

Radio Test Report (Bluetooth LE)

Report No.: RJ190311C11-2

Test Model: H2B

Received Date: Mar. 20, 2019

Test Date: Apr. 11 ~ Apr. 12, 2019

Issued Date: Apr. 18, 2019

Applicant: Google LLC

Address: 1600 Amphitheatre Parkway, Mountain View, CA 94043, USA

Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch

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Test Location: No.19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City 33383, TAIWAN (R.O.C.)



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Table of Contents

Release Control Record	3
1 Certificate of Conformity	4
2 Summary of Test Results	5
2.1 Test Instruments	6
2.2 Measurement Uncertainty	6
2.3 Modification Record	6
3 General Information	7
3.1 General Description of EUT	7
3.2 Description of Test Modes	8
3.3 Test Conditions	9
3.4 Assembly	9
3.5 Antenna Specifications	9
3.5.1 Antenna Gain	9
3.5.2 Antenna Pattern	9
4 Test Results	10
4.1 Frequency Tolerance Measurement	10
4.1.1 Limits of Frequency Tolerance Measurement	10
4.1.2 Test Setup	10
4.1.3 Test Results	10
4.2 Occupied Bandwidth Measurement (99% power bandwidth)	11
4.2.1 Limits of Occupied Bandwidth Measurement	11
4.2.2 Test Setup	11
4.2.3 Test Results	12
4.3 Spreading Bandwidth Measurement (90% power bandwidth)	13
4.3.1 Limits of Spreading Bandwidth and Spreading Factor Measurement	13
4.3.2 Test Setup	13
4.3.3 Test Results	13
4.4 Spurious Emissions for Transmitter Measurement	15
4.4.1 Limits of Spurious Emissions	15
4.4.2 Test Setup	15
4.4.3 Test Results	16
4.5 Antenna Power Measurement	20
4.5.1 Limits of Antenna Power	20
4.5.2 Test Setup	20
4.5.3 Test Results	21
4.6 Spurious Emissions for Receiver	22
4.6.1 Limits of Spurious Emissions for Receiver	22
4.6.2 Test Setup	22
4.6.3 Test Result	23
4.7 Interference Prevention Function	25
4.7.1 Limits of Interference Prevention Function	25
4.7.2 Test Setup	25
4.7.3 Test Results	25
5 Photographs of the Test Configuration	26
Appendix - Information of the Testing Laboratories	27

Release Control Record

Issue No.	Description	Date Issued
RJ190311C11-2	Original release	Apr. 18, 2019

1 Certificate of Conformity

Product: Media Device

Test Model: H2B

Sample Status: Engineering sample

Applicant: Google LLC

Test Date: Apr. 11 ~ Apr. 12, 2019

Standards: ARIB STD-T66 (V3.7), MIC notice 88 Appendix 43
Certification Ordinance Article 2-1-19

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

Prepared by : Polly Chien , **Date:** Apr. 18, 2019
Polly Chien / Specialist

Approved by : Bruce Chen , **Date:** Apr. 18, 2019
Bruce Chen / Project Engineer

2 Summary of Test Results

The EUT has been tested according to the following specifications:

Notice 88 Appendix 43 Reference	ARIB STD-T66 Ref.	Report Reference	Parameter	Test Results (Note)
General Provisions				
C	3.2 (4)	4.1	Frequency tolerance	C
D	3.2 (7)	4.2	Occupied bandwidth	C
E	3.2 (6)	4.4	Spurious emissions	C
Transmitting Equipment				
F	3.2 (2)	4.5	Antenna power	C
--	--	--	SAR	NA
Transmitting Antenna				
--	--	3.5	Type, configuration, etc. of transmitting antenna	C
--	--	3.5	Direction pattern of transmitting antenna	C
Receiving Equipment				
G	3.3 (1)	4.6	Spurious emissions of receiver	C
--	--	3.6	Refer to all articles for transmitting antenna	C
Operating Frequency 2400 to 2483.5MHz				
--	3.7 (1)a	3.2	Radio Frequency	C
--	3.7 (1)a	3.4	Modulation section cannot be opened easily	C
--	3.1 (1)	3.1	Communication method	C
--	3.2 (1)a	3.1	Modulation method	C
--	3.2 (1)a	3.1	Spread spectrum method	C
--	3.2 (2)	4.5	Antenna power	C
--	3.6 (2)	3.5.2	Absolute gain of transmitting antenna	C
--	3.6 (2)	--	Angular width of principal radiation (AWPR)	NA
--	3.2 (10)	--	Number of carriers within 1 MHz bandwidth in OFDM	NA
--	3.2 (8)	4.3	Spreading bandwidth	C
--	3.2 (9)	4.3	Spreading factor	C
--	3.2 (11)	--	Frequency retention time (FH employed)	NA
--	3.4.1(1)	4.7	Interference Prevention Function	C
Note: C = Conform NC = Not Conform NT = Not Tested NA = Not Applicable				

