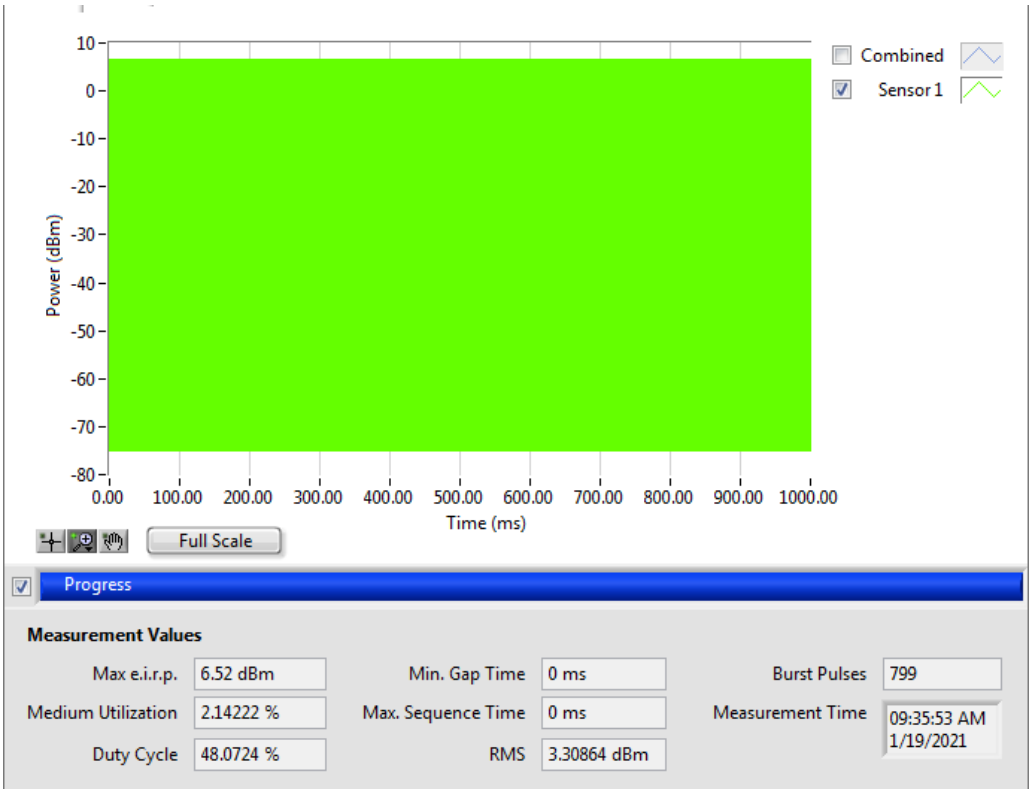

Figure 8.3-2: *Output power, 2402 MHz*

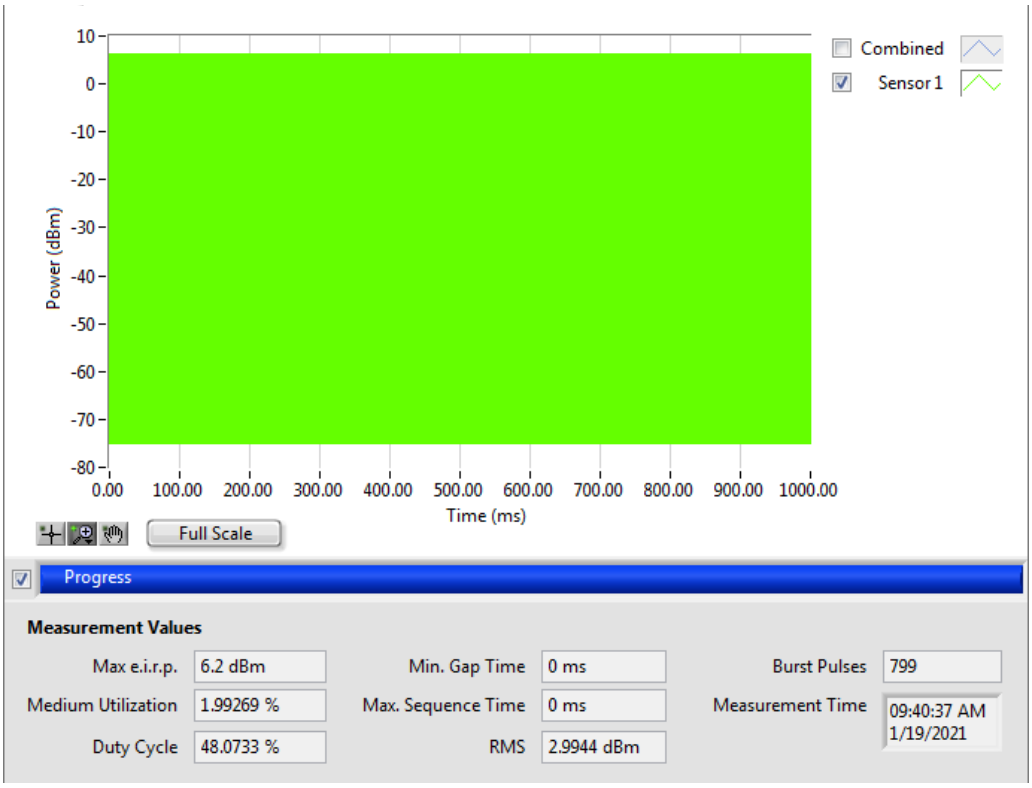

Figure 8.3-3: *Output power, 2440 MHz*

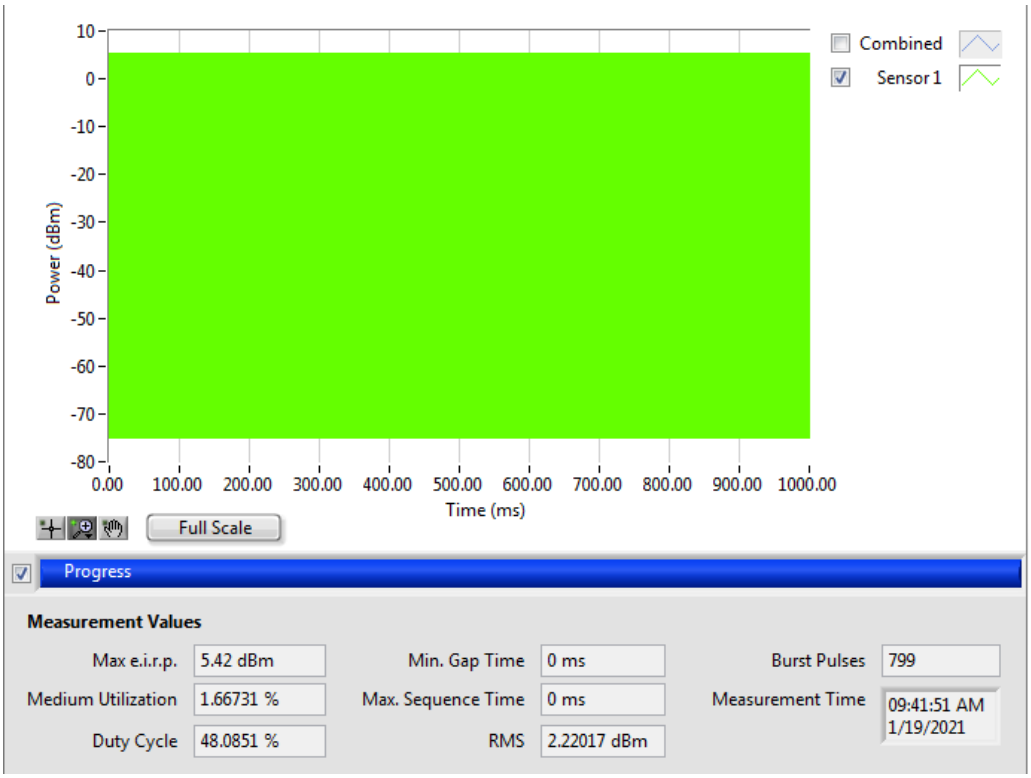

Figure 8.3-4: *Output power, 2480 MHz*

8.4 FCC Part 15.247(d) and RSS-247 5.5 Conducted band-edge spurious emissions

8.4.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(d)

(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)).

RSS-247 → §5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

8.4.2 Test summary

Verdict	Pass		
Test date	January 19, 2021	Temperature	25 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	997 mbar
Test location	Wireless bench	Relative humidity	31 %

8.4.3 Notes

The EUT was configured to transmit continuously on the lowest and highest channels.

For conducted measurements, the loss of the connected cable and attenuator was input into the spectrum analyzer as a transducer factor.

8.4.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench
Measurement details	Conducted band edge measurement performed as per C63.10 §6.10.4

Spectrum analyzer settings for conducted spurious emissions:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.4.5 Test data

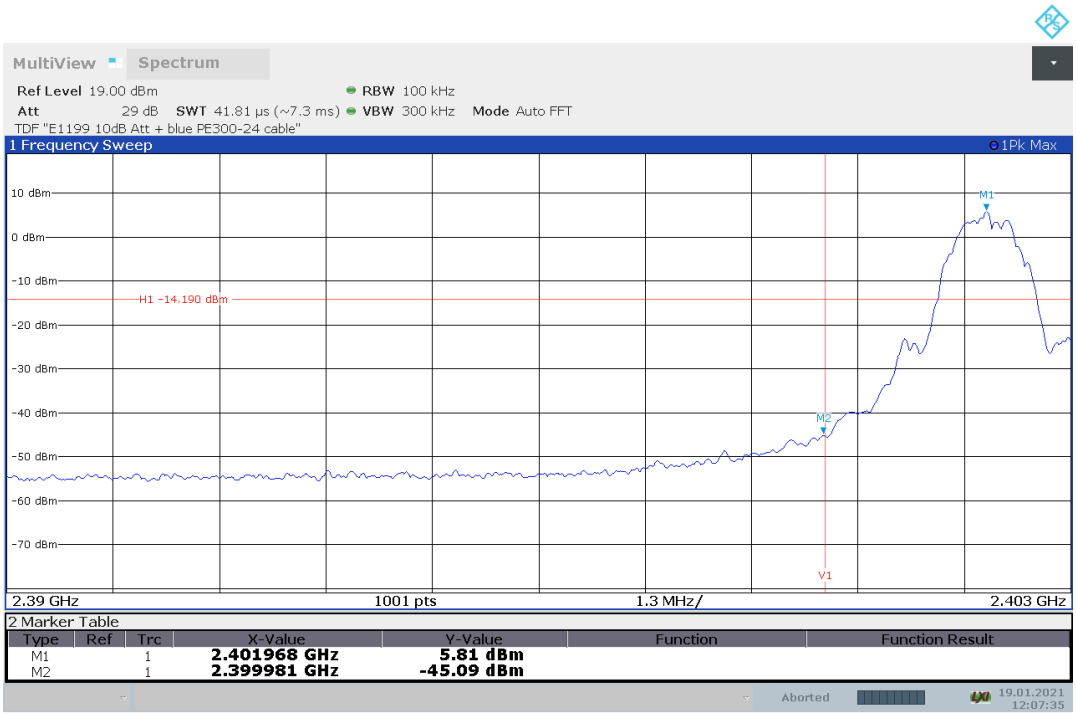

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Figure 8.4-1: Band edge measurement, 2402 MHz

