FCC PART 15.247

TEST REPORT

For

ControlBright, Inc.

5019 Airport Road, Hermantown, MN 55811 United States

FCC ID: 2AR4F-CBDMX-4

Report Type:	**Equipment Name:**
Original Report	ControlBright

Report Number:	RSC190125001-0C
Date of Report Issue:	2019-04-29
Reviewed By:	Sula Huang
Prepared By:	Bay Area Compliance Laboratories Corp. (Chengdu) No.5040, Huilongwan Plaza, No. 1, Shawan Road, Jinniu District, Chengdu, Sichuan, China Tel: +86-28-65525123 Fax: +86-28-65525125 www.baclcorp.com

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant	ControlBright, Inc.
Product	ControlBright
Tested Models	CB-DMX-4, CB-DMX-1
Multiple Model#	CB-DMX-1xx,CB-DMX-4xx, WIFI-DMX-1xx, WIFI-DMX-4xx (where "x" can be used as "A-Z", or "0-9", or "-1", or blank for software changes and marketing purposes only and the software changes will not change the RF parameters).
FCC ID	2AR4F-CBDMX-4
Wi-Fi Frequency Range	802.11b/g/n-HT20: 2412-2462 MHz 802.11n-HT40: 2422-2452 MHz
Voltage Range	DC 12V from adapter
Measure approximately	202 mm (L) x 104 mm (W) x 44.5 mm (H)
Sample serial number	190125001/01 (assigned by the BACL, Chengdu)
Received date	2019-01-25
Sample/EUT Status	Good condition
Adapter Information	Manufacturer: GOIDEN PROFIT ELECTRONICS LRD Model: GPE024D-120200D Input: AC 100-240V, 50Hz/60Hz, 0.75A Output: DC 12V, 2000mA, 24W

Note: EUT conformed to test requirements and all measurement and test data in this report was gathered from final production sample. It may have deviation from any other sample.

Objective

This report is prepared on behalf of **ControlBright, Inc.** in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communications Commission's rules.

The tests were performed in order to determine the compliance of the EUT with FCC Part 15 Subpart C, section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

No.

Measurement Uncertainty

Item			Uncertainty
AC power line conducted emission			2.93 dB
Radiated Emission(Field Strength)	30MHz-200MHz	H	4.63 dB
		V	4.88 dB
	200MHz-1GHz	H	5.02 dB
		V	6.06 dB
	1GHz-6GHz		4.51 dB
	6GHz-18GHz		4.49 dB
	18GHz-40GHz		5.48 dB
Conducted RF Power			±0.61dB
Power Spectrum Density			±0.61dB
Occupied Bandwidth			±5%
Conducted Emission			±1.5dB
Humidity			±5%
Temperature			±1℃

Note: Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Methodology

All measurements contained in this report were conducted with:

1. ANSI C63.10-2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

2. KDB558074 D01 DTS Meas Guidance v05r02.

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Chengdu) to collect test data is located No.5040, Huilongwan Plaza, No. 1, Shawan Road, Jinniu District, Chengdu, Sichuan, China.

Bay Area Compliance Laboratories Corp. (Chengdu) lab is accredited to ISO/IEC 17025 by A2LA (Lab code: 4324.01) and the FCC designation No. CN1186 under the FCC KDB 974614 D01. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2014.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured in testing mode, which was provided by manufacturer.

For Wi-Fi mode, 802.11b, 802.11g, and 802.11n-HT20 mode, 11 channels are provided to testing:

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

For 802.11b, 802.11g, and 802.11n HT20 modes were tested with Channel 1, 6 and 11.

For 802.11n-HT40 mode, 7 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
3	2422	7	2442
4	2427	8	2447
5	2432	9	2452
6	2437	-	-

802.11n HT40 was tested with Channel 3, 6 and 9.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

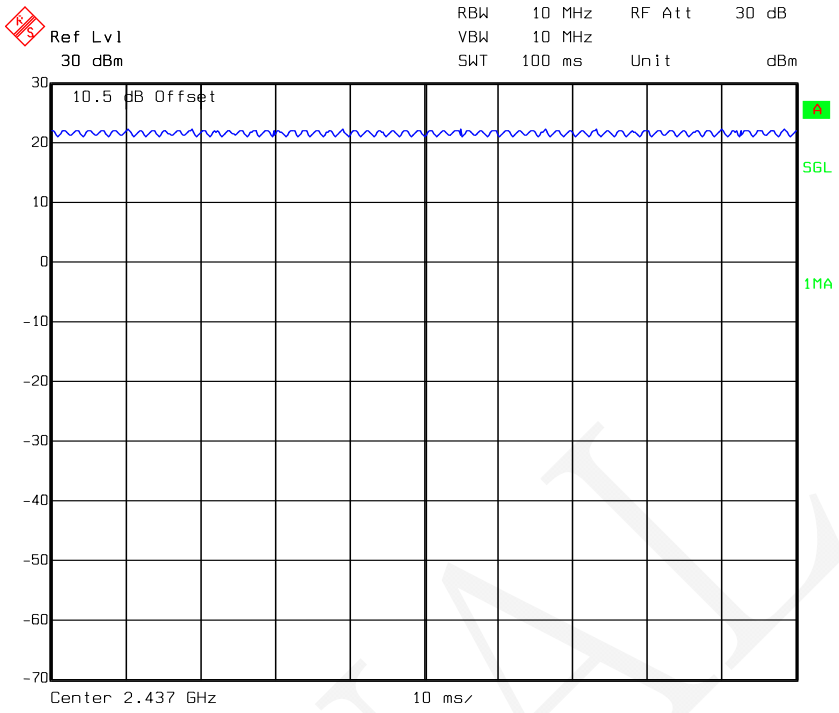
The worst condition (maximum power with maximum duty cycle) was setting by the software as following table:

Test Mode	Test Software Version	RF Test Tool		
802.11b	Test Frequency	2412MHz	2437MHz	2462MHz
	Data Rate	CCK 1M	CCK 1M	CCK 1M
	Power Level	40	40	40
802.11g	Test Frequency	2412MHz	2437MHz	2462MHz
	Data Rate	OFDM 6M	OFDM 6M	OFDM 6M
	Power Level	46	46	46
802.11n-HT20	Test Frequency	2412MHz	2437MHz	2462MHz
	Data Rate	MCS0	MCS0	MCS0
	Power Level	46	46	46
802.11n-HT40	Test Frequency	2422MHz	2437MHz	2452MHz
	Data Rate	MCS0	MCS0	MCS0
	Power Level	46	46	46

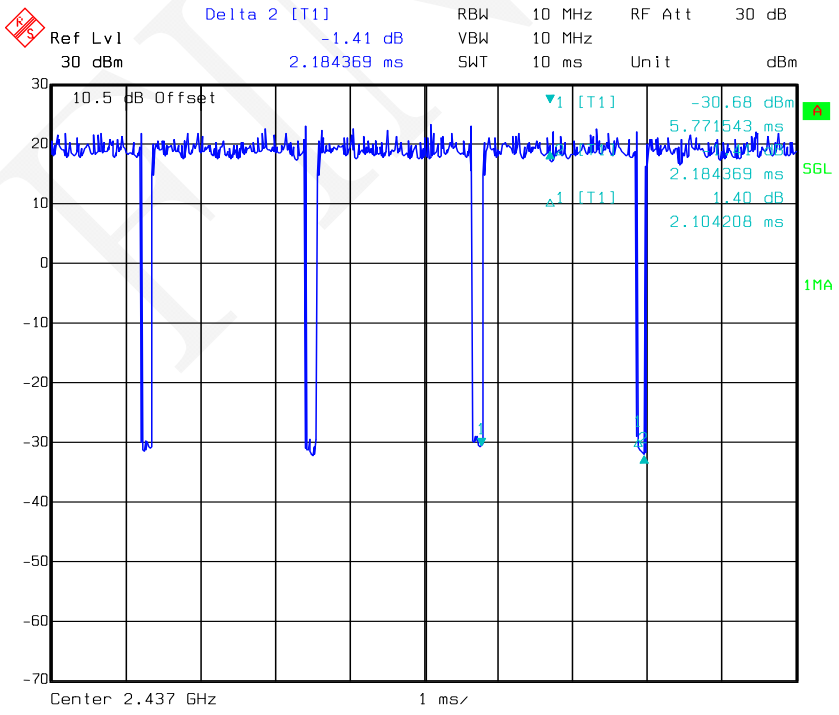
Duty Cycle information is below:

Mode	T_{on} (ms)	T_{on+off} (ms)	Duty Cycle (%)
802.11b	100.00	100.00	100.00
802.11g	2.10	2.18	96.33
802.11n-HT20	1.96	2.04	96.08
802.11n-HT40	0.96	1.08	88.89

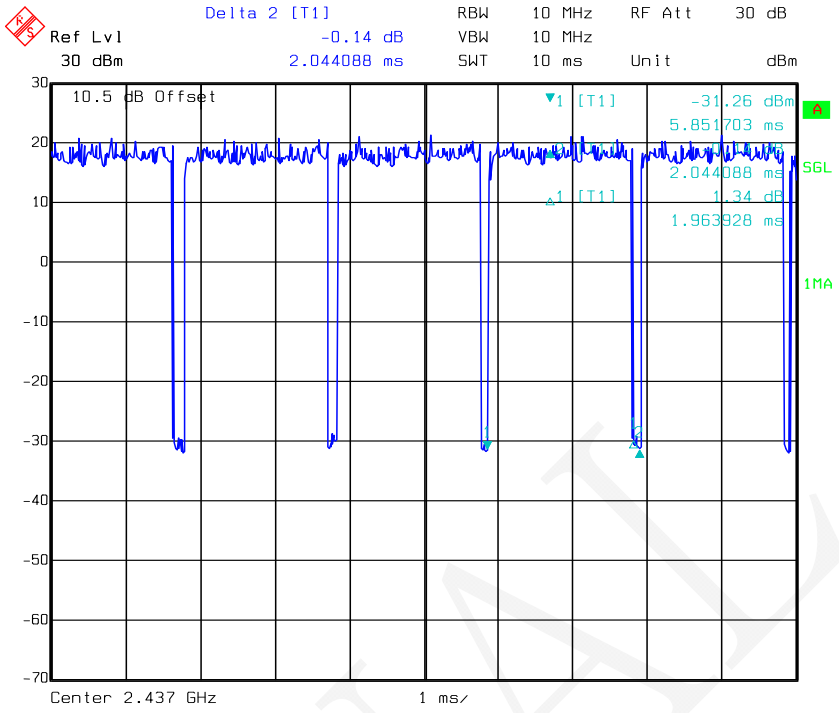
802.11b



802.11g



802.11n-HT20



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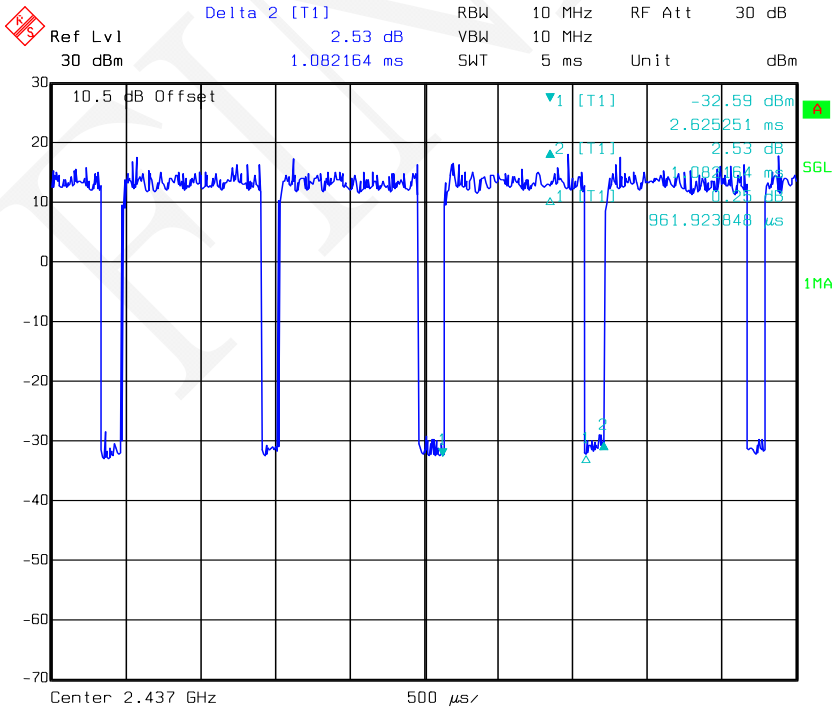
802.11n-HT40



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Support Equipment List and Details

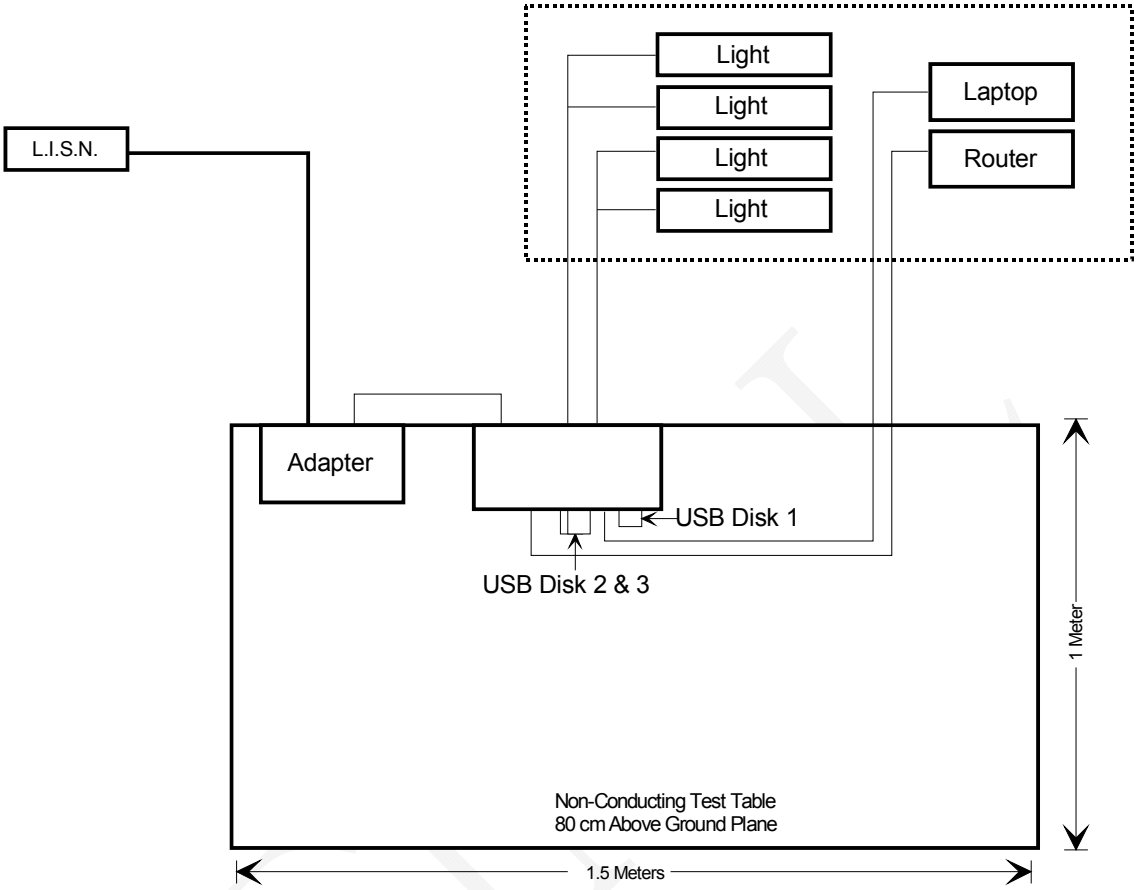
Manufacturer	Description	Model Number	Serial Number
Unknown	USB Disk 1	Unknown	Unknown
Unknown	USB Disk2	Unknown	Unknown
Unknown	USB Disk 2	Unknown	Unknown
DL	Laptop	E75	PCOR364L
Unknown	Light	Unknown	Unknown
ANTER	Router	EGW802	0508350054-1B

External I/O Cable

Cable Description	Length (m)	From	To
Unshielded Power Cable	1.5	EUT	Adapter
Unshielded RJ45 Cable x2	8.0	EUT	Light
Unshielded RJ45 Cable	8.0	EUT	Laptop
Unshielded RJ45 Cable	8.0	EUT	Router

Block Diagram of Test Setup

Conducted Emissions



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
FCC §15.247 & §1.1310 & §2.1091	Maximum Permissible Exposure (MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207 (a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247 (a)(2)	6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	Maximum conducted output power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

Note: For test model: CB-DMX-4, all tests were performed and listed in this report, and multiple model: CB-DMX-1, only AC line conducted emission and radiation emission (below 1GHz) were performed.