2.1 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Date of Calibration	Due Date of Calibration	Calibration Authority	Cal. Method
Spectrum Analyzer / Rohde & Schwarz	FSV40	100980	Apr. 17, 2018	Apr. 16, 2019	Electronics Testing Center, Taiwan	c)
Signal Generator / Agilent	E4438C	MY45094468	Nov. 19, 2018	Nov. 18, 2019	Electronics Testing Center, Taiwan	c)
Power Meter / Anritsu	ML2495A	1232003	Dec. 25, 2018	Dec. 24, 2019	Electronics Testing Center, Taiwan	c)
Power Sensor / Anritsu	MA2411B	1207333	Dec. 25, 2018	Dec. 24, 2019	Electronics Testing Center, Taiwan	c)
AC Power Supply Extech	6905S	1991553	NA	NA	NA	d)
True RMS Clamp Meter / Fluke	325	31130711WS	May 22, 2018	May 21, 2019	Electronics Testing Center, Taiwan	c)

NOTE: Calibration Method

a) : Calibration conducted by the National Institute of Information and Communications Technology~NICT~ or a designated calibration agency under Article 102-18 paragraph (1)~ TELEC EngineeringCenter, Intertek Japan K.K., Keysight Technologies, Inc~.

b) : Correction conducted pursuant to the provisions of Article 135 or Article 144 of the MeasurementLaw (Law No. 51 of 1992)~Japan Calibration Service Syste~

c) : Calibration conducted in foreign countries, which shall be equivalent to the calibration conducted bythe NICT or a designated calibration agency under Article 102-18 paragraph (1)~ TELEC EngineeringCenter, Intertek Japan K.K., Keysight Technologies, Inc~.

d) : Calibration conducted by using other equipment that listed above from a) to c)

2.2 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in TR 100 028-1.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Parameter	Uncertainty
Occupied Bandwidth	491.896Hz
Spurious emissions	3.508dB
Output power density	2.889dB
Adjacent Channel Leakage Power	1.35dB
Out of band radiated power	3.93dB
Frequency Tolerance	6805.18Hz
Burst length	0.01%

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.3 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Media Device
Test Model	H2B
Status of EUT	Engineering sample
Nominal Voltage	3.8Vdc (Battery)
Modulation Type	GFSK
Transfer Rate	1Mbps
Operating Frequency	2402 ~ 2480MHz
Number of Channel	40
Rated RF Output Power Density	6.00mW
Conducted RF Output Power Density	5.023mW
Radiated RF Output Power Density	12.133mW
Antenna Type	Refer to note
Antenna Connector	Refer to note
Accessory Device	Refer to note
Data Cable Supplied	Refer to note

Note:

1. The EUT accessories list refers to EUT Photo.pdf.
2. The following antennas were provided to the EUT.

Ant. No.	Type	Connector	Gain (dBi)
			2.4G
1	Loop Antenna	Mini Murata	3.83

3. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

3.2 Description of Test Modes

40 channels are provided to this EUT:

CHANNEL	FREQ. (MHz)	CHANNEL	FREQ. (MHz)	CHANNEL	FREQ. (MHz)	CHANNEL	FREQ. (MHz)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

By means of test software (Gotham_CMD) provided by manufacture, the power levels during the tests were set according to the following codes:

Modulation type: GFSK	
Channel	Power Setting
0	Default
19	Default
39	Default

3.3 Test Conditions

Test Conditions	Voltage (Vdc)
V_{normal}	3.80

Note: When the input voltage to receiver RF circuit varies below $\pm 1\%$ as the input voltage from the external power supply to the receiver varies $\pm 10\%$ (excluding power supply).

3.4 Assembly

The RF module is shielded by soldering the metal housing to the PC-Board and used a kind of particular screw which are not capable of being opened easily.

