

# FCC Test Report

**FCC ID** : TVE-130503  
**Equipment** : 3T3R PCIeModule- 2.4GHz  
**Model No.** : WMDQ-175AC  
**Brand Name** : Fortinet, Inc.  
**Applicant** : Fortinet Inc.  
**Address** : 899 Kifer Road Sunnyvale, CA 94086, USA  
**Standard** : 47 CFR FCC Part 15.247  
**Received Date** : Mar. 10, 2015  
**Tested Date** : Mar. 13 ~ Apr. 16, 2015

We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Approved & Reviewed by:

  
\_\_\_\_\_  
Gary Chang / Manager



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## Release Record

Report No.	Version	Description	Issued Date
FR531002	Rev. 01	Initial issue	May 20, 2015
FR531002	Rev. 02	Modify ANSI C63.10 version	May 27, 2015

## Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	[dBuV]: 0.162MHz 53.30 (Margin -12.04dB) - QP	Pass
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 2483.50MHz 52.50 (Margin -1.50dB) – AV [dBuV/m at 3m]: 2390.00MHz 52.50 (Margin -1.50dB) – AV	Pass
15.247(b)(3)	Maximum Output Power	Max Power [dBm]: 29.48	Pass
15.247(a)(2)	6dB Bandwidth	Meet the requirement of limit	Pass
15.247(e)	Power Spectral Density	Meet the requirement of limit	Pass
15.203	Antenna Requirement	Meet the requirement of limit	Pass

## 1 General Description

### 1.1 Information

#### 1.1.1 Specification of the Equipment under Test (EUT)

RF General Information					
Frequency Range (MHz)	IEEE Std. 802.11	Ch. Freq. (MHz)	Channel Number	Transmit Chains (N <sub>Tx</sub> )	Data Rate / MCS
2400-2483.5	b	2412-2462	1-11 [11]	3	1-11 Mbps
2400-2483.5	g	2412-2462	1-11 [11]	3	6-54 Mbps
2400-2483.5	n (HT20)	2412-2462	1-11 [11]	3	MCS 0-23
2400-2483.5	n (HT40)	2422-2452	3-9 [7]	3	MCS 0-23

Note 1: RF output power specifies that Maximum Peak Conducted Output Power.  
Note 2: 802.11b uses a combination of DSSS-DBPSK, DQPSK, CCK modulation.  
Note 3: 802.11g/n uses a combination of OFDM-BPSK, QPSK, 16QAM, 64QAM modulation.

#### 1.1.2 Antenna Details

Ant. No.	Model	Type	Connector	Operating Frequency / Gain (dBi)
				2400~2483.5MHz
1	AK51010200	Dipole	R-SMA	4.59
2	LG19	PIFA	IPEX	6.38
3	FPC_ANT (Cable: 95mm)	PIFA	IPEX	4.16
4	FPC_ANT (Cable: 355mm)	PIFA	IPEX	2.87
5	FPC_ANT (Cable: 150mm)	PIFA	IPEX	3.57

Note:

- 1) There are six different cable lengths for Dipole antenna. They should be 100mm, 130mm, 180mm, 205mm, 230mm and 265mm. The shortest cable length 100mm and the longest cable length 265mm was chosen for final testing.
- 2) PIFA antenna with highest gain (model LG19) was chosen for final testing.

#### 1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	3.3Vdc from host
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#### 1.1.4 Accessories

N/A

### 1.1.5 Channel List

Frequency band (MHz)		2400~2483.5	
802.11 b / g / n HT20		802.11n HT40	
Channel	Frequency(MHz)	Channel	Frequency(MHz)
1	2412	3	2422
2	2417	4	2427
3	2422	5	2432
4	2427	6	2437
5	2432	7	2442
6	2437	8	2447
7	2442	9	2452
8	2447	---	---
9	2452	---	---
10	2457	---	---
11	2462	---	---

### 1.1.6 Test Tool and Duty Cycle

Test Tool	ART2-GUI, version: 2.3		
Duty Cycle and Duty Factor	Mode	Duty cycle (%)	Duty factor (dB)
	11b	100.00%	0.00
	11g	96.91%	0.14
	HT20	97.05%	0.13
	HT40	93.08%	0.31

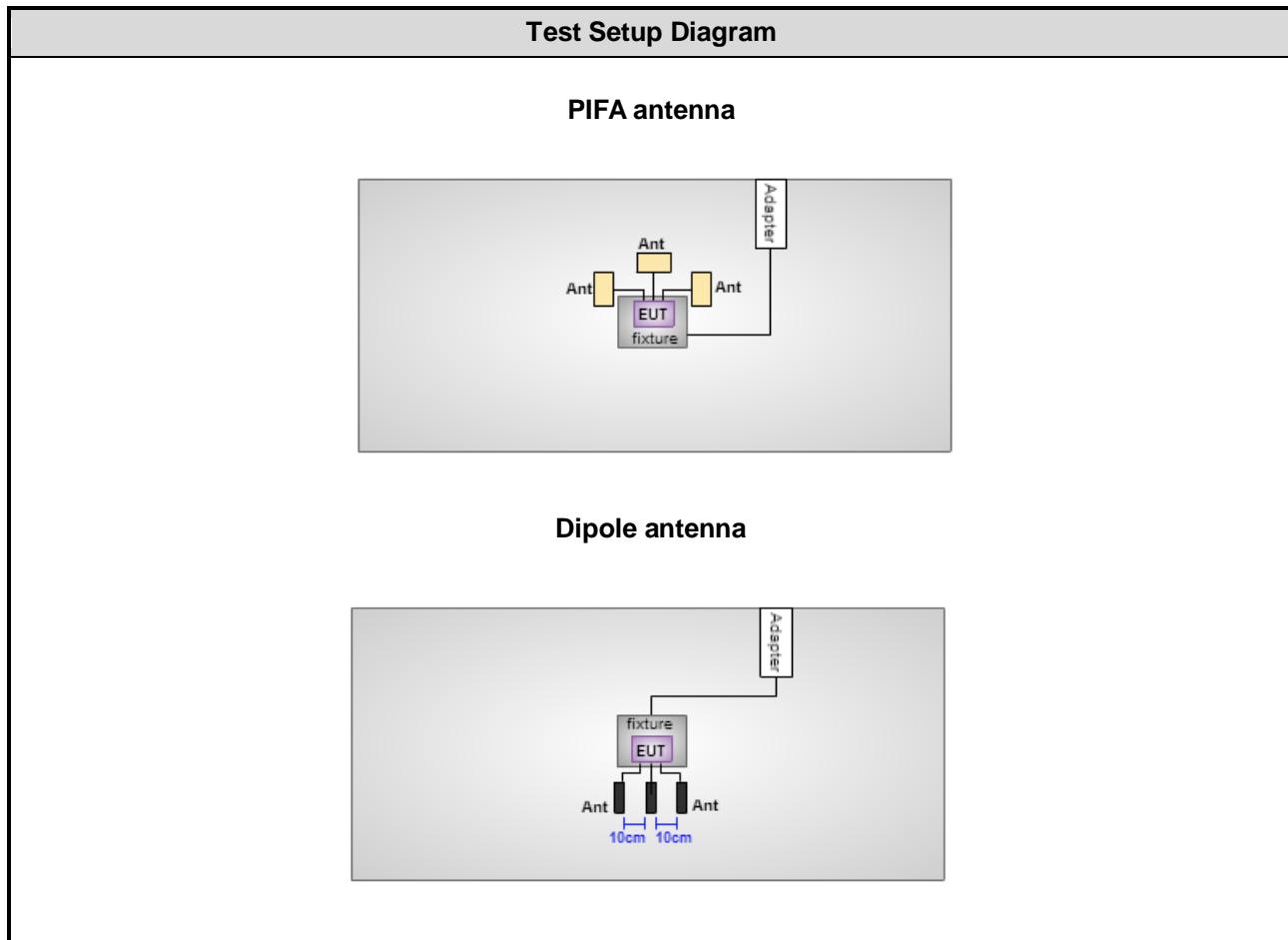
### 1.1.7 Power Setting

Modulation Mode	Test Frequency (MHz)	Power Set
11b	2412	16
11b	2437	21
11b	2462	17
11g	2412	13
11g	2437	17.5
11g	2462	15
HT20	2412	11.5
HT20	2437	17.5
HT20	2462	13
HT40	2422	7
HT40	2437	14
HT40	2452	7.5

## 1.2 Local Support Equipment List

Support Equipment List					
No.	Equipment	Brand	Model	FCC ID	Signal cable / Length (m)
1	Fixture	---	WAPQ-230ACN	---	---
2	Fixture adapter	CWT	SAG024F 4 US	---	---

## 1.3 Test Setup Chart



## 1.4 The Equipment List

<b>Test Item</b>	Conducted Emission				
<b>Test Site</b>	Conduction room 1 / (CO01-WS)				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
EMC Receiver	R&S	ESCS 30	100169	Oct. 17, 2014	Oct. 16, 2015
LISN	SCHWARZBECK	Schwarzbeck 8127	8127-667	Nov. 17, 2014	Nov. 16, 2015
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Dec. 31, 2014	Dec. 30, 2015
Measurement Software	AUDIX	e3	6.120210k	NA	NA

Note: Calibration Interval of instruments listed above is one year.

<b>Test Item</b>	Radiated Emission				
<b>Test Site</b>	966 chamber1 / (03CH01-WS)				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101498	Dec. 09, 2014	Dec. 08, 2015
Receiver	R&S	ESR3	101658	Nov. 10, 2014	Nov. 09, 2015
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Sep. 05, 2014	Sep. 04, 2015
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1096	Dec. 11, 2014	Dec. 10, 2015
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 10, 2014	Nov. 09, 2015
Loop Antenna	R&S	HFH2-Z2	11900	Nov. 10, 2014	Nov. 09, 2015
Preamplifier	Burgeon	BPA-530	SN:100219	Sep. 09, 2014	Sep. 08, 2015
Preamplifier	Agilent	83017A	MY39501308	Oct. 09, 2014	Oct. 08, 2015
Preamplifier	EMC	EMC184045B	980192	Aug. 26, 2014	Aug. 25, 2015
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16014/4	Dec. 15, 2014	Dec. 14, 2015
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Dec. 15, 2014	Dec. 14, 2015
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16139/4	Dec. 15, 2014	Dec. 14, 2015
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Dec. 15, 2014	Dec. 14, 2015
LF cable 10M	Woken	CFD400NL-LW	CFD400NL-002	Dec. 15, 2014	Dec. 14, 2015
Measurement Software	AUDIX	e3	6.120210g	NA	NA

Note: Calibration Interval of instruments listed above is one year.

<b>Test Item</b>	RF Conducted				
<b>Test Site</b>	(TH01-WS)				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101063	Feb. 03, 2015	Feb. 02, 2016
Power Meter	Anritsu	ML2495A	1241002	Sep. 29, 2014	Sep. 28, 2015
Power Sensor	Anritsu	MA2411B	1207366	Sep. 29, 2014	Sep. 28, 2015
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA

Note: Calibration Interval of instruments listed above is one year.

## 1.5 Test Standards

According to the specification of EUT, the EUT must comply with following standards and KDB documents.

47 CFR FCC Part 15.247

ANSI C63.10-2009

FCC KDB 558074 D01 DTS Meas Guidance v03r02

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

Note: FCC's permission to use 1.5m as an alternative per TCBC Conf call of Dec. 2, 2014

## 1.6 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)

Measurement Uncertainty	
Parameters	Uncertainty
Bandwidth	±34.134 Hz
Conducted power	±0.808 dB
Power density	±0.463 dB
Conducted emission	±2.670 dB
AC conducted emission	±2.92 dB
Radiated emission ≤ 1GHz	±3.72 dB
Radiated emission > 1GHz	±5.65 dB

## 2 Test Configuration

### 2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	22°C / 64%	Peter Lin
Radiated Emissions	03CH01-WS	23°C / 67%	aska Huang Morgan Chen
RF Conducted	TH01-WS	22°C / 65%	Felix Sung

➤ FCC site registration No.: 657002

➤ IC site registration No.: 10807A-1

### 2.2 The Worst Test Modes and Channel Details

Test item	Modulation Mode	Test Frequency (MHz)	Data Rate (Mbps) / MCS	Test Configuration
Conducted Emissions	11g	2437	6 Mbps	1, 2
Radiated Emissions ≤1GHz	11g	2437	6 Mbps	1, 2
Radiated Emissions >1GHz	11b	2412 / 2437 / 2462	1 Mbps	
Maximum Output Power	11g	2412 / 2437 / 2462	6 Mbps	
6dB bandwidth	HT20	2412 / 2437 / 2462	MCS 0	1
Power spectral density	HT40	2422 / 2437 / 2452	MCS 0	

**NOTE:**

- The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The worst planes of each antenna and test configurations are listed as follows:
  - Test configuration 1: Dipole antenna, **Y-plane**.
    - Two antenna cable lengths, **100mm** and **265mm** were for final radiated emission below 1GHz test.
    - The **100mm** cable for final radiated emission above 1GHz test.
  - Test configuration 2: PIFA antenna, **Y-plane**.

## 3 Transmitter Test Results

### 3.1 Conducted Emissions

#### 3.1.1 Limit of Conducted Emissions

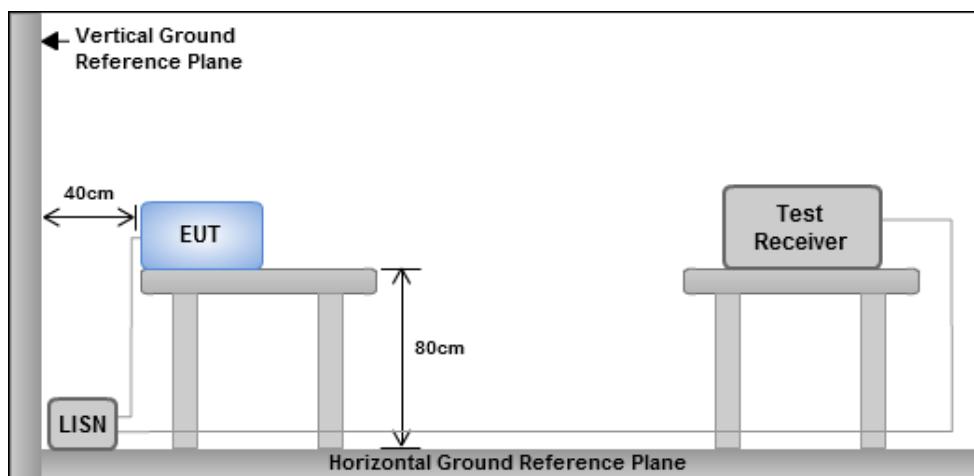
Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

Note 1: \* Decreases with the logarithm of the frequency.

#### 3.1.2 Test Procedures

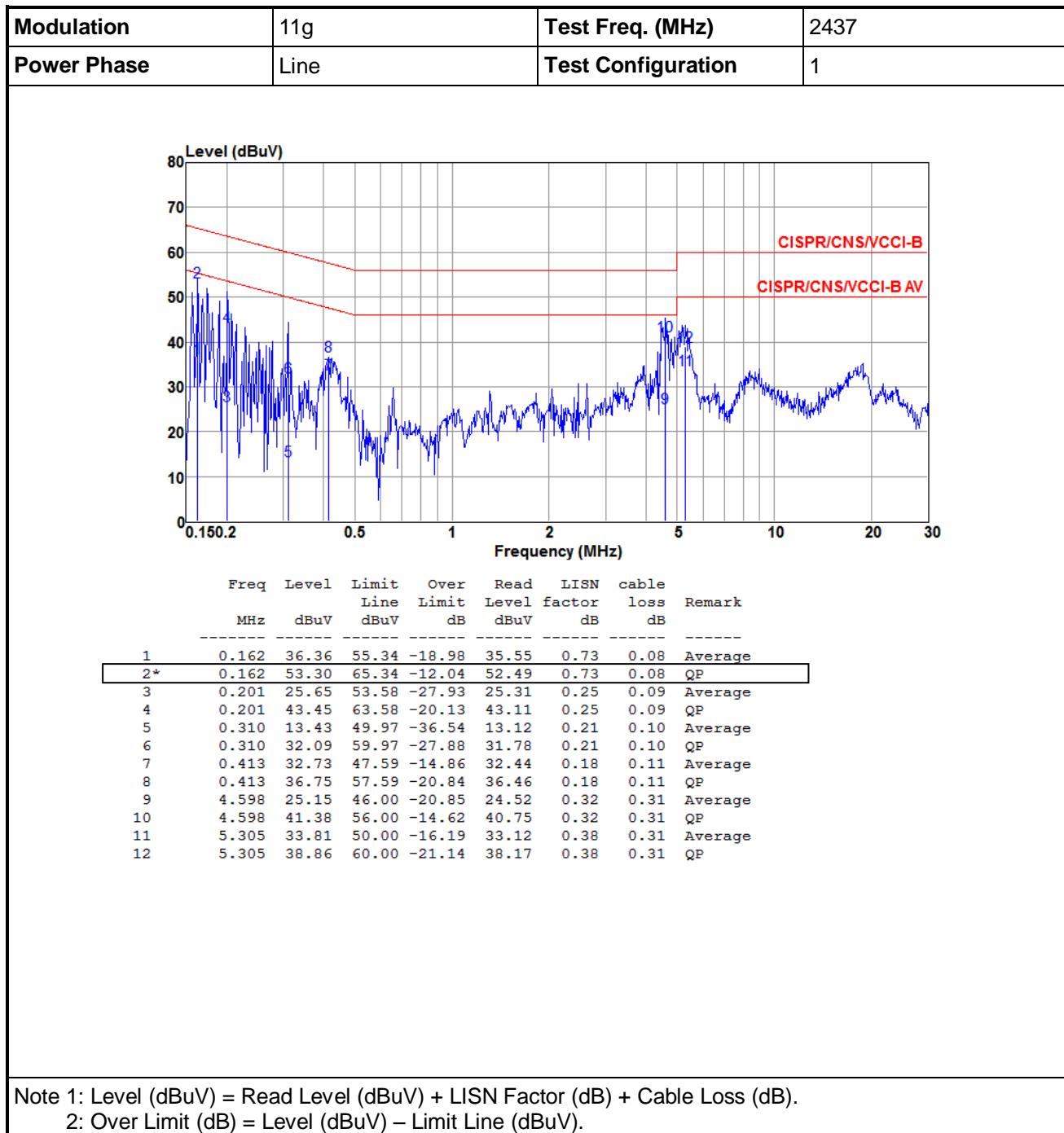
1. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
2. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
3. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
4. This measurement was performed with AC 120V / 60Hz.

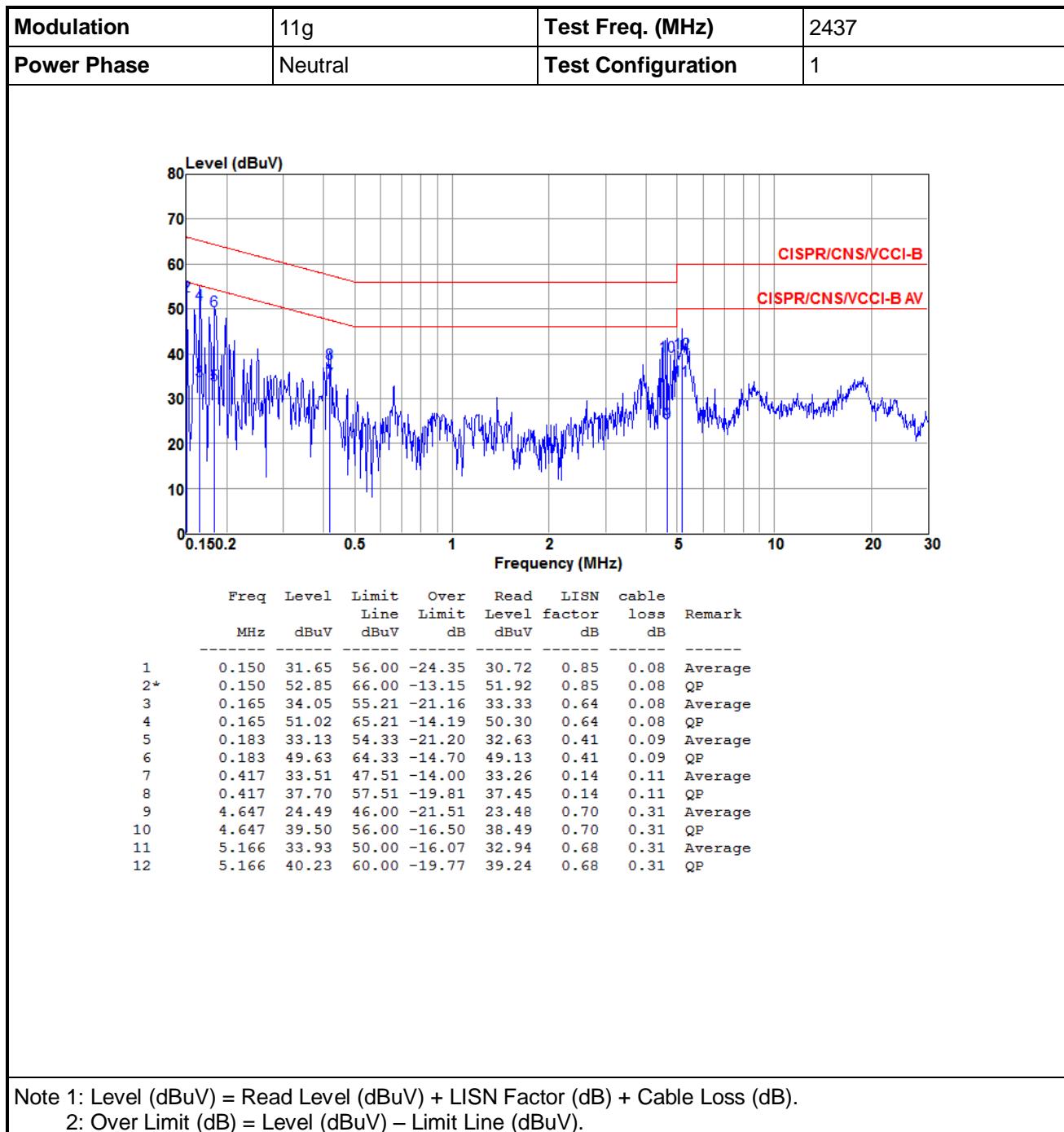
#### 3.1.3 Test Setup



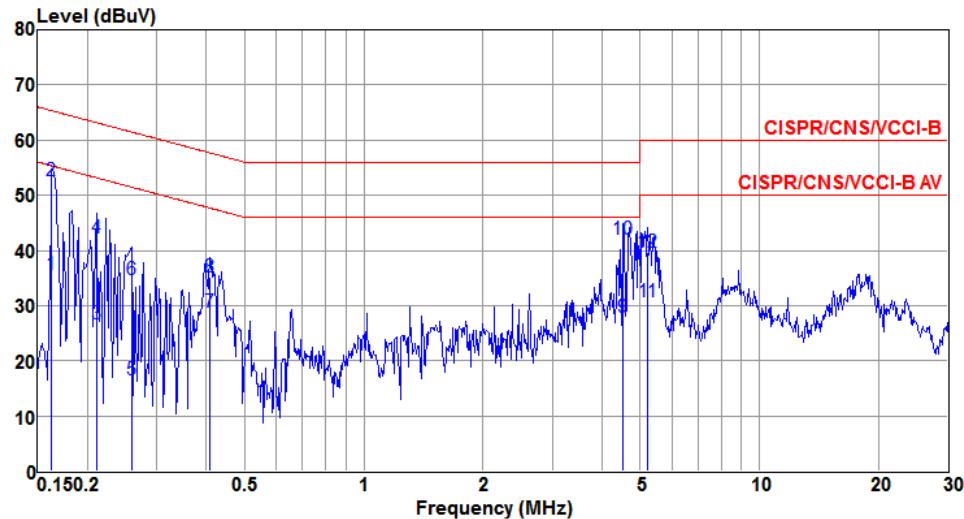
- Note: 1. Support units were connected to second LISN.  
 2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

### 3.1.4 Test Result of Conducted Emissions





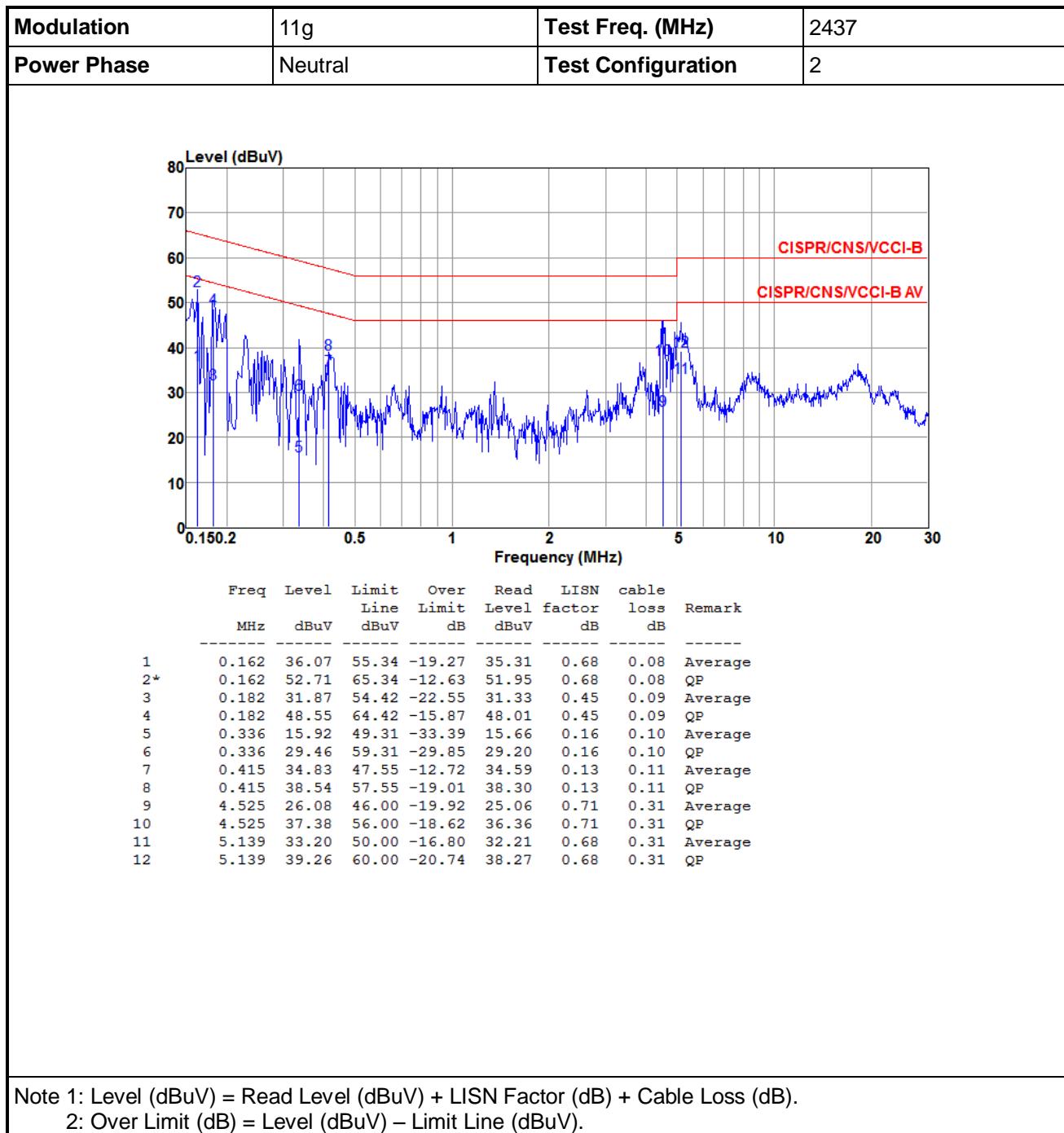
<b>Modulation</b>	11g	<b>Test Freq. (MHz)</b>	2437
<b>Power Phase</b>	Line	<b>Test Configuration</b>	2



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor	cable loss dB	Remark
1	0.162	35.61	55.34	-19.73	34.80	0.73	0.08	Average
2*	0.162	52.52	65.34	-12.82	51.71	0.73	0.08	QP
3	0.211	26.69	53.18	-26.49	26.36	0.24	0.09	Average
4	0.211	42.20	63.18	-20.98	41.87	0.24	0.09	QP
5	0.259	16.49	51.47	-34.98	16.17	0.22	0.10	Average
6	0.259	34.75	61.47	-26.72	34.43	0.22	0.10	QP
7	0.408	28.85	47.68	-18.83	28.56	0.18	0.11	Average
8	0.408	35.13	57.68	-22.55	34.84	0.18	0.11	QP
9	4.525	27.87	46.00	-18.13	27.25	0.31	0.31	Average
10	4.525	42.03	56.00	-13.97	41.41	0.31	0.31	QP
11	5.221	30.76	50.00	-19.24	30.07	0.38	0.31	Average
12	5.221	39.67	60.00	-20.33	38.98	0.38	0.31	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).

2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).



## 3.2 6dB and Occupied Bandwidth

### 3.2.1 Limit of 6dB Bandwidth

The minimum 6dB bandwidth shall be at least 500 kHz.

### 3.2.2 Test Procedures

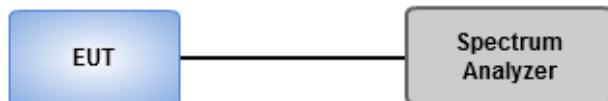
#### 6dB Bandwidth

1. Set resolution bandwidth (RBW) = 100 kHz, Video bandwidth = 300 kHz.
2. Detector = Peak, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6dB relative to the maximum level measured in the fundamental emission.

