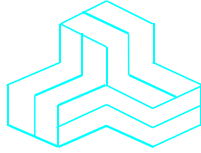


# ENGINEERING TEST REPORT



**Pico 1W 2.4GHz 802.11bgn WiFi Module**  
**Model: pX2 Gen2**  
**FCC ID: NS9A15PX2**

*Applicant:*

**Microhard Systems Inc.**  
150 Country Hills Landing NW  
Calgary, Alberta  
Canada T3K 5P3

*In Accordance With*

**Federal Communications Commission (FCC)**  
**Part 15, Subpart C, Section 15.247**  
**Digital Modulation Systems (DTS) Operating in 2400 – 2483.5 MHz Band**

**UltraTech's File No.: 22MCRS118\_FCC15C247**

This Test report is Issued under the Authority of  
Tri M. Luu  
Vice President of Engineering  
UltraTech Group of Labs

Date: June 23, 2022

Report Prepared by: Dan Huynh

Tested by: Hung Trinh

Issued Date: June 23, 2022

Test Dates:  
January 4 - April 15, 2022

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by any agency of the US Government.*
- *This test report shall not be reproduced, except in full, without a written approval from UltraTech*

## UltraTech

3000 Bristol Circle, Oakville, Ontario, Canada, L6H 6G4  
Tel.: (905) 829-1570 Fax.: (905) 829-8050  
Website: [www.ultratech-labs.com](http://www.ultratech-labs.com), Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Email: [tri@ultratech-labs.com](mailto:tri@ultratech-labs.com)



1309



CA0001-2049



AT-1945



SL2-IN-E-1119R



**TABLE OF CONTENTS**

**EXHIBIT 1. INTRODUCTION..... 1**

1.1. SCOPE ..... 1

1.2. RELATED SUBMITTAL(S)/GRANT(S) ..... 1

1.3. NORMATIVE REFERENCES ..... 1

**EXHIBIT 2. PERFORMANCE ASSESSMENT ..... 2**

2.1. CLIENT INFORMATION ..... 2

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION ..... 2

2.3. EUT'S TECHNICAL SPECIFICATIONS..... 3

2.4. ASSOCIATED ANTENNA DESCRIPTIONS ..... 3

2.5. LIST OF EUT'S PORTS..... 3

2.6. ANCILLARY EQUIPMENT ..... 4

**EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS ..... 5**

3.1. CLIMATE TEST CONDITIONS ..... 5

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS..... 5

**EXHIBIT 4. SUMMARY OF TEST RESULTS..... 6**

4.1. LOCATION OF TESTS ..... 6

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS ..... 6

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES ..... 6

**EXHIBIT 5. TEST DATA ..... 7**

5.1. POWER LINE CONDUCTED EMISSIONS [§15.207(a)]..... 7

5.2. OCCUPIED BANDWIDTH [§ 15.247(a)(2)]..... 12

5.3. PEAK CONDUCTED OUTPUT POWER - DTS [§ 15.247(b)(3)] ..... 15

5.4. TRANSMITTER BAND-EDGE & SPURIOUS CONDUCTED EMISSIONS [§ 15.247(d)] ..... 23

5.5. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205] ..... 25

5.6. POWER SPECTRAL DENSITY [§ 15.247(e)]..... 31

5.7. RF EXPOSURE REQUIRMENTS [§§ 15.247(i), 1.1310 & 2.1091]..... 34

**EXHIBIT 6. TEST EQUIPMENT LIST ..... 40**

**EXHIBIT 7. MEASUREMENT UNCERTAINTY ..... 41**

**APPENDIX A. 6 dB BANDWIDTH**

**APPENDIX B. SPURIOUS RF CONDUCTED EMISSIONS IN NON-RESTRICTED FREQUENCY BANDS**

**APPENDIX C. SPURIOUS RF CONDUCTED EMISSIONS IN RESTRICTED FREQUENCY BANDS**

**APPENDIX D. BAND-EDGE RF CONDUCTED EMISSIONS**

## EXHIBIT 1. INTRODUCTION

### 1.1. SCOPE

<b>Reference:</b>	FCC Part 15, Subpart C, Section 15.247
<b>Title:</b>	Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15 – Radio Frequency Devices
<b>Purpose of Test:</b>	Equipment Certification for Digital Modulation Systems (DTS) Operating Under §15.247
<b>Test Procedures:</b>	<ul style="list-style-type: none"><li>▪ ANSI C63.4</li><li>▪ ANSI C63.10</li><li>▪ FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02</li></ul>
<b>Environmental Classification:</b>	<input checked="" type="checkbox"/> Commercial, industrial or business environment <input checked="" type="checkbox"/> Residential environment

### 1.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

### 1.3. NORMATIVE REFERENCES

Publication	Year	Title
47 CFR Parts 0-19	2021	Code of Federal Regulations (CFR), Title 47 – Telecommunication
ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 KHz to 40 GHz
ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
FCC, KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02	2019	GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES

## EXHIBIT 2. PERFORMANCE ASSESSMENT

### 2.1. CLIENT INFORMATION

Applicant	
<b>Name:</b>	Microhard Systems Inc.
<b>Address:</b>	150 Country Hills Landing NW Calgary, Alberta Canada T3K 5P3

Manufacturer	
<b>Name:</b>	Microhard Systems Inc.
<b>Address:</b>	150 Country Hills Landing NW Calgary, Alberta Canada T3K 5P3

### 2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

<b>Brand Name:</b>	Microhard Systems Inc.
<b>Product Name:</b>	Pico 1W 2.4GHz 802.11bgn WiFi Module
<b>Model Name or Number:</b>	pX2 Gen2
<b>Serial Number:</b>	Test Sample
<b>Type of Equipment:</b>	Digital Transmission System (DTS)
<b>Input Power Supply Type:</b>	External DC Power Supply
<b>Primary User Functions of EUT:</b>	OEM module

**2.3. EUT’S TECHNICAL SPECIFICATIONS**

Transmitter			
<b>Equipment Type:</b>	<ul style="list-style-type: none"> <li>• Mobile</li> <li>• Base Station (fixed use)</li> </ul>		
<b>Intended Operating Environment:</b>	<ul style="list-style-type: none"> <li>▪ Commercial, industrial or business environment</li> <li>▪ Residential environment</li> </ul>		
<b>Power Supply Requirement:</b>	3.3 VDC		
<b>RF Output Power Rating:</b>	16 – 30 dBm typical combined power		
<b><sup>1</sup>Raw Power Setting:</b>	0-70		
<b>Operating Frequency Range:</b>	Channel Bandwidth	<sup>2</sup> Data Rate 1, 2, 3	<sup>2</sup> Data Rate 4, 5, 6, 7
	20 MHz 40 MHz	2412 - 2462 MHz 2422 - 2452 MHz	2412 - 2462 MHz 2422 - 2452 MHz
<b>RF Output Impedance:</b>	50 Ω		
<b>Duty Cycle:</b>	Continuous		
<b>Modulation Type:</b>	BPSK,QPSK, OFDM		
<b>Antenna Connector Types:</b>	U.FL		

<sup>1</sup>Raw Power Setting is a factory tune-up parameter, not available to end users

<sup>2</sup>Refer to operational description exhibit for more information on data rates and operational restrictions.

**2.4. ASSOCIATED ANTENNA DESCRIPTIONS**

Antenna Type	Maximum Gain (dBi)
Rubber Ducky	2.5
Patch Antenna	14
Yagi Antenna	14.5
Omni Directional Antenna	15

**2.5. LIST OF EUT’S PORTS**

Port Number	EUT’s Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	RF port	2	U.FL	Shielded cable
2	DC supply and I/O port	1	Pin header	Direct connection (no cable)

## 2.6. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

<b>Ancillary Equipment # 1</b>	
Description:	Test Jig
Brand name:	Microhard Systems Inc.
Model Name or Number:	N/A
Connected to EUT's Port:	I/O Port

<b>Ancillary Equipment # 2</b>	
Description:	AC/DC Adapter
Brand name:	Flypower
Model Name or Number:	PS30D120K2000UD
Connected to EUT's Port:	Test Jig of the EUT

**EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS**

**3.1. CLIMATE TEST CONDITIONS**

The climate conditions of the test environment are as follows:

Temperature:	21 to 23 °C
Humidity:	45 to 58%
Pressure:	102 kPa
Power Input Source:	3.3 VDC

**3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS**

<b>Operating Modes:</b>	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
<b>Special Test Software:</b>	Test software provided by the Applicant to operate the EUT at each channel frequency continuously and in the range of typical modes of operation.
<b>Special Hardware Used:</b>	Test Jig
<b>Transmitter Test Antenna:</b>	The EUT is tested with the antenna fitted in a manner typical of normal intended use as non-integral antenna equipment as described with the test results.

