

FCC Test Report

FCC ID : 2AMUGTBG100
Equipment : LoRaWAN Gateway
Model No. : TBGW100
Brand Name : Tabs
Applicant : TrackNet, Inc
Address : 900 LAFAYETTE ST #329, SANTA CLARA,
California, United States, 95050
Standard : 47 CFR FCC Part 15.247
Received Date : Oct. 05, 2017
Tested Date : Oct. 12 ~ Nov. 06, 2017

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.

Reviewed by:



Along Chen / Assistant Manager

Approved by:



Gary Chang / Manager



Table of Contents

1	GENERAL DESCRIPTION	5
1.1	Information.....	5
1.2	Local Support Equipment List	8
1.3	Test Setup Chart	8
1.4	The Equipment List	9
1.5	Test Standards	10
1.6	Measurement Uncertainty	10
2	TEST CONFIGURATION	11
2.1	Testing Condition	11
2.2	The Worst Test Modes and Channel Details	11
3	TRANSMITTER TEST RESULTS.....	12
3.1	Conducted Emissions.....	12
3.2	6dB and Occupied Bandwidth	15
3.3	RF Output Power	18
3.4	Power Spectral Density	20
3.5	Unwanted Emissions into Restricted Frequency Bands	22
3.6	Emissions in Non-Restricted Frequency Bands.....	50
4	TEST LABORATORY INFORMATION	63

Release Record

Report No.	Version	Description	Issued Date
FR7O0501AC	Rev. 01	Initial issue	Nov. 22, 2017

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	[dBuV]: 0.312MHz 37.92 (Margin -12.01dB) - AV	Pass
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 2483.50MHz 53.37 (Margin -0.63dB) - AV	Pass
15.247(b)(3)	Maximum Output Power	Max Power [dBm]: 28.36	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 _{TX})	Data Rate / MCS
2400-2483.5	b	2412-2462	1-11 [11]	2	1-11 Mbps
2400-2483.5	g	2412-2462	1-11 [11]	2	6-54 Mbps
2400-2483.5	n (HT20)	2412-2462	1-11 [11]	2	MCS 0-15
2400-2483.5	n (HT40)	2422-2452	3-9 [7]	2	MCS 0-15
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	Frequency band (MHz) / Antenna Gain (dBi)		
				2400~2483.5	5150~5250	5725~5850
1	N2410DTR-PK1-G55UR2	Embedded Antenna	I-PEX	2.7	5.7	5.7
2	N2410DBK-T-PK1-G45UR3	Embedded Antenna	I-PEX	2.16	3.78	3.78

1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	12Vdc from AC adapter
-------------------	-----------------------

1.1.4 Accessories

Accessories		
No.	Equipment	Description
1	AC adapter 1	Brand: APD Model: WA-24Q12FU Power Rating: I/P: 100-240Vac, 50-60Hz, 0.7A Max. O/P: 12Vdc, 2A Power Line: AC 1.2m non-shielded without core
2	AC adapter 2	Brand: PHIHONG Model: PSAC24A-120L6 Power Rating: I/P: 100-240Vac, 50-60Hz, 0.6A O/P: 12Vdc, 2A Power Line: AC 1.2m non-shielded without core
3	USB cable	1m shielded without core
4	RJ45 (Flat)	1m non-shielded without core

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	PUTTY, Version: V0.6		
Duty Cycle and Duty Factor	Mode	Duty cycle (%)	Duty factor (dB)
	11b	100.00	0.00
	11g	88.2	0.55
	HT20	87.76	0.57
	HT40	77.44	1.11

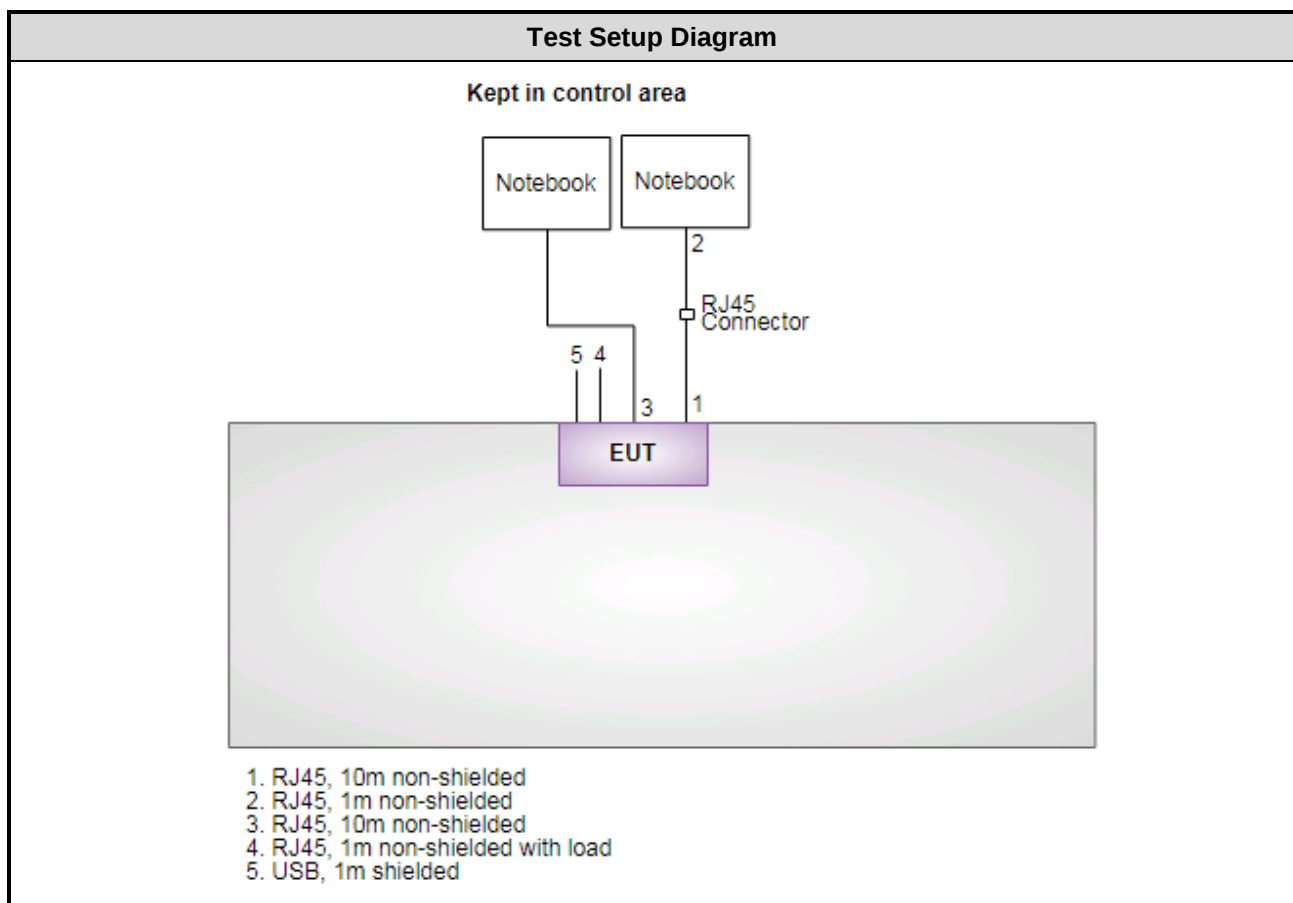
1.1.7 Power Setting

Modulation Mode	Test Frequency (MHz)	Power Set
11b	2412	26/27
11b	2437	35/35
11b	2462	25/25
11g	2412	13/13
11g	2437	35/35
11g	2462	6/6
HT20	2412	10/10
HT20	2437	33/33
HT20	2462	4/4
HT40	2422	09/10
HT40	2437	17/17
HT40	2452	3/3

1.2 Local Support Equipment List

Support Equipment List					
No.	Equipment	Brand	Model	FCC ID	Signal cable / Length (m)
1	Notebook	DELL	Latitude E6430	DoC	RJ45, 10m non-shielded.
2	Notebook	DELL	Latitude E5420	DoC	RJ45, 10m non-shielded.

1.3 Test Setup Chart



1.4 The Equipment List

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Tested Date	Nov. 06, 2017				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101657	Dec. 21, 2016	Dec. 20, 2017
LISN	SCHWARZBECK	Schwarzbeck 8127	8127-667	Nov. 08, 2016	Nov. 07, 2017
RF Cable-CON	EMC	EMCCFD300-BM-BM-6000	50821	Dec. 20, 2016	Dec. 19, 2017
Measurement Software	AUDIX	e3	6.120210k	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emission				
Test Site	966 chamber1 / (03CH01-WS)				
Tested Date	Oct. 12 ~ Oct. 16, 2017				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101498	Nov. 25, 2016	Nov. 24, 2017
Receiver	R&S	ESR3	101658	Nov. 24, 2016	Nov. 23, 2017
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Jul. 25, 2017	Jul. 24, 2018
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1096	Dec. 21, 2016	Dec. 20, 2017
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Oct. 25, 2016	Oct. 24, 2017
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 10, 2016	Nov. 09, 2017
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Dec. 09, 2016	Dec. 08, 2017
Preamplifier	EMC	EMC02325	980225	Jul. 28, 2017	Jul. 27, 2018
Preamplifier	Agilent	83017A	MY39501308	Oct. 06, 2017	Oct. 05, 2018
Preamplifier	EMC	EMC184045B	980192	Aug. 22, 2017	Aug. 21, 2018
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16014/4	Dec. 09, 2016	Dec. 08, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Dec. 09, 2016	Dec. 08, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16139/4	Dec. 09, 2016	Dec. 08, 2017
LF cable 1M	EMC	EMCCFD400-NM-N M-1000	16052	Dec. 09, 2016	Dec. 08, 2017
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Dec. 09, 2016	Dec. 08, 2017
LF cable 10M	Woken	CFD400NL-LW	CFD400NL-002	Dec. 09, 2016	Dec. 08, 2017
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Tested Date	Nov. 01, 2017				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101063	Mar. 15, 2017	Mar. 14, 2018
Power Meter	Anritsu	ML2495A	1241002	Oct. 16, 2017	Oct. 15, 2018
Power Sensor	Anritsu	MA2411B	1207366	Oct. 16, 2017	Oct. 15, 2018
Signal Generator	R&S	SMB100A	175727	Oct. 26, 2017	Oct. 25, 2018
AC POWER SOURCE	G.W .	APS-9102	EL920581	Jun. 03, 2017	Jun. 02, 2018
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 C63.10-2013

FCC KDB 558074 D01 DTS Meas Guidance v04

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

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	±2.90 dB
Radiated emission ≤ 1GHz	±3.66 dB
Radiated emission > 1GHz	±5.63 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	23°C / 59%	Alex Tsai
Radiated Emissions	03CH01-WS	25°C / 64-66%	Aska Huang Vincent Yeh
RF Conducted	TH01-WS	22°C / 64%	Brad Wu

- FCC Designation No.: TW2732
- FCC site registration No.: 181692
- IC site registration No.: 10807A-1

2.2 The Worst Test Modes and Channel Details

Test item	Modulation Mode	Test Frequency (MHz)	Data Rate	Test Configuration
Conducted Emissions	11g	2437	6 Mbps	---
Radiated Emissions ≤1GHz	11g	2437	6 Mbps	---
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	
Power spectral density	HT40	2422 / 2437 / 2452	MCS 0	

NOTE:

1. Two adapters (APD & PHIHONG) had been covered during the pretest and found that **PHIHONG adapter** was the worst case and was selected for final testing.

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.