3.5 Antenna Specifications

3.5.1 Antenna Gain

Ant. No.	Type	Connector	Gain (dBi)
			2.4G
1	Loop Antenna	Mini Murata	3.83

3.5.2 Antenna Pattern

Provided by client.

4 Test Results

4.1 Frequency Tolerance Measurement

4.1.1 Limits of Frequency Tolerance Measurement

Tolerance of frequency shall be +/- 50ppm

4.1.2 Test Setup



4.1.3 Test Results

Environmental Conditions		25 deg.C, 60% RH	
Channel	Frequency (MHz)	V _{normal}	
		Carrier frequency (MHz)	Frequency tolerance (ppm)
0	2402	2402.029200	12.156
19	2440	2440.034000	13.934
39	2480	2480.038800	15.645

4.2 Occupied Bandwidth Measurement (99% power bandwidth)

4.2.1 Limits of Occupied Bandwidth Measurement

Item	Limit
Occupied bandwidth	<26MHz

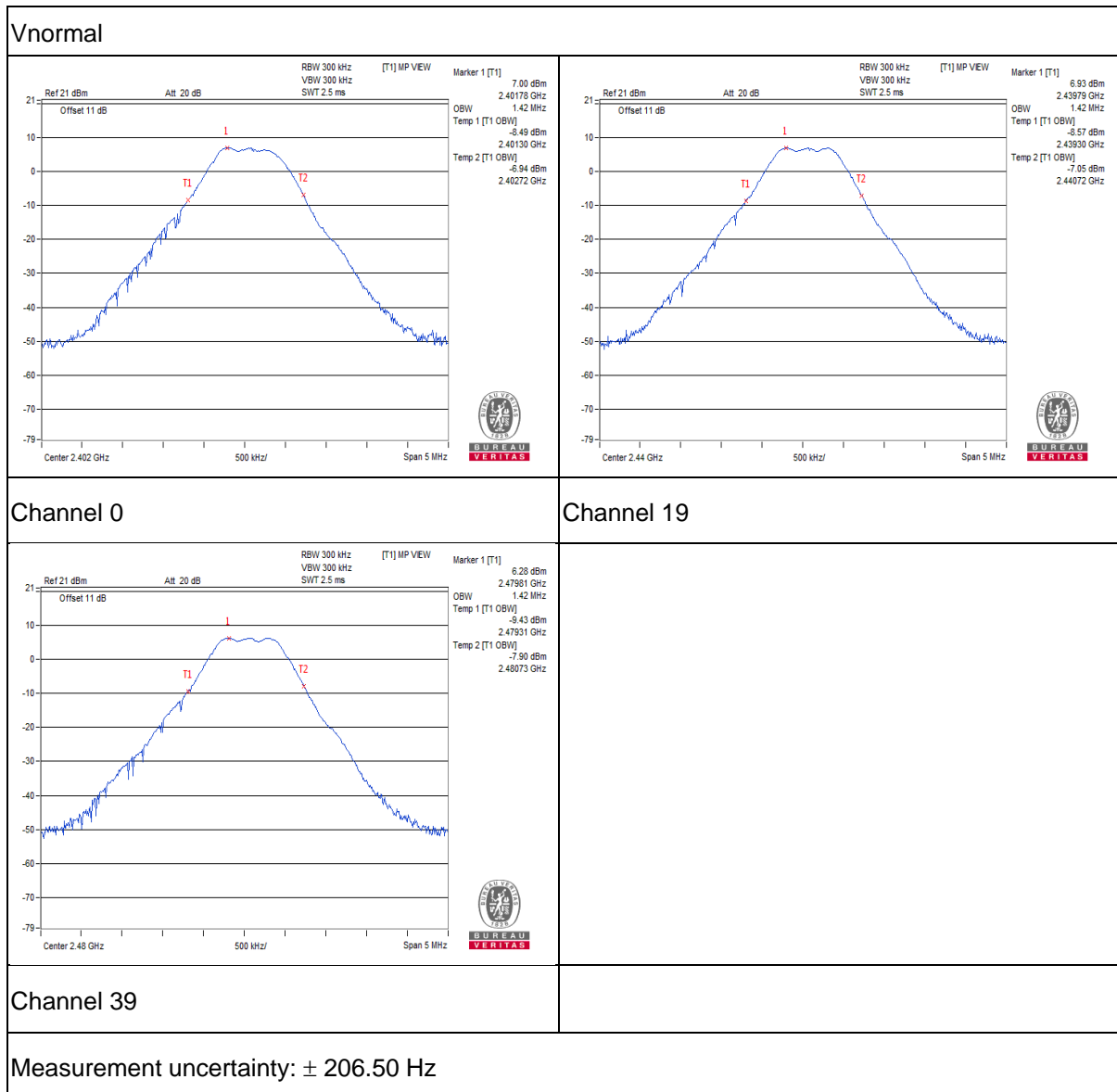
4.2.2 Test Setup



