

## FCC PART 15.247

## TEST REPORT

For

### Shanghai HowayGIS Co., Ltd

RM230,Fawkes Building, No. 1985, Road Chunshen, Shanghai, China

**FCC ID: 2AAZD-T1024WM**

<b>Report Type:</b> Original Report	<b>Product Type:</b> Industrial Data Controller/Collector
<b>Test Engineer:</b> Max Min	<i>Max Min</i>
<b>Report Number:</b> RKSA180302001-00C	
<b>Report Date:</b> 2018-04-13	
<b>Reviewed By:</b> RF Leader	<i>Oscar Ye</i>
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F I N A L

## GENERAL INFORMATION

### Product Description for Equipment under Test (EUT)

Applicant	Shanghai HowayGIS Co., Ltd
Tested Model	T18
Series Model	T18M, T18N, T18P, T18T, HC3, S18
Model Difference	Model name
Product Type	Industrial Data Controller/Collector
Dimension	533 mm (L)* 322 mm (W)*232 mm(H)
Power Supply	DC 3.7V from battery and 5.0V charging by adapter

*Adapter Information:*

*Model: PSM10R-050*

*Input: AC100-240 V 50/60Hz 0.3A*

*Output: 5.0V, 2.0A*

*\*All measurement and test data in this report was gathered from production sample serial number: 20180302001.  
(Assigned by the BACL. The EUT supplied by the applicant was received on 2018-03-02)*

### Objective

This report is prepared on behalf of Shanghai HowayGIS Co., Ltd in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules.

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

### Related Submittal(s)/Grant(s)

FCC Part 15.247 DSS, Part 22H24E PCB and Part 15B JBP submissions with FCC ID: 2AAZD-T1024WM.

### Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and FCC KDB558074 D01 DTS Meas Guidance v04.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Kunshan). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

**Measurement Uncertainty**

Item		Uncertainty
AC Power Lines Conducted Emissions		3.19dB
RF conducted test with spectrum		0.9dB
RF Output Power with Power meter		0.5dB
Radiated emission	30MHz~1GHz	6.11dB
	1GHz~6GHz	4.45dB
	6GHz~18GHz	5.23dB
	18GHz~40GHz	5.65dB
Occupied Bandwidth		0.5kHz
Temperature		1.0°C
Humidity		6%

**Test Facility**

The test site used by Bay Area Compliance Laboratories Corp. (Kunshan) to collect test data is located on the No.248 Chenghu Road, Kunshan, Jiangsu province, China.

Bay Area Compliance Laboratories Corp. (Kunshan) Lab is accredited to ISO/IEC 17025 by A2LA (Lab code: 4323.01) and the FCC designation No. CN1185 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

Test channel list is as below:

For 802.11b, 802.11g and 802.11n-HT20 mode, EUT was tested with Channel 1, 6 and 11;

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	/	/

### Equipment Modifications

No modification was made to the EUT tested.

### EUT Exercise Software

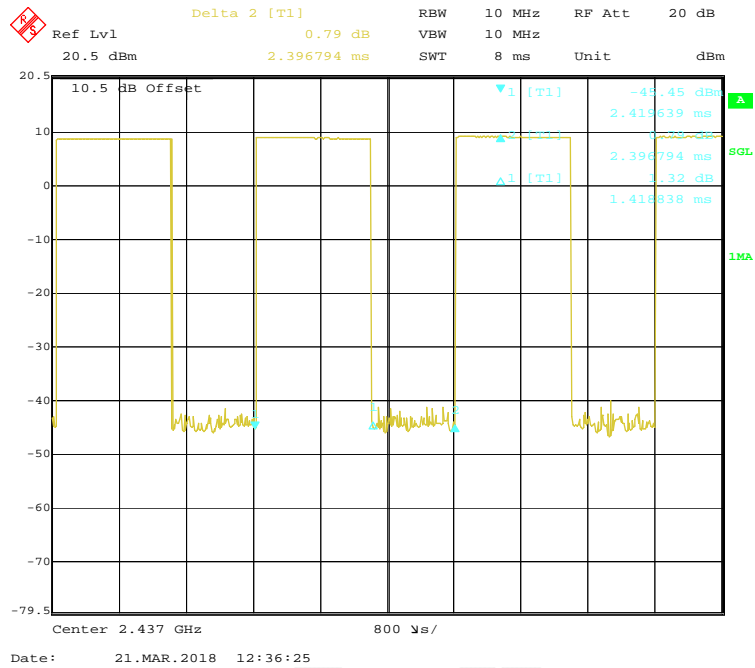
RF test tool: TrioScope

Pre-scan with all the data rates, and the worst case was performed as below:

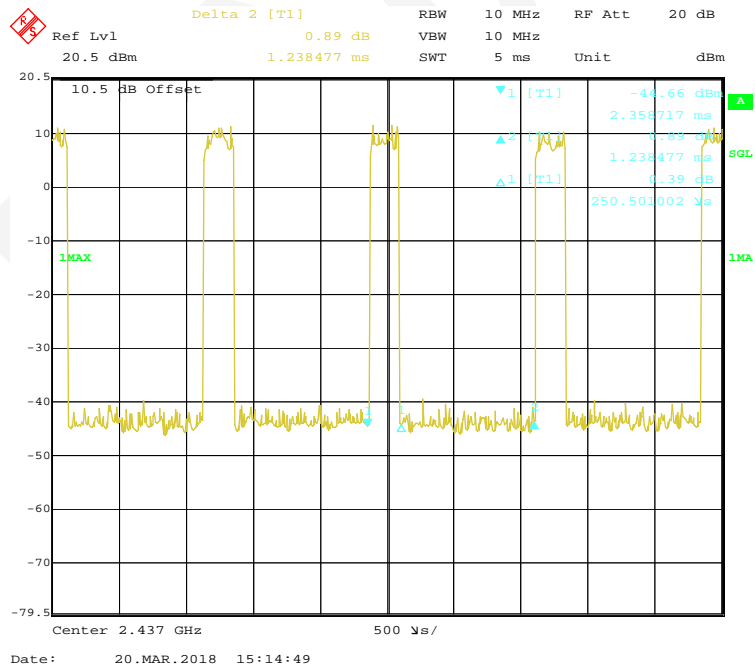
Mode	Data Rate	Power Level
802.11b	1 Mbps	6
802.11g	6 Mbps	4
802.11n-HT20	MCS0	4

Duty Cycle:

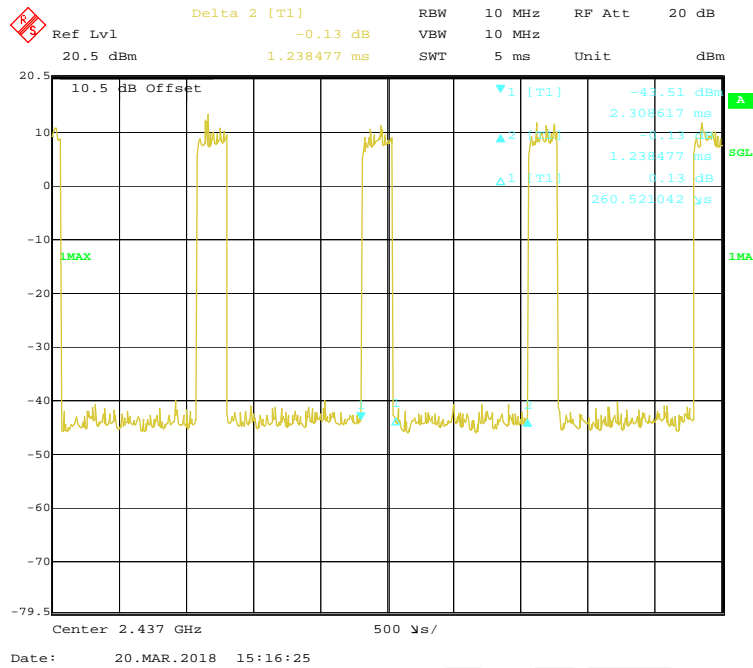
802.11b Mode Middle Channel



802.11g Mode Middle Channel



**802.11n-HT20 Mode Middle Channel**



Mode	Duty Cycle(%)	T(us)	1/T(kHz)	10log(1/x)
802.11b	59.20	1419	0.70	2.28
802.11g	20.27	251	3.98	6.93
802.11n-HT20	21.08	261	3.83	6.76

Note: "x" means the Duty Cycle.

**Support Equipment List and Details**

Manufacturer	Description	Model	Serial Number
/	/	/	/

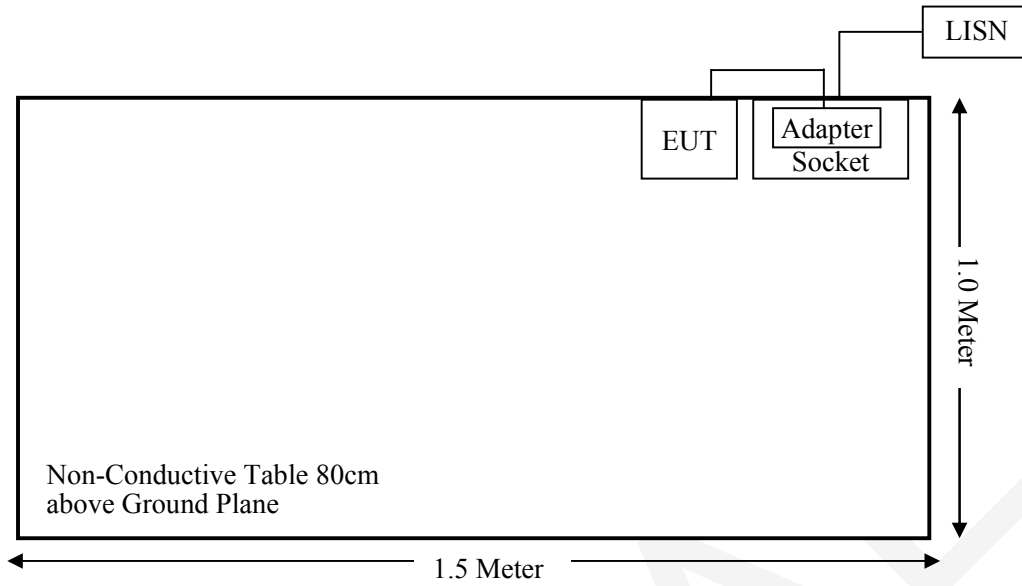
**External I/O Cable**

Cable Description	Shielding Type	Length (m)	From Port	To
/	/	/	/	/

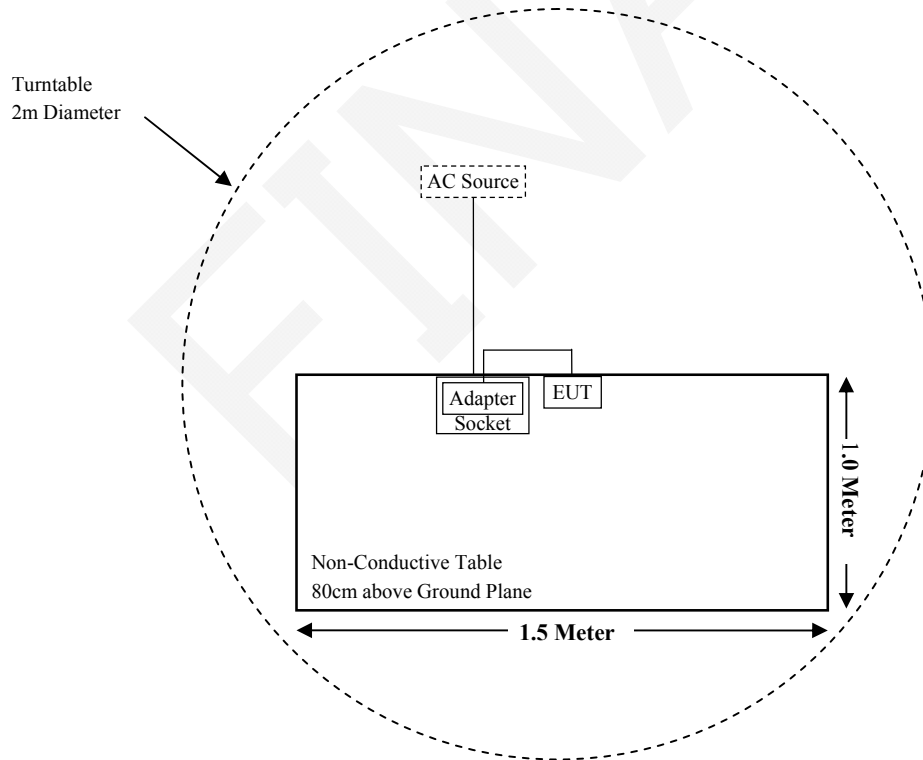


### Block Diagram of Test Setup

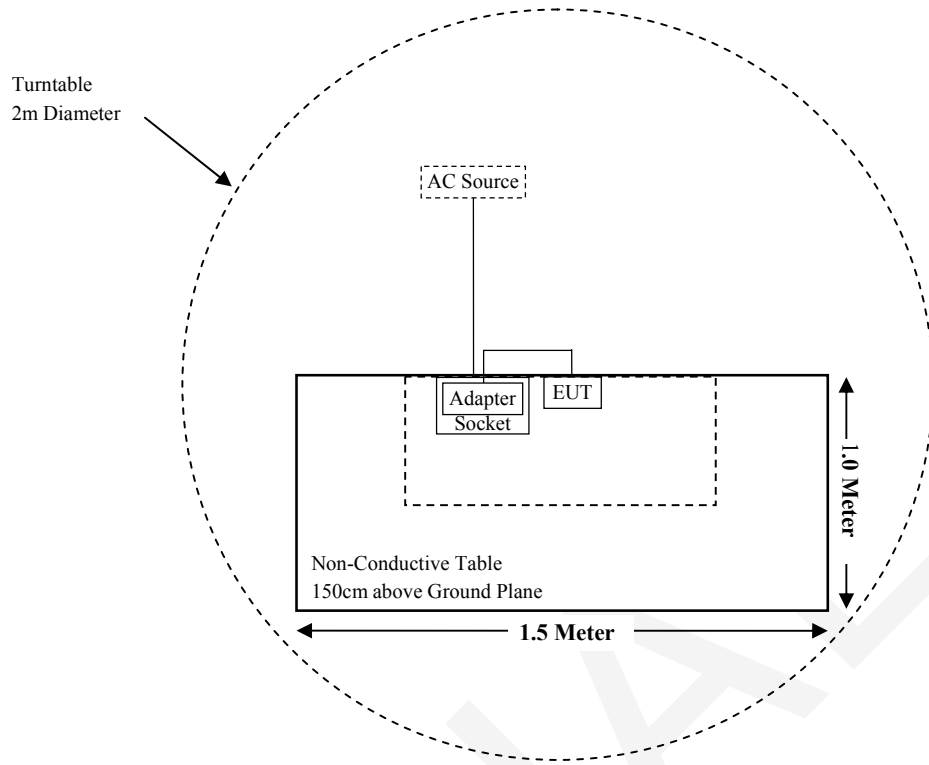
For Conducted Emissions:



For Radiated Emissions(Below 1GHz):



For Radiated Emissions(Above 1GHz):



**SUMMARY OF TEST RESULTS**

<b>FCC Rules</b>	<b>Description of Test</b>	<b>Result</b>
§15.247 (I), §1.1310 & §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207 (a)	AC Line Conducted Emissions	Compliance
§15.247(d)	Spurious Emissions at Antenna Port	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

**TEST EQUIPMENT LIST**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
<b>Radiated Emission Test (Chamber 1#)</b>					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2017-11-12	2018-11-11
Sunol Sciences	Broadband Antenna	JB3	A090413-1	2016-12-26	2019-12-25
Sonoma Instrument	Pre-amplifier	310N	171205	2017-08-15	2018-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-8	008	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-9	009	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-10	010	2017-08-15	2018-08-14
<b>Radiated Emission Test (Chamber 2#)</b>					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2017-08-27	2018-08-26
ETS-LINDGREN	Horn Antenna	3115	6229	2016-01-11	2019-01-10
ETS-LINDGREN	Horn Antenna	3116	00084159	2016-10-18	2019-10-17
Narda	Pre-amplifier	AFS42-00101800	2001270	2017-12-22	2018-12-21
QuinStar	Amplifier	QLW-18405536-J0	15964001009	2017-12-22	2018-12-21
MICRO-TRONICS	Band Reject Filter	BRM50702	/	2017-08-05	2018-08-04
Narda	Attenuator/10dB	10dB	/	2017-08-15	2018-08-14
Rohde & Schwarz	Auto test Software	EMC32	100361	/	/
MICRO-COAX	Coaxial Cable	Cable-6	006	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-11	011	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-12	012	2017-08-15	2018-08-14
MICRO-COAX	Coaxial Cable	Cable-13	013	2017-08-15	2018-08-14
<b>RF Conducted Test</b>					
Rohde & Schwarz	Signal Analyzer	FSIQ26	836131/009	2017-09-21	2018-09-20
Agilent	Power Meter	N1912A	MY5000492	2017-12-18	2018-12-17
Agilent	Power Sensor	N1921A	MY54210024	2017-12-18	2018-12-17
Narda	Attenuator/10dB	10dB	/	2017-08-15	2018-08-14
Shanghai HowayGIS	RF Cable	/	/	Each Time	/
<b>Conducted Emission Test</b>					
Rohde & Schwarz	EMI Test Receiver	ESCS30	834115/007	2017-11-12	2018-11-11
Rohde & Schwarz	LISN	ENV216	3560655016	2017-11-25	2018-11-24
BACL	Auto test Software	BACL-EMC	CE001	/	/
Narda	Attenuator/6dB	10690812-2	26850-6	2018-01-10	2019-01-09
MICRO-COAX	Coaxial Cable	Cable-15	015	2017-08-15	2018-08-14

\* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Kunshan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

## FCC §15.247 (I) & §1.1310 & §2.1093 - RF EXPOSURE

### Applicable Standard

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

According to KDB447498 D01 General RF Exposure Guidance v06:

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances  $\leq 50$  mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$  for 1-g SAR and  $\leq 7.5$  for 10-g extremity SAR, where

- $f(\text{GHz})$  is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is  $\leq 50$  mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is  $< 5$  mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

### Measurement Result

Mode	Frequency Range (MHz)	Target Output Power		Minimum test separation distance required for the exposure conditions (mm)
		(dBm)	(mW)	
802.11b	2412-2462	4.8	3.02	5.00
802.11g		4.8	3.02	5.00
802.11n-HT20		4.8	3.02	5.00

**Note:** The target output power was declared by the manufacturer.

**Result:**  $[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})]$

- $[\sqrt{f(\text{GHz})}] = 3.02/5 \cdot \sqrt{2.462} = 0.9 < 3.0$

**So the stand-alone SAR evaluation is not necessary.**

## **FCC §15.203 - ANTENNA REQUIREMENT**

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### **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.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### **Antenna Connector Construction**

The EUT has a dielectric PIFA antenna for Wi-Fi, which the antenna gain is 0dBi, fulfill the requirement of this section. Please refer to the EUT photos.

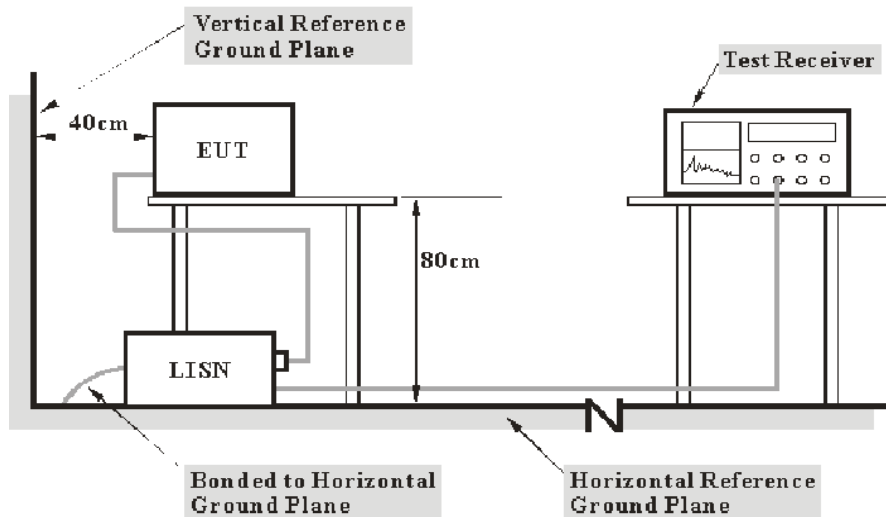
**Result:** Compliance.

## FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

### Applicable Standard

FCC §15.207(a)

### 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 measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

### 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

ANSI C63.10-2013 clause 6.2

During the conducted emission test, the adapter was connected to the outlet of the LISN.

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

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

## Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Corrected Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

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

$$\text{Margin} = \text{Limit} - \text{Reading}$$

## Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207.

### Test Data

#### Environmental Conditions

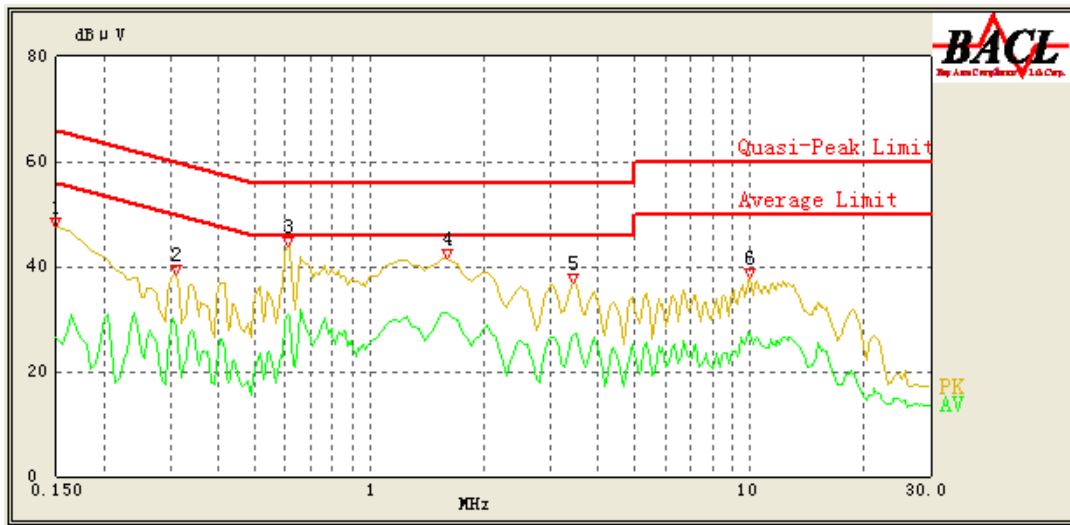
<b>Temperature:</b>	20.2 °C
<b>Relative Humidity:</b>	51 %
<b>ATM Pressure:</b>	101.3 kPa

*The testing was performed by Max Min on 2018-04-02.*

*EUT operation mode: Transmitting in 802.11g mode low channel(worst case)*

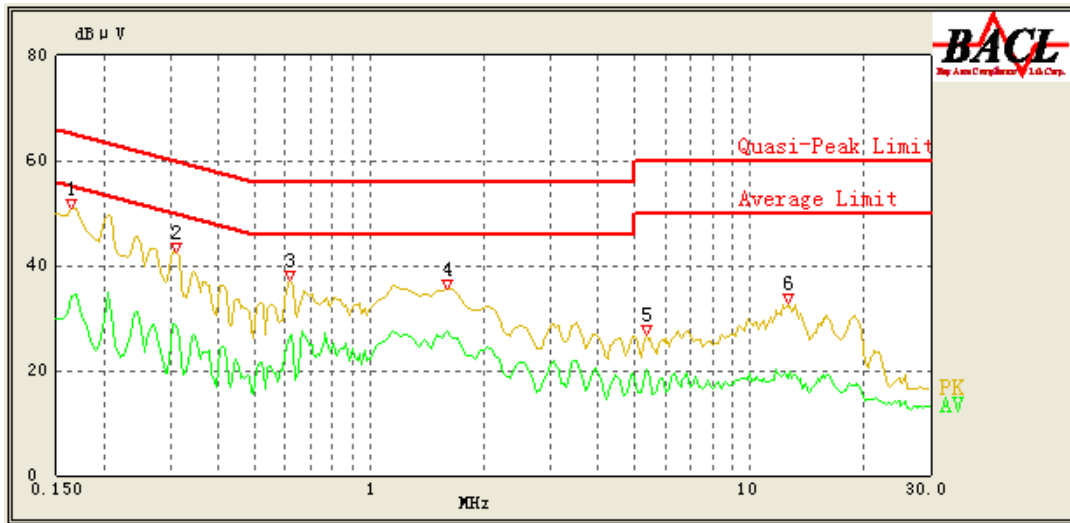


AC 120V/60 Hz, Line



Frequency (MHz)	Reading (dBµV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Corrected Factor (dB)	Limit (dBµV)	Margin (dB)	Comment
0.150	47.60	QP	9.000	L1	16.06	66.00	18.40	Compliance
0.150	26.49	AV	9.000	L1	16.06	56.00	29.51	Compliance
0.310	38.55	QP	9.000	L1	16.04	61.43	22.88	Compliance
0.310	28.39	AV	9.000	L1	16.04	51.43	23.04	Compliance
0.610	43.88	QP	9.000	L1	16.01	56.00	12.12	Compliance
0.610	30.79	AV	9.000	L1	16.01	46.00	15.21	Compliance
1.600	41.54	QP	9.000	L1	15.86	56.00	14.46	Compliance
1.600	31.13	AV	9.000	L1	15.86	46.00	14.87	Compliance
3.450	36.85	QP	9.000	L1	15.85	56.00	19.15	Compliance
3.450	26.81	AV	9.000	L1	15.85	46.00	19.19	Compliance
10.000	37.81	QP	9.000	L1	16.06	60.00	22.19	Compliance
10.000	27.21	AV	9.000	L1	16.06	50.00	22.79	Compliance

**AC 120V/60 Hz, Neutral**



Frequency (MHz)	Reading (dBμV)	Detector (PK/AV/QP)	Bandwidth (kHz)	Line	Corrected Factor (dB)	Limit (dBμV)	Margin (dB)	Comment
0.165	50.84	QP	9.000	N	16.06	65.57	14.73	Compliance
0.165	34.05	AV	9.000	N	16.06	55.57	21.52	Compliance
0.310	42.43	QP	9.000	N	16.07	61.43	19.00	Compliance
0.310	28.61	AV	9.000	N	16.07	51.43	22.82	Compliance
0.620	37.33	QP	9.000	N	16.04	56.00	18.67	Compliance
0.625	26.70	AV	9.000	N	16.03	46.00	19.30	Compliance
1.600	35.48	QP	9.000	N	15.92	56.00	20.52	Compliance
1.600	27.60	AV	9.000	N	15.92	46.00	18.40	Compliance
5.350	26.78	QP	9.000	N	15.88	60.00	33.22	Compliance
5.350	20.22	AV	9.000	N	15.88	50.00	29.78	Compliance
12.700	32.77	QP	9.000	N	16.00	60.00	27.23	Compliance
12.800	19.89	AV	9.000	N	16.00	50.00	30.11	Compliance

**Note:**

- 1) Corrected Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation
- 2) Margin = Limit – Reading

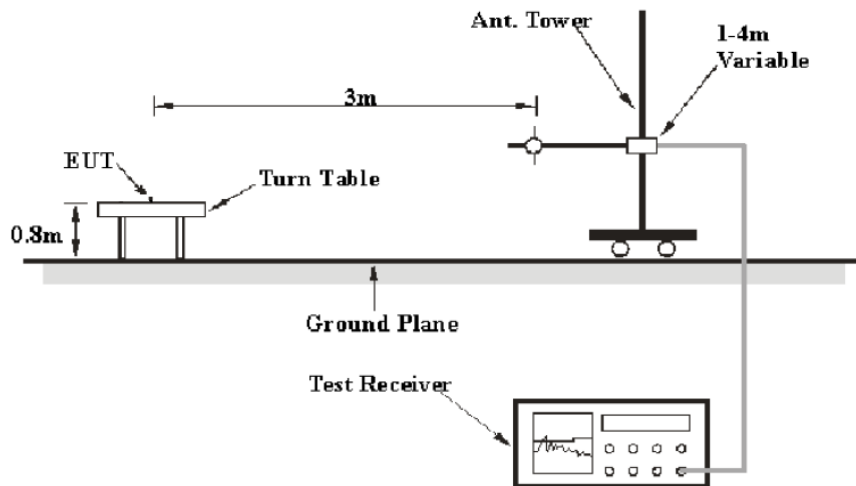
## FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

### Applicable Standard

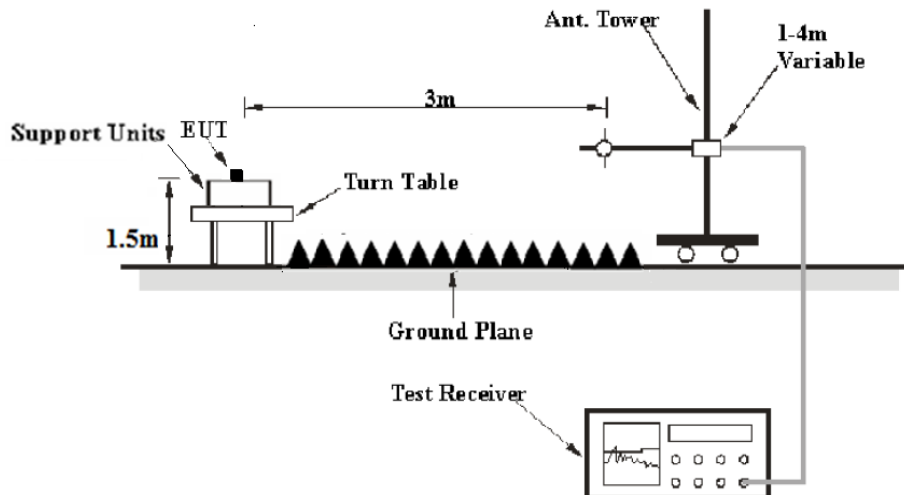
FCC §15.247 (d); §15.209; §15.205;

### EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters 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.

### EMI Test Receiver Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver Setup were 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	/	Ave.

### Test Procedure

According to KDB558074 D01 DTS Meas Guidance v04 sub-clause 12.1 and 12.2. and ANSI C63.10-2013 clause 6.5, 6.6 and 6.7.

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 mode for frequencies above 1 GHz.

### Corrected Amplitude & Margin Calculation

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

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

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:

$$\text{Margin} = \text{Limit} - \text{Corrected Amplitude}$$

### Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

**Test Data**

**Environmental Conditions**

<b>Temperature:</b>	24.1 °C
<b>Relative Humidity:</b>	50 %
<b>ATM Pressure:</b>	101.2kPa

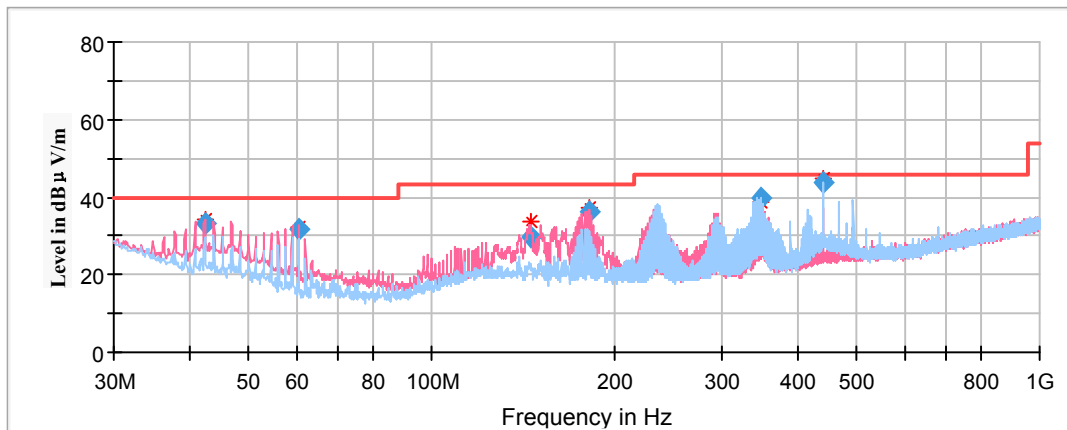
The testing was performed by Max Min on 2018-03-21 & 2018-04-12.

EUT operation mode: Transmitting

**Spurious Emission Test:**

**30MHz-1GHz:**

Pre-scan with 802.11b, 802.11g and 802.11n-HT20 modes of operation in the X,Y and Z axes of orientation, the worst case 802.11g mode(low channel:2412MHz) in X-axis of orientation was recorded



Frequency (MHz)	Corrected Amplitude	Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	QuasiPeak (dBµV/m)	Height (cm)	Polar (H/V)				
42.369300	33.03	101.0	V	67.0	-12.8	40.00	6.97
60.535200	31.83	101.0	V	242.0	-18.3	40.00	8.17
145.334800	29.55	101.0	V	145.0	-12.6	43.50	13.95
181.606900	36.20	101.0	V	2.0	-14.0	43.50	7.30
348.086450	39.58	101.0	H	289.0	-9.9	46.00	6.42
441.996400	43.00	101.0	H	66.0	-7.6	46.00	3.00

**1GHz-18GHz:**

**802.11b Mode:**

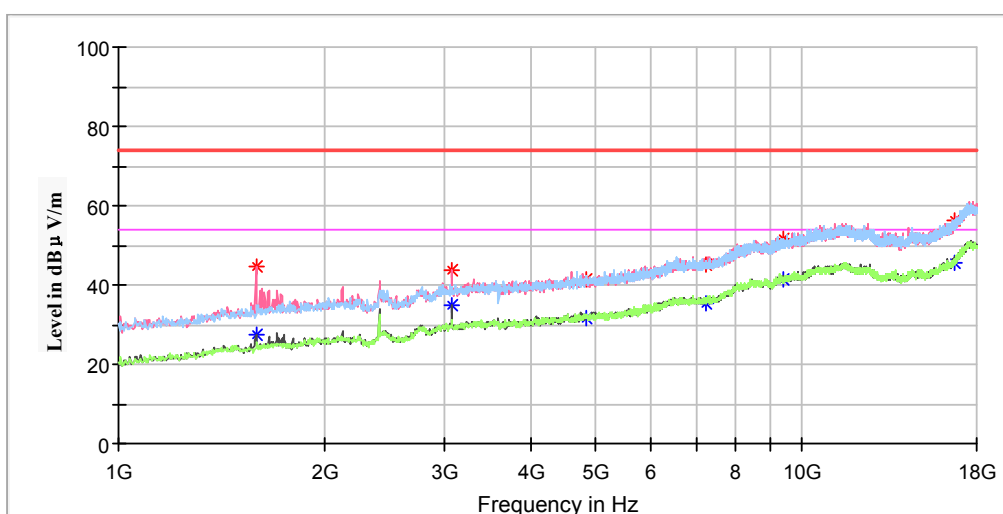
(Pre-scan in the X,Y and Z axes of orientation, the worst case X-axis of orientation was recorded)

Note:

1. This test was performed with the 2.4-2.5GHz band reject filter.
2. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
3. Corrected Amplitude = Corrected Factor + Reading
4. Margin = Limit - Corrected. Amplitude

**Low Channel: 2412MHz**

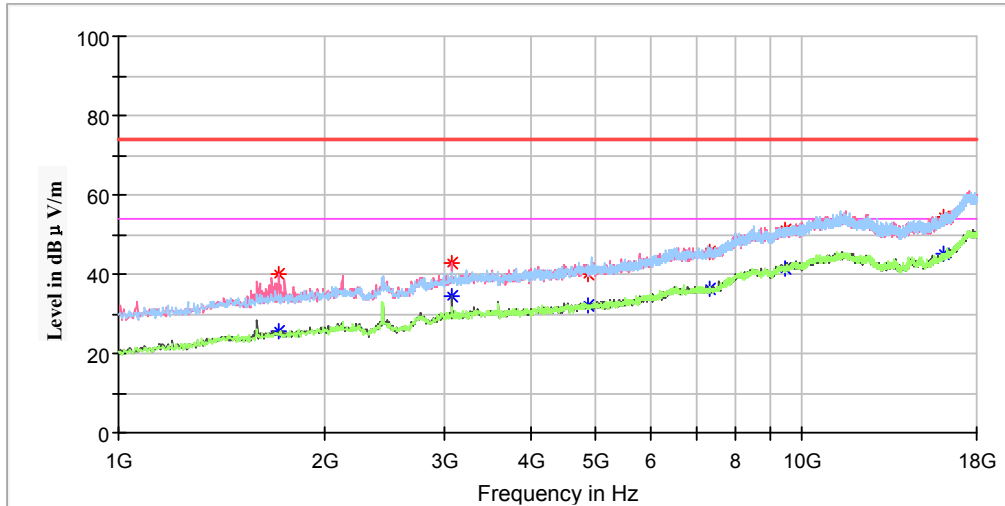
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1588.200000	---	27.43	200.0	V	176.0	-7.6	54.00	26.57
1588.200000	44.51	---	200.0	V	176.0	-7.6	74.00	29.49
3070.600000	43.71	---	150.0	V	197.0	-1.9	74.00	30.29
3070.600000	---	34.68	150.0	V	197.0	-1.9	54.00	19.32
4824.000000	41.37	---	200.0	V	4.0	2.5	74.00	32.63
4824.000000	---	31.59	200.0	V	4.0	2.5	54.00	22.41
7236.000000	---	35.34	150.0	V	107.0	9.8	54.00	18.66
7236.000000	44.94	---	150.0	V	107.0	9.8	74.00	29.06
9411.600000	---	41.29	200.0	H	143.0	14.5	54.00	12.71
9411.600000	51.66	---	200.0	H	143.0	14.5	74.00	22.34
16680.800000	---	45.75	150.0	V	36.0	19.5	54.00	8.25
16680.800000	56.38	---	150.0	V	36.0	19.5	74.00	17.62

**Middle Channel: 2437MHz**

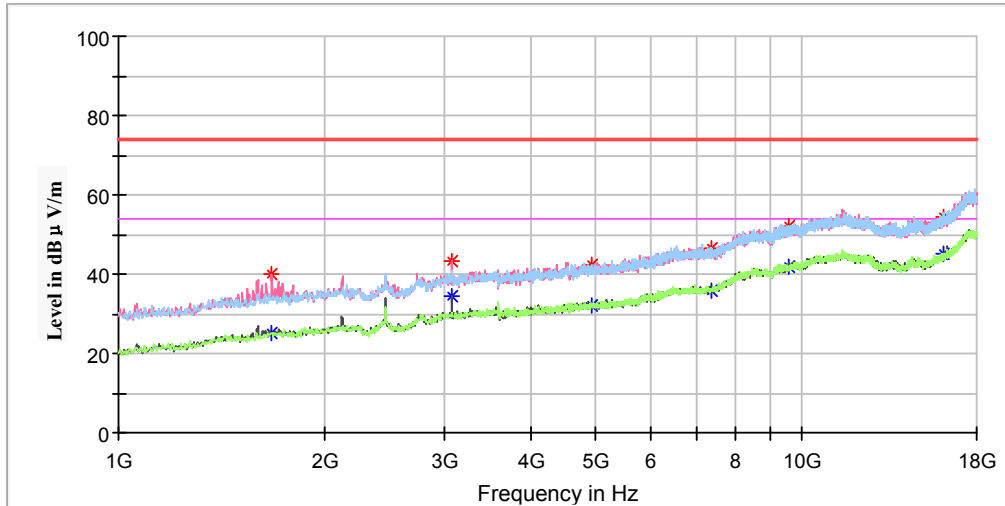
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1717.400000	---	25.64	150.0	V	95.0	-7.1	54.00	28.36
1717.400000	39.94	---	150.0	V	95.0	-7.1	74.00	34.06
3070.600000	---	34.24	150.0	V	202.0	-1.9	54.00	19.76
3070.600000	42.73	---	150.0	V	202.0	-1.9	74.00	31.27
4874.000000	39.84	---	200.0	V	282.0	2.6	74.00	34.16
4874.000000	---	31.87	200.0	V	282.0	2.6	54.00	22.13
7311.000000	---	36.30	200.0	V	279.0	10.0	54.00	17.70
7311.000000	45.56	---	200.0	V	279.0	10.0	74.00	28.44
9438.800000	---	41.28	100.0	H	355.0	14.6	54.00	12.72
9438.800000	51.34	---	100.0	H	355.0	14.6	74.00	22.66
16079.000000	---	45.00	250.0	V	162.0	17.9	54.00	9.00
16079.000000	54.24	---	250.0	V	162.0	17.9	74.00	19.76

**High Channel: 2462MHz**

Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1673.200000	---	25.22	200.0	V	176.0	-7.3	54.00	28.78
1676.600000	39.81	---	200.0	V	176.0	-7.3	74.00	34.19
3070.600000	---	34.23	200.0	V	124.0	-1.9	54.00	19.77
3070.600000	43.30	---	200.0	V	124.0	-1.9	74.00	30.70
4924.000000	---	32.24	200.0	V	149.0	2.8	54.00	21.76
4924.000000	42.44	---	200.0	V	149.0	2.8	74.00	31.56
7386.000000	---	35.89	150.0	V	203.0	10.1	54.00	18.11
7386.000000	46.30	---	150.0	V	203.0	10.1	74.00	27.70
9585.000000	---	41.84	150.0	H	113.0	14.9	54.00	12.16
9585.000000	52.01	---	150.0	H	113.0	14.9	74.00	21.99
16113.000000	---	44.89	150.0	H	274.0	17.9	54.00	9.11
16113.000000	54.63	---	150.0	H	274.0	17.9	74.00	19.37



**802.11g Mode:**

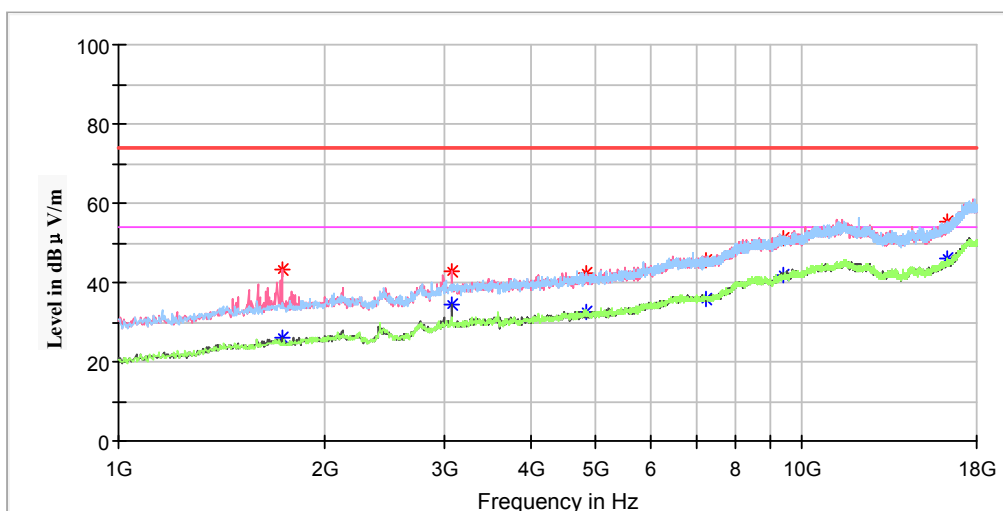
(Pre-scan in the X,Y and Z axes of orientation, the worst case X-axis of orientation was recorded)

Note:

1. This test was performed with the 2.4-2.5GHz band reject filter.
2. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
3. Corrected Amplitude = Corrected Factor + Reading
4. Margin = Limit - Corrected. Amplitude

**Low Channel: 2412MHz**

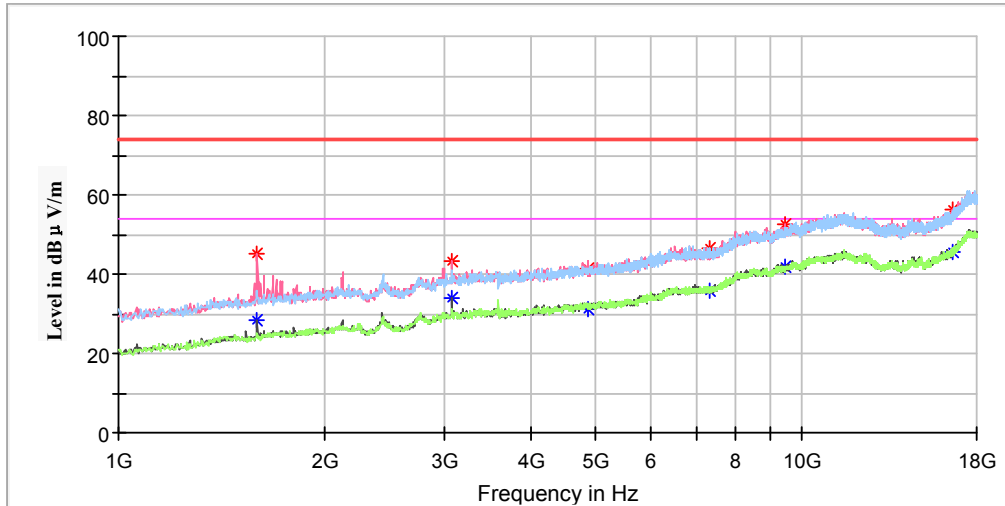
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1734.400000	---	25.96	150.0	V	193.0	-7.0	54.00	28.04
1734.400000	43.35	---	150.0	V	193.0	-7.0	74.00	30.65
3070.600000	---	34.37	150.0	V	169.0	-1.9	54.00	19.63
3070.600000	42.68	---	150.0	V	169.0	-1.9	74.00	31.32
4824.000000	---	32.33	150.0	V	203.0	2.5	54.00	21.67
4824.000000	42.25	---	150.0	V	203.0	2.5	74.00	31.75
7236.000000	---	35.73	200.0	V	41.0	9.8	54.00	18.27
7236.000000	45.54	---	200.0	V	41.0	9.8	74.00	28.46
9411.600000	---	41.67	200.0	H	211.0	14.5	54.00	12.33
9411.600000	51.06	---	200.0	H	211.0	14.5	74.00	22.94
16330.600000	---	45.90	250.0	V	271.0	18.3	54.00	8.10
16330.600000	55.44	---	250.0	V	271.0	18.3	74.00	18.56

**Middle Channel: 2437MHz**

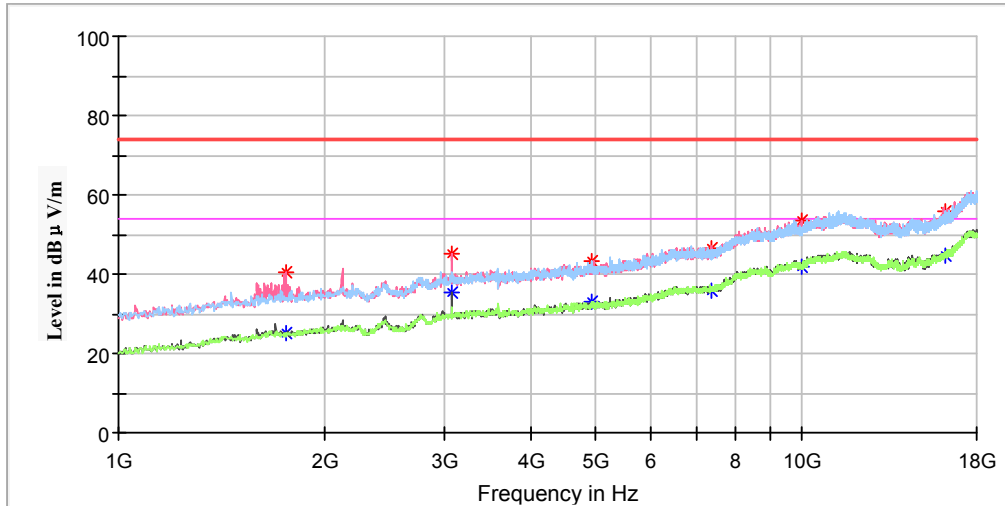
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1595.000000	---	28.20	200.0	V	176.0	-7.6	54.00	25.80
1595.000000	45.20	---	200.0	V	176.0	-7.6	74.00	28.80
3070.600000	---	34.12	150.0	V	202.0	-1.9	54.00	19.88
3070.600000	43.10	---	150.0	V	202.0	-1.9	74.00	30.90
4874.000000	---	31.14	150.0	V	288.0	2.6	54.00	22.86
4874.000000	41.45	---	150.0	V	288.0	2.6	74.00	32.55
7311.000000	---	35.90	150.0	V	114.0	10.0	54.00	18.10
7311.000000	46.39	---	150.0	V	114.0	10.0	74.00	27.61
9452.400000	---	41.78	150.0	H	338.0	14.7	54.00	12.22
9452.400000	52.68	---	150.0	H	338.0	14.7	74.00	21.32
16589.000000	---	45.38	200.0	V	194.0	19.0	54.00	8.62
16589.000000	56.48	---	200.0	V	194.0	19.0	74.00	17.52

**High Channel: 2462MHz**

Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1758.200000	---	24.91	250.0	V	39.0	-6.9	54.00	29.09
1758.200000	40.50	---	250.0	V	39.0	-6.9	74.00	33.50
3070.600000	44.99	---	250.0	V	128.0	-1.9	74.00	29.01
3070.600000	---	35.17	250.0	V	128.0	-1.9	54.00	18.83
4924.000000	---	33.03	150.0	V	333.0	2.7	54.00	20.97
4924.000000	43.43	---	150.0	V	333.0	2.7	74.00	30.57
7386.000000	---	36.03	200.0	V	70.0	10.1	54.00	17.97
7386.000000	46.66	---	200.0	V	70.0	10.1	74.00	27.34
9955.600000	---	42.07	250.0	V	268.0	14.9	54.00	11.93
9955.600000	53.52	---	250.0	V	268.0	14.9	74.00	20.48
16170.800000	---	44.88	200.0	V	328.0	18.0	54.00	9.12
16170.800000	55.94	---	200.0	V	328.0	18.0	74.00	18.06

**802.11n-HT20 Mode:**

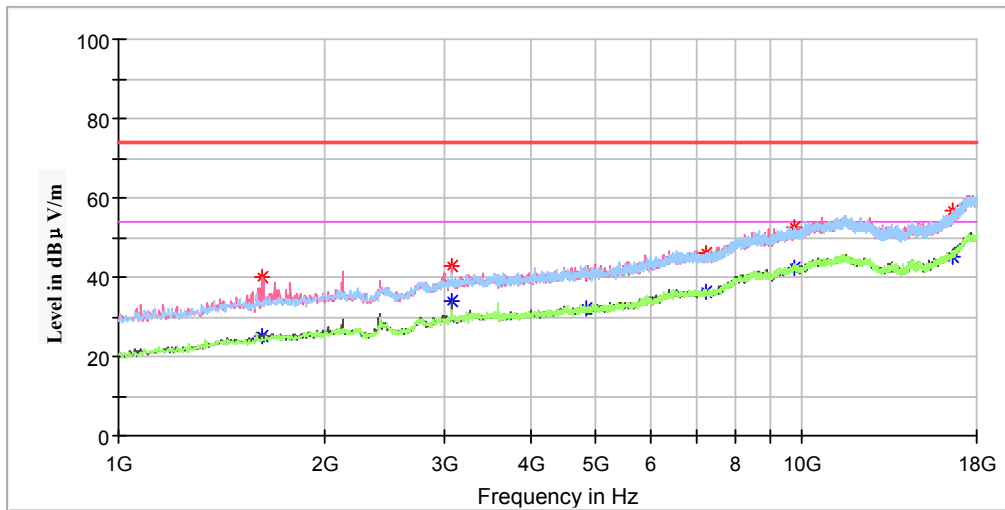
(Pre-scan in the X,Y and Z axes of orientation, the worst case X-axis of orientation was recorded)

Note:

1. This test was performed with the 2.4-2.5GHz band reject filter.
2. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
3. Corrected Amplitude = Corrected Factor + Reading
4. Margin = Limit - Corrected. Amplitude

**Low Channel: 2412MHz**

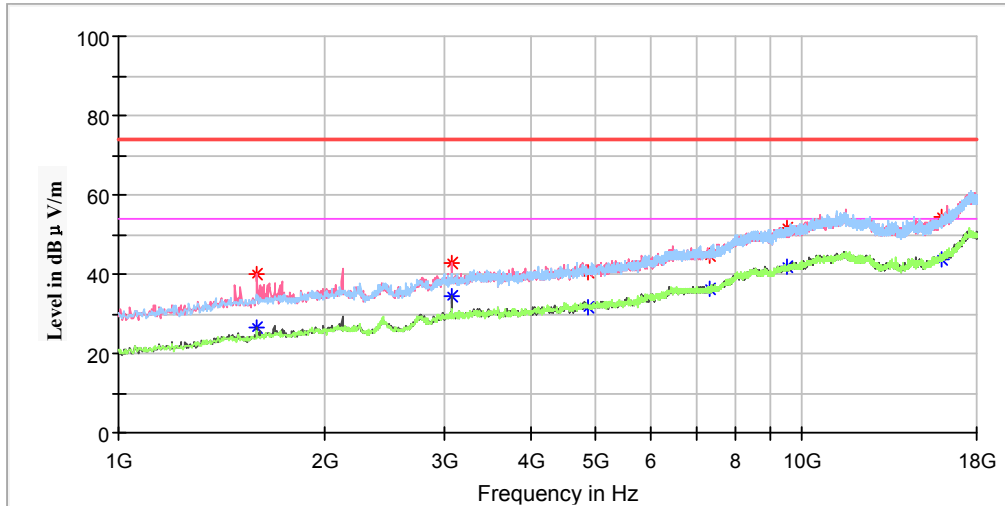
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
1625.600000	---	25.00	200.0	V	184.0	-7.5	54.00	29.00
1625.600000	39.88	---	200.0	V	184.0	-7.5	74.00	34.12
3070.600000	---	34.15	150.0	V	193.0	-1.9	54.00	19.85
3070.600000	42.99	---	150.0	V	193.0	-1.9	74.00	31.01
4824.000000	---	32.02	200.0	V	50.0	2.5	54.00	21.98
4824.000000	41.13	---	200.0	V	50.0	2.5	74.00	32.87
7236.000000	---	36.16	200.0	V	184.0	9.8	54.00	17.84
7236.000000	45.86	---	200.0	V	184.0	9.8	74.00	28.14
9755.000000	---	42.28	150.0	H	257.0	14.9	54.00	11.72
9755.000000	52.58	---	150.0	H	257.0	14.9	74.00	21.42
16558.400000	---	45.17	200.0	H	117.0	18.9	54.00	8.83
16558.400000	56.79	---	200.0	H	117.0	18.9	74.00	17.21

**Middle Channel: 2437MHz**

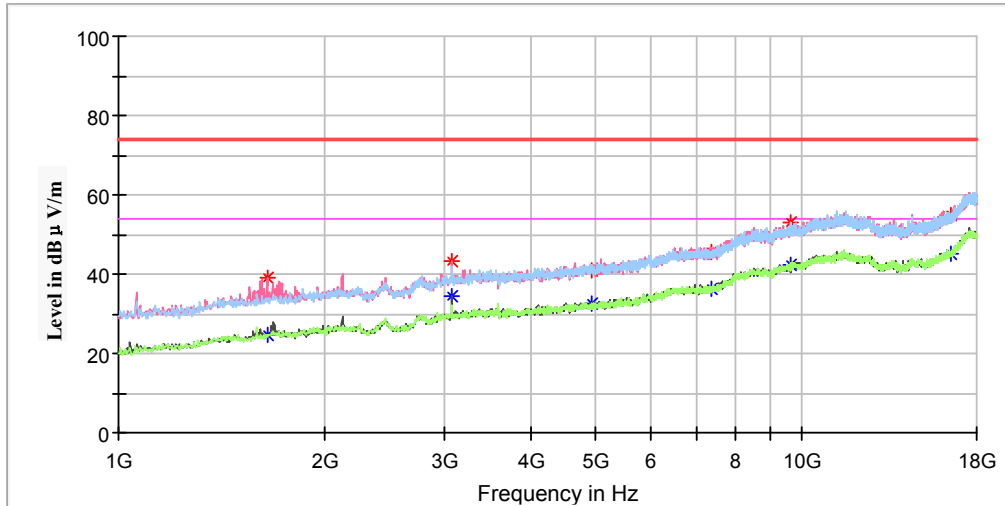
Full Spectrum



Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1591.600000	---	26.61	150.0	V	184.0	-7.6	54.00	27.39
1591.600000	40.18	---	150.0	V	184.0	-7.6	74.00	33.82
3070.600000	---	34.38	200.0	V	145.0	-1.9	54.00	19.62
3070.600000	42.68	---	200.0	V	145.0	-1.9	74.00	31.32
4874.000000	---	31.56	200.0	V	86.0	2.6	54.00	22.44
4874.000000	40.39	---	200.0	V	86.0	2.6	74.00	33.61
7311.000000	---	36.19	150.0	V	180.0	10.0	54.00	17.81
7311.000000	44.73	---	150.0	V	180.0	10.0	74.00	29.27
9520.400000	---	41.90	200.0	H	14.0	14.9	54.00	12.10
9520.400000	51.53	---	200.0	H	14.0	14.9	74.00	22.47
16011.000000	---	43.86	200.0	V	172.0	17.8	54.00	10.14
16011.000000	54.61	---	200.0	V	172.0	17.8	74.00	19.39

**High Channel: 2462MHz**

Full Spectrum

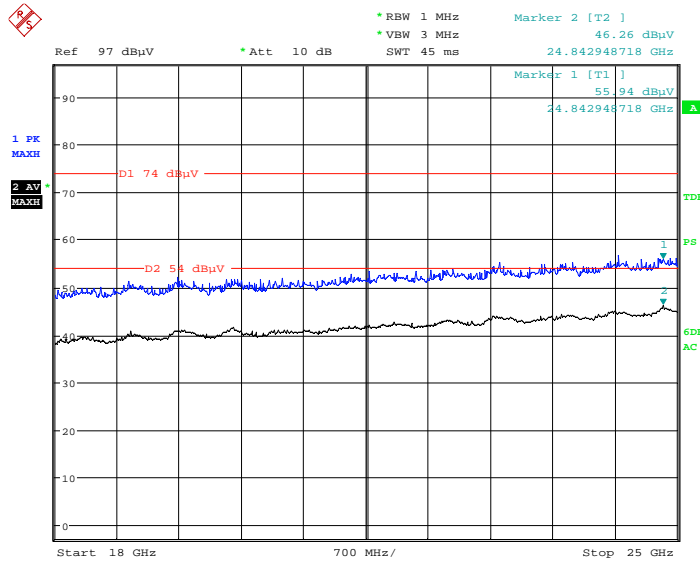


Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBμV/m)	Margin (dB)
	MaxPeak (dBμV /m)	Average (dBμV /m)	Height (cm)	Polar (H/V)				
1649.400000	---	24.45	150.0	V	153.0	-7.4	54.00	29.55
1649.400000	39.08	---	150.0	V	153.0	-7.4	74.00	34.92
3070.600000	43.27	---	150.0	V	189.0	-1.9	74.00	30.73
3070.600000	---	34.46	150.0	V	189.0	-1.9	54.00	19.54
4924.000000	40.70	---	200.0	V	130.0	2.7	74.00	33.30
4924.000000	---	32.69	200.0	V	130.0	2.7	54.00	21.31
7386.000000	---	36.31	200.0	V	174.0	10.1	54.00	17.69
7386.000000	45.60	---	200.0	V	174.0	10.1	74.00	28.40
9595.200000	---	42.52	150.0	H	246.0	14.9	54.00	11.48
9595.200000	53.01	---	150.0	H	246.0	14.9	74.00	20.99
16490.400000	---	45.19	200.0	H	228.0	18.6	54.00	8.81
16490.400000	55.00	---	200.0	H	228.0	18.6	74.00	19.00

**18GHz-25GHz:**

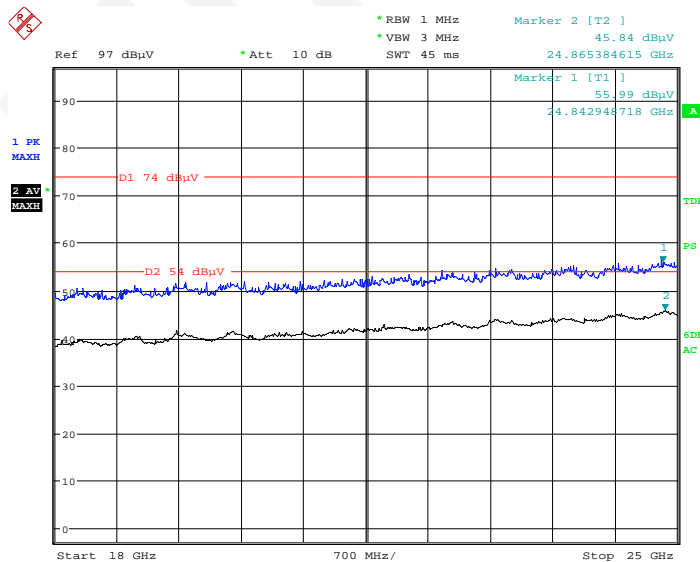
Pre-scan with 802.11b, 802.11g and 802.11n-HT20 modes of operation in the X,Y and Z axes of orientation, the worst case 802.11g mode(low channel:2412MHz) in X-axis of orientation was recorded

**Horizontal**



Date: 12.APR.2018 18:15:31

**Vertical**



Date: 12.APR.2018 18:26:11

**Fundamental Test & Restricted Bands Emissions Test:**

Note:

1. Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
2. Corrected Amplitude = Corrected Factor + Reading
3. Margin = Limit - Corrected. Amplitude

**802.11b Mode:** (Pre-scan in the X,Y and Z axes of orientation, the worst case X-axis of orientation was recorded)

Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
Low Channel: 2412MHz								
2412.000000	94.32	---	200.0	V	92.0	5.1	/	/
2412.000000	---	91.42	200.0	V	92.0	5.1	/	/
2390.000000	---	39.48	100.0	V	36.0	5.1	54.00	14.52
2390.000000	49.95	---	100.0	V	36.0	5.1	74.00	24.05
Middle Channel: 2437MHz								
2437.000000	93.89	---	200.0	V	305.0	5.2	/	/
2437.000000	---	90.78	200.0	V	305.0	5.2	/	/
High Channel: 2462MHz								
2462.000000	---	90.29	150.0	V	188.0	5.2	/	/
2462.000000	93.43	---	150.0	V	188.0	5.2	/	/
2483.500000	---	40.17	150.0	V	171.0	5.3	54.00	13.83
2483.500000	49.22	---	250.0	V	171.0	5.3	74.00	24.78

**802.11g Mode:** (Pre-scan in the X,Y and Z axes of orientation, the worst case X-axis of orientation was recorded)

Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
Low Channel: 2412MHz								
2412.000000	94.62	---	200.0	V	84.0	5.1	/	/
2412.000000	---	87.42	200.0	V	84.0	5.1	/	/
2390.000000	---	39.76	150.0	V	321.0	5.3	54.00	14.24
2390.000000	49.87	---	250.0	V	321.0	5.3	74.00	24.13
Middle Channel: 2437MHz								
2437.000000	93.99	---	200.0	V	75.0	5.2	/	/
2437.000000	---	86.87	200.0	V	75.0	5.2	/	/
High Channel: 2462MHz								
2462.000000	---	86.57	150.0	V	191.0	5.2	/	/
2462.000000	93.61	---	150.0	V	191.0	5.2	/	/
2483.500000	---	40.15	150.0	V	121.0	5.3	54.00	13.85
2483.500000	49.67	---	250.0	V	121.0	5.3	74.00	24.33

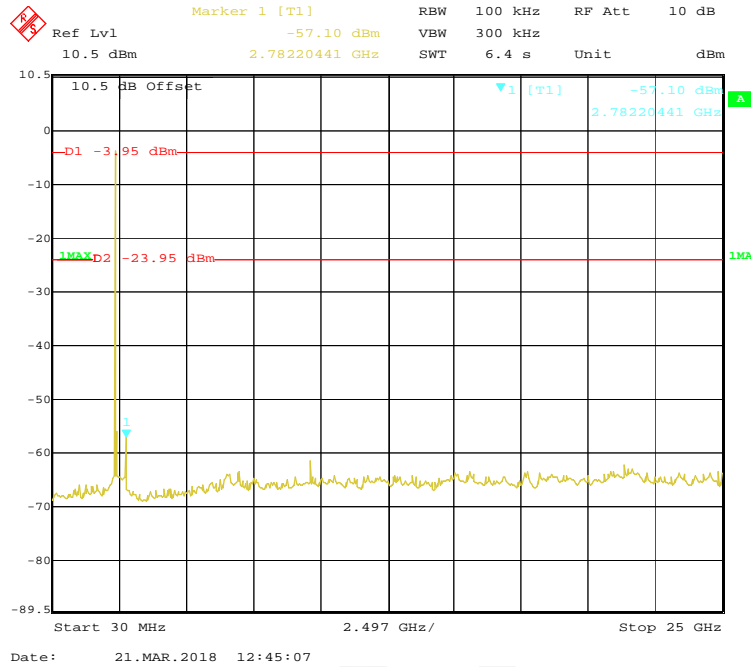


**802.11n-HT20 Mode:** (Pre-scan in the X,Y and Z axes of orientation, the worst case X-axis of orientation was recorded)

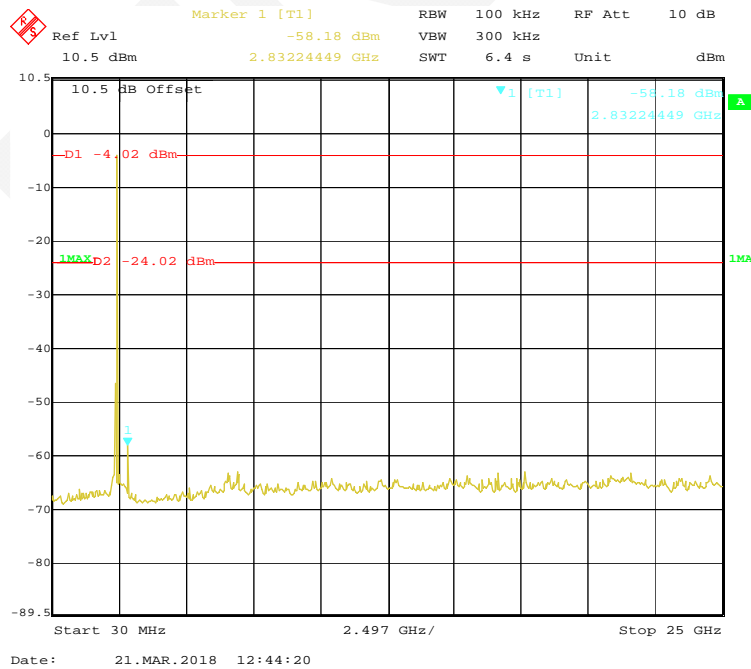
Frequency (MHz)	Corrected Amplitude		Rx Antenna		Turntable Degree	Corrected Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
	MaxPeak (dBµV /m)	Average (dBµV /m)	Height (cm)	Polar (H/V)				
Low Channel: 2412MHz								
2412.000000	94.34	---	200.0	V	84.0	5.1	/	/
2412.000000	---	87.29	200.0	V	84.0	5.1	/	/
2390.000000	---	39.76	150.0	V	179.0	5.3	54.00	14.24
2390.000000	49.47	---	150.0	V	179.0	5.3	74.00	24.53
Middle Channel: 2437MHz								
2437.000000	93.87	---	200.0	V	65.0	5.2	/	/
2437.000000	---	86.87	200.0	V	65.0	5.2	/	/
High Channel: 2462MHz								
2462.000000	---	86.54	150.0	V	191.0	5.2	/	/
2462.000000	93.45	---	150.0	V	191.0	5.2	/	/
2483.500000	---	40.33	200.0	V	88.0	5.3	54.00	13.67
2483.500000	49.83	---	200.0	V	88.0	5.3	74.00	24.17

### Conducted Spurious Emissions at Antenna Port

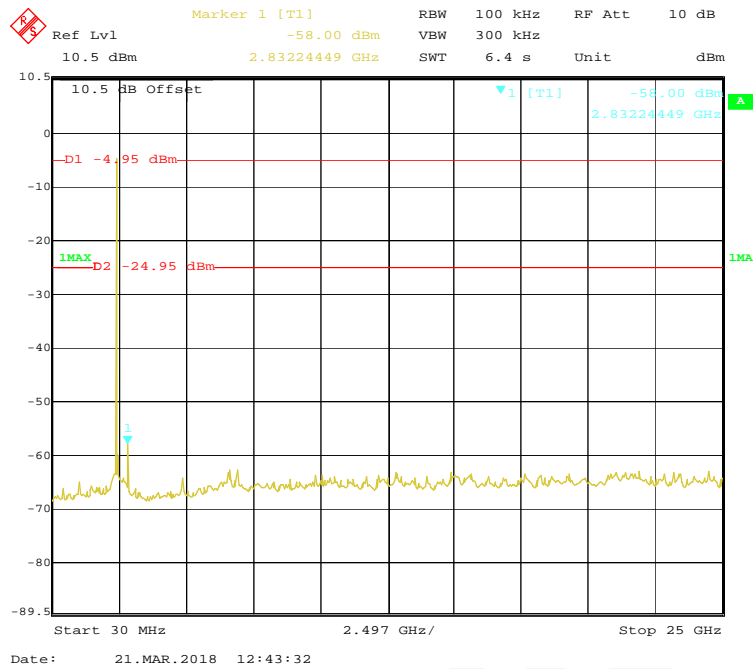
#### 802.11b Mode Low Channel



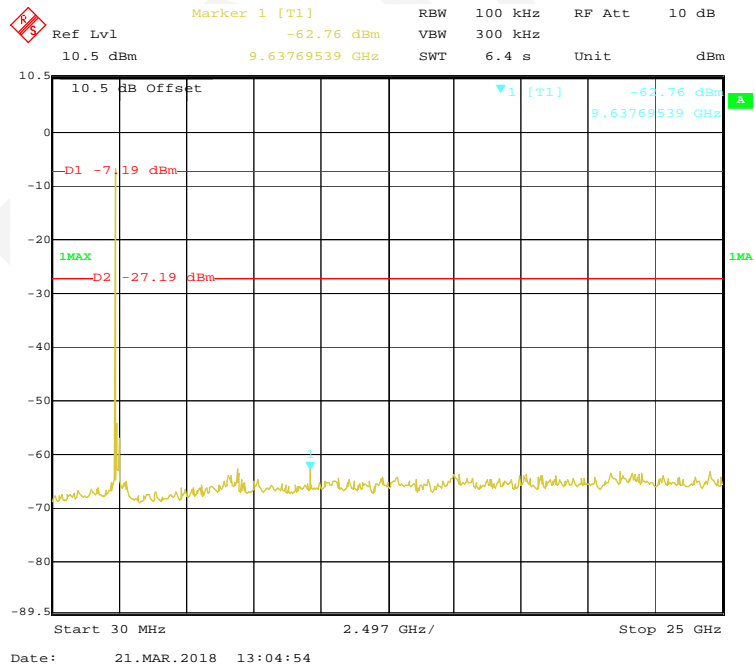
#### 802.11b Mode Middle Channel



### 802.11b Mode High Channel



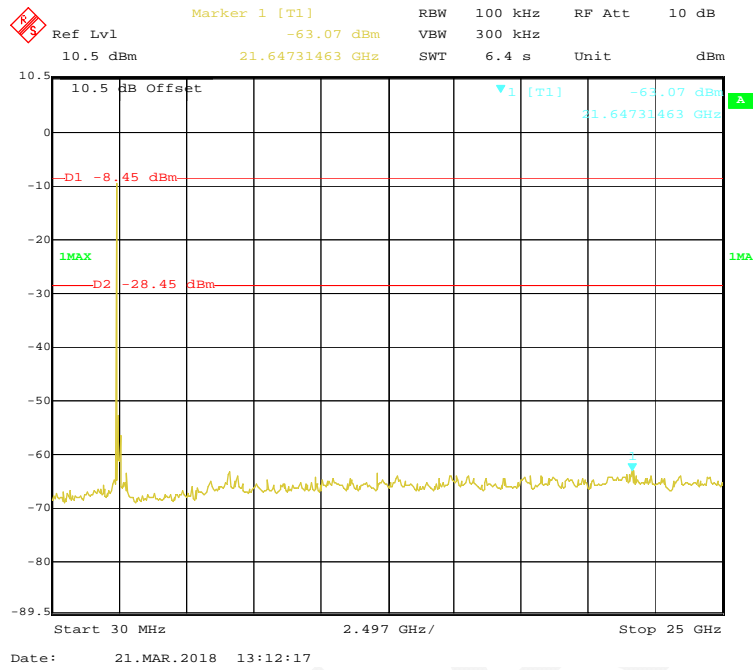
### 802.11g Mode Low Channel







### 802.11n-HT20 Mode High Channel



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

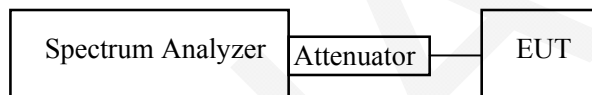
**Applicable Standard**

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**

According to KDB558074 D01 DTS Meas Guidance v04 sub-clause 8.1

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. 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**

<b>Temperature:</b>	24 °C
<b>Relative Humidity:</b>	51 %
<b>ATM Pressure:</b>	101.3 kPa

*The testing was performed by Max Min on 2018-03-20 & 2018-03-21.*

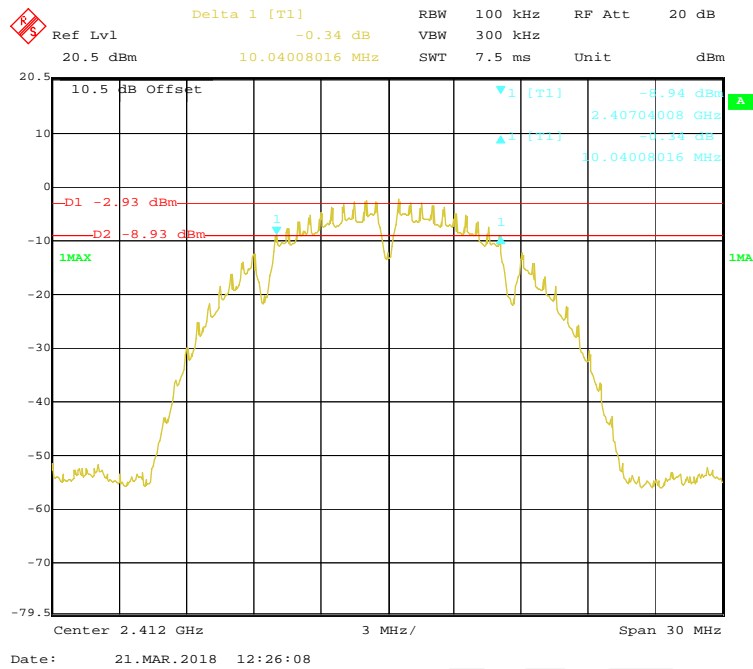
*EUT operation mode: Transmitting*

**Test Result:** Pass

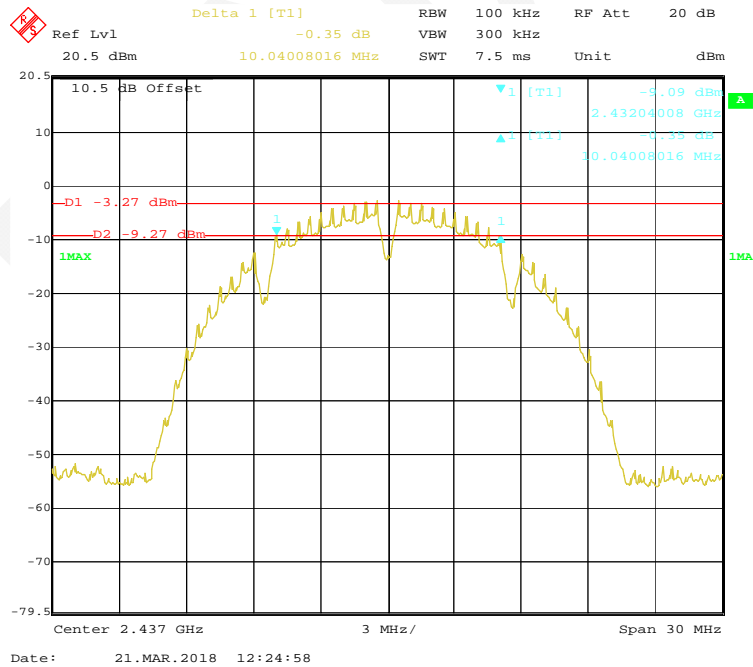
Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (MHz)
802.11b Mode			
Low	2412	10.040	$\geq 0.5$
Middle	2437	10.040	$\geq 0.5$
High	2462	10.040	$\geq 0.5$
802.11g Mode			
Low	2412	16.112	$\geq 0.5$
Middle	2437	16.172	$\geq 0.5$
High	2462	16.052	$\geq 0.5$
802.11n-HT20 Mode			
Low	2412	16.713	$\geq 0.5$
Middle	2437	16.954	$\geq 0.5$
High	2462	16.834	$\geq 0.5$



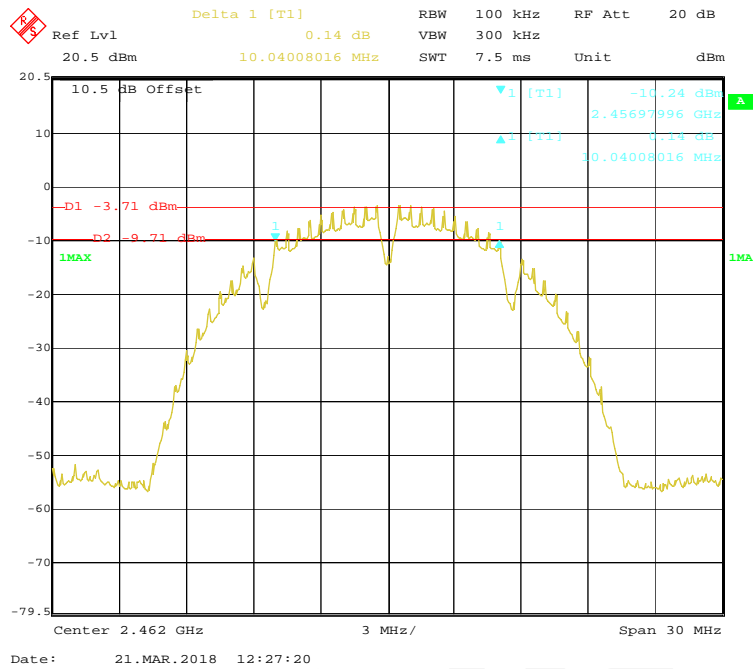
### 802.11b Mode Low Channel



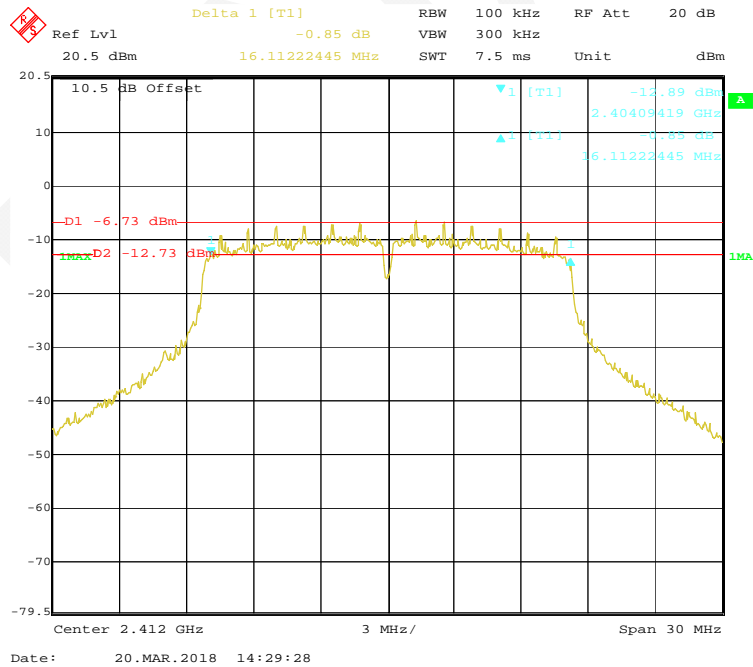
### 802.11b Mode Middle Channel



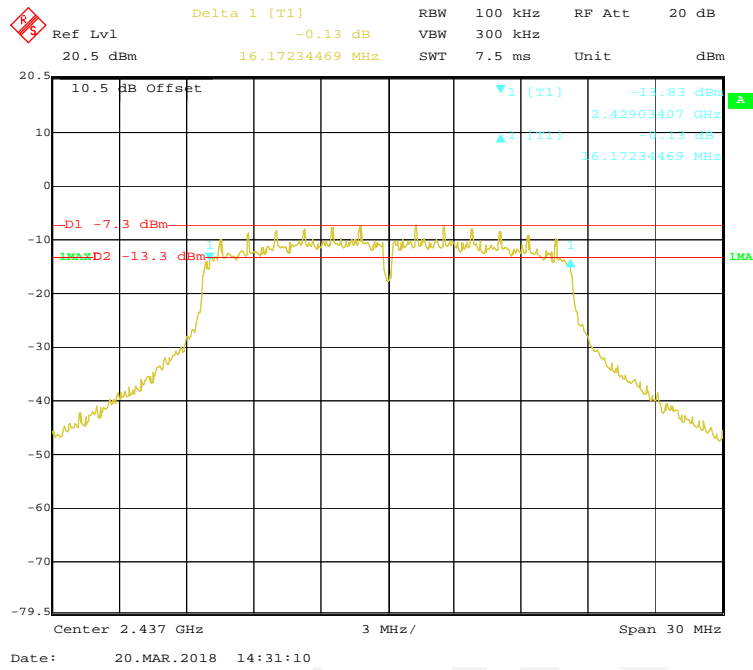
### 802.11b Mode High Channel



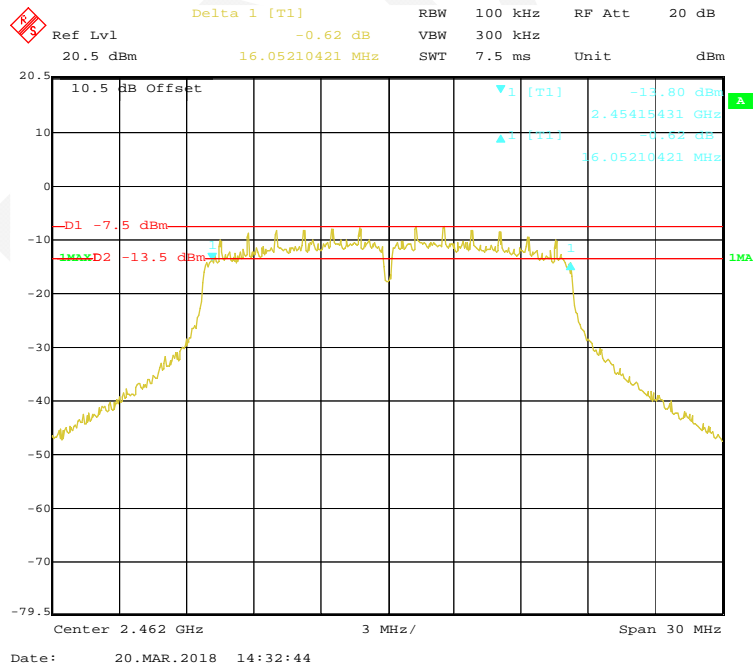
### 802.11g Mode Low Channel



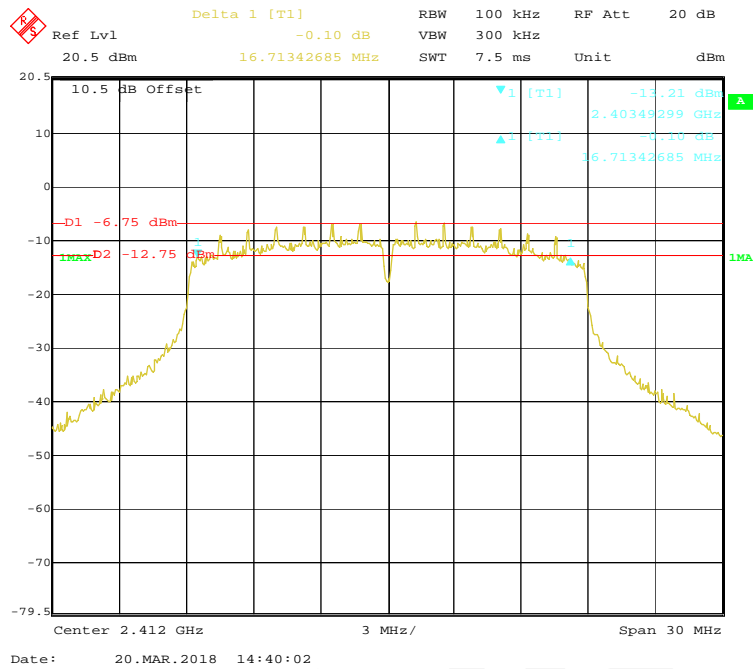
### 802.11g Mode Middle Channel



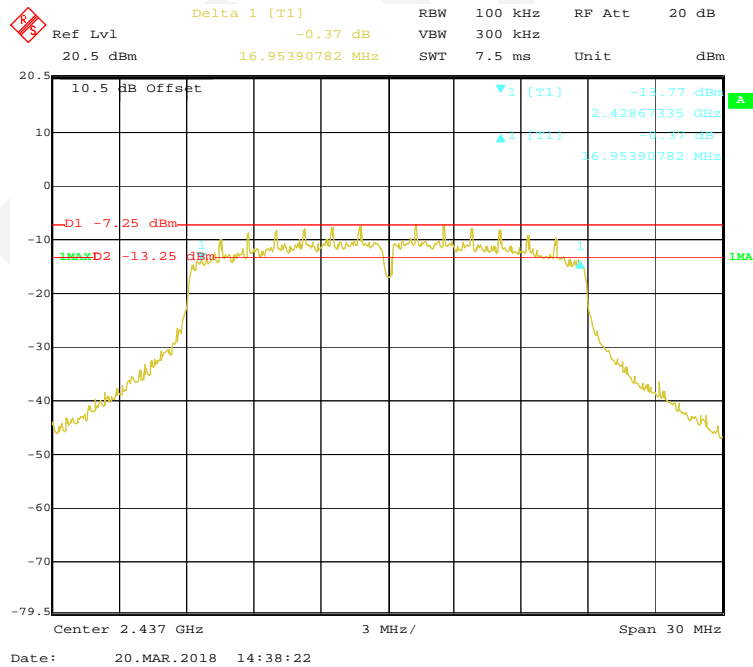
### 802.11g Mode High Channel



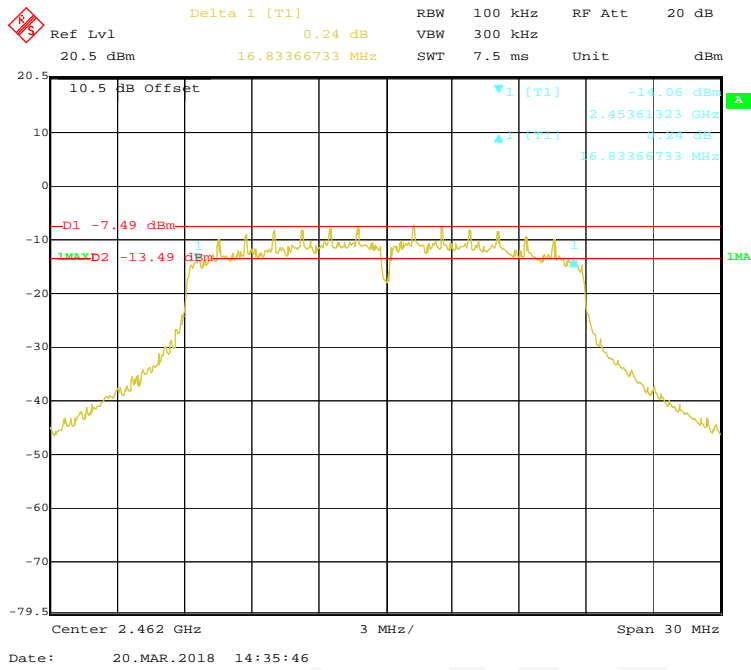
### 802.11n-HT20 Mode Low Channel



### 802.11n-HT20 Mode Middle Channel



### 802.11n-HT20 Mode High Channel



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

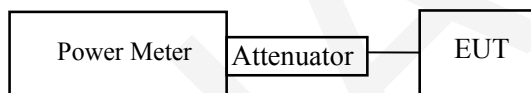
### **Applicable Standard**

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**

According to KDB558074 D01 DTS Meas Guidance v04 sub-clause 9.1.3

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall use a fast-responding diode detector.



### **Test Data**

#### **Environmental Conditions**

<b>Temperature:</b>	23.8°C
<b>Relative Humidity:</b>	54 %
<b>ATM Pressure:</b>	101.2 kPa

*The testing was performed by Max Min on 2018-03-20.*

*EUT operation mode: Transmitting*

Channel	Frequency (MHz)	Max Conducted Peak Output Power (dBm)	Max Conducted Average Output Power (dBm)	Limit (dBm)	Result
802.11b Mode					
Low	2412	8.44	4.78	30	Pass
Middle	2437	7.96	4.45	30	Pass
High	2462	7.47	4.11	30	Pass
802.11g Mode					
Low	2412	10.56	4.71	30	Pass
Middle	2437	9.97	4.27	30	Pass
High	2462	9.74	4.11	30	Pass
802.11n-HT20 Mode					
Low	2412	10.50	4.61	30	Pass
Middle	2437	9.88	4.18	30	Pass
High	2462	9.71	4.01	30	Pass

## **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**

According to KDB558074 D01 DTS Meas Guidance v04 sub-clause 13.2 and ANSI C63.10-2013 clause 6.10.

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**

<b>Temperature:</b>	24.3 °C
<b>Relative Humidity:</b>	50 %
<b>ATM Pressure:</b>	101.3 kPa

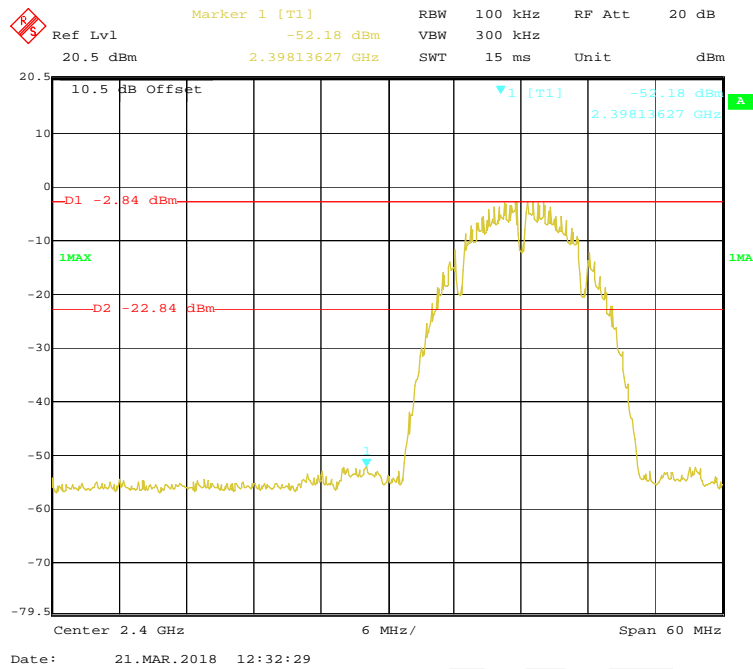
*The testing was performed by Max Min on 2018-03-20 & 2018-03-21.*

*EUT operation mode: Transmitting*

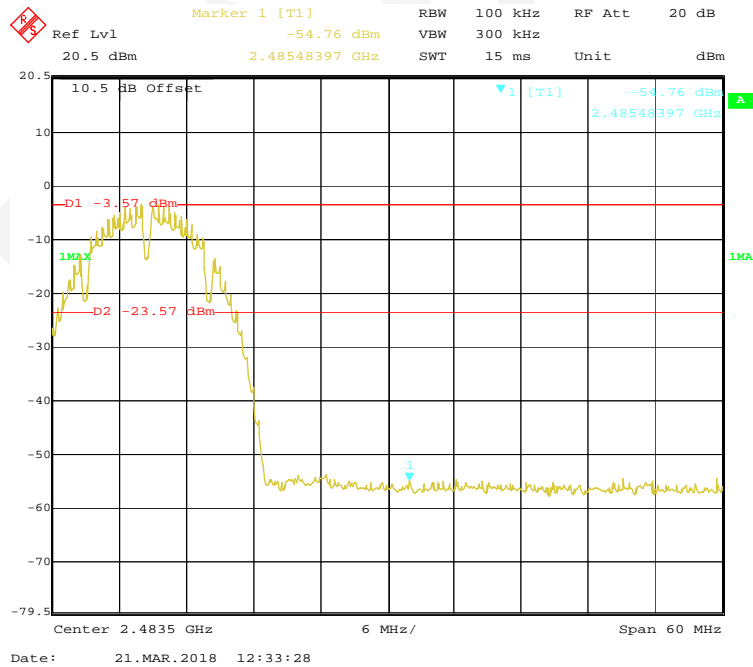
**Test Result:** Compliance



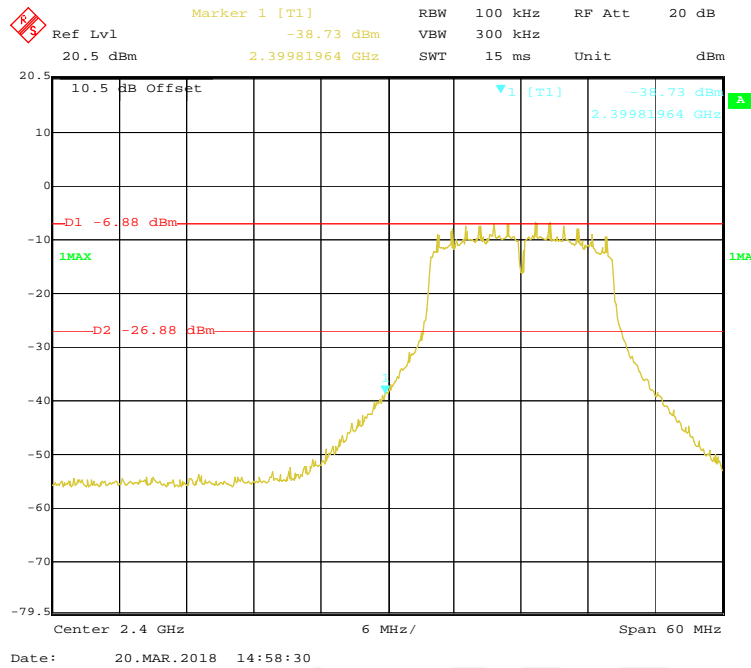
### 802.11b Mode Left Side



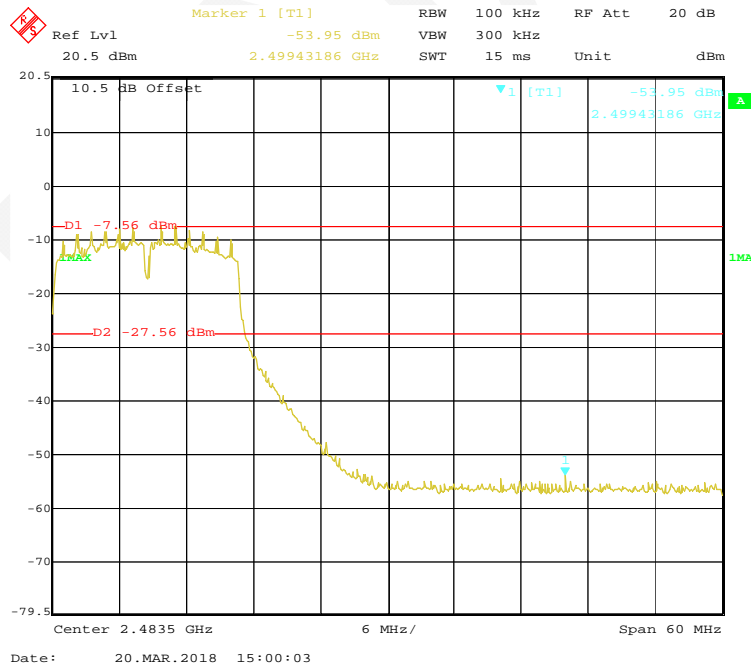
### 802.11b Mode Right Side



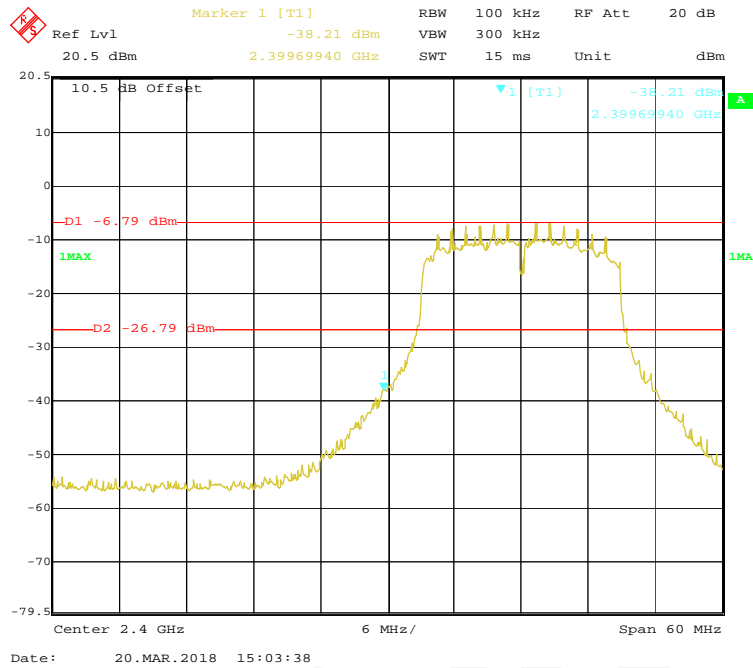
### 802.11g Mode Left Side



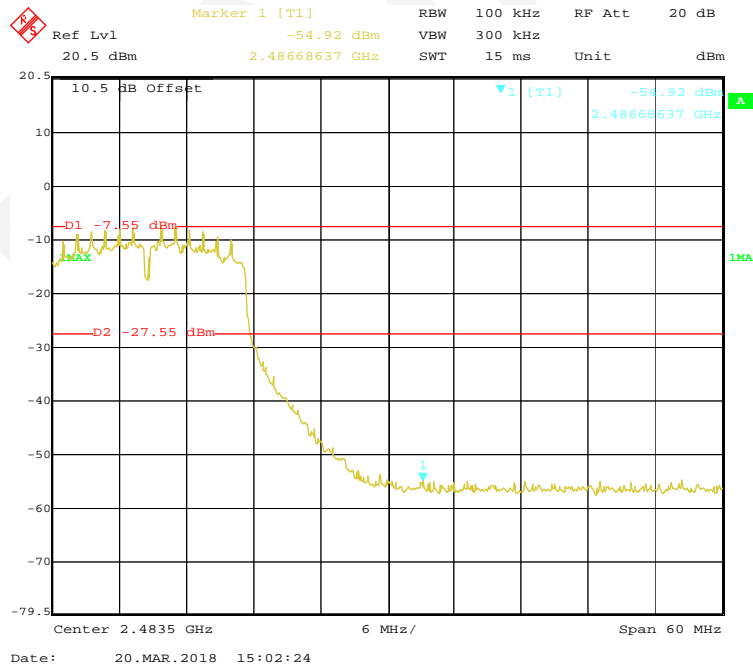
### 802.11g Mode Right Side



**802.11n-HT20 Mode Left Side**



**802.11n-HT20 Mode 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**

According to KDB558074 D01 DTS Meas Guidance v04 sub-clause 10.2

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW to:  $3\text{kHz} \leq \text{RBW} \leq 100\text{ kHz}$ .
3. Set the VBW  $\geq 3 \times \text{RBW}$ .
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### **Test Data**

#### **Environmental Conditions**

<b>Temperature:</b>	24.1 °C
<b>Relative Humidity:</b>	50%
<b>ATM Pressure:</b>	101.3 kPa

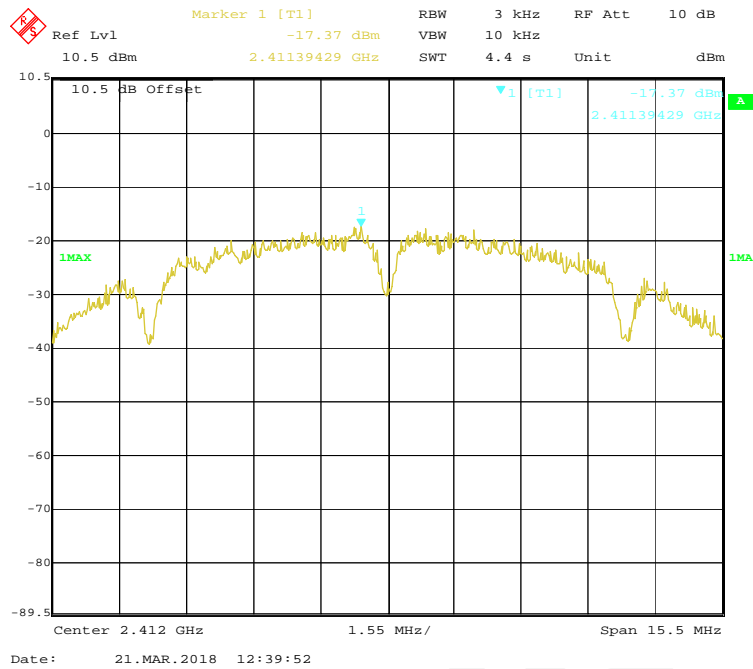
*The testing was performed by Max Min on 2018-03-20 & 2018-03-21.*

*EUT operation mode: Transmitting*

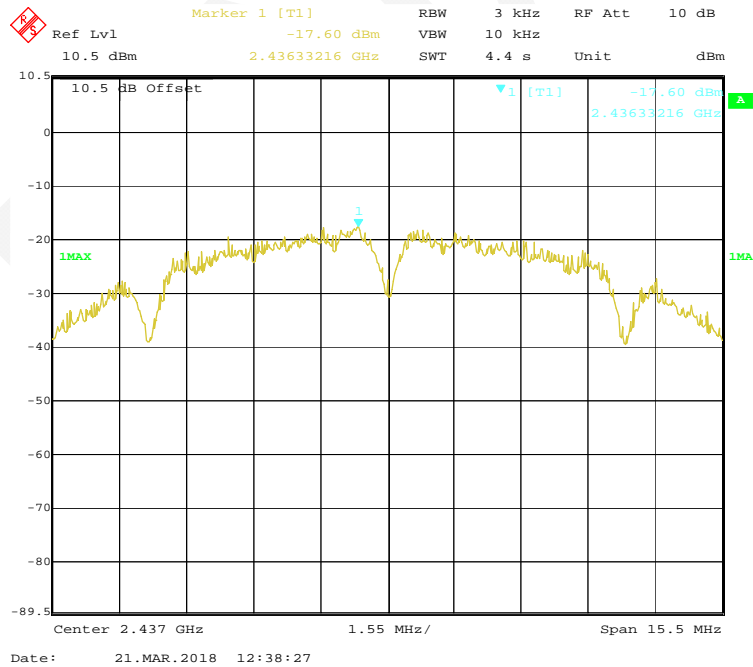
**Test Result:** Pass

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
802.11b Mode			
Low	2412	-17.37	≤8
Middle	2437	-17.60	≤8
High	2462	-18.65	≤8
802.11g Mode			
Low	2412	-21.28	≤8
Middle	2437	-22.02	≤8
High	2462	-22.63	≤8
802.11n-HT20 mode			
Low	2412	-23.50	≤8
Middle	2437	-23.33	≤8
High	2462	-22.08	≤8

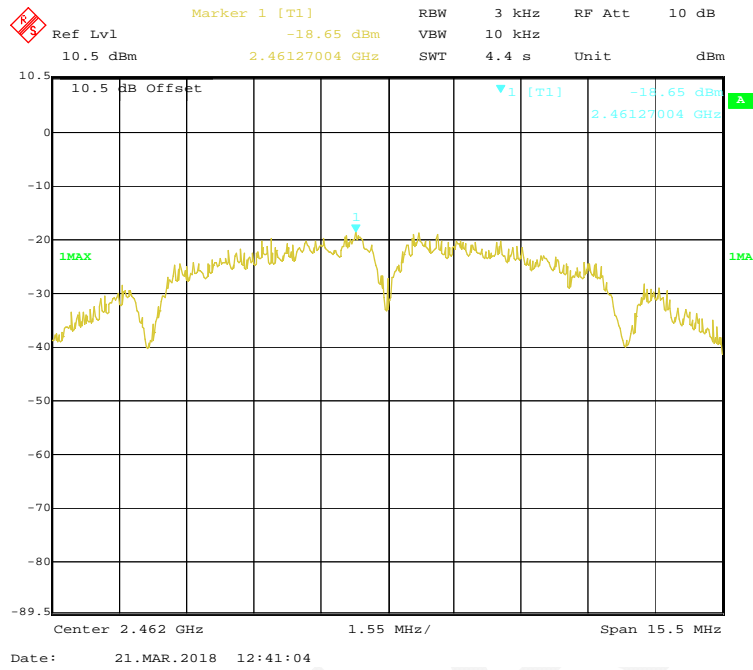
### 802.11b Mode Low Channel



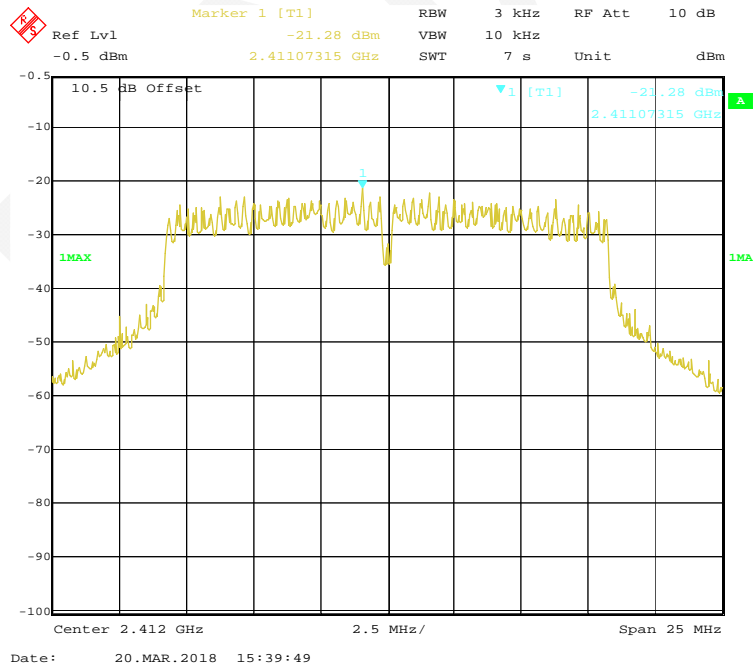
### 802.11b Mode Middle Channel



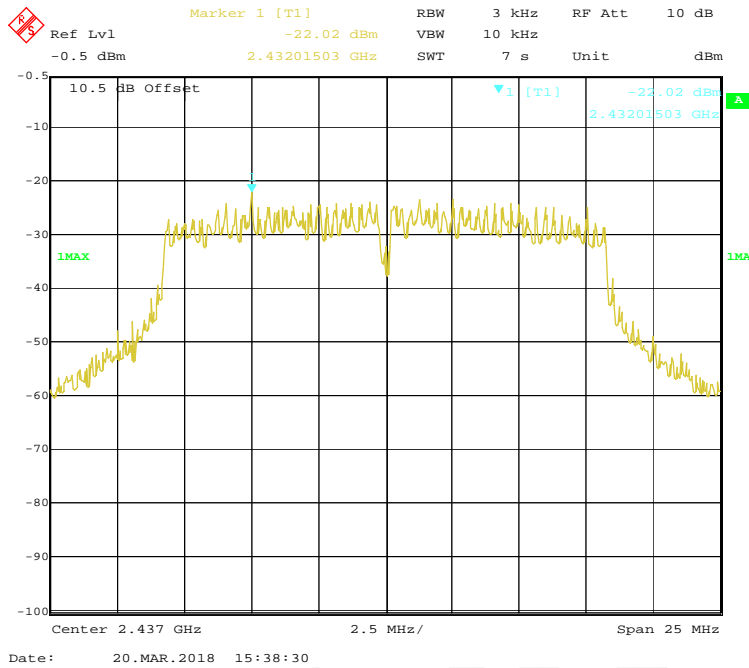
### 802.11b Mode High Channel



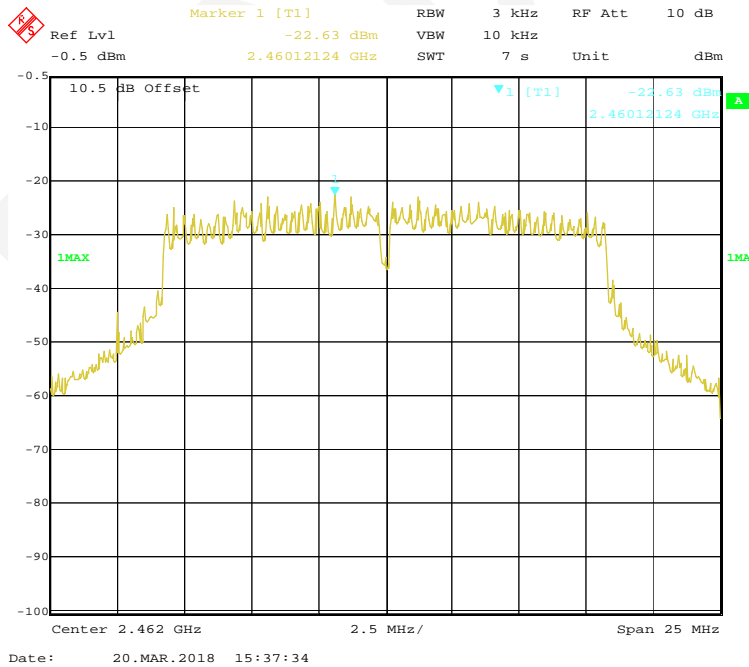
### 802.11g Mode Low Channel



### 802.11g Mode Middle Channel

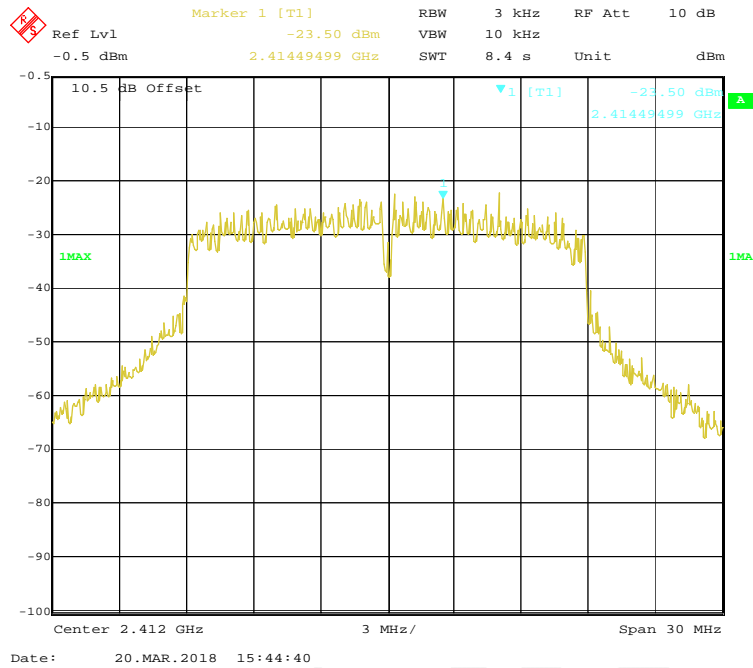


### 802.11g Mode High Channel

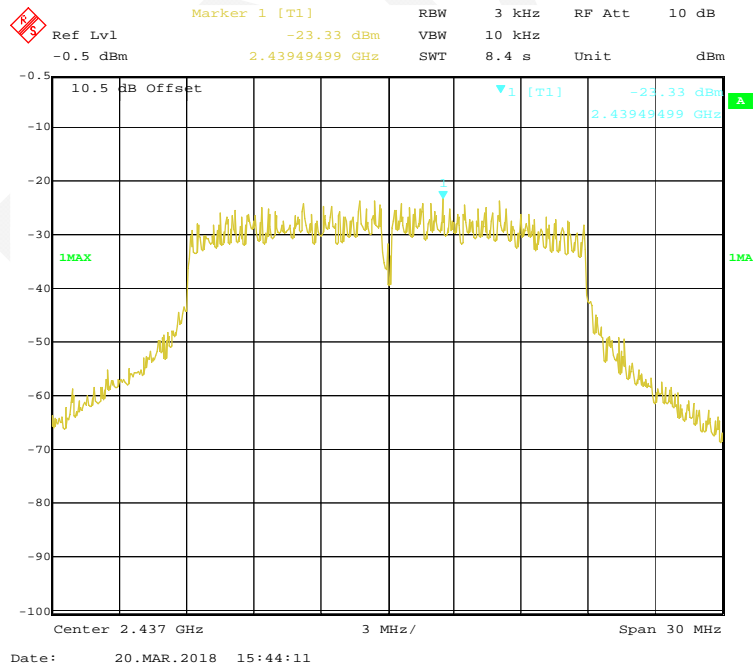




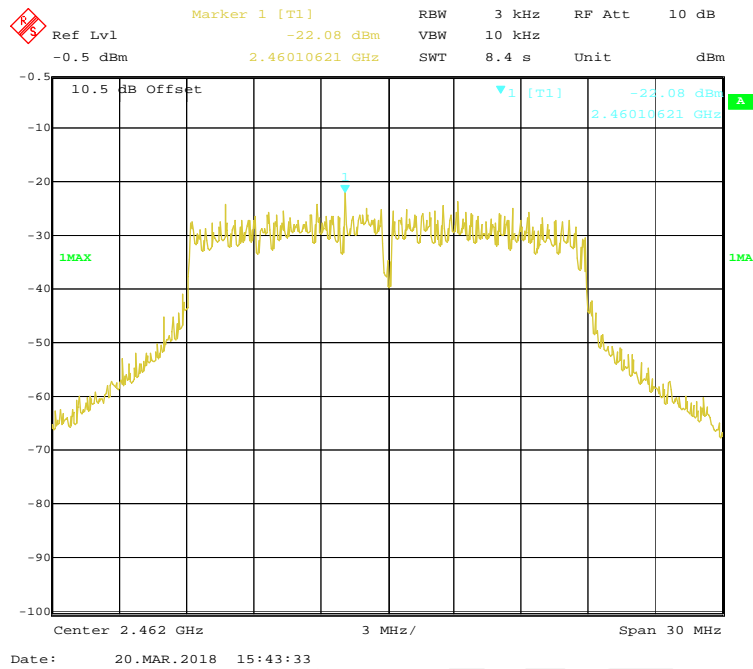
### 802.11n-HT20 Mode Low Channel



### 802.11n-HT20 Mode Middle Channel



802.11n-HT20 Mode High Channel



\*\*\*\*\* END OF REPORT \*\*\*\*\*