FCC/IC - TEST REPORT

Report Number	:	**709502306120-00A**	Date of Issue:	March 12, 2024

Model	:	AccuFab-CEL
Product Type	:	3D Printer
Applicant	:	SHINING 3D Tech. Co., Ltd.
Address	:	No.1398, Xiangbin Road, Wenyan, Xiaoshan, Hangzhou, Zhejiang, China
Production Facility	:	SHINING 3D Tech. Co., Ltd.
Address	:	No.1398, Xiangbin Road, Wenyan, Xiaoshan, Hangzhou, Zhejiang, China

Test Result	:	■ **Positive** ☐ **Negative**
Total pages including Appendices	:	85

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2 Details about the Test Laboratory

Details about the Test Laboratory
Test Site 1

Company name:	TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch No.16 Lane, 1951 Du Hui Road, Shanghai 201108, P.R. China
Telephone:	+86 21 6141 0123
Fax:	+86 21 6140 8600
FCC Registration No.:	820234
FCC Designation Number:	CN1183
ISED CAB identifier	CN0101
IC Registration No.:	31668

3 Description of the Equipment under Test

Product:	3D Printer
Model no.:	AccuFab-CEL
Hardware Version Identification No. (HVIN)	AccuFab-CEL
Product Marketing Name (PMN)	AccuFab-CEL
FCC ID:	2AMG4-CEL
IC:	24652-CEL
Options and accessories:	NA
Rating:	AC 110-240V, 50/60Hz
RF Transmission Frequency:	For NFC: 13.56 MHz For 2.4G Wi-Fi: For 802.11b/g/n-HT20: 2412~2462 MHz

For 5G Wi-Fi:

Band (GHz)	Operating Channel Number	Channel center frequencies for 20MHz bandwidth (MHz)
5.15GHz~5.25GHz	36	5180
	40	5200
	44	5220
	48	5240
5.25GHz~5.35GHz	52	5260
	56	5280
	60	5300
	64	5320
5.5GHz~5.7GHz	100	5500
	104	5520
	108	5540
	112	5560
	116	5580
	132	5660
	136	5680
	140	5700
5.725GHz~5.825GHz	149	5745
	153	5765
	157	5785
	161	5805
	165	5825

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Band (GHz)	Operating Channel Number	Channel center frequencies for 40MHz bandwidth (MHz)
5.15GHz~5.25GHz	38	5190
	46	5230
5.25GHz~5.35GHz	54	5270
	62	5310
5.5GHz~5.7GHz	102	5510
	110	5550
	118	5590
	134	5670
5.725GHz~5.825GHz	151	5755
	159	5795

Band (GHz)	Operating Channel Number	Channel center frequencies for 80MHz bandwidth (MHz)
5.15GHz~5.25GHz	42	5210
5.25GHz~5.35GHz	58	5290
5.5GHz~5.7GHz	106	5530
5.725GHz~5.825GHz	155	5775

The device shall not be capable of transmitting in the 5600-5650 MHz band.

No. of Operated Channel:

For NFC: 13.56 MHz

For 2.4G Wi-Fi:
11 for 802.11b/802.11g/802.11n(H20)

For 5G Wi-Fi:
5180~5240 MHz (U-NII-1)
5260~5320 MHz (U-NII-2A)
5500~5700 MHz (U-NII-2C)
5745~5825 MHz (U-NII-3)

Modulation:

For NFC: ASK

For 2.4G Wi-Fi:
SISO: Direct Sequence Spread Spectrum (DSSS) for 802.11b
Orthogonal Frequency Division Multiplexing (OFDM) for 802.11g
MIMO: Orthogonal Frequency Division Multiplexing (OFDM) for 802.11n

For 5G Wi-Fi:
MIMO: Orthogonal Frequency Division Multiplexing (OFDM) for 802.11a/n/ac

Hardware Version:

A040

Software Version:

3.5.30

Data speed:

2.4G Wi-Fi:
SISO:11b 1-11Mbps
11g 6-54Mbps

MIMO: 11n HT20 6.5 ~ 144.4Mbps

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	5G Wi-Fi: MIMO: 11a 6 ~ 54Mbps, 11n HT20 13 ~ 144.4Mbps, 11n HT 40 27 ~ 300Mbps, 11ac VHT20 13 ~ 173.3Mbps, 11ac VHT40 27 ~ 400Mbps, 11ac VHT80 58.5 ~ 866.7Mbps
Antenna Type:	For NFC: PCB loop For 2.4GHz & 5GHz: FPC
Antenna Gain:	For NFC: 2dBi Antenna1: 5.39 dBi for 2.4GWi-Fi, Antenna2: 3.23 dBi for 2.4GWi-Fi Antenna1: 4.3 dBi for 5GWi-Fi, Antenna2: 5.72 dBi for 5GWi-Fi
Directional gain:	For 2.4GHz Wi-Fi output power & power spectral density: 7.39 dBi Directional gain = 10 log[($10^{G1/20}$ + $10^{G2/20}$ + … + $10^{GN/20}$) ^{2} /N_{ANT}] dBi G1 = 5.39 dBi, G2 = 3.23 dBi, N_{ANT} = 2 So Directional gain = 10 log[($10^{G1/20}$ + $10^{G2/20}$ + … + $10^{GN/20}$) ^{2} /N_{ANT}] dBi = 10 log[($10^{5.39/20}$ + $10^{3.23/20}$) ^{2} /2]dBi =7.39 dBi For 5GHz Wi-Fi output power & power spectral density: 8.05 dBi Directional gain = 10 log[($10^{G1/20}$ + $10^{G2/20}$ + … + $10^{GN/20}$) ^{2} /N_{ANT}] dBi G1 = 4.3 dBi, G2 = 5.72 dBi, N_{ANT} = 2 So Directional gain = 10 log[($10^{G1/20}$ + $10^{G2/20}$ + … + $10^{GN/20}$) ^{2} /N_{ANT}] dBi = 10 log[($10^{4.3/20}$ + $10^{5.72/20}$) ^{2} /2]dBi =8.05 dBi The Equipment supports MIMO and does not support beamforming and CDD modulation, and all antennas have the different gain, According to KDB662911 D01 chapter F d) (i) : Directional gain = 10 log[($10^{G1/20}$ + $10^{G2/20}$ + … + $10^{GN/20}$) ^{2} /N_{ANT}] dBi [Note the “20”s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]
Description of the EUT:	The Equipment Under Test (EUT) is a 3D Printer with NFC and Wi-Fi Module. The EUT support NFC operated at 13.56MHz and Wi-Fi operated at 2.4GHz and 5GHz.
Test sample no.:	SHA-748811-1 (Radiated sample) SHA-748811-2 (Conducted sample)

The sample’s mentioned in this report is/are submitted/ supplied/ manufactured by client. The laboratory therefore assumes no responsibility for accuracy of information on the brand name, model number, origin of manufacture, consignment, antenna gain or any information supplied.