4.2.3 Test Results

Environmental Conditions		25 deg.C, 60% RH
Channel	Frequency (MHz)	V _{normal}
		Occupied Bandwidth (MHz)
0	2402	1.42
19	2440	1.42
39	2480	1.42

Note: 1. For the test plots please refer to the below pages.



4.3 Spreading Bandwidth Measurement (90% power bandwidth)

4.3.1 Limits of Spreading Bandwidth and Spreading Factor Measurement

Item	Limit	Remark
Spreading Bandwidth	$\geq 500\text{kHz}$	
Spreading Factor	≥ 5	Operating frequency 2400 to 2483.5MHz

4.3.2 Test Setup

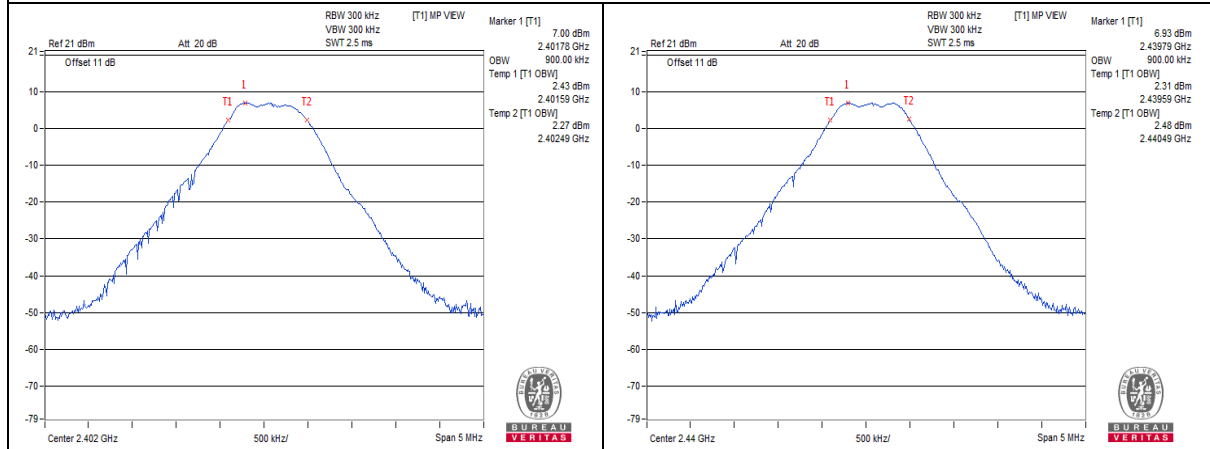


4.3.3 Test Results

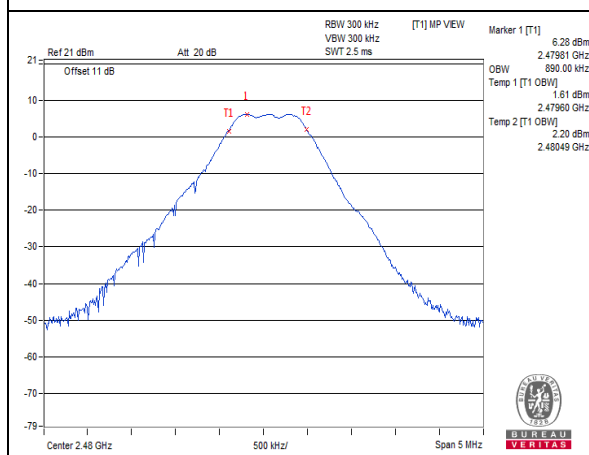
Environmental Conditions		25 deg.C, 60% RH	
Channel	Frequency (MHz)	V _{normal}	
		Occupied Bandwidth (MHz)	Spreading Factor
0	2402	0.90	14.40
19	2440	0.90	14.40
39	2480	0.89	14.24