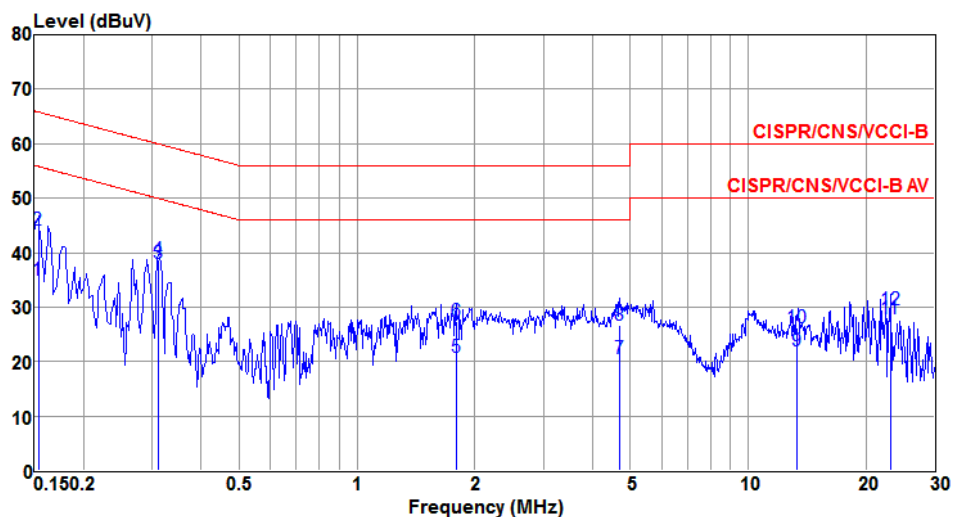
3.1.3 Test Setup



- 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

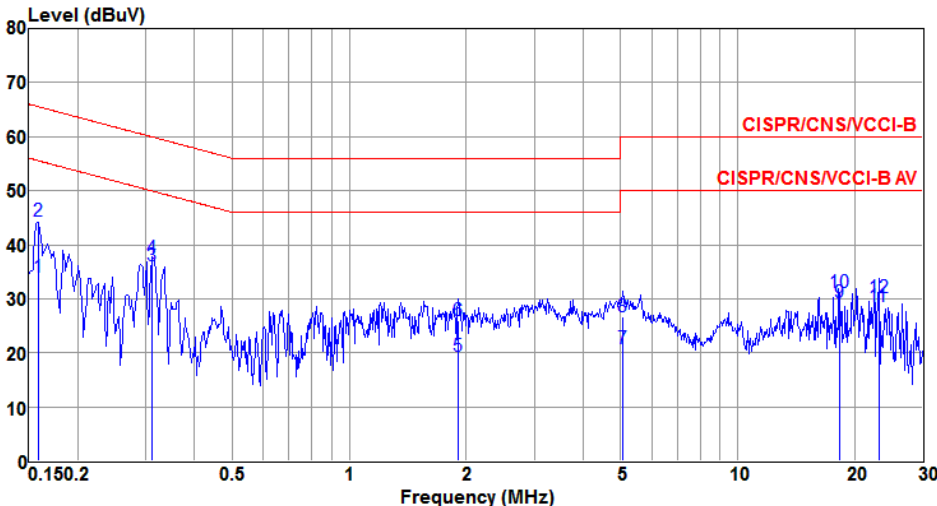
Modulation	11g	Test Freq. (MHz)	2437
Power Phase	Line		



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.153	35.01	55.82	-20.81	34.90	0.07	0.04	Average
2	0.153	44.24	65.82	-21.58	44.13	0.07	0.04	QP
3a	0.312	37.92	49.93	-12.01	37.75	0.13	0.04	Average
4	0.312	38.71	59.93	-21.22	38.54	0.13	0.04	QP
5	1.790	20.75	46.00	-25.25	20.60	0.11	0.04	Average
6	1.790	27.44	56.00	-28.56	27.29	0.11	0.04	QP
7	4.696	20.58	46.00	-25.42	20.20	0.21	0.17	Average
8	4.696	26.58	56.00	-29.42	26.20	0.21	0.17	QP
9	13.360	22.01	50.00	-27.99	21.51	0.27	0.23	Average
10	13.360	26.27	60.00	-33.73	25.77	0.27	0.23	QP
11	23.129	27.93	50.00	-22.07	27.30	0.35	0.28	Average
12	23.129	29.52	60.00	-30.48	28.89	0.35	0.28	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
 Note 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

Modulation	11g	Test Freq. (MHz)	2437
Power Phase	Neutral		



	Freq	Level	Limit	Over	Read	LISN	cable	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	dB	
1	0.159	33.96	55.52	-21.56	33.86	0.06	0.04	Average
2	0.159	44.40	65.52	-21.12	44.30	0.06	0.04	QP
3e	0.312	36.13	49.93	-13.80	35.98	0.11	0.04	Average
4	0.312	37.45	59.93	-22.48	37.30	0.11	0.04	QP
5	1.908	19.45	46.00	-26.55	19.30	0.11	0.04	Average
6	1.908	26.00	56.00	-30.00	25.85	0.11	0.04	QP
7	5.058	20.77	50.00	-29.23	20.39	0.20	0.18	Average
8	5.058	26.71	60.00	-33.29	26.33	0.20	0.18	QP
9	18.243	29.29	50.00	-20.71	28.70	0.34	0.25	Average
10	18.243	31.21	60.00	-28.79	30.62	0.34	0.25	QP
11	23.129	28.49	50.00	-21.51	27.81	0.40	0.28	Average
12	23.129	30.11	60.00	-29.89	29.43	0.40	0.28	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.

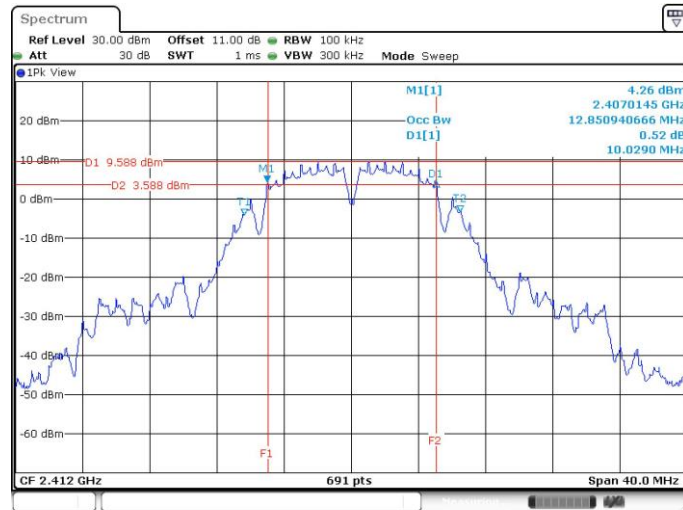
3.2.3 Test Setup



3.2.4 Test Result of 6dB and Occupied Bandwidth

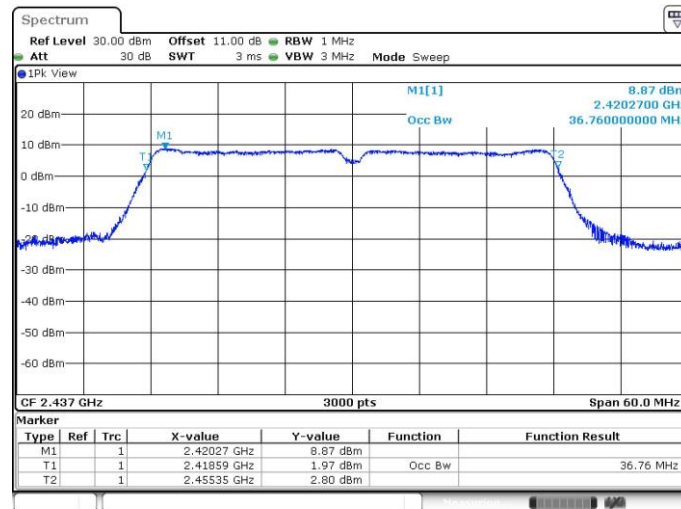
Modulation Mode	N _{TX}	Freq. (MHz)	6dB Bandwidth (MHz)				Limit (kHz)
			Chain 0	Chain 1	Chain 2	Chain 3	
11b	2	2412	10.03	10.09	---	---	500
11b	2	2437	10.09	10.09	---	---	500
11b	2	2462	10.03	10.03	---	---	500
11g	2	2412	16.35	16.35	---	---	500
11g	2	2437	16.35	16.35	---	---	500
11g	2	2462	16.35	16.35	---	---	500
HT20	2	2412	17.57	17.10	---	---	500
HT20	2	2437	16.93	17.28	---	---	500
HT20	2	2462	17.33	17.10	---	---	500
HT40	2	2422	36.06	36.06	---	---	500
HT40	2	2437	36.29	36.29	---	---	500
HT40	2	2452	35.83	35.83	---	---	500

Worst Plot



Modulation Mode	N _{TX}	Freq. (MHz)	99% Occupied Bandwidth (MHz)			
			Chain 0	Chain 1	Chain 2	Chain 3
11b	2	2412	12.97	12.84	---	---
11b	2	2437	14.55	14.36	---	---
11b	2	2462	12.66	12.64	---	---
11g	2	2412	16.99	16.96	---	---
11g	2	2437	23.27	23.27	---	---
11g	2	2462	16.89	16.90	---	---
HT20	2	2412	17.75	17.72	---	---
HT20	2	2437	22.36	22.55	---	---
HT20	2	2462	17.72	17.71	---	---
HT40	2	2422	36.74	36.68	---	---
HT40	2	2437	36.76	36.68	---	---
HT40	2	2452	36.68	36.66	---	---

Worst Plot



3.3 RF Output Power

3.3.1 Limit of RF Output Power

Conducted power shall not exceed 1Watt.

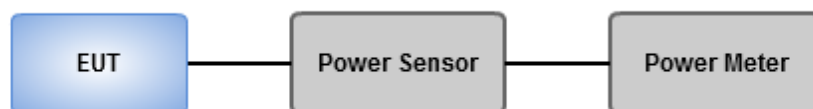
- ☒ Antenna gain $\leq 6\text{dBi}$, no any corresponding reduction is in output power limit.
- ☐ Antenna gain $> 6\text{dBi}$
 - ☐ Non Fixed, point to point operations.
The conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna 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 _{TX}	Freq. (MHz)	Peak conducted Output Power (dBm)							Ant. Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)
			Chain 0	Chain 1	Chain 2	Chain 3	Total Power (mW)	Total Power (dBm)	Limit (dBm)			
11b	2	2412	23.6	23.64	---	---	460.293	26.63	30.00	2.70	29.33	36.00
11b	2	2437	24.76	24.99	---	---	614.727	27.89	30.00	2.70	30.59	36.00
11b	2	2462	23.06	23.14	---	---	408.365	26.11	30.00	2.70	28.81	36.00
11g	2	2412	24.09	23.12	---	---	461.565	26.64	30.00	2.70	29.34	36.00
11g	2	2437	25.21	25.49	---	---	685.892	28.36	30.00	2.70	31.06	36.00
11g	2	2462	22.21	22.08	---	---	327.777	25.16	30.00	2.70	27.86	36.00
HT20	2	2412	22.91	22.52	---	---	374.083	25.73	30.00	2.70	28.43	36.00
HT20	2	2437	25.21	25.39	---	---	677.834	28.31	30.00	2.70	31.01	36.00
HT20	2	2462	21.32	20.73	---	---	253.823	24.05	30.00	2.70	26.75	36.00
HT40	2	2422	21.07	21.06	---	---	255.582	24.08	30.00	2.70	26.78	36.00
HT40	2	2437	23.22	23.07	---	---	412.662	26.16	30.00	2.70	28.86	36.00
HT40	2	2452	18.88	18.76	---	---	152.430	21.83	30.00	2.70	24.53	36.00

Modulation Mode	N _{TX}	Freq. (MHz)	Conducted (Average) Output Power (dBm)				Total Power (mW)	Total Power (dBm)	Limit (dBm)
			Chain 0	Chain 1	Chain 2	Chain 3			
11b	2	2412	20.92	20.86	---	---	245.494	23.90	---
11b	2	2437	22.97	23.06	---	---	400.455	26.03	---
11b	2	2462	20.08	20.25	---	---	207.785	23.18	---
11g	2	2412	16.36	15.83	---	---	81.534	19.11	---
11g	2	2437	22.39	22.59	---	---	354.932	25.50	---
11g	2	2462	13.02	12.55	---	---	38.033	15.80	---
HT20	2	2412	15.21	14.35	---	---	60.416	17.81	---
HT20	2	2437	21.88	21.85	---	---	307.279	24.88	---
HT20	2	2462	11.98	11.49	---	---	29.869	14.75	---
HT40	2	2422	12.55	12.19	---	---	34.546	15.38	---
HT40	2	2437	15.62	15.22	---	---	69.741	18.43	---
HT40	2	2452	10.02	9.55	---	---	19.062	12.80	---

Note: Conducted average output power is for reference only.

3.4 Power Spectral Density

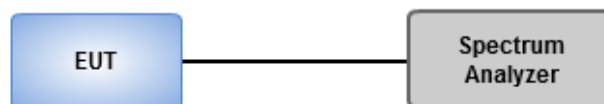
3.4.1 Limit of Power Spectral Density

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.