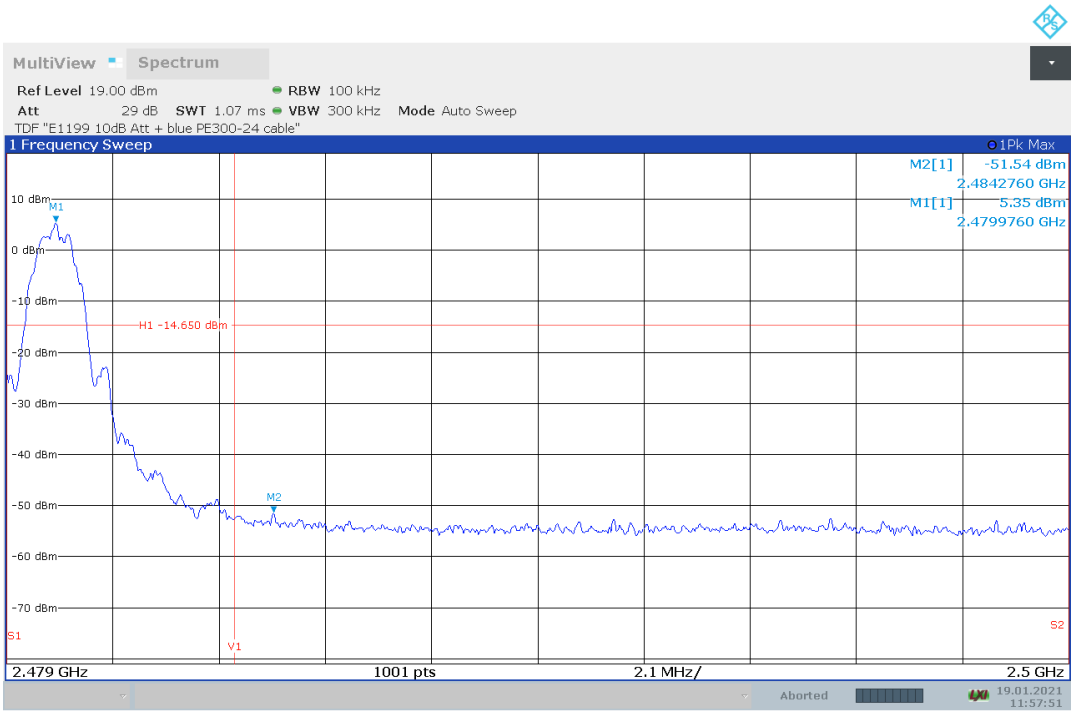

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Figure 8.4-2: Band edge measurement, 2480 MHz

8.5 FCC 15.247(d) and RSS-247 5.5 Conducted spurious emissions

8.5.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(d)

(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)).

RSS-247 → §5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

8.5.1 Test summary

Verdict	Pass		
Test date	January 19, 2021	Temperature	25 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	997 mbar
Test location	Wireless bench	Relative humidity	31 %

8.5.2 Notes

In each measurement, the limit was derived by subtracting 20 dB from the power spectral density measurements in Section 8.7

8.5.3 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench
Measurement details	Conducted spurious emissions measurement performed as per C63.10 §11.11.3

Spectrum analyzer settings for conducted spurious emissions:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.5.4 Test data

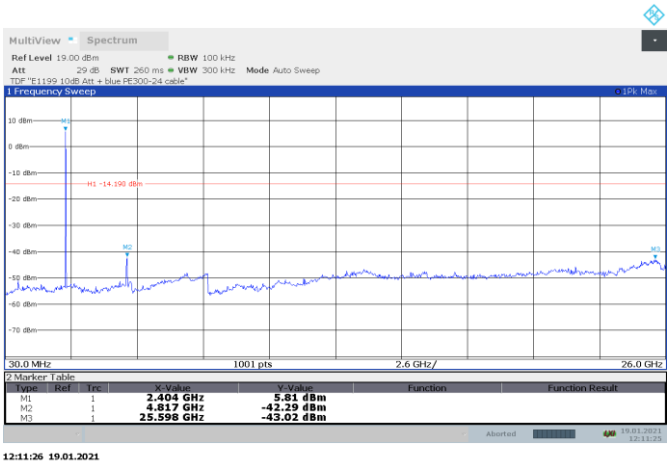


Figure 8.5-1: *Conducted spurious emissions, 2402 MHz*

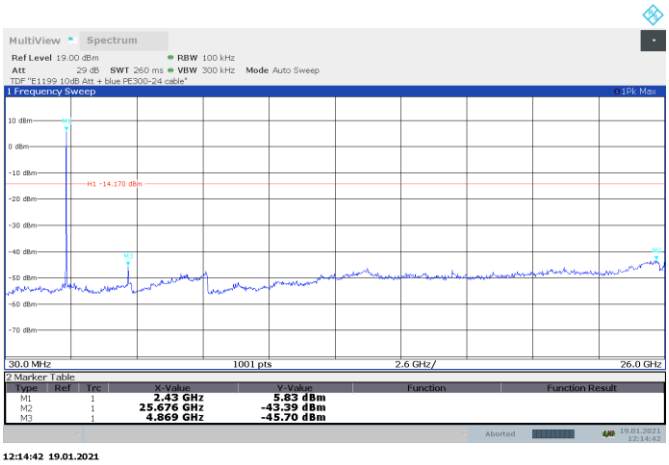


Figure 8.5-2: *Conducted spurious emissions, 2440 MHz*

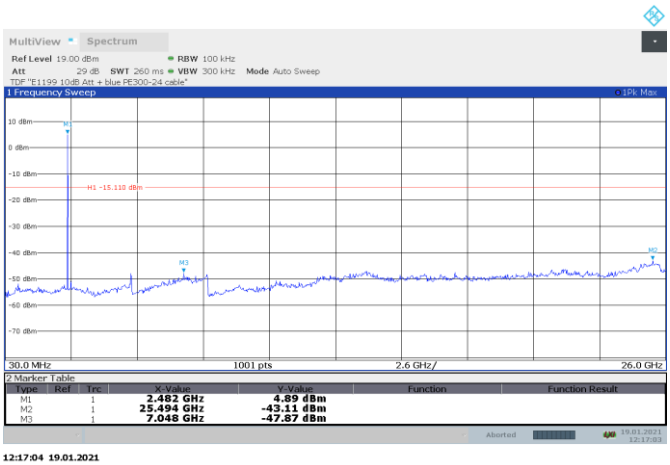


Figure 8.5-3: *Conducted spurious emissions, 2480 MHz*

Note: For conducted emissions plots above, peaks within 2400-2483.5MHz are transmitter fundamentals signals and are not evaluated against the relevant limits.

8.6 FCC 15.247(d) and RSS-247 5.5 Radiated restricted band-edges and spurious emission

8.6.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(d)

(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)).

RSS-247 → §5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Table 8.6-1: *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 8.6-2: *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			

8.6.2 Test summary

Verdict	Pass		
Test date	January 22, 2021	Temperature	22 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1008 mbar
Test location	3m semi-anechoic chamber (Radiated)	Relative humidity	51 %

8.6.3 Notes

The EUT was configured to transmit continuously on the lowest, middle and highest channels.

The spectrum was search from 30 MHz to 26 GHz (above the 10th harmonic of the highest transmit frequency of 2480 MHz).

Radiated measurements were performed at a 3 m measurement distance.

8.6.4 Setup details

EUT setup configuration	Tabletop
Test facility	Nemko San Diego
Measurement details	Radiated spurious emissions measurement performed as per C63.10 §11.12

Receiver settings for radiated measurements within restricted bands below 1 GHz:

Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	Peak (preview measurements) Quasi-Peak (final measurements)
Trace mode	Max Hold
Measurement time	5 s (final measurements)

Receiver settings for radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Average and peak (final measurements)
Trace mode	Max Hold
Measurement time	5 s (final measurements)

8.6.5 Test data

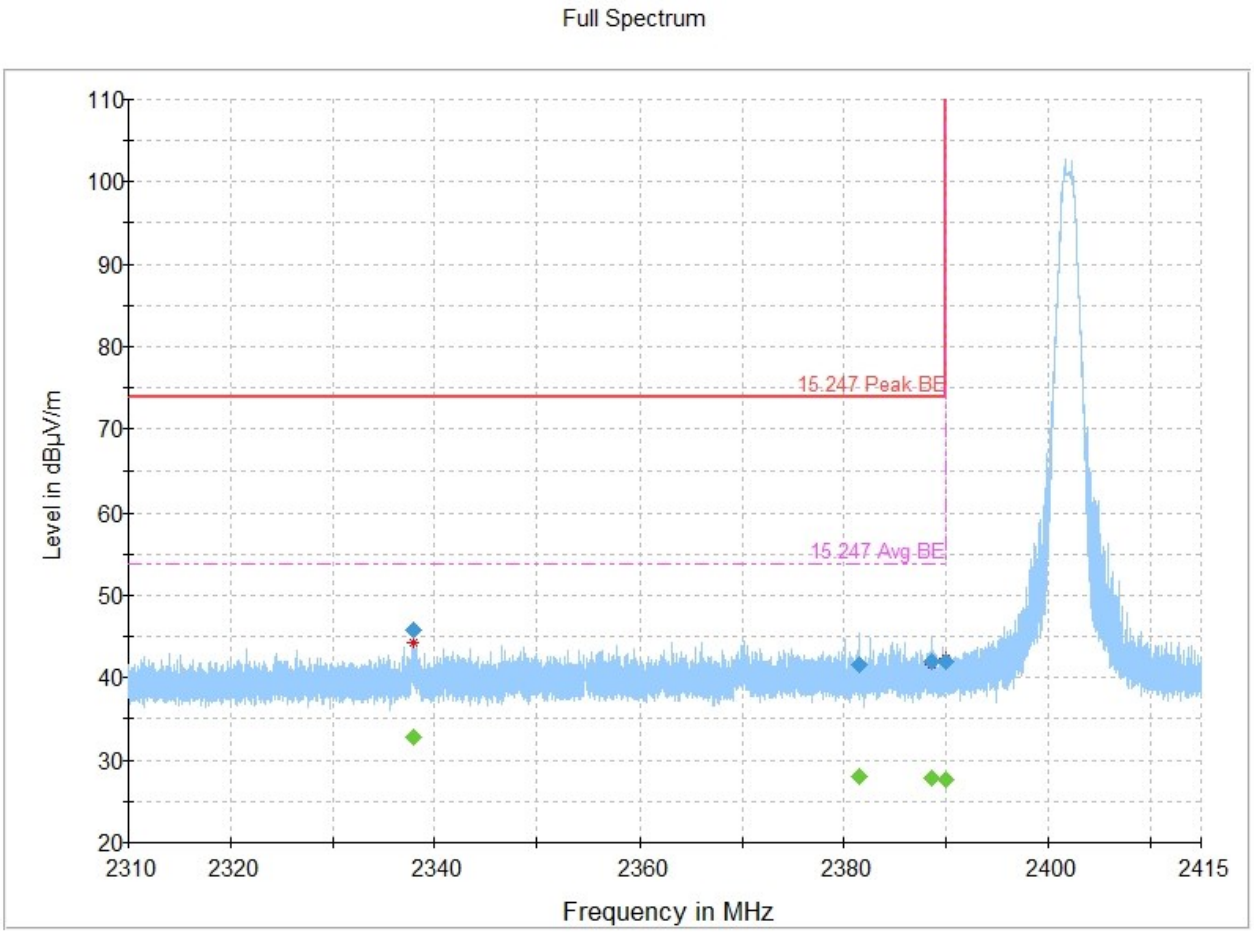


Figure 8.6-1: *Radiated emissions, restricted band edge, low*

Table 8.6-2: *Radiated emissions, restricted band edge, low*

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)
2337.888000	45.84	---	73.90	28.06	5000.0	1000.000	138.0	H	28.0	-10.4
2337.888000	---	32.72	53.90	21.18	5000.0	1000.000	138.0	H	28.0	-10.4
2381.484000	---	28.10	53.90	25.80	5000.0	1000.000	160.0	V	0.0	-10.1
2381.484000	41.68	---	73.90	32.22	5000.0	1000.000	160.0	V	0.0	-10.1
2388.652000	---	27.87	53.90	26.03	5000.0	1000.000	157.0	V	354.0	-10.1
2388.652000	42.01	---	73.90	31.89	5000.0	1000.000	157.0	V	354.0	-10.1
2390.000000	---	27.70	53.90	26.20	5000.0	1000.000	113.0	V	0.0	-10.1
2390.000000	41.88	---	73.90	32.02	5000.0	1000.000	113.0	V	0.0	-10.1