- Note: 1. For the test plots please refer to the below pages.
 2. Spreading Factor: 90% channel power bandwidth / 0.0625

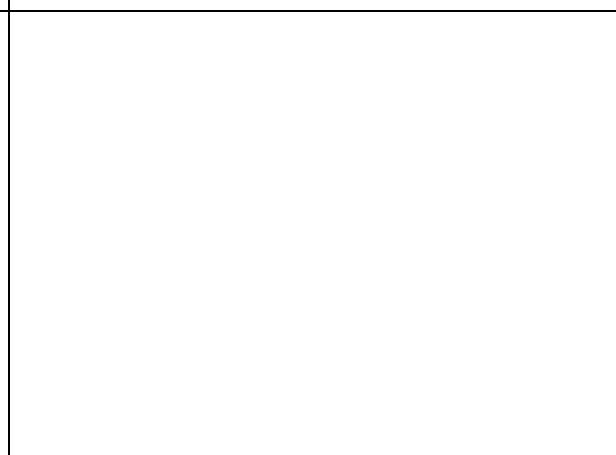
Vnormal



Channel 0



Channel 19



Channel 39

Measurement uncertainty: ± 206.50 Hz

4.4 Spurious Emissions for Transmitter Measurement

4.4.1 Limits of Spurious Emissions

Frequencies (MHz)	Limit
Operating frequency 2400 to 2483.5MHz	
30.0MHz to 1000.0MHz	$\leq 0.25 \text{ uW/100kHz}$
1000.0MHz to 2387MHz	$\leq 2.5 \text{ uW/MHz}$
2387.0MHz to 2400.0MHz	$\leq 25 \text{ uW/MHz}$
2483.5MHz to 2496.5MHz	$\leq 25 \text{ uW/MHz}$
2496.5MHz to 12500.0MHz	$\leq 2.5 \text{ uW/MHz}$

4.4.2 Teset Setup



4.4.3 Test Results

Environmental Conditions		25 deg.C, 60% RH					
Test Channel		CH 0 (2402MHz)		CH 19 (2440MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value	Frequency (MHz)	Measured Value		
V _{normal}	30.0MHz to 1000.0MHz	167.740	0.018707uW	553.800	0.018281uW	0.25uW/100kHz	PASS
	1000.0MHz to 2387MHz	1441.060	0.01652uW	1463.250	0.014555uW	2.5uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2400.000	Note 2	2395.110	0.007709uW	25uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2487.530	0.009162uW	2485.470	0.008035uW	25uW/MHz	PASS
	2496.5MHz to 12500.0MHz	9278.870	0.062373uW	3136.720	0.050119uW	2.5uW/MHz	PASS
Test Channel		CH 39 (2480MHz)				Limit	Result
Test Condition	Frequency Range	Frequency (MHz)		Measured Value			
V _{normal}	30.0MHz to 1000.0MHz	809.880		0.02037uW		0.25uW/100kHz	PASS
	1000.0MHz to 2387MHz	1488.220		0.014825uW		2.5uW/MHz	PASS
	2387.0MHz to 2400.0MHz	2391.600		0.01uW		25uW/MHz	PASS
	2483.5MHz to 2496.5MHz	2483.500		0.737904uW		25uW/MHz	PASS
	2496.5MHz to 12500.0MHz	3016.680		0.052966uW		2.5uW/MHz	PASS