TEST EQUIPMENTS LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emission					
Rohde & Schwarz	EMI Test Receiver	ESCI	100028	2018-04-18	2019-04-17
ROHDE&SCHWARZ	L.I.S.N.	ENV216	3560.6550.16	2019-02-25	2020-02-24
HP	RF Limiter	11947A	3107A01270	2018-11-02	2019-11-01
Unknown	Conducted Cable	L-E003	000003	2018-11-02	2019-11-01
Rohde & Schwarz	EMC32	N/A	V 8.52.0	NCR	NCR
Radiated Emission					
EMCT	Semi-Anechoic Chamber	966	001	2017-05-18	2020-05-17
SONOMA INSTRUMENT	Pre-Amplifier	310 N	186684	2018-08-24	2019-08-23
SUNOL SCIENCES	Broadband Antenna	JB3	A121808	2017-05-19	2020-05-18
Rohde & Schwarz	EMI Test Receiver	ESR 3	102456	2018-06-22	2019-06-21
Rohde & Schwarz	Spectrum Analyzer	FSU26	200835	2018-05-09	2019-05-08
A.H. Systems, Inc	Pre-Amplifier	PAM-0118P	467	2018-10-19	2019-10-18
EM Electronics	RF Pre-Amplifier	EM18G40	060725	2019-03-27	2020-03-26
SUNOL SCIENCES	Broadband Antenna	JB3	A121808	2017-05-19	2020-05-18
ETS	Horn Antenna	3115	003-6076	2017-05-19	2020-05-18
A.H. Systems, Inc	Horn Antenna	SAS-574	510	2017-05-19	2020-05-18
INMET	Attenuator	18N-6dB	64671	2018-11-27	2019-11-26
Sinoscite.,Co Ltd	Reject Band Filter	BSF 2402-2480MN	0898-005	2018-11-10	2019-11-09
Unknown	RF Cable (below 1GHz)	L-E005	000005	2018-11-27	2019-11-26
Unknown	RF Cable (below 1GHz)	T-E128	000128	2018-11-27	2019-11-26
Unknown	RF Cable (below 1GHz)	T-E129	000129	2018-11-27	2019-11-26
Unknown	RF Cable (above 1GHz)	T-E069	000069	2018-11-10	2019-11-09
Micro-coax	RF Cable (Above 1GHz)	T-E209	MFR 64639 2310	2019-03-14	2020-03-13
Rohde & Schwarz	EMC32	EMC32	V9.10.00	NCR	NCR

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Rohde & Schwarz	Spectrum Analyzer	FSEM30	100018	2018-05-09	2019-05-08
WEINSCHEL ENGINEERING	Attenuator	1A 10dB	AA4135	2018-11-10	2019-11-09
Agilent	USB Wideband Power Sensor	U2021XA	MY53320008	2019-01-17	2020-01-16
E-Microwave	DC Block	EMDCB-00036	OE01304225	2018-11-27	2019-11-26
Unknown	RF Cable	No	000007	Each Time	Each Time

*** Statement of Traceability:** BACL (Chengdu) attested that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

FCC §15.247 & §1.1310 & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (minutes)**
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f²)	30
30–300	27.5	0.073	0.2	30
300–1500	/	/	f/1500	30
1500–100,000	/	/	1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = PG/4\pi R^2$$

Where:
S = power density (in appropriate units, e.g. mW/cm^2);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

Calculated Data:

Mode	**Frequency Range (MHz)**	**Antenna Gain**		**Tune-up Conducted Power**		**Evaluation Distance (cm)**	**Power Density (mW/cm^2)**	**MPE Limit (mW/cm^2)**
		(dBi)	**(numeric)**	**(dBm)**	**(mW)**			
Wi-Fi	2412-2462	2.00	1.58	22.0	158.49	20	0.050	1.00

Result: The device meets MPE at distance 20cm.

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 15.203, 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 shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

a. Antenna must be permanently attached to the unit.
b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

Antenna Connector Construction

The device use one external antenna with one reverse female SMA connector and the antenna gain is 2dBi, fulfill the requirement of this section. Please refer to the EUT photos.

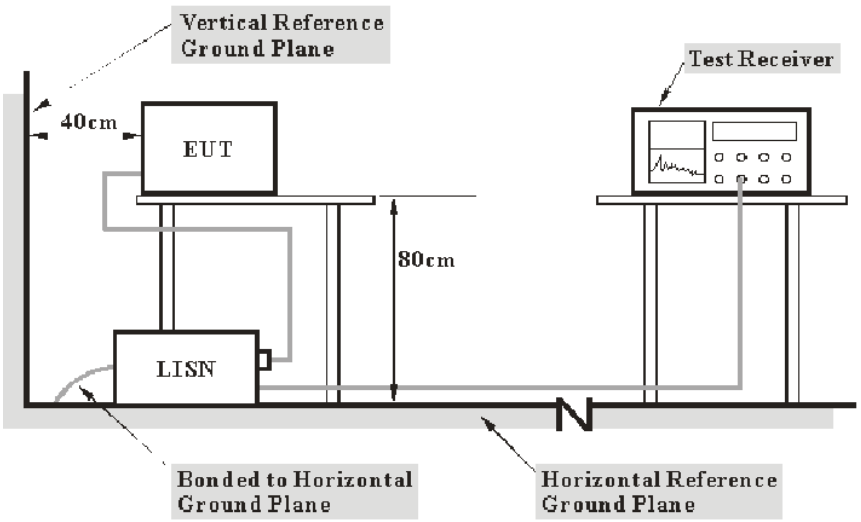
Result: Compliance

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

The spacing between the peripherals was 10 cm.

The adapter was connected to AC 120V/60Hz.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the first L.I.S.N.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data was recorded in the Quasi-peak and average detection mode.

Corrected Amplitude & Margin Calculation

The basic equation is as follows:

$V_C = V_R + A_C + VDF$
$C_f = A_C + VDF$

Herein,
V_C (cord. Reading): corrected voltage amplitude
V_R: reading voltage amplitude
A_c: attenuation caused by cable loss
VDF: voltage division factor of AMN
C_f: Correction Factor

The "**Margin**" column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin = Limit – Corrected Amplitude

Test Data

Environmental Conditions

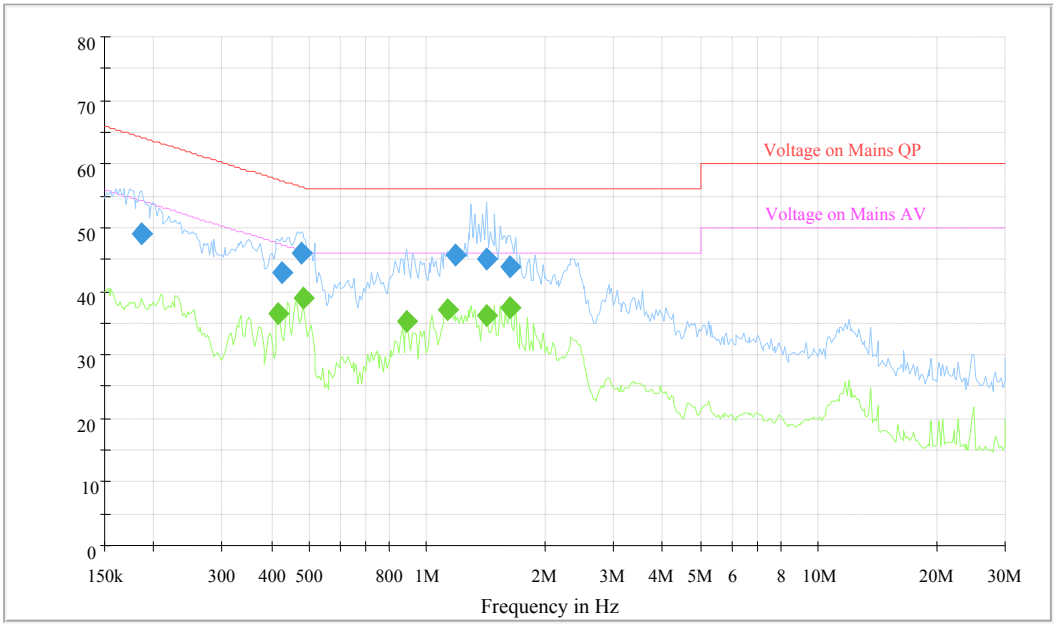
Temperature:	20 °C
Relative Humidity:	48 %
ATM Pressure:	96.5 kPa

The testing was performed by Tom Tang on 2019-03-12.

Test Mode: Transmitting (802.11n20-Low channel - Worst Case)

Model: CB-DMX-4

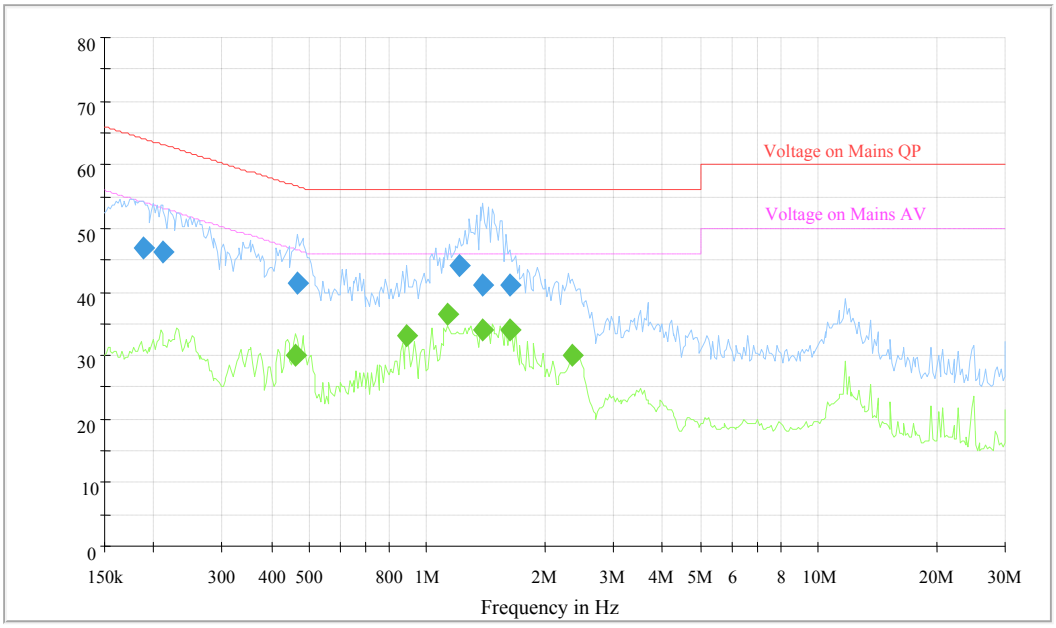
AC120 V, 60 Hz, Line:



Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.186708	49.1	100.0	9.000	L1	19.6	15.1	64.2
0.426418	43.0	100.0	9.000	L1	19.6	14.3	57.3
0.475741	46.0	100.0	9.000	L1	19.6	10.4	56.4
1.176565	45.7	100.0	9.000	L1	19.6	10.3	56.0
1.421419	45.2	100.0	9.000	L1	19.6	10.8	56.0
1.633884	43.9	100.0	9.000	L1	19.6	12.1	56.0

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.418016	36.4	100.0	9.000	L1	19.6	11.1	47.5
0.480499	38.9	100.0	9.000	L1	19.6	7.4	46.3
0.890466	35.2	100.0	9.000	L1	19.6	10.8	46.0
1.130656	37.0	100.0	9.000	L1	19.6	9.0	46.0
1.421419	36.2	100.0	9.000	L1	19.6	9.8	46.0
1.633884	37.5	100.0	9.000	L1	19.6	8.5	46.0

AC120 V, 60 Hz, Neutral:

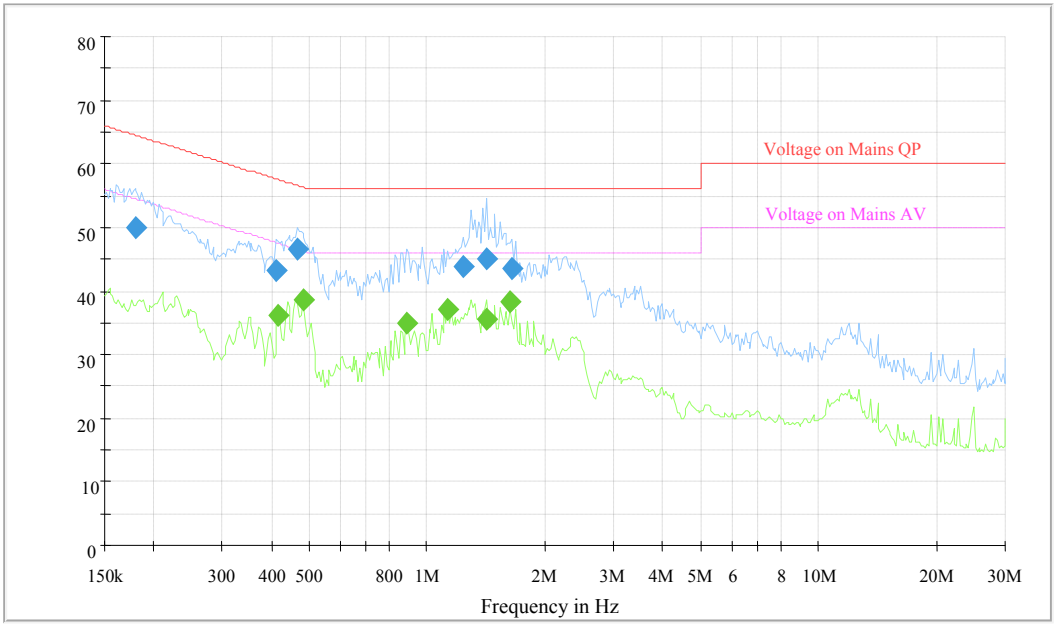


Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.188575	46.8	100.0	9.000	N	19.6	17.3	64.1
0.210387	46.3	100.0	9.000	N	19.6	16.9	63.2
0.466367	41.5	100.0	9.000	N	19.6	15.1	56.6
1.212216	44.1	100.0	9.000	N	19.7	11.9	56.0
1.393411	41.1	100.0	9.000	N	19.6	14.9	56.0
1.633884	41.2	100.0	9.000	N	19.6	14.8	56.0

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.461750	30.0	100.0	9.000	N	19.6	16.7	46.7
0.890466	33.1	100.0	9.000	N	19.6	12.9	46.0
1.130656	36.5	100.0	9.000	N	19.7	9.5	46.0
1.393411	34.0	100.0	9.000	N	19.6	12.0	46.0
1.633884	34.2	100.0	9.000	N	19.6	11.8	46.0
2.361088	30.0	100.0	9.000	N	19.6	16.0	46.0

