Prüfbericht-Nr.: *Test Report No.:*	**50375196 001**	**Auftrags-Nr.:** *Order No.:*	**244223141**	**Seite 1 von 46** *Page 1 of 46*
Kunden-Referenz-Nr.: *Client Reference No.:*	**2144128**	**Auftragsdatum:** *Order date:*	**17.03.2020**	
Auftraggeber: *Client:*	**Zhejiang Xinyi Shengao Mechanical Transmission Co., Ltd.** Economic &Technological Development Zone, Hangzhou Bay, Shangyu District, Shaoxing City,312369 Zhejiang, P.R. China			
Prüfgegenstand: *Test item:*	**Bluetooth Control Box**			
Bezeichnung / Typ-Nr.: *Identification / Type No.:*	**ZEN-BT-AS-01** **FCC ID: 2AVW9ZEN-BT-AS-01**			
Auftrags-Inhalt: *Order content:*	**Complete test**			
Prüfgrundlage: *Test specification:*	**FCC CFR47 Part 15, Subpart C Section 15.247** **KDB 558074 D01 15.247 Meas Guidance v05r02** **RSS-Gen Issue 5, Amendment 1, March 2019** **RSS-247 Issue 2, February 2017** **ANSI C63.10: 2013**			
Wareneingangsdatum: *Date of receipt:*	**06.01.2020**			
Prüfmuster-Nr.: *Test sample No.:*	**A001056315-001**			
Prüfzeitraum: *Testing period:*	**29.04.2020 to 12.05.2020**			
Ort der Prüfung: *Place of testing:*	**TÜV Rheinland (Shanghai) Co., Ltd.**			
Prüflaboratorium: *Testing laboratory:*	**TÜV Rheinland (Shanghai) Co., Ltd.**			
Prüfergebnis*: *Test result*:*	**Pass**			

geprüft von / *tested by*: Tony C.L.chen

03.06.2020	TonyC.L.Chen / PE	
Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*

kontrolliert von / *reviewed by*: Elliot Zhang

03.06.2020	Elliot Zhang / Reviewer	
Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*

Sonstiges / *Other*

Zustand des Prüfgegenstandes bei Anlieferung:
Condition of the test item at delivery:

Prüfmuster vollständig und unbeschädigt
Test item complete and undamaged

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.

This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.

V04

TEST SUMMARY

5.1.1 ANTENNA REQUIREMENT
RESULT: Pass

5.1.2 6DB & 99% BANDWIDTH
RESULT: Pass

5.1.3 PEAK OUTPUT POWER
RESULT: Pass

5.1.4 POWER SPECTRAL DENSITY
RESULT: Pass

5.1.5 CONDUCTED BAND EDGE AND OUT-OF BAND EMISSIONS
RESULT: Pass

5.2.1 CONDUCTED EMISSION
RESULT: Pass

5.3.1 RADIATED BAND-EDGE
RESULT: Pass

5.3.2 RADIATED SPURIOUS EMISSION
RESULT: Pass

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1. General Remarks

1.1 Complementary Materials

Null.

2. Test Sites

2.1 Test Facilities

TÜV Rheinland (Shanghai) Co., Ltd.

Shanghai TUV Rheinland Building No. 177, 178 Lane 777, West Guangzhong Rd, Jing'an District, Shanghai, China

The used test equipment is in accordance with CISPR 16 for measurement of radio interference.

The Federal Communications Commission has reviewed the technical characteristics of the radiated and conducted emission facility, and has found these test facilities to be in compliance with the requirements of section 2.948 of the FCC rules. The description of the test facility is listed under FCC registration number 958801.

The Innovation, Science and Economic Development Canada has reviewed the technical characteristics of the radiated and conducted emission facility, and has found these test facilities to be in compliance. The description of the test facility is listed under chambers filing number 2932F.

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Instrument	Manufacturer	Type No.	Asset No.	Cali. Due Date
3m Anechoic Chamber	Frankonia	SAC3	FJ129002	13.05.2022
EMI Test Receiver	R&S	ESCI	100280	31.10.2020
Spectrum Analyzer	R&S	FSV40	101258	31.10.2021
BiLog Antenna	Teseq	CBL 6112D	40530	13.02.2021
Log-periodic Antenna	R&S	HL050	100692	16.02.2021
Preamplifier	Taiwan EMC Instruments Corporation	EMC051845SE	980612	05.03.2021
Broadband Horn Antenna	Schwarzbeck	BBHA 9170	9170-305	09.07.2021
Preamplifier	Taiwan EMC Instruments Corporation	EMC184045SE	980596	05.03.2021
Spectrum Analyzer	Keysight	N9020A	MY54500180	08.05.2021
DC Power Supply	ALLPOWER	ADC50-20	99223	12.10.2020
Thermohygrometer	Testo	608-H1	1241320614	13.10.2020
EMI test receiver	R&S	ESIB26	G1811380	06.03.2021
Artificial main network	R&S	ENV432	G1830003	01.11.2020
EMC measurement software	R&S	EMC32	G1824845	N/A

2.3 Traceability

All measurement equipment calibrations are traceable to NIST or where calibration is performed outside the United States, to equivalent nationally recognized standards organizations.

2.4 Calibration

Equipment requiring calibration is calibrated periodically by the manufacturer or according to manufacturer’s specifications. Additionally all equipment is verified for proper performance on a regular basics using in house standards or comparisons.

2.5 Measurement Uncertainty

Table 2: Measurement Uncertainty

Measurement Type	Frequency	Uncertainty
Antenna Port Conducted Emission	< 1GHz	±0.39dB
	> 1GHz	±0.68dB
Radiated Emission	9kHz – 30MHz	±2.93dB
	30MHz - 1GHz	±5.34dB
	> 1GHz	±5.40dB

3. General Product Information

3.1 Product Function and Intended Use

The EUT (Equipment Under Test) is an ordinary Bluetooth control box which support Bluetooth Low Energy.

The aim of this report is to evalute the RF characteristic of the Bluetooth Low Energy Part of this module.

For details refer to the User Manual and Circuit Diagram.

3.2 Ratings and System Details

Table 3: Technical Specification of EUT

General Description of EUT	
Product Name:	Bluetooth Control Box
Model No.:	ZEN-BT-AS-01
Rated Voltage:	DC 5 V, 100 mA Max
Bluetooth Low Energy	
Frequency Range:	2402 to 2480MHz
Modulation Type:	GFSK
Antenna Type:	PCB Antenna
Antenna Gain:	2dBi

3.3 Independent Operation Modes

Table 4: Independent Operation Modes

Test Mode	Channel	Frequency
TM1	00	2402
TM2	19	2440
TM3	39	2480
TM4	Normal Operating Mode	

3.4 Noise Generating and Noise Suppressing Parts

Refer to the Circuit Diagram.

3.5 Submitted Documents

- Bill of Material
- PCB Layout
- Photo Document
- Circuit Diagram
- Instruction Manual
- Rating Label

4. Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

The equipment under test (EUT) was configured to measure its maximum power level. The test modes were adapted accordingly in reference to the instructions for use.

4.2 Test Operation and Test Software

Test operation refers to test setup in chapter 5. All testing were performed according to the procedures in ANSI C63.10: 2013.
Test Software used: EMI_TEST_v1.1

4.3 Special Accessories and Auxiliary Equipment

Table 5: Auxiliary Equipment

Product Name	Model Name	Manufactory
Control unit	M1.2-XYZ650-00	ZGO
Linear actuator	LIL04-JS	ZGO

Note: Above auxiliary equipment was used for Conducted Emission test.

4.4 Countermeasures to achieve EMC Compliance

Null.

5. Test Results

5.1 Conducted Testing at Antenna Port

5.1.1 Antenna Requirement

RESULT: **Pass**

According to the manufacturer declared, the EUT has one PCB antenna, the directional gain of antenna is 2dBi and the antenna is designed with permanent attachment and no consideration of replacement. Therefore the EUT is considered sufficient to comply with the provision.

Table 6: Antenna Requirement

FCC 15.203 – Antenna Requirement 1		
Requirement:	No antenna other than that furnished by the responsible party shall be used with the device	
Results:	Antenna type:	PCB antenna
Verdict:	Pass	

FCC 15.204 – Antenna Requirement 2	
Requirement:	An intentional radiator may be operated only with the antenna with which it is authorized. If an antenna is marketed with the intentional radiator, it shall be of a type which is authorized with the intentional radiator.
Results:	Only one integral antenna can be used
Verdict:	Pass

RSS-Gen 6.4 – External Controls	
Requirement:	The device shall not have any external controls accessible to the user that enable it to be adjusted, selected or programmed to operate in violation of the regulatory requirements, including RSS-Gen and the applicable RSSs.
Results:	The device does not have any external controls accessible to the user that enable it to be adjusted, selected or programmed to operate in violation of the regulatory requirements, including RSS-Gen and the applicable RSSs.
Verdict:	Pass

RSS-Gen 6.8 – Antenna Requirement		
Requirement:	When measurements at the antenna port are used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.	
Results:	a) Aennta type:	PCB
	b) Manufacture:	N/A
	c) Model No.:	N/A
	d) Gain with reference to an isotropic radiator:	2dBi
Verdict:	Pass	

5.1.2 6dB & 99% Bandwidth

RESULT: **Pass**

Date of testing	:	13.05.2020
Ambient temperature	:	20.6°C
Relative humidity	:	58.6%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC Part 15.247(a)(2) RSS-247 Issue 2, February 2017, Clause 5.2(a)
Test procedure	:	KDB 558074 D01v05r02 ANSI C63.10: 2013
Test voltage	:	DC 5V
Test modes applied	:	TM1 to TM3

Table 7: 6dB & 99% Bandwidth

Test Mode	CH.	Freq. [MHz]	6dB Bandwidth [kHz]	99% Bandwidth [kHz]
TM1	00	2402	669.0	1018.8
TM2	19	2440	675.3	1027.0
TM3	39	2480	677.5	1020.2

Note:
For frequency hopping systems operating in the 2400 – 2483.5MHz band, no bandwidth limit is specified. The test data is provide for reference.
And according to FCC, when the occupied bandwidth limit is not stated in the applicable FCC or reference measurement method, the transmitted signal band width shall be reported as the 99% emission bandwidth.

