

# TEST REPORT

Reference No..... : WTX20X07045384W  
FCC ID ..... : 2AD56HLK-B20  
Applicant ..... : ShenZhen HaiLingKe Electronic co.,Ltd  
Address ..... : 3F Caiyue Mansion, No.24 Liuxian blvd, LongHua District, Shenzhen,  
Guangdong, China  
Product Name ..... : BLE 4.2 wireless module  
Test Model. .... : HLK-B20  
Standards ..... : FCC Part 15.247  
Date of Receipt sample .... : Jul. 14, 2020  
Date of Test..... : Jul. 14, 2020 to Jul. 31, 2020  
Date of Issue ..... : Jul. 31, 2020  
Test Result..... : **Pass**

Remarks:

The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

**Prepared By:**

**Waltek Testing Group (Shenzhen) Co., Ltd.**

Address: 1/F., Room 101, Building 1, Hongwei Industrial Park, Liuxian 2nd Road,  
Block 70 Bao'an District, Shenzhen, Guangdong, China

Tel.: +86-755-33663308

Fax.: +86-755-33663309

Tested by:

*Jack Huang*

Jack Huang / Project Engineer

Reviewed By:

*Lion Cai*

Lion Cai / RF Manager

Approved & Authorized By:

*Silin Chen*

Silin Chen / Manager

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**Report version**

Version No.	Date of issue	Description
Rev.00	Jul. 31, 2020	Original
/	/	/

## 1. GENERAL INFORMATION

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### 1.1 Product Description for Equipment Under Test (EUT)

#### Client Information

Applicant: ShenZhen HaiLingKe Electronic co.,Ltd  
 Address of applicant: 3F Caiyue Mansion, No.24 Liuxian blvd, LongHua District,  
 Shenzhen, Guangdong, China

Manufacturer: ShenZhen HaiLingKe Electronic co.,Ltd  
 Address of manufacturer: 3F Caiyue Mansion, No.24 Liuxian blvd, LongHua District,  
 Shenzhen, Guangdong, China

General Description of EUT	
Product Name:	BLE 4.2 wireless module
Trade Name	HI-LINK
Model No.:	HLK-B20
Adding Model(s):	/
Rated Voltage:	DC 5.0V
Power Adapter:	/
Software Version:	HLK-B20(b.1.00.120200801185806)
Hardware Version:	HLK-B20-V1.0
<i>Note: The test data is gathered from a production sample, provided by the manufacturer.</i>	

Technical Characteristics of EUT	
Bluetooth Version:	V4.2 (BLE mode)
Frequency Range:	2402-2480MHz
RF Output Power:	3.807dBm (Conducted)
Data Rate:	1Mbps
Modulation:	GFSK
Quantity of Channels:	40
Channel Separation:	2MHz
Type of Antenna:	PCB Antenna
Antenna Gain:	1.0dBi

## 1.2 Test Standards

The tests were performed according to following standards:

**FCC Rules Part 15.247**: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

**558074 D01 15.247 Meas Guidance v05r02**: 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.

**ANSI C63.10-2013**: American National Standard for Testing Unlicensed Wireless Devices.

**Maintenance of compliance** is the responsibility of the manufacturer. Any modification of the product, which result in lowering the emission, should be checked to ensure compliance has been maintained.

## 1.3 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02.

The equipment under test (EUT) was configured to measure its highest possible emission level. The test modes were adapted accordingly in reference to the Operating Instructions.

## 1.4 Test Facility

### **Address of the test laboratory**

Laboratory: Waltek Testing Group (Shenzhen) Co., Ltd.

Address: 1/F., Room 101, Building 1, Hongwei Industrial Park, Liuxian 2nd Road, Block 70 Bao'an District, Shenzhen, Guangdong, China

### **FCC – Registration No.: 125990**

Waltek Testing Group (Shenzhen) Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintained in our files. The Designation Number is CN5010, and Test Firm Registration Number is 125990.

### **Industry Canada (IC) Registration No.: 11464A**

The 3m Semi-anechoic chamber of Waltek Testing Group (Shenzhen) Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 11464A.

## 1.5 EUT Setup and Test Mode

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. All testing shall be performed under maximum output power condition, with a duty cycle equal to 100%, and to measure its highest possible emissions level, more detailed description as follows:

Test Mode List		
Test Mode	Description	Remark
TM1	Low	2402MHz
TM2	Middle	2440MHz
TM3	High	2480MHz

Test Conditions	
Temperature:	22~25 °C
Relative Humidity:	50~55 %.
ATM Pressure:	1019 mbar

EUT Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
/	/	/	/

Special Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
USB Cable	1.0	Unshielded	Without Ferrite

Auxiliary Equipment List and Details			
Description	Manufacturer	Model	Serial Number
Notebook	Lenovo	E445	EB12648265

## 1.6 Measurement Uncertainty

Measurement uncertainty		
Parameter	Conditions	Uncertainty
RF Output Power	Conducted	±0.42dB
Occupied Bandwidth	Conducted	±1.5%
Power Spectral Density	Conducted	±1.8dB
Conducted Spurious Emission	Conducted	±2.17dB
Conducted Emissions	Conducted	9-150kHz ±3.74dB
		0.15-30MHz ±3.34dB
Transmitter Spurious Emissions	Radiated	30-200MHz ±4.52dB
		0.2-1GHz ±5.56dB
		1-6GHz ±3.84dB
		6-18GHz ±3.92dB

**1.7 Test Equipment List and Details**

No.	Description	Manufacturer	Model	Serial No.	Cal Date	Due Date
SEMT-1072	Spectrum Analyzer	Agilent	E4407B	MY41440400	2020-04-28	2021-04-27
SEMT-1031	Spectrum Analyzer	Rohde & Schwarz	FSP30	836079/035	2020-04-28	2021-04-27
SEMT-1007	EMI Test Receiver	Rohde & Schwarz	ESVB	825471/005	2020-04-28	2021-04-27
SEMT-1008	Amplifier	Agilent	8447F	3113A06717	2020-04-28	2021-04-27
SEMT-1043	Amplifier	C&D	PAP-1G18	2002	2020-04-28	2021-04-27
SEMT-1011	Broadband Antenna	Schwarz beck	VULB9163	9163-333	2019-05-05	2021-05-04
SEMT-1042	Horn Antenna	ETS	3117	00086197	2019-05-05	2021-05-04
SEMT-1121	Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170582	2019-05-05	2021-05-04
SEMT-1069	Loop Antenna	Schwarz beck	FMZB 1516	9773	2019-05-05	2021-05-04
SEMT-1001	EMI Test Receiver	Rohde & Schwarz	ESPI	101611	2020-04-28	2021-04-27
SEMT-1003	L.I.S.N	Schwarz beck	NSLK8126	8126-224	2020-04-28	2021-04-27
SEMT-1002	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100911	2020-04-28	2021-04-27
SEMT-1168	Pre-amplifier	Direction Systems Inc.	PAP-0126	14141-12838	2020-04-28	2021-04-27
SEMT-1169	Pre-amplifier	Direction Systems Inc.	PAP-2640	14145-14153	2020-04-28	2021-04-27
SEMT-1163	Spectrum Analyzer	Rohde & Schwarz	FSP40	100612	2020-04-28	2021-04-27
SEMT-1170	DRG Horn Antenna	A.H. SYSTEMS	SAS-574	571	2019-05-05	2021-05-04
SEMT-1166	Power Limiter	Agilent	N9356B	MY45450376	2020-04-28	2021-04-27
SEMT-1048	RF Limiter	ATTEN	AT-BSF-2400~2500	/	2020-04-28	2021-04-27
SEMT-1076	RF Switcher	Top Precision	RCS03-A2	/	2020-04-28	2021-04-27
SEMT-C001	Cable	Zheng DI	LL142-07-07-10M(A)	/	2020-03-17	2021-03-16
SEMT-C002	Cable	Zheng DI	ZT40-2.92J-2.92J-6M	/	2020-03-17	2021-03-16
SEMT-C003	Cable	Zheng DI	ZT40-2.92J-2.92J-2.5M	/	2020-03-17	2021-03-16
SEMT-C004	Cable	Zheng DI	2M0RFC	/	2020-03-17	2021-03-16
SEMT-C005	Cable	Zheng DI	1M0RFC	/	2020-03-17	2021-03-16
SEMT-C006	Cable	Zheng DI	1M0RFC	/	2020-03-17	2021-03-16

<b>Software List</b>			
<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>	<b>Version</b>
EMI Test Software (Radiated Emission)*	Farad	EZ-EMC	RA-03A1
EMI Test Software (Conducted Emission)*	Farad	EZ-EMC	RA-03A1

\*Remark: indicates software version used in the compliance certification testing



## 2. SUMMARY OF TEST RESULTS

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<b>FCC Rules</b>	<b>Description of Test Item</b>	<b>Result</b>
§2.1093	RF Exposure	Compliant
§15.203; §15.247(b)(4)(i)	Antenna Requirement	Compliant
§15.205	Restricted Band of Operation	Compliant
§15.207(a)	Conducted Emission	Compliant
§15.247(e)	Power Spectral Density	Compliant
§15.247(a)(2)	DTS Bandwidth	Compliant
§15.247(b)(3)	RF Output Power	Compliant
§15.209(a)	Radiated Emission	Compliant
§15.247(d)	Band Edge (Out of Band Emissions)	Compliant

N/A: Not applicable

### **3. RF Exposure**

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#### **3.1 Standard Applicable**

According to §1.1307 and §2.1093, the portable transmitter must comply the RF exposure requirements.

#### **3.2 Test Result**

This product complied with the requirement of the RF exposure, please see the RF Exposure Report.

## **4. Antenna Requirement**

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### **4.1 Standard Applicable**

According to FCC Part 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

### **4.2 Evaluation Information**

This product has a PCB antenna, fulfill the requirement of this section.

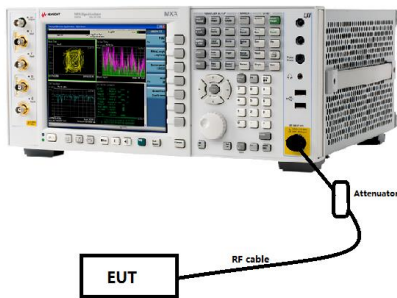
## 5. Power Spectral Density

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### 5.1 Standard Applicable

According to 15.247(a)(1)(iii), 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.