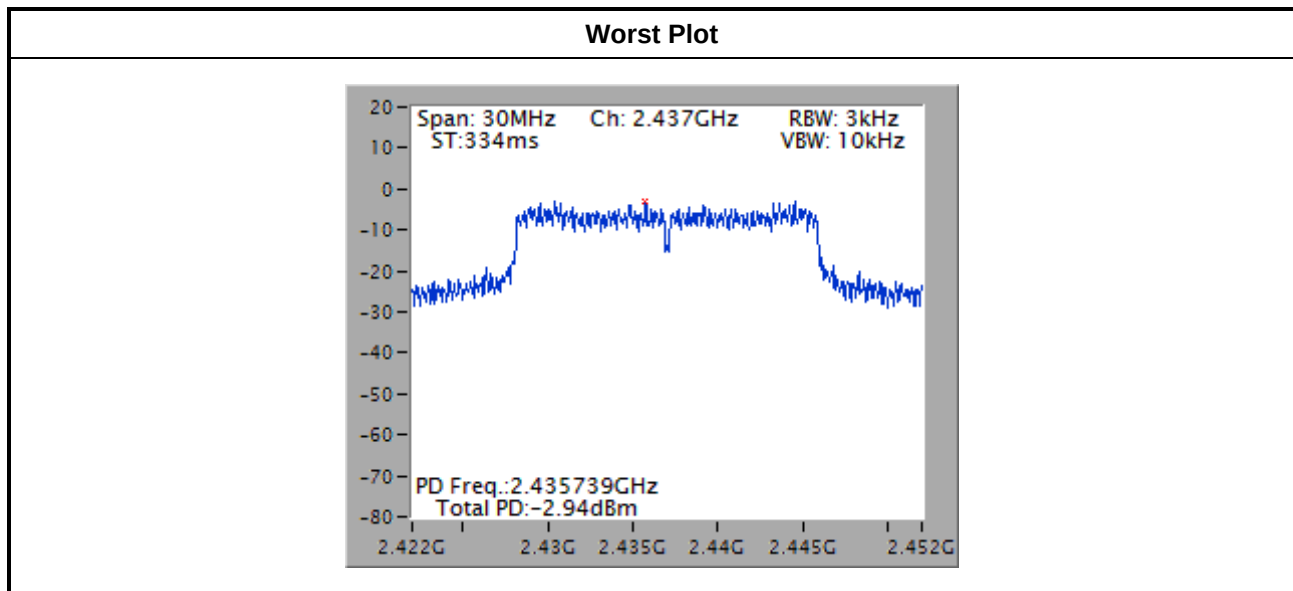
3.4.3 Test Setup



3.4.4 Test Result of Power Spectral Density

Modulation Mode	N _{TX}	Freq. (MHz)	Total Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
11b	2	2412	-6.15	8.00
11b	2	2437	-3.92	8.00
11b	2	2462	-6.73	8.00
11g	2	2412	-9.61	8.00
11g	2	2437	-3.10	8.00
11g	2	2462	-12.87	8.00
HT20	2	2412	-10.64	8.00
HT20	2	2437	-2.94	8.00
HT20	2	2462	-13.56	8.00
HT40	2	2422	-15.29	8.00
HT40	2	2437	-12.55	8.00
HT40	2	2452	-18.16	8.00

Note: Test result for is bin-by-bin summing measured value of each TX port.



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

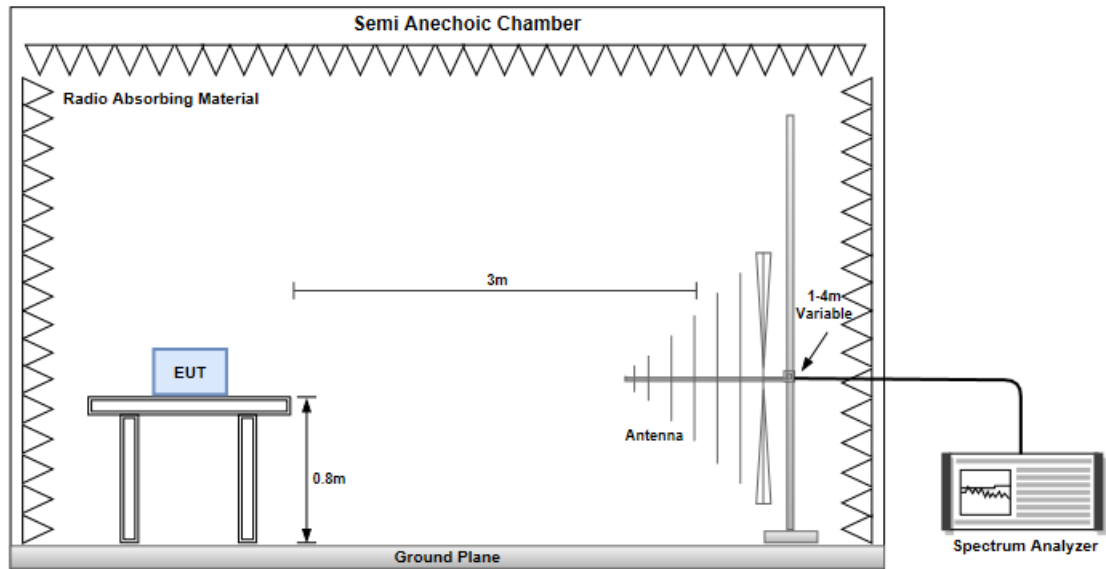
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission 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:

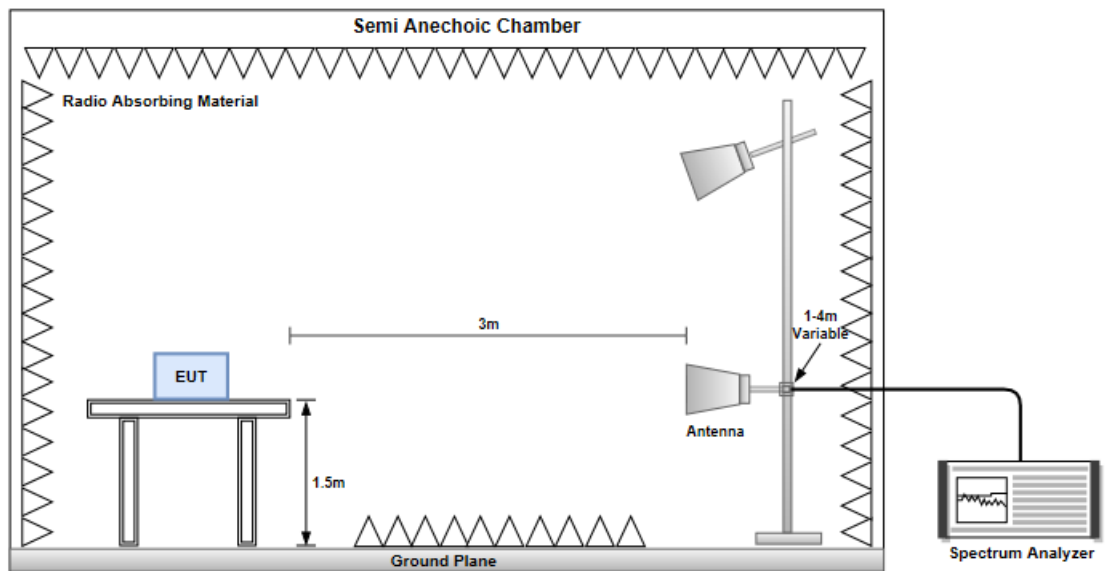
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. RBW=1MHz, VBW=3MHz and Peak detector is for peak measured value of radiated emission above 1GHz.
3. RBW=1MHz, VBW=1/T and Peak detector is for average measured value of radiated emission above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

3.5.3 Test Setup

Radiated Emissions below 1 GHz

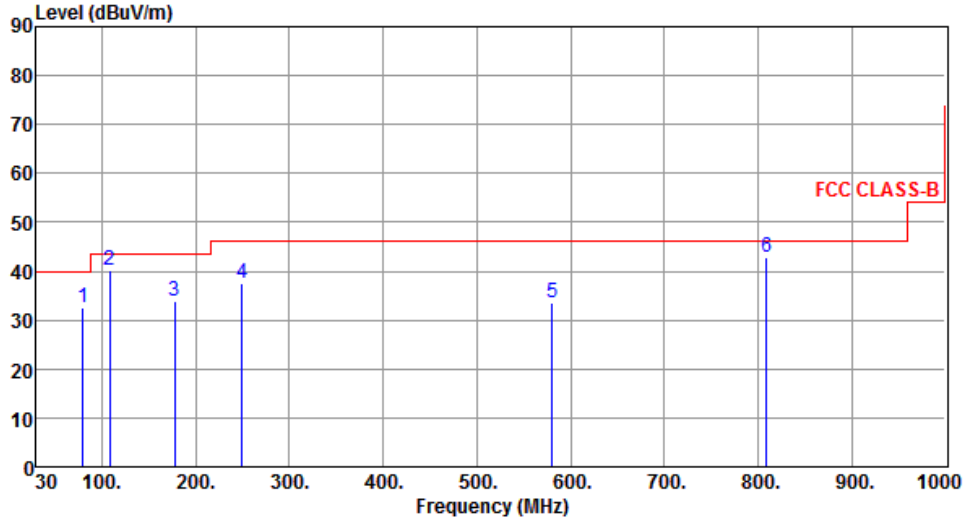


Radiated Emissions above 1 GHz



3.5.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	11g	Test Freq. (MHz)	2437
Polarization	Horizontal		

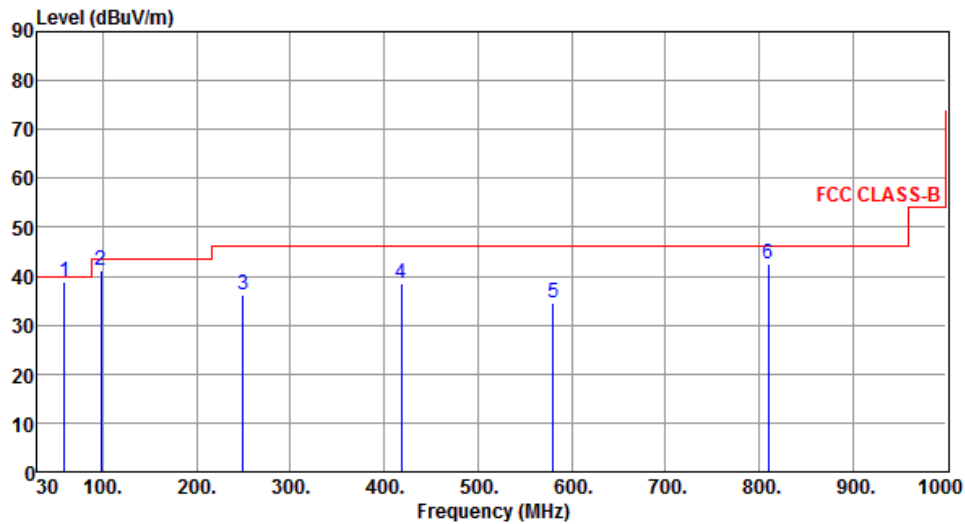


The graph displays the emission level in dBUV/m on the y-axis (0 to 90) against frequency in MHz on the x-axis (30 to 1000). A red line represents the FCC CLASS-B limit, which is 40 dBUV/m from 30 to 100 MHz, 45 dBUV/m from 100 to 200 MHz, and 55 dBUV/m from 200 to 1000 MHz. Six blue vertical lines indicate measured peaks at various frequencies, labeled 1 through 6.

	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	79.47	32.57	40.00	-7.43	45.38	-12.81	Peak	---	---
2	108.57	40.28	43.50	-3.22	52.01	-11.73	Peak	---	---
3	177.44	33.83	43.50	-9.67	43.31	-9.48	Peak	---	---
4	249.22	37.50	46.00	-8.50	46.88	-9.38	Peak	---	---
5	579.99	33.45	46.00	-12.55	34.58	-1.13	Peak	---	---
6	809.33	42.72	46.00	-3.28	40.30	2.42	QP	100	214

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.

Modulation	11g	Test Freq. (MHz)	2437
Polarization	Vertical		



	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	59.10	38.98	40.00	-1.02	47.41	-8.43	QP	100	284
2	97.90	41.25	43.50	-2.25	54.52	-13.27	Peak	---	---
3	249.22	36.34	46.00	-9.66	45.72	-9.38	Peak	---	---
4	418.00	38.41	46.00	-7.59	42.94	-4.53	Peak	---	---
5	579.99	34.60	46.00	-11.40	35.73	-1.13	Peak	---	---
6	809.88	42.49	46.00	-3.51	40.06	2.43	Peak	---	---

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

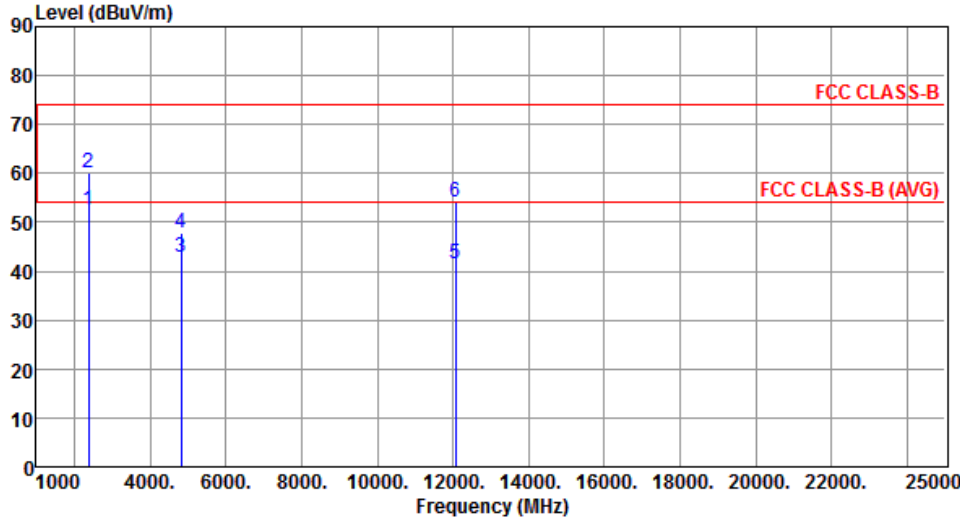
*Factor includes antenna factor , cable loss and amplifier gain

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.

