

TEST REPORT

Report No.: SHE21040013-02FE

Date: 2021-06-07

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Applicant : Leica Geosystems AG
Address of Applicant : Heinrich-Wild-Strasse, CH-9435 Heerbrugg

Product Name : Rugged Windows Field Controller
Model No. : CS30 LTE LRBT
Sample No. : E21040013-01 #05
E21040013-01 #01
FCC ID : RFD-CS30LRBT
ISED Number : 3177A-CS30LRBT

Standards : FCC CFR47 Part 15, Subpart C
RSS-Gen (Issue 5, March 2019)
RSS-247 (Issue 2, February 2017)

Date of Receipt : 2021-04-25
Date of Test : 2021-04-25 ~ 2021-06-07
Date of Issue : 2021-06-07

Remark:

This report details the results of the testing carried out on one sample, the results contained in this report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

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(Jennifer Zhou)

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(Authorized signatory: Guoyou Chi)

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1 General Information

1.1 Testing Laboratory

Company Name	ICAS Testing Technology Service (Shanghai) Co., Ltd.
Address	No.1298 Pingan Rd, Minhang District, Shanghai, China
Telephone	0086 21-51682999
Fax	0086 21-54711112
Homepage	www.icasiso.com

1.2 Details of Application

Applicant Company Name	Leica Geosystems AG
Address	Heinrich-Wild-Strasse, CH-9435 Heerbrugg
Contact Person	Patrick Rayero
Telephone	+4171 727 4664
Email	patrick.rayero@leica-geosystems.com
Manufacturer Company Name	Leica Geosystems AG
Address	Heinrich-Wild-Strasse, CH-9435 Heerbrugg
Factory Company Name	Shenzhen UniStrong Science & Technology Co.,Ltd.
Address	B,4-4Factory, Zhengcheng Road, Fuyong Baoan District, Shenzhen, China

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1.3 Details of EUT

Product Name	Rugged Windows Field Controller
Brand Name	Leica
Test Model No.	CS30 LTE LRBT
FCC ID	RFD-CS30LRBT
ISED Number	3177A-CS30LRBT

Technical Information

Mode of Operation	Bluetooth BLE
Frequency Range	2400MHz ~ 2483.5MHz
Number of Channels	40 (at intervals of 2 MHz)
Modulation Type	GFSK
Antenna Type	Internal Antenna and External Antenna
Antenna Gain	1.97 dBi (for internal module) 2.00 dBi (for external module)
Extreme Temperature Range	-20°C ~ +60°C
Test Voltage	DC 11.1V
Hardware version	PCB V0.4
Software version	R.ED.00.02.03
RF power setting in TEST SW	DRTU and Serial Port Adapter Toolbox

1.4 Test Methodology

47 CFR Part 15, Subpart C (10-1-16 Edition)	Miscellaneous Wireless Communications Services
KDB Publication 558074 D01 v05r02	15.247 Meas Guidance
RSS-Gen (Issue 5, March 2019)	General Requirements for Compliance of Radio Apparatus
RSS-247 (Issue 2, February 2017)	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices

Note(s):

All test items were verified and recorded according to the standards and without any addition/deviation/exclusion during the test.

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1.5 Test Summary

Test Item	FCC Rules	ISED RULES	Result
Antenna Requirement	FCC Part 15.247(b)(4), Part 15.203	RSS-247 5.4(6)	PASS
Peak Output Power and E.I.R.P	FCC Part 15.247(b)(3)	RSS-247 5.4(4)	PASS
6dB Bandwidth and 99% Bandwidth	FCC Part 15.247(a)(2)	RSS-247 5.2(1) RSS-Gen 6.7	PASS
Power Spectral Density	FCC Part 15.247(e)	RSS-247 5.2(2)	PASS
Conducted Spurious Emission & Authorized-band band-edge	FCC Part 15.247(d)	RSS-247 5.5	PASS
Radiated Spurious Emission	FCC Part 15.247(d), 15.205, 15.209	RSS-247 5.5	PASS
Band Edge (Restricted-band band-edge)	FCC Part 15.247(d), 15.205, 15.209	RSS-247 5.5	PASS
Conducted Emission on AC Mains	FCC Part 15.207(a)	RSS-Gen 8.8	PASS

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2 Test Condition

2.1 Environmental conditions

Temperature (°C)	18-25
Humidity (%RH)	40-65
Barometric Pressure (mbar)	960-1060

2.2 Equipment List

Name of Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due Date
Spectrum Analyzer	Keysight	N9020B	MY59260184	2020-08-19	2021-08-18
Spectrum Analyzer	Rohde & Schwarz	FSV40N	101450	2020-06-09	2021-06-08
EMI Test Receiver	Rohde & Schwarz	ESPI3	100173	2020-06-09	2021-06-08
EMI Test Receiver	Rohde & Schwarz	ESR 7	101911	2020-06-09	2021-06-08
V-network	SCHWARZBECK	NSLK 8127	8127-902	2020-07-29	2021-07-28
Wideband Radio Communication Tester	Rohde & Schwarz	CMW 500	100687	2020-08-19	2021-08-18
Broadband Antenna	SCHWARZBECK	VULB9163	9163-1037	2020-06-09	2021-06-08
Horn Antenna-18G	SCHWARZBECK	BBHA9120D	9120D-1775	2020-07-29	2021-07-28
Loop Antenna	SCHWARZBECK	FMZB 1513	N/A	2020-11-23	2021-11-22
Horn Antenna-40G	YINGLIAN	LB-180400-K F	N/A	2020-07-27	2021-07-26
EMC chamber 9*6*6 (L*W*H)	CHANGNING	966	N/A	2020-06-09	2023-06-08
Shielded Enclosure 8*5*4 (L*W*H)	CHANGNING	854	N/A	2020-06-09	2021-06-08
Test Software	BL	BL410_E	N/A	N/A	N/A
Test Software	BL	BL410_R	N/A	N/A	N/A

2.3 Measurement Uncertainty

Parameter	Frequency	Uncertainty
Antenna Port Conducted Emission	< 1GHz	± 1.5 dB
	> 1GHz	± 1.5 dB
Radiated Emission	30MHz – 1GHz	± 3 dB
	> 1GHz	± 3 dB
Conducted Emission on AC Mains	9KHz-30MHz	± 1.96 dB

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3 Test Set-up and Operation Modes

3.1 Details of Test Mode

Using test software was control EUT work in continuous transmitter and receiver mode. Select test channel as below:

Channel	Frequency
The lowest channel(CH0)	2402MHz
The middle channel(CH19)	2440MHz
The Highest channel(CH39)	2480MHz

The basic operation modes are:

- A. On
 - 1. BLE mode
 - a. Transmitting
 - i. Low Channel
 - ii. Middle Channel
 - iii. High Channel
 - b. Receiving
 - 2. Normal working with Bluetooth on
- B. Standby
- C. Off

3.2 Special Accessories and Auxiliary Equipment

Description	Manufacturer	Model No.	Serial No.
Laptop	Lenovo	TP00083A	N/A

3.3 Support Software

Description	Manufacturer	Software Name
Software	N/A	Serial Port Adapter Toolbox and DRTU

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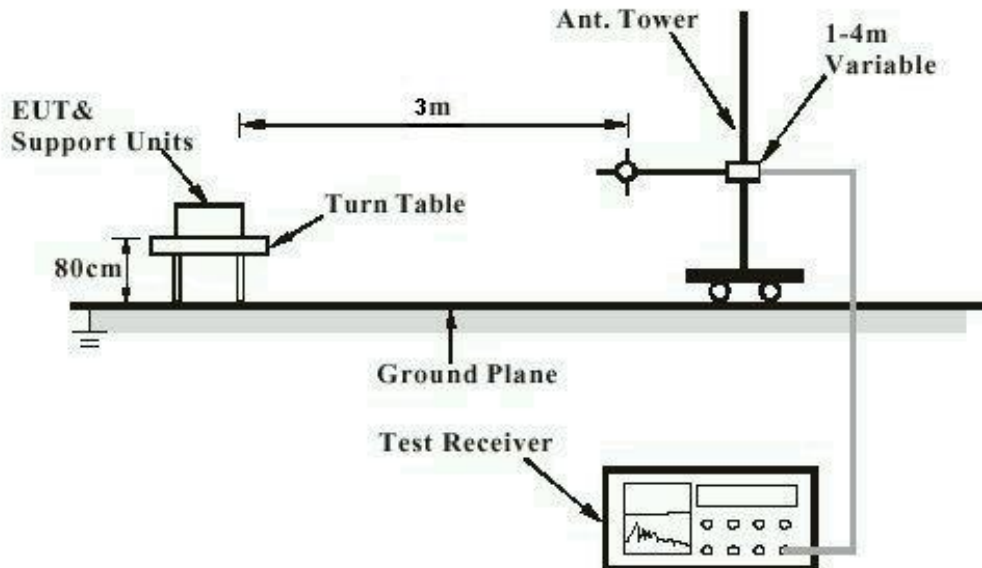
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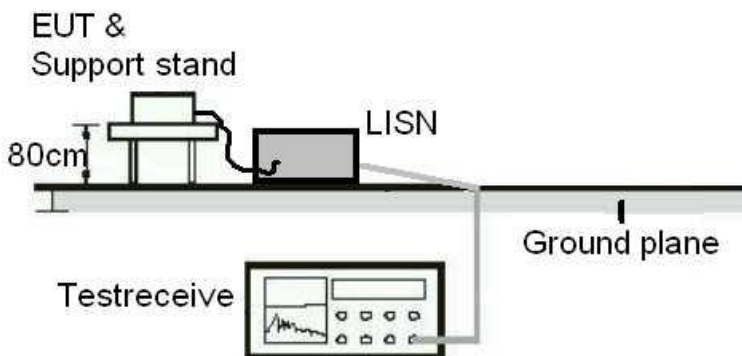
3.4 Test Setup Diagram

Diagram of Measurement Configuration for Radiation Test



Note: Measurements above 1GHz are done with a table height of 1.5m. In addition, there is RF absorbing material on the floor of the test site for above 1GHz measurement.

Diagram of Measurement Equipment Configuration for Conduction Measurement



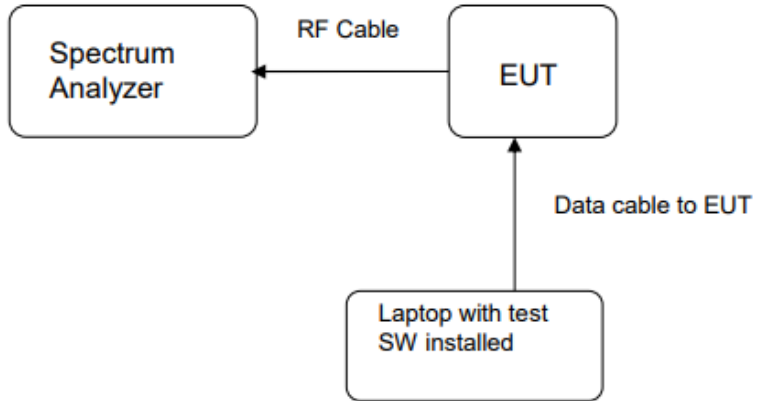
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Diagram of Measurement Equipment Configuration for Transmitter Measurement



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4 Test Results

4.1 Transmitter Requirement & Test Suites

4.1.1 Antenna Requirement

RESULT:

PASS

Test standard : FCC Part 15.247(b)(4), Part 15.203
RSS-247 5.4(6)

Requirement : The use of approved antennas only with directional gains that do not exceed 6dBi

According to the manufacturer declaration, the EUT had an antenna with a directional gain of 2.00 dBi. The antenna is an external antenna with no possibility of replacement with a non-approved antenna by the end-user.

Therefore, the EUT is considered to comply with this provision.

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4.1.2 Peak Output Power and E.I.R.P

RESULT:

PASS

Test standard : FCC Part 15.247(b)(3)
RSS-247 5.4(4)
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High
Operation Mode : A.1.a
Ambient temperature : 23°C
Relative humidity : 52%

Internal Module (Contain Table 1, Table 2 and Figure 1)

Table 1: Peak Output Power

Test Mode	Test Channel (MHz)	Measured Peak Power		Limit (W)
		(dBm)	(mW)	
BLE	2402	2.41	1.74	≤1
	2440	2.73	1.87	
	2480	2.75	1.88	

Table 2: E.I.R.P

Test Mode	Test Channel (MHz)	E.I.R.P		Limit (W)
		(dBm)	(mW)	
BLE	2402	4.38	2.74	≤4
	2440	4.70	2.95	
	2480	4.72	2.96	

Note: The antenna gain is 1.97dBi

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External Module (Contain Table 3, Table 4 and Figure 2)

Table 3: Peak Output Power

Test Mode	Test Channel (MHz)	Measured Peak Power		Limit (W)
		(dBm)	(mW)	
BLE	2402	4.05	2.54	≤1
	2440	3.62	2.30	
	2480	0.36	1.09	

Table 4: E.I.R.P

Test Mode	Test Channel (MHz)	E.I.R.P		Limit (W)
		(dBm)	(mW)	
BLE	2402	6.05	4.03	≤4
	2440	5.62	3.65	
	2480	2.36	1.72	

Note: The antenna gain is 2.00 dBi

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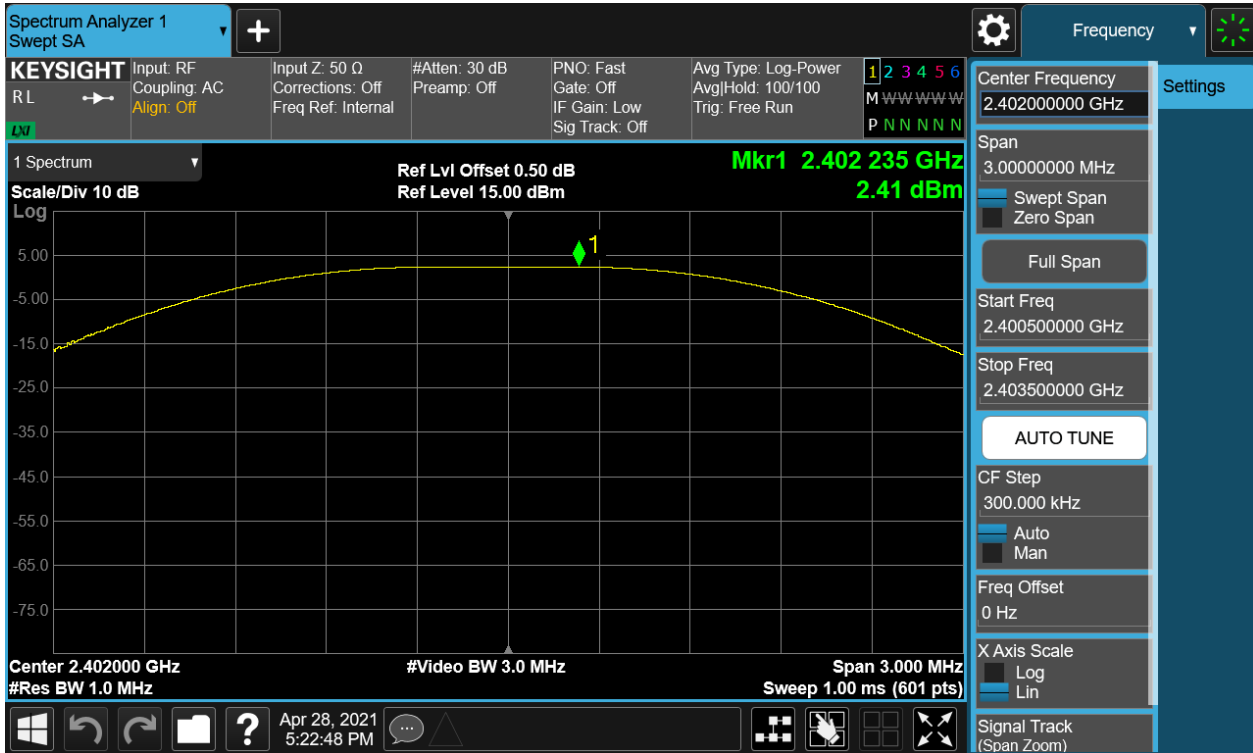
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Figure 1: Internal Module-Peak Output Power, 2402MHz



Internal Module-Peak Output Power, 2440MHz



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Internal Module-Peak Output Power, 2480MHz

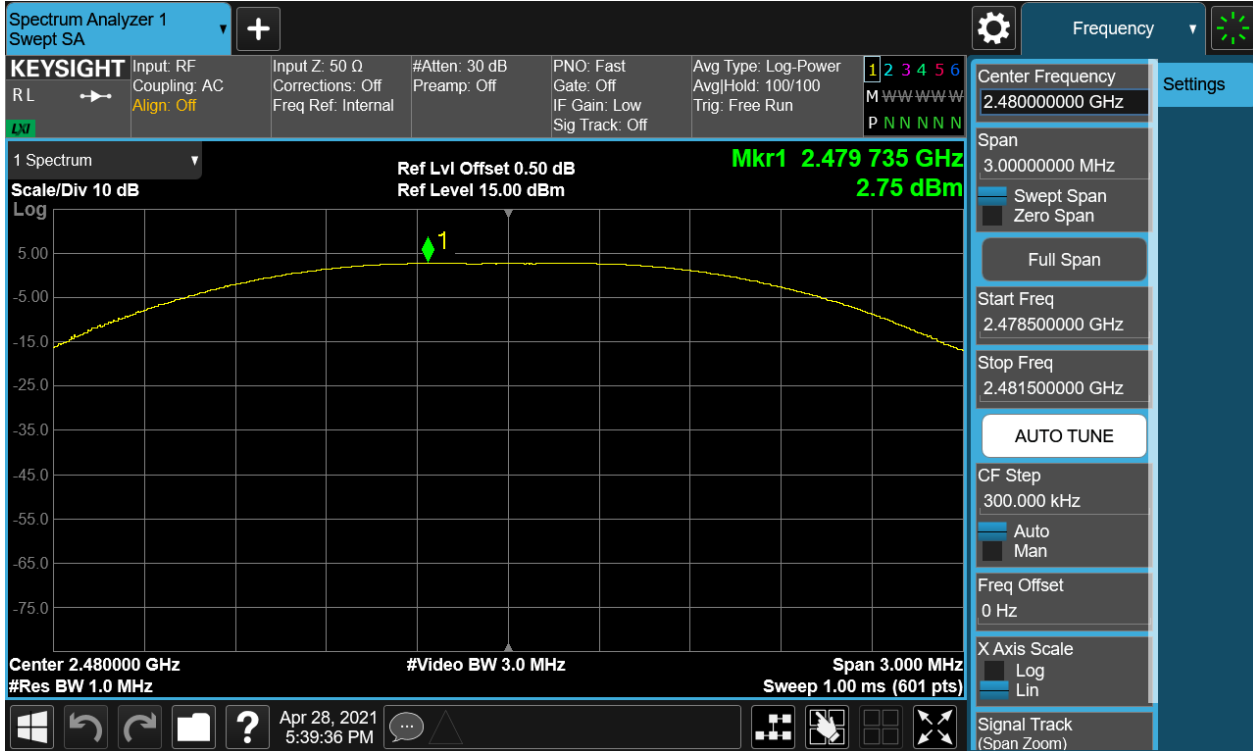
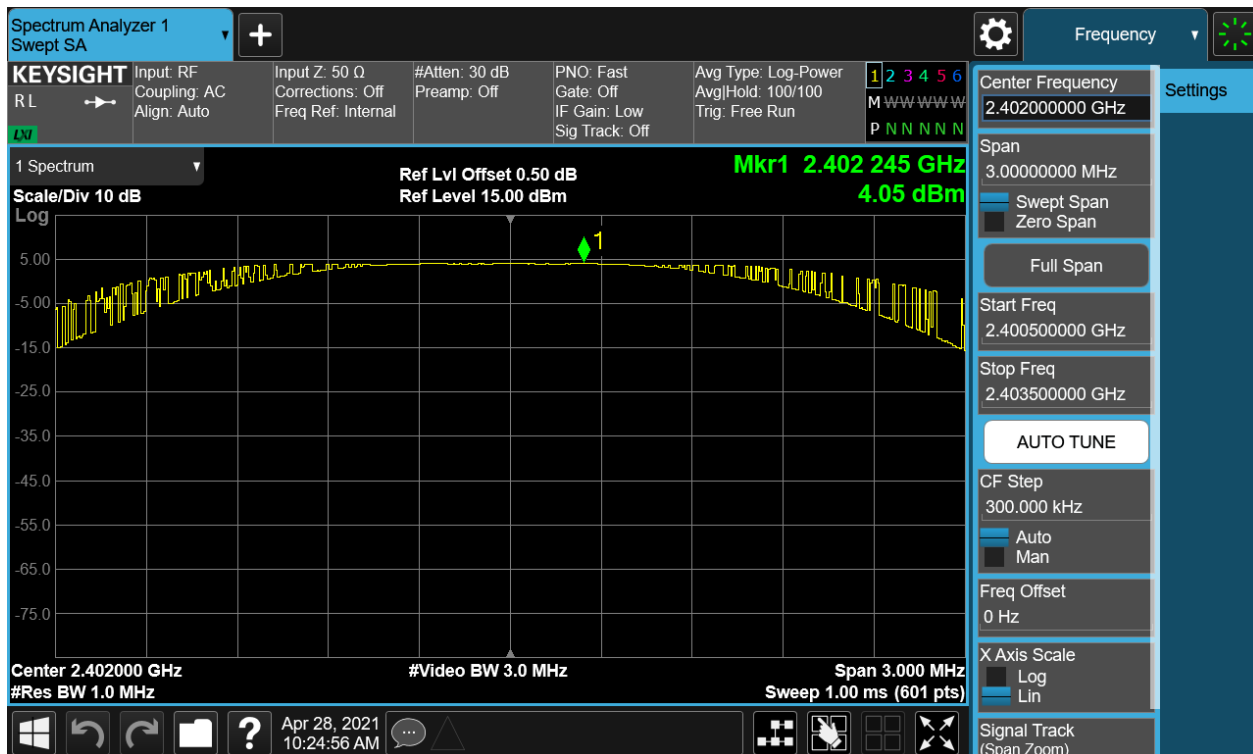


Figure 2: External Module-Peak Output Power, 2402MHz



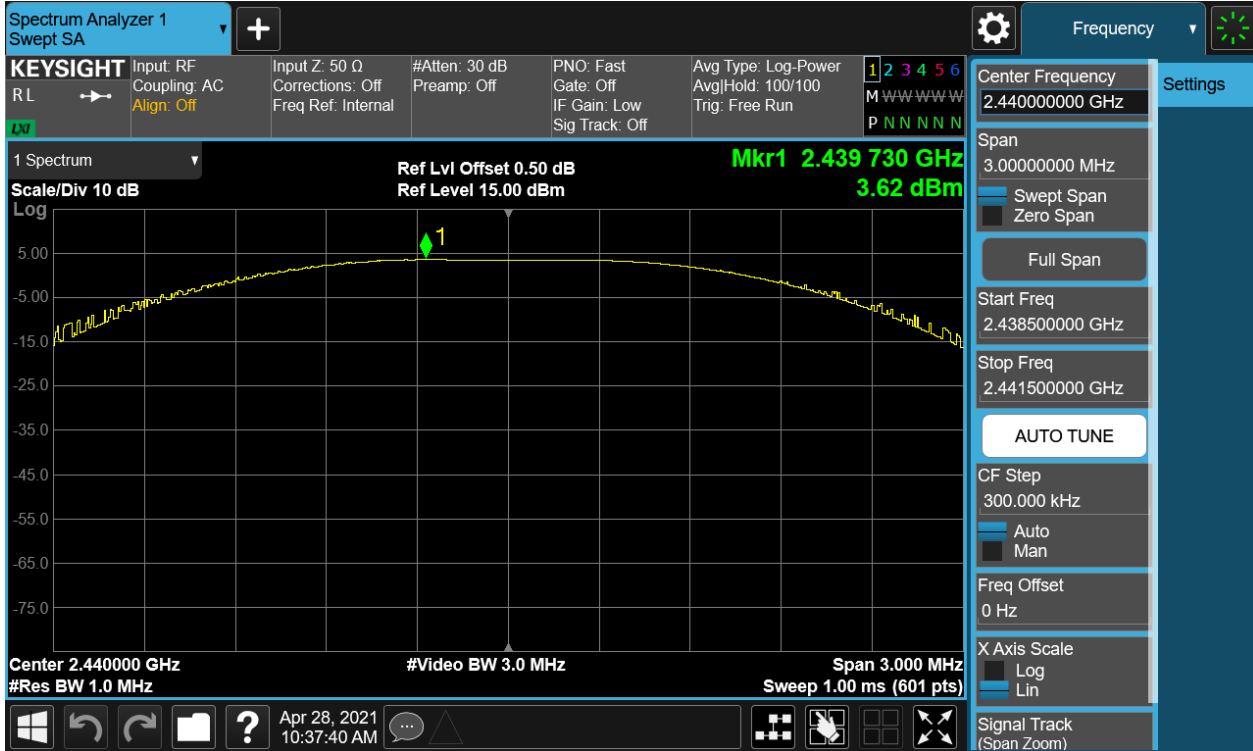
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External Module-Peak Output Power, 2440MHz



External Module-Peak Output Power, 2480MHz



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4.1.3 6dB Bandwidth and 99% Bandwidth

RESULT:

PASS

Test standard : FCC Part 15.247(a)(2)
RSS-247 5.2(1)
RSS-Gen 6.7
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High
Operation Mode : A.1.a
Ambient temperature : 23°C
Relative humidity : 52%

Internal Module (Contain Table 5 and Figure 3)

Table 5: 6dB Bandwidth and 99% Bandwidth

Test Mode	Test Channel (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)	6dB Bandwidth Limit
BLE	2402	0.6530	1.0353	≥0.5 MHz
	2440	0.6862	1.0255	
	2480	0.6627	1.0367	

External Module (Contain Table 6 and Figure 4)

Table 6: 6dB Bandwidth and 99% Bandwidth

Test Mode	Test Channel (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)	6dB Bandwidth Limit
BLE	2402	0.6569	1.2081	≥0.5 MHz
	2440	0.6566	1.0094	
	2480	0.6416	1.0192	

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Figure 3: Internal Module-6dB Bandwidth and 99% Bandwidth, 2402MHz



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Internal Module-6dB Bandwidth and 99% Bandwidth, 2440MHz



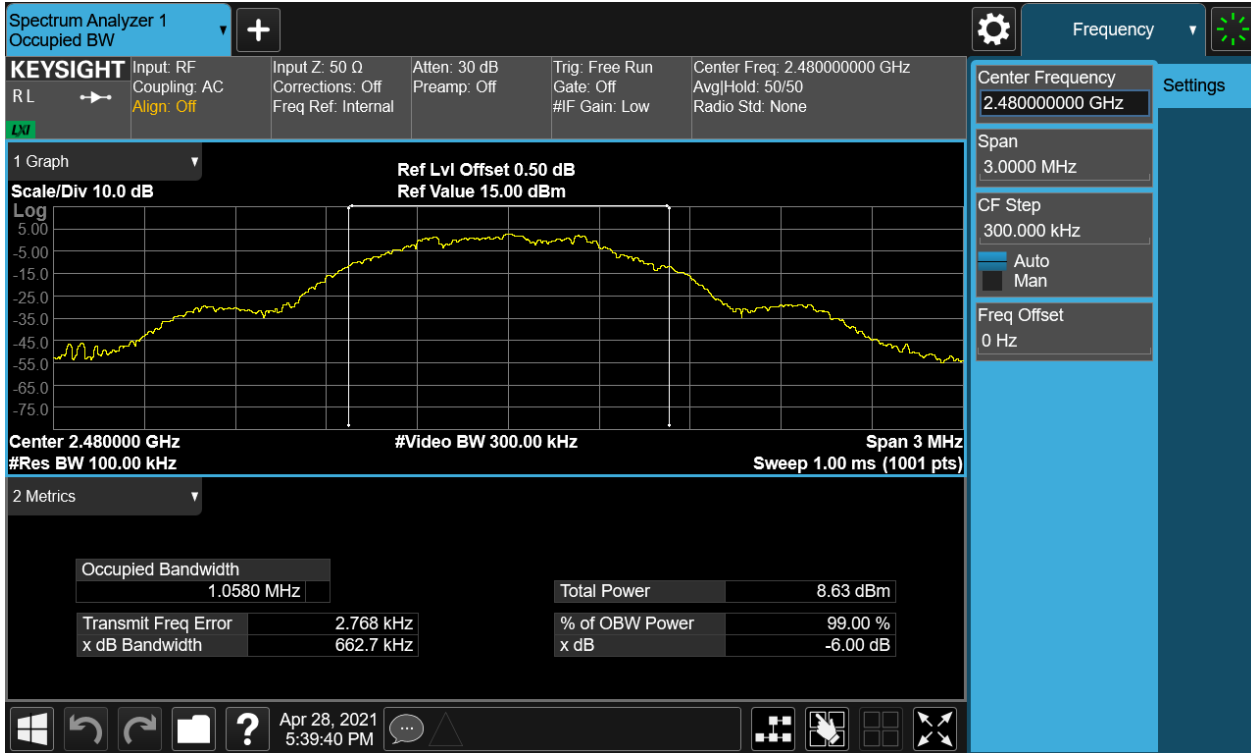
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Internal Module-6dB Bandwidth and 99% Bandwidth, 2480MHz



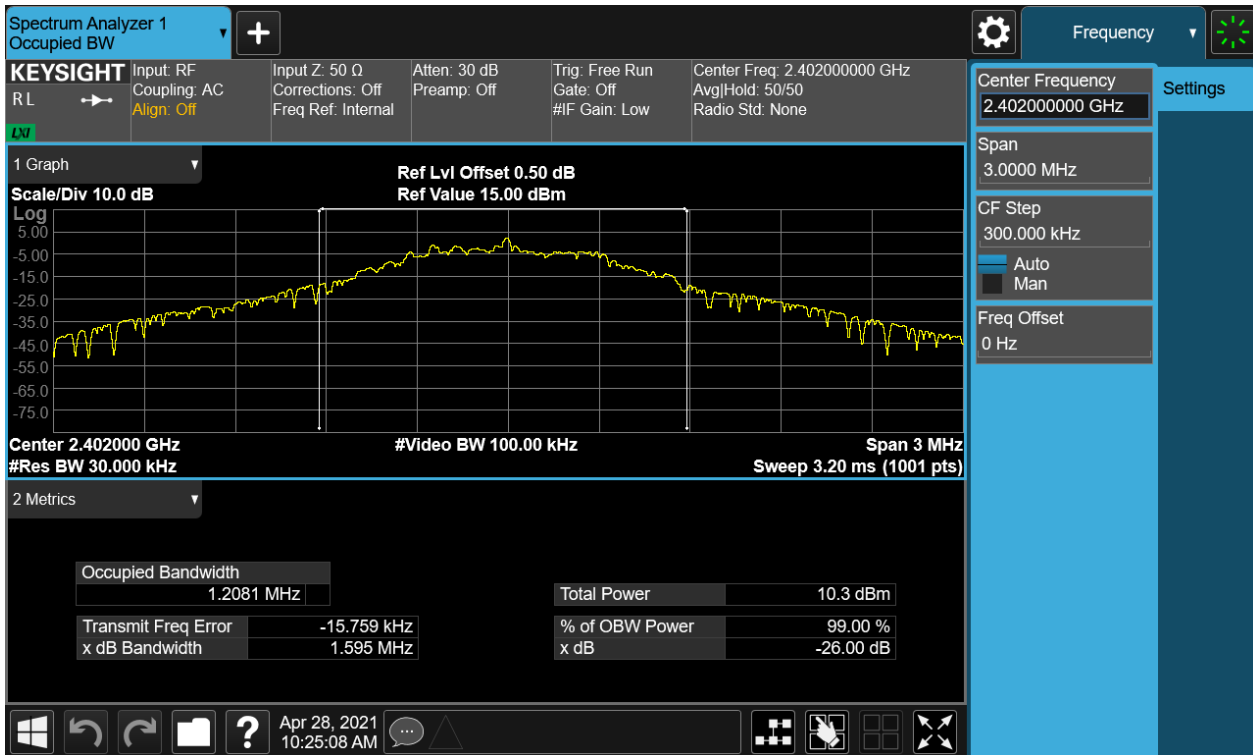
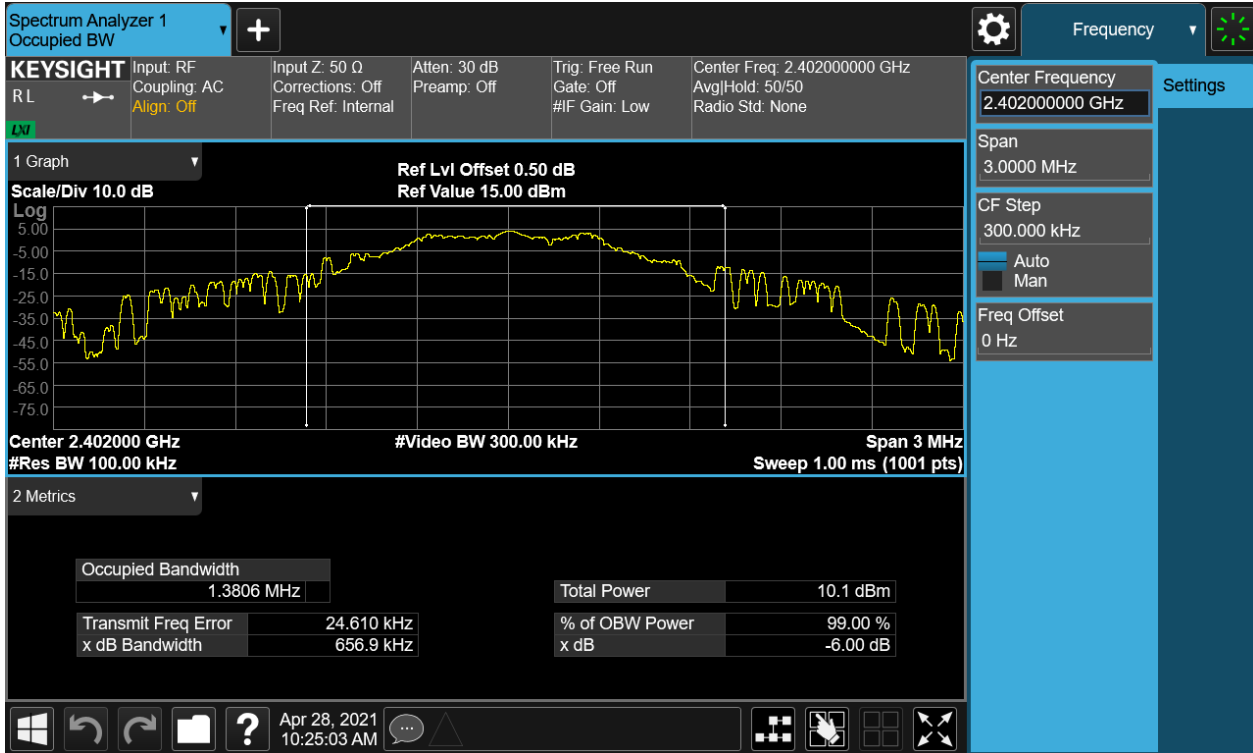
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Figure 4: External Module-6dB Bandwidth and 99% Bandwidth, 2402MHz



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External Module -6dB Bandwidth and 99% Bandwidth, 2440MHz



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External Module-6dB Bandwidth and 99% Bandwidth, 2480MHz



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4.1.4 Power Spectral Density

RESULT:

PASS

Test standard : FCC Part 15.247(e)
RSS-247 5.2(2)
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High
Operation Mode : A.1.a
Ambient temperature : 23°C
Relative humidity : 52%

Internal Module (Contain Table 7 and Figure 5)

Table 7: Power Spectral Density

Test Mode	Test Channel (MHz)	Measured Result (dBm/3kHz)	Limit (dBm/3kHz)
BLE	2402	-13.73	≤8
	2440	-13.74	
	2480	-13.56	

External Module (Contain Table 8 and Figure 6)

Table 8: Power Spectral Density

Test Mode	Test Channel (MHz)	Measured Result (dBm/3kHz)	Limit (dBm/3kHz)
BLE	2402	-12.02	≤8
	2440	-11.97	
	2480	-14.96	

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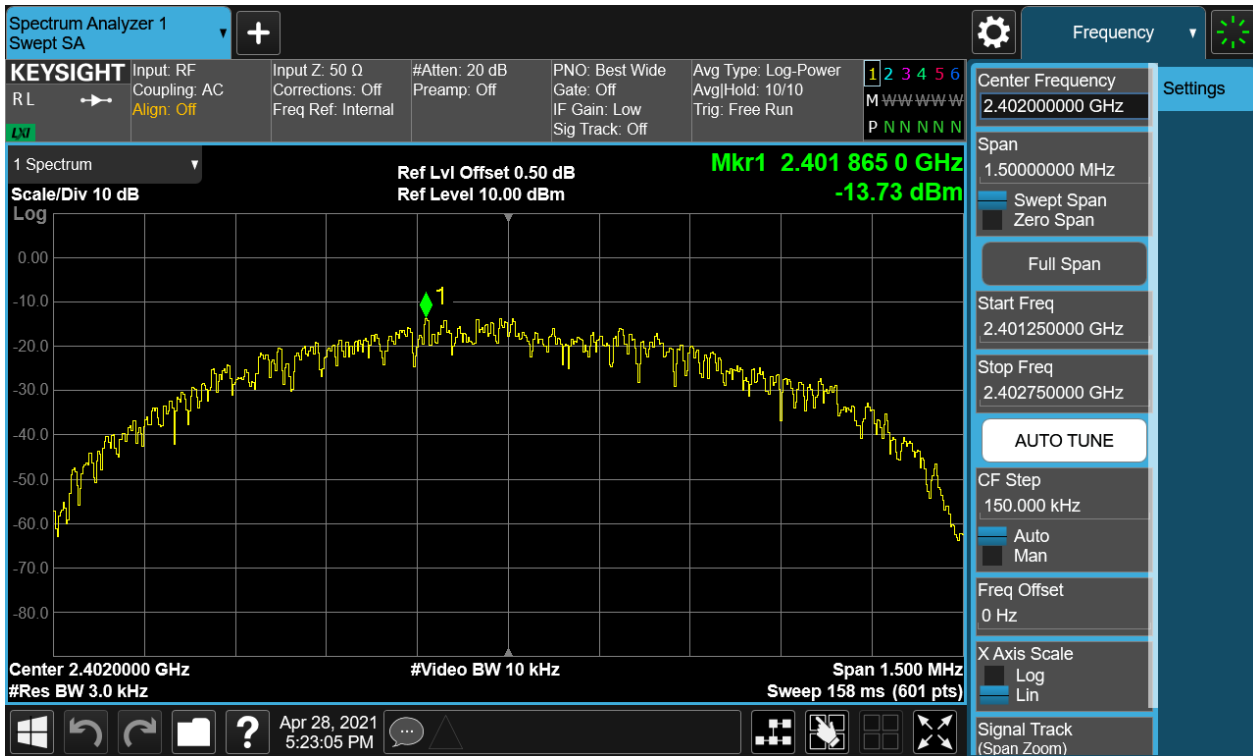
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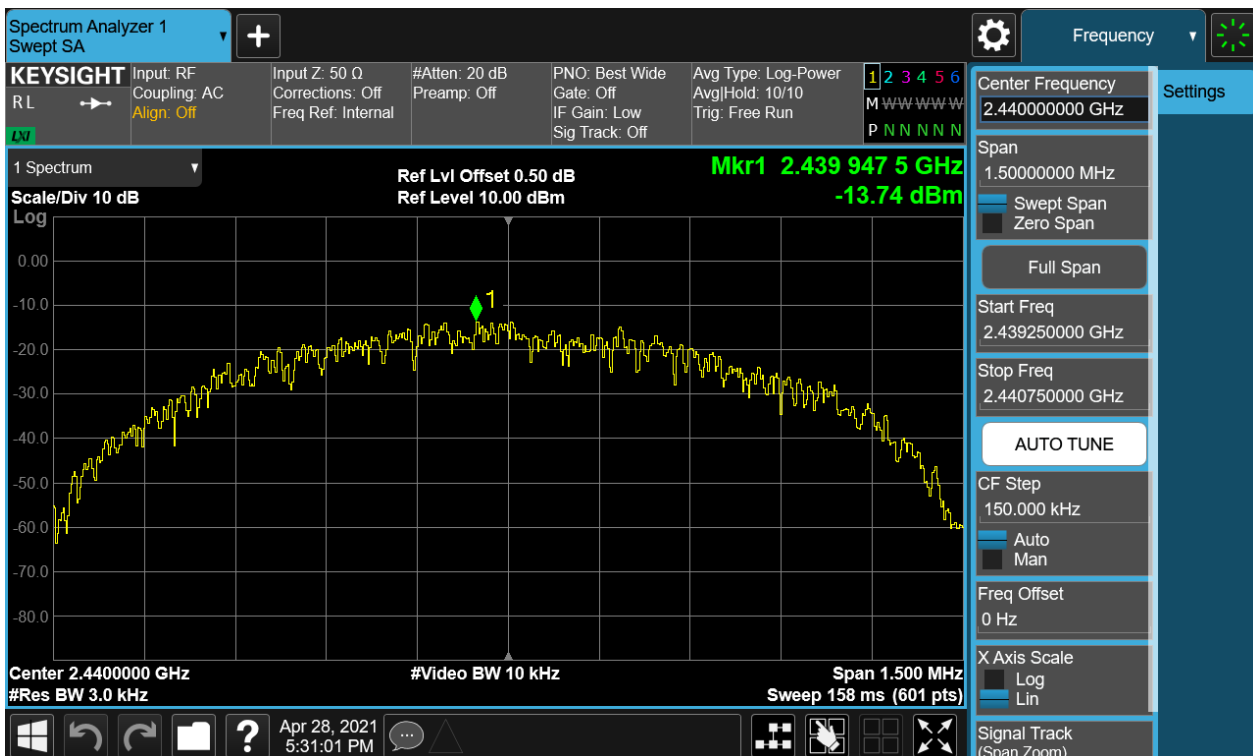
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Figure 5: Internal Module-Power Spectral Density, 2402MHz



Internal Module-Power Spectral Density, 2440MHz



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Internal Module-Power Spectral Density, 2480MHz

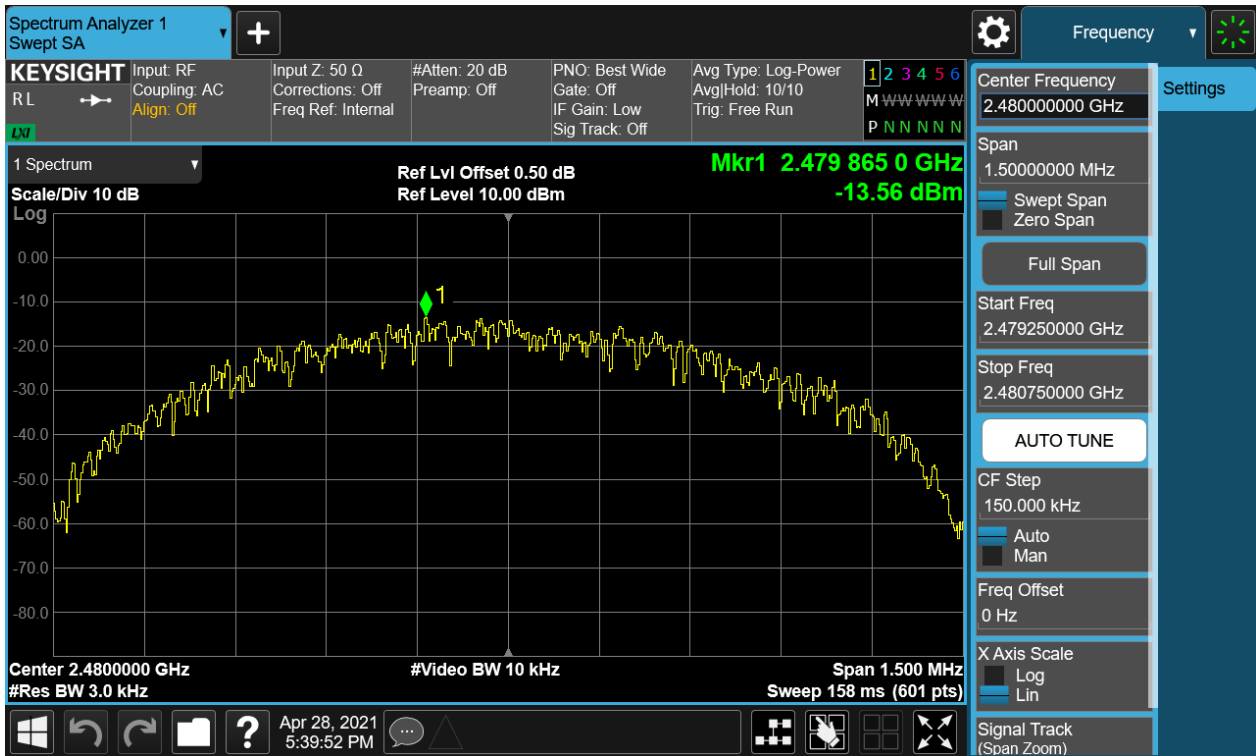
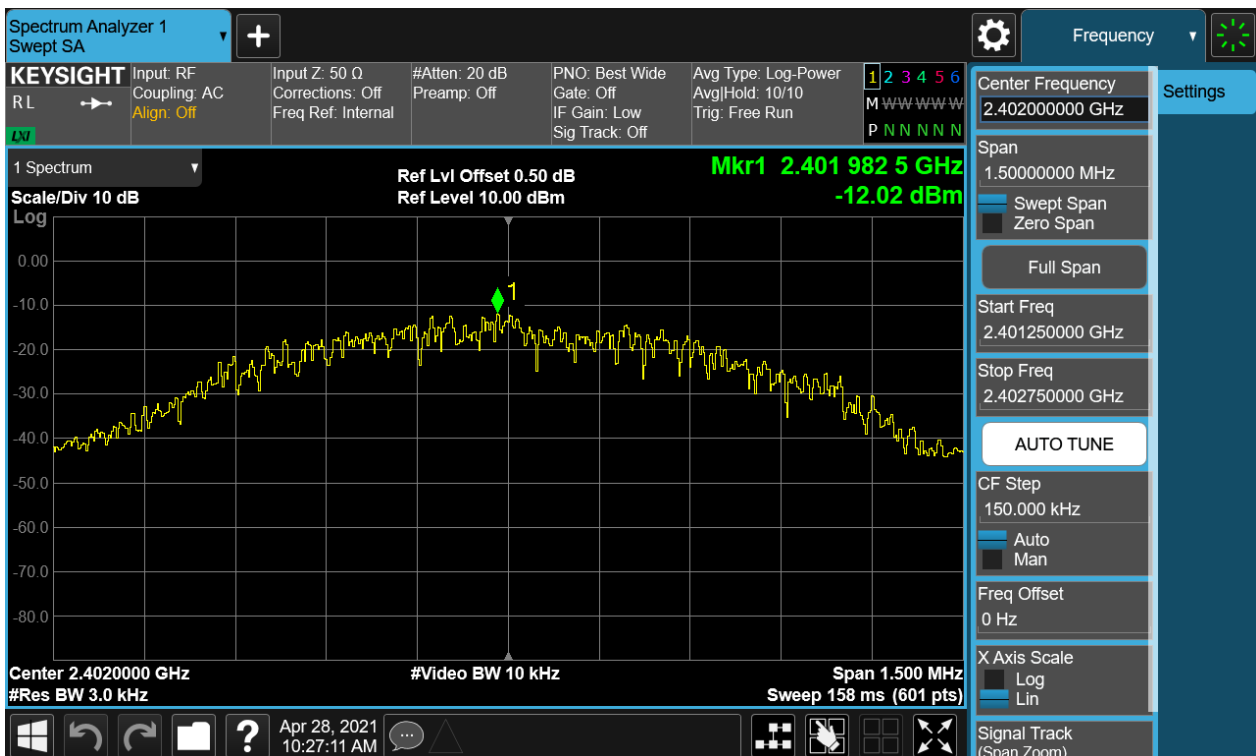


Figure 6: External Module-Power Spectral Density, 2402MHz



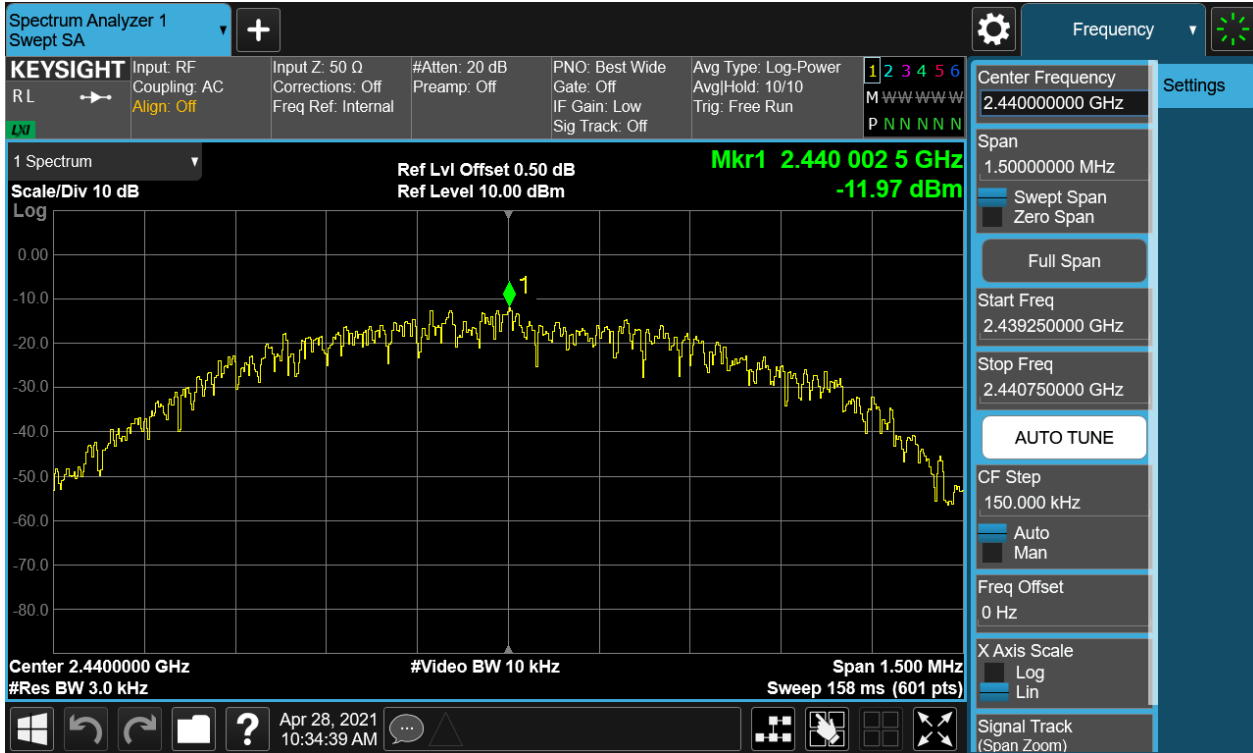
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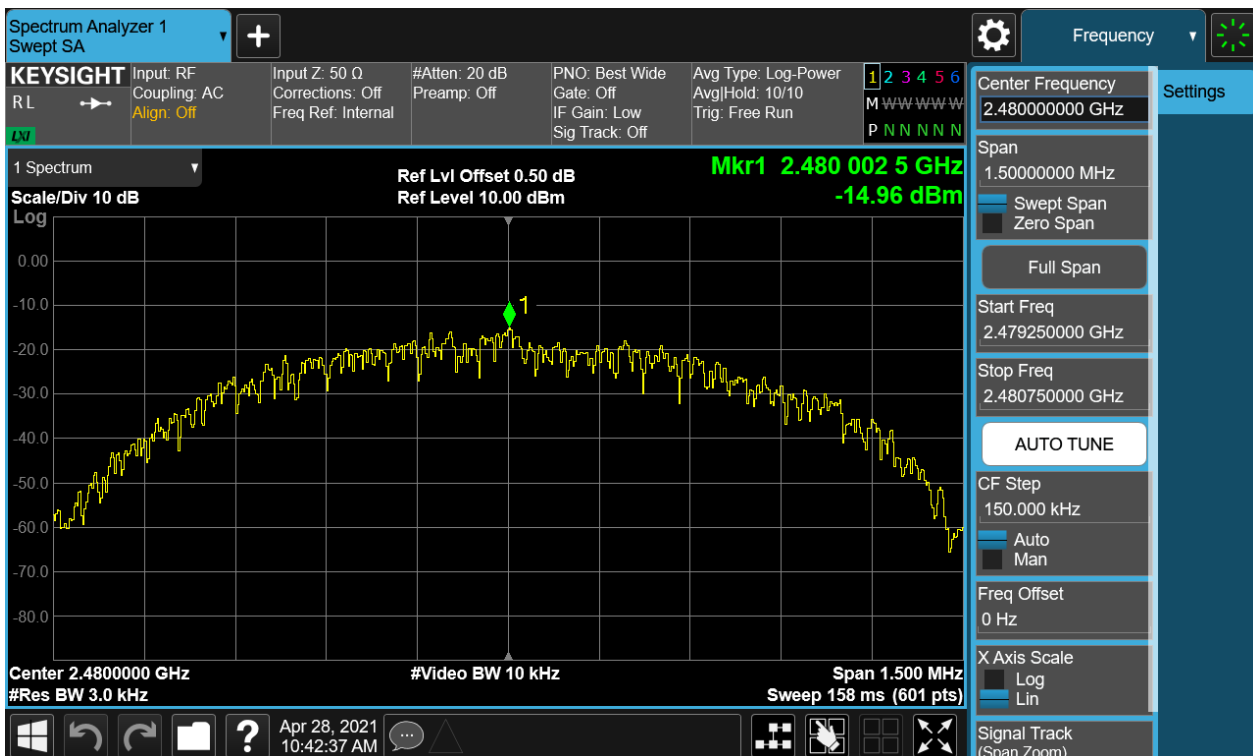
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External Module -Power Spectral Density, 2440MHz



External Module -Power Spectral Density, 2480MHz



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4.1.5 Conducted Spurious Emission & Authorized-band band-edge

RESULT:

PASS

Test standard : FCC Part 15.247(d)
RSS-247 5.5
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : Shielded room

Test setup

Test Channel : Low/Middle/High for spurious, Low/High for Band
Edge
Operation Mode : A.1.a
Ambient temperature : 23°C
Relative humidity : 52%

For details refer to following test plot.

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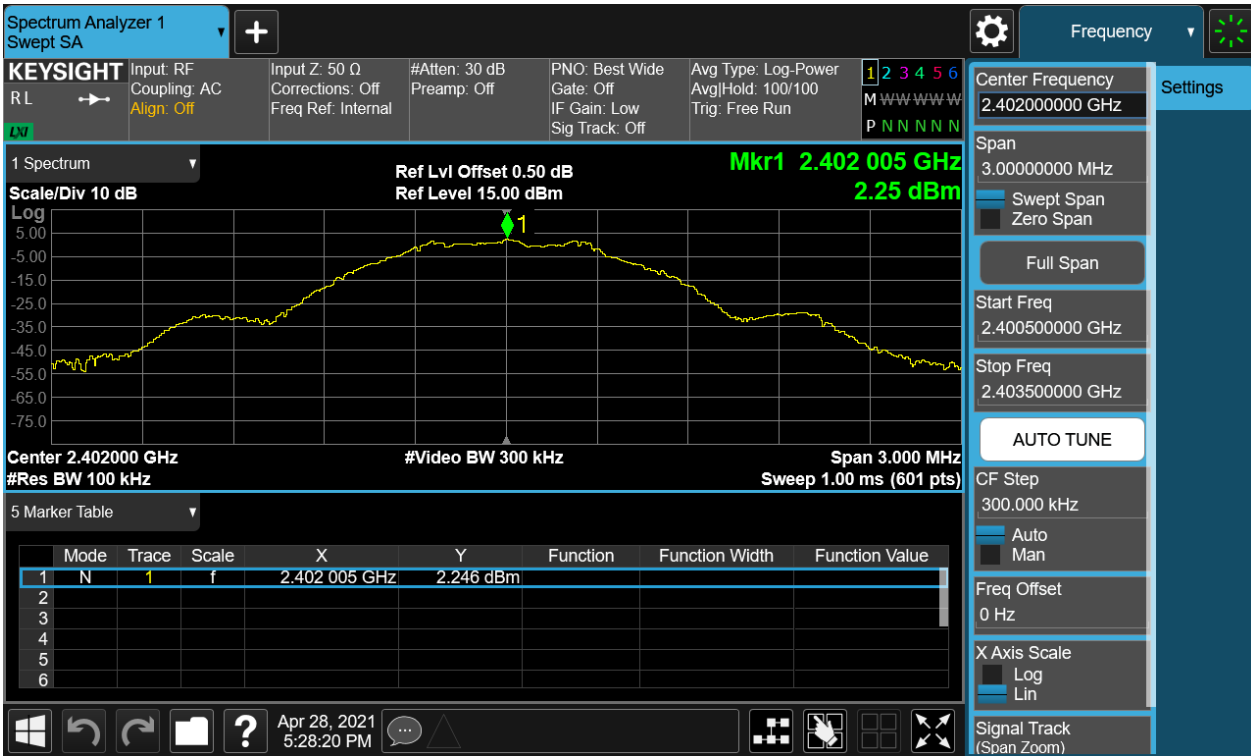
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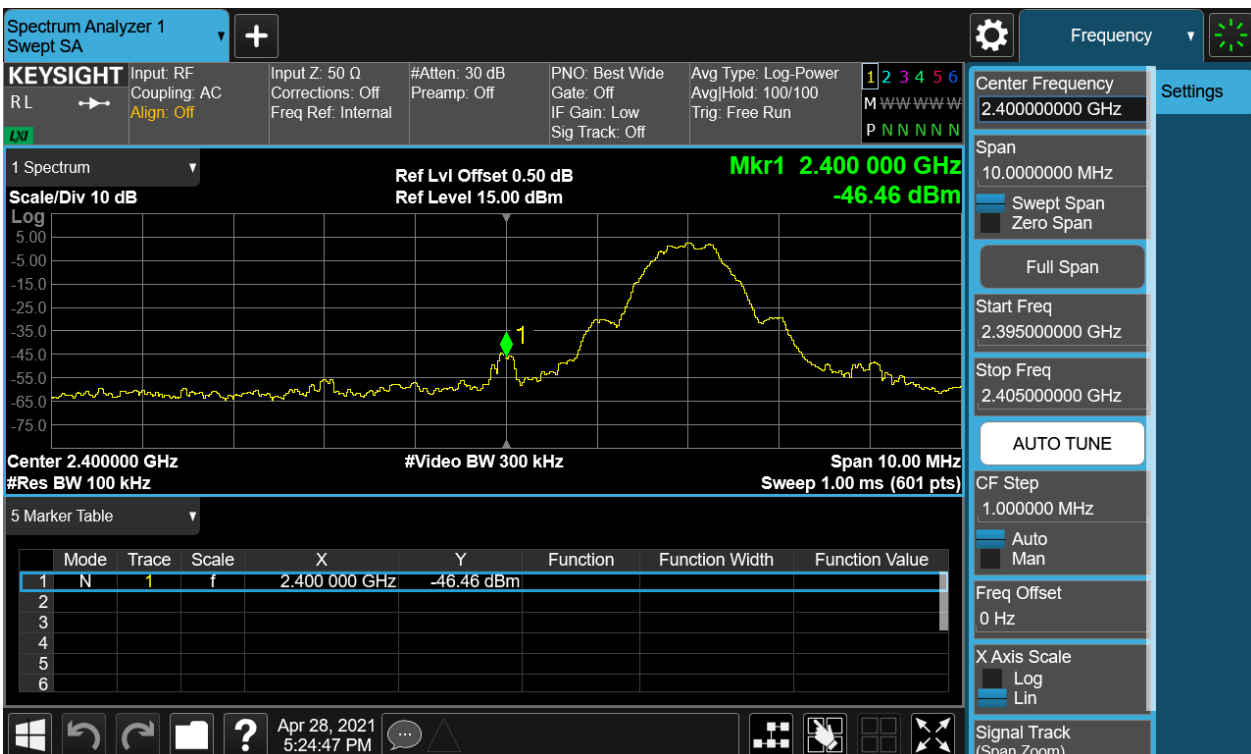
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Figure 7: Internal Module-Conducted Spurious Emission & Authorized-band band-edge, 2402MHz, BLE Carrier Level



Band Edge



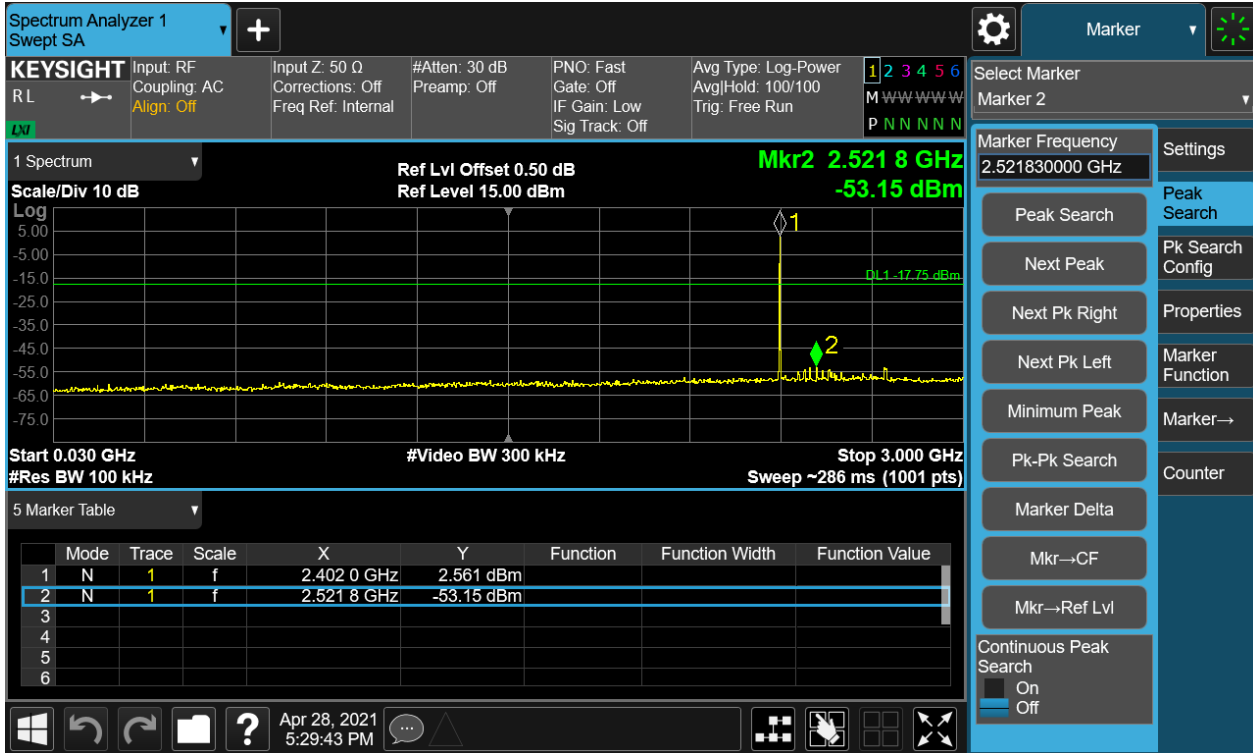
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Conducted spurious emissions 30MHz-25GHz



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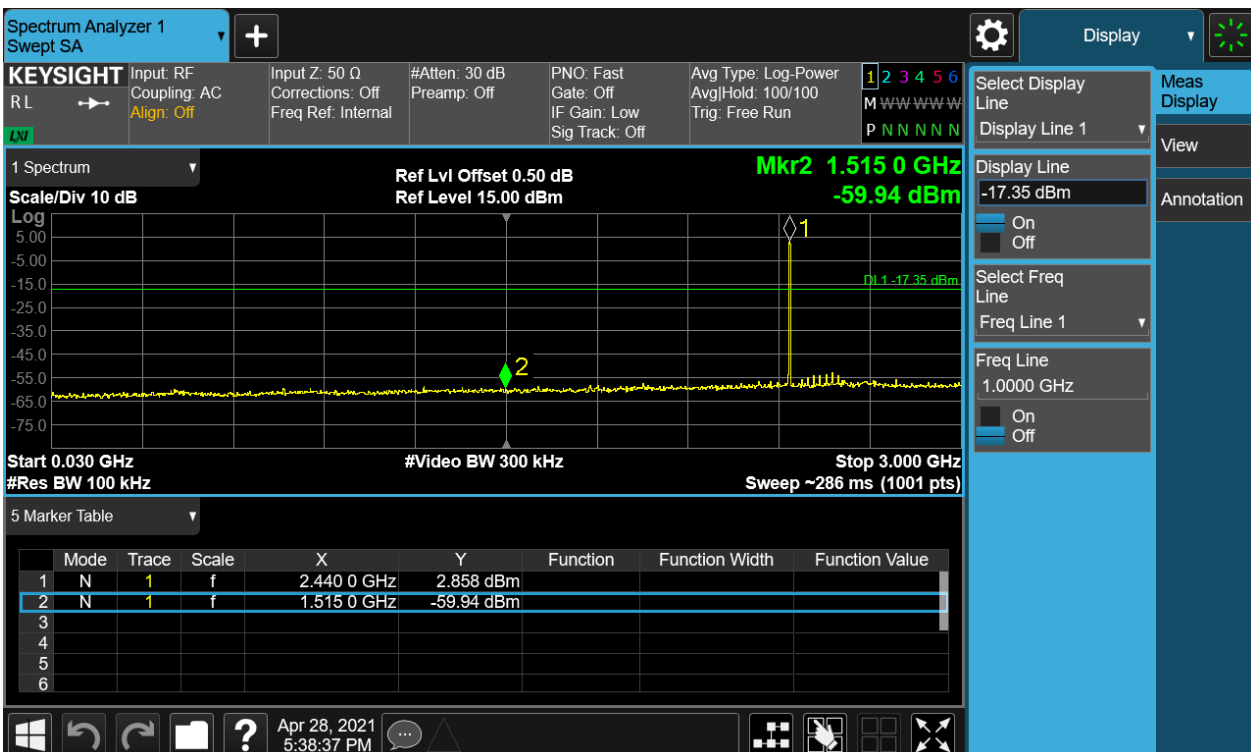
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Figure 8: Internal Module-Conducted Spurious Emission & Authorized-band band-edge, 2440MHz, BLE Carrier Level



Conducted spurious emissions 30MHz-25GHz



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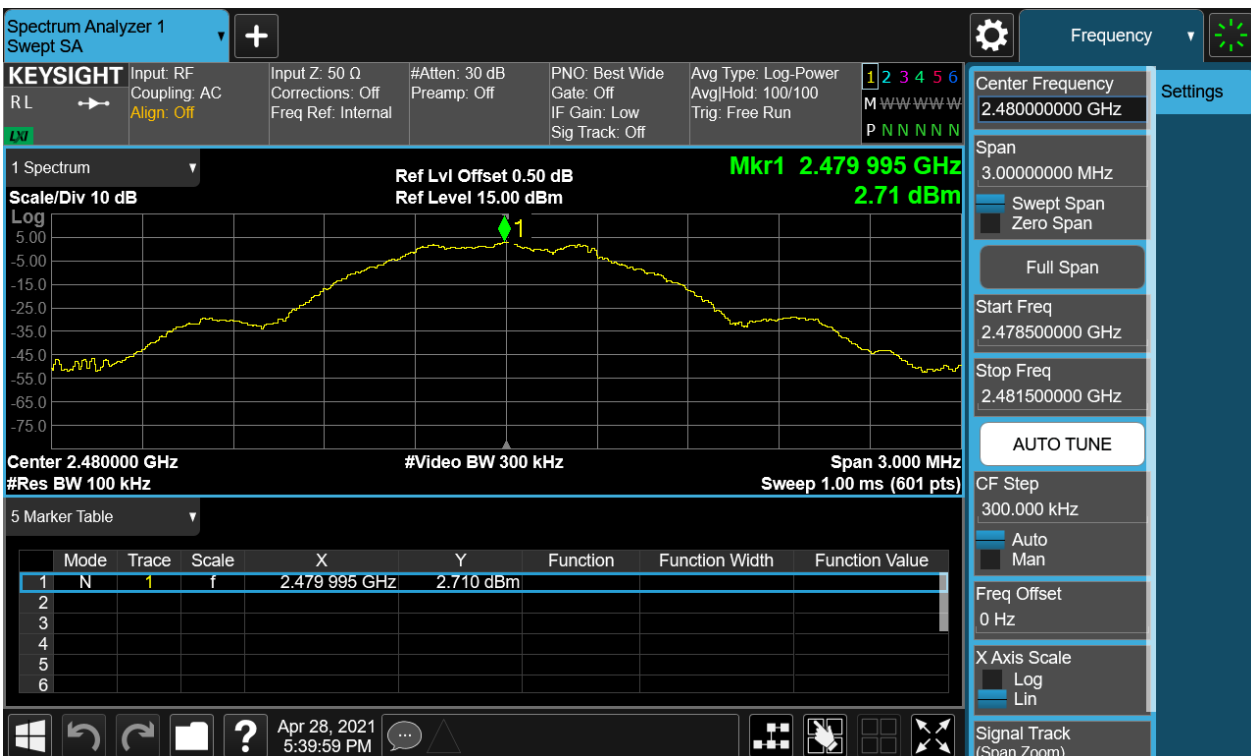
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Figure 9: Internal Module-Conducted Spurious Emission & Authorized-band band-edge, 2480MHz, BLE Carrier Level



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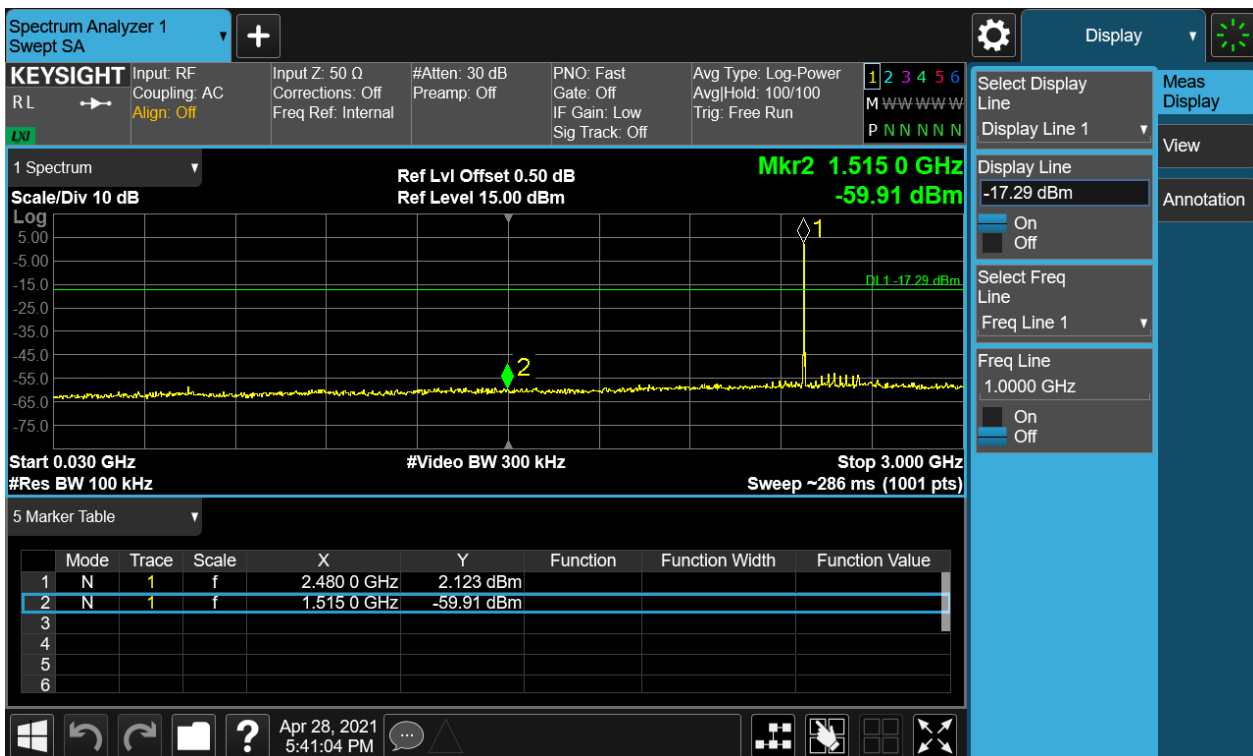
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Band Edge



Conducted spurious emissions 30MHz-25GHz



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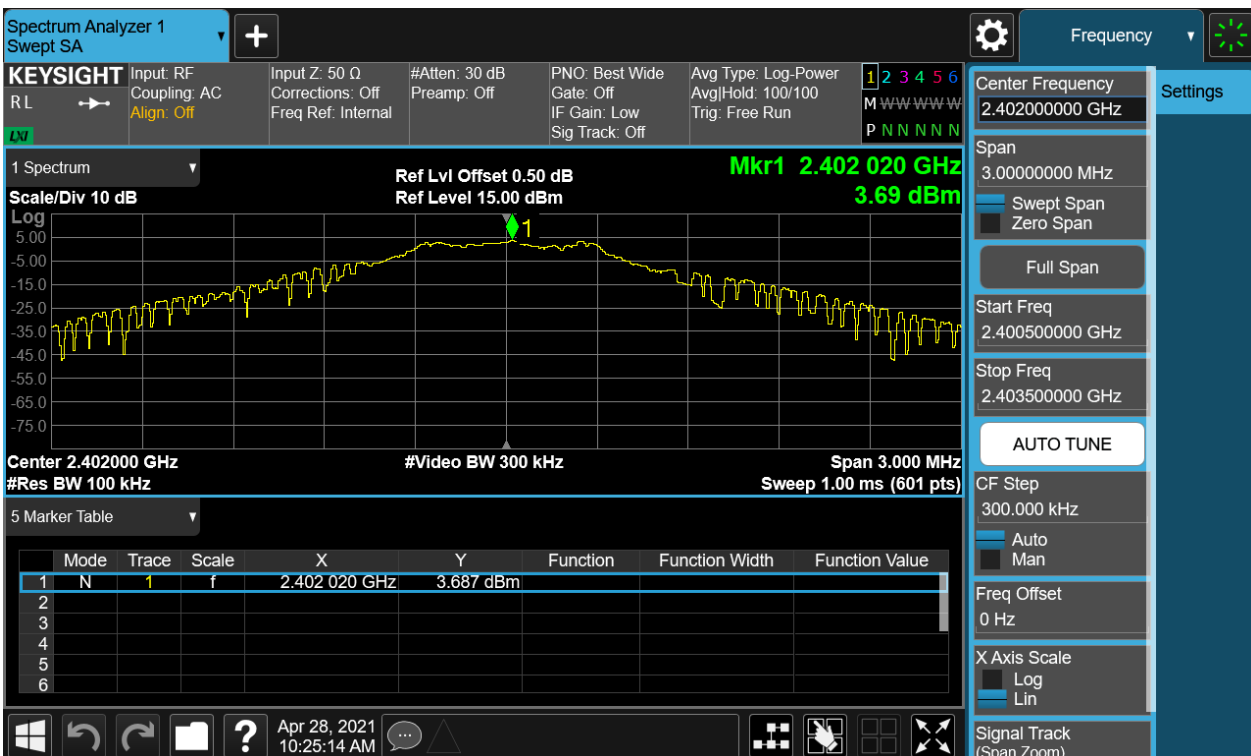
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Figure 10: External Module-Conducted Spurious Emission & Authorized-band band-edge, 2402MHz, BLE Carrier Level



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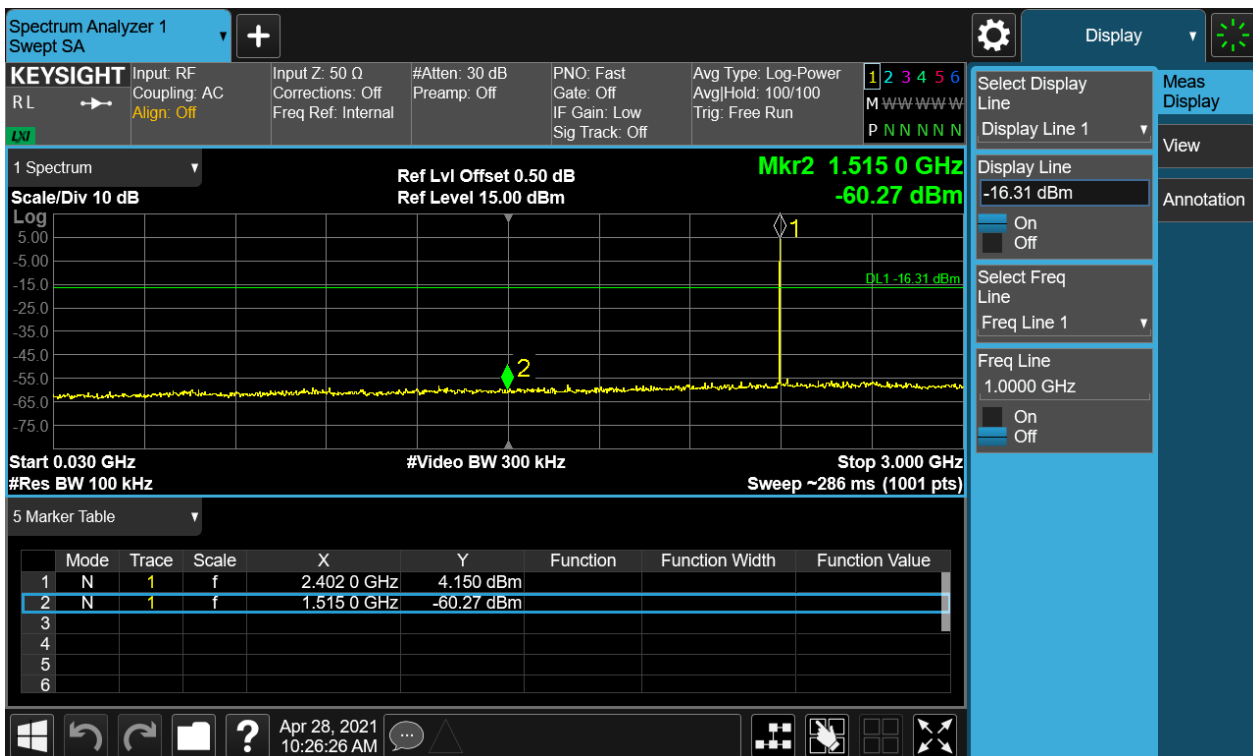
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Band Edge



Conducted spurious emissions 30MHz-25GHz



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Figure 11: External Module-Conducted Spurious Emission & Authorized-band band-edge, 2440MHz, BLE Carrier Level



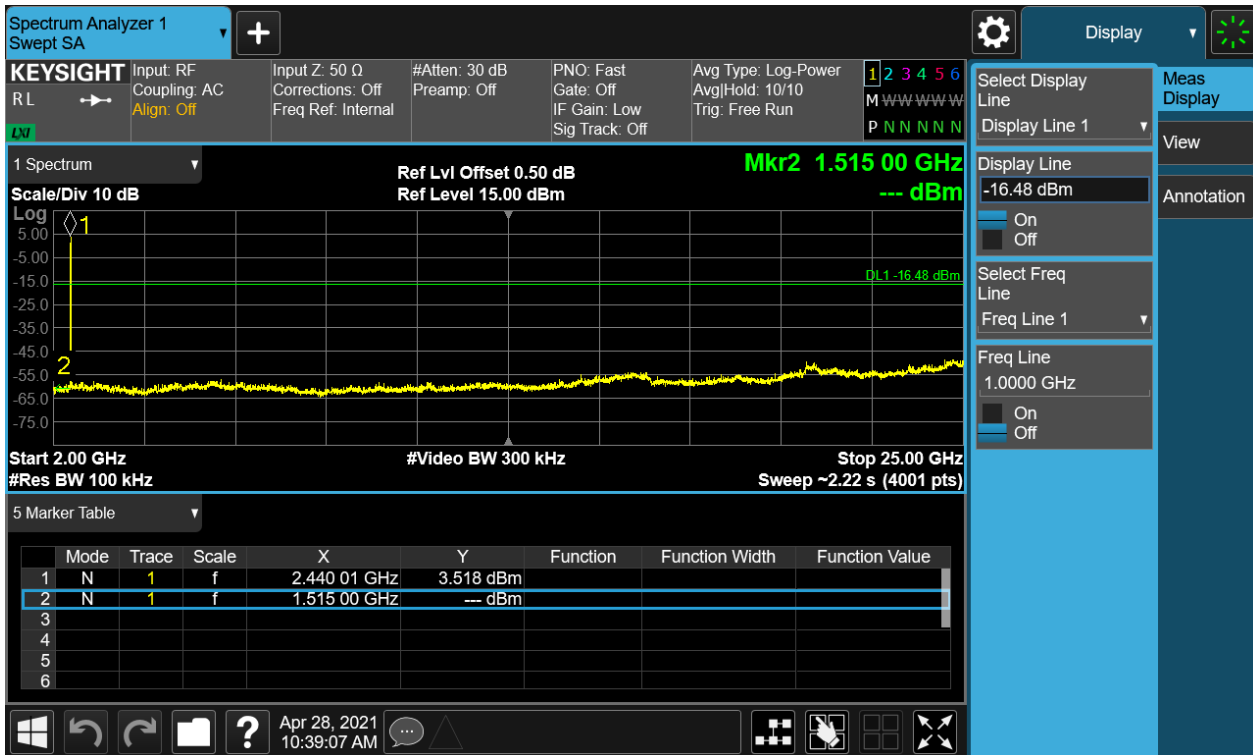
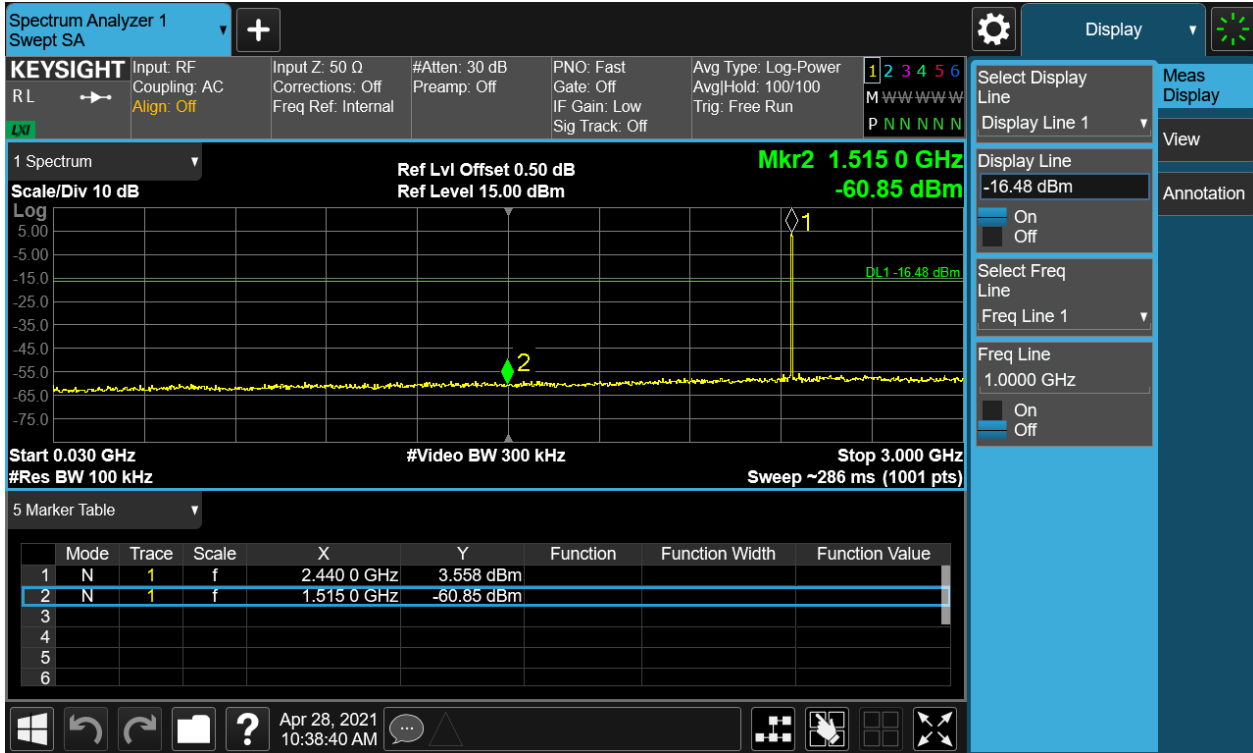
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Conducted spurious emissions 30MHz-25GHz



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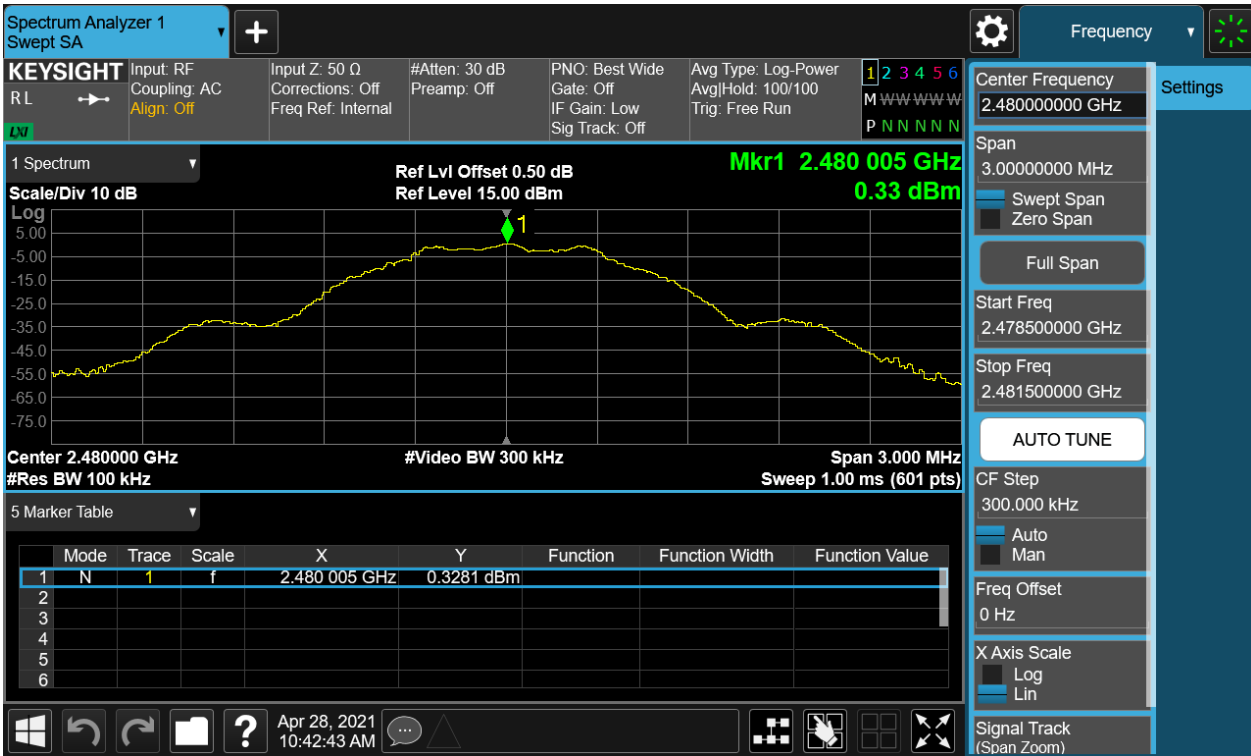
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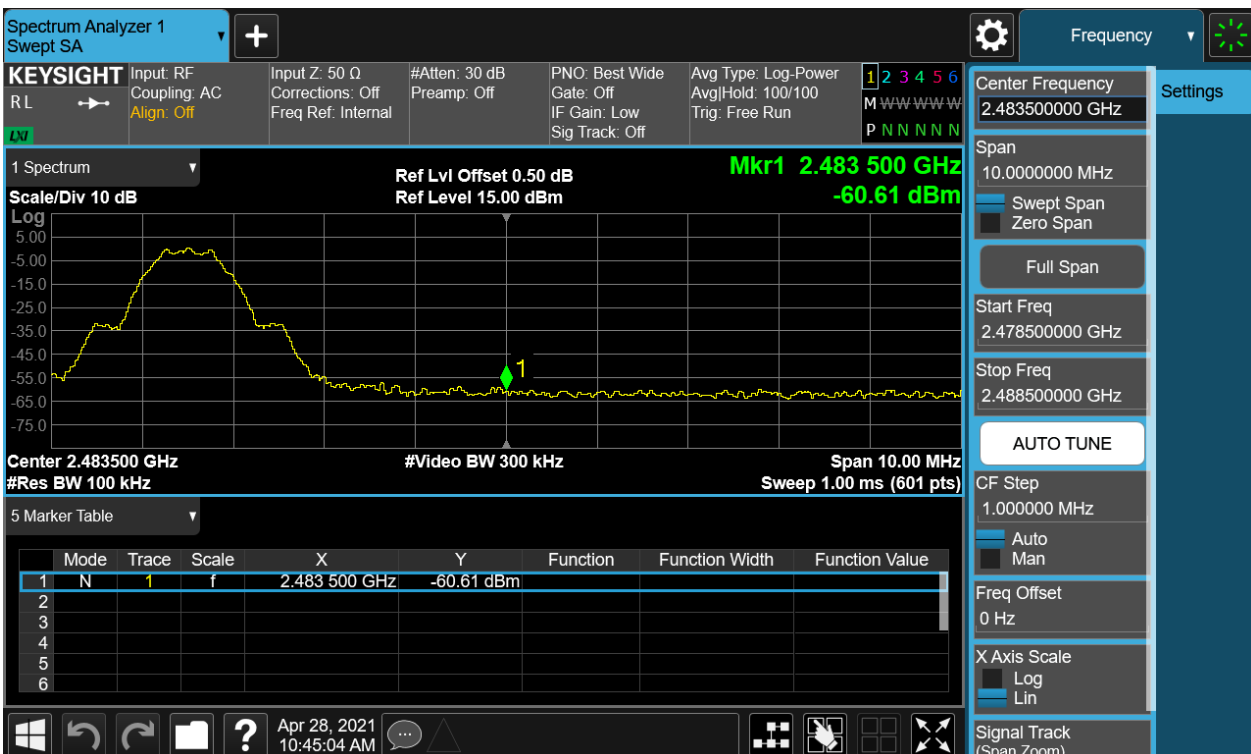
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Figure 12: External Module-Conducted Spurious Emission & Authorized-band band-edge, 2480MHz, BLE Carrier Level



Band Edge



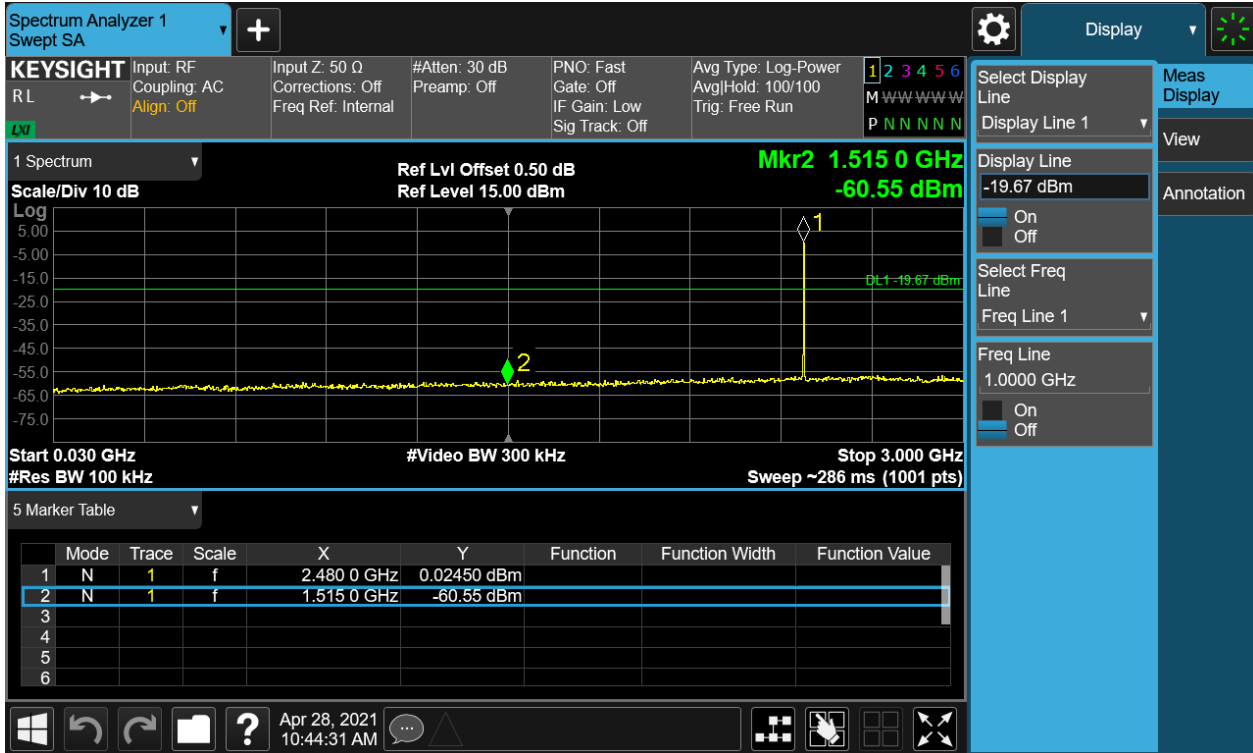
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Conducted spurious emissions 30MHz-25GHz



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4.1.6 Radiated Spurious Emission

RESULT:

PASS

Test standard : FCC Part 15.247(d), 15.205, 15.209
RSS-247 5.5
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : 3m Semi-Anechoic Chamber

Test setup

Test Channel : Low/Middle/High
Operation Mode : A
Ambient temperature : 23°C
Relative humidity : 52%

Notes

Test plots please refer to the annex document "SHE21040013-02FE Internal Module DATA BLE-TX EXHIBIT A and SHE21040013-02FE External Module DATA BLE-TX EXHIBIT B".

1. For 9 kHz ~ 30 MHz, the amplitude of spurious emissions that are attenuated by more than 20dB below the permissible. The value has no need to be reported.
2. The spurious above 18GHz is noise only and 20dB below the limit. The value has no need to be reported.
3. The EUT is working in the Normal link mode below 1 GHz.
4. The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement -X, Y, and Z-plane. The X-plane results were found as the worst case and were shown in this report.

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4.1.7 Band Edge (Restricted-band band-edge)

RESULT:

PASS

Test standard : FCC Part 15.247(d), 15.205, 15.209
RSS-247 5.5
Requirement : ANSI C63.10-2013, KDB 558074
Kind of test site : 3m Semi-Anechoic Chamber

Test setup

Test Channel : Low/Middle/High
Operation Mode : A.1
Ambient temperature : 23°C
Relative humidity : 52%

Notes

Test plots please refer to the annex document "SHE21040013-02FE Internal Module DATA BLE-TX EXHIBIT A and SHE21040013-02FE External module DATA BLE-TX EXHIBIT B".

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4.2 Mains Emissions

4.2.1 Conducted Emission on AC Mains

RESULT:

PASS

Test standard : FCC Part 15.207(a)
RSS-Gen 8.8
Requirement : ANSI C63.10-2013
Kind of test site : Shielded room

Test setup

Input Voltage : AC 120V, 60Hz
Operation Mode : A.2
Earthing : Not Connected
Ambient temperature : 23°C
Relative humidity : 52%

For details refer to following test plot.

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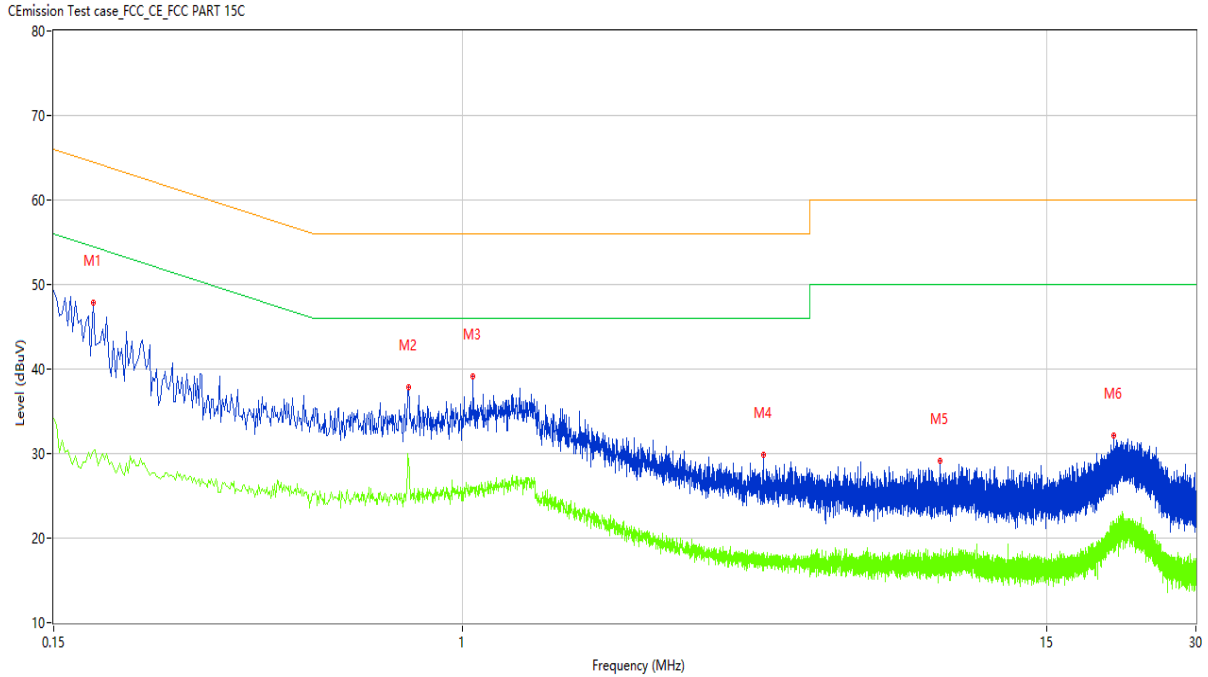
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Note: The all configurations were tested respectively, but only the worst configuration shown here.

Figure 13: Conducted Emission on AC Mains, L Phase



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.180	48.58	9.66	64.49	-15.91	Peak	L	Pass
1*	0.180	40.05	9.66	64.49	-24.44	QP	L	Pass
1**	0.180	30.32	9.66	54.49	-24.17	AV	L	Pass
2	0.778	31.97	9.75	56.00	-24.03	Peak	L	Pass
2*	0.778	25.58	9.75	56.00	-30.42	QP	L	Pass
2**	0.778	29.03	9.75	46.00	-16.97	AV	L	Pass
3	1.050	29.90	9.66	56.00	-26.10	Peak	L	Pass
3*	1.050	22.04	9.66	56.00	-33.96	QP	L	Pass
3**	1.050	25.87	9.66	46.00	-20.13	AV	L	Pass
4	4.040	21.55	9.68	56.00	-34.45	Peak	L	Pass
4*	4.040	14.49	9.68	56.00	-41.51	QP	L	Pass
4**	4.040	18.33	9.68	46.00	-27.67	AV	L	Pass
5	9.154	21.53	9.66	60.00	-38.47	Peak	L	Pass
5*	9.154	14.96	9.66	60.00	-45.04	QP	L	Pass
5**	9.154	17.24	9.66	50.00	-32.76	AV	L	Pass
6	20.514	29.61	9.43	60.00	-30.39	Peak	L	Pass
6*	20.514	24.49	9.43	60.00	-35.51	QP	L	Pass
6**	20.514	21.57	9.43	50.00	-28.43	AV	L	Pass

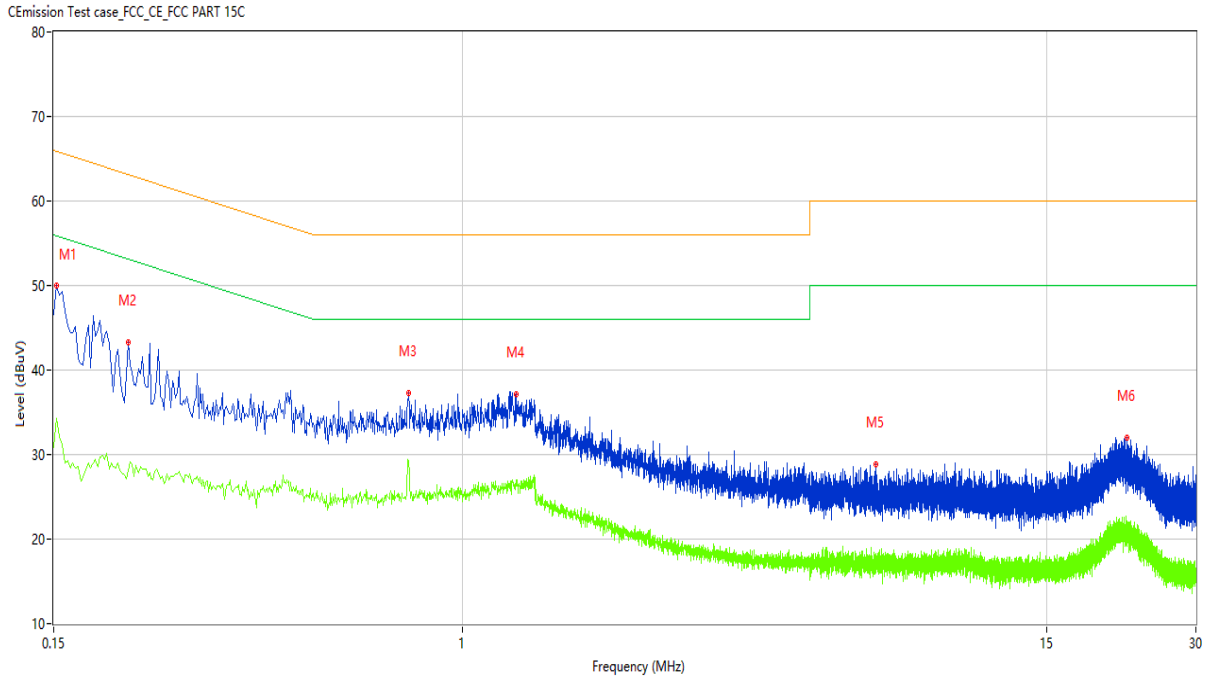
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Figure 14: Conducted Emission on AC Mains, N Phase



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.150	52.59	9.67	66.00	-13.41	Peak	N	Pass
1*	0.150	45.59	9.67	66.00	-20.41	QP	N	Pass
1**	0.150	30.83	9.67	56.00	-25.17	AV	N	Pass
2	0.212	44.38	9.67	63.13	-18.75	Peak	N	Pass
2*	0.212	34.67	9.67	63.13	-28.46	QP	N	Pass
2**	0.212	28.16	9.67	53.13	-24.97	AV	N	Pass
3	0.778	32.93	9.75	56.00	-23.07	Peak	N	Pass
3*	0.778	25.78	9.75	56.00	-30.22	QP	N	Pass
3**	0.778	29.27	9.75	46.00	-16.73	AV	N	Pass
4	1.284	29.95	9.67	56.00	-26.05	Peak	N	Pass
4*	1.284	22.51	9.67	56.00	-33.49	QP	N	Pass
4**	1.284	27.05	9.67	46.00	-18.95	AV	N	Pass
5	6.814	22.19	9.68	60.00	-37.81	Peak	N	Pass
5*	6.814	15.28	9.68	60.00	-44.72	QP	N	Pass
5**	6.814	17.60	9.68	50.00	-32.40	AV	N	Pass
6	21.746	29.40	9.44	60.00	-30.60	Peak	N	Pass
6*	21.746	24.60	9.44	60.00	-35.40	QP	N	Pass
6**	21.746	19.89	9.44	50.00	-30.11	AV	N	Pass

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5 Appendixes

5.1 Photographs of the Sample



Front of the sample



Rear of the sample

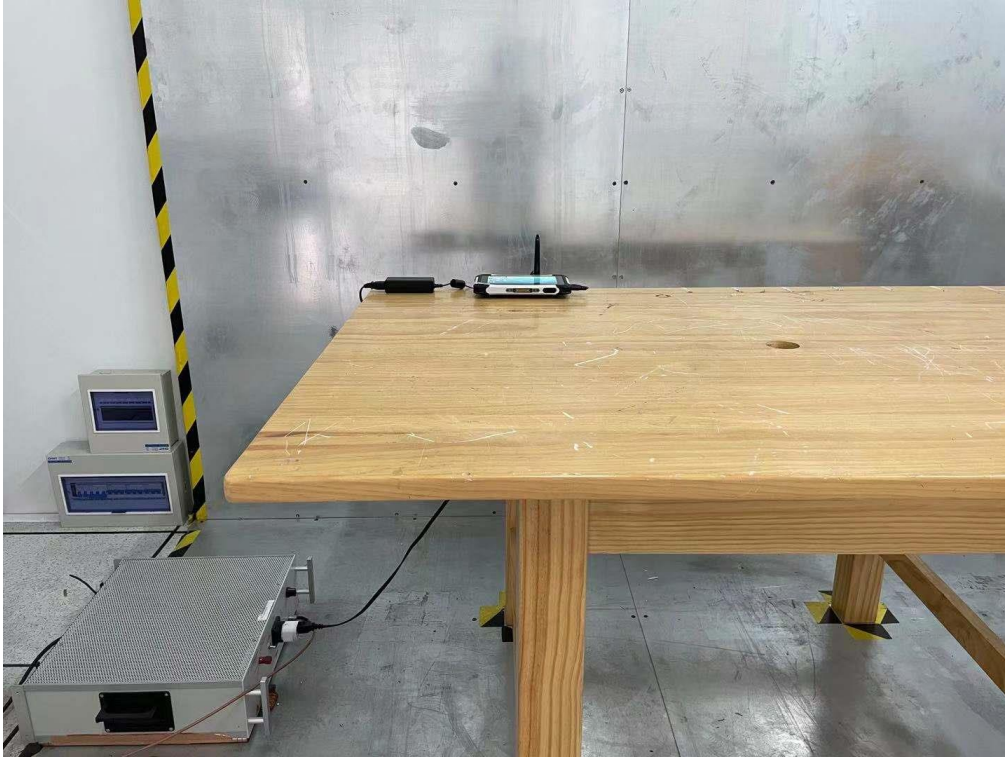
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5.2 Set-up for Conducted Emissions



5.3 Set-up for Conducted RF test at Antenna Port



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5.4 Set-up for Spurious Emissions below 1GHz



5.5 Set-up for Spurious Emissions above 1GHz



End of the report