### 5.2 Test Setup Block Diagram



### 5.3 Test Procedure

According to the KDB 558074 D01 v05r02 Subclause 8.4 and ANSI C63.10-2013 Subclause 11.10.2, the test method of power spectral density as below:

- a) Set analyzer center frequency to DTS channel center frequency.
- b) Set the span to 1.5 times the DTS bandwidth.
- c) Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
- d) Set the VBW  $\geq 3 \times \text{RBW}$ .
- e) Detector = peak.
- f) Sweep time = auto couple.
- g) Trace mode = max hold.
- h) Allow trace to fully stabilize.
- i) Use the peak marker function to determine the maximum amplitude level within the RBW.
- j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### 5.4 Summary of Test Results/Plots

Test Mode	Test Channel	Power Spectral Density dBm/3kHz	Limit dBm/3kHz
GFSK(BLE)	Low	-10.52	8
	Middle	-10.41	8
	High	-10.31	8

Please refer to the following test plots:

<p>Low</p>	<p>Agilent R T          Ref 10 dBm Atten 20 dB Mkr1 2.4018920 GHz -10.52 dBm          #Peak Log 10 dB/Offset 1 dB          M1 S2 S3 FC AA          Marker 2.401892000 GHz -10.52 dBm          Center 2.402 GHz Span 1.5 MHz          #Res BW 3 kHz #VBW 10 kHz Sweep 171.5 ms (1001 pts)</p>
<p>Middle</p>	<p>Agilent R T          Ref 10 dBm Atten 20 dB Mkr1 2.4398920 GHz -10.41 dBm          #Peak Log 10 dB/Offset 1 dB          M1 S2 S3 FC AA          Marker 2.439892000 GHz -10.41 dBm          Center 2.44 GHz Span 1.5 MHz          #Res BW 3 kHz #VBW 10 kHz Sweep 171.5 ms (1001 pts)</p>
<p>High</p>	<p>Agilent R T          Ref 10 dBm Atten 20 dB Mkr1 2.4798905 GHz -10.31 dBm          #Peak Log 10 dB/Offset 1 dB          M1 S2 S3 FC AA          Marker 2.479890500 GHz -10.31 dBm          Center 2.48 GHz Span 1.5 MHz          #Res BW 3 kHz #VBW 10 kHz Sweep 171.5 ms (1001 pts)</p>

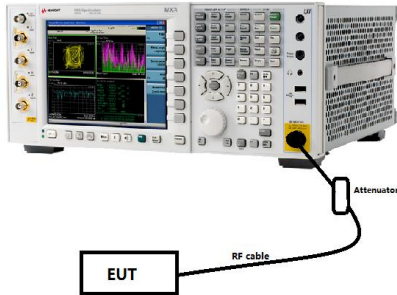
## 6. DTS Bandwidth

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### 6.1 Standard Applicable

According to 15.247(a)(2), systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### 6.2 Test Setup Block Diagram



### 6.3 Test Procedure

According to the KDB 558074 D01 v05r02 Subclause 8.2 and ANSI C63.10-2013 Subclause 11.8.1, the test method of DTS Bandwidth as below:

- Set RBW = 100 kHz.
- Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
- Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Allow the trace to stabilize.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

### 6.4 Summary of Test Results/Plots

Test Mode	Test Channel	6 dB Bandwidth MHz	Limit kHz
GFSK(BLE)	Low	0.885	$\geq 500$
	Middle	0.797	$\geq 500$
	High	0.777	$\geq 500$

Please refer to the following test plots:

<p>Low</p>	<p>Agilent R T</p> <p>Ch Freq 2.402 GHz Trig Free</p> <p>Occupied Bandwidth</p> <p>Ref 10 dBm Atten 20 dB</p> <p>#Peak Log 10 dB/ Offst 1 dB</p> <p>Center 2.402 GHz Span 3 MHz</p> <p>#Res BW 100 kHz #VBW 300 kHz Sweep 10 ms (1001 pts)</p> <table border="1"> <tr> <td><b>Occupied Bandwidth</b></td> <td>Occ BW % Pwr</td> <td>99.00 %</td> </tr> <tr> <td>1.5825 MHz</td> <td>x dB</td> <td>-6.00 dB</td> </tr> <tr> <td>Transmit Freq Error</td> <td colspan="2">-142.656 kHz</td> </tr> <tr> <td>x dB Bandwidth</td> <td colspan="2">884.769 kHz</td> </tr> </table> <p>Marker</p> <p>Select Marker 1 2 3 4</p> <p>Normal</p> <p>Delta</p> <p>Delta Pair (Tracking Ref) Ref Delta</p> <p>Span Pair Span Center</p> <p>Off</p> <p>More 1 of 2</p>	<b>Occupied Bandwidth</b>	Occ BW % Pwr	99.00 %	1.5825 MHz	x dB	-6.00 dB	Transmit Freq Error	-142.656 kHz		x dB Bandwidth	884.769 kHz	
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1.5825 MHz	x dB	-6.00 dB											
Transmit Freq Error	-142.656 kHz												
x dB Bandwidth	884.769 kHz												
<p>Middle</p>	<p>Agilent R T</p> <p>Ch Freq 2.44 GHz Trig Free</p> <p>Occupied Bandwidth</p> <p>Ref 10 dBm Atten 20 dB</p> <p>#Peak Log 10 dB/ Offst 1 dB</p> <p>Center 2.44 GHz Span 3 MHz</p> <p>#Res BW 100 kHz #VBW 300 kHz Sweep 10 ms (1001 pts)</p> <table border="1"> <tr> <td><b>Occupied Bandwidth</b></td> <td>Occ BW % Pwr</td> <td>99.00 %</td> </tr> <tr> <td>1.6618 MHz</td> <td>x dB</td> <td>-6.00 dB</td> </tr> <tr> <td>Transmit Freq Error</td> <td colspan="2">-128.595 kHz</td> </tr> <tr> <td>x dB Bandwidth</td> <td colspan="2">797.265 kHz</td> </tr> </table> <p>Marker</p> <p>Select Marker 1 2 3 4</p> <p>Normal</p> <p>Delta</p> <p>Delta Pair (Tracking Ref) Ref Delta</p> <p>Span Pair Span Center</p> <p>Off</p> <p>More 1 of 2</p>	<b>Occupied Bandwidth</b>	Occ BW % Pwr	99.00 %	1.6618 MHz	x dB	-6.00 dB	Transmit Freq Error	-128.595 kHz		x dB Bandwidth	797.265 kHz	
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<p>High</p>	<p>Agilent R T</p> <p>Ch Freq 2.48 GHz Trig Free</p> <p>Occupied Bandwidth</p> <p>Ref 10 dBm Atten 20 dB</p> <p>#Peak Log 10 dB/ Offst 1 dB</p> <p>Center 2.48 GHz Span 3 MHz</p> <p>#Res BW 100 kHz #VBW 300 kHz Sweep 10 ms (1001 pts)</p> <table border="1"> <tr> <td><b>Occupied Bandwidth</b></td> <td>Occ BW % Pwr</td> <td>99.00 %</td> </tr> <tr> <td>1.6653 MHz</td> <td>x dB</td> <td>-6.00 dB</td> </tr> <tr> <td>Transmit Freq Error</td> <td colspan="2">-119.492 kHz</td> </tr> <tr> <td>x dB Bandwidth</td> <td colspan="2">776.528 kHz</td> </tr> </table> <p>Marker</p> <p>Select Marker 1 2 3 4</p> <p>Normal</p> <p>Delta</p> <p>Delta Pair (Tracking Ref) Ref Delta</p> <p>Span Pair Span Center</p> <p>Off</p> <p>More 1 of 2</p>	<b>Occupied Bandwidth</b>	Occ BW % Pwr	99.00 %	1.6653 MHz	x dB	-6.00 dB	Transmit Freq Error	-119.492 kHz		x dB Bandwidth	776.528 kHz	
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1.6653 MHz	x dB	-6.00 dB											
Transmit Freq Error	-119.492 kHz												
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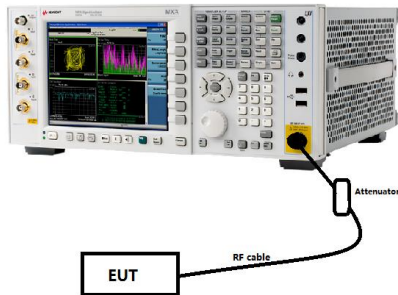
## 7. RF Output Power

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### 7.1 Standard Applicable

According to 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.

### 7.2 Test Setup Block Diagram



### 7.3 Test Procedure

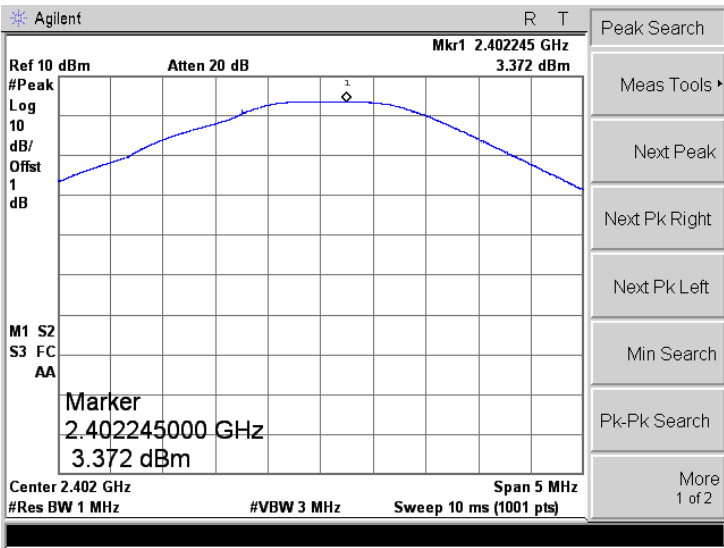
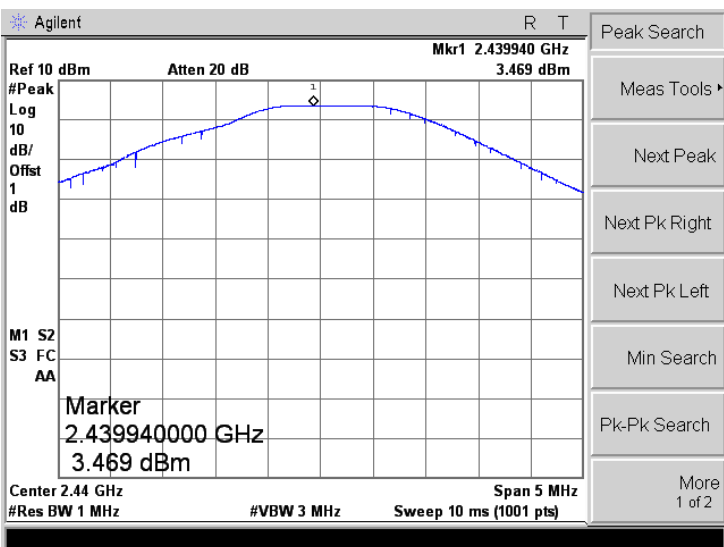
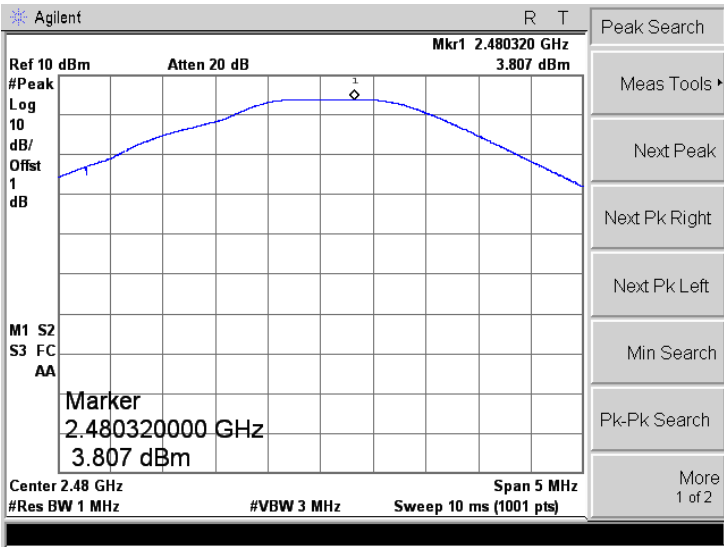
According to the KDB-558074 D01 v05r02 Subclause 8.3.1.1 and ANSI C63.10-2013 Subclause 11.9.1.1, this procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

- Set the RBW  $\geq$  DTS bandwidth.
- Set VBW  $\geq 3 \times$  RBW.
- Set span  $\geq 3 \times$  RBW
- Sweep time = auto couple.
- Detector = peak.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use peak marker function to determine the peak amplitude level.