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

Modulation	11b	Test Freq. (MHz)	2412
Polarization	Horizontal		



	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	52.40	54.00	-1.60	57.48	-5.08	Average	226	220
2	2390.00	60.10	74.00	-13.90	65.18	-5.08	Peak	226	220
3	4824.00	42.80	54.00	-11.20	41.31	1.49	Average	100	91
4	4824.00	47.73	74.00	-26.27	46.24	1.49	Peak	100	91
5	12060.00	41.37	54.00	-12.63	27.89	13.48	Average	100	302
6	12060.00	54.09	74.00	-19.91	40.61	13.48	Peak	100	302

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).

Modulation	11b	Test Freq. (MHz)	2412
Polarization	Vertical		
Level (dBUV/m) <			

Modulation	11b	Test Freq. (MHz)	2437
Polarization	Horizontal		
Level (dBuV/m)			

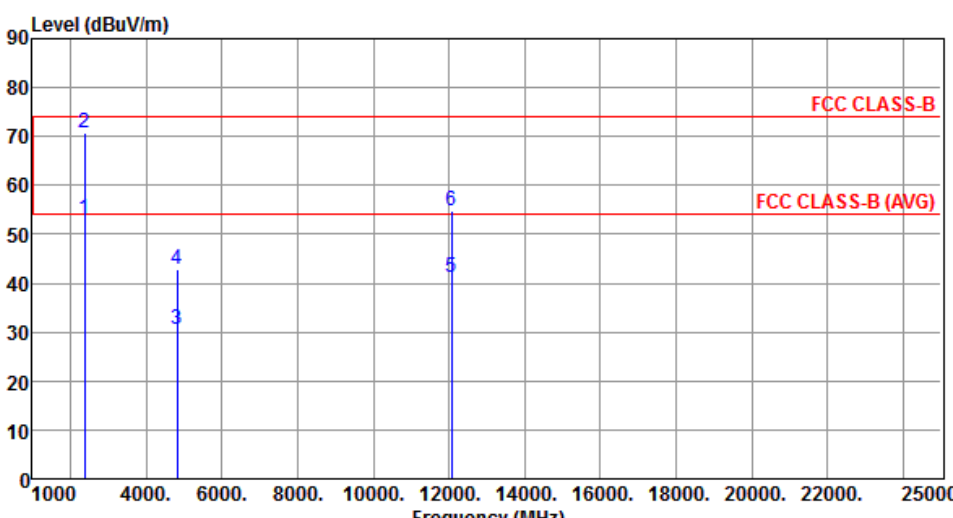
Modulation	11b	Test Freq. (MHz)	2437
Polarization	Vertical		
Level (dBuV/m)			

Modulation	11b	Test Freq. (MHz)	2462
Polarization	Horizontal		
Level (dBUV/m) <			

Modulation	11b	Test Freq. (MHz)	2462
Polarization	Vertical		
Level (dBuV/m) </			

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

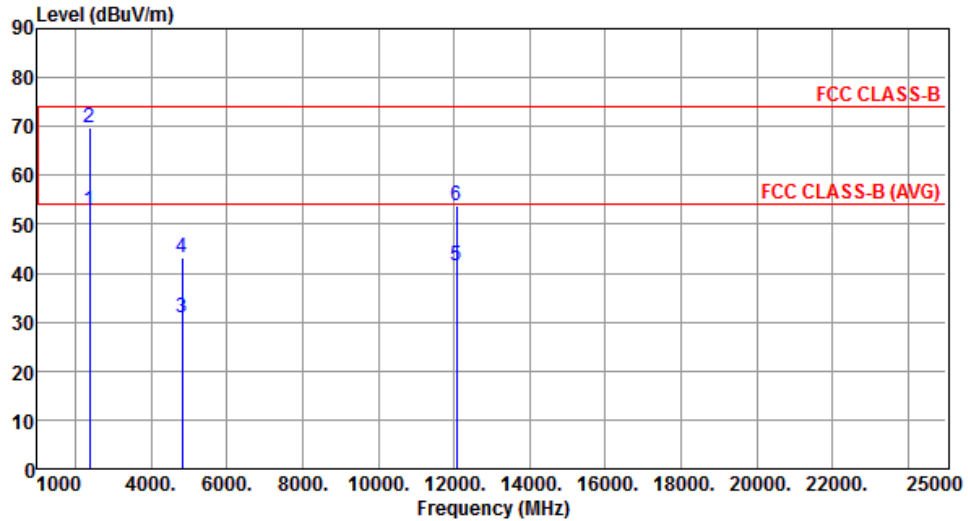
Modulation	11g	Test Freq. (MHz)	2412
Polarization	Horizontal		



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	52.99	54.00	-1.01	58.07	-5.08	Average	221	215
2	2390.00	70.72	74.00	-3.28	75.80	-5.08	Peak	221	215
3	4824.00	30.66	54.00	-23.34	29.17	1.49	Average	100	258
4	4824.00	42.88	74.00	-31.12	41.39	1.49	Peak	100	258
5	12060.00	41.35	54.00	-12.65	27.87	13.48	Average	100	126
6	12060.00	54.94	74.00	-19.06	41.46	13.48	Peak	100	126

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).

Modulation	11g	Test Freq. (MHz)	2412
Polarization	Vertical		



	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	52.92	54.00	-1.08	58.00	-5.08	Average	162	205
2	2390.00	69.68	74.00	-4.32	74.76	-5.08	Peak	162	205
3	4824.00	30.74	54.00	-23.26	29.25	1.49	Average	100	133
4	4824.00	43.15	74.00	-30.85	41.66	1.49	Peak	100	133
5	12060.00	41.47	54.00	-12.53	27.99	13.48	Average	100	205
6	12060.00	53.67	74.00	-20.33	40.19	13.48	Peak	100	205

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).

Modulation	11g	Test Freq. (MHz)	2437
Polarization	Horizontal		
Level (dBUV/m) </			

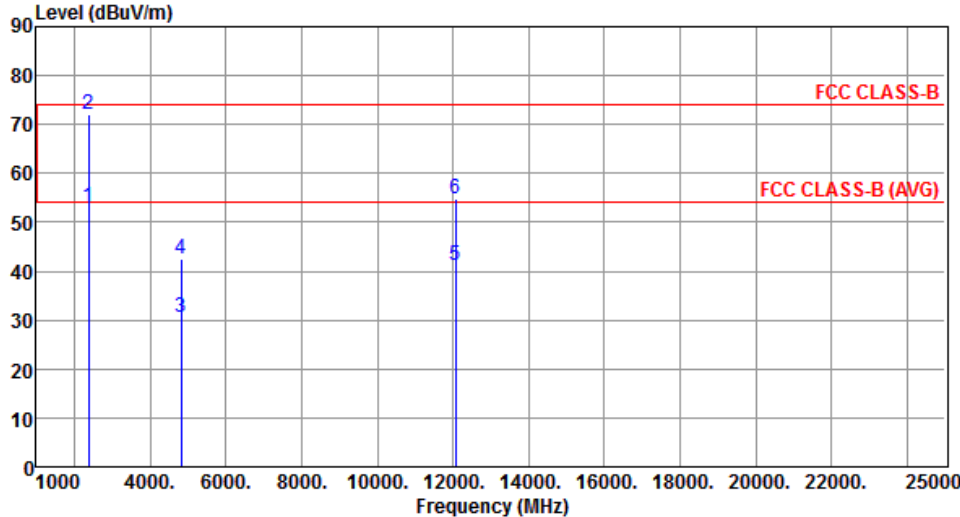
Modulation	11g	Test Freq. (MHz)	2437
Polarization	Vertical		
Level (dBuV/m) </			

Modulation	11g	Test Freq. (MHz)	2462
Polarization	Horizontal		
Level (dBUV/m) </			

Modulation	11g	Test Freq. (MHz)	2462
Polarization	Vertical		
Level (dBUV/m)			

3.5.7 Transmitter Radiated Unwanted Emissions (Above 1GHz) for HT20

Modulation	HT20	Test Freq. (MHz)	2412
Polarization	Horizontal		

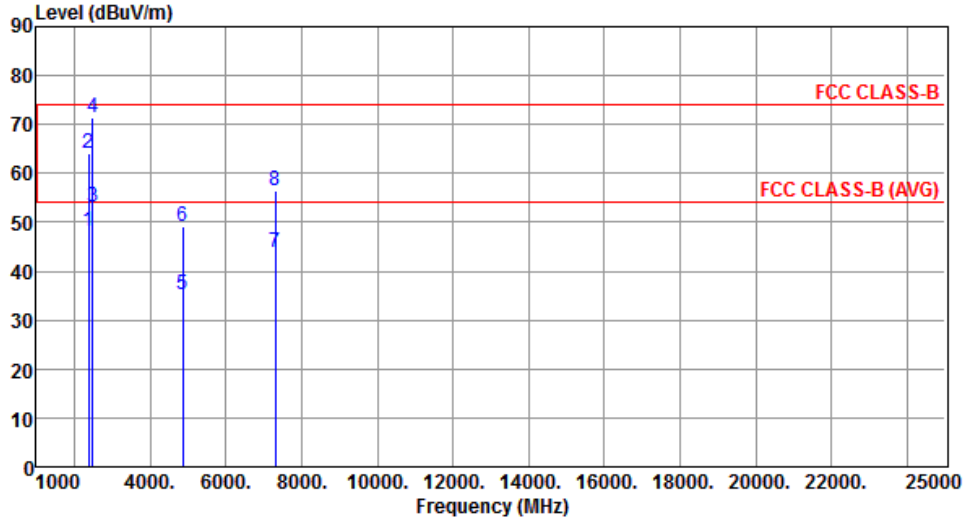


	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	53.19	54.00	-0.81	58.27	-5.08	Average	193	219
2	2390.00	71.99	74.00	-2.01	77.07	-5.08	Peak	193	219
3	4824.00	30.52	54.00	-23.48	29.03	1.49	Average	100	261
4	4824.00	42.63	74.00	-31.37	41.14	1.49	Peak	100	261
5	12060.00	41.29	54.00	-12.71	27.81	13.48	Average	100	122
6	12060.00	54.82	74.00	-19.18	41.34	13.48	Peak	100	122

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).

Modulation	HT20	Test Freq. (MHz)	2412
Polarization	Vertical		
Level (dBUV/m)			

Modulation	HT20	Test Freq. (MHz)	2437
Polarization	Horizontal		



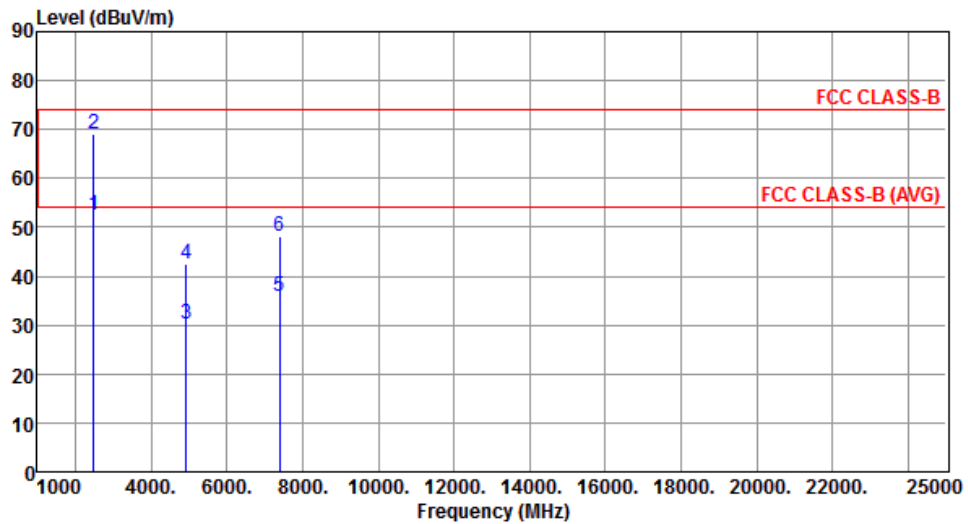
	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	48.17	54.00	-5.83	53.25	-5.08	Average	196	16
2	2390.00	64.18	74.00	-9.82	69.26	-5.08	Peak	196	16
3	2483.50	53.15	54.00	-0.85	57.90	-4.75	Average	196	29
4	2483.50	71.37	74.00	-2.63	76.12	-4.75	Peak	196	29
5	4874.00	35.07	54.00	-18.93	33.43	1.64	Average	256	222
6	4874.00	49.17	74.00	-24.83	47.53	1.64	Peak	256	222
7	7311.00	43.88	54.00	-10.12	36.28	7.60	Average	100	286
8	7311.00	56.42	74.00	-17.58	48.82	7.60	Peak	100	286

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).