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4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2021 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators
RSS-Gen Issue 5 Amendment 2 February 2021	General Requirements for the Certification of Radio Apparatus
RSS-247 Issue 3 August 2023	Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and License-Exempt Local Area Network (LE-LAN) Devices

All the test methods were according to KDB 558074 D01 15.247 Measurement Guidance v05r02 and ANSI C63.10 (2013).

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5 Summary of Test Results

Technical Requirements						
FCC Part 15 Subpart C & RSS-247 Issue 3/RSS-Gen Issue 5						
Test Condition		Pages	Test Site	Test Result		
				Pass	Fail	N/A
§15.207 & RSS-GEN 8.8	Conducted emission AC power port	15-17	Site 1	☒	☐	☐
§15.247 (b) (3) & RSS-247 5.4(d)	Conducted peak output power and EIRP	18-19	Site 1	☒	☐	☐
§15.247(a)(1) & RSS-247 5.1(b)	20dB bandwidth and 99% Occupied Bandwidth	---	---	☐	☐	☒
§15.247(a)(1) & RSS-247 5.1(b)	Carrier frequency separation	---	---	☐	☐	☒
§15.247(a)(1)(iii) & RSS-247 5.1(d)	Number of hopping frequencies	---	---	☐	☐	☒
§15.247(a)(1)(iii) & RSS-247 5.1(d)	Dwell Time - Average Time of Occupancy	---	---	☐	☐	☒
§15.247(a)(2) & RSS-247 5.2(a) & RSSGEN 6.7	6dB bandwidth and 99% Occupied Bandwidth	20-33	Site 1	☒	☐	☐
§15.247(e) & RSS-247 5.2(b)	Power spectral density	34-40	Site 1	☒	☐	☐
§15.247(d) & RSS-247 5.5	Spurious RF conducted emissions	41-59	Site 1	☒	☐	☐
§15.247(d) & RSS-247 5.5	Band edge	60-72	Site 1	☒	☐	☐
§15.247(d) & §15.209 & RSS-247 5.5 & RSS-Gen 6.13	Spurious radiated emissions for transmitter	73-81	Site 1	☒	☐	☐
§15.203 & RSS-Gen 6.8	Antenna requirement	See note 1		☒	☐	☐

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Note 1: The EUT uses a PCB loop antenna and two FPC antenna, which PCB gain is 2dBi and FPC gain is Antenna1: 5.39 dBi for 2.4GWi-Fi, Antenna2: 3.23 dBi for 2.4GWi-Fi, Antenna1: 4.3 dBi for 5GWi-Fi, Antenna2: 5.72 dBi for 5GWi-Fi. In accordance to §15.203 and RSS-Gen 6.8, It is considered sufficiently to comply with the provisions of this section.

15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. 15.247(c) (1)(i) requirement: (i) Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi

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6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: 2AMG4-CEL, IC: 24652-CEL complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C Rules and RSS-247, RSS-GEN.

This report is only for 2.4GHz Wi-Fi test report, for the 5GHz Wi-Fi test report please refer to 709502306120-00B, for the 13.56MHz NFC test report please refer to 709502306120-00D.

We tested it and listed the worst data in this report.

SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

☐ - **Not** Performed

The Equipment under Test

■ - **Fulfills** the general approval requirements.

☐ - **Does not** fulfill the general approval requirements.

Sample Received Date:	January 2, 2024
Testing Start Date:	January 2, 2024
Testing End Date:	March 8, 2024

-TÜV SÜD Certification and Testing (China) Co., Ltd. Shanghai Branch

Reviewed by:	Prepared by:	Tested by:
Hui TONG	Wenqiang LU	Chengjie GUO
Review Engineer	Project Engineer	Test Engineer

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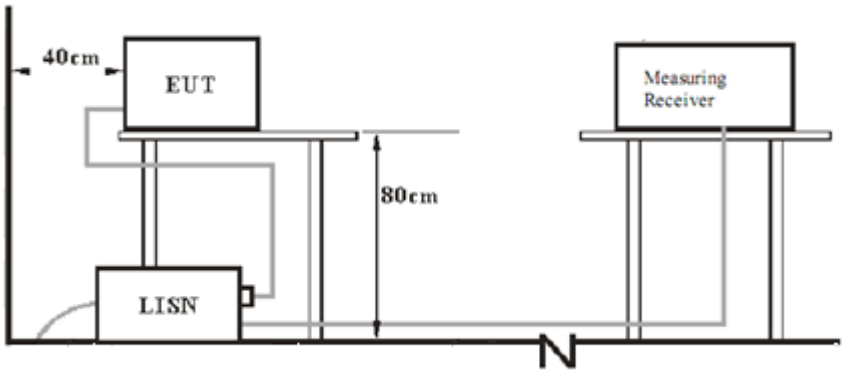
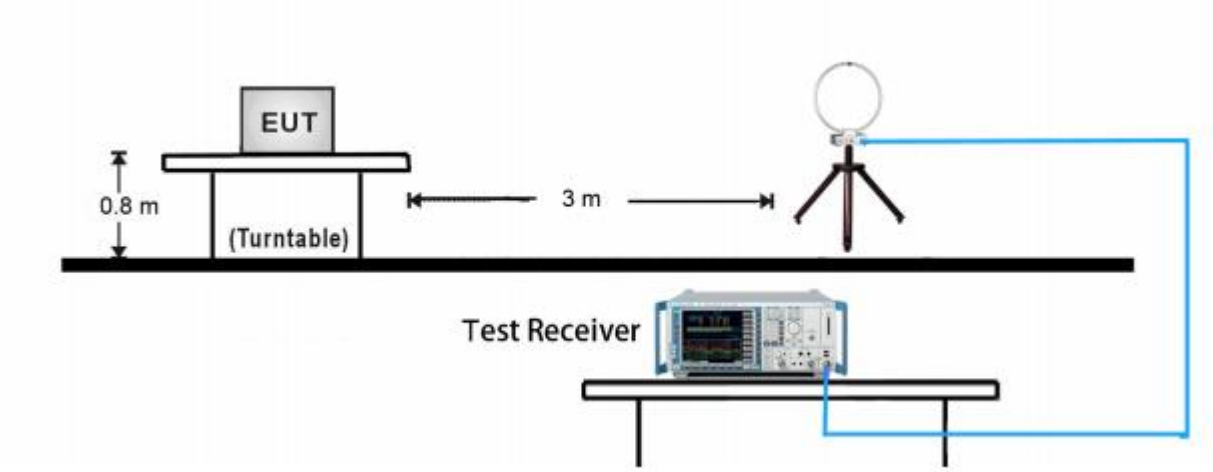
7 Test Setups