Model: CB-DMX-1

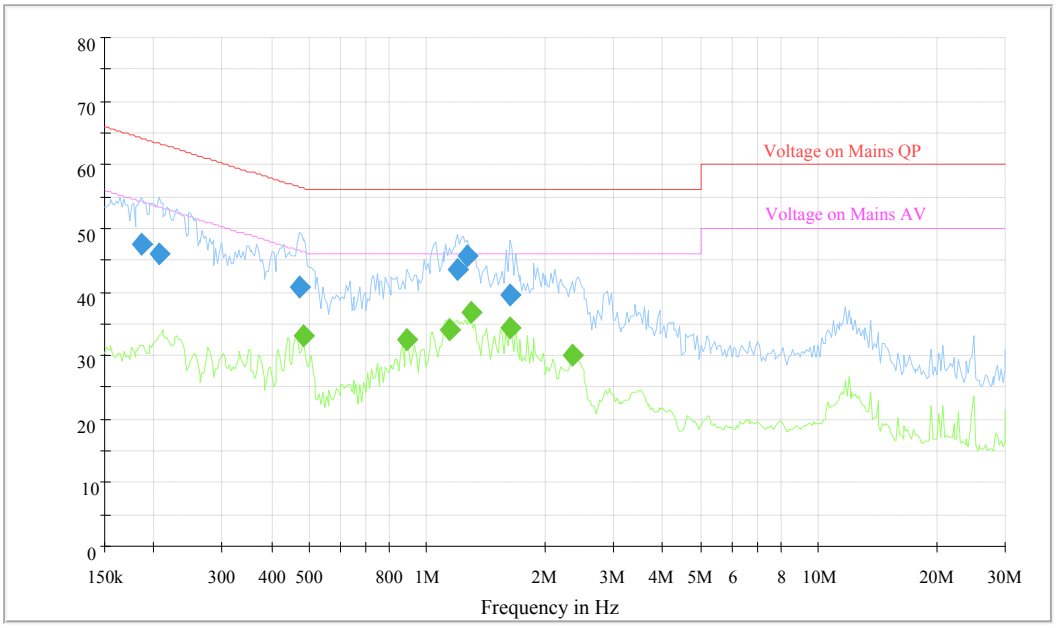
AC120V/60Hz, Line



Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.179422	50.1	100.0	9.000	L1	19.6	14.4	64.5
0.413877	43.2	100.0	9.000	L1	19.6	14.4	57.6
0.466367	46.6	100.0	9.000	L1	19.6	10.0	56.6
1.236582	43.9	100.0	9.000	L1	19.6	12.1	56.0
1.421419	45.0	100.0	9.000	L1	19.6	11.0	56.0
1.650223	43.5	100.0	9.000	L1	19.6	12.5	56.0

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.418016	36.2	100.0	9.000	L1	19.6	11.2	47.5
0.480499	38.7	100.0	9.000	L1	19.6	7.6	46.3
0.890466	34.9	100.0	9.000	L1	19.6	11.1	46.0
1.130656	37.2	100.0	9.000	L1	19.6	8.8	46.0
1.421419	35.6	100.0	9.000	L1	19.6	10.4	46.0
1.633884	38.2	100.0	9.000	L1	19.6	7.8	46.0

AC120V/60Hz, Neutral



Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.186708	47.5	100.0	9.000	N	19.6	16.7	64.2
0.206241	45.8	100.0	9.000	N	19.6	17.6	63.4
0.471031	40.6	100.0	9.000	N	19.6	15.9	56.5
1.200214	43.5	100.0	9.000	N	19.7	12.5	56.0
1.261437	45.6	100.0	9.000	N	19.7	10.4	56.0
1.633884	39.6	100.0	9.000	N	19.6	16.4	56.0

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.480499	33.2	100.0	9.000	N	19.6	13.1	46.3
0.890466	32.5	100.0	9.000	N	19.6	13.5	46.0
1.141962	33.9	100.0	9.000	N	19.7	12.1	46.0
1.299660	36.9	100.0	9.000	N	19.7	9.1	46.0
1.633884	34.3	100.0	9.000	N	19.6	11.7	46.0
2.361088	30.1	100.0	9.000	N	19.6	15.9	46.0

Note:
1) Correction Factor =LISN VDF (Voltage Division Factor) + Cable Loss + Transient Limiter Attenuation
The corrected factor has been input into the transducer of the test software.
2) Corrected Amplitude = Reading + Correction Factor
3) Margin = Limit – Corrected Amplitude

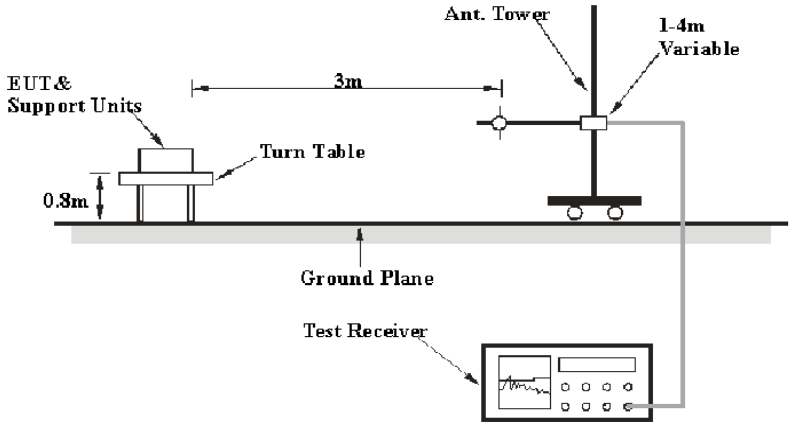
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

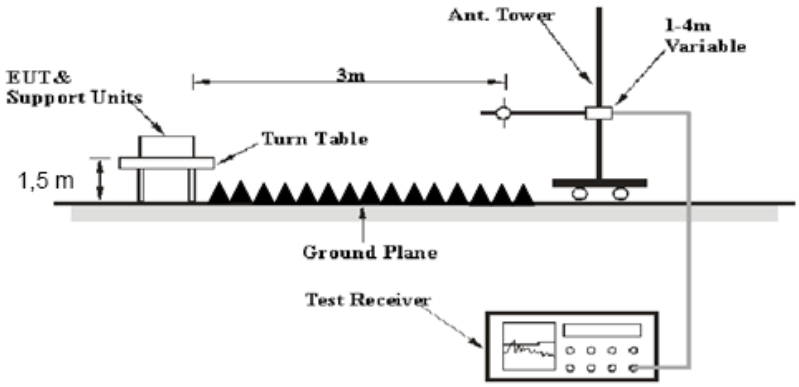
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

Below 1GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters chamber test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.

The adapter was connected to AC 120V/60Hz.

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver Setup was set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Detector
30 MHz–1000 MHz	120 kHz	300 kHz	120 kHz	QP
Above 1GHz	1MHz	3 MHz	/	PK
	1MHz	3 MHz	/	AV

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection modes for frequencies above 1 GHz.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Loss and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Corrected Amplitude = Meter Reading + Antenna Loss + Cable Loss - Amplifier Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin = Limit –Corrected Amplitude

Test Data

Environmental Conditions

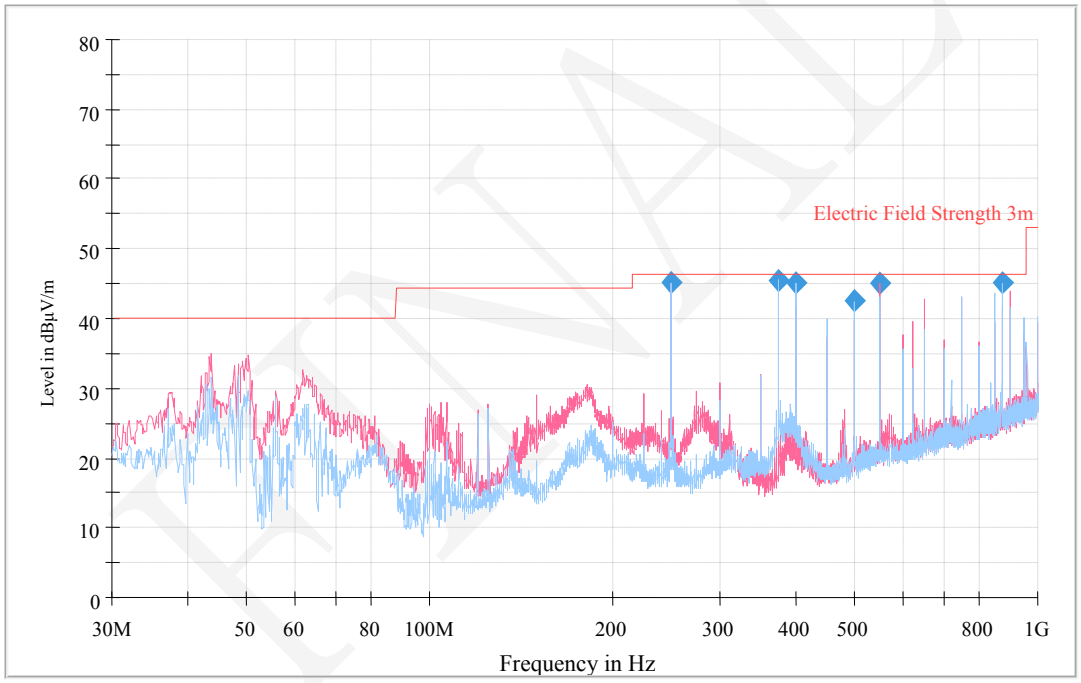
Temperature:	19 °C
Relative Humidity:	46 %
ATM Pressure:	95.8 kPa

The testing was performed by Tom Tang on 2019-04-10.

Test Mode: Transmitting

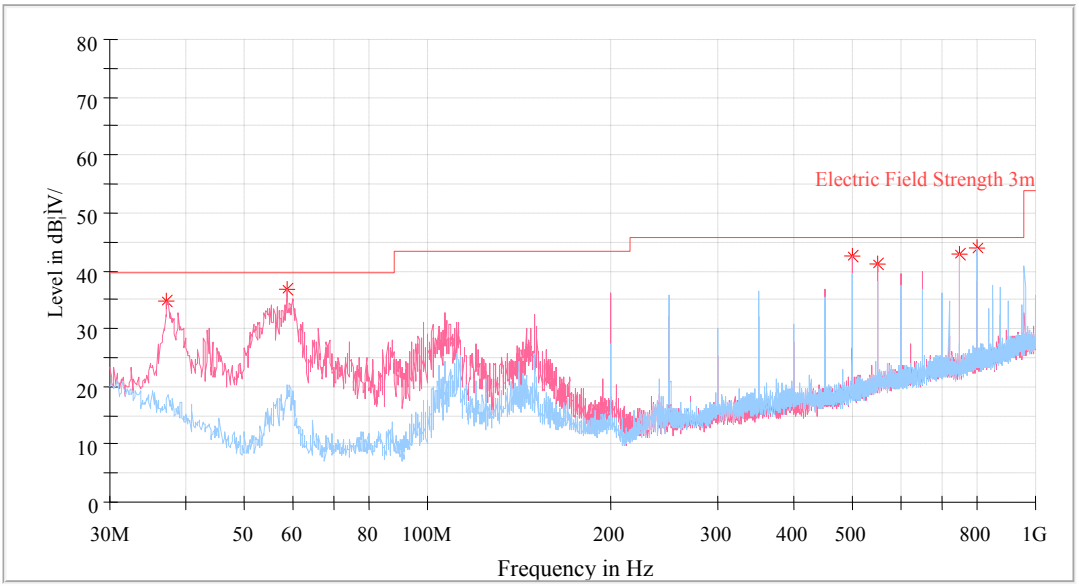
30 MHz to 1 GHz (802.11b-High channel - Worst Case)

Model: CB-DMX-4



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Polarization	Azimuth (deg)	Corrected Factor (dB/m)
249.947500	43.75	46.00	2.25	100.0	V	342.0	-12.4
374.956250	45.04	46.00	0.96	100.0	H	268.0	-9.0
400.055000	45.34	46.00	0.66	100.0	H	118.0	-8.6
499.965000	43.46	46.00	2.54	100.0	H	290.0	-6.8
550.041250	45.11	46.00	0.89	100.0	V	77.0	-5.2
874.991250	45.11	46.00	0.89	100.0	H	341.0	-0.1

Model: CB-DMX-1



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Polarization	Azimuth (deg)	Corrected Factor (dB/m)
37.275000	34.91	40.00	5.09	100.0	V	288.0	-9.3
58.736250	36.95	40.00	3.05	100.0	V	108.0	-17.3
499.965000	42.63	46.00	3.37	100.0	V	145.0	-6.8
550.041250	41.14	46.00	4.86	100.0	V	173.0	-5.2
750.103750	42.79	46.00	3.21	100.0	H	238.0	-2.8
800.058750	44.04	46.00	1.96	100.0	H	355.0	-1.4

Above 1 GHz

802.11b Mode

Frequency	Receiver		Rx Antenna		Cable loss	Amplifier Gain	Corrected Amplitude	Limit	Margin
	Reading	Measurement	Polar	Factor					
MHz	dBµV	PK/AV	H/V	(dB/m)	dB	dB	dBµV/m	dBµV/m	dB
Frequency: 2412MHz									
2412	70.27	PK	H	28.74	3.07	0.00	102.08	N/A	N/A
2412	65.79	AV	H	28.74	3.07	0.00	97.60	N/A	N/A
2412	73.87	PK	V	28.74	3.07	0.00	105.68	N/A	N/A
2412	68.92	AV	V	28.74	3.07	0.00	100.73	N/A	N/A
2390	28.34	PK	V	28.67	3.06	0.00	60.07	74.00	13.93
2390	16.09	AV	V	28.67	3.06	0.00	47.82	54.00	6.18
4824	65.38	PK	V	33.91	4.36	44.72	58.93	74.00	15.07
4824	55.19	AV	V	33.91	4.36	44.72	48.74	54.00	5.26
7236	55.52	PK	V	36.43	5.42	44.00	53.37	74.00	20.63
7236	49.61	AV	V	36.43	5.42	44.00	47.46	54.00	6.54
Frequency: 2437MHz									
2437	71.98	PK	H	28.81	3.09	0.00	103.88	N/A	N/A
2437	67.39	AV	H	28.81	3.09	0.00	99.29	N/A	N/A
2437	74.76	PK	V	28.81	3.09	0.00	106.66	N/A	N/A
2437	69.93	AV	V	28.81	3.09	0.00	101.83	N/A	N/A
4874	66.99	PK	V	34.05	4.39	44.72	60.71	74.00	13.29
4874	56.42	AV	V	34.05	4.39	44.72	50.14	54.00	3.86
7311	57.43	PK	V	36.54	5.44	44.20	55.21	74.00	18.79
7311	49.17	AV	V	36.54	5.44	44.20	46.95	54.00	7.05
Frequency: 2462MHz									
2462	73.99	PK	H	28.89	3.10	0.00	105.98	N/A	N/A
2462	69.14	AV	H	28.89	3.10	0.00	101.13	N/A	N/A
2462	76.21	PK	V	28.89	3.10	0.00	108.20	N/A	N/A
2462	71.34	AV	V	28.89	3.10	0.00	103.33	N/A	N/A
2483.5	29.84	PK	V	28.95	3.12	0.00	61.91	74.00	12.09
2483.5	17.24	AV	V	28.95	3.12	0.00	49.31	54.00	4.69
4924	69.16	PK	V	34.19	4.42	44.71	63.06	74.00	10.94
4924	57.94	AV	V	34.19	4.42	44.71	51.84	54.00	**2.16**
7386	59.46	PK	V	36.64	5.46	44.40	57.16	74.00	16.84
7386	48.93	AV	V	36.64	5.46	44.40	46.63	54.00	7.37

802.11g Mode

Frequency	Receiver		Rx Antenna		Cable loss	Amplifier Gain	Corrected Amplitude	Limit	Margin
	Reading	Measurement	Polar	Factor					
MHz	dBµV	PK/AV	H/V	(dB/m)	dB	dB	dBµV/m	dBµV/m	dB
Frequency: 2412MHz									
2412	70.46	PK	H	28.74	3.07	0.00	102.27	N/A	N/A
2412	59.31	AV	H	28.74	3.07	0.00	91.12	N/A	N/A
2412	72.25	PK	V	28.74	3.07	0.00	104.06	N/A	N/A
2412	62.05	AV	V	28.74	3.07	0.00	93.86	N/A	N/A
2390	28.55	PK	V	28.67	3.06	0.00	60.28	74.00	13.72
2390	16.04	AV	V	28.67	3.06	0.00	47.77	54.00	6.23
4824	63.61	PK	V	33.91	4.36	44.72	57.16	74.00	16.84
4824	49.96	AV	V	33.91	4.36	44.72	43.51	54.00	10.49
7236	57.82	PK	V	36.43	5.42	44.00	55.67	74.00	18.33
7236	42.42	AV	V	36.43	5.42	44.00	40.27	54.00	13.73
Frequency: 2437MHz									
2437	71.15	PK	H	28.81	3.09	0.00	103.05	N/A	N/A
2437	60.52	AV	H	28.81	3.09	0.00	92.42	N/A	N/A
2437	73.52	PK	V	28.81	3.09	0.00	105.42	N/A	N/A
2437	63.21	AV	V	28.81	3.09	0.00	95.11	N/A	N/A
4874	67.01	PK	V	34.05	4.39	44.72	60.73	74.00	13.27
4874	52.60	AV	V	34.05	4.39	44.72	46.32	54.00	7.68
7311	61.26	PK	V	36.54	5.44	44.20	59.04	74.00	14.96
7311	45.41	AV	V	36.54	5.44	44.20	43.19	54.00	10.81
Frequency: 2462MHz									
2462	71.82	PK	H	28.89	3.10	0.00	103.81	N/A	N/A
2462	61.49	AV	H	28.89	3.10	0.00	93.48	N/A	N/A
2462	74.74	PK	V	28.89	3.10	0.00	106.73	N/A	N/A
2462	64.22	AV	V	28.89	3.10	0.00	96.21	N/A	N/A
2483.5	33.12	PK	V	28.95	3.12	0.00	65.19	74.00	8.81
2483.5	17.62	AV	V	28.95	3.12	0.00	49.69	54.00	4.31
4924	70.24	PK	V	34.19	4.42	44.71	64.14	74.00	9.86
4924	54.84	AV	V	34.19	4.42	44.71	48.74	54.00	5.26
7386	64.14	PK	V	36.64	5.46	44.40	61.84	74.00	12.16
7386	48.26	AV	V	36.64	5.46	44.40	45.96	54.00	8.04

