

9.6 Spurious RF Conducted Emissions

Test Method

1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector, Sweep = auto, Span = wide enough to capture the peak level of the in-band emission and all spurious emissions, Trace = max hold. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section.
4. Measure and record the results in the test report.
5. The RF fundamental frequency should be excluded against the limit line in the operating frequency.

Limit

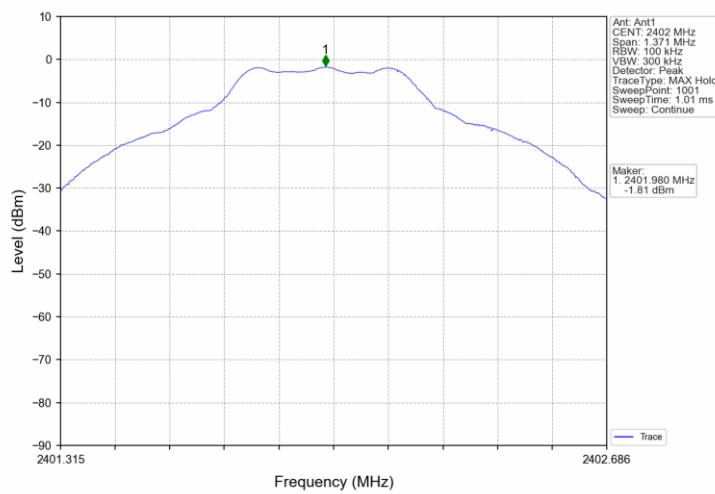
According to §15.247(d), Spurious RF Conducted Emissions limit as below:

Frequency Range MHz	Limit (dBc)
30-25000	-20

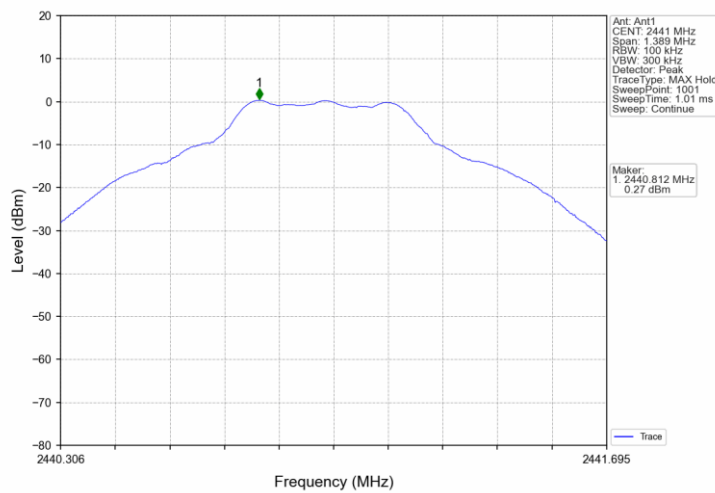
Spurious RF Conducted Emissions

Mode	TX Type	Frequency (MHz)	Packet Type	ANT	Level of Reference (dBm)	Limit (dBm)	Verdict
GFSK	SISO	2402	DH5	1	-1.81	-21.81	Pass
		2441	DH5	1	0.27	-19.73	Pass
		2480	DH5	1	0.11	-19.89	Pass
Pi/4DQPSK	SISO	2402	2DH5	1	-7.18	-27.18	Pass
		2441	2DH5	1	-5.51	-25.51	Pass
		2480	2DH5	1	-5.56	-25.56	Pass
8DPSK	SISO	2402	3DH5	1	-7.08	-27.08	Pass
		2441	3DH5	1	-5.42	-25.42	Pass
		2480	3DH5	1	-5.47	-25.47	Pass

