

TEST REPORT

Applicant : Hosiden Corporation
Address : 4-33, Kitakyuhoji 1-Chome, Yao-City, Osaka 581-0071, Japan

Products : Bluetooth Low Energy Module
Model No. : HRM1079
Serial No. : 11, 14
FCC ID : VIYHRM1079

Test Standard : CFR 47 FCC Rules and Regulations Part 15

Test Results : Passed

Date of Test : August 30, 2018 ~ September 6, 2018



Kousei Shibata

Manager

Japan Quality Assurance Organization

KITA-KANSAI Testing Center

SAITO EMC Branch

7-3-10, Saito-asagi, Ibaraki-shi, Osaka 567-0085, Japan



-
- The test results in this test report was made by using the measuring instruments which are traceable to national standards of measurement in accordance with ISO/IEC 17025.
 - The applicable standard, testing condition and testing method which were used for the tests are based on the request of the applicant.
 - The test results presented in this report relate only to the offered test sample.
 - The contents of this test report cannot be used for the purposes, such as advertisement for consumers.
 - This test report shall not be reproduced except in full without the written approval of JQA.
 - VLAC does not approve, certify or warrant the product by this test report.

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DEFINITIONS FOR ABBREVIATION AND SYMBOLS USED IN THIS TEST REPORT

EUT	: Equipment Under Test	EMC	: Electromagnetic Compatibility
AE	: Associated Equipment	EMI	: Electromagnetic Interference
N/A	: Not Applicable	EMS	: Electromagnetic Susceptibility
N/T	: Not Tested		

- indicates that the listed condition, standard or equipment is applicable for this report.
 - indicates that the listed condition, standard or equipment is not applicable for this report.

1 Description of the Equipment Under Test

1. Manufacturer : Hosiden Corporation
4-33, Kitakyuhoji 1-Chome, Yao-City, Osaka 581-0071, Japan
2. Products : Bluetooth Low Energy Module
3. Model No. : HRM1079
4. Serial No. : 11, 14
5. Product Type : Pre-production
6. Date of Manufacture : --
7. Power Rating : 3.0VDC
8. Grounding : None
9. Operating Frequency : 2402 MHz (00CH) – 2480 MHz (39CH)
10. Max. RF Output Power : 3.16 dBm (Measured Value)
11. Antenna Type : λ/4 reverse F antenna on PWB (Integral)
12. Antenna Gain : + 0.242 dBi
13. Category : DTS
14. EUT Authorization : Certification
15. Received Date of EUT : August 27, 2018

16. Channel Plan

The carrier spacing is 2 MHz.

The carrier frequency is designated by the absolute frequency channel number (ARFCN).

The carrier frequency is expressed in the equation shown as follows:

$$\text{Transmitting Frequency (in MHz)} = 2402.0 + 2 \times n$$

$$\text{Receiving Frequency (in MHz)} = 2402.0 + 2 \times n$$

where, n : channel number ($0 \leq n \leq 39$)

2 Summary of Test Results

Applied Standard : CFR 47 FCC Rules and Regulations Part 15
Subpart C - Intentional Radiators

The EUT described in clause 1 was tested according to the applied standard shown above.

Details of the test configuration is shown in clause 6.

The conclusion for the test items of which are required by the applied standard is indicated under the test result.

- The test result was **passed** for the test requirements of the applied standard.

- The test result was **failed** for the test requirements of the applied standard.

- The test result was **not judged** the test requirements of the applied standard.

In the approval of test results,

- Determining compliance with the limits in this report was based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.
- No deviations were employed from the applied standard.
- No modifications were conducted by JQA to achieve compliance to the limitations.

Reviewed by:



Shigeru Osawa
Deputy Manager
JQA KITA-KANSAI Testing Center
SAITO EMC Branch

Tested by:



Yasuhisa Sakai
Manager
JQA KITA-KANSAI Testing Center
SAITO EMC Branch

3 Test Procedure

Test Requirements : §15.247, §15.207 and §15.209

Test Procedure : ANSI C63.10-2013
Testing unlicensed wireless devices.

KDB 558074 D01
DTS Meas Guidance v05: August 24, 2018

KDB 414788 D01
Radiated Test Site v01r01: July 12, 2018

4 Test Location

Japan Quality Assurance Organization (JQA)
KITA-KANSAI Testing Center
7-7, Ishimaru, 1-chome, Minoh-shi, Osaka, 562-0027, Japan
SAITO EMC Branch
7-3-10, Saito-asagi, Ibaraki-shi, Osaka 567-0085, Japan

5 Recognition of Test Laboratory

JQA KITA-KANSAI Testing Center SAITO EMC Branch is accredited under ISO/IEC 17025 by following accreditation bodies and the test facility is registered by the following bodies.

VLAC Accreditation No. : VLAC-001-2 (Expiry date : March 30, 2020)
VCCI Registration No. : A-0002 (Expiry date : March 30, 2020)
FCC Accreditation No. : JP5008 (Expiry date : March 30, 2020)
IC Registration No. : 2079E-3, 2079E-4 (Expiry date : June 26, 2020)
BSMI Registration No. : SL2-IS-E-6006, SL2-IN-E-6006, SL2-R1/R2-E-6006, SL2-A1-E-6006
(Expiry date : September 14, 2019)
CNAS Accreditation No. : L8352 (Expiry date : February 19, 2019)

Accredited as conformity assessment body for Japan electrical appliances and material law by METI.
(Expiry date : February 22, 2019)

6 Description of Test Setup

6.1 Test Configuration

The equipment under test (EUT) consists of :

	Item	Manufacturer	Model No.	Serial No.	FCC ID
A	Bluetooth Low Energy Module	Hosiden	HRM1079	14 *1, 11 *2	VIYHRM1079

*1) Used for AC Powerline Conducted Emission and Field Strength of Spurious Emission

*2) Used for Antenna Conducted Emission

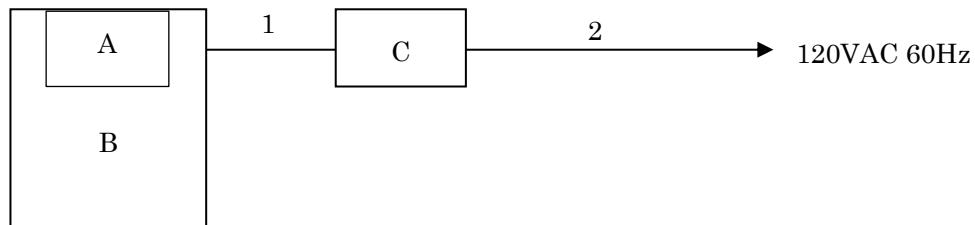
The auxiliary equipment used for testing :

	Item	Manufacturer	Model No.	Serial No.	FCC ID
B	Jig Board Bluetooth Low Energy Module	Hosiden	HRM1083	--	N/A
C	DC Power Supply	KIKUSUI	PBZ40-10	QB001800	N/A

Type of Cable:

No.	Description	Identification (Manu. etc.)	Connector Shielded	Cable Shielded	Ferrite Core	Length (m)
1	DC Cable	--	--	NO	NO	0.3
2	AC Cable	--	NO	NO	NO	1.8

6.2 Test Arrangement (Drawings)



6.3 Operating Condition

Power Supply Voltage : 3.0VDC

Operation Mode

The EUT is set with the test mode, the specification of the test mode is as follows.

Bluetooth Low Energy Mode (Bluetooth 5.0 +LE):

Transmitting frequency : 2402 MHz (00CH) – 2480 MHz (39CH)

Receiver frequency : 2402 MHz (00CH) – 2480 MHz (39CH)

Modulation Type

LE Packet (GFSK)

The tests were performed in the following worst condition.

Mode	Condition
Bluetooth Low Energy	1 Mbps, 2 Mbps

The EUT was rotated through three orthogonal axis (X, Y and Z axis) in radiated measurement.

The EUT with temporary antenna port was used in conducted measurement.

The tests were performed using the following test program supplied by applicant;

- Software Name : Tera Term
- Software Version : Version 4.99
- Storage Location : Controller PC

7 Test Requirements

7.0 Summary of the Test Results

Test Item	FCC Specification	Reference of the Test Report	Results	Remarks
Antenna Requirement	Section 15.203	Section 1.12	Passed	-
Channel Separation	Section 15.247(a)(1)	-		-
Minimum Hopping Channel	Section 15.247(a)(1)(iii)	-	-	-
Occupied Bandwidth	Section 15.247(a)(2)	Section 7.3	Passed	-
Dwell Time	Section 15.247(a)(1)(iii)	-	-	-
Peak Output Power (Conduction)	Section 15.247(b)(3)	Section 7.5	Passed	-
Peak Power Density (Conduction)	Section 15.247(e)	Section 7.6	Passed	-
Spurious Emissions (Conduction)	Section 15.247(d)	Section 7.7	Passed	-
AC Powerline Conducted Emission	Section 15.207	Section 7.8	Passed	-
Radiated Emission	Section 15.205 Section 15.209	Section 7.9	Passed	-
RF Exposure	Section 15.247(i)	Section 7.10	Passed	

7.1 Channel Separation

For the requirements, - Applicable [- Tested. - Not tested by applicant request.]
 - Not Applicable

7.2 Minimum Hopping Channel

For the requirements, - Applicable [- Tested. - Not tested by applicant request.]
 - Not Applicable

7.3 Occupied Bandwidth

For the requirements, - Applicable [- Tested. - Not tested by applicant request.]
 - Not Applicable

7.3.1 Test Results

For the standard, - Passed - Failed - Not judged

99% Bandwidth of BLE 1 Mbps is 1059.2 kHz at 2440.0/2480.0 MHz
99% Bandwidth of BLE 2 Mbps is 2094.1 kHz at 2480.0 MHz

6dB Bandwidth of BLE 1 Mbps is 741.0 kHz at 2480.0 MHz
6dB Bandwidth of BLE 2 Mbps is 1256.0 kHz at 2440.0 MHz

Uncertainty of Measurement Results ± 0.9 %(2σ)

Remarks : _____

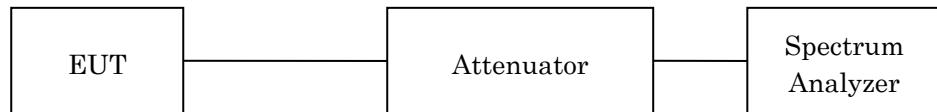
7.3.2 Test Instruments

Shielded Room S4				
Type	Model	Serial No. (ID)	Manufacturer	Cal. Due
Spectrum Analyzer	E4446A	US44300388 (A-39)	Agilent	2019/03/27
Attenuator	54A-10	W5732 (D-30)	Weinschel	2019/08/08
RF Cable	SF102	14253/2 (C-52)	HUBER+SUHNER	2019/08/08

NOTE : The calibration interval of the above test instruments is 12 months.

7.3.3 Test Method and Test Setup (Diagrammatic illustration)

The test system is shown as follows:



The setting of the spectrum analyzer are shown as follows:

99% Occupied Bandwidth

Test Mode	Bluetooth LE 1 Mbps	Bluetooth LE 2 Mbps
Res. Bandwidth	30 kHz *1	30 kHz *1
Video Bandwidth	91 kHz	91 kHz
Span	3 MHz	6 MHz
Sweep Time	AUTO	AUTO
Trace	Maxhold	Maxhold

*1) RBW is set to the range of 1 % to 5 % of the occupied bandwidth.

-6dBc Occupied Bandwidth

Test Mode	Bluetooth LE 1 Mbps	Bluetooth LE 2 Mbps
Res. Bandwidth	100 kHz	100 kHz
Video Bandwidth	300 kHz	300 kHz
Span	3 MHz	6 MHz
Sweep Time	AUTO	AUTO
Trace	Maxhold	Maxhold

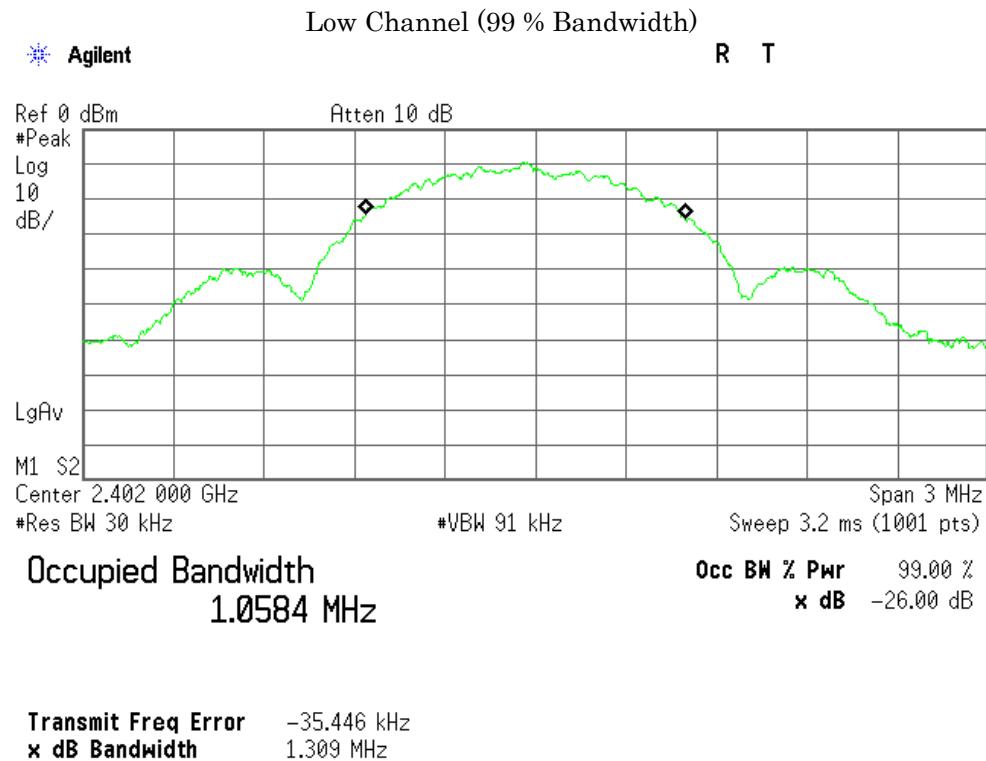
7.3.4 Test Data

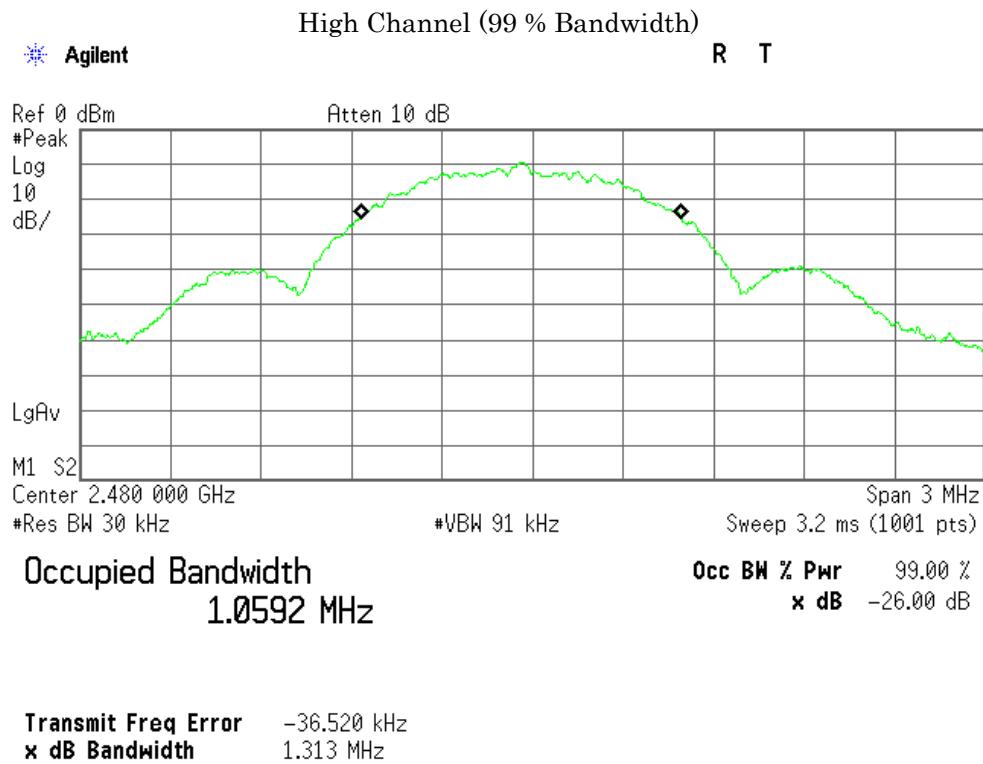
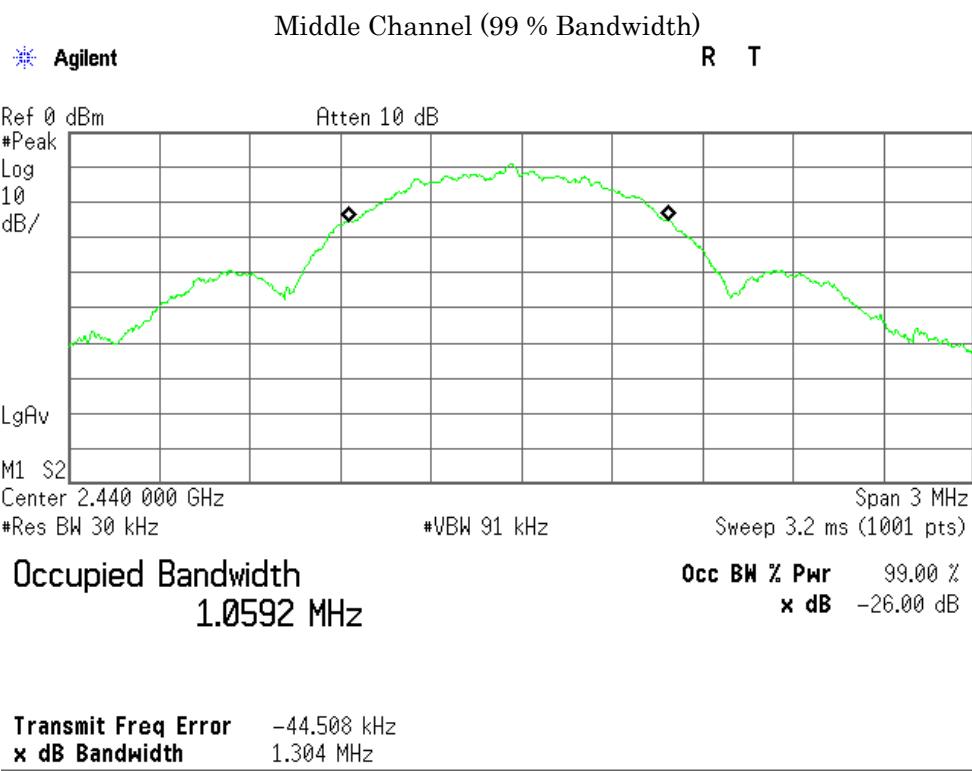
The resolution bandwidth was set to 100 kHz (for 6dB BW) or 1 - 5% of emission bandwidth (for 99% BW), -6dBc display line was placed on the screen (or 99% bandwidth), the occupied bandwidth is the delta frequency between the two points where the display line intersects the signal trace.