7.1 AC Power Line Conducted Emission test setups



7.2 Radiated test setups

9kHz ~ 30MHz Test Setup:



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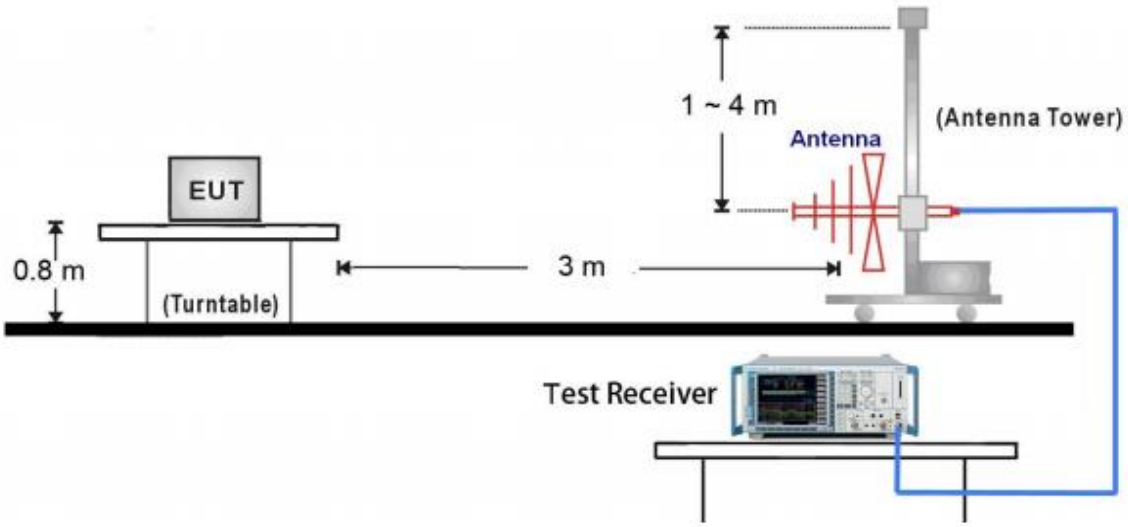
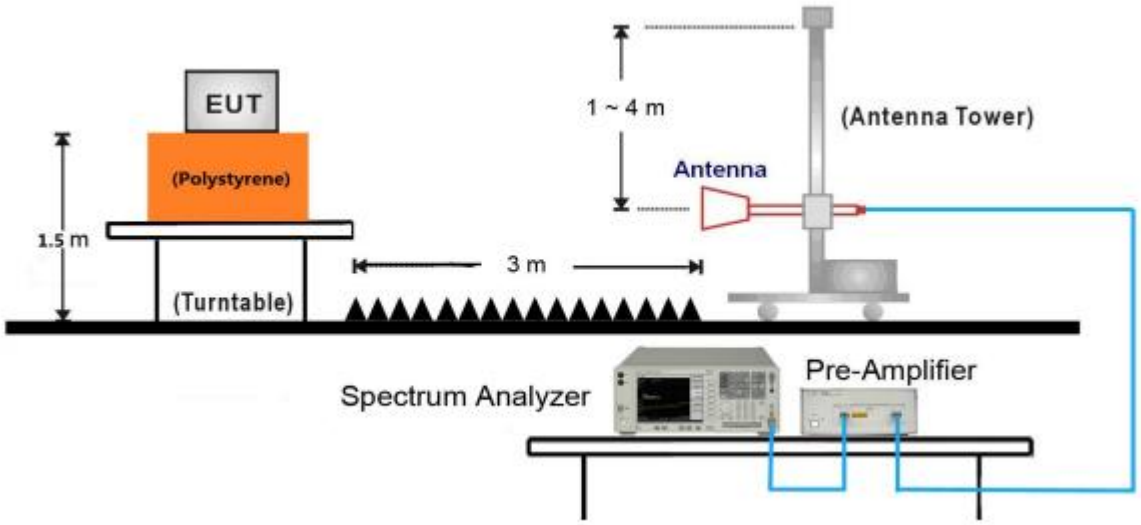
30MHz ~ 1GHz Test Setup:



1GHz ~ 18GHz Test Setup:



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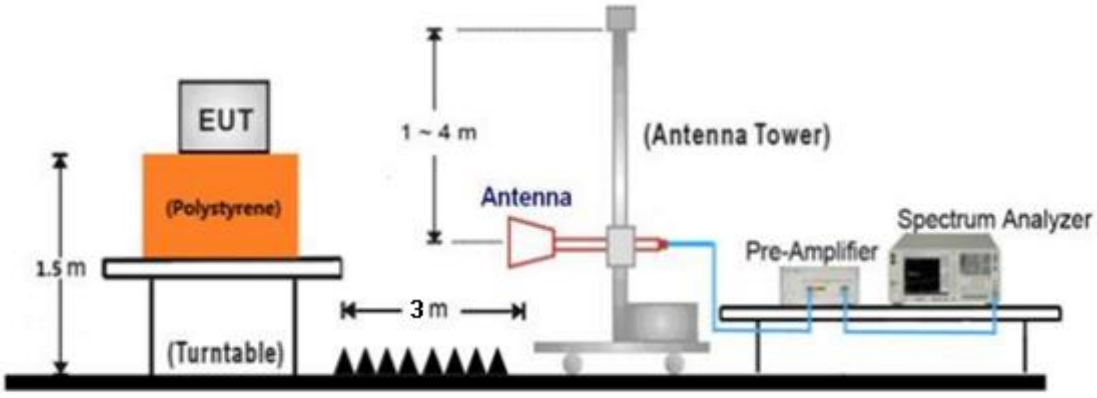
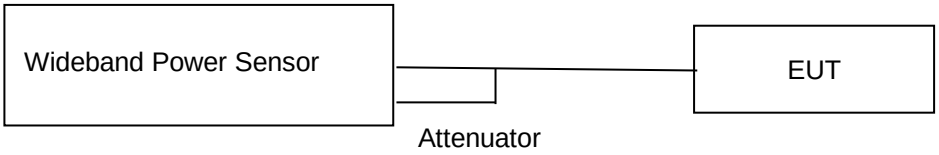
18GHz ~ 25GHz Test Setup:

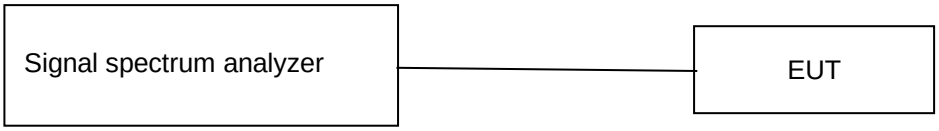


7.3 Conducted RF test setups

For Conducted peak output power



For other test items



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8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.(SHIELD)	S/N(LENGTH)
Notebook	Lenove	E470	PF-OU5TS7 17/09

Test software: SecureCRT.exe, which used to control the EUT in continues transmitting mode.

The system was configured to channel 1(2412MHz), 6(2437MHz), and 11(2462MHz) for 802.11 b/g/n HT20 test.

Test Mode Applicability and Tested Channel Detail:

Mode	Tested Channel	Data Rate (Mbps)	Modulation	Index Value (Power level setting)
802.11b	1	1	CCK	default
	6	1	CCK	default
	11	1	CCK	default
802.11g	1	6	OFDM	default
	6	6	OFDM	default
	11	6	OFDM	default
802.11n HT20	1	MCS0	OFDM	default
	6	MCS0	OFDM	default
	11	MCS0	OFDM	default

Non-hopping mode: The system was configured to operate at a signal channel transmitting. The test software allows the configuration and operation at the worst-case duty and the highest transmit power.

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9 Technical Requirement

9.1 Conducted Emission

Test Method

1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. An EMI test receiver is used to test the emissions from both sides of AC line

Limit

According to §15.207 & RSS-GEN 8.8, conducted emissions limit as below:

Frequency MHz	QP Limit dBµV	AV Limit dBµV
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

Decreasing linearly with logarithm of the frequency

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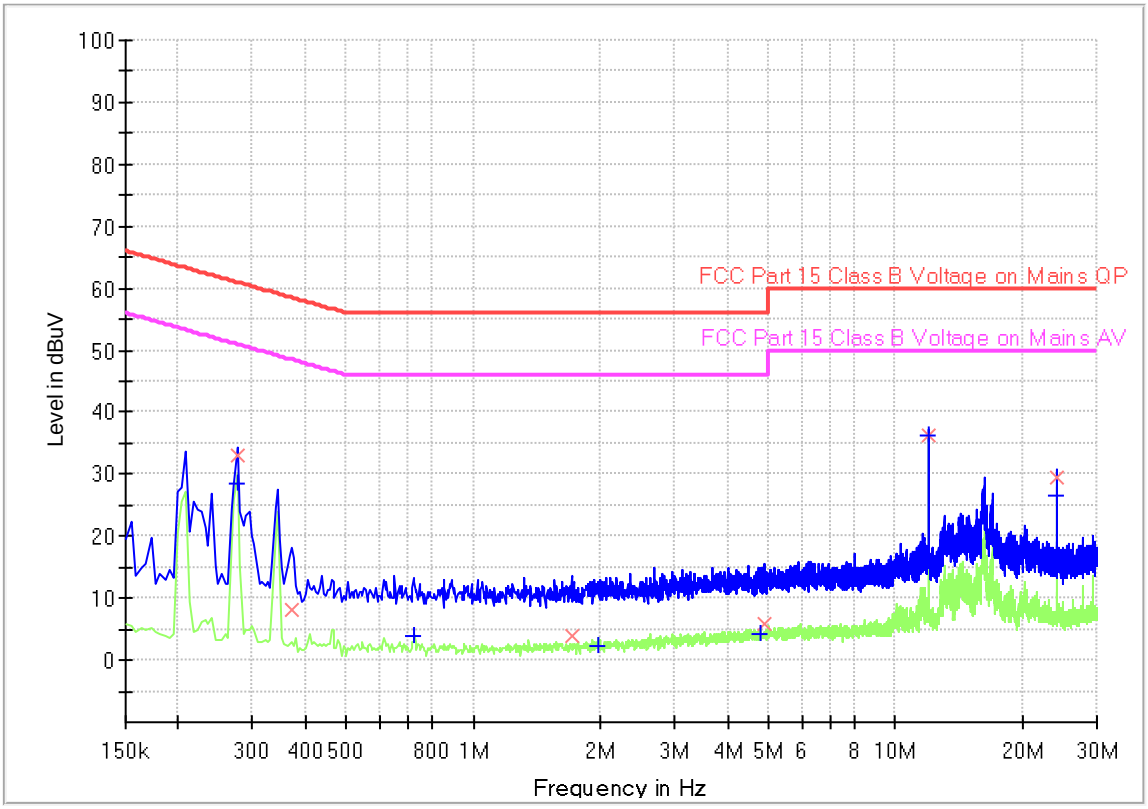
Product Type	:	3D Printer
M/N	:	AccuFab-CEL
Operating Condition	:	Mode 1: Tx_2462MHz for 802.11HT20 (worst case)
Test Specification	:	L-line
Comment	:	AC 120V/60Hz



Final_Result

Frequency (MHz)	Quasi Peak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.276000	---	28.46	50.94	22.48	1000.0	9.000	L1	19.5
0.276000	33.07	---	60.94	27.87	1000.0	9.000	L1	19.5
0.370500	8.23	---	58.49	50.26	1000.0	9.000	L1	19.5
0.726000	---	3.82	46.00	42.18	1000.0	9.000	L1	19.5
1.707000	3.80	---	56.00	52.20	1000.0	9.000	L1	19.5
1.977000	---	2.33	46.00	43.67	1000.0	9.000	L1	19.5
4.762500	---	4.11	46.00	41.89	1000.0	9.000	L1	19.6
4.888500	5.81	---	56.00	50.19	1000.0	9.000	L1	19.6
12.003000	36.16	---	60.00	23.84	1000.0	9.000	L1	19.9
12.003000	---	36.24	50.00	13.76	1000.0	9.000	L1	19.9
24.000000	---	26.56	50.00	23.44	1000.0	9.000	L1	20.9
24.000000	29.50	---	60.00	30.50	1000.0	9.000	L1	20.9