### 7.4 Summary of Test Results/Plots

Test Mode	Test Channel	Reading dBm	Output Power mW	Limit mW
GFSK(BLE)	Low	3.372	2.174	1000
	Middle	3.469	2.223	1000
	High	3.807	2.403	1000



<p>Low</p>	
<p>Middle</p>	
<p>High</p>	

## 8. Field Strength of Spurious Emissions

### 8.1 Standard Applicable

According to §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).

The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply. Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

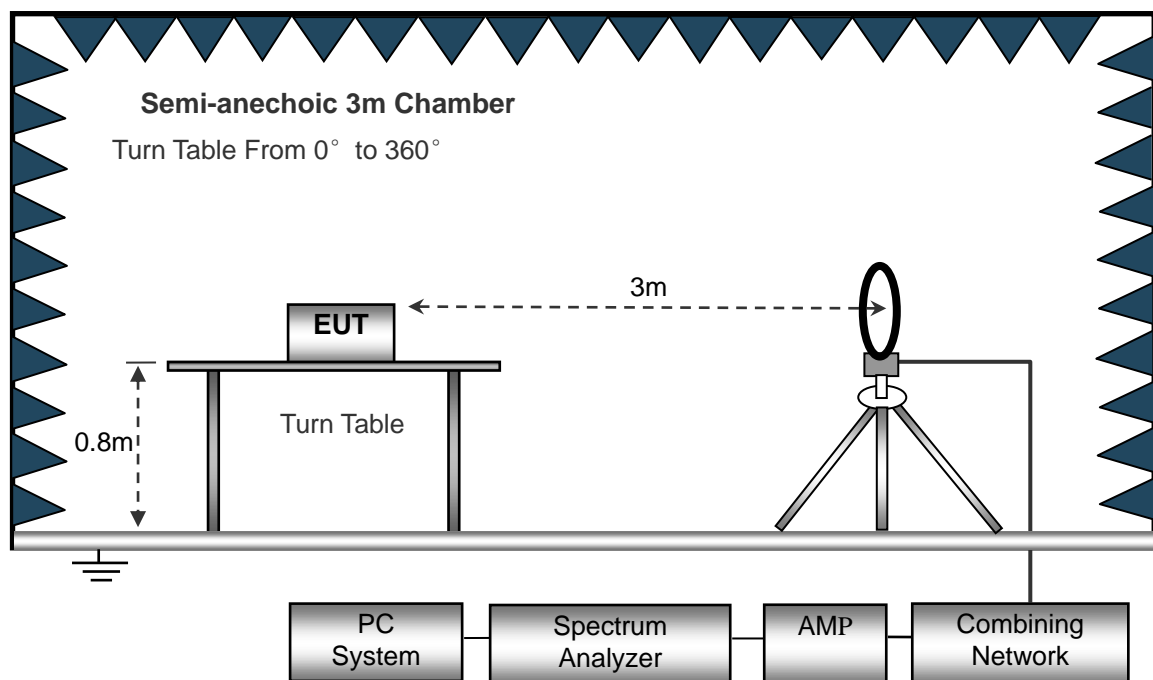
### 8.2 Test Procedure

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.205 15.247(a) and FCC Part 15.209 Limit.

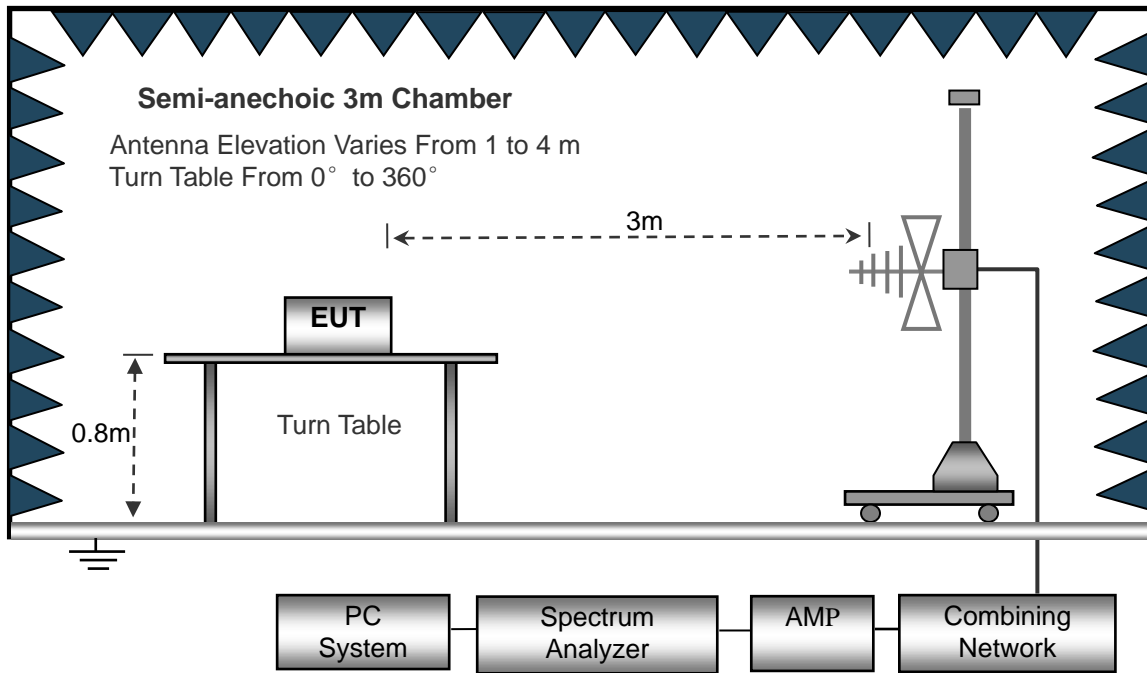
The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.

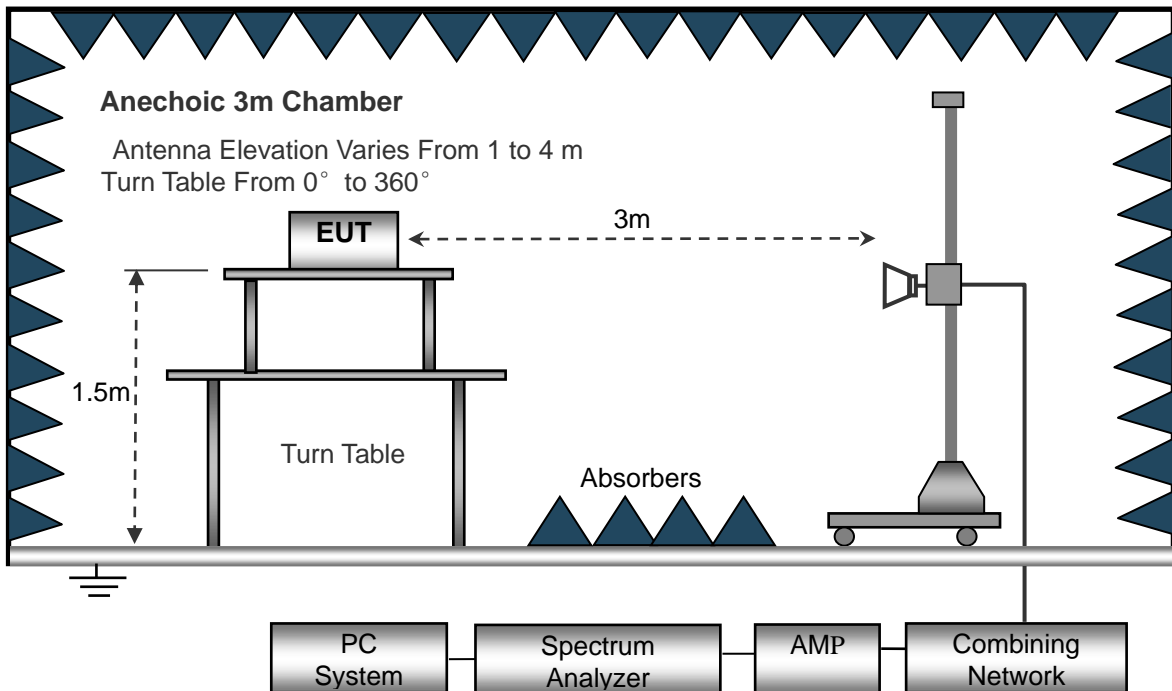
The test setup for emission measurement below 30MHz..



The test setup for emission measurement from 30 MHz to 1 GHz..



The test setup for emission measurement above 1 GHz..



Frequency :9kHz-30MHz

RBW=10KHz,

VBW =30KHz

Sweep time= Auto

Trace = max hold

Detector function = peak

Frequency :30MHz-1GHz

RBW=120KHz,

VBW=300KHz

Sweep time= Auto

Trace = max hold

Detector function = peak, QP

Frequency :Above 1GHz

RBW=1MHz,

VBW=3MHz(Peak), 10Hz(AV)

Sweep time= Auto

Trace = max hold

Detector function = peak, AV

### 8.3 Corrected Amplitude & Margin Calculation

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

$$\text{Corr. Ampl.} = \text{Indicated Reading} + \text{Ant. Factor} + \text{Cable Loss} - \text{Ampl. Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -6dB $\mu$ V means the emission is 6dB $\mu$ V below the maximum limit. The equation for margin calculation is as follows:

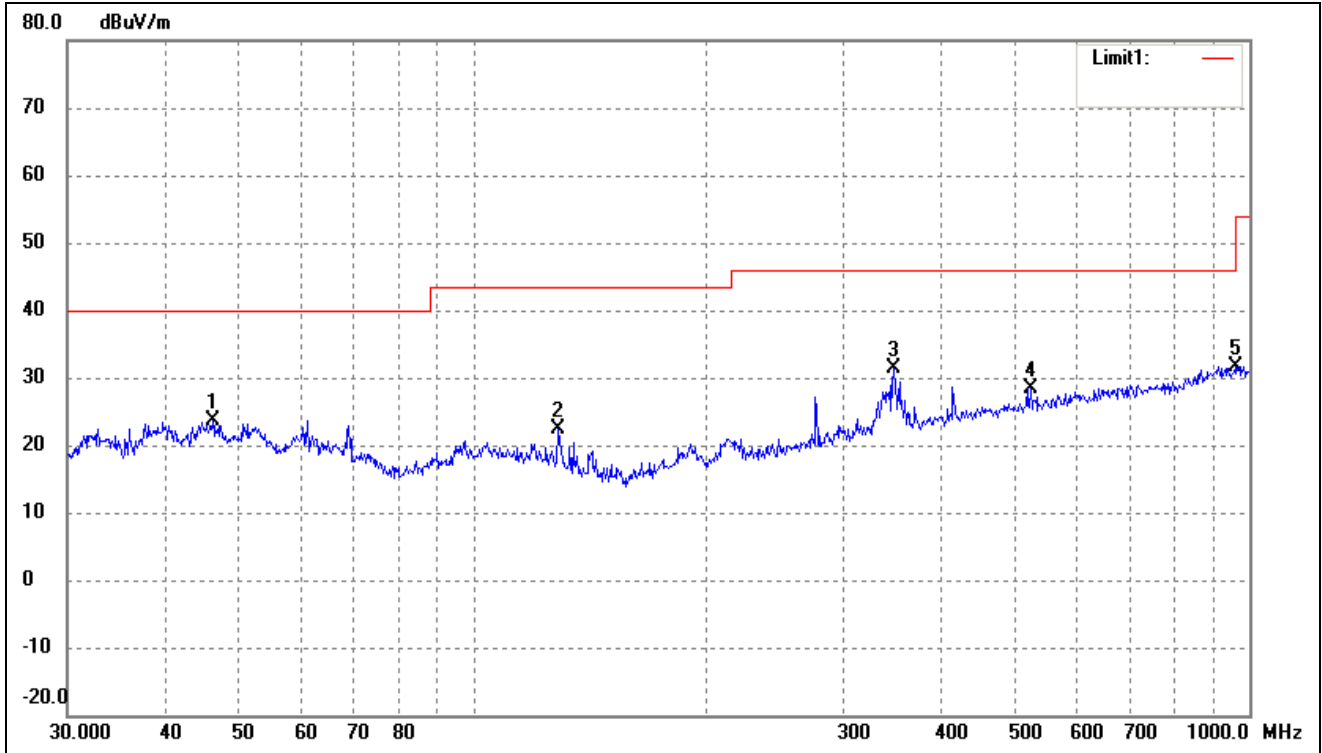
$$\text{Margin} = \text{Corr. Ampl.} - \text{FCC Part 15 Limit}$$

### 8.4 Summary of Test Results/Plots

*Note: this EUT was tested in 3 orthogonal positions and the worst case position data was reported.*

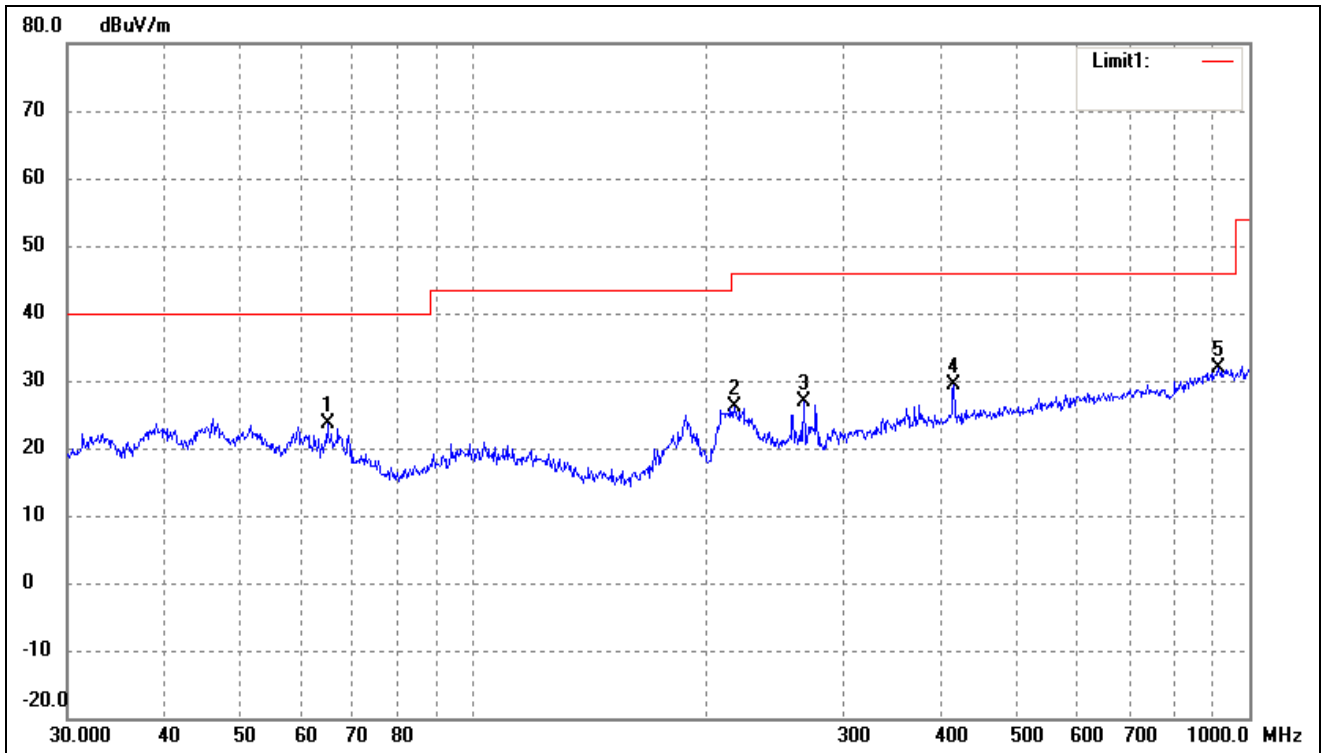
➤ Spurious Emissions Below 1GHz

Test Channel	Low	Polarity:	Horizontal
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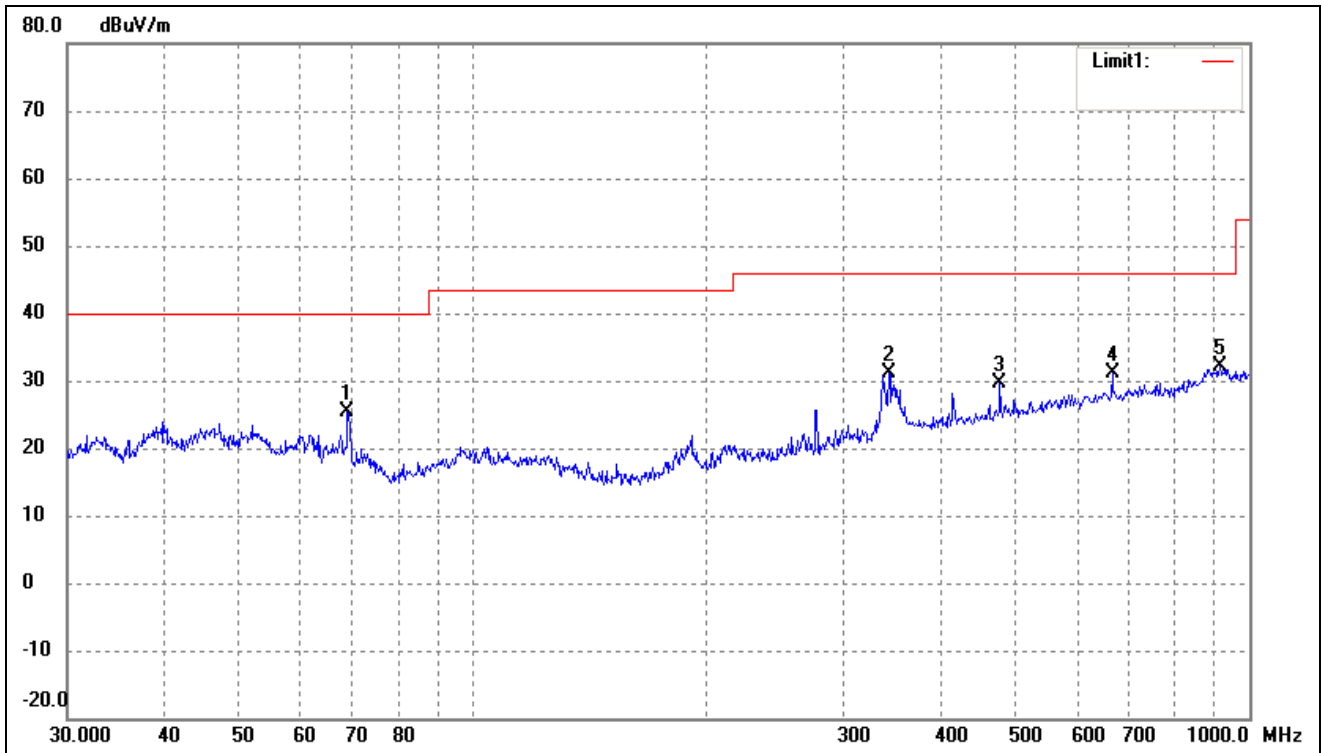
No.	Frequency (MHz)	Reading (dBuV/m)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree ( )	Height (cm)	Remark
1	46.1780	35.33	-11.73	23.60	40.00	-16.40	-	-	peak
2	128.5630	38.89	-16.58	22.31	43.50	-21.19	-	-	peak
3	348.0274	38.95	-7.55	31.40	46.00	-14.60	-	-	peak
4	522.7180	32.56	-4.16	28.40	46.00	-17.60	-	-	peak
5	958.7943	30.27	1.40	31.67	46.00	-14.33	-	-	peak