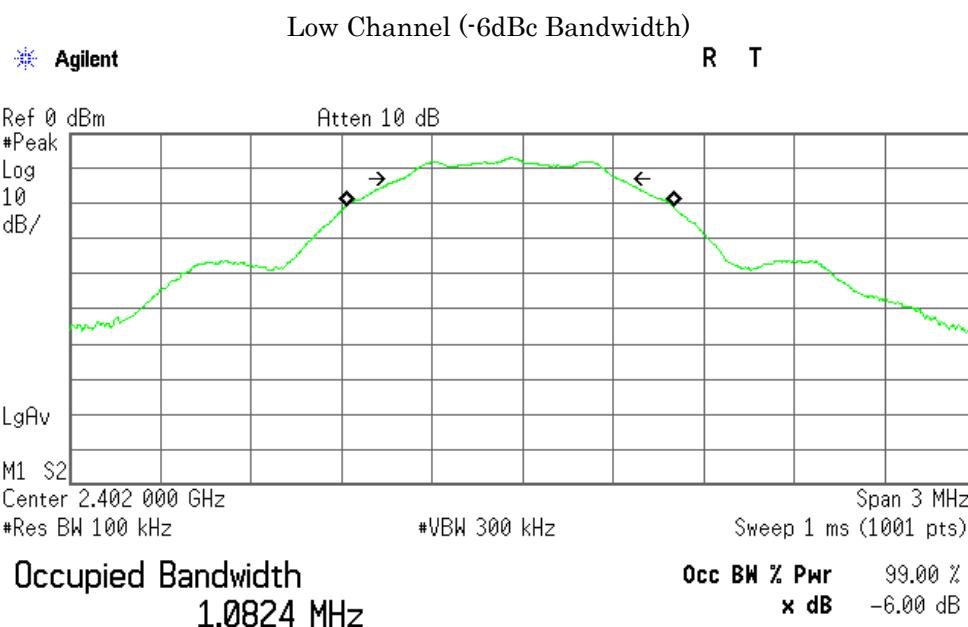
Test Date: August 30, 2018
Temp.: 26 °C, Humi: 64 %

1) Bluetooth Low Energy 1 Mbps

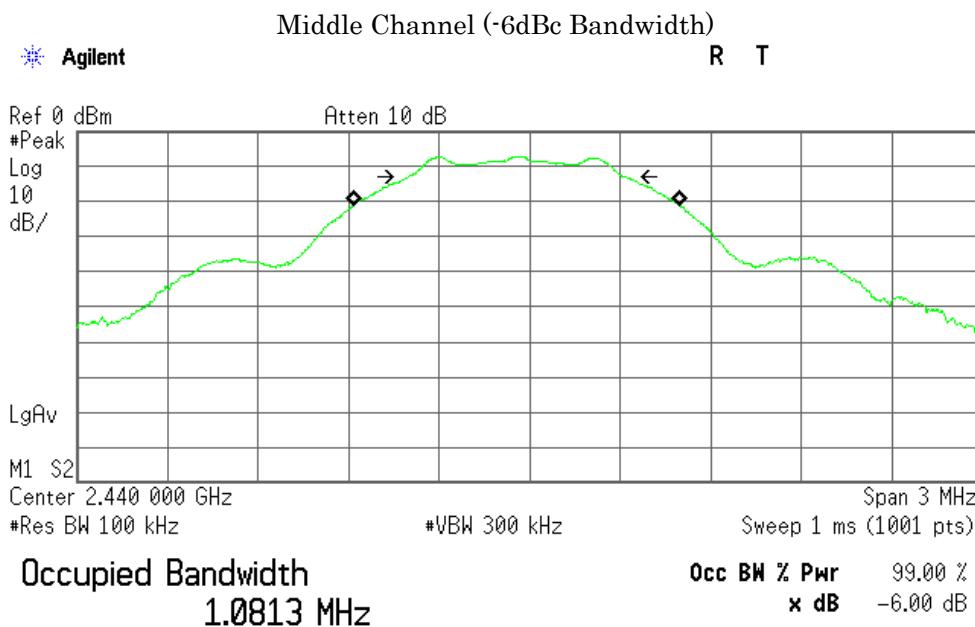
Channel	Frequency (MHz)	99% Bandwidth (kHz)	-6dBc Bandwidth (kHz)	Minimum -6dBc Bandwidth Limit (kHz)
00	2402.0	1058.4	726.5	500
19	2440.0	1059.2	724.6	500
39	2480.0	1059.2	741.0	500



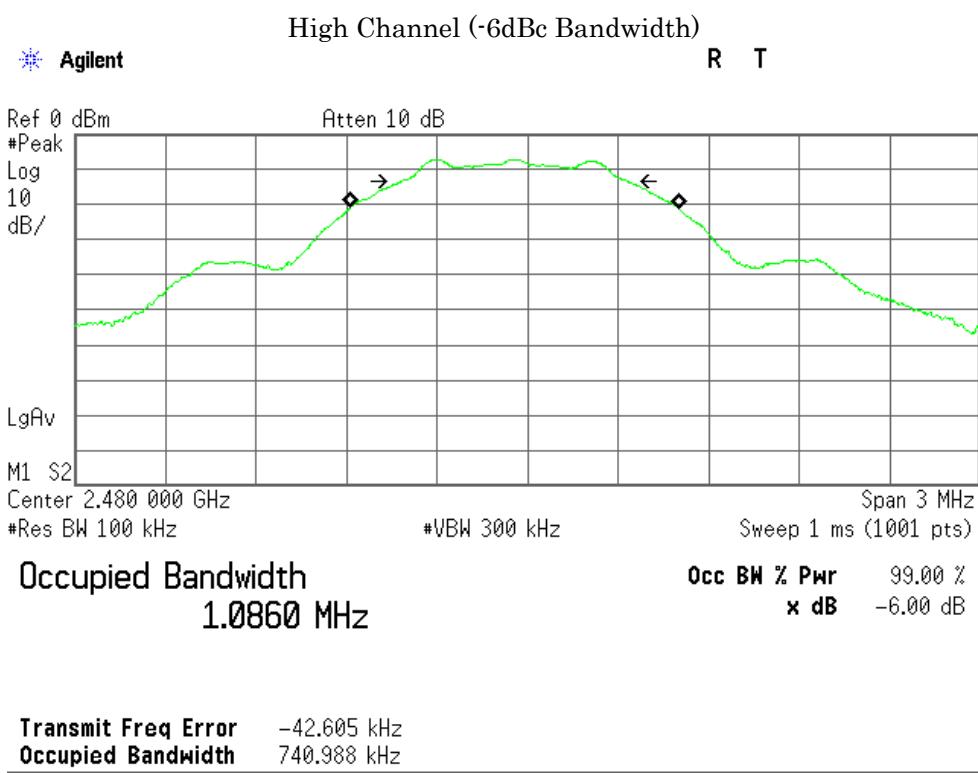




Transmit Freq Error -41.163 kHz
Occupied Bandwidth 726.492 kHz

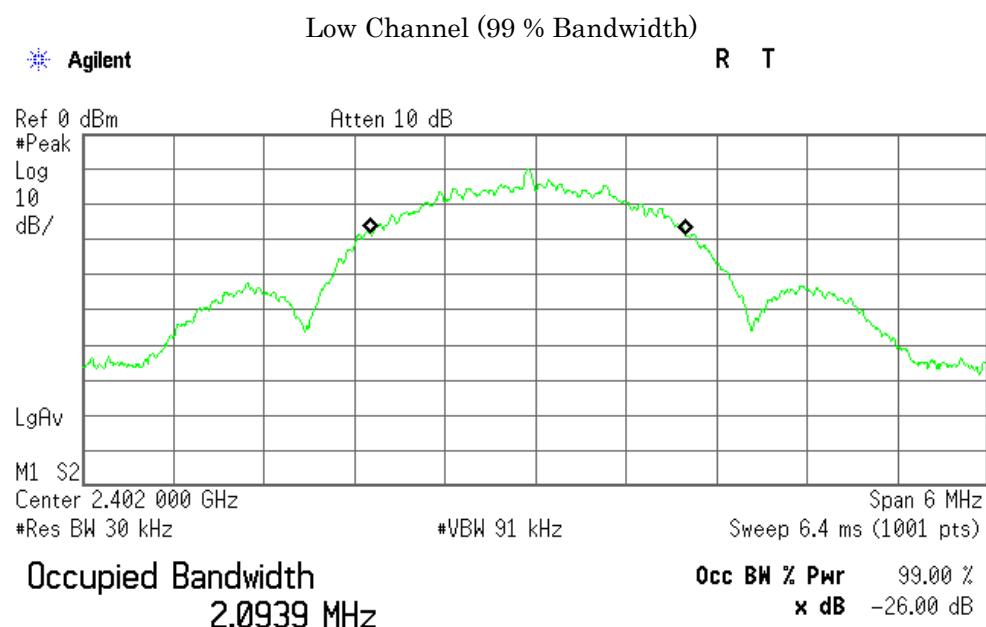


Transmit Freq Error -42.796 kHz
Occupied Bandwidth 724.625 kHz

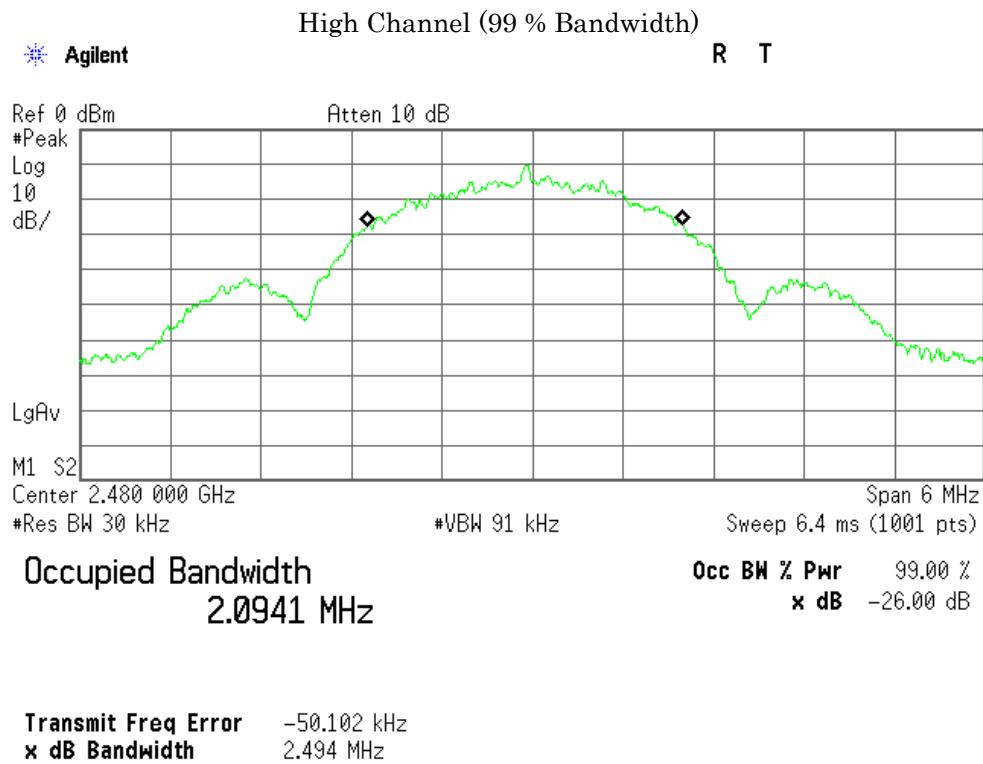
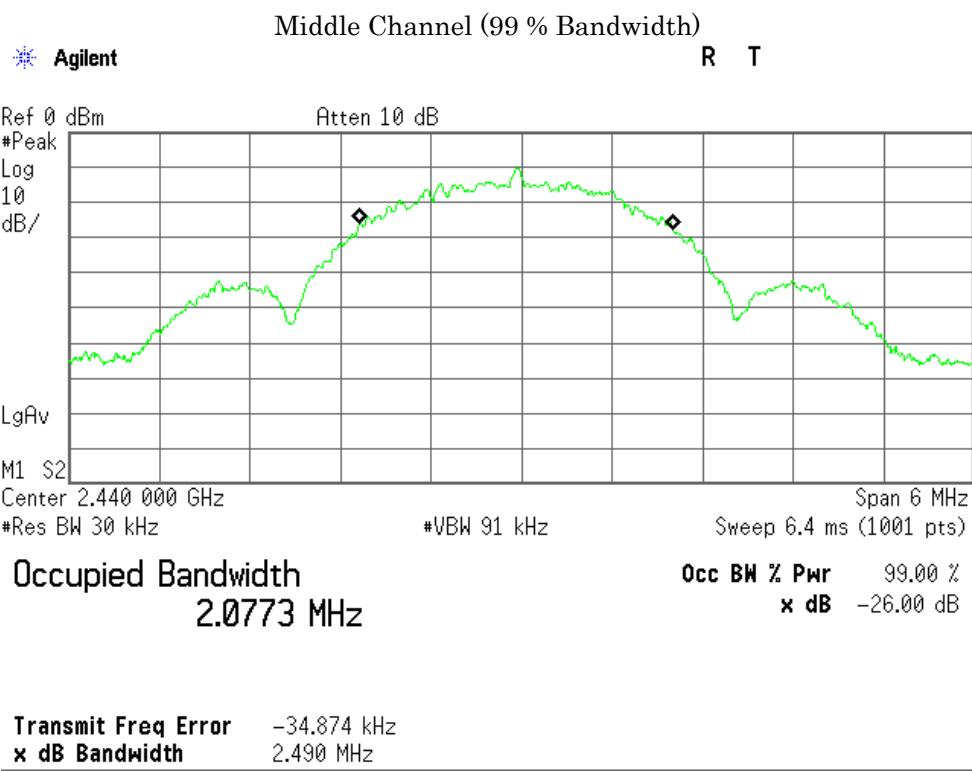


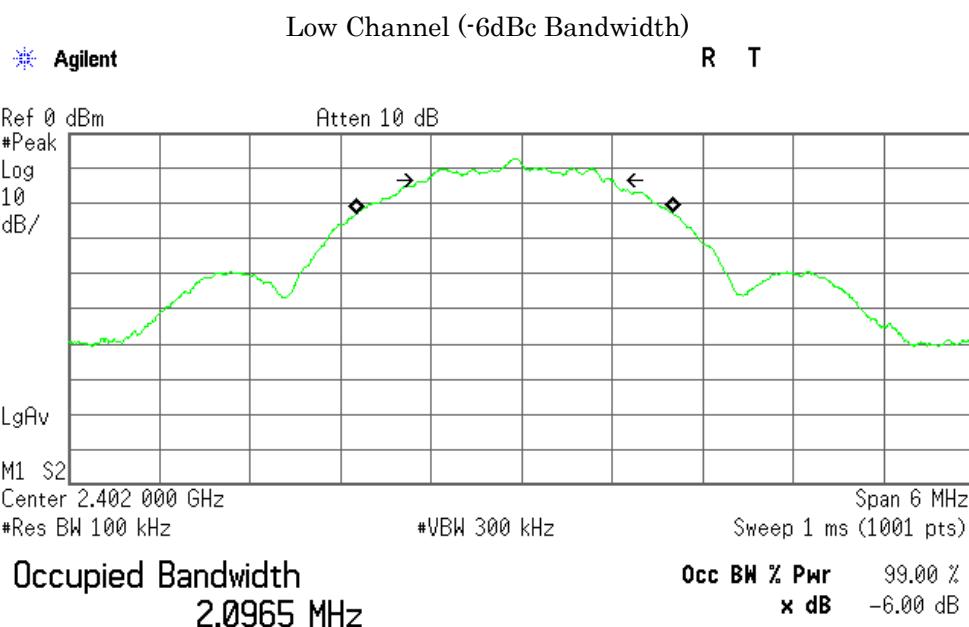
2) Bluetooth Low Energy 2 Mbps

Channel	Frequency (MHz)	99% Bandwidth (kHz)	-6dBc Bandwidth (kHz)	Minimum -6dBc Bandwidth Limit (kHz)
00	2402.0	2093.9	1223.0	500
19	2440.0	2077.3	1256.0	500
39	2480.0	2094.1	1177.0	500

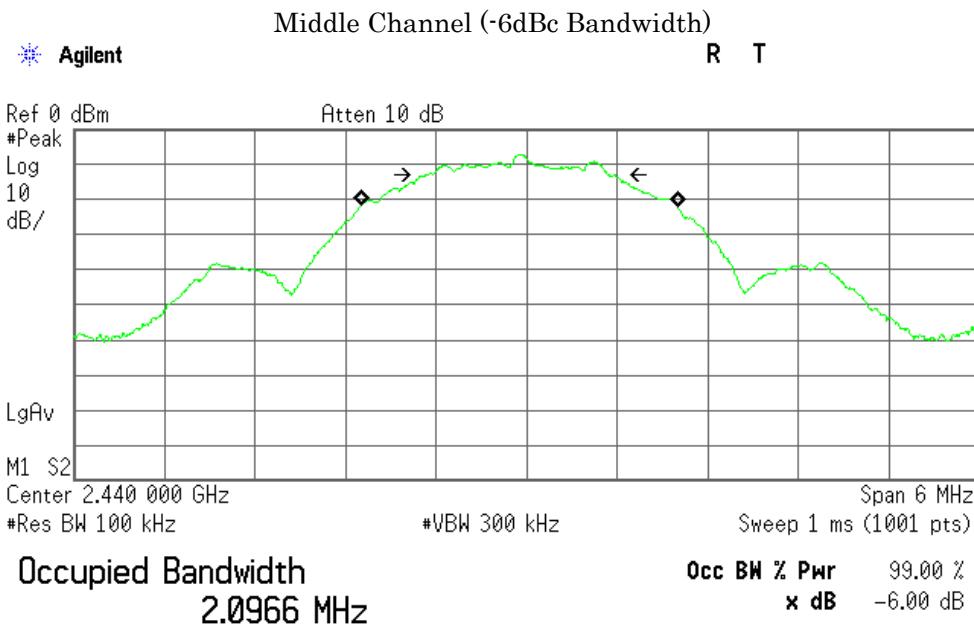


Transmit Freq Error -53.235 kHz
x dB Bandwidth 2.493 MHz

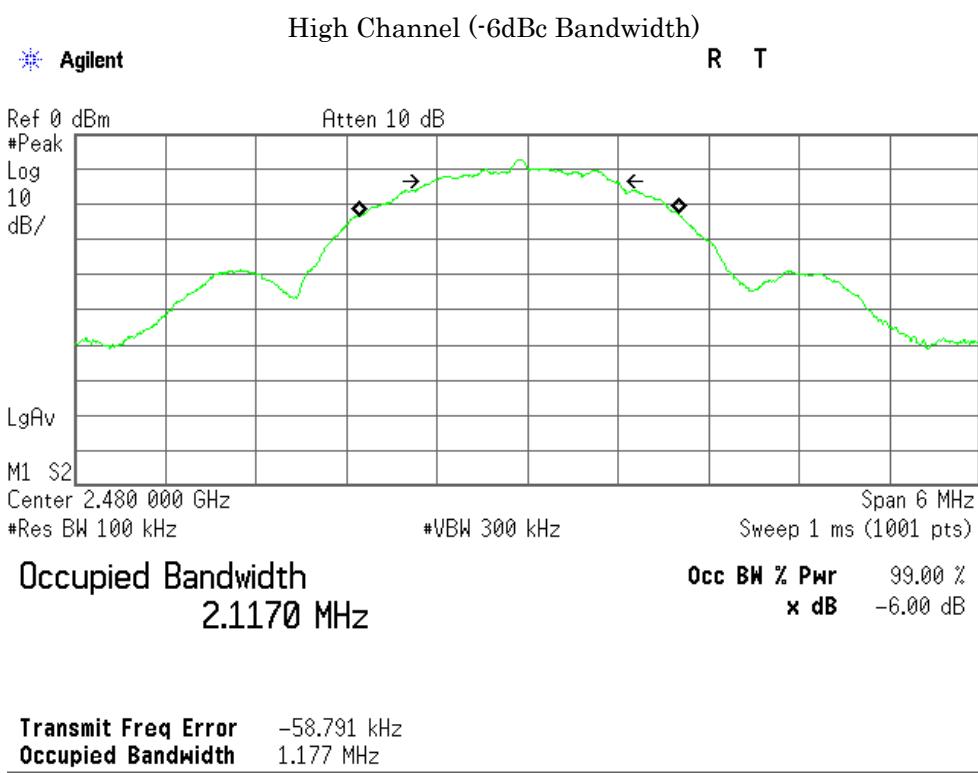




Transmit Freq Error -48.525 kHz
Occupied Bandwidth 1.223 MHz



Transmit Freq Error -46.059 kHz
Occupied Bandwidth 1.256 MHz



7.4 Dwell Time

For the requirements, - Applicable [- Tested. - Not tested by applicant request.]
 - Not Applicable

7.5 Peak Output Power (Conduction)

For the requirements, - Applicable [- Tested. - Not tested by applicant request.]
 - Not Applicable

7.5.1 Test Results

For the standard, - Passed - Failed - Not judged

Peak Output Power 3.16 dBm at 2402.0 MHz

Uncertainty of Measurement Results ± 0.9 dB(2σ)

Remarks : _____

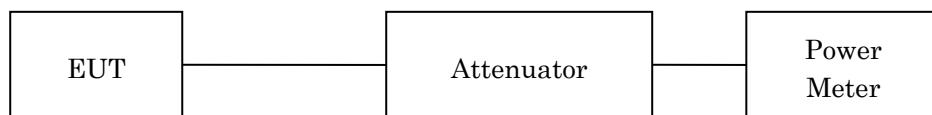
7.5.2 Test Instruments

Shielded Room S4				
Type	Model	Serial No. (ID)	Manufacturer	Cal. Due
Attenuator	54A-10	W5732 (D-30)	Weinschel	2019/08/08
Power Meter	N1911A	GB45100291 (B-63)	Agilent	2019/07/25
Power Sensor	N1921A	US44510470 (B-64)	Agilent	2019/07/25
RF Cable	SF102	14253/2 (C-52)	HUBER+SUHNER	2019/08/08

NOTE : The calibration interval of the above test instruments is 12 months.

7.5.3 Test Method and Test Setup (Diagrammatic illustration)

The Conducted RF Power Output was measured with a power meter, one attenuator and a short, low loss cable.



7.5.4 Test Data

1) Bluetooth Low Energy 1 Mbps

Test Date: August 30, 2018
Temp.: 26 °C. Humi: 64 %

CH	Transmitting Frequency [MHz]	Correction Factor [dB]	Meter Reading [dBm]	Conducted Peak Output Power		Limits [dBm]	Margin [dB]
				[dBm]	[mW]		
00	2402	10.25	- 7.09	3.16	2.07	30.00	+26.84
19	2440	10.25	- 7.17	3.08	2.03	30.00	+26.92
39	2480	10.25	- 7.27	2.98	1.99	30.00	+27.02

Calculated result at 2402.000 MHz, as the worst point shown on underline:

$$\begin{array}{rcl} \text{Correction Factor} & = & 10.25 \text{ dB} \\ +) \underline{\text{Meter Reading}} & = & \underline{-7.09 \text{ dBm}} \\ \text{Result} & = & 3.16 \text{ dBm} = 2.07 \text{ mW} \end{array}$$

Minimum Margin: $30.00 - 3.16 = 26.84$ (dB)

NOTES

1. The correction factor shows the attenuation pad loss including the short, low loss cable or adapter.
2. Setting of measuring instrument(s) :

Detector Function	Video B.W.
Peak	Off

** Although the DC power supply voltage was varied between 85% and 115% of the nominal rated voltage, the Peak Output Power did not change.

2) Bluetooth Low Energy 2 Mbps

Test Date: August 30, 2018
Temp.: 26 °C. Humi: 64 %

CH	Transmitting Frequency [MHz]	Correction Factor [dB]	Meter Reading [dBm]	Conducted Peak Output Power [dBm] [mW]		Limits [dBm]	Margin [dB]
				Peak [dBm]	Output Power [mW]		
00	2402	10.25	- 7.09	3.16	2.07	30.00	+26.84
19	2440	10.25	- 7.17	3.08	2.03	30.00	+26.92
39	2480	10.25	- 7.27	2.98	1.99	30.00	+27.02

Calculated result at 2402.000 MHz, as the worst point shown on underline:

$$\begin{array}{rcl} \text{Correction Factor} & = & 10.25 \text{ dB} \\ +) \underline{\text{Meter Reading}} & = & -7.09 \text{ dBm} \\ \text{Result} & = & 3.16 \text{ dBm} = 2.07 \text{ mW} \end{array}$$

Minimum Margin: $30.00 - 3.16 = 26.84$ (dB)

NOTES

1. The correction factor shows the attenuation pad loss including the short, low loss cable or adapter.
2. Setting of measuring instrument(s) :

Detector Function	Video B.W.
Peak	Off

** Although the DC power supply voltage was varied between 85% and 115% of the nominal rated voltage, the Peak Output Power did not change.