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

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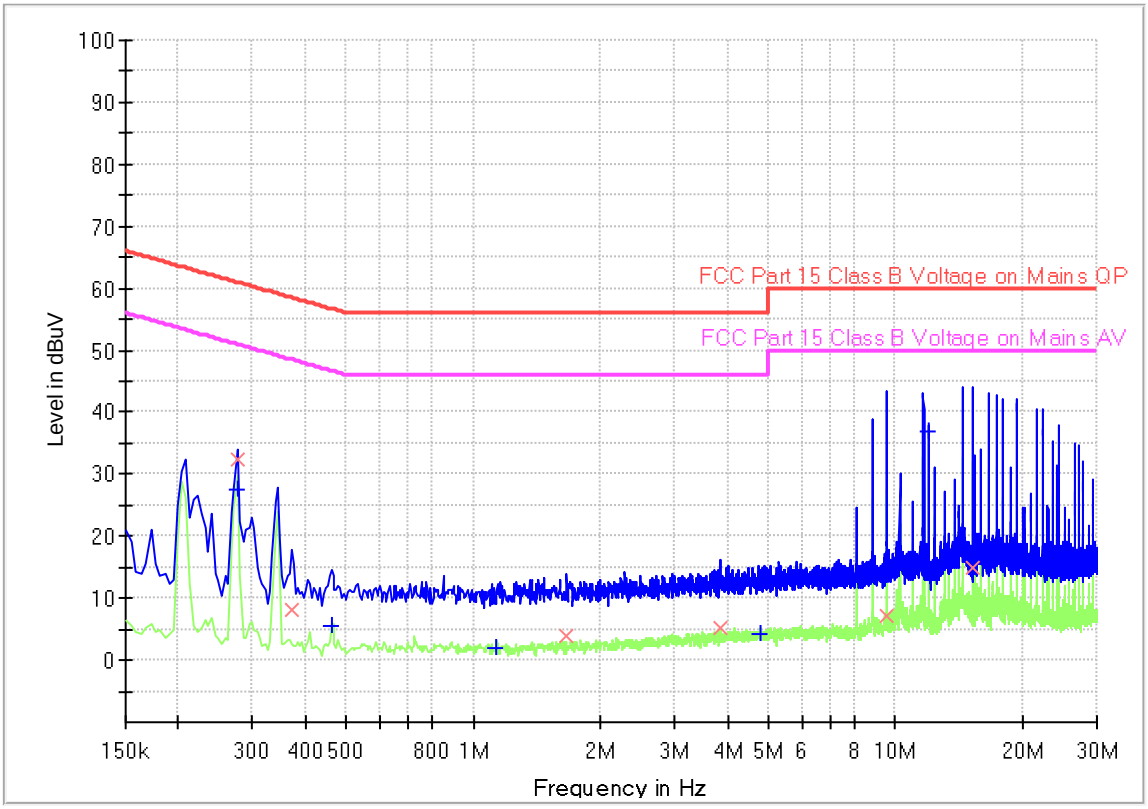
Product Type	:	3D Printer
M/N	:	AccuFab-CEL
Operating Condition	:	Mode 1: Tx_2462MHz for 802.11HT20 (worst case)
Test Specification	:	N-line
Comment	:	AC 120V/60Hz



Final_Result

Frequency (MHz)	Quasi Peak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.276000	---	27.63	50.94	23.31	1000.0	9.000	N	19.5
0.276000	32.49	---	60.94	28.45	1000.0	9.000	N	19.5
0.370500	8.07	---	58.49	50.42	1000.0	9.000	N	19.5
0.460500	---	5.69	46.68	40.99	1000.0	9.000	N	19.5
1.135500	---	1.89	46.00	44.11	1000.0	9.000	N	19.5
1.666500	3.92	---	56.00	52.08	1000.0	9.000	N	19.5
3.862500	5.20	---	56.00	50.80	1000.0	9.000	N	19.6
4.794000	---	4.13	46.00	41.87	1000.0	9.000	N	19.6
9.523500	7.27	---	60.00	52.73	1000.0	9.000	N	19.7
12.003000	---	36.81	50.00	13.19	1000.0	9.000	N	19.8
14.478000	---	17.00	50.00	33.00	1000.0	9.000	N	19.9
15.180000	14.86	---	60.00	45.14	1000.0	9.000	N	19.9

Note 1: Measure Level (dBuV/m) = Reading Level (dBuV) + Factor (dB)
Factor (dB) = Cable Loss (dB) + LISN Factor (dB) + 10dB Attenuator

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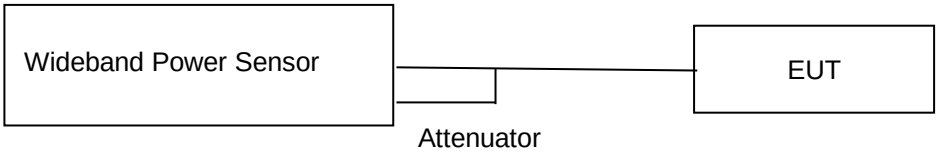
9.2 Conducted peak output power and EIRP

Test Method

1) The EUT is configured to transmit continuously, or to transmit with a constant duty cycle.
2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power control level.
3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

4) Measure the peak power of the transmitter. This measurement is a peak over both the ON and OFF periods of the transmitter.