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

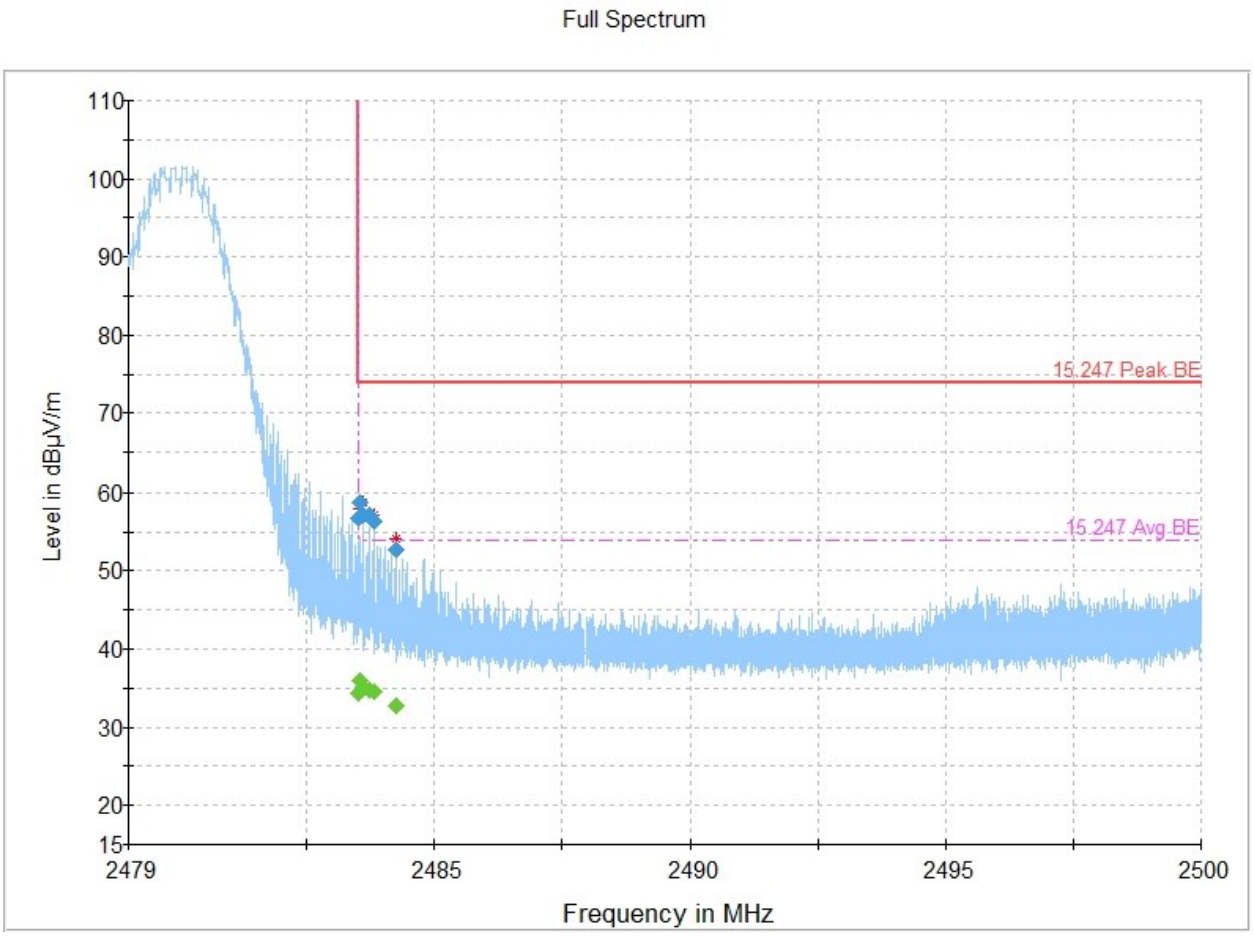
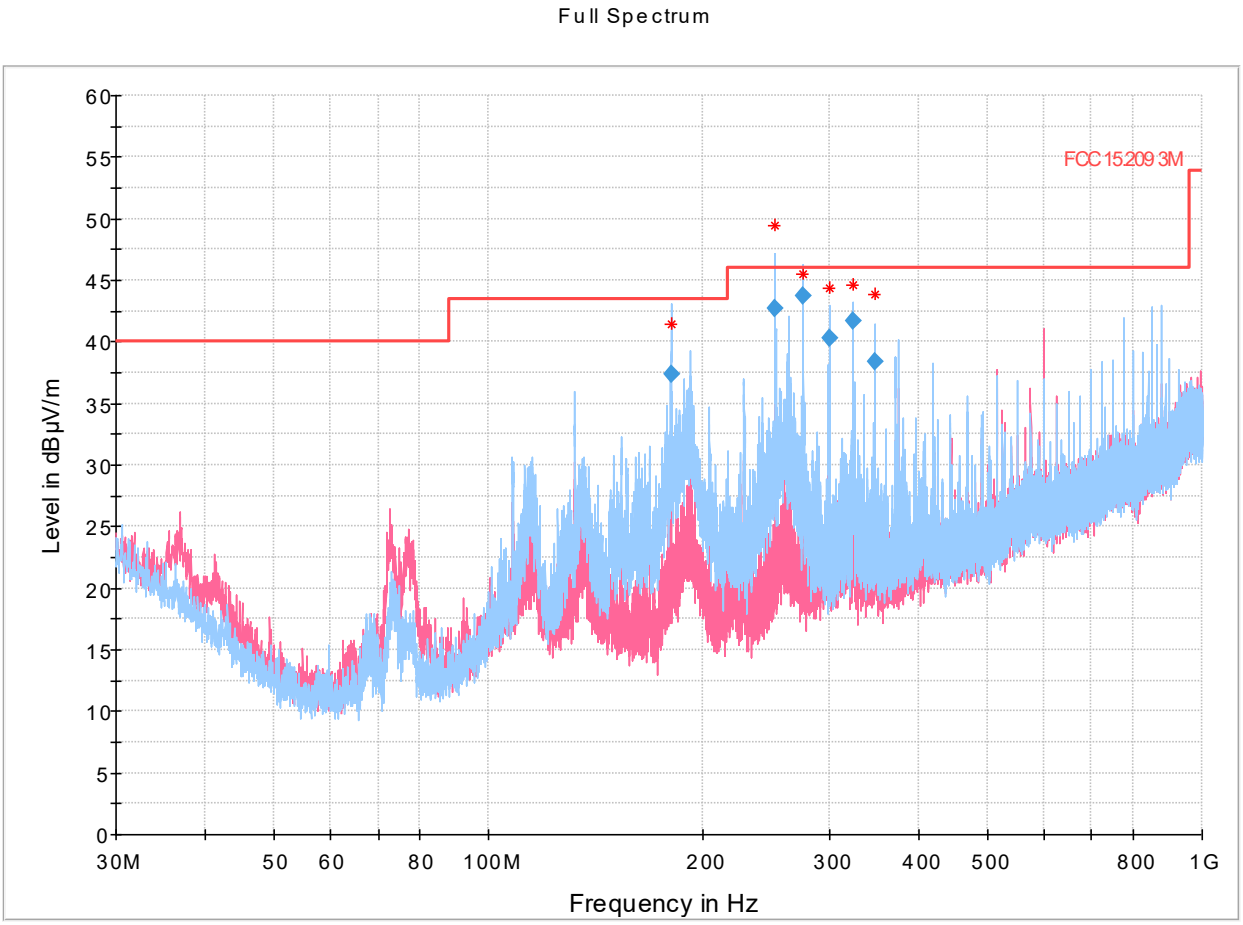


Figure 8.6-2: *Radiated emissions, restricted band edge, high*

Table 8.6-3: *Radiated emissions, restricted band edge, high*

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)
2483.500000	56.65	---	73.90	17.25	5000.0	1000.000	116.0	V	12.0	-9.5
2483.500000	---	34.43	53.90	19.47	5000.0	1000.000	116.0	V	12.0	-9.5
2483.526200	58.74	---	73.90	15.16	5000.0	1000.000	100.0	H	293.0	-9.5
2483.526200	---	36.00	53.90	17.90	5000.0	1000.000	100.0	H	293.0	-9.5
2483.610200	57.18	---	73.90	16.72	5000.0	1000.000	115.0	H	306.0	-9.5
2483.610200	---	35.14	53.90	18.76	5000.0	1000.000	115.0	H	306.0	-9.5
2483.737600	57.11	---	73.90	16.79	5000.0	1000.000	98.0	H	284.0	-9.5
2483.737600	---	34.68	53.90	19.22	5000.0	1000.000	98.0	H	284.0	-9.5
2483.822300	56.39	---	73.90	17.51	5000.0	1000.000	98.0	H	285.0	-9.5
2483.822300	---	34.60	53.90	19.30	5000.0	1000.000	98.0	H	285.0	-9.5
2484.244400	52.78	---	73.90	21.12	5000.0	1000.000	98.0	H	50.0	-9.5
2484.244400	---	32.72	53.90	21.18	5000.0	1000.000	98.0	H	50.0	-9.5

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)
[3] Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.



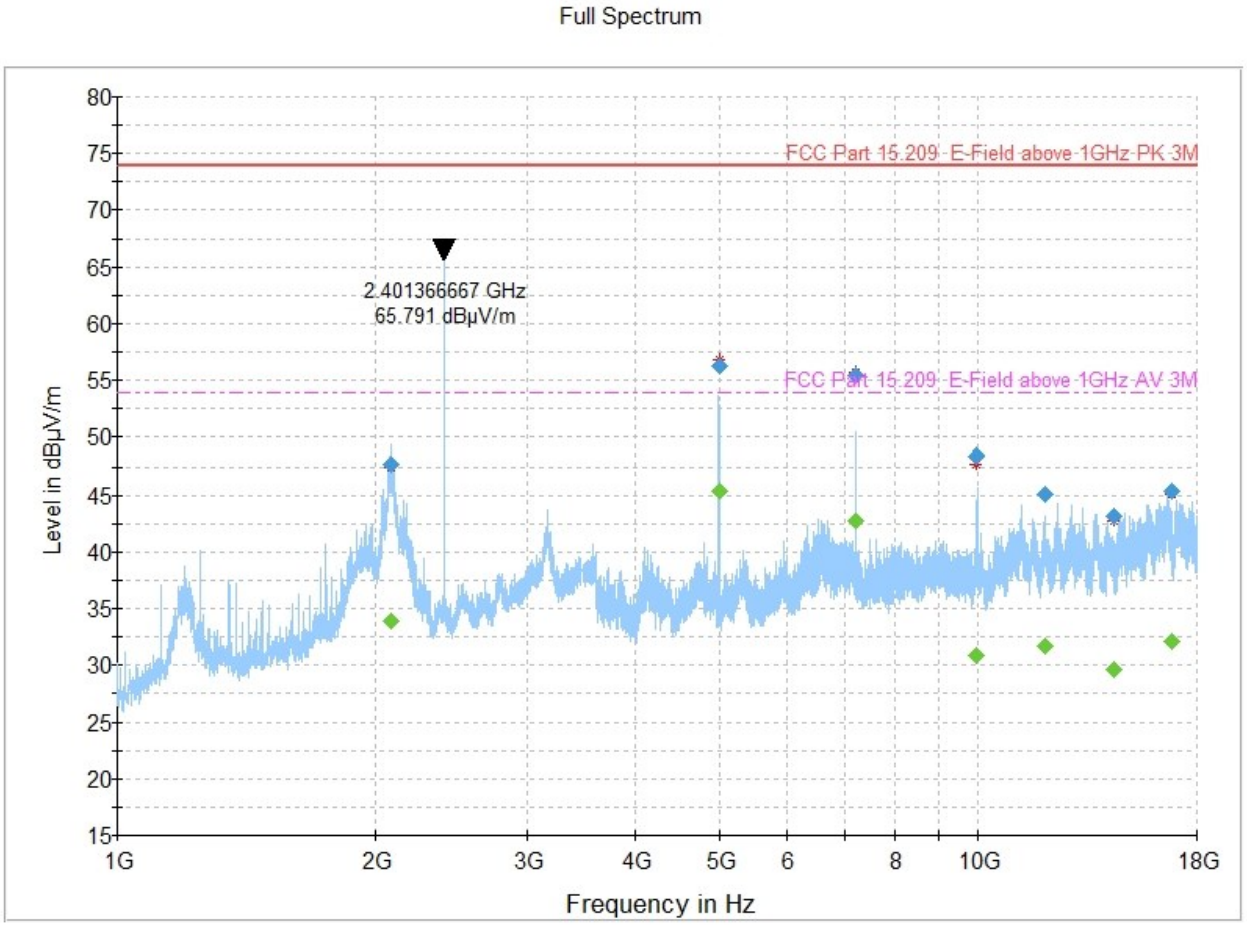
The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.6-3: *Radiated emissions, low channel, 30 – 1000 MHz spectral plot*