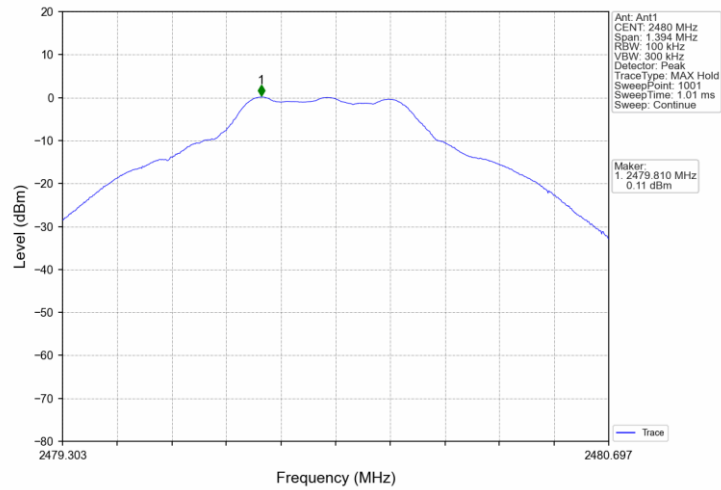
GFSK_DH5_LCH_2402MHz_Ant1_NTNV



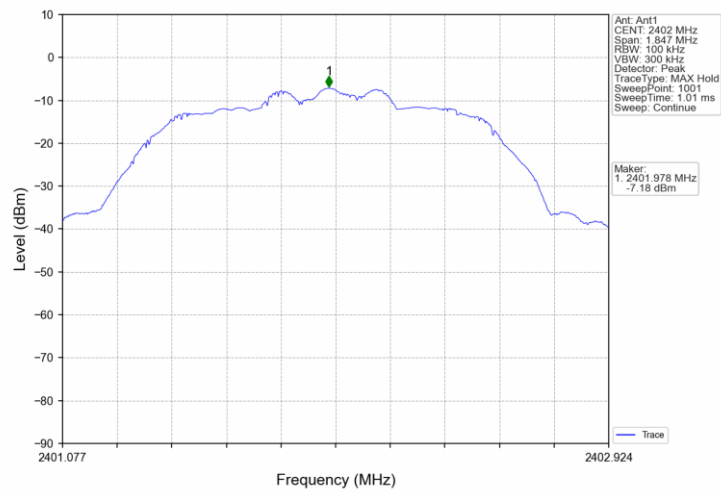
GFSK_DH5_MCH_2441MHz_Ant1_NTNV



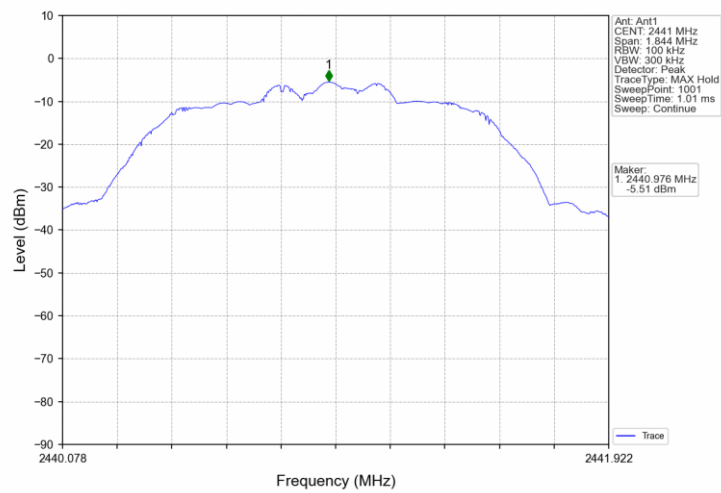
GFSK_DH5_HCH_2480MHz_Ant1_NTNV



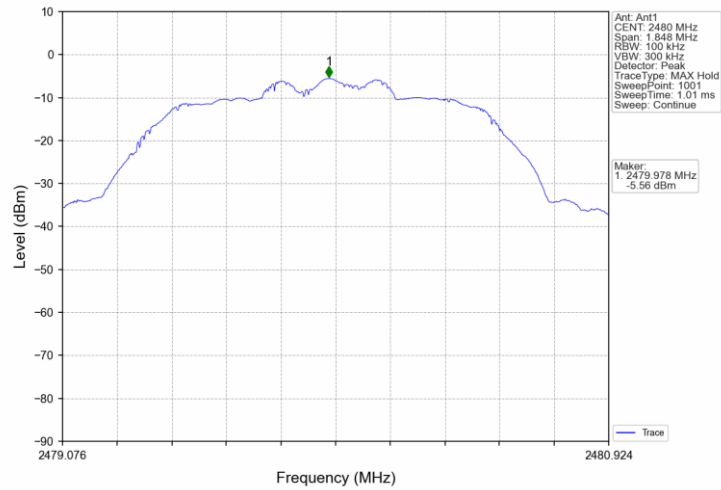
Pi/4DQPSK_2DH5_LCH_2402MHz_Ant1_NTNV



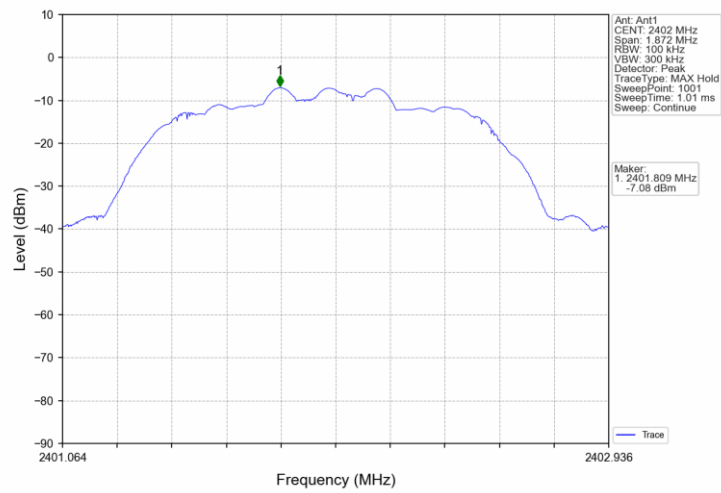
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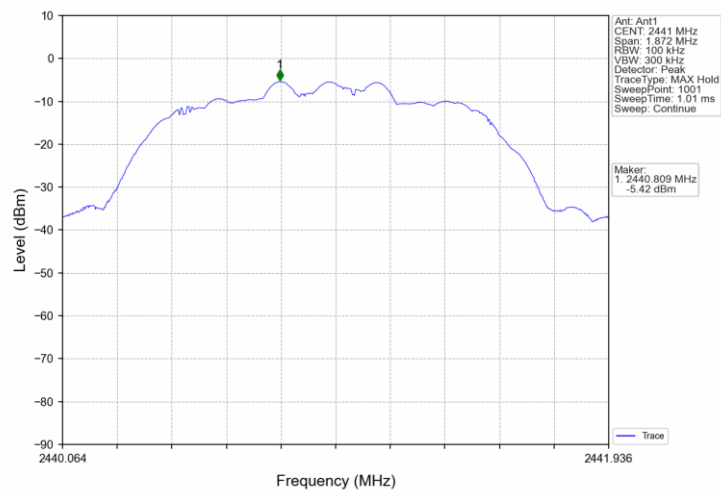
Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV



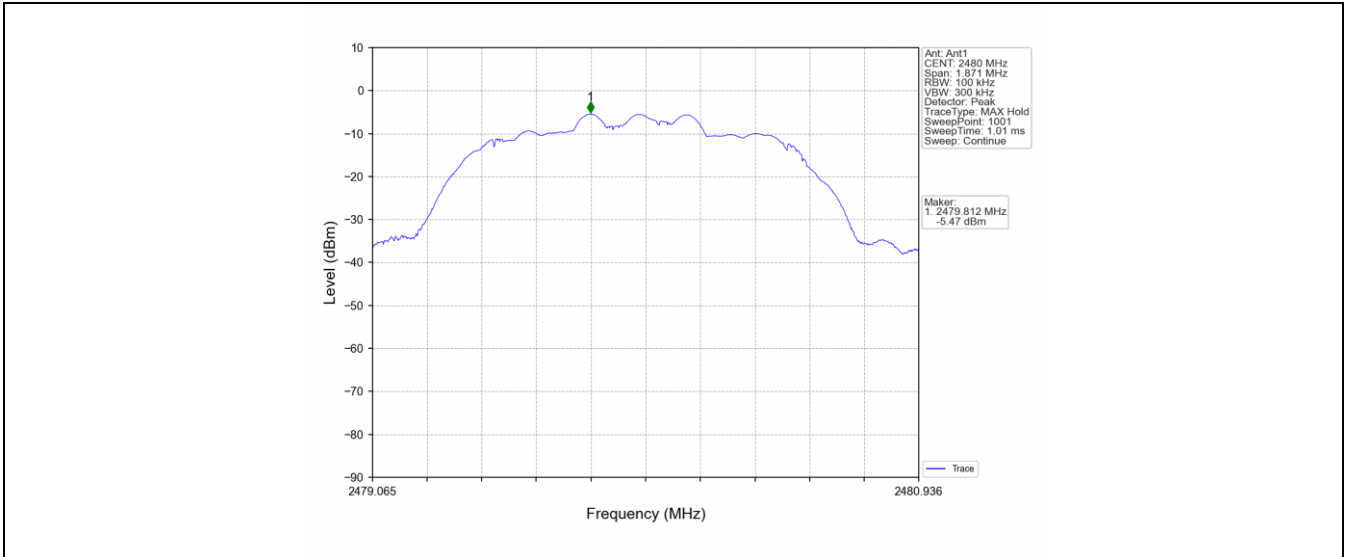
8DPSK_3DH5_LCH_2402MHz_Ant1_NTNV



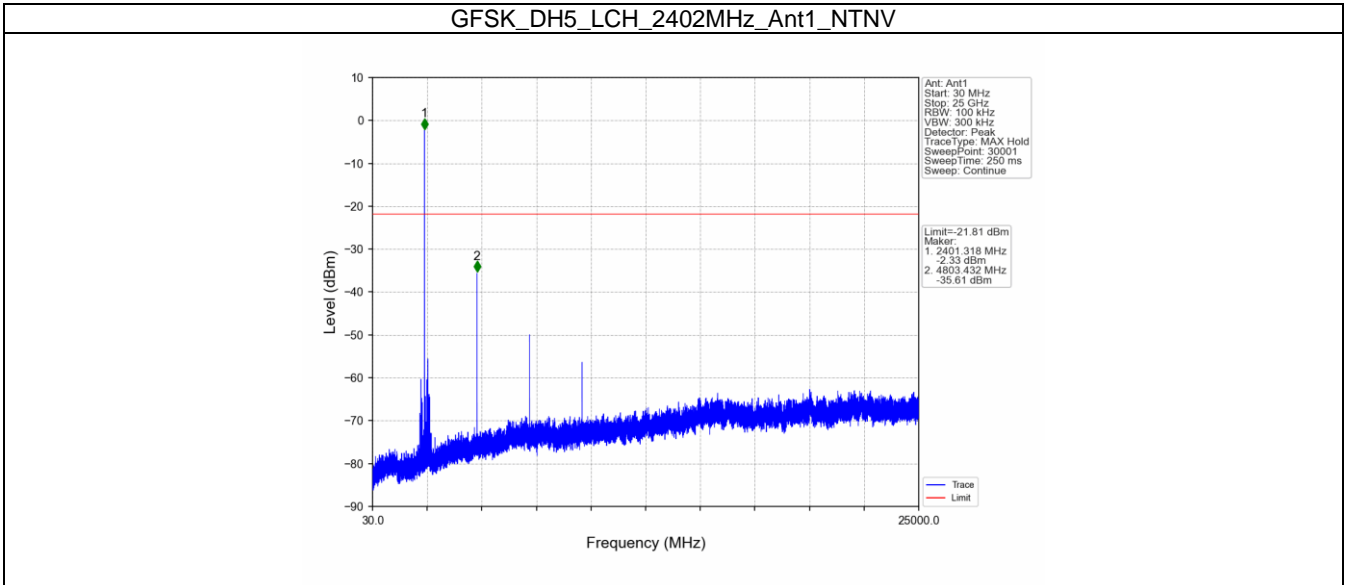
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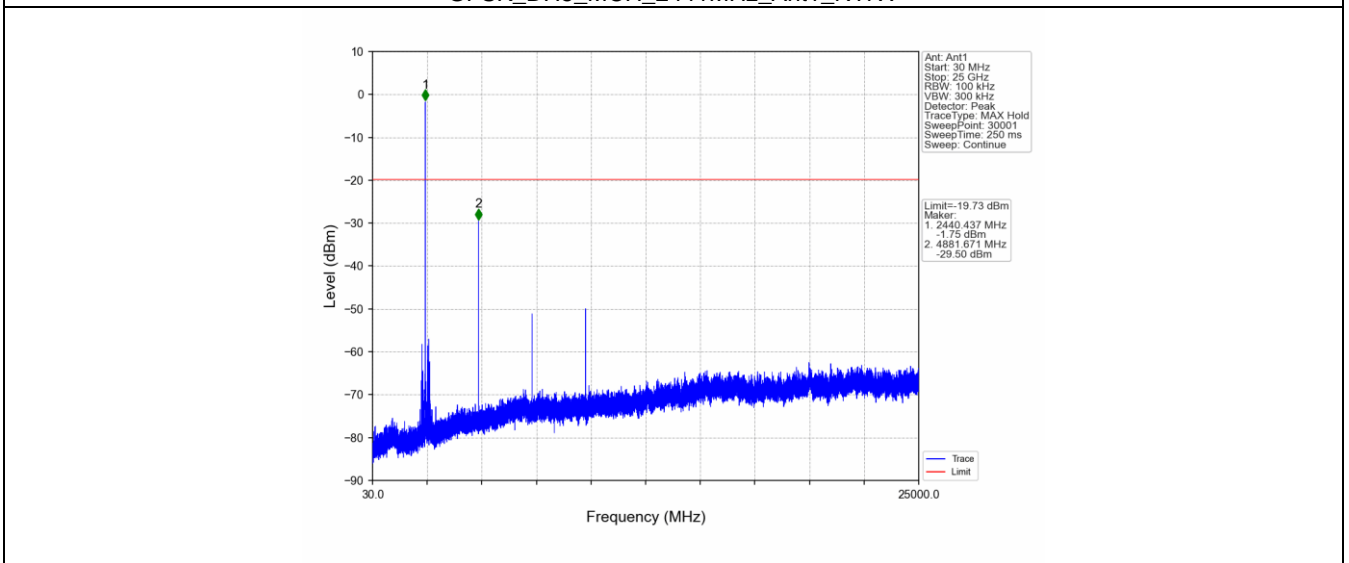
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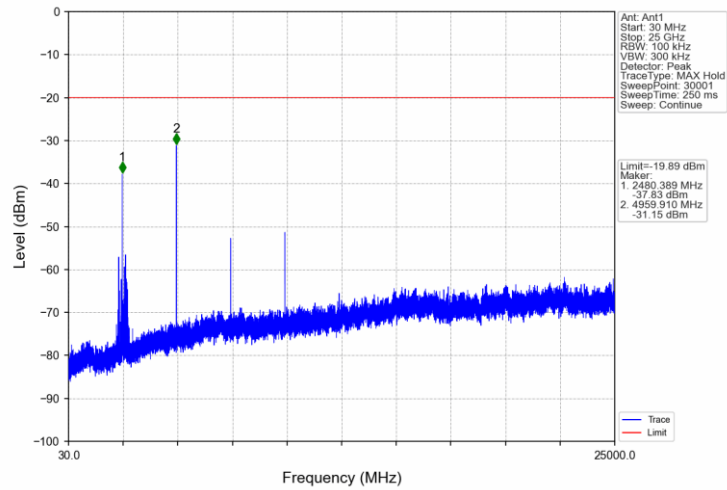
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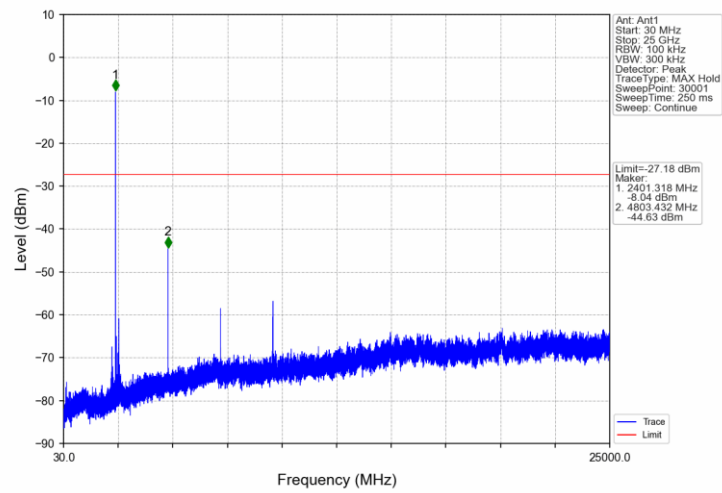
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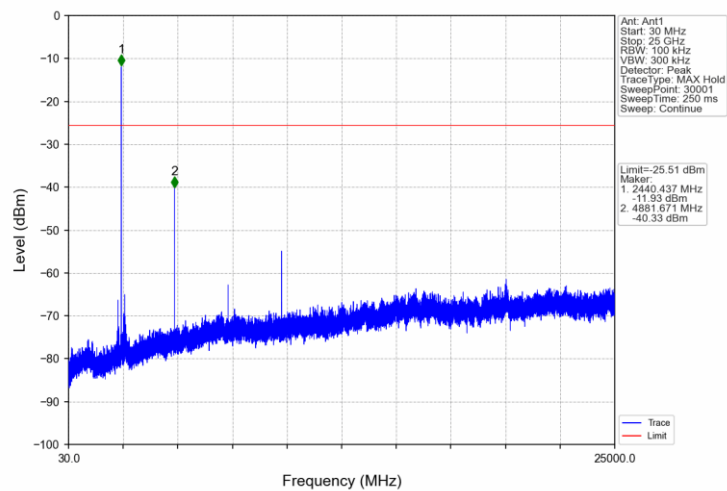
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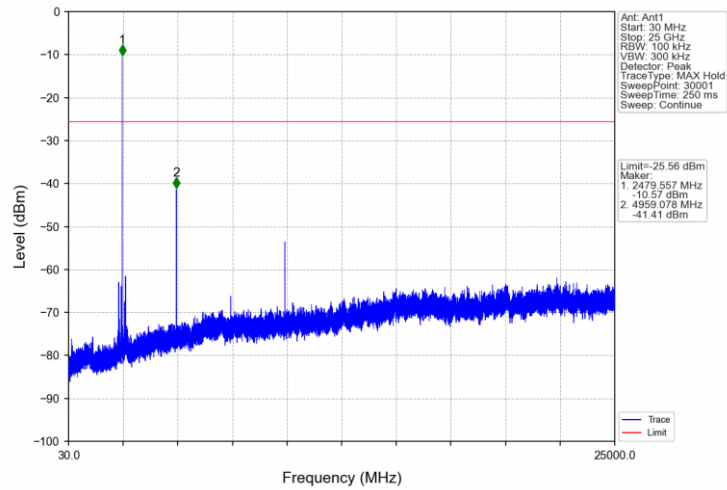
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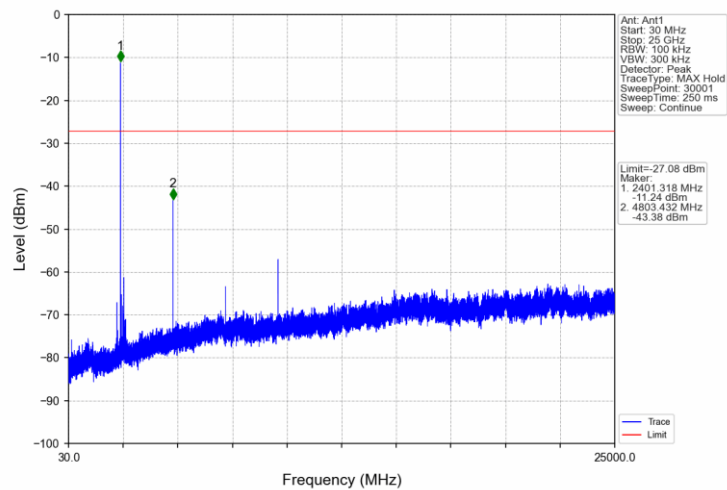
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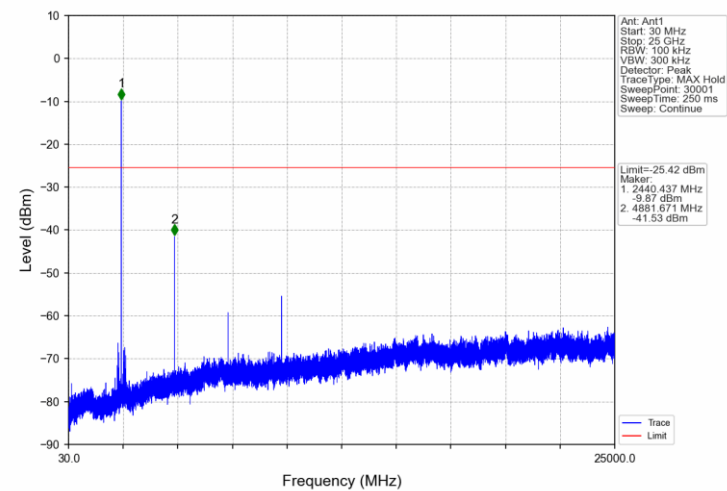
Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV



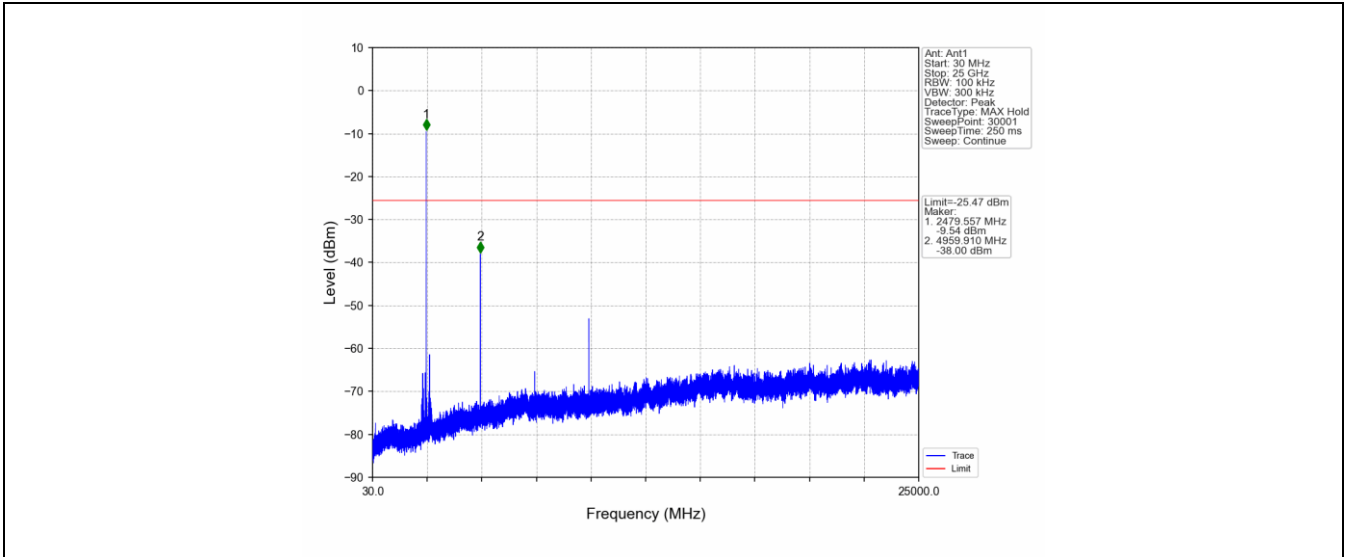
8DPSK_3DH5_LCH_2402MHz_Ant1_NTNV



8DPSK_3DH5_MCH_2441MHz_Ant1_NTNV



8DPSK_3DH5_HCH_2480MHz_Ant1_NTNV



9.7 Band Edge Testing

Test Method

1. The RF output of EUT was connected to the test receiver by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously. Set the EUT to the lowest frequency channel.
3. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector, Trace: Max hold, Sweep time: Coupled, Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation. Allow the trace to stabilize.
4. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
5. Set the EUT to the highest frequency channel and repeat step 2) to 4)
6. Enable the EUT hopping mode, repeat the test.

Limit:

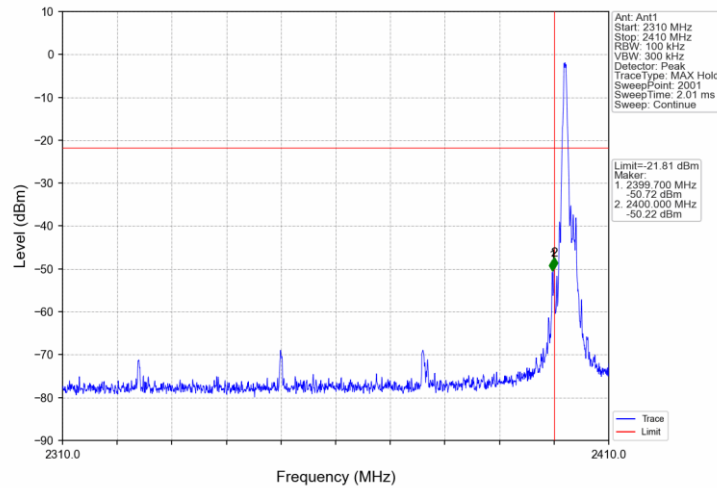
According to §15.247(d), Band Edge limit as below:

In any 100kHz 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.

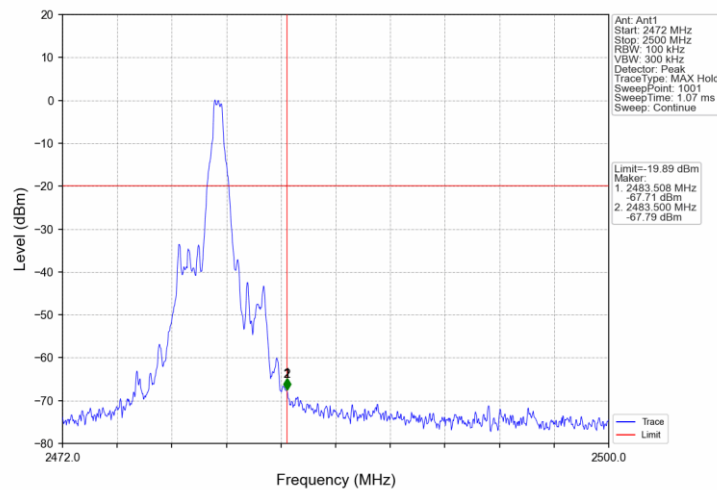
Band Edge

Mode	TX Type	Frequency (MHz)	Packet Type	ANT	Level of Reference (dBm)	Limit (dBm)	Verdict
GFSK	SISO	2402	DH5	1	-1.81	-21.81	Pass
		2441	DH5	1	0.27	-19.73	Pass
		2480	DH5	1	0.11	-19.89	Pass
		HOPP	DH5	1	0.49	-19.51	Pass
					0.49	-19.51	Pass
Pi/4DQPSK	SISO	2402	2DH5	1	-7.18	-27.18	Pass
		2441	2DH5	1	-5.51	-25.51	Pass
		2480	2DH5	1	-5.56	-25.56	Pass
		HOPP	2DH5	1	-5.37	-25.37	Pass
					-5.37	-25.37	Pass
8DPSK	SISO	2402	3DH5	1	-7.08	-27.08	Pass
		2441	3DH5	1	-5.42	-25.42	Pass
		2480	3DH5	1	-5.47	-25.47	Pass
		HOPP	3DH5	1	-5.39	-25.39	Pass
					-5.39	-25.39	Pass

