FCC Test Report

Report No.:	CIDG-ESH-P23020103B-2
FCC ID:	2A789SC053
Product:	Smart Camera
Model:	SC053-WQ2, SC053-WQ2A, SC053-WQ2B, SC053-WQ2C, SC053-WQ1, SC053-WQ1A, SC053-WQ1B, SC053-WQ1C, SC053-WQ3, SC053-WQ3A, SC053-WQ3B, SC053-WQ3C
Received Date:	Feb.22, 2023
Test Date:	Feb.22 to Mar.02, 2023
Issued Date:	Mar.08, 2023

Applicant:	Ningbo Lingzhu Technology CO., Ltd.
Address:	No.578,Building 7,No.535 Kangqiao South Road, Jiangbei District, Ningbo City, Zhejiang Province, China
Manufacturer:	Ningbo Lingzhu Technology CO., Ltd.
Address:	No.578,Building 7,No.535 Kangqiao South Road, Jiangbei District, Ningbo City, Zhejiang Province, China
Issued By:	BUREAU VERITAS ADT (Shanghai) Corporation
Lab Address:	No. 829, Xinzhuan Road, Shanghai, P.R.China (201612)
FCC Registration / Designation Number:	176467/ CN1213

ACCREDITED
Test Lab
Cert 2343.01

Table of Contents

Release Control Record

Issue No.	Description	Date Issued
CIDG-ESH-P23020103B-2	Original release	Mar.08, 2023

1 Certificate of Conformity

Product: Smart Camera

Brand: --

Model: SC053-WQ2, SC053-WQ2A, SC053-WQ2B, SC053-WQ2C, SC053-WQ1, SC053-WQ1A, SC053-WQ1B, SC053-WQ1C, SC053-WQ3, SC053-WQ3A, SC053-WQ3B, SC053-WQ3C

Applicant: Ningbo Lingzhu Technology CO., Ltd.

Test Date: Feb.22 to Mar.02, 2023

Standards: 47 CFR FCC Part 15, Subpart C (Section 15.247)
ANSI C63.10:2020

The above equipment has been tested by **BUREAU VERITAS ADT (Shanghai) Corporation**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : Yuan Zhang , **Date:** Mar.08, 2023

Yuan ZHANG

Project Engineer

Approved by : Sean YU , **Date:** Mar.08, 2023

Sean YU

RF Supervisor

2 Summary of Test Results

The EUT has been tested according to the following specifications:

47 CFR FCC Part 15, Subpart C (SECTION 15.247)			
FCC Clause	Test Item	Result	Remarks
15.203	Antenna Requirement	PASS	No antenna connector is used.
15.207	AC Power Conducted Emission	PASS	Meet the requirement of limit.
15.247(a)(2)	Minimum 6dB Bandwidth	PASS	Meet the requirement of limit.
15.247(b)	Conducted Output Power	PASS	Meet the requirement of limit.
15.247(e)	Power Spectral Density	PASS	Meet the requirement of limit.
15.247(d)	Conducted Band Edges Measurement	PASS	Meet the requirement of limit.
15.247(d)	Conducted Spurious Emissions	PASS	Meet the requirement of limit.
15.247(d)	Emissions in restricted frequency bands	PASS	Meet the requirement of limit.
15.205 / 15.209 / 15.247(d)	Radiated Emissions Measurement	PASS	Meet the requirement of limit.

2.1 Test Instruments

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
Loop Antenna	ETS-LINDGREN	6502	E1A1039	Jul.23,22	Jul.22,23
Hybrid Antenna(25MHz-1.5GHz)	Schwarzbeck	VULB9168	E1A1001	Dec.20,21	Dec.19,23
Horn Antenna(1GHz -18GHz)	Schwarzbeck	BBHA9120D	E1A1017	Jul.25,22	Jul.24,24
Double Ridge Horn Antenna(18G-40G)	COM-POWER	AH-840	E1A1040	Jul.25,22	Jul.24,24
Pre-Amplifier(100kHz-1.3GHz)	Agilent	8447D	E1A2001	Mar.03,22	Mar.02,23
Pre-Amplifier(0.5GHz-18GHz)	EMCI	EMC184045SE	E1A2009	Aug.04,22	Aug.03,23
Pre-Amplifier(18GHz-40GHz)	EMCI	EMC051845SE	E1A2008	Aug.04,22	Aug.03,23
EMI test recerver	R&S	ESR7	E1R1005	Mar.03,22	Mar.02,23
Spectrum Analyzer	Keysight	N9030B	E1S1003	Sep.14, 22	Sep.13, 23
Spectrum Analyzer	Keysight	N9020A	E1S1004	Mar.03,22	Mar.02,23
EMI test recerver	R&S	ESR3	E1R1008	Jul.20, 22	Jul.19, 23
LISN	R&S	ENV216	E1L1011	Jul.20, 22	Jul.19, 23
Humidity&Temp Tester	ESPEC	SE TH-Z-042U	C1TH002	Jun.08,22	Jun.07,23
RF Control Unit	Toscend	JS0806-2	E1C5003	N/A	N/A
Test Software	Toscend	JS32-CE	N/A	N/A	N/A
Test Software	Toscend	JS32-RE	N/A	N/A	N/A
Test Software	Toscend	JS1120	N/A	N/A	N/A
Test Software	Toscend	JS1120-3	N/A	N/A	N/A

2.2 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT:

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	1.83 dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	5.36 dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	3.47 dB
	6GHz ~ 18GHz	3.75 dB
	18GHz ~ 40GHz	3.30 dB

2.3 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Smart Camera
Brand	--
Model	SC053-WQ2, SC053-WQ2A, SC053-WQ2B, SC053-WQ2C, SC053-WQ1, SC053-WQ1A, SC053-WQ1B, SC053-WQ1C, SC053-WQ3, SC053-WQ3A, SC053-WQ3B, SC053-WQ3C
Difference	sensor, color and tiny enclosure difference, such as different chamfering These differences are not related to the radio frequency function. 1, 2, 3 in model name for different sensor and A, B, C in model name for different color and tiny enclosure difference.
Power Rating	DC 5V 1A
Modulation Type	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM
Modulation Technology	DSSS, OFDM
Operating Frequency	2412MHz ~ 2462MHz
Number of Channel	802.11b, 802.11g and 802.11n (HT20):11
Output Power	15.21dBm
Antenna Type	FPC Antenna
Antenna Connector	--
Antenna Gain	3.83dBi

Note:

1. For more details, please refer to the User's manual of the EUT.

Modulation Mode	TX /RX Function
802.11b	1TX / 1RX
802.11g	1TX / 1RX
802.11n (HT20)	1TX / 1RX

3.2 Description of Test Modes

11 channels are provided for 802.11b, 802.11g and 802.11n (HT20).

