Test report

443623-2TRFWL

Date of issue: August 20, 2021

Applicant:
Panduit Corp.

Product:
Network Management Card

Model:
PAN100

FCC ID:
2AVV3-PAN100

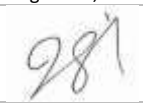
IC certification number:
11688B-PAN100

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	August 20, 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

Table of Contents

Section 1 Report summary

1.1 Applicant

Company name	Panduit Corp.
Address	18900 Panduit Drive
City	Tinley Park
Province/State	IL
Postal/Zip code	60487
Country	USA

1.2 Manufacturer

Company name	Panduit Corp.
Address	18900 Panduit Drive
City	Tinley Park
Province/State	IL
Postal/Zip code	60487
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

Variation of power source test could not be performed on the EUT because the EUT receives 5 V_{DC} via USB cable from the support laptop. Adjusting the voltage of the AC mains supply to the support laptop would have been irrelevant to the nature of the test because it would not have changed the supply voltage to the EUT itself.

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 except as noted in section 1.5 above. 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
443623-2TRFWL	Original report issued
Notes:	None

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	Not tested
§15.203	Antenna requirement	Pass

Notes: EUT is DC powered via USB micro, and voltage could not be varied.
The antenna is located within the protective cover of EUT

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	Pass
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Not applicable
§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	Pass
§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	Not applicable
§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	Pass
5.1 (b)	Minimum channel spacing for frequency hopping systems	Pass
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	Pass
5.1 (e)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
5.2 (a)	Minimum 6 dB bandwidth	Not applicable
5.2 (b)	Maximum power spectral density	Not applicable
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	Pass
5.4 (c)	Frequency hopping systems operating in the 5725–5850 MHz	Not applicable
5.4 (d)	Systems employing digital modulation techniques	Not applicable
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	June 25, 2021
Nemko sample ID number	NEx: 443623

3.2 EUT information

Product name	Network Management Card
Model	irUPS NMC
Serial number	N/A
Part number	ESP32-WROVER-IE

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
Type of modulation	GFSK π/4-DQPSK 8-DPSK
Power requirements	5 V_{DC}, 0.5 A
Antenna information	TAOGLAS FXP840 antenna 3.6 dBi gain antenna attached via U.FL connector

3.4 EUT exercise and monitoring details

The EUT was controlled by support laptop running ESP_RF_test_tool_v2.5 and set to transmit Bluetooth signals at max power while on the Low, Middle, and High channels—as applicable per test—using the GFSK, π/4-DQPSK, and 8-DPSK modulations schemes.

Table 3.4-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number	Rev.
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Table 3.4-2: *EUT interface ports*

Description	Qty.
USB micro	1

Table 3.4-3: *Support equipment*

Description	Brand name	Model/Part number	Serial number	Rev.
Support Laptop	Dell	Inspiron 5548		--

Table 3.4-4: *Inter-connection cables*

Cable description	From	To	Length (m)
USB	Support laptop	EUT	1.0

3.5 EUT setup diagram

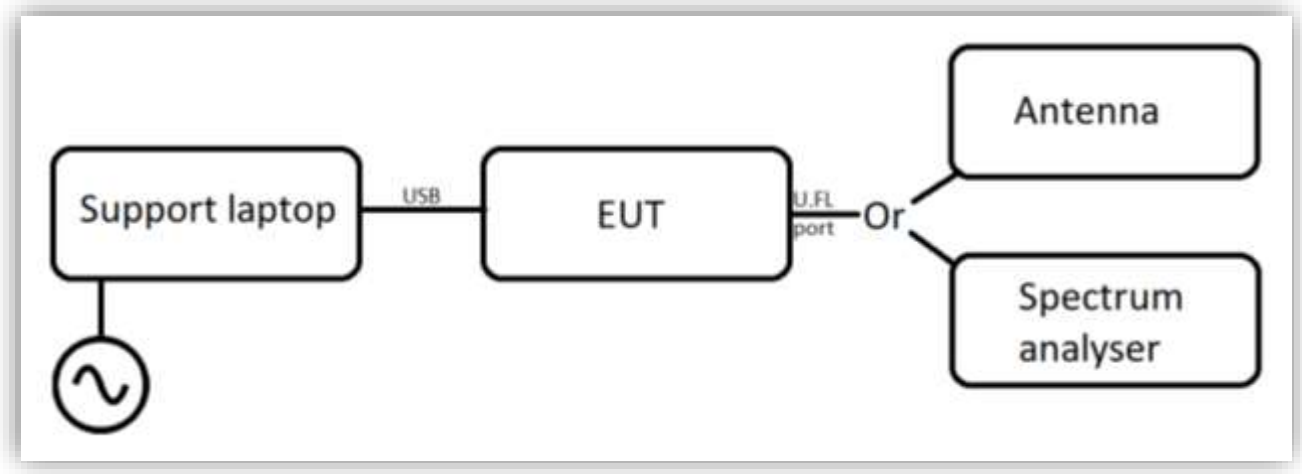

Figure 3.5-1: *Setup diagram*

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

Nemko USA Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 "Uncertainty in EMC measurements." Measurement uncertainty was calculated using the methods described in CISPR 16-4-2 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics, and limit modelling – Measurement instrumentation uncertainty. The expression of Uncertainty in EMC testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

Table 6.1-1: *Measurement uncertainty calculations*

Measurement		U_{cispr} dB	U_{lab} dB
Conducted disturbance at AC mains and other port power using a V-AMN	9 kHz to 150 kHz	3.8	2.9
	150 kHz to 30 MHz	3.4	2.3
Conducted disturbance at telecommunication port using AAN	150 kHz to 30 MHz	5.0	4.3
Conducted disturbance at telecommunication port using CVP	150 kHz to 30 MHz	3.9	2.9
Conducted disturbance at telecommunication port using CP	150 kHz to 30 MHz	2.9	1.4
Conducted disturbance at telecommunication port using CP and CVP	150 kHz to 30 MHz	4.0	3.1
Radiated disturbance (electric field strength in a SAC)	30 MHz to 1 GHz	6.3	5.5
Radiated disturbance (electric field strength in a FAR)	1 GHz to 6 GHz	5.2	4.7
Radiated disturbance (electric field strength in a FAR)	6 GHz to 18 GHz	5.5	5.0

Notes: Compliance assessment:

If U_{lab} is less than or equal to U_{cispr} then:

- compliance is deemed to occur is no measured disturbance level exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit

If U_{lab} is greater than U_{cispr} then:

- compliance is deemed to occur is no measured disturbance level, increased by (U_{lab} - U_{cispr}), exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance level, increased by (U_{lab} - U_{cispr}), exceeds the disturbance limit

V-AMN: V type artificial mains network
AAN: Asymmetric artificial network
CP: Current probe
CVP: Capacitive voltage probe
SAC: Semi-anechoic chamber
FAR: Fully anechoic room

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	1 yr	24 Feb 2022
Transient Limiter	Hewlett-Packard	11947A	681	1 yr	11 Feb 2022
Two Line V-Network	Rohde & Schwarz	ENV216	E1020	1 yr	2 Sep 2022
Signal and spectrum analyzer	Rohde & Schwarz	FSV40	E1120	2 yr	19 Nov 2021
Signal and spectrum analyzer	Rohde & Schwarz	FSW43	E1302	1 yr	18 Sep 2021
Power sensor	ETS Lindgren	7002-006	E1061	1 yr	20 May 2022
Power sensor	ETS Lindgren	7002-006	E1062	1 yr	14 Oct 2021
EMI Test Receiver	Rohde & Schwarz	ESU40	E1121	1 yr	19 May 2022
System Controller	Sunol Sciences	SC104V	E1191	NCR	NCR
Bilog Antenna (30-1000 MHz)	Schaffner	CBL 6111D	1763	2 yr	18 Feb 2022
DRG Horn (1-18 GHz)	ETS-Lindgren	3117-PA	E1160	1 yr	2 Dec 2021
Horn antenna (18-26 GHz)	SAGE	SAR-2309-42-S2	E1143	2 yr	13 Nov 2022
Low noise amplifier	Sage Millimeter, Inc.	SBL-1834034030-KFKF	E1228	VOU	VOU
2.4GHz notch filter	Micro-Tonics	HPM50110-01	E1142	NCR	NCR

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)

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	July 22, 2021	Temperature	22 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1005 mbar
Test location	Ground Plane	Relative humidity	69 %

8.1.3 Notes

Testing was performed with the Bluetooth transmitter operating on a fixed channel at full power. Low, middle, and high channels were tested using GFSK, π/4-DQPSK, and 8-DPSK modulation schemes.

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

8.1.4 Setup details

Port under test	AC mains of host support laptop
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 (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)

8.1.5 Test data

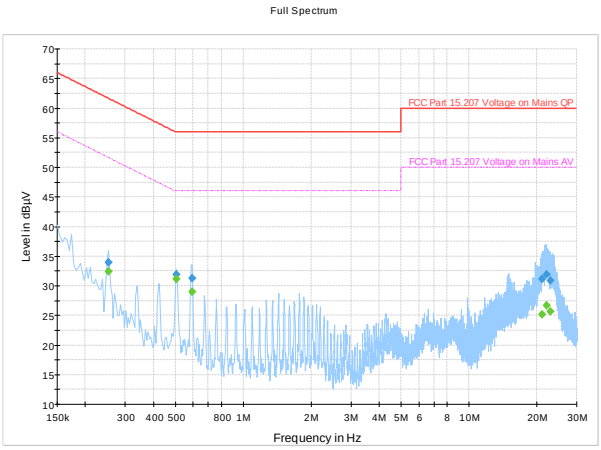

Figure 8.1-1: *AC conducted emissions spectral plot, Low channel, GFSK modulation*

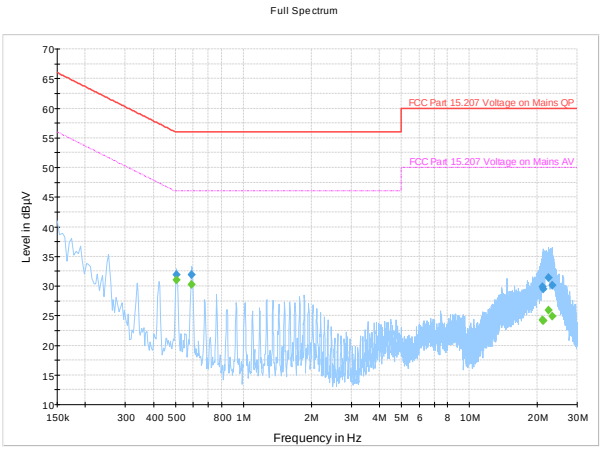

Figure 8.1-2: *AC conducted emissions spectral plot, Low channel, π/4-DQPSK modulation*

Table 8.1-2: *AC conducted emissions tabular data, 150 kHz – 30 MHz, Low channel, GFSK modulation*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.254000	---	32.41	51.63	19.22	5000.0	9.000	N	ON	19.4
0.254000	33.93	---	61.63	27.69	5000.0	9.000	N	ON	19.4
0.506000	---	31.12	46.00	14.88	5000.0	9.000	N	ON	19.4
0.506000	31.92	---	56.00	24.08	5000.0	9.000	N	ON	19.4
0.594000	---	29.04	46.00	16.96	5000.0	9.000	N	ON	19.4
0.594000	31.26	---	56.00	24.74	5000.0	9.000	N	ON	19.4
21.010000	---	25.13	50.00	24.87	5000.0	9.000	N	ON	20.1
21.010000	31.15	---	60.00	28.85	5000.0	9.000	N	ON	20.1
21.998000	---	26.70	50.00	23.30	5000.0	9.000	N	ON	20.1
21.998000	31.89	---	60.00	28.11	5000.0	9.000	N	ON	20.1
22.962000	---	25.67	50.00	24.33	5000.0	9.000	N	ON	20.0
22.962000	30.84	---	60.00	29.16	5000.0	9.000	N	ON	20.0

Notes: Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)

Table 8.1-3: *AC conducted emissions tabular data, 150 kHz – 30 MHz, Low channel, π/4-DQPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.506000	---	31.03	46.00	14.97	5000.0	9.000	N	ON	19.4
0.506000	31.90	---	56.00	24.10	5000.0	9.000	N	ON	19.4
0.590000	---	30.26	46.00	15.74	5000.0	9.000	N	ON	19.4
0.590000	31.89	---	56.00	24.11	5000.0	9.000	N	ON	19.4
21.050000	---	24.28	50.00	25.72	5000.0	9.000	N	ON	20.1
21.050000	29.94	---	60.00	30.06	5000.0	9.000	N	ON	20.1
21.254000	---	24.20	50.00	25.80	5000.0	9.000	N	ON	20.1
21.254000	29.45	---	60.00	30.55	5000.0	9.000	N	ON	20.1
22.414000	---	25.88	50.00	24.12	5000.0	9.000	N	ON	20.1
22.414000	31.41	---	60.00	28.59	5000.0	9.000	N	ON	20.1
23.270000	---	24.84	50.00	25.16	5000.0	9.000	N	ON	20.0
23.270000	30.12	---	60.00	29.88	5000.0	9.000	N	ON	20.0

Notes: Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)

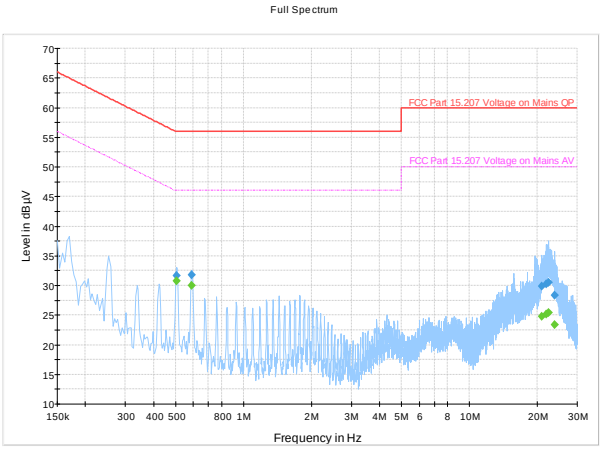

Figure 8.1-3: *AC conducted emissions spectral plot, Low channel, 8-DPSK modulation*

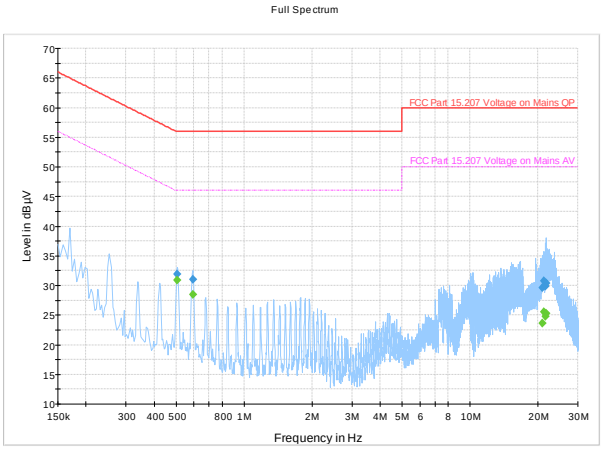

Figure 8.1-4: *AC conducted emissions spectral plot, Mid channel, GFSK modulation*

Table 8.1-4: *AC conducted emissions tabular data, 150 kHz – 30 MHz, Low channel, 8-DPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.506000	---	30.81	46.00	15.19	5000.0	9.000	N	ON	19.4
0.506000	31.71	---	56.00	24.29	5000.0	9.000	N	ON	19.4
0.590000	---	30.04	46.00	15.96	5000.0	9.000	N	ON	19.4
0.590000	31.73	---	56.00	24.27	5000.0	9.000	N	ON	19.4
20.874000	---	24.82	50.00	25.18	5000.0	9.000	N	ON	20.1
20.874000	29.90	---	60.00	30.10	5000.0	9.000	N	ON	20.1
21.874000	---	25.14	50.00	24.86	5000.0	9.000	N	ON	20.1
21.874000	30.31	---	60.00	29.69	5000.0	9.000	N	ON	20.1
22.466000	---	25.40	50.00	24.60	5000.0	9.000	N	ON	20.1
22.466000	30.57	---	60.00	29.43	5000.0	9.000	N	ON	20.1
23.810000	---	23.32	50.00	26.68	5000.0	9.000	N	ON	20.0
23.810000	28.35	---	60.00	31.65	5000.0	9.000	N	ON	20.0

Notes: Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)

Table 8.1-5: *AC conducted emissions tabular data, 150 kHz – 30 MHz, Mid channel, GFSK modulation*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.506000	---	30.95	46.00	15.05	5000.0	9.000	N	ON	19.4
0.506000	31.88	---	56.00	24.12	5000.0	9.000	N	ON	19.4
0.594000	---	28.52	46.00	17.48	5000.0	9.000	N	ON	19.4
0.594000	31.03	---	56.00	24.97	5000.0	9.000	N	ON	19.4
20.898000	---	23.57	50.00	26.43	5000.0	9.000	N	ON	20.1
20.898000	29.56	---	60.00	30.44	5000.0	9.000	N	ON	20.1
21.286000	---	25.48	50.00	24.52	5000.0	9.000	N	ON	20.1
21.286000	30.77	---	60.00	29.23	5000.0	9.000	N	ON	20.1
21.626000	---	24.79	50.00	25.21	5000.0	9.000	N	ON	20.1
21.626000	29.89	---	60.00	30.11	5000.0	9.000	N	ON	20.1
21.798000	---	25.29	50.00	24.71	5000.0	9.000	N	ON	20.1
21.798000	30.43	---	60.00	29.57	5000.0	9.000	N	ON	20.1

Notes: Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)

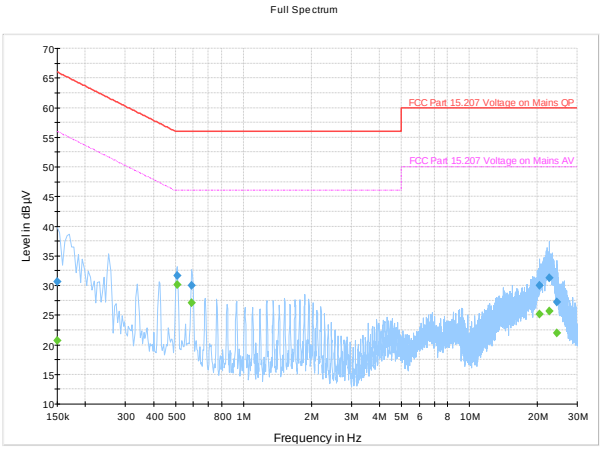

Figure 8.1-5: *AC conducted emissions spectral plot, Mid channel, π/4-DQPSK modulation*

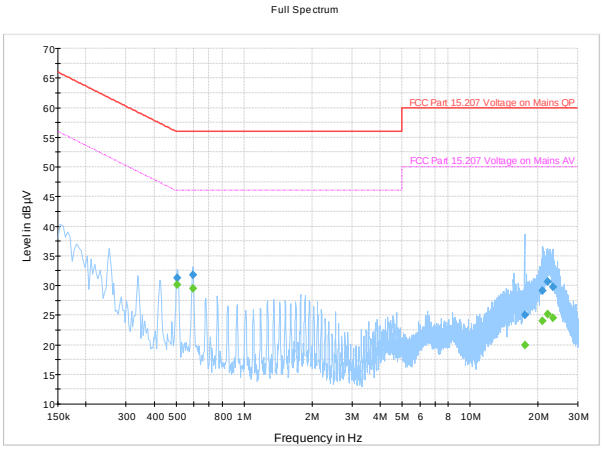

Figure 8.1-6: *AC conducted emissions spectral plot, Mid channel, 8-DPSK modulation*

Table 8.1-6: *AC conducted emissions tabular data, 150 kHz – 30 MHz, Mid channel, π/4-DQPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.150000	---	20.72	56.00	35.28	5000.0	9.000	N	ON	19.6
0.150000	30.63	---	66.00	35.37	5000.0	9.000	N	ON	19.6
0.510000	---	30.11	46.00	15.89	5000.0	9.000	N	ON	19.4
0.510000	31.60	---	56.00	24.40	5000.0	9.000	N	ON	19.4
0.590000	---	27.12	46.00	18.88	5000.0	9.000	N	ON	19.4
0.590000	30.05	---	56.00	25.95	5000.0	9.000	N	ON	19.4
20.478000	---	25.16	50.00	24.84	5000.0	9.000	N	ON	20.2
20.478000	30.00	---	60.00	30.00	5000.0	9.000	N	ON	20.2
22.526000	---	25.67	50.00	24.33	5000.0	9.000	N	ON	20.1
22.526000	31.24	---	60.00	28.76	5000.0	9.000	N	ON	20.1
24.306000	---	22.00	50.00	28.00	5000.0	9.000	N	ON	20.0
24.306000	27.24	---	60.00	32.76	5000.0	9.000	N	ON	20.0

Notes: Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)

Table 8.1-7: *AC conducted emissions tabular data, 150 kHz – 30 MHz, Mid channel, 8-DPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.506000	31.30	---	56.00	24.70	5000.0	9.000	N	ON	19.4
0.506000	---	30.11	46.00	15.89	5000.0	9.000	N	ON	19.4
0.594000	---	29.46	46.00	16.54	5000.0	9.000	N	ON	19.4
0.594000	31.84	---	56.00	24.16	5000.0	9.000	N	ON	19.4
17.446000	25.06	---	60.00	34.94	5000.0	9.000	L1	ON	20.3
17.446000	---	19.90	50.00	30.10	5000.0	9.000	L1	ON	20.3
20.974000	---	23.96	50.00	26.04	5000.0	9.000	N	ON	20.1
20.974000	29.07	---	60.00	30.93	5000.0	9.000	N	ON	20.1
22.134000	---	25.17	50.00	24.83	5000.0	9.000	N	ON	20.1
22.134000	30.63	---	60.00	29.37	5000.0	9.000	N	ON	20.1
23.214000	---	24.57	50.00	25.43	5000.0	9.000	N	ON	20.0
23.214000	29.80	---	60.00	30.20	5000.0	9.000	N	ON	20.0