Modulation	HT20	Test Freq. (MHz)	2437
Polarization	Vertical		
Level (dBuV/m) </			

Modulation	HT20	Test Freq. (MHz)	2462
Polarization	Horizontal		
Level (dBUV/m) </			

Modulation	HT20	Test Freq. (MHz)	2462
Polarization	Vertical		



	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2483.50	52.58	54.00	-1.42	57.33	-4.75	Average	170	286
2	2483.50	69.23	74.00	-4.77	73.98	-4.75	Peak	170	286
3	4924.00	30.32	54.00	-23.68	28.54	1.78	Average	100	147
4	4924.00	42.61	74.00	-31.39	40.83	1.78	Peak	100	147
5	7386.00	35.95	54.00	-18.05	28.22	7.73	Average	100	255
6	7386.00	48.20	74.00	-25.80	40.47	7.73	Peak	100	255

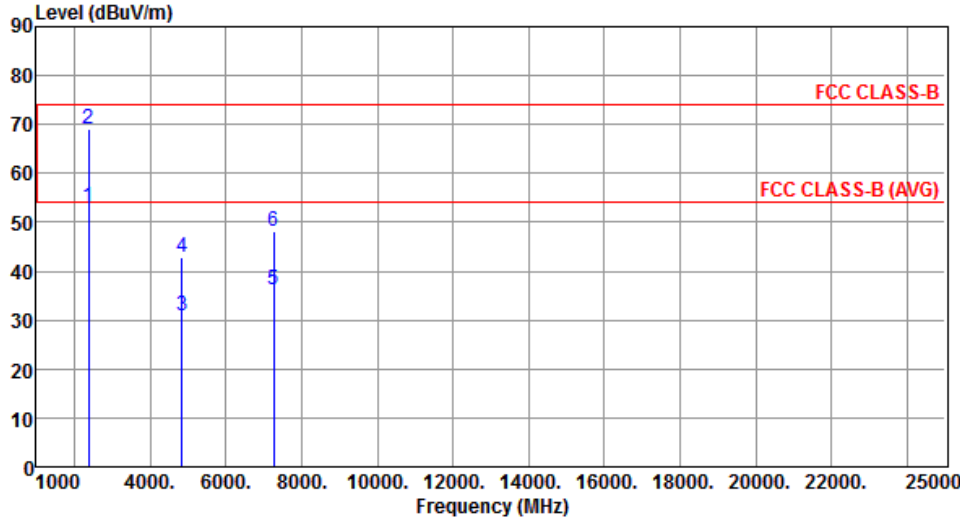
Note 1: Emission Level (dBUV/m) = SA Reading (dBUV/m) + Factor* (dB)

*Factor includes antenna factor , cable loss and amplifier gain

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

3.5.8 Transmitter Radiated Unwanted Emissions (Above 1GHz) for HT40

Modulation	HT40	Test Freq. (MHz)	2422
Polarization	Horizontal		

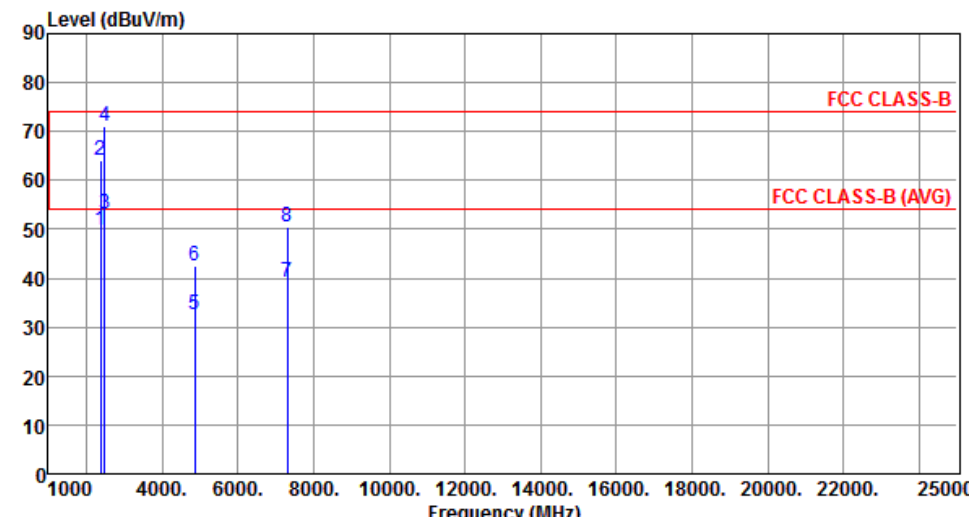


	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	53.04	54.00	-0.96	58.12	-5.08	Average	247	207
2	2390.00	68.93	74.00	-5.07	74.01	-5.08	Peak	247	207
3	4844.00	30.74	54.00	-23.26	29.19	1.55	Average	100	256
4	4844.00	42.80	74.00	-31.20	41.25	1.55	Peak	100	256
5	7266.00	36.32	54.00	-17.68	28.81	7.51	Average	100	233
6	7266.00	48.17	74.00	-25.83	40.66	7.51	Peak	100	233

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).

Modulation	HT40	Test Freq. (MHz)	2422
Polarization	Vertical		
Level (dBUV/m)			

Modulation	HT40	Test Freq. (MHz)	2437
Polarization	Horizontal		



	Freq. MHz	Emission level dBUV/m	Limit dBUV/m	Margin dB	SA reading dBUV	Factor dB	Remark	ANT High cm	Turn Table deg
1	2390.00	49.78	54.00	-4.22	54.86	-5.08	Average	204	17
2	2390.00	63.94	74.00	-10.06	69.02	-5.08	Peak	204	17
3	2483.50	53.01	54.00	-0.99	57.76	-4.75	Average	204	38
4	2483.50	71.03	74.00	-2.97	75.78	-4.75	Peak	204	38
5	4874.00	32.45	54.00	-21.55	30.81	1.64	Average	252	200
6	4874.00	42.46	74.00	-31.54	40.82	1.64	Peak	252	200
7	7311.00	39.06	54.00	-14.94	31.46	7.60	Average	100	291
8	7311.00	50.33	74.00	-23.67	42.73	7.60	Peak	100	291

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).

Modulation	HT40	Test Freq. (MHz)	2437
Polarization	Vertical		
Level (dBuV/m) </			

Modulation	HT40	Test Freq. (MHz)	2452
Polarization	Horizontal		
Level (dBUV/m) </			

Modulation	HT40	Test Freq. (MHz)	2452
Polarization	Vertical		
Level (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 Test Procedures

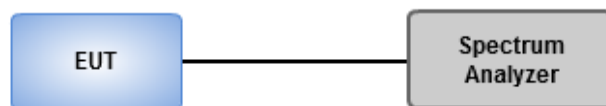
Reference level measurement

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

3.6.3 Test Setup

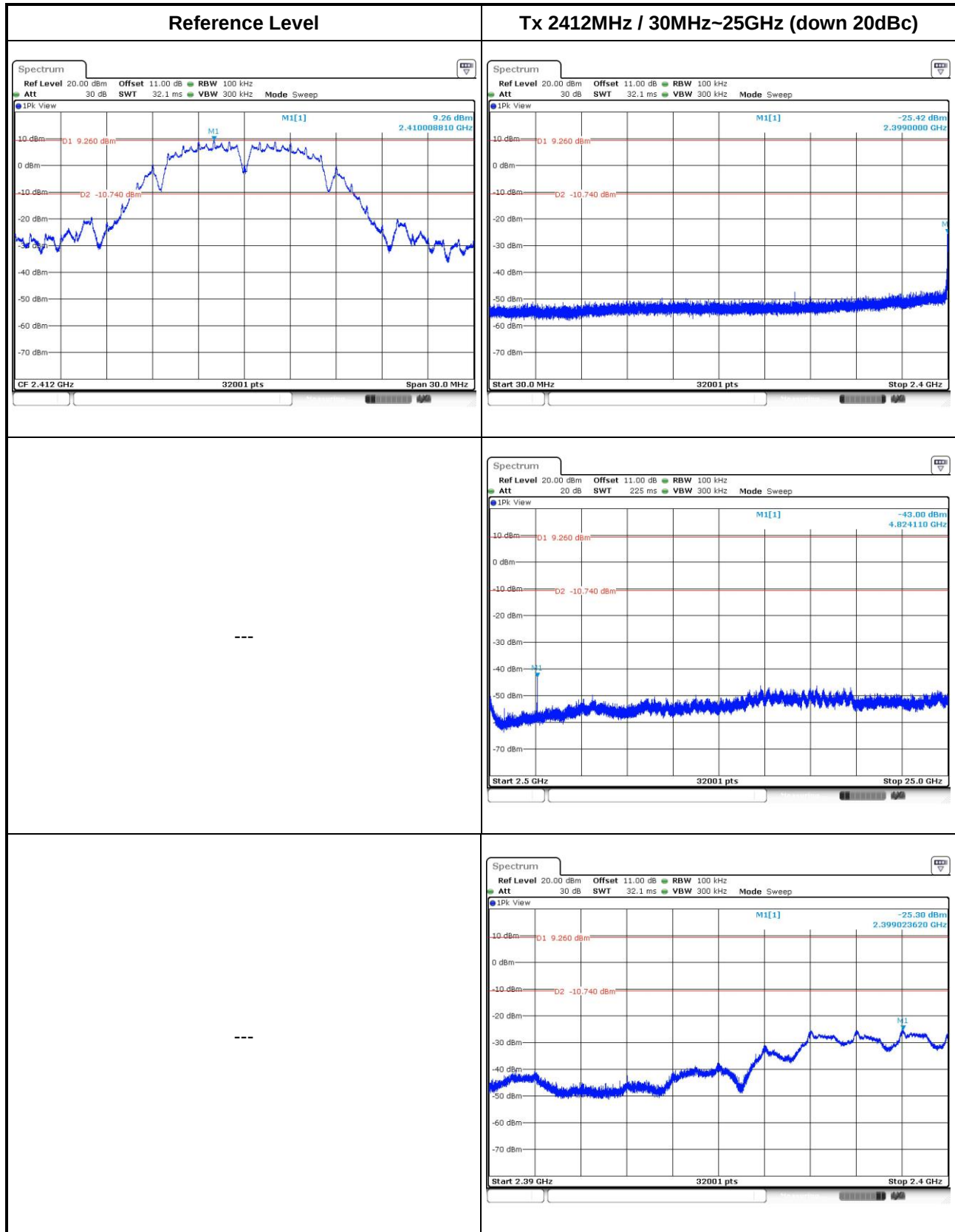


3.6.4 Test Result of Emissions in non-restricted frequency bands

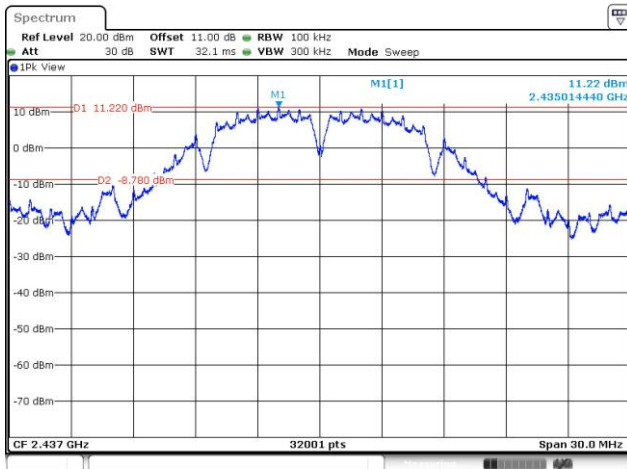
This test item is performed on each TX output individually without summing or adding $10 \log(N_{ANT})$ since measurements are made relative to the in-band emissions on the individual outputs. Only worst test result of each operating mode is presented.