Figure 1: 6dB Bandwidth, 2402MHz

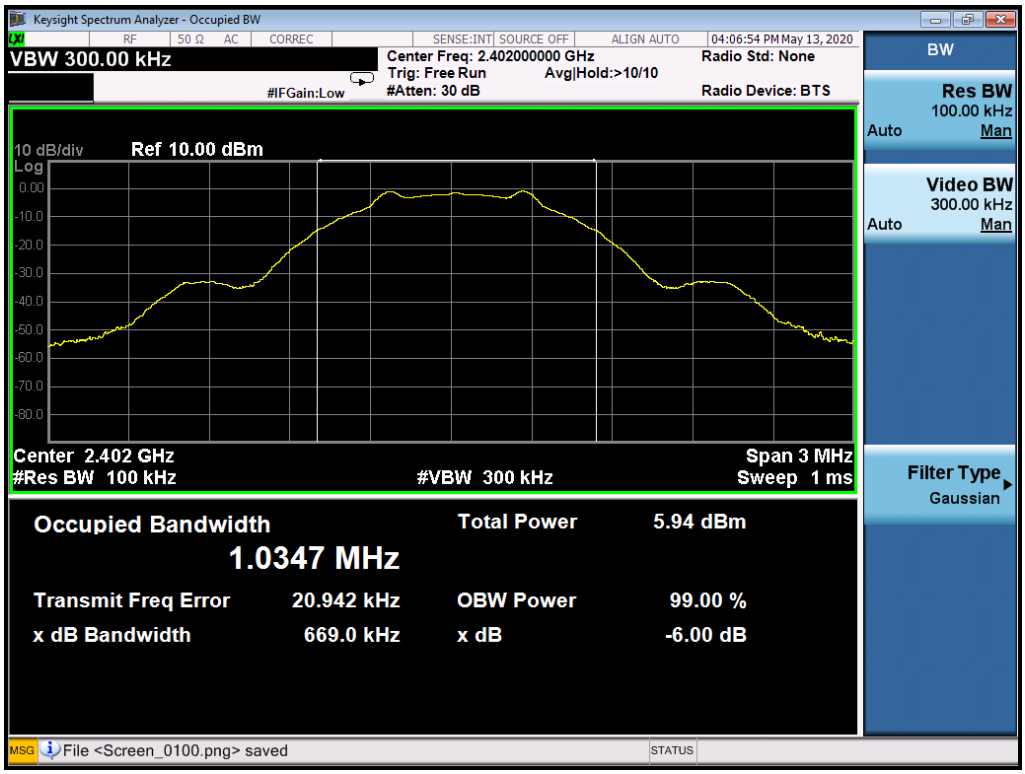


Figure 2: 6dB Bandwidth, 2440MHz

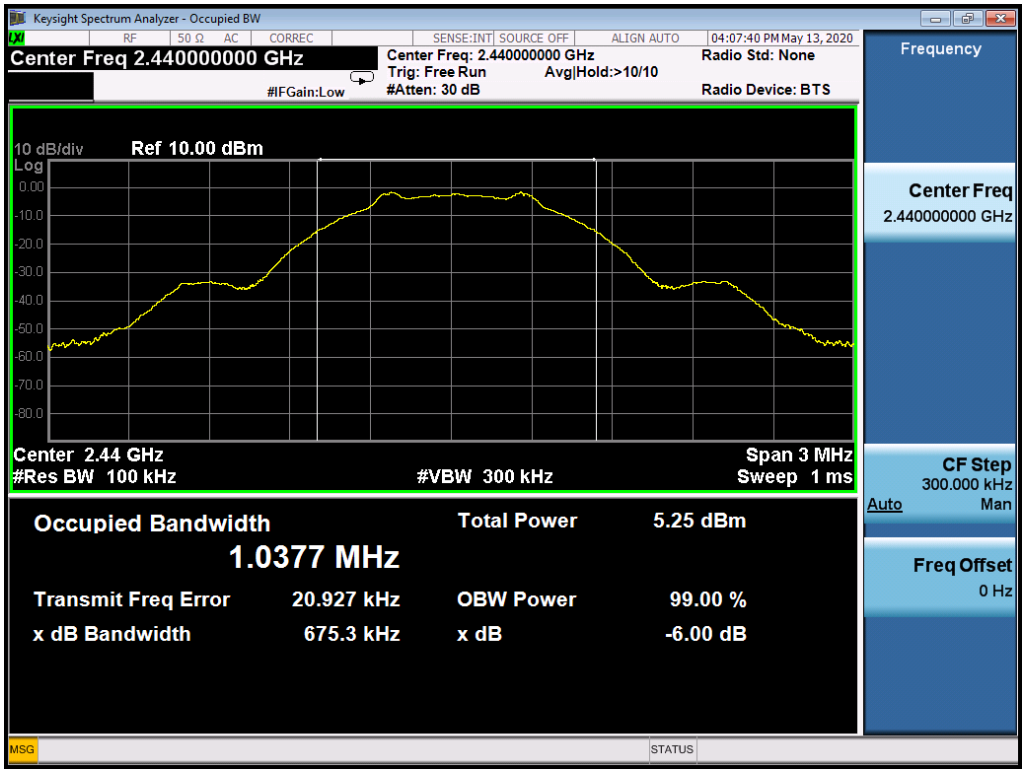


Figure 3: 6dB Bandwidth, 2480MHz

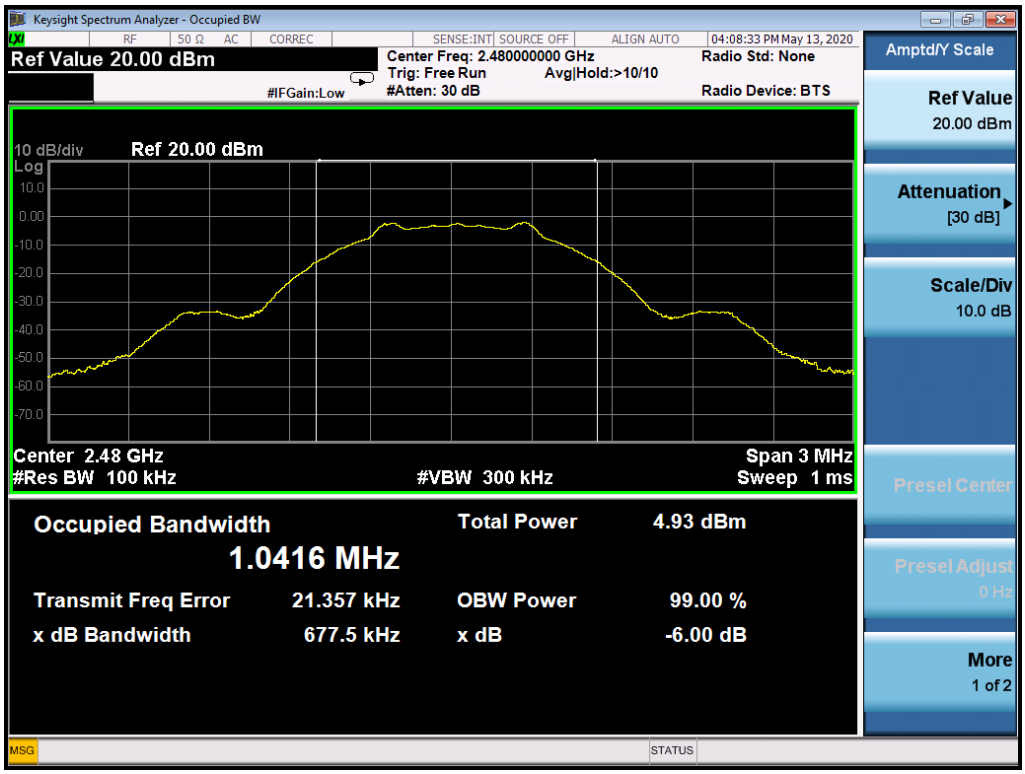


Figure 4: 99% Bandwidth, 2402MHz

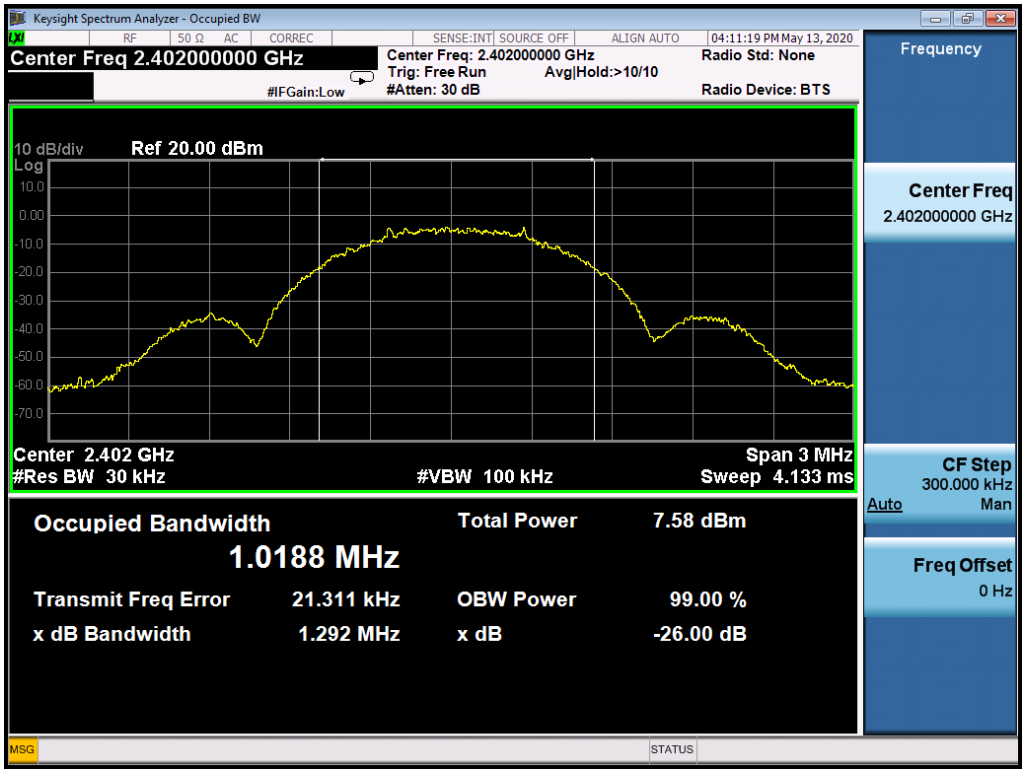


Figure 5: 99% Bandwidth, 2440MHz

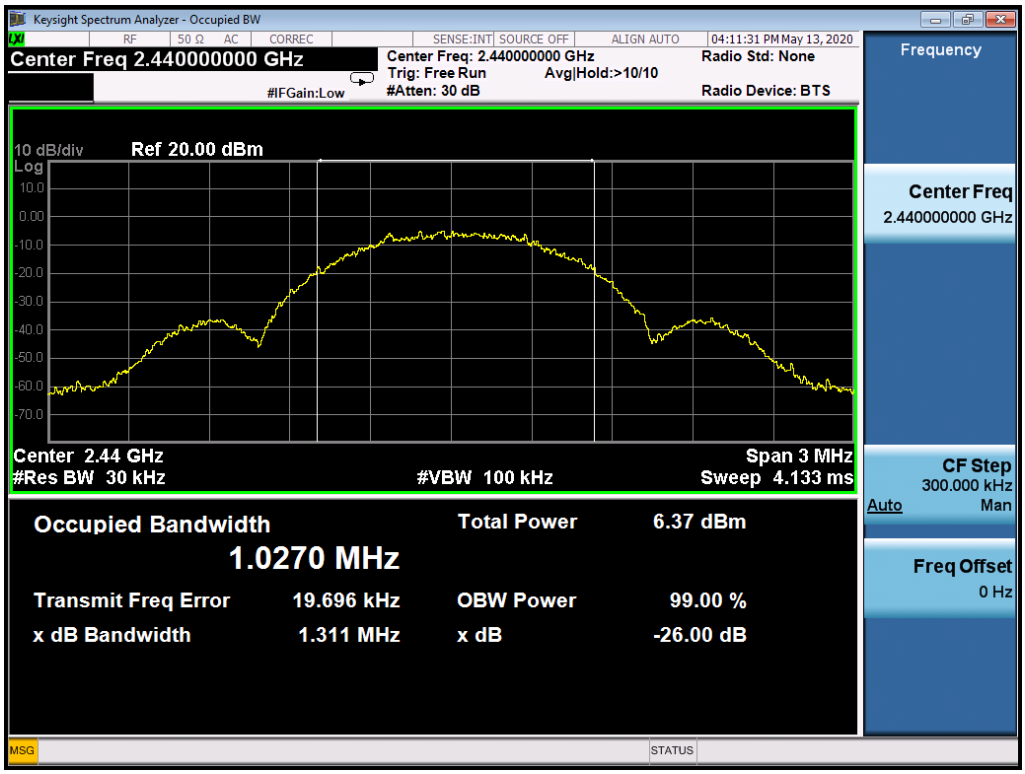
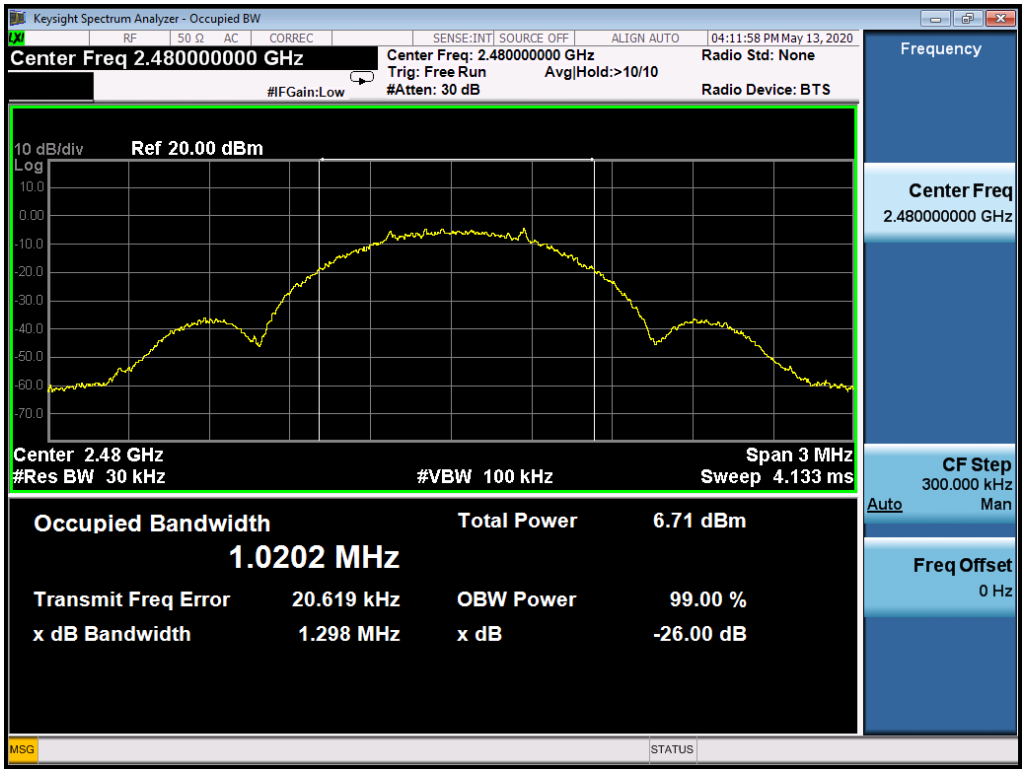


Figure 6: 99% Bandwidth, 2480MHz



5.1.3 Peak Output Power

RESULT: **Pass**

Date of testing	:	13.05.2020
Ambient temperature	:	23.1°C
Relative humidity	:	48.5%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC Part 15.247(b)(3) RSS-247 Issue 2, February 2017, Clause 5.4(d)
Test procedure	:	KDB 558074 D01v05r02 ANSI C63.10: 2013
Test voltage	:	DC 5V
Test modes applied	:	TM1 to TM3

Table 8: Peak Output Power

Mode	Antenna Gain [dBi]	CH.	Freq. [MHz]	Maximum Peak Conducted Output Power [dBm]	Peak Conducted Output Power Limit [dBm]	Maximum EIRP [dBm]	EIRP Limit [dBm]
TM1	**2**	**00**	**2402**	**-0.872**	**30**	**1.128**	**36**
TM2		19	2440	-1.372	30	0.628	36
TM3		39	2480	-1.821	30	0.179	36

Note:
EIRP=Peak Conducted Output Power + Antenna Gain

Figure 7: Peak Output Power, 2402MHz

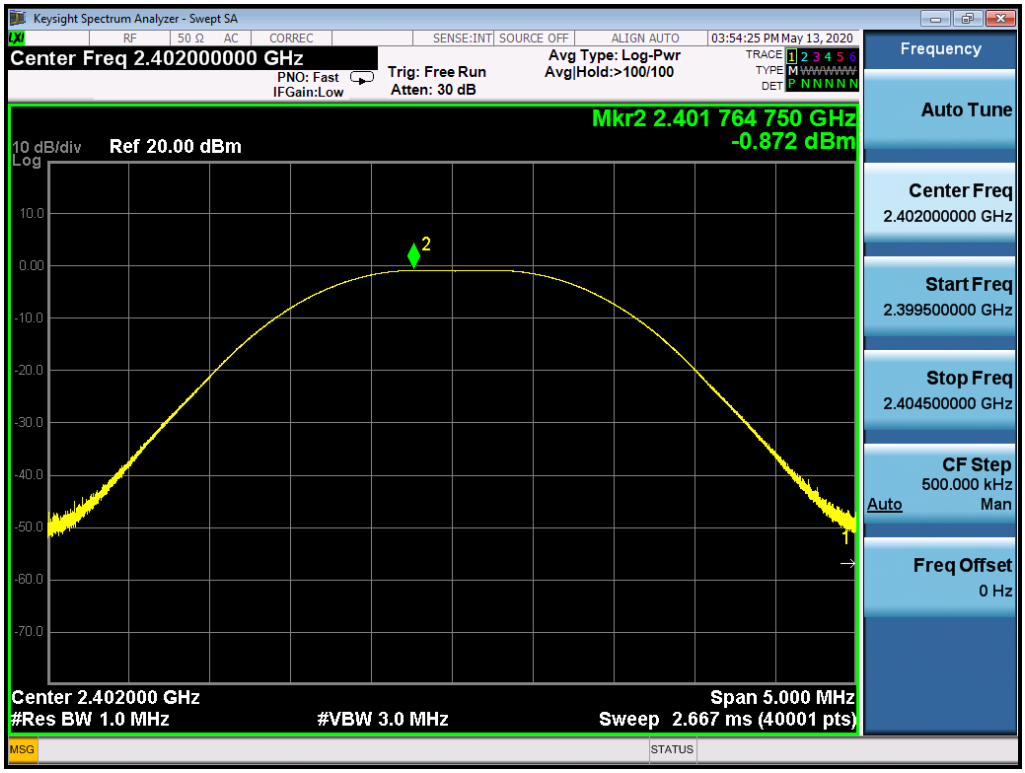


Figure 8: Peak Output Power, 2440MHz

Figure 9: Peak Output Power, 2480MHz

5.1.4 Power Spectral Density

RESULT: **Pass**

Date of testing	:	13.05.2020
Ambient temperature	:	21.4°C
Relative humidity	:	56.1%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC Part 15.247(e) RSS-247 Issue 2, February 2017, Clause 5.2(b)
Test procedure	:	KDB 558074 D01v05r02 ANSI C63.10: 2013
Test voltage	:	DC 5V
Test modes applied	:	TM1 to TM3

Table 9: Power Spectral Density

Mode	CH.	Frequency [MHz]	Result [dBm/3kHz]	Limit [dBm/3kHz]
TM1	00	2402	-9.108	8
TM2	19	2440	-11.175	8
TM3	39	2480	-11.125	8