<b>Transmitter Test Signals</b>	
<b>Frequency Band(s):</b>	2412 - 2462 MHz 2422 - 2452 MHz
<b>Frequency(ies) Tested:</b>	Refer to test data in this report
<b>RF Power Output:</b> (measured maximum output power at antenna terminals)	30.00 dBm Total Peak Power
<b>Normal Test Modulation:</b>	BPSK,QPSK, OFDM
<b>Modulating Signal Source:</b>	Internal

## EXHIBIT 4. SUMMARY OF TEST RESULTS

### 4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).
- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with ANAB File No.: AT-1945.

### 4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Compliance (Yes/No)
15.203	Antenna requirements	Yes
15.207(a)	AC Power Line Conducted Emissions	Yes
15.247(a)(2)	6 dB Bandwidth	Yes
15.247(b)(3)	Peak Conducted Output Power - DTS	Yes
15.247(d)	Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
15.247(d), 15.209 & 15.205	Transmitter Spurious Radiated Emissions	Yes
15.247(e)	Power Spectral Density	Yes
15.247(i), 1.1307, 1.1310, 2.1091	RF Exposure	Yes

### 4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.



**EXHIBIT 5. TEST DATA**

**5.1. POWER LINE CONDUCTED EMISSIONS [§15.207(a)]**

**5.1.1. Limit(s)**

The equipment shall meet the limits of the following table:

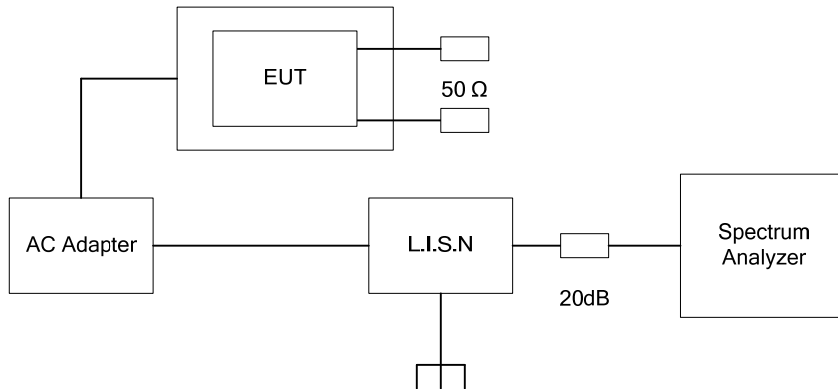
Frequency of emission (MHz)	Conducted Limits (dBμV)	
	Quasi-peak	Average
0.15–0.5 .....	66 to 56* .....	56 to 46*
0.5–5 .....	56 .....	46
5–30 .....	60 .....	50

\*Decreases linearly with the logarithm of the frequency

**5.1.2. Method of Measurements**

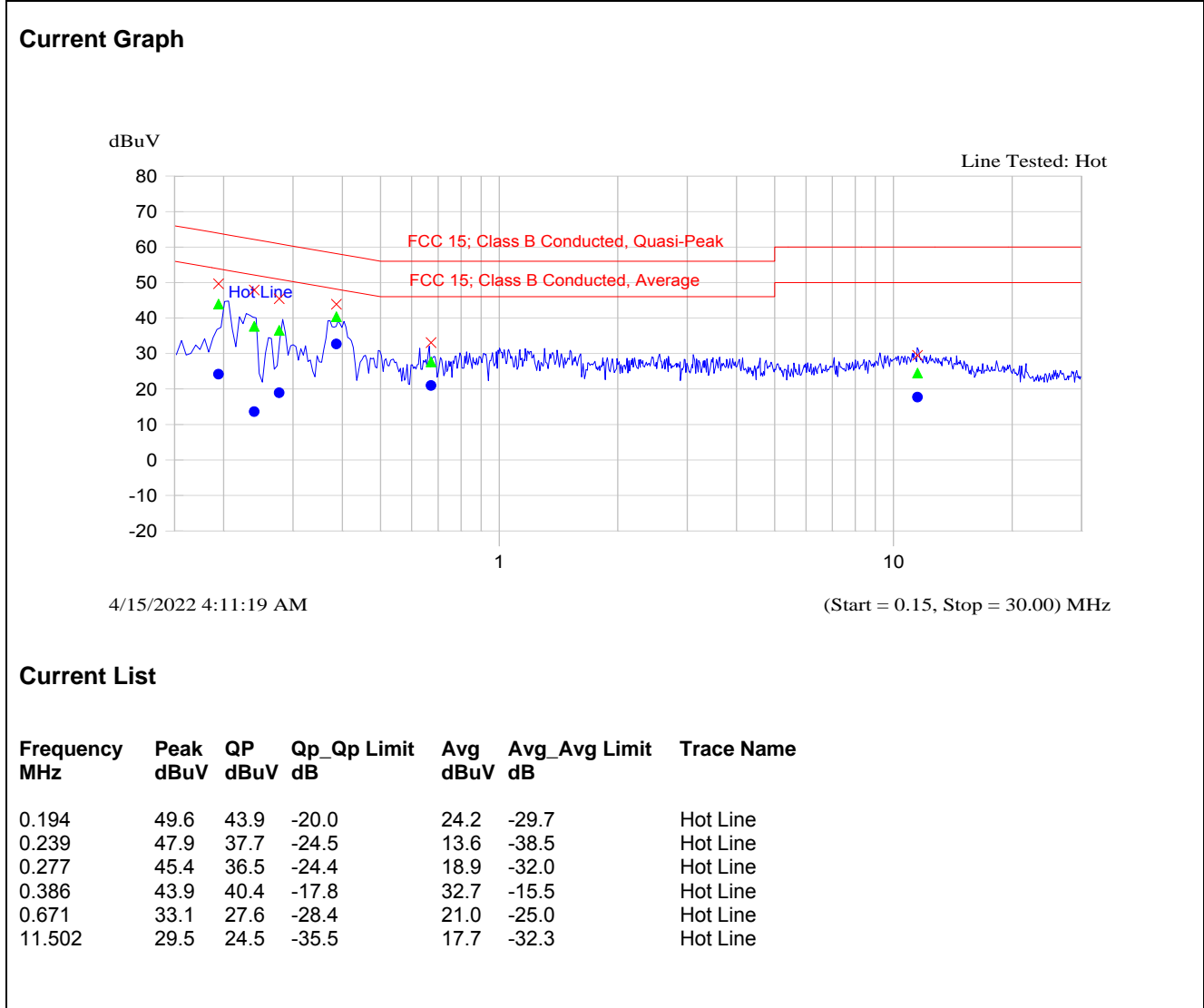
ANSI C63.4

**5.1.3. Test Arrangement**



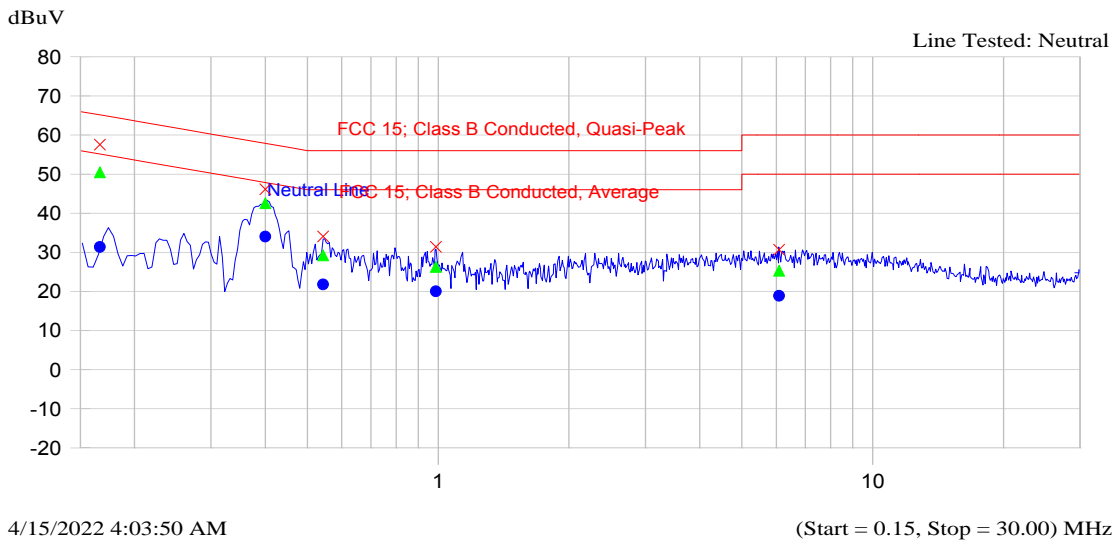
5.1.4. Test Data

Plot 5.1.4.1. Power Line Conducted Emissions (Test Configuration 1: Tx Mode)  
Line Voltage: 120 VAC; Line Tested: Hot



Plot 5.1.4.2. Power Line Conducted Emissions (Test Configuration 1: Tx Mode)  
Line Voltage 120 VAC; Line Tested: Neutral