Channel	Frequency	Channel	Frequency
1	2412MHz	7	2442MHz
2	2417MHz	8	2447MHz
3	2422MHz	9	2452MHz
4	2427MHz	10	2457MHz
5	2432MHz	11	2462MHz
6	2437MHz	-	-

3.2.1 Test Mode Applicability:

EUT Configure Mode	Applicable to				Description
	RE ≥ 1G	RE < 1G	PLC	APCM	
-	√	√	√	√	-

Where **RE≥1G:** Radiated Emission above 1GHz **RE< 1G:** Radiated Emission below 1GHz

PLC: Power Line Conducted Emission **APCM:** Antenna Port Conducted Measurement

Radiated Emission Test (Above 1 GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11b	1 to 11	1, 6, 11	DSSS	DBPSK	1.0
-	802.11g	1 to 11	1, 6, 11	OFDM	BPSK	6.0
-	802.11n (HT20)	1 to 11	1, 6, 11	OFDM	BPSK	6.5

Radiated Emission Test (Below 1 GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11b	1 to 11	1	DSSS	DBPSK	1.0

Power Line Conducted Emission Test:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11b	1 to 11	1	DSSS	DBPSK	1.0

Antenna Port Conducted Measurement

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11b	1 to 11	1, 6, 11	DSSS	DBPSK	1.0
-	802.11g	1 to 11	1, 6, 11	OFDM	BPSK	6.0
-	802.11n (HT20)	1 to 11	1, 6, 11	OFDM	BPSK	6.5

3.2.2 Test Condition:

Applicable to	Normal Environmental Conditions	Normal Input Power
RE ≥ 1G	23deg. C, 58%RH	DC 5V 1A , Powered by battery
RE < 1G	23deg. C, 58%RH	DC 5V 1A , Powered by battery
PLC	23deg. C, 58%RH	DC 5V 1A
APCM	25deg. C, 60%RH	Powered by battery

3.3 Duty Cycle of Test Signal

Test Mode	Antenna	Channel [MHz]	Duty Cycle [%]	10log(1/x) Factor[dB]
11B	Ant1	2412	98.48	0.07
		2437	98.37	0.07
		2462	97.80	0.10
11G	Ant1	2412	94.00	0.27
		2437	89.17	0.50
		2462	93.96	0.27
11N20SISO	Ant1	2412	92.31	0.35
		2437	93.57	0.29
		2462	92.25	0.35

Note: Duty Cycle Factor=10* Log[1/Duty Cycle(%)*100], Duty Cycle= T_{on}/T_{period} *100%

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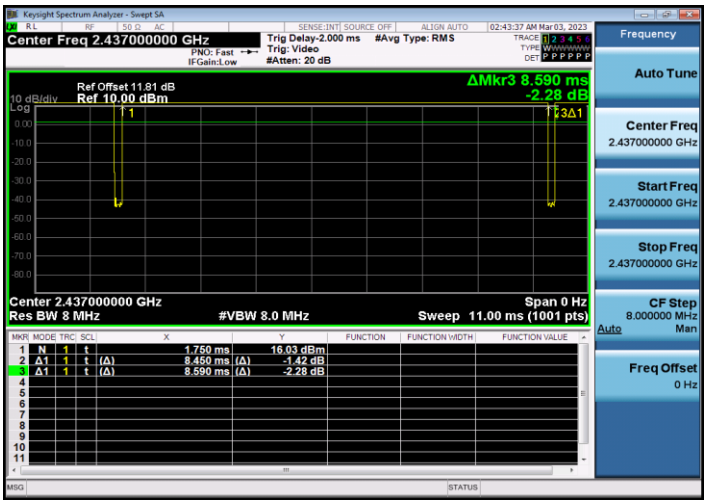
11B_Ant1_2437

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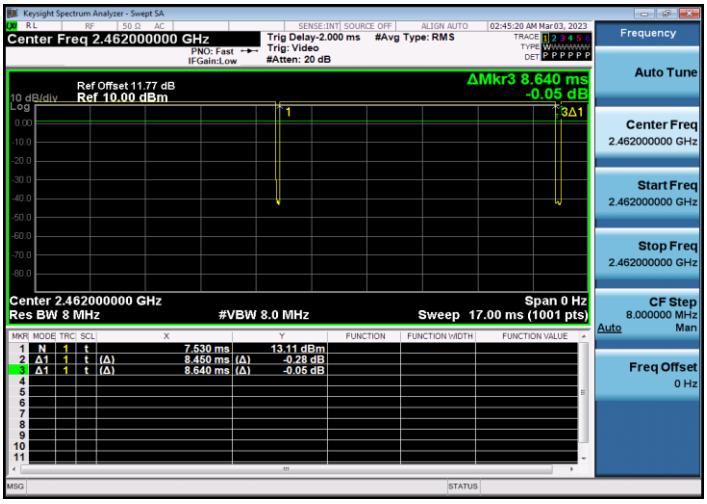

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11G_Ant1_2437

11G_Ant1_2462


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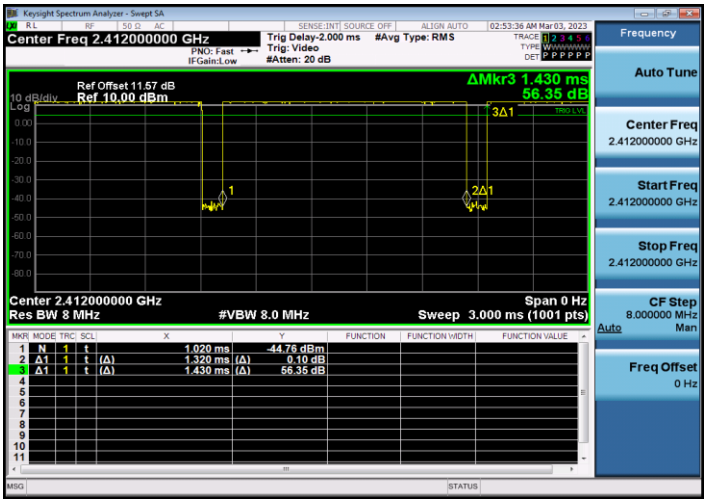
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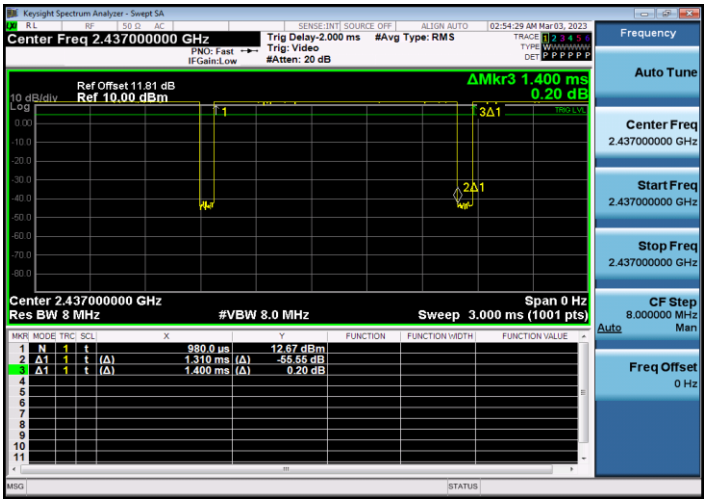

11N20SISO_Ant1_2462


3.4 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units.