Notes: Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)

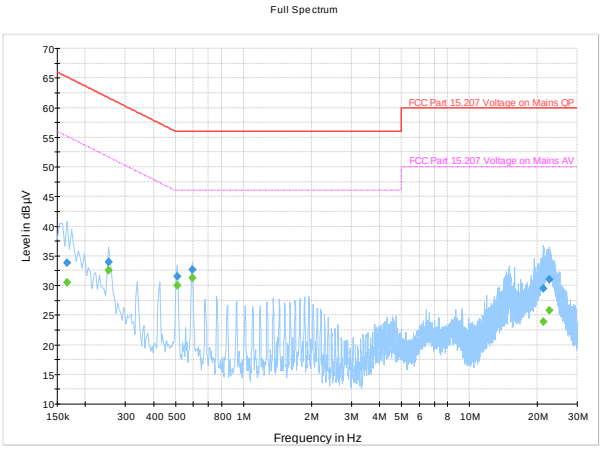

Figure 8.1-7: *AC conducted emissions spectral plot, High channel, GFSK modulation*

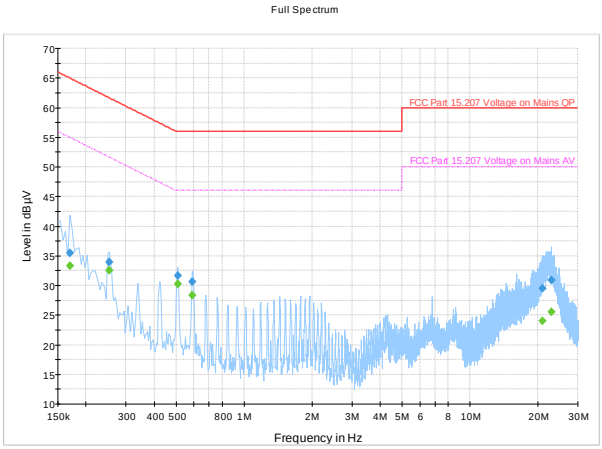

Figure 8.1-8: *AC conducted emissions spectral plot, High channel, π/4-DQPSK modulation*

Table 8.1-8: *AC conducted emissions tabular data, 150 kHz – 30 MHz, High channel, GFSK modulation*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.166000	---	30.50	55.16	24.66	5000.0	9.000	N	ON	19.5
0.166000	33.82	---	65.16	31.34	5000.0	9.000	N	ON	19.5
0.254000	---	32.54	51.63	19.09	5000.0	9.000	N	ON	19.4
0.254000	33.96	---	61.63	27.66	5000.0	9.000	N	ON	19.4
0.510000	---	29.97	46.00	16.03	5000.0	9.000	N	ON	19.4
0.510000	31.47	---	56.00	24.53	5000.0	9.000	N	ON	19.4
0.594000	---	31.23	46.00	14.77	5000.0	9.000	N	ON	19.4
0.594000	32.71	---	56.00	23.29	5000.0	9.000	N	ON	19.4
21.290000	---	23.85	50.00	26.15	5000.0	9.000	N	ON	20.1
21.290000	29.48	---	60.00	30.52	5000.0	9.000	N	ON	20.1
22.606000	---	25.79	50.00	24.21	5000.0	9.000	N	ON	20.1
22.606000	31.00	---	60.00	29.00	5000.0	9.000	N	ON	20.1

Notes: Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)

Table 8.1-9: *AC conducted emissions tabular data, 150 kHz – 30 MHz, High channel, π/4-DQPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.170000	---	33.37	54.96	21.59	5000.0	9.000	N	ON	19.5
0.170000	35.52	---	64.96	29.44	5000.0	9.000	N	ON	19.5
0.254000	---	32.55	51.63	19.08	5000.0	9.000	N	ON	19.4
0.254000	33.95	---	61.63	27.68	5000.0	9.000	N	ON	19.4
0.510000	---	30.25	46.00	15.75	5000.0	9.000	N	ON	19.4
0.510000	31.65	---	56.00	24.35	5000.0	9.000	N	ON	19.4
0.590000	---	28.38	46.00	17.62	5000.0	9.000	N	ON	19.4
0.590000	30.70	---	56.00	25.30	5000.0	9.000	N	ON	19.4
20.890000	---	23.97	50.00	26.03	5000.0	9.000	N	ON	20.1
20.890000	29.49	---	60.00	30.51	5000.0	9.000	N	ON	20.1
22.870000	---	25.58	50.00	24.42	5000.0	9.000	N	ON	20.0
22.870000	30.84	---	60.00	29.16	5000.0	9.000	N	ON	20.0

Notes: Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)

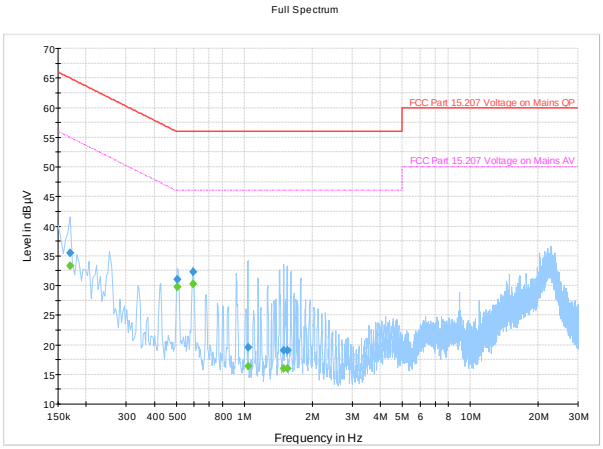

***Figure 8.1-9**: AC conducted emissions spectral plot, High channel, 8-DPSK modulation*

***Table 8.1-10:** AC conducted emissions tabular data, 150 kHz – 30 MHz, High channel, 8-DPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.170000	35.47	---	64.96	29.49	5000.0	9.000	N	ON	19.5
0.170000	---	33.28	54.96	21.68	5000.0	9.000	N	ON	19.5
0.506000	---	29.75	46.00	16.25	5000.0	9.000	N	ON	19.4
0.506000	31.04	---	56.00	24.96	5000.0	9.000	N	ON	19.4
0.594000	32.25	---	56.00	23.75	5000.0	9.000	N	ON	19.4
0.594000	---	30.29	46.00	15.71	5000.0	9.000	N	ON	19.4
1.038000	19.52	---	56.00	36.48	5000.0	9.000	N	ON	19.4
1.038000	---	16.32	46.00	29.68	5000.0	9.000	N	ON	19.4
1.498000	19.08	---	56.00	36.92	5000.0	9.000	N	ON	19.4
1.498000	---	16.02	46.00	29.98	5000.0	9.000	N	ON	19.4
1.550000	---	15.97	46.00	30.03	5000.0	9.000	L1	ON	19.4
1.550000	19.09	---	56.00	36.91	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)

8.2 FCC 15.247(a)(1) and RSS-247 5.2(a) 20 dB Occupied bandwidth

8.2.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(a)(1)

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

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

RSS-247 → §5.1(a)

(a) The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped. The system's radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

8.2.2 Test summary

Test date	August 4, 2021	Temperature	22 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1004 mbar
Test location	Wireless bench (Conducted)	Relative humidity	67 %

8.2.1 Notes

Testing was performed with the Bluetooth transmitter operating on a fixed channel at full power. Low, middle, and high channels were tested using GFSK, π/4-DQPSK, and 8-DPSK modulation schemes.

8.2.2 Setup details

EUT setup configuration	Table top
Test facility	Nemko San Diego
Measurement method	ANSI C63.10 § 6.9.2

Receiver/spectrum analyzer settings:

Resolution bandwidth	50 kHz
Video bandwidth	200 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: *20 dB occupied bandwidth data*

Test Frequency (MHz)	Modulation	20 dB occupied bandwidth
2402	GFSK	959.22 kHz
2402	π/4-DQPSK	1.303178 MHz
2402	8-DPSK	1.309084 MHz
2440	GFSK	957.814 kHz
2440	π/4-DQPSK	1.313584 MHz
2440	8-DPSK	1.313584 MHz
2480	GFSK	970.845 kHz
2480	π/4-DQPSK	1.300553 MHz
2480	8-DPSK	1.31799 MHz

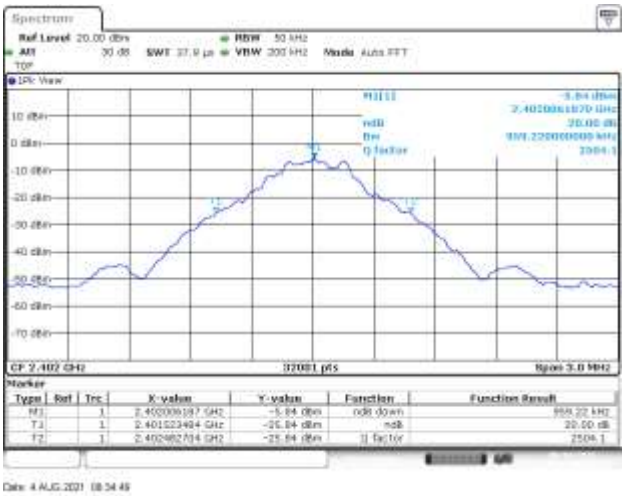

Figure 8.2-1: *20 dB occupied bandwidth, Low channel, GFSK modulation*

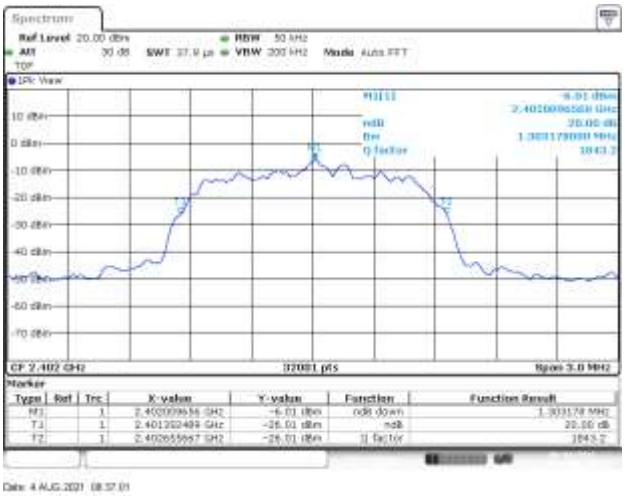

Figure 8.2-2: *20 dB occupied bandwidth, Low channel, π/4-DQPSK modulation*

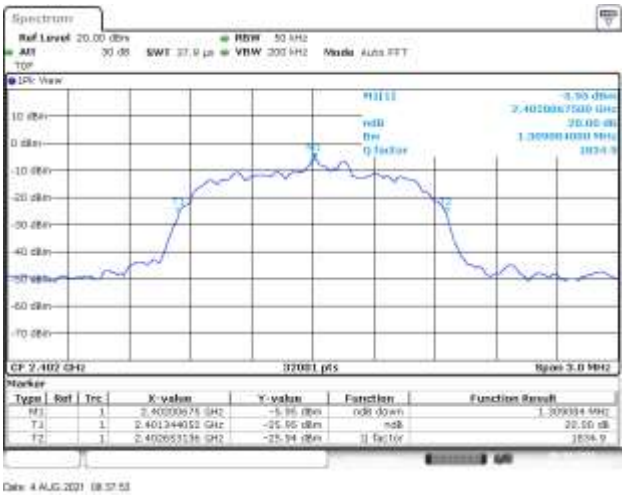

Figure 8.2-3: *20 dB occupied bandwidth, Low channel, 8-DPSK modulation*

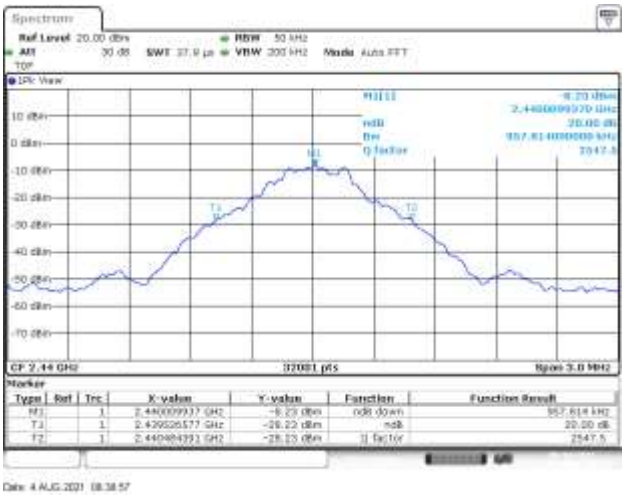

Figure 8.2-4: *20 dB occupied bandwidth, Mid channel, GFSK modulation*

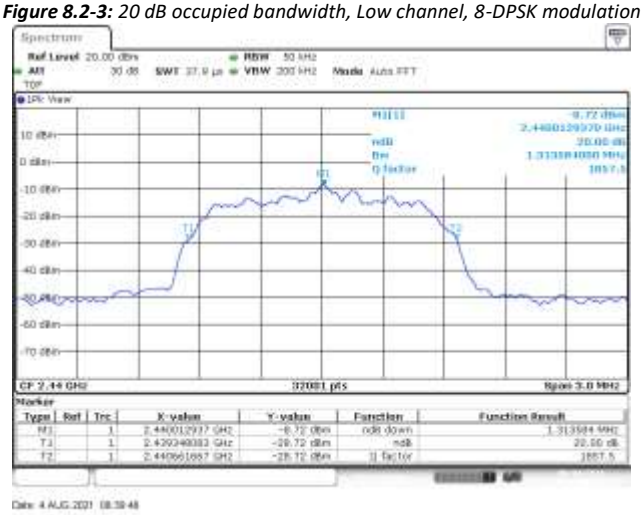

Figure 8.2-5: *20 dB occupied bandwidth, Mid channel, π/4-DQPSK modulation*

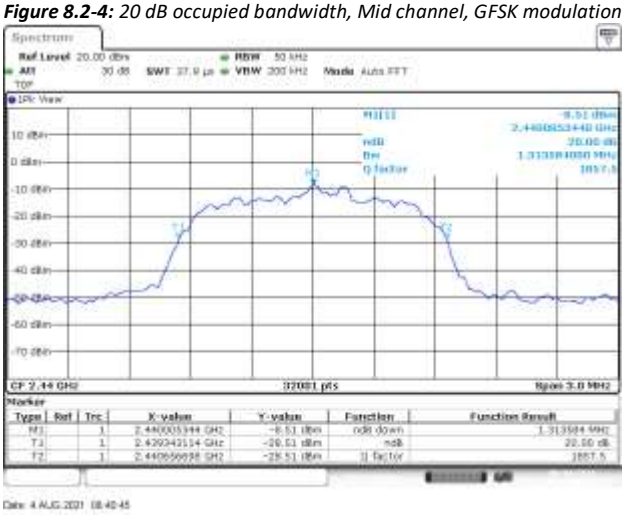

Figure 8.2-6: *20 dB occupied bandwidth, Mid channel, 8-DPSK modulation*

Figure 8.2-7: *20 dB occupied bandwidth, High channel, GFSK modulation*

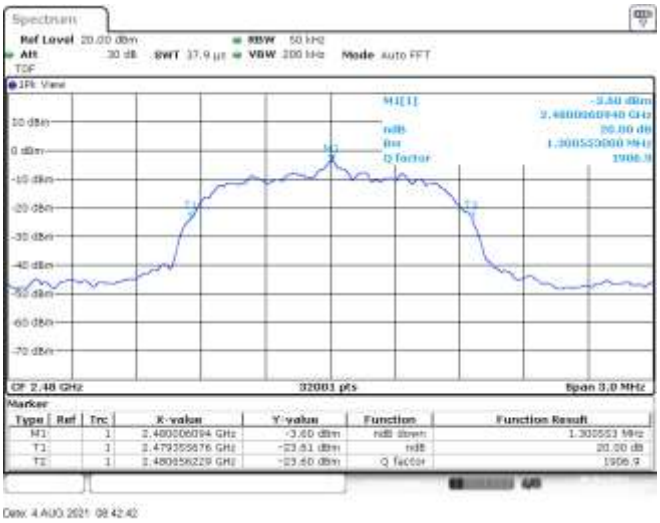

Figure 8.2-8: *20 dB occupied bandwidth, High channel, π/4-DQPSK modulation*

Figure 8.2-9: *20 dB occupied bandwidth, High channel, 8-DPSK modulation*

8.3 FCC 15.247(a)(1) and RSS-247 5.1(b) Frequency hopping systems operating in the 2400–2483.5 MHz band - Carrier frequency separation

8.3.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(a)(1)

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

(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

RSS-247 → §5.1(b)

(b) FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, FHSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

8.3.2 Test summary

Verdict	Pass		
Test date	July 13, 2021	Temperature	23 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1005 mbar
Test location	Wireless bench (Conducted)	Relative humidity	69 %

8.3.3 Notes

None

8.3.4 Setup details

EUT setup configuration	Table top
Test facility	Nemko San Diego
Measurement method	ANSI C63.10 §7.8.2

Receiver/spectrum analyzer settings:

Resolution bandwidth	200 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.3.5 Test data

Table 8.3-1: *Carrier frequency separation*

Bluetooth Modulation	Carrier frequency separation (kHz)	Limit
GFSK	1000.34	The greater of: 25 kHz or two thirds of the 20 dB bandwidth
π/4-DQPSK	1005.47	
8-DPSK	1003.22	

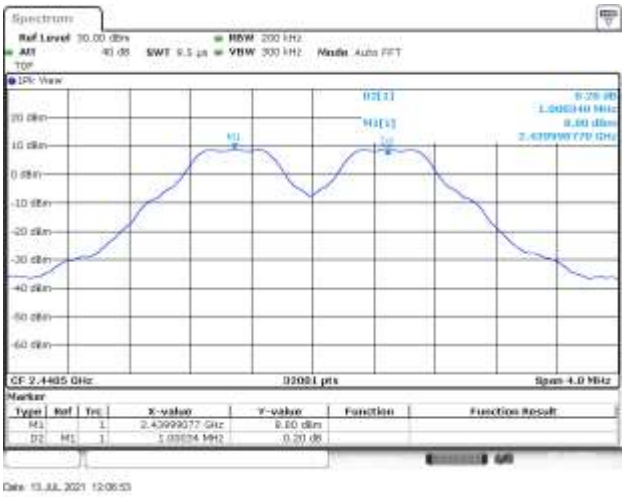

Figure 8.3-1: *Carrier frequency separation, GFSK modulation*

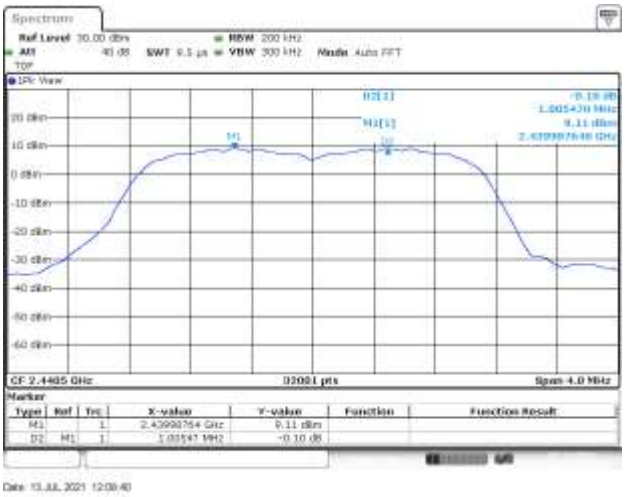

Figure 8.3-2: *Carrier frequency separation, π/4-DQPSK modulation*

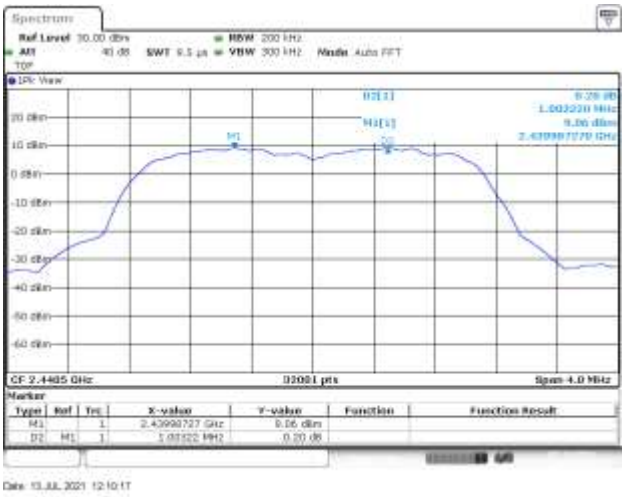

Figure 8.3-3: *Carrier frequency separation, 8-DPSK modulation*

8.4 FCC 15.247(a)(1)(iii) and RSS-247 5.1(d) Frequency hopping systems operating in the 2400–2483.5 MHz band – Number of hopping channels

8.4.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(a)(1)

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

(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

RSS-247 → §5.1(d)

(d) FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

8.4.2 Test summary

Verdict	Pass		
Test date	July 13, 2021	Temperature	23 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1005 mbar
Test location	Wireless bench (Conducted)	Relative humidity	69 %

8.4.3 Notes

None

8.4.4 Setup details

EUT setup configuration	Table top
Test facility	Nemko San Diego
Measurement method	ANSI C63.10 §7.8.3

Receiver/spectrum analyzer settings:

Resolution bandwidth	200 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

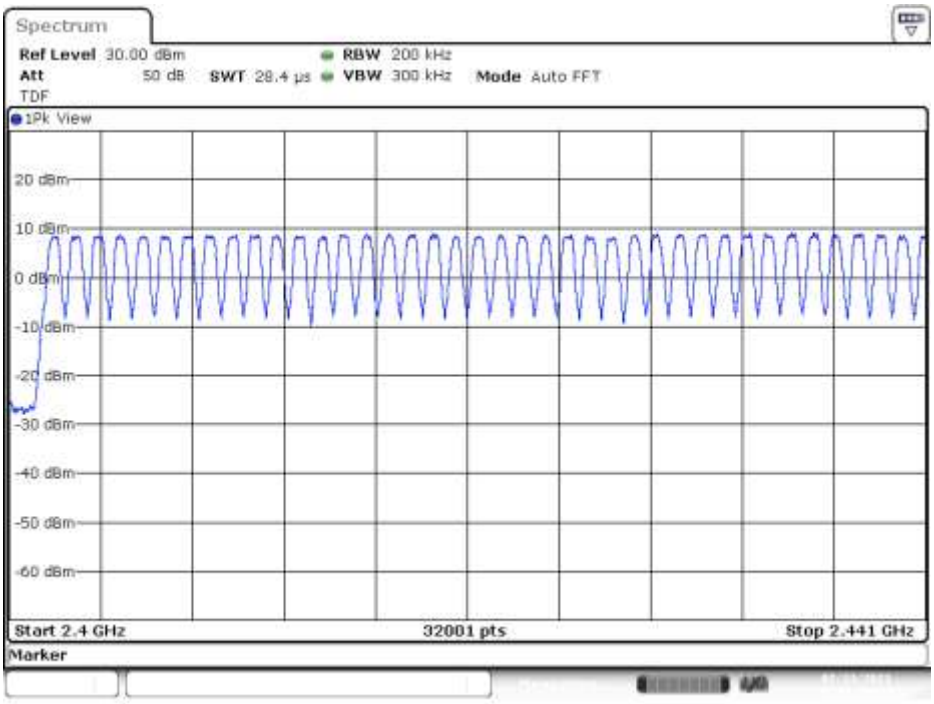

Figure 8.4-1: *Number of hopping channels, 2402 MHz to 2440 MHz*

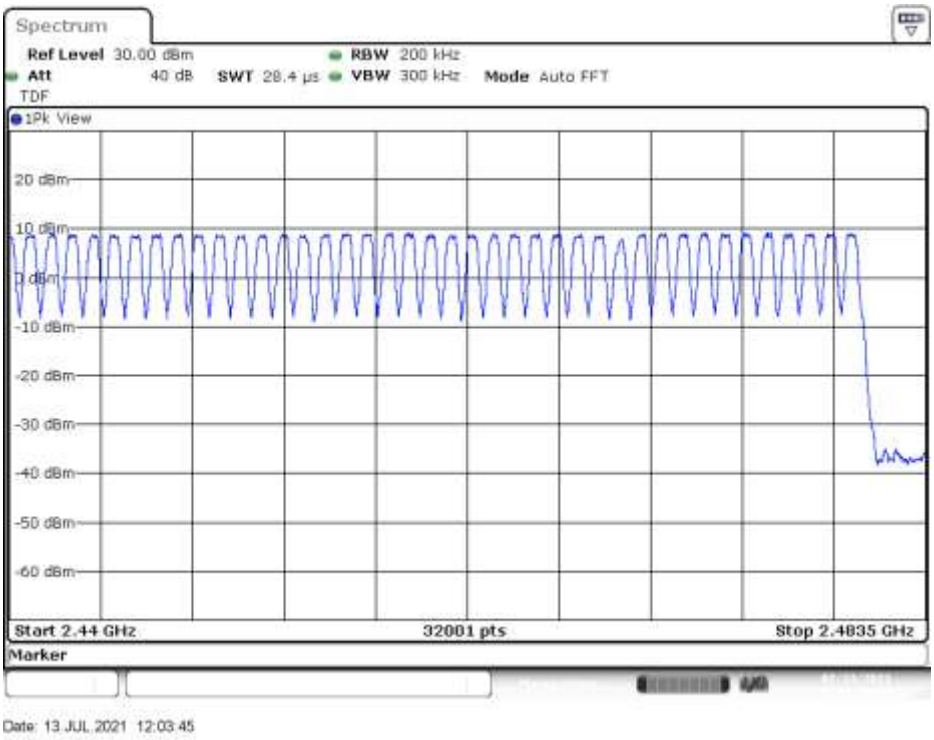

Figure 8.4-2: *Number of hopping channels, 2440 MHz to 2480 MHz*

8.5 FCC 15.247(a)(1)(iii) and RSS-247 5.1(d) Frequency hopping systems operating in the 2400–2483.5 MHz band – Time of occupancy

8.5.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(a)(1)

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

(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

RSS-247 → §5.1(d)

(d) FHSs operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

8.5.2 Test summary

Verdict	Pass		
Test date	July 13, 2021	Temperature	23 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1005 mbar
Test location	Wireless bench (Conducted)	Relative humidity	69 %

8.5.3 Notes

Calculations for the time of occupancy of the Bluetooth device under test in normal hopping mode using DH5 time slots are as follows:
Occupancy limit = (time limit per standard) x (number of channels) = (0.4 sec) x (79 channels) = **31.6 sec**
Hopping rate = (hopping rate) ÷ (Bluetooth time period) ÷ (number of channels) = (1600 Hz) ÷ (6 slots) ÷ (79 channels) = **3.3755 hops per sec per period**
Hops within the occupancy period = (Occupancy limit) x (Hopping rate) = (31.6 sec) x (3.376 hops per sec per period) = **106.67 hops per period**
Average Time of Occupancy = (hops within the occupancy period) x (measured transmit time per hop)

8.5.4 Setup details

EUT setup configuration	Table top
Test facility	Nemko San Diego
Measurement method	ANSI C63.10 §7.8.4

Receiver/spectrum analyzer settings:

Resolution bandwidth	1 MHz
Video bandwidth	1 MHz
Detector mode	Peak
Trace mode	Max Hold
Span	Zero span
Trigger type	Video trigger

8.5.5 Test data

Table 8.5-1: *Time of occupancy*

Bluetooth mode	Modulation Type	Frequency (MHz)	Occupancy limit (sec)	Hopping rate (hop/s/period)	Hops within occupancy period (hop/period)	Measured transmit time (s/period)	Average time of occupancy (s/period)
Normal	GFSK	2440	31.6	3.3755	106.67	0.002880	0.3072096
Normal	π/4 DQPSK	2440	31.6	3.3755	106.67	0.002884	0.30763628
Normal	8DPSK	2440	31.6	3.3755	106.67	0.002888	0.30806296

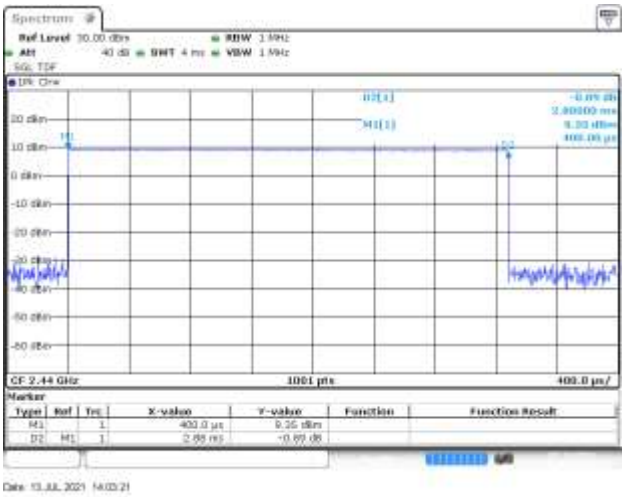

Figure 8.5-1: *Normal operational mode, GFSK modulation*

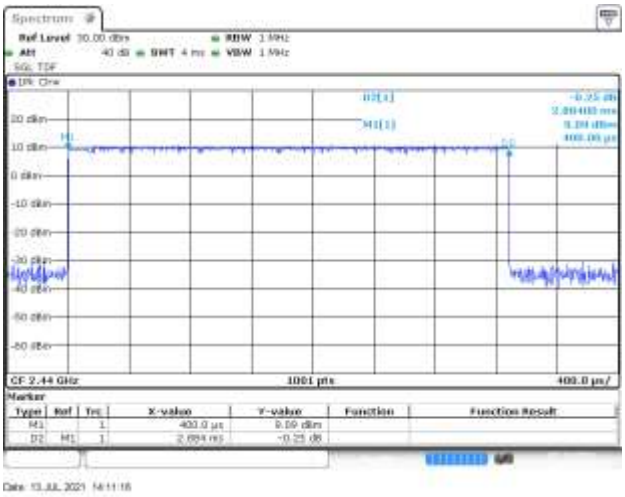

Figure 8.5-2: *Normal operational mode, π/4 DQPSK modulation*

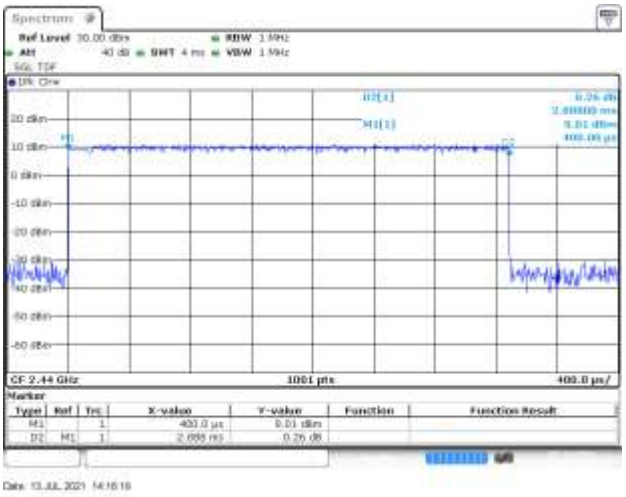

Figure 8.5-3: *Normal operational mode, DQPSK modulation*

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

8.6.1 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.

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.

8.6.2 Test summary

Verdict	Pass		
Test date	July 13, 2021	Temperature	23 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1005 mbar
Test location	Wireless bench (Conducted)	Relative humidity	69 %

8.6.3 Notes

Testing was performed with the Bluetooth transmitter operating on a fixed channel at full power. Low, middle, and high channels were tested using GFSK, π/4-DQPSK, and 8-DPSK modulation schemes.

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

The antenna gain is 3.6 dBi per client declaration.

EIRP = Conducted Power + Declared Antenna Gain

8.6.4 Setup details

EUT setup configuration	Table top
Test facility	Nemko San Diego
Measurement method	ANSI C63.10 §7.8.5 - Output power test procedure for frequency-hopping spread-spectrum (FHSS) devices

Receiver/spectrum analyzer settings:

Resolution bandwidth	> 20 dB bandwidth of the emission being measured
Video bandwidth	≥ RBW
Detector mode	Peak
Trace mode	Max Hold
Span	Approximately five times the 20 dB bandwidth, centered on a hopping channel

8.6.5 Test data

Table 8.6-1: *Output power*

Test Frequency (MHz)	Modulation	Maximum Peak Conducted Output Power (dBm)	Conducted Limit (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)
2402	GFSK	9.13	30.0	3.6	12.73	36.0
2402	π/4-DQPSK	11.03	30.0	3.6	14.63	36.0
2402	8-DPSK	11.36	30.0	3.6	14.96	36.0
2440	GFSK	9.45	30.0	3.6	13.05	36.0
2440	π/4-DQPSK	11.05	30.0	3.6	14.65	36.0
2440	8-DPSK	11.5	30.0	3.6	15.1	36.0
2480	GFSK	9.66	30.0	3.6	13.26	36.0
2480	π/4-DQPSK	11.67	30.0	3.6	15.27	36.0
2480	8-DPSK	11.9	30.0	3.6	15.5	36.0

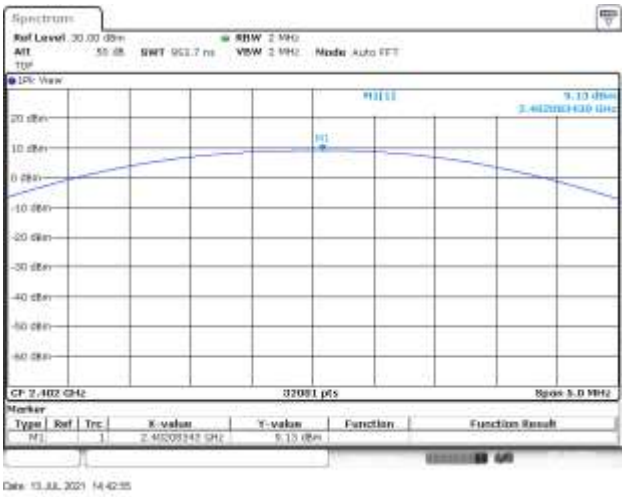

Figure 8.6-1: *Output power, Low channel, GFSK modulation*

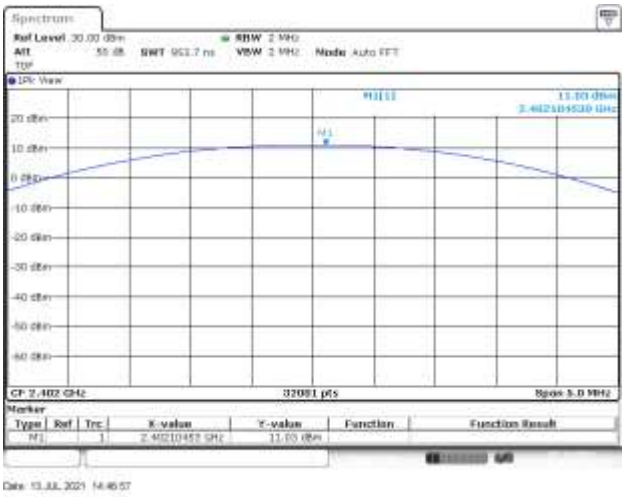

Figure 8.6-2: *Output power, Low channel, π/4-DQPSK modulation*

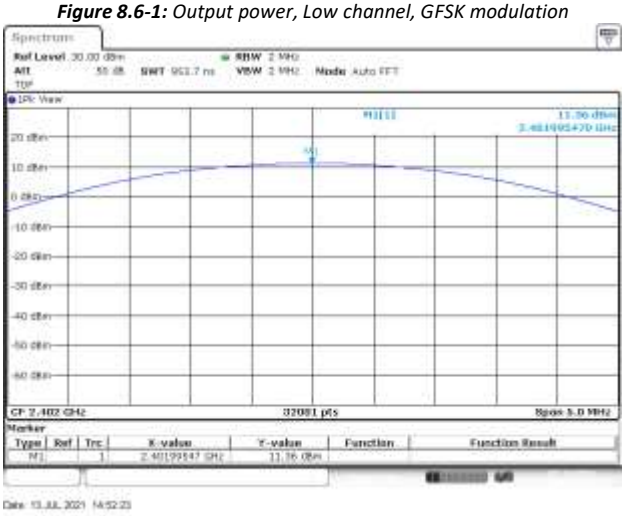

Figure 8.6-3: *Output power, Low channel, 8-DPSK modulation*

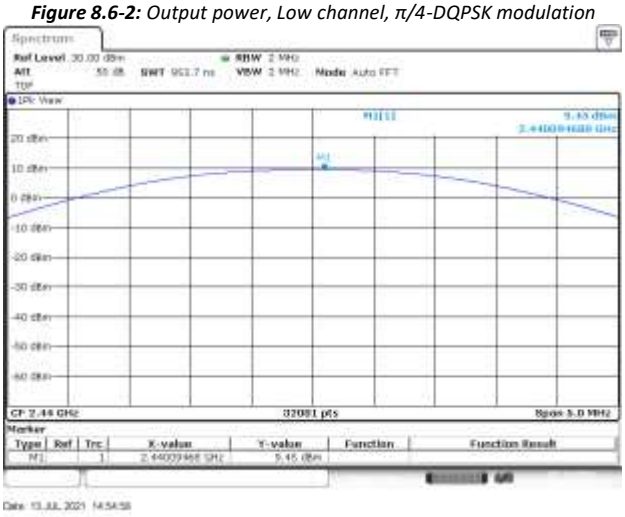

Figure 8.6-4: *Output power, Mid channel, GFSK modulation*

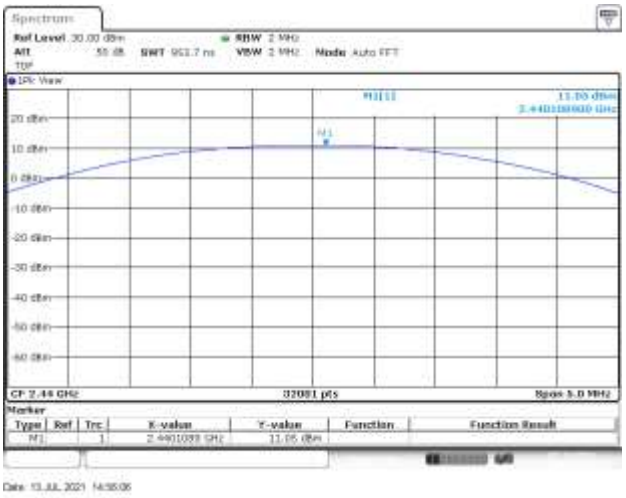

Figure 8.6-5: *Output power, Mid channel, π/4-DQPSK modulation*

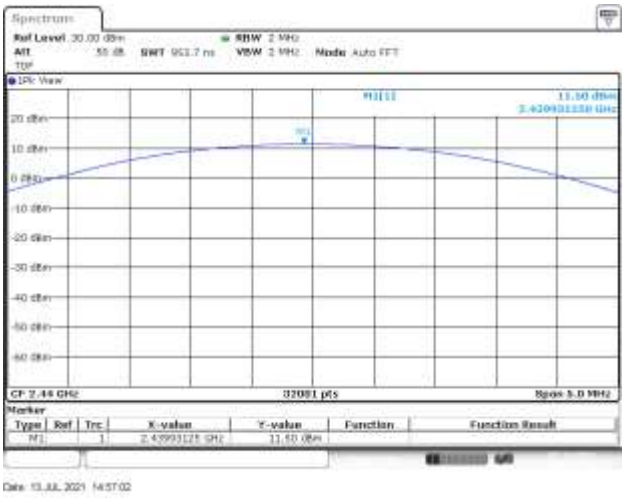

Figure 8.6-6: *Output power, Mid channel, 8-DPSK modulation*

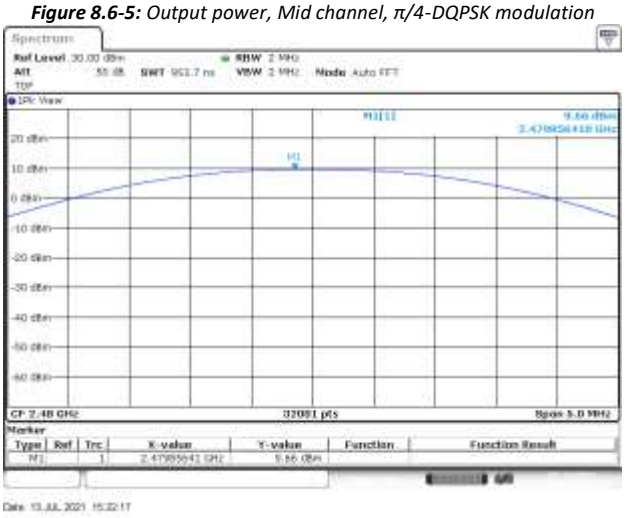

Figure 8.6-7: *Output power, High channel, GFSK modulation*

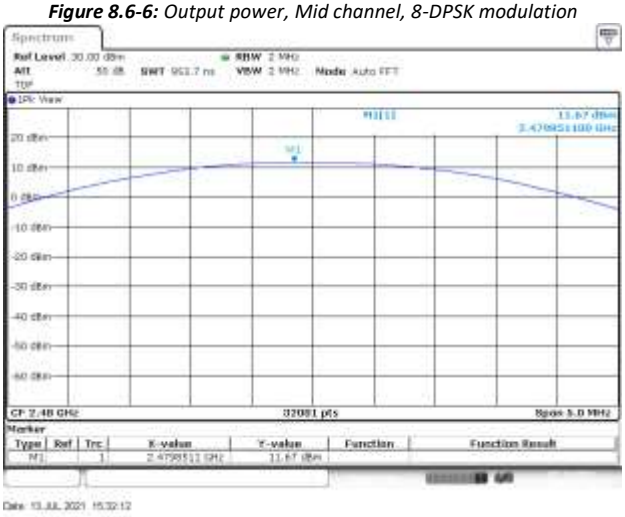

Figure 8.6-8: *Output power, High channel, π/4-DQPSK modulation*

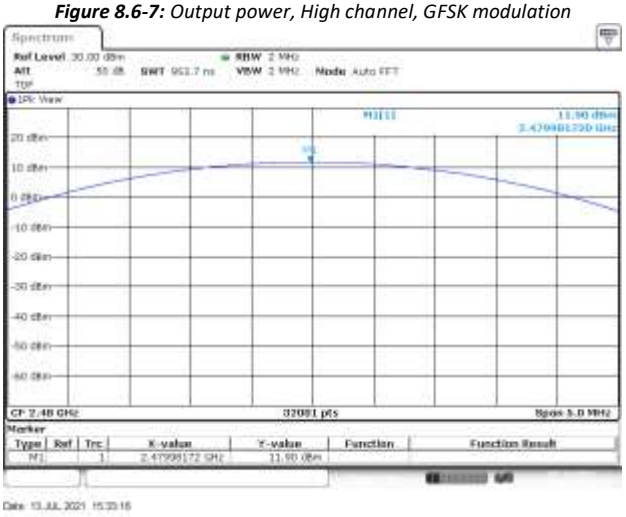

Figure 8.6-9: *Output power, High channel, 8-DPSK modulation*

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

8.7.1 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.

8.7.2 Test summary

Verdict	Pass		
Test date	July 14, 2021	Temperature	22 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1006 mbar
Test location	Wireless bench (Conducted)	Relative humidity	71 %

8.7.3 Notes

The EUT was configured to transmit continuously on the lowest and highest channels for each modulation scheme.