802.11n-HT20 Mode

Frequency	Receiver		Rx Antenna		Cable loss	Amplifier Gain	Corrected Amplitude	Limit	Margin
	Reading	Measurement	Polar	Factor					
MHz	dBµV	PK/AV	H/V	(dB/m)	dB	dB	dBµV/m	dBµV/m	dB
Frequency: 2412MHz									
2412	69.27	PK	H	28.74	3.07	0.00	101.08	N/A	N/A
2412	58.89	AV	H	28.74	3.07	0.00	90.70	N/A	N/A
2412	72.28	PK	V	28.74	3.07	0.00	104.09	N/A	N/A
2412	61.86	AV	V	28.74	3.07	0.00	93.67	N/A	N/A
2390	28.75	PK	V	28.67	3.06	0.00	60.48	74.00	13.52
2390	16.14	AV	V	28.67	3.06	0.00	47.87	54.00	6.13
4824	63.89	PK	V	33.91	4.36	44.72	57.44	74.00	16.56
4824	49.68	AV	V	33.91	4.36	44.72	43.23	54.00	10.77
7236	58.26	PK	V	36.43	5.42	44.00	56.11	74.00	17.89
7236	42.07	AV	V	36.43	5.42	44.00	39.92	54.00	14.08
Frequency: 2437MHz									
2437	69.99	PK	H	28.81	3.09	0.00	101.89	N/A	N/A
2437	59.13	AV	H	28.81	3.09	0.00	91.03	N/A	N/A
2437	73.44	PK	V	28.81	3.09	0.00	105.34	N/A	N/A
2437	62.86	AV	V	28.81	3.09	0.00	94.76	N/A	N/A
4874	66.33	PK	V	34.05	4.39	44.72	60.05	74.00	13.95
4874	52.14	AV	V	34.05	4.39	44.72	45.86	54.00	8.14
7311	60.92	PK	V	36.54	5.44	44.20	58.70	74.00	15.30
7311	44.96	AV	V	36.54	5.44	44.20	42.74	54.00	11.26
Frequency: 2462MHz									
2462	70.87	PK	H	28.89	3.10	0.00	102.86	N/A	N/A
2462	59.68	AV	H	28.89	3.10	0.00	91.67	N/A	N/A
2462	74.61	PK	V	28.89	3.10	0.00	106.60	N/A	N/A
2462	63.94	AV	V	28.89	3.10	0.00	95.93	N/A	N/A
2483.5	33.68	PK	V	28.95	3.12	0.00	65.75	74.00	8.25
2483.5	17.78	AV	V	28.95	3.12	0.00	49.85	54.00	4.15
4924	68.84	PK	V	34.19	4.42	44.71	62.74	74.00	11.26
4924	54.94	AV	V	34.19	4.42	44.71	48.84	54.00	5.16
7386	64.11	PK	V	36.64	5.46	44.40	61.81	74.00	12.19
7386	48.27	AV	V	36.64	5.46	44.40	45.97	54.00	8.03

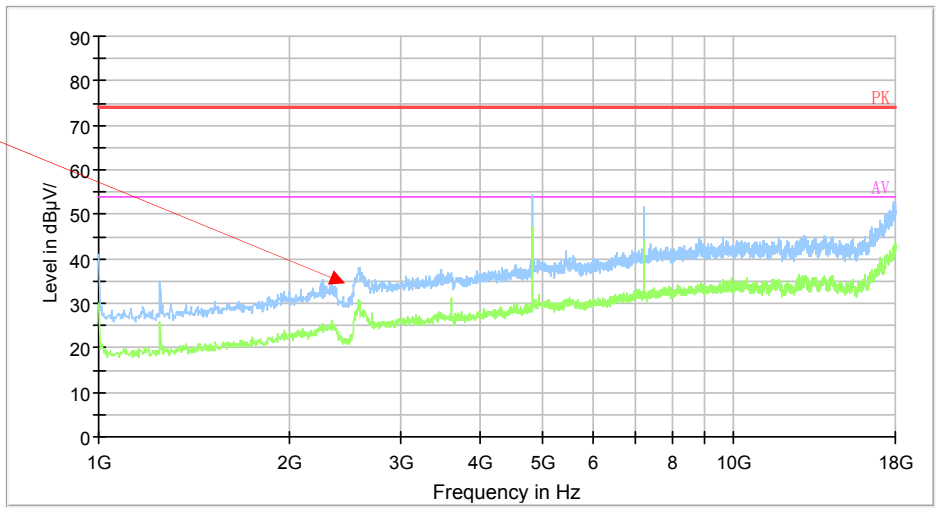
802.11n-HT40 Mode

Frequency	Receiver		Rx Antenna		Cable loss	Amplifier Gain	Corrected Amplitude	Limit	Margin
	Reading	Measurement	Polar	Factor					
MHz	dBμV	PK/AV	H/V	(dB/m)	dB	dB	dBμV/m	dBμV/m	dB
Frequency: 2422MHz									
2422	65.05	PK	H	28.77	3.08	0.00	96.90	N/A	N/A
2422	53.54	AV	H	28.77	3.08	0.00	85.39	N/A	N/A
2422	70.28	PK	V	28.77	3.08	0.00	102.13	N/A	N/A
2422	58.71	AV	V	28.77	3.08	0.00	90.56	N/A	N/A
2390	27.79	PK	V	28.67	3.06	0.00	59.52	74.00	14.48
2390	16.53	AV	V	28.67	3.06	0.00	48.26	54.00	5.74
4844	61.64	PK	V	33.96	4.38	44.72	55.26	74.00	18.74
4844	47.16	AV	V	33.96	4.38	44.72	40.78	54.00	13.22
7266	55.36	PK	V	36.47	5.43	44.08	53.18	74.00	20.82
7266	39.36	AV	V	36.47	5.43	44.08	37.18	54.00	16.82
Frequency: 2437MHz									
2437	66.25	PK	H	28.81	3.09	0.00	98.15	N/A	N/A
2437	55.08	AV	H	28.81	3.09	0.00	86.98	N/A	N/A
2437	70.60	PK	V	28.81	3.09	0.00	102.50	N/A	N/A
2437	59.18	AV	V	28.81	3.09	0.00	91.08	N/A	N/A
4874	62.61	PK	V	34.05	4.39	44.72	56.33	74.00	17.67
4874	48.40	AV	V	34.05	4.39	44.72	42.12	54.00	11.88
7311	56.59	PK	V	36.54	5.44	44.20	54.37	74.00	19.63
7311	40.88	AV	V	36.54	5.44	44.20	38.66	54.00	15.34
Frequency: 2452MHz									
2452	67.77	PK	H	28.86	3.10	0.00	99.73	N/A	N/A
2452	57.05	AV	H	28.86	3.10	0.00	89.01	N/A	N/A
2452	71.25	PK	V	28.86	3.10	0.00	103.21	N/A	N/A
2452	59.91	AV	V	28.86	3.10	0.00	91.87	N/A	N/A
2483.5	33.79	PK	V	28.95	3.12	0.00	65.86	74.00	8.14
2483.5	18.45	AV	V	28.95	3.12	0.00	50.52	54.00	3.48
4904	63.86	PK	V	34.13	4.41	44.71	57.69	74.00	16.31
4904	49.81	AV	V	34.13	4.41	44.71	43.64	54.00	10.36
7356	58.16	PK	V	36.60	5.45	44.32	55.89	74.00	18.11
7356	42.42	AV	V	36.60	5.45	44.32	40.15	54.00	13.85

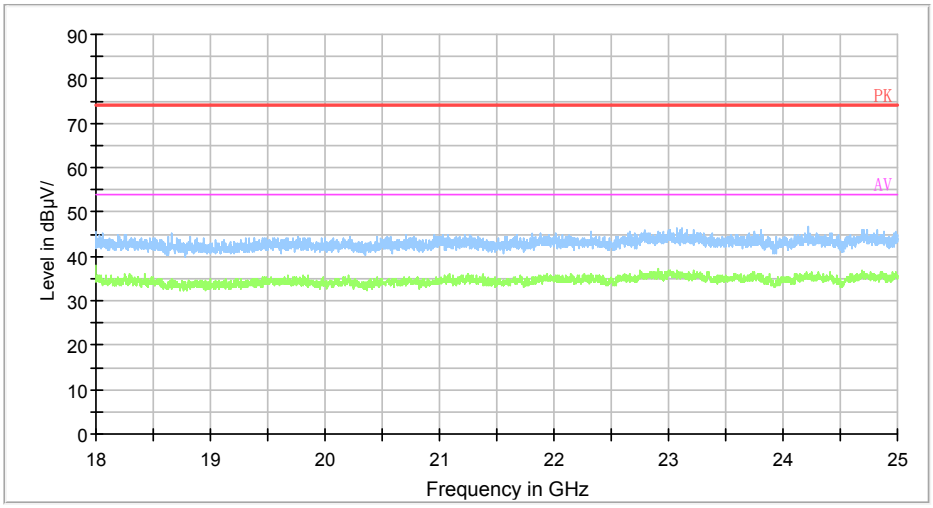
Please refer to the below pre-scan plot of worst case:

802.11b Mode: High Channel_Horizontal_1GHz-18GHz

Fundamental with Reject Band Filter

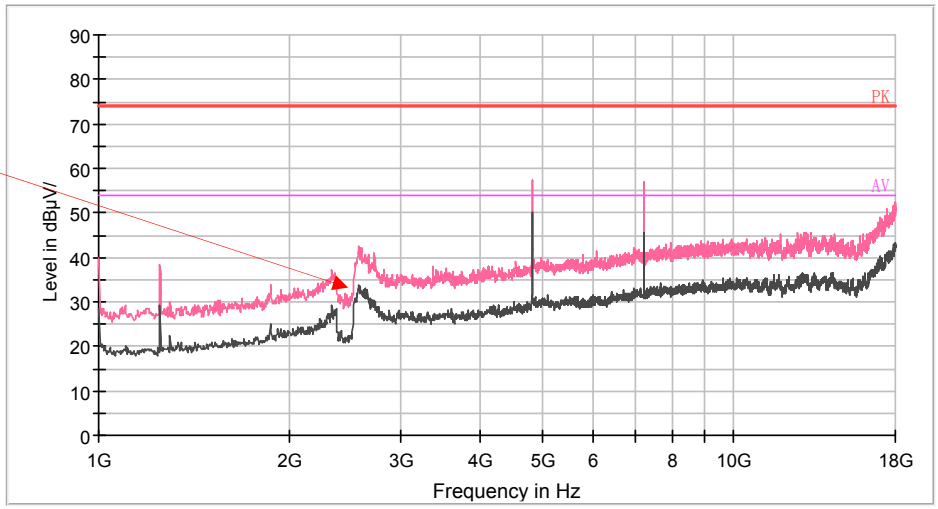


802.11b Mode: High Channel_Horizontal_18GHz-25GHz

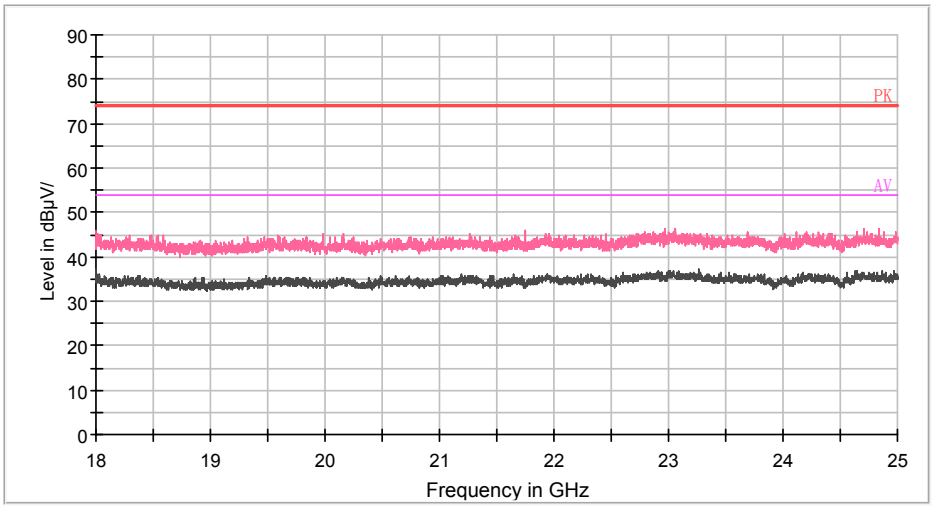


802.11b Mode: High Channel_Vertical_1GHz-18GHz

Fundamental with Reject Band Filter



802.11b Mode: High Channel_Vertical_18GHz-25GHz



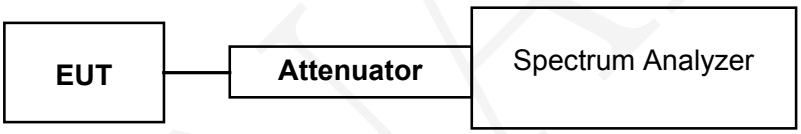
FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH

Applicable Standard

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Procedure

a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3×RBW
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.



Test Data

Environmental Conditions

Temperature:	19 °C
Relative Humidity:	50 %
ATM Pressure:	95.8 kPa

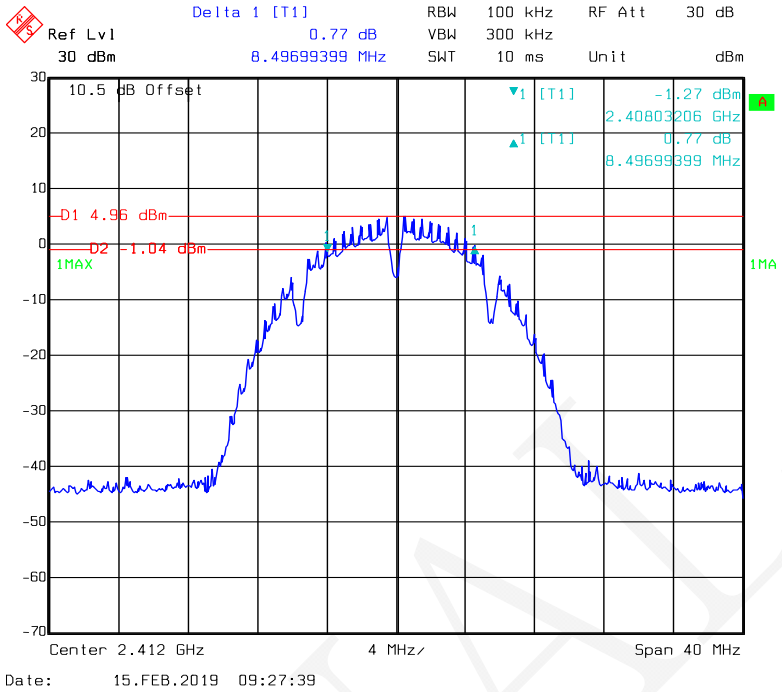
The testing was performed by Tom Tang on 2019-02-15.