NO.	PRODUCT	BRAND/ Manufacturer	MODEL NO.
1	AC/DC Adapter	--	KA06E-0501000US
2.	Laptop	Lenovo	L470

3.5 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standard:

FCC Part 15, Subpart C (15.247)

KDB 558074 D01 DTS Meas Guidance v05r02

ANSI C63.10:2013

All relaxed test items have been performed and recorded as per the above standard.

4 Test Procedure and Results

4.1 AC Power Conducted Emission

4.1.1 Limits

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies.

2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.1.2 Test Procedures

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.

b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

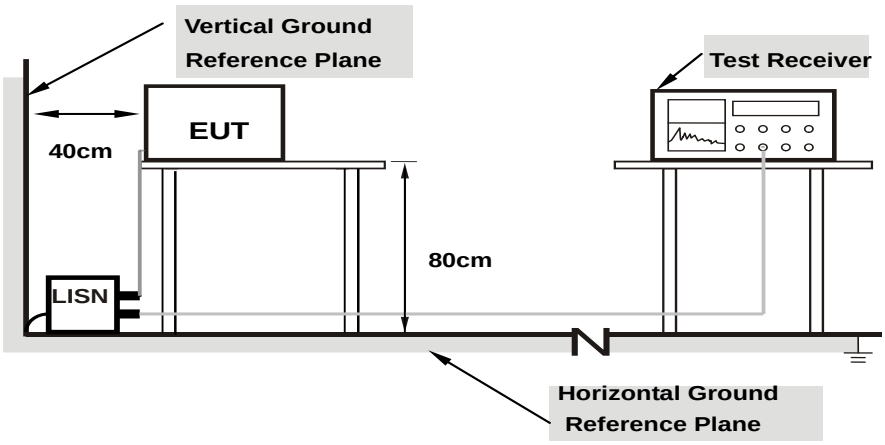
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

4.1.3 Deviation from Test Standard

No deviation.

4.1.4 Test Setup



Note: 1.Support units were connected to second LISN.

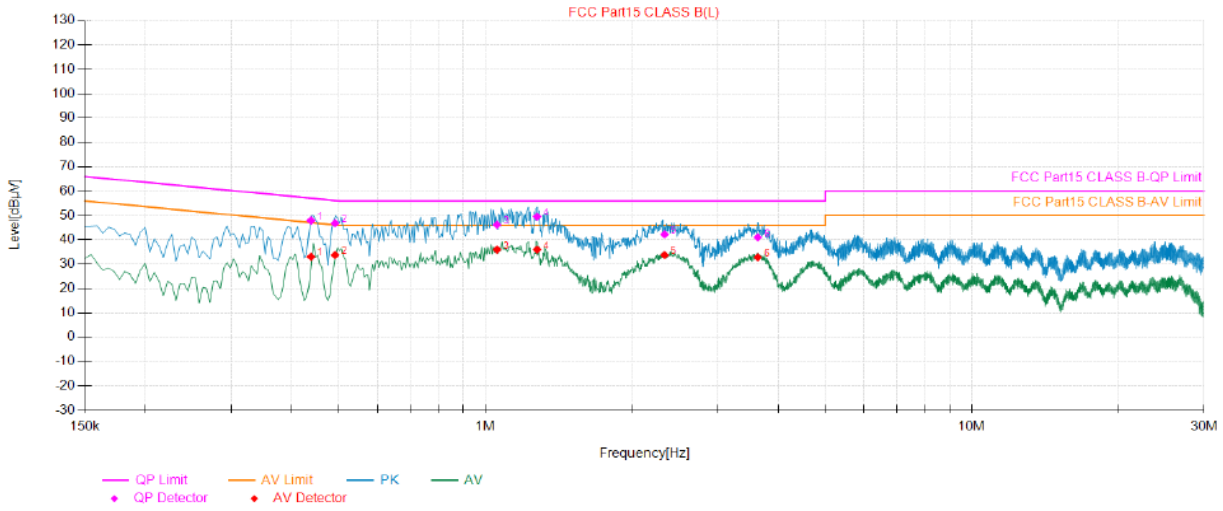
For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.5 EUT Operating Conditions

Same as 4.1.6.

4.1.6 Test Results

Phase	Line (L)	Detector Function	Quasi-Peak (QP) / Average (AV)
Power supply	AC 120V, 60Hz		
Test Mode	Charging and Working		



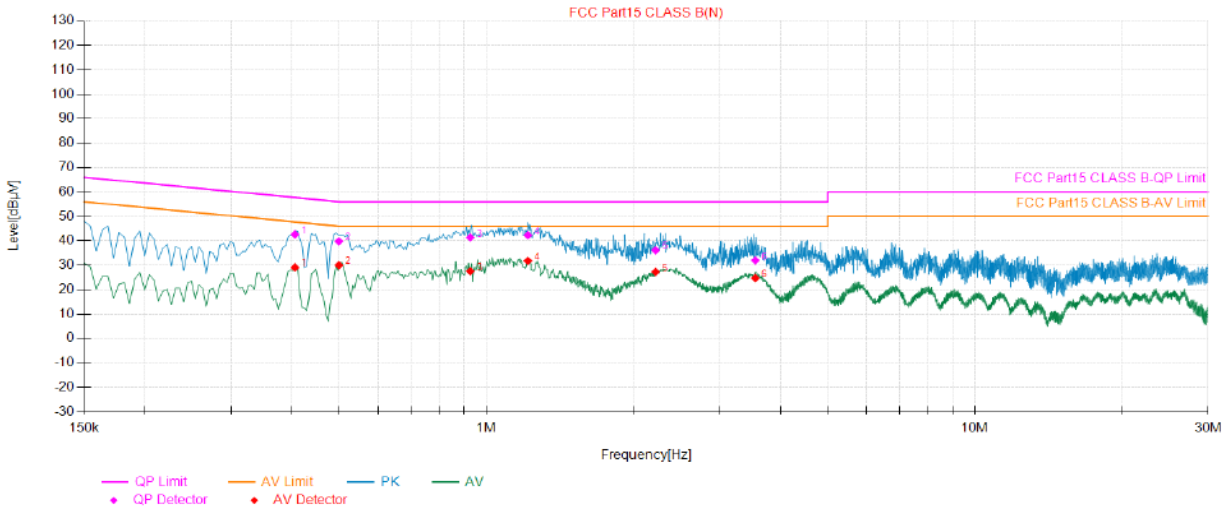
Final Data List

NO.	Freq. [MHz]	Factor [dB]	QP Reading Value [dBµV]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Reading Value [dBµV]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Type	Verdict
1	0.4376	9.59	38.33	47.92	57.11	9.19	23.41	33.00	47.11	14.11	L	PASS
2	0.4905	9.59	37.23	46.82	56.16	9.34	24.14	33.73	46.16	12.43	L	PASS
3	1.0555	9.49	36.69	46.18	56.00	9.82	26.45	35.94	46.00	10.06	L	PASS
4	1.2772	9.54	39.97	49.51	56.00	6.49	26.4	35.94	46.00	10.06	L	PASS
5	2.3328	9.69	32.55	42.24	56.00	13.76	24.02	33.71	46.00	12.29	L	PASS
6	3.6274	9.76	31.25	41.01	56.00	14.99	23.02	32.78	46.00	13.22	L	PASS