Wideband Power Sensor conducted test setup

Limits

According to §15.247 (b) (3) & RSS-247 5.4(d), conducted peak output power limit as below:

	Frequency Range	Limit	Limit
	MHz	W	dBm
Conducted peak output power	2400-2483.5	≤1	≤30

	Frequency Range	Limit (EIRP)	Limit
	MHz	W	dBm
Conducted peak output power	2400-2483.5	≤4	≤36

Test result as below table

802.11b: Ant1: 5.39 dBi, Ant2: 3.23 dBi				
Frequency (MHz)	Conducted Peak Output Power (dBm)			
	Ant1 Result	Ant2 Result	limit	Verdict
2412MHz	18.09	18.77	≤30	Pass
2437MHz	18.15	18.79	≤30	Pass
2462MHz	18.68	19.22	≤30	Pass

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802.11g: Ant1: 5.39 dBi, Ant2: 3.23 dBi				
Frequency (MHz)	Conducted Peak Output Power (dBm)			
	Ant1 Result	Ant2 Result	limit	Verdict
2412MHz	20.55	20.89	≤30	Pass
2437MHz	21.28	21.08	≤30	Pass
2462MHz	21.47	21.51	≤30	Pass

802.11n(HT20): Ant1: 5.39 dBi, Ant2: 3.23 dBi					
Frequency (MHz)	Conducted Peak Output Power (dBm)				
	Ant1 Result	Ant2 Result	Sum Result	limit	Verdict
2412MHz	21.29	21.29	24.30	≤29	Pass
2437MHz	21.72	21.46	24.60	≤29	Pass
2462MHz	21.79	21.76	24.79	≤29	Pass

802.11b: Ant1: 5.39 dBi, Ant2: 3.23 dBi				
Frequency (MHz)	EIRP (dBm)			
	Ant1 Result	Ant2 Result	Limit	Verdict
2412MHz	23.48	22	≤36	Pass
2437MHz	23.54	22.02	≤36	Pass
2462MHz	24.07	22.45	≤36	Pass

802.11g: Ant1: 5.39 dBi, Ant2: 3.23 dBi				
Frequency (MHz)	EIRP (dBm)			
	Ant1 Result	Ant2 Result	Limit	Verdict
2412MHz	25.94	24.12	≤36	Pass
2437MHz	26.67	24.31	≤36	Pass
2462MHz	26.86	24.74	≤36	Pass

802.11n(HT20): Ant1: 5.39 dBi, Ant2: 3.23 dBi					
Frequency (MHz)	EIRP (dBm)				
	Ant1 Result	Ant2 Result	Sum Result	Limit	Verdict
2412MHz	26.68	24.52	31.69	≤35	Pass
2437MHz	27.11	24.69	31.99	≤35	Pass
2462MHz	27.18	24.99	32.18	≤35	Pass

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9.3 6dB bandwidth and 99% Occupied Bandwidth

Test Method for 6 dB Bandwidth

1. The RF output of EUT was connected to the spectrum analyzer. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
   RBW=100KHz, VBW≥3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Use the automatic bandwidth measurement capability of an instrument, use the X dB bandwidth mode with X set to 6 dB.
5. Allow the trace to stabilize, record the 6 dB Bandwidth value.

Limit

6dB bandwidth Limit [kHz]
≥500

Test Method for 99 % Bandwidth

1. Use the following spectrum analyzer settings:
   RBW=1% to 5% of the actual occupied, VBW≥3RBW, Sweep = auto,
   Detector function = peak, Trace = max hold
2. Use the automatic bandwidth measurement capability of an instrument, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.
3. Allow the trace to stabilize, record the X dB Bandwidth value.

Limit

Limit [kHz]
N/A

Test result

Test Mode	Frequency MHz	6dB bandwidth (MHz)			Result
		Ant1 Result	Ant2 Result	limit	verdict
802.11b	2412	8.08	9.047	≥0.5	Pass
	2437	8.553	8.541	≥0.5	Pass
	2462	7.561	8.103	≥0.5	Pass
802.11g	2412	16.361	16.384	≥0.5	Pass
	2437	16.33	16.391	≥0.5	Pass
	2462	16.396	16.344	≥0.5	Pass
802.11n(HT20)	2412	17.557	17.61	≥0.5	Pass
	2437	17.562	17.62	≥0.5	Pass
	2462	17.553	17.603	≥0.5	Pass

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Test Mode	Frequency MHz	99% Occupied Bandwidth (MHz)		Result
		Ant1 Result	Ant2 Result	verdict
802.11b	2412	11.502	11.757	Pass
	2437	11.301	11.773	Pass
	2462	11.245	11.519	Pass
802.11g	2412	16.709	16.912	Pass
	2437	16.716	16.71	Pass
	2462	16.753	16.71	Pass
802.11n(HT20)	2412	17.888	17.934	Pass
	2437	17.848	17.865	Pass
	2462	17.881	17.803	Pass

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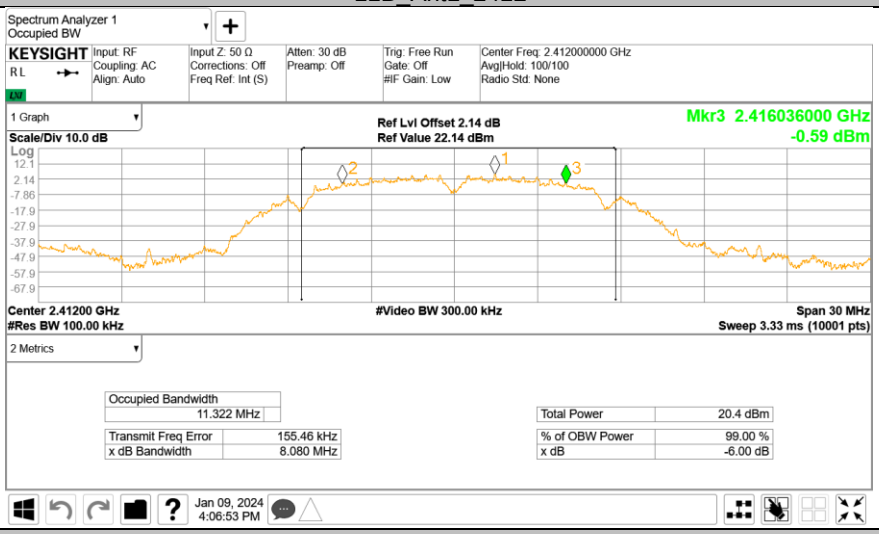
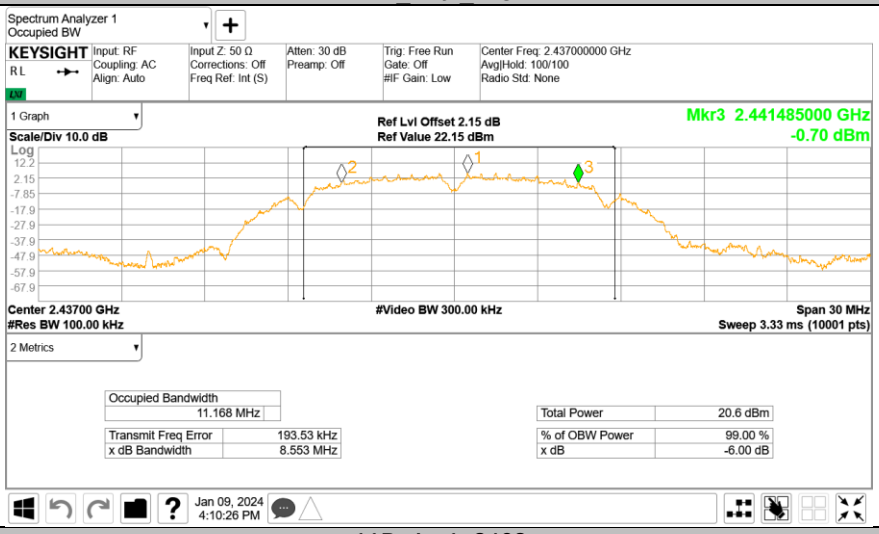
6 dB Bandwidth