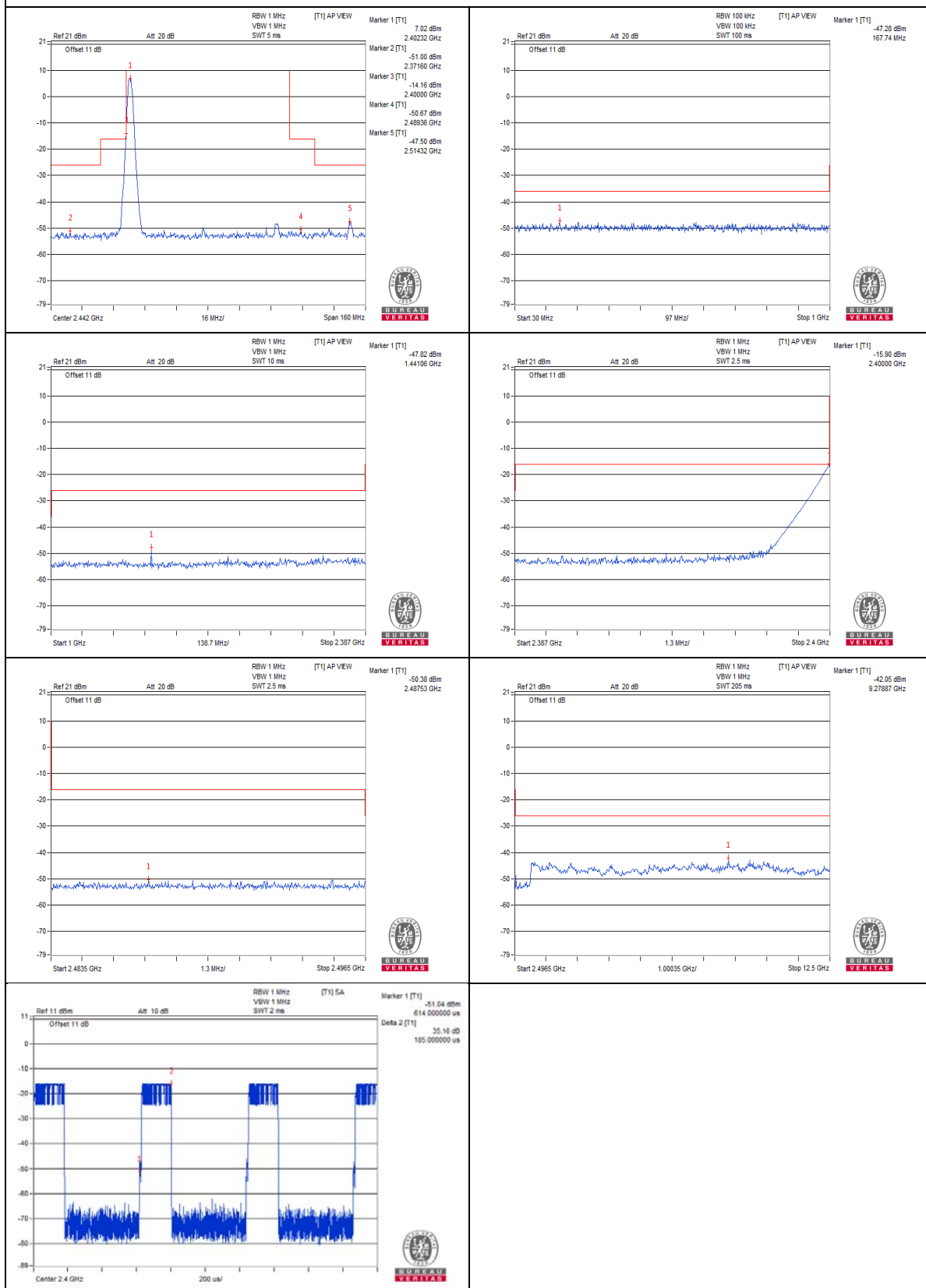
Note: 1. The worst value in each frequency range v.s. each channel has been marked by boldface.

2. Take the value of total data point (501 points) and calculate the total power.

Divides total power by 501 data point to get the average value.