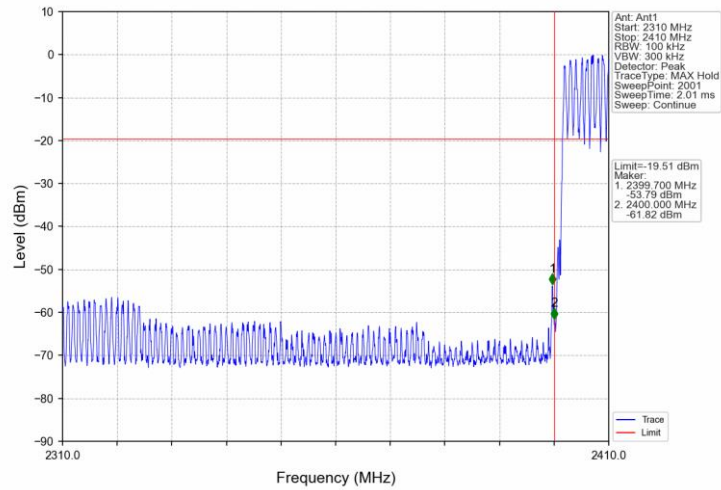
GFSK_DH5_LCH_2402MHz_Ant1_NTNV



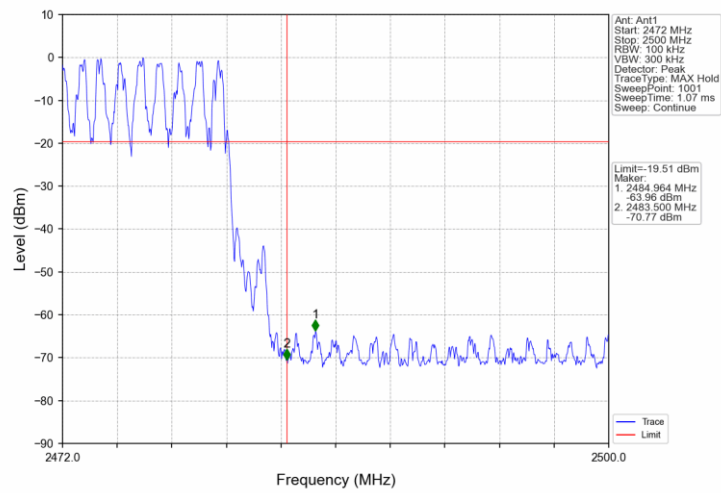
GFSK_DH5_HCH_2480MHz_Ant1_NTNV



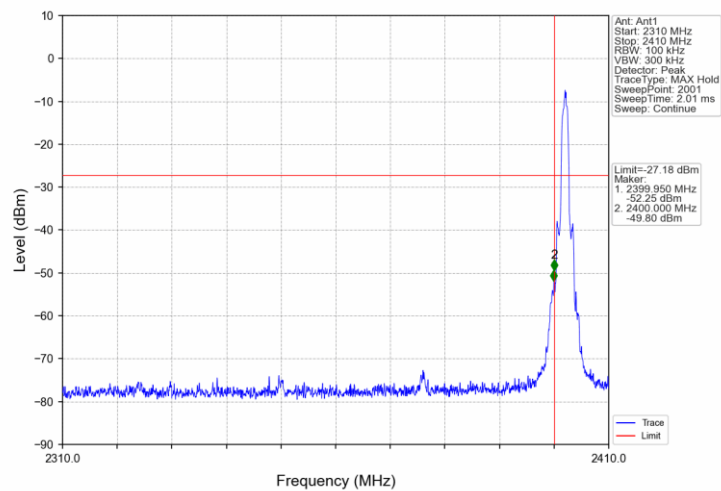
GFSK_DH5_HOPP_Ant1_NTNV



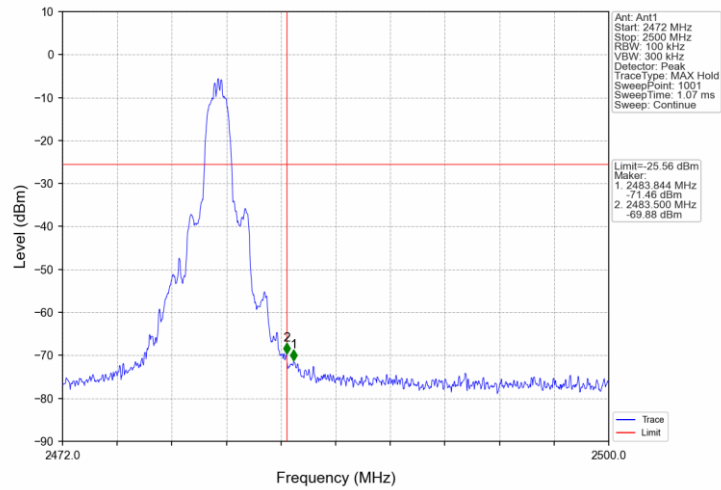
GFSK_DH5_HOPP_Ant1_NTNV



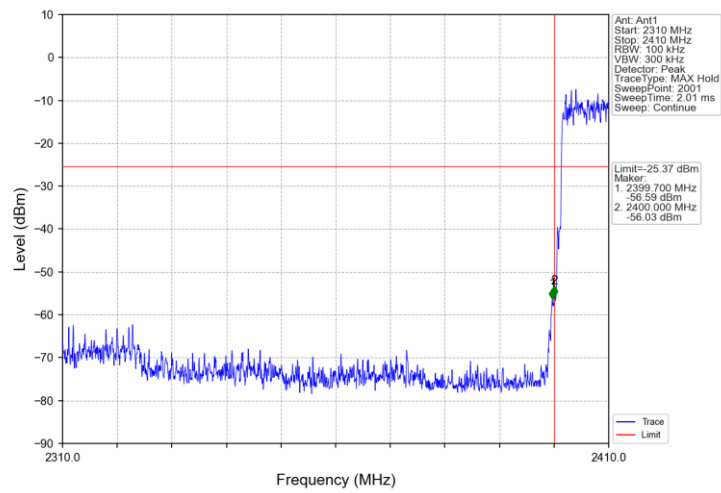
Pi/4DQPSK_2DH5_LCH_2402MHz_Ant1_NTNV



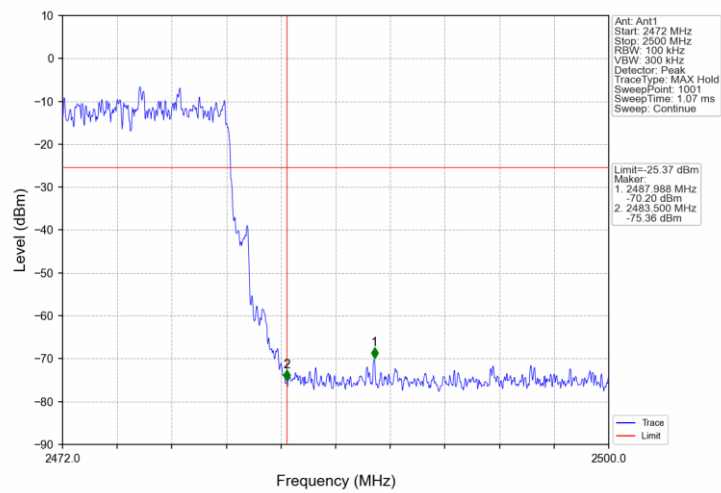
Pi/4DQPSK_2DH5_HCH_2480MHz_Ant1_NTNV



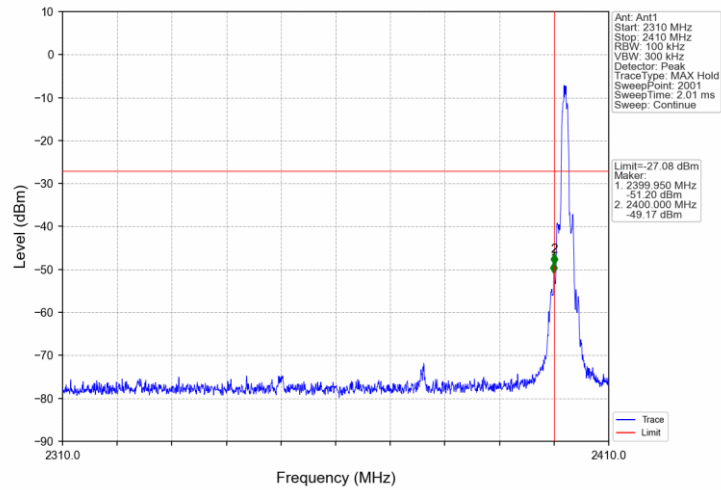
Pi/4DQPSK_2DH5_HOPP_Ant1_NTNV



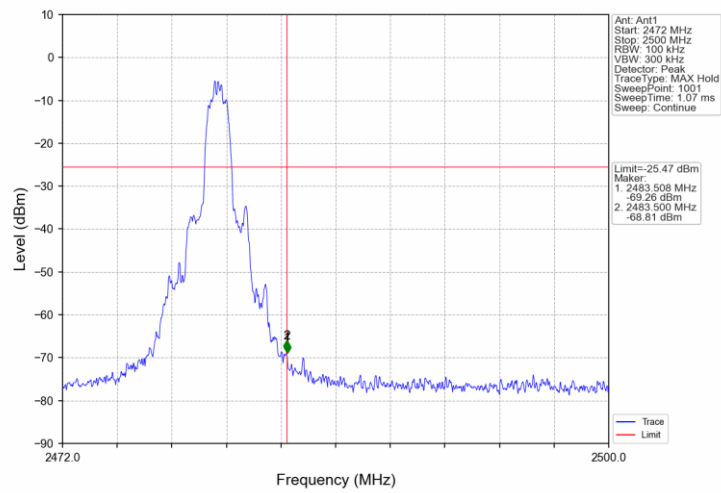
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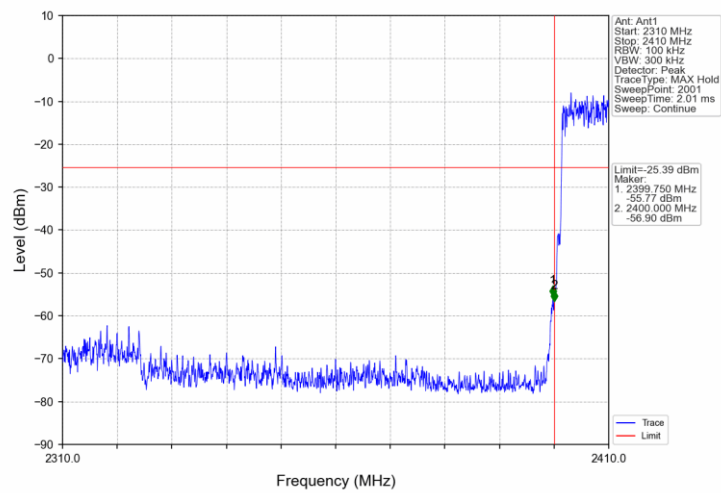
8DPSK_3DH5_LCH_2402MHz_Ant1_NTNV