Table 8.6-4: *Radiated emissions, low channel, 30 – 1000 MHz (Quasi-Peak) results*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
180.014333	37.39	43.50	6.11	5000.0	120.000	175.4	H	336.0	16.0
251.757667	42.70	46.00	3.30	5000.0	120.000	98.0	H	0.0	20.1
275.876667	43.70	46.00	2.30	5000.0	120.000	131.5	H	184.0	20.3
299.746333	40.29	46.00	5.71	5000.0	120.000	109.0	H	275.0	20.7
323.930000	41.64	46.00	4.36	5000.0	120.000	113.3	H	248.0	21.4
348.241333	38.37	46.00	7.63	5000.0	120.000	110.7	H	230.0	22.1

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.
[4] Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.



The signal seen at 2.4014 GHz is the fundamental of the intentional radiator, and not measured against the FCC 15.209 limits.

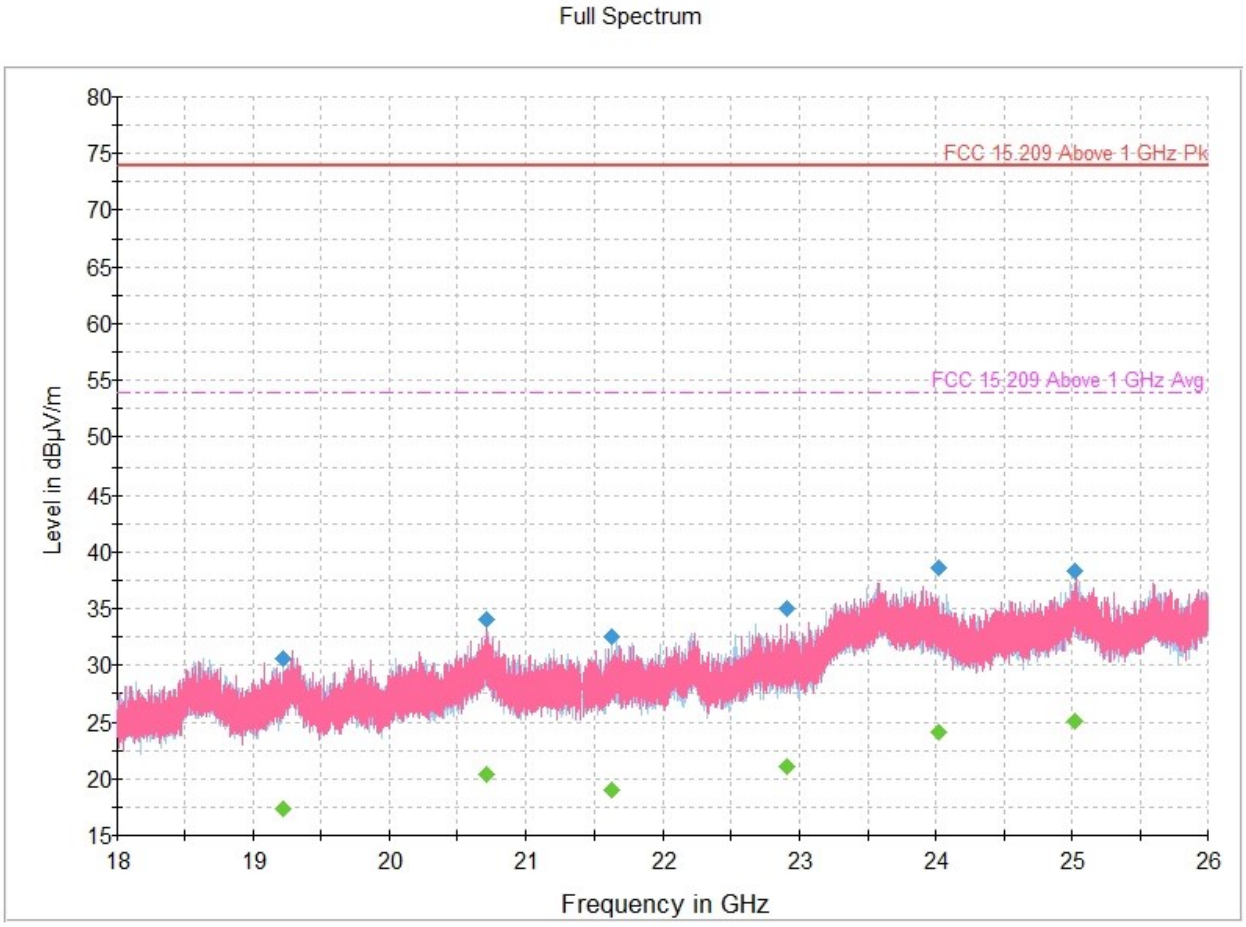
The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.6-4: *Radiated emissions, low channel, 1 – 18 GHz spectral plot*

Table 8.6-5: *Radiated emissions, low channel, 1 – 18 GHz (Quasi-Peak) results*

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)
2081.600000	---	33.94	53.90	19.96	5000.0	1000.000	141.0	H	51.0	-11.2
2081.600000	47.71	---	73.90	26.19	5000.0	1000.000	141.0	H	51.0	-11.2
4999.866667	---	45.34	53.90	8.56	5000.0	1000.000	245.0	H	51.0	-2.1
4999.866667	56.22	---	73.90	17.68	5000.0	1000.000	245.0	H	51.0	-2.1
7206.600000	55.50	---	73.90	18.40	5000.0	1000.000	249.0	H	12.0	0.7
7206.600000	---	42.76	53.90	11.14	5000.0	1000.000	249.0	H	12.0	0.7
9983.533333	48.39	---	73.90	25.51	5000.0	1000.000	165.0	V	354.0	3.9
9983.533333	---	30.93	53.90	22.97	5000.0	1000.000	165.0	V	354.0	3.9
12002.800000	---	31.67	53.90	22.23	5000.0	1000.000	274.0	V	316.0	6.1
12002.800000	45.03	---	73.90	28.87	5000.0	1000.000	274.0	V	316.0	6.1
14420.000000	---	29.65	53.90	24.25	5000.0	1000.000	286.0	H	164.0	9.6
14420.000000	43.10	---	73.90	30.80	5000.0	1000.000	286.0	H	164.0	9.6
16810.400000	---	32.12	53.90	21.78	5000.0	1000.000	159.0	V	230.0	13.8
16810.400000	45.33	---	73.90	28.57	5000.0	1000.000	159.0	V	230.0	13.8

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.



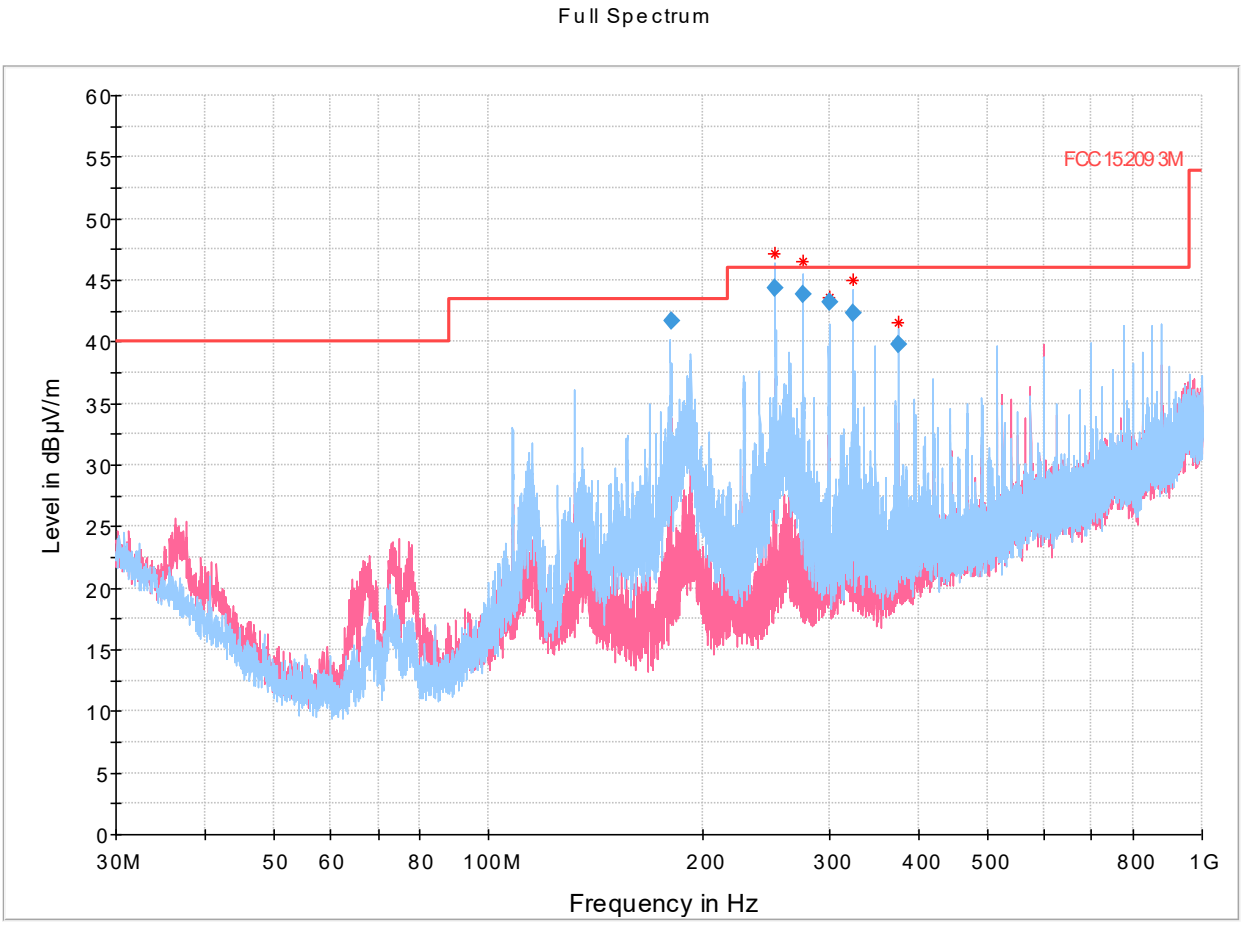
The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.6-5: *Radiated emissions, low channel, 18 – 26 GHz spectral plot*

Table 8.6-6: *Radiated emissions, low channel, 18 – 26 GHz (Quasi-Peak) results*

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)
19213.800000	---	17.40	53.90	36.50	5000.0	1000.000	116.0	H	106.0	18.2
19213.800000	30.58	---	73.90	43.32	5000.0	1000.000	116.0	H	106.0	18.2
20716.333333	34.08	---	73.90	39.82	5000.0	1000.000	110.0	V	268.0	20.7
20716.333333	---	20.41	53.90	33.49	5000.0	1000.000	110.0	V	268.0	20.7
21618.600000	32.52	---	73.90	41.38	5000.0	1000.000	170.0	V	182.0	18.8
21618.600000	---	18.95	53.90	34.95	5000.0	1000.000	170.0	V	182.0	18.8
22903.533333	34.97	---	73.90	38.93	5000.0	1000.000	191.0	V	238.0	20.8
22903.533333	---	21.03	53.90	32.87	5000.0	1000.000	191.0	V	238.0	20.8
24026.600000	38.55	---	73.90	35.35	5000.0	1000.000	158.0	V	41.0	22.6
24026.600000	---	24.11	53.90	29.79	5000.0	1000.000	158.0	V	41.0	22.6
25019.400000	---	25.01	53.90	28.89	5000.0	1000.000	212.0	V	156.0	23.1
25019.400000	38.36	---	73.90	35.54	5000.0	1000.000	212.0	V	156.0	23.1

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.