**Current Graph**

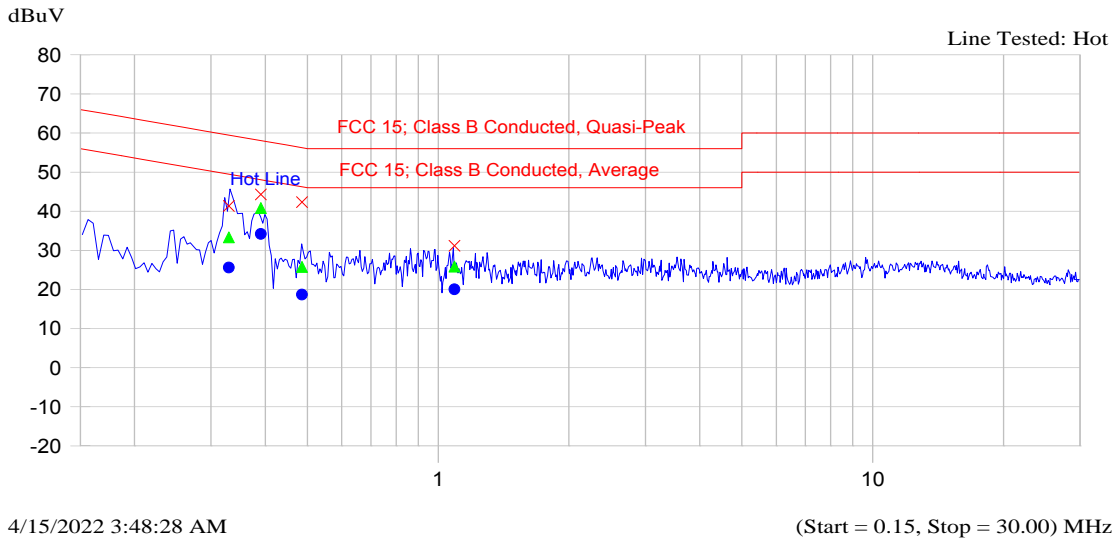


**Current List**

Frequency MHz	Peak dBuV	QP dBuV	Qp_Qp Limit dB	Avg dBuV	Avg_Avg Limit dB	Trace Name
0.166	57.5	50.5	-14.7	31.4	-23.8	Neutral Line
0.400	46.1	42.6	-15.3	34.0	-13.8	Neutral Line
0.543	34.1	29.2	-26.8	21.8	-24.2	Neutral Line
0.988	31.4	26.3	-29.7	20.0	-26.0	Neutral Line
6.089	30.7	25.3	-34.7	18.9	-31.1	Neutral Line

Plot 5.1.4.3. Power Line Conducted Emissions (Test Configuration 2: Rx Mode)  
Line Voltage 120 VAC; Line Tested: Hot

**Current Graph**

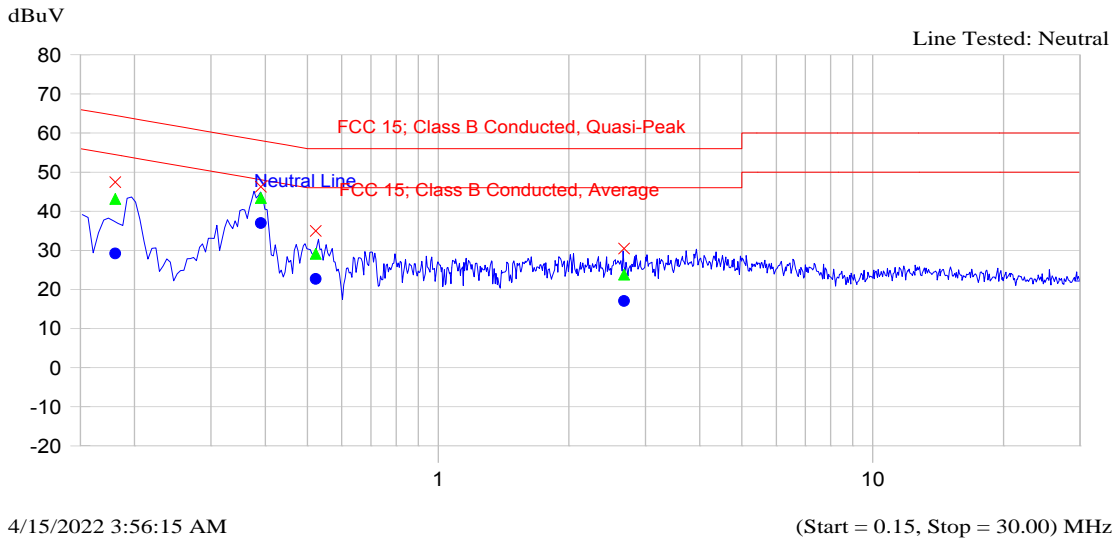


**Current List**

Frequency MHz	Peak dBuV	QP dBuV	Qp_Qp Limit dB	Avg dBuV	Avg_Avg Limit dB	Trace Name
0.330	41.3	33.3	-26.2	25.6	-23.9	Hot Line
0.391	44.3	40.8	-17.2	34.2	-13.9	Hot Line
0.486	42.3	25.7	-30.5	18.7	-27.6	Hot Line
1.090	31.2	25.8	-30.2	20.0	-26.0	Hot Line

Plot 5.1.4.4. Power Line Conducted Emissions (Test Configuration 2: Rx Mode)  
Line Voltage 120 VAC; Line Tested: Neutral

**Current Graph**



**Current List**

Frequency MHz	Peak dBuV	QP dBuV	Qp_Qp Limit dB	Avg dBuV	Avg_Avg Limit dB	Trace Name
0.181	47.4	43.2	-21.3	29.2	-25.3	Neutral Line
0.390	46.2	43.4	-14.7	37.0	-11.1	Neutral Line
0.523	35.0	29.1	-26.9	22.7	-23.3	Neutral Line
2.676	30.5	23.8	-32.2	17.1	-28.9	Neutral Line

## 5.2. OCCUPIED BANDWIDTH [§ 15.247(a)(2)]

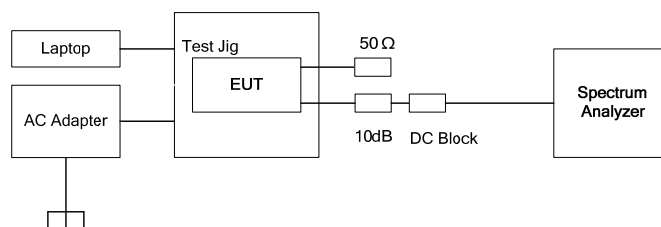
### 5.2.1. Limit(s)

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

### 5.2.2. Method of Measurements

KDB 558074 D01 15.247 Meas Guidance v05r02, Section 8.2, DTS bandwidth, Option 2

### 5.2.3. Test Arrangement



5.2.4. Test Data

Channel Bandwidth: 20 MHz, Data Rates: 1, 2, 3, 4, 5, 6 and 7					
Data Rate	Frequency (MHz)	Raw Power Setting	6dB Bandwidth (MHz)		Min. Limit (kHz)
			Antenna 1	Antenna 2	
1	2412	26	10.016	10.056	500
	2437	26	10.096	10.056	500
	2462	26	10.016	10.096	500
2	2412	26	10.016	9.896	500
	2437	26	10.016	9.936	500
	2462	26	10.016	9.856	500
3	2412	26	9.615	9.415	500
	2437	26	9.215	9.175	500
	2462	26	9.054	9.415	500
4	2412	21	15.200	15.088	500
	2437	21	15.200	15.088	500
	2462	21	15.200	15.088	500
5	2412	21	15.200	15.200	500
	2437	21	15.200	15.200	500
	2462	21	15.200	15.200	500
6	2412	23	16.490	16.490	500
	2437	23	16.490	16.490	500
	2462	23	16.490	16.490	500
7	2412	23	16.490	16.490	500
	2437	23	16.490	16.490	500
	2462	23	16.490	16.490	500

Channel Bandwidth: 40 MHz, Data Rates: 1, 2, 3, 4, 5, 6 and 7					
Data Rate	Frequency (MHz)	Raw Power Setting	6dB Bandwidth (MHz)		Min. Limit (kHz)
			Antenna 1	Antenna 2	
1	2422	13	35.128	33.974	500
	2437	22	33.974	35.128	500
	2452	15	35.000	35.128	500
2	2422	13	35.128	35.128	500
	2437	22	35.128	35.128	500
	2452	15	35.128	35.128	500
3	2422	13	35.128	35.000	500
	2437	22	35.128	35.000	500
	2452	15	35.128	35.000	500
4	2422	20	36.410	35.897	500
	2437	24	36.410	36.410	500
	2452	22	35.897	36.410	500
5	2422	20	36.410	36.026	500
	2437	24	36.282	36.282	500
	2452	22	36.026	36.410	500
6	2422	20	36.410	36.410	500
	2437	24	36.410	36.410	500
	2452	22	36.410	36.410	500
7	2422	20	36.410	36.410	500
	2437	24	36.410	36.410	500
	2452	22	36.410	36.410	500

Refer to Appendix A for 6 dB bandwidth test data plots.