Test Mode: Transmitting

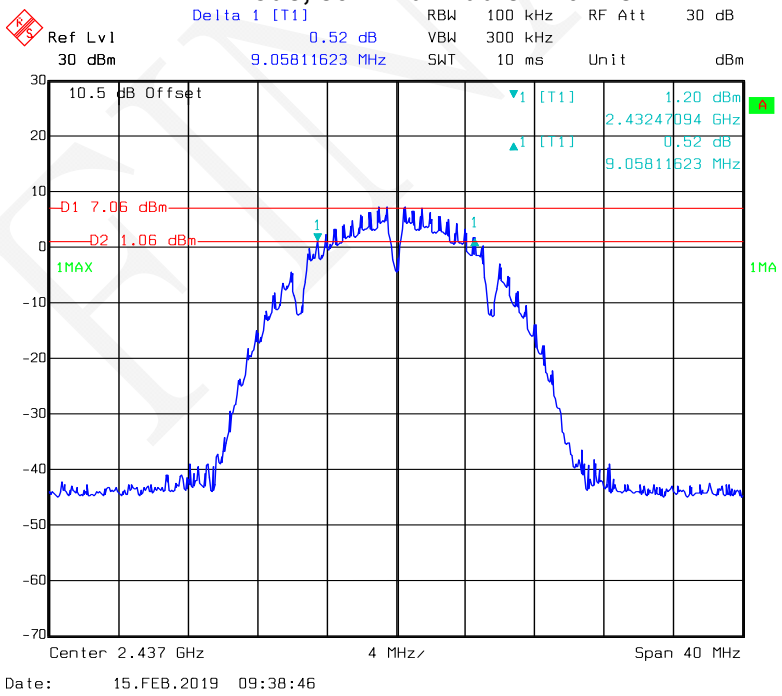
Test Result: Compliance. Please refer to the following table and plots.

Mode	Channel	Frequency (MHz)	6dB Emission Bandwidth (MHz)	Limit (MHz)
802.11b	Low	2412	8.50	≥0.50
	Middle	2437	9.06	≥0.50
	High	2462	8.58	≥0.50
802.11g	Low	2412	16.43	≥0.50
	Middle	2437	16.43	≥0.50
	High	2462	16.43	≥0.50
802.11n-HT20	Low	2412	17.56	≥0.50
	Middle	2437	17.31	≥0.50
	High	2462	17.39	≥0.50
802.11n-HT40	Low	2422	35.91	≥0.50
	Middle	2437	36.07	≥0.50
	High	2452	35.91	≥0.50