7.6 Peak Power Density (Conduction)

For the requirements, - Applicable [- Tested. - Not tested by applicant request.]
 - Not Applicable

7.6.1 Test Results

For the standard, - Passed - Failed - Not judged

Peak Power Density of BLE 1 Mbps is 0.97 dBm at 2440.0 MHz
Peak Power Density of BLE 2 Mbps is 0.32 dBm at 2440.0 MHz

Uncertainty of Measurement Results ± 1.7 dB(2σ)

Remarks : _____

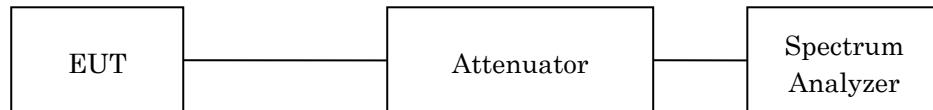
7.6.2 Test Instruments

Shielded Room S4				
Type	Model	Serial No. (ID)	Manufacturer	Cal. Due
Spectrum Analyzer	E4446A	US44300388 (A-39)	Agilent	2019/03/27
Attenuator	54A-10	W5732 (D-30)	Weinschel	2019/08/08
RF Cable	SF102	14253/2 (C-52)	HUBER+SUHNER	2019/08/08

NOTE : The calibration interval of the above test instruments is 12 months.

7.6.3 Test Method and Test Setup (Diagrammatic illustration)

The test system is shown as follows:



7.6.4 Test Data

1) Bluetooth Low Energy 1 Mbps

Test Date: August 30, 2018
Temp.: 26 °C, Humi: 64 %

Transmitting Frequency CH	[MHz]	Correction Factor [dB]	Meter Reading [dBm]	Conducted Peak Power Density		Limits [dBm]	Margin [dB]
				[dBm]	[mW]		
00	2402	10.25	-9.51	0.74	1.19	8.00	+ 7.26
19	2440	10.25	-9.28	0.97	1.25	8.00	+ 7.03
39	2480	10.25	-9.71	0.54	1.13	8.00	+ 7.46

Calculated result at 2440.000 MHz, as the worst point shown on underline:

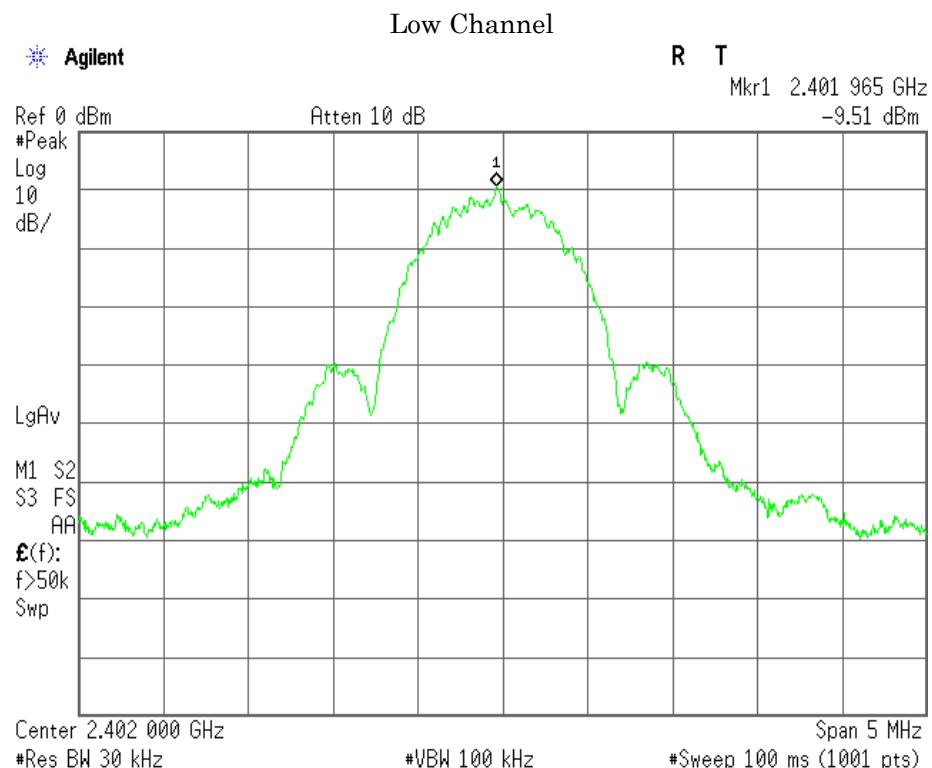
$$\begin{aligned}
 \text{Correction Factor} &= 10.25 \text{ dB} \\
 +) \underline{\text{Meter Reading}} &= -9.28 \text{ dBm} \\
 \text{Result} &= 0.97 \text{ dBm} = 1.25 \text{ mW}
 \end{aligned}$$

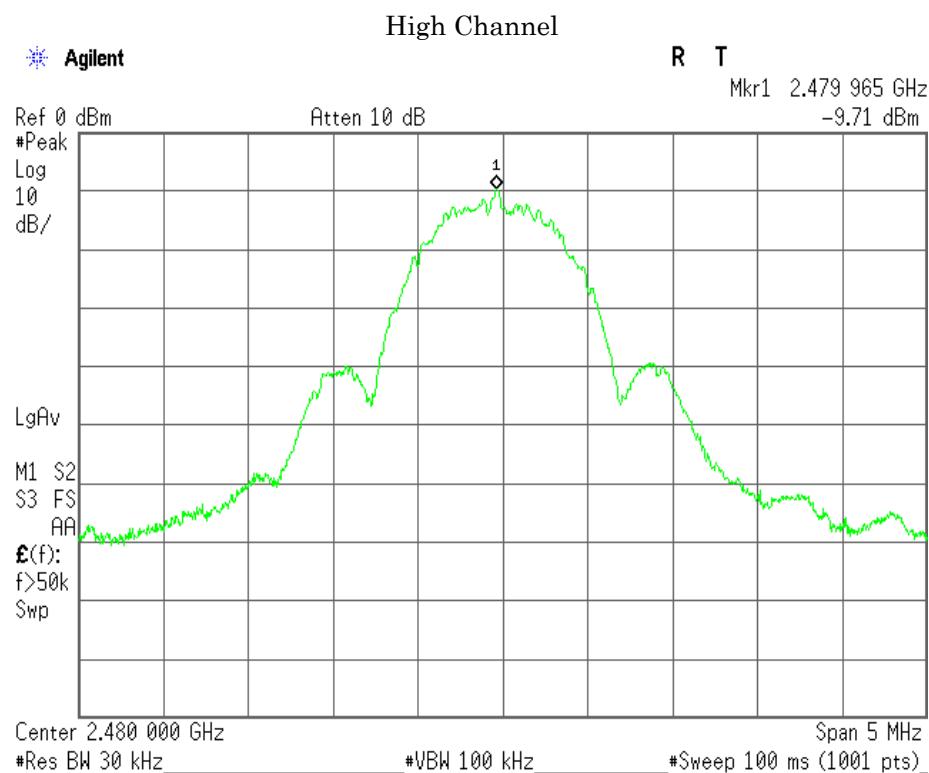
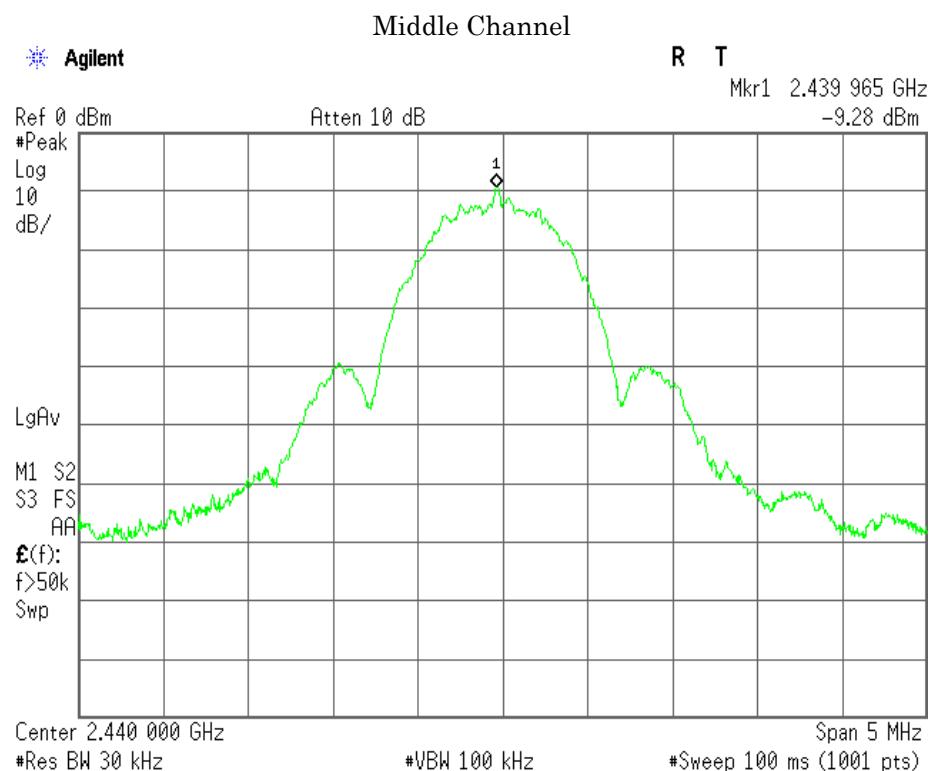
Minimum Margin: $8.00 - 0.97 = 7.03$ (dB)

NOTES

1. The peak power density complied with the limit using 30 kHz resolution bandwidth of Spectrum Analyzer.
2. The correction factor shows the attenuation pad loss including the short, low loss cable or adapter.
3. Setting of measuring instrument(s) :

Detector Function	RES B.W.	Video B.W.
Peak	30kHz	100kHz





2) Bluetooth Low Energy 2 Mbps

Test Date: August 30, 2018
Temp.: 26 °C, Humi: 64 %

Transmitting Frequency		Correction Factor [dB]	Meter Reading [dBm]	Conducted Peak Power Density		Limits [dBm]	Margin [dB]
CH	[MHz]			[dBm]	[mW]		
00	2402	10.25	-10.96	-0.71	0.85	8.00	+ 8.71
19	2440	10.25	<u>-9.93</u>	0.32	1.08	8.00	+ 7.68
39	2480	10.25	-10.41	-0.16	0.96	8.00	+ 8.16

Calculated result at 2440.000 MHz, as the worst point shown on underline:

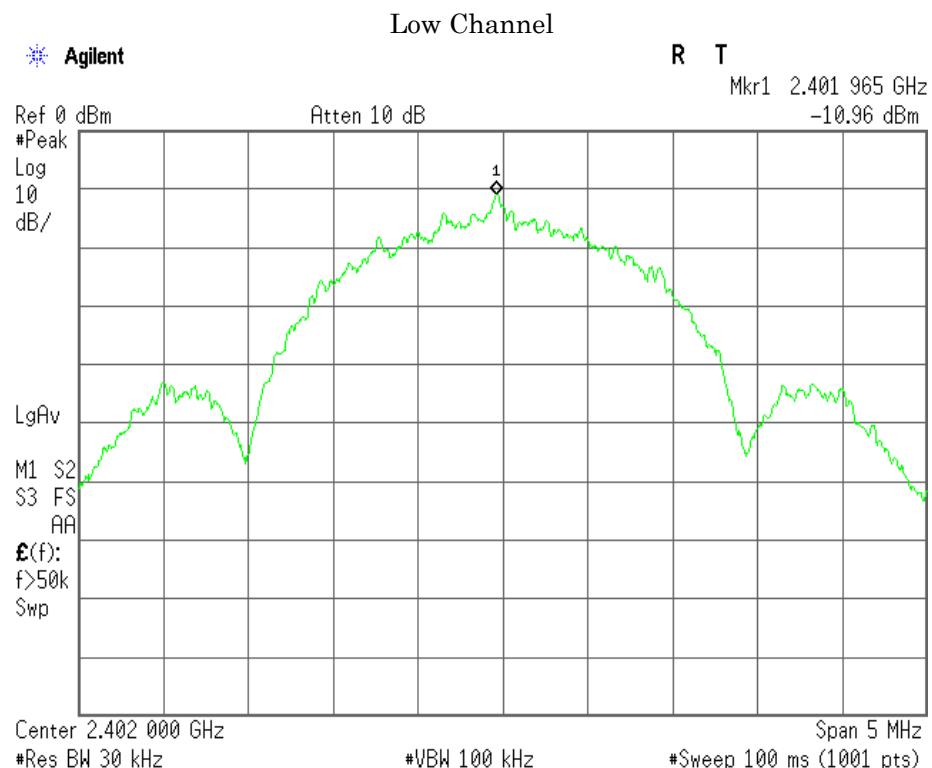
$$\begin{aligned}
 \text{Correction Factor} &= 10.25 \text{ dB} \\
 +) \underline{\text{Meter Reading}} &= -9.93 \text{ dBm} \\
 \text{Result} &= 0.32 \text{ dBm} = 1.08 \text{ mW}
 \end{aligned}$$

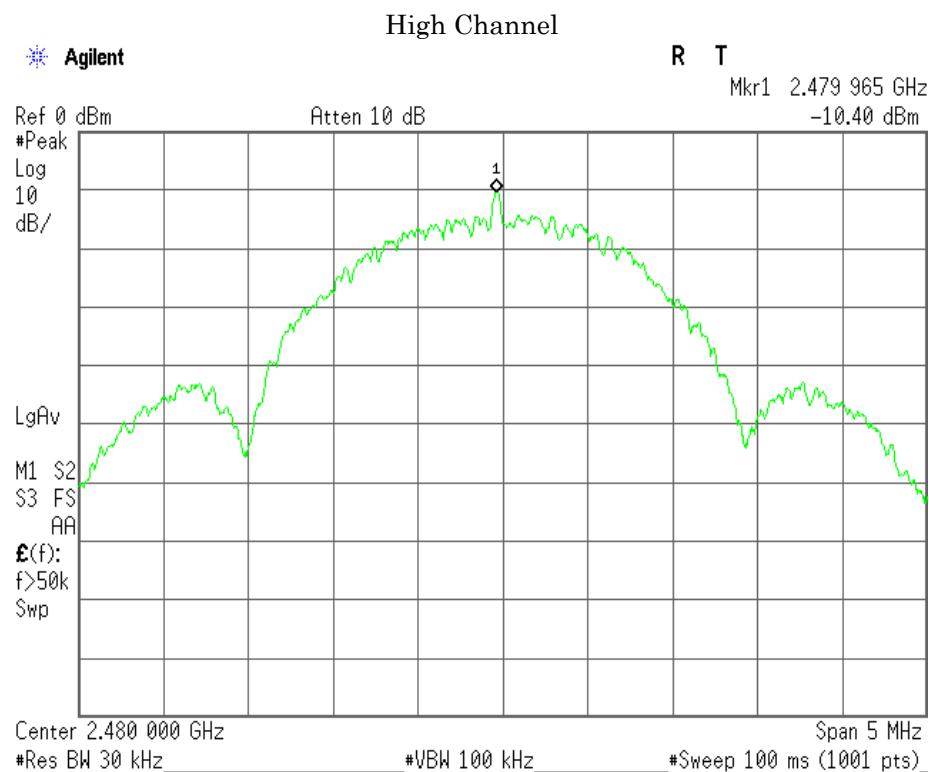
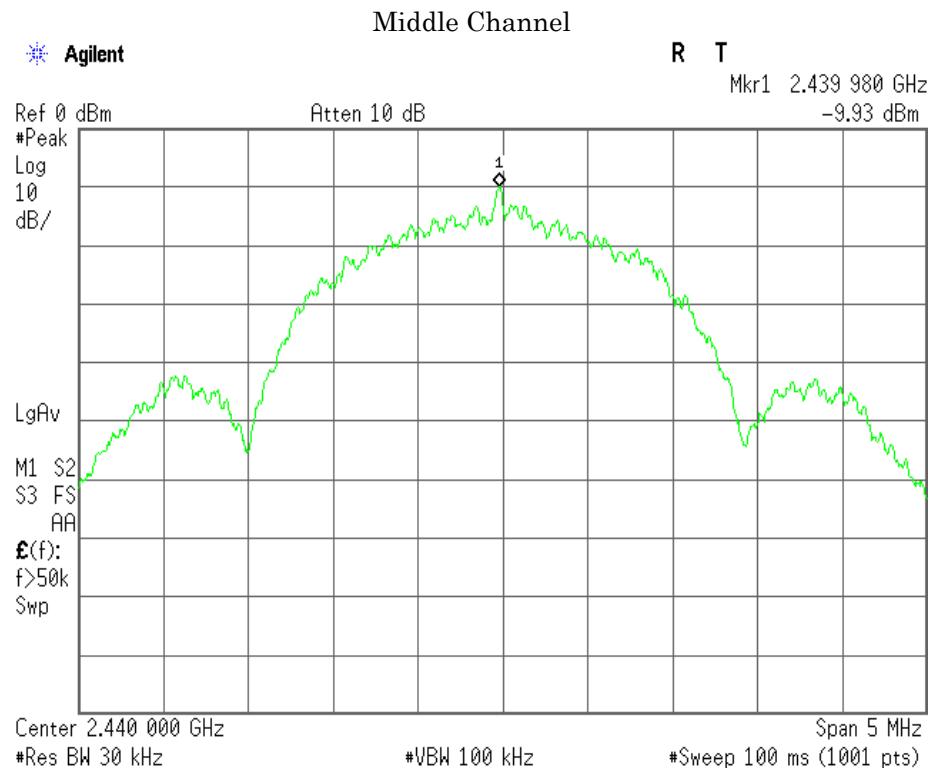
Minimum Margin: $8.00 - 0.32 = 7.68$ (dB)

NOTES

1. The peak power density complied with the limit using 30 kHz resolution bandwidth of Spectrum Analyzer.
2. The correction factor shows the attenuation pad loss including the short, low loss cable or adapter.
3. Setting of measuring instrument(s) :

Detector Function	RES B.W.	Video B.W.
Peak	30kHz	100kHz





7.7 Spurious Emissions (Conduction)

For the requirements, - Applicable [- Tested. - Not tested by applicant request.]
 - Not Applicable

7.7.1 Test Results

For the standard, - Passed - Failed - Not judged

Uncertainty of Measurement Results	9 kHz – 1 GHz	<u>± 1.4</u>	dB(2σ)
	1 GHz – 18 GHz	<u>± 1.7</u>	dB(2σ)
	18 GHz – 40 GHz	<u>± 2.3</u>	dB(2σ)

Remarks : _____

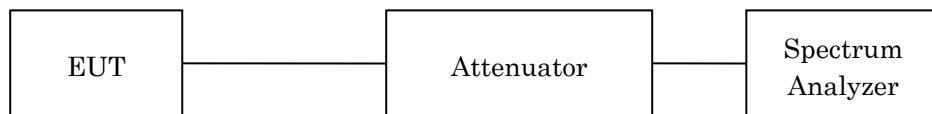
7.7.2 Test Instruments

Shielded Room S4				
Type	Model	Serial No. (ID)	Manufacturer	Cal. Due
Spectrum Analyzer	E4446A	US44300388 (A-39)	Agilent	2019/03/27
Attenuator	54A-10	W5732 (D-30)	Weinschel	2019/08/08
RF Cable	SF102	14253/2 (C-52)	HUBER+SUHNER	2019/08/08

NOTE : The calibration interval of the above test instruments is 12 months.