### 5.3. PEAK CONDUCTED OUTPUT POWER - DTS [§ 15.247(b)(3)]

#### 5.3.1. Limit(s)

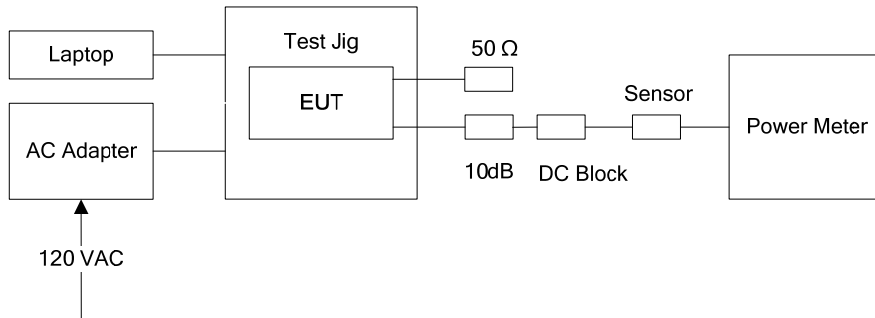
**§ 15.247(b)(3):** For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output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

**§ 15.247(b)(4):** The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### 5.3.2. Method of Measurements & Test Arrangement

KDB 558074 D01 DTS Meas Guidance v05r02, Section 8.3.1.3 PKPM1 Peak-reading power meter method  
KDB 662911 D01 Multiple Transmitter Output v02r01, Section (E)(1) Measure-and sum technique

#### 5.3.3. Test Arrangement



**5.3.4. Test Data**

Remarks:

- The EIRP shall be calculated based on the transmitter antenna gain ( $G_{dBi}$ ), cable loss ( $CL_{dB}$ ) and peak output power at antenna terminal ( $P_{dBm}$ ). Calculated EIRP =  $P_{dBm} + G_{dBi} - CL_{dB}$
- If transmit antennas with an effective directional gain greater than 6 dBi are used, the conducted output power from the EUT shall be reduced by the amount in dB that the directional gain of the transmitting antenna exceeds 6 dBi, the applicable output power limit shall be calculated as follows:

$$P_{out} = P_{Limit} - (G_{Tx} - 6)$$

Where:  $P_{Out}$  is the maximum conducted output power in dBm,  
 $P_{Limit}$  is the output power limit in dBm,  
 $G_{Tx}$  is the maximum transmitting antenna directional gain in dBi.

Maximum Peak Conducted Output Power for High Power, 20 MHz Channel Bandwidth at Data Rates 1 to 7								
Operating Mode	Data Rate (1 – 7)	Frequency (MHz)	Raw Power Setting (0 – 70)	Peak Power (dBm)		Total Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)
				Chain # 1	Chain # 2			
High Power 20 MHz Channel Bandwidth	1	2412	26.0	26.41	25.80	29.13	30	-0.87
		2437	26.0	27.50	26.41	30.00	30	0.00
		2462	26.0	26.61	26.25	29.44	30	-0.56
	2	2412	26.0	26.60	26.03	29.33	30	-0.67
		2437	26.0	27.31	26.47	29.92	30	-0.08
		2462	26.0	26.83	25.91	29.40	30	-0.60
	3	2412	26.0	26.90	25.98	29.47	30	-0.53
		2437	26.0	27.45	26.47	30.00	30	0.00
		2462	26.0	27.45	26.39	29.96	30	-0.04
	4	2412	21.0	27.53	25.98	29.83	30	-0.17
		2437	21.0	27.67	26.16	29.99	30	-0.01
		2462	21.0	27.54	26.25	29.95	30	-0.05
	5	2412	21.0	27.26	25.66	29.54	30	-0.46
		2437	21.0	27.71	26.07	29.98	30	-0.02
		2462	21.0	27.51	26.31	29.96	30	-0.04
	6	2412	23.0	26.84	25.73	29.33	30	-0.67
		2437	23.0	27.81	25.97	30.00	30	0.00
		2462	23.0	27.71	25.96	29.93	30	-0.07
	7	2412	23.0	26.96	24.55	28.93	30	-1.07
		2437	23.0	27.87	25.86	29.99	30	-0.01
		2462	23.0	27.60	25.82	29.81	30	-0.19

Maximum Peak Conducted Output Power for High Power, 40 MHz Channel Bandwidth at Data Rates 1 to 7									
Operating Mode	Data Rate (1 – 7)	Frequency (MHz)	Raw Power Setting (0 – 70)	Peak Power (dBm)		Total Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)	
				Chain # 1	Chain # 2				
High Power 40 MHz Channel Bandwidth	1	2422	13.0	22.93	21.26	25.19	30	-4.81	
		2423	14.0	23.12	21.38	25.35	30	-4.65	
		2424	15.0	23.75	21.83	25.91	30	-4.09	
		2425	16.0	23.89	22.24	26.15	30	-3.85	
		2426	17.0	24.24	22.69	26.54	30	-3.46	
		2429	17.0	23.95	22.51	26.30	30	-3.70	
		2430	19.0	25.29	24.14	27.76	30	-2.24	
		2431	20.0	25.66	24.16	27.98	30	-2.02	
		2432	21.0	26.32	24.44	28.49	30	-1.51	
		2433	21.0	26.25	24.91	28.64	30	-1.36	
		2434	22.0	27.64	26.22	30.00	30	0.00	
		2437	22.0	27.47	26.27	29.92	30	-0.08	
		2443	22.0	27.46	26.36	29.96	30	-0.04	
		2444	22.0	27.08	25.78	29.49	30	-0.51	
	2445	21.0	26.59	24.89	28.83	30	-1.17		
	2446	21.0	26.16	24.94	28.60	30	-1.40		
	2447	20.0	25.69	24.23	28.03	30	-1.97		
	2448	20.0	25.54	24.33	27.99	30	-2.01		
	2449	19.0	25.36	23.86	27.68	30	-2.32		
	2450	18.0	24.85	23.37	27.18	30	-2.82		
	2451	17.0	24.27	23.21	26.78	30	-3.22		
	2452	15.0	23.16	22.17	25.70	30	-4.30		
	2422	2	2422	13.0	22.88	21.25	25.15	30	-4.85
	2423		2423	14.0	23.03	21.46	25.33	30	-4.67
	2424		2424	15.0	23.22	22.04	25.68	30	-4.32
	2425		2425	16.0	23.76	22.14	26.04	30	-3.96
	2426		2426	17.0	24.23	22.53	26.47	30	-3.53
	2429		2429	17.0	23.97	22.65	26.37	30	-3.63
2430	2430		19.0	25.15	24.09	27.66	30	-2.34	
2431	2431		20.0	26.09	24.14	28.23	30	-1.77	
2432	2432	21.0	26.10	24.62	28.43	30	-1.57		

**ULTRATECH GROUP OF LABS**

3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4  
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: [vic@ultratech-labs.com](mailto:vic@ultratech-labs.com), Website: <http://www.ultratech-labs.com>

File #: 22MCRS118\_FCC15C247  
June 23, 2022

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Maximum Peak Conducted Output Power for High Power, 40 MHz Channel Bandwidth at Data Rates 1 to 7								
Operating Mode	Data Rate (1 – 7)	Frequency (MHz)	Raw Power Setting (0 – 70)	Peak Power (dBm)		Total Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)
				Chain # 1	Chain # 2			
High Power 40 MHz Channel Bandwidth	2	2433	21.0	26.29	24.79	28.61	30	-1.39
		2434	22.0	27.69	25.79	29.85	30	-0.15
		2437	22.0	27.68	26.17	30.00	30	0.00
		2443	22.0	27.40	26.30	29.90	30	-0.10
		2444	22.0	26.96	25.42	29.27	30	-0.73
		2445	21.0	26.52	24.51	28.64	30	-1.36
		2446	21.0	26.24	24.63	28.52	30	-1.48
		2447	20.0	25.66	24.37	28.07	30	-1.93
		2448	20.0	25.45	24.27	27.91	30	-2.09
		2449	19.0	25.26	23.93	27.66	30	-2.34
		2450	18.0	24.93	23.23	27.17	30	-2.83
		2451	17.0	24.41	23.14	26.83	30	-3.17
		2452	15.0	23.07	22.11	25.63	30	-4.37
		3	2422	13.0	22.54	21.24	24.95	30
	2423		14.0	22.71	21.63	25.21	30	-4.79
	2424		15.0	23.36	21.89	25.70	30	-4.30
	2425		16.0	23.96	22.51	26.31	30	-3.69
	2426		17.0	24.26	22.79	26.60	30	-3.40
	2429		17.0	23.94	22.78	26.41	30	-3.59
	2430		19.0	25.26	23.45	27.46	30	-2.54
	2431		20.0	26.08	24.19	28.25	30	-1.75
	2432		21.0	26.02	24.69	28.42	30	-1.58
	2433		21.0	26.19	24.79	28.56	30	-1.44
	2434		22.0	27.44	25.86	29.73	30	-0.27
	2437		22.0	27.65	25.96	29.90	30	-0.10