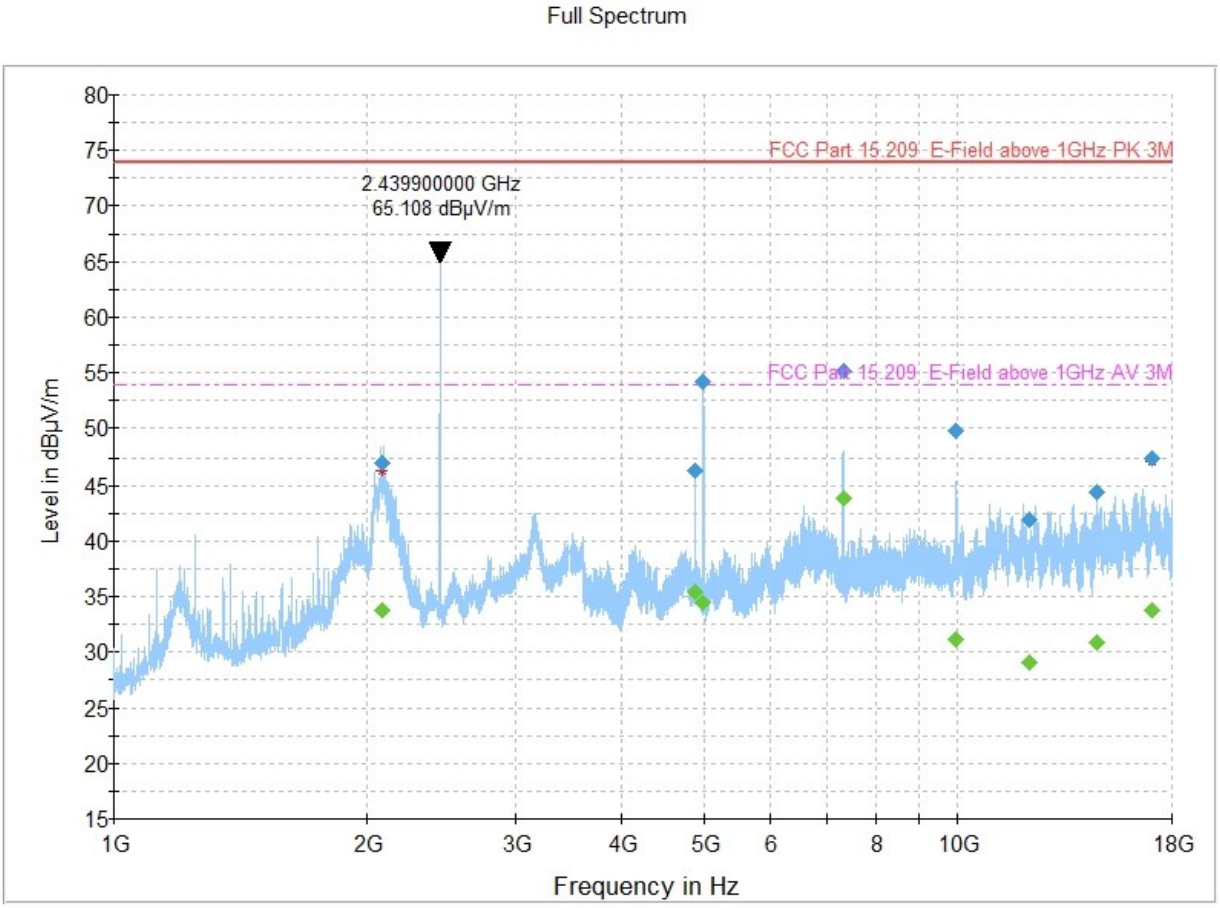
The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.6-6: *Radiated emissions, middle channel, 30 – 1000 MHz spectral plot*

Table 8.6-7: *Radiated emissions, middle channel, 30 – 1000 MHz (Quasi-Peak) results*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
179.932667	41.65	43.50	1.85	5000.0	120.000	110.8	H	312.0	16.0
252.179000	44.38	46.00	1.62	5000.0	120.000	98.0	H	340.0	20.1
275.993333	43.82	46.00	2.18	5000.0	120.000	147.4	H	199.0	20.3
299.849333	43.22	46.00	2.78	5000.0	120.000	98.0	H	275.0	20.7
323.793000	42.38	46.00	3.62	5000.0	120.000	126.5	H	242.0	21.4
374.976667	39.79	46.00	6.21	5000.0	120.000	109.3	H	129.0	23.0

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.
[4] Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.



The signal seen at 2.4399 GHz is the fundamental of the intentional radiator, and not measured against the FCC 15.209 limits.

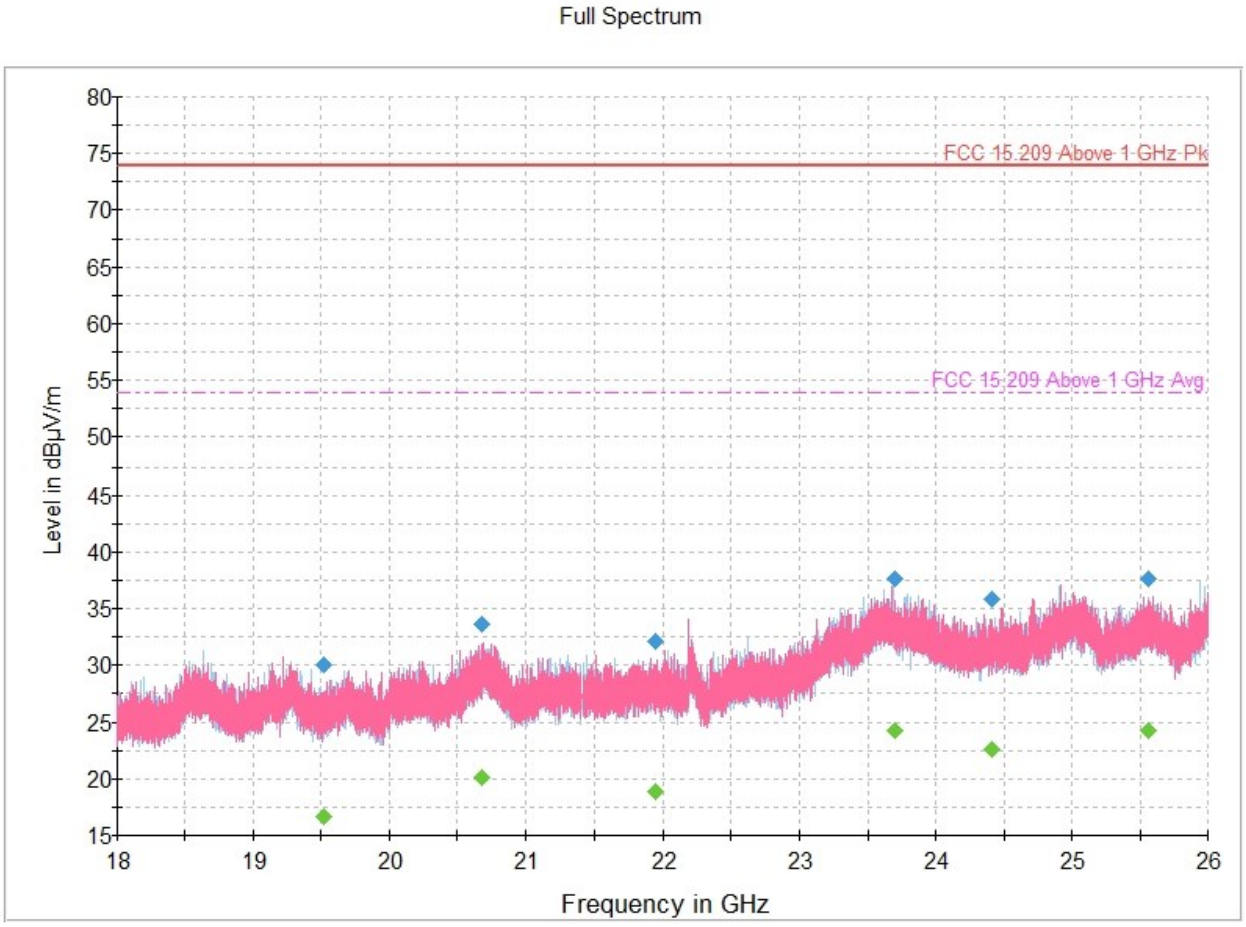
The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.6-7: *Radiated emissions, middle channel, 1 – 18 GHz spectral plot*

Table 8.6-8: *Radiated emissions, middle channel, 1 – 18 GHz (Quasi-Peak) results*

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)
2081.700000	---	33.80	53.90	20.10	5000.0	1000.000	142.0	H	51.0	-11.2
2081.700000	46.99	---	73.90	26.91	5000.0	1000.000	142.0	H	51.0	-11.2
4879.800000	---	35.37	53.90	18.53	5000.0	1000.000	134.0	H	309.0	-2.0
4879.800000	46.32	---	73.90	27.58	5000.0	1000.000	134.0	H	309.0	-2.0
4994.633333	54.20	---	73.90	19.70	5000.0	1000.000	267.0	H	51.0	-2.1
4994.633333	---	34.48	53.90	19.42	5000.0	1000.000	267.0	H	51.0	-2.1
7319.966667	55.15	---	73.90	18.75	5000.0	1000.000	250.0	H	12.0	0.8
7319.966667	---	43.90	53.90	10.00	5000.0	1000.000	250.0	H	12.0	0.8
9980.533333	---	31.13	53.90	22.77	5000.0	1000.000	155.0	V	0.0	3.9
9980.533333	49.77	---	73.90	24.13	5000.0	1000.000	155.0	V	0.0	3.9
12206.800000	41.96	---	73.90	31.94	5000.0	1000.000	384.0	H	288.0	6.8
12206.800000	---	29.12	53.90	24.78	5000.0	1000.000	384.0	H	288.0	6.8
14634.400000	---	30.82	53.90	23.08	5000.0	1000.000	130.0	H	274.0	9.6
14634.400000	44.39	---	73.90	29.51	5000.0	1000.000	130.0	H	274.0	9.6
17078.400000	47.48	---	73.90	26.42	5000.0	1000.000	410.0	H	328.0	13.4
17078.400000	---	33.78	53.90	20.12	5000.0	1000.000	410.0	H	328.0	13.4

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.