7.7.3 Test Method and Test Setup (Diagrammatic illustration)

The test system is shown as follows:



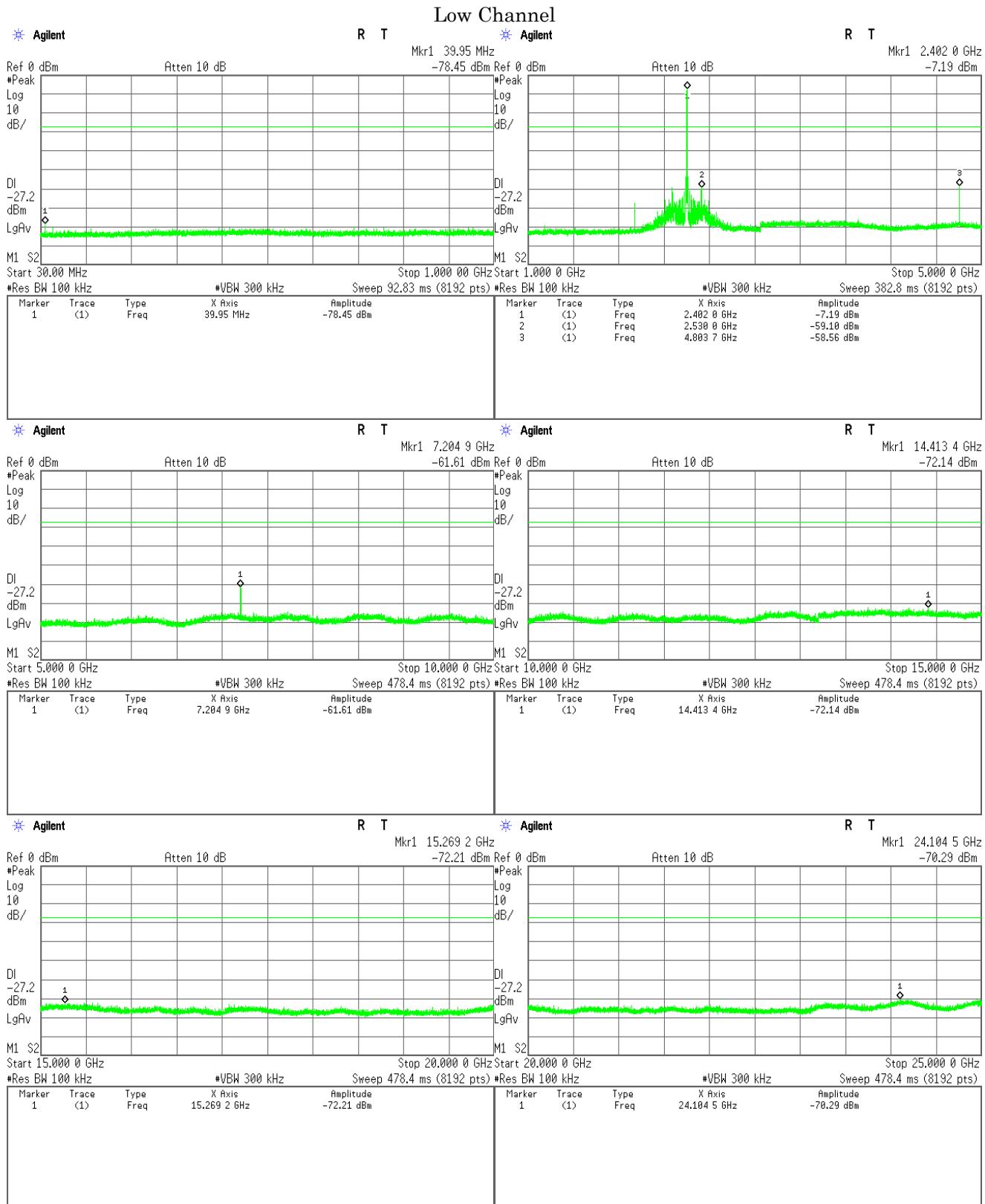
The setting of the spectrum analyzer are shown as follows:

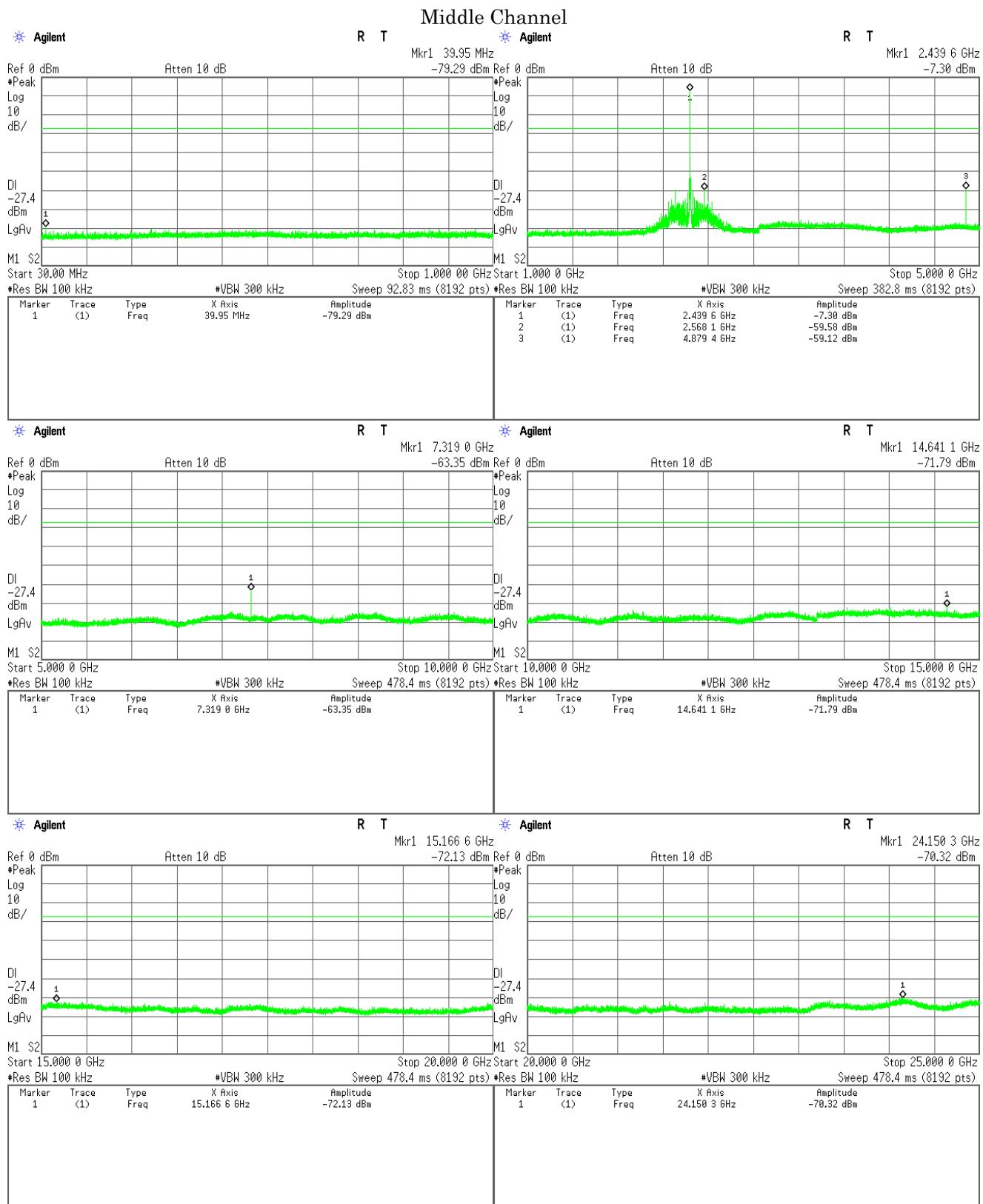
Frequency Range	30 MHz - 25 GHz	Band-Edge
Res. Bandwidth	100 kHz	100 kHz
Video Bandwidth	300 kHz	300 kHz
Sweep Time	AUTO	AUTO
Trace	Maxhold	Maxhold