Maximum Peak Conducted Output Power for High Power, 40 MHz Channel Bandwidth at Data Rates 1 to 7								
Operating Mode	Data Rate (1 – 7)	Frequency (MHz)	Raw Power Setting (0 – 70)	Peak Power (dBm)		Total Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)
				Chain # 1	Chain # 2			
High Power 40 MHz Channel Bandwidth	3	2449	19.0	25.34	23.93	27.70	30	-2.30
		2450	18.0	24.89	23.36	27.20	30	-2.80
		2451	17.0	24.32	23.28	26.84	30	-3.16
		2452	15.0	23.45	22.27	25.91	30	-4.09
High Power 40 MHz Channel Bandwidth	4	2422	20.0	25.07	24.19	27.66	30	-2.34
		2423	21.0	25.49	24.37	27.98	30	-2.02
		2424	21.0	25.29	25.04	28.18	30	-1.82
		2425	22.0	25.79	25.87	28.84	30	-1.16
		2426	23.0	26.75	26.21	29.50	30	-0.50
		2427	24.0	27.48	26.43	30.00	30	0.00
		2437	24.0	27.45	26.45	29.99	30	-0.01
		2450	24.0	27.67	26.17	29.99	30	-0.01
		2451	23.0	26.32	26.09	29.22	30	-0.78
		2452	22.0	25.26	25.04	28.16	30	-1.84
	5	2422	20.0	24.49	23.97	27.25	30	-2.75
		2423	21.0	25.23	24.26	27.78	30	-2.22
		2424	21.0	25.29	24.56	27.95	30	-2.05
		2425	22.0	26.03	25.13	28.61	30	-1.39
		2426	23.0	26.17	25.44	28.83	30	-1.17
		2427	24.0	27.50	26.27	29.94	30	-0.06
		2437	24.0	27.82	25.97	30.00	30	0.00
		2450	24.0	27.21	26.02	29.67	30	-0.33
		2451	23.0	26.11	25.94	29.04	30	-0.96
		2452	22.0	25.77	25.61	28.70	30	-1.30
	6	2422	20.0	25.67	24.06	27.95	30	-2.05
		2423	21.0	25.66	24.14	27.98	30	-2.02
		2424	21.0	25.22	24.55	27.91	30	-2.09
		2425	22.0	25.64	25.06	28.37	30	-1.63
		2426	23.0	26.26	25.31	28.82	30	-1.18
		2427	24.0	27.68	26.14	29.99	30	-0.01
		2437	24.0	27.59	26.27	29.99	30	-0.01

Maximum Peak Conducted Output Power for High Power, 40 MHz Channel Bandwidth at Data Rates 1 to 7								
Operating Mode	Data Rate (1 – 7)	Frequency (MHz)	Raw Power Setting (0 – 70)	Peak Power (dBm)		Total Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)
				Chain # 1	Chain # 2			
High Power 40 MHz Channel Bandwidth	6	2450	24.0	27.52	26.17	29.91	30	-0.09
		2451	23.0	26.22	25.37	28.83	30	-1.17
		2452	22.0	25.87	25.04	28.49	30	-1.51
	7	2422	20.0	24.54	23.88	27.23	30	-2.77
		2423	21.0	25.64	24.07	27.94	30	-2.06
		2424	21.0	25.58	24.57	28.11	30	-1.89
		2425	22.0	25.93	24.83	28.43	30	-1.57
		2426	23.0	26.09	25.39	28.76	30	-1.24
		2427	24.0	27.09	25.57	29.41	30	-0.59
		2437	24.0	27.79	26.01	30.00	30	0.00
		2450	24.0	27.67	26.11	29.97	30	-0.03
		2451	23.0	26.18	25.77	28.99	30	-1.01
		2452	22.0	25.71	25.23	28.49	30	-1.51

Maximum Peak Conducted Output Power for Low Power, 20 MHz Channel Bandwidth at Data Rates 1 to 7								
Operating Mode	Data Rate (1 – 7)	Frequency (MHz)	Raw Power Setting (0 – 70)	Peak Power (dBm)		Total Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)
				Chain # 1	Chain # 2			
Low Power 20 MHz Channel Bandwidth	1	2412	0	14.00	13.07	16.57	30	-13.43
		2437	0	14.28	13.37	16.86	30	-13.14
		2462	0	14.21	13.65	16.95	30	-13.05
	2	2412	0	13.91	12.94	16.46	30	-13.54
		2437	0	14.36	13.45	16.94	30	-13.06
		2462	0	14.21	13.29	16.78	30	-13.22
	3	2412	0	13.86	12.81	16.38	30	-13.62
		2437	0	14.34	13.25	16.84	30	-13.16
		2462	0	14.05	13.24	16.67	30	-13.33
Low Power 20 MHz Channel Bandwidth	4	2412	0	17.17	15.69	19.50	30	-10.50
		2437	0	17.56	16.03	19.87	30	-10.13
		2462	0	17.45	16.15	19.86	30	-10.14
	5	2412	0	17.52	15.72	19.72	30	-10.28
		2437	0	17.45	16.03	19.81	30	-10.19
		2462	0	17.34	16.32	19.87	30	-10.13
	6	2412	0	15.56	13.55	17.68	30	-12.32
		2437	0	15.95	14.61	18.34	30	-11.66
		2462	0	16.12	14.51	18.40	30	-11.60
	7	2412	0	15.77	13.87	17.93	30	-12.07
		2437	0	15.53	13.80	17.76	30	-12.24
		2462	0	15.58	14.49	18.08	30	-11.92

Maximum Peak Conducted Output Power for Low Power, 40 MHz Channel Bandwidth at Data Rates 1 to 7								
Operating Mode	Data Rate (1 – 7)	Frequency (MHz)	Raw Power Setting (0 – 70)	Peak Power (dBm)		Total Peak Power (dBm)	Peak Power Limit (dBm)	Margin (dBm)
				Chain # 1	Chain # 2			
Low Power 40 MHz Channel Bandwidth	1	2422	0	16.45	14.87	18.74	30	-11.26
		2437	0	16.58	15.11	18.92	30	-11.08
		2452	0	16.65	15.54	19.14	30	-10.86
	2	2422	0	16.33	14.84	18.66	30	-11.34
		2437	0	16.79	15.14	19.05	30	-10.95
		2452	0	16.64	15.36	19.06	30	-10.94
	3	2422	0	16.29	14.61	18.54	30	-11.46
		2437	0	16.68	15.21	19.02	30	-10.98
		2452	0	16.55	15.33	18.99	30	-11.01
Low Power 40 MHz Channel Bandwidth	4	2422	0	16.17	13.97	18.22	30	-11.78
		2437	0	16.13	14.06	18.23	30	-11.77
		2452	0	16.29	14.56	18.52	30	-11.48
	5	2422	0	15.13	13.88	17.56	30	-12.44
		2437	0	15.62	14.11	17.94	30	-12.06
		2452	0	15.54	14.08	17.88	30	-12.12
	6	2422	0	15.24	14.25	17.78	30	-12.22
		2437	0	16.07	13.58	18.01	30	-11.99
		2452	0	15.16	14.52	17.86	30	-12.14
	7	2422	0	15.57	14.47	18.07	30	-11.93
		2437	0	15.43	13.95	17.76	30	-12.24
		2452	0	15.29	14.11	17.75	30	-12.25



## 5.4. TRANSMITTER BAND-EDGE & SPURIOUS CONDUCTED EMISSIONS [§ 15.247(d)]

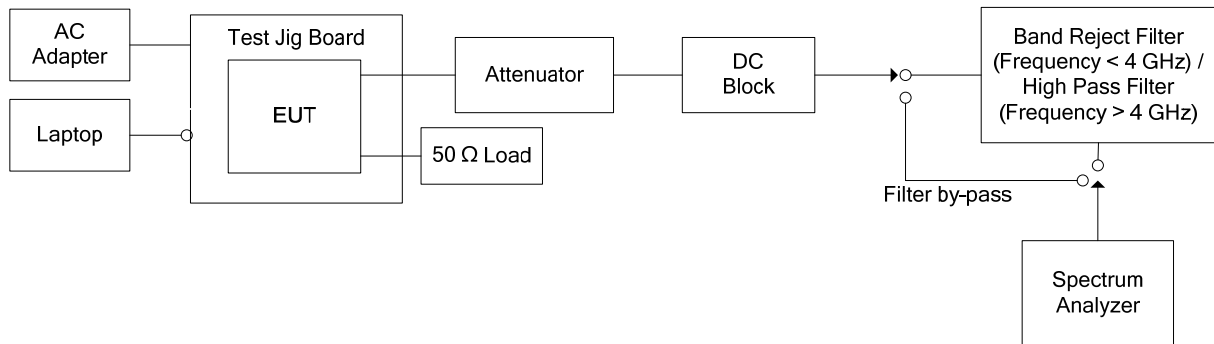
### 5.4.1. Limit(s)

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

### 5.4.2. Method of Measurements

KDB 558074 D01 15.247 Meas Guidance v05r02, Section 8.5, 8.6 and 8.7  
KDB 662911 D01 Multiple Transmitter Output v02r01 section E) 3) b)  
ANSI C63.10, Sections 6.10.4, 11.11 and 11.12

### 5.4.3. Test Arrangement



#### 5.4.4. Test Data

Remark(s): Exploratory tests performed to determined worst-case test configurations, the following test results represent the worst-case.