Test Channel	Low	Polarity:	Vertical
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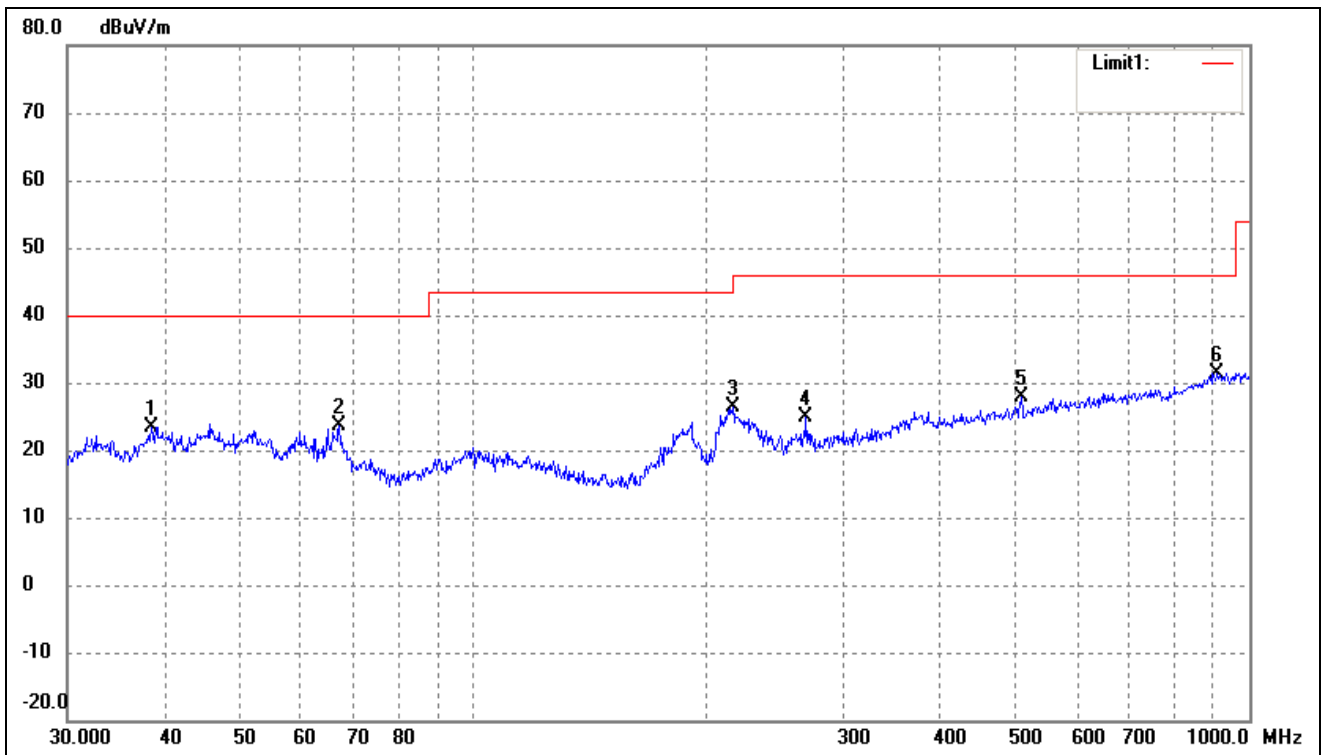
No.	Frequency (MHz)	Reading (dBuV/m)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree ( )	Height (cm)	Remark
1	64.8865	37.57	-13.91	23.66	40.00	-16.34	-	-	peak
2	216.7828	38.42	-12.23	26.19	46.00	-19.81	-	-	peak
3	266.6089	37.68	-10.81	26.87	46.00	-19.13	-	-	peak
4	416.1791	35.52	-6.08	29.44	46.00	-16.56	-	-	peak
5	912.8620	30.24	1.71	31.95	46.00	-14.05	-	-	peak

Test Channel	Middle	Polarity:	Horizontal
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct dB/m	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree ( )	Height (cm)	Remark
1	68.8721	39.75	-14.47	25.28	40.00	-14.72	-	-	peak
2	343.1800	38.94	-7.84	31.10	46.00	-14.90	-	-	peak
3	477.1694	34.36	-4.74	29.62	46.00	-16.38	-	-	peak
4	665.8035	33.26	-2.05	31.21	46.00	-14.79	-	-	peak
5	916.0687	30.31	1.75	32.06	46.00	-13.94	-	-	peak

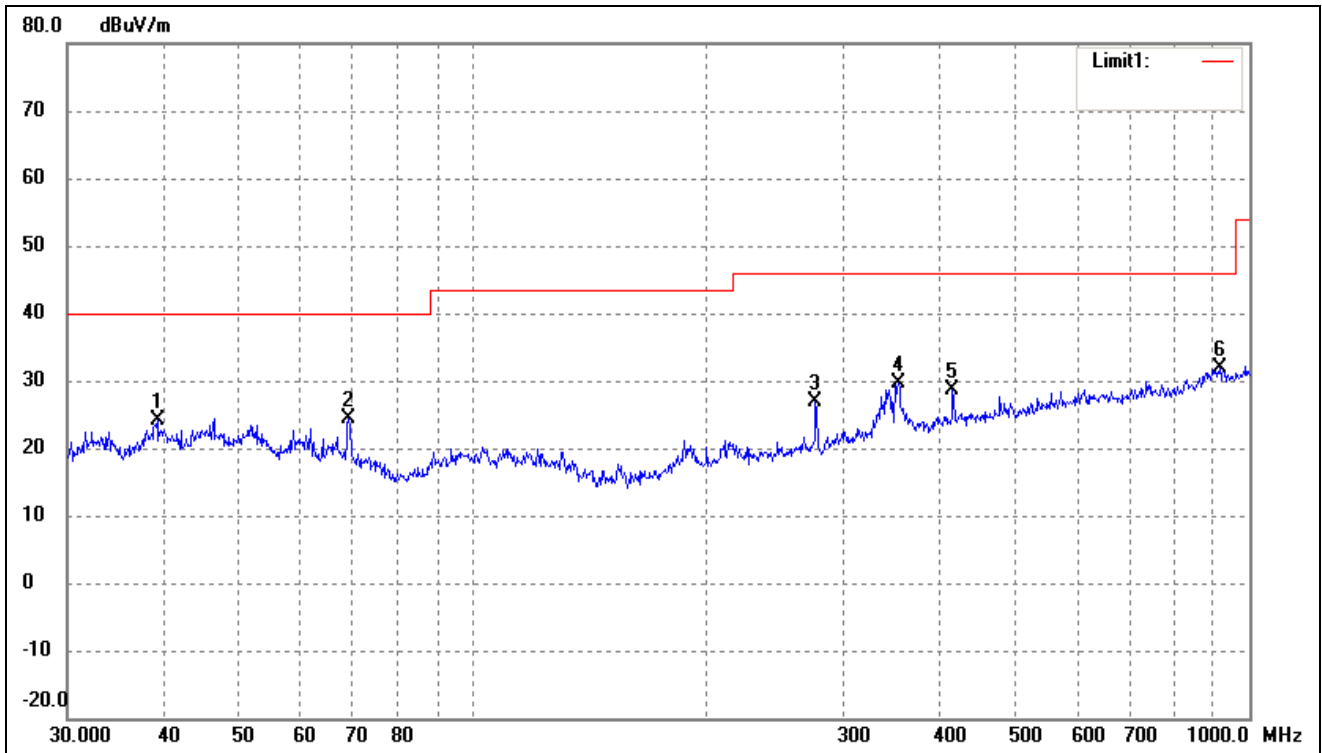
Test Channel	Middle	Polarity:	Vertical
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree ( )	Height (cm)	Remark
1	38.4809	35.91	-12.56	23.35	40.00	-16.65	-	-	peak
2	67.2022	37.76	-14.23	23.53	40.00	-16.47	-	-	peak
3	216.0240	38.67	-12.24	26.43	46.00	-19.57	-	-	peak
4	268.4853	35.75	-10.78	24.97	46.00	-21.03	-	-	peak
5	508.2582	31.90	-4.09	27.81	46.00	-18.19	-	-	peak
6	909.6667	29.71	1.67	31.38	46.00	-14.62	-	-	peak

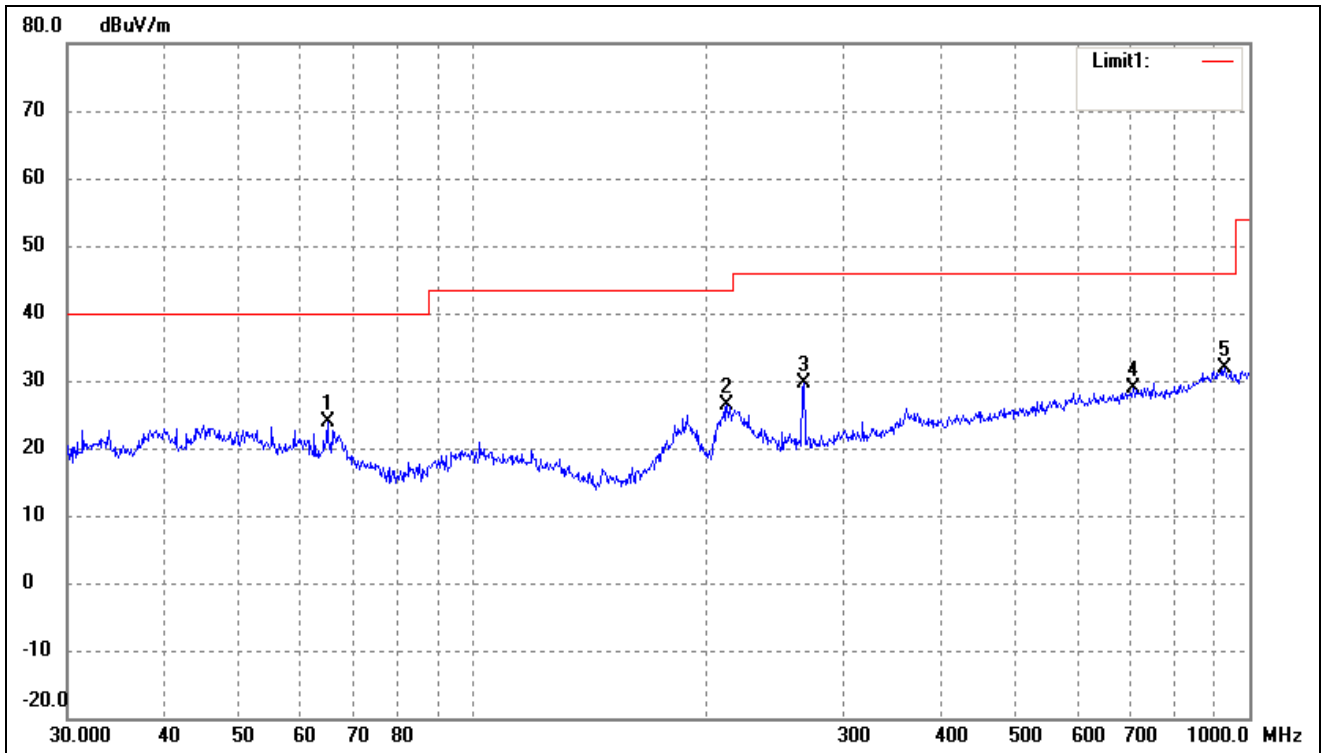


Test Channel	High	Polarity:	Horizontal
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree ( )	Height (cm)	Remark
1	39.1616	36.50	-12.30	24.20	40.00	-15.80	-	-	peak
2	69.1141	38.83	-14.51	24.32	40.00	-15.68	-	-	peak
3	276.1236	37.44	-10.68	26.76	46.00	-19.24	-	-	peak
4	352.9434	37.01	-7.40	29.61	46.00	-16.39	-	-	peak
5	414.7223	34.84	-6.12	28.72	46.00	-17.28	-	-	peak
6	916.0687	30.13	1.75	31.88	46.00	-14.12	-	-	peak

Test Channel	High	Polarity:	Vertical
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree ( )	Height (cm)	Remark
1	64.8865	37.85	-13.91	23.94	40.00	-16.06	-	-	peak
2	212.2695	38.73	-12.28	26.45	43.50	-17.05	-	-	peak
3	266.6089	40.38	-10.81	29.57	46.00	-16.43	-	-	peak
4	709.1823	30.51	-1.54	28.97	46.00	-17.03	-	-	peak
5	929.0082	30.09	1.77	31.86	46.00	-14.14	-	-	peak

Remark: '-' Means the test Degree and Height are not recorded by the test software and only show the worst case in the test report.