Figure 10: Power Spectral Density, 2402MHz

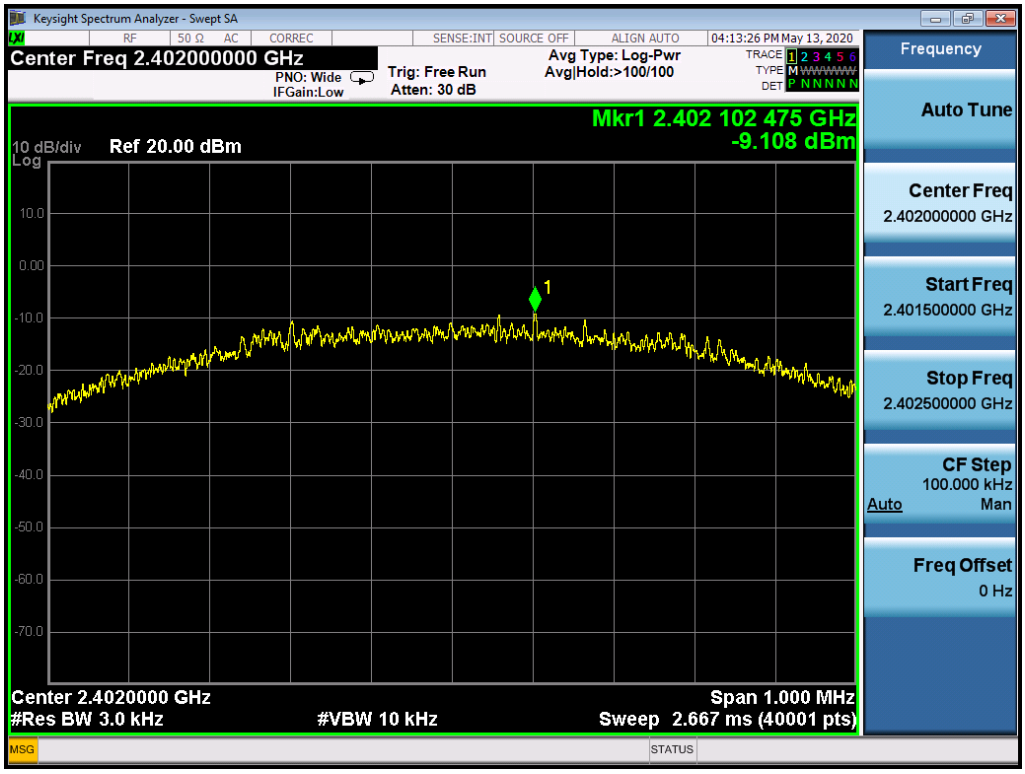


Figure 11: Power Spectral Density, 2440MHz

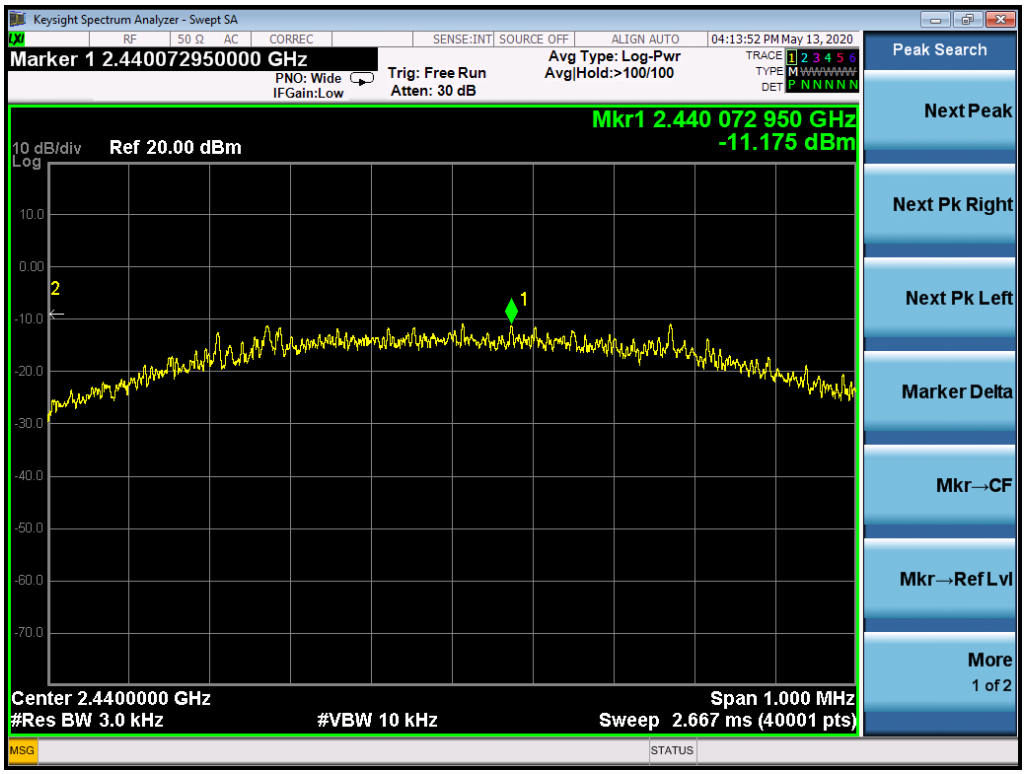
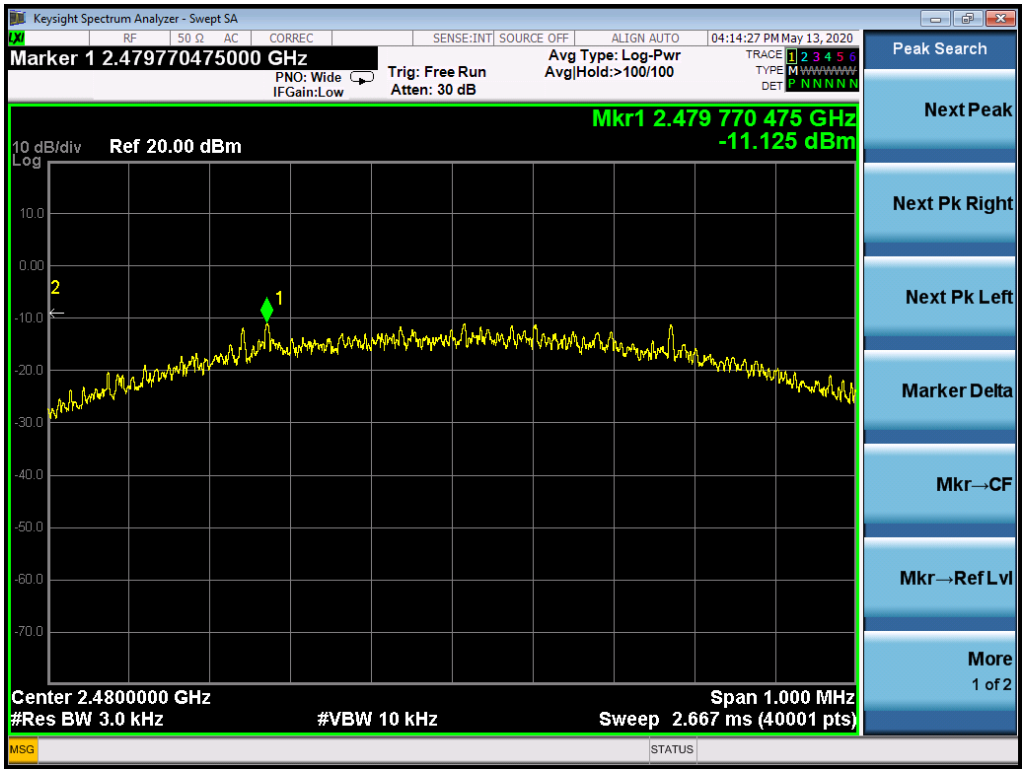


Figure 12: Power Spectral Density, 2480MHz



5.1.5 Conducted Band Edge and out-of Band Emissions

RESULT: **Pass**

Date of testing	:	13.05.2020
Ambient temperature	:	21.4°C
Relative humidity	:	56.1%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC Part 15.247(d) RSS-247 Issue 2, February 2017, Clause 5.5
Test procedure	:	KDB 558074 D01v05r02 ANSI C63.10: 2013
Test voltage	:	DC 5V
Test modes applied	:	TM1 to TM3