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

8.7.4 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

8.7.5 Test data

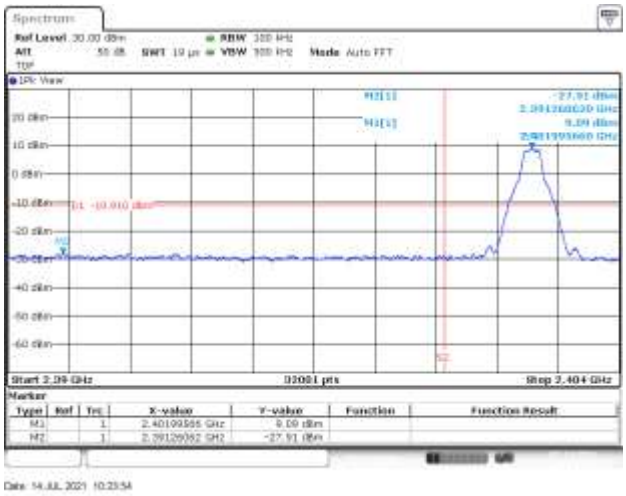

Figure 8.7-1: *Band edge measurement, Low channel, GFSK modulation*

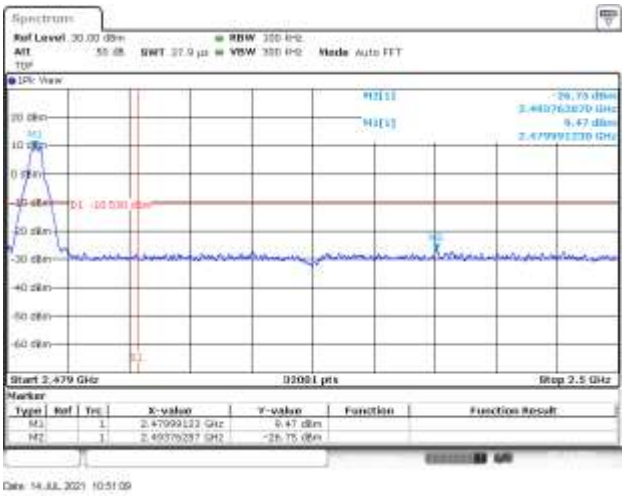

Figure 8.7-2: *Band edge measurement, High channel, GFSK modulation*

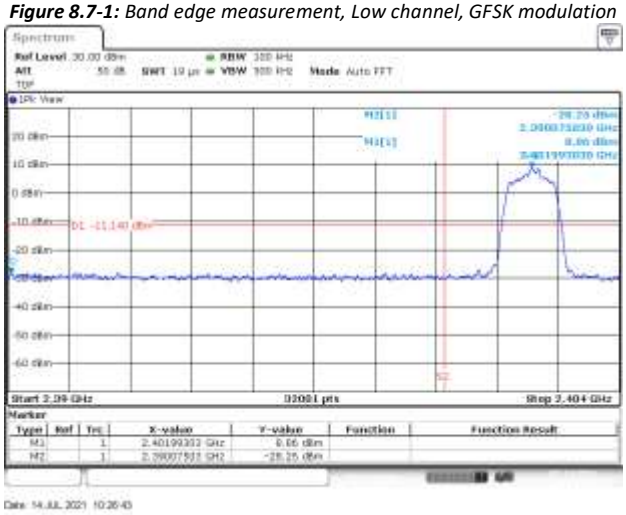

Figure 8.7-3: *Band edge measurement, Low channel, π/4-DQPSK modulation*

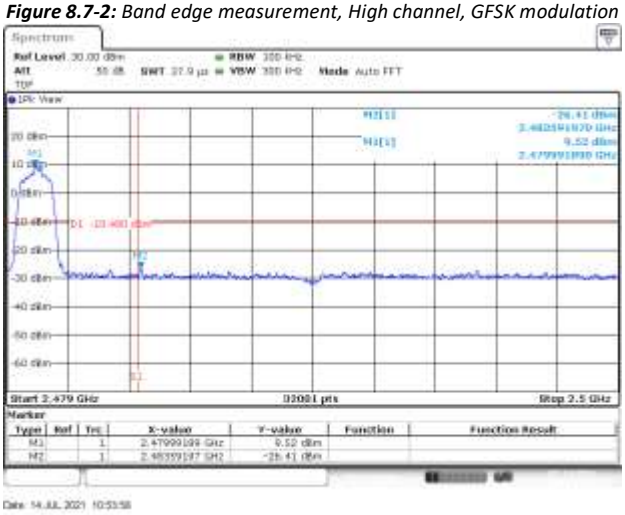

Figure 8.7-4: *Band edge measurement, High channel, π/4-DQPSK modulation*

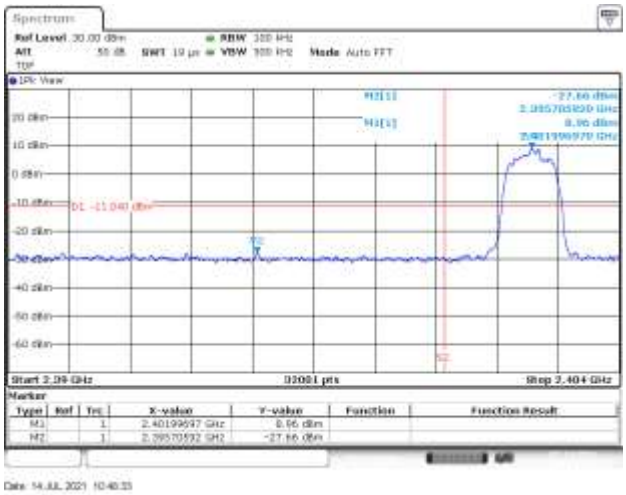

Figure 8.7-5: *Band edge measurement, Low channel, 8-DPSK modulation*

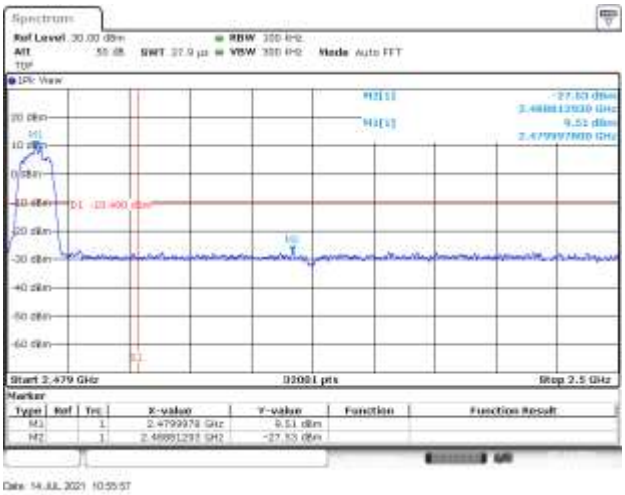

Figure 8.7-6: *Band edge measurement, High channel, 8-DPSK modulation*

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

8.8.1 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.

8.8.1 Test summary

Verdict	Pass		
Test date	July 14, 2021	Temperature	22 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1006 mbar
Test location	Wireless bench (Conducted)	Relative humidity	71 %

8.8.2 Notes

The EUT was configured to transmit continuously at max power on the low, mid, and high channels for each modulation scheme.

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

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

In each measurement, the limit was derived by subtracting 20 dB from a power spectral density reference measurement.

8.8.3 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

8.8.4 Test data

Figure 8.8-1: *Conducted spurious reference, Low channel, GFSK modulation*

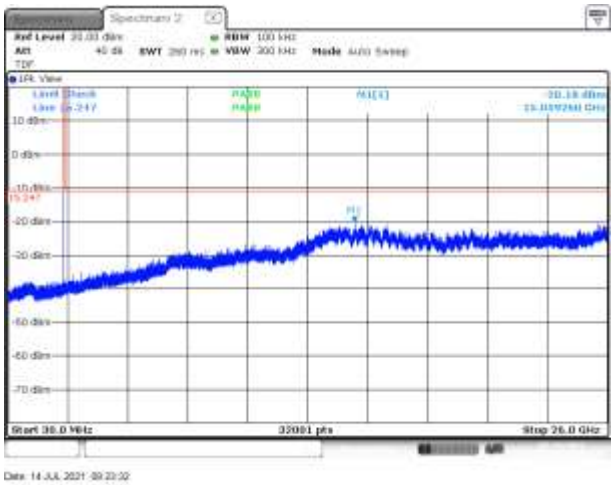

Figure 8.8-2: *Conducted spurious emissions, Low channel, GFSK modulation*

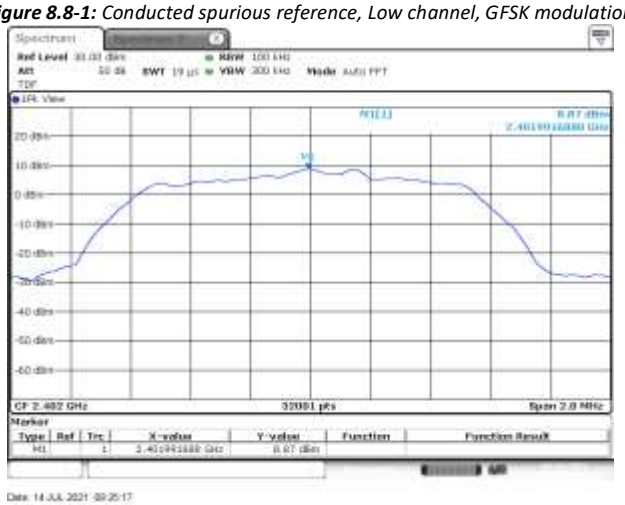

Figure 8.8-3: *Conducted spurious reference, Low channel, π/4-DQPSK modulation*

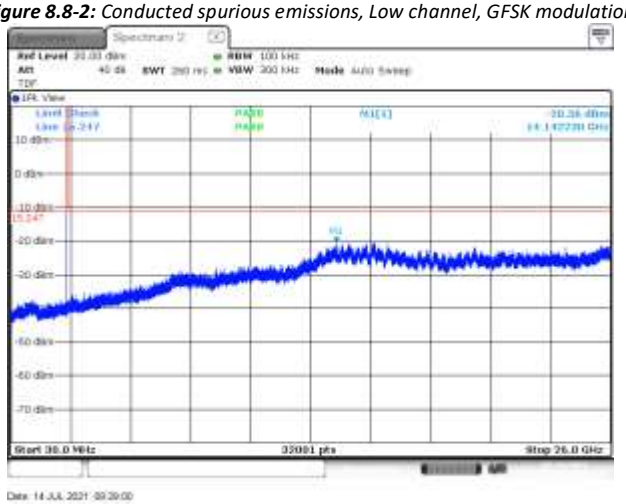

Figure 8.8-4: *Conducted spurious emissions, Low channel, π/4-DQPSK modulation*

Figure 8.8-5: *Conducted spurious reference, Low channel, 8-DPSK modulation*

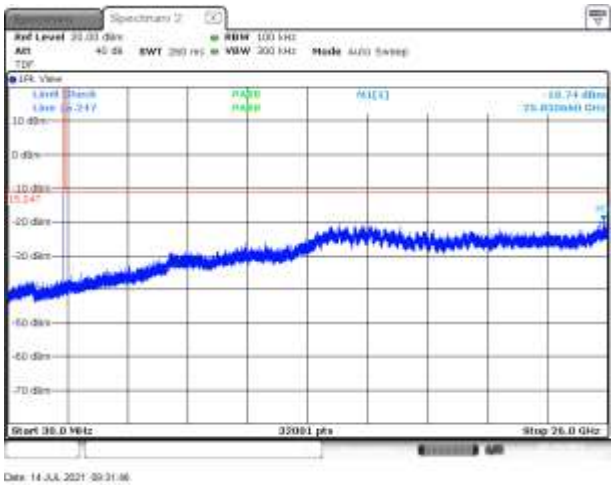

Figure 8.8-6: *Conducted spurious emissions, Low channel, 8-DPSK modulation*

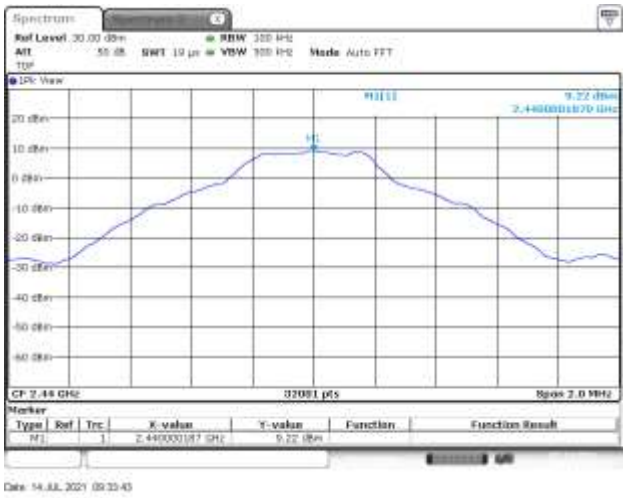

Figure 8.8-7: *Conducted spurious reference, Mid channel, GFSK modulation*

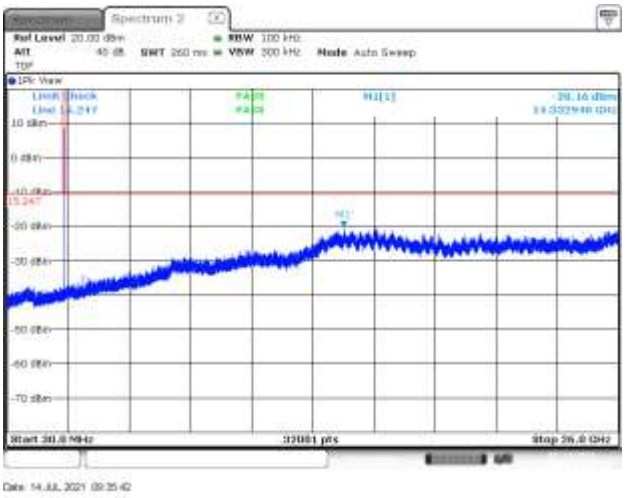

Figure 8.8-8: *Conducted spurious emissions, Mid channel, GFSK modulation*

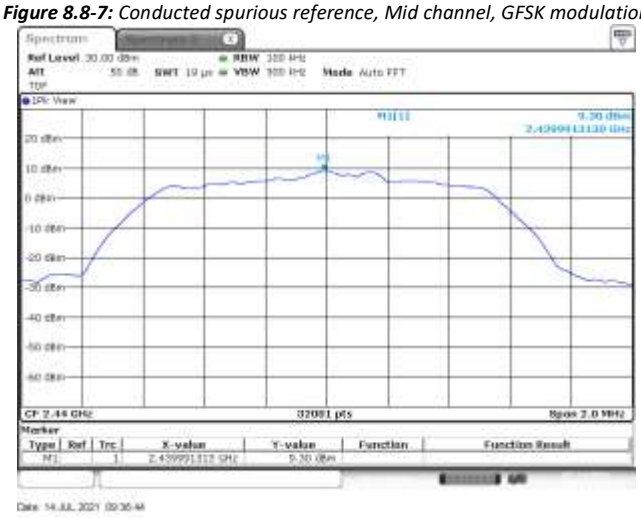

Figure 8.8-9: *Conducted spurious reference, Mid channel, π/4-DQPSK modulation*

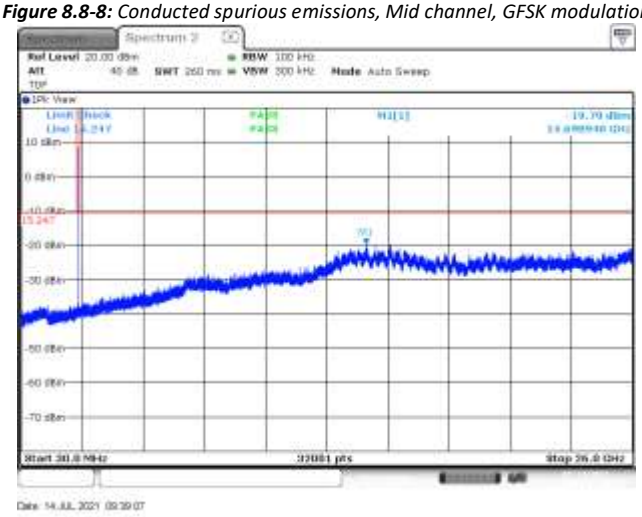

Figure 8.8-10: *Conducted spurious emissions, Mid channel, π/4-DQPSK modulation*

Figure 8.8-11: *Conducted spurious reference, Mid channel, 8-DPSK modulation*

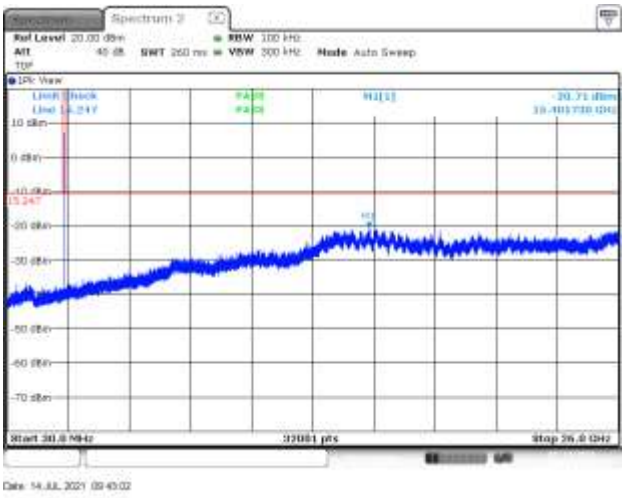

Figure 8.8-12: *Conducted spurious emissions, Mid channel, 8-DPSK modulation*

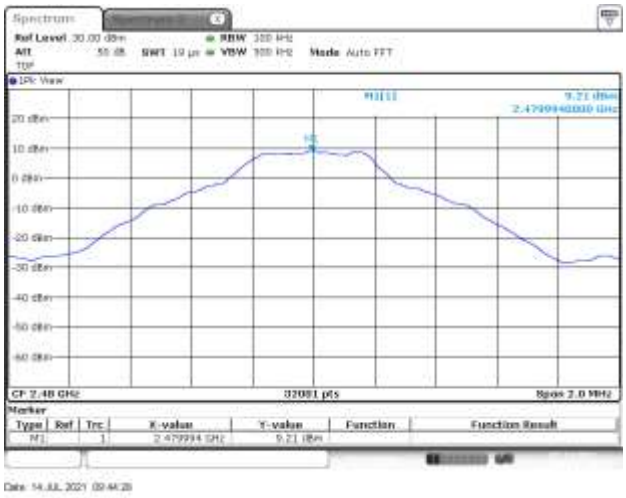

Figure 8.8-13: *Conducted spurious reference, High channel, GFSK modulation*

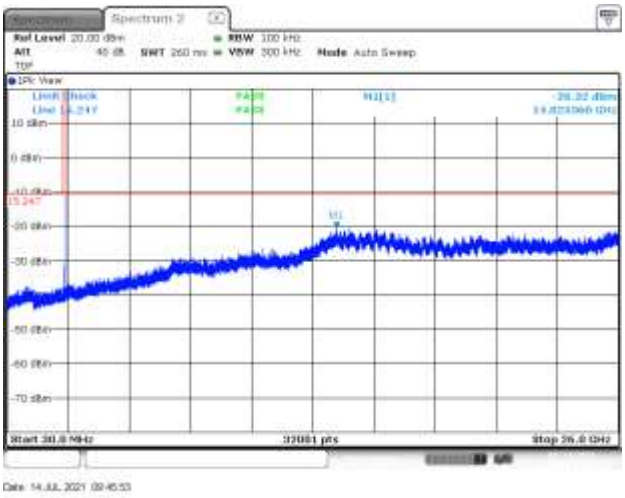

Figure 8.8-14: *Conducted spurious emissions, High channel, GFSK modulation*

Figure 8.8-15: *Conducted spurious reference, High channel, π/4-DQPSK modulation*

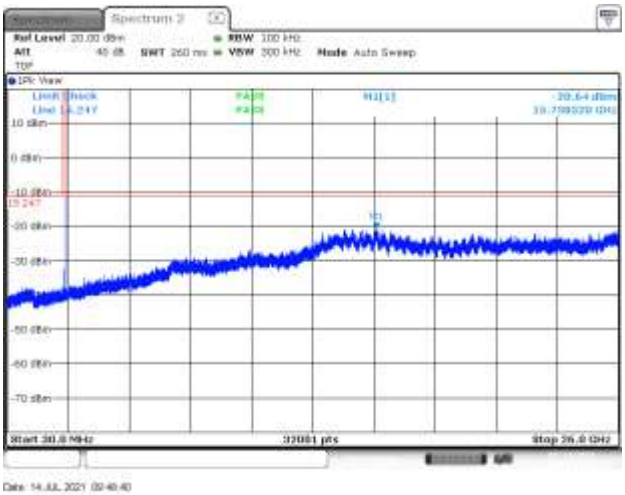

Figure 8.8-16: *Conducted spurious emissions, High channel, π/4-DQPSK modulation*

Figure 8.8-17: *Conducted spurious reference, High channel, 8-DPSK modulation*

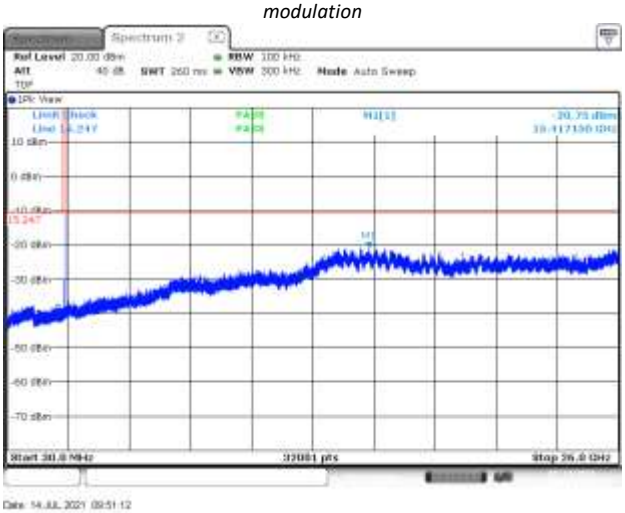

Figure 8.8-18: *Conducted spurious emissions, High channel, 8-DPSK modulation*

8.9 FCC 15.247(d) and RSS-247 5.5 Radiated restricted band-edges and spurious emissions

8.9.1 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 8.9-1: *FCC §15.209– Radiated emission limits*

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/m	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

Table 8.9-2: *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			

8.9.2 Test summary

Verdict	Pass		
Test date	July 16, 2021	Temperature	22 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1006 mbar
Test location	3m semi-anechoic chamber (Radiated)	Relative humidity	64 %
Test date	July 19, 2021	Temperature	23 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1007 mbar
Test location	3m semi-anechoic chamber (Radiated)	Relative humidity	60 %
Test date	July 21, 2021	Temperature	22 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1003 mbar
Test location	3m semi-anechoic chamber (Radiated)	Relative humidity	63 %
Test date	July 28, 2021	Temperature	23 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1007 mbar
Test location	3m semi-anechoic chamber (Radiated)	Relative humidity	66 %
Test date	July 29, 2021	Temperature	22 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1005 mbar
Test location	3m semi-anechoic chamber (Radiated)	Relative humidity	69 %
Test date	August 2, 2021	Temperature	24 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1006 mbar
Test location	3m semi-anechoic chamber (Radiated)	Relative humidity	60 %
Test date	August 3, 2021	Temperature	23 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1006 mbar
Test location	3m semi-anechoic chamber (Radiated)	Relative humidity	63 %

8.9.3 Notes

The EUT was configured to transmit continuously at max power on the low, mid, and high channels, and in all three modulation schemes.