##### 5.4.4.1. Spurious RF Conducted Emissions in Non-restricted Frequency Bands

Refer to Appendix B for spurious RF conducted emissions in non-restricted frequency bands.

##### 5.4.4.2. Spurious RF Conducted Emissions in Restricted Frequency Bands

Refer to Appendix C for spurious RF conducted emissions in restricted frequency bands.

##### 5.4.4.3. Band-Edge RF Conducted Emissions

Refer to Appendix D for band-edge RF conducted emissions.

**5.5. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205]**

**5.5.1. Limit(s)**

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

**Section 15.205(a) - Restricted Bands of Operation**

MHz	MHz	MHz	GHz
0.090–0.110 .....	16.42–16.423	399.9–410	4.5–5.15
<sup>1</sup> 0.495–0.505 .....	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905 .....	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128 .....	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775 .....	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775 .....	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218 .....	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825 .....	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225 .....	123–138	2200–2300	14.47–14.5
8.291–8.294 .....	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366 .....	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675 .....	156.7–156.9	2655–2900	22.01–23.12
8.41425–8.41475 .....	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293 .....	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025 .....	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725 .....	322–335.4	3600–4400	( <sup>2</sup> )
13.36–13.41.			

<sup>1</sup>Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.

<sup>2</sup>Above 38.6

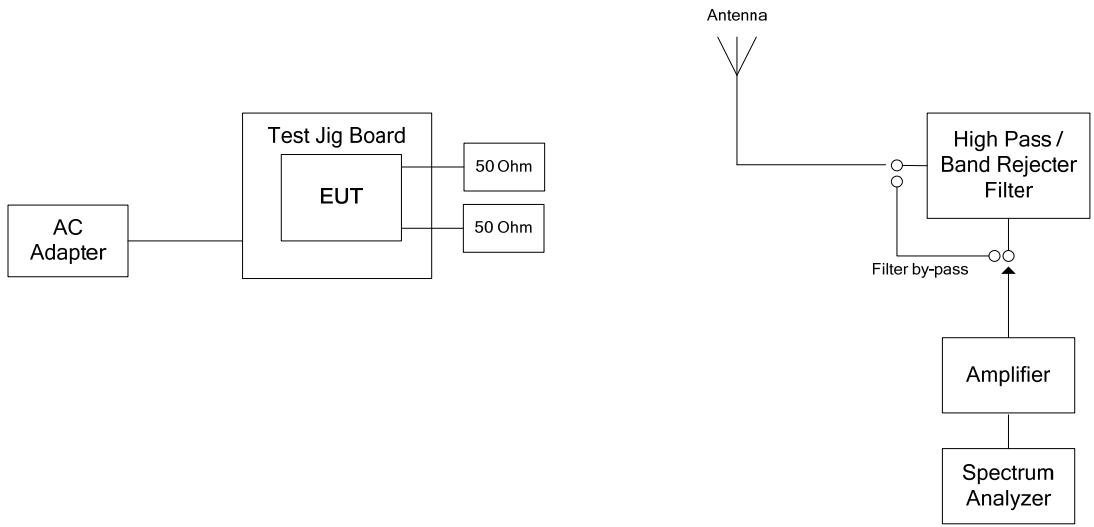
**Section 15.209(a) - Field Strength Limits within Restricted Frequency Bands**

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2,400 / F (kHz)	300
0.490 - 1.705	24,000 / F (kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

### 5.5.2. Method of Measurements

ANSI C63.10, Sections 6.3, 6.5, and 6.6.

### 5.5.3. Test Arrangement



**5.5.4. Test Data**

**Remark(s):**

- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT shall be tested in three orthogonal positions.
- § 15.247 (d) spurious emission limit:  
 $E = (EIRP - 20\log(d) + 104.8) - 20 = (36 \text{ dBm} - 20\log(3) + 104.8) - 20 = 111.3 \text{ dB}\mu\text{V/m}$
- Exploratory tests performed to determined worst-case test configurations, the following test results at high power setting to represent the worst-case.

**5.5.4.1. 20 MHz Channel Bandwidth, Data Rate 1**

Fundamental Frequency:		2412 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBμV/m)	RF Avg Level (dBμV/m)	Antenna Plane (H/V)	Limit 15.209 (dBμV/m)	Limit 15.247 (dBμV/m)	Margin (dB)	Pass/Fail
4824	48.60	43.80	V	54.0	111.3	-10.2	Pass*
4824	47.10	41.60	H	54.0	111.3	-12.4	Pass*
*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.							

Fundamental Frequency:		2437 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBμV/m)	RF Avg Level (dBμV/m)	Antenna Plane (H/V)	Limit 15.209 (dBμV/m)	Limit 15.247 (dBμV/m)	Margin (dB)	Pass/Fail
30 - 25000	*	*	H/V	*	*	*	*
*All spurious emissions and harmonics are more than 20 dB below the applicable limit.							

Fundamental Frequency:		2462 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBμV/m)	RF Avg Level (dBμV/m)	Antenna Plane (H/V)	Limit 15.209 (dBμV/m)	Limit 15.247 (dBμV/m)	Margin (dB)	Pass/Fail
4924	49.00	42.00	H	54.0	111.3	-12.0	Pass*
*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.							

**5.5.4.2. 20 MHz Channel Bandwidth, Data Rate 4**

Fundamental Frequency:		2412 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
30 - 25000	*	*	H/V	*	*	*	*
*All spurious emissions and harmonics are more than 20 dB below the applicable limit.							

Fundamental Frequency:		2437 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
30 - 25000	*	*	H/V	*	*	*	*
*All spurious emissions and harmonics are more than 20 dB below the applicable limit.							

Fundamental Frequency:		2462 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
30 - 25000	*	*	H/V	*	*	*	*
*All spurious emissions and harmonics are more than 20 dB below the applicable limit.							

**5.5.4.3. 40 MHz Channel Bandwidth, Data Rate 1**

Fundamental Frequency:		2422 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
30 - 25000	*	*	H/V	*	*	*	*
*All spurious emissions and harmonics are more than 20 dB below the applicable limit.							

Fundamental Frequency:		2437 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
30 - 25000	*	*	H/V	*	*	*	*
*All spurious emissions and harmonics are more than 20 dB below the applicable limit.							

Fundamental Frequency:		2452 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
30 - 25000	*	*	H/V	*	*	*	*
*All spurious emissions and harmonics are more than 20 dB below the applicable limit.							

**5.5.4.4. 40 MHz Channel Bandwidth, Data Rate 4**

Fundamental Frequency:		2422 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
30 - 25000	*	*	H/V	*	*	*	*
*All spurious emissions and harmonics are more than 20 dB below the applicable limit.							

Fundamental Frequency:		2437 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
30 - 25000	*	*	H/V	*	*	*	*
*All spurious emissions and harmonics are more than 20 dB below the applicable limit.							

Fundamental Frequency:		2452 MHz					
Frequency Test Range:		30 MHz – 25 GHz					
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit 15.247 (dBµV/m)	Margin (dB)	Pass/Fail
30 - 25000	*	*	H/V	*	*	*	*
*All spurious emissions and harmonics are more than 20 dB below the applicable limit.							



## 5.6. POWER SPECTRAL DENSITY [§ 15.247(e)]

### 5.6.1. Limit(s)

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

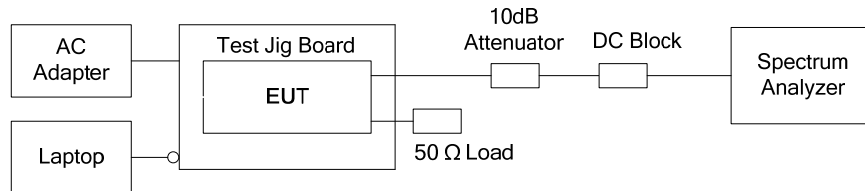
### 5.6.2. Method of Measurements

KDB 558074 D01 15.247 Meas Guidance v05r02, Section 8.4 DTS maximum PSD level in the fundamental emissions

KDB 662911 D01 Multiple Transmitter Output v02r01, Section (E)(2)(a) Measure-and sum the spectra across the outputs.