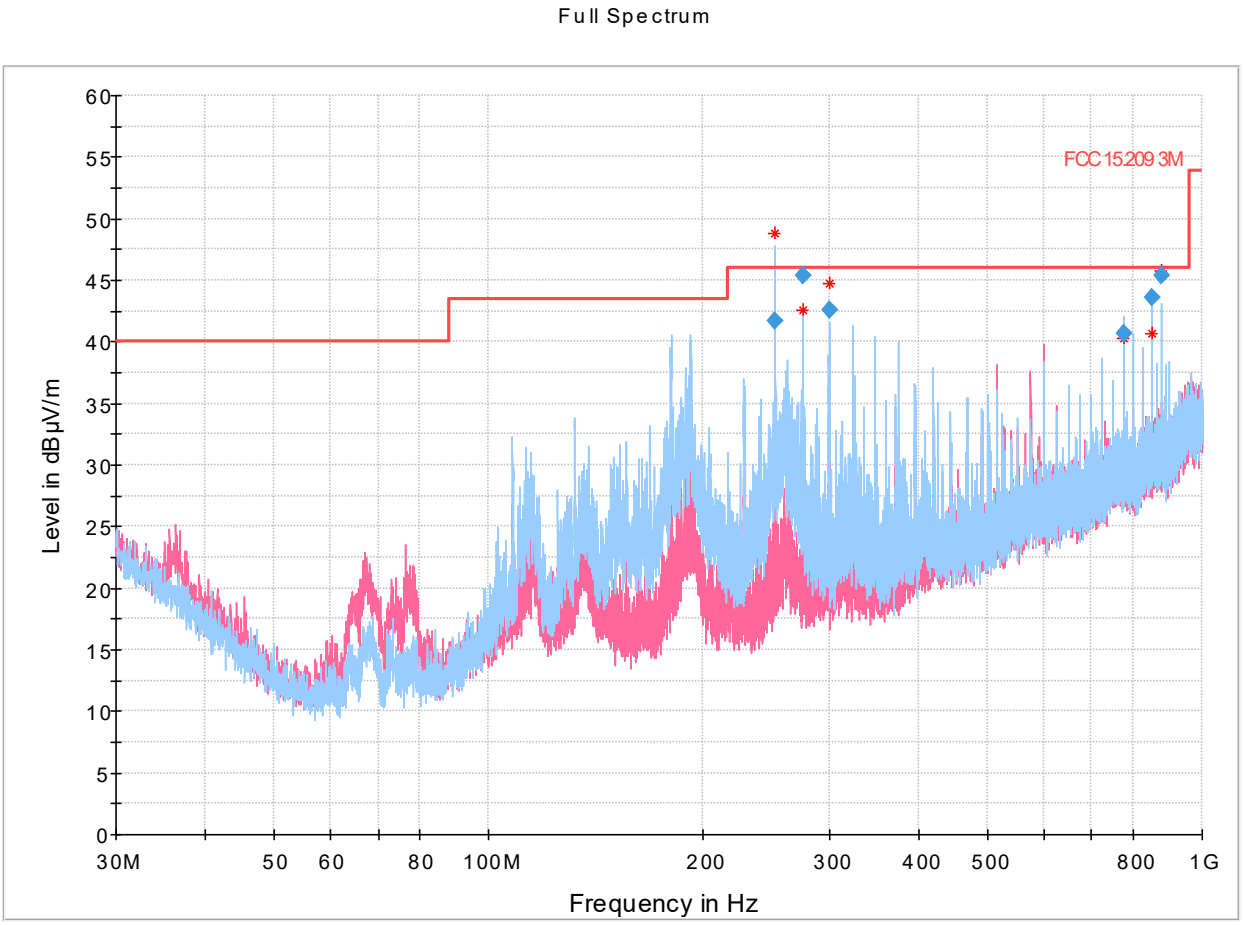
The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.6-8: *Radiated emissions, middle channel, 18 – 26 GHz spectral plot*

Table 8.6-9: *Radiated emissions, middle channel, 18 – 26 GHz (Quasi-Peak) results*

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)
19516.200000	29.99	---	73.90	43.91	5000.0	1000.000	361.0	V	11.0	17.6
19516.200000	---	16.60	53.90	37.30	5000.0	1000.000	361.0	V	11.0	17.6
20672.866667	---	20.07	53.90	33.83	5000.0	1000.000	402.0	V	305.0	20.3
20672.866667	33.58	---	73.90	40.32	5000.0	1000.000	402.0	V	305.0	20.3
21947.000000	---	18.83	53.90	35.07	5000.0	1000.000	126.0	H	238.0	19.0
21947.000000	32.09	---	73.90	41.81	5000.0	1000.000	126.0	H	238.0	19.0
23697.800000	---	24.28	53.90	29.62	5000.0	1000.000	341.0	H	77.0	23.1
23697.800000	37.69	---	73.90	36.21	5000.0	1000.000	341.0	H	77.0	23.1
24408.600000	---	22.63	53.90	31.27	5000.0	1000.000	325.0	V	220.0	21.5
24408.600000	35.80	---	73.90	38.10	5000.0	1000.000	325.0	V	220.0	21.5
25560.066667	37.66	---	73.90	36.24	5000.0	1000.000	368.0	H	321.0	22.7
25560.066667	---	24.29	53.90	29.61	5000.0	1000.000	368.0	H	321.0	22.7

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.



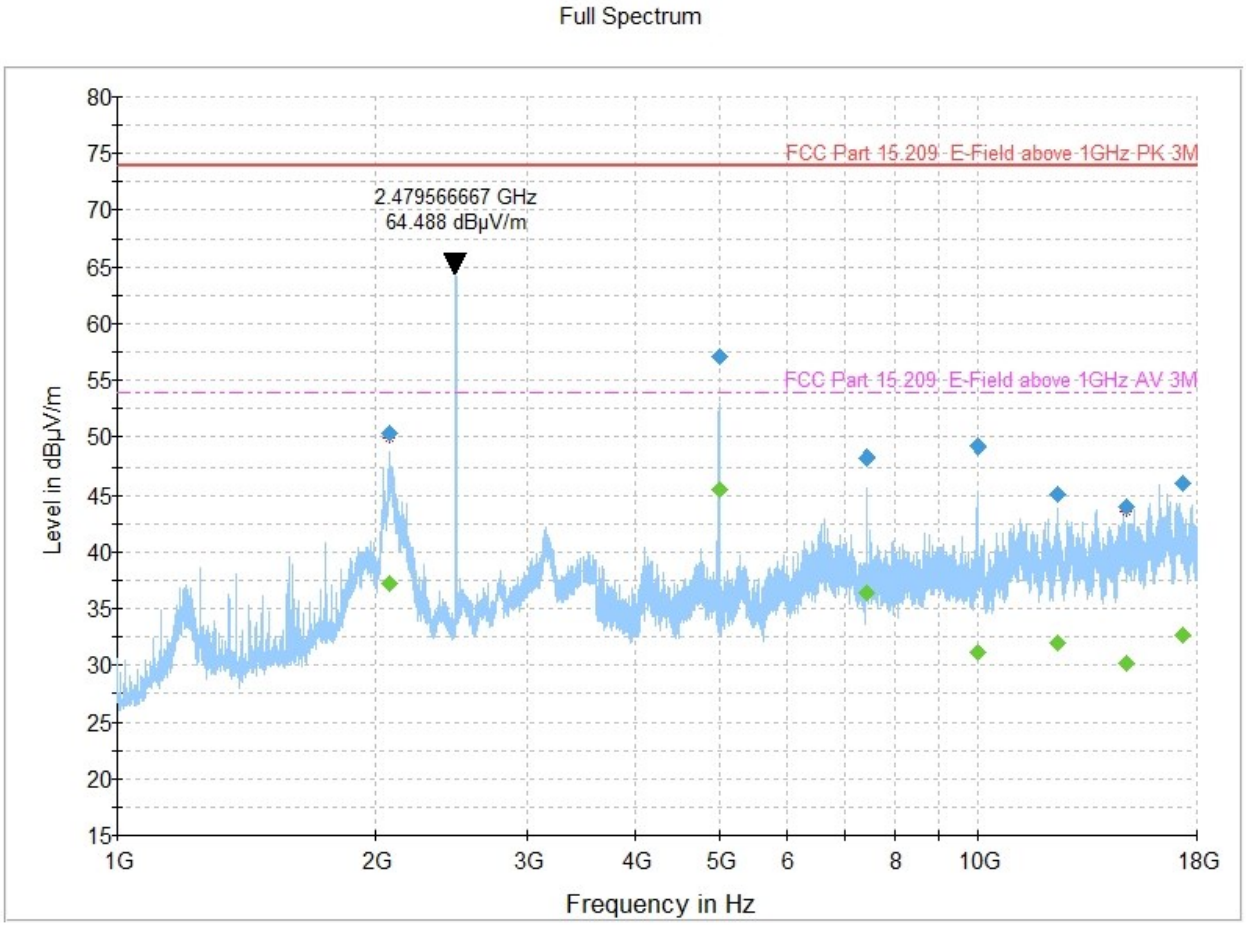
The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.6-9: *Radiated emissions, high channel, 30 – 1000 MHz spectral plot*

Table 8.6-10: *Radiated emissions, high channel, 30 – 1000 MHz (Quasi-Peak) results*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
252.087000	41.74	46.00	4.26	5000.0	120.000	160.1	H	206.0	20.1
275.926000	45.38	46.00	0.62	5000.0	120.000	119.9	H	176.0	20.3
299.797333	42.61	46.00	3.39	5000.0	120.000	109.2	H	272.0	20.7
775.004667	40.62	46.00	5.38	5000.0	120.000	109.1	H	237.0	31.6
850.025667	43.59	46.00	2.41	5000.0	120.000	98.0	H	323.0	32.8
875.011667	45.32	46.00	0.68	5000.0	120.000	98.0	H	237.0	32.6

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.
[4] Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.



The signal seen at 2.4796 GHz is the fundamental of the intentional radiator, and not measured against the FCC 15.209 limits.