Figure 13: Reference level, 2402MHz

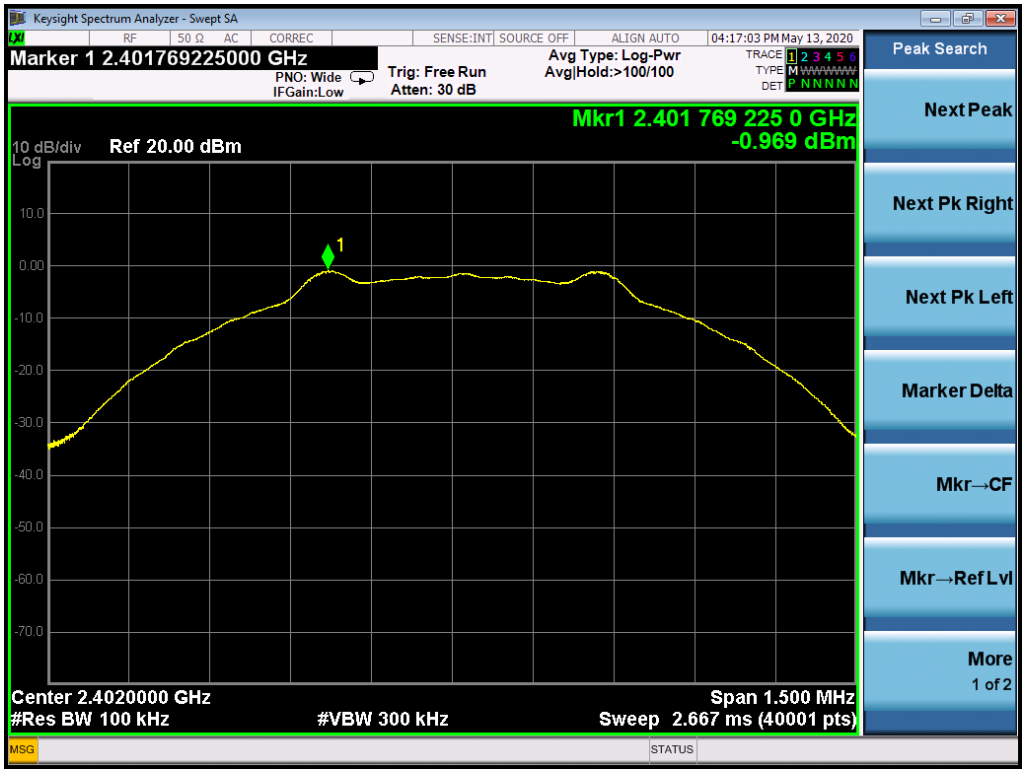


Figure 14: Reference level, 2440MHz

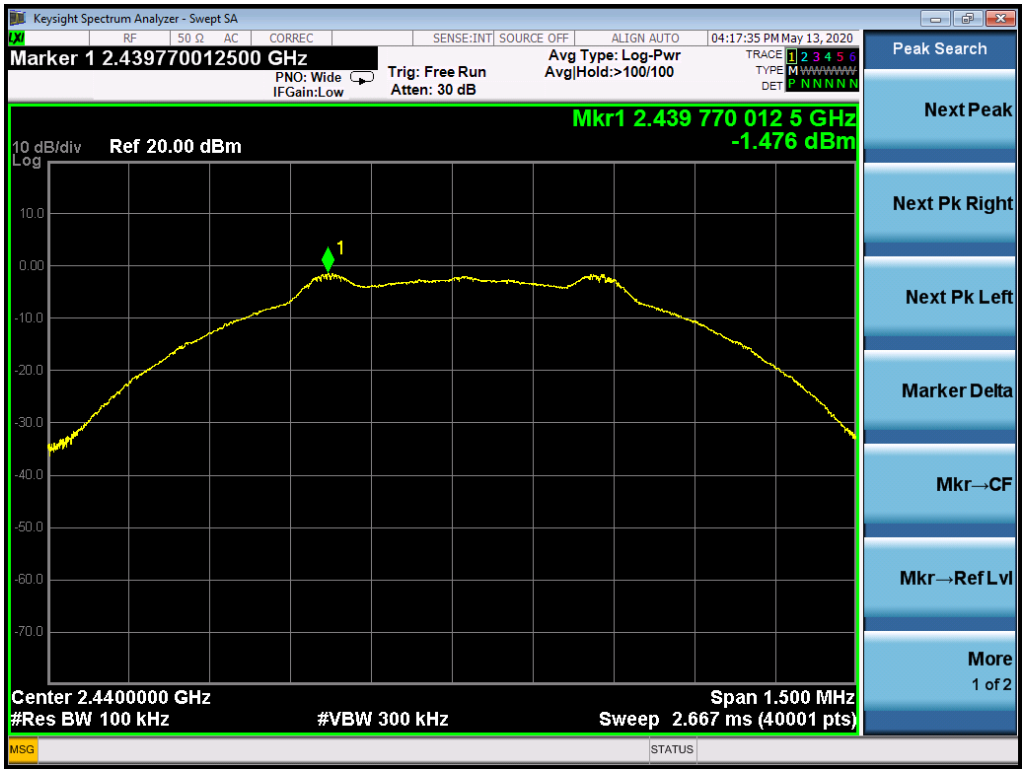


Figure 15: Reference level, 2480MHz

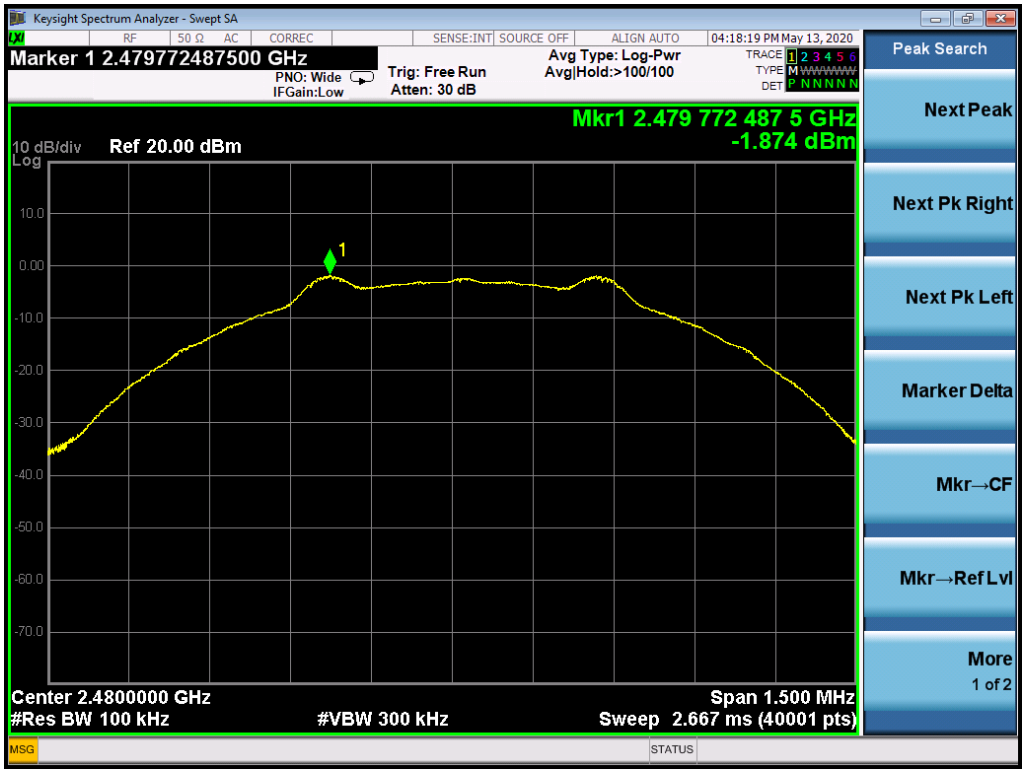


Figure 16: Conducted Spurious Emission, 2402MHz

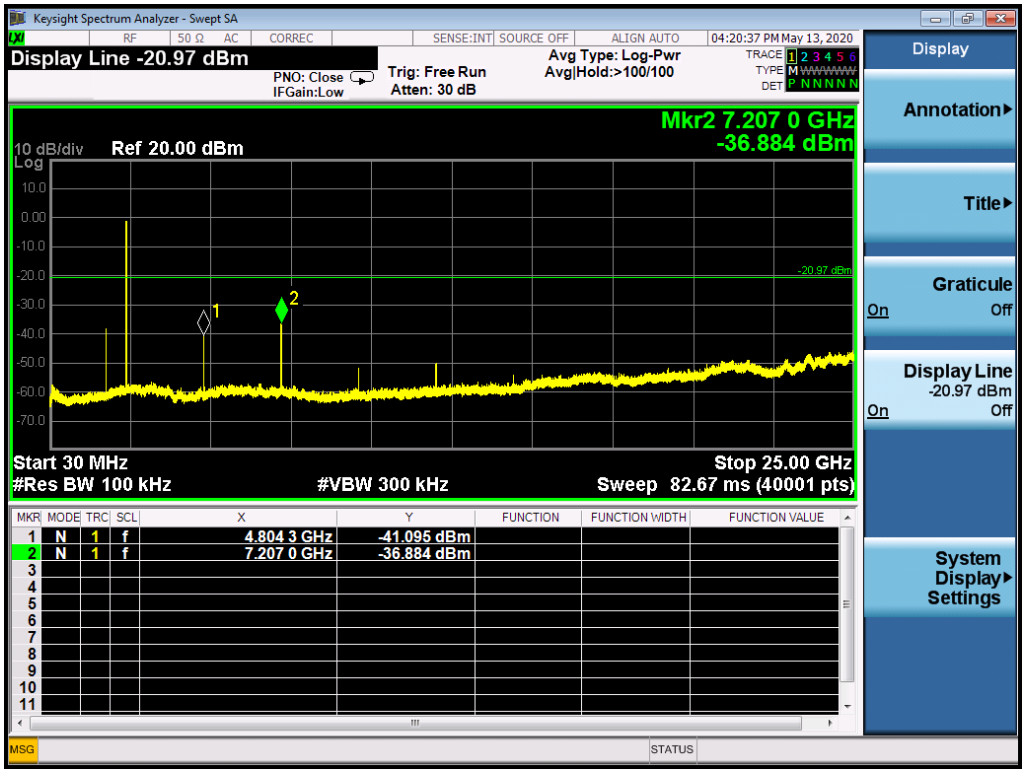


Figure 17: Conducted Spurious Emission, 2440MHz

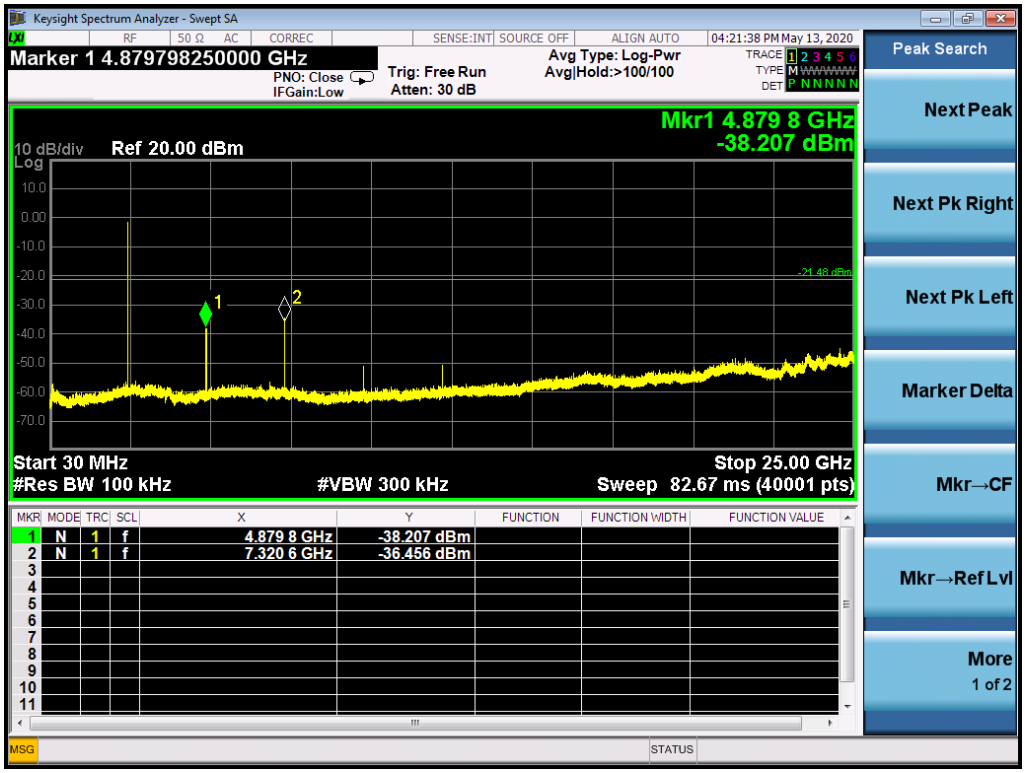


Figure 18: Conducted Spurious Emission, 2480MHz

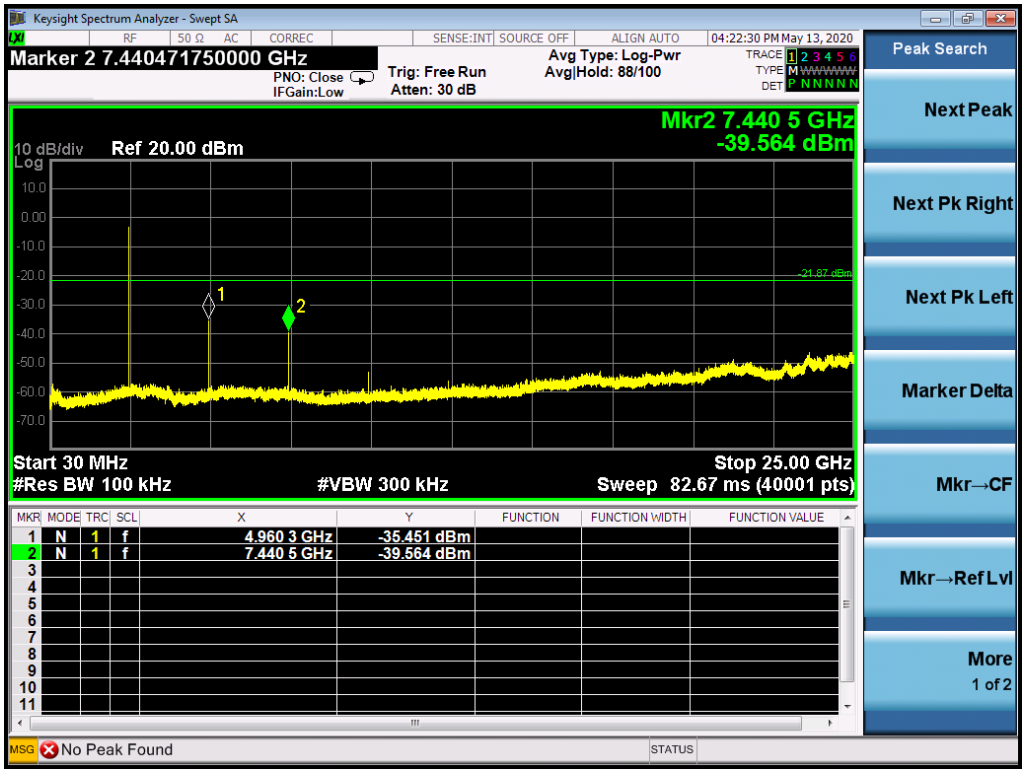


Figure 19: Conducted Band Edge, Lower Band

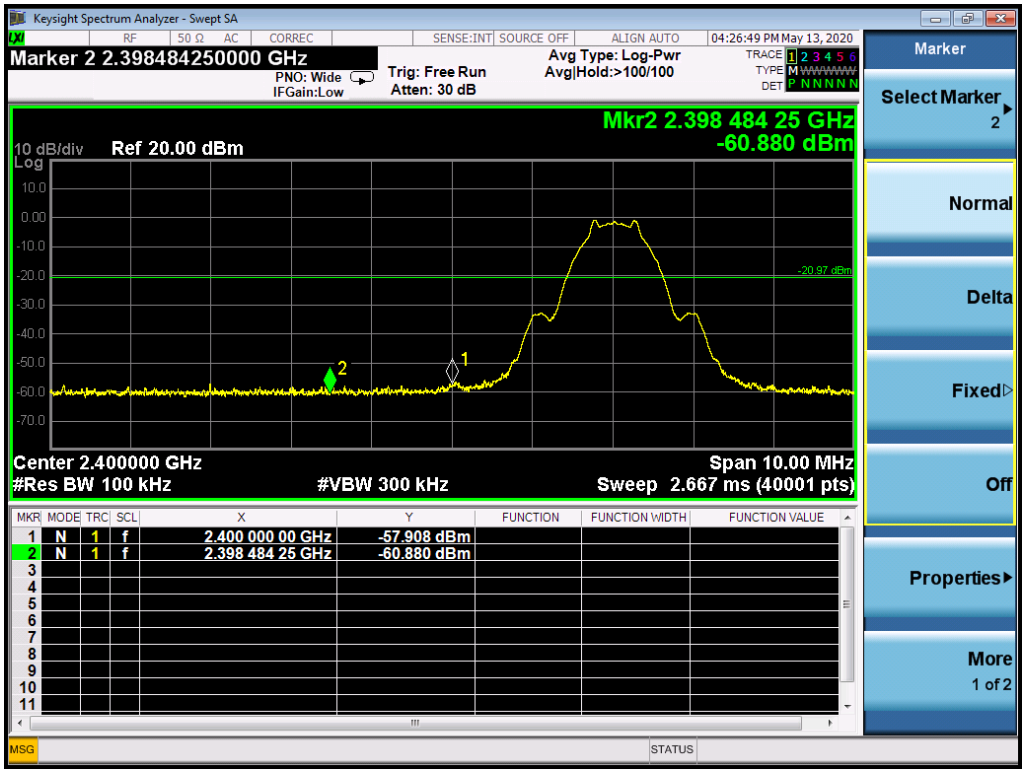
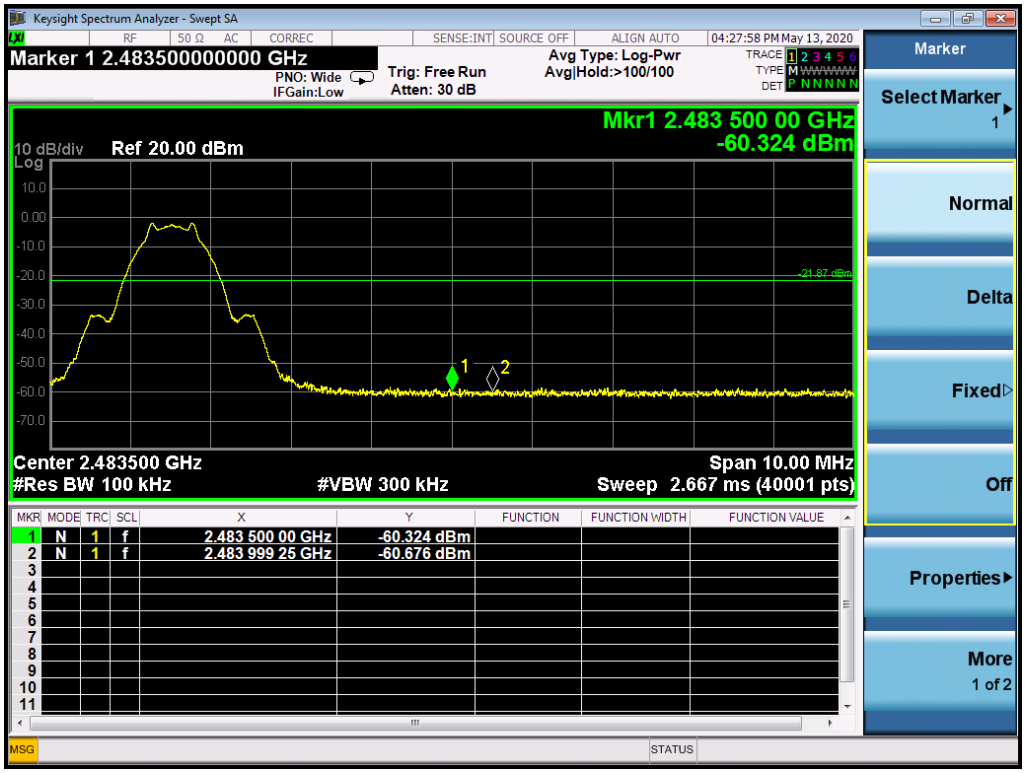


Figure 20: Conducted Band Edge, Higher Band



5.2 Emission in the Frequency Range up to 30MHz

5.2.1 Conducted Emission

RESULT: **Pass**

Date of testing	:	12.05.2020
Ambient temperature	:	26.1°C
Relative humidity	:	32.7%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC Part 15.207 (a) RSS-Gen Issue 5, Amendment 1, March 2019, Clause 8.8
Test procedure	:	KDB 558074 D01v05r02 ANSI C63.10: 2013
Test voltage	:	AC 220V, 60Hz
Test modes applied	:	TM4

Figure 21: Conducted Emission, L

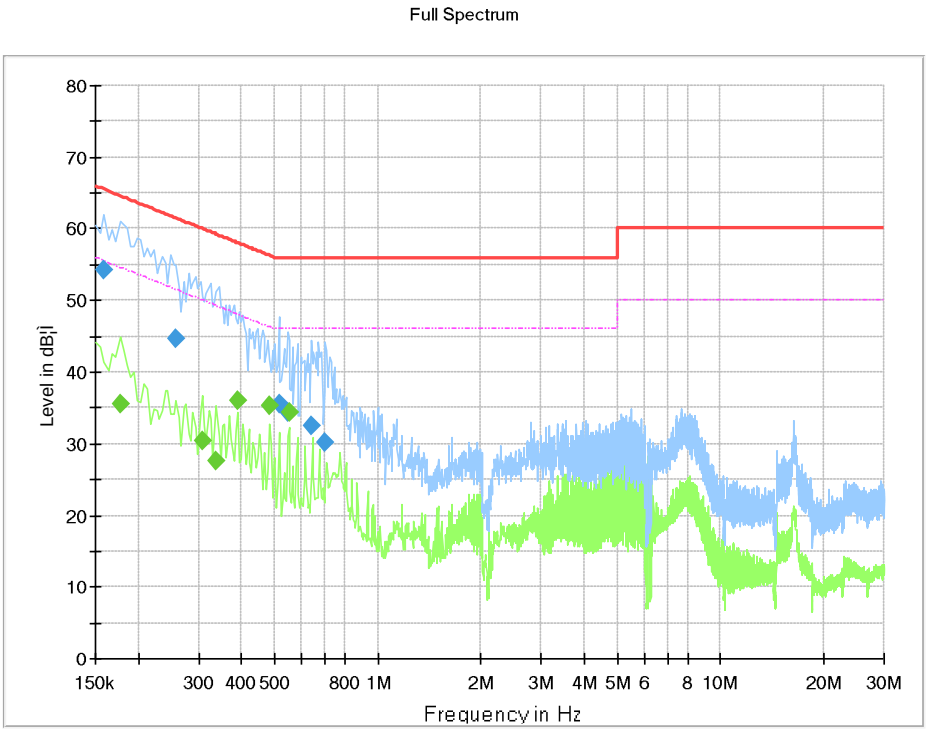


Table 10: Conducted Emission, L, Final Result_QPK

Frequency [MHz]	QuasiPeak [dBµV]	Limit [dBµV]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Line	Corr. (dB)
0.159000	54.19	65.52	11.32	1000.0	9.000	L1	9.5
0.258000	44.59	61.50	16.91	1000.0	9.000	L1	9.5
0.514500	35.58	56.00	20.42	1000.0	9.000	L1	9.6
0.546000	34.28	56.00	21.72	1000.0	9.000	L1	9.6
0.640500	32.62	56.00	23.38	1000.0	9.000	L1	9.6
0.703500	30.27	56.00	25.73	1000.0	9.000	L1	9.6

Table 11: Conducted Emission, L, Final Result_CAV

Frequency [MHz]	CAverage [dBµV]	Limit [dBµV]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Line	Corr. (dB)
0.177000	35.51	54.63	19.11	1000.0	9.000	L1	9.5
0.307500	30.30	50.04	19.74	1000.0	9.000	L1	9.6
0.339000	27.67	49.23	21.56	1000.0	9.000	L1	9.6
0.388500	35.91	48.10	12.19	1000.0	9.000	L1	9.6
0.483000	35.38	46.29	10.90	1000.0	9.000	L1	9.6
0.550500	34.34	46.00	11.66	1000.0	9.000	L1	9.6