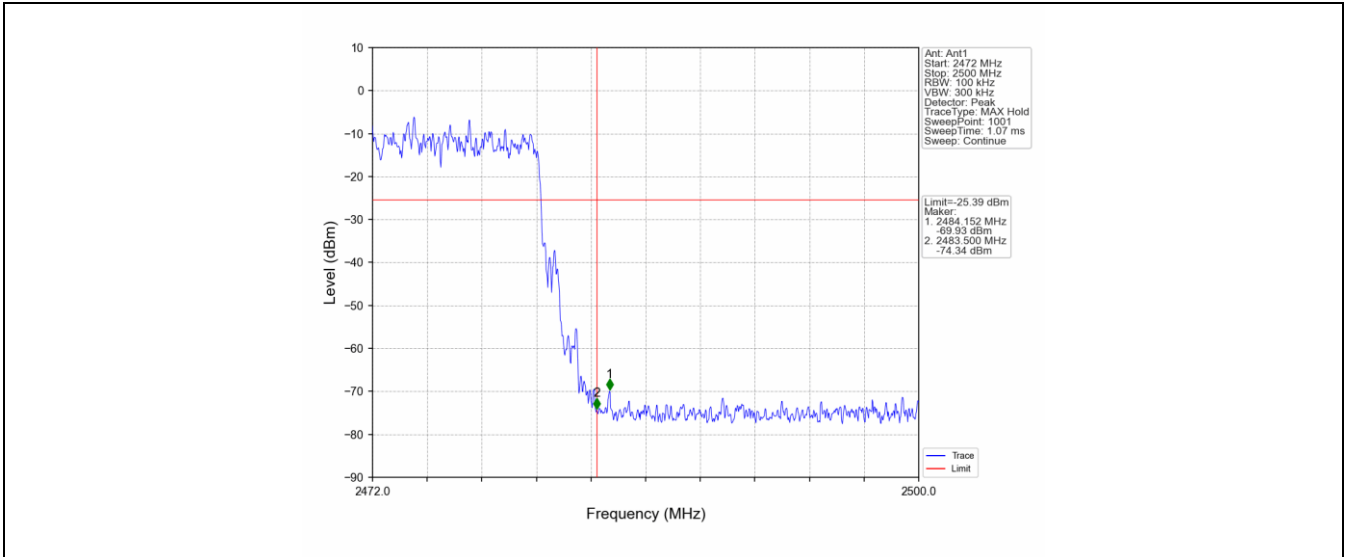
8DPSK_3DH5_HCH_2480MHz_Ant1_NTNV



8DPSK_3DH5_HOPP_Ant1_NTNV



8DPSK_3DH5_HOPP_Ant1_NTNV



9.8 Spurious Radiated Emissions for Transmitter

Test Method

1. The EUT was placed on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meters chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
4. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
5. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
6. Use the following test receiver settings According to C63.10:
 - (1) Span shall wide enough to fully capture the emission being measured;
 - (2) Set RBW=100 kHz to 120KHz for $f < 1$ GHz; $VBW \geq RBW$; Sweep = auto; Detector function = QP; Trace = max hold;
 - (3) Set RBW = 1 MHz, VBW= 3MHz for $f \geq 1$ GHz for peak measurement.

For average measurement:

The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 3MHz for RMS Average ((duty cycle < 98%) for Average detection (AV) at frequency above 1GHz, then the measurement results was added to a correction factor ($20\log(1/\text{duty cycle})$).

The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 10Hz (duty cycle > 98%) for Average detection (AV) at frequency above 1GHz.

7. Repeat above procedures until all frequencies measured were complete.

Spurious Radiated Emissions for Transmitter

Limit

The radio emission outside the operating frequency band 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. Radiated emissions which fall in the restricted bands, as defined in section 15.205, must comply with the radiated emission limits specified in section 15.209.

Frequency MHz	Field Strength $\mu\text{V/m}$	Field Strength $\text{dB}\mu\text{V/m}$	Detector	Measurement distance meters
0.009-0.490	2400/F(kHz)	48.5-13.8	AV	300
0.490-1.705	24000/F(kHz)	33.8-23.0	QP	30
1.705-30	30	29.5	QP	30
30-88	100	40	QP	3
88-216	150	43.5	QP	3
216-960	200	46	QP	3
960-1000	500	54	QP	3
Above 1000	500	54	AV	3
Above 1000	5000	74	PK	3

Note 1: $\text{Limit } 3\text{m}(\text{dB}\mu\text{V/m}) = \text{Limit } 300\text{m}(\text{dB}\mu\text{V/m}) + 40\text{Log}(300\text{m}/3\text{m})$ (Below 30MHz)

Note 2: $\text{Limit } 3\text{m}(\text{dB}\mu\text{V/m}) = \text{Limit } 30\text{m}(\text{dB}\mu\text{V/m}) + 40\text{Log}(30\text{m}/3\text{m})$ (Below 30MHz)

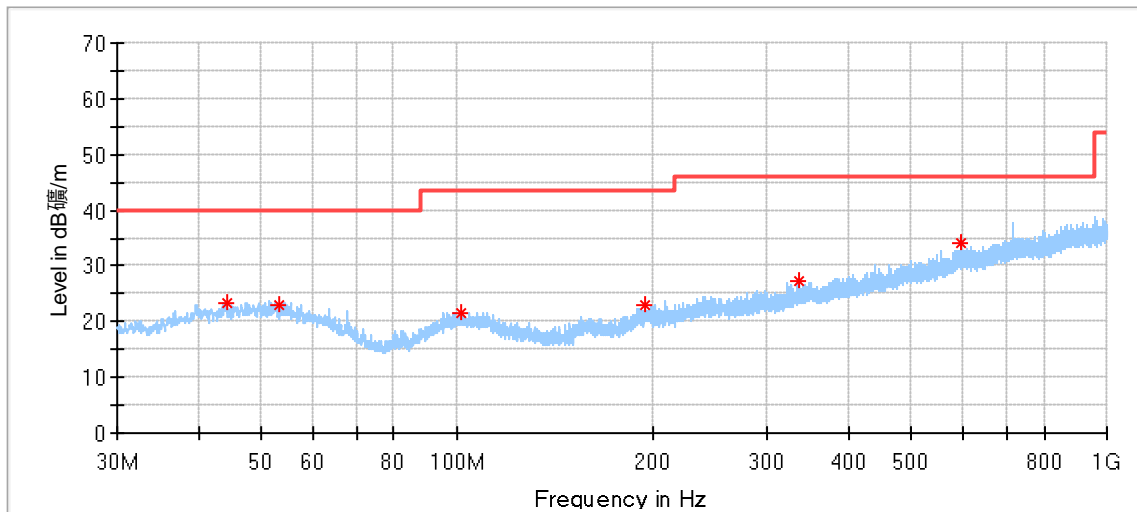
Spurious radiated emissions for transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

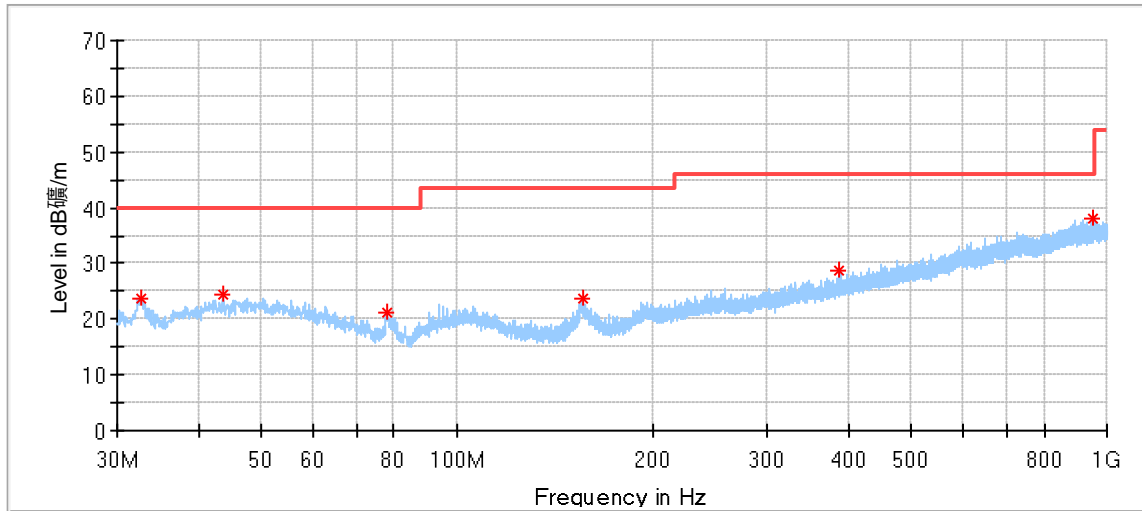
The only worse case (which is subject to the GFSK mode) test result is listed in the report.

Transmitting spurious emission test result as below:

Test data_30MHz to 1000MHz

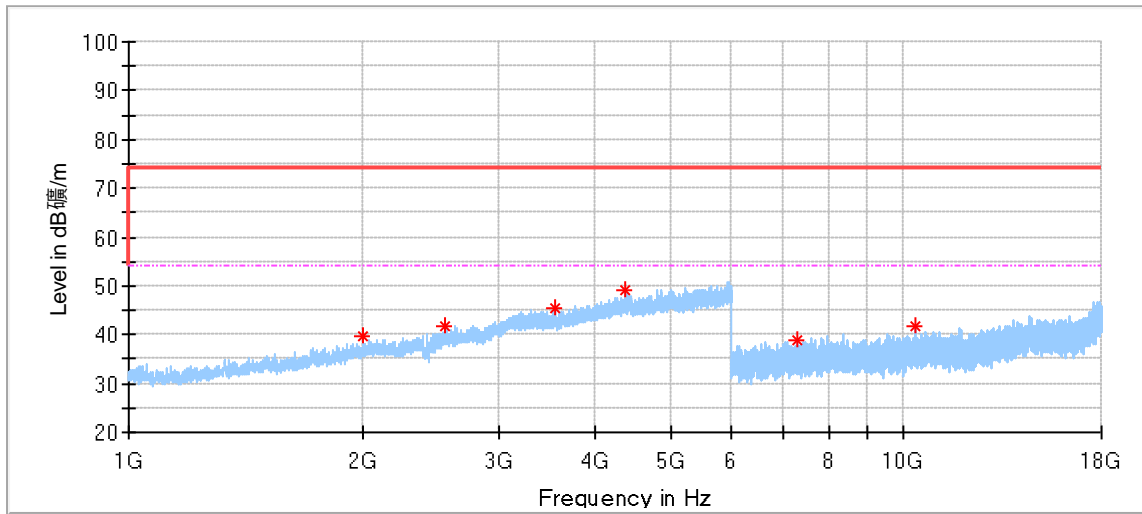


Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
44.172778	23.26	40.00	16.74	100.0	H	29.0	17.91
53.226111	22.83	40.00	17.17	100.0	H	0.0	17.97
101.295000	21.52	43.50	21.98	200.0	H	74.0	15.92
194.684444	23.02	43.50	20.48	100.0	H	155.0	16.08
335.873333	27.25	46.00	18.75	200.0	H	251.0	19.36
596.641667	34.11	46.00	11.89	200.0	H	251.0	24.71