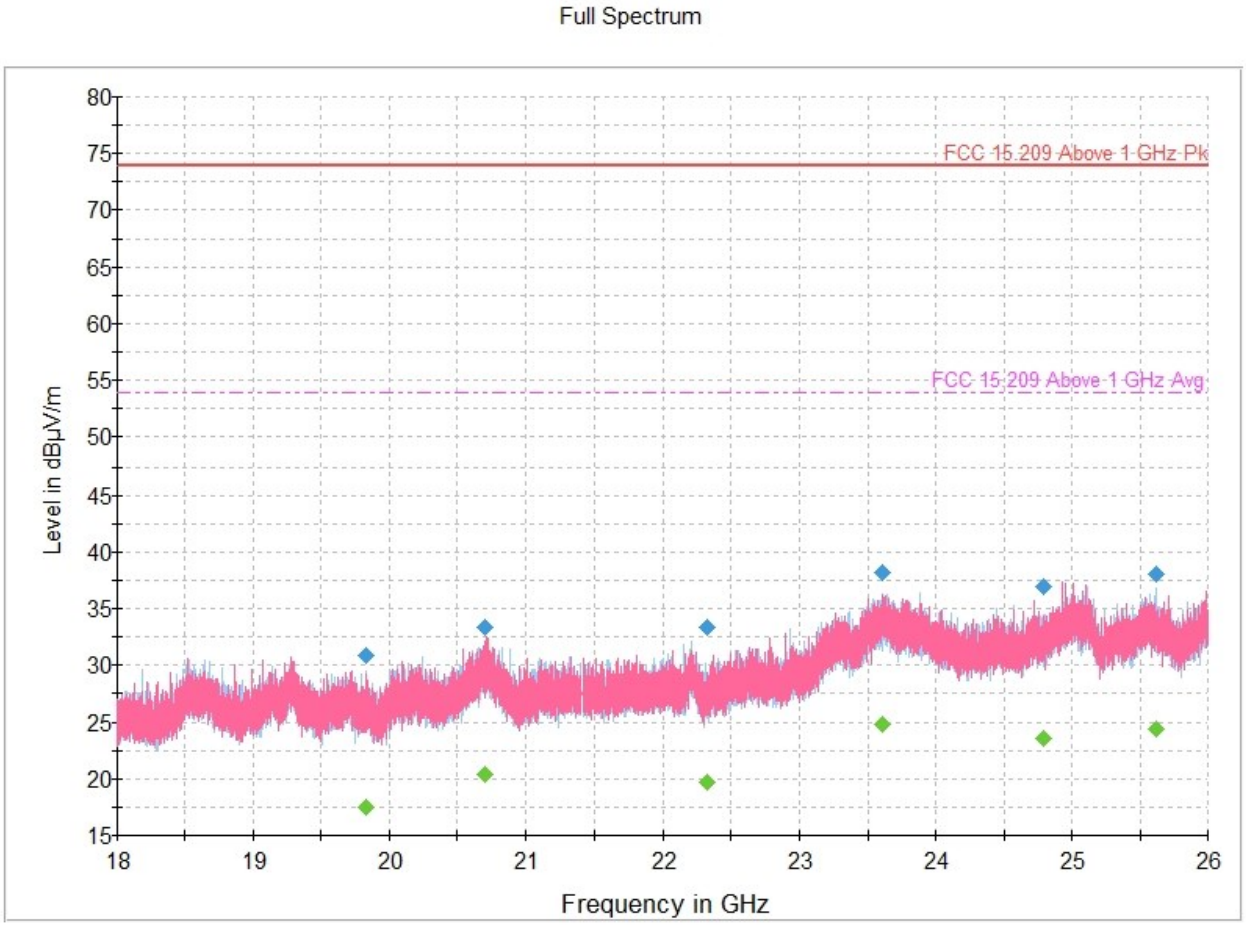
The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.6-10: *Radiated emissions, high channel, 1 – 18 GHz spectral plot*

Table 8.6-11: *Radiated emissions, high channel, 1 – 18 GHz (Quasi-Peak) results*

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)
2074.533333	---	37.28	53.90	16.62	5000.0	1000.000	147.0	H	62.0	-11.2
2074.533333	50.38	---	73.90	23.52	5000.0	1000.000	147.0	H	62.0	-11.2
4999.900000	---	45.45	53.90	8.45	5000.0	1000.000	265.0	H	50.0	-2.1
4999.900000	57.09	---	73.90	16.81	5000.0	1000.000	265.0	H	50.0	-2.1
7440.000000	---	36.38	53.90	17.52	5000.0	1000.000	212.0	V	23.0	1.3
7440.000000	48.23	---	73.90	25.67	5000.0	1000.000	212.0	V	23.0	1.3
9985.666667	---	31.09	53.90	22.81	5000.0	1000.000	160.0	V	0.0	3.9
9985.666667	49.28	---	73.90	24.62	5000.0	1000.000	160.0	V	0.0	3.9
12398.800000	---	31.96	53.90	21.94	5000.0	1000.000	324.0	H	0.0	7.4
12398.800000	45.13	---	73.90	28.77	5000.0	1000.000	324.0	H	0.0	7.4
14882.800000	44.00	---	73.90	29.90	5000.0	1000.000	385.0	H	64.0	10.0
14882.800000	---	30.17	53.90	23.73	5000.0	1000.000	385.0	H	64.0	10.0
17363.200000	46.03	---	73.90	27.87	5000.0	1000.000	322.0	H	0.0	13.5
17363.200000	---	32.66	53.90	21.24	5000.0	1000.000	322.0	H	0.0	13.5

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.



The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.6-11: *Radiated emissions, high channel, 18 – 26 GHz spectral plot*

Table 8.6-12: *Radiated emissions, high channel, 18 – 26 GHz (Quasi-Peak) results*

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)
19829.800000	30.85	---	73.90	43.05	5000.0	1000.000	402.0	V	168.0	17.8
19829.800000	---	17.52	53.90	36.38	5000.0	1000.000	402.0	V	168.0	17.8
20703.400000	---	20.41	53.90	33.49	5000.0	1000.000	337.0	V	105.0	20.6
20703.400000	33.40	---	73.90	40.50	5000.0	1000.000	337.0	V	105.0	20.6
22319.000000	33.37	---	73.90	40.53	5000.0	1000.000	179.0	H	154.0	19.2
22319.000000	---	19.70	53.90	34.20	5000.0	1000.000	179.0	H	154.0	19.2
23606.733333	---	24.86	53.90	29.04	5000.0	1000.000	309.0	H	174.0	23.8
23606.733333	38.15	---	73.90	35.75	5000.0	1000.000	309.0	H	174.0	23.8
24795.800000	36.93	---	73.90	36.97	5000.0	1000.000	277.0	V	12.0	22.4
24795.800000	---	23.60	53.90	30.30	5000.0	1000.000	277.0	V	12.0	22.4
25617.400000	38.00	---	73.90	35.90	5000.0	1000.000	315.0	H	190.0	22.7
25617.400000	---	24.34	53.90	29.56	5000.0	1000.000	315.0	H	190.0	22.7

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.

8.7 FCC 15.247(e) and RSS-247 5.2(b) Power spectral density of digital transmission system

8.7.1 References

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(e) / ANSI C63.10: 2013

(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.

RSS-247 → §5.2(b)

(a) The transmitter power spectral density conducted from the transmitter 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 Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

8.7.2 Test summary

Verdict	Pass		
Test date	January 19, 2021	Temperature	25 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	997 mbar
Test location	Wireless bench	Relative humidity	31 %

8.7.3 Notes

Testing was performed in Tx mode and the EUT transmitting on a fixed channel at full power.

The EUT antenna port was connected to the spectrum analyzer via low loss cable and a suitable attenuator. The loss of this assembly was corrected for via a transducer factor in the spectrum analyzer.

The duty cycle correction factor of 2.2 dB (refer to section 8.3.5) is included as a reference level offset in the spectrum analyzer.

8.7.4 Setup details

EUT setup configuration	Table top
Test facility	Nemko San Diego
Measurement details	Measurement performed as per C63.10 §11.10.5 Method AVGPSD-2

Receiver/spectrum analyzer settings:

Resolution bandwidth	3 kHz
Video bandwidth	10 kHz (≥ 3 x RBW)
Frequency span	1.5 x DTS bandwidth
Detector mode	RMS
Trace mode	Averaging
Averaging sweeps	100

8.7.5 Test data

Table 8.7-1: *Power spectral density of DTS*

Transmitter Frequency (MHz)	Measured Level (dBm/3 kHz)	Limit (dBm/3 kHz)
2402	-19.91	8.00
2440	-18.41	8.00
2480	-16.64	8.00

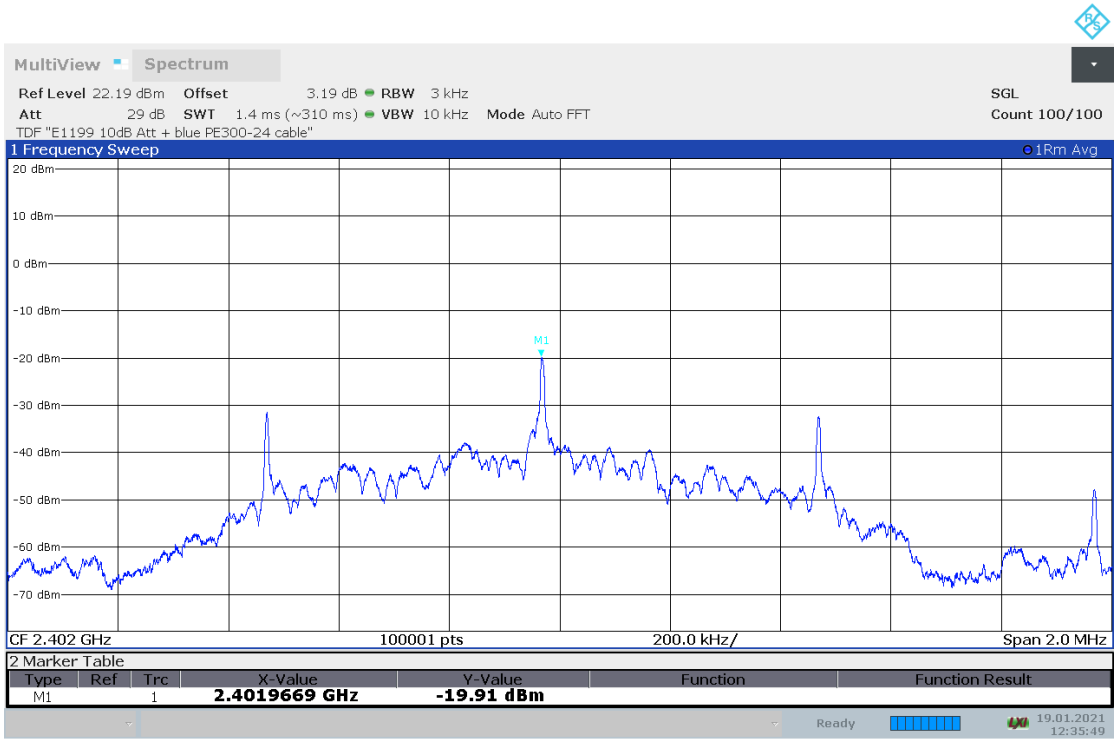


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Figure 8.7-1: *Power spectral density of digital transmission system, 2402 MHz*

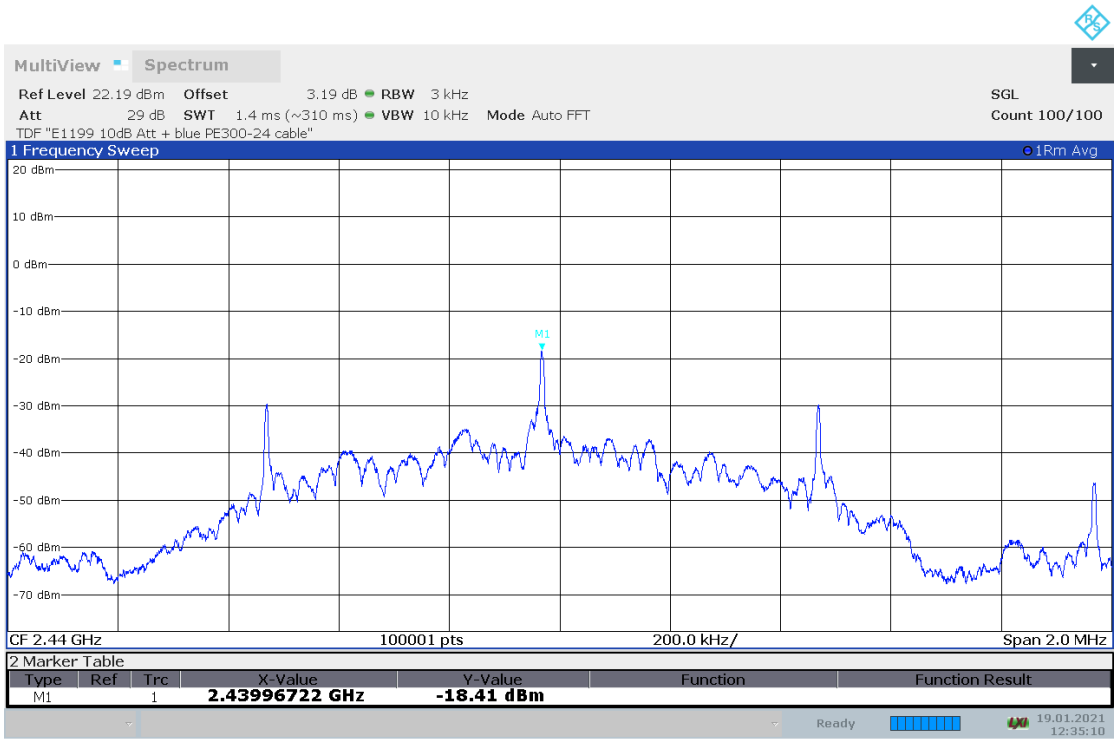

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Figure 8.7-2: *Power spectral density of digital transmission system, 2440 MHz*