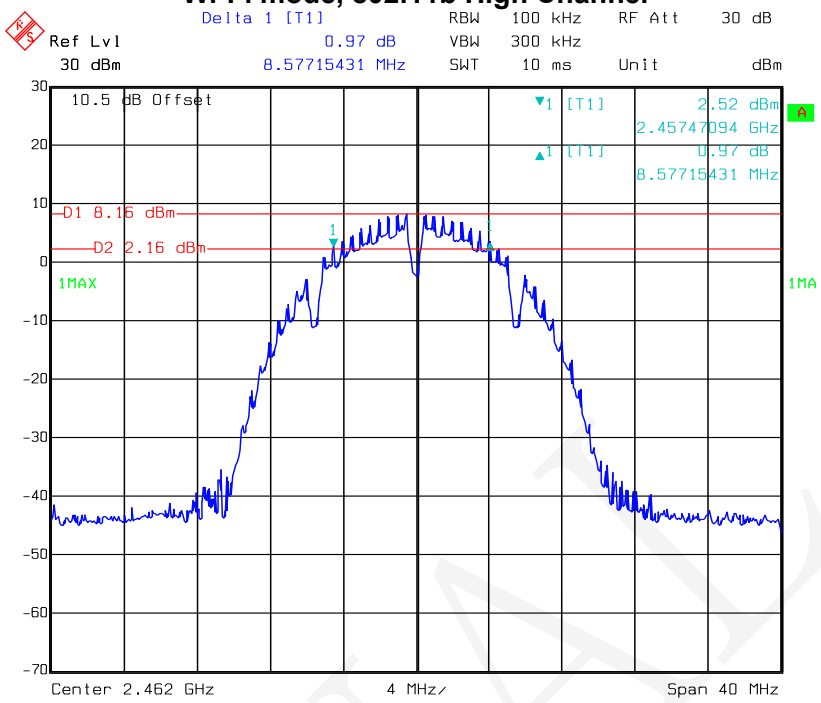
Wi-Fi mode, 802.11b Low Channel



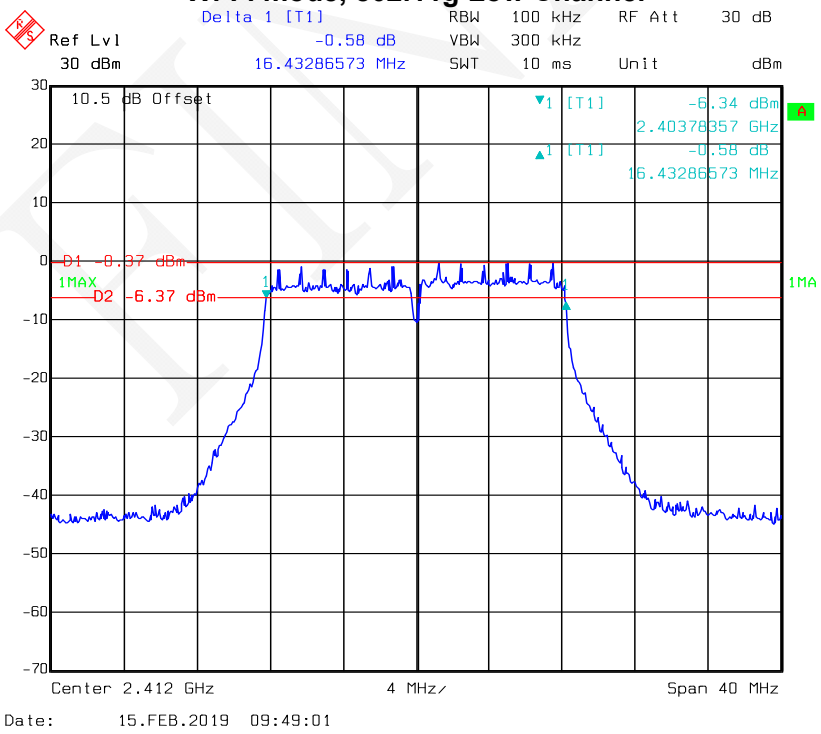
Wi-Fi mode, 802.11b Middle Channel



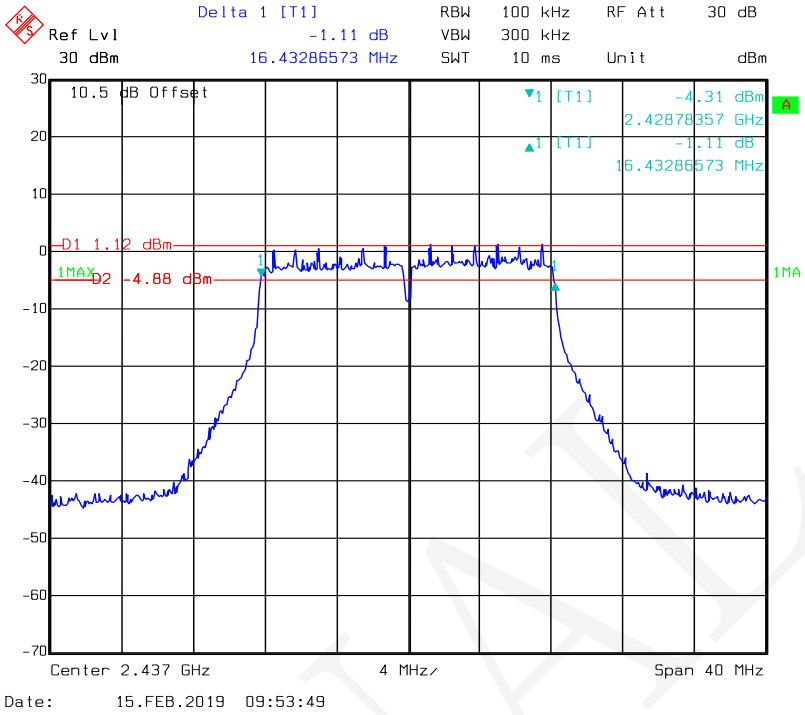
Wi-Fi mode, 802.11b High Channel



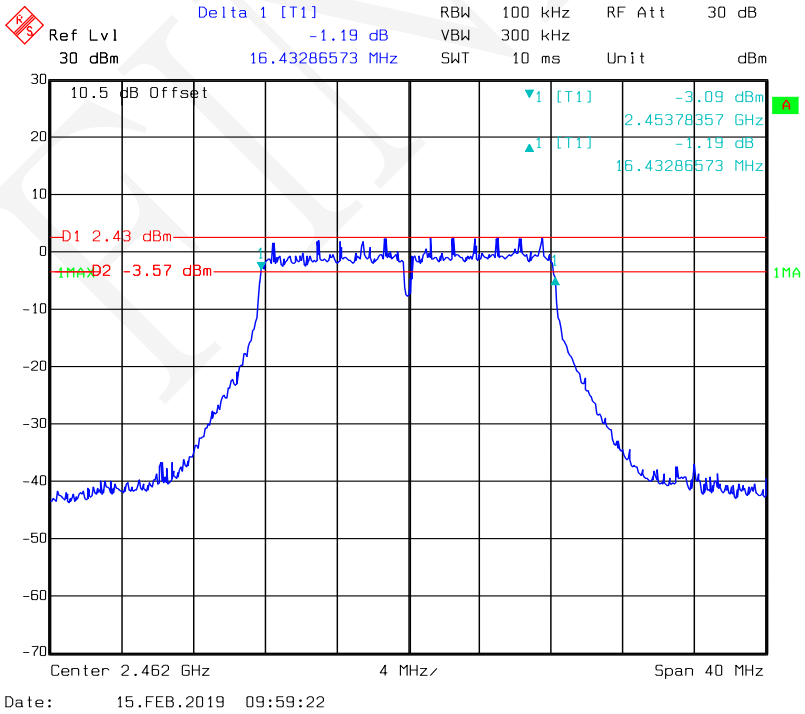
Wi-Fi mode, 802.11g Low Channel



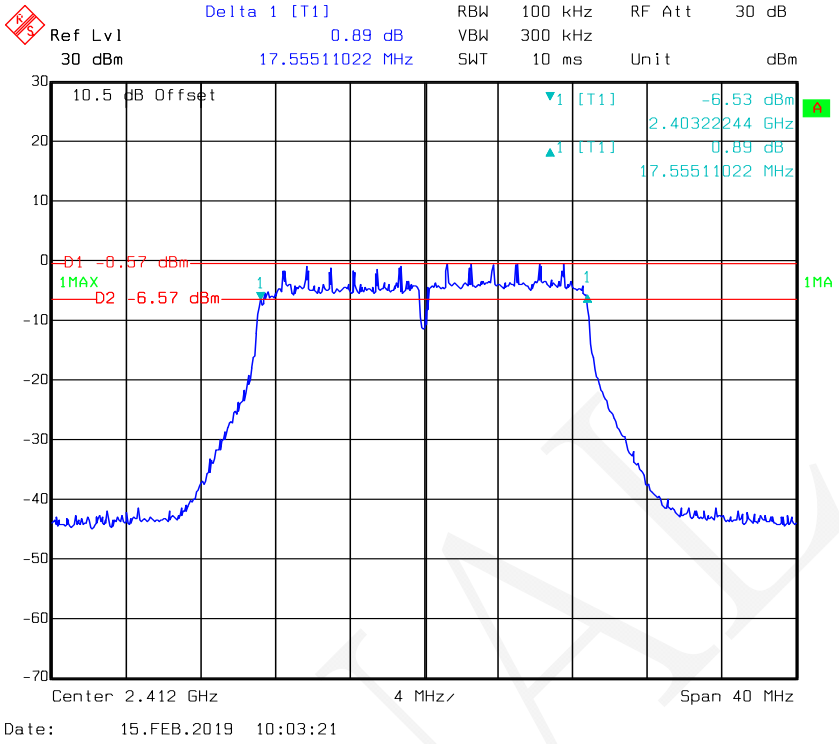
Wi-Fi mode, 802.11g Middle Channel



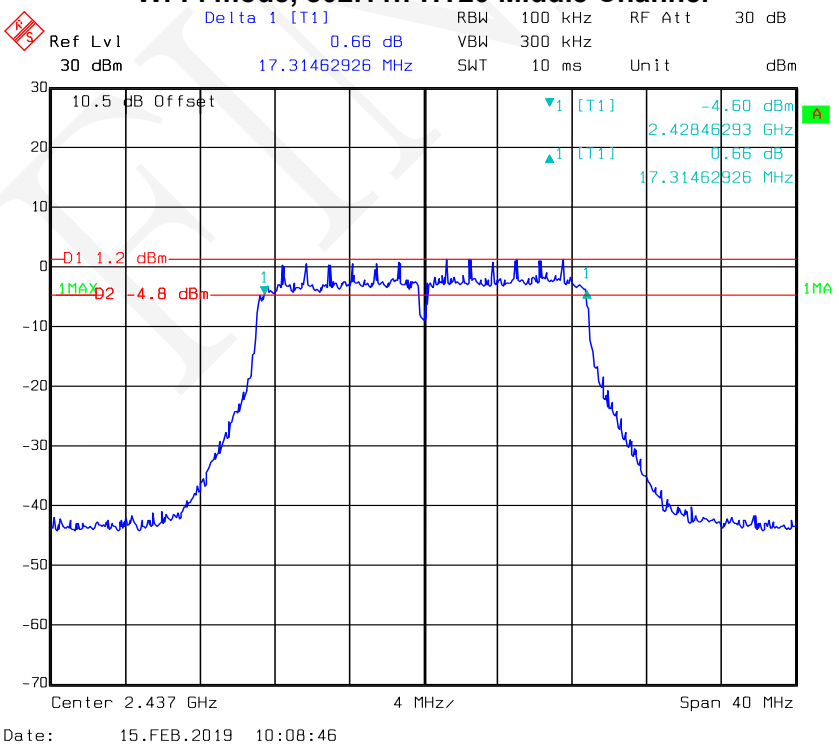
Wi-Fi mode, 802.11g High Channel



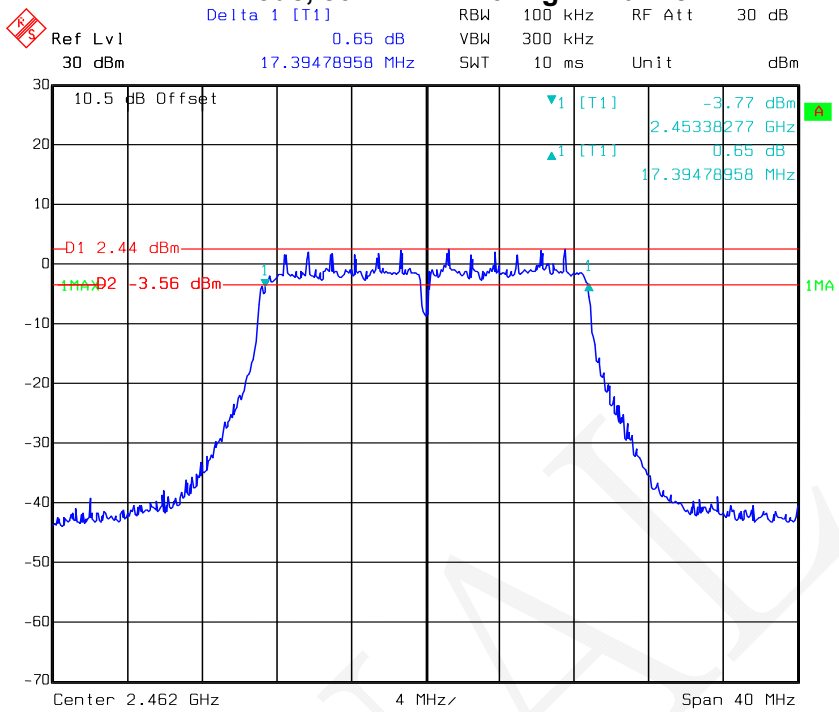
Wi-Fi mode, 802.11n-HT20 Low Channel



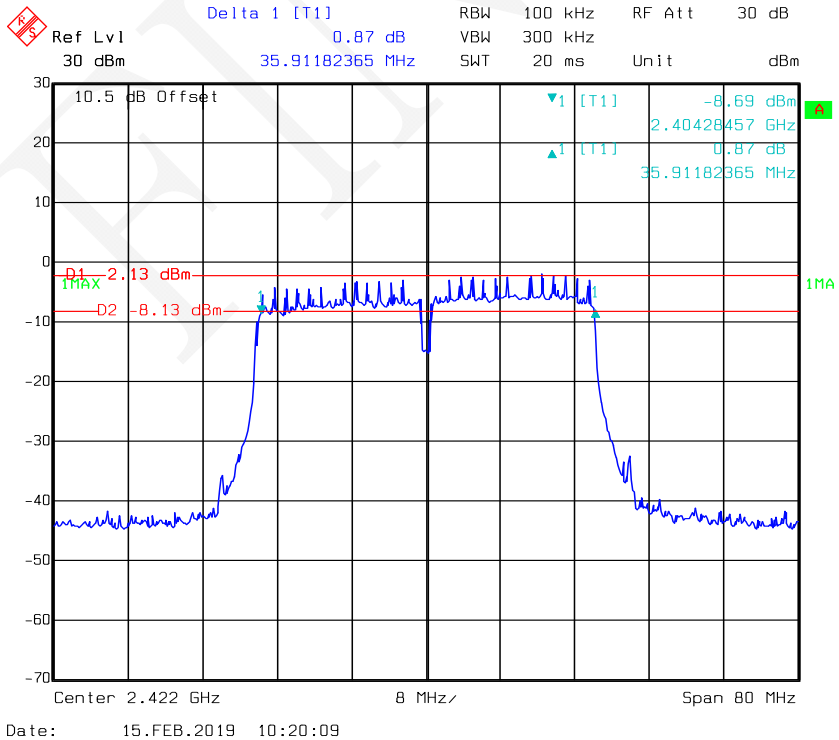
Wi-Fi mode, 802.11n-HT20 Middle Channel



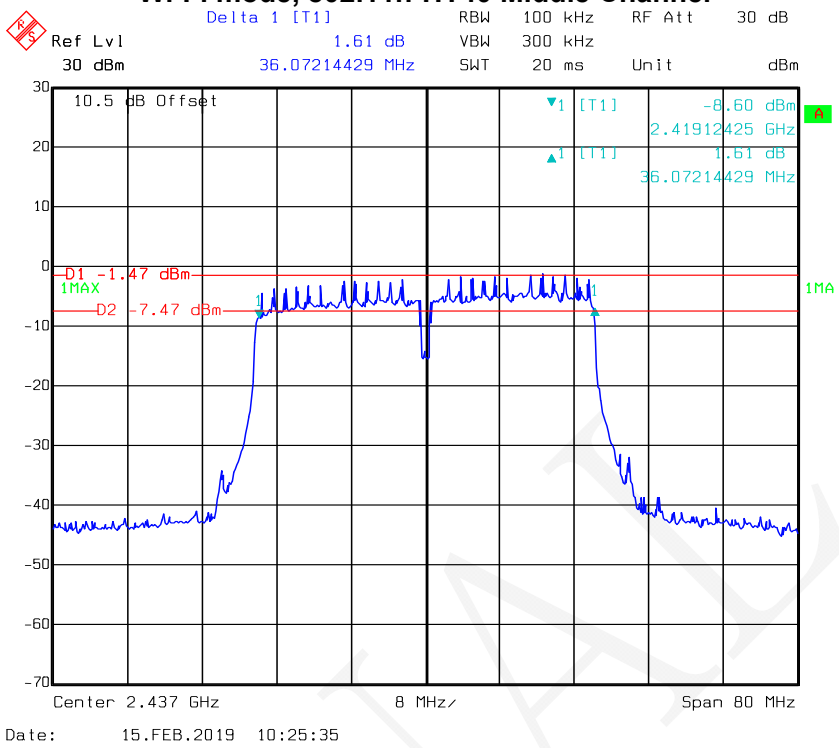
Wi-Fi mode, 802.11n-HT20 High Channel



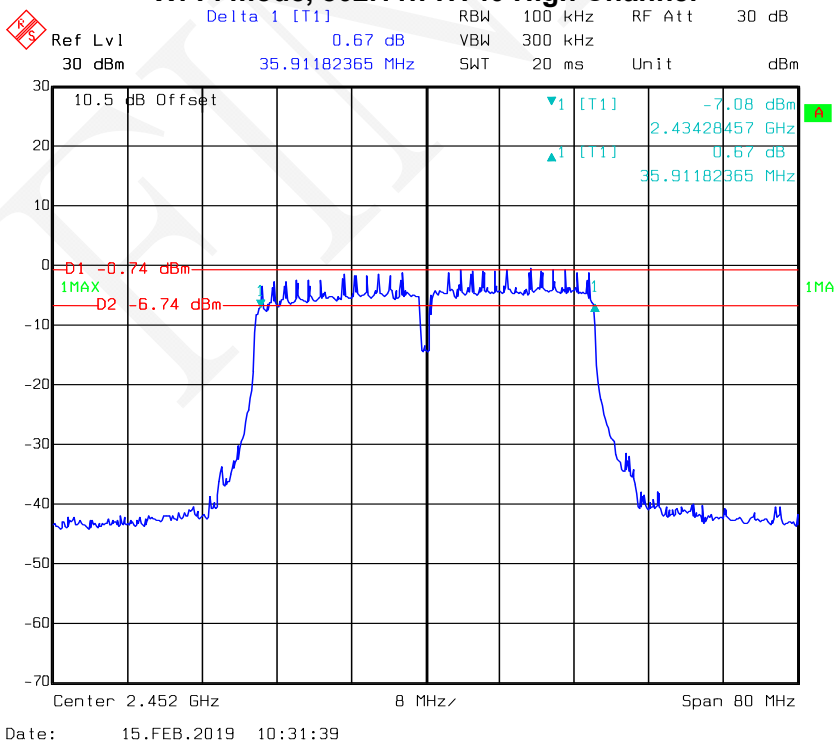
Wi-Fi mode, 802.11n-HT40 Low Channel



Wi-Fi mode, 802.11n-HT40 Middle Channel



Wi-Fi mode, 802.11n-HT40 High Channel



FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

Applicable Standard

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to test equipment.
3. Add a correction factor to the display.

Test Data

Environmental Conditions

Temperature:	19 °C
Relative Humidity:	50 %
ATM Pressure:	95.8 kPa

The testing was performed by Tom Tang on 2019-02-15.

Test Mode: Transmitting

Test Result: Compliance. Please refer to the following table.

Mode	Channel	Frequency (MHz)	Max Peak Conducted Output Power (dBm)	Max Average Conducted Output Power (dBm)	Limit (dBm)
802.11b	Low	2412	15.96	12.68	30
	Middle	2437	18.10	14.81	30
	High	2462	19.19	15.87	30
802.11g	Low	2412	18.66	11.85	30
	Middle	2437	20.29	13.95	30
	High	2462	21.73	15.63	30
802.11n-HT20	Low	2412	18.54	10.85	30
	Middle	2437	20.23	12.96	30
	High	2462	21.53	14.55	30
802.11n-HT40	Low	2422	19.29	10.99	30
	Middle	2437	20.20	12.12	30
	High	2452	20.95	12.48	30

FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

Applicable Standard

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Test Data

Environmental Conditions

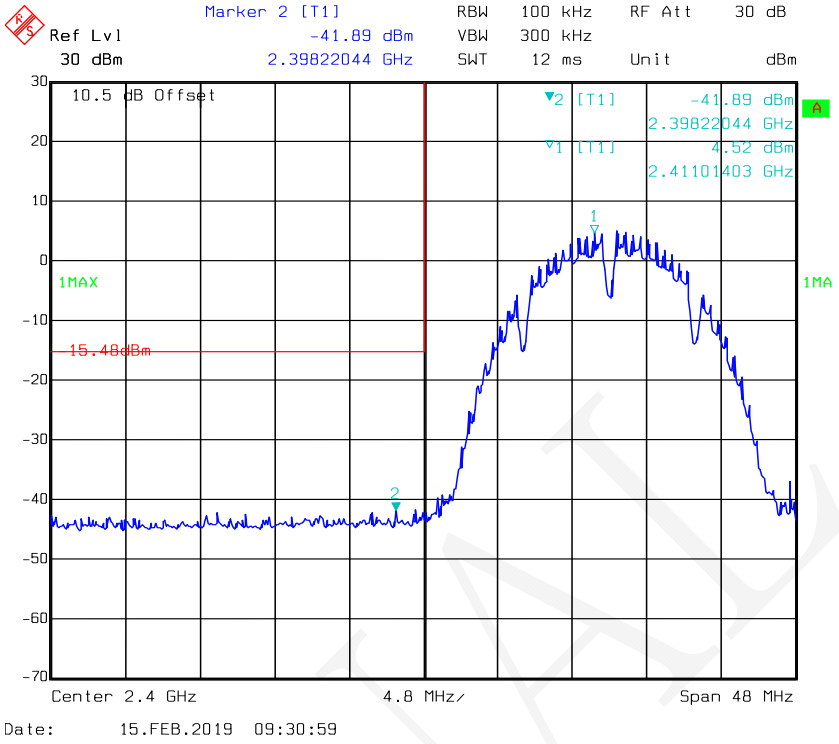
Temperature:	19 °C
Relative Humidity:	50 %
ATM Pressure:	95.8 kPa

The testing was performed by Tom Tang on 2019-02-15.

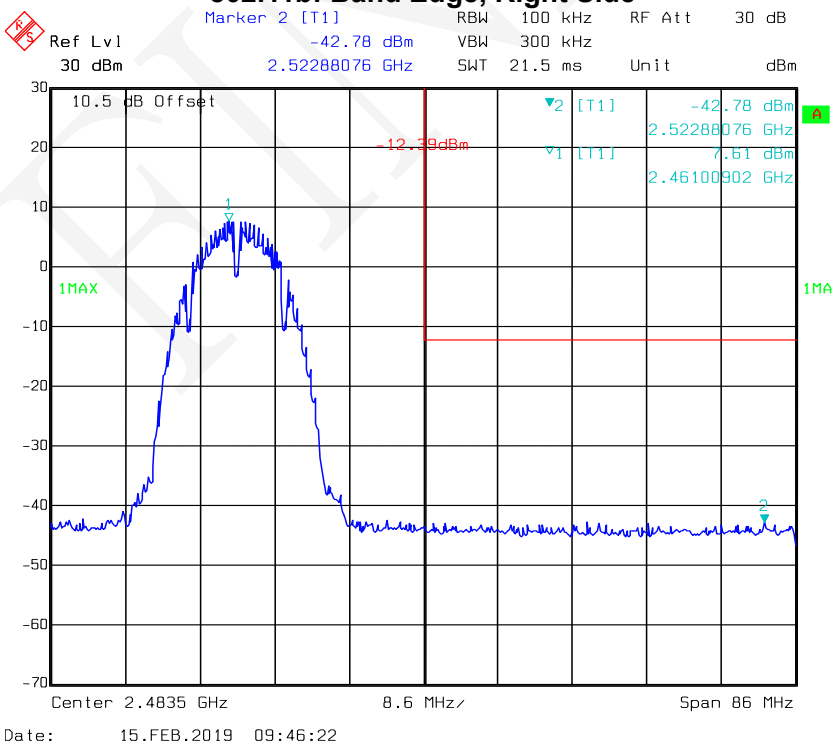
Test mode: Transmitting

Test Result: Compliance. Please refer to following plots.