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.

8.9.4 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

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

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak and Average (final measurements)
Trace mode	Max Hold

8.9.5 Test data

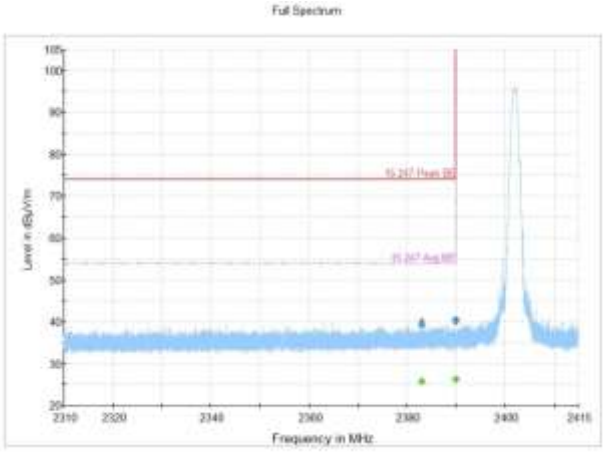

Figure 8.9-1: *Restricted band edge spectral plot, Low channel, GFSK modulation*

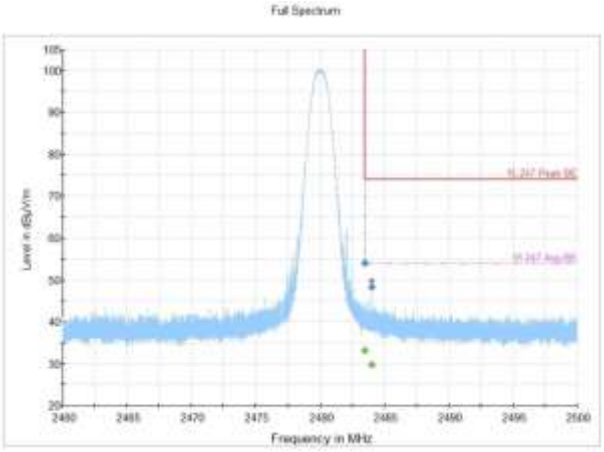

Figure 8.9-2: *Restricted band edge spectral plot, High channel, GFSK modulation*

Table 8.9-2: *Restricted band edge tabular data, Low channel, GFSK modulation*

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)
2383.038000	---	25.78	53.90	28.12	5000.0	1000.000	311.0	H	170.0	-9.1
2383.038000	39.29	---	73.90	34.61	5000.0	1000.000	311.0	H	170.0	-9.1
2390.000000	---	26.36	53.90	27.54	5000.0	1000.000	303.0	H	177.0	-9.1
2390.000000	40.50	---	73.90	33.40	5000.0	1000.000	303.0	H	177.0	-9.1

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)

Table 8.9-3: *Restricted band edge tabular data, High channel, GFSK modulation*

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	---	33.26	53.90	20.64	5000.0	1000.000	279.0	H	0.0	-8.7
2483.500000	54.13	---	73.90	19.77	5000.0	1000.000	279.0	H	0.0	-8.7
2483.982667	---	29.73	53.90	24.17	5000.0	1000.000	105.0	V	102.0	-8.7
2483.982667	48.30	---	73.90	25.60	5000.0	1000.000	105.0	V	102.0	-8.7

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)

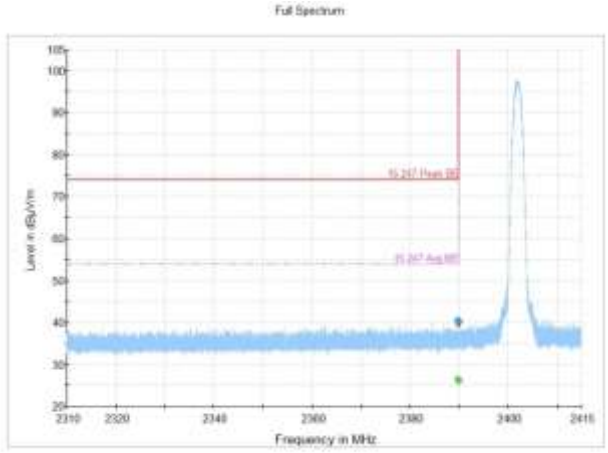

Figure 8.9-3: *Restricted band edge spectral plot, Low channel, π/4-DQPSK modulation*

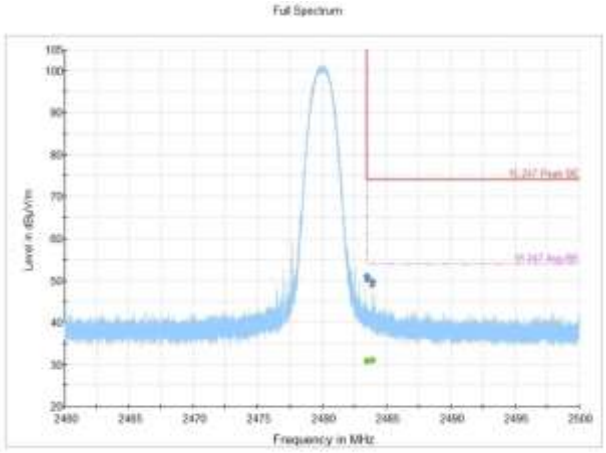

Figure 8.9-4: *Restricted band edge spectral plot, High channel, π/4-DQPSK modulation*

Table 8.9-4: *Restricted band edge tabular data, Low channel, π/4-DQPSK modulation*

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)
2389.859500	---	26.46	53.90	27.44	5000.0	1000.000	300.0	H	0.0	-9.1
2389.859500	40.59	---	73.90	33.31	5000.0	1000.000	300.0	H	0.0	-9.1
2390.000000	---	26.16	53.90	27.74	5000.0	1000.000	102.0	V	320.0	-9.1
2390.000000	40.37	---	73.90	33.53	5000.0	1000.000	102.0	V	320.0	-9.1

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)

Table 8.9-5: *Restricted band edge tabular data, High channel, π/4-DQPSK modulation*

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	---	30.88	53.90	23.02	5000.0	1000.000	105.0	V	44.0	-8.7
2483.500000	50.98	---	73.90	22.92	5000.0	1000.000	105.0	V	44.0	-8.7
2483.881333	---	30.94	53.90	22.96	5000.0	1000.000	142.0	V	98.0	-8.7
2483.881333	49.76	---	73.90	24.14	5000.0	1000.000	142.0	V	98.0	-8.7

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)

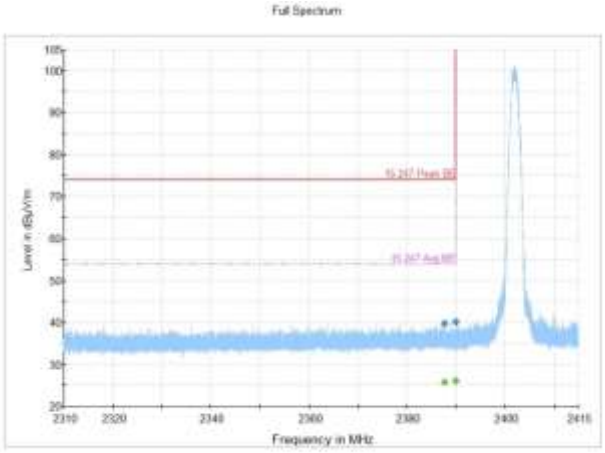

Figure 8.9-5: *Restricted band edge spectral plot, Low channel, 8-DPSK modulation*

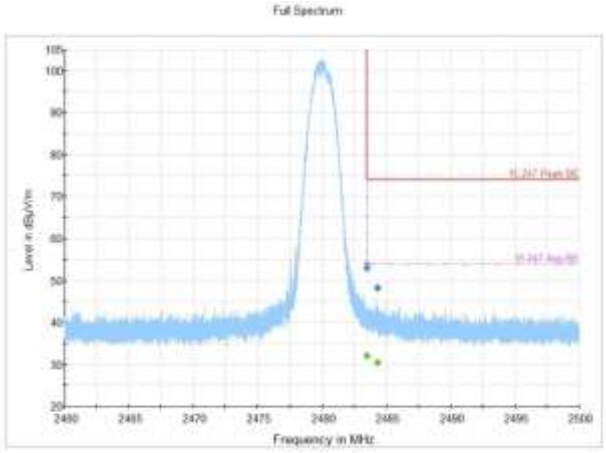

Figure 8.9-6: *Restricted band edge spectral plot, High channel, 8-DPSK modulation*

Table 8.9-6: *Restricted band edge tabular data, Low channel, 8-DPSK modulation*

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)
2387.644000	---	25.86	53.90	28.04	5000.0	1000.000	291.0	H	188.0	-9.1
2387.644000	39.86	---	73.90	34.04	5000.0	1000.000	291.0	H	188.0	-9.1
2390.000000	---	26.16	53.90	27.74	5000.0	1000.000	228.0	V	292.0	-9.1
2390.000000	40.25	---	73.90	33.65	5000.0	1000.000	228.0	V	292.0	-9.1

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)

Table 8.9-7: *Restricted band edge tabular data, High channel, 8-DPSK modulation*

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	---	32.16	53.90	21.74	5000.0	1000.000	277.0	H	188.0	-8.7
2483.500000	53.09	---	73.90	20.81	5000.0	1000.000	277.0	H	188.0	-8.7
2484.265333	---	30.41	53.90	23.49	5000.0	1000.000	102.0	V	11.0	-8.7
2484.265333	48.27	---	73.90	25.63	5000.0	1000.000	102.0	V	11.0	-8.7

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)

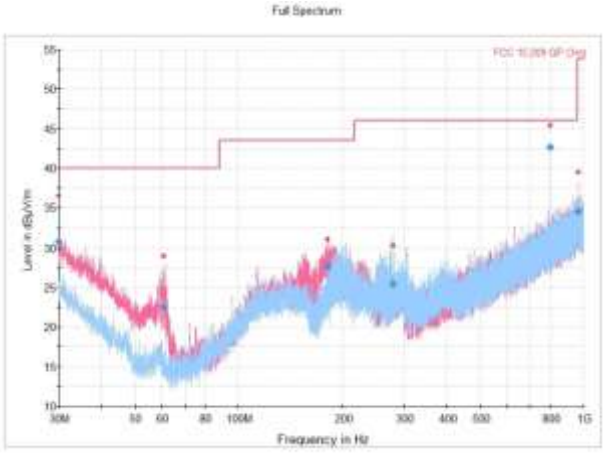

Figure 8.9-7: *Radiated spurious emissions 30-1000 MHz, Low channel, GFSK modulation*

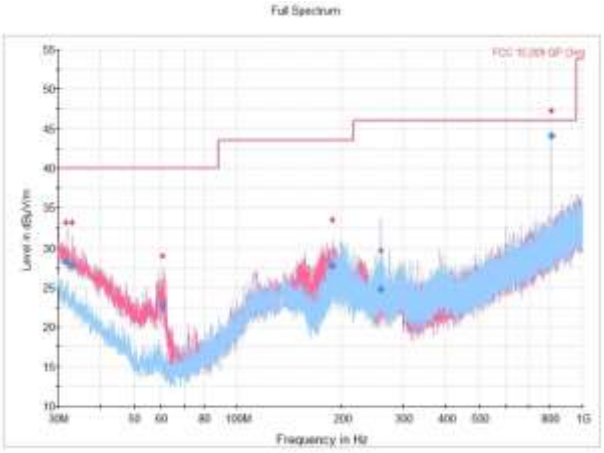

Figure 8.9-8: *Radiated spurious emissions 30-1000 MHz, Mid channel, GFSK modulation*

Table 8.9-8: *Radiated spurious emissions tabular data, Low channel, GFSK modulation*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.020000	30.85	40.00	9.15	5000.0	120.000	100.0	V	211.0	26.6
60.629333	22.53	40.00	17.47	5000.0	120.000	149.0	V	203.0	12.7
180.174333	27.64	43.50	15.86	5000.0	120.000	100.0	V	219.0	17.1
279.368667	25.46	46.00	20.54	5000.0	120.000	100.0	H	246.0	21.4
800.765000	42.72	46.00	3.28	5000.0	120.000	175.0	H	149.0	31.8
965.500000	34.57	53.90	19.33	5000.0	120.000	242.0	V	102.0	34.7

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[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.

Table 8.9-9: *Radiated spurious emissions tabular data, Mid channel, GFSK modulation*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.672333	28.24	40.00	11.76	5000.0	120.000	110.0	V	43.0	25.6
33.005667	27.73	40.00	12.27	5000.0	120.000	100.0	V	273.0	24.8
60.667667	22.75	40.00	17.25	5000.0	120.000	148.0	V	57.0	12.7
187.829667	27.79	43.50	15.71	5000.0	120.000	100.0	V	219.0	17.1
258.883000	24.84	46.00	21.16	5000.0	120.000	130.0	H	253.0	22.0
813.264333	44.11	46.00	1.89	5000.0	120.000	165.0	H	136.0	32.0

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] 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.

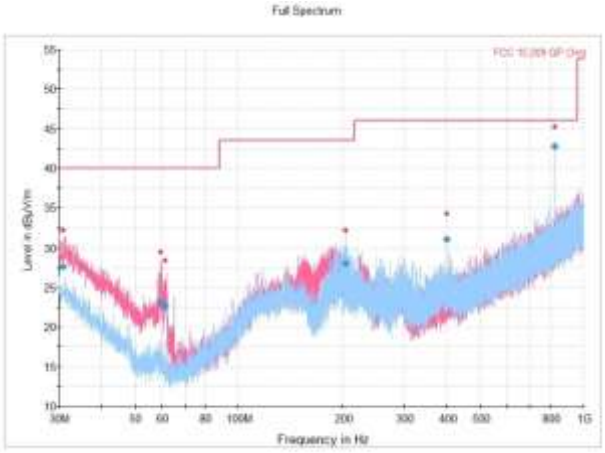

Figure 8.9-9: *Radiated spurious emissions 30-1000 MHz, High channel, GFSK modulation*

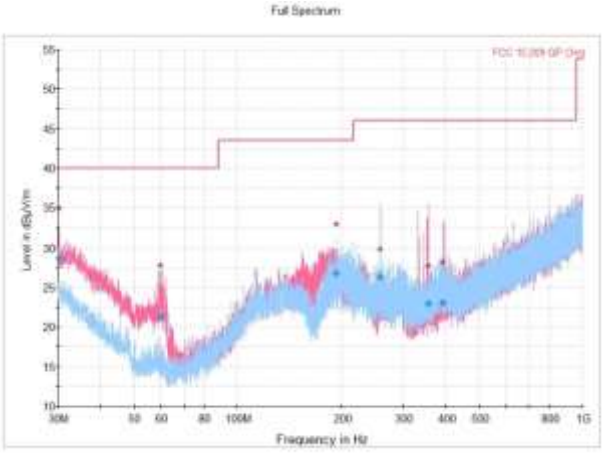

Figure 8.9-10: *Radiated spurious emissions 30-1000 MHz, Low channel, π/4-DQPSK modulation*

Table 8.9-10: *Radiated spurious emissions tabular data, High channel, GFSK modulation*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.854667	27.65	40.00	12.35	5000.0	120.000	140.0	V	0.0	26.1
59.411000	23.16	40.00	16.84	5000.0	120.000	143.0	V	253.0	12.7
61.300667	22.69	40.00	17.31	5000.0	120.000	157.0	V	137.0	12.7
203.847333	28.10	43.50	15.40	5000.0	120.000	155.0	H	243.0	18.0
399.970333	31.08	46.00	14.92	5000.0	120.000	203.0	H	161.0	25.0
826.648667	42.76	46.00	3.24	5000.0	120.000	289.0	H	128.0	32.4

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[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.

Table 8.9-11: *Radiated spurious emissions tabular data, Low channel, π/4-DQPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.340000	28.68	40.00	11.32	5000.0	120.000	115.0	V	220.0	26.4
59.562333	21.30	40.00	18.70	5000.0	120.000	138.0	V	147.0	12.7
192.278000	26.86	43.50	16.64	5000.0	120.000	104.0	H	228.0	17.3
258.363000	26.29	46.00	19.71	5000.0	120.000	126.0	H	262.0	21.9
356.187667	22.97	46.00	23.03	5000.0	120.000	102.0	V	112.0	24.0
393.203333	23.11	46.00	22.89	5000.0	120.000	350.0	V	214.0	24.9

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] 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.

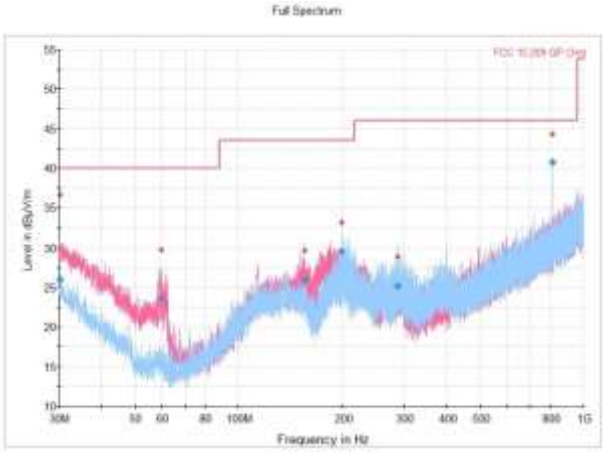

Figure 8.9-11: *Radiated spurious emissions 30-1000 MHz, Mid channel, π/4-DQPSK modulation*

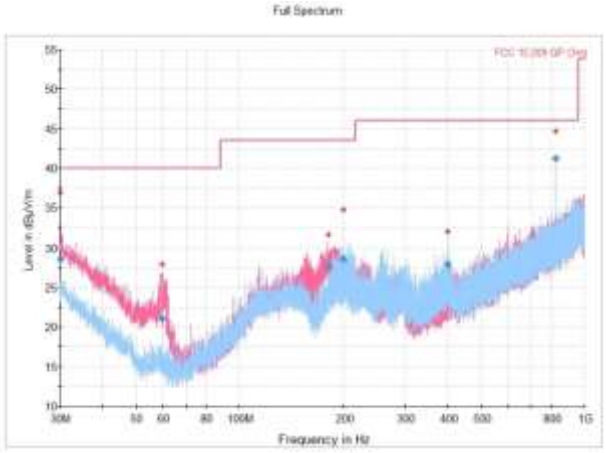

Figure 8.9-12: *Radiated spurious emissions 30-1000 MHz, High channel, π/4-DQPSK modulation*

Table 8.9-12: *Radiated spurious emissions tabular data, Mid channel, π/4-DQPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.259000	26.06	40.00	13.94	5000.0	120.000	321.0	V	32.0	26.4
59.672333	23.69	40.00	16.31	5000.0	120.000	149.0	V	148.0	12.7
154.899000	25.92	43.50	17.58	5000.0	120.000	128.0	V	169.0	19.0
198.322667	29.60	43.50	13.90	5000.0	120.000	151.0	H	256.0	17.7
288.103000	25.21	46.00	20.79	5000.0	120.000	100.0	H	244.0	21.6
813.484000	40.77	46.00	5.23	5000.0	120.000	161.0	H	138.0	32.0

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] 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.

Table 8.9-13: *Radiated spurious emissions tabular data, High channel, π/4-DQPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.220000	28.59	40.00	11.41	5000.0	120.000	130.0	V	246.0	26.4
59.549667	21.11	40.00	18.89	5000.0	120.000	138.0	V	56.0	12.7
179.912333	27.63	43.50	15.87	5000.0	120.000	100.0	V	141.0	17.1
199.976000	28.65	43.50	14.85	5000.0	120.000	104.0	H	240.0	17.8
400.042667	27.93	46.00	18.07	5000.0	120.000	177.0	H	160.0	25.0
826.681000	41.21	46.00	4.79	5000.0	120.000	319.0	H	138.0	32.4

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[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.