## ➤ Spurious Emissions Above 1GHz

Frequency	Reading	Correct	Result	Limit	Margin	Polar	Detector
(MHz)	(dBuV/m)	dB	(dBuV/m)	(dBuV/m)	(dB)	H/V	
Low Channel-2402MHz							
3472.118	52.86	-7.28	45.58	74.00	-28.42	H	PK
4736.600	52.42	-4.56	47.86	74.00	-26.14	H	PK
7209.015	53.35	-2.20	51.15	74.00	-22.85	H	PK
3525.555	52.54	-7.17	45.37	74.00	-28.63	V	PK
4858.720	51.78	-4.47	47.31	74.00	-26.69	V	PK
7209.015	54.80	-2.20	52.60	74.00	-21.40	V	PK
Middle Channel-2440MHz							
3489.840	52.63	-7.22	45.41	74.00	-28.59	H	PK
4797.271	51.45	-4.52	46.93	74.00	-27.07	H	PK
8419.999	51.46	-0.29	51.17	74.00	-22.83	H	PK
3233.257	51.36	-7.97	43.39	74.00	-30.61	V	PK
5850.919	51.09	-3.33	47.76	74.00	-26.24	V	PK
9181.198	50.55	1.09	51.64	74.00	-22.36	V	PK
High Channel-2480MHz							
3973.622	52.47	-6.77	45.70	74.00	-28.30	H	PK
5284.497	52.17	-4.24	47.93	74.00	-26.07	H	PK
7451.168	36.90	-2.12	34.78	54.00	-19.22	H	AV
7451.566	60.85	-2.12	58.73	74.00	-15.27	H	PK
4202.500	53.87	-5.92	47.95	74.00	-26.05	V	PK
5836.044	51.21	-3.37	47.84	74.00	-26.16	V	PK
7451.170	36.85	-2.12	34.73	54.00	-19.27	V	AV
7451.566	61.13	-2.12	59.01	74.00	-14.99	V	PK

Note: 1. Testing is carried out with frequency rang 9kHz to the tenth harmonics, other than listed in the table above are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

2. Average measurement was not performed if peak level is lower than average limit(54 dBuV/m) for above 1GHz.

## 9. Out of Band Emissions

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### 9.1 Standard Applicable

According to §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).

### 9.2 Test Procedure

According to the KDB 558074 D01 v05r02 Subclause 8.4 and ANSI C63.10-2013 Subclause 11.11, the Emissions in nonrestricted frequency bands test method as follows:

- a) Set the center frequency and span to encompass frequency range to be measured.
- b) Set the RBW = 100 kHz.
- c) Set the VBW  $\geq [3 \times \text{RBW}]$ .
- d) Detector = peak.
- e) Sweep time = auto couple.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use the peak marker function to determine the maximum amplitude level.

According to the KDB 558074 D01 v05r02 Subclause 8.5 and ANSI C63.10-2013 Subclause 11.12, the Emissions in restricted frequency bands test method as follows:

#### A. Radiated emission measurements:

Set span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation (2310MHz to 2420MHz for low bandedge, 2460MHz to 2500MHz for the high bandedge)

RBW = 1MHz, VBW = 1MHz for peak value measured

RBW = 1MHz, VBW = 10Hz for average value measured

Sweep = auto; Detector function = peak/average; Trace = max hold

All the trace to stabilize, set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. Those emission must comply with the 15.209 limit for fall in the restricted bands listed in section 15.205. Note that the method of measurement

KDB publication number: 913591 may be used for the radiated bandedge measurements.

#### B. Antenna-port conducted measurements

Peak emission levels are measured by setting the instrument as follows:

- a) RBW = as specified in Table 9.
- b) VBW  $\geq$   $[3 \times \text{RBW}]$ .
- c) Detector = peak.
- d) Sweep time = auto.
- e) Trace mode = max hold.
- f) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be lengthened for low-duty-cycle applications.)

RBW as a function of frequency

Frequency	RBW
9kHz to 150kHz	200Hz to 300Hz
0.15MHz to 30MHz	9kHz to 10kHz
30MHz to 1000MHz	100kHz to 120kHz
>1000MHz	1MHz

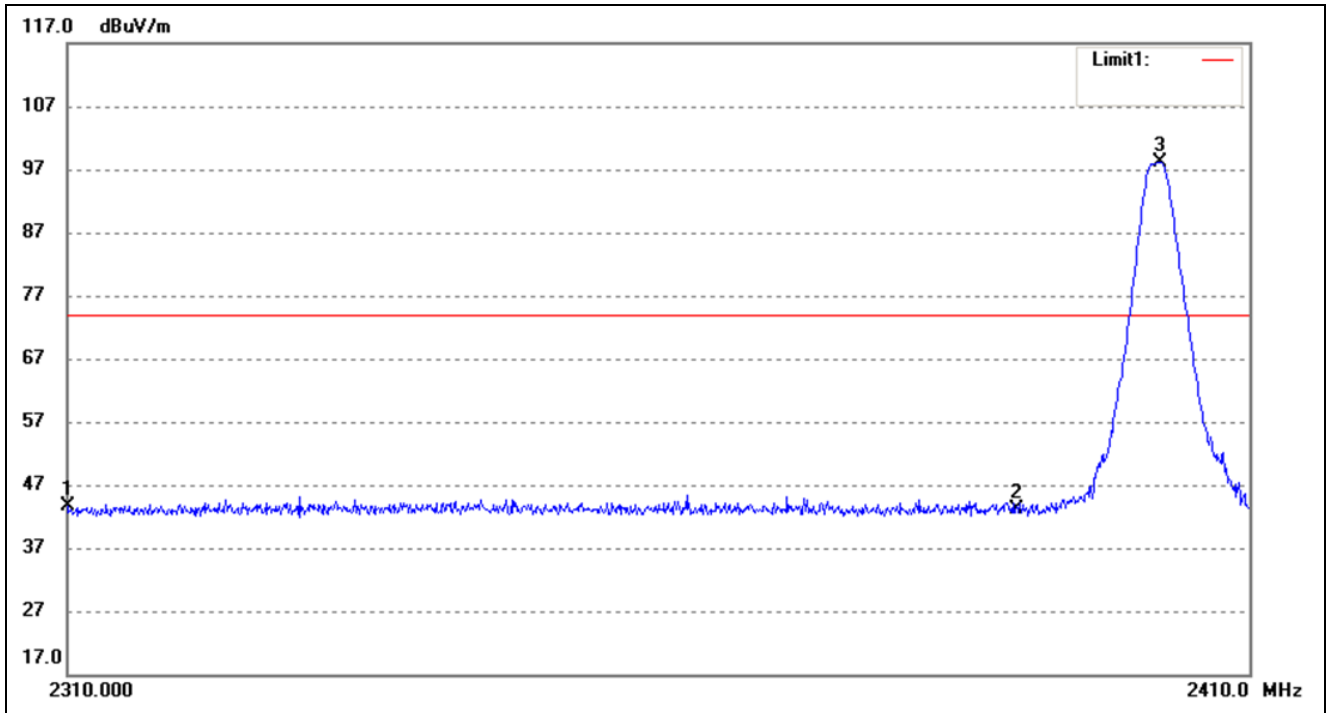
If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in section 8.1. Report the three highest emissions relative to the limit.

### 9.3 Summary of Test Results/Plots

➤ Radiated test

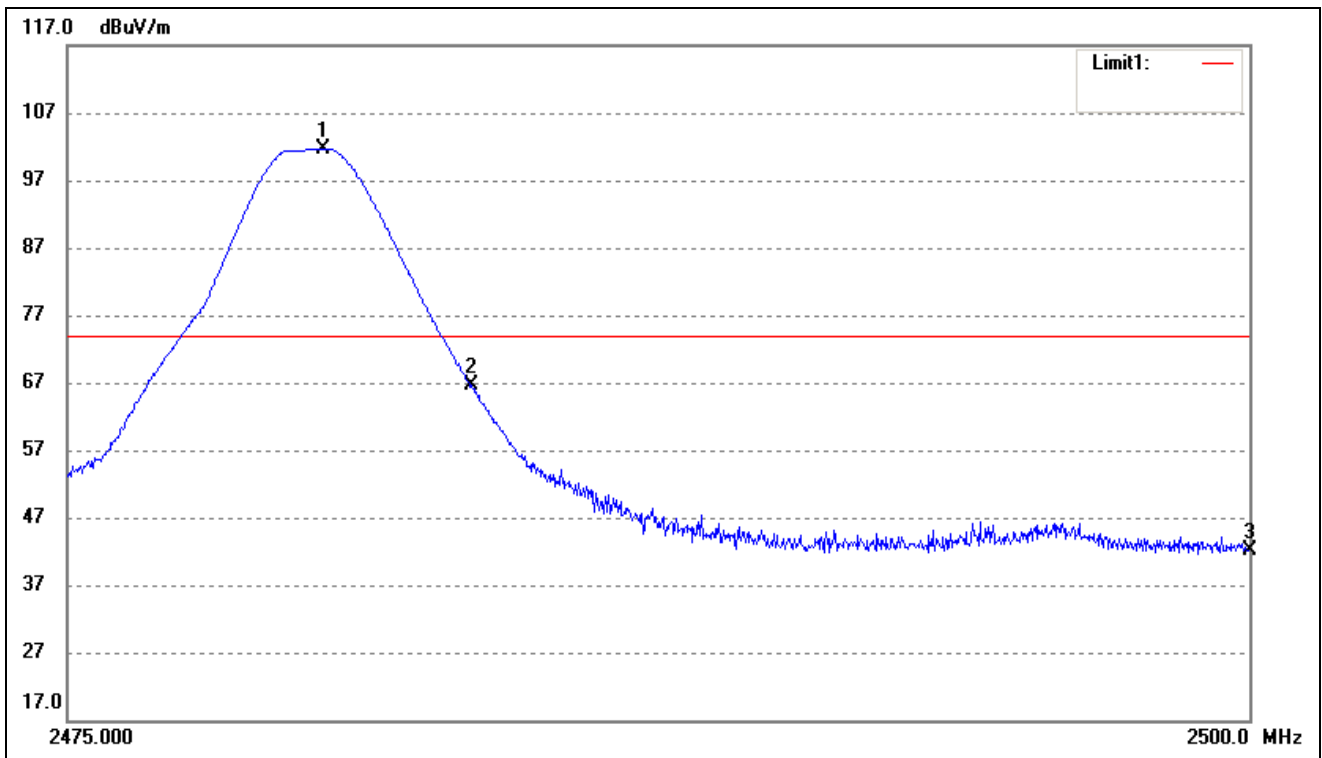
Test Channel	Low	Polarity:	Horizontal (worst case)
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct Factor(dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	2310.000	53.23	-9.66	43.57	74.00	-30.43	Peak Detector
2	2390.000	52.69	-9.50	43.19	74.00	-30.81	Peak Detector
3	2402.352	107.55	-9.47	98.08	/	/	Peak Detector

Note:1. Average measurement was not performed if peak level is lower than average limit(54 dBuV/m) for above 1GHz.