REMARKS:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Limit value - Emission level
4. Correction factor = Insertion loss + Cable loss
5. QP/AV Value= QP/AV Reading Value+ Correction factor

Phase	Neutral (N)	Detector Function	Quasi-Peak (QP) / Average (AV)
Power supply	AC 120V, 60Hz		
Test Mode	Charging and Working		



Final Data List

NO.	Freq. [MHz]	Factor [dB]	QP Reading Value [dBµV]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Reading Value [dBµV]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Type	Verdict
1	0.4058	9.57	33.07	42.64	57.73	15.09	19.50	29.07	47.73	18.66	N	PASS
2	0.4987	9.59	30.19	39.78	56.02	16.24	20.40	29.99	46.02	16.03	N	PASS
3	0.9273	9.50	31.87	41.37	56.00	14.63	18.04	27.54	46.00	18.46	N	PASS
4	1.2159	9.53	32.78	42.31	56.00	13.69	22.24	31.77	46.00	14.23	N	PASS
5	2.2215	9.63	26.47	36.10	56.00	19.90	17.64	27.27	46.00	18.73	N	PASS
6	3.5489	9.71	22.25	31.96	56.00	24.04	15.03	24.74	46.00	21.26	N	PASS

REMARKS:

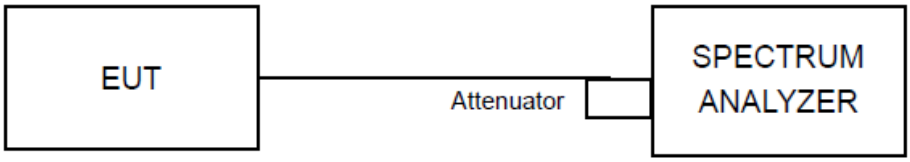
1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Limit value - Value level
4. Correction factor = Insertion loss + Cable loss
5. QP/AV Value= QP/AV Reading Value+ Correction factor

4.2 Minimum 6dB Bandwidth

4.2.1 Limit

For digital modulation systems, the minimum 6dB bandwidth shall be at least 500 kHz

4.2.2 Test Setup



4.2.3 Test Procedures

The EUT was tested according to DTS test procedure of “KDB558074 D01 DTS Meas Guidance” for compliance to FCC 47CFR 15.247 requirements (clause 8.2).

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW $\geqslant$ 3 · RBW, peak detector with maximum hold) is implemented by the instrumentation function.

4.2.4 Deviation of Test Standard

No deviation.

4.2.5 Test Results

Test Mode	Antenna	Channel [MHz]	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit [MHz]	Verdict
11B	Ant1	2412	9.520	2407.040	2416.560	>=0.5	PASS
		2437	9.080	2432.480	2441.560	>=0.5	PASS
		2462	9.520	2457.520	2467.040	>=0.5	PASS
11G	Ant1	2412	15.320	2404.280	2419.600	>=0.5	PASS
		2437	12.560	2430.760	2443.320	>=0.5	PASS
		2462	14.160	2455.400	2469.560	>=0.5	PASS
11N20SISO	Ant1	2412	11.240	2405.800	2417.040	>=0.5	PASS
		2437	15.120	2429.480	2444.600	>=0.5	PASS
		2462	11.400	2455.720	2467.120	>=0.5	PASS

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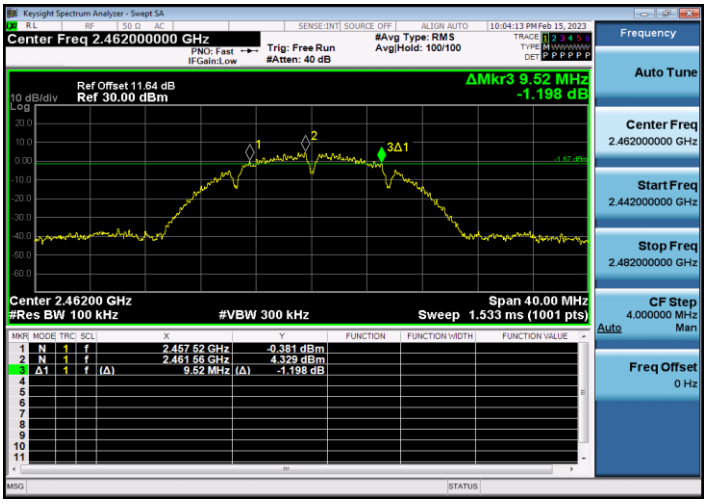
11B_Ant1_2437