ANSI C63.10-2013 Section 11.10.2 Method PKPSD

### 5.6.3. Test Arrangement



5.6.4. Test Data

Channel Bandwidth: 20 MHz, Data Rates: 1, 2, 3, 4, 5, 6 and 7						
Data Rate	Frequency (MHz)	Raw Power Setting (0-70)	Combine PSD (dBm)	Array Gain (dB)	PSD (dBm)	Max. Limit (dBm)
1	2412	26	3.22	3.01	6.23	8
	2437	26	3.18	3.01	6.19	8
	2462	26	3.53	3.01	6.54	8
2	2412	26	3.81	3.01	6.82	8
	2437	26	4.65	3.01	7.66	8
	2462	26	4.95	3.01	7.96	8
3	2412	26	2.97	3.01	5.98	8
	2437	26	3.07	3.01	6.08	8
	2462	26	2.78	3.01	5.79	8
4	2412	21	-1.72	3.01	1.29	8
	2437	21	-0.75	3.01	2.26	8
	2462	21	-1.05	3.01	1.97	8
5	2412	21	-1.54	3.01	1.47	8
	2437	21	0.34	3.01	3.35	8
	2462	21	-1.11	3.01	1.90	8
6	2412	23	-5.20	3.01	-2.19	8
	2437	23	-4.19	3.01	-1.18	8
	2462	23	-4.31	3.01	-1.30	8
7	2412	23	-5.47	3.01	-2.46	8
	2437	23	-4.17	3.01	-1.16	8
	2462	23	-5.08	3.01	-2.07	8

Channel Bandwidth: 40 MHz, Data Rates: 1, 2, 3, 4, 5, 6 and 7						
Data Rate	Frequency (MHz)	Raw Power Setting (0-70)	Combine PSD (dBm)	Array Gain (dB)	PSD (dBm)	Max. Limit (dBm)
1	2422	13	-8.58	3.01	-5.57	8
	2437	22	-4.30	3.01	-1.29	8
	2452	15	-6.84	3.01	-3.82	8
2	2422	13	-8.24	3.01	-5.23	8
	2437	22	-4.42	3.01	-1.41	8
	2452	15	-7.13	3.01	-4.12	8
3	2422	13	-8.51	3.01	-5.50	8
	2437	22	-4.30	3.01	-1.29	8
	2452	15	-6.98	3.01	-3.97	8
4	2422	20	-9.45	3.01	-6.44	8
	2437	24	-7.00	3.01	-3.99	8
	2452	22	-8.08	3.01	-5.07	8
5	2422	20	-8.38	3.01	-5.37	8
	2437	24	-7.37	3.01	-4.36	8
	2452	22	-8.23	3.01	-5.22	8
6	2422	20	-9.14	3.01	6.13	8
	2437	24	-6.95	3.01	-3.94	8
	2452	22	-8.08	3.01	-5.07	8
7	2422	20	-9.64	3.01	-6.63	8
	2437	24	-7.35	3.01	-4.34	8
	2452	22	-8.25	3.01	-5.24	8

**5.7. RF EXPOSURE REQUIRMENTS [§§ 15.247(i), 1.1310 & 2.1091]**

**5.7.1. Limits**

§ 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

**Limits for Maximum Permissible Exposure (MPE)**

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
<b>(A) Limits for Occupational/Controlled Exposures</b>				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f <sup>2</sup> )	6
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5	6
<b>(B) Limits for General Population/Uncontrolled Exposure</b>				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f <sup>2</sup> )	30
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

f = frequency in MHz

\* = Plane-wave equivalent power density

Note 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

Note 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

**5.7.2. Method of Measurements**

**Calculation Method of Power Density/RF Safety Distance:**

$$S = \frac{PG}{4\pi \cdot r^2} = \frac{EIRP}{4\pi \cdot r^2}$$

Where, P: power input to the antenna in mW  
EIRP: Equivalent (effective) isotropic radiated power.  
S: power density mW/cm<sup>2</sup>  
G: numeric gain of antenna relative to isotropic radiator  
r: distance to centre of radiation in cm

**5.7.3. RF Evaluation**

**5.7.3.1. Standalone MPE Evaluation**

Frequency (MHz)	EIRP (dBm)	EIRP (mW)	Evaluation Distance, r (cm)	Power Density, S (mW/cm <sup>2</sup> )	MPE Limit (mW/cm <sup>2</sup> )	Margin (mW/cm <sup>2</sup> )
2412	36.00	3981.072	25	0.507	1.0	-0.493

**5.7.3.2. Co-location MPE Evaluation**

Pursuant to KDB 447498 D01 General RF Exposure Guidance v06, Section 7.2:

*Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0, according to calculated/estimated, numerically modeled, or measured field strengths or power density.*

The table below is the possible co-located options of the EUT:

Source Option	EUT, Microhard Systems Inc. WiFi Module, pX2 Gen2 (FCC ID: NS9A15PX2)	Quectel Wireless Solutions Company Limited, LTE Module, EC25-AF; EC25-AF MINIPCIE (FCC ID: XMR201808EC25AF)	Quectel Wireless Solutions Company Limited, LTE Module, EG25-G, EG25-G MINIPCIE (FCC ID: XMR201903EG25G)	Quectel Wireless Solutions Company Limited, LTE Cat M1 & Cat NB2 & EGPRS Module, BG95-M3, BG95-M3 MINIPCIE (FCC ID: XMR201910BG95M3)	Quectel Wireless Solutions Company Limited, LTE-A Cat 12 M.2 Module, EM12-G (FCC ID: XMR201901EM12G)
1	X	X	--	--	--
2	X	--	X	--	--
3	X	--	--	X	--
4	X	--	--	--	X

Co-location evaluation will only applies to EUT with 2.5 dBi dipole antenna, evaluated at a separation distance of 38 cm. The table below is the calculation for all the possible options and the sum of the MPE ratios from all sources.

Source Option	Maximum MPE Ratio					Sum of the MPE ratios from all sources
	EUT, Microhard Systems Inc. WiFi Module, pX2 Gen2 (FCC ID: NS9A15PX2)	Quectel Wireless Solutions Company Limited, LTE Module, EC25-AF; EC25-AF MINIPICIE (FCC ID: XMR201808EC25AF)	Quectel Wireless Solutions Company Limited, LTE Module, EG25-G; EG25-G MINIPICIE (FCC ID: XMR201903EG25G)	Quectel Wireless Solutions Company Limited, LTE Cat M1 & Cat NB2 & EGPRS Module, BG95-M3, BG95-M3 MINIPICIE (FCC ID: XMR201910BG95M3)	Quectel Wireless Solutions Company Limited, LTE-A Cat 12 M.2 Module, EM12-G (FCC ID: XMR201901EM12G)	
1	0.120	0.277	--	--	--	0.397
2	0.120	--	0.470	--	--	0.590
3	0.120	--	--	0.277	--	0.397
4	0.120	--	--	--	0.114	0.234

The sum of the MPE ratios from all sources is < 1. Thus, in compliant with the general public (uncontrolled environment) MPE limit.

For detailed MPE ratios calculation, refer to the following tables.

Calculated MPE Ratio for EUT Module					
Frequency (MHz)	<sup>1</sup> Maximum EIRP (dBm)	Maximum EIRP (mW)	Power Density at 38cm (mW/cm <sup>2</sup> )	Limit (mW/cm <sup>2</sup> )	MPE Ratio
2412	33.38	2177.710	0.1200	1.000	<b>0.120</b>

<sup>1</sup> The EUT EIRP is derived from the maximum conducted power of 27.87 dBm + 2.5 dBi antenna gain + array gain of 10\*log(2).

Calculated MPE Ratio for Quectel Wireless Solutions Company Limited, LTE Module, EC25-AF; EC25-AF MINIPICIE								
Operating Mode	<sup>1</sup> Maximum Conducted Power (dBm)	<sup>1</sup> Maximum Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	Evaluation Distance (cm)	Power Density (mW/cm <sup>2</sup> )	Limit (mW/cm <sup>2</sup> )	MPE Ratio
WCDMA II	25.00	8.000	33.000	1995.262	38	0.110	1.000	0.110
WCDMA IV	25.00	5.000	30.000	1000.000	38	0.055	1.000	0.055
WCDMA V	25.00	9.416	34.416	2764.394	38	0.152	0.550	<b>0.277</b>
LTE Band 2	25.00	8.000	33.000	1995.262	38	0.110	1.000	0.110
LTE Band 4	25.00	5.000	30.000	1000.000	38	0.055	1.000	0.055
LTE Band 5	25.00	9.416	34.416	2764.394	38	0.152	0.550	0.277
LTE Band 12	25.00	8.734	33.734	2362.653	38	0.130	0.470	0.277
LTE Band 13	25.00	9.173	34.173	2613.966	38	0.144	0.520	0.277
LTE Band 14	25.00	9.255	34.255	2663.790	38	0.147	0.530	0.277
LTE Band 66	25.00	5.000	30.000	1000.000	38	0.055	1.000	0.055
LTE Band 71	25.00	8.545	33.545	2262.039	38	0.125	0.450	0.277

<sup>1</sup> Data derived from Quectel LTE Module MPE test report, Test Report No. R1806A0301-M1V3.