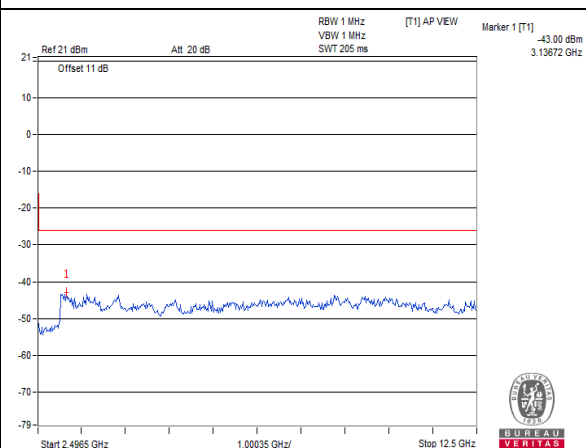
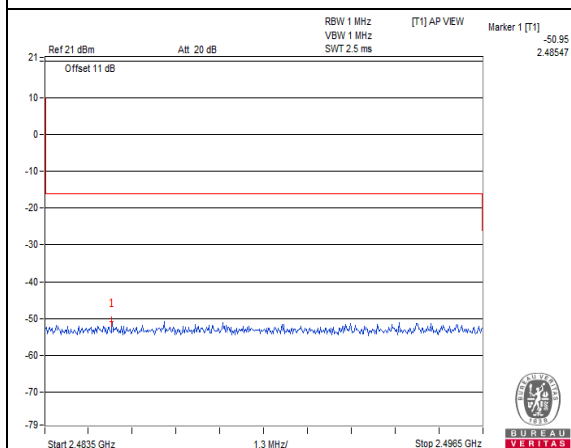
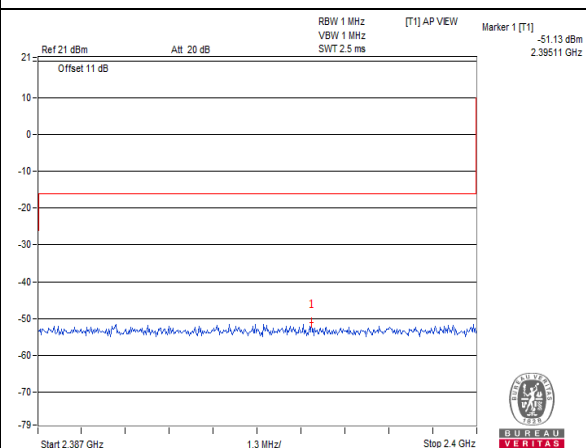
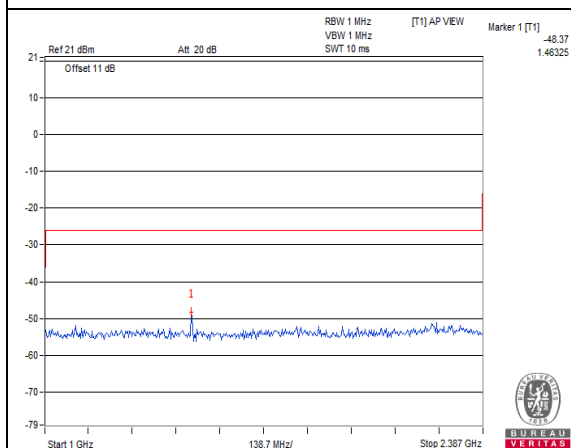
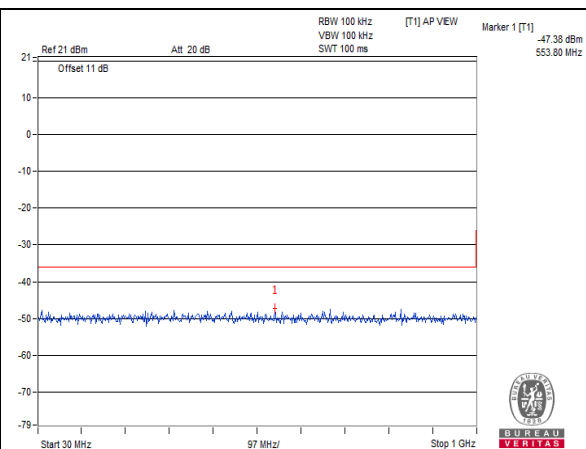
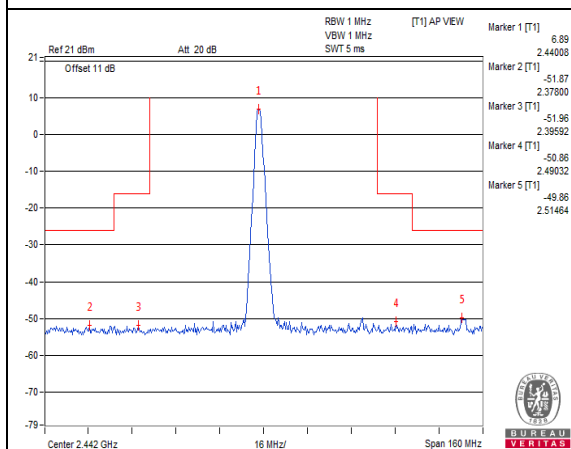
TEST CONDITION	Average power (dBm)	Average power (uW)
CHANNEL 0		
V _{normal}	-18.278908	14.863094