11B_Ant1_2462


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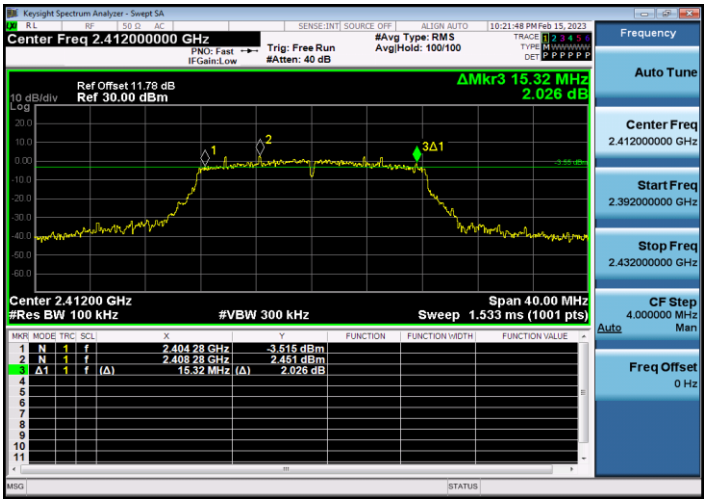
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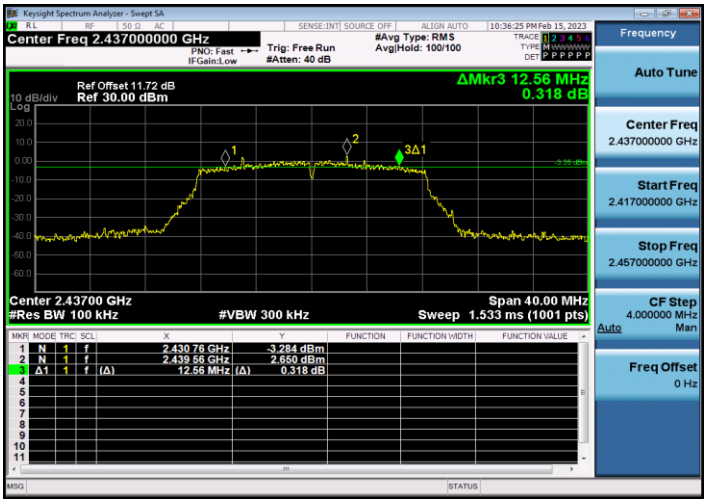
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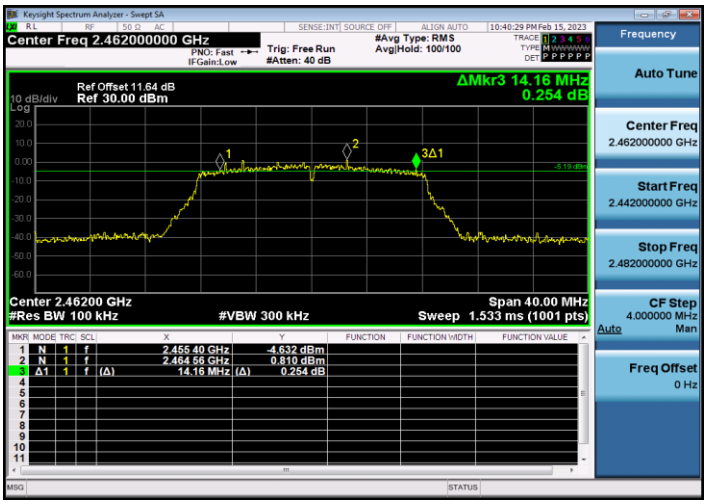

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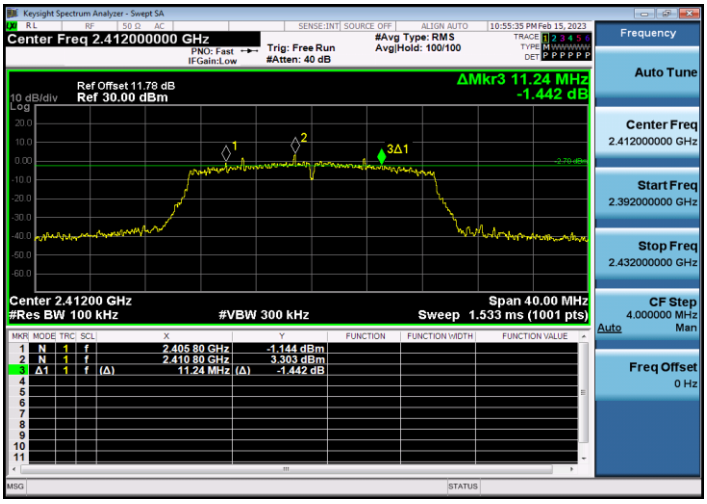
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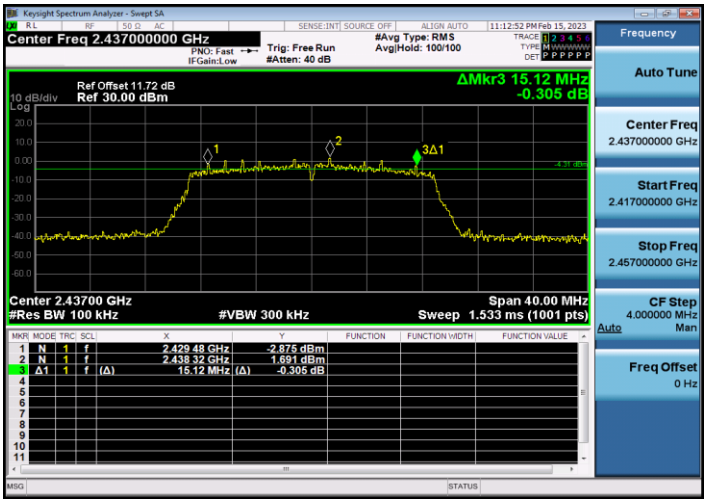
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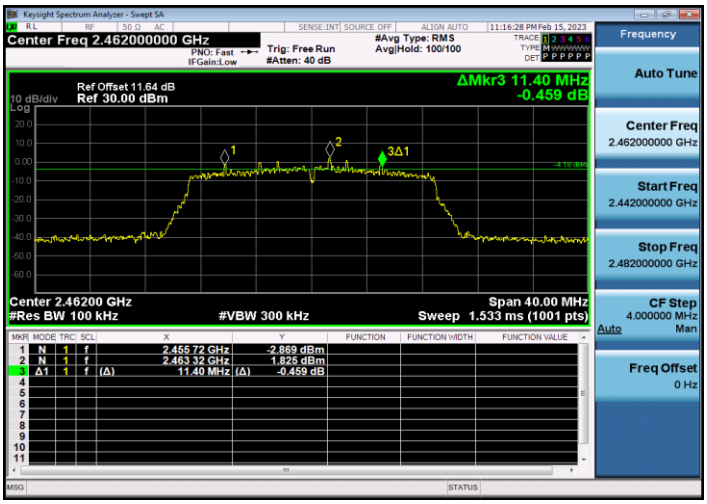
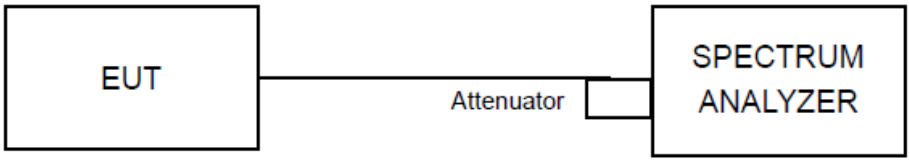


4.3 Conducted Output Power

4.3.1 Limit

For systems using digital modulation in the 2400 – 2483.5 MHz bands: 1 Watt (30 dBm)

4.3.2 Test Setup



4.3.3 Test Procedures

The EUT was tested according to DTS test procedure of “KDB558074 D01 DTS Meas Guidance” for compliance to FCC 47CFR 15.247 requirements (clause 9.2.2.4).

a) Measure the duty cycle, x, of the transmitter output signal as described in Section 6.0.

b) Set span to at least 1.5 OBW.

c) Set RBW = 1 % to 5 % of the OBW, not to exceed 1 MHz.

d) Set VBW ≥ 3 RBW.