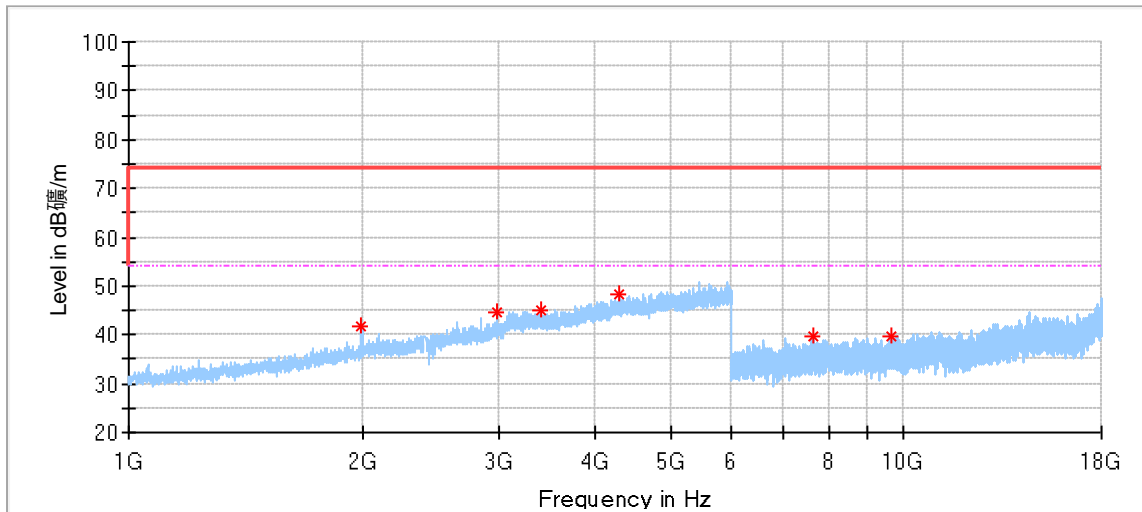


Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
32.694444	23.67	40.00	16.33	100.0	V	66.0	14.25
43.526111	24.55	40.00	15.45	100.0	V	332.0	17.79
77.961111	21.18	40.00	18.82	100.0	V	121.0	10.88
155.830556	23.56	43.50	19.94	100.0	V	90.0	12.72
387.445000	28.62	46.00	17.38	100.0	V	190.0	20.62
953.170556	37.98	46.00	8.02	100.0	V	216.0	29.08

Test data 1GHz to 18GHz:
DH5_2402MHz:

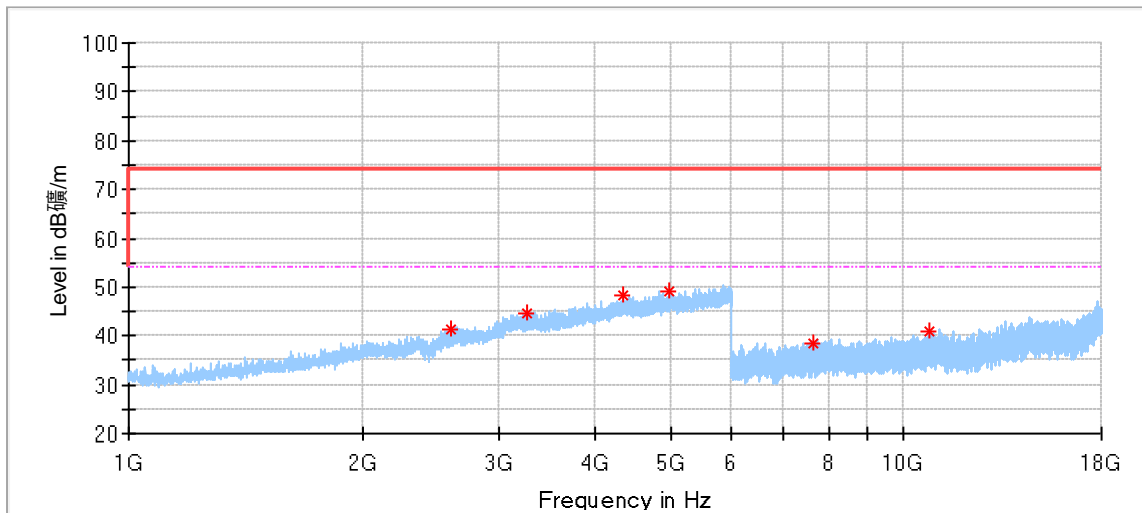


Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2008.000000	39.49	74.00	34.51	150.0	H	321.0	-7.10
2558.000000	41.58	74.00	32.42	150.0	H	347.0	-4.88
3556.000000	45.52	74.00	28.48	150.0	H	0.0	-0.49
4364.000000	49.30	74.00	24.70	150.0	H	130.0	2.80
7302.000000	38.74	74.00	35.26	150.0	H	58.0	5.92
10351.000000	41.85	74.00	32.15	150.0	H	195.0	8.91

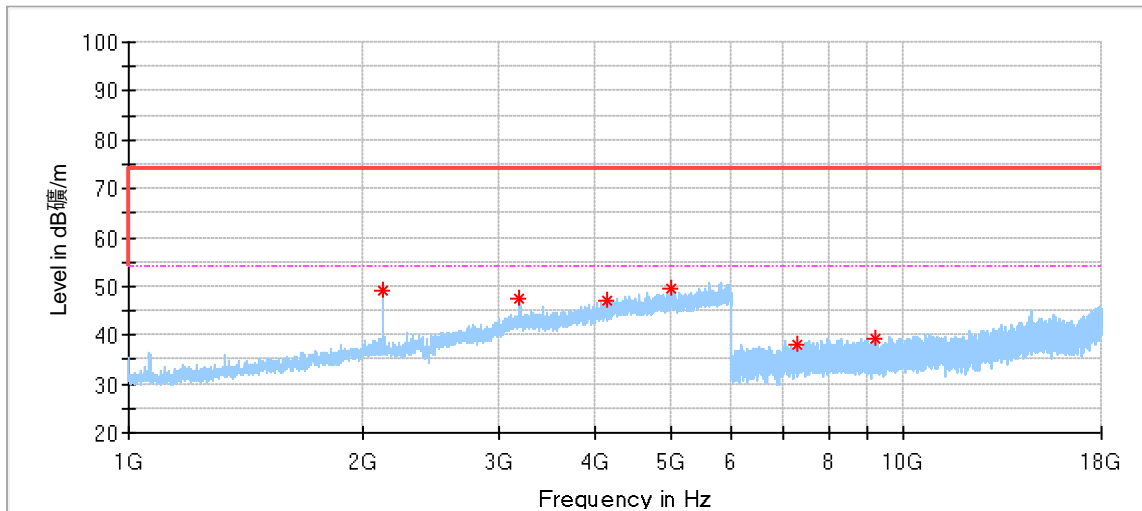


Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1998.000000	41.79	74.00	32.21	150.0	V	10.0	-7.19
2983.000000	44.71	74.00	29.29	150.0	V	185.0	-2.77
3401.500000	44.92	74.00	29.08	150.0	V	62.0	-0.73
4285.500000	48.11	74.00	25.89	150.0	V	144.0	2.34
7636.500000	39.59	74.00	34.41	150.0	V	229.0	6.59
9668.000000	39.57	74.00	34.43	150.0	V	96.0	8.27

DH5_2440MHz:

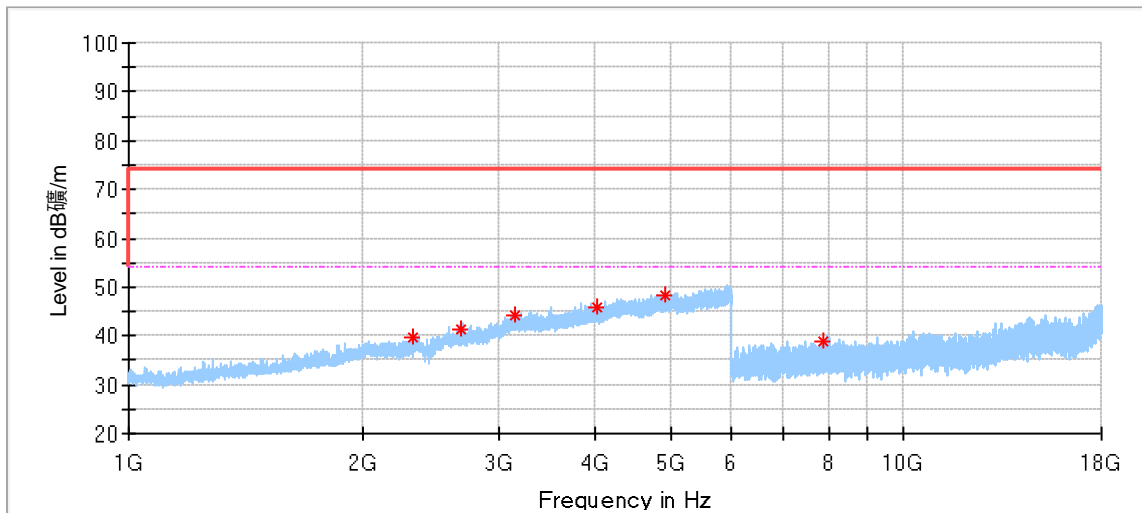


Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2601.000000	41.50	74.00	32.50	150.0	H	103.0	-4.63
3272.000000	44.70	74.00	29.30	150.0	H	116.0	-0.96
4355.500000	48.20	74.00	25.80	150.0	H	89.0	2.78
4989.000000	49.23	74.00	24.77	150.0	H	321.0	4.43
7654.500000	38.55	74.00	35.45	150.0	H	303.0	6.65
10794.000000	40.80	74.00	33.20	150.0	H	172.0	9.11

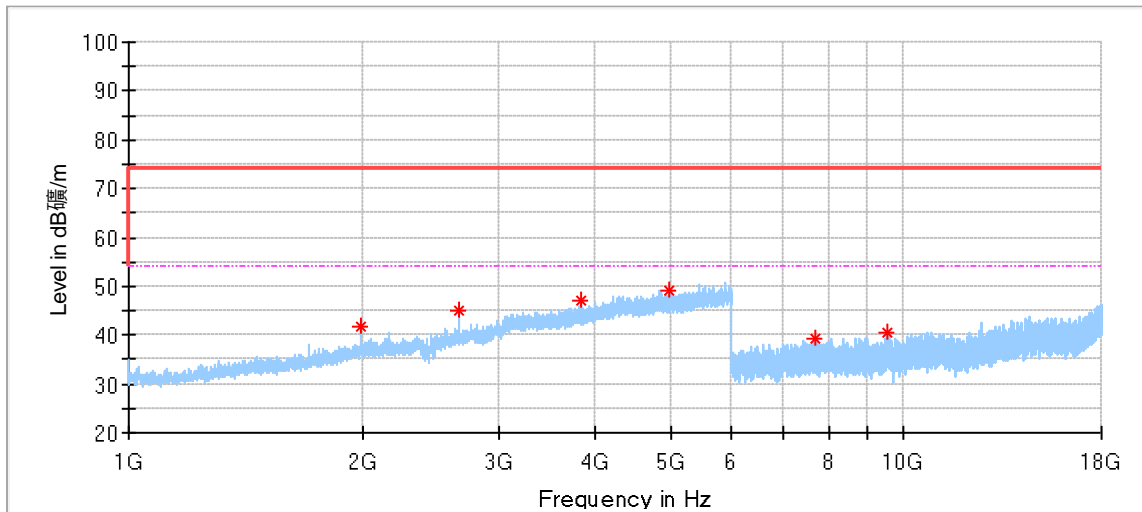


Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2130.000000	49.32	74.00	24.68	150.0	V	239.0	-6.84
3198.000000	47.66	74.00	26.34	150.0	V	267.0	-1.14
4131.000000	46.88	74.00	27.12	150.0	V	267.0	1.57
5024.500000	49.74	74.00	24.26	150.0	V	99.0	4.49
7269.000000	38.06	74.00	35.94	150.0	V	351.0	5.89
9194.500000	39.44	74.00	34.56	150.0	V	223.0	7.91

DH5_2480MHz:



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2324.000000	39.83	74.00	34.17	150.0	H	99.0	-6.15
2690.500000	41.38	74.00	32.62	150.0	H	236.0	-4.24
3145.000000	44.31	74.00	29.69	150.0	H	168.0	-1.27
4010.000000	45.85	74.00	28.15	150.0	H	195.0	1.13
4927.000000	48.48	74.00	25.52	150.0	H	181.0	4.23
7886.500000	38.96	74.00	35.04	150.0	H	330.0	6.71



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1990.500000	41.86	74.00	32.14	150.0	V	0.0	-7.28
2665.500000	45.17	74.00	28.83	150.0	V	21.0	-4.21
3827.000000	47.19	74.00	26.81	150.0	V	21.0	0.61
4971.500000	49.27	74.00	24.73	150.0	V	130.0	4.33
7708.000000	39.16	74.00	34.84	150.0	V	353.0	6.74
9504.000000	40.67	74.00	33.33	150.0	V	278.0	8.38

Remark:

- (1) Data of measurement within frequency range 9kHz-30MHz and 18GHz-40GHz are the noise floor or attenuated more than 20dB below the permissible limits or the field strength is too small to be measured, so test data does not present in this report.
- (2) Corrected Amplitude = Read level + Corrector factor
 Above 1GHz: Corrector factor = Antenna Factor + Cable Loss- Amplifier Gain
 Below 1GHz: Corrector factor = Antenna Factor + Cable Loss

10 Test Equipment List

List of Test Instruments

Radiated Emission 1# Test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL INTERVAL (YEAR)	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 7	68-4-74-19-001	102176	1	2024-5-20
Loop Antenna	Rohde & Schwarz	HFH2-Z2	68-4-80-14-006	100398	1	2024-8-7
3m Semi-anechoic chamber	TDK	SAC-3 #1	68-4-90-14-001	----	3	2024-5-28
Test software	Rohde & Schwarz	EMC32	68-4-90-14-001-A10	Version10.35.02	N/A	N/A

Radiated Emission 2# Test

DESCRIPTION	MANUFACTURER	MODEL NO.	EQUIPMENT ID	SERIAL NO.	CAL INTERVAL (YEAR)	CAL. DUE DATE
EMI Test Receiver	Rohde & Schwarz	ESR 26	68-4-74-14-002	101269	1	2024-5-20
Trilog Super Broadband Test Antenna	Schwarzbeck	VULB 9162	68-4-80-19-003	284	1	2025-2-22
Wave Guide Antenna	ETS	3117	68-4-80-19-001	00218954	1	2024-4-26
Pre-amplifier	Rohde & Schwarz	SCU 18F	68-4-29-19-001	100745	1	2024-5-19
Sideband Horn Antenna	Q-PAR	QWH-SL-18-40-K-SG	68-4-80-14-008	12827	1	2024-7-11
Pre-amplifier	Rohde & Schwarz	SCU 40A	68-4-29-14-002	100432	1	2024-8-1
Attenuator	Mini-circuits	UNAT-6+	68-4-81-21-002	15542	1	2024-5-19
3m Semi-anechoic chamber	TDK	SAC-3 #2	68-4-90-19-006	----	2	2024-5-28
Test software	Rohde & Schwarz	EMC32	68-4-90-19-006-A01	Version10.35.02	N/A	N/A

RF Conducted Test

Description	Manufacturer	Model no.	Equipment ID	Serial no.	Cal interval (year)	Cal. due date
Signal Analyzer	Rohde & Schwarz	FSV40	68-4-74-14-004	101030	1	2024-5-19
Test software	TST PASS	System for BT/WIFI	68-4-93-23-001-A03	Version 2.0	N/A	N/A
Shielding Room	TDK	TS8997	68-4-90-19-003	----	3	2025-10-15

11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

System Measurement Uncertainty	
Test Items	Extended Uncertainty
Uncertainty for Radiated Emission in 3m chamber (68-4-90-14-001) 9kHz-30MHz	4.70dB
Uncertainty for Radiated Emission in new 3m chamber (68-4-90-19-006) 30MHz-1000MHz	Horizontal: 4.63dB; Vertical: 4.78dB;
Uncertainty for Radiated Emission in new 3m chamber (68-4-90-19-006) 1000MHz-18000MHz	Horizontal: 5.38dB; Vertical: 5.38dB;
Uncertainty for Radiated Emission in new 3m chamber (68-4-90-19-006) 18GHz-40GHz	Horizontal: 5.29dB; Vertical: 5.29dB;
Uncertainty for Conducted RF test with TS 8997	RF Power Conducted: 1.31dB Frequency test involved: 0.6×10 ⁻⁸ or 1%

Measurement Uncertainty Decision Rule:

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115: 2021, clause 4.4.3 and 4.5.1.

THE END