3.6.5 Unwanted Emissions into Non-Restricted Frequency Bands

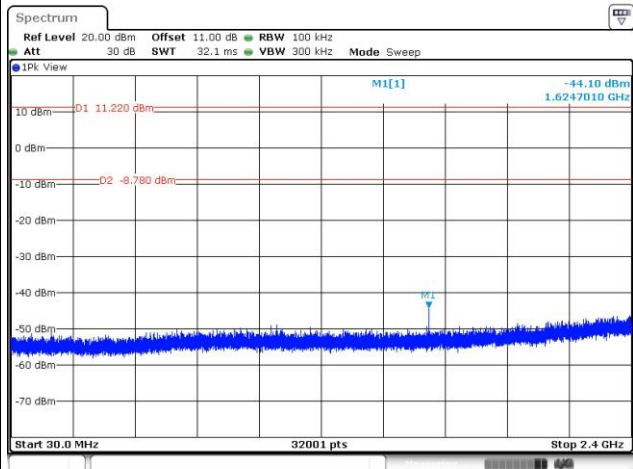
802.11b

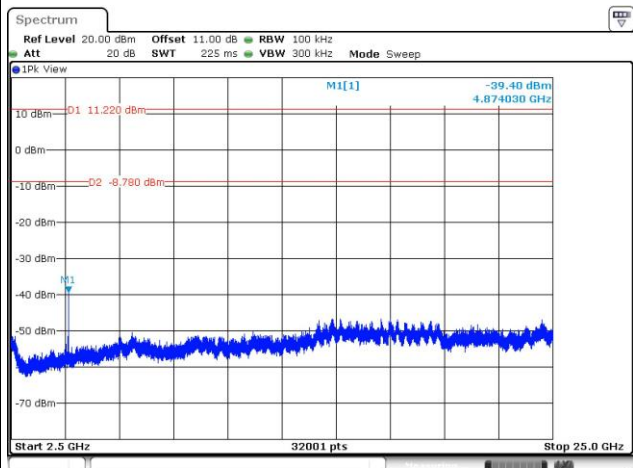


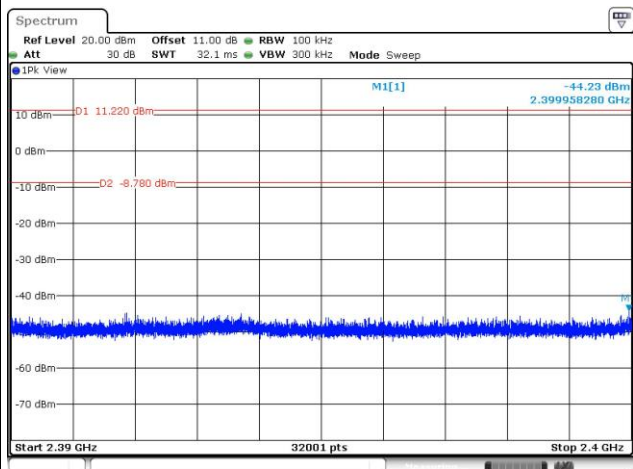
Reference Level

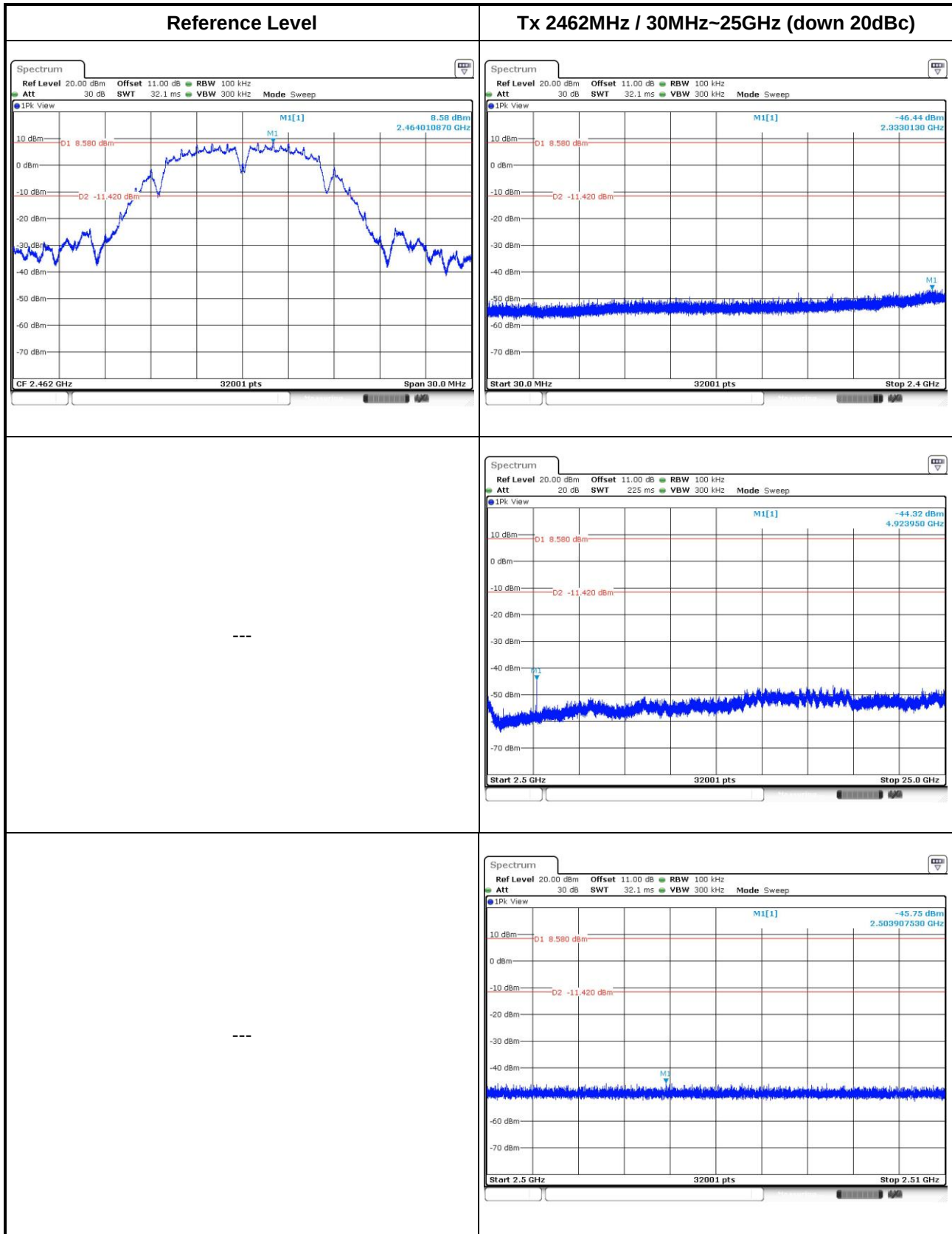


Tx 2437MHz / 30MHz~25GHz (down 20dBc)