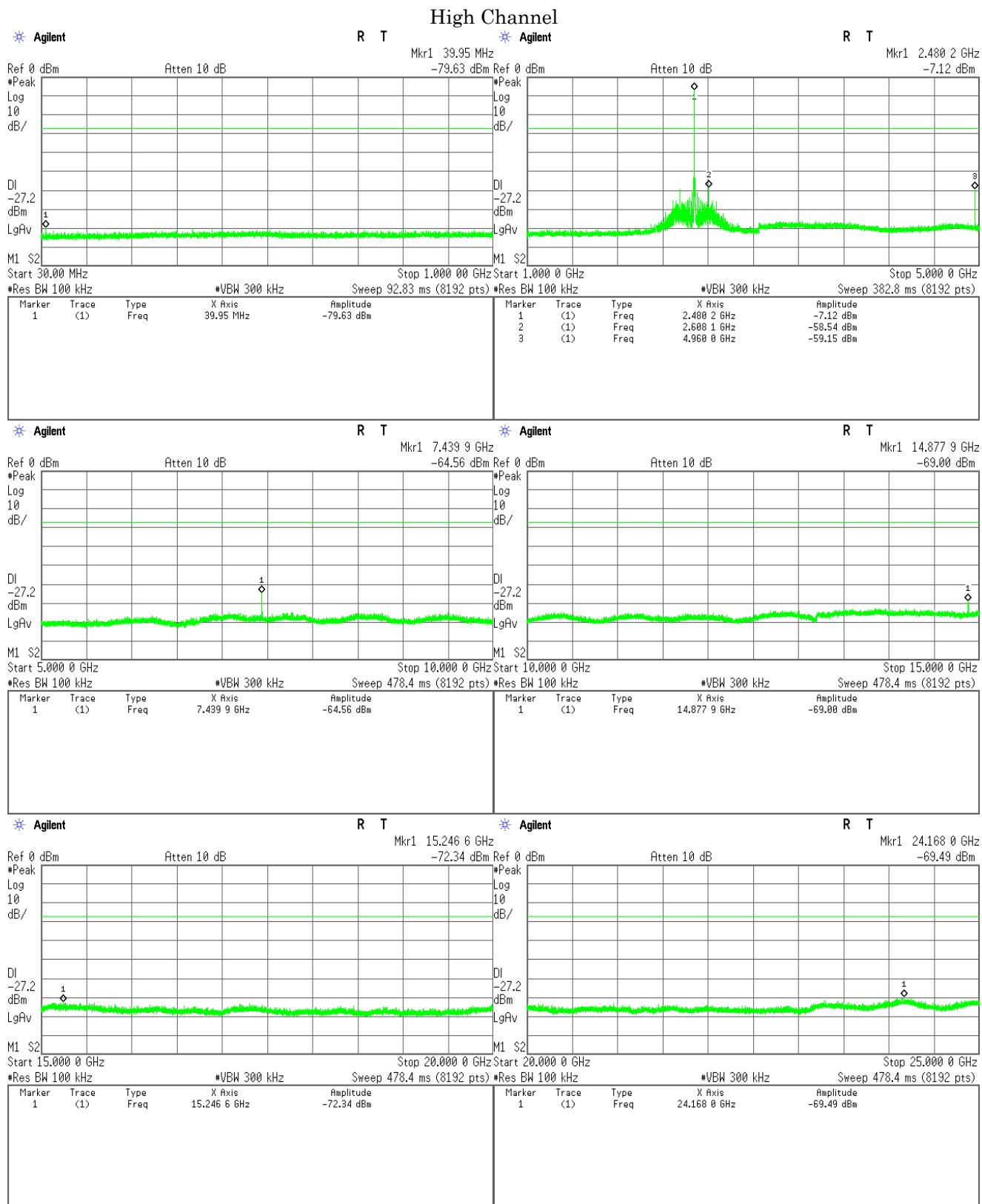
7.7.4 Test Data

Test Date: August 30, 2018
 Temp.: 26 °C, Humi: 64 %

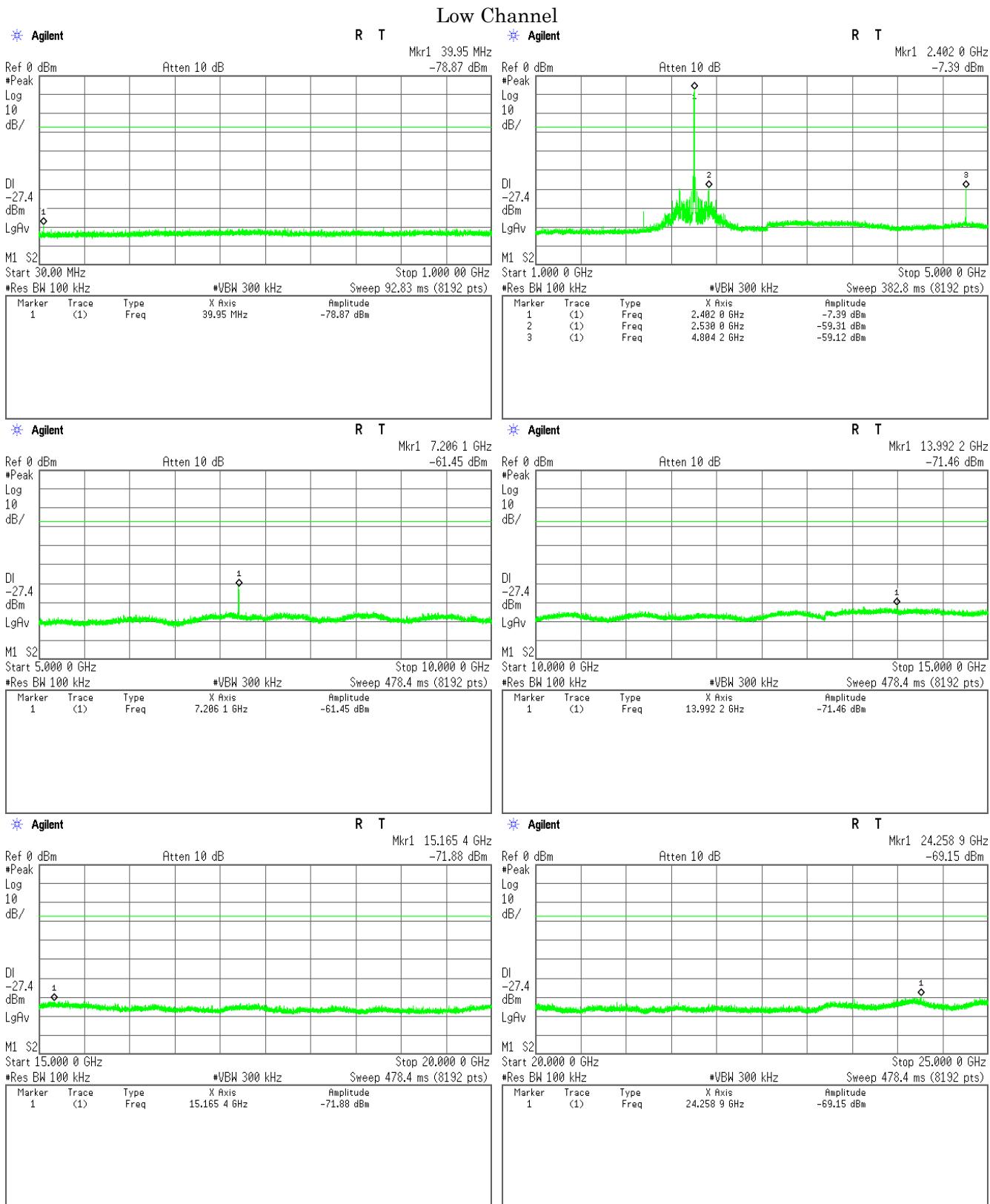
1) Bluetooth Low Energy 1 Mbps

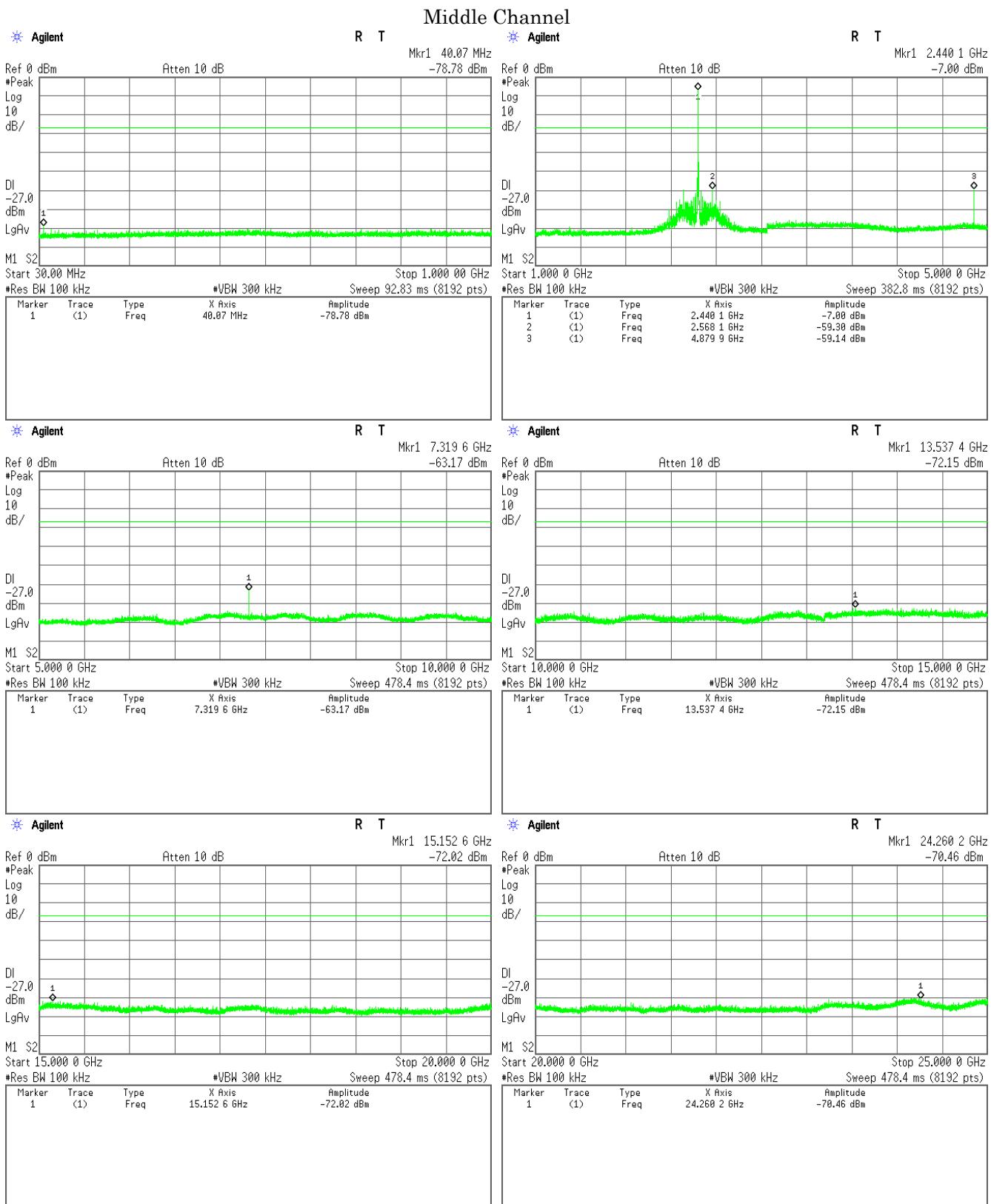


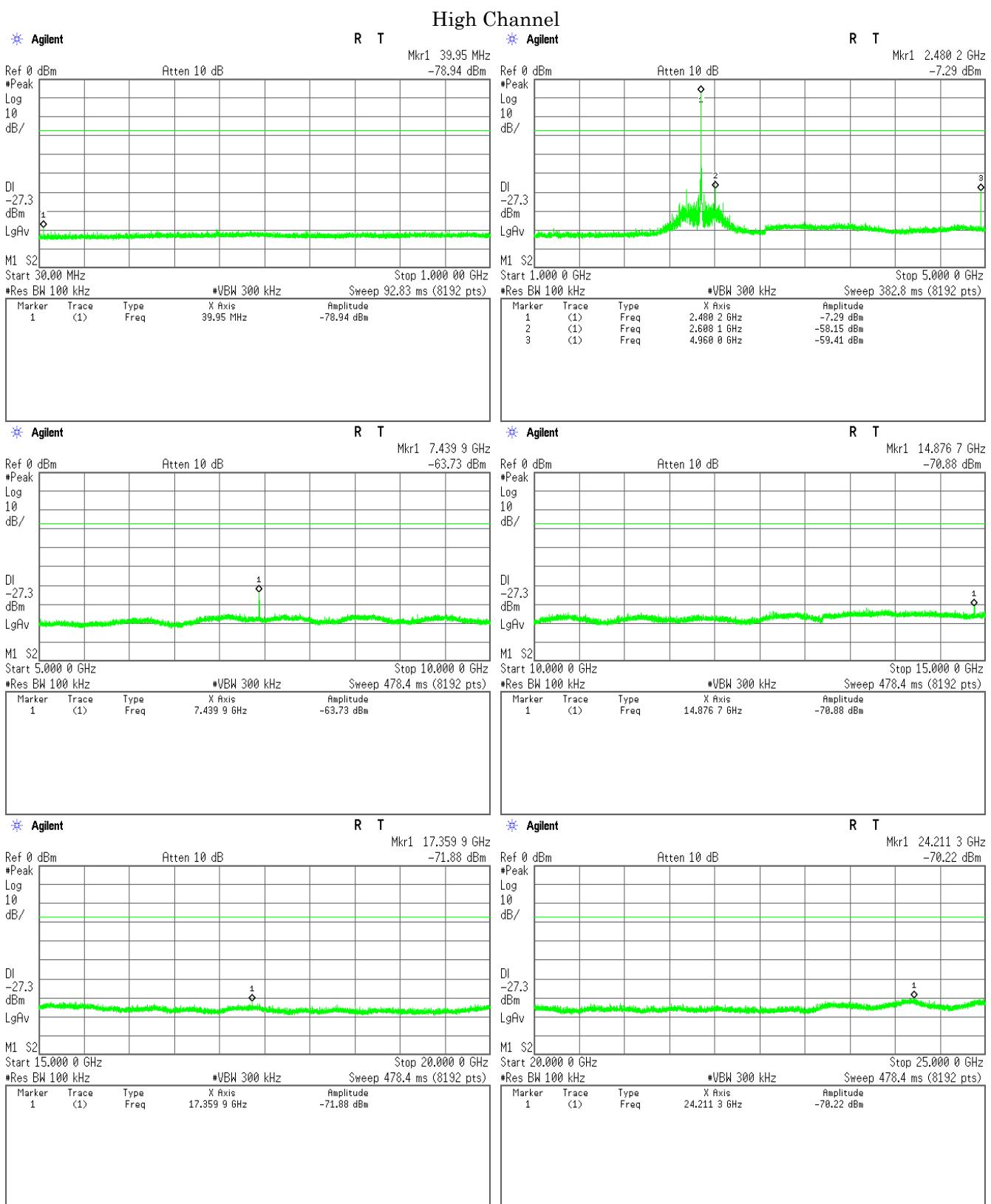




2) Bluetooth Low Energy 2 Mbps



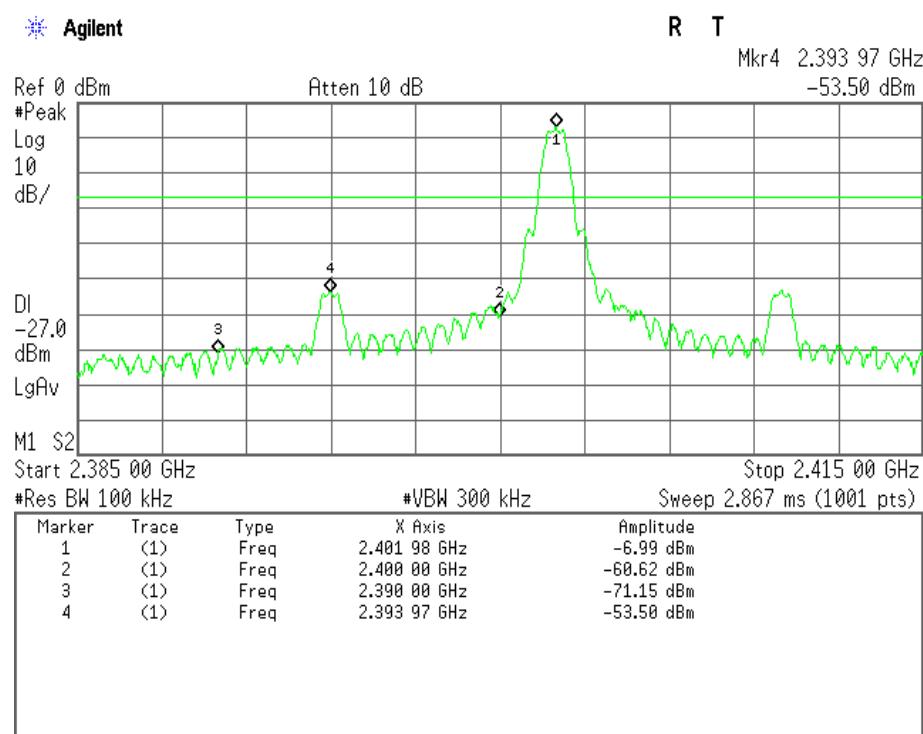




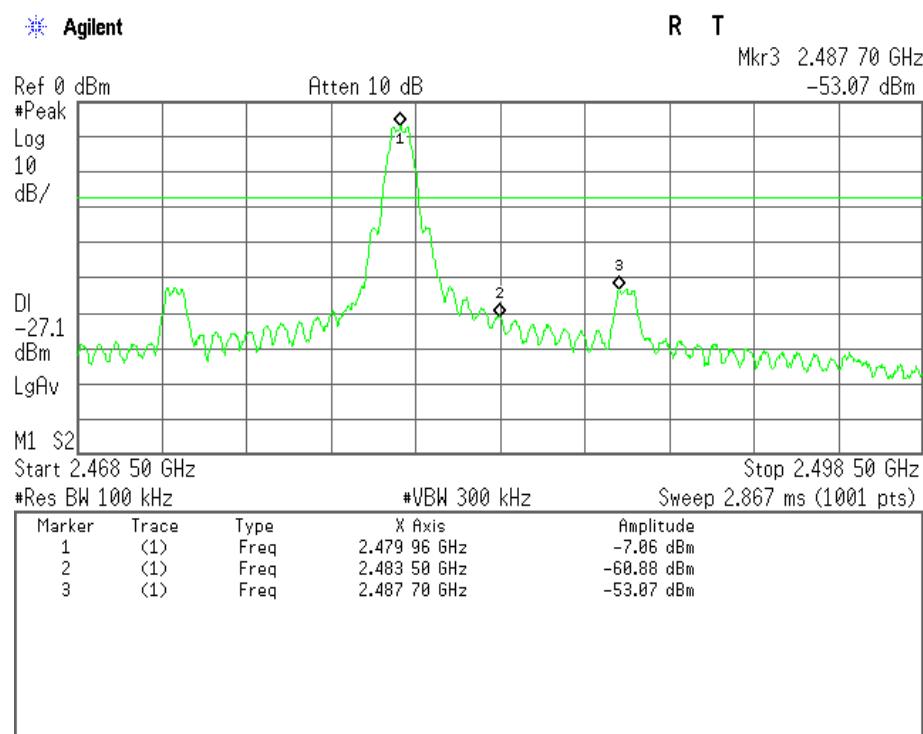
Band-Edge EmissionTest Date: August 30, 2018
Temp.: 26 °C, Humi: 64 %

1) Bluetooth Low Energy 1 Mbps

Low Channel

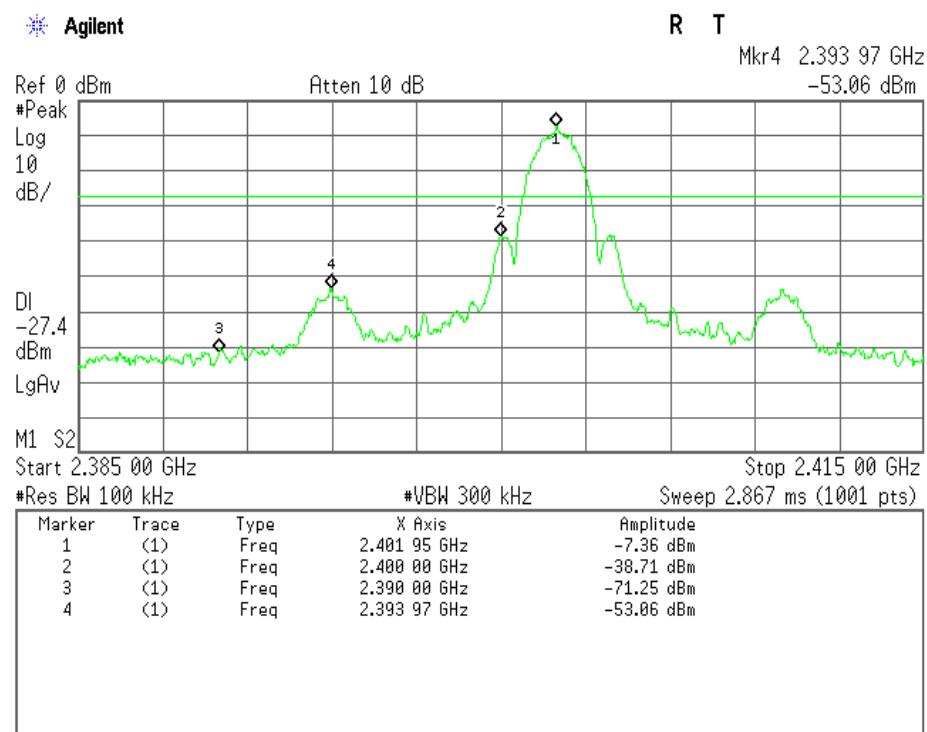


High Channel

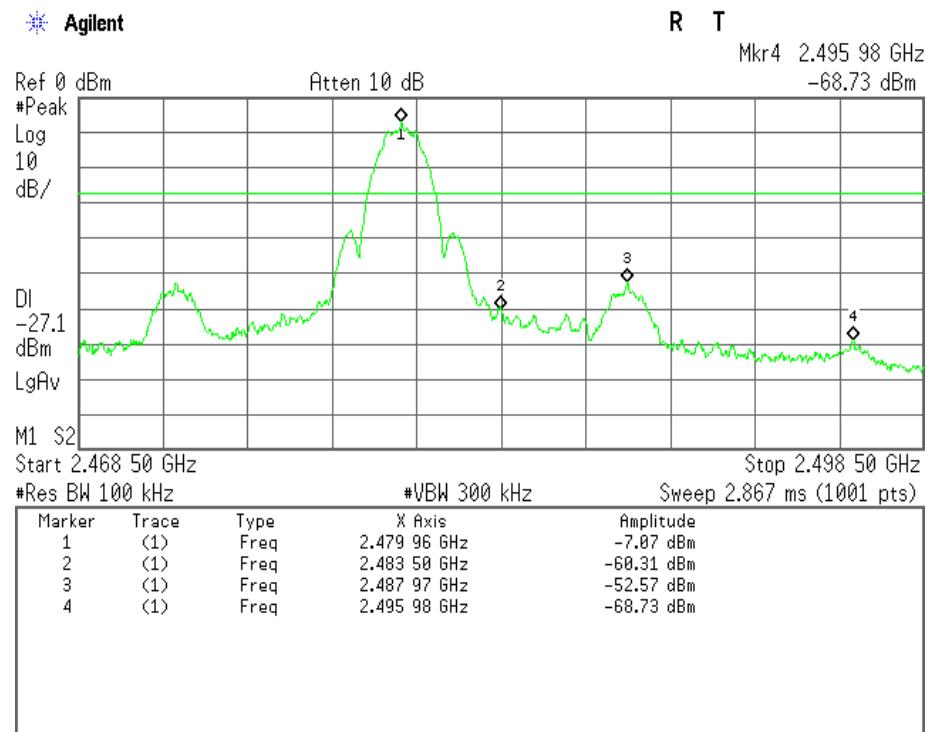


2) Bluetooth Low Energy 2 Mbps

Low Channel



High Channel



7.8 AC Powerline Conducted Emission

For the requirements, - Applicable [- Tested. - Not tested by applicant request.]
 - Not Applicable

7.8.1 Test Results

For the standard, - Passed - Failed - Not judged

Min. Limit Margin (Average) 5.2 dB at 0.4468 MHz

Uncertainty of Measurement Results ± 2.6 dB(2σ)

Remarks : _____

7.8.2 Test Instruments

Measurement Room M2				
Type	Model	Serial No. (ID)	Manufacturer	Cal. Due
Test Receiver	ESU 26	100170 (A-6)	Rohde & Schwarz	2018/11/09
AMN (main)	KNW-242	8-431-14 (D-7)	Kyoritsu	2018/11/08
RF Cable	RG223/U	--- (H-9)	HUBER+SUHNER	2019/07/31

NOTE : The calibration interval of the above test instruments is 12 months.

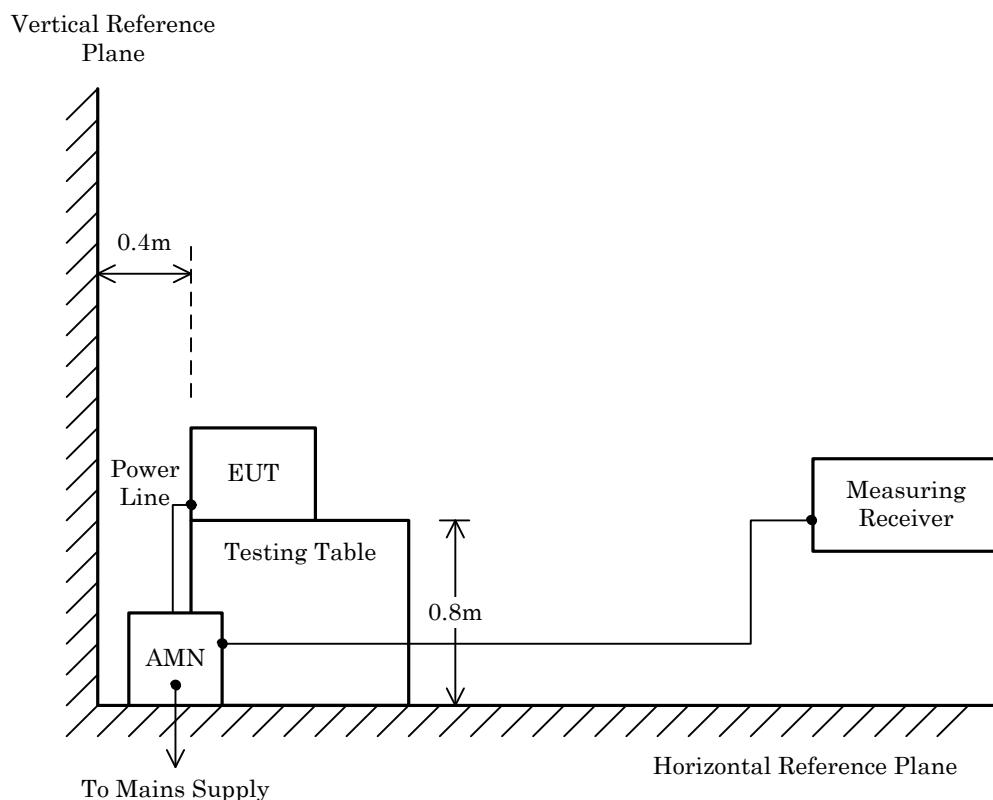
7.8.3 Test Method and Test Setup (Diagrammatic illustration)

The preliminary tests were performed using the scan mode of test receiver or spectrum analyzer to observe the emissions characteristics of the EUT.

The EUT configuration, cable configuration and mode of operation were determined for producing the maximum level of emissions.

This configurations was used for final tests.

(Reference divisional instruction No. G703649)



NOTE

AMN : Artificial Mains Network

7.8.4 Test Data

Mode of EUT : All modes have been investigated and the worst case mode for channel (19ch: 2440MHz / 1 Mbps and 2 Mbps) has been listed.

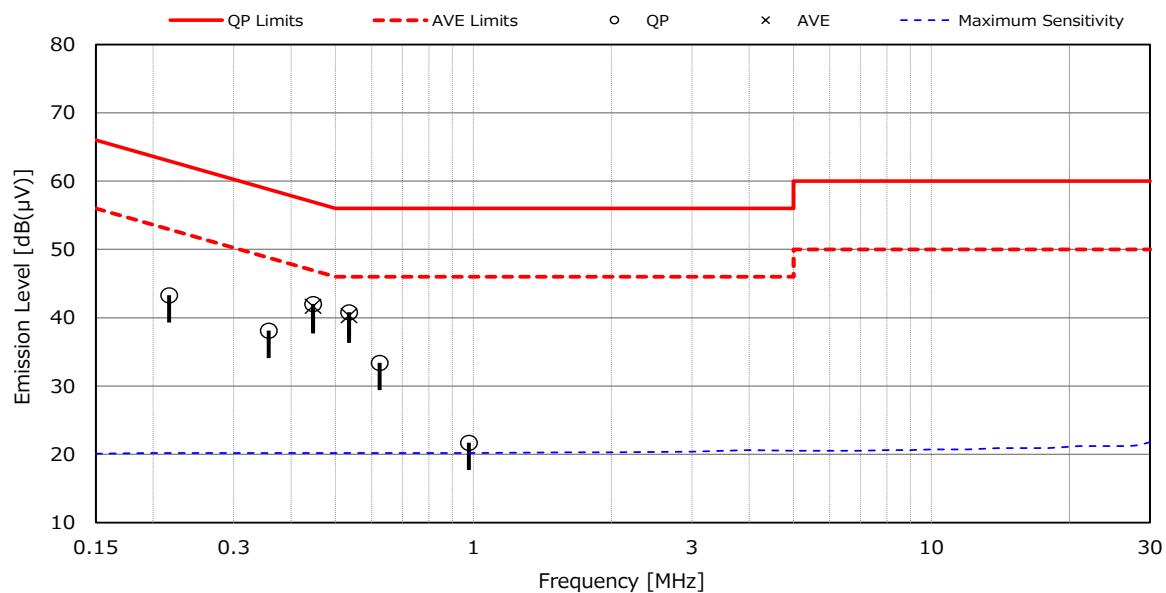
Test voltage : 3VDC (DC Power Supply 120VAC 60Hz)

Test Date: September 6, 2018

Temp.: 24 °C, RH: 61 %, Atm.: 993 hPa

Measured phase : L1

Frequency [MHz]	Factor [dB]	Readings [dB(μV)]		Limits [dB(μV)]		Results [dB(μV)]		Margin [dB]		Remarks
		QP	AVE	QP	AVE	QP	AVE	QP	AVE	
0.2167	10.2	33.1	--	62.9	52.9	43.3	--	+ 19.6	--	-
0.3575	10.2	27.9	--	58.8	48.8	38.1	--	+ 20.7	--	-
0.4468	10.2	31.8	31.5	56.9	46.9	42.0	41.7	+ 14.9	+ 5.2	-
0.5352	10.2	30.6	30.1	56.0	46.0	40.8	40.3	+ 15.2	+ 5.7	-
0.6244	10.2	23.2	--	56.0	46.0	33.4	--	+ 22.6	--	-
0.9775	10.2	11.5	--	56.0	46.0	21.7	--	+ 34.3	--	-



NOTES

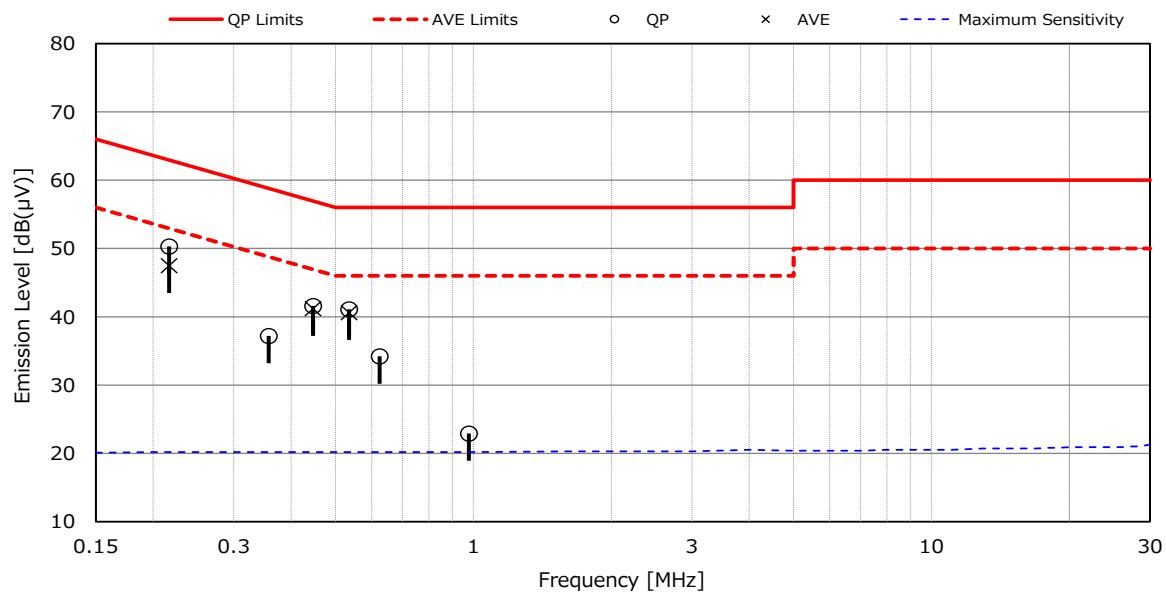
- 1) The spectrum was checked from 150 kHz to 30 MHz.
- 2) The factor includes the AMN voltage division factor and the cable loss.
- 3) The symbol of “--” means “not applicable”.
- 4) Calculated result as the worst point shown on underline :
Factor + Reading (AVE) = 10.2 + 31.5 = 41.7 dB(μV) at 0.4468 MHz
- 5) QP : Quasi-Peak detector, AVE : Average detector
- 6) Bandwidth : 9 kHz (150 kHz - 30 MHz)

Test voltage : 3VDC (DC Power Supply 120VAC 60Hz)

Test Date: September 6, 2018
Temp.: 24 °C, RH: 61 %, Atm.: 993 hPa

Measured phase : L2

Frequency [MHz]	Factor [dB]	Readings [dB(μV)]		Limits [dB(μV)]		Results [dB(μV)]		Margin [dB]		Remarks
		QP	AVE	QP	AVE	QP	AVE	QP	AVE	
0.2167	10.2	40.1	37.3	62.9	52.9	50.3	47.5	+ 12.6	+ 5.4	-
0.3575	10.2	27.0	--	58.8	48.8	37.2	--	+ 21.6	--	-
0.4468	10.2	31.4	31.0	56.9	46.9	41.6	41.2	+ 15.3	+ 5.7	-
0.5352	10.2	30.9	30.4	56.0	46.0	41.1	40.6	+ 14.9	+ 5.4	-
0.6244	10.2	24.0	--	56.0	46.0	34.2	--	+ 21.8	--	-
0.9775	10.2	12.7	--	56.0	46.0	22.9	--	+ 33.1	--	-



NOTES

- 1) The spectrum was checked from 150 kHz to 30 MHz.
- 2) The factor includes the AMN voltage division factor and the cable loss.
- 3) The symbol of "--" means "not applicable".
- 4) Calculated result as the worst point shown on underline :
- Factor + Reading (AVE) = 10.2 + 37.3 = 47.5 dB(μV) at 0.2167 MHz
- 5) QP : Quasi-Peak detector, AVE : Average detector
- 6) Bandwidth : 9 kHz (150 kHz - 30 MHz)

7.9 Radiated Emission

For the requirements, - Applicable [- Tested. - Not tested by applicant request.]
 - Not Applicable

7.9.1 Test Results

For the standard, - Passed - Failed - Not judged

Min. Limit Margin (Average) 2.4 dB at 2488.08 MHz

Uncertainty of Measurement Results	9 kHz – 30 MHz	<u>± 3.0</u>	dB(2σ)
	30 MHz – 200 MHz	<u>± 3.6</u>	dB(2σ)
	200 MHz – 1000 MHz	<u>± 5.2</u>	dB(2σ)
	1 GHz – 6 GHz	<u>± 4.7</u>	dB(2σ)
	6 GHz – 18 GHz	<u>± 4.6</u>	dB(2σ)
	18 GHz – 40 GHz	<u>± 5.5</u>	dB(2σ)

Remarks : Worst case : BLE 1 Mbps 39ch (Z-axis position)

The measurement result is within the range of measurement uncertainty.

7.9.2 Test Instruments

Anechoic Chamber A2				
Type	Model	Serial No. (ID)	Manufacturer	Cal. Due
Test Receiver	ESU 26	100170 (A-6)	Rohde & Schwarz	2018/11/09
Loop Antenna	HFH2-Z2	860605/030 (C-3)	Rohde & Schwarz	2019/08/02
Biconical Antenna	VHA9103/BBA9106	2355 (C-30)	Schwarzbeck	2019/05/30
Log-periodic Antenna	VULP9118B	870 (C-25)	Schwarzbeck	2018/11/28
Double-Ridge Guide Horn Antenna	TR17206	73370006 (C-29)	ADVANTEST	2019/06/14
Horn Antenna	3160-07	9902-1113 (C-58)	EMCO	2019/06/14
Horn Antenna	3160-08	9904-1099 (C-59)	EMCO	2019/06/14
Horn Antenna	3160-09	9808-1117 (C-48)	EMCO	2019/06/24
Pre-Amplifier	TPA0118-36	1010 (A-37)	TOYO	2019/05/20
Pre-Amplifier	RP1826G-45H	RP140121-11 (A-53)	EMCS	2019/06/24
Attenuator	54A-10	W5713 (D-29)	Weinschel	2019/08/08
RF Cable	RG213/U	--- (H-29)	HUBER+SUHNER	2019/08/02
RF Cable	S 10162 B-11 etc.	--- (H-4)	HUBER+SUHNER	2019/04/01
RF Cable	SF102E	6683/2E (C-70)	HUBER+SUHNER	2018/12/03
RF Cable	SF102E	10055/2E (C-75)	HUBER+SUHNER	2019/01/11
RF Cable	SF102EA	3041/2EA (C-69)	HUBER+SUHNER	2019/01/10

NOTE : The calibration interval of the above test instruments is 12 months.