Calculated MPE Ratio for Quectel Wireless Solutions Company Limited, LTE Module, EG25-G, EG25-G MINIPCIE										
Operating Band	<sup>1</sup> Frequency (MHz)	<sup>1</sup> Max Conducted Average Output Power (dBm)	<sup>1</sup> Output Power to Antenna (dBm)	<sup>1</sup> Max Gain Allowed (dBi)	Max. E.I.R.P. (dBm)	Max. E.I.R.P. (mW)	Evaluation Distance (cm)	Power Density (mW/cm <sup>2</sup> )	FCC Limit (mW/cm <sup>2</sup> )	MPE Ratio
GSM850	824.2	25.81	25.95	8.60	34.55	2851.018	38	0.157	0.5495	0.286
GSM1900	1850.2	22.81	24.40	10.19	34.59	2877.398	38	0.159	1.0000	0.159
WCDMA B2	1852.4	25.00	26.59	8.00	34.59	2877.398	38	0.159	1.0000	0.159
WCDMA B4	1712.4	25.00	27.00	5.00	32.00	1584.893	38	0.087	1.0000	0.087
WCDMA B5	826.4	25.00	25.14	9.42	34.56	2857.591	38	0.157	0.5509	0.285
LTE B2	1850.7	25.00	26.59	8.00	34.59	2877.398	38	0.159	1.0000	0.159
LTE B4	1710.7	25.00	27.00	5.00	32.00	1584.893	38	0.087	1.0000	0.087
LTE B5	824.7	25.00	25.14	9.41	34.55	2851.018	38	0.157	0.5498	0.286
LTE B7	2502.5	25.00	28.00	8.00	36.00	3981.072	38	0.219	1.0000	0.219
LTE B12	699.7	25.00	26.11	8.70	34.81	3026.913	38	0.167	0.4665	0.358
LTE B13	779.5	25.00	27.30	9.16	36.46	4425.884	38	0.244	0.5197	<b>0.470</b>
LTE B25	1850.7	25.00	26.59	8.00	34.59	2877.398	38	0.159	1.0000	0.159
LTE B26 (814-824)	814.7	25.00	25.38	9.36	34.74	2978.516	38	0.164	0.5431	0.302
LTE B26 (824-849)	824.7	25.00	25.38	9.41	34.79	3013.006	38	0.166	0.5498	0.302
LTE B38	2572.5	25.00	27.06	8.00	35.06	3206.269	38	0.177	1.0000	0.177
LTE B41	2498.5	25.00	28.00	8.00	36.00	3981.072	38	0.219	1.0000	0.219

<sup>1</sup> Data derived from Quectel LTE Module MPE test report, Test Report No. HR/2019/1001602.

Calculated MPE Ratio for Quectel Wireless Solutions Company Limited, LTE Cat M1 & Cat NB2 & EGPRS Module, BG95-M3, BG95-M3 MINIPCIE					
Band	<sup>1</sup> EIRP (mW)	Evaluation Distance (cm)	Power Desnity (mW/cm <sup>2</sup> )	Power Density Limit (mW/cm <sup>2</sup> )	MPE Ratio
GSM850	2845.116	38	0.157	0.566	<b>0.277</b>
GSM1900	1995.262	38	0.110	1.000	0.110
LTE Band 2	1995.262	38	0.110	1.000	0.110
LTE Band 4	1000.000	38	0.055	1.000	0.055
LTE Band 5	2845.116	38	0.157	0.566	0.277
LTE Band 12	2397.728	38	0.132	0.477	0.277
LTE Band 13	2638.761	38	0.145	0.525	0.277
LTE Band 25	1995.262	38	0.110	1.000	0.110
LTE Band 26	2845.116	38	0.157	0.566	0.277
LTE Band 66	1000.000	38	0.055	1.000	0.055
LTE Band 85	2397.728	38	0.132	0.477	0.277
NB-IOT Band 2	1995.262	38	0.110	1.000	0.110
NB-IOT Band 4	1000.000	38	0.055	1.000	0.055
NB-IOT Band 5	2845.116	38	0.157	0.566	0.277
NB-IOT Band 12	2397.728	38	0.132	0.477	0.277
NB-IOT Band 13	2638.761	38	0.145	0.525	0.277
NB-IOT Band 25	1995.262	38	0.110	1.000	0.110
NB-IOT Band 66	1000.000	38	0.055	1.000	0.055
NB-IOT Band 71	2337.222	38	0.129	0.465	0.277
NB-IOT Band 85	2397.728	38	0.132	0.477	0.277

<sup>1</sup> Data derived from Quectel LTE Module MPE test report, Test Report No. R2006A0361-M1V1.



Calculated MPE Ratio for Quectel Wireless Solutions Company Limited, LTE-A Cat 12 M.2 Module, EM12-G									
Band	<sup>1</sup> Frequency (MHz)	<sup>1</sup> Antenna Gain (dBi)	<sup>1</sup> Maximum Power (dBm)	Maximum EIRP (dBm)	Maximum EIRP (mW)	Evaluation Distance (cm)	Power Density (mW/cm <sup>2</sup> )	<sup>1</sup> Limit (mW/cm <sup>2</sup> )	MPE Ratio
WCDMA Band II	1852.4	7.00	24.00	31.000	1258.925	38	0.069	1.000	0.069
WCDMA Band IV	1712.4	5.00	24.00	29.000	794.328	38	0.044	1.000	0.044
WCDMA Band V	826.4	6.00	24.00	30.000	1000.000	38	0.055	0.551	0.100
LTE Band 2	1850.7	7.00	24.50	31.500	1412.538	38	0.078	1.000	0.078
LTE Band 4	1710.7	5.00	24.50	29.500	891.251	38	0.049	1.000	0.049
LTE Band 5	824.7	6.00	24.50	30.500	1122.018	38	0.062	0.550	0.112
LTE Band 7	2502.5	7.00	24.50	31.500	1412.538	38	0.078	1.000	0.078
LTE Band 12	699.7	5.00	24.50	29.500	891.251	38	0.049	0.466	0.105
LTE Band 13	779.5	5.00	24.50	29.500	891.251	38	0.049	0.520	0.094
LTE Band 14	790.5	5.00	24.50	29.500	891.251	38	0.049	0.527	0.093
LTE Band 17	706.5	5.00	24.50	29.500	891.251	38	0.049	0.471	0.104
LTE Band 25	1850.7	7.00	24.50	31.500	1412.538	38	0.078	1.000	0.078
LTE Band 26	814.7	6.00	24.50	30.500	1122.018	38	0.062	0.543	<b>0.114</b>
LTE Band 30	2307.5	4.00	20.50	24.500	281.838	38	0.016	1.000	0.016
LTE Band 38	2572.5	7.00	24.50	31.500	1412.538	38	0.078	1.000	0.078
LTE Band 41	2498.5	7.00	24.50	31.500	1412.538	38	0.078	1.000	0.078
LTE Band 66	1710.7	5.00	24.50	29.500	891.251	38	0.049	1.000	0.049

<sup>1</sup> Data derived from Quectel LTE Module MPE test report, Test Report No. FA8N2911.

**EXHIBIT 6. TEST EQUIPMENT LIST**

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Cal. Due Date
Spectrum Analyzer	Hewlett Packard	HP 8593EM	3710A00223	9 kHz–22 GHz	05 Nov 2022
High Pass filter	Rohde & Schwarz	EZ-25	830164/006	Cut off 150kHz	06 Aug 2022
LISN Used	Schwarzbeck	NSLK8127	8127276	9 kHz–30 MHz	20 Oct 2022
Spectrum Analyzer	Rohde & Schwarz	FSU26	200946	20Hz–26.5 GHz	11 Mar 2023
DC Block	Hewlett Packard	11742A	12460	0.045 – 26.5 GHz	See Note 1
Attenuator	Hewlett Packard	8493C	0465	DC–18 GHz	See Note 1
Laptop EMC2	Lenovo Thinkpad	0578	---	---	---
Peak Power Analyzer	Hewlett Packard	8991A	3342A00657	0.5 - 40 GHz	11 Mar 2024
Peak Power Sensor	Hewlett Packard	84814A	3205A00175	0.5 - 40 GHz	11 Mar 2024
Adjustable Attenuator	Hewlett Packard	8494B &8495B	11716A	DC–18 GHz	See Note 1
High Pass Filter	K & L	11SH10-4000/T12000	4	Cut off 2.4 GHz	See Note 1
Band Reject Filter	Micro-Tronics	BRM50701	105	Cut off 2.4-2.483 GHz	See Note 1
RF Amplifier	Hewlett Packard	84498	3008A00769	1 – 26.5 GHz	04 Jan 2023
Biconilog Antenna	EMCO	3142C	34792	26 – 3000 MHz	16 May 2022
Horn Antenna	EMCO	3155	5061	1 – 18 GHz	10 Jun 2022
Horn Antenna	ETS-Lindgren	3160-09	001183858	18 – 26.5 GHz	22 Jan 2023
Note 1: Internal Verification/Calibration check					

**EXHIBIT 7. MEASUREMENT UNCERTAINTY**

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

Test Description	Expanded Uncertainty, K=2 for 95% Confidence Level
Power Line Conducted Emissions	$\pm 2.62$
Conducted Output Power	$\pm 0.62$ dB
Power Spectral Density	$\pm 0.20$ Hz / $\pm 0.63$ dB
Occupied Bandwidth	$\pm 0.20$ Hz / $\pm 0.63$ dB
Transmitter Conducted Spurious Emissions	+/- 0.72 dB
Transmitter Spurious Radiated Emissions	$\pm 4.20$ dB (30 MHz – 1 GHz)
	$\pm 2.70$ dB (1 – 18 GHz)