Figure 22: Conducted Emission, N

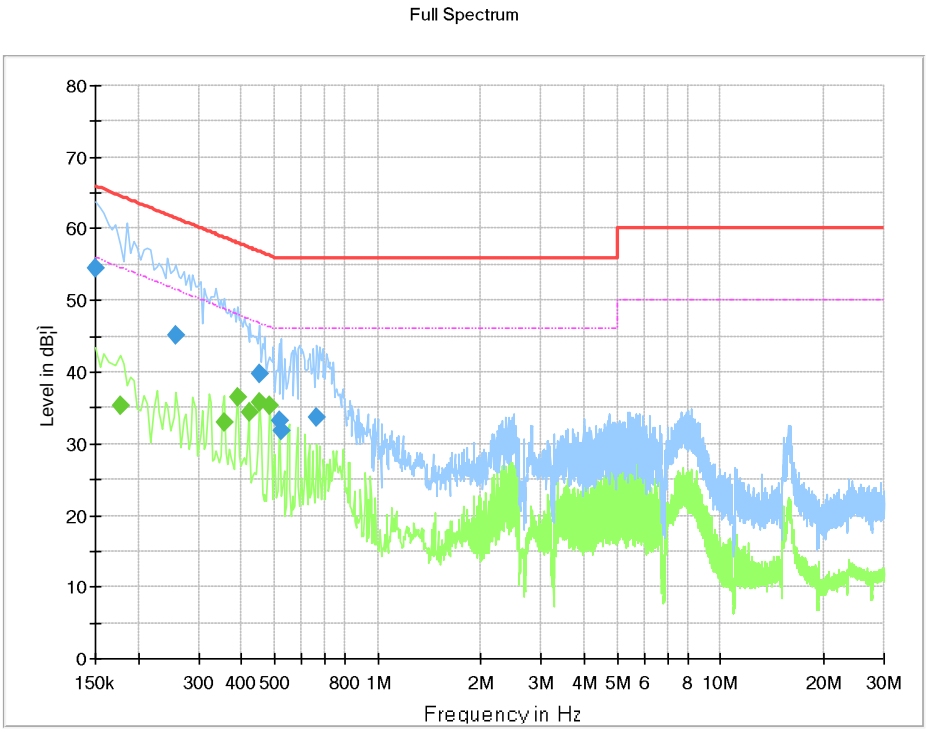


Table 12: Conducted Emission, N, Final Result_QPK

Frequency [MHz]	QuasiPeak [dBµV]	Limit [dBµV]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Line	Corr. (dB)
0.150000	54.41	66.00	11.59	1000.0	0.200	N	9.5
0.258000	45.07	61.50	16.42	1000.0	9.000	N	9.5
0.451500	39.72	56.85	17.12	1000.0	9.000	N	9.6
0.514500	33.20	56.00	22.80	1000.0	9.000	N	9.6
0.523500	31.78	56.00	24.22	1000.0	9.000	N	9.6
0.663000	33.79	56.00	22.21	1000.0	9.000	N	9.6

Table 13: Conducted Emission, N, Final Result_CAV

Frequency [MHz]	CAverage [dBµV]	Limit [dBµV]	Margin [dB]	Meas. Time [ms]	Bandwidth [kHz]	Line	Corr. (dB)
0.177000	35.39	54.63	19.24	1000.0	9.000	N	9.5
0.357000	33.03	48.80	15.76	1000.0	9.000	N	9.6
0.388500	36.49	48.10	11.61	1000.0	9.000	N	9.6
0.420000	34.44	47.45	13.01	1000.0	9.000	N	9.6
0.451500	35.70	46.85	11.15	1000.0	9.000	N	9.6
0.483000	35.23	46.29	11.06	1000.0	9.000	N	9.6

5.3 Emission in the Frequency Range above 30MHz

5.3.1 Radiated Band-Edge

RESULT: **Pass**

Date of testing	:	11.05.2020
Ambient temperature	:	26.1°C
Relative humidity	:	32.7%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC 15.247(d) FCC 15.205(a) FCC 15.209(a) Clause 5.5 of RSS-247 Issue 2 February 2017 Clause 8.90 of RSS-Gen Issue 5, March 2019 Clause 8.10 of RSS-Gen Issue 5, March 2019
Test procedure	:	KDB 558074 D01v05r02 ANSI C63.10: 2013
Test voltage	:	DC 5V
Test modes applied	:	TM1, TM3

Note:
All the test modes were applied, ony the worst case were shown in this report.

Figure 23: Radiated Band-Edge, TM1, H

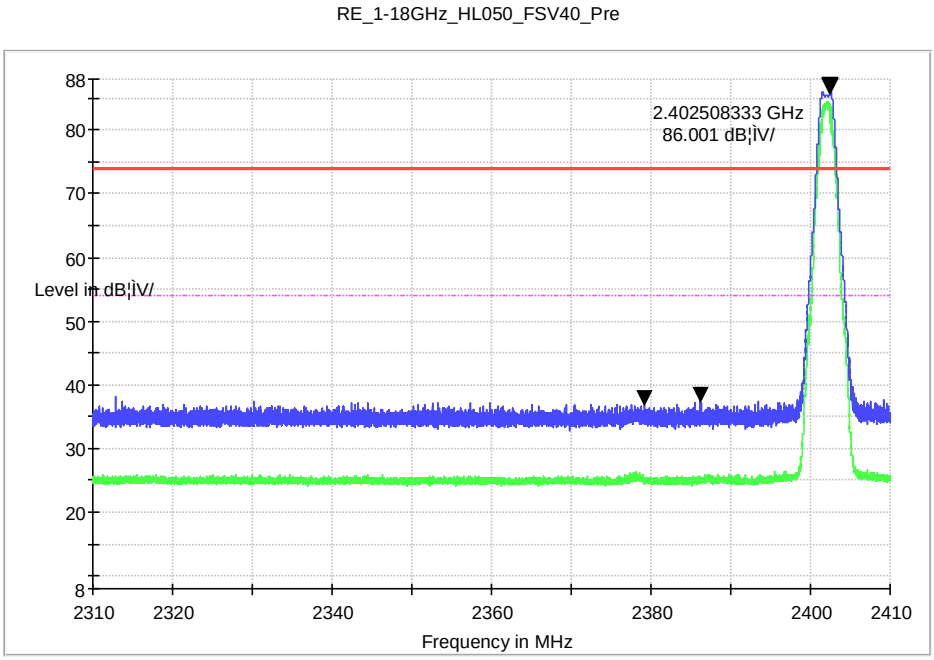


Table 14: Radiated Band-Edge, TM1, H

Frequency [MHz]	Measure Level [dBuV/m]	Reading Level [dBµV]	Over Limit [dB]	Limit [dBuV/m]	Factor	Type
2379.326	36.744	13.910	-37.256	74.000	22.834	PK
2387.560	37.065	15.490	-36.935	74.000	21.575	PK
2402.508	86.001	64.882	12.001	74.000	21.119	PK

Note: Measure Level (dBµV/m) = Reading Level (dBµV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

Figure 24: Radiated Band-Edge, TM1, V

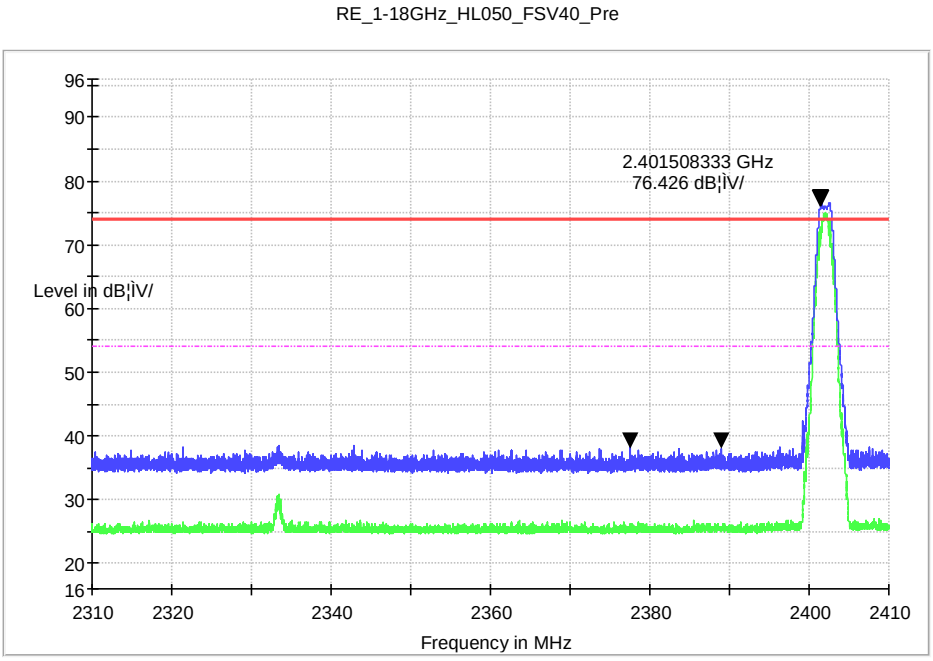


Table 15: Radiated Band-Edge, TM1, V

Frequency [MHz]	Measure Level [dBuV/m]	Reading Level [dBµV]	Over Limit [dB]	Limit [dBuV/m]	Factor	Type
2378.160	38.645	17.157	-35.355	74.000	21.488	PK
2388.552	38.265	15.762	-35.735	74.000	22.503	PK
2401.508	76.426	55.274	2.426	74.000	21.152	PK

Note: Measure Level (dBµV/m) = Reading Level (dBµV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

Figure 25: Radiated Band-Edge, TM3, H

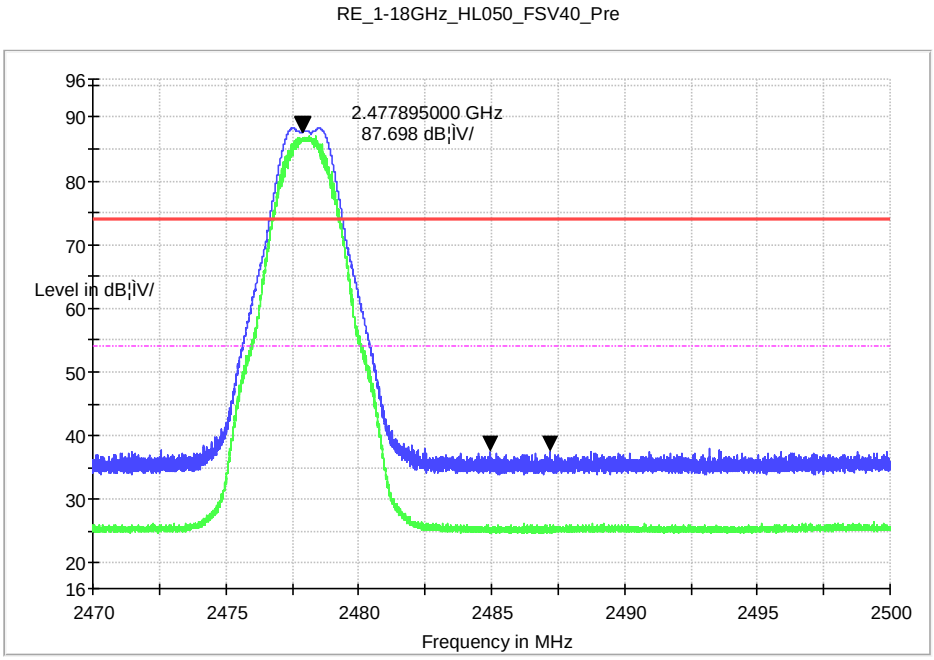


Table 16: Radiated Band-Edge, TM3, H

Frequency [MHz]	Measure Level [dBuV/m]	Reading Level [dBµV]	Over Limit [dB]	Limit [dBuV/m]	Factor	Type
2486.960	38.269	15.683	-35.731	74.000	22.586	PK
2485.000	37.064	15.490	-36.936	74.000	21.574	PK
2477.895	87.698	66.149	13.698	74.000	21.549	PK

Note: Measure Level (dBµV/m) = Reading Level (dBµV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

Figure 26: Radiated Band-Edge, TM3, V

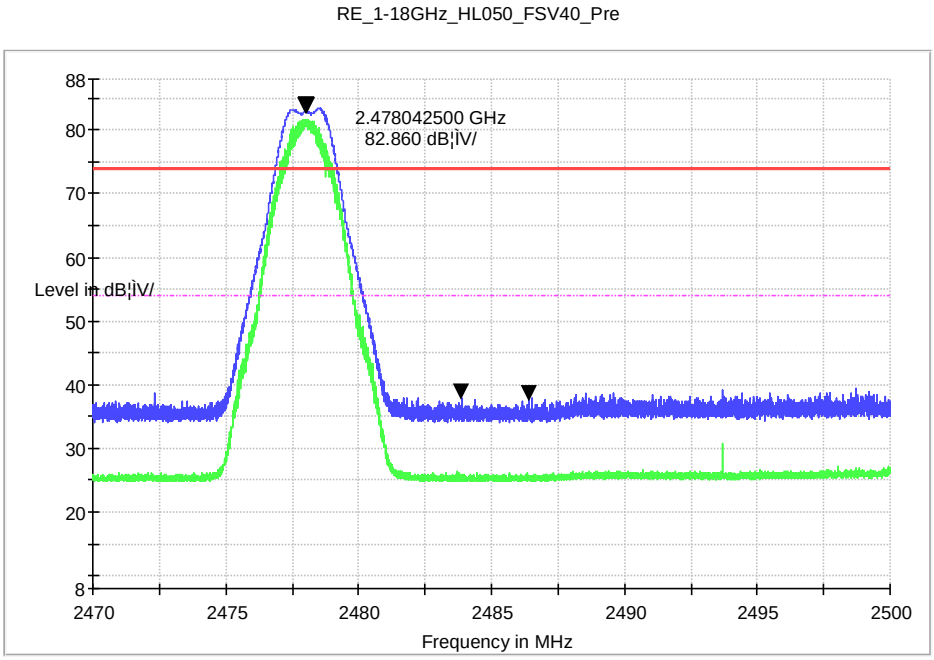


Table 17: Radiated Band-Edge, TM3, V

Frequency [MHz]	Measure Level [dBuV/m]	Reading Level [dBµV]	Over Limit [dB]	Limit [dBuV/m]	Factor	Type
2487.160	38.744	16.904	-35.256	74.000	21.840	PK
2483.500	38.065	16.930	-35.935	74.000	21.135	PK
2478.042	82.860	60.021	8.860	74.000	22.839	PK

Note: Measure Level (dBµV/m) = Reading Level (dBµV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + Antenna Factor (dB/m)

5.3.2 Radiated Spurious Emission

RESULT: **Pass**

Date of testing	:	29.04.2020~12.05.2020
Ambient temperature	:	23.2°C
Relative humidity	:	38.5%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC Part 15.209(a) FCC Part 15.247(d) RSS-247 Issue 2, February 2017, Clause 5.5 RSS-Gen Issue 5, Amendment 1, March 2019, Clause 8.9
Test procedure	:	KDB 558074 D01v05r02 ANSI C63.10: 2013
Test voltage	:	DC 5V
Test modes applied	:	TM1 to TM3
Kind of test site		3m Anechoic Chamber