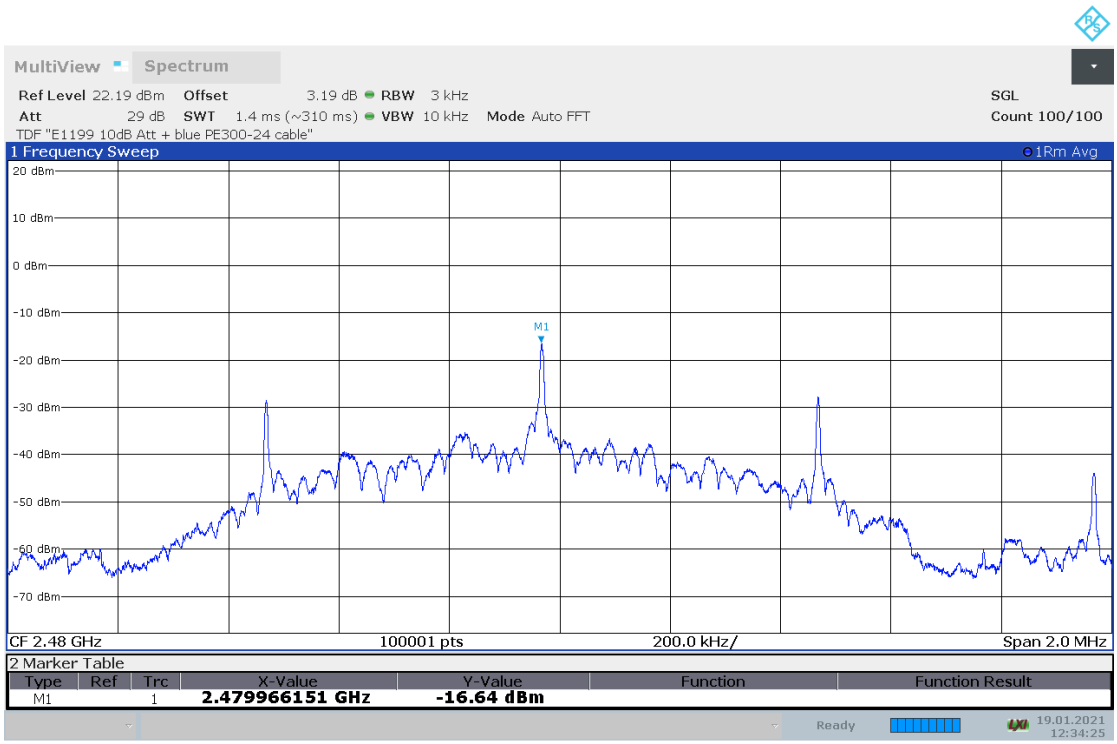

Figure 8.7-3: *Power spectral density of digital transmission system, 2480 MHz*

8.8 RSS-GEN 6.7 Occupied bandwidth (or 99% emission bandwidth)

8.8.1 References

RSS-Gen → §6.7

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.

8.8.2 Test summary

Test date	January 19, 2021	Temperature	25 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	997 mbar
Test location	Wireless bench	Relative humidity	31 %

8.8.3 Notes

Testing was performed in Tx mode and the EUT transmitting on a fixed channel at full power.

8.8.4 Setup details

EUT setup configuration	Tabletop
Test facility	Nemko San Diego
Measurement details	Measurement performed as per C63.10 §6.9.3 using the built-in function of the spectrum analyzer

Receiver/spectrum analyzer settings:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.8.5 Test data

Table 8.8-1: *99% Occupied bandwidth*

Test Frequency (MHz)	M1 (MHz)	T1 (MHz)	T2 (MHz)	99%Bandwidth (MHz)
2402 (Low channel)	2401.9684	2401.428243	2402.513783	1.08554
2440 (Mid channel)	2439.979	2439.43017	2440.512749	1.08258
2480 (High channel)	2479.979	2479.428979	2480.51341	1.08443

8.8.5 Test data, continued

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Figure 8.8-1: *99% bandwidth, 2402 MHz*

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Figure 8.8-2: *99% bandwidth, 2440 MHz*

Figure 8.8-3: *99% bandwidth, 2480 MHz*

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up

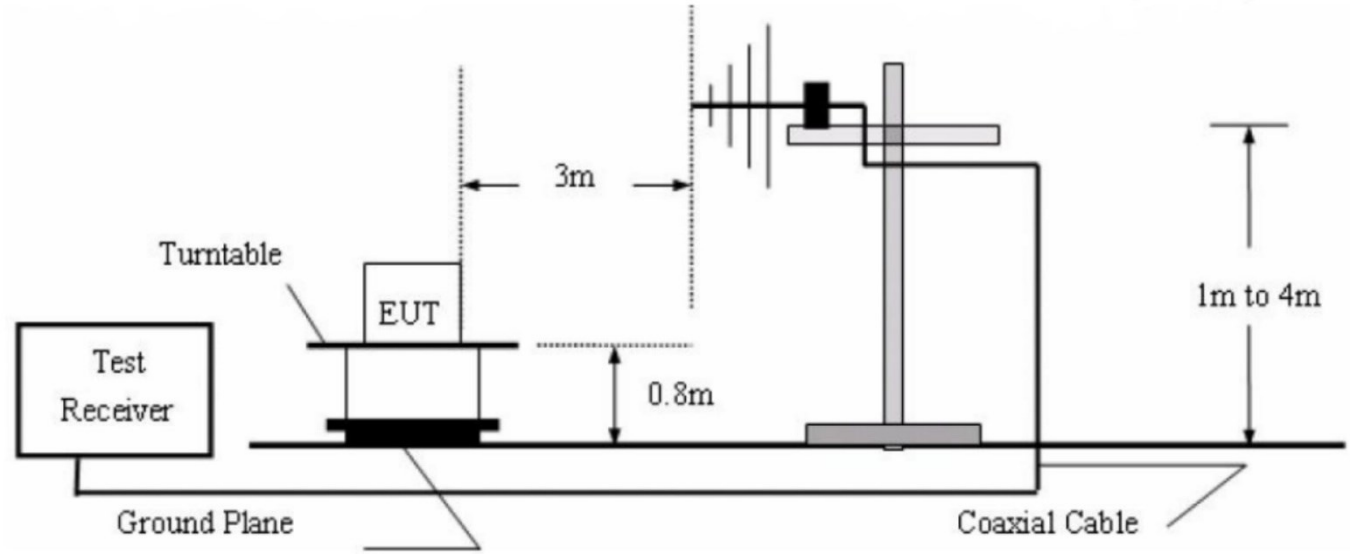

Figure 9.1-1: *30 MHz - 1000 MHz Setup*

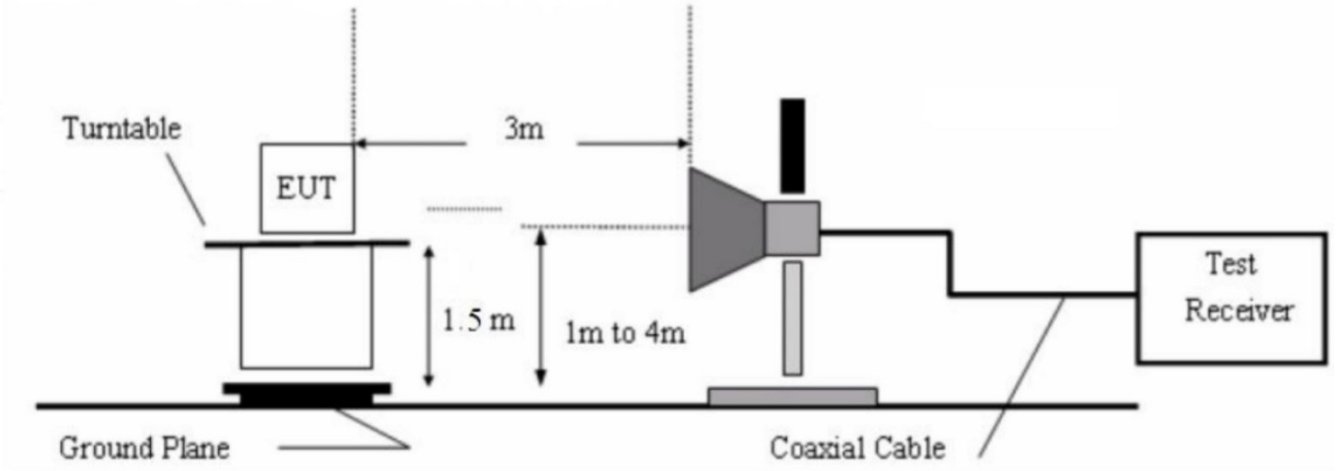

Figure 9.1-2: 1 GHz - 26 GHz Setup

9.2 Conducted emissions set-up

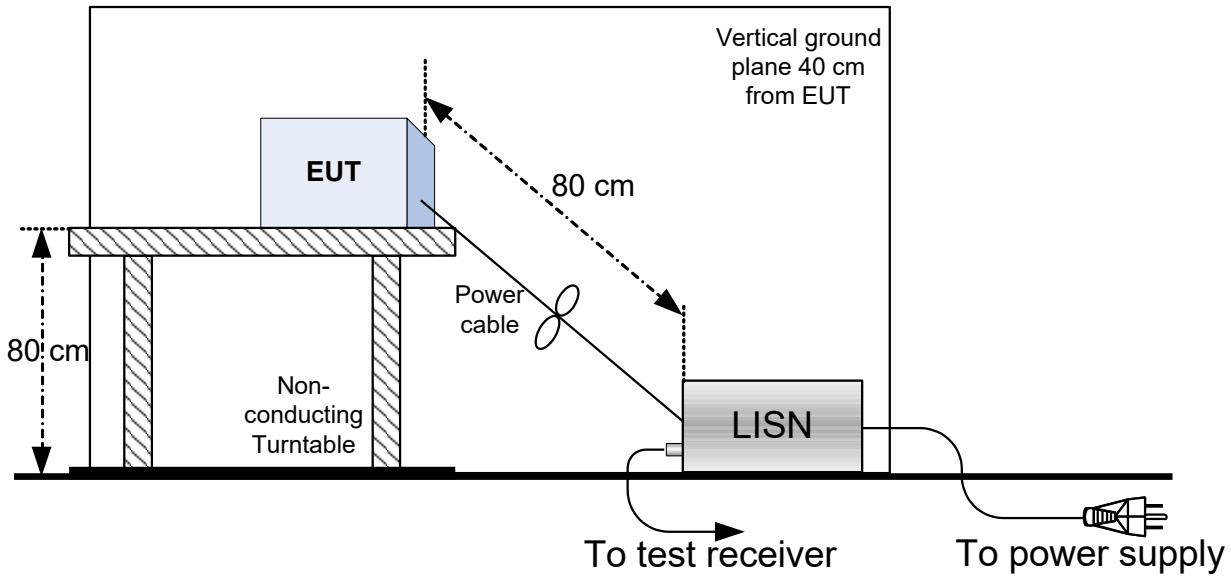

Figure 9.2-1: *150 kHz to 30 MHz Conducted Emissions Setup*