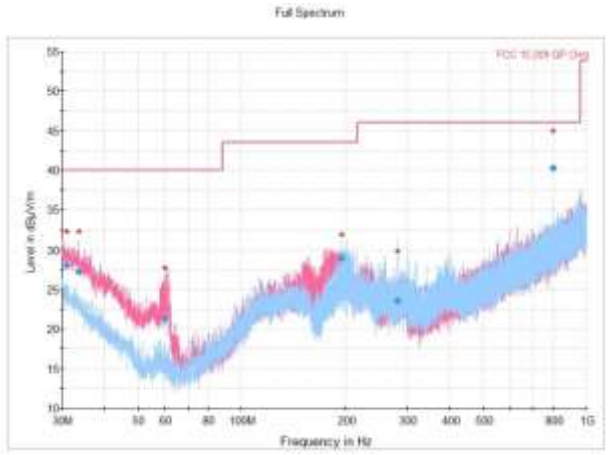

Figure 8.9-13: *Radiated spurious emissions 30-1000 MHz, Low channel, 8-DPSK modulation*

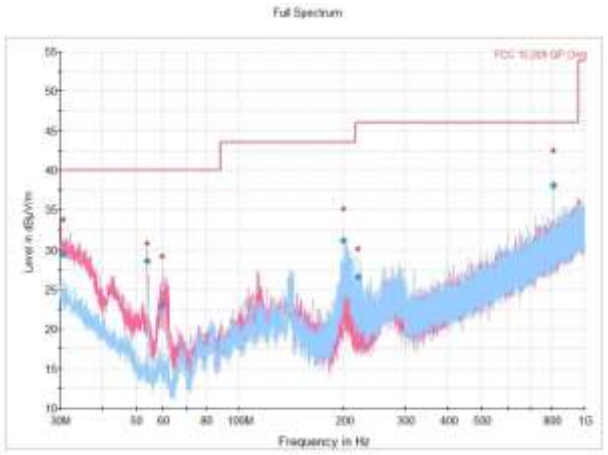

Figure 8.9-14: *Radiated spurious emissions 30-1000 MHz, Mid channel, 8-DPSK modulation*

Table 8.9-14: *Radiated spurious emissions tabular data, Low channel, 8-DPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.097333	28.01	40.00	11.99	5000.0	120.000	155.0	V	207.0	25.9
33.632000	27.27	40.00	12.73	5000.0	120.000	112.0	V	198.0	24.5
60.021000	21.36	40.00	18.64	5000.0	120.000	137.0	V	248.0	12.7
194.465667	28.98	43.50	14.52	5000.0	120.000	168.0	H	269.0	17.5
282.326333	23.52	46.00	22.48	5000.0	120.000	107.0	H	33.0	21.5
800.633000	40.25	46.00	5.75	5000.0	120.000	173.0	H	134.0	31.8

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[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.

Table 8.9-15: *Radiated spurious emissions tabular data, Mid channel, 8-DPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.740000	29.51	40.00	10.49	5000.0	120.000	107.0	V	222.0	26.1
54.011333	28.64	40.00	11.36	5000.0	120.000	104.0	V	219.0	14.2
59.536000	22.98	40.00	17.02	5000.0	120.000	111.0	V	271.0	12.7
199.850000	31.21	43.50	12.29	5000.0	120.000	100.0	H	261.0	17.8
219.736667	26.65	46.00	19.35	5000.0	120.000	100.0	H	262.0	18.1
813.335000	38.05	46.00	7.95	5000.0	120.000	275.0	H	125.0	32.0

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] 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.

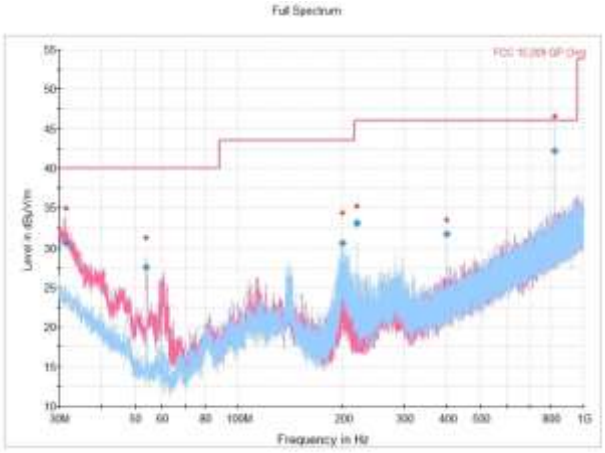

Figure 8.9-15: *Radiated spurious emissions 30-1000 MHz, High channel, 8-DPSK modulation*

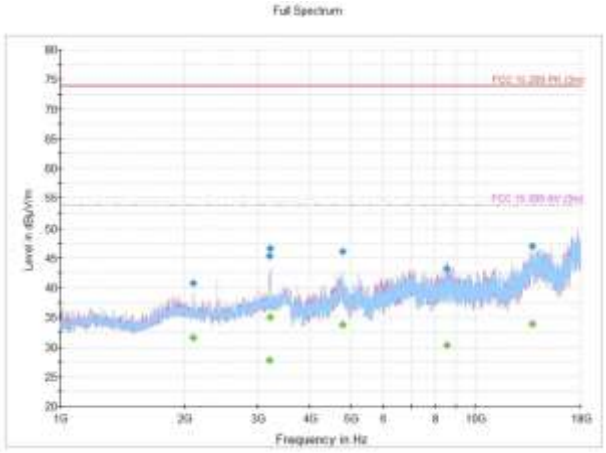

Figure 8.9-16: *Radiated spurious emissions 1-18 GHz, Low channel, GFSK modulation*

Table 8.9-16: *Radiated spurious emissions tabular data, High channel, 8-DPSK modulation*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.562667	30.68	40.00	9.32	5000.0	120.000	104.0	V	240.0	25.6
54.019000	27.60	40.00	12.40	5000.0	120.000	101.0	V	148.0	14.2
199.903667	30.60	43.50	12.90	5000.0	120.000	167.0	H	279.0	17.8
219.550333	33.08	46.00	12.92	5000.0	120.000	127.0	H	264.0	18.0
400.010333	31.77	46.00	14.23	5000.0	120.000	255.0	H	172.0	25.0
826.681000	42.23	46.00	3.77	5000.0	120.000	100.0	H	32.0	32.4

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[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.

Table 8.9-17: *Radiated spurious emissions tabular data, Low channel, GFSK modulation*

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)
2099.877778	40.82	---	73.90	33.08	5000.0	1000.000	151.0	V	158.0	-10.0
2099.877778	---	31.56	53.90	22.34	5000.0	1000.000	151.0	V	158.0	-10.0
3205.244444	45.41	---	73.90	28.49	5000.0	1000.000	261.0	V	125.0	-6.3
3205.244444	---	27.78	53.90	26.12	5000.0	1000.000	261.0	V	125.0	-6.3
3229.288889	---	35.04	53.90	18.86	5000.0	1000.000	102.0	V	136.0	-6.2
3229.288889	46.69	---	73.90	27.21	5000.0	1000.000	102.0	V	136.0	-6.2
4803.677778	---	33.74	53.90	20.16	5000.0	1000.000	255.0	H	8.0	-0.8
4803.677778	46.18	---	73.90	27.72	5000.0	1000.000	255.0	H	8.0	-0.8
8572.522222	---	30.31	53.90	23.59	5000.0	1000.000	361.0	V	295.0	3.6
8572.522222	43.15	---	73.90	30.75	5000.0	1000.000	361.0	V	295.0	3.6
13761.188889	---	33.88	53.90	20.02	5000.0	1000.000	163.0	V	79.0	13.0
13761.188889	47.03	---	73.90	26.87	5000.0	1000.000	163.0	V	79.0	13.0

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)

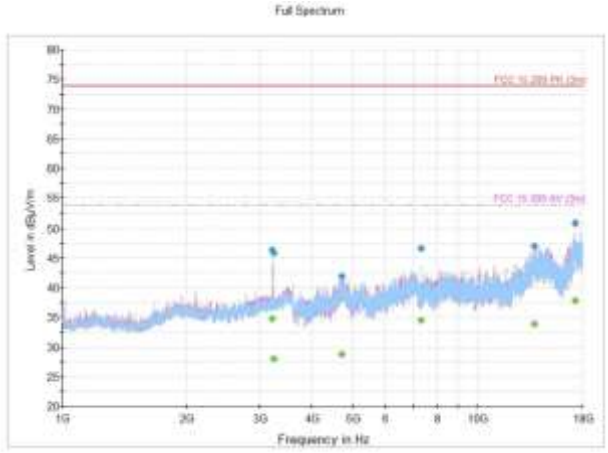

Figure 8.9-17: *Radiated spurious emissions 1-18 GHz, Mid channel, GFSK modulation*

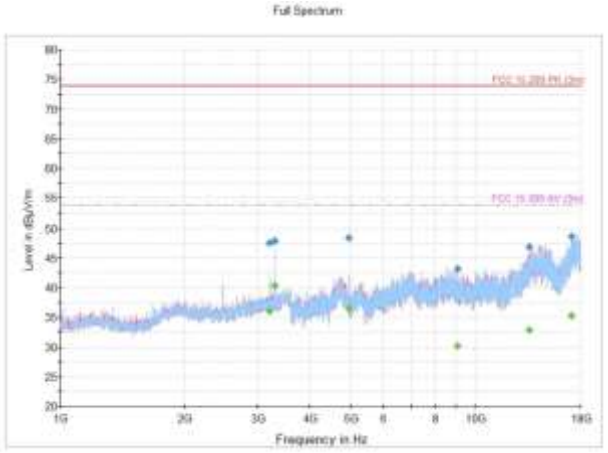

Figure 8.9-18: *Radiated spurious emissions 1-18 GHz, High channel, GFSK modulation*

Table 8.9-18: *Radiated spurious emissions tabular data, Mid channel, GFSK modulation*

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)
3229.288889	46.33	---	73.90	27.57	5000.0	1000.000	107.0	V	125.0	-6.2
3229.288889	---	34.72	53.90	19.18	5000.0	1000.000	107.0	V	125.0	-6.2
3256.100000	45.87	---	73.90	28.03	5000.0	1000.000	107.0	H	194.0	-6.1
3256.100000	---	28.06	53.90	25.84	5000.0	1000.000	107.0	H	194.0	-6.1
4721.800000	41.86	---	73.90	32.04	5000.0	1000.000	113.0	V	216.0	-0.7
4721.800000	---	28.83	53.90	25.07	5000.0	1000.000	113.0	V	216.0	-0.7
7320.077778	---	34.51	53.90	19.39	5000.0	1000.000	191.0	H	309.0	1.7
7320.077778	46.65	---	73.90	27.25	5000.0	1000.000	191.0	H	309.0	1.7
13784.766667	---	33.83	53.90	20.07	5000.0	1000.000	305.0	H	126.0	13.1
13784.766667	46.95	---	73.90	26.95	5000.0	1000.000	305.0	H	126.0	13.1
17275.611111	50.79	---	73.90	23.11	5000.0	1000.000	300.0	H	289.0	16.6
17275.611111	---	37.78	53.90	16.12	5000.0	1000.000	300.0	H	289.0	16.6

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) - pre amp (dB)

Table 8.9-19: *Radiated spurious emissions tabular data, High channel, GFSK modulation*

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)
3216.066667	---	36.02	53.90	17.88	5000.0	1000.000	274.0	H	110.0	-6.2
3216.066667	47.50	---	73.90	26.40	5000.0	1000.000	274.0	H	110.0	-6.2
3306.733333	---	40.40	53.90	13.50	5000.0	1000.000	263.0	H	181.0	-6.0
3306.733333	47.84	---	73.90	26.06	5000.0	1000.000	263.0	H	181.0	-6.0
4960.311111	48.36	---	73.90	25.54	5000.0	1000.000	235.0	V	74.0	-1.1
4960.311111	---	36.57	53.90	17.33	5000.0	1000.000	235.0	V	74.0	-1.1
9081.355556	---	30.23	53.90	23.67	5000.0	1000.000	385.0	V	160.0	4.1
9081.355556	43.14	---	73.90	30.76	5000.0	1000.000	385.0	V	160.0	4.1
13554.644444	---	32.90	53.90	21.00	5000.0	1000.000	325.0	V	0.0	11.5
13554.644444	46.85	---	73.90	27.05	5000.0	1000.000	325.0	V	0.0	11.5
17145.211111	48.62	---	73.90	25.28	5000.0	1000.000	217.0	V	215.0	15.5
17145.211111	---	35.33	53.90	18.57	5000.0	1000.000	217.0	V	215.0	15.5

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)

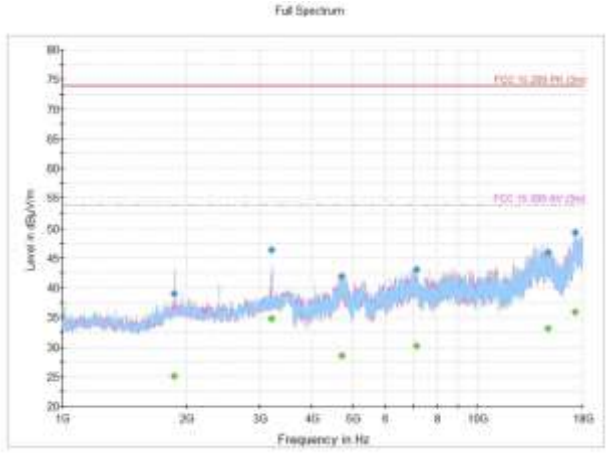

Figure 8.9-19: *Radiated spurious emissions 1-18 GHz, Low channel, π/4-DQPSK modulation*

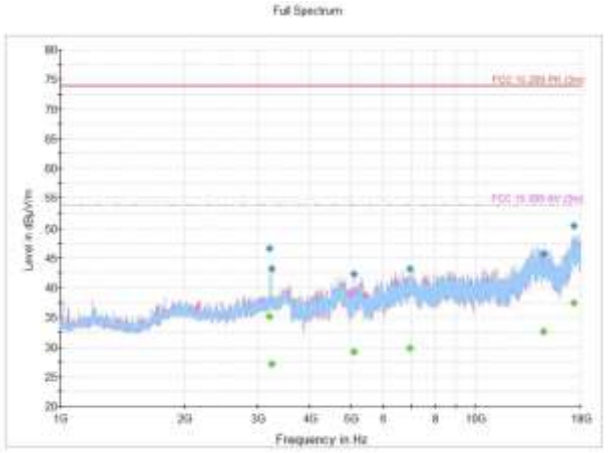

Figure 8.9-20: *Radiated spurious emissions 1-18 GHz, Mid channel, π/4-DQPSK modulation*

Table 8.9-20: *Radiated spurious emissions tabular data, Low channel, π/4-DQPSK modulation*

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)
1868.044444	---	25.10	53.90	28.80	5000.0	1000.000	294.0	V	0.0	-10.3
1868.044444	39.03	---	73.90	34.87	5000.0	1000.000	294.0	V	0.0	-10.3
3216.066667	---	34.76	53.90	19.14	5000.0	1000.000	244.0	H	158.0	-6.2
3216.066667	46.32	---	73.90	27.58	5000.0	1000.000	244.0	H	158.0	-6.2
4714.500000	---	28.47	53.90	25.43	5000.0	1000.000	281.0	V	0.0	-0.6
4714.500000	41.96	---	73.90	31.94	5000.0	1000.000	281.0	V	0.0	-0.6
7149.277778	---	30.18	53.90	23.72	5000.0	1000.000	390.0	V	351.0	1.8
7149.277778	43.00	---	73.90	30.90	5000.0	1000.000	390.0	V	351.0	1.8
14856.088889	46.00	---	73.90	27.90	5000.0	1000.000	368.0	H	0.0	12.1
14856.088889	---	33.07	53.90	20.83	5000.0	1000.000	368.0	H	0.0	12.1
17233.333333	49.25	---	73.90	24.65	5000.0	1000.000	323.0	V	316.0	16.4
17233.333333	---	35.91	53.90	17.99	5000.0	1000.000	323.0	V	316.0	16.4

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)

Table 8.9-21: *Radiated spurious emissions tabular data, Mid channel, π/4-DQPSK modulation*

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)
3216.066667	---	35.15	53.90	18.75	5000.0	1000.000	267.0	H	108.0	-6.2
3216.066667	46.63	---	73.90	27.27	5000.0	1000.000	267.0	H	108.0	-6.2
3256.277778	---	27.18	53.90	26.72	5000.0	1000.000	105.0	H	183.0	-6.1
3256.277778	43.15	---	73.90	30.75	5000.0	1000.000	105.0	H	183.0	-6.1
5120.355556	---	29.13	53.90	24.77	5000.0	1000.000	112.0	V	155.0	-1.2
5120.355556	42.34	---	73.90	31.56	5000.0	1000.000	112.0	V	155.0	-1.2
6987.266667	---	29.80	53.90	24.10	5000.0	1000.000	155.0	V	288.0	2.0
6987.266667	43.18	---	73.90	30.72	5000.0	1000.000	155.0	V	288.0	2.0
14633.488889	45.75	---	73.90	28.15	5000.0	1000.000	269.0	H	246.0	11.3
14633.488889	---	32.57	53.90	21.33	5000.0	1000.000	269.0	H	246.0	11.3
17348.922222	50.41	---	73.90	23.49	5000.0	1000.000	402.0	H	10.0	15.9
17348.922222	---	37.41	53.90	16.49	5000.0	1000.000	402.0	H	10.0	15.9

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)

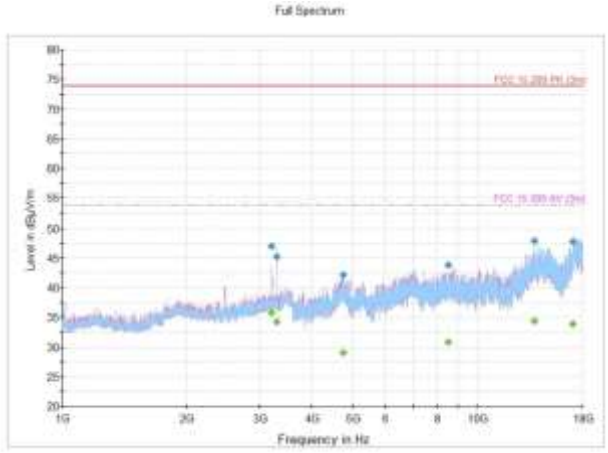

Figure 8.9-21: *Radiated spurious emissions 1-18 GHz, High channel, π/4-DQPSK modulation*

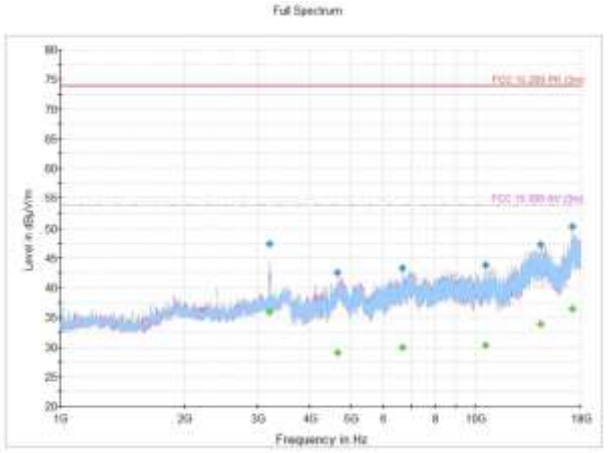

Figure 8.9-22: *Radiated spurious emissions 1-18 GHz, Low channel, 8-DPSK modulation*

Table 8.9-22: *Radiated spurious emissions tabular data, High channel, π/4-DQPSK modulation*

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)
3216.066667	47.03	---	73.90	26.87	5000.0	1000.000	120.0	V	124.0	-6.2
3216.066667	---	35.75	53.90	18.15	5000.0	1000.000	120.0	V	124.0	-6.2
3306.733333	45.18	---	73.90	28.72	5000.0	1000.000	245.0	H	135.0	-6.0
3306.733333	---	34.28	53.90	19.62	5000.0	1000.000	245.0	H	135.0	-6.0
4754.677778	42.18	---	73.90	31.72	5000.0	1000.000	375.0	V	98.0	-0.7
4754.677778	---	29.10	53.90	24.80	5000.0	1000.000	375.0	V	98.0	-0.7
8534.566667	---	30.81	53.90	23.09	5000.0	1000.000	402.0	V	168.0	3.7
8534.566667	43.79	---	73.90	30.11	5000.0	1000.000	402.0	V	168.0	3.7
13782.433333	47.87	---	73.90	26.03	5000.0	1000.000	167.0	H	0.0	13.1
13782.433333	---	34.35	53.90	19.55	5000.0	1000.000	167.0	H	0.0	13.1
17049.633333	---	33.88	53.90	20.02	5000.0	1000.000	312.0	H	170.0	14.3
17049.633333	47.82	---	73.90	26.08	5000.0	1000.000	312.0	H	170.0	14.3

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)

Table 8.9-23: *Radiated spurious emissions tabular data, Low channel, 8-DPSK modulation*

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)
3216.066667	47.38	---	73.90	26.52	5000.0	1000.000	120.0	V	125.0	-6.2
3216.066667	---	35.92	53.90	17.98	5000.0	1000.000	120.0	V	125.0	-6.2
4667.022222	42.58	---	73.90	31.32	5000.0	1000.000	389.0	H	293.0	-0.8
4667.022222	---	29.05	53.90	24.85	5000.0	1000.000	389.0	H	293.0	-0.8
6683.122222	43.35	---	73.90	30.55	5000.0	1000.000	315.0	H	340.0	1.8
6683.122222	---	29.89	53.90	24.01	5000.0	1000.000	315.0	H	340.0	1.8
10590.511111	43.83	---	73.90	30.07	5000.0	1000.000	259.0	V	280.0	5.6
10590.511111	---	30.35	53.90	23.55	5000.0	1000.000	259.0	V	280.0	5.6
14411.211111	47.24	---	73.90	26.66	5000.0	1000.000	308.0	H	200.0	12.2
14411.211111	---	33.85	53.90	20.05	5000.0	1000.000	308.0	H	200.0	12.2
17163.544444	50.35	---	73.90	23.55	5000.0	1000.000	380.0	V	32.0	15.9
17163.544444	---	36.39	53.90	17.51	5000.0	1000.000	380.0	V	32.0	15.9