7.9.3 Test Method and Test Setup (Diagrammatic illustration)

7.9.3.1 Radiated Emission 9 kHz – 30 MHz

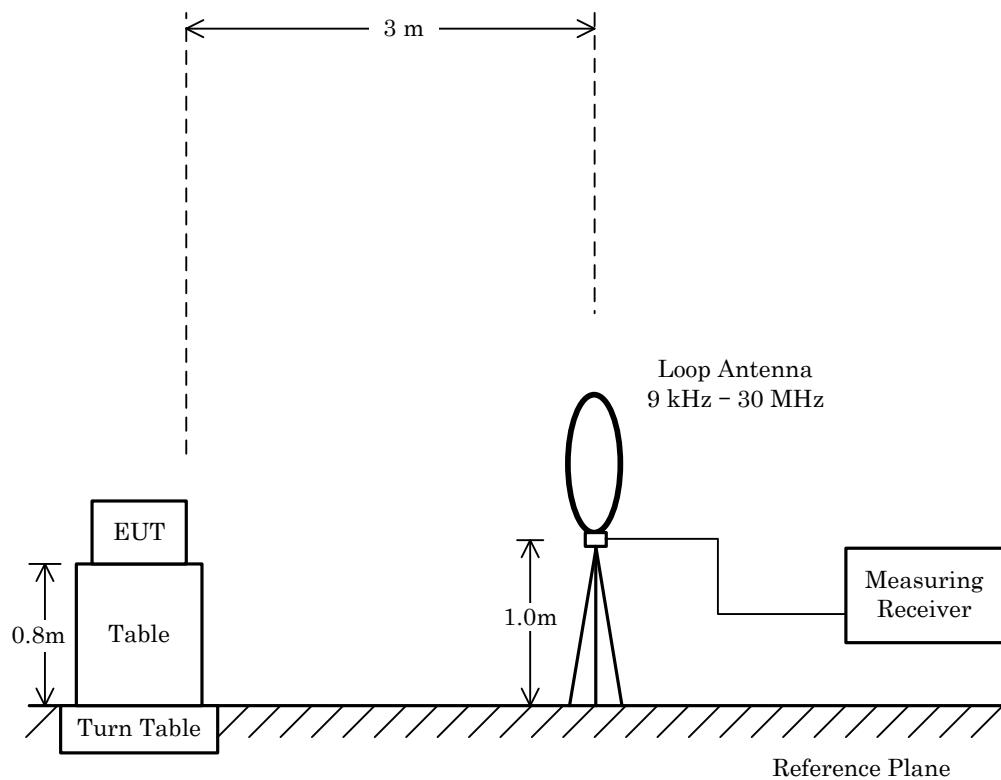
The preliminary tests were performed at the measurement distance that specified for compliance to determine the emission characteristics of the EUT.

The EUT configuration (in X, Y and Z axis), cable configuration and mode of operation were determined for producing the maximum level of emissions.

The measurement were performed about three antenna orientations (parallel, perpendicular, and ground-parallel).

According to KDB 414788, a used anechoic chamber were equivalent to those on an open fields site based on comparison measurements.

This configurations was used for the final tests.

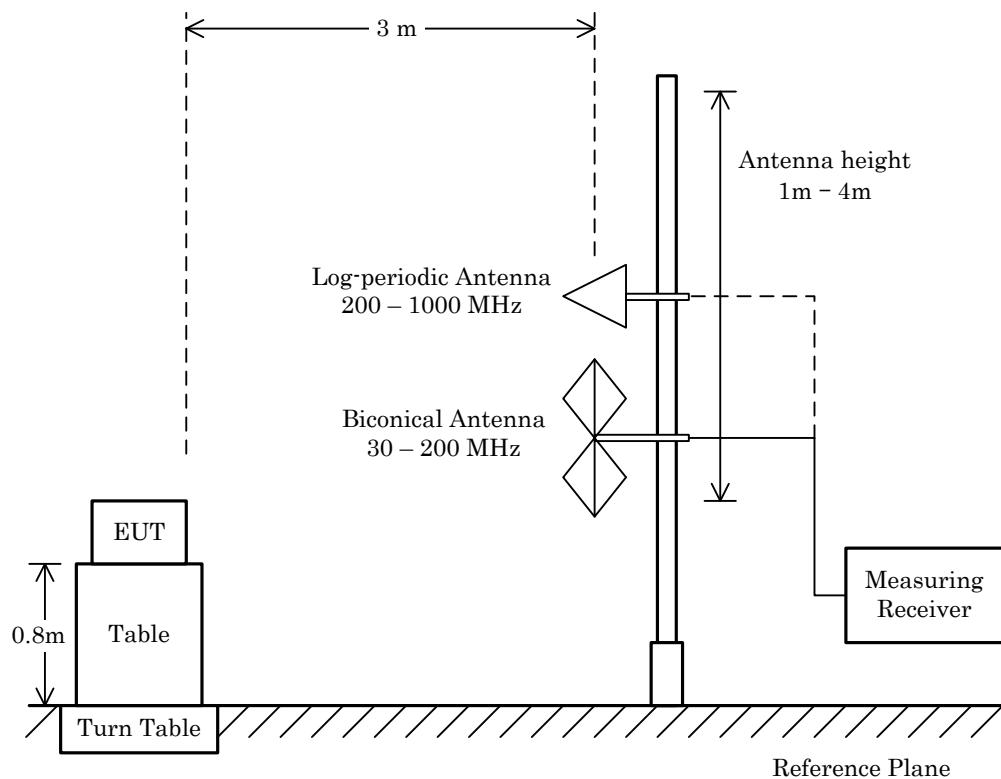


7.9.3.2 Radiated Emission 30 MHz – 1000 MHz

The preliminary tests were performed at the measurement distance that specified for compliance to determine the emission characteristics of the EUT.

The EUT configuration (in X, Y and Z axis), cable configuration and mode of operation were determined for producing the maximum level of emissions.

This configurations was used for the final tests.



7.9.3.3 Radiated Emission above 1 GHz

The preliminary tests were performed at the measurement distance that specified for compliance to determine the emission characteristics of the EUT.

The EUT configuration (in X, Y and Z axis), cable configuration and mode of operation were determined for producing the maximum level of emissions.

This configurations was used for the final tests.

The setting of the measuring instruments are shown as follows:

Type	Peak	Average
Detector Function	Peak	Peak
Res. Bandwidth	1 MHz	1 MHz
Video Bandwidth	3 MHz	$\geq 1/T^*)$
Video Filtering	Linear Voltage	Linear Voltage
Sweep Time	AUTO	AUTO
Trace	Max Hold	Max Hold

*) T: Minimum transmission duration

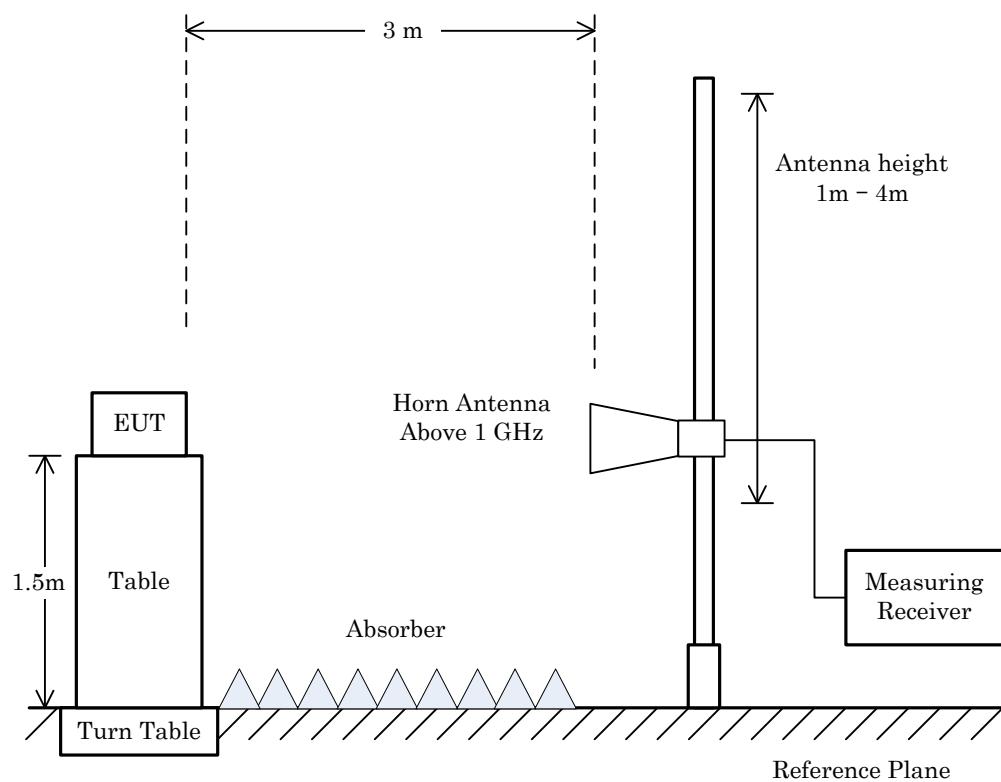
Average (VBW) Setting:

1) Bluetooth Low Energy 1 Mbps

Mode	Interval	Cycle	Duty cycle	Burst on period(T)	Min. VBW(1/T)	VBW Setting
	(msec)	(msec)	(%)	(msec)	(kHz)	(kHz)
BLE 1 Mbps	2.10	2.23	5.8%	0.13	7.69	10.00

2) Bluetooth Low Energy 2 Mbps

Mode	Interval	Cycle	Duty cycle	Burst on period(T)	Min. VBW(1/T)	VBW Setting
	(msec)	(msec)	(%)	(msec)	(kHz)	(kHz)
BLE 2 Mbps	1.06	1.18	10.2%	0.12	8.33	10.00

**NOTE**

When the EUT is manipulated through three different orientations, the scan height upper range for the measurement antenna is limited to 2.5 m or 0.5 m above the top of the EUT.

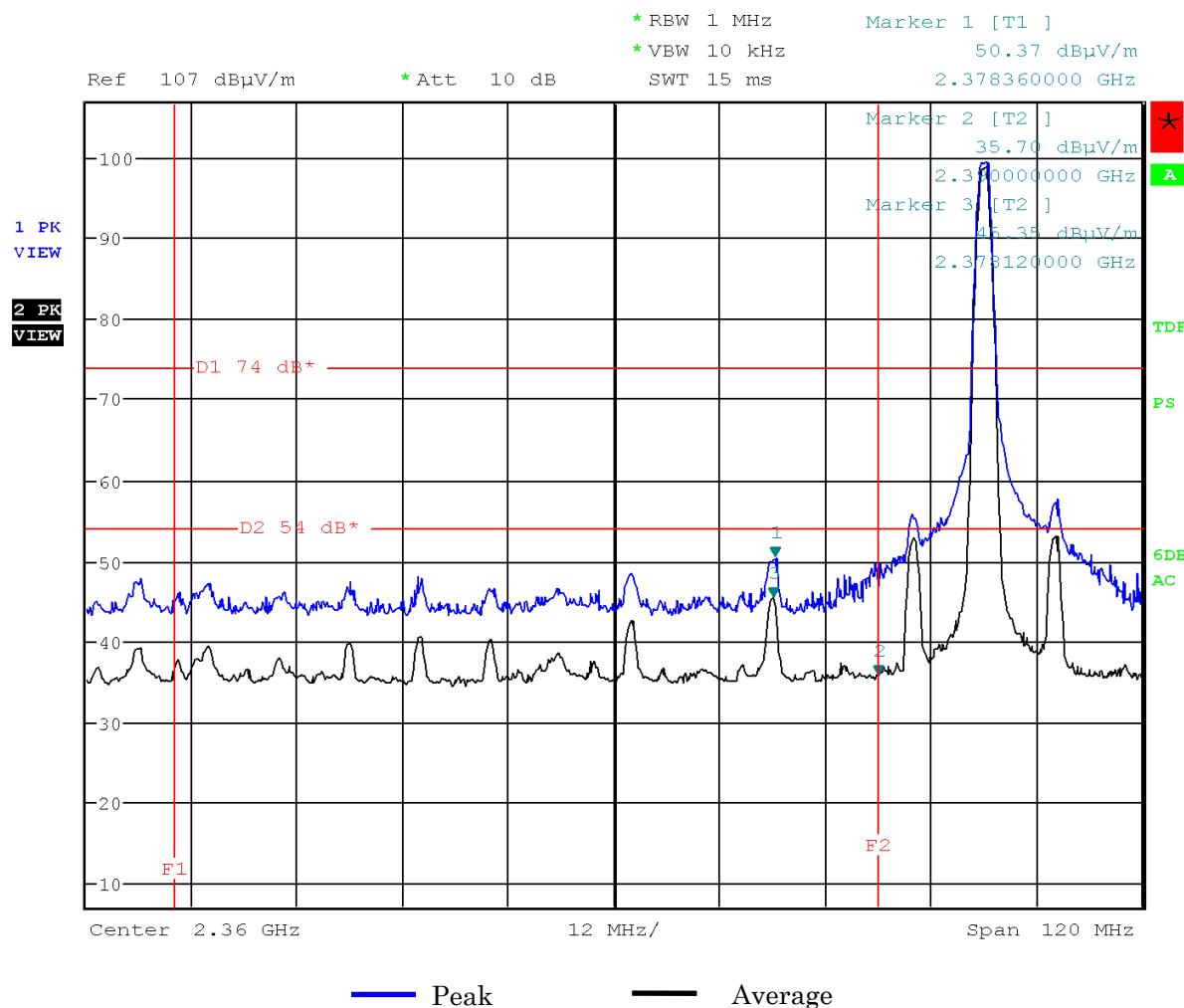
7.9.4 Test Data

7.9.4.1 Band-edge Compliance

Test Date: September 3, 2018
Temp.: 22 °C, Humi: 68 %

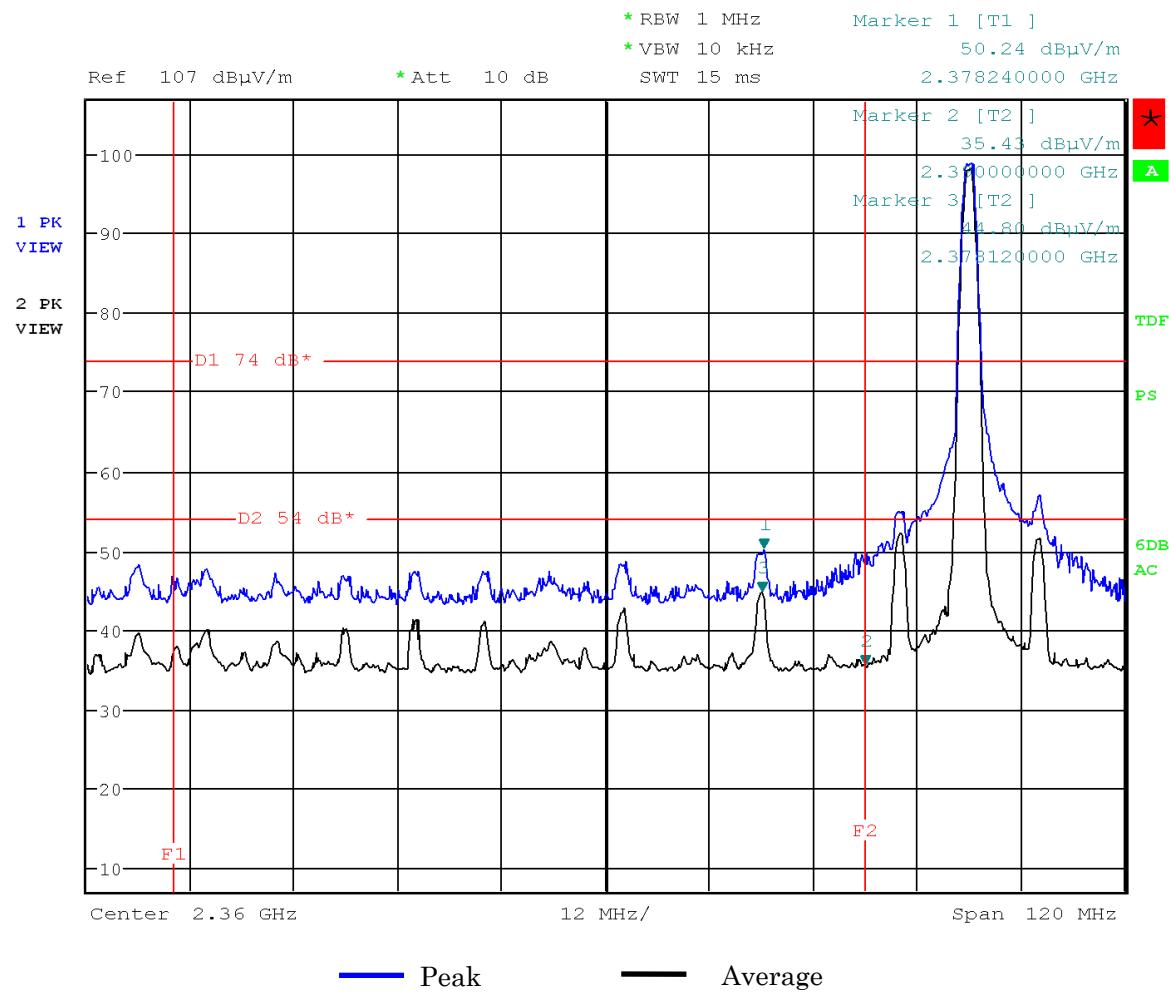
Mode of EUT : 0ch: 2402 MHz, (1 Mbps)

Antenna Polarization : Horizontal



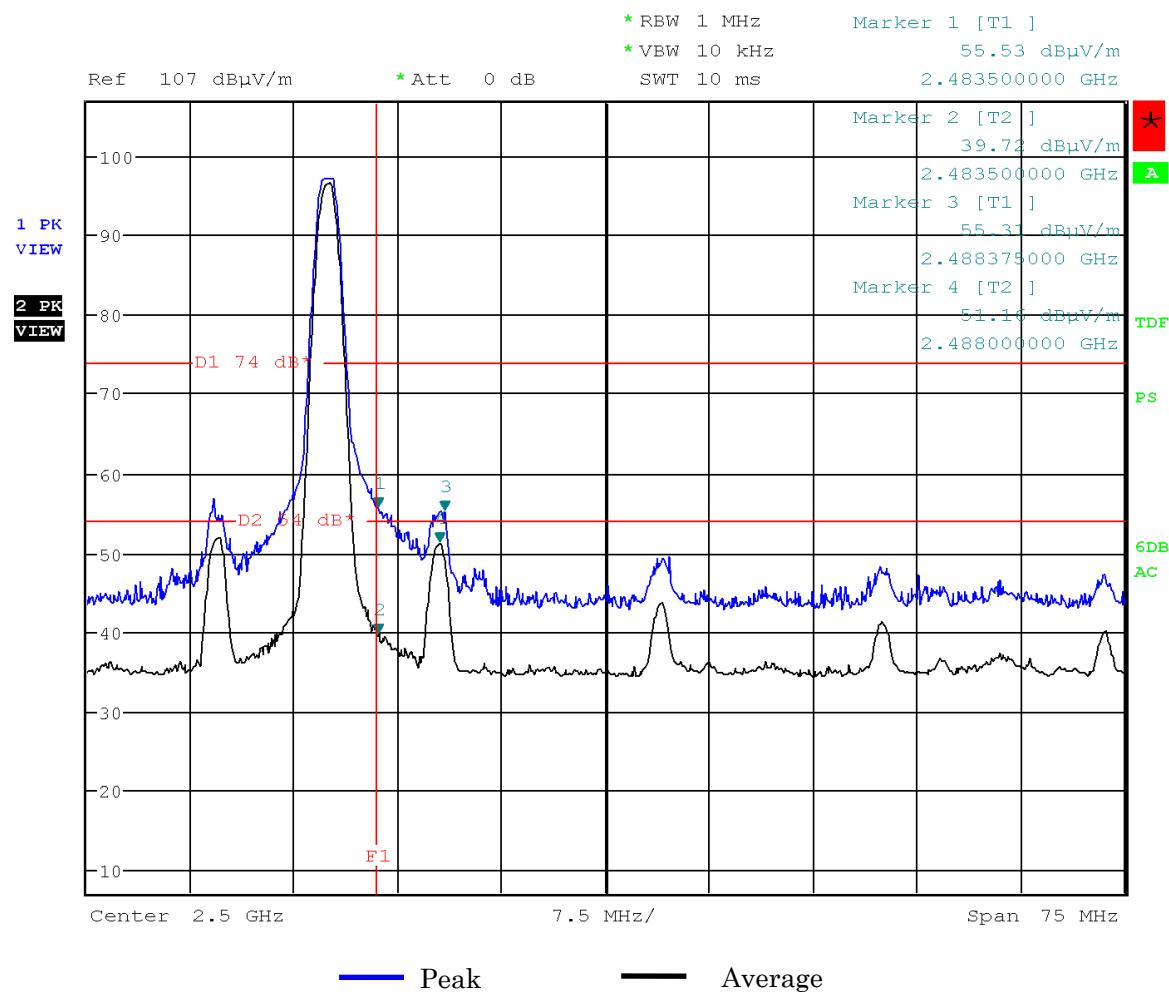
Mode of EUT : 0ch: 2402 MHz, (1 Mbps)