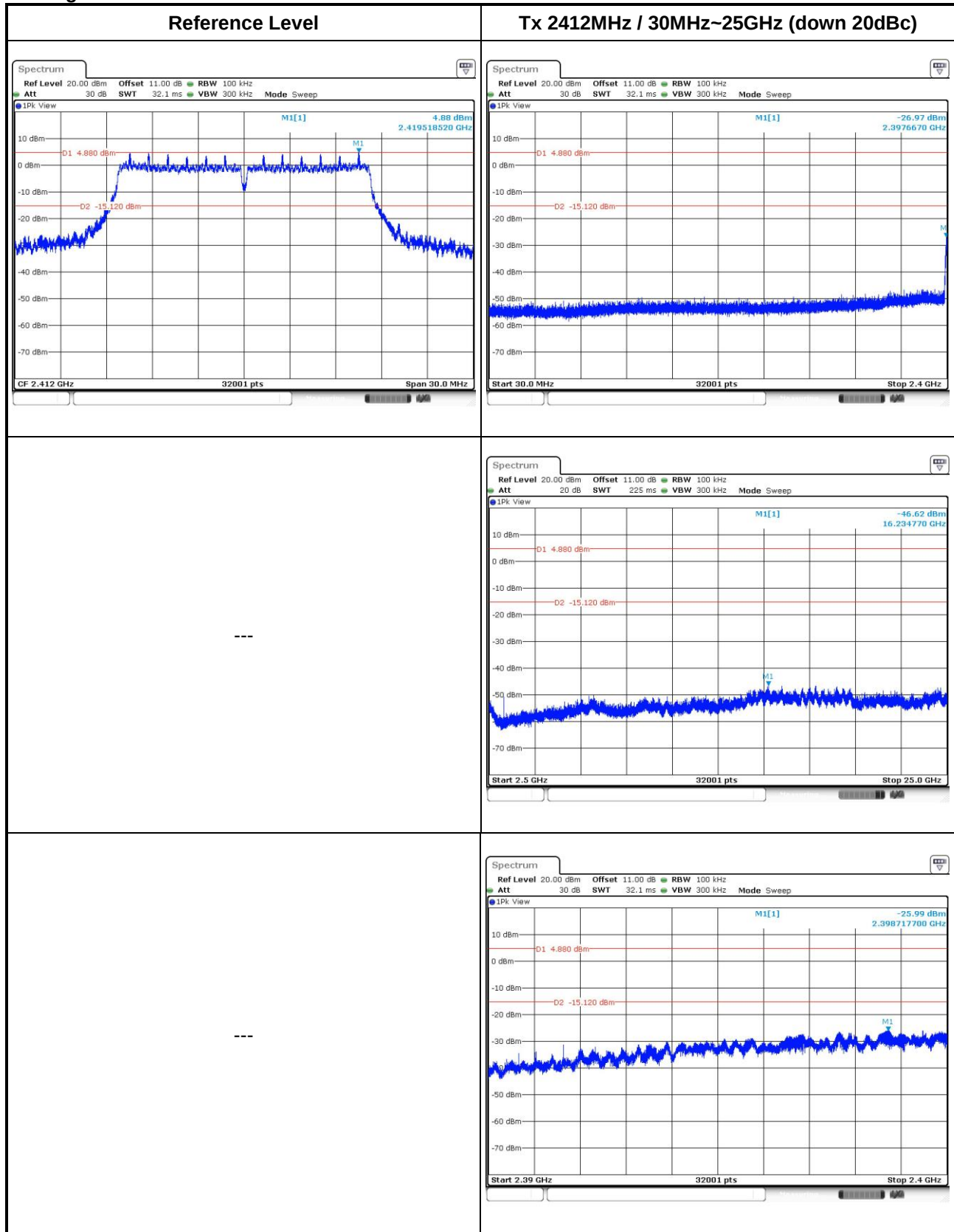




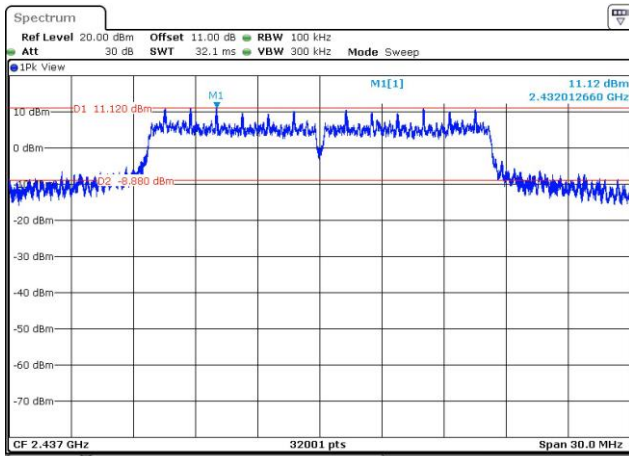




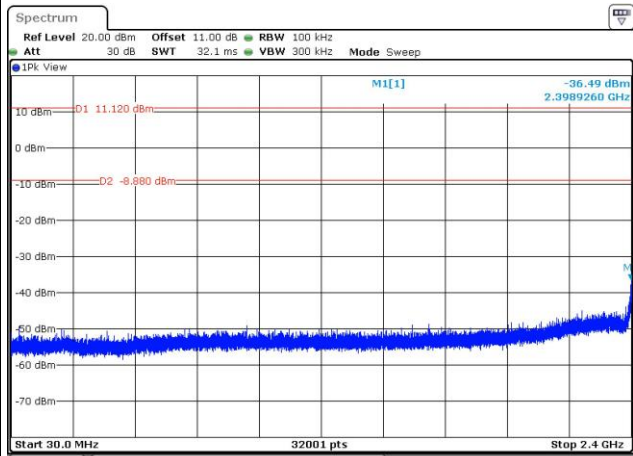
802.11g

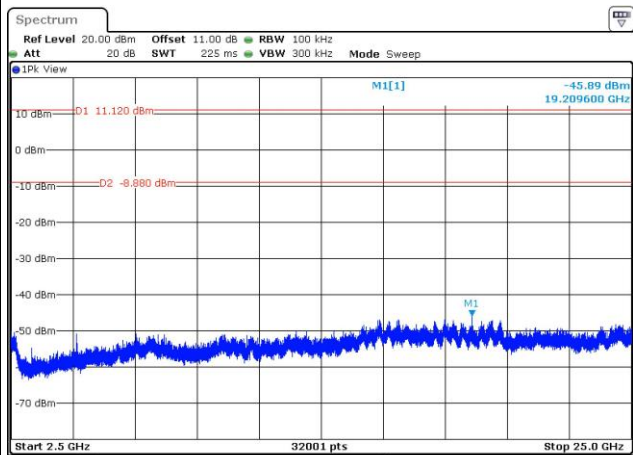


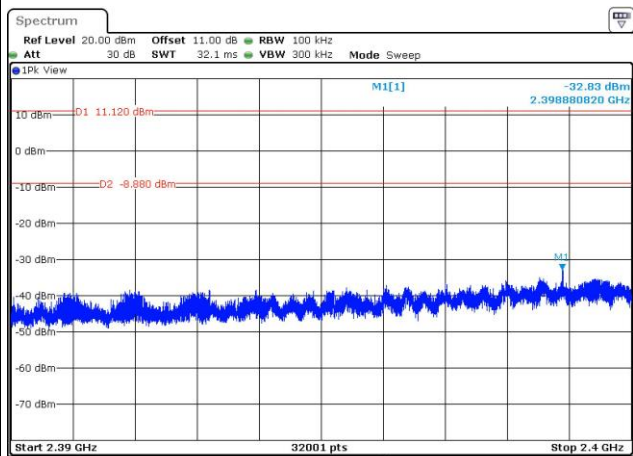
Reference Level

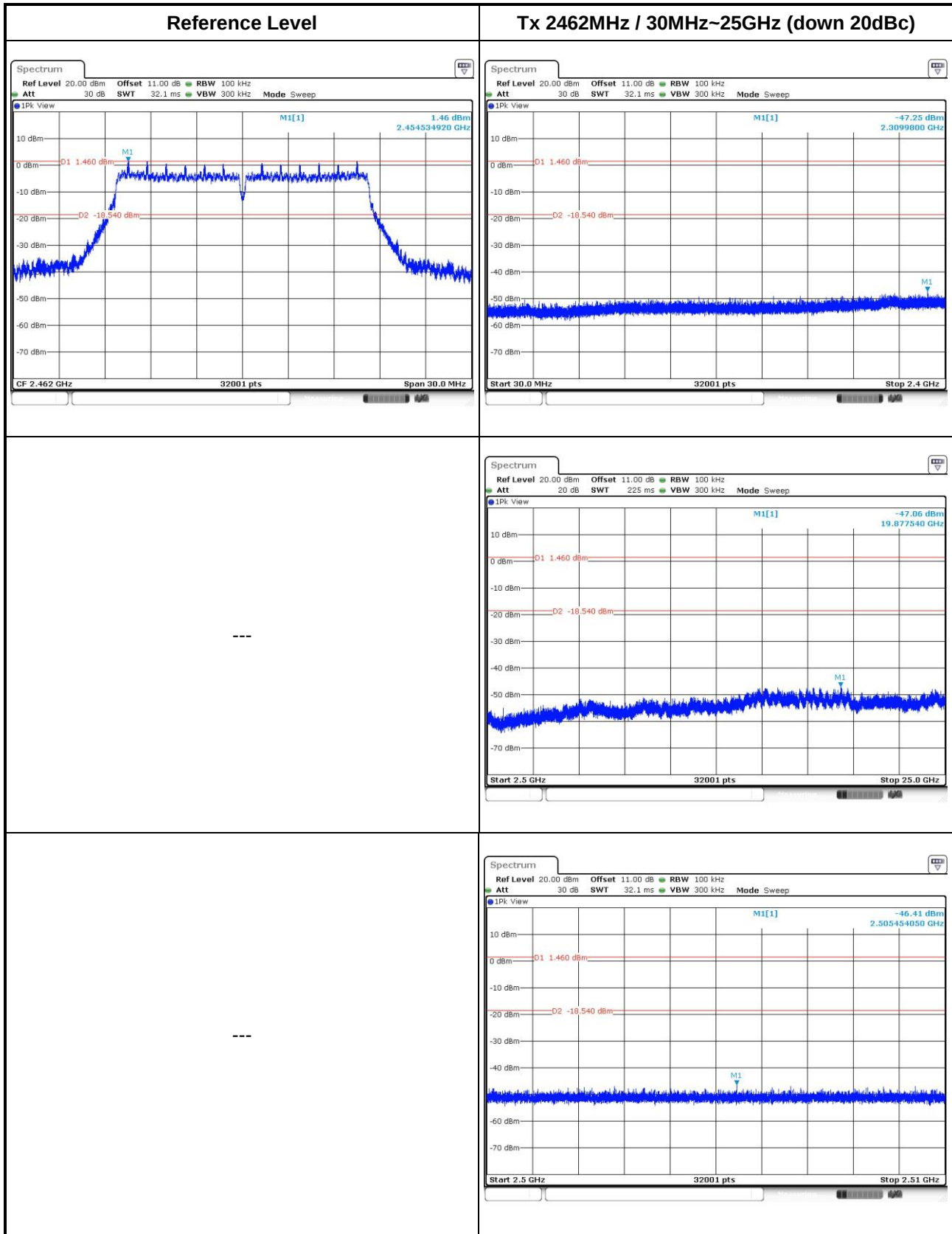


Tx 2437MHz / 30MHz~25GHz (down 20dBc)