Vnormal Channel 0



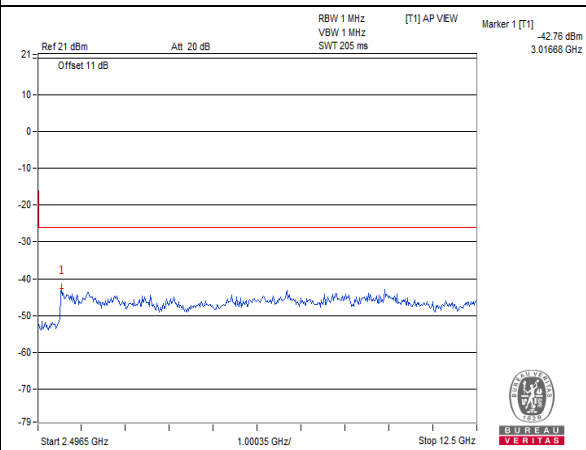
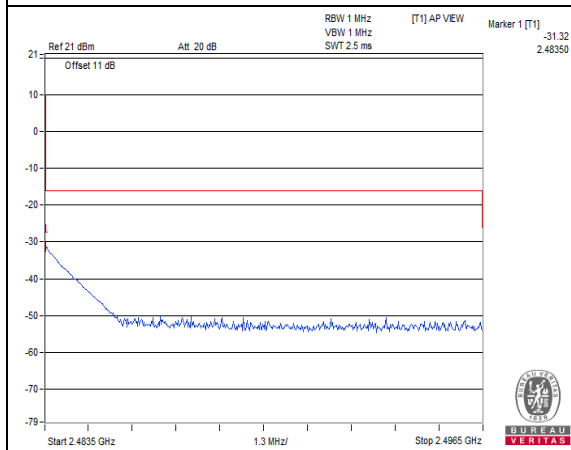
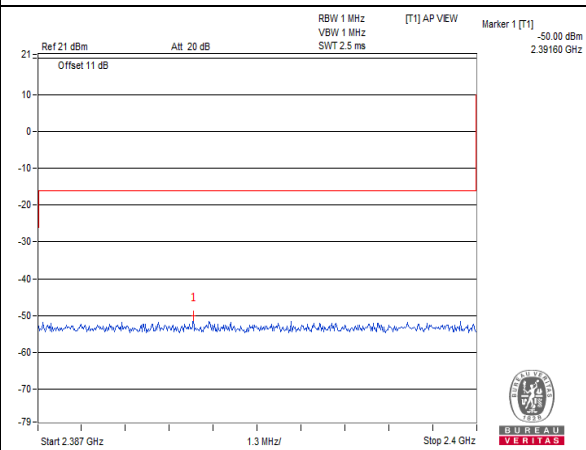
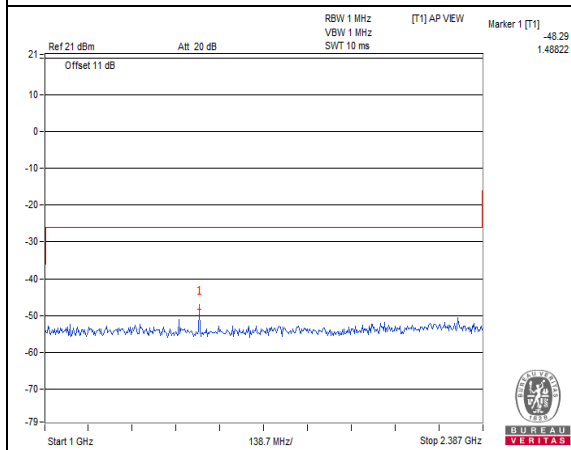
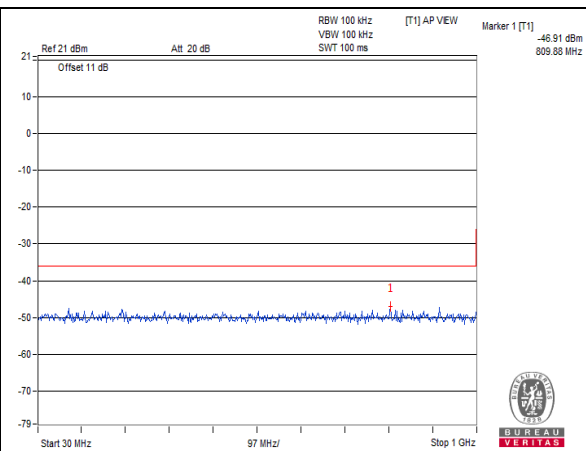