Figure 27: Radiated Spurious Emission, TM1, 30MHz to 1GHz, H

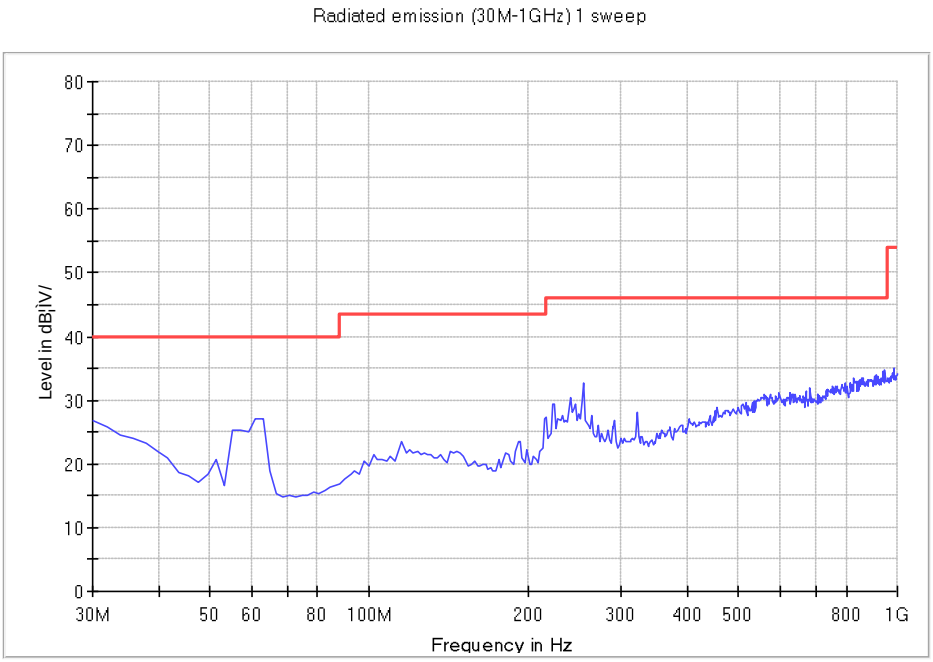


Figure 28: Radiated Spurious Emission, TM1, 30MHz to 1GHz, V

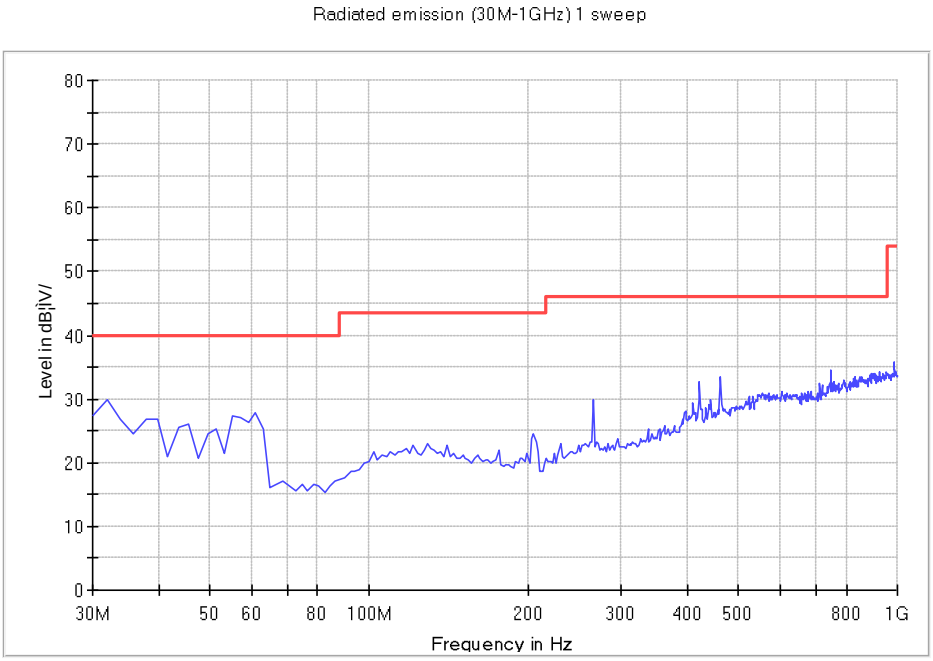


Figure 29: Radiated Spurious Emission, TM1, 1GHz to 7GHz, H

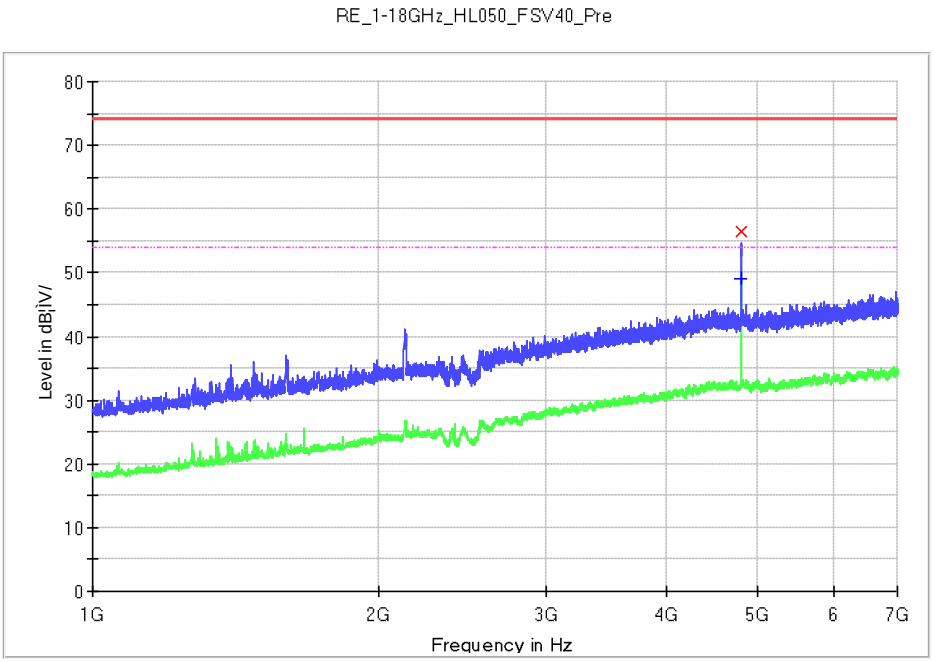


Figure 30: Radiated Spurious Emission, TM1, 1GHz to 7GHz, V

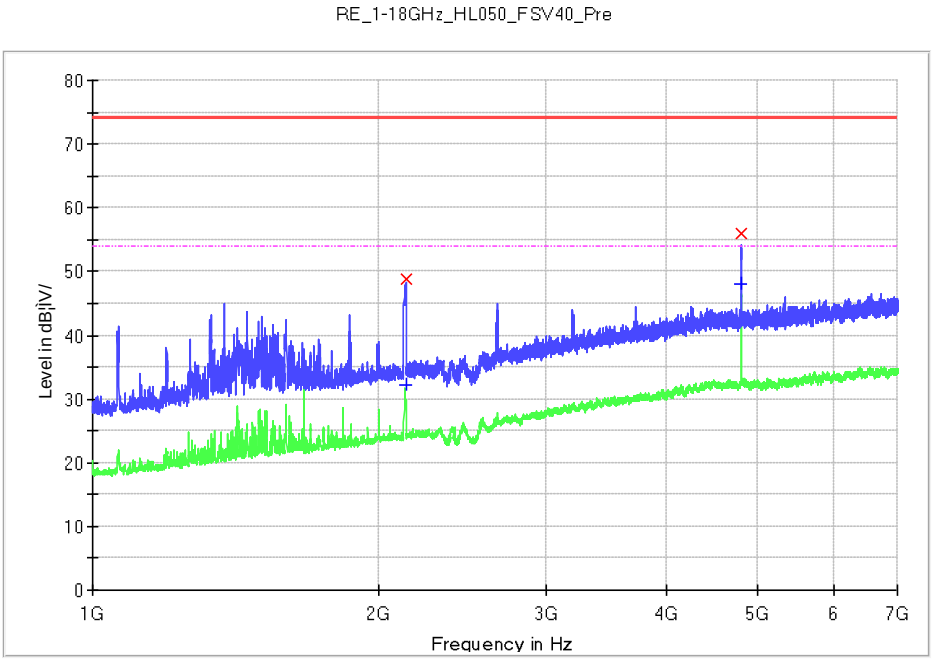


Figure 31: Radiated Spurious Emission, TM1, 7GHz to 18GHz, H

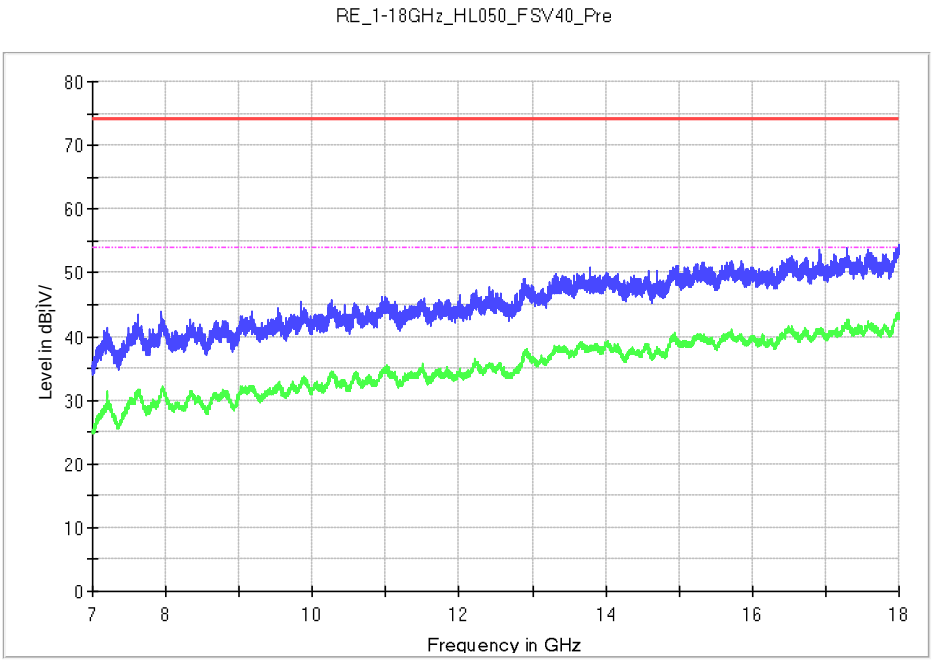


Figure 32: Radiated Spurious Emission, TM1, 7GHz to 18GHz, V

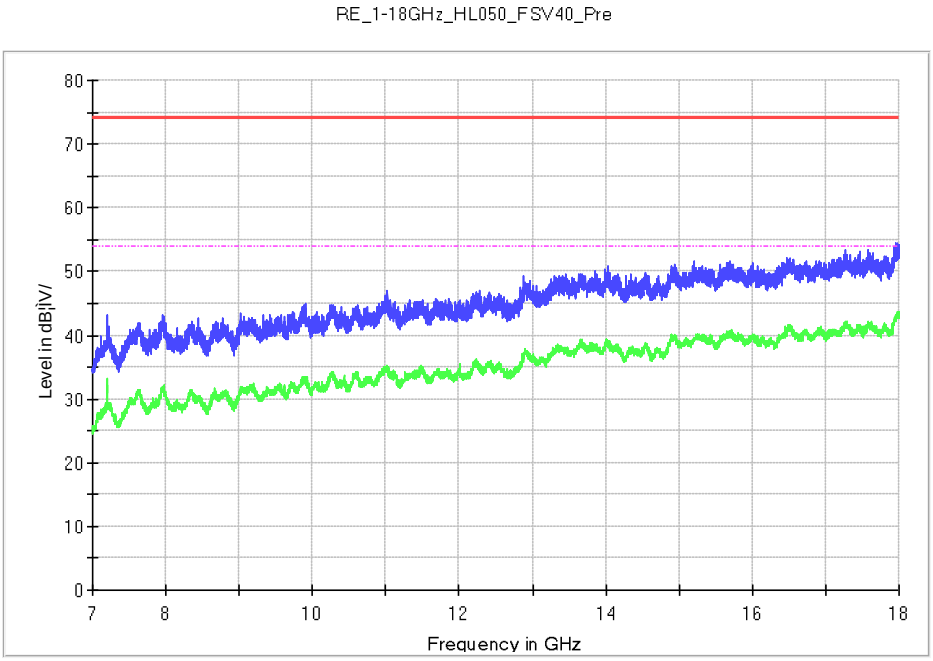


Figure 33: Radiated Spurious Emission, TM1, 18GHz to 25GHz, H

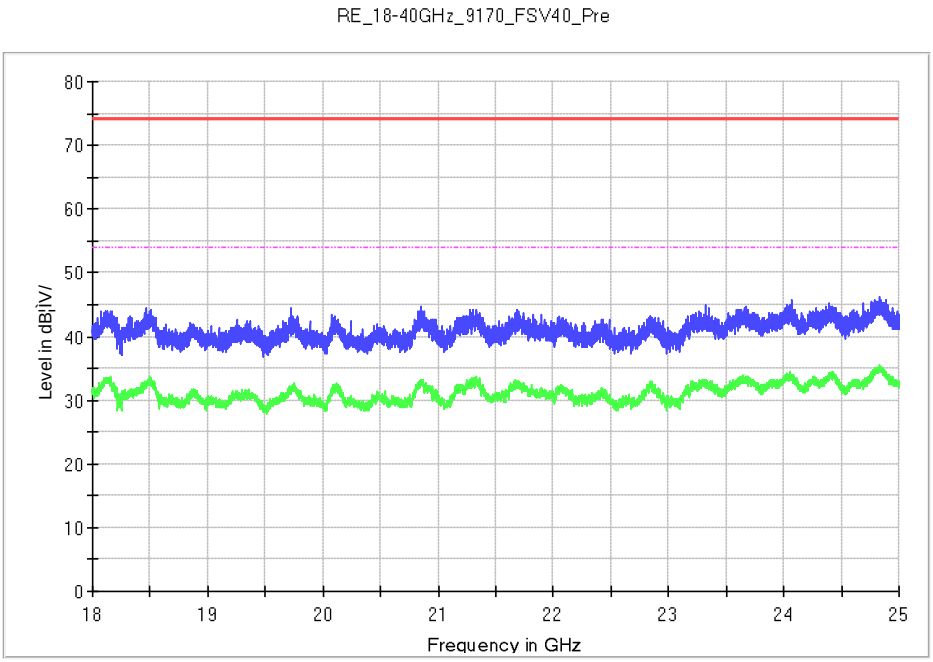


Figure 34: Radiated Spurious Emission, TM1, 18GHz to 25GHz, V

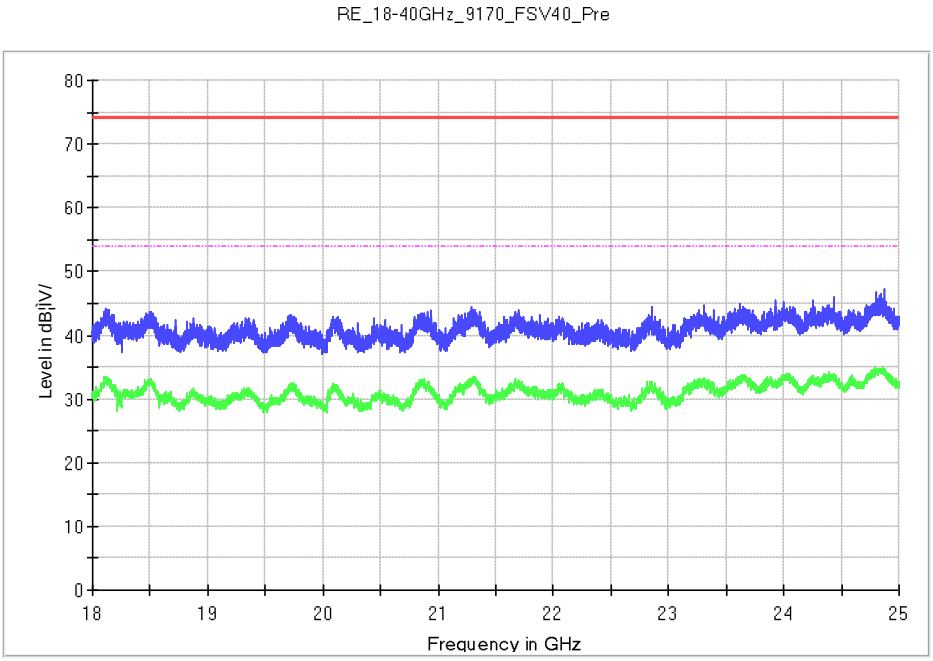