Antenna Polarization : Vertical



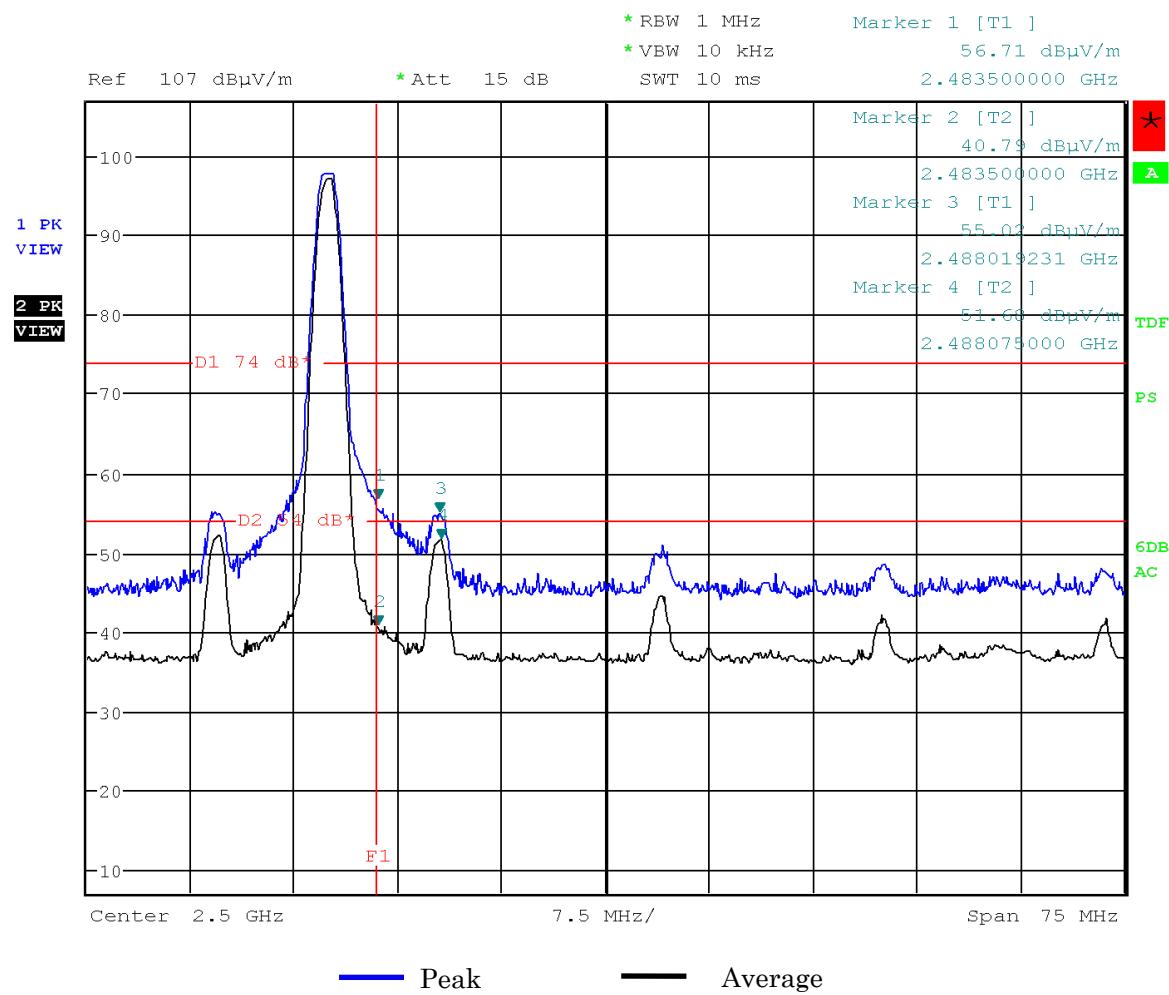
Mode of EUT : 39ch: 2480 MHz, (1 Mbps)

Antenna Polarization : Horizontal



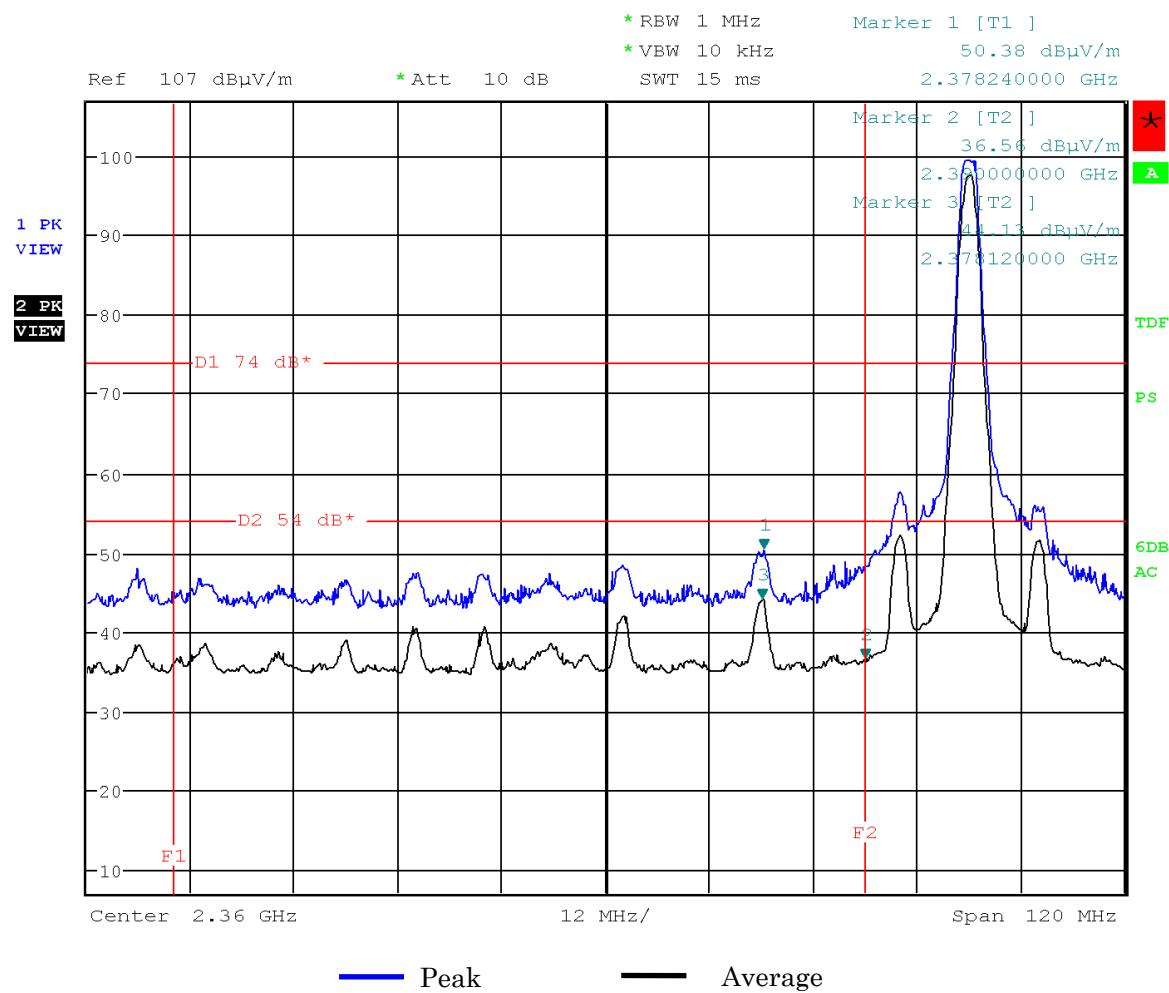
Mode of EUT : 39ch: 2480 MHz, (1 Mbps)

Antenna Polarization : Vertical



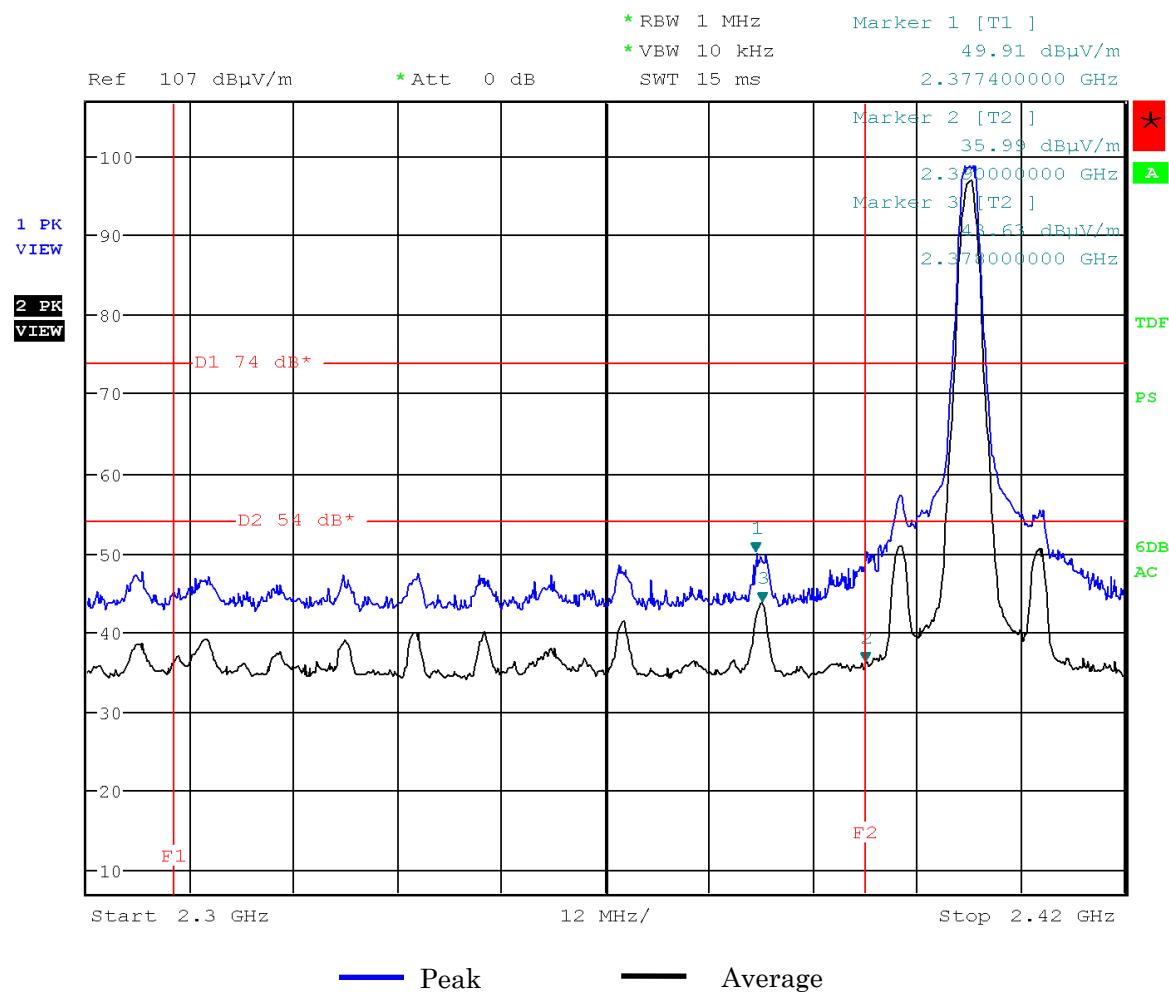
Mode of EUT : 0ch: 2402 MHz, (2 Mbps)

Antenna Polarization : Horizontal



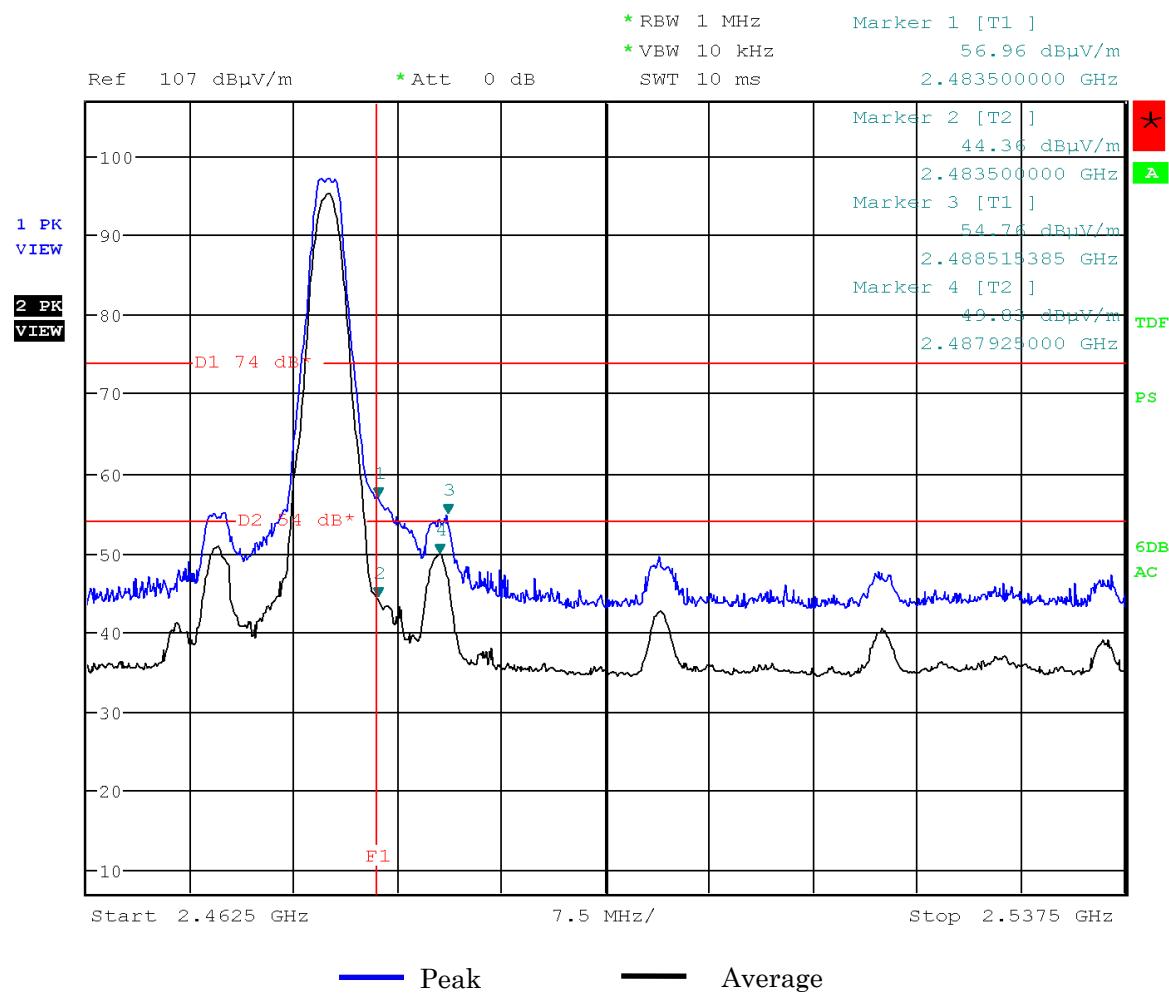
Mode of EUT : 0ch: 2402 MHz, (2 Mbps)

Antenna Polarization : Vertical



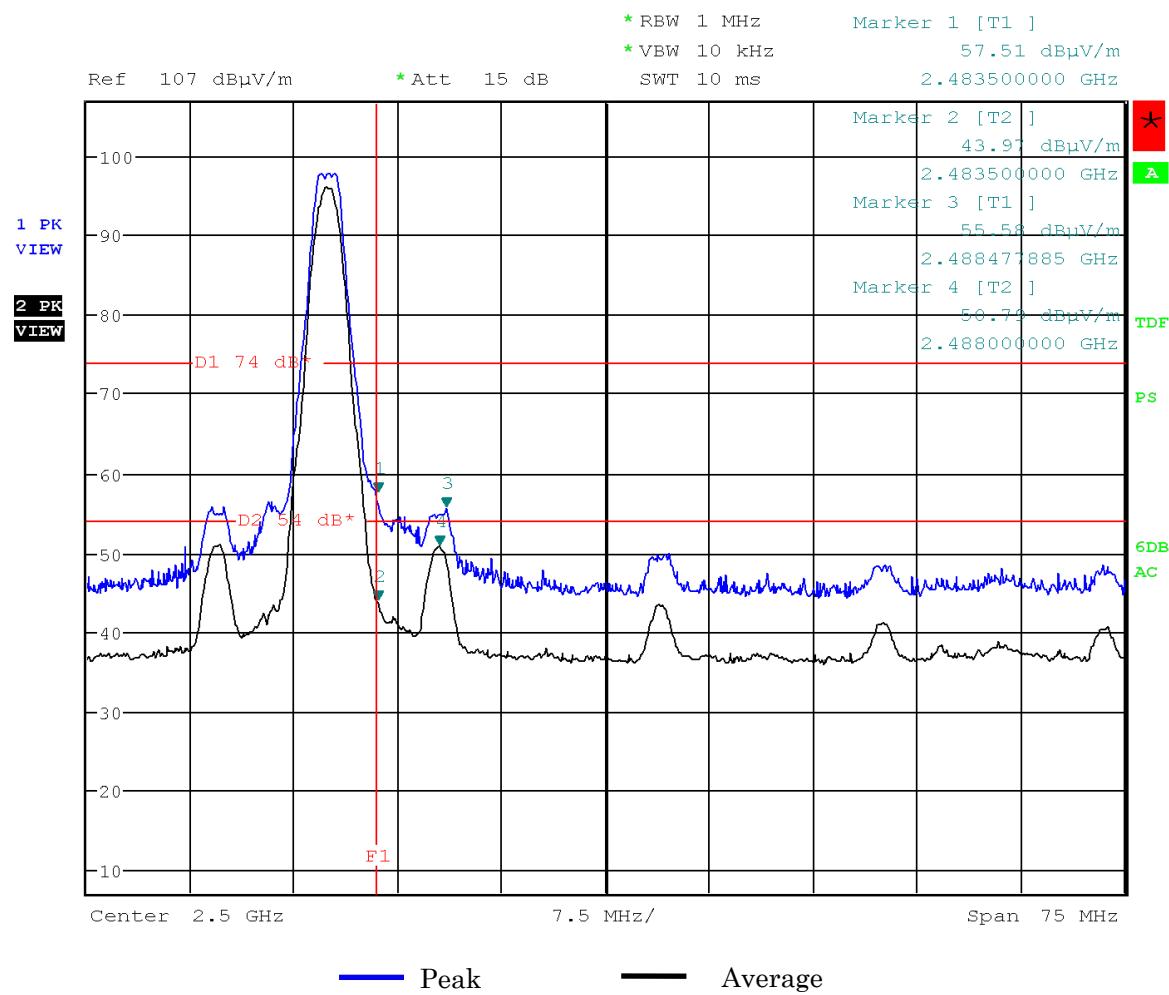
Mode of EUT : 39ch: 2480 MHz, (2 Mbps)

Antenna Polarization : Horizontal



Mode of EUT : 39ch: 2480 MHz, (2 Mbps)

Antenna Polarization : Vertical

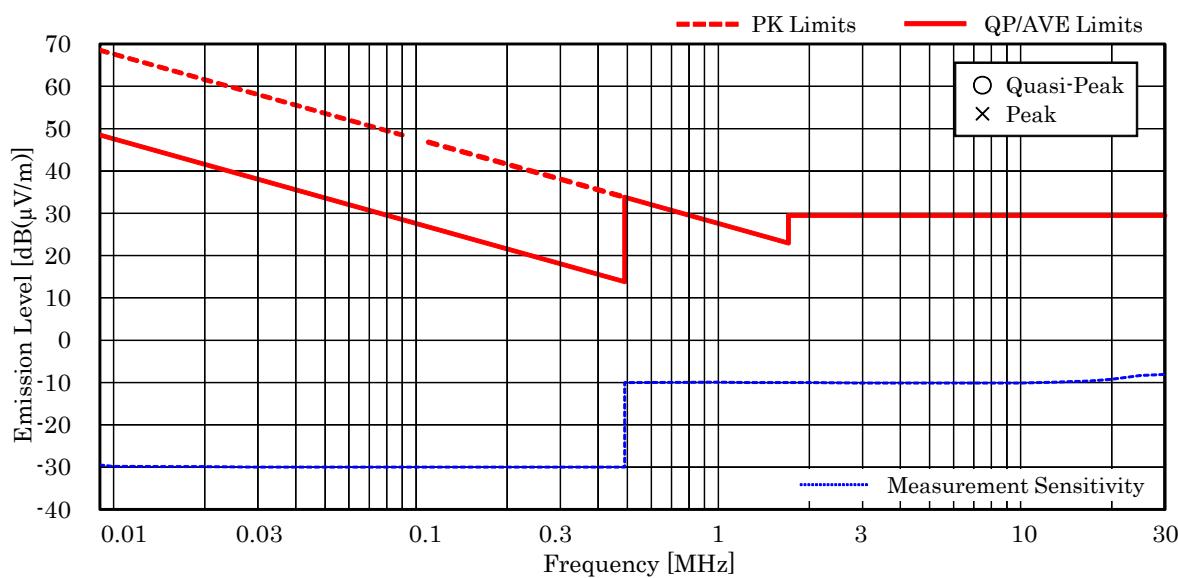


7.9.4.2 Other Spurious Emission (9kHz – 30MHz)

Test Date: September 4, 2018
Temp.: 23 °C. Humi: 67 %

Mode of EUT : All modes have been investigated and the worst case mode has been listed.

Results : No spurious emissions in the range 20dB below the limit.