e) Number of points in sweep ≥ 2 span / RBW. (This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)

f) Sweep time = auto.

g) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.

h) Do not use sweep triggering. Allow the sweep to “free run”.

i) Trace average at least 100 traces in power averaging (i.e., RMS) mode; however, the number of traces to be averaged shall be increased above 100 as needed such that the average accurately represents the true average over the on and off periods of the transmitter.

j) Compute power by integrating the spectrum across the OBW of the signal using the instrument’s band power measurement function with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

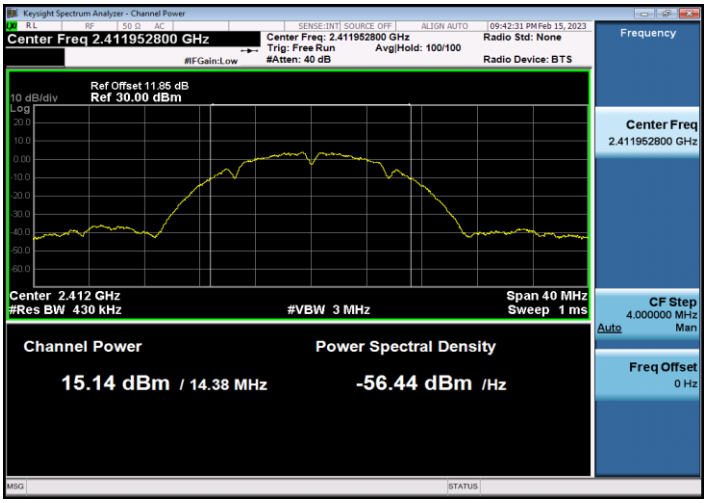
k) Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on- and off-times of the transmission). For example, add 10 log (1/0.25) = 6 dB if the duty cycle is 25 %.

4.3.4 Deviation of Test Standard

No deviation.

4.3.5 Test Results

Test Mode	Antenna	Channel [MHz]	Level [dBm]	10log(1/x) Factor[dB]	Power [dBm]	Limit [dBm]	Verdict
11B	Ant1	2412	15.14	0.07	15.21	<=30	PASS
		2437	14.32	0.07	14.39	<=30	PASS
		2462	13.40	0.10	13.50	<=30	PASS
11G	Ant1	2412	14.47	0.27	14.74	<=30	PASS
		2437	13.52	0.50	14.02	<=30	PASS
		2462	12.41	0.27	12.68	<=30	PASS
11N20SISO	Ant1	2412	13.03	0.35	13.38	<=30	PASS
		2437	12.15	0.29	12.44	<=30	PASS
		2462	11.52	0.35	11.87	<=30	PASS

11B_Ant1_2412

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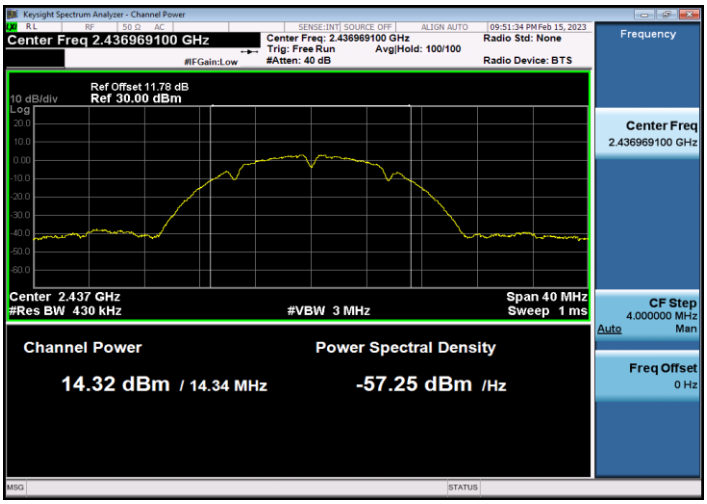
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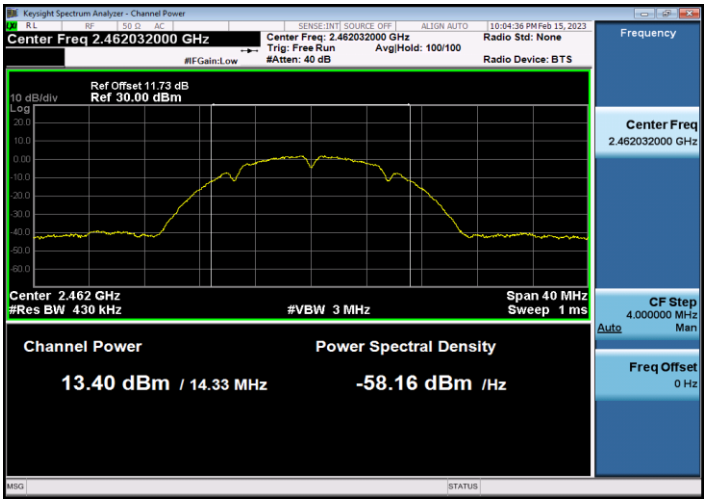

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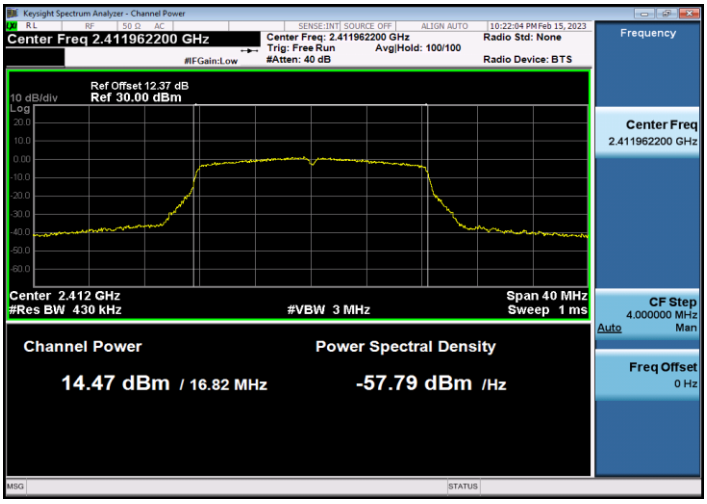
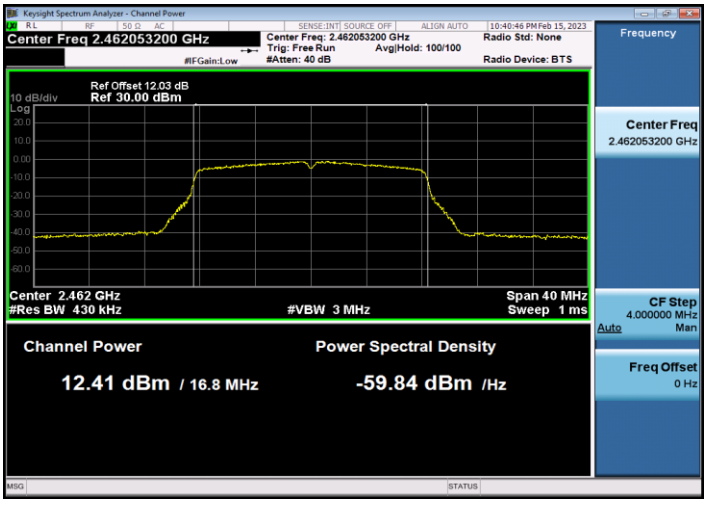