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)

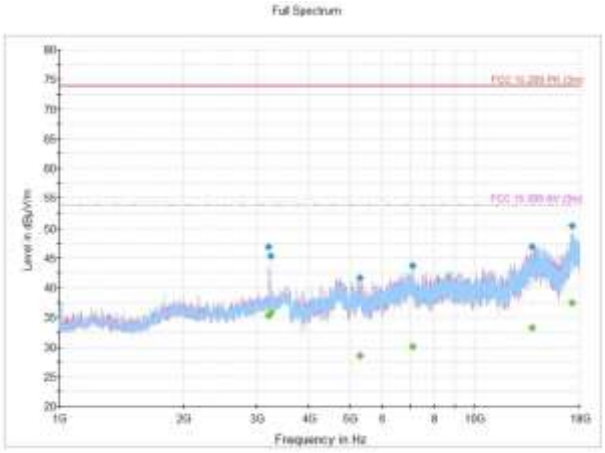

Figure 8.9-23: *Radiated spurious emissions 1-18 GHz, Mid channel, 8-DPSK modulation*

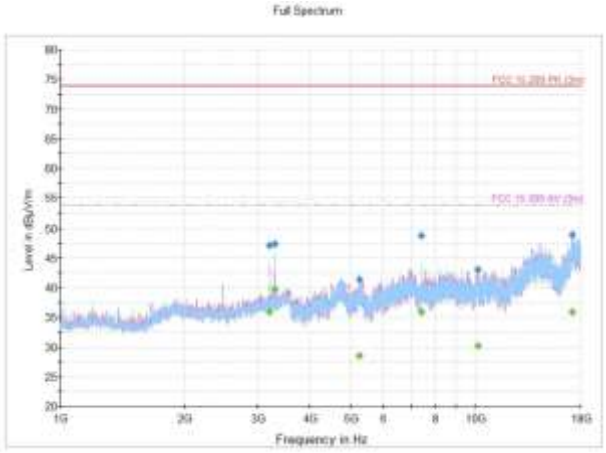

Figure 8.9-24: *Radiated spurious emissions 1-18 GHz, High channel, 8-DPSK modulation*

Table 8.9-24: *Radiated spurious emissions tabular data, Mid channel, 8-DPSK modulation*

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)
3216.066667	46.92	---	73.90	26.98	5000.0	1000.000	107.0	V	122.0	-6.2
3216.066667	---	35.35	53.90	18.55	5000.0	1000.000	107.0	V	122.0	-6.2
3253.300000	45.31	---	73.90	28.59	5000.0	1000.000	273.0	H	180.0	-6.1
3253.300000	---	35.82	53.90	18.08	5000.0	1000.000	273.0	H	180.0	-6.1
5313.133333	41.70	---	73.90	32.20	5000.0	1000.000	187.0	V	350.0	-0.7
5313.133333	---	28.55	53.90	25.35	5000.0	1000.000	187.0	V	350.0	-0.7
7119.844444	---	30.06	53.90	23.84	5000.0	1000.000	223.0	H	219.0	1.8
7119.844444	43.66	---	73.90	30.24	5000.0	1000.000	223.0	H	219.0	1.8
13813.233333	46.88	---	73.90	27.02	5000.0	1000.000	301.0	V	288.0	13.1
13813.233333	---	33.29	53.90	20.61	5000.0	1000.000	301.0	V	288.0	13.1
17255.422222	---	37.47	53.90	16.43	5000.0	1000.000	331.0	H	260.0	16.3
17255.422222	50.40	---	73.90	23.50	5000.0	1000.000	331.0	H	260.0	16.3

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)

Table 8.9-25: *Radiated spurious emissions tabular data, High channel, 8-DPSK modulation*

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)
3216.066667	---	35.87	53.90	18.03	5000.0	1000.000	107.0	V	124.0	-6.2
3216.066667	47.16	---	73.90	26.74	5000.0	1000.000	107.0	V	124.0	-6.2
3306.733333	---	39.76	53.90	14.14	5000.0	1000.000	262.0	H	179.0	-6.0
3306.733333	47.33	---	73.90	26.57	5000.0	1000.000	262.0	H	179.0	-6.0
5264.677778	---	28.51	53.90	25.39	5000.0	1000.000	235.0	V	0.0	-0.9
5264.677778	41.38	---	73.90	32.52	5000.0	1000.000	235.0	V	0.0	-0.9
7439.622222	48.80	---	73.90	25.10	5000.0	1000.000	214.0	H	224.0	2.2
7439.622222	---	35.97	53.90	17.93	5000.0	1000.000	214.0	H	224.0	2.2
10182.066667	43.07	---	73.90	30.83	5000.0	1000.000	353.0	V	228.0	5.3
10182.066667	---	30.21	53.90	23.69	5000.0	1000.000	353.0	V	228.0	5.3
17160.311111	---	35.87	53.90	18.03	5000.0	1000.000	221.0	H	0.0	15.8
17160.311111	48.87	---	73.90	25.03	5000.0	1000.000	221.0	H	0.0	15.8

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)

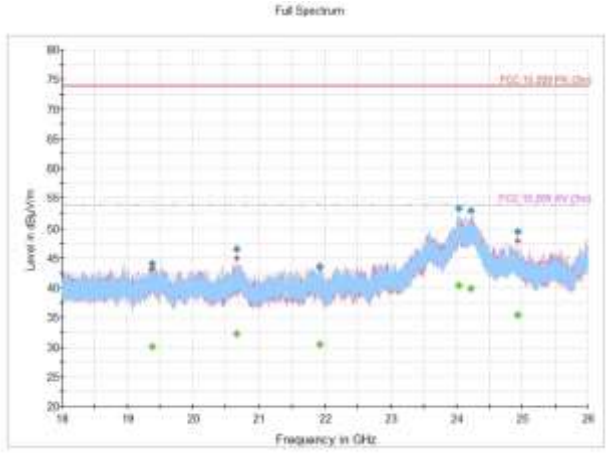

Figure 8.9-25: *Radiated spurious emissions 18-26 GHz, Low channel, GFSK modulation*

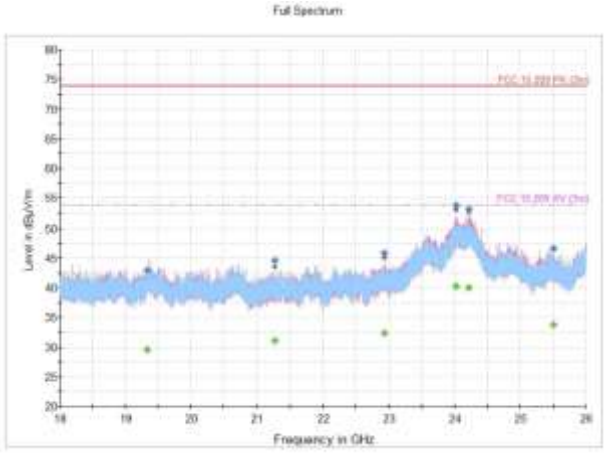

Figure 8.9-26: *Radiated spurious emissions 18-26 GHz, Mid channel, GFSK modulation*

Table 8.9-26: *Radiated spurious emissions tabular data, Low channel, GFSK modulation*

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)
19384.633333	44.06	---	73.90	29.84	5000.0	1000.000	131.0	V	31.0	18.4
19384.633333	---	30.12	53.90	23.78	5000.0	1000.000	131.0	V	31.0	18.4
20670.633333	46.48	---	73.90	27.42	5000.0	1000.000	100.0	H	236.0	19.8
20670.633333	---	32.28	53.90	21.62	5000.0	1000.000	100.0	H	236.0	19.8
21923.966667	43.40	---	73.90	30.50	5000.0	1000.000	166.0	H	270.0	19.1
21923.966667	---	30.47	53.90	23.43	5000.0	1000.000	166.0	H	270.0	19.1
24039.433333	---	40.33	53.90	13.58	5000.0	1000.000	132.0	H	357.0	29.7
24039.433333	53.31	---	73.90	20.59	5000.0	1000.000	132.0	H	357.0	29.7
24223.966667	---	39.93	53.90	13.97	5000.0	1000.000	237.0	V	30.0	29.1
24223.966667	52.85	---	73.90	21.05	5000.0	1000.000	237.0	V	30.0	29.1
24926.500000	49.46	---	73.90	24.44	5000.0	1000.000	254.0	H	11.0	24.7
24926.500000	---	35.46	53.90	18.44	5000.0	1000.000	254.0	H	11.0	24.7

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)

Table 8.9-27: *Radiated spurious emissions tabular data, Mid channel, GFSK modulation*

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)
19338.766667	42.93	---	73.90	30.97	5000.0	1000.000	298.0	V	-1.0	18.5
19338.766667	---	29.59	53.90	24.31	5000.0	1000.000	298.0	V	-1.0	18.5
21276.500000	---	31.04	53.90	22.86	5000.0	1000.000	191.0	H	168.0	18.9
21276.500000	44.65	---	73.90	29.25	5000.0	1000.000	191.0	H	168.0	18.9
22933.166667	---	32.32	53.90	21.58	5000.0	1000.000	244.0	V	327.0	21.1
22933.166667	45.80	---	73.90	28.10	5000.0	1000.000	244.0	V	327.0	21.1
24026.100000	---	40.21	53.90	13.69	5000.0	1000.000	207.0	V	19.0	29.7
24026.100000	53.75	---	73.90	20.15	5000.0	1000.000	207.0	V	19.0	29.7
24220.233333	53.15	---	73.90	20.75	5000.0	1000.000	317.0	V	134.0	29.1
24220.233333	---	40.05	53.90	13.85	5000.0	1000.000	317.0	V	134.0	29.1
25506.300000	---	33.76	53.90	20.14	5000.0	1000.000	324.0	H	248.0	24.2
25506.300000	46.61	---	73.90	27.29	5000.0	1000.000	324.0	H	248.0	24.2

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)

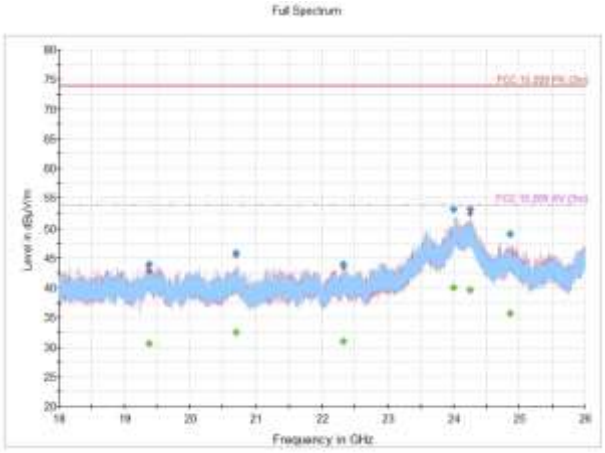

Figure 8.9-27: *Radiated spurious emissions 18-26 GHz, High channel, GFSK modulation*

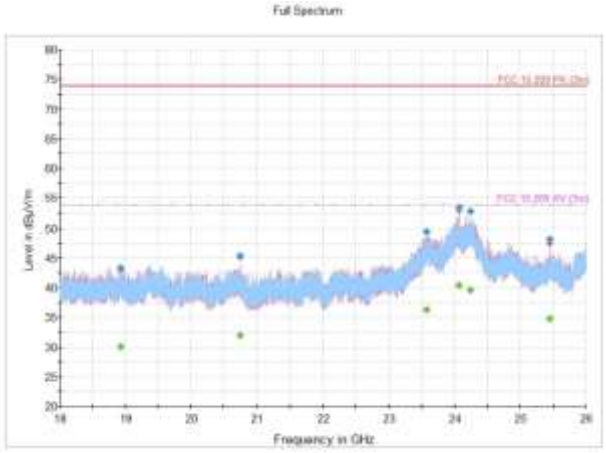

Figure 8.9-28: *Radiated spurious emissions 18-26 GHz, Low channel, π/4-DQPSK modulation*

Table 8.9-28: *Radiated spurious emissions tabular data, High channel, GFSK modulation*

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)
19384.633333	---	30.54	53.90	23.36	5000.0	1000.000	278.0	V	67.0	18.4
19384.633333	43.97	---	73.90	29.93	5000.0	1000.000	278.0	V	67.0	18.4
20699.566667	---	32.49	53.90	21.41	5000.0	1000.000	160.0	H	314.0	20.1
20699.566667	45.91	---	73.90	27.99	5000.0	1000.000	160.0	H	314.0	20.1
22326.900000	---	30.96	53.90	22.94	5000.0	1000.000	351.0	V	357.0	19.5
22326.900000	43.90	---	73.90	30.00	5000.0	1000.000	351.0	V	357.0	19.5
24003.566667	---	40.02	53.90	13.88	5000.0	1000.000	257.0	H	144.0	29.4
24003.566667	53.15	---	73.90	20.75	5000.0	1000.000	257.0	H	144.0	29.4
24255.900000	---	39.58	53.90	14.32	5000.0	1000.000	282.0	H	171.0	29.0
24255.900000	53.17	---	73.90	20.73	5000.0	1000.000	282.0	H	171.0	29.0
24858.300000	---	35.71	53.90	18.19	5000.0	1000.000	173.0	V	305.0	24.7
24858.300000	49.03	---	73.90	24.87	5000.0	1000.000	173.0	V	305.0	24.7

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)

Table 8.9-29: *Radiated spurious emissions tabular data, Low channel, π/4-DQPSK modulation*

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)
18935.766667	43.25	---	73.90	30.65	5000.0	1000.000	338.0	V	0.0	17.5
18935.766667	---	30.12	53.90	23.78	5000.0	1000.000	338.0	V	0.0	17.5
20745.566667	45.30	---	73.90	28.60	5000.0	1000.000	304.0	V	122.0	19.9
20745.566667	---	32.02	53.90	21.88	5000.0	1000.000	304.0	V	122.0	19.9
23575.633333	49.47	---	73.90	24.43	5000.0	1000.000	342.0	H	42.0	26.0
23575.633333	---	36.33	53.90	17.57	5000.0	1000.000	342.0	H	42.0	26.0
24070.100000	---	40.36	53.90	13.54	5000.0	1000.000	344.0	V	158.0	29.7
24070.100000	53.44	---	73.90	20.46	5000.0	1000.000	344.0	V	158.0	29.7
24239.633333	52.76	---	73.90	21.14	5000.0	1000.000	198.0	H	192.0	29.0
24239.633333	---	39.59	53.90	14.31	5000.0	1000.000	198.0	H	192.0	29.0
25446.766667	---	34.83	53.90	19.07	5000.0	1000.000	368.0	V	46.0	23.9
25446.766667	48.12	---	73.90	25.78	5000.0	1000.000	368.0	V	46.0	23.9

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)

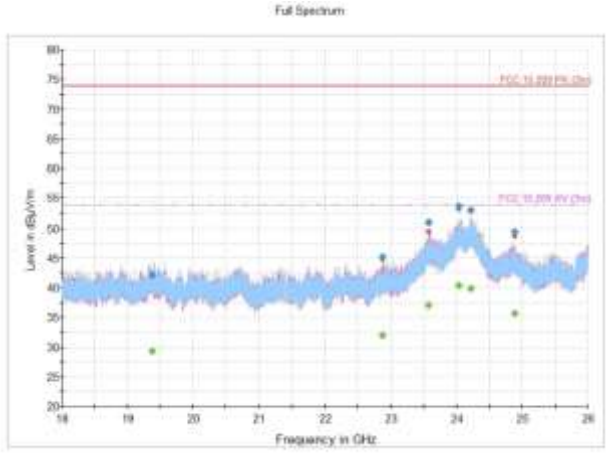

Figure 8.9-29: *Radiated spurious emissions 18-26 GHz, Mid channel, π/4-DQPSK modulation*

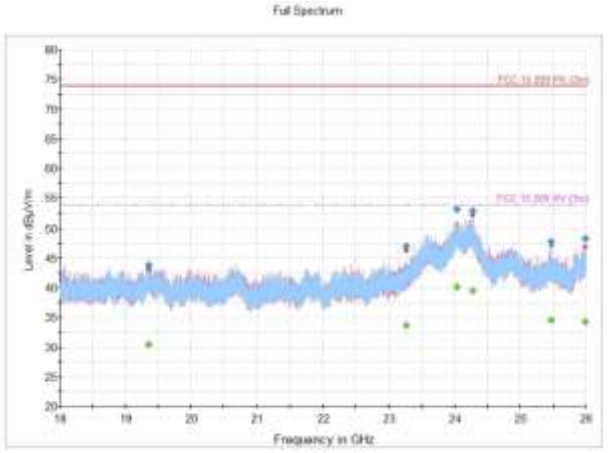

Figure 8.9-30: *Radiated spurious emissions 18-26 GHz, High channel, π/4-DQPSK modulation*

Table 8.9-30: *Radiated spurious emissions tabular data, Mid channel, π/4-DQPSK modulation*

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)
19374.366667	---	29.24	53.90	24.66	5000.0	1000.000	123.0	H	215.0	18.4
19374.366667	42.13	---	73.90	31.77	5000.0	1000.000	123.0	H	215.0	18.4
22874.766667	45.21	---	73.90	28.69	5000.0	1000.000	340.0	V	0.0	21.2
22874.766667	---	31.92	53.90	21.98	5000.0	1000.000	340.0	V	0.0	21.2
23577.833333	51.01	---	73.90	22.89	5000.0	1000.000	402.0	V	0.0	25.9
23577.833333	---	37.08	53.90	16.82	5000.0	1000.000	402.0	V	0.0	25.9
24035.366667	---	40.35	53.90	13.55	5000.0	1000.000	389.0	V	54.0	29.7
24035.366667	53.61	---	73.90	20.29	5000.0	1000.000	389.0	V	54.0	29.7
24223.233333	---	39.93	53.90	13.97	5000.0	1000.000	274.0	V	102.0	29.1
24223.233333	53.03	---	73.90	20.87	5000.0	1000.000	274.0	V	102.0	29.1
24883.966667	---	35.66	53.90	18.24	5000.0	1000.000	312.0	V	323.0	24.7
24883.966667	49.41	---	73.90	24.49	5000.0	1000.000	312.0	V	323.0	24.7

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)

Table 8.9-31: *Radiated spurious emissions tabular data, High channel, π/4-DQPSK modulation*

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)
19360.966667	43.77	---	73.90	30.13	5000.0	1000.000	125.0	V	151.0	18.5
19360.966667	---	30.42	53.90	23.48	5000.0	1000.000	125.0	V	151.0	18.5
23265.633333	47.05	---	73.90	26.85	5000.0	1000.000	402.0	V	30.0	22.6
23265.633333	---	33.59	53.90	20.31	5000.0	1000.000	402.0	V	30.0	22.6
24030.100000	53.15	---	73.90	20.75	5000.0	1000.000	266.0	V	112.0	29.7
24030.100000	---	40.17	53.90	13.73	5000.0	1000.000	266.0	V	112.0	29.7
24273.500000	---	39.54	53.90	14.36	5000.0	1000.000	304.0	V	20.0	28.7
24273.500000	52.91	---	73.90	20.99	5000.0	1000.000	304.0	V	20.0	28.7
25470.100000	---	34.55	53.90	19.35	5000.0	1000.000	270.0	V	79.0	24.0
25470.100000	47.72	---	73.90	26.18	5000.0	1000.000	270.0	V	79.0	24.0
25985.900000	48.30	---	73.90	25.60	5000.0	1000.000	130.0	H	350.0	25.3
25985.900000	---	34.29	53.90	19.61	5000.0	1000.000	130.0	H	350.0	25.3

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)

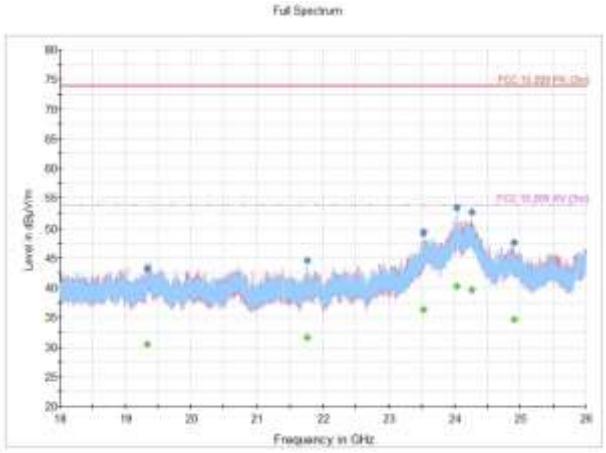

Figure 8.9-31: *Radiated spurious emissions 18-26 GHz, Low channel, 8-DPSK modulation*

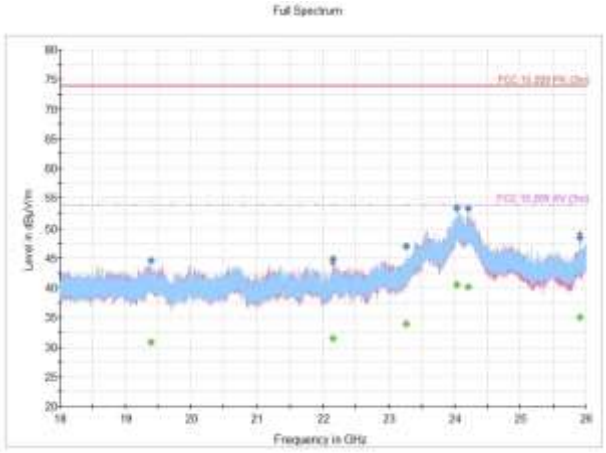

Figure 8.9-32: *Radiated spurious emissions 18-26 GHz, Mid channel, 8-DPSK modulation*

Table 8.9-32: *Radiated spurious emissions tabular data, Low channel, 8-DPSK modulation*