**NOTES**

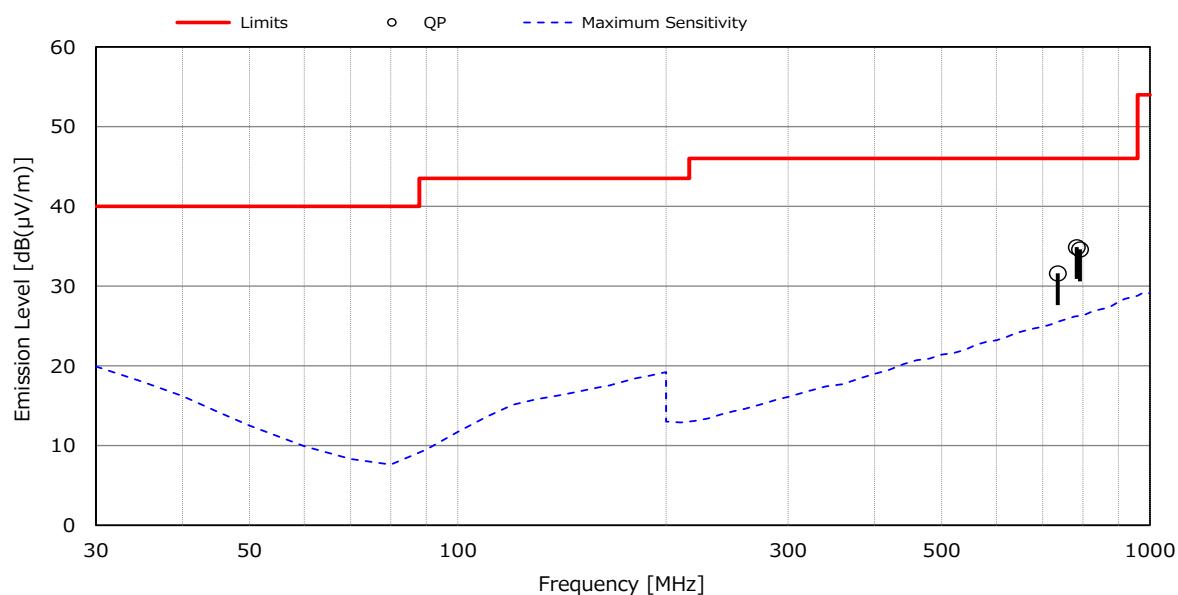
1. Test Distance : 3 m (Specified Distance D [m] = 300 m (9 kHz - 490 kHz) / 30 m (490 kHz - 30 MHz))
2. The spectrum was checked from 9 kHz to 30 MHz.
3. The distance conversion factor (40dB/decade) is applied for the test result calculation.
4. PK : Peak Detector / QP : Quasi-Peak Detector / AVE : Average Detector
5. Test receiver setting(s) :
PK/AVE 200 Hz (9 kHz - 90 kHz, 110 kHz - 150 kHz) / PK/AVE 9 kHz (150 kHz - 490 kHz)
CISPR QP 200 Hz (90 kHz - 110 kHz) / CISPR QP 9 kHz (490 kHz - 30 MHz)
6. Since the average limit is met when using a peak detector, the results are deemed to meet both limits.

7.9.4.3 Other Spurious Emission (30MHz – 1000MHz)

Mode of EUT : All modes have been investigated and the worst case mode for channel (19ch: 2440MHz / 1 Mbps and 2 Mbps) has been listed.

Test voltage : 3VDCTest Date: September 4, 2018
Temp.: 22 °C, RH: 70 %, Atm.: 977 hPaAntenna polarization : Horizontal

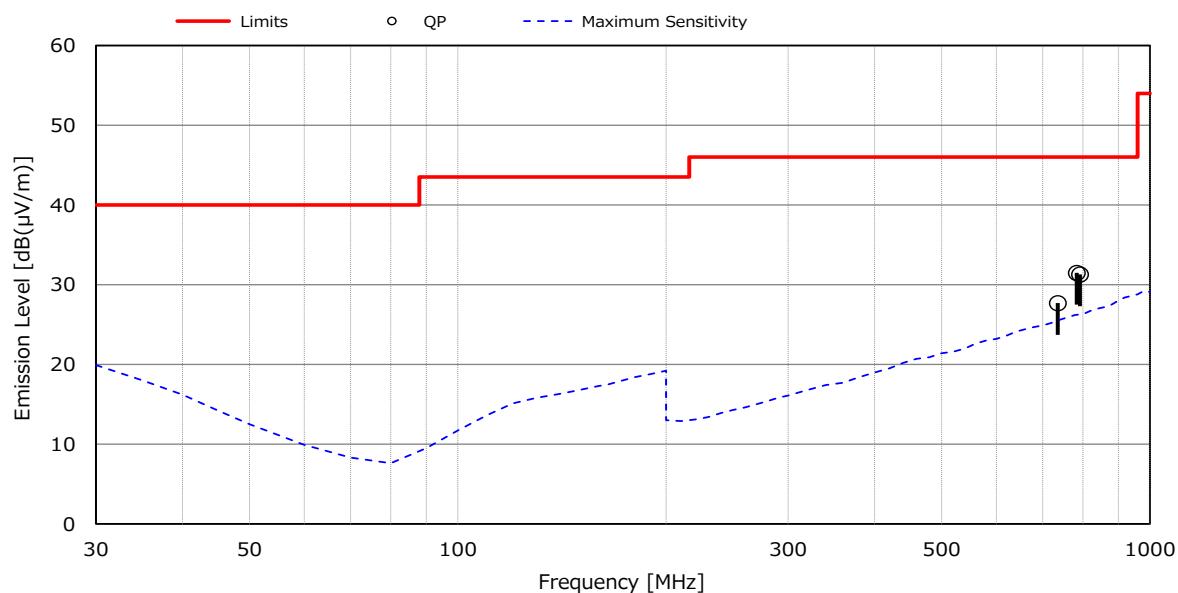
Frequency	Factor	Readings	Limits	Results	Margin	Remarks
[MHz]	[dB]	[dB(μV)]	[dB(μV/m)]	[dB(μV/m)]	[dB]	
736.000	25.5	6.1	46.0	31.6	+ 14.4	-
784.000	26.2	8.7	46.0	34.9	+ 11.1	-
792.000	26.2	8.4	46.0	34.6	+ 11.4	-

**NOTES**

- 1) Measurement Distance : 3 m
- 2) The spectrum was checked from 30 MHz to 1000 MHz.
- 3) The factor includes the antenna factor and the cable loss.
- 4) Calculated result as the worst point shown on underline :
Factor + Reading (QP) = 26.2 + 8.7 = 34.9 dB(μV) at 784.000 MHz
Antenna Height : 100 cm, Turntable Rotation Position : 147 °
- 5) QP : Quasi-Peak detector
- 6) Bandwidth : 120 kHz (30 MHz - 1000 MHz)

Test voltage : 3VDCTest Date: September 4, 2018
Temp.: 22 °C, RH: 70 %, Atm.: 977 hPaAntenna polarization : Vertical

Frequency [MHz]	Factor [dB]	Readings [dB(μV)]	Limits [dB(μV/m)]	Results [dB(μV/m)]	Margin [dB]	Remarks
736.000	25.5	2.2	46.0	27.7	+ 18.3	-
784.000	26.2	5.3	46.0	31.5	+ 14.5	-
792.000	26.2	5.1	46.0	31.3	+ 14.7	-

**NOTES**

- 1) Measurement Distance : 3 m
- 2) The spectrum was checked from 30 MHz to 1000 MHz.
- 3) The factor includes the antenna factor and the cable loss.
- 4) Calculated result as the worst point shown on underline :
Factor + Reading (QP) = 26.2 + 5.3 = 31.5 dB(μV) at 784.000 MHz
Antenna Height : 114 cm, Turntable Rotation Position : 200 °
- 5) QP : Quasi-Peak detector
- 6) Bandwidth : 120 kHz (30 MHz - 1000 MHz)

7.9.4.4 Other Spurious Emission (above 1 GHz)

Mode of EUT : BLE 1 Mbps

Test Date: September 3, 2018
Temp.: 22 °C, Humi: 68 %

Frequency [MHz]	Antenna Factor [dB(1/m)]	Corr. Factor [dB]	Meter Readings [dB(μV)]				Limits [dB(μV/m)]		Results [dB(μV/m)]		Margin [dB]	Remarks
			Horizontal		Vertical		PK	AVE	PK	AVE		
Test condition : Tx Low Ch												
4804.0	33.0	-22.2	39.8	35.4	39.6	35.0	74.0	54.0	50.6	46.2	+ 7.8	-
12010.0	33.8	-19.3	< 38.0	< 28.0	< 38.0	< 28.0	74.0	54.0	< 52.5	< 42.5	> +11.5	-
19216.0	-5.6	3.7	< 50.0	< 40.0	< 50.0	< 40.0	74.0	54.0	< 48.1	< 38.1	> +15.9	-
Test condition : TX Middle Ch												
4880.0	33.1	-22.1	39.8	35.5	39.4	35.2	74.0	54.0	50.8	46.5	+ 7.5	-
7320.0	36.4	-21.6	39.8	33.9	39.9	34.1	74.0	54.0	54.7	48.9	+ 5.1	-
12200.0	33.7	-19.6	< 38.0	< 28.0	< 38.0	< 28.0	74.0	54.0	< 52.1	< 42.1	> +11.9	-
19520.0	-5.5	3.7	< 50.0	< 40.0	< 50.0	< 40.0	74.0	54.0	< 48.2	< 38.2	> +15.8	-
Test condition : TX High Ch												
4960.0	33.3	-22.0	39.3	35.0	39.6	35.3	74.0	54.0	50.9	46.6	+ 7.4	-
7440.0	36.6	-21.6	38.7	32.3	38.8	32.4	74.0	54.0	53.8	47.4	+ 6.6	-
12400.0	33.7	-20.1	< 38.0	< 28.0	< 38.0	< 28.0	74.0	54.0	< 51.6	< 41.6	> +12.4	-
19840.0	-5.7	3.7	< 50.0	< 40.0	< 50.0	< 40.0	74.0	54.0	< 48.0	< 38.0	> +16.0	-
22320.0	-6.1	3.9	< 50.0	< 40.0	< 50.0	< 40.0	74.0	54.0	< 47.8	< 37.8	> +16.2	-

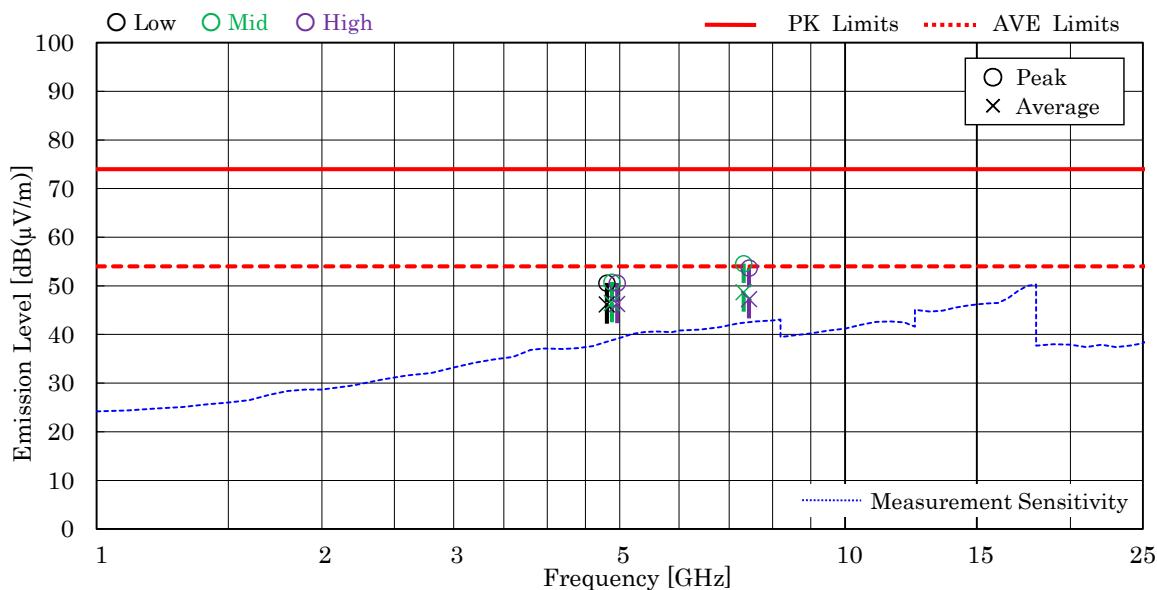
Calculated result at 7320.0 MHz, as the worst point shown on underline:

$$\begin{aligned}
 \text{Antenna Factor} &= 36.4 \text{ dB(1/m)} \\
 \text{Corr. Factor} &= -21.6 \text{ dB} \\
 +) \text{ Meter Reading} &= 34.1 \text{ dB(μV)} \\
 \text{Result} &= 48.9 \text{ dB(μV/m)}
 \end{aligned}$$

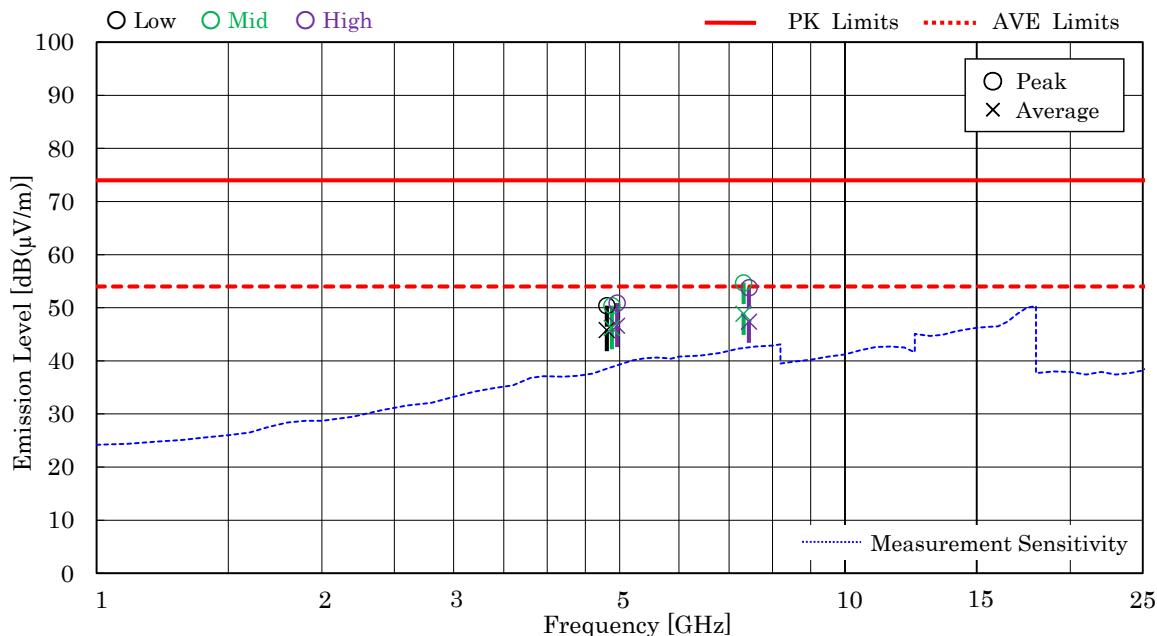
Minimum Margin: $54.0 - 48.9 = 5.1 \text{ (dB)}$ **NOTES**

1. Test Distance : 3 m
2. The spectrum was checked from 1 GHz to 25 GHz (10th harmonic of the highest fundamental frequency).
3. The correction factor is shown as follows:
 - Corr. Factor [dB] = Cable Loss + 20dB Pad Att. - Pre-Amp. Gain [dB] (1.0 - 8.2 GHz)
 - Corr. Factor [dB] = Cable Loss + 10dB Pad Att. - Pre-Amp. Gain [dB] (8.2 - 18.0 GHz)
 - Corr. Factor [dB] = Cable Loss - Pre-Amp. Gain [dB] (over 18 GHz)
4. The symbol of “<” means “or less”.
5. The symbol of “>” means “more than”.
6. PK : Peak / AVE : Average

Antenna Pole : Horizontal



Antenna Pole : Vertical



Mode of EUT : BLE 2 Mbps

Test Date: September 3, 2018
Temp.: 22 °C, Humi: 68 %

Frequency [MHz]	Antenna Factor [dB(1/m)]	Corr. Factor [dB]	Meter Readings [dB(μV)]				Limits [dB(μV/m)]		Results [dB(μV/m)]		Margin [dB]	Remarks
			Horizontal		Vertical		PK	AVE	PK	AVE		
Test condition : Tx Low Ch												
4804.0	33.0	-22.2	39.7	35.3	39.2	34.9	74.0	54.0	50.5	46.1	+ 7.9	-
12010.0	33.8	-19.3	< 38.0	< 28.0	< 38.0	< 28.0	74.0	54.0	< 52.5	< 42.5	> +11.5	-
19216.0	-5.6	3.7	< 50.0	< 40.0	< 50.0	< 40.0	74.0	54.0	< 48.1	< 38.1	> +15.9	-
Test condition : TX Middle Ch												
4880.0	33.1	-22.1	39.5	35.4	39.3	34.9	74.0	54.0	50.5	46.4	+ 7.6	-
7320.0	36.4	-21.6	39.3	33.0	39.7	33.2	74.0	54.0	54.5	48.0	+ 6.0	-
12200.0	33.7	-19.6	< 38.0	< 28.0	< 38.0	< 28.0	74.0	54.0	< 52.1	< 42.1	> +11.9	-
19520.0	-5.5	3.7	< 50.0	< 40.0	< 50.0	< 40.0	74.0	54.0	< 48.2	< 38.2	> +15.8	-
Test condition : TX High Ch												
4960.0	33.3	-22.0	39.0	34.9	39.6	35.0	74.0	54.0	50.9	46.3	+ 7.7	-
7440.0	36.6	-21.6	38.5	32.2	38.6	32.3	74.0	54.0	53.6	47.3	+ 6.7	-
12400.0	33.7	-20.1	< 38.0	< 28.0	< 38.0	< 28.0	74.0	54.0	< 51.6	< 41.6	> +12.4	-
19840.0	-5.7	3.7	< 50.0	< 40.0	< 50.0	< 40.0	74.0	54.0	< 48.0	< 38.0	> +16.0	-
22320.0	-6.1	3.9	< 50.0	< 40.0	< 50.0	< 40.0	74.0	54.0	< 47.8	< 37.8	> +16.2	-

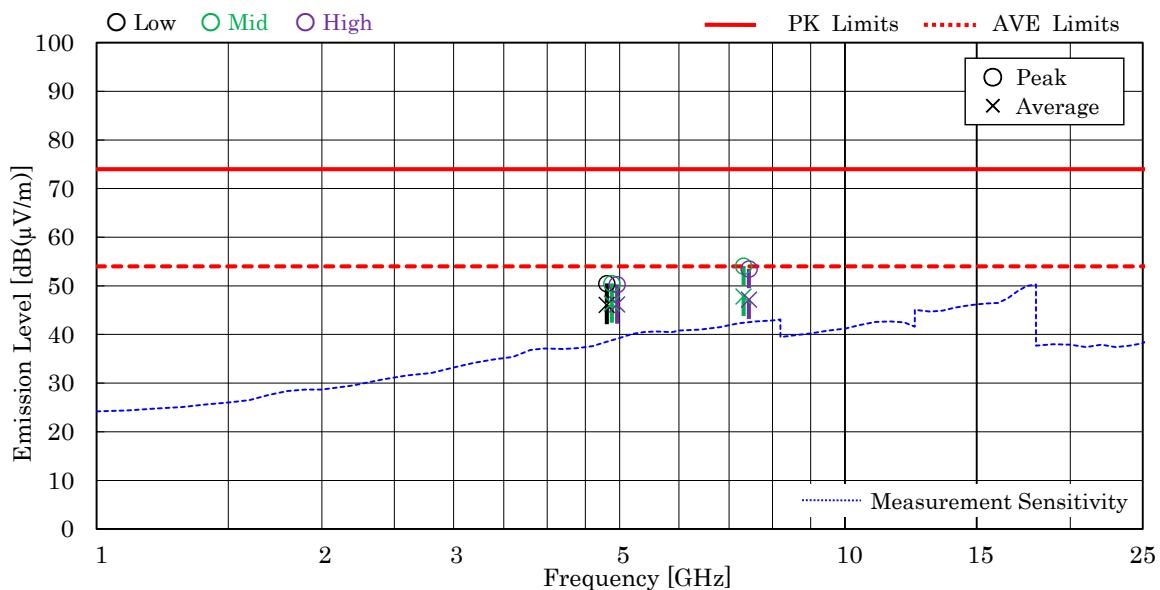
Calculated result at 7320.0 MHz, as the worst point shown on underline:

$$\begin{aligned}
 \text{Antenna Factor} &= 36.4 \text{ dB(1/m)} \\
 \text{Corr. Factor} &= -21.6 \text{ dB} \\
 +) \text{ Meter Reading} &= 33.2 \text{ dB(μV)} \\
 \text{Result} &= 48.0 \text{ dB(μV/m)}
 \end{aligned}$$

Minimum Margin: $54.0 - 48.0 = 6.0$ (dB)**NOTES**

1. Test Distance : 3 m
2. The spectrum was checked from 1 GHz to 25 GHz (10th harmonic of the highest fundamental frequency).
3. The correction factor is shown as follows:
 - Corr. Factor [dB] = Cable Loss + 20dB Pad Att. - Pre-Amp. Gain [dB] (1.0 - 8.2 GHz)
 - Corr. Factor [dB] = Cable Loss + 10dB Pad Att. - Pre-Amp. Gain [dB] (8.2 - 18.0 GHz)
 - Corr. Factor [dB] = Cable Loss - Pre-Amp. Gain [dB] (over 18 GHz)
4. The symbol of "<" means "or less".
5. The symbol of ">" means "more than".
6. PK : Peak / AVE : Average

Antenna Pole : Horizontal



Antenna Pole : Vertical