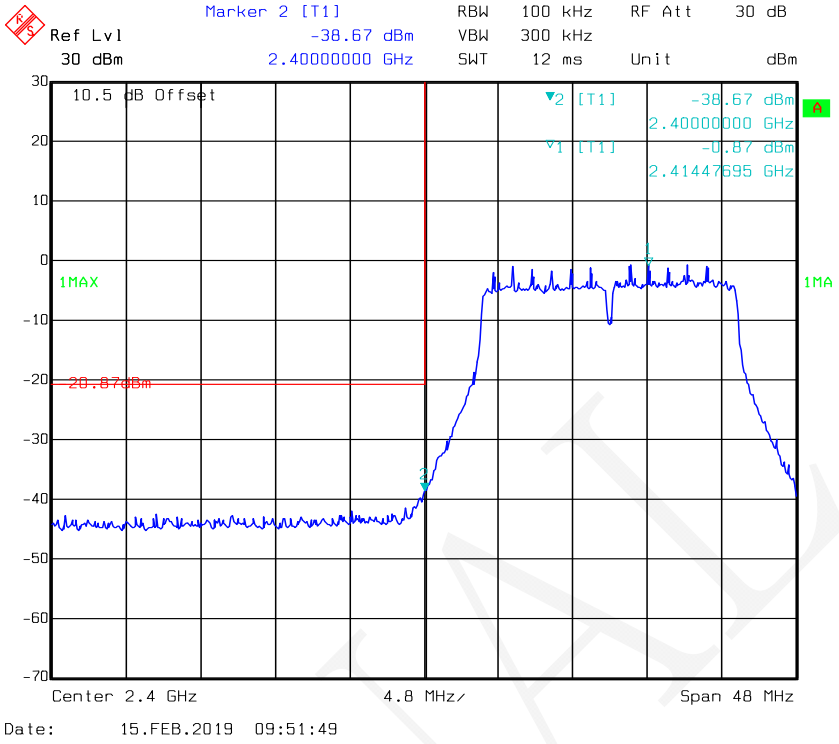
802.11b: Band Edge, Left Side



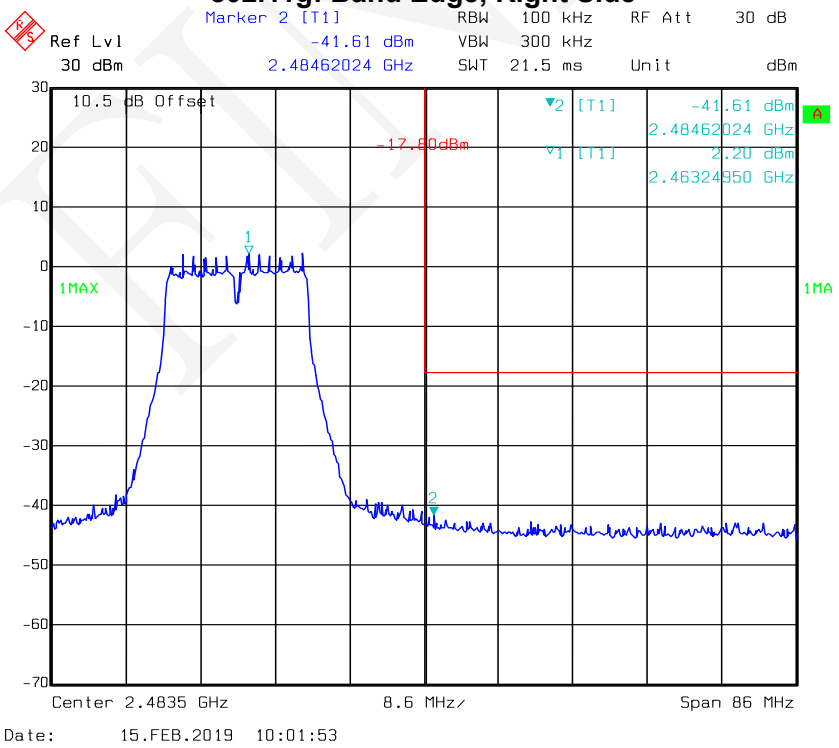
802.11b: Band Edge, Right Side



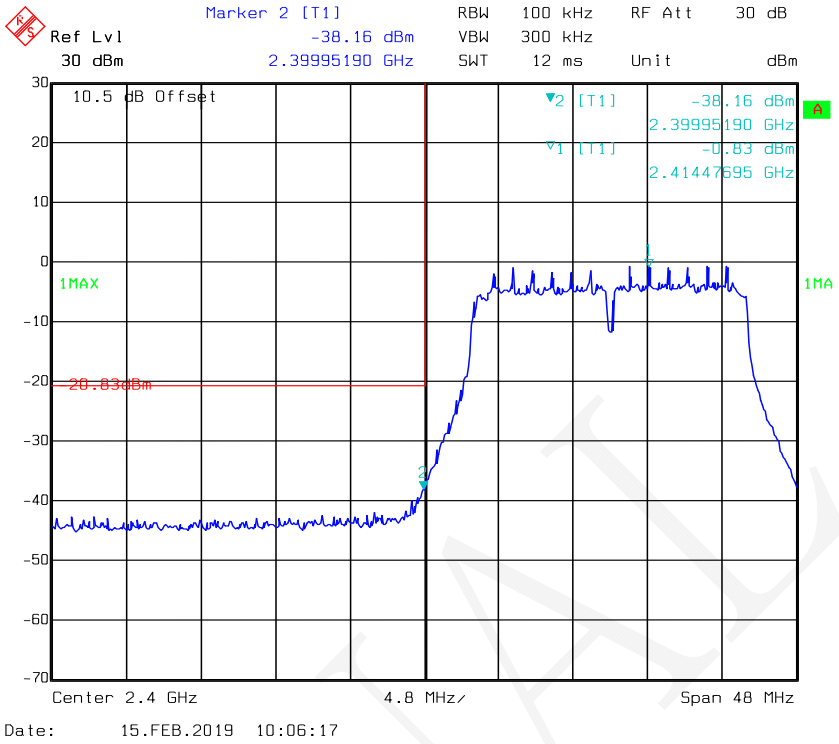
802.11g: Band Edge, Left Side



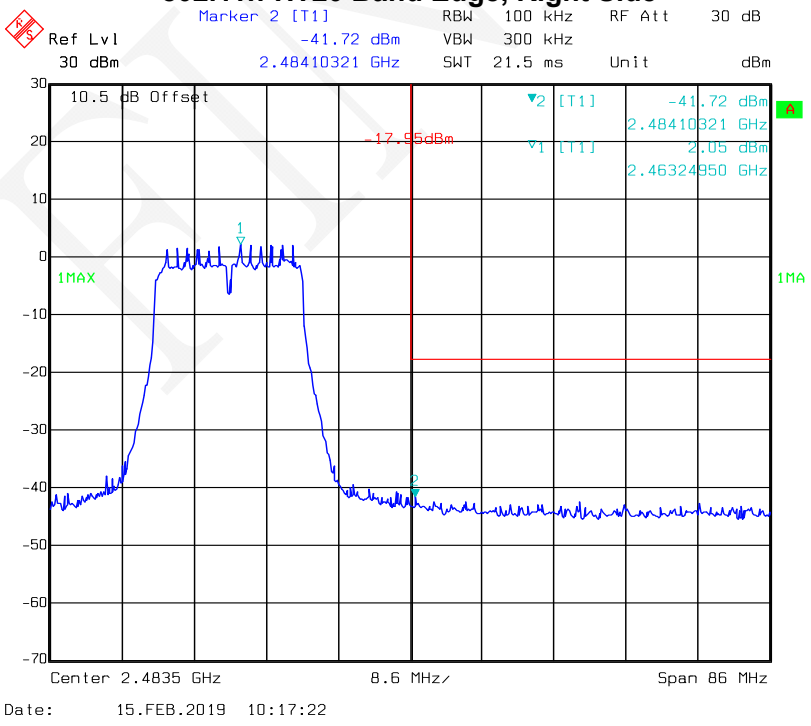
802.11g: Band Edge, Right Side



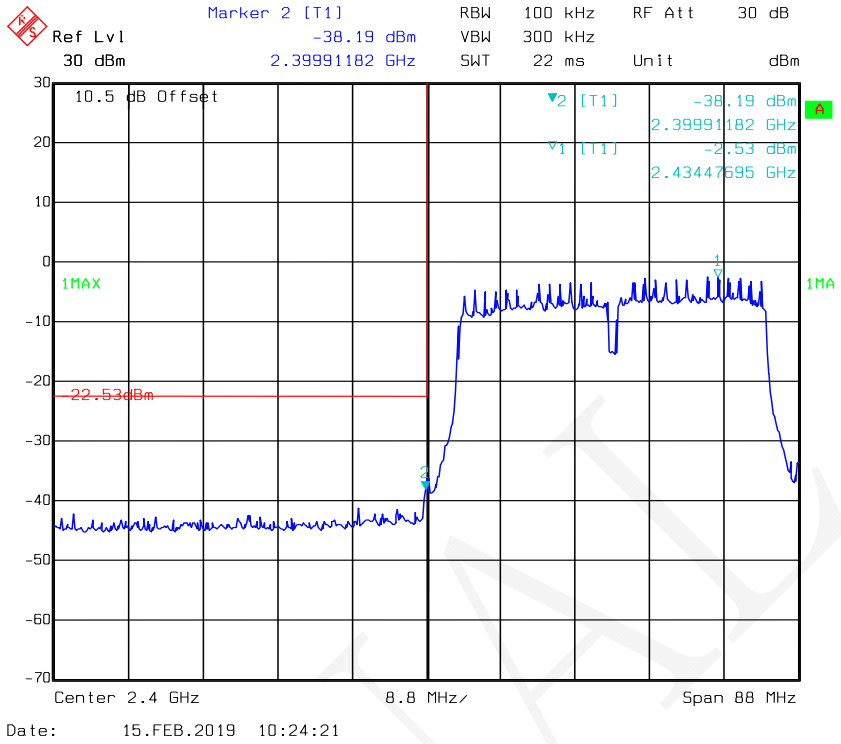
802.11n-HT20 Band Edge, Left Side



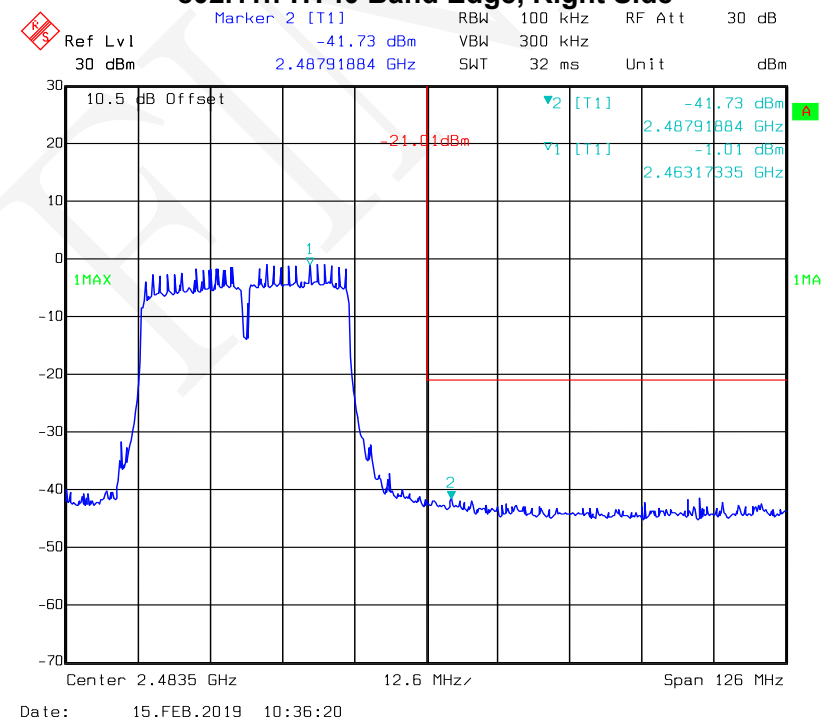
802.11n-HT20 Band Edge, Right Side



802.11n-HT40 Band Edge, Left Side



802.11n-HT40 Band Edge, Right Side



FCC §15.247(e) - POWER SPECTRAL DENSITY

Applicable Standard

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Procedure

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 ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ 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.

Test Data

Environmental Conditions

Temperature:	19 °C
Relative Humidity:	50 %
ATM Pressure:	95.8 kPa

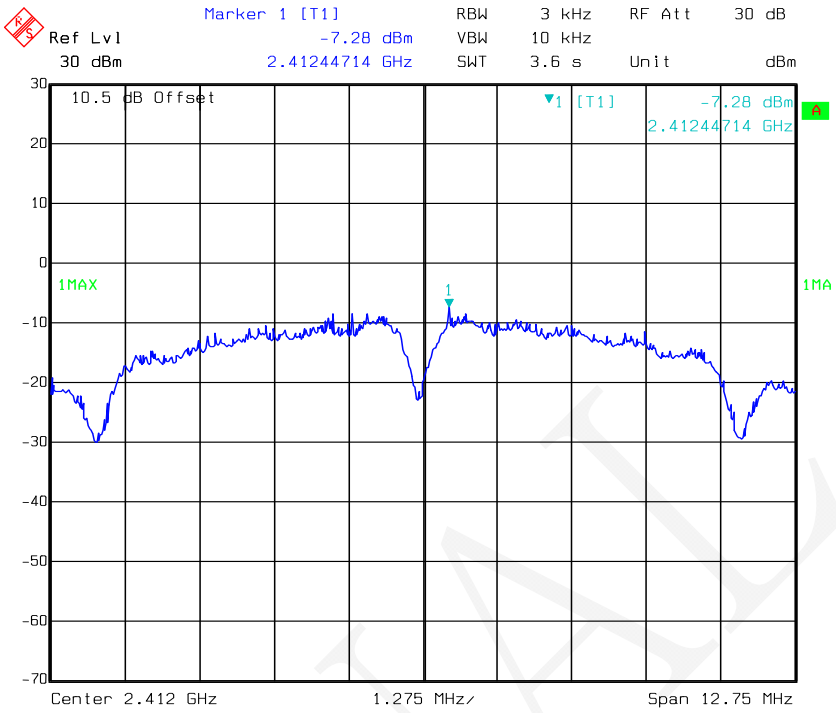
The testing was performed by Tom Tang on 2019-02-15.

Test Mode: Transmitting

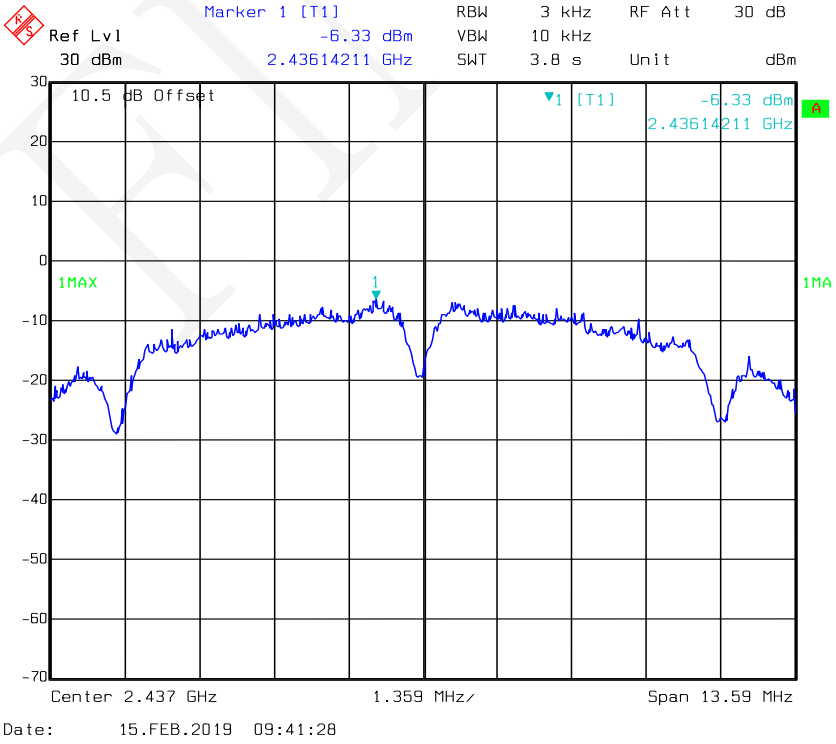
Test Result: Compliance. Please refer to the following table and plots

Mode	Channel	Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
802.11b	Low	2412	-7.28	≤8
	Middle	2437	-6.33	≤8
	High	2462	-4.57	≤8
802.11g	Low	2412	-14.42	≤8
	Middle	2437	-12.71	≤8
	High	2462	-11.96	≤8
802.11n-HT20	Low	2412	-14.41	≤8
	Middle	2437	-13.04	≤8
	High	2462	-11.71	≤8
802.11n-HT40	Low	2422	-16.43	≤8
	Middle	2437	-14.36	≤8
	High	2452	-14.91	≤8

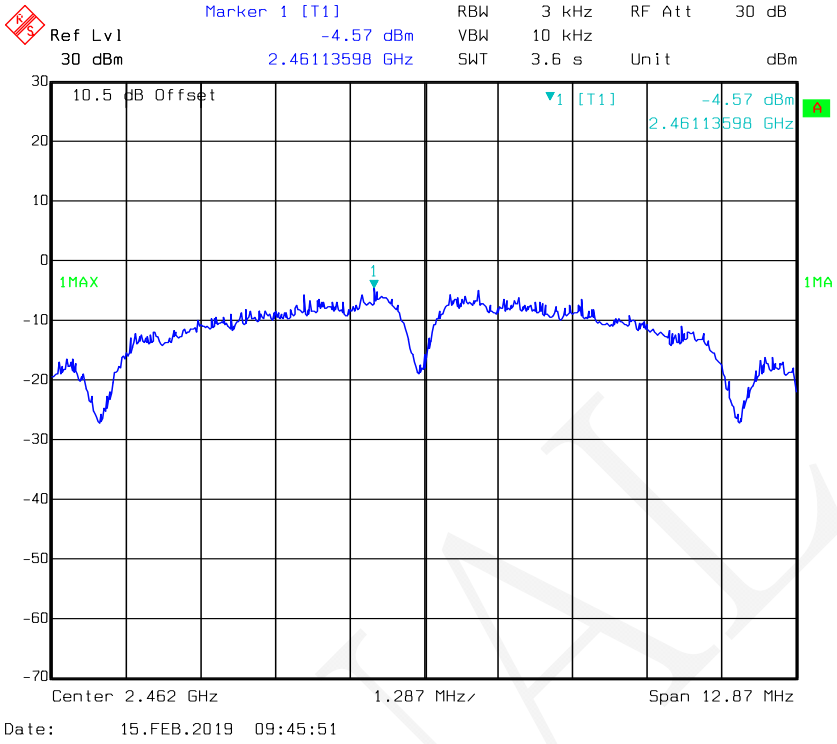
Power Spectral Density, 802.11b Low Channel



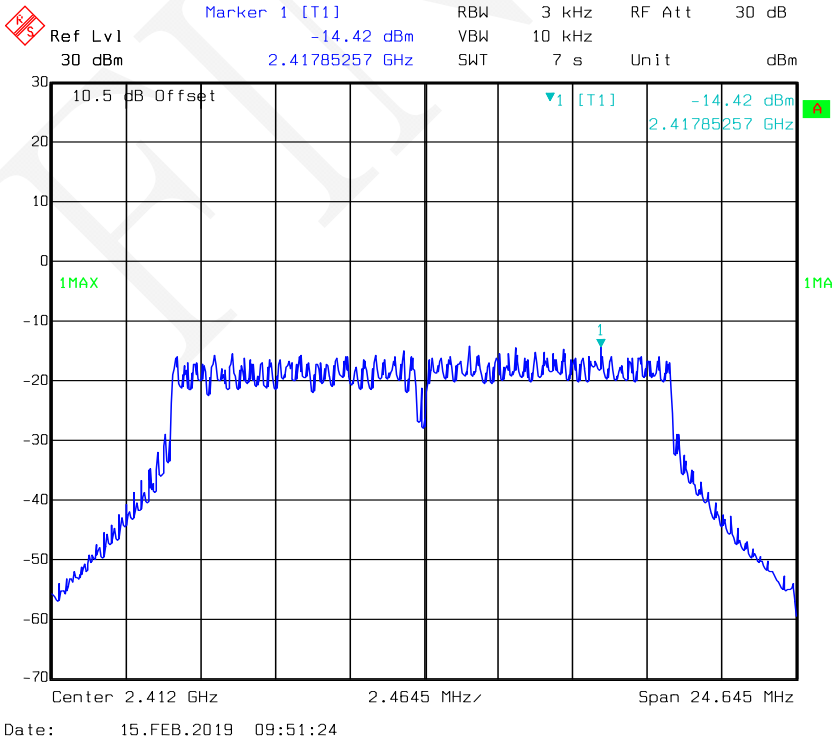
Power Spectral Density, 802.11b Middle Channel