#### Occupied Bandwidth

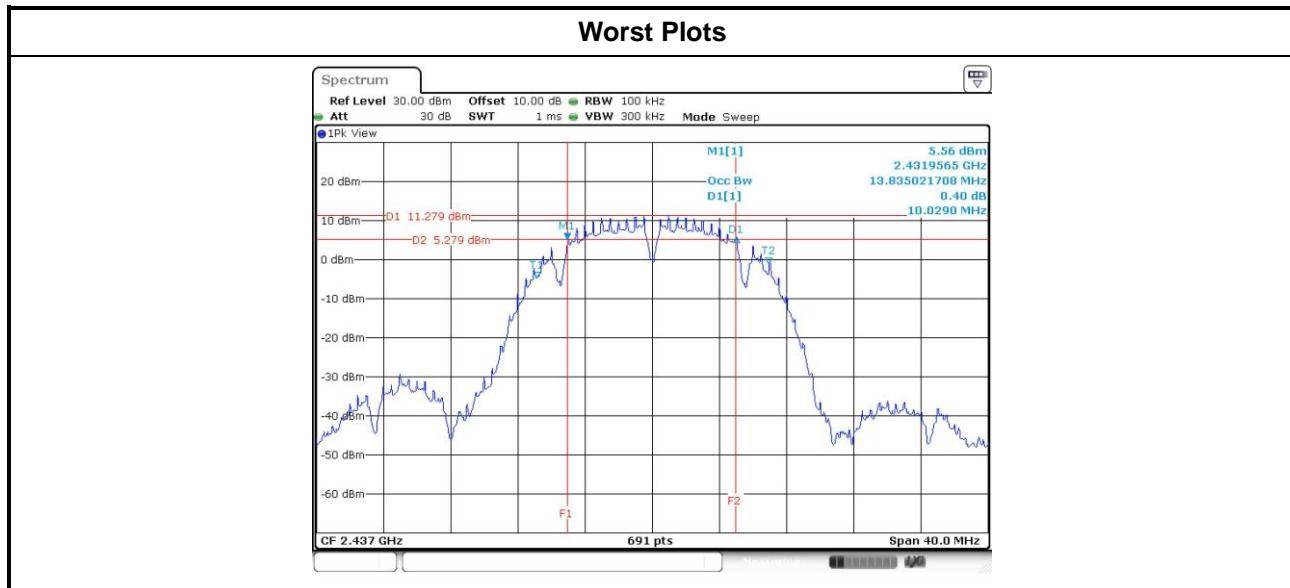
1. Set resolution bandwidth (RBW) = 1 MHz, Video bandwidth = 3 MHz.
2. Detector = Sample, Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Use the OBW measurement function of spectrum analyzer to measure the occupied bandwidth.

### 3.2.3 Test Setup

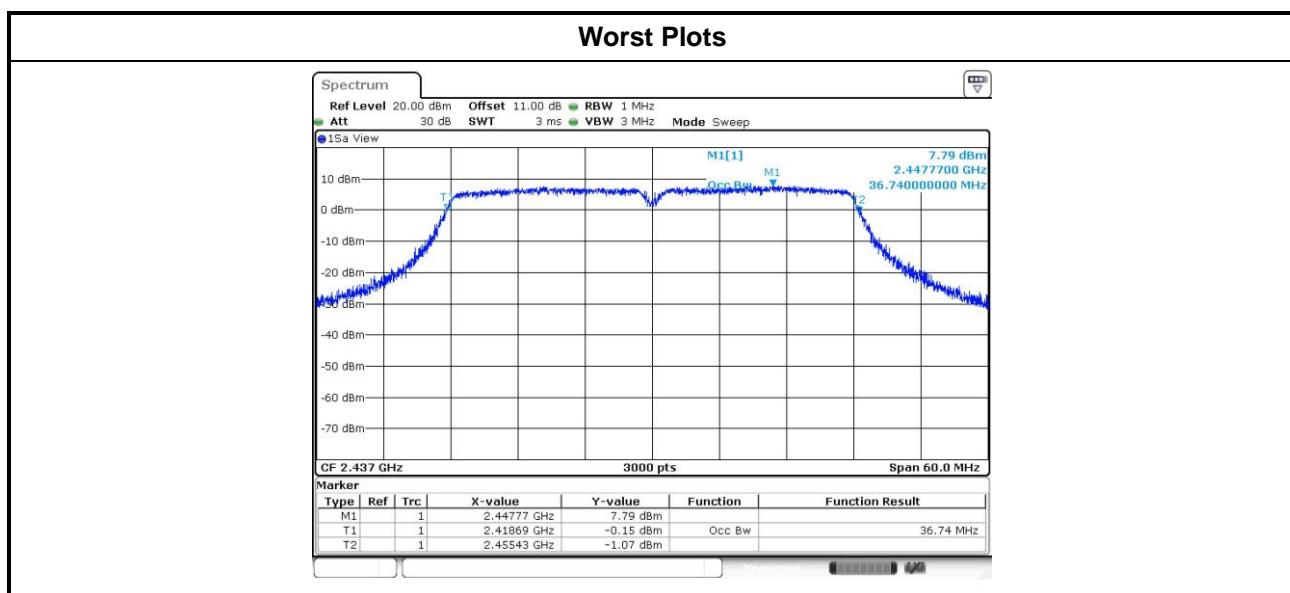


### 3.2.4 Test Result of 6dB and Occupied Bandwidth

Modulation Mode	N <sub>TX</sub>	Freq. (MHz)	6dB Bandwidth (MHz)				Limit (kHz)
			Chain 0	Chain 1	Chain 2	Chain 3	
11b	3	2412	10.09	10.09	10.09	---	500
11b	3	2437	10.03	10.09	10.09	---	500
11b	3	2462	10.09	10.09	10.09	---	500
11g	3	2412	16.35	16.35	16.35	---	500
11g	3	2437	16.35	16.29	16.35	---	500
11g	3	2462	16.35	16.35	16.35	---	500
HT20	3	2412	17.57	17.57	17.51	---	500
HT20	3	2437	17.28	17.10	17.57	---	500
HT20	3	2462	17.28	17.28	17.57	---	500
HT40	3	2422	35.83	35.48	35.94	---	500
HT40	3	2437	35.94	35.25	35.94	---	500
HT40	3	2452	35.71	35.25	35.83	---	500



Modulation Mode	N <sub>TX</sub>	Freq. (MHz)	99% Occupied Bandwidth (MHz)			
			Chain 0	Chain 1	Chain 2	Chain 3
11b	3	2412	13.90	13.88	13.84	---
11b	3	2437	13.84	13.84	13.77	---
11b	3	2462	13.92	13.88	13.89	---
11g	3	2412	16.63	16.62	16.57	---
11g	3	2437	16.62	16.62	16.56	---
11g	3	2462	16.65	16.61	16.57	---
HT20	3	2412	17.80	17.73	17.75	---
HT20	3	2437	17.71	17.76	17.70	---
HT20	3	2462	17.76	17.74	17.76	---
HT40	3	2422	36.58	36.48	36.72	---
HT40	3	2437	36.74	36.44	36.66	---
HT40	3	2452	36.60	36.52	36.68	---



### 3.3 RF Output Power

#### 3.3.1 Limit of RF Output Power

Conducted power shall not exceed 1Watt.

- Antenna gain <= 6dBi, no any corresponding reduction is in output power limit.
- Antenna gain > 6dBi
  - Non Fixed, point to point operations.  
The conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dB
  - Fixed, point to point operations  
Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point Operations, maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.  
  
Systems operating in the 5725–5850 MHz band that are used exclusively for fixed, point-to-point operations ,no any corresponding reduction is in transmitter peak output power

#### 3.3.2 Test Procedures

- Maximum Peak Conducted Output Power
  - Spectrum analyzer**
    1. Set RBW = 1MHz, VBW = 3MHz, Detector = Peak.
    2. Sweep time = auto, Trace mode = max hold, Allow trace to fully stabilize.
    3. Use the spectrum analyzer channel power measurement function with the band limits set equal to the DTS bandwidth edges.
  - Power meter**
    1. A broadband Peak RF power meter is used for output power measurement. The video bandwidth of power meter is greater than DTS bandwidth of EUT. If duty cycle of test signal is not 100 %, trigger and gating function of power meter will be enabled to capture transmission burst for measuring output power.
- Maximum Conducted Output Power ( For reference only )
  - Power meter**
    1. A broadband Average RF power meter is used for output power measurement. The video bandwidth of power meter is greater than DTS bandwidth of EUT. If duty cycle of test signal is not 100 %, trigger and gating function of power meter will be enabled to capture transmission burst for measuring output power.

#### 3.3.3 Test Setup



### 3.3.4 Test Result of Maximum Output Power

Modulation Mode	N <sub>TX</sub>	Freq. (MHz)	Peak conducted output power (dBm)				Total Power (mW)	Total Power (dBm)	Limit (dBm)
			Chain 0	Chain 1	Chain 2	Chain 3			
11b	3	2412	20.61	20.08	19.93	---	315.340	24.99	29.62
11b	3	2437	24.86	24.13	24.61	---	854.086	29.32	29.62
11b	3	2462	21.06	20.02	20.69	---	345.325	25.38	29.62
11g	3	2412	21.06	20.75	20.84	---	367.833	25.66	29.62
11g	3	2437	25.02	24.38	24.71	---	887.646	<b>29.48</b>	29.62
11g	3	2462	22.71	21.76	22.61	---	518.996	27.15	29.62
HT20	3	2412	19.57	19.23	19.15	---	256.550	24.09	29.62
HT20	3	2437	25.06	24.31	24.65	---	882.144	29.46	29.62
HT20	3	2462	20.51	19.67	20.05	---	306.301	24.86	29.62
HT40	3	2422	15.23	14.34	14.72	---	90.155	19.55	29.62
HT40	3	2437	21.73	20.92	21.56	---	415.750	26.19	29.62
HT40	3	2452	15.45	14.72	15.21	---	97.913	19.91	29.62

Note: The maximum antenna gain 6.38dB<sub>i</sub> is higher than 6dB<sub>i</sub>, so the limit of output power shall be reduced to 30 dBm – ( 6.38 dB<sub>i</sub> – 6 dB<sub>i</sub>) = 29.62 dBm

Modulation Mode	N <sub>TX</sub>	Freq. (MHz)	Conducted (average) output power (dBm)				Total Power (mW)	Total Power (dBm)	Limit (dBm)
			Chain 0	Chain 1	Chain 2	Chain 3			
11b	3	2412	18.16	17.81	17.62	---	183.668	22.64	30.00
11b	3	2437	22.19	21.57	21.99	---	467.251	<b>26.70</b>	30.00
11b	3	2462	18.62	17.82	18.51	---	204.270	23.10	30.00
11g	3	2412	15.09	14.70	14.68	---	91.174	19.60	30.00
11g	3	2437	18.85	18.33	18.59	---	217.090	23.37	30.00
11g	3	2462	16.65	15.75	16.59	---	129.426	21.12	30.00
HT20	3	2412	13.52	13.22	13.16	---	64.181	18.07	30.00
HT20	3	2437	19.02	18.31	18.65	---	220.846	23.44	30.00
HT20	3	2462	14.37	13.64	14.22	---	76.897	18.86	30.00
HT40	3	2422	9.16	8.49	8.53	---	22.433	13.51	30.00
HT40	3	2437	15.72	15.03	15.28	---	102.896	20.12	30.00
HT40	3	2452	9.43	8.62	9.16	---	24.289	13.85	30.00

Note: Conducted average output power is for reference only.

## 3.4 Power Spectral Density

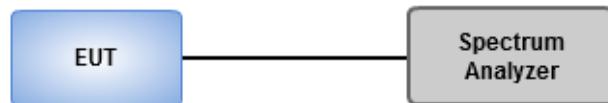
### 3.4.1 Limit of Power Spectral Density

Power spectral density shall not be greater than 8 dBm in any 3 kHz band.

### 3.4.2 Test Procedures

- Maximum peak conducted output power was used to demonstrate compliance to the fundamental output power limit.
  1. Set the RBW = 3kHz, VBW = 10kHz.
  2. Detector = Peak, Sweep time = auto couple.
  3. Trace mode = max hold, allow trace to fully stabilize.
  4. Use the peak marker function to determine the maximum amplitude level.
- Maximum (average) conducted output power was used to demonstrate compliance to the fundamental output power limit.
  1. Set the RBW = 100kHz, VBW = 300 kHz.
  2. Detector = RMS, Sweep time = auto couple.
  3. Set the sweep time to:  $\geq 10 \times (\text{number of measurement points in sweep}) \times (\text{maximum data rate per stream})$ .
  4. Perform the measurement over a single sweep.
  5. Use the peak marker function to determine the maximum amplitude level.

### 3.4.3 Test Setup

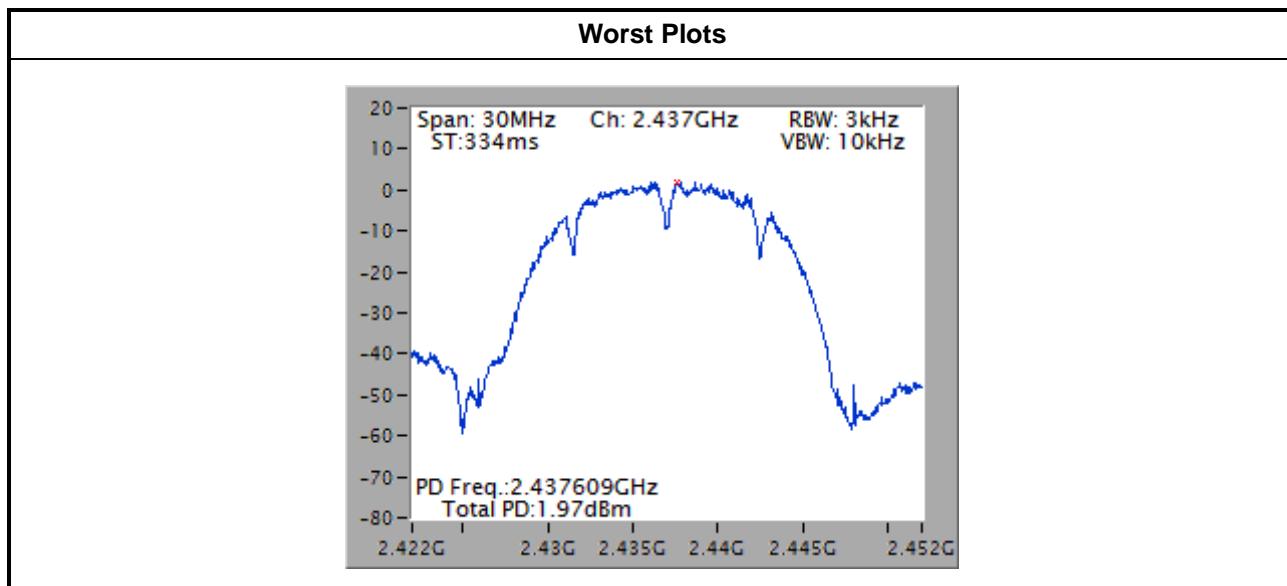


### 3.4.4 Test Result of Power Spectral Density

Modulation Mode	N <sub>TX</sub>	Freq. (MHz)	Total Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
11b	3	2412	-2.82	2.85
11b	3	2437	1.97	2.85
11b	3	2462	-1.15	2.85
11g	3	2412	-7.07	2.85
11g	3	2437	-3.50	2.85
11g	3	2462	-5.51	2.85
HT20	3	2412	-8.98	2.85
HT20	3	2437	-3.18	2.85
HT20	3	2462	-7.51	2.85
HT40	3	2422	-16.15	2.85
HT40	3	2437	-10.10	2.85
HT40	3	2452	-15.32	2.85

**Note:**

1. Test results are bin-by-bin summing measured value of each TX port.
2. Directional gain =  $6.38 + 10 \log(3/1) = 11.15 \text{ dBi} > 6 \text{ dBi}$ .  
Limit shall be reduced to  $8 \text{ dBm} - (11.15 \text{ dBi} - 6 \text{ dBi}) = 2.85 \text{ dBm}$ .



## 3.5 Unwanted Emissions into Restricted Frequency Bands

### 3.5.1 Limit of Unwanted Emissions into Restricted Frequency Bands

Restricted Band Emissions Limit			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

**Note 1:**  
Quasi-Peak value is measured for frequency below 1GHz except for 9–90 kHz, 110–490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit

**Note 2:**  
Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

### 3.5.2 Test Procedures

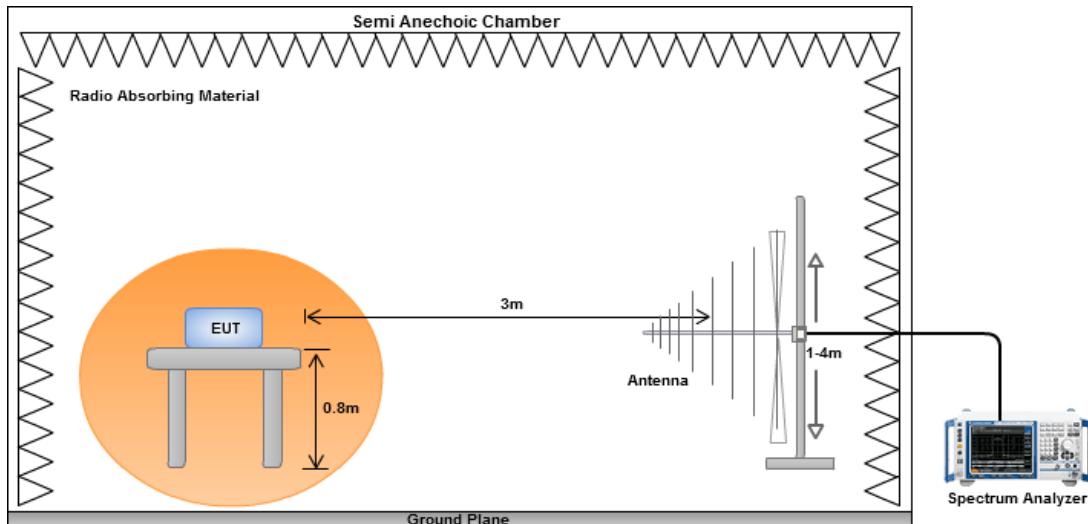
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at test table. For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height is 1.5 m
2. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
3. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

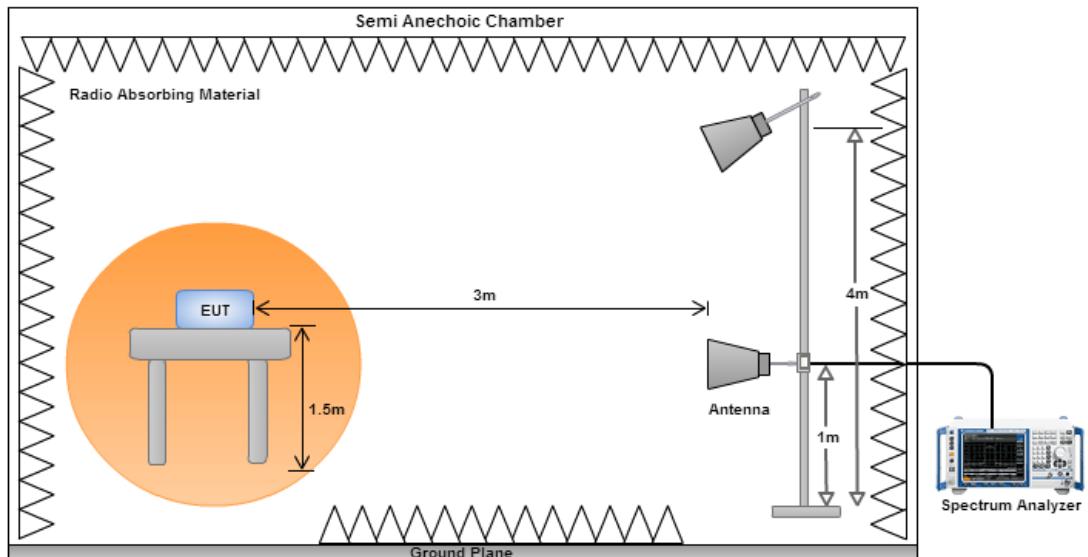
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above 1GHz.

### 3.5.3 Test Setup

#### Radiated Emissions below 1 GHz

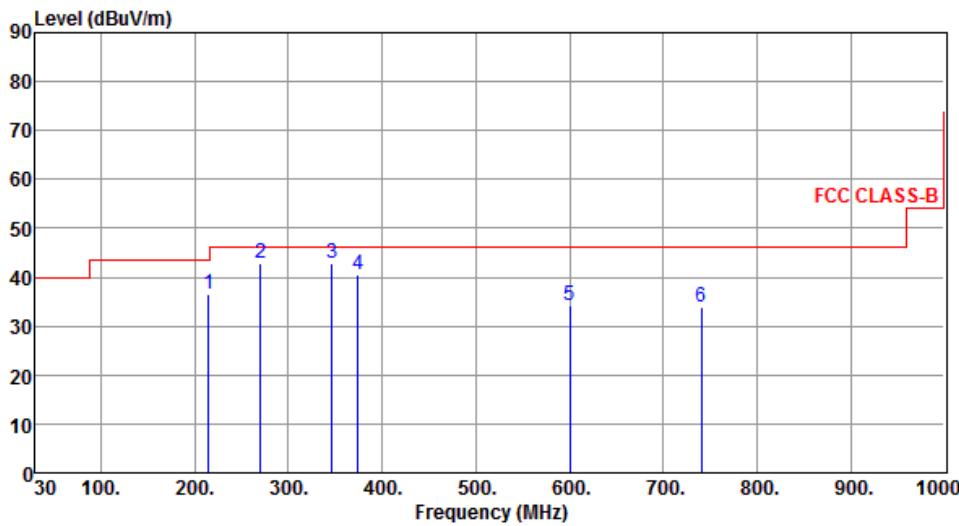
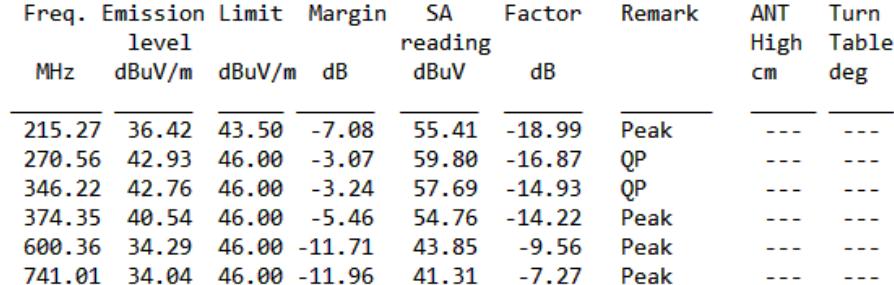


#### Radiated Emissions above 1 GHz

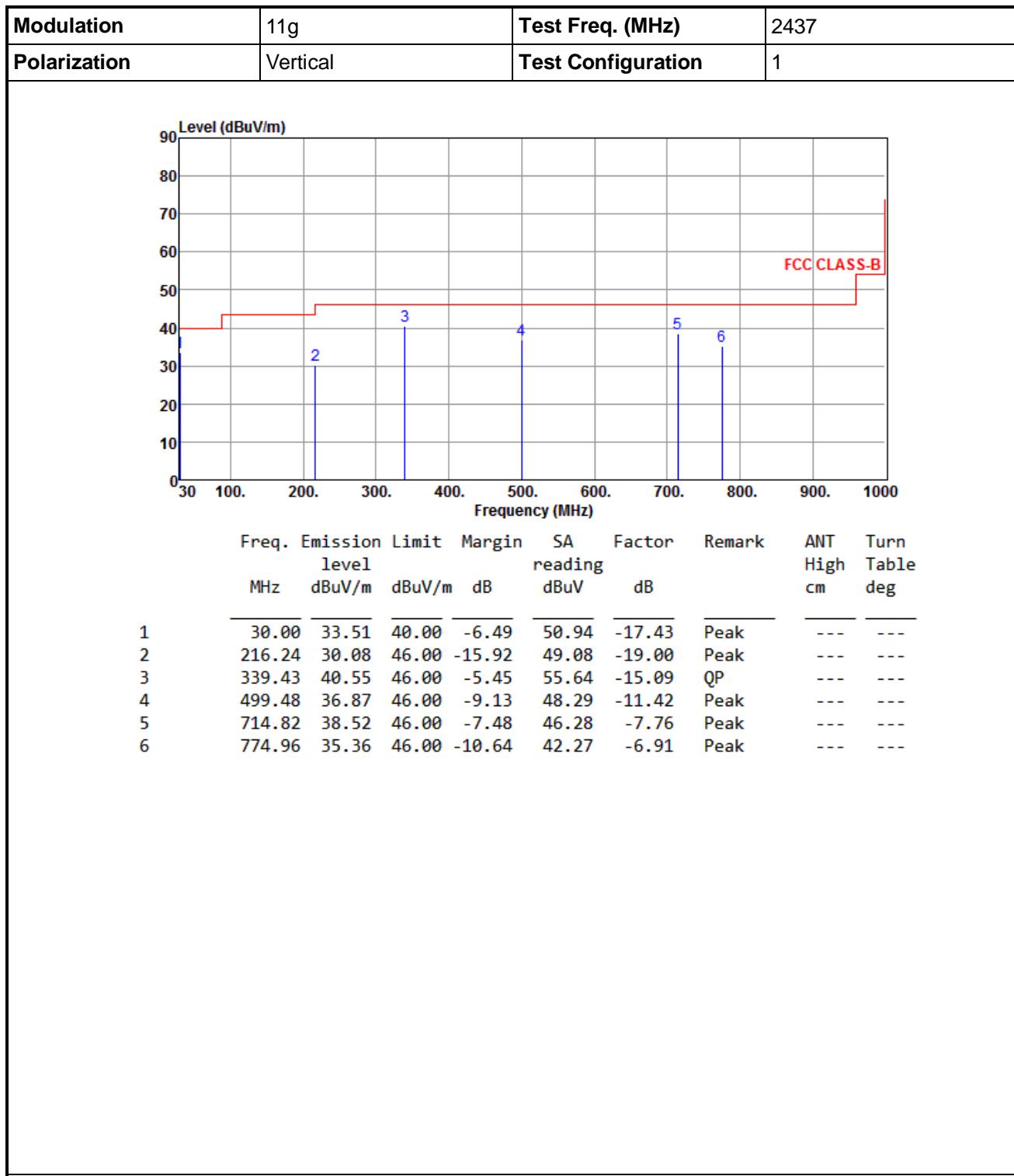


## Dipole antenna

### 3.5.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)\_100mm antenna cable

<b>Modulation</b>	11g	<b>Test Freq. (MHz)</b>	2437						
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	1						
									
									
1	215.27	36.42	43.50	-7.08	55.41	-18.99	Peak	---	---
2	270.56	42.93	46.00	-3.07	59.80	-16.87	QP	---	---
3	346.22	42.76	46.00	-3.24	57.69	-14.93	QP	---	---
4	374.35	40.54	46.00	-5.46	54.76	-14.22	Peak	---	---
5	600.36	34.29	46.00	-11.71	43.85	-9.56	Peak	---	---
6	741.01	34.04	46.00	-11.96	41.31	-7.27	Peak	---	---

Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)  
\*Factor includes antenna factor , cable loss and amplifier gain  
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).  
Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.