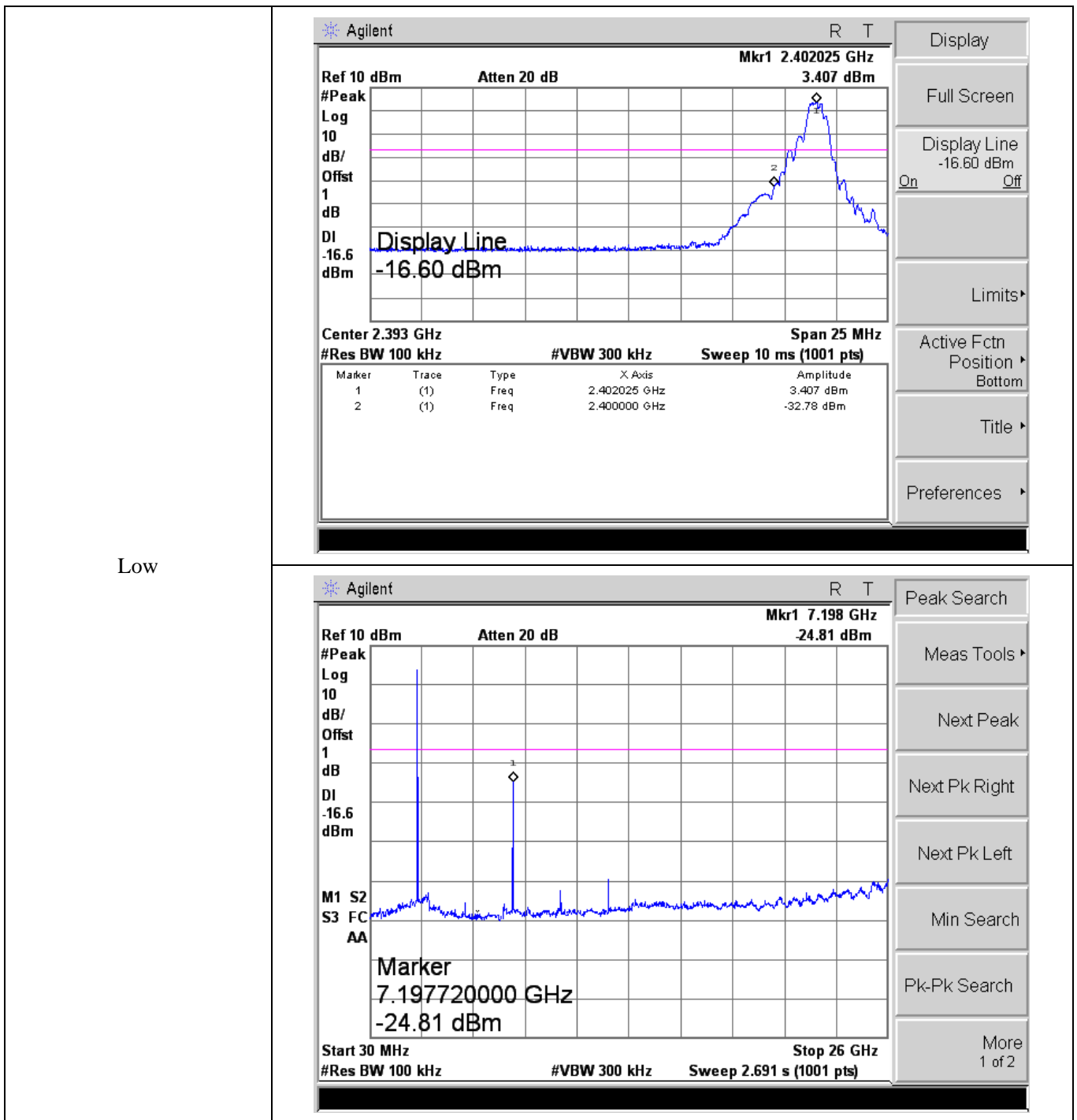
Test Channel	High	Polarity:	Horizontal (worst case)
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No.	Frequency (MHz)	Reading (dBuV/m)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	2480.404	110.98	-9.32	101.66	/	/	Peak Detector
2	2483.500	75.86	-9.31	66.55	74.00	-7.45	Peak Detector
	2483.500	47.44	-9.31	38.13	54.00	-15.87	Average Detector
3	2500.000	51.35	-9.28	42.07	74.00	-31.93	Peak Detector

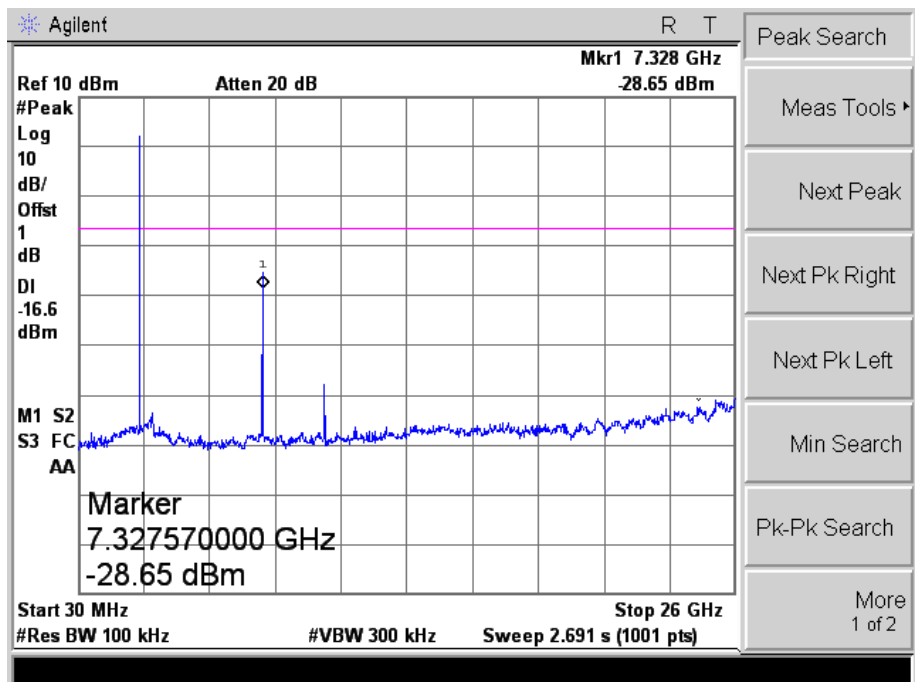
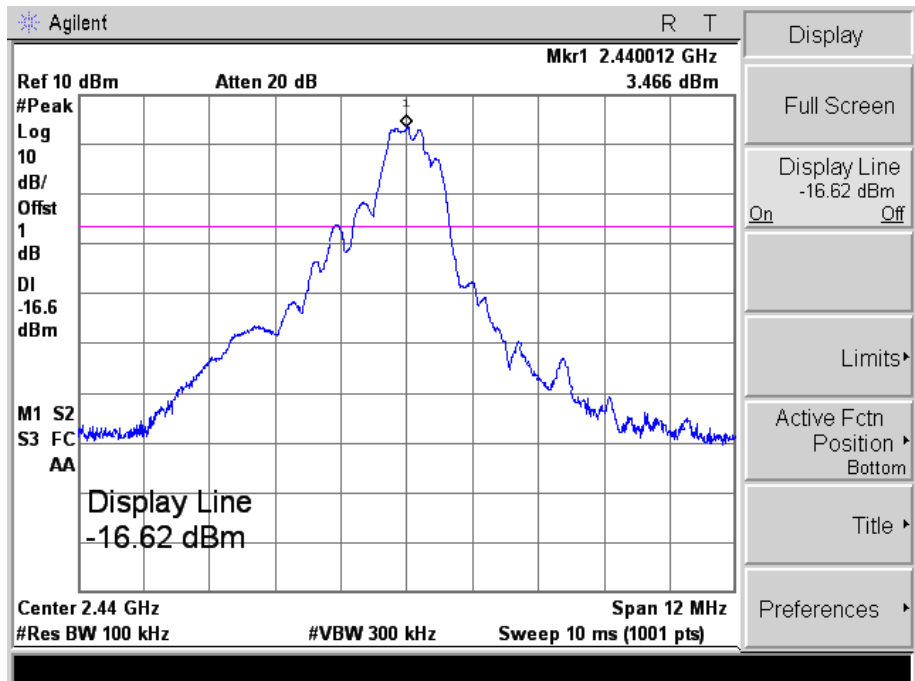
Note: 1. Average measurement was not performed if peak level is lower than average limit(54 dBuV/m) for above 1GHz.

➤ Conducted test

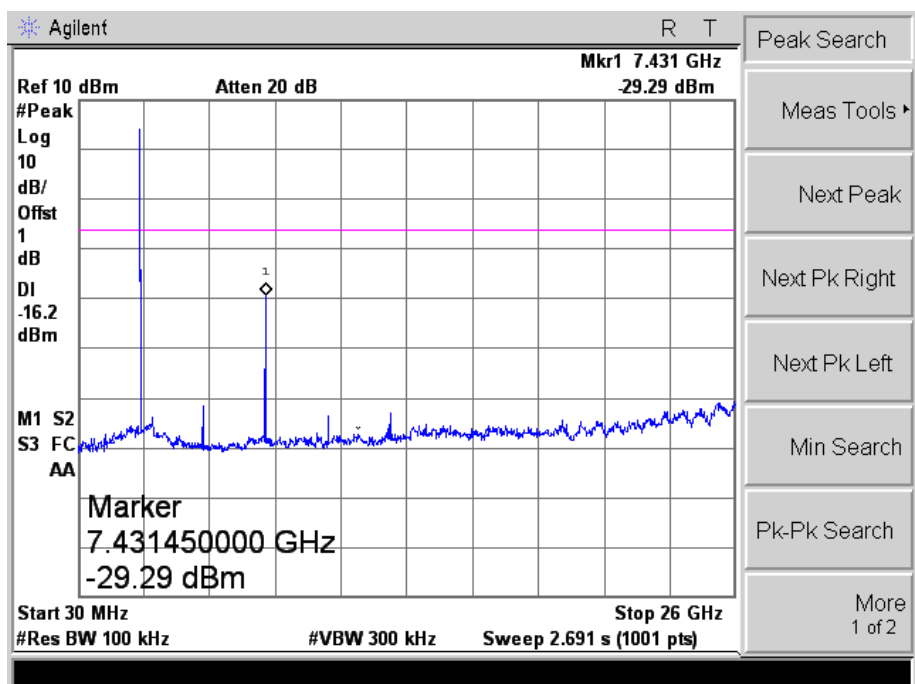
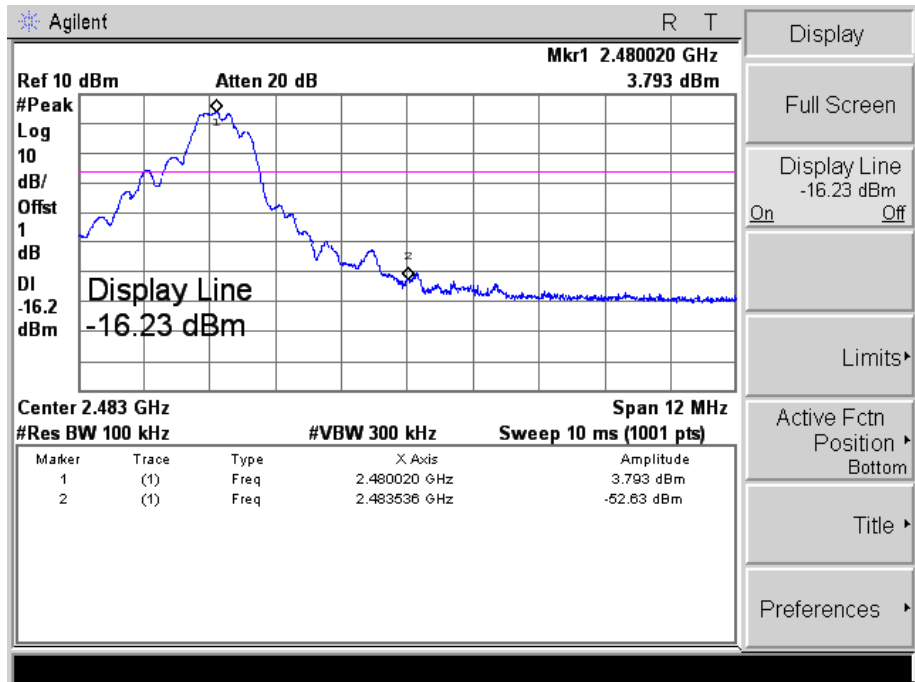