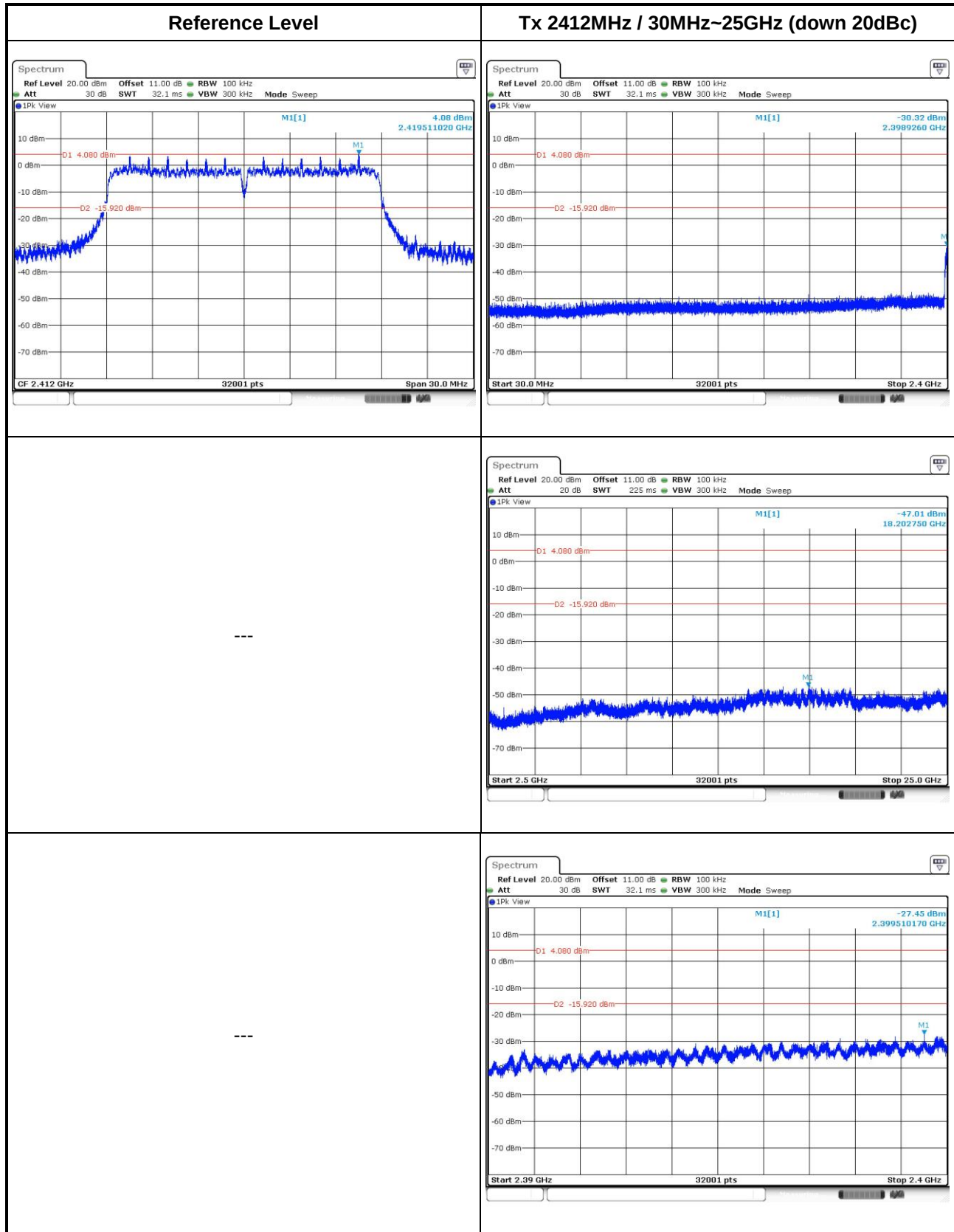


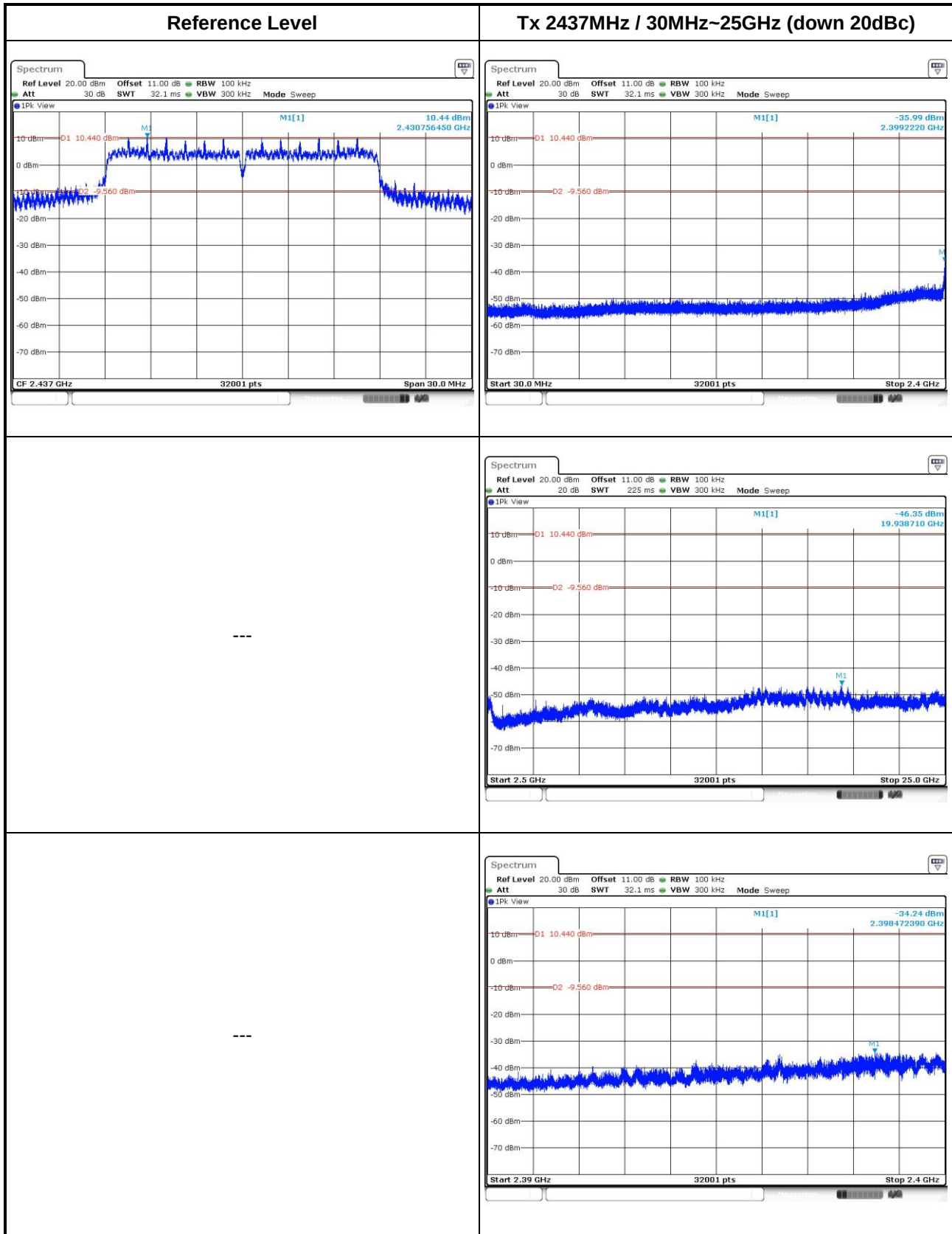




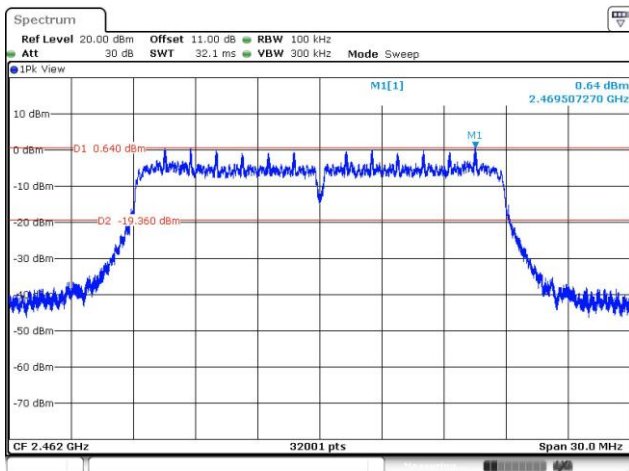


802.11n HT20

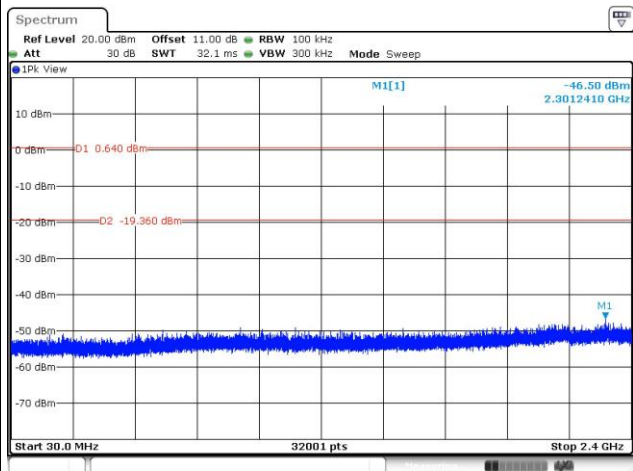


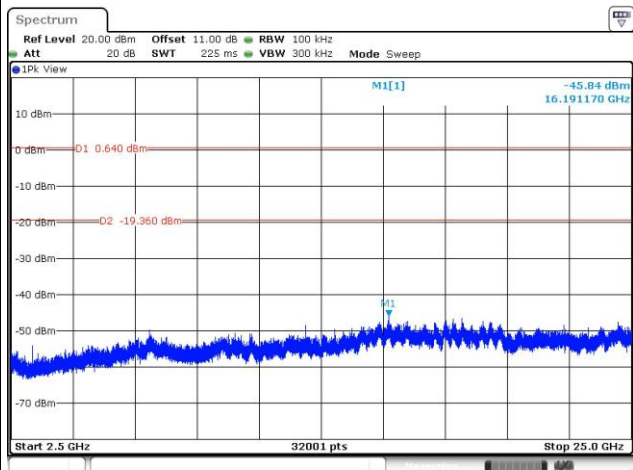


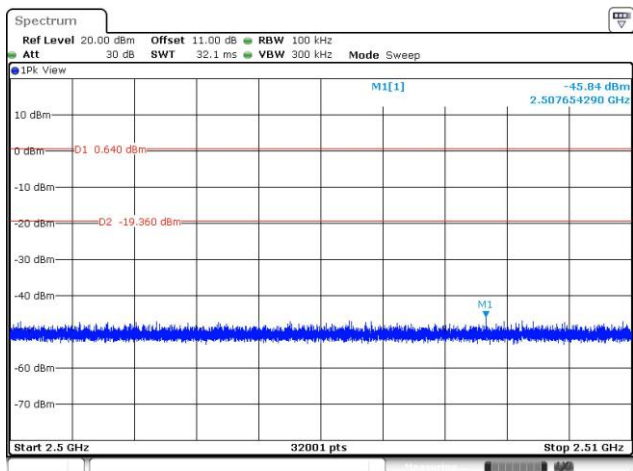
Reference Level



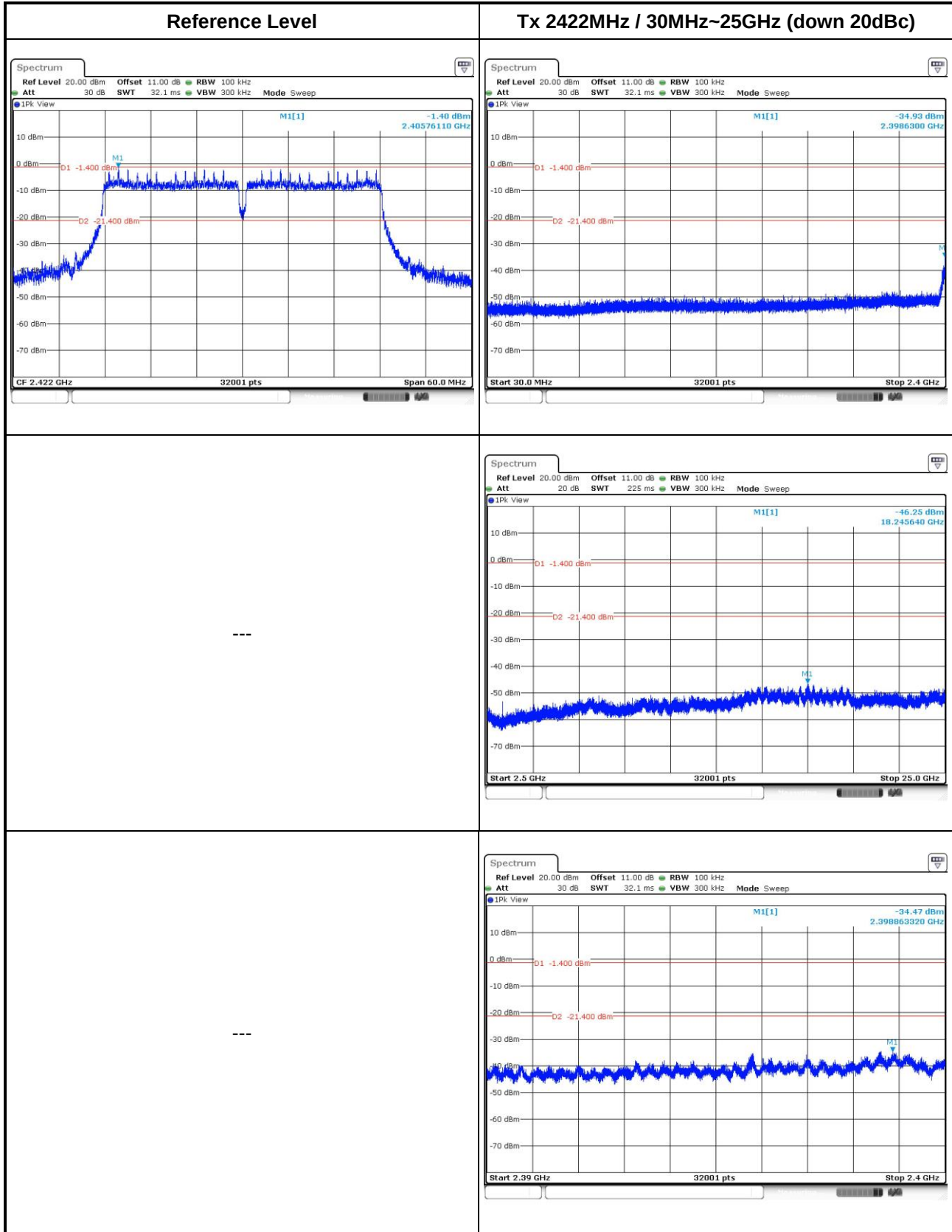
Tx 2462MHz / 30MHz~25GHz (down 20dBc)



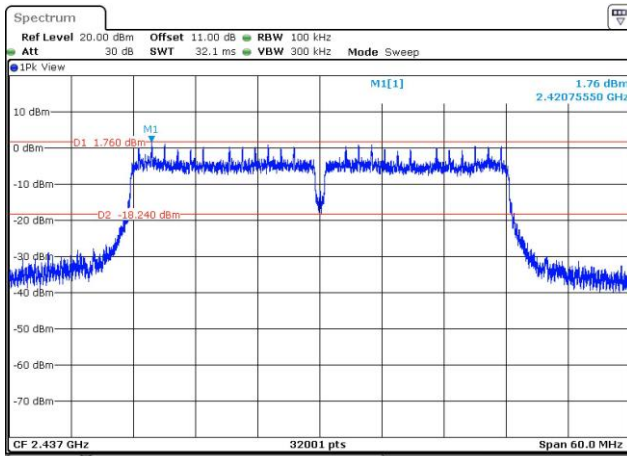




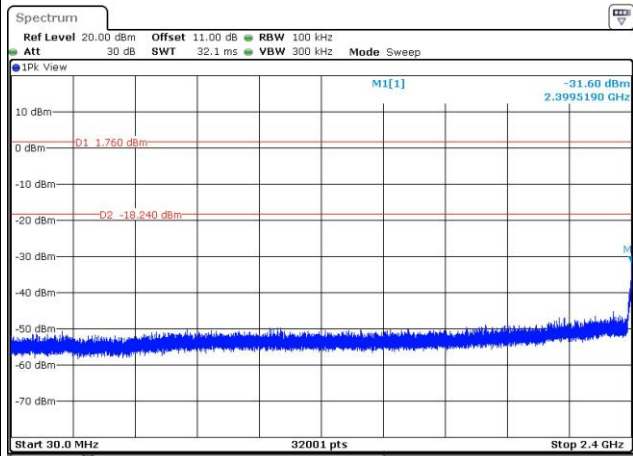
802.11n HT40

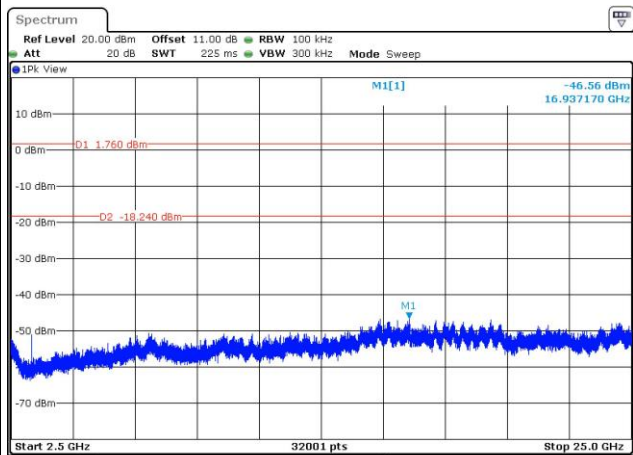


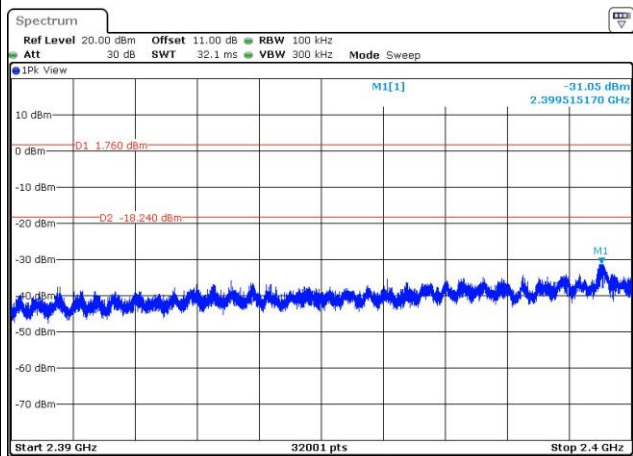
Reference Level



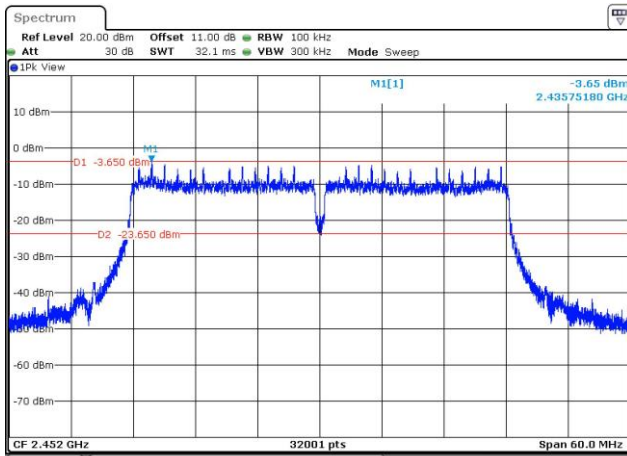
Tx 2437MHz / 30MHz~25GHz (down 20dBc)



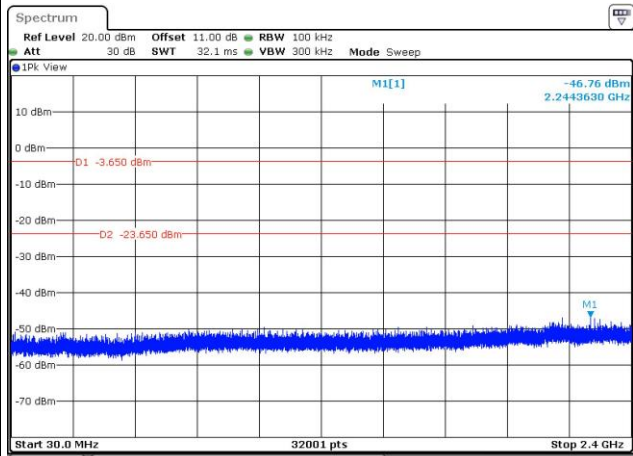


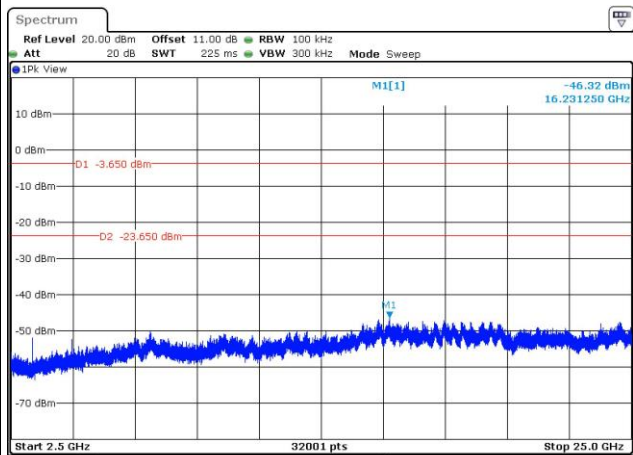


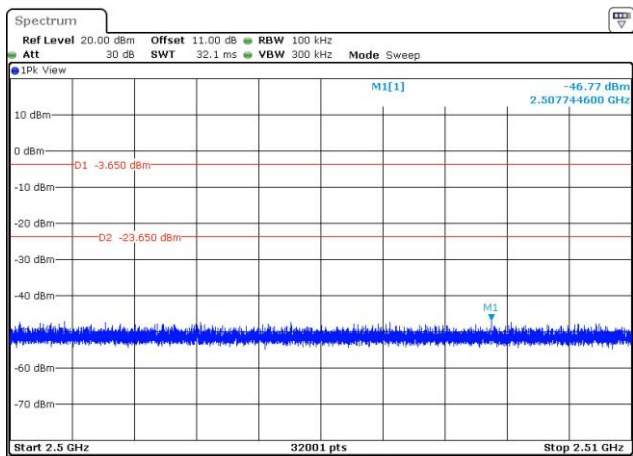
Reference Level



Tx 2452MHz / 30MHz~25GHz (down 20dBc)







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 (EMC and Wireless Communication Laboratory), 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 District. 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 District, Tao Yuan City
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 District, Tao Yuan
City 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

==END==