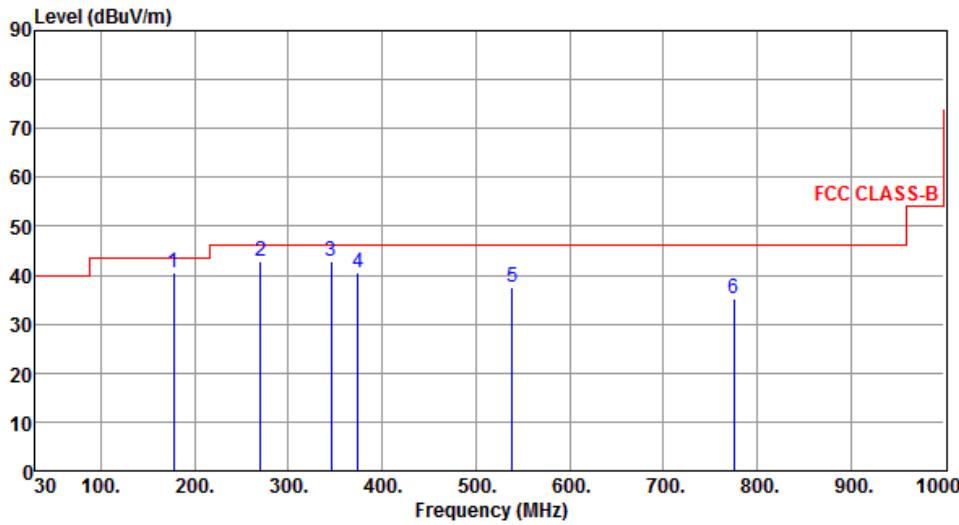
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

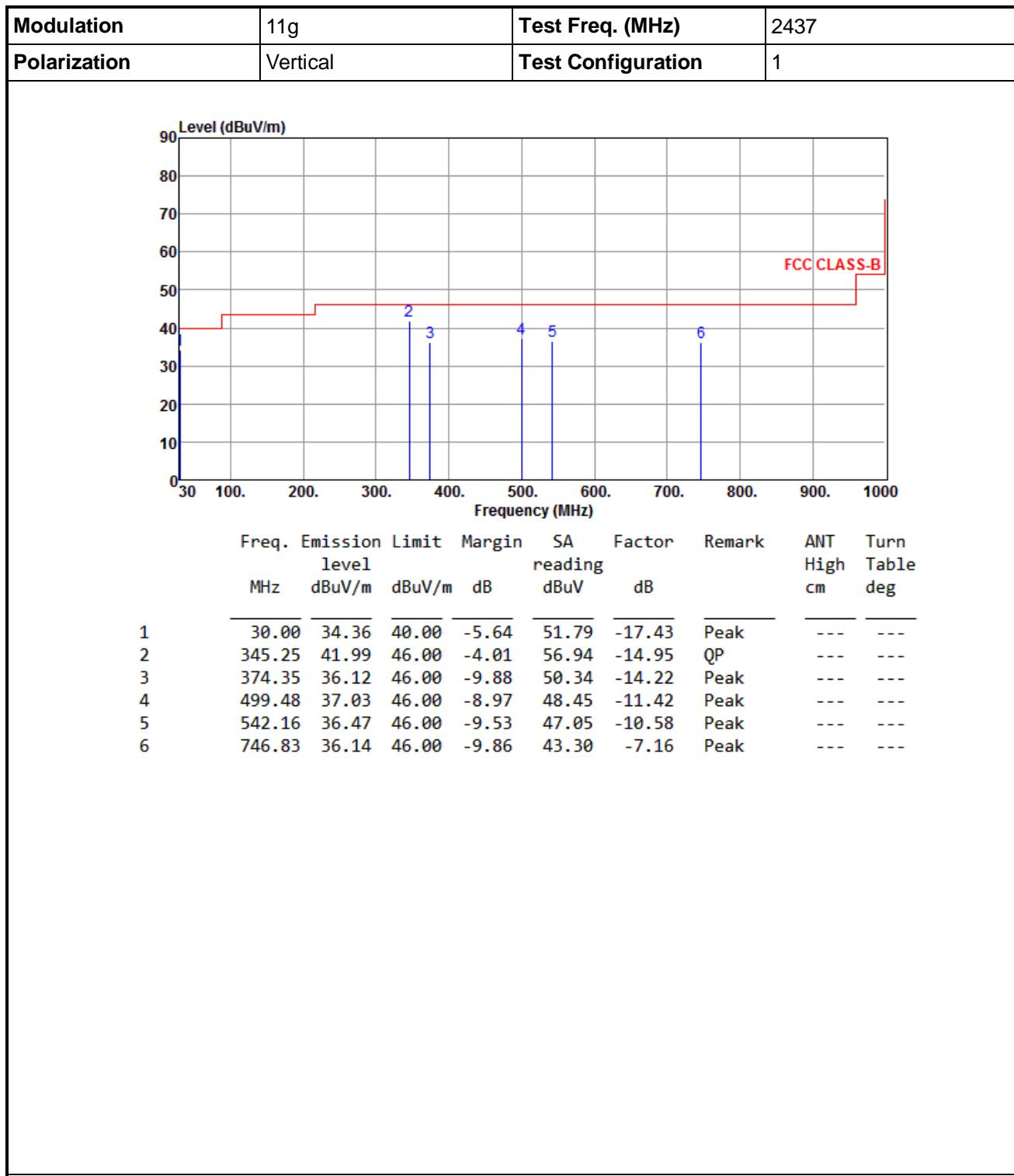
\*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

### 3.5.5 Transmitter Radiated Unwanted Emissions (Below 1GHz) 265mm antenna cable

<b>Modulation</b>	11g	<b>Test Freq. (MHz)</b>	2437																																																																					
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	1																																																																					
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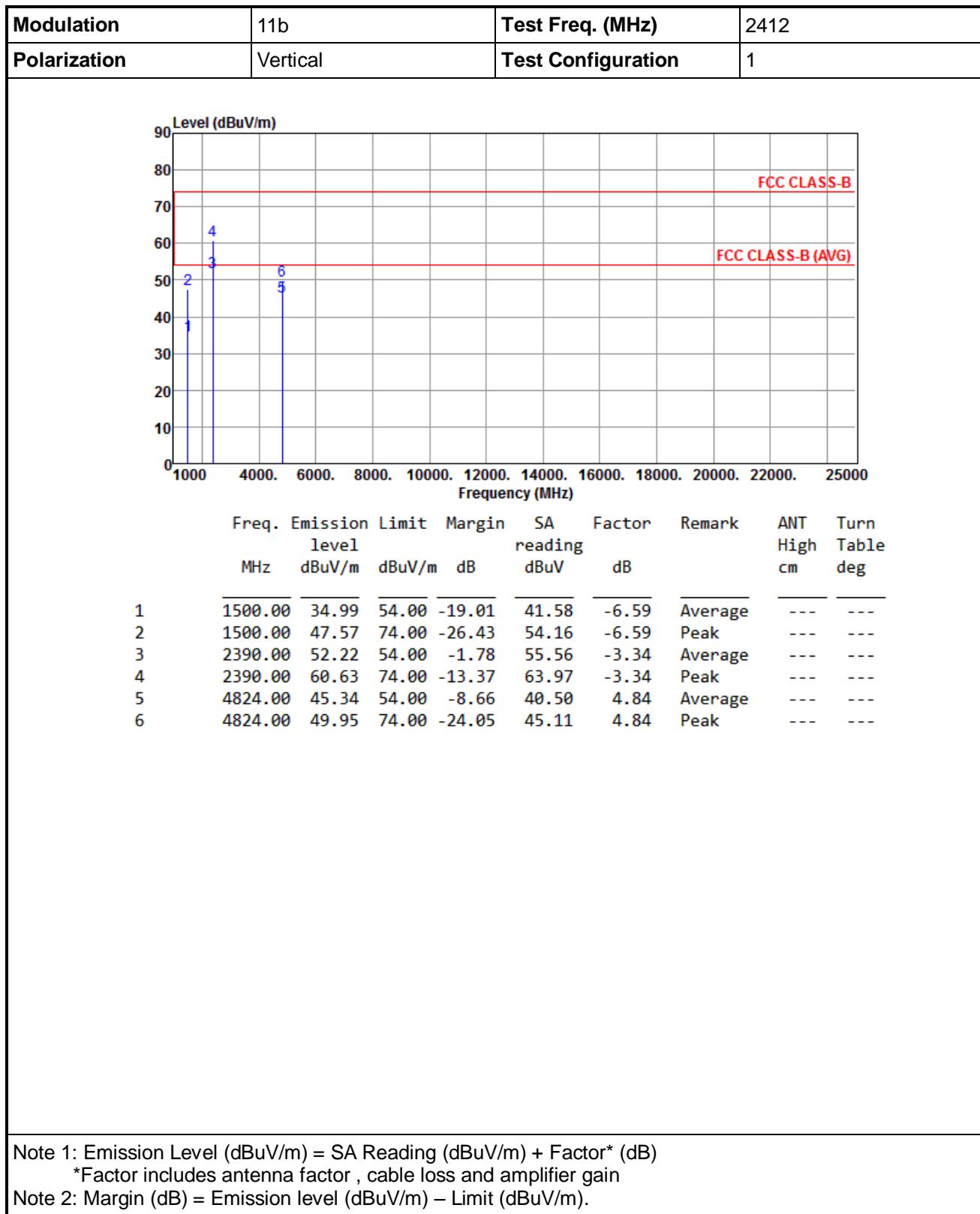
\*Factor includes antenna factor , cable loss and amplifier gain

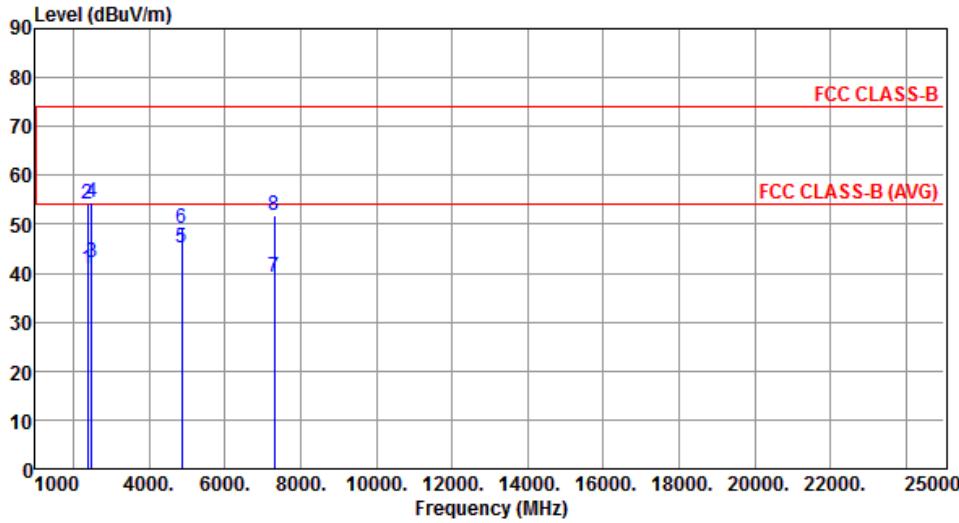
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

### 3.5.6 Transmitter Radiated Unwanted Emissions (Above 1GHz) for 11b

<b>Modulation</b>	11b	<b>Test Freq. (MHz)</b>	2412																																																														
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	1																																																														
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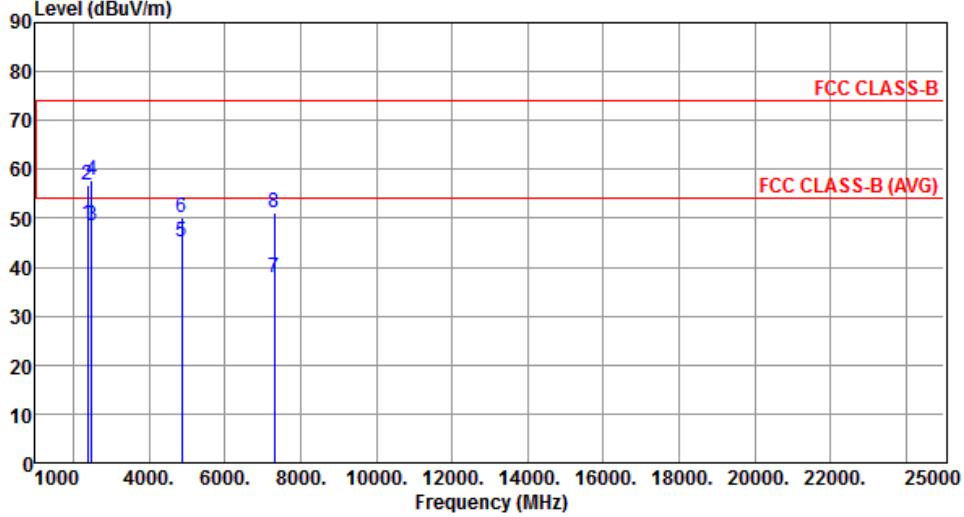


<b>Modulation</b>	11b	<b>Test Freq. (MHz)</b>	2437																																																																																									
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\*Factor includes antenna factor , cable loss and amplifier gain

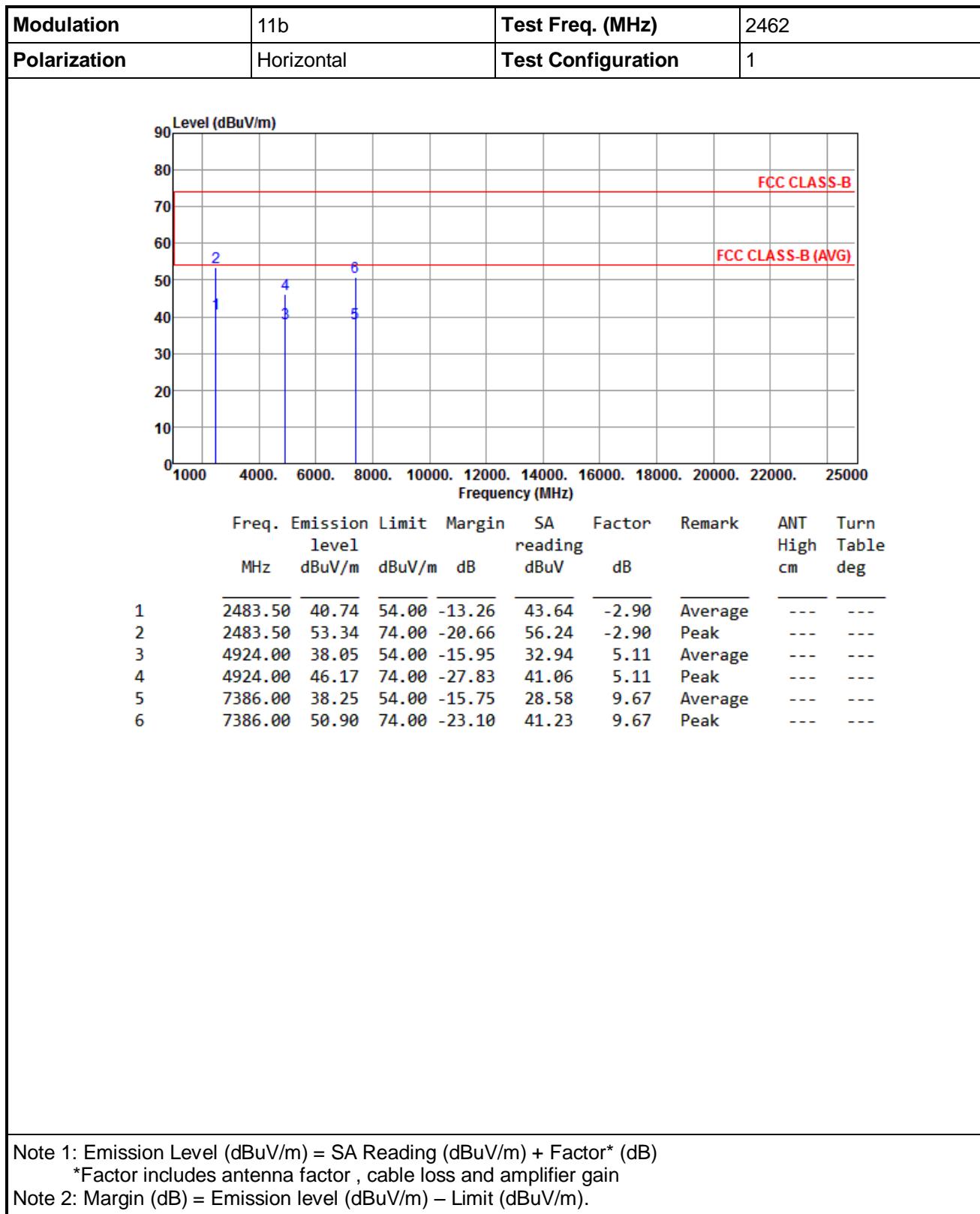
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

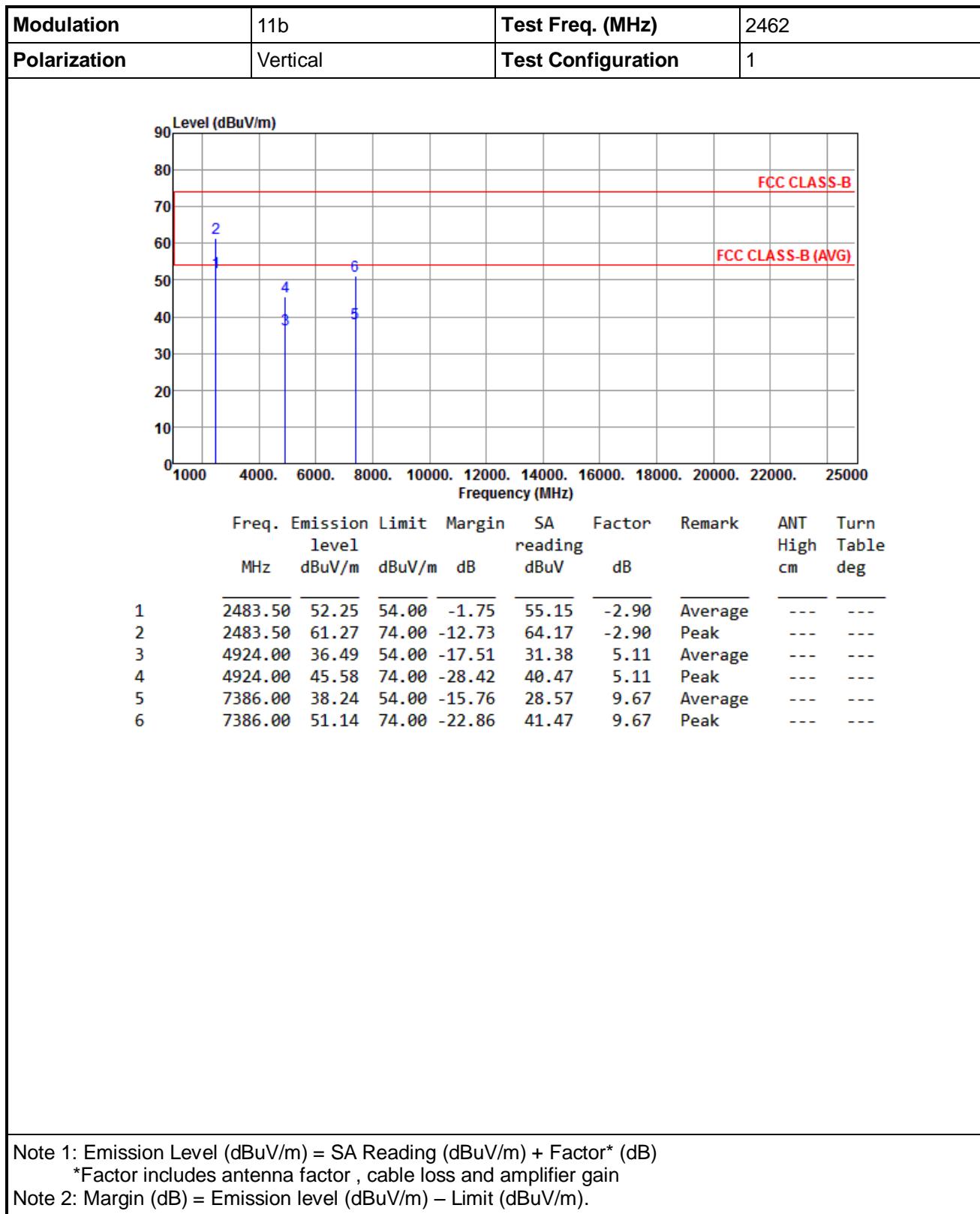
<b>Modulation</b>	11b	<b>Test Freq. (MHz)</b>	2437																																																																																	
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Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

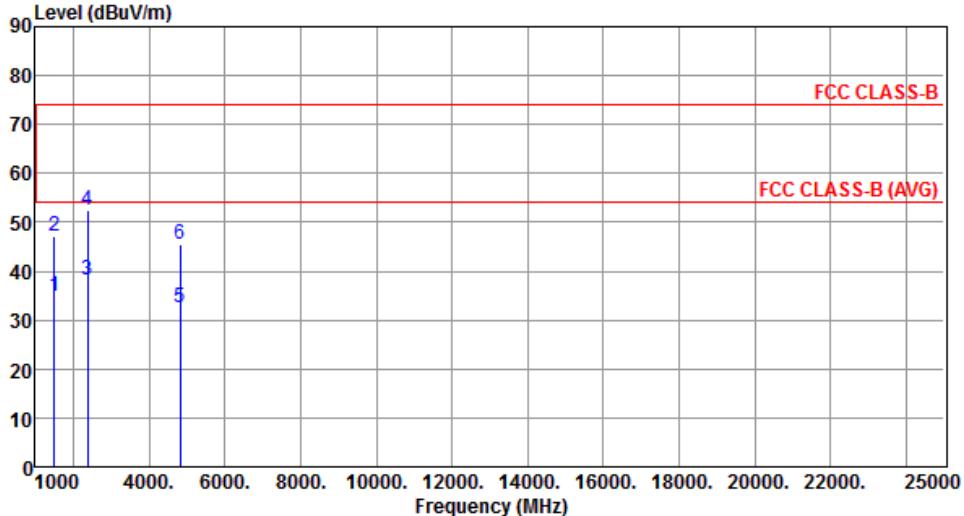
\*Factor includes antenna factor , cable loss and amplifier gain

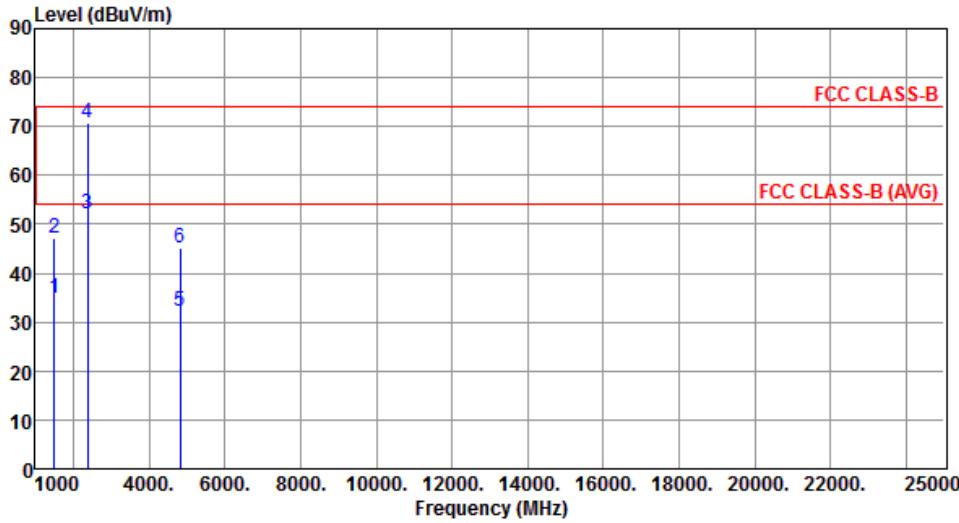
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).





### 3.5.7 Transmitter Radiated Unwanted Emissions (Above 1GHz) for 11g

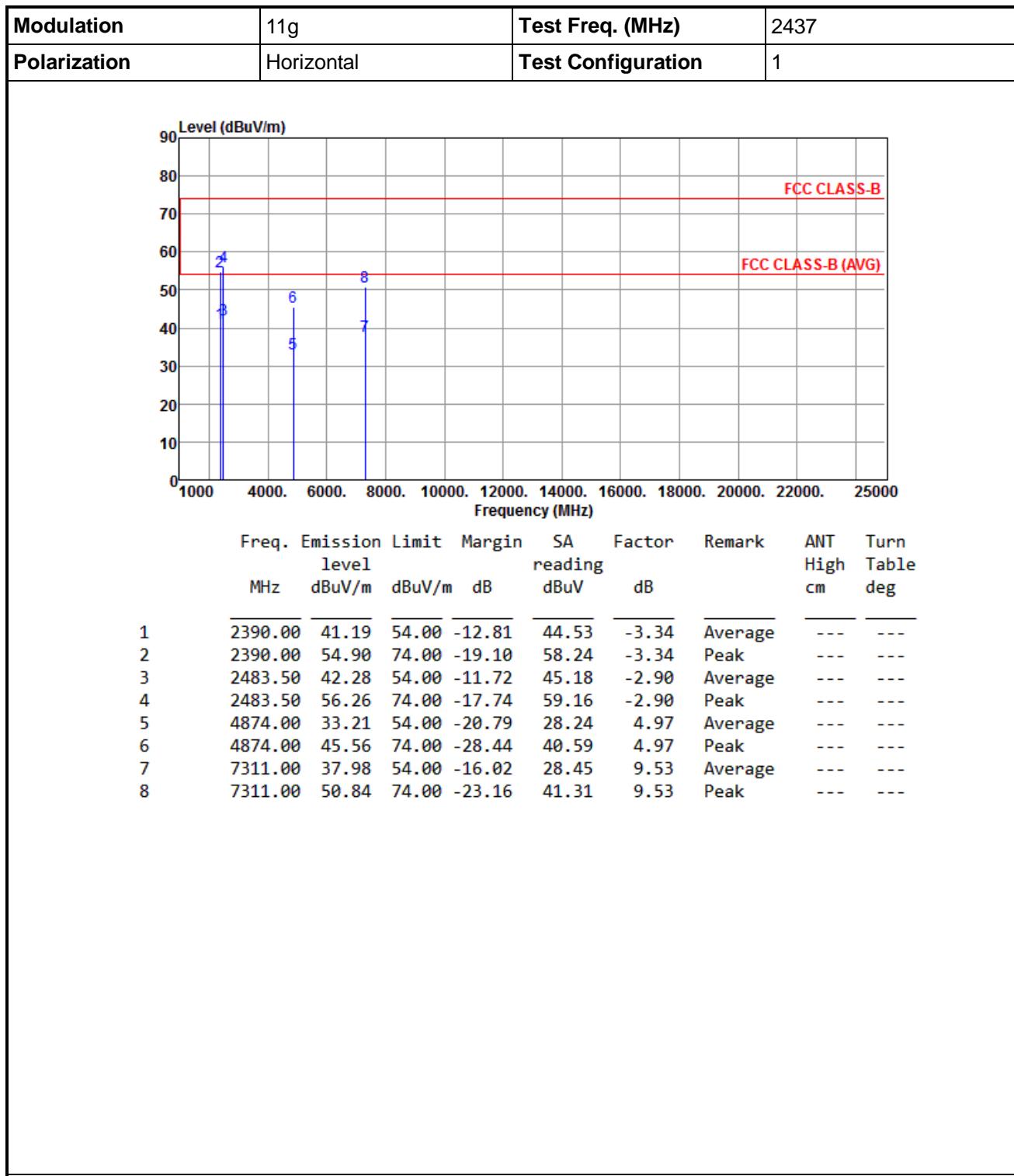
<b>Modulation</b>	11g	<b>Test Freq. (MHz)</b>	2412																																																														
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	1																																																														
																																																																	
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<b>Modulation</b>	11g	<b>Test Freq. (MHz)</b>	2412																																																																					
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Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

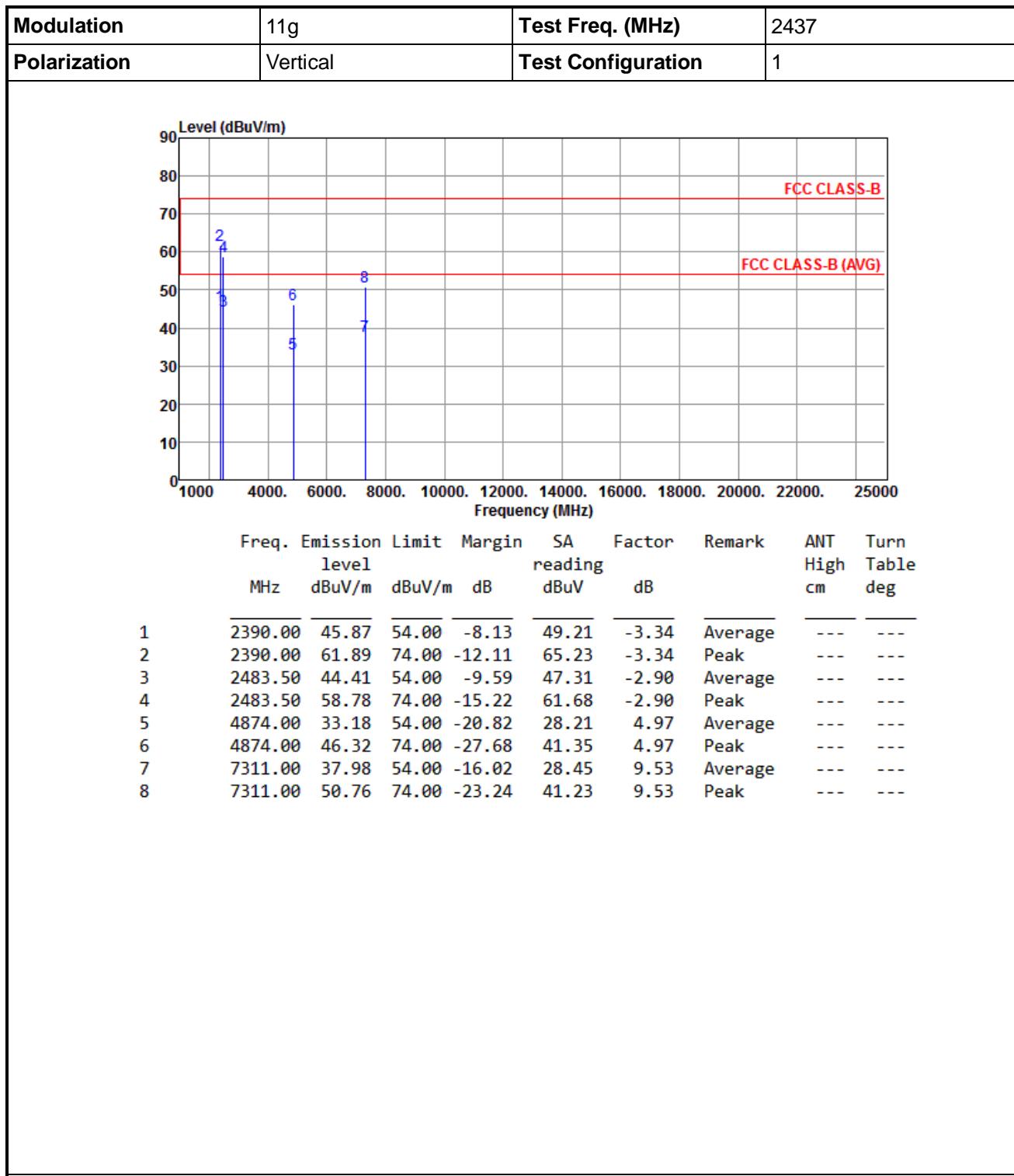
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).



Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

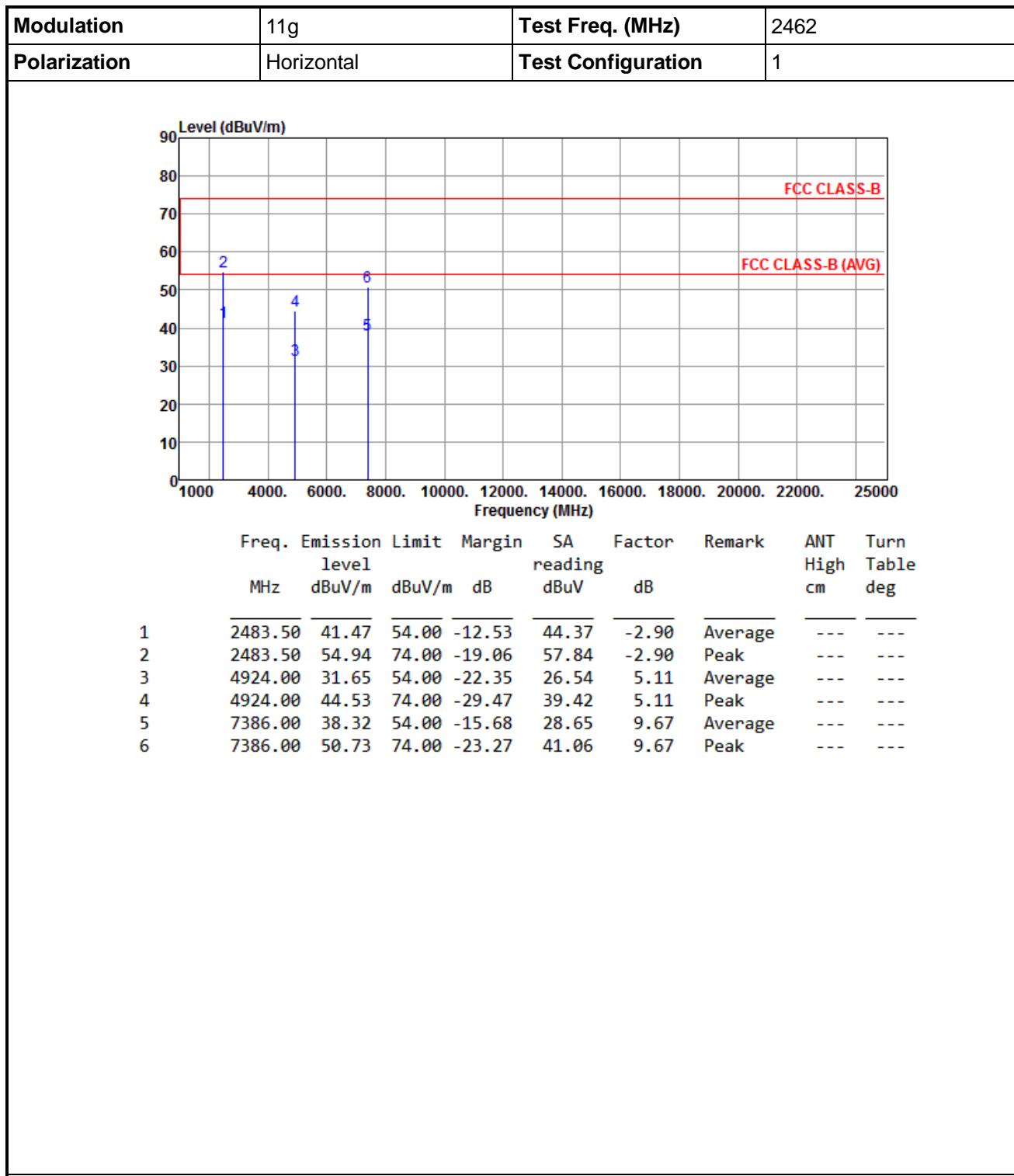
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).



Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

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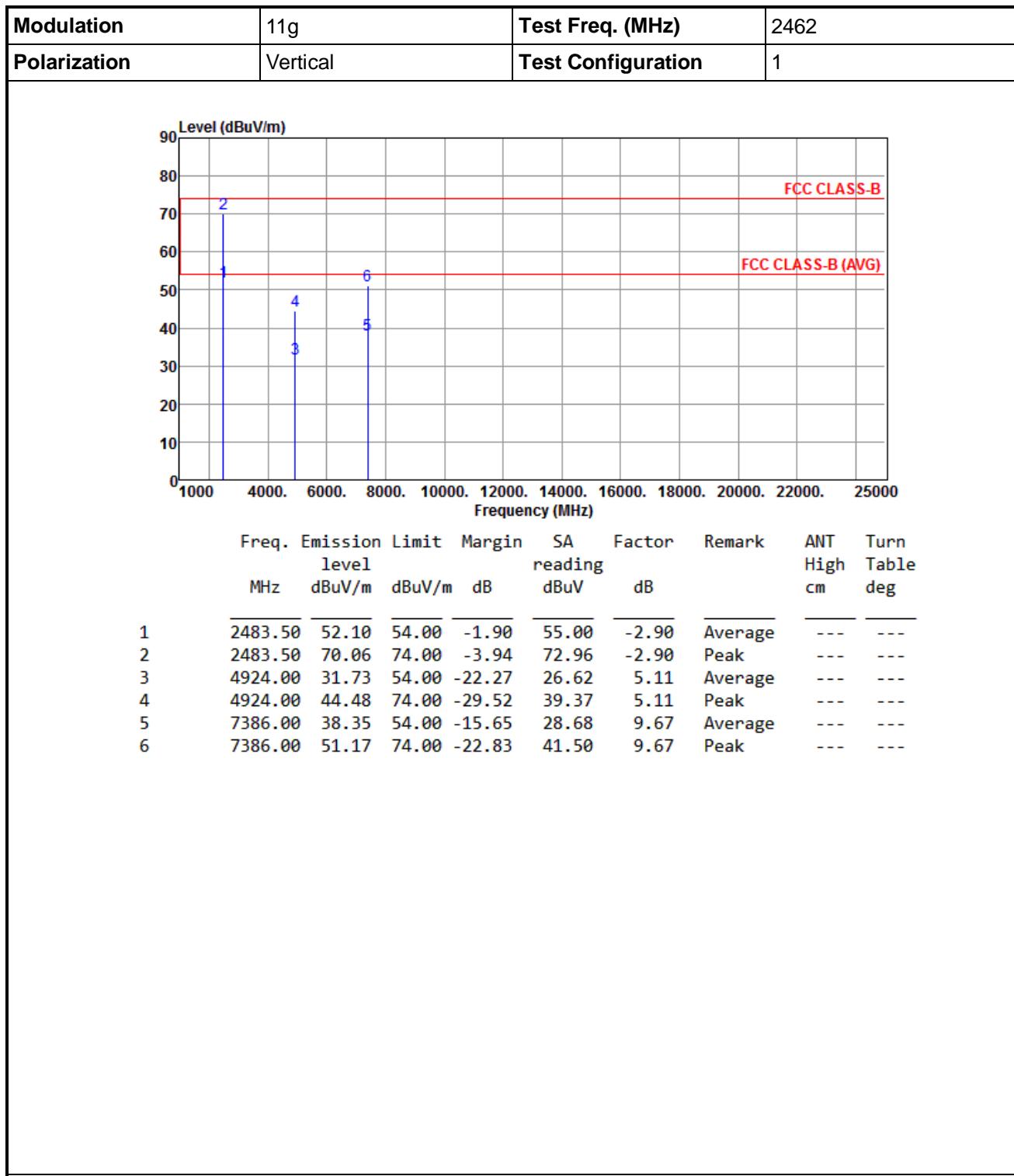
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).



Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

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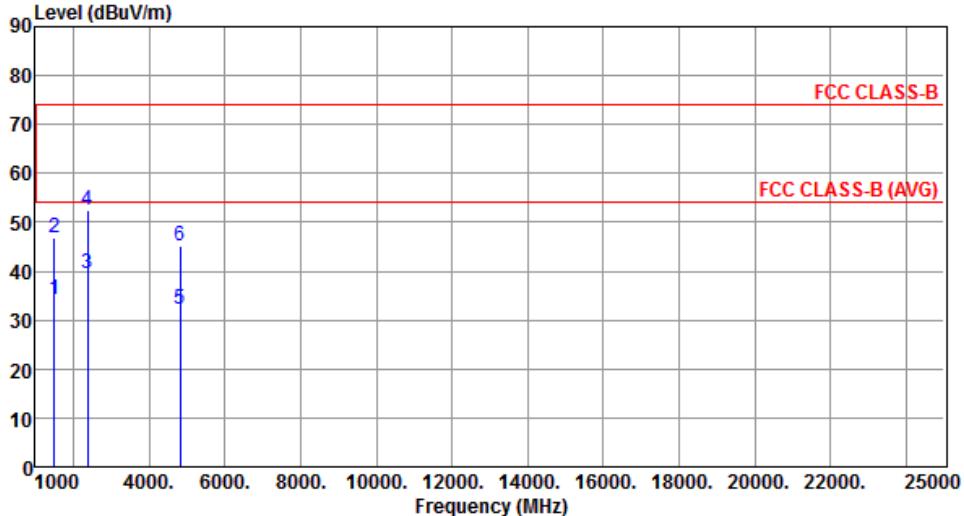


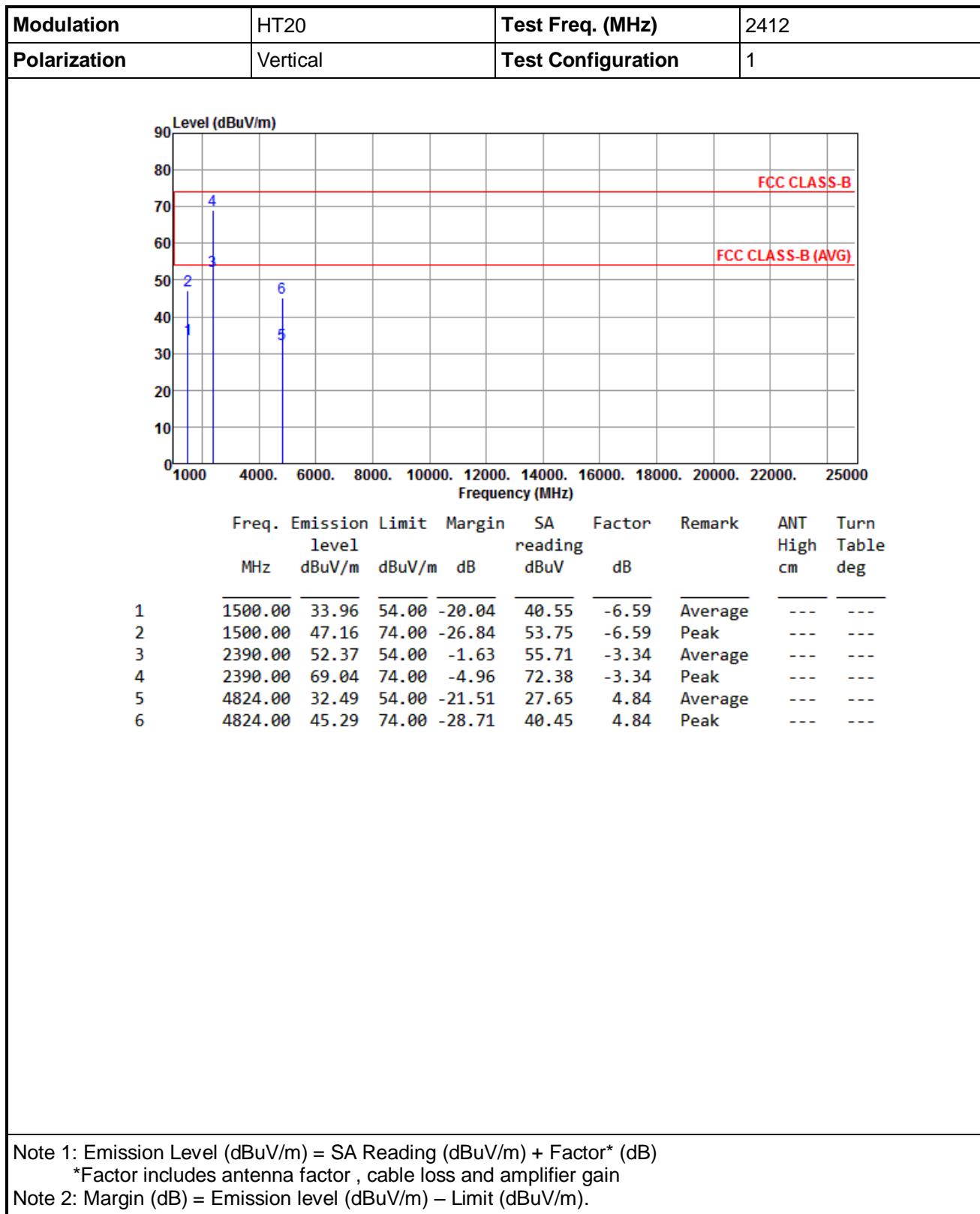
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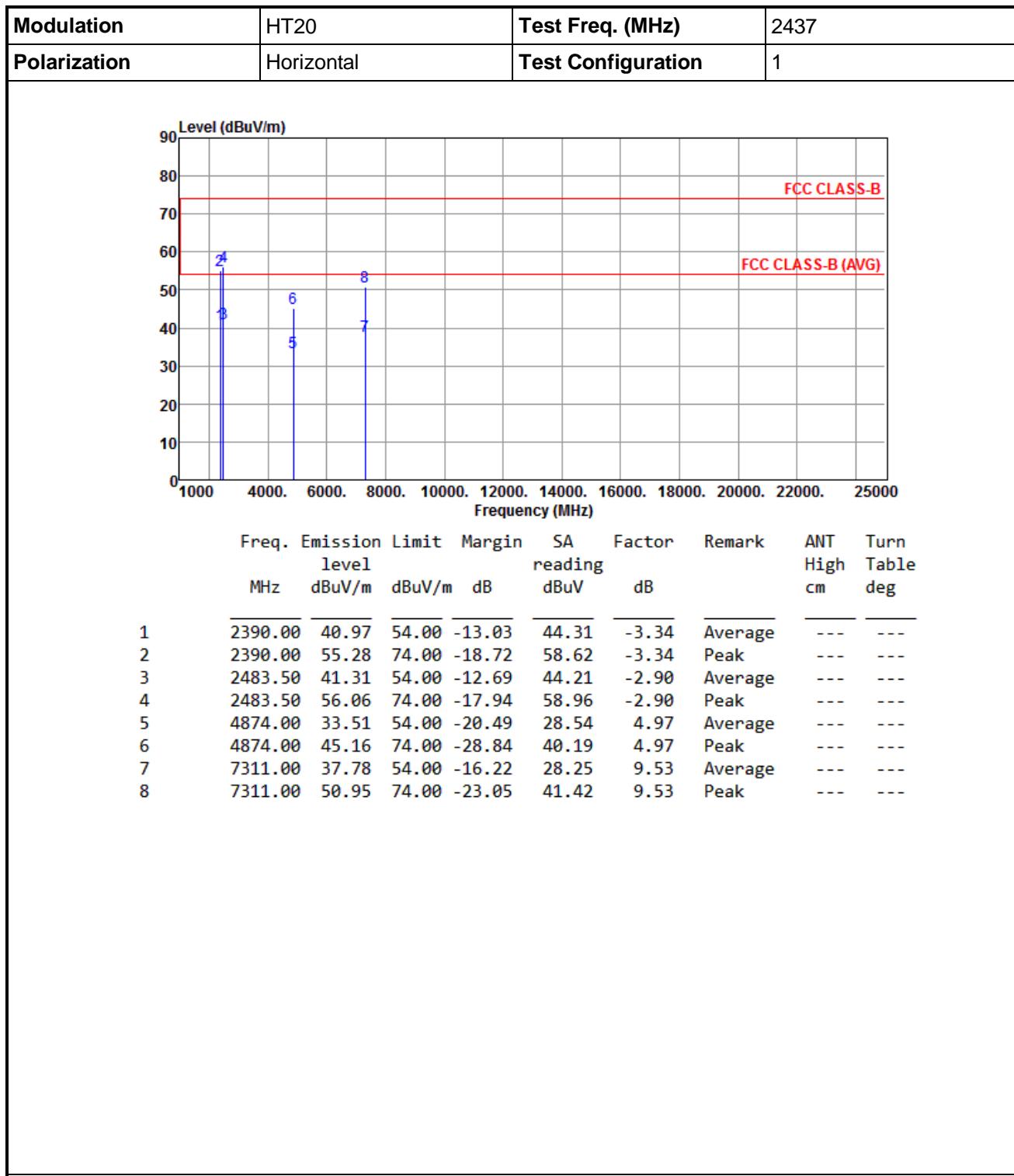
\*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

### 3.5.8 Transmitter Radiated Unwanted Emissions (Above 1GHz) for HT20

<b>Modulation</b>	HT20	<b>Test Freq. (MHz)</b>	2412																																																														
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	1																																																														
																																																																	
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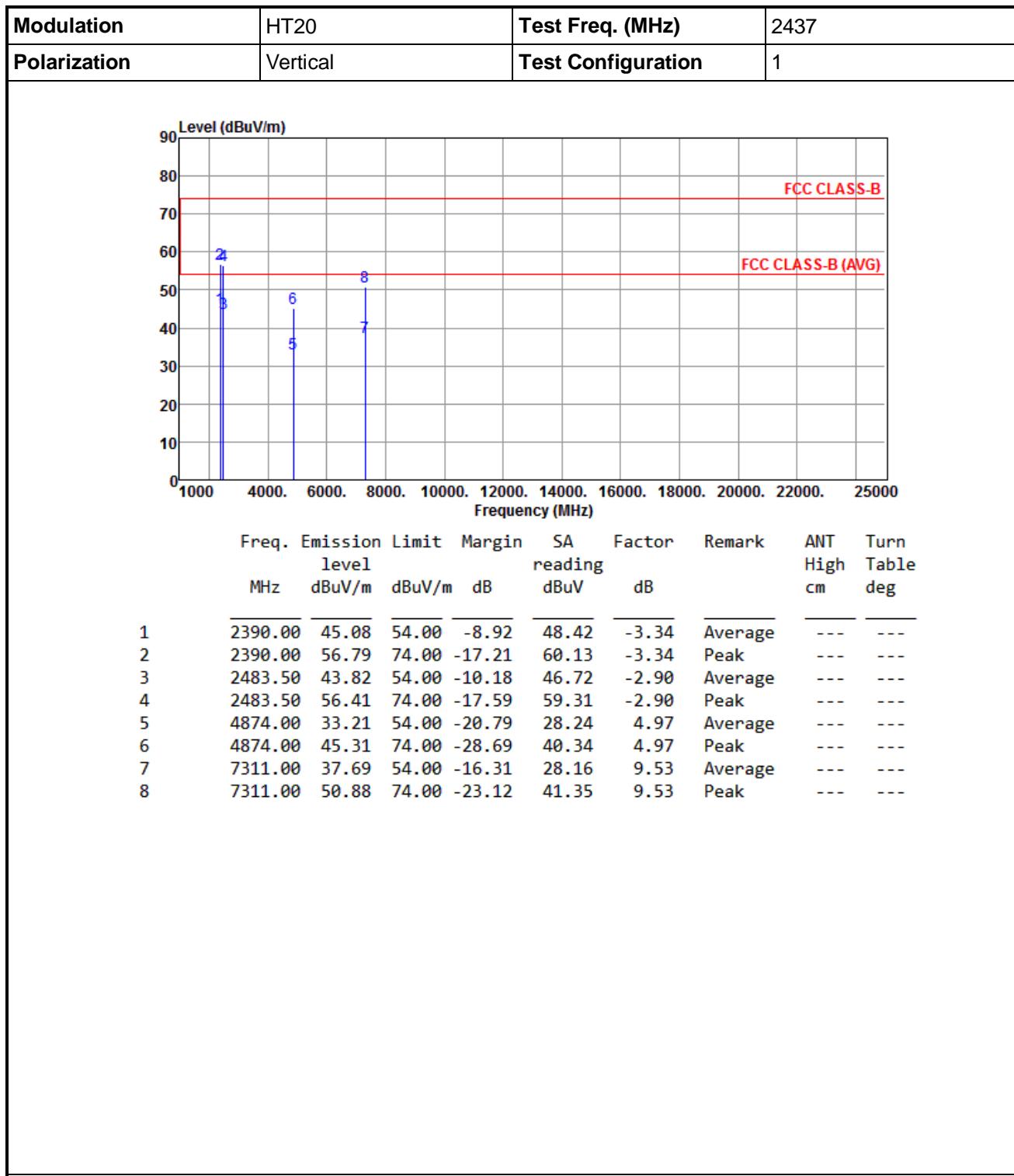




Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

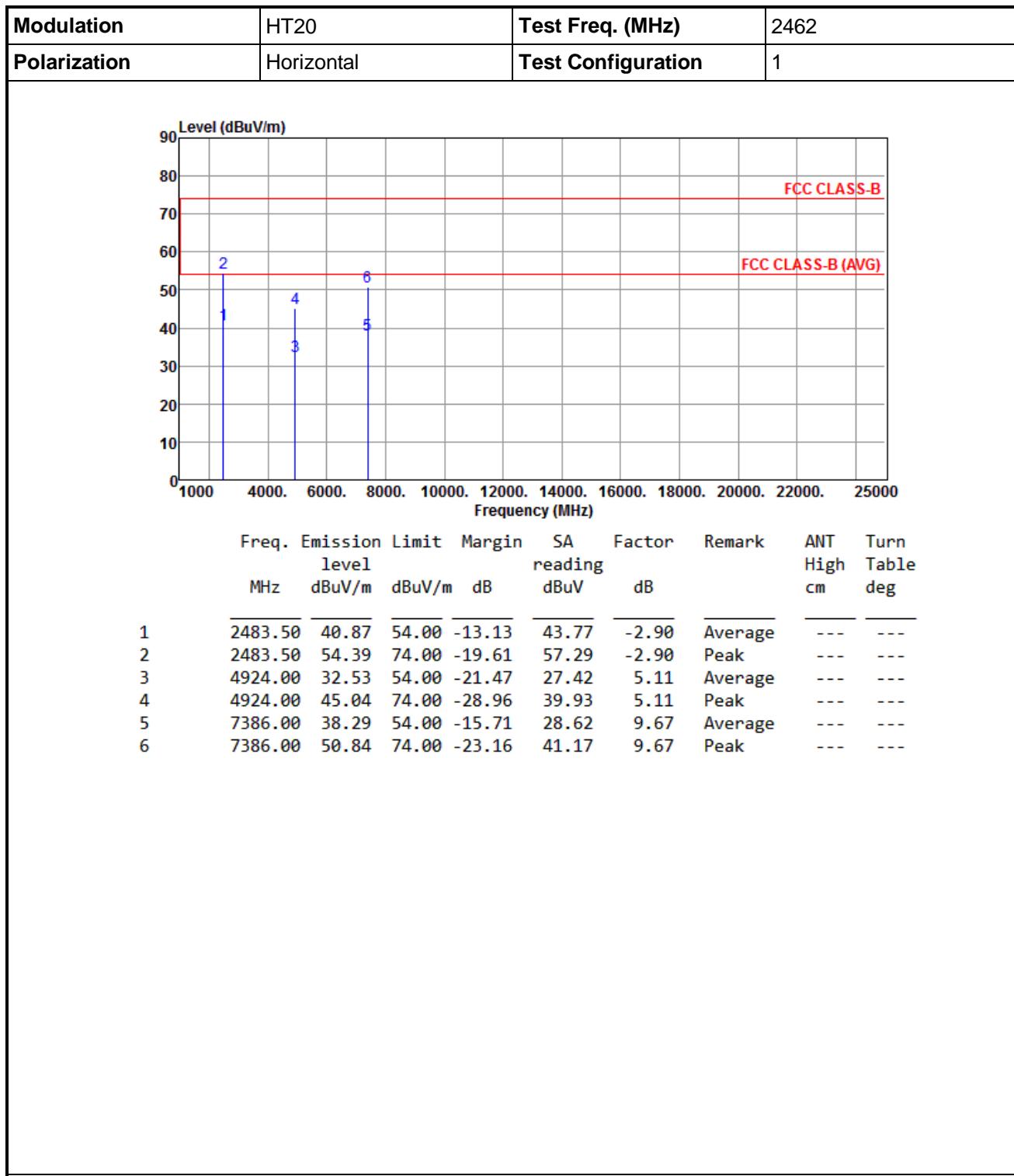
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).



Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

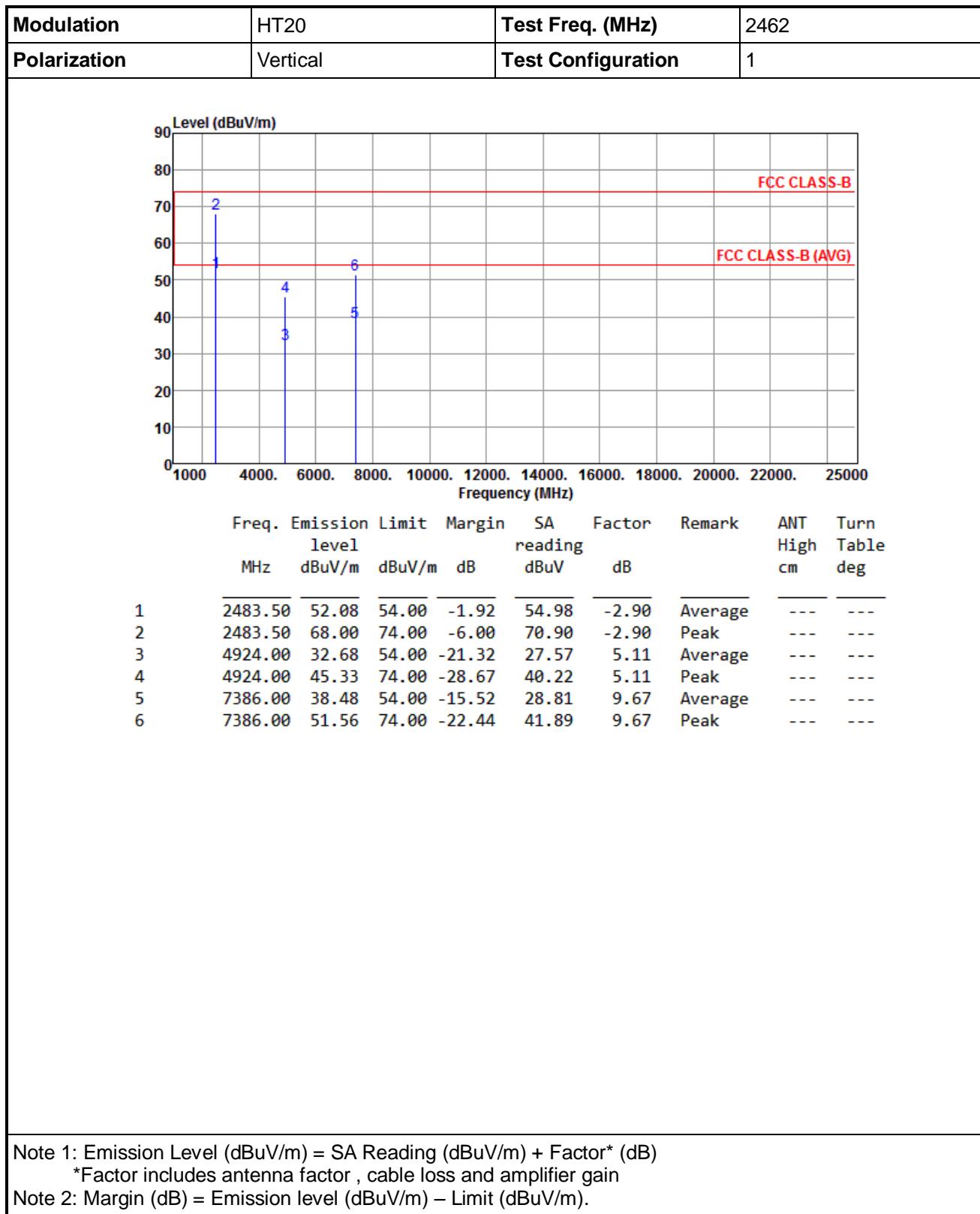
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).