11G_Ant1_2437


11G_Ant1_2462


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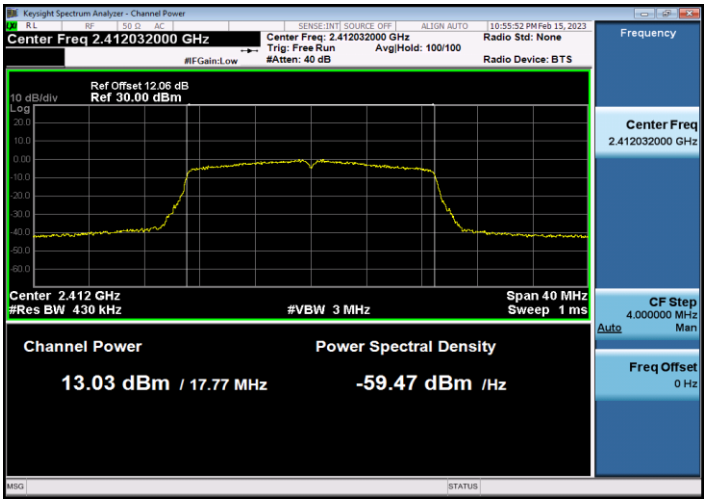

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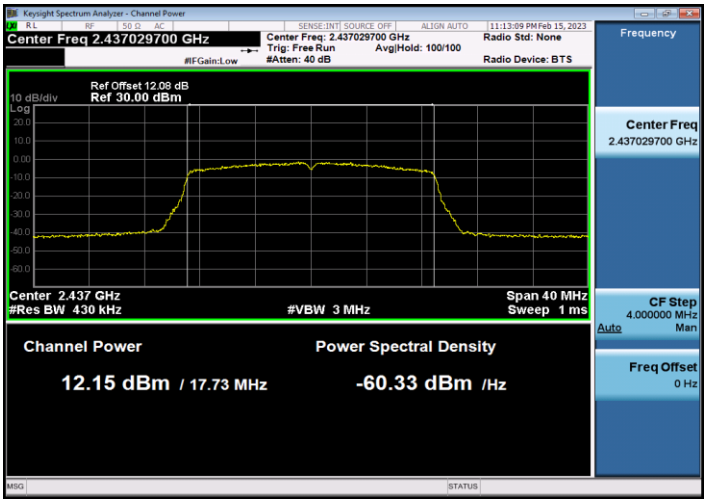

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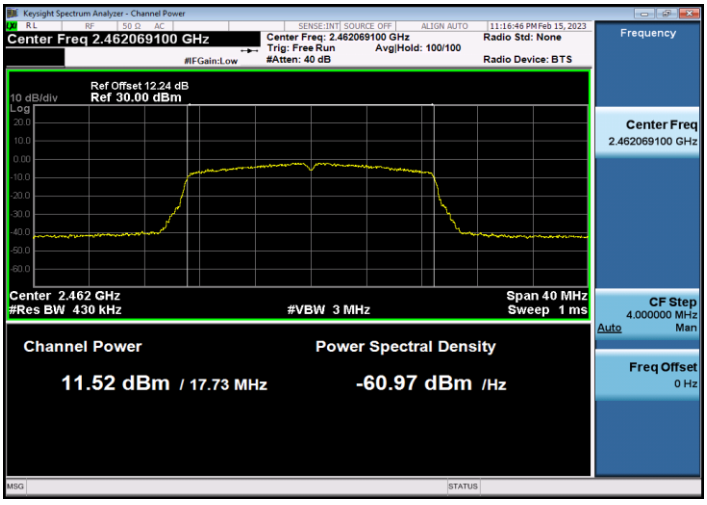
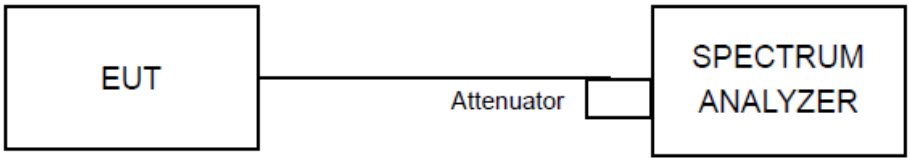


4.4 Power Spectral Density

4.4.1 Limit

The Maximum of Power Spectral Density Measurement is 8 dBm.

4.4.2 Test Setup



4.4.3 Test Procedures

The power output per FCC § 15.247(e) was tested according to DTS test procedure of “KDB558074 D01 DTS Meas Guidance” (clause 10.5) for compliance to FCC 47CFR 15.247 requirements.

a) Set analyzer center frequency to DTS channel center frequency.

b) Set the span to 1.5 times the DTS bandwidth.

c) Set the RBW to: 3 kHz $\leqslant$ RBW $\leqslant$ 100 kHz.

d) Set the VBW $\geqslant$ 3 ×RBW.

e) Detector = peak.

f) Sweep time = auto couple.

g) Trace mode = max hold.

h) Allow trace to fully stabilize.

i) Use the peak marker function to determine the maximum amplitude level within the RBW.

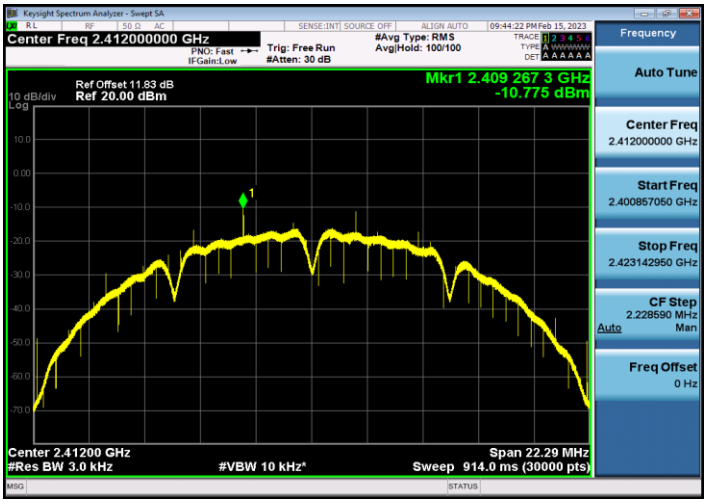
j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

4.4.4 Deviation of Test Standard

No deviation.