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)
19332.100000	43.34	---	73.90	30.56	5000.0	1000.000	377.0	V	66.0	18.5
19332.100000	---	30.44	53.90	23.46	5000.0	1000.000	377.0	V	66.0	18.5
21762.966667	44.55	---	73.90	29.35	5000.0	1000.000	386.0	H	76.0	19.5
21762.966667	---	31.56	53.90	22.34	5000.0	1000.000	386.0	H	76.0	19.5
23525.900000	49.42	---	73.90	24.48	5000.0	1000.000	166.0	H	149.0	25.4
23525.900000	---	36.28	53.90	17.62	5000.0	1000.000	166.0	H	149.0	25.4
24038.233333	---	40.24	53.90	13.66	5000.0	1000.000	217.0	V	281.0	29.7
24038.233333	53.39	---	73.90	20.51	5000.0	1000.000	217.0	V	281.0	29.7
24267.966667	---	39.56	53.90	14.34	5000.0	1000.000	148.0	V	20.0	28.8
24267.966667	52.56	---	73.90	21.34	5000.0	1000.000	148.0	V	20.0	28.8
24910.100000	47.64	---	73.90	26.26	5000.0	1000.000	359.0	H	144.0	24.7
24910.100000	---	34.69	53.90	19.21	5000.0	1000.000	359.0	H	144.0	24.7

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)

Table 8.9-33: *Radiated spurious emissions tabular data, Mid channel, 8-DPSK modulation*

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)
19391.766667	44.53	---	73.90	29.37	5000.0	1000.000	402.0	V	0.0	18.4
19391.766667	---	30.88	53.90	23.02	5000.0	1000.000	402.0	V	0.0	18.4
22149.833333	---	31.52	53.90	22.38	5000.0	1000.000	330.0	H	264.0	19.8
22149.833333	44.83	---	73.90	29.07	5000.0	1000.000	330.0	H	264.0	19.8
23260.900000	---	33.89	53.90	20.01	5000.0	1000.000	202.0	H	89.0	22.5
23260.900000	46.95	---	73.90	26.95	5000.0	1000.000	202.0	H	89.0	22.5
24032.366667	---	40.48	53.90	13.42	5000.0	1000.000	359.0	H	222.0	29.7
24032.366667	53.20	---	73.90	20.70	5000.0	1000.000	359.0	H	222.0	29.7
24212.500000	---	40.11	53.90	13.79	5000.0	1000.000	313.0	V	0.0	29.1
24212.500000	53.29	---	73.90	20.61	5000.0	1000.000	313.0	V	0.0	29.1
25908.766667	48.42	---	73.90	25.48	5000.0	1000.000	144.0	H	88.0	24.8
25908.766667	---	35.01	53.90	18.89	5000.0	1000.000	144.0	H	88.0	24.8

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)

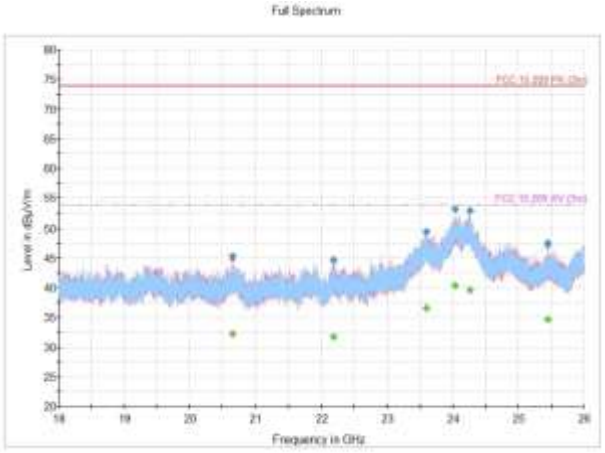

Figure 8.9-33: *Radiated spurious emissions 18-26 GHz, High channel, 8-DPSK modulation*

Table 8.9-34: *Radiated spurious emissions tabular data, High channel, 8-DPSK modulation*

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)
20653.300000	---	32.23	53.90	21.67	5000.0	1000.000	181.0	V	194.0	19.7
20653.300000	45.36	---	73.90	28.54	5000.0	1000.000	181.0	V	194.0	19.7
22178.766667	---	31.74	53.90	22.16	5000.0	1000.000	151.0	V	89.0	19.9
22178.766667	44.76	---	73.90	29.14	5000.0	1000.000	151.0	V	89.0	19.9
23597.566667	---	36.53	53.90	17.37	5000.0	1000.000	110.0	V	354.0	25.9
23597.566667	49.36	---	73.90	24.54	5000.0	1000.000	110.0	V	354.0	25.9
24030.766667	---	40.37	53.90	13.53	5000.0	1000.000	391.0	V	0.0	29.7
24030.766667	53.16	---	73.90	20.74	5000.0	1000.000	391.0	V	0.0	29.7
24262.766667	---	39.66	53.90	14.24	5000.0	1000.000	320.0	V	300.0	28.9
24262.766667	52.90	---	73.90	21.00	5000.0	1000.000	320.0	V	300.0	28.9
25444.100000	---	34.66	53.90	19.24	5000.0	1000.000	146.0	V	194.0	23.9
25444.100000	47.56	---	73.90	26.34	5000.0	1000.000	146.0	V	194.0	23.9

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)

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

8.10.1 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.

8.10.2 Test summary

Test date	July 14, 2021	Temperature	22 °C
Test engineer	David Hewitt, EMC Specialist	Air pressure	1006 mbar
Test location	Wireless bench (conducted)	Relative humidity	71 %

8.10.3 Notes

The EUT was configured to transmit continuously on the low, mid, and high channels, and in all three modulation schemes.

8.10.4 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	50 kHz
Video bandwidth	200 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.10.5 Test data

Table 8.10-1: *99% Occupied bandwidth*

Test Frequency (MHz)	Modulation	99% Occupied Bandwidth
2402	GFSK	853.75 kHz
2402	π/4-DQPSK	1.1808 MHz
2402	8-DPSK	1.1830 MHz
2440	GFSK	850.34 kHz
2440	π/4-DQPSK	1.1813 MHz
2440	8-DPSK	1.1819 MHz
2480	GFSK	853.85 kHz
2480	π/4-DQPSK	1.1805 MHz
2480	8-DPSK	1.1826 MHz

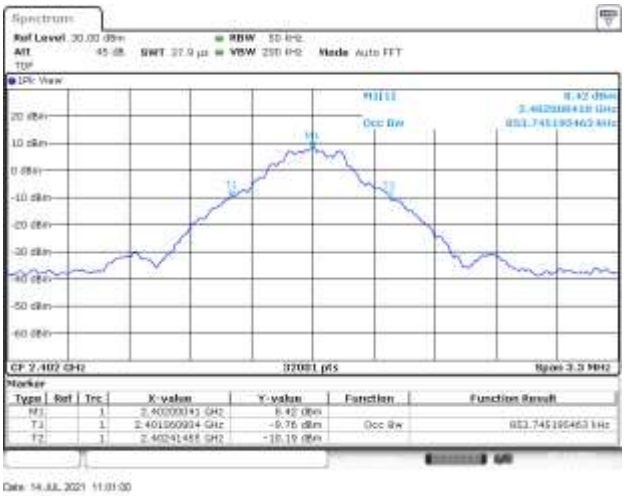

Figure 8.10-1: *99% occupied bandwidth, Low channel, GFSK modulation*

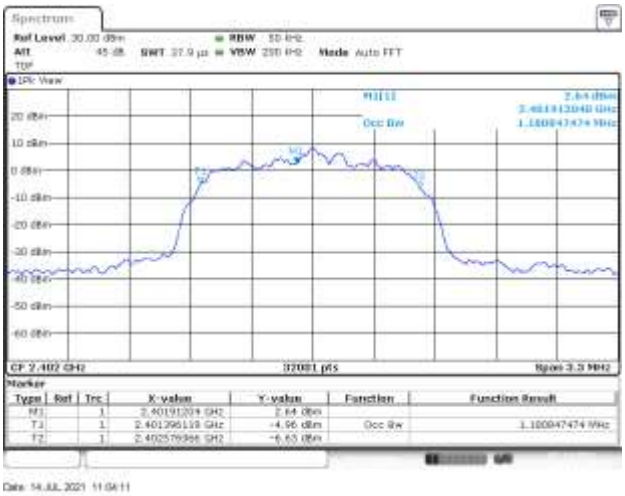

Figure 8.10-2: *99% occupied bandwidth, Low channel, π/4-DQPSK modulation*

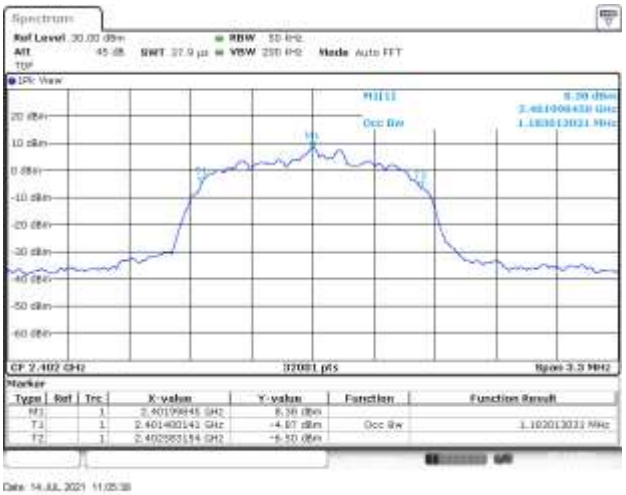

Figure 8.10-3: *99% occupied bandwidth, Low channel, 8-DPSK modulation*

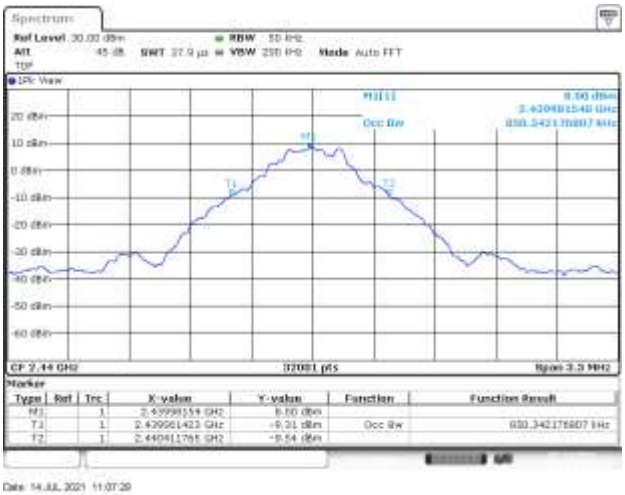

Figure 8.10-4: *99% occupied bandwidth, Mid channel, GFSK modulation*

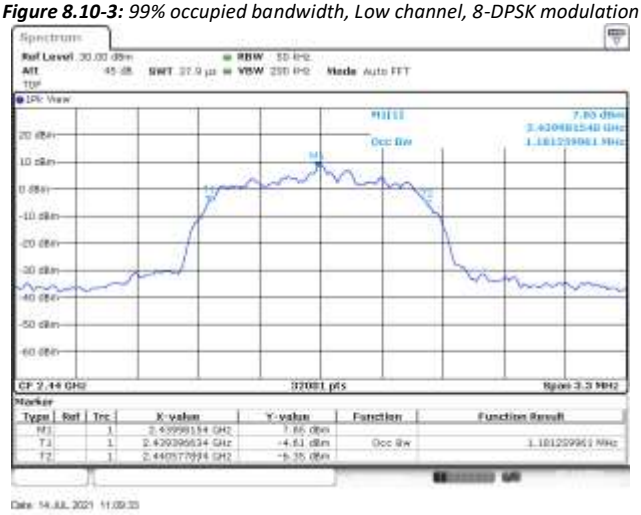

Figure 8.10-5: *99% occupied bandwidth, Mid channel, π/4-DQPSK modulation*

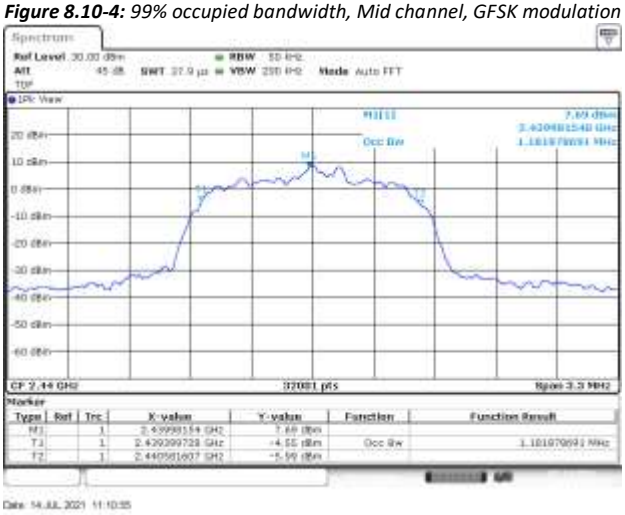

Figure 8.10-6: *99% occupied bandwidth, Mid channel, 8-DPSK modulation*

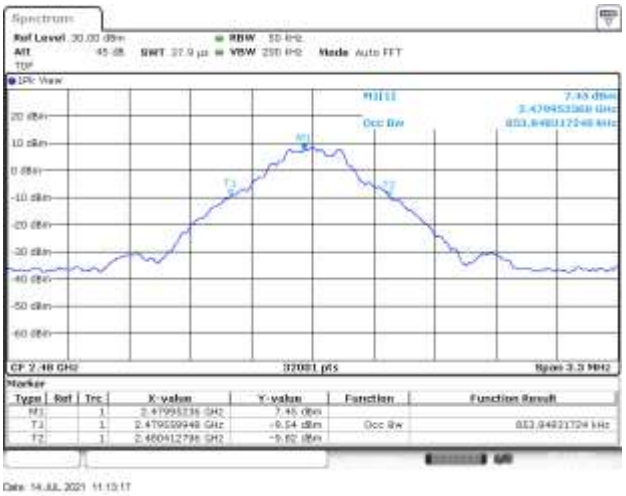

Figure 8.10-7: *99% occupied bandwidth, High channel, GFSK modulation*

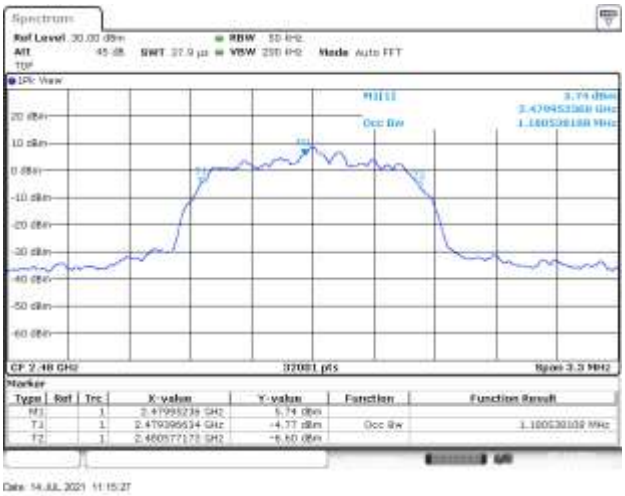

Figure 8.10-8: *99% occupied bandwidth, High channel, π/4-DQPSK modulation*

Figure 8.10-9: *99% occupied bandwidth, High channel, 8-DPSK modulation*

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up

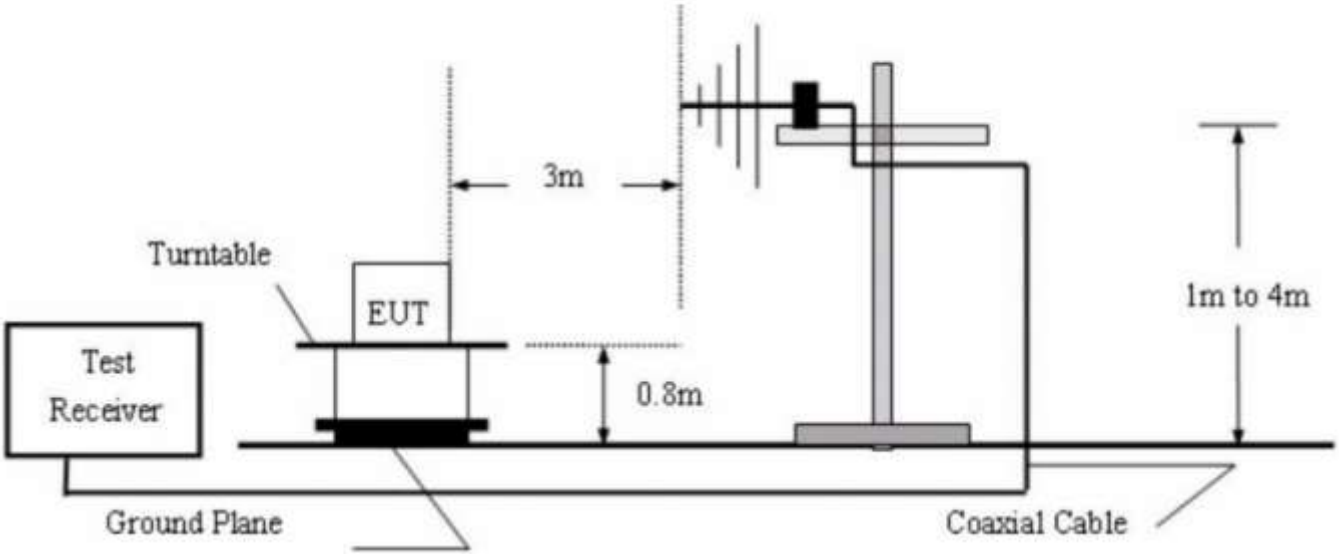

Figure 9.1-1: *30 MHz - 1000 MHz Setup*

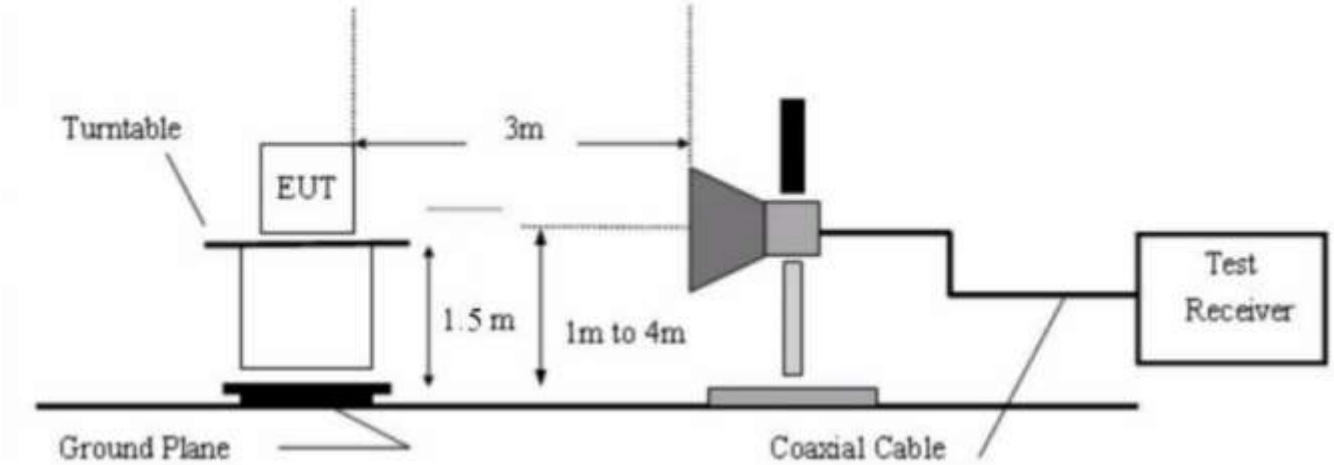

Figure 9.1-2: 1 GHz - 26 GHz Setup

9.2 Conducted emissions set-up

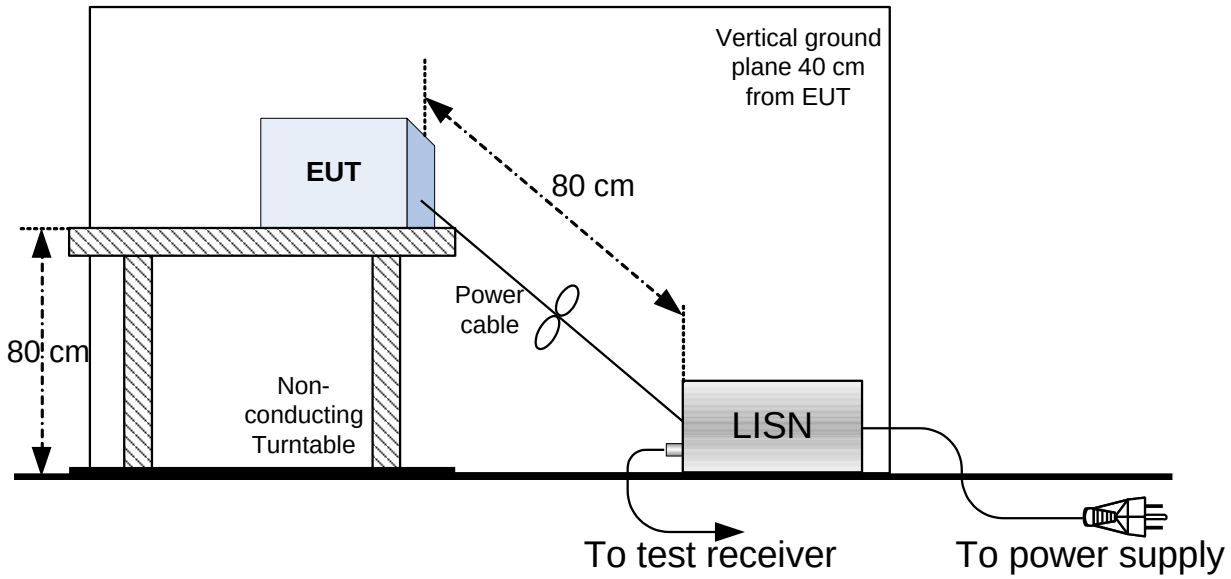

Figure 9.2-1: *150 kHz to 30 MHz Conducted Emissions Setup*