Middle



High



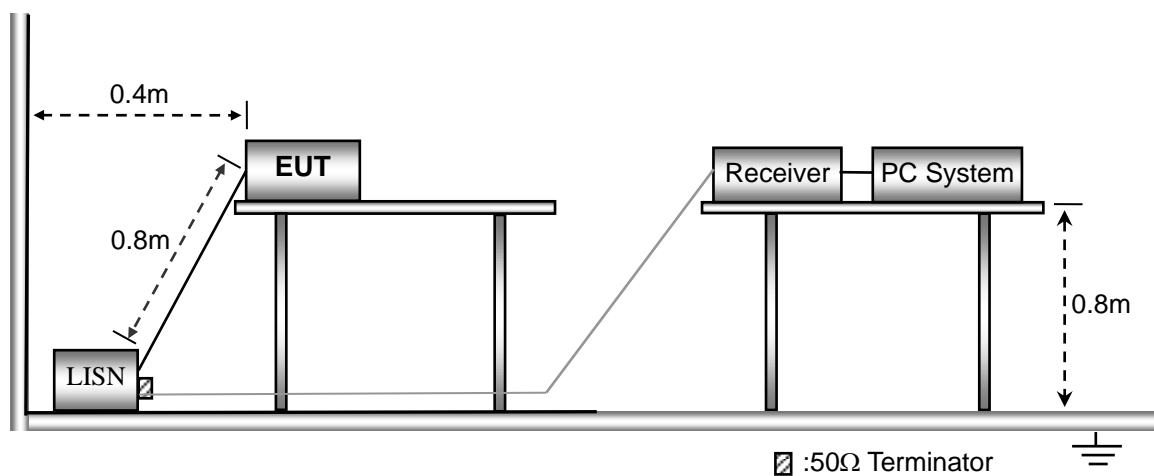
## 10. Conducted Emissions

### 10.1 Test Procedure

The setup of EUT is according with per ANSI C63.4-2014 measurement procedure. The specification used was with the FCC Part 15.207 Limit.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle. The spacing between the peripherals was 10 cm.

### 10.2 Basic Test Setup Block Diagram



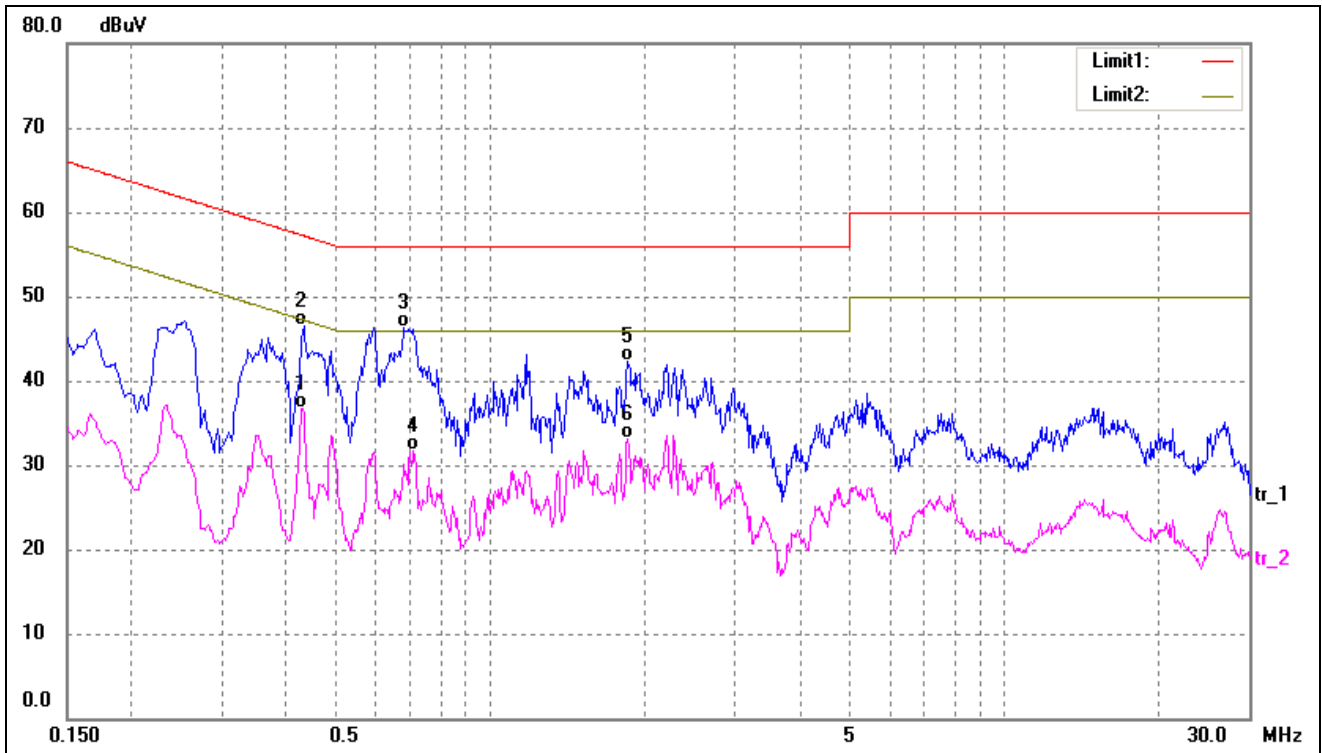
### 10.3 Test Receiver Setup

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

Start Frequency .....	150 kHz
Stop Frequency .....	30 MHz
Sweep Speed .....	Auto
IF Bandwidth.....	10 kHz
Quasi-Peak Adapter Bandwidth .....	9 kHz
Quasi-Peak Adapter Mode .....	Normal

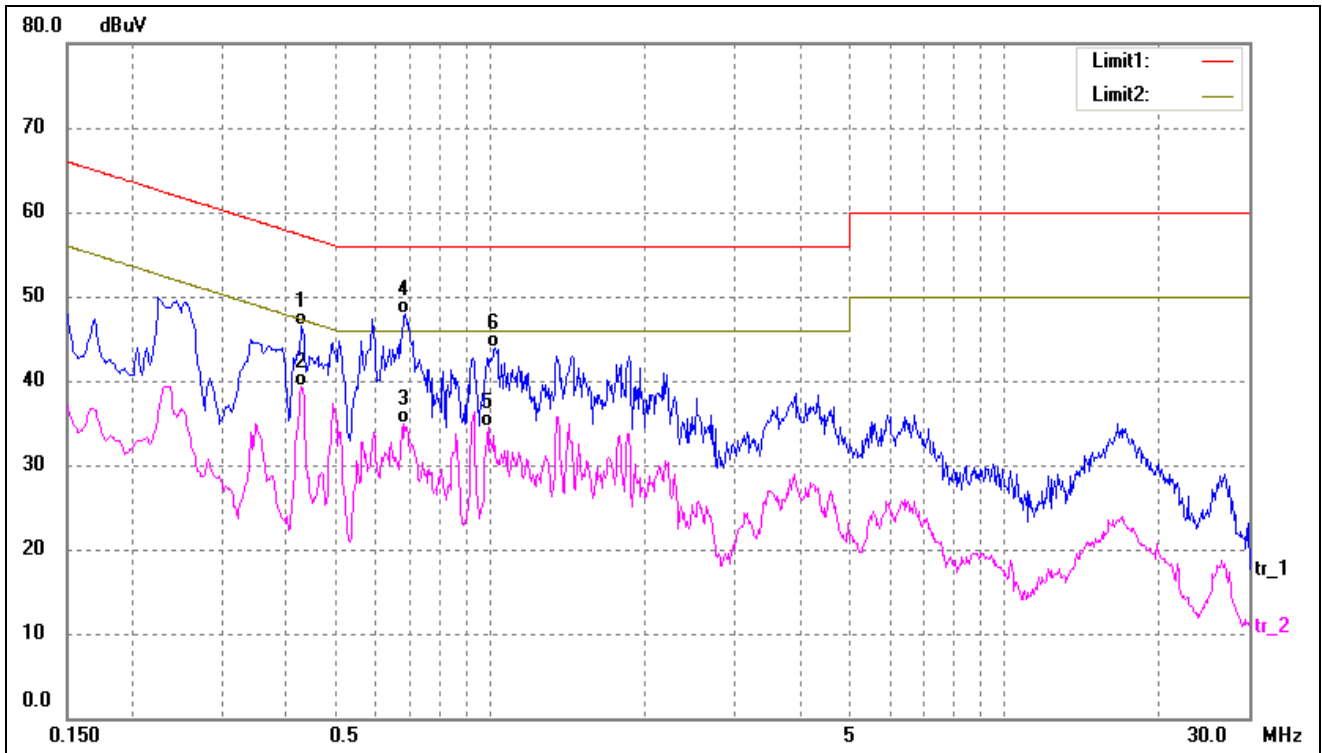
### 10.4 Summary of Test Results/Plots

Test Mode	Communication	AC120V 60Hz	Polarity:	Neutral
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No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.4300	26.54	10.22	36.76	47.25	-10.49	AVG
2	0.4340	36.37	10.22	46.59	57.18	-10.59	QP
3*	0.6820	36.12	10.17	46.29	56.00	-9.71	QP
4	0.7100	21.57	10.17	31.74	46.00	-14.26	AVG
5	1.8540	31.99	10.27	42.26	56.00	-13.74	QP
6	1.8540	22.79	10.27	33.06	46.00	-12.94	AVG

Test Mode	Communication	AC120V 60Hz	Polarity:	Line
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No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.4300	36.19	10.22	46.41	57.25	-10.84	QP
2*	0.4300	29.16	10.22	39.38	47.25	-7.87	AVG
3	0.6780	24.64	10.17	34.81	46.00	-11.19	AVG
4	0.6860	37.64	10.17	47.81	56.00	-8.19	QP
5	0.9940	24.22	10.20	34.42	46.00	-11.58	AVG
6	1.0260	33.62	10.20	43.82	56.00	-12.18	QP

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