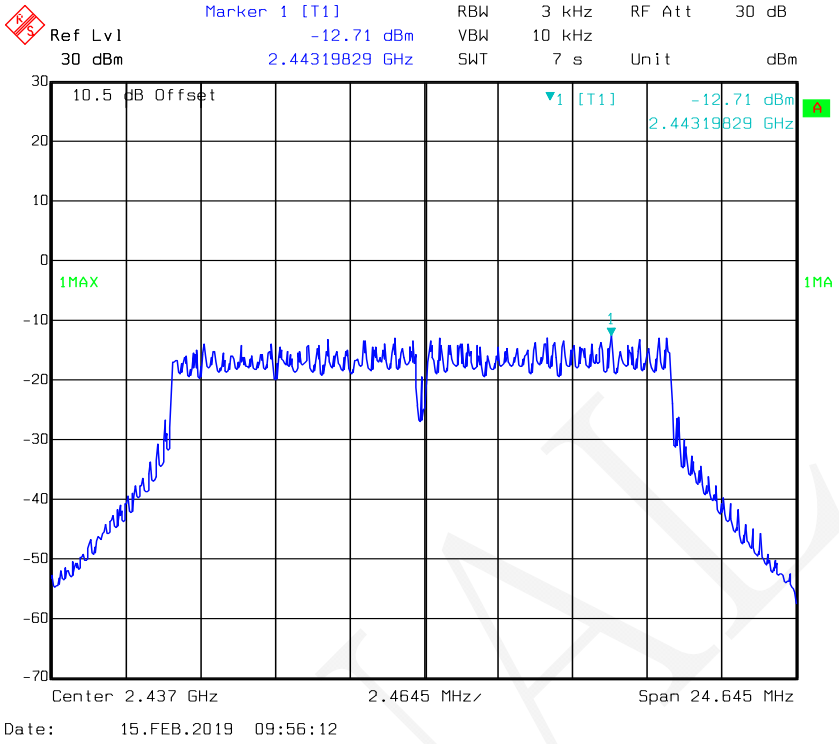
Power Spectral Density, 802.11b High Channel



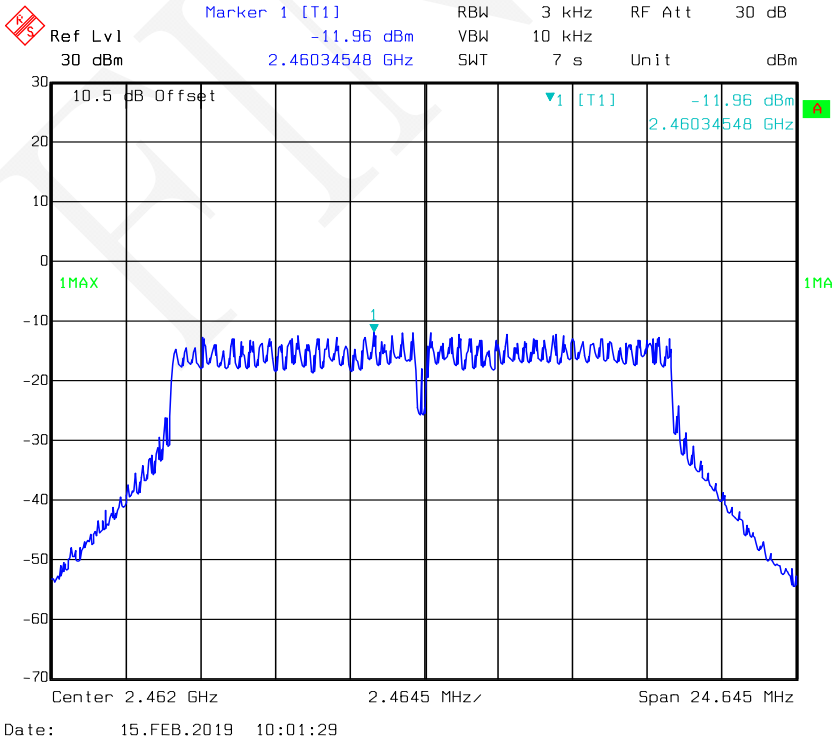
Power Spectral Density, 802.11g Low Channel



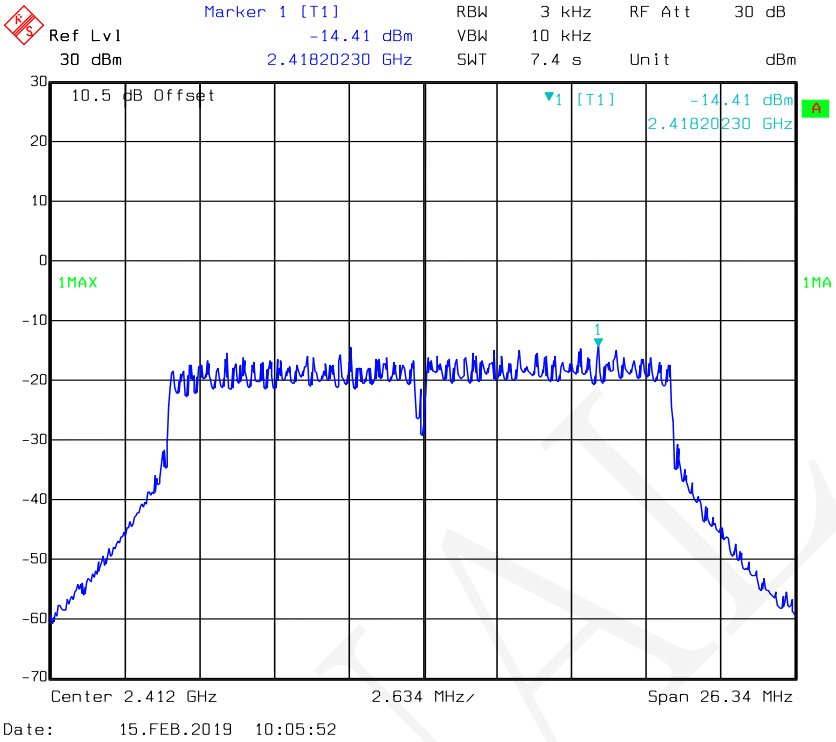
Power Spectral Density, 802.11g Middle Channel



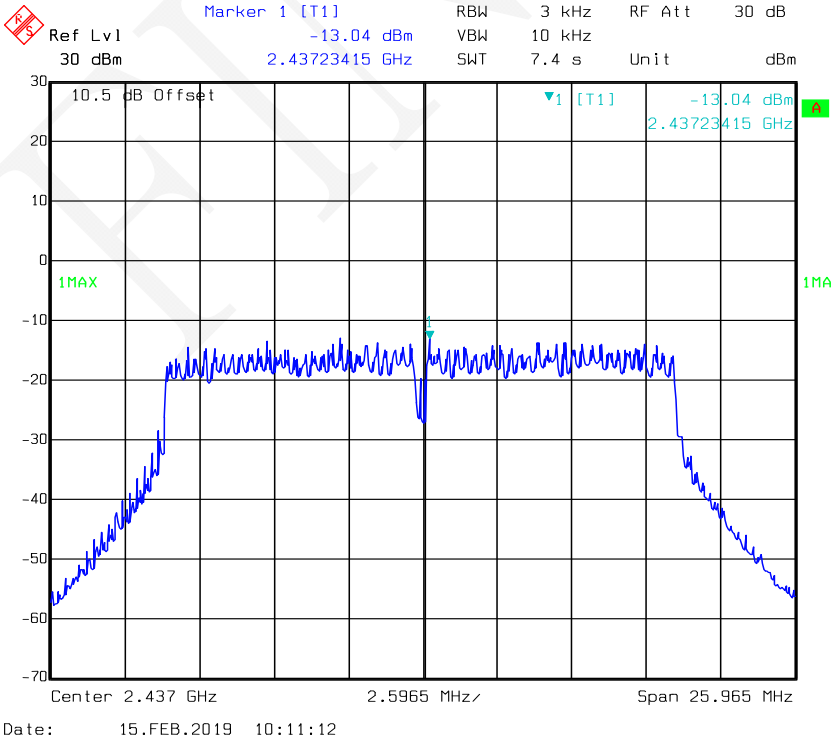
Power Spectral Density, 802.11g High Channel



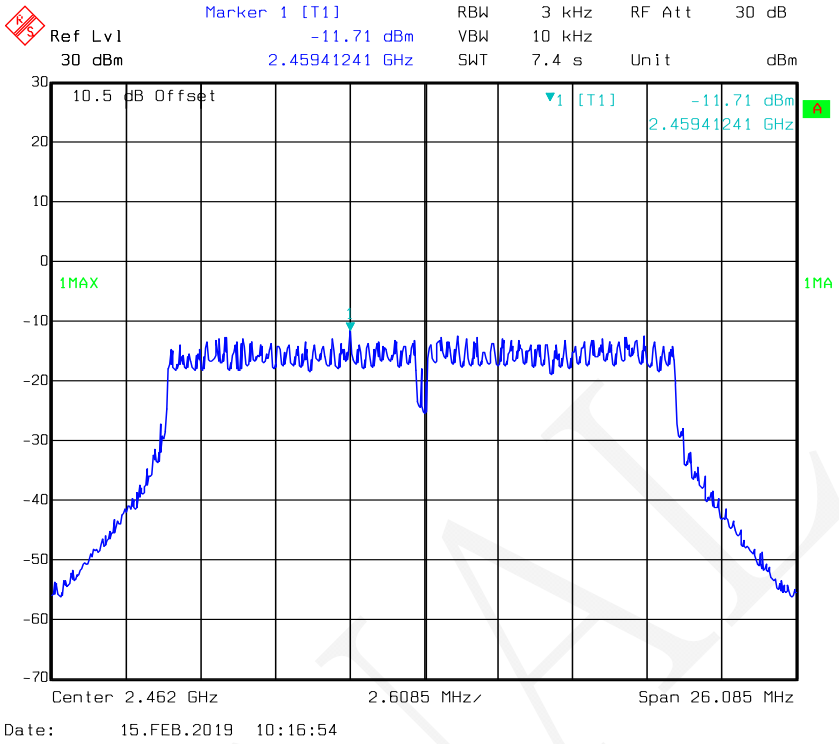
Power Spectral Density, 802.11n-HT20 Low Channel



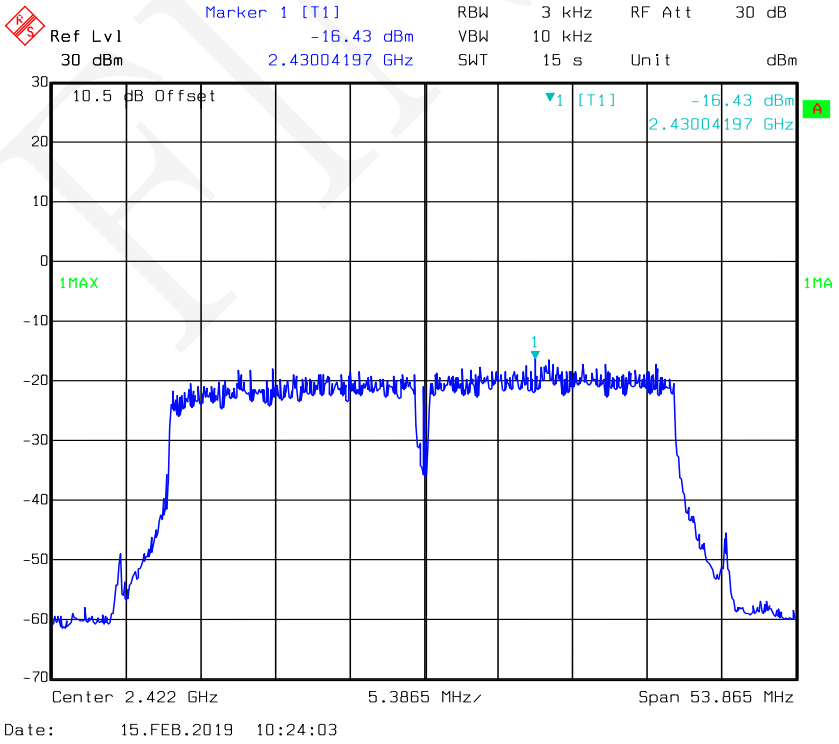
Power Spectral Density, 802.11n-HT20 Middle Channel



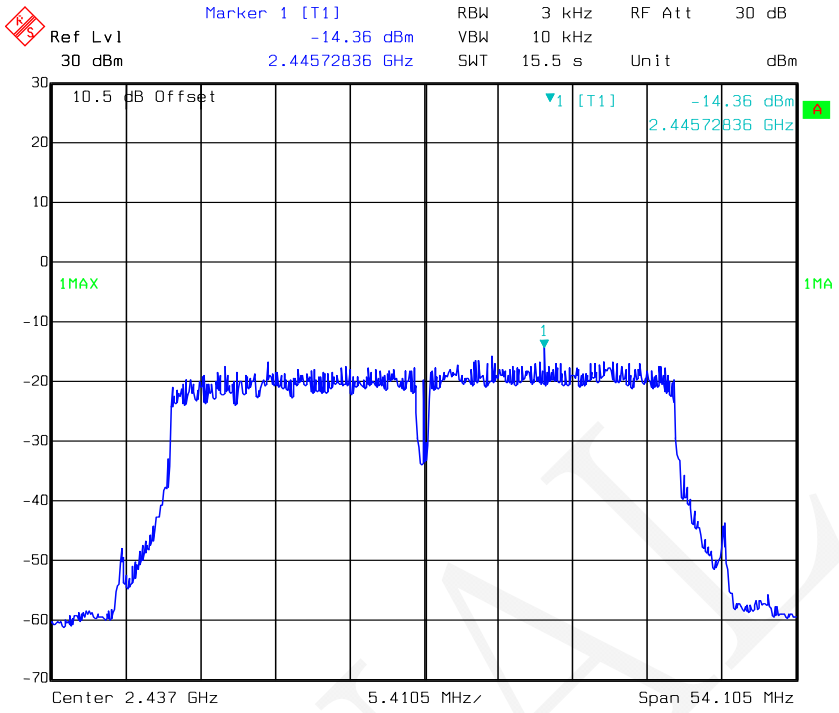
Power Spectral Density, 802.11n-HT20 High Channel



Power Spectral Density, 802.11n-HT40 Low Channel



Power Spectral Density, 802.11n-HT40 Middle Channel



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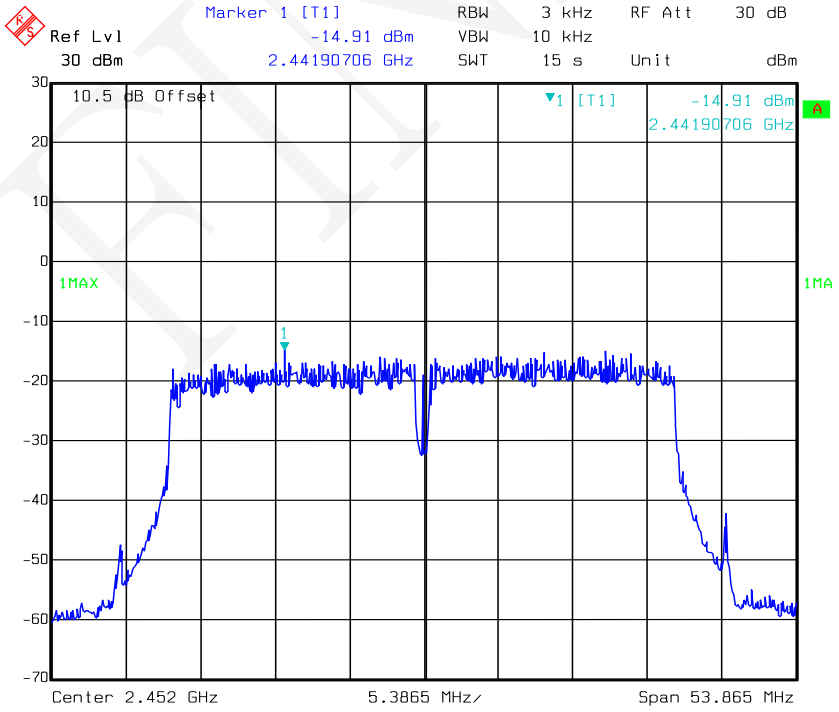
Power Spectral Density, 802.11n-HT40 High Channel



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