Figure 35: Radiated Spurious Emission, TM2, 30MHz to 1GHz, H

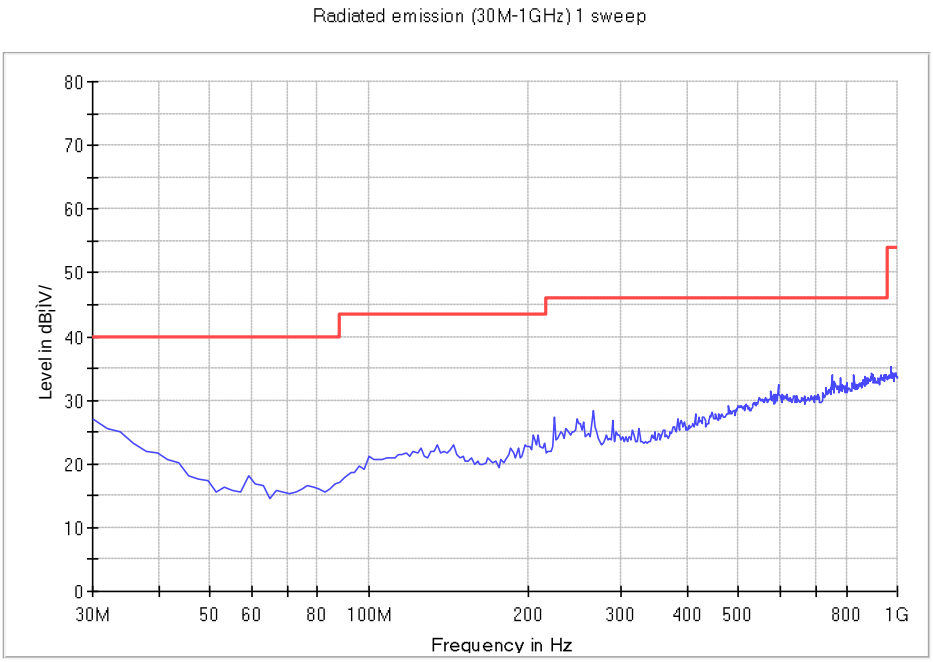


Figure 36: Radiated Spurious Emission, TM2, 30MHz to 1GHz, V

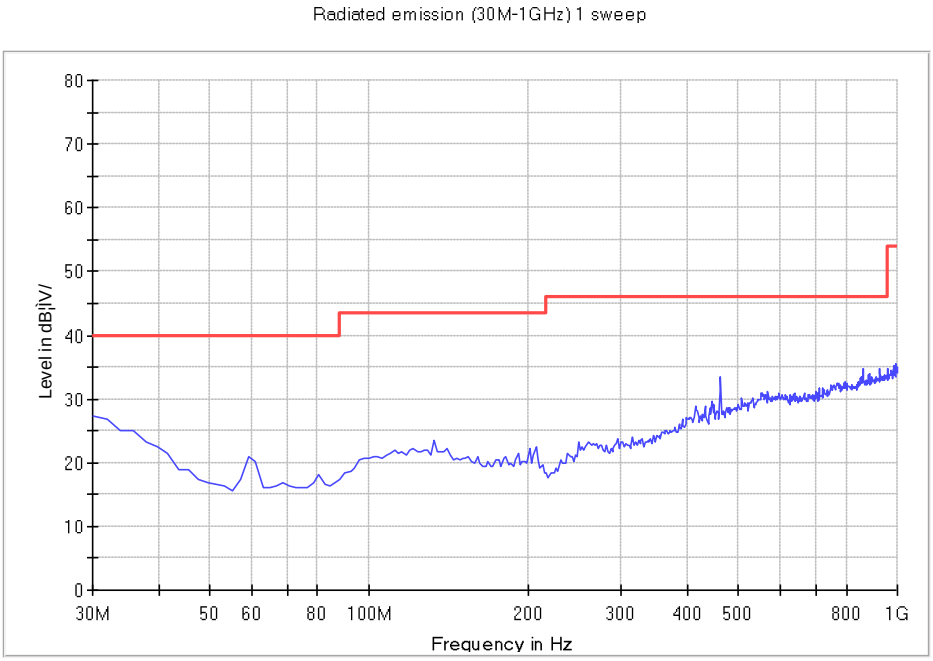


Figure 37: Radiated Spurious Emission, TM2, 1GHz to 7GHz, H

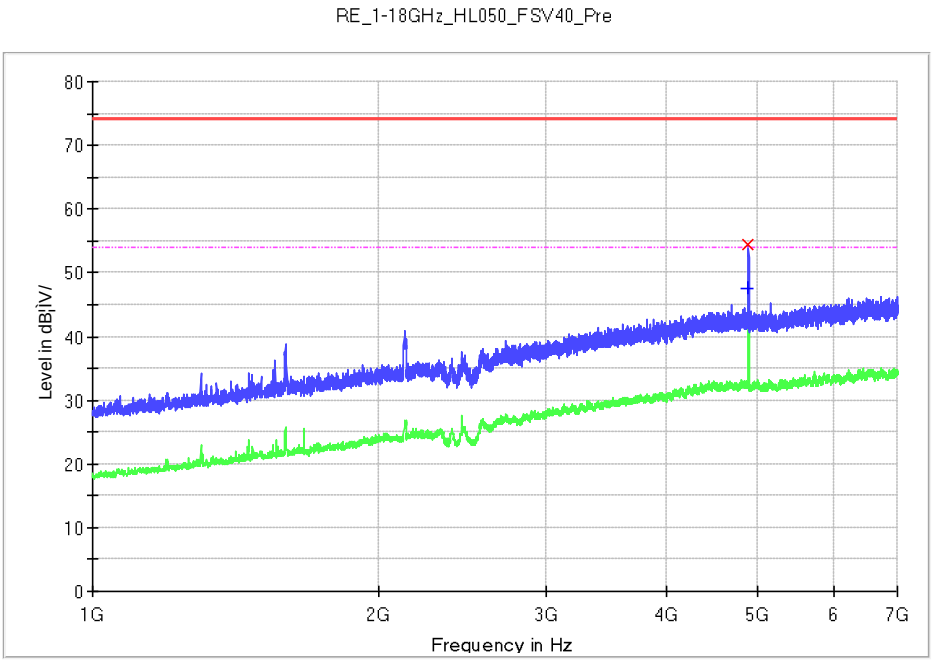


Figure 38: Radiated Spurious Emission, TM2, 1GHz to 7GHz, V

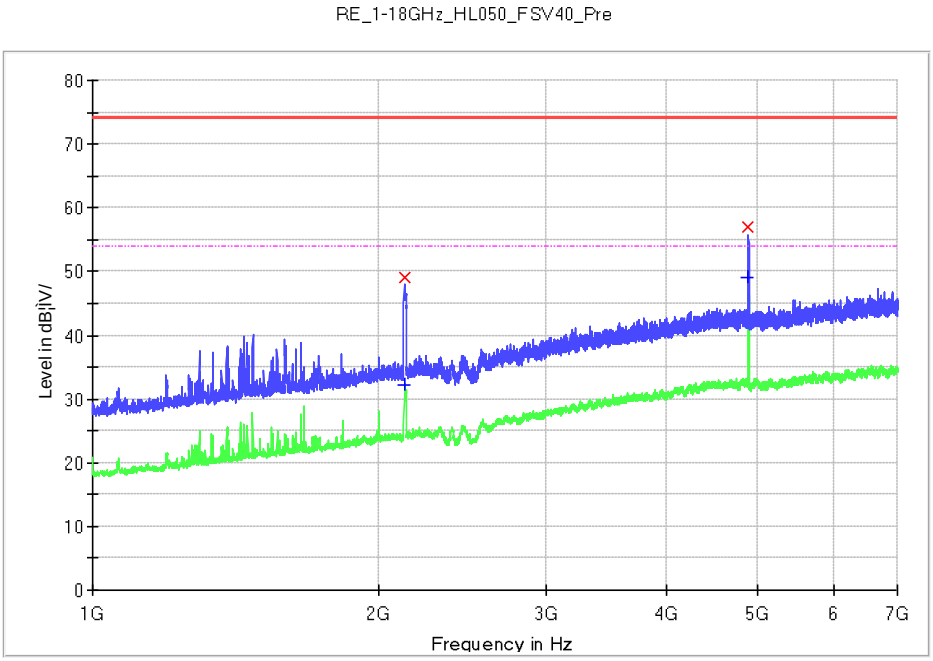


Figure 39: Radiated Spurious Emission, TM2, 7GHz to 18GHz, H

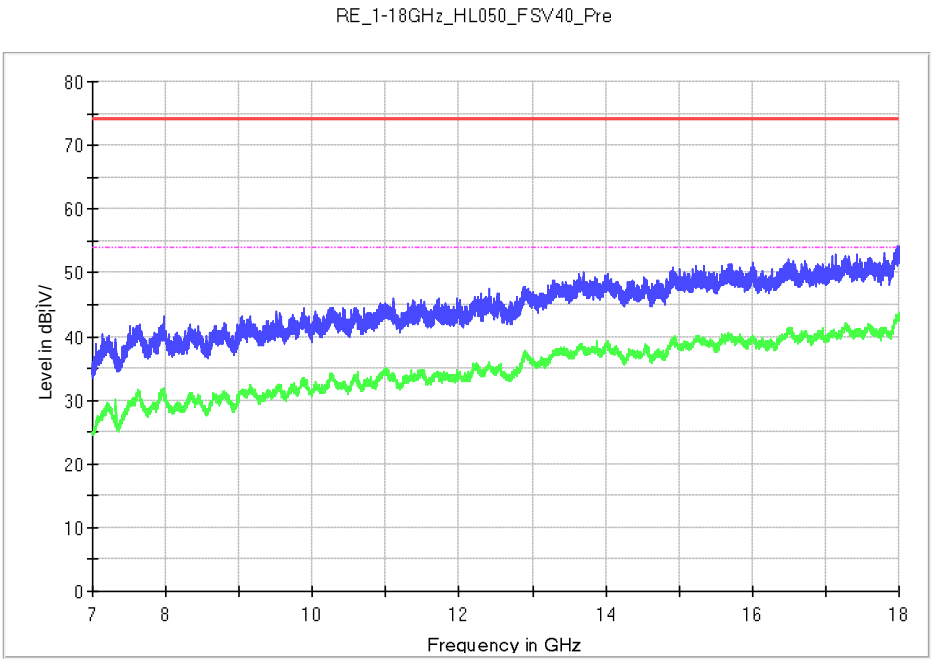


Figure 40: Radiated Spurious Emission, TM2, 7GHz to 18GHz, V

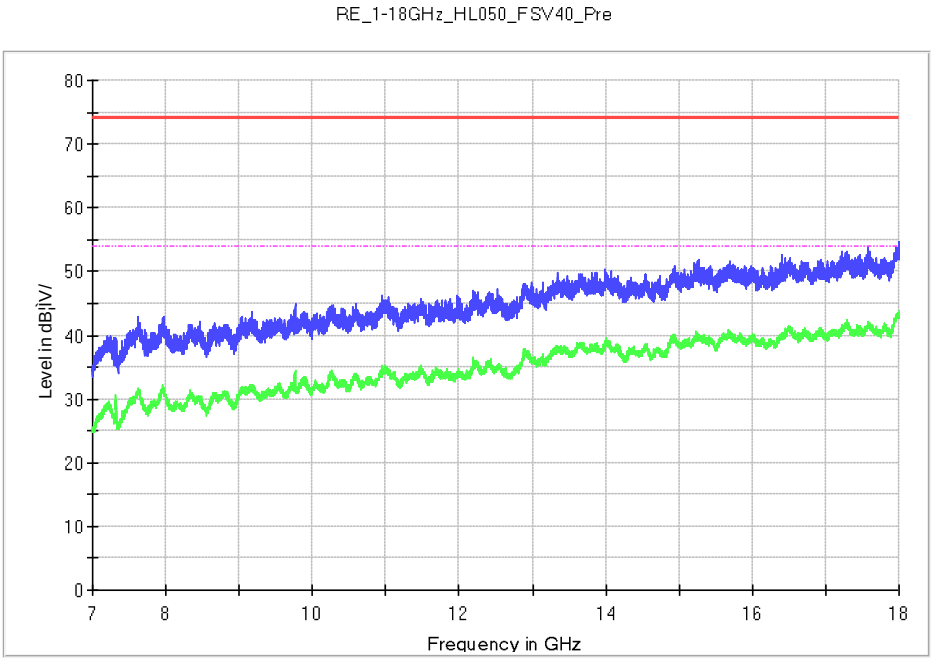


Figure 41: Radiated Spurious Emission, TM2, 18GHz to 25GHz, H

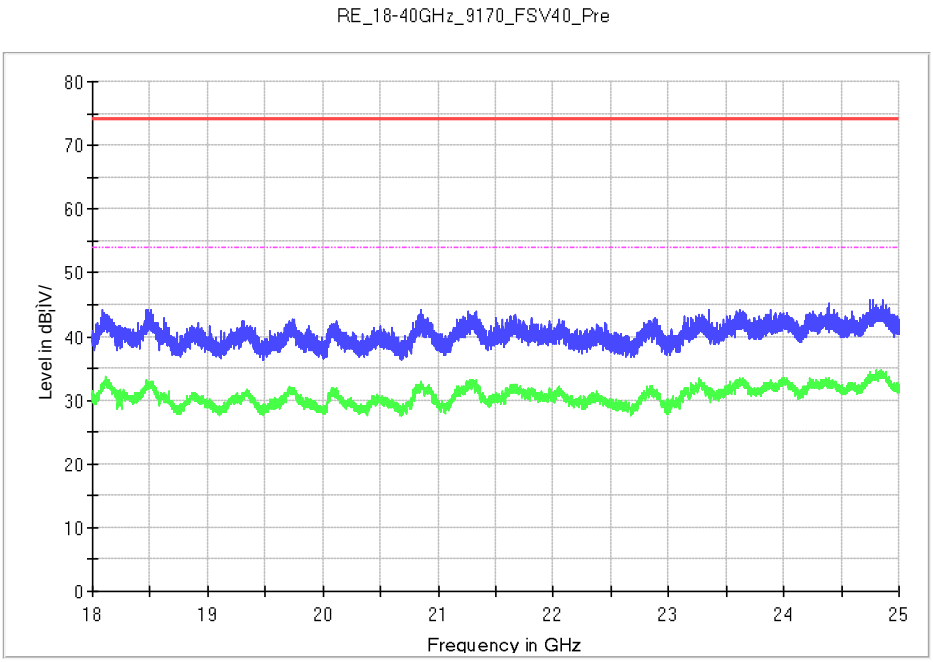


Figure 42: Radiated Spurious Emission, TM2, 18GHz to 25GHz, V

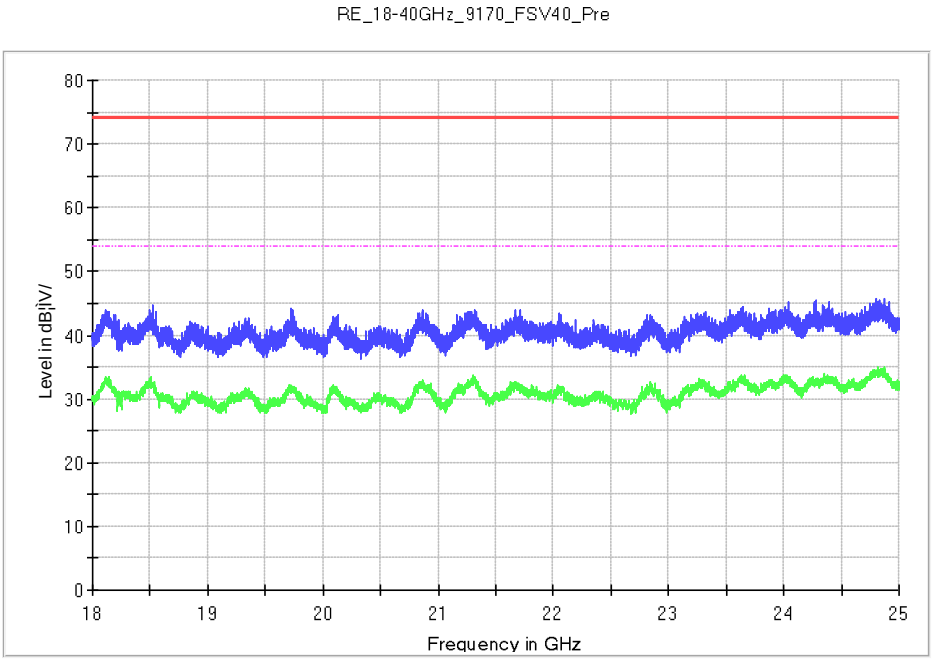


Figure 43: Radiated Spurious Emission, TM3, 30MHz to 1GHz, H

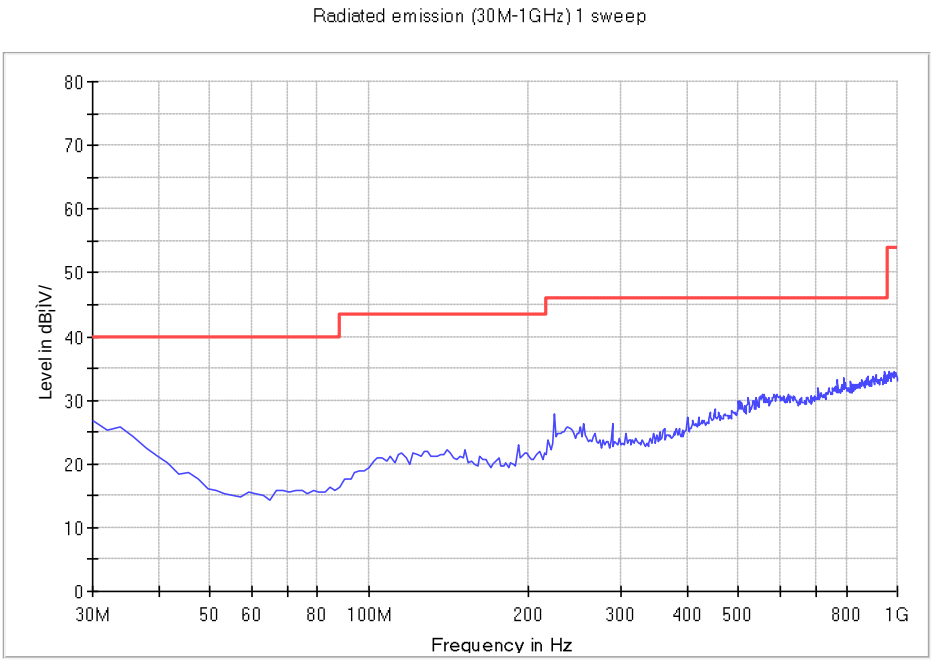


Figure 44: Radiated Spurious Emission, TM3, 30MHz to 1GHz, V

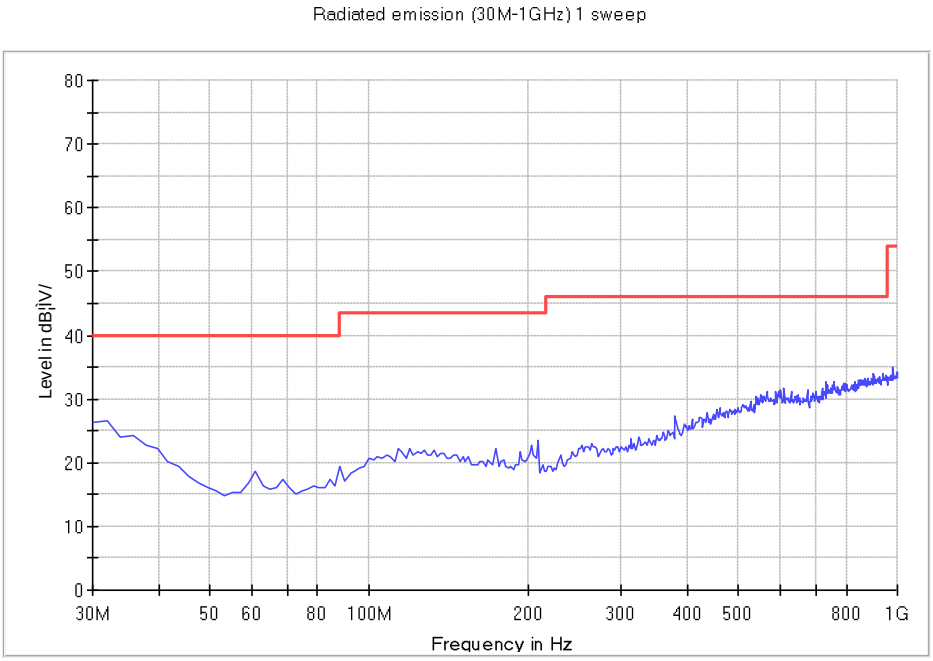


Figure 45: Radiated Spurious Emission, TM3, 1GHz to 7GHz, H

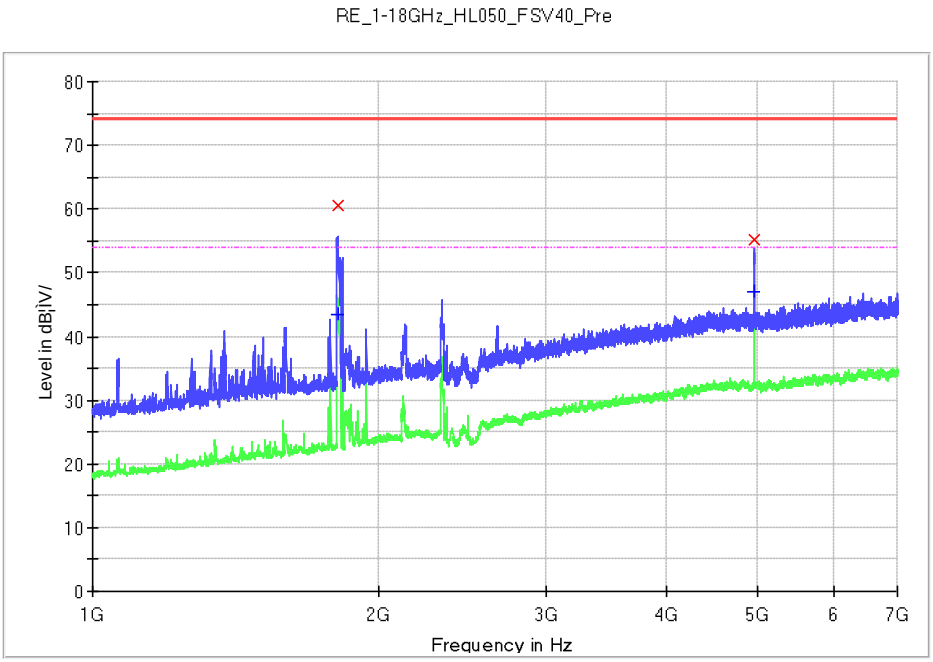


Figure 46: Radiated Spurious Emission, TM3, 1GHz to 7GHz, V

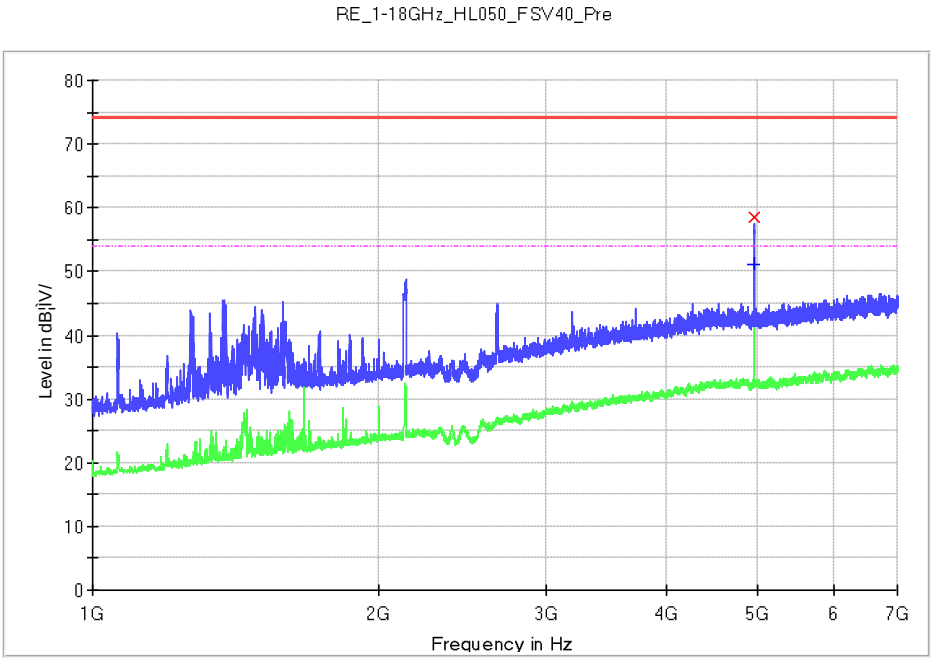


Figure 47: Radiated Spurious Emission, TM3, 7GHz to 18GHz, H

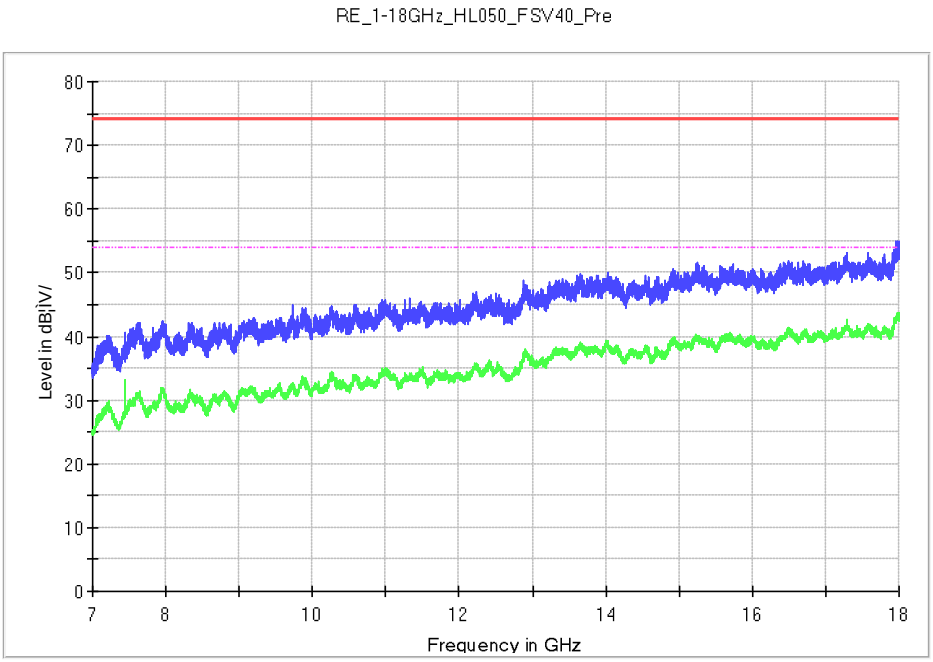


Figure 48: Radiated Spurious Emission, TM3, 7GHz to 18GHz, V

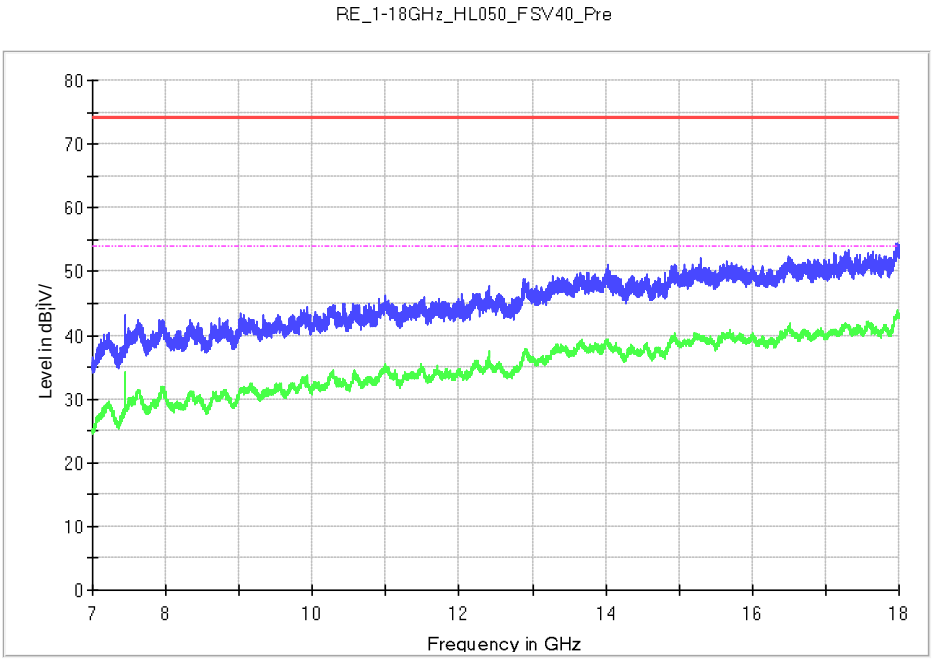


Figure 49: Radiated Spurious Emission, TM3, 18GHz to 25GHz, H

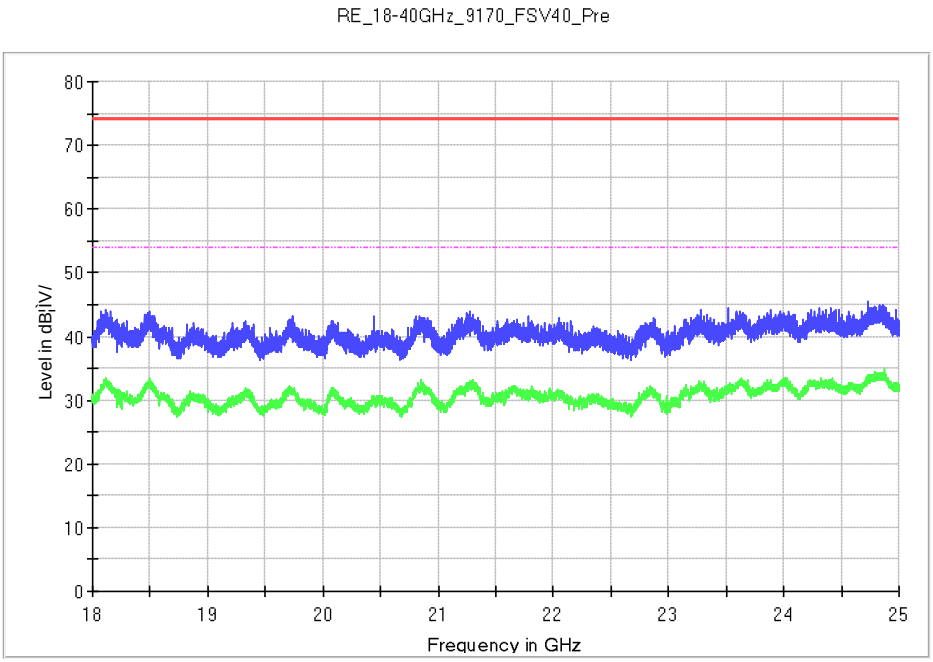
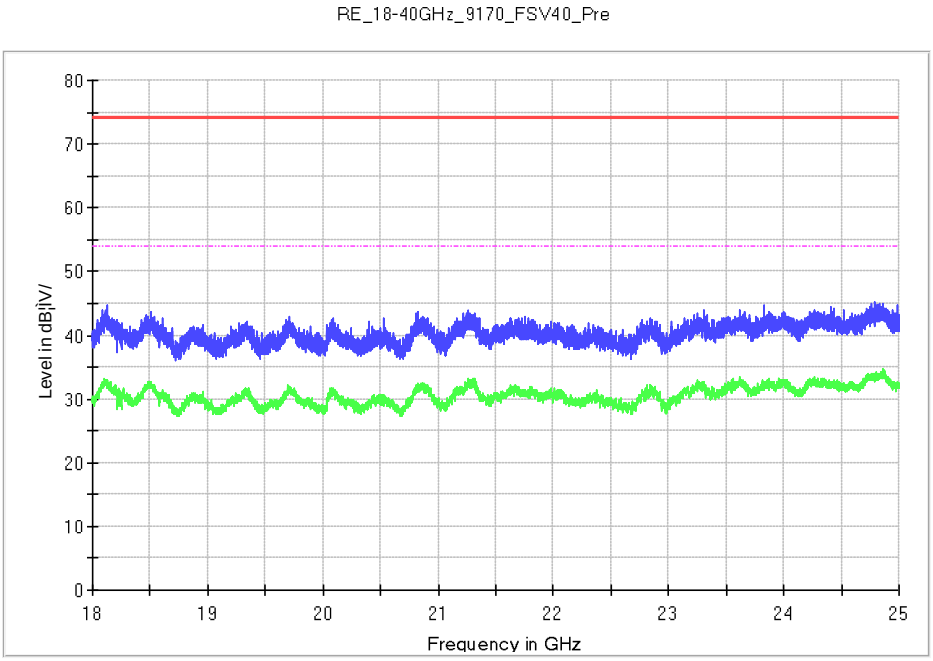


Figure 50: Radiated Spurious Emission, TM3, 18GHz to 25GHz, V



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