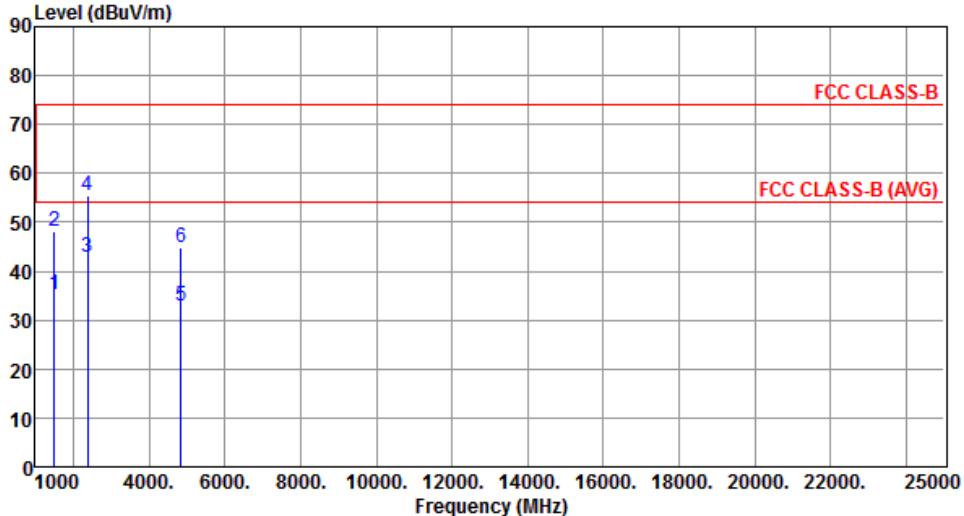
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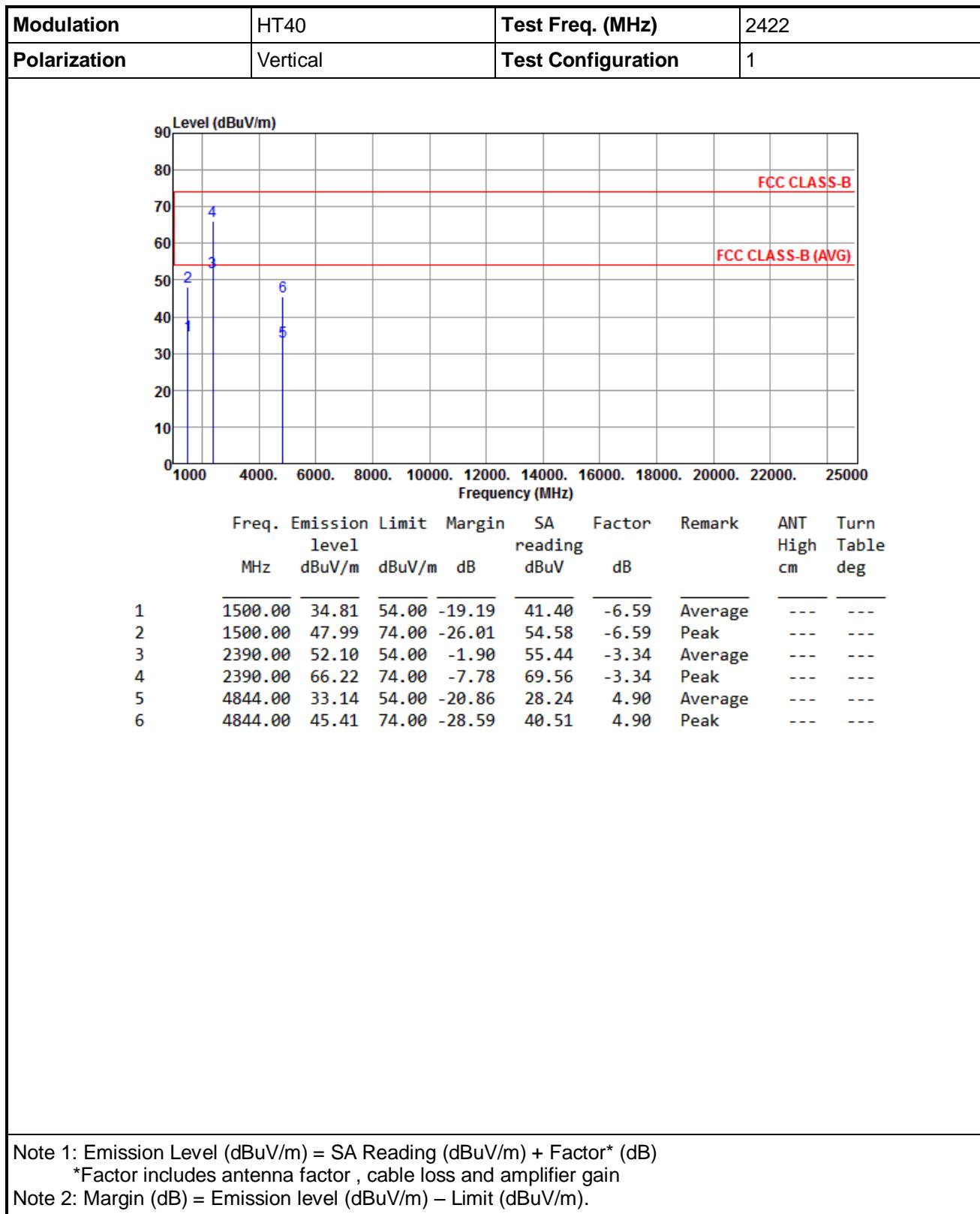
\*Factor includes antenna factor , cable loss and amplifier gain

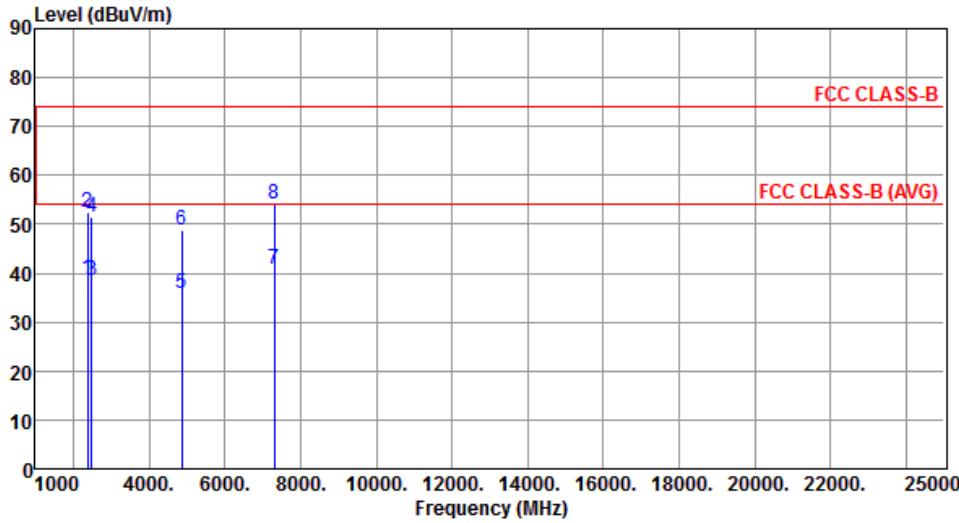
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).



### 3.5.9 Transmitter Radiated Unwanted Emissions (Above 1GHz) for HT40

<b>Modulation</b>	HT40	<b>Test Freq. (MHz)</b>	2422																																																															
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	1																																																															
																																																																		
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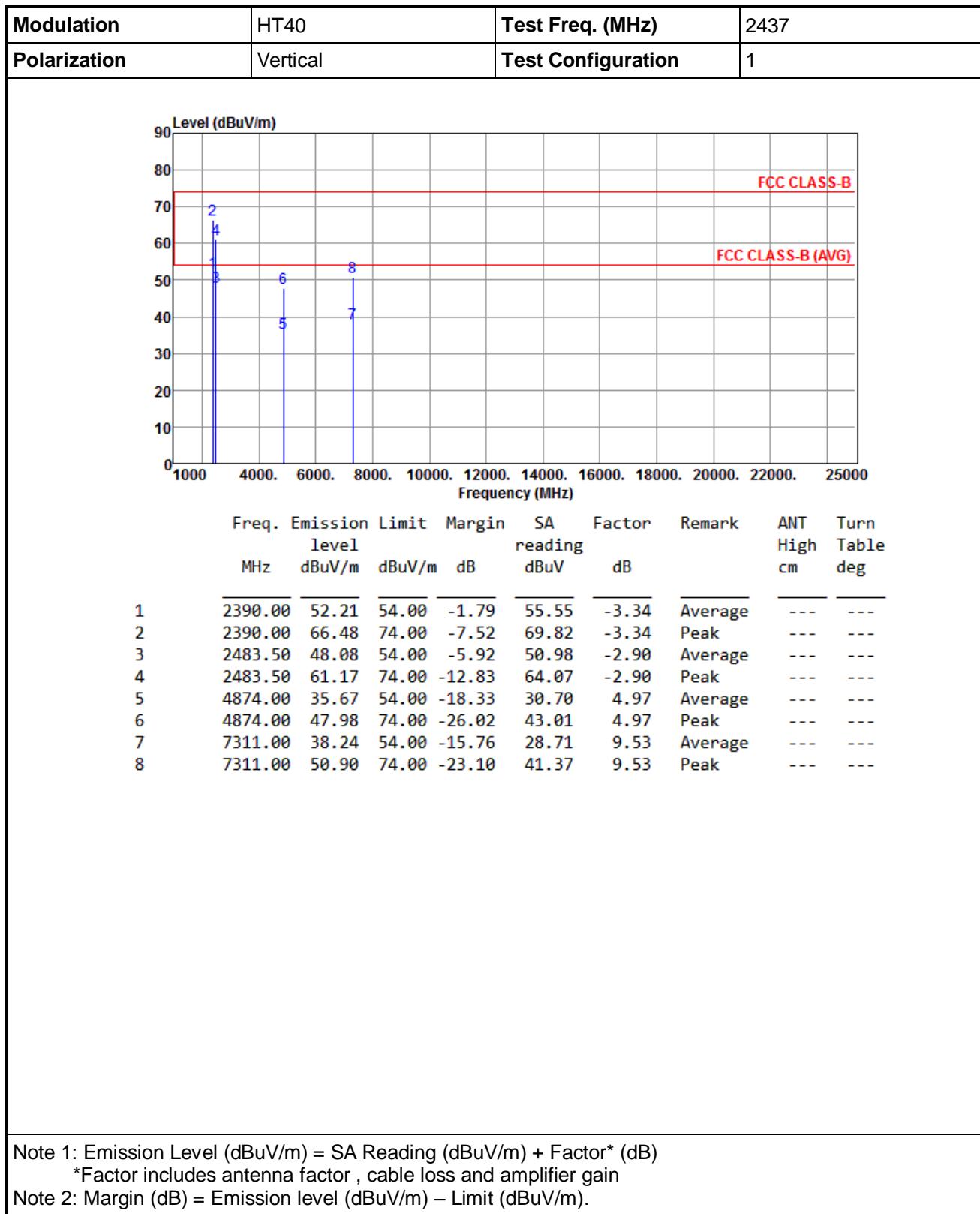


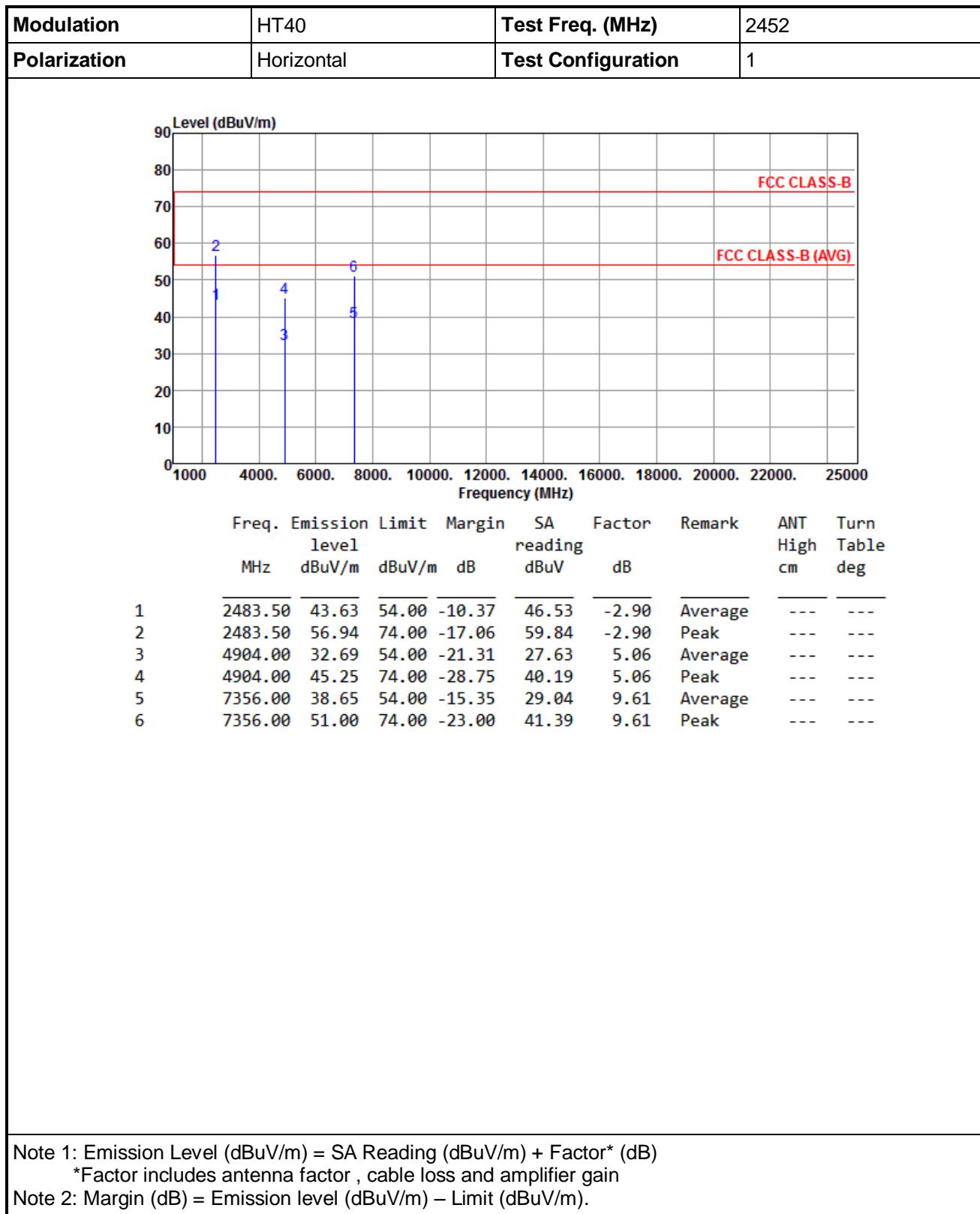
<b>Modulation</b>	HT40	<b>Test Freq. (MHz)</b>	2437																																																																																																
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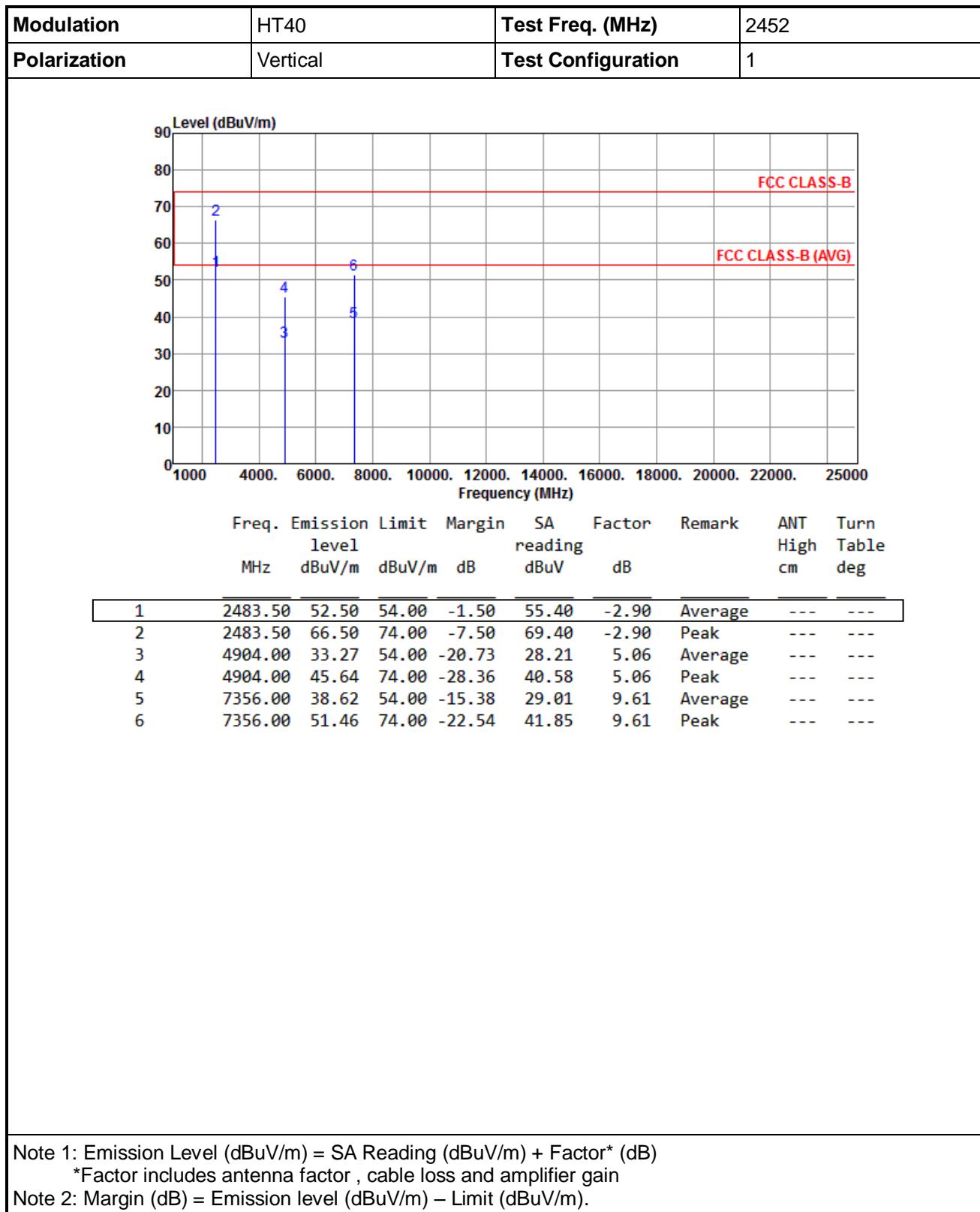
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).







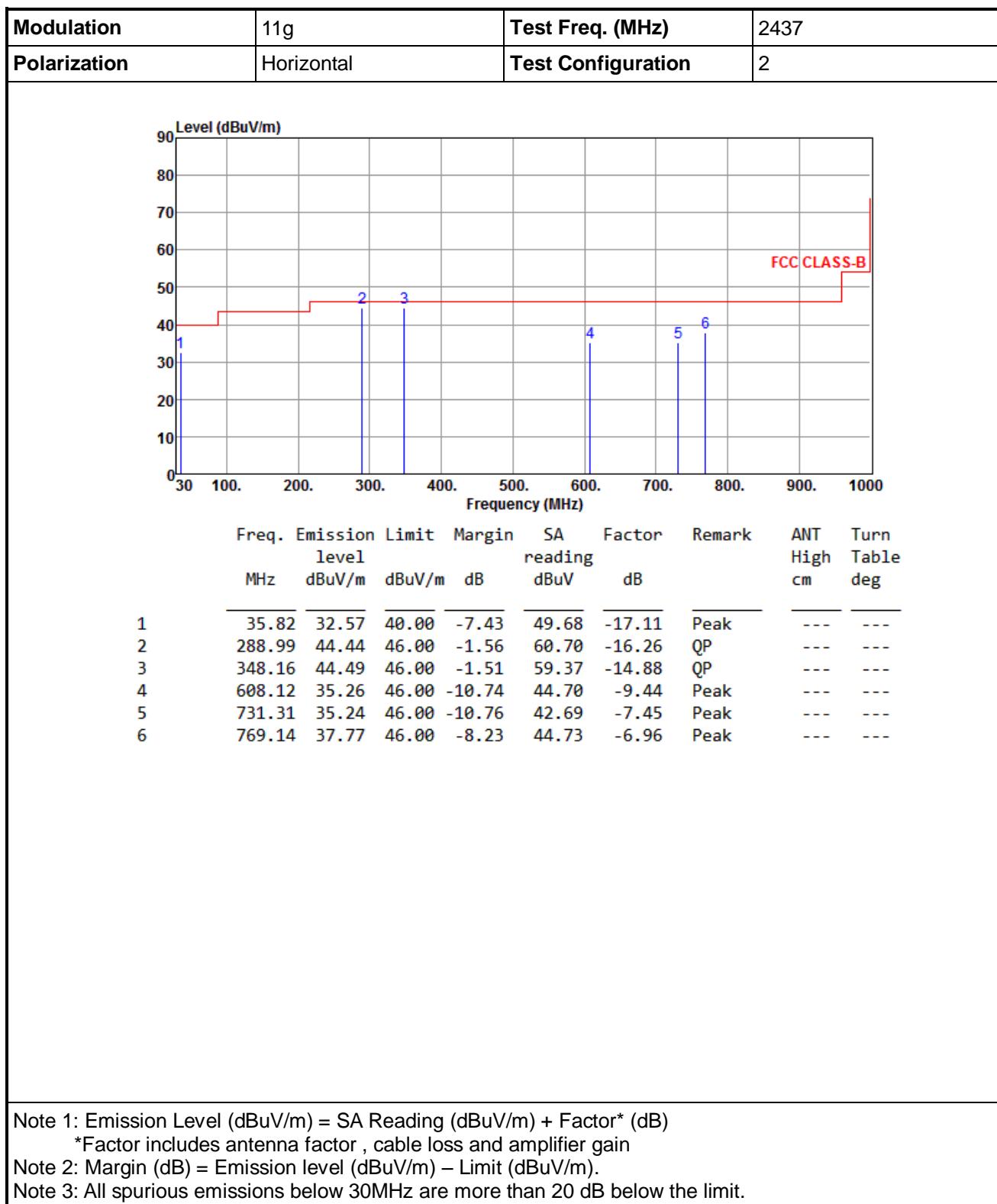
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

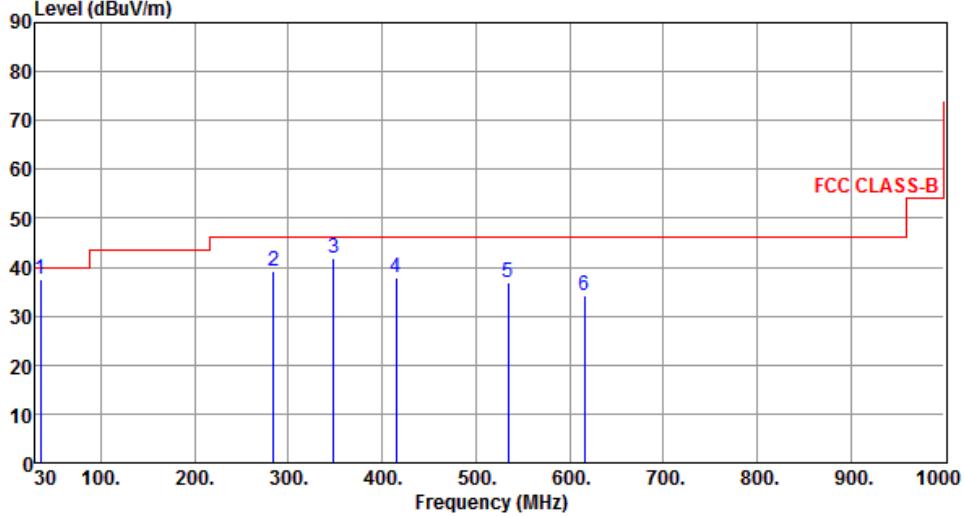
\*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

## PIFA antenna

### 3.5.10 Transmitter Radiated Unwanted Emissions (Below 1GHz)



<b>Modulation</b>	11g	<b>Test Freq. (MHz)</b>	2437																																																																
<b>Polarization</b>	Vertical	<b>Test Configuration</b>	2																																																																
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Freq.	Emission level	Margin	SA reading	Factor	Remark	ANT High	Turn Table																																																												
MHz	dBuV/m	dBuV/m	dB	dB		cm	deg																																																												
1	35.82	37.53	40.00	-2.47	QP	---	---																																																												
2	284.14	39.27	46.00	-6.73	Peak	---	---																																																												
3	348.16	41.88	46.00	-4.12	Peak	---	---																																																												
4	415.09	37.97	46.00	-8.03	Peak	---	---																																																												
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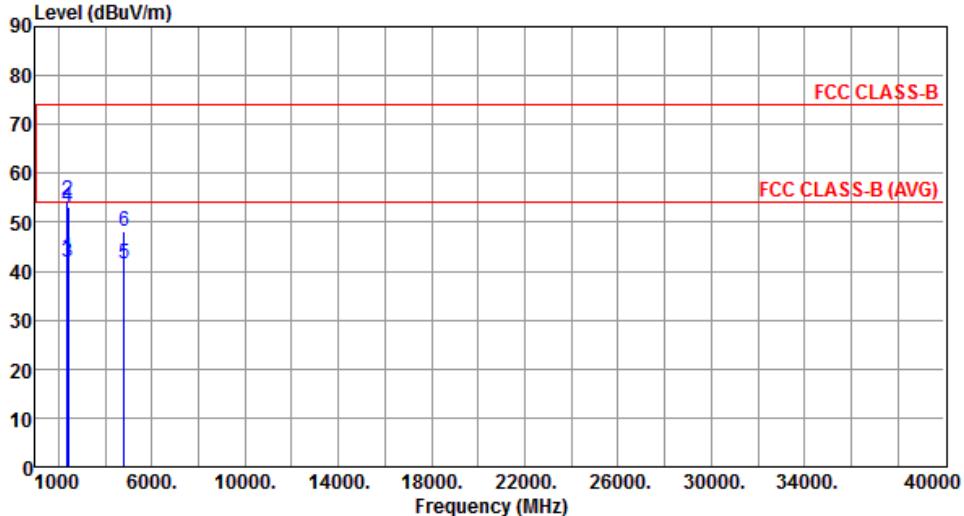
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

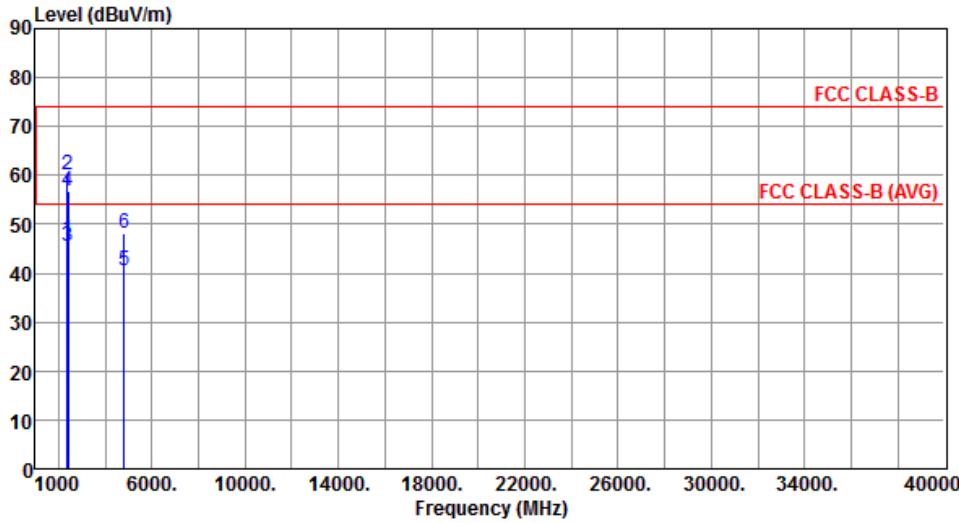
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

### 3.5.11 Transmitter Radiated Unwanted Emissions (Above 1GHz) for 11b

<b>Modulation</b>	11b	<b>Test Freq. (MHz)</b>	2412																																																															
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	2																																																															
																																																																		
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Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg																																																										
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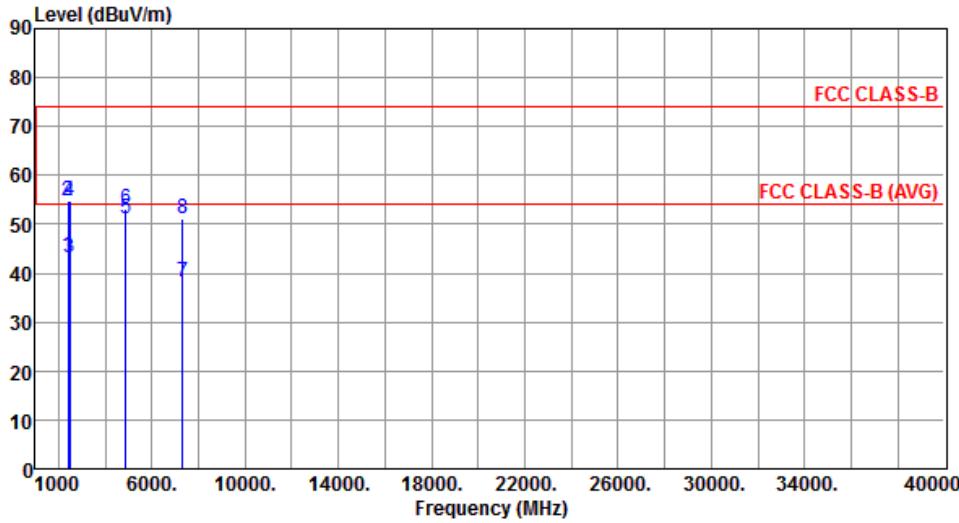
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)  
 \*Factor includes antenna factor , cable loss and amplifier gain  
 Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

<b>Modulation</b>	11b	<b>Test Freq. (MHz)</b>	2412																																																																					
<b>Polarization</b>	Vertical	<b>Test Configuration</b>	2																																																																					
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Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg																																																																
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Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

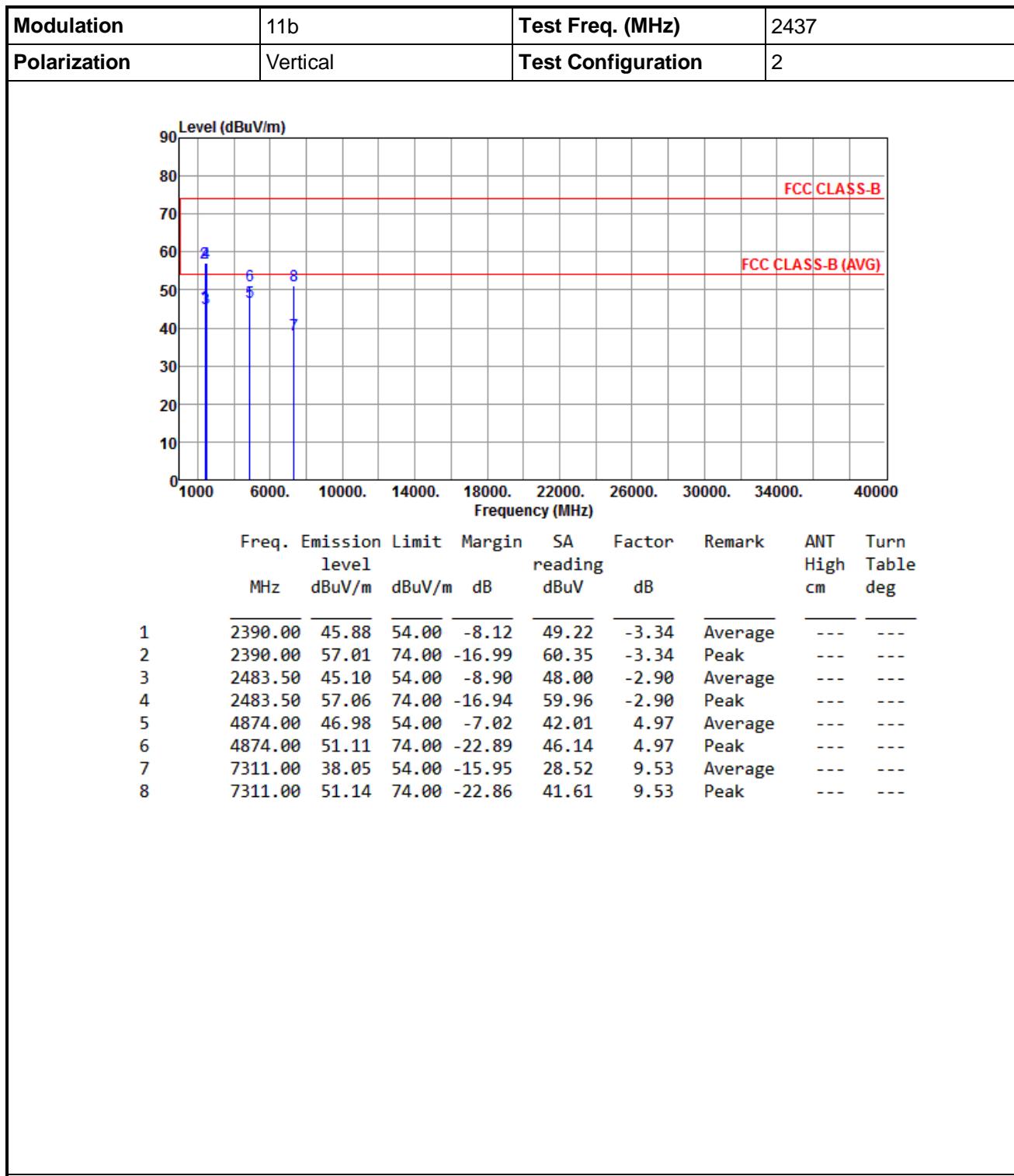
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