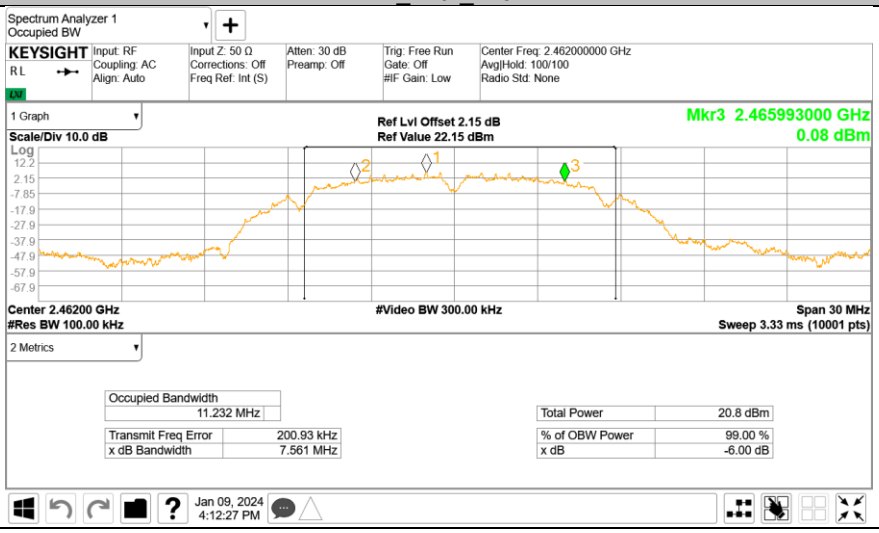
11B_Ant1_2412



11B_Ant1_2437

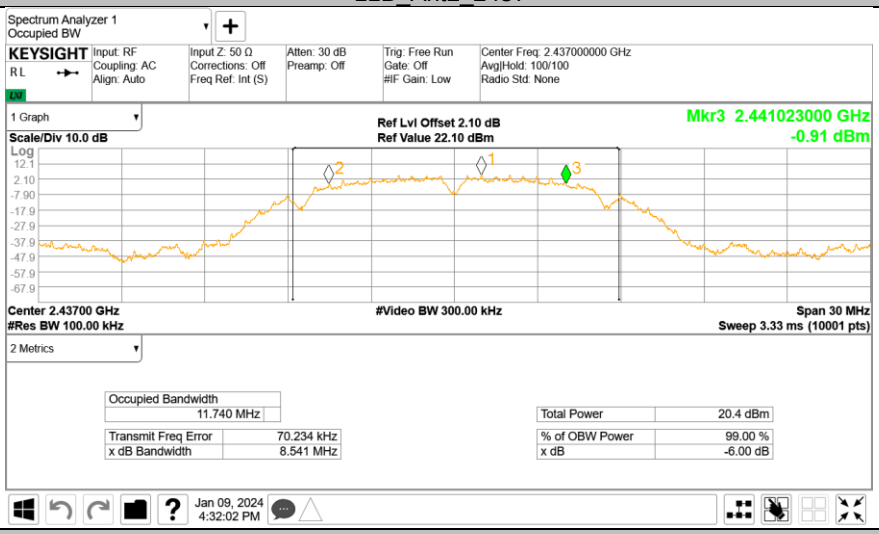


11B_Ant1_2462

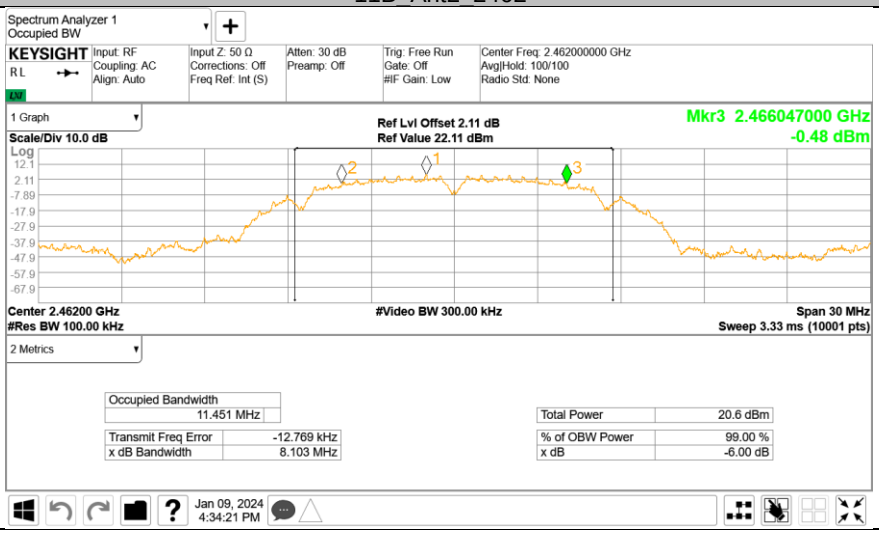


11B_Ant2_2412

11B_Ant2_2437



11B_Ant2_2462



11G_Ant1_2412

11G_Ant1_2437

11G_Ant1_2462

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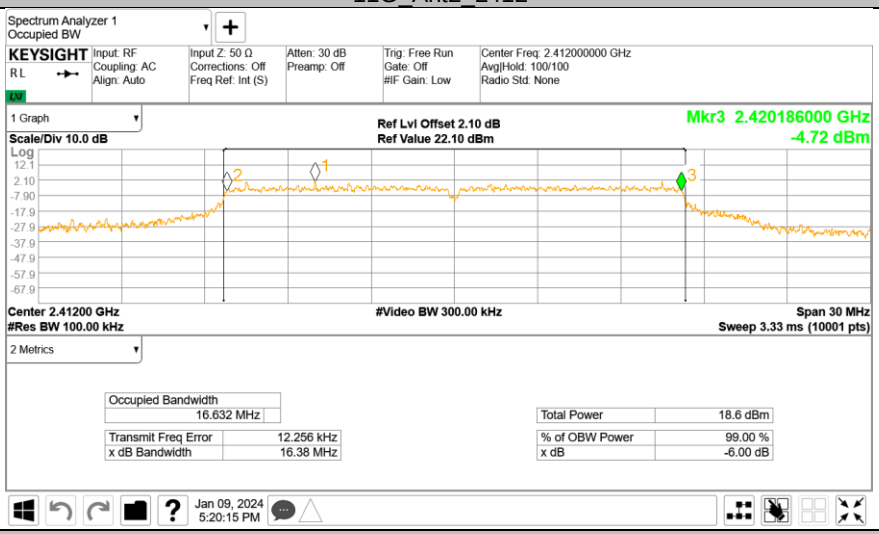
11G_Ant2_2412



11G_Ant2_2437

11G_Ant2_2462

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11N20_Ant1_2412

11N20_Ant1_2437