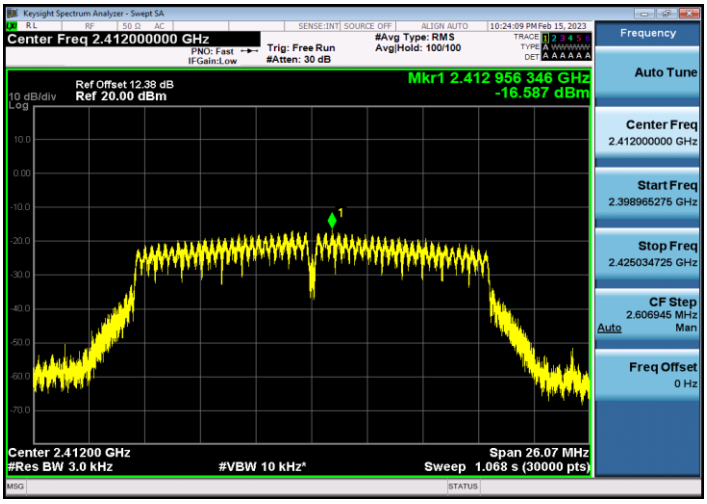
4.4.5 Test Results

Test Mode	Antenna	Channel [MHz]	Level [dBm]	10log(1/x) Factor[dB]	PSD [dBm/3kHz]	Limit [dBm/3kHz]	Verdict
11B	Ant1	2412	-10.78	0.07	-10.71	<=8	PASS
		2437	-15.41	0.07	-15.34	<=8	PASS
		2462	-17.10	0.10	-17.00	<=8	PASS
11G	Ant1	2412	-16.59	0.27	-16.32	<=8	PASS
		2437	-17.72	0.50	-17.22	<=8	PASS
		2462	-18.92	0.27	-18.65	<=8	PASS
11N20SISO	Ant1	2412	-18.52	0.35	-18.17	<=8	PASS
		2437	-18.76	0.29	-18.47	<=8	PASS
		2462	-20.19	0.35	-19.84	<=8	PASS

11B_Ant1_2412


11B_Ant1_2437


11B_Ant1_2462


11G_Ant1_2412

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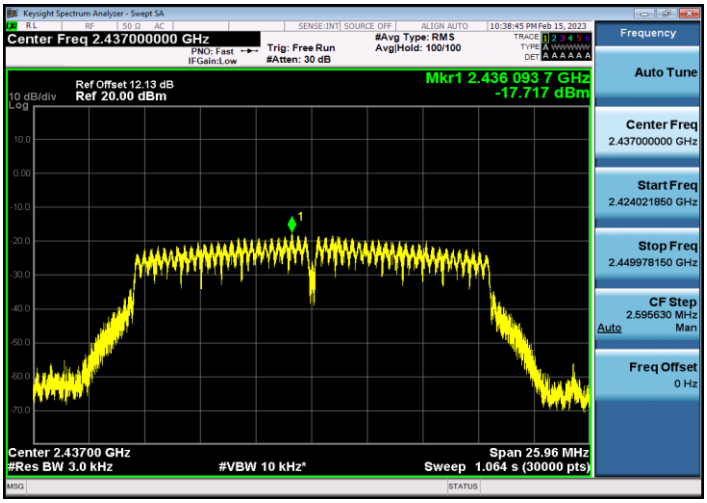
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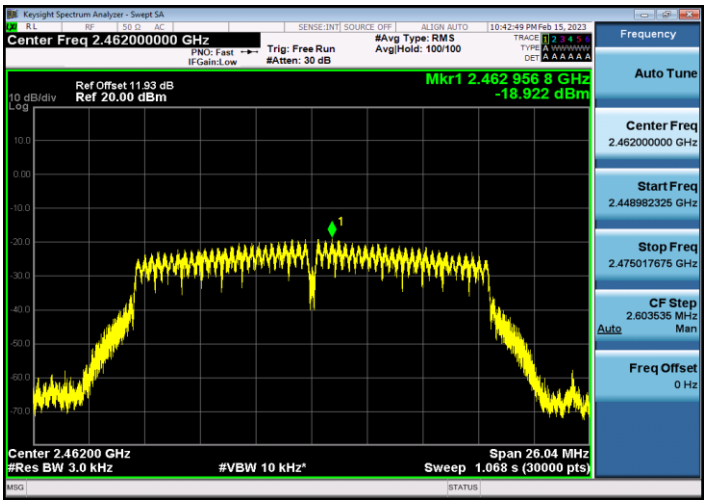

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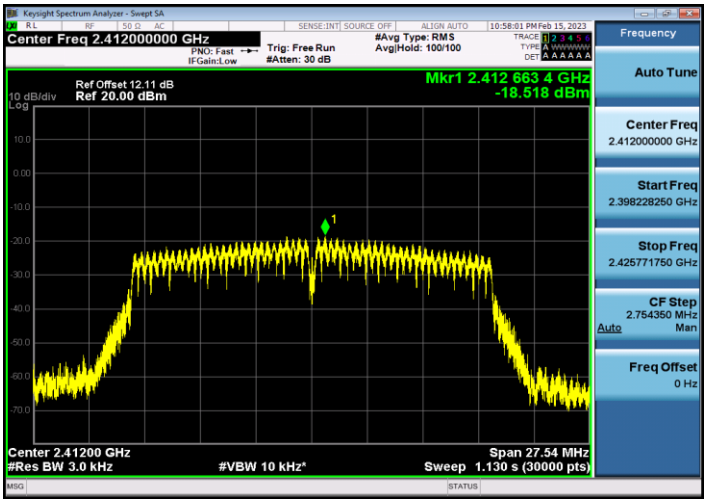
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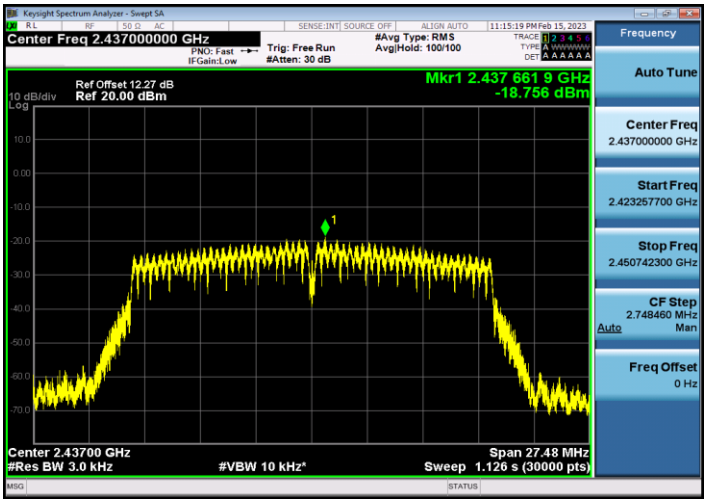
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