<b>Modulation</b>	11b	<b>Test Freq. (MHz)</b>	2437																																																																																										
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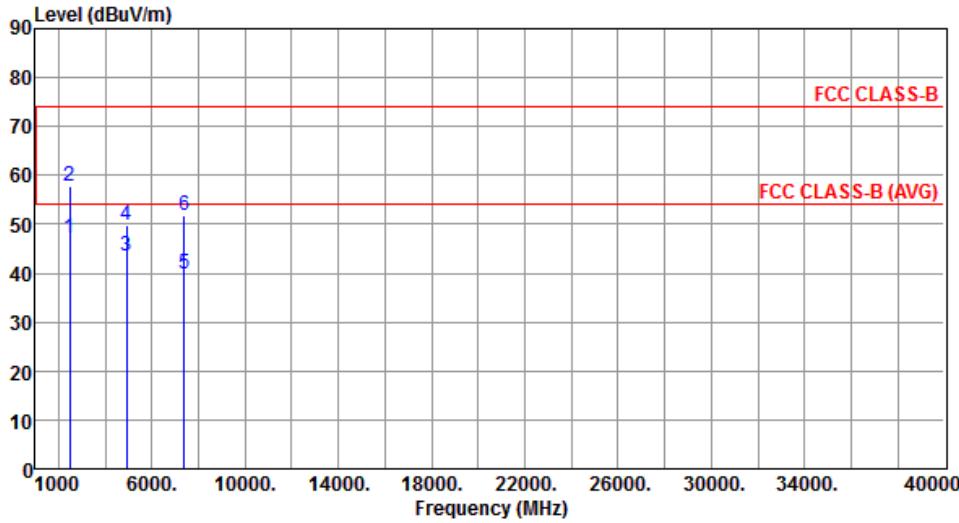
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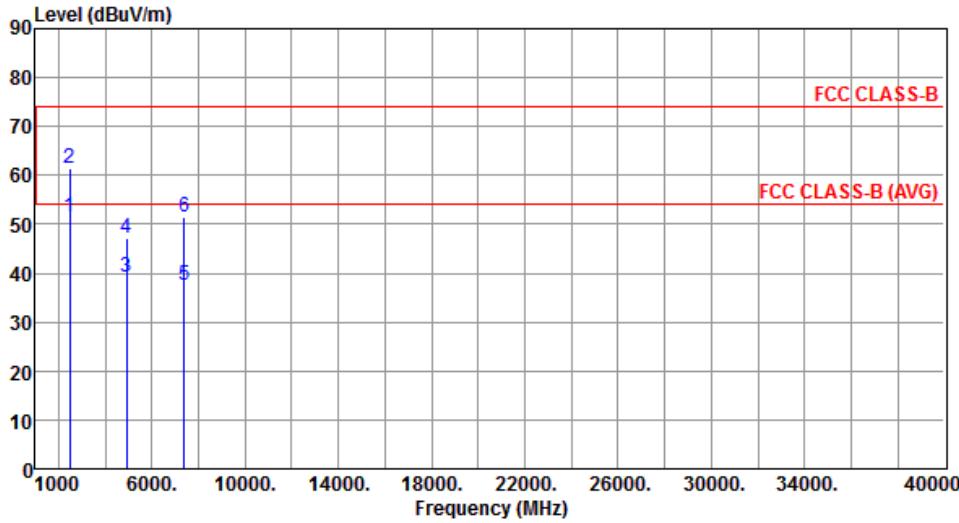
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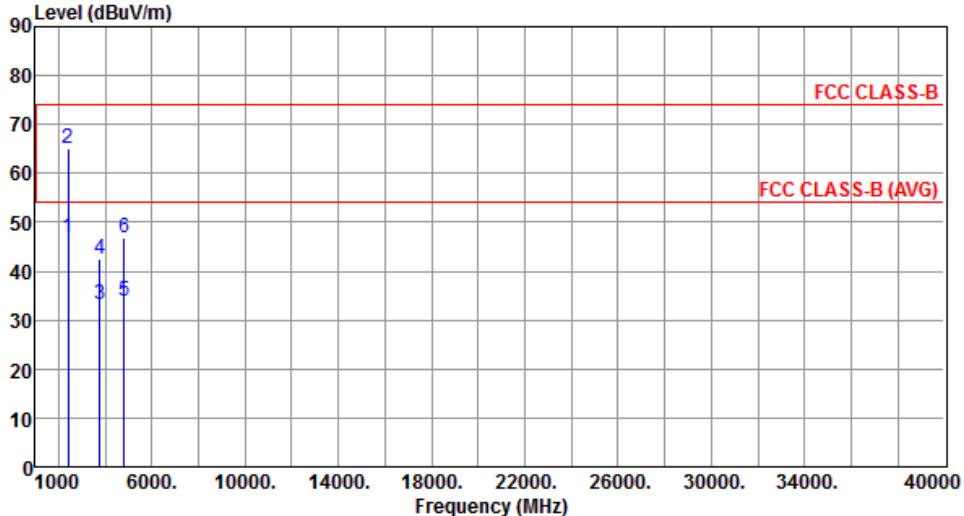
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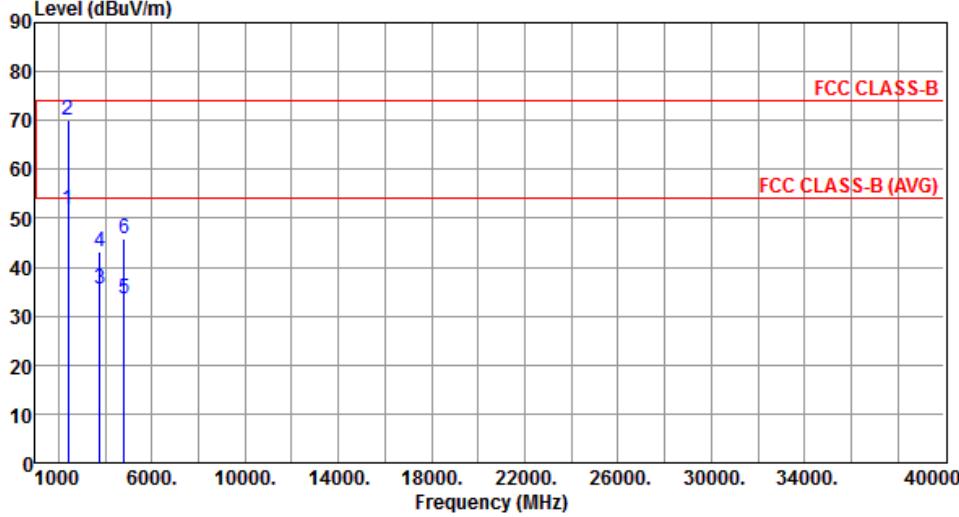
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

### 3.5.12 Transmitter Radiated Unwanted Emissions (Above 1GHz) for 11g

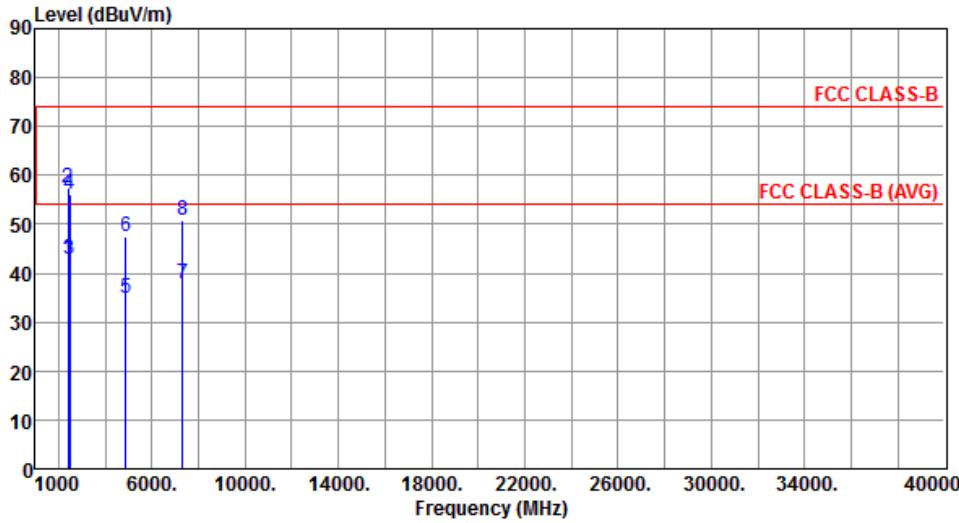
<b>Modulation</b>	11g	<b>Test Freq. (MHz)</b>	2412																																																															
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	2																																																															
																																																																		
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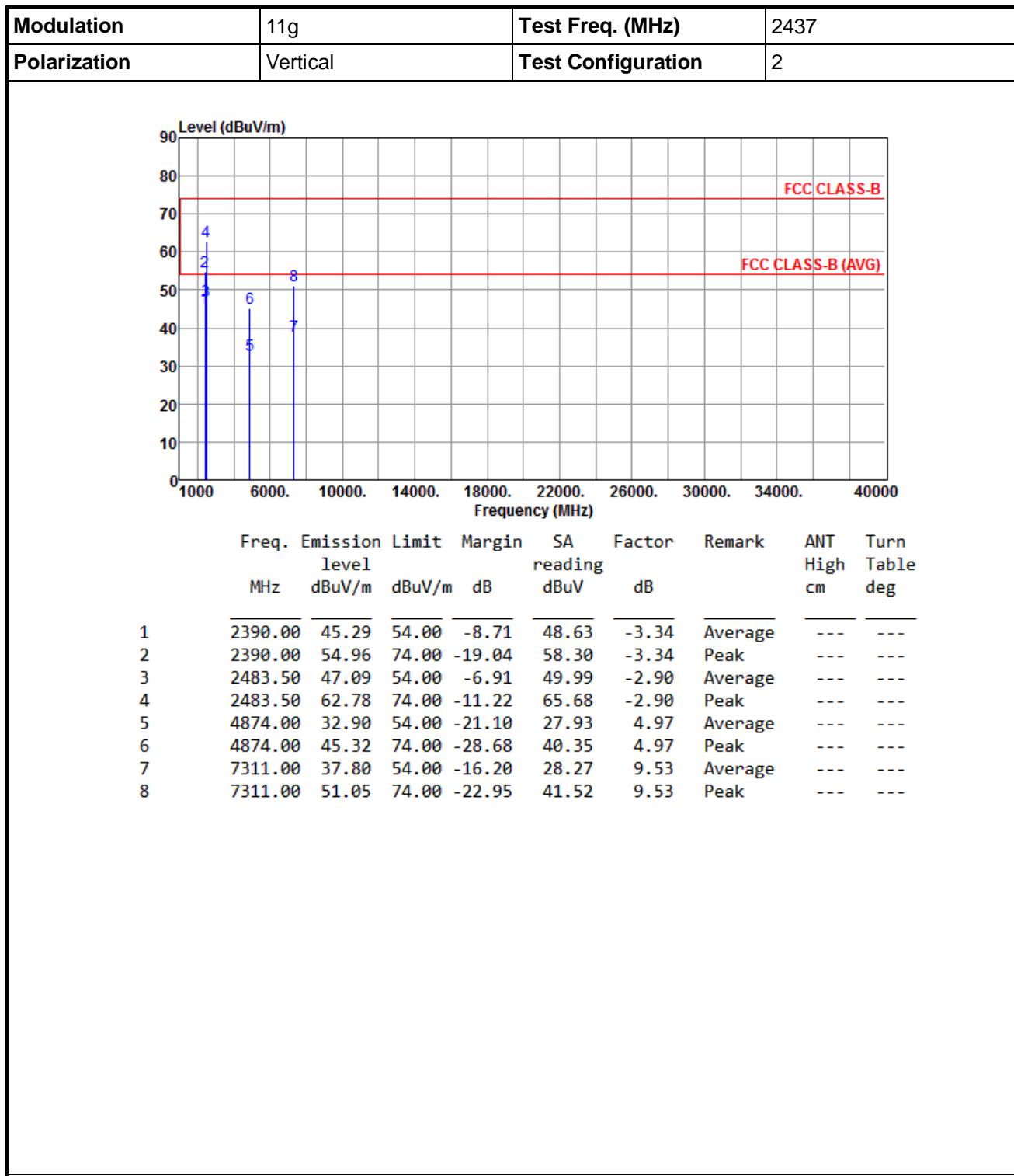
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Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

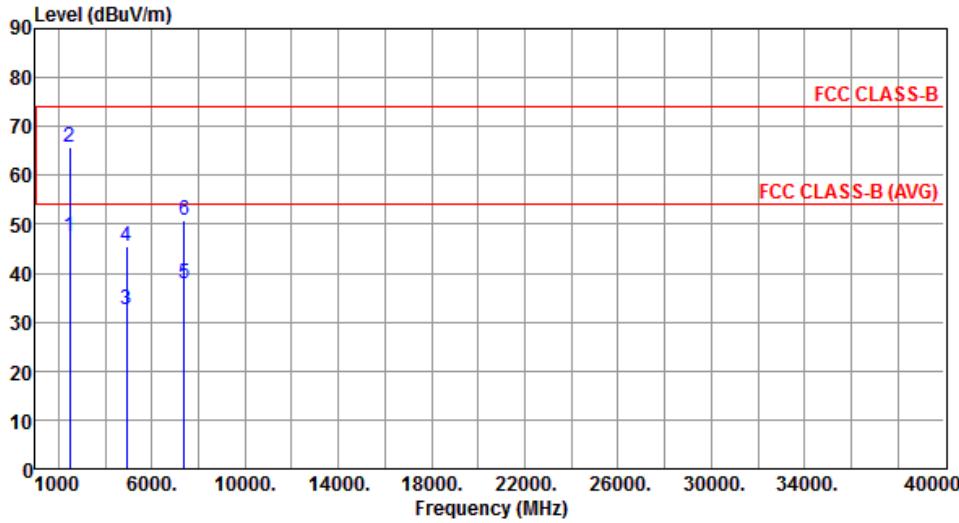
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).



Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

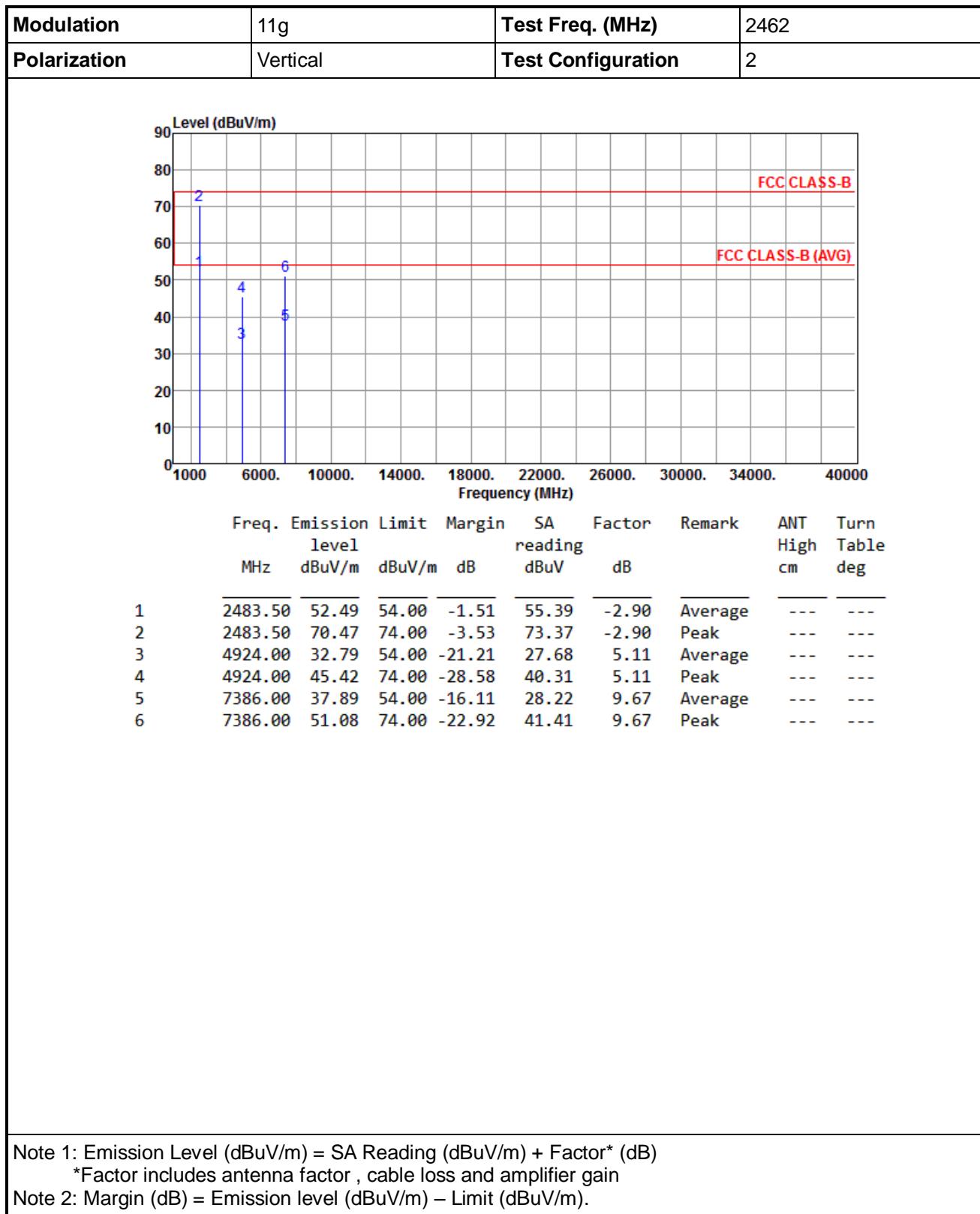
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

<b>Modulation</b>	11g	<b>Test Freq. (MHz)</b>	2462																																																																					
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	2																																																																					
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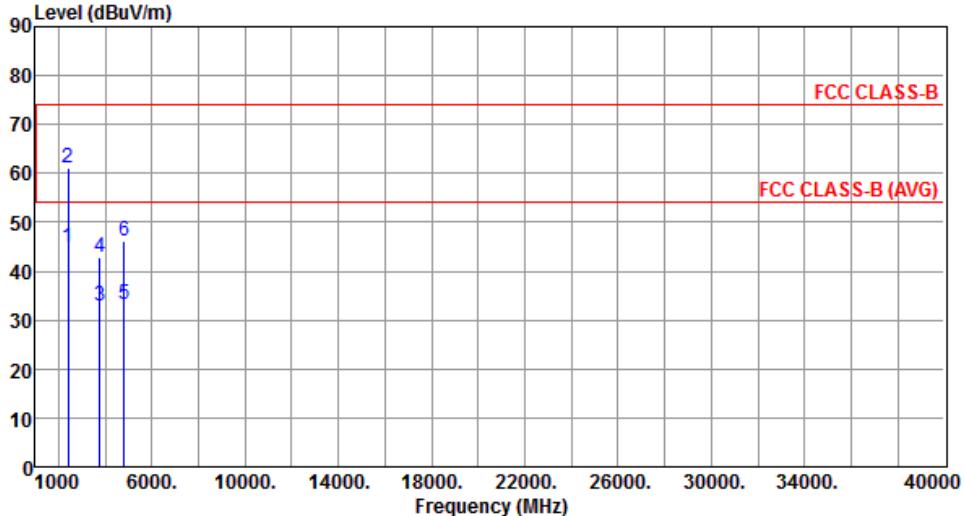
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

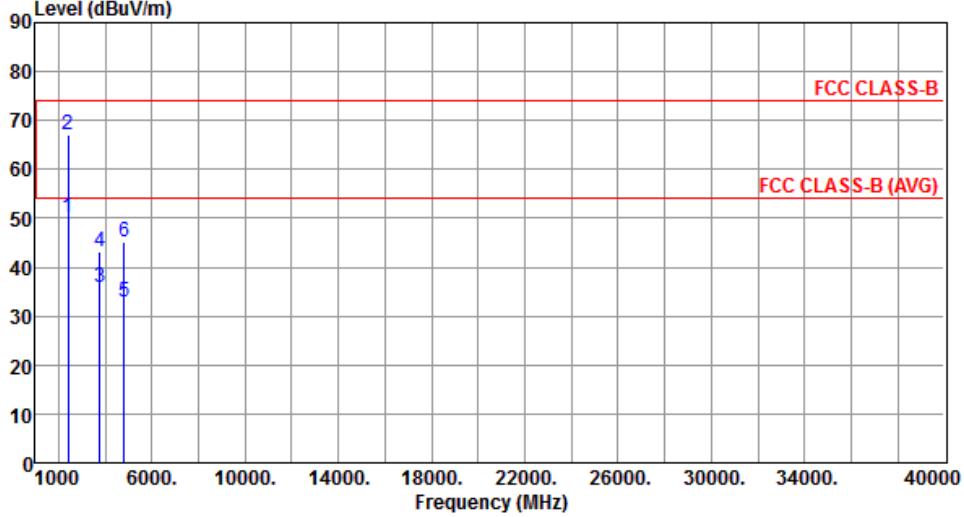
\*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).



### 3.5.13 Transmitter Radiated Unwanted Emissions (Above 1GHz) for HT20

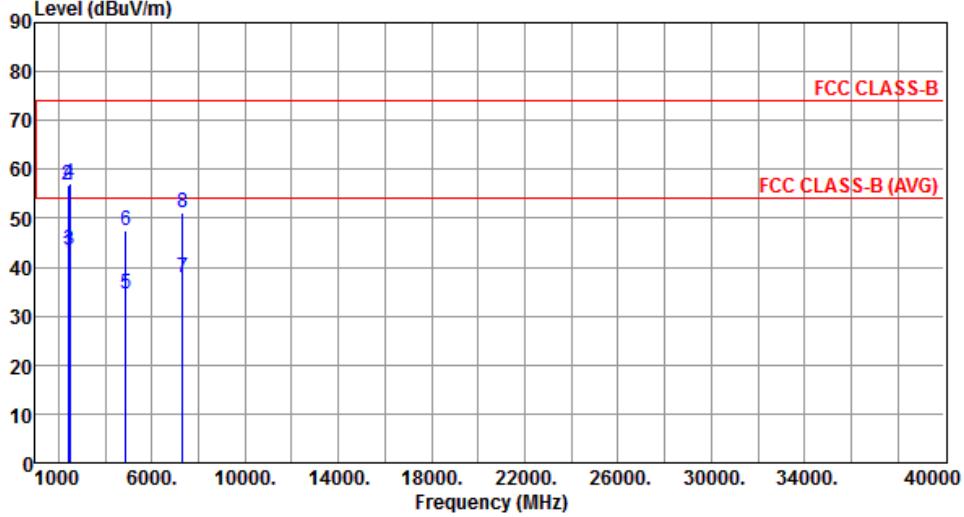
<b>Modulation</b>	HT20	<b>Test Freq. (MHz)</b>	2412																																																															
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	2																																																															
																																																																		
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<b>Modulation</b>	HT20	<b>Test Freq. (MHz)</b>	2412																																																																					
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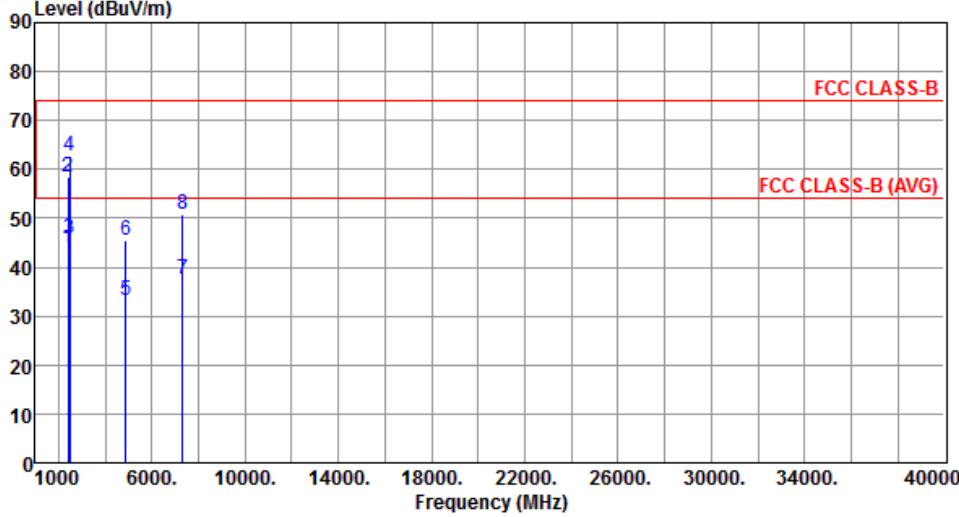
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

<b>Modulation</b>	HT20	<b>Test Freq. (MHz)</b>	2437																																																																																	
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	2																																																																																	
																																																																																				
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<b>Modulation</b>	HT20	<b>Test Freq. (MHz)</b>	2437																																																																																									
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Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

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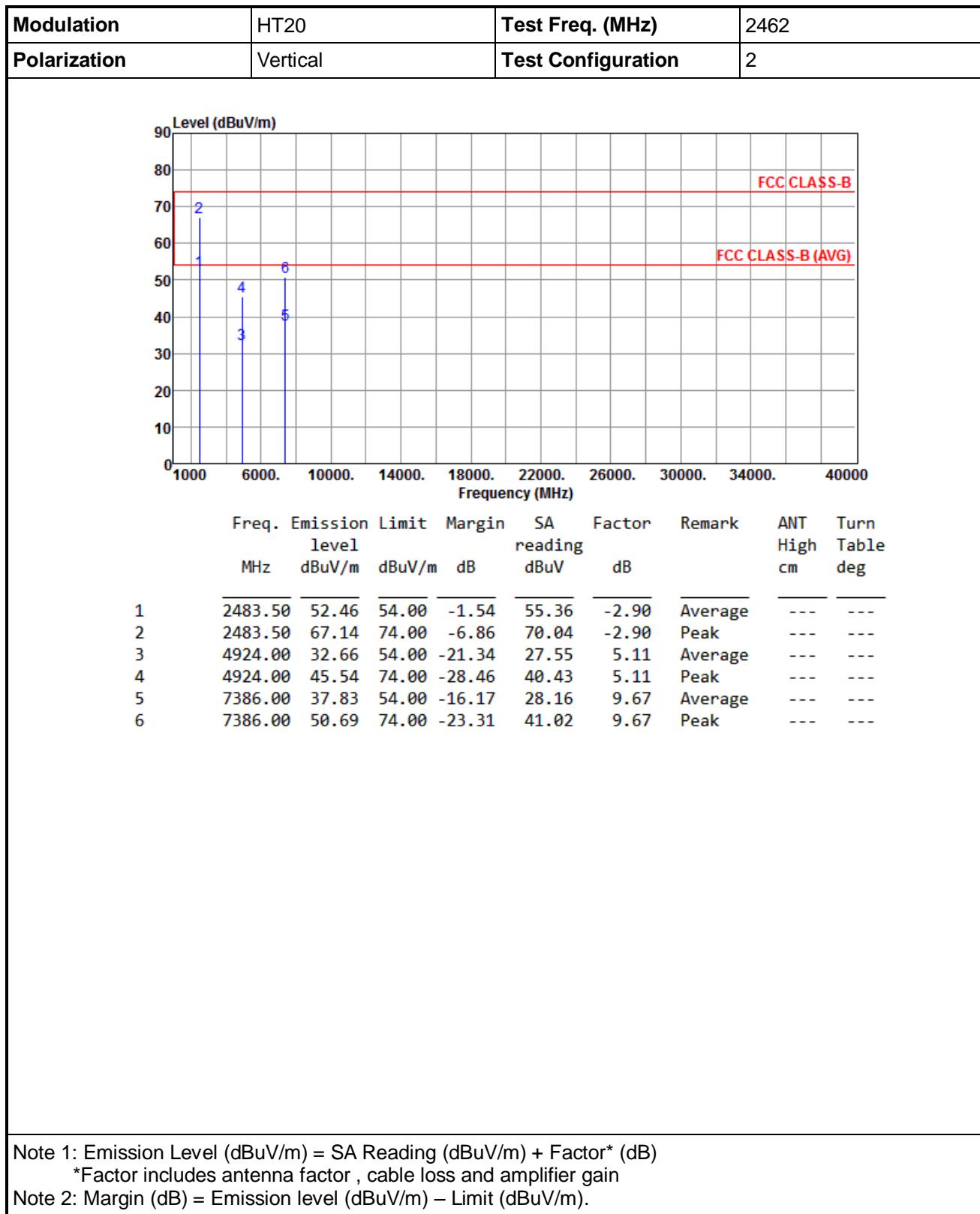
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

<b>Modulation</b>	HT20	<b>Test Freq. (MHz)</b>	2462																																																																					
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	2																																																																					
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Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

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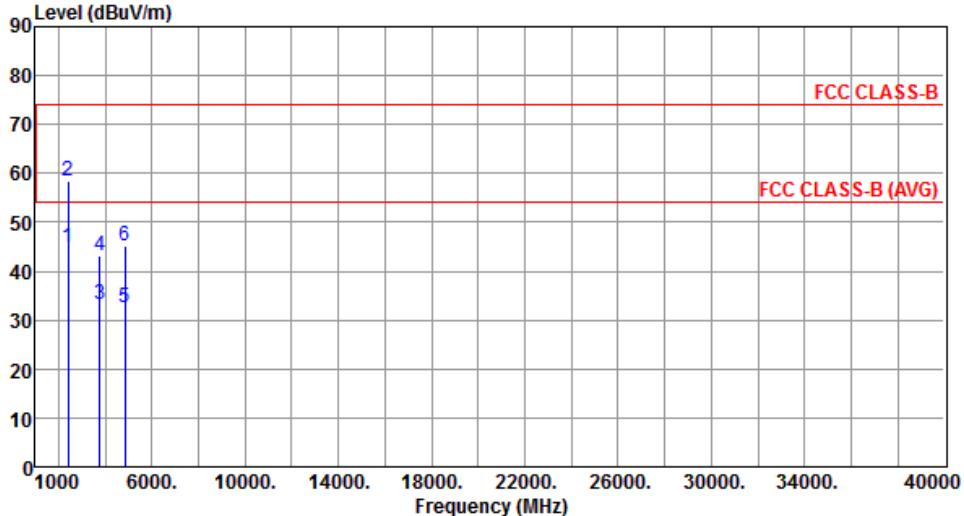


Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

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### 3.5.14 Transmitter Radiated Unwanted Emissions (Above 1GHz) for HT40

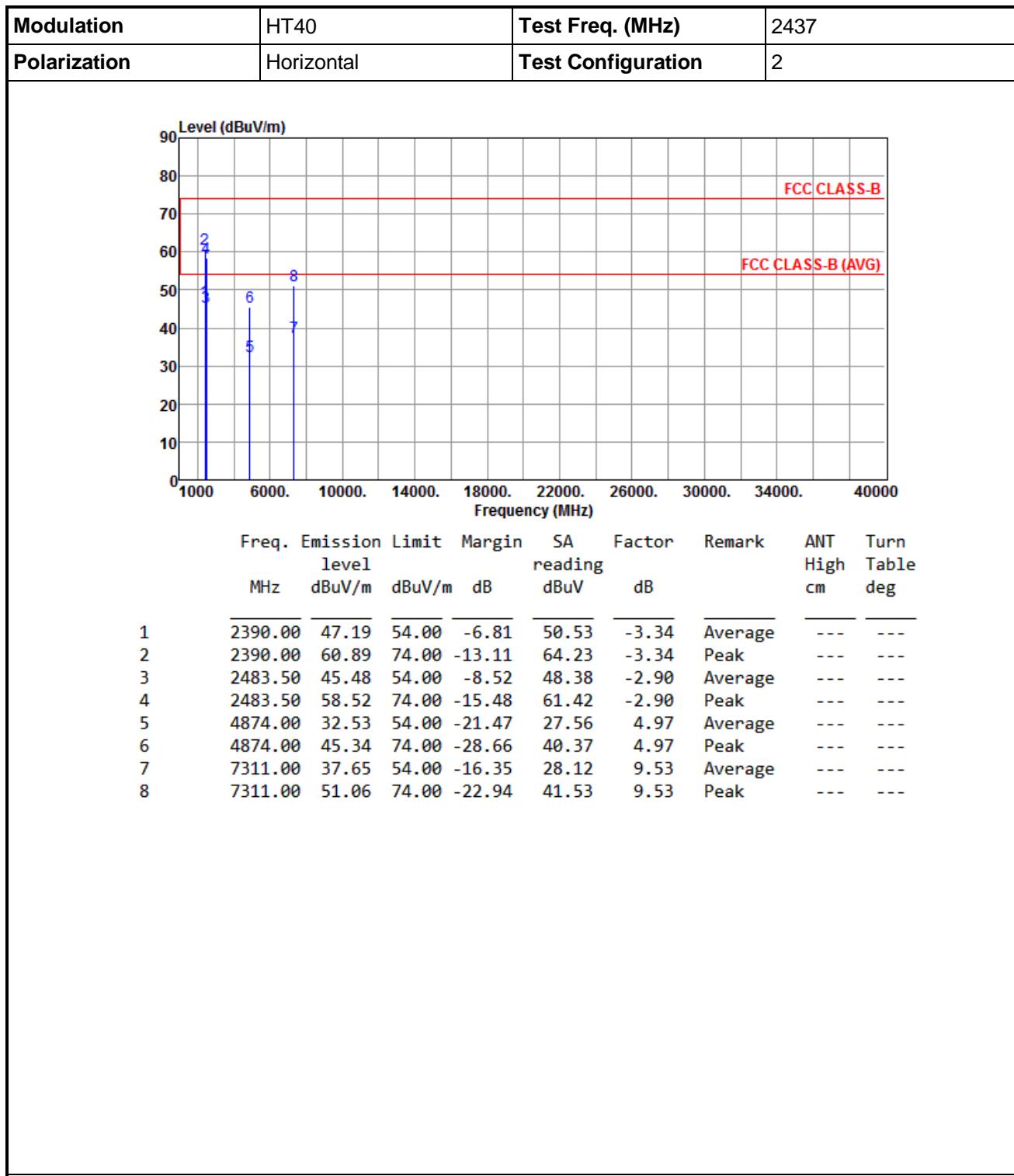
<b>Modulation</b>	HT40	<b>Test Freq. (MHz)</b>	2422																																																															
<b>Polarization</b>	Horizontal	<b>Test Configuration</b>	2																																																															
																																																																		
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<b>Modulation</b>	HT40	<b>Test Freq. (MHz)</b>	2422																																																																					
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Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

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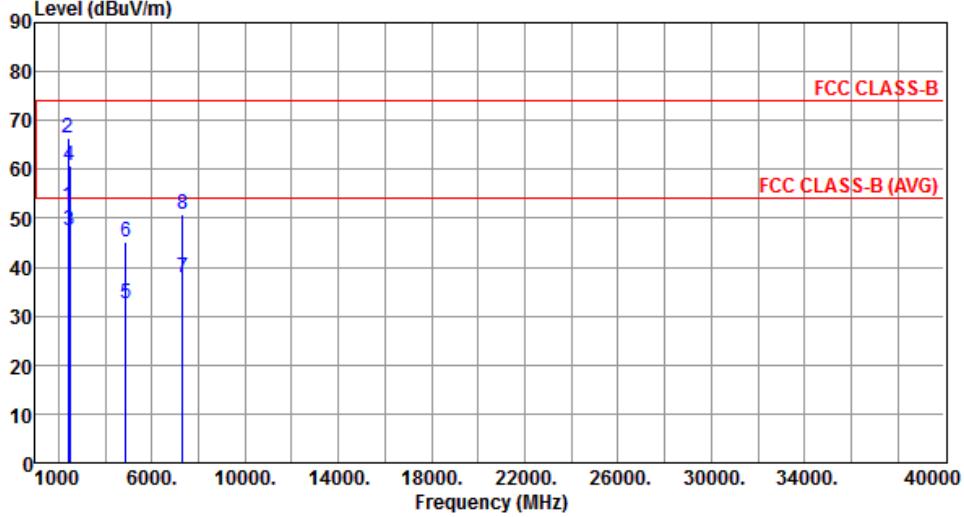
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).



Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

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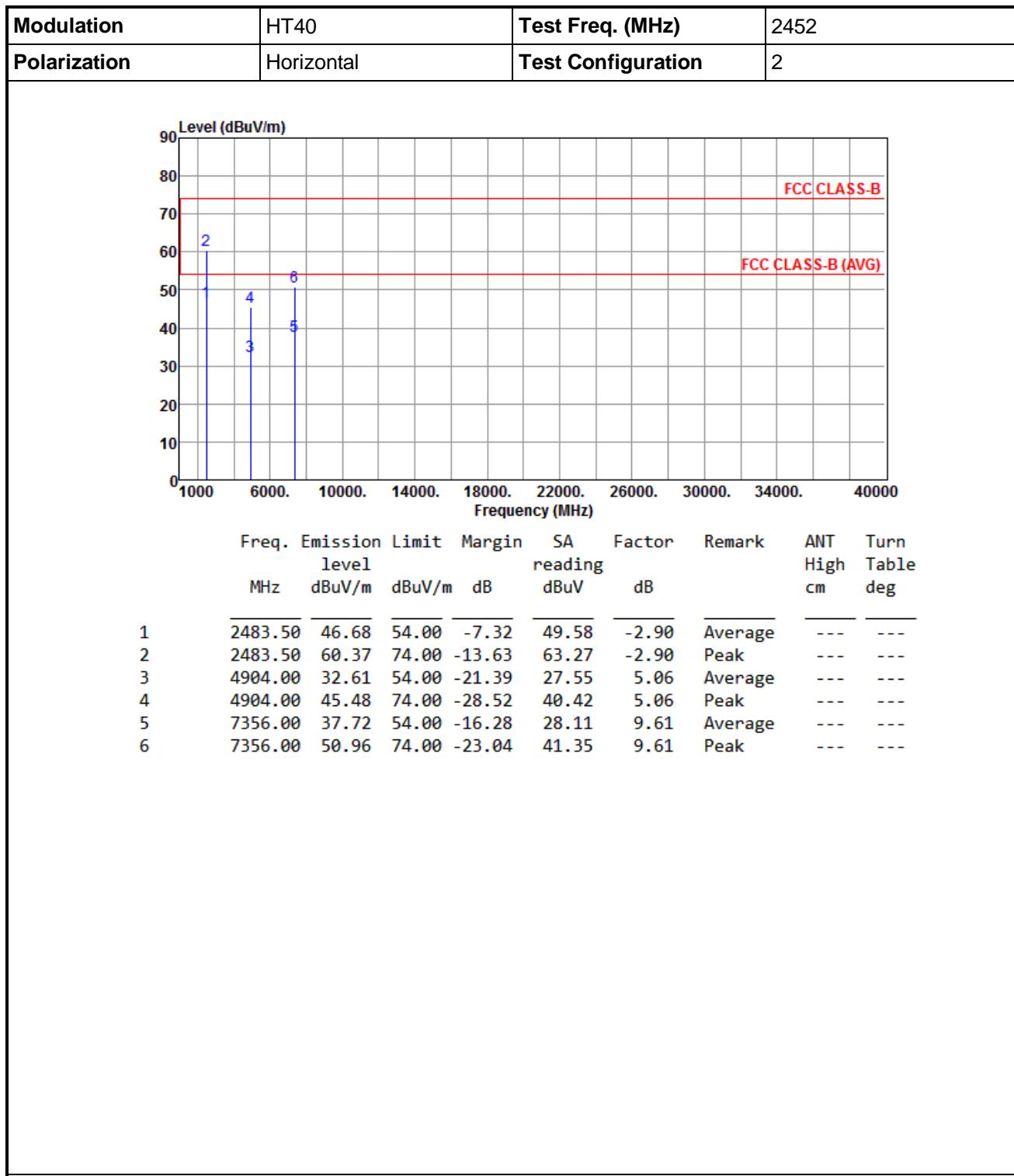
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<b>Modulation</b>	HT40	<b>Test Freq. (MHz)</b>	2437																																																																																									
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Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

\*Factor includes antenna factor , cable loss and amplifier gain

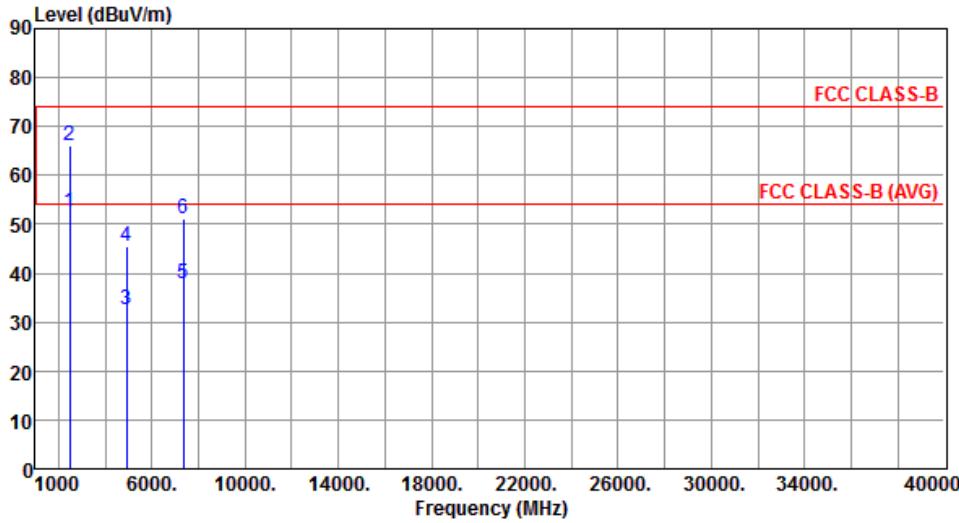
Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).



Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor\* (dB)

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<b>Modulation</b>	HT40	<b>Test Freq. (MHz)</b>	2452																																																															
<b>Polarization</b>	Vertical	<b>Test Configuration</b>	2																																																															
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Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

## 3.6 Emissions in Non-Restricted Frequency Bands

### 3.6.1 Emissions in Non-Restricted Frequency Bands Limit

Peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz

### 3.6.2 Measuring Instruments

Refer a test equipment and calibration data table in this test report.

### 3.6.3 Test Procedures

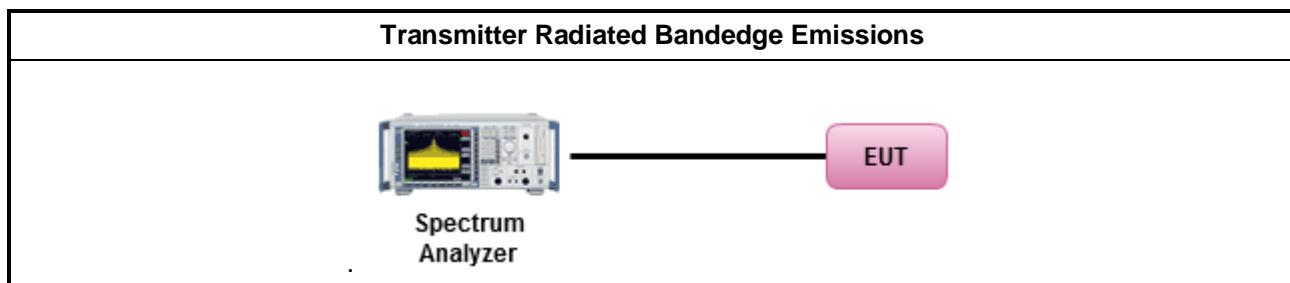
#### Reference level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Use the peak marker function to determine the maximum PSD level

#### Emission level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Scan Frequency range is up to 25GHz
4. Use the peak marker function to determine the maximum amplitude level

### 3.6.4 Test Setup

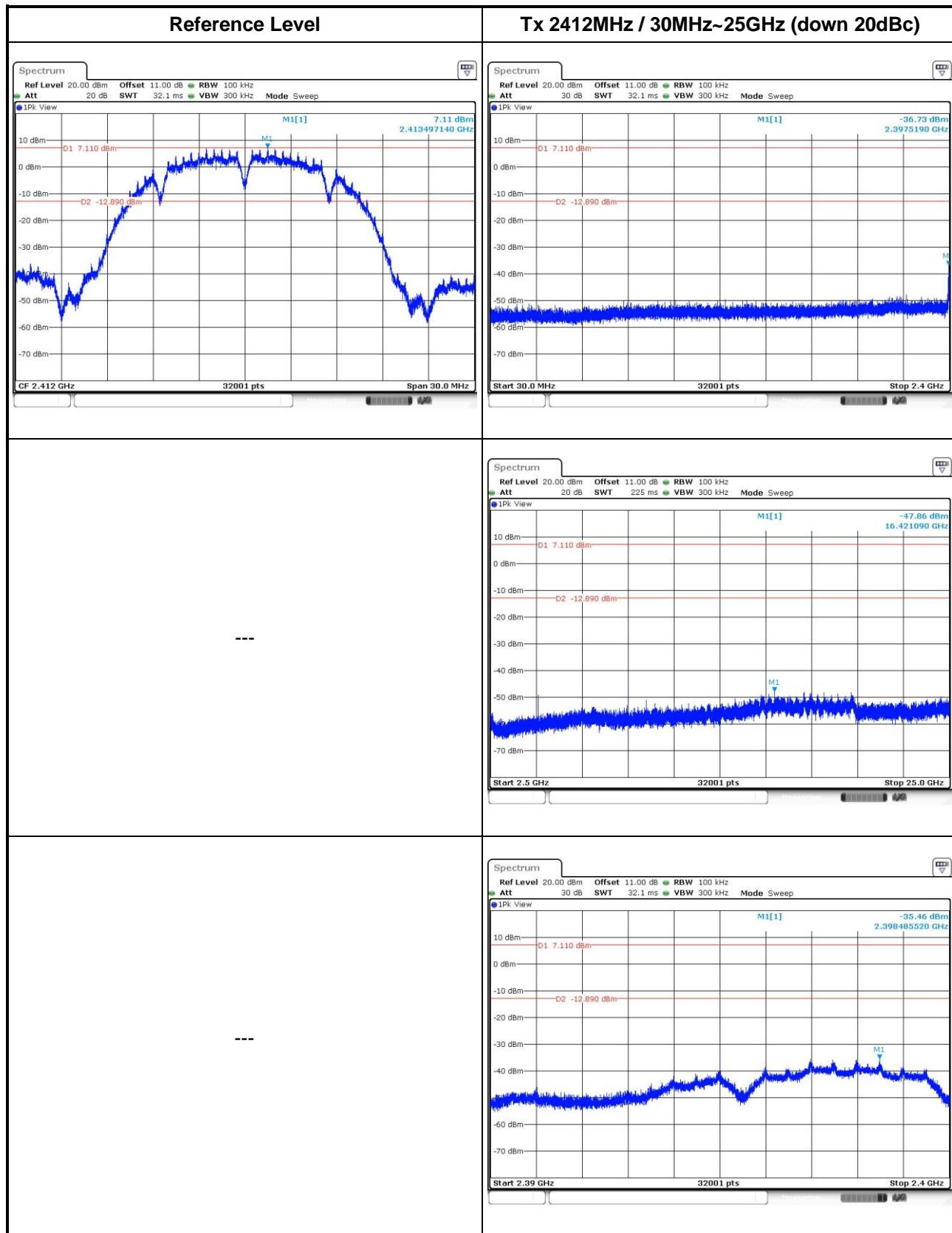


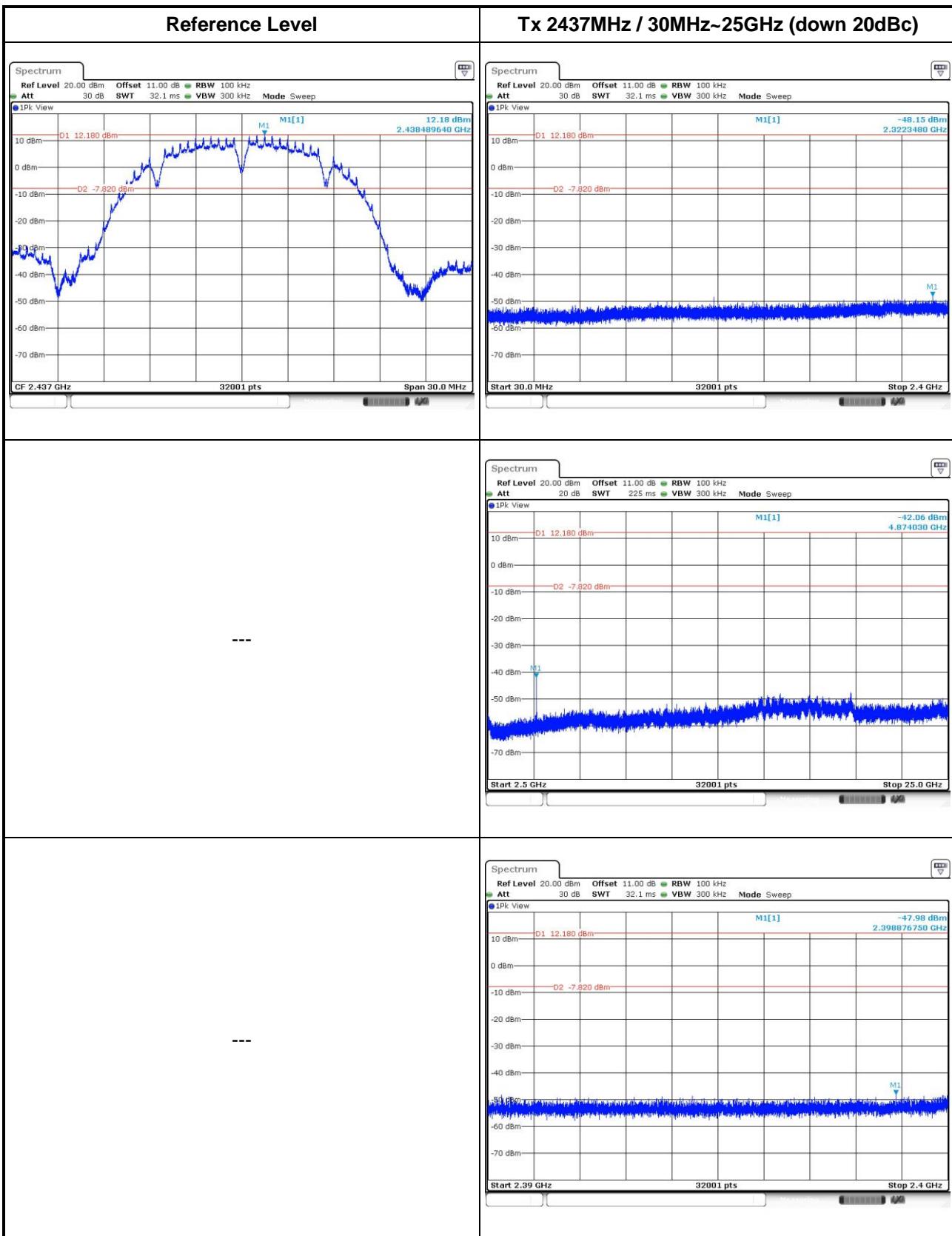
### 3.6.5 Test Result of Emissions in non-restricted frequency bands

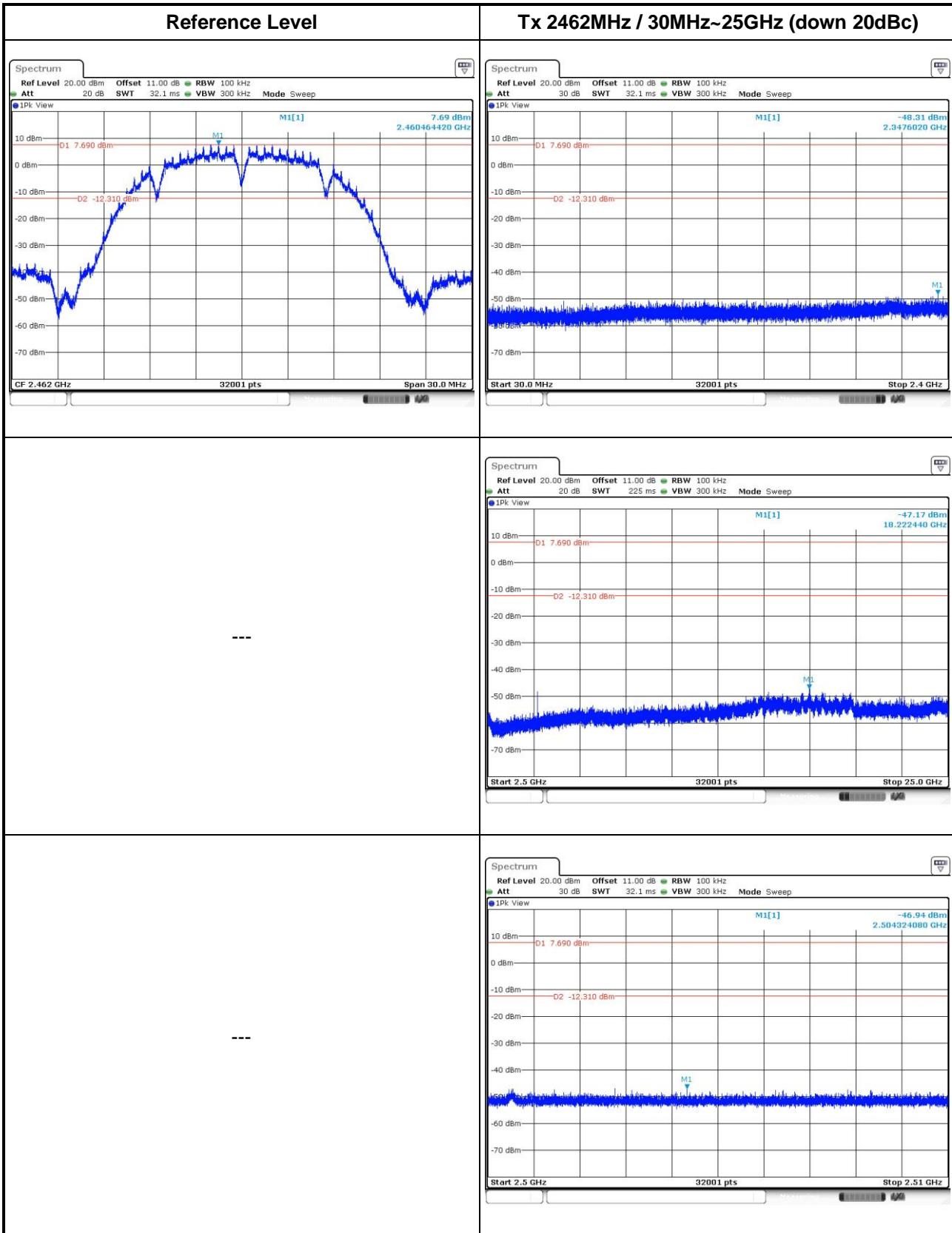
This test item is performed on each TX output individually without summing or adding  $10 \log(N_{ANT})$  since measurements are made relative to the in-band emissions on the individual outputs. Only worst test result of each operating mode is presented.

### 3.6.6 Unwanted Emissions into Non-Restricted Frequency Bands

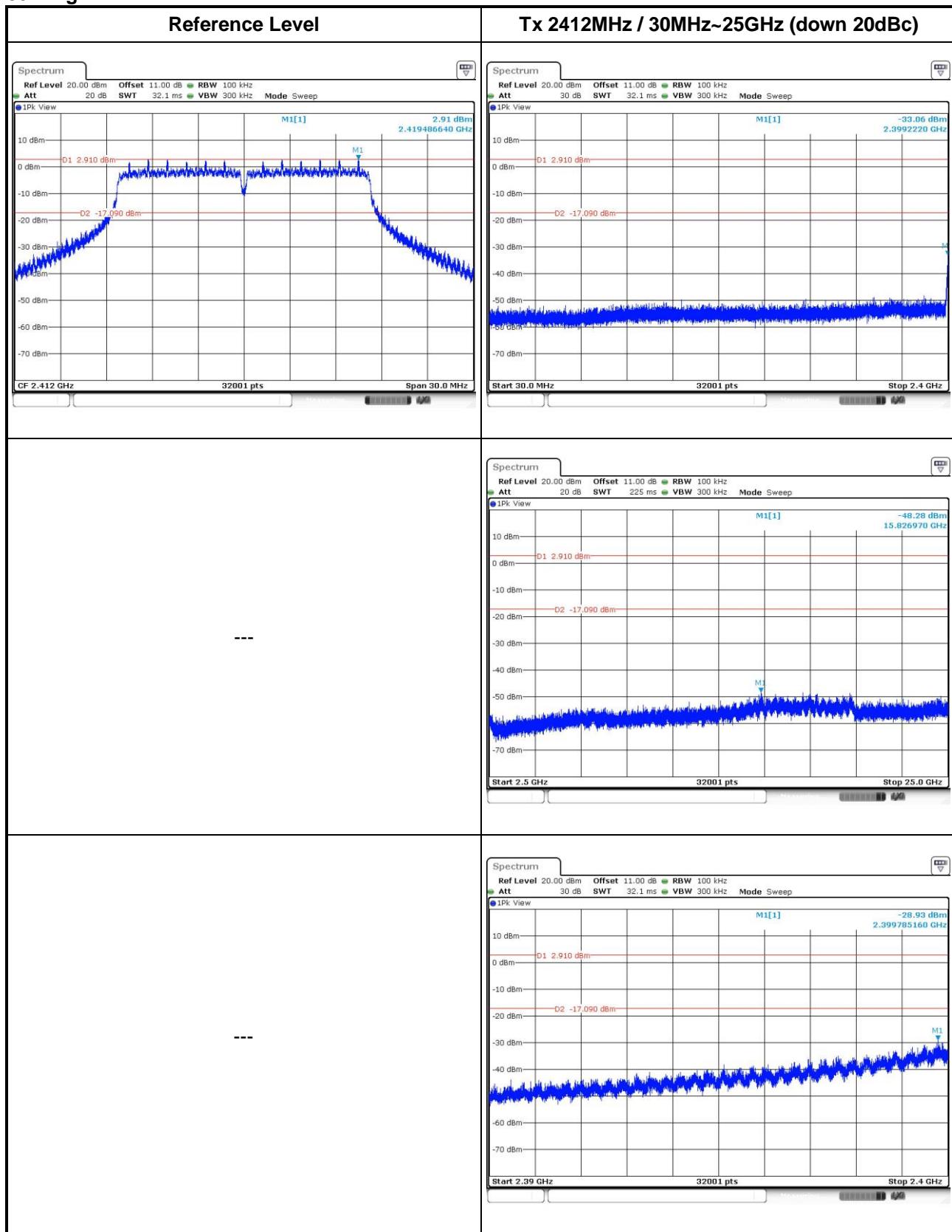
802.11b

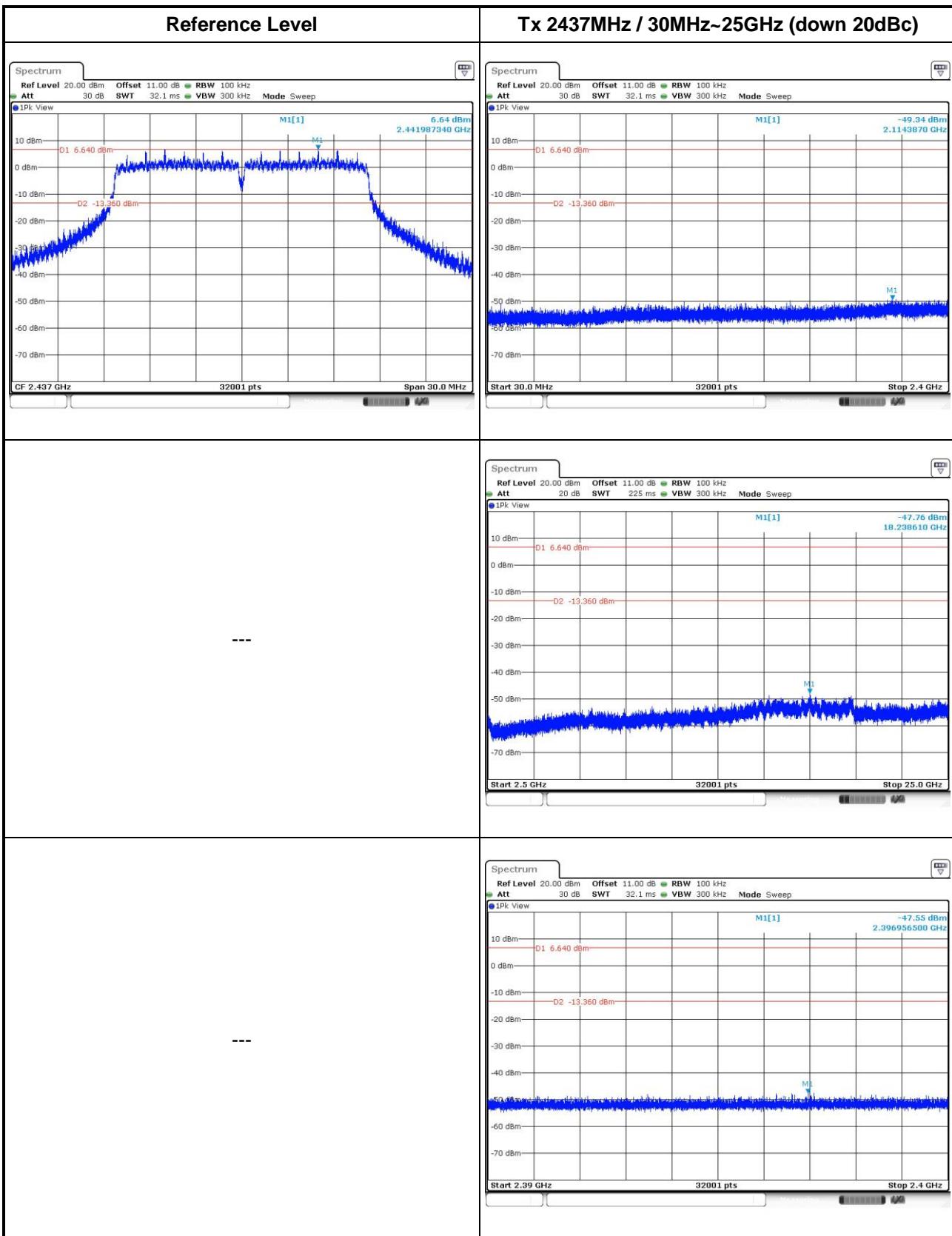


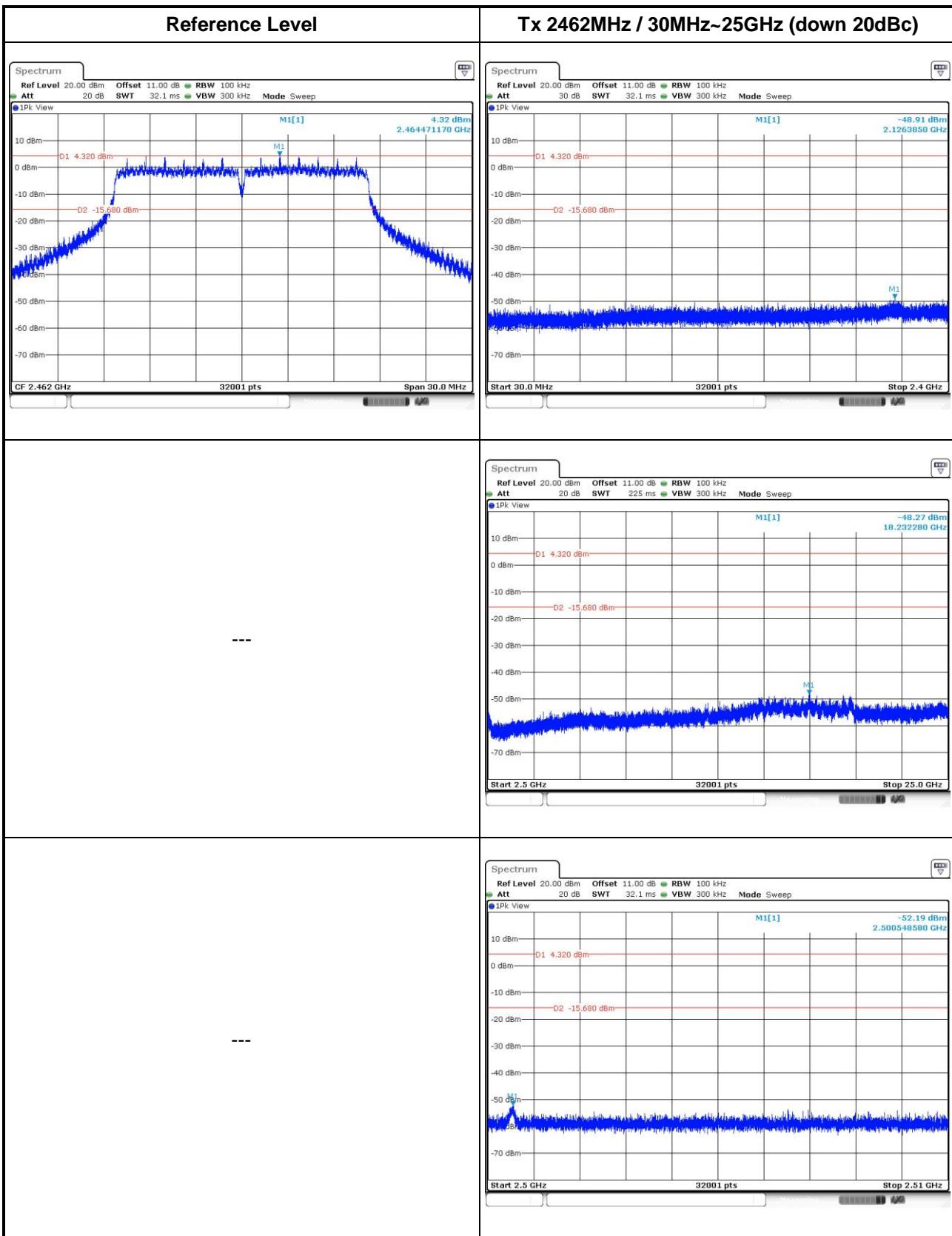




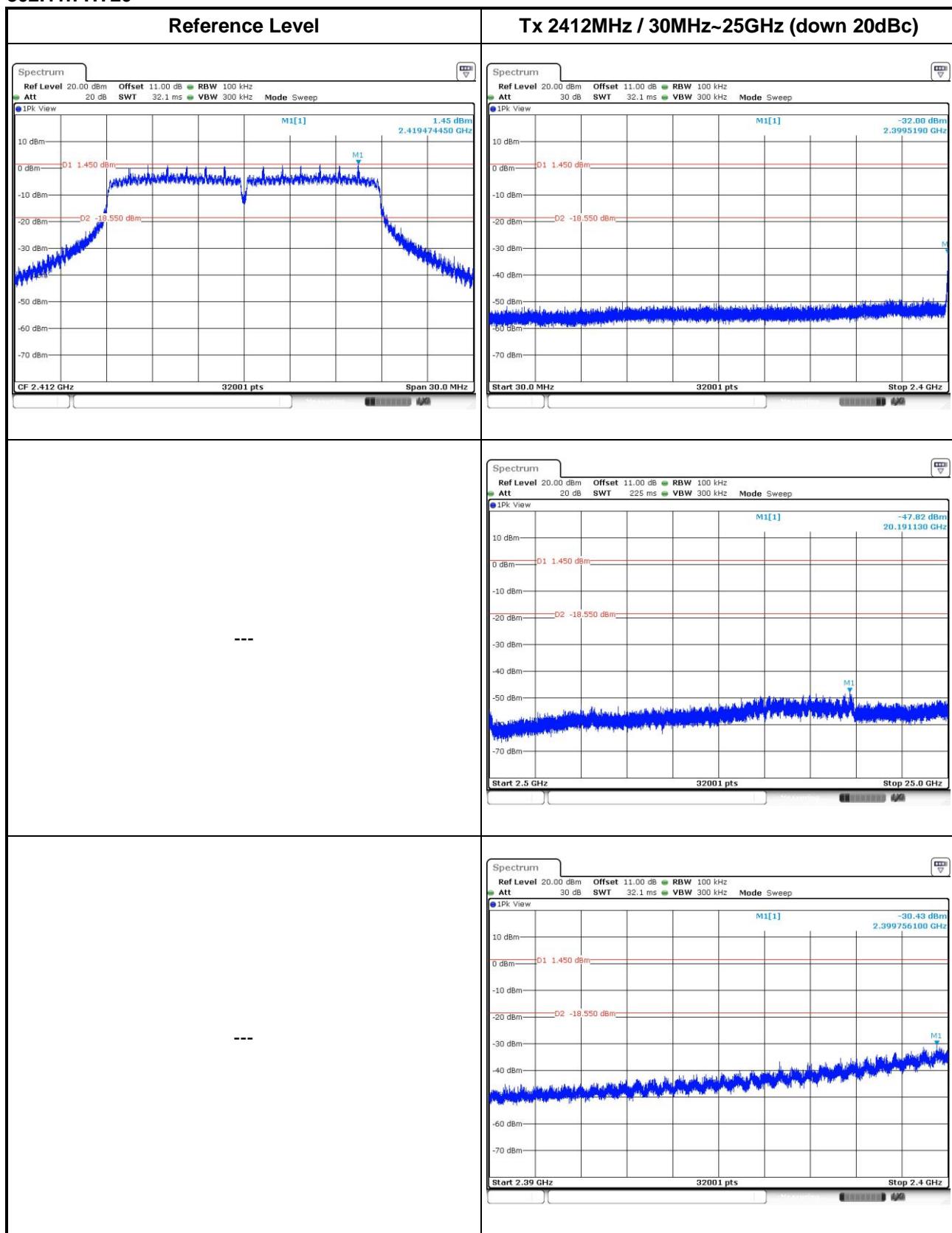
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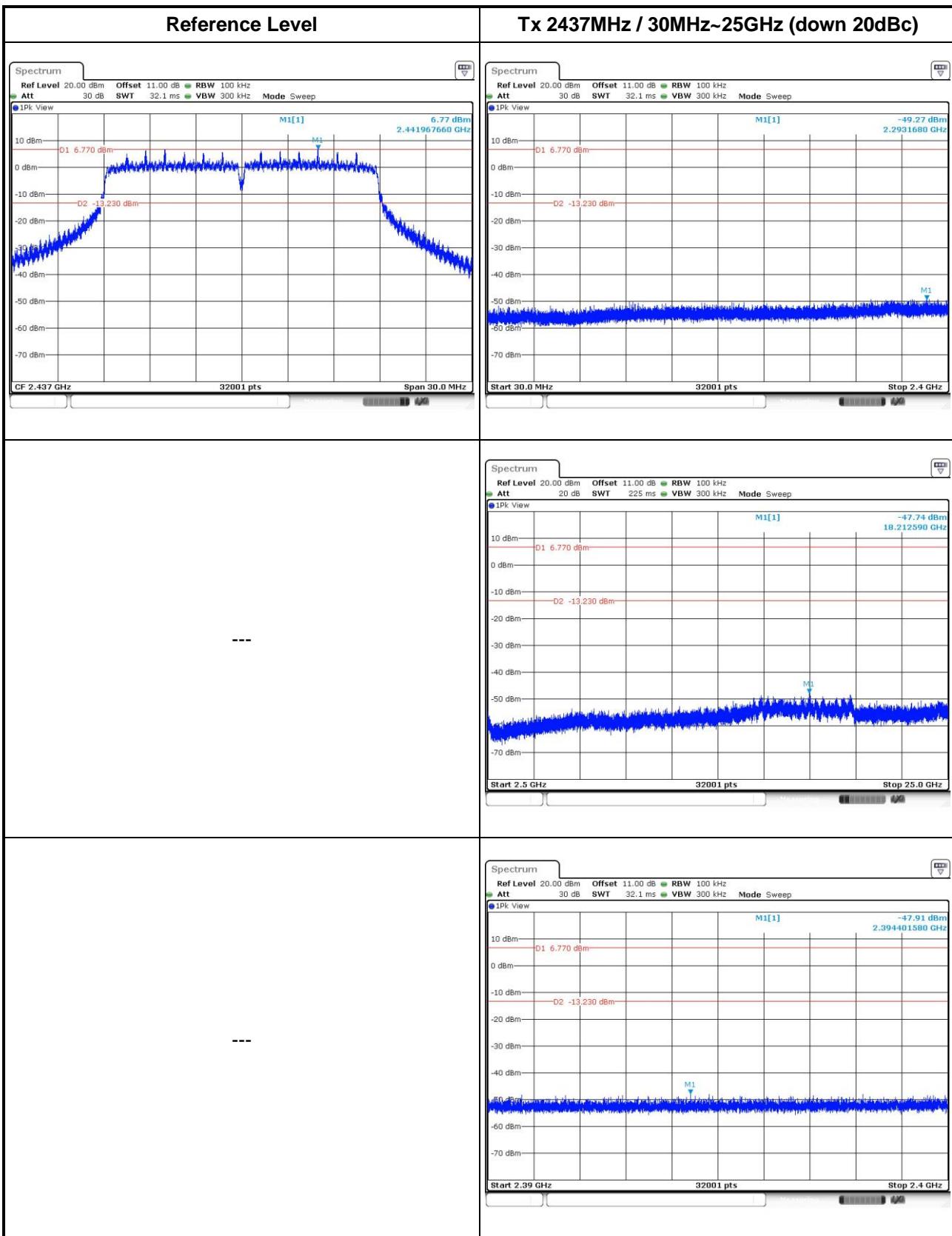


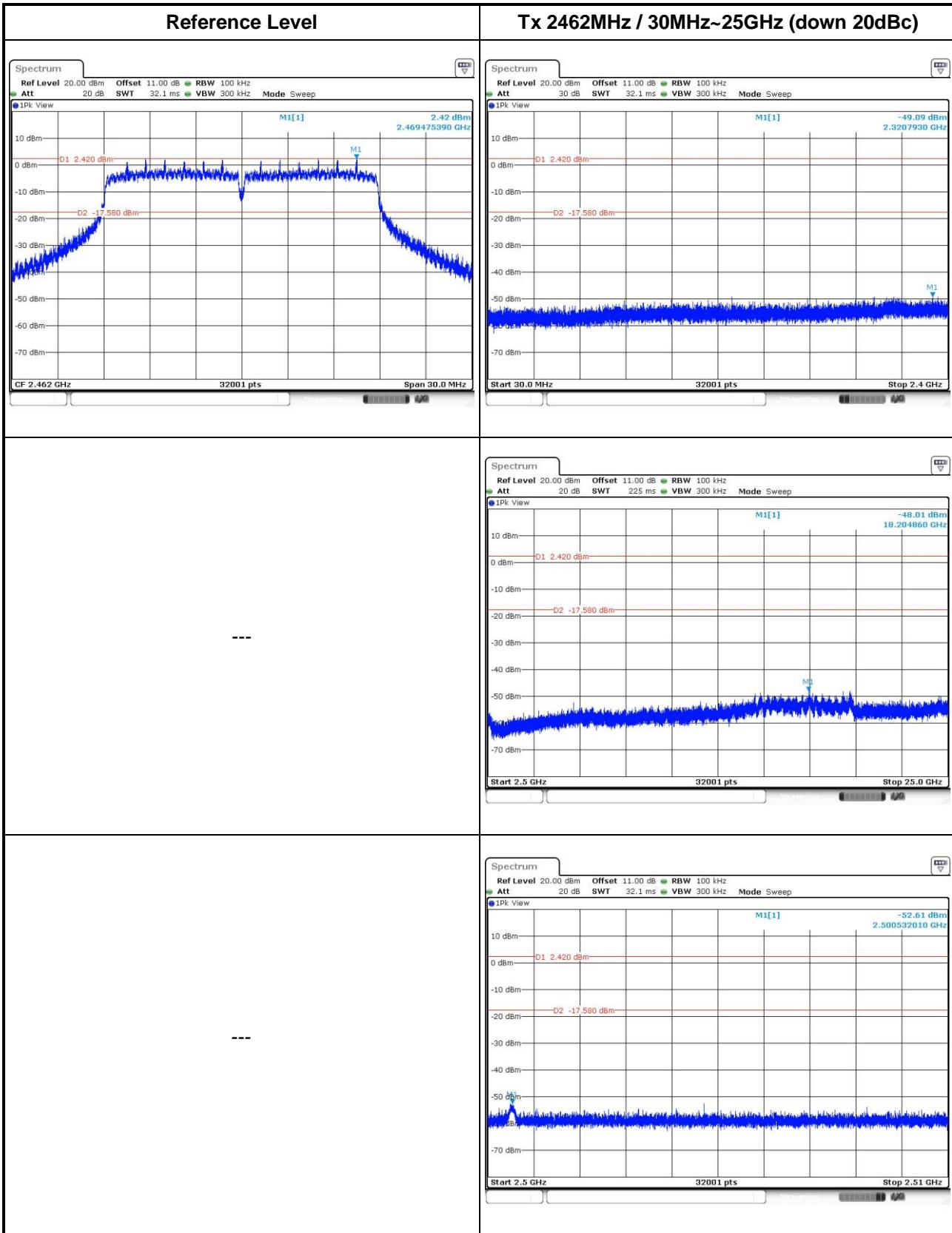




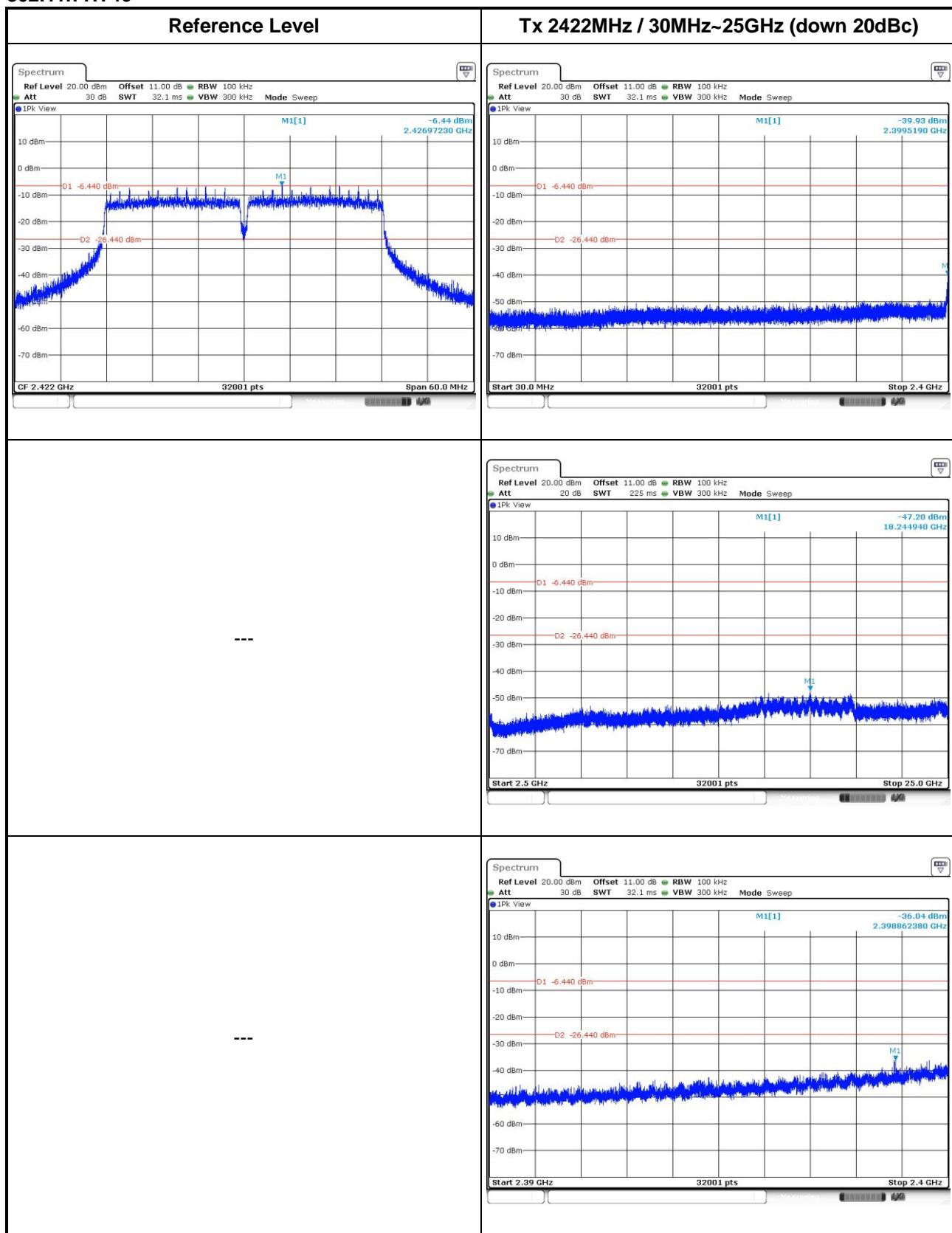
## 802.11n HT20

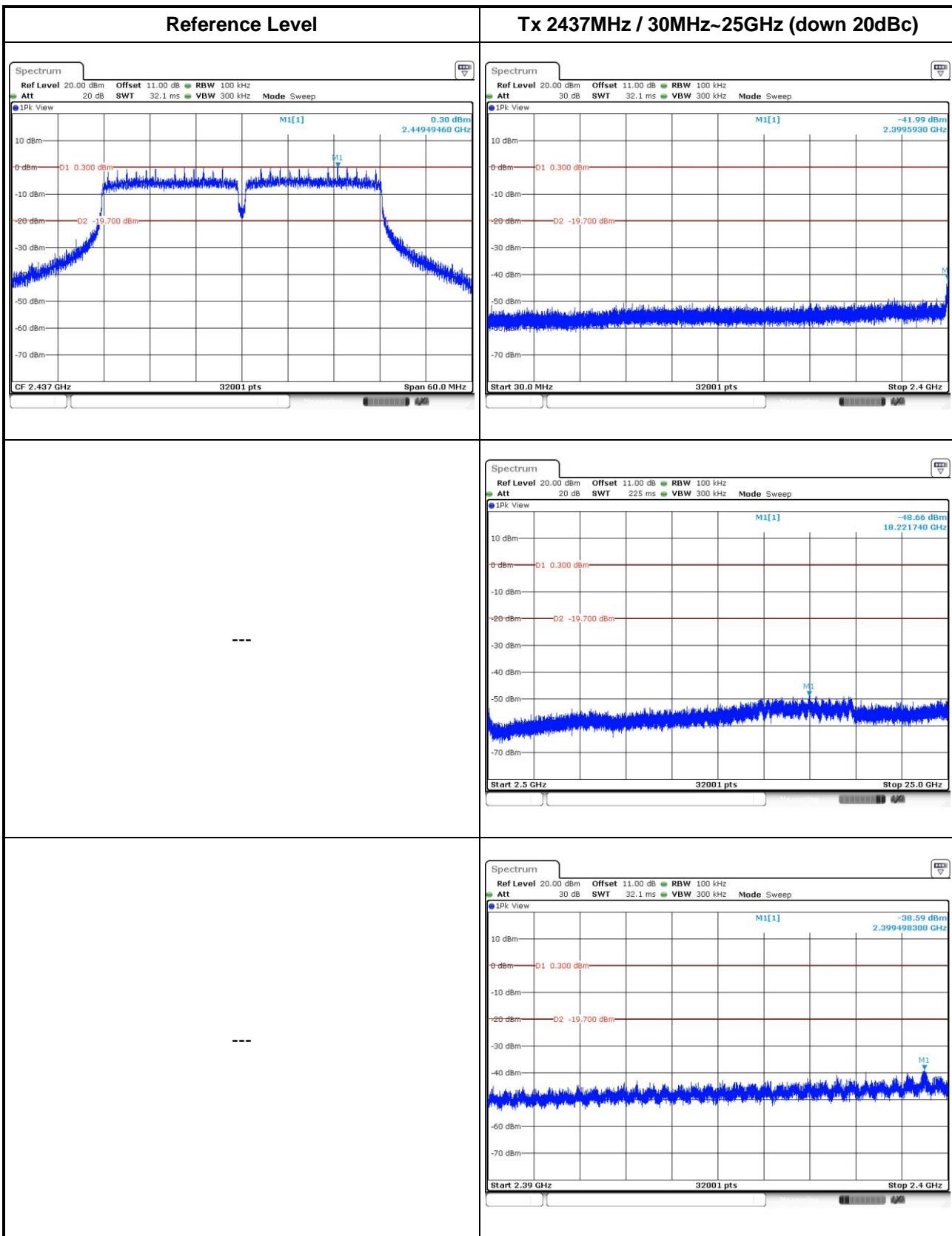


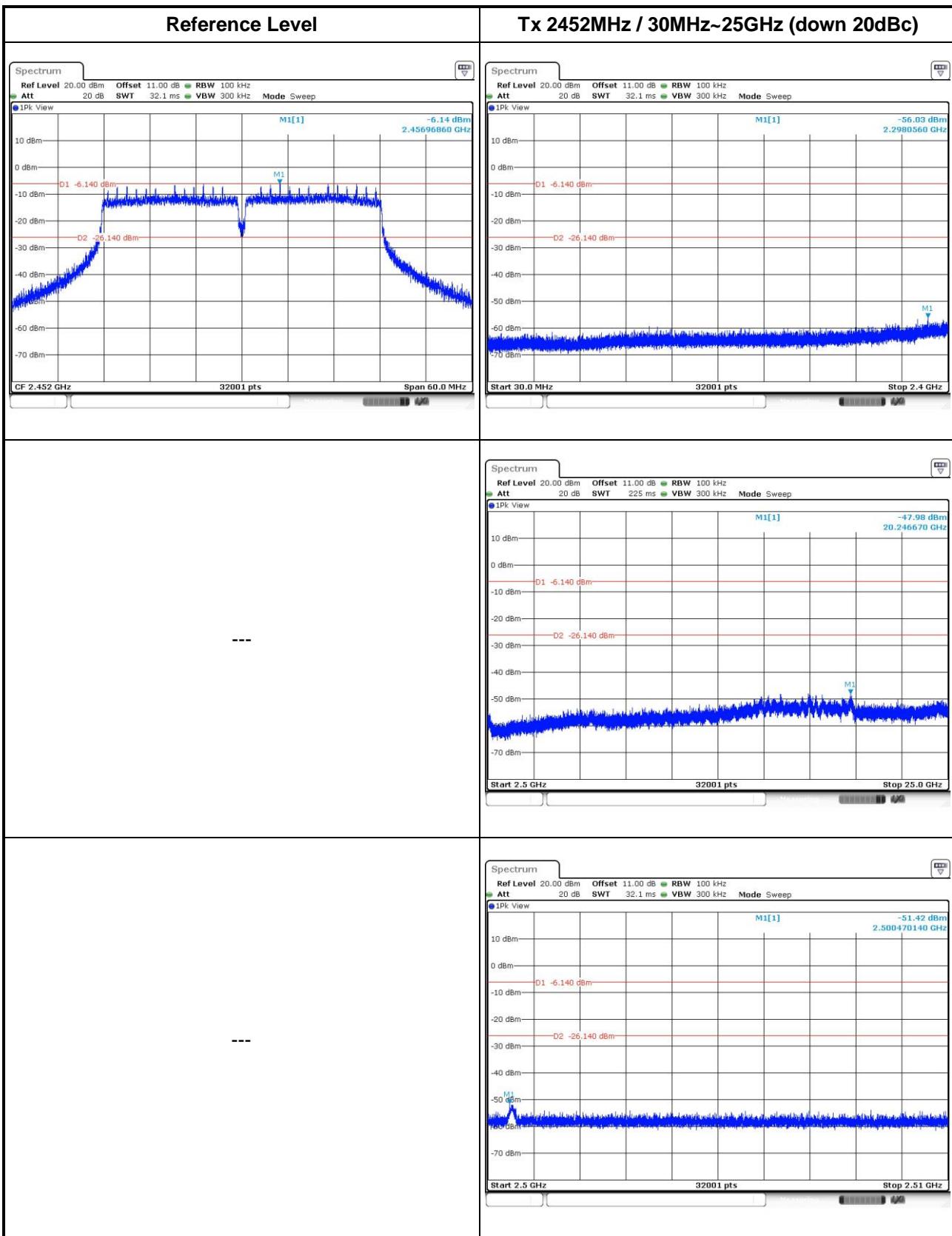




## 802.11n HT40







## 4 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp, it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan Hsiang. Location map can be found on our website <http://www.icertifi.com.tw>.

### Linkou

Tel: 886-2-2601-1640

No. 30-2, Ding Fwu Tsuen, Lin Kou  
District, New Taipei City, Taiwan,  
R.O.C.

### Kwei Shan

Tel: 886-3-271-8666

No. 3-1, Lane 6, Wen San 3rd  
St., Kwei Shan Hsiang, Tao Yuan  
Hsien 333, Taiwan, R.O.C.

### Kwei Shan Site II

Tel: 886-3-271-8640

No. 14-1, Lane 19, Wen San 3rd  
St., Kwei Shan Hsiang, Tao Yuan  
Hsien 333, Taiwan, R.O.C.

If you have any suggestion, please feel free to contact us as below information

Tel: 886-3-271-8666

Fax: 886-3-318-0155

Email: [ICC\\_Service@icertifi.com.tw](mailto:ICC_Service@icertifi.com.tw)

==END==