11N20_Ant1_2462


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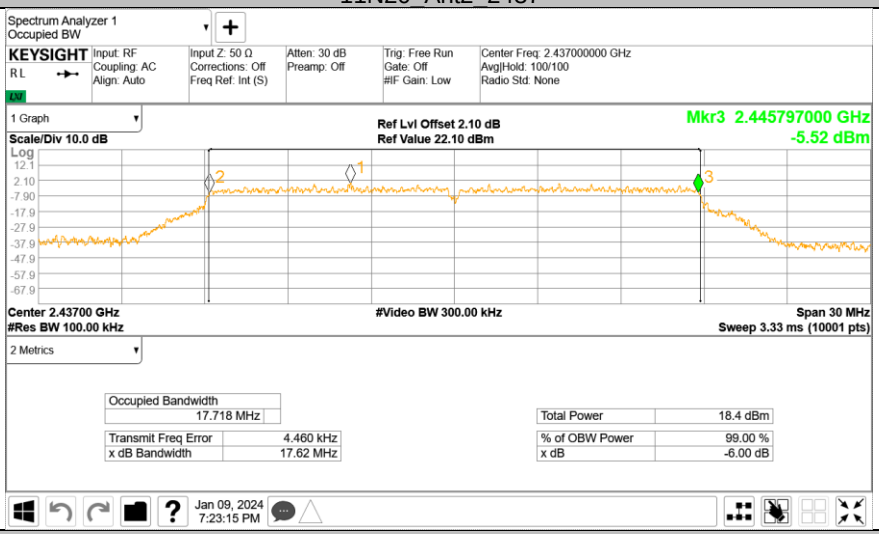
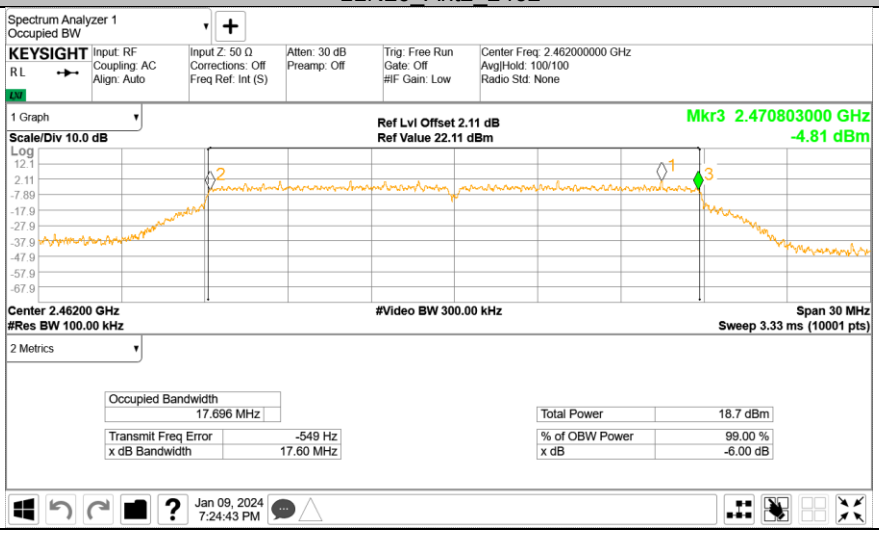
11N20_Ant2_2412

11N20_Ant2_2437



11N20_Ant2_2462



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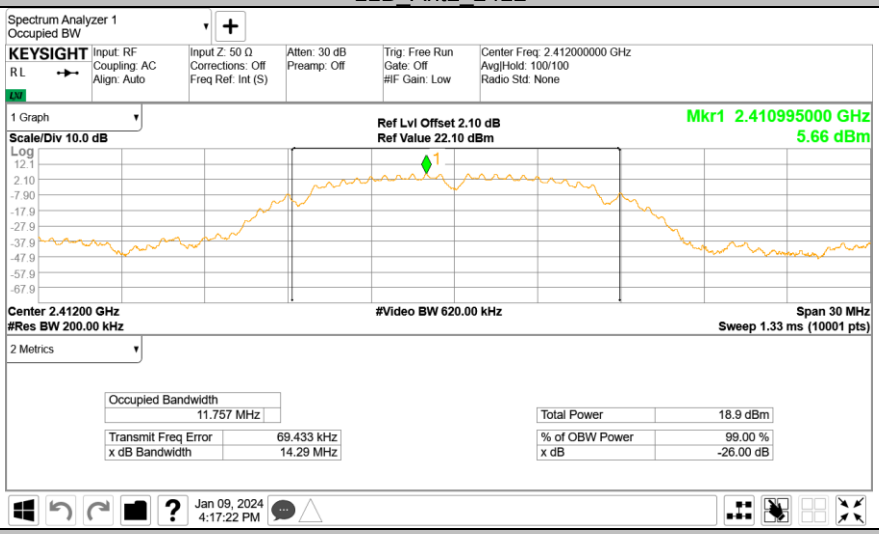
99% Occupied Bandwidth

11B_Ant1_2412

11B_Ant1_2437

11B_Ant1_2462

11B_Ant2_2412



11B_Ant2_2437

11B_Ant2_2462

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11G_Ant1_2412

11G_Ant1_2437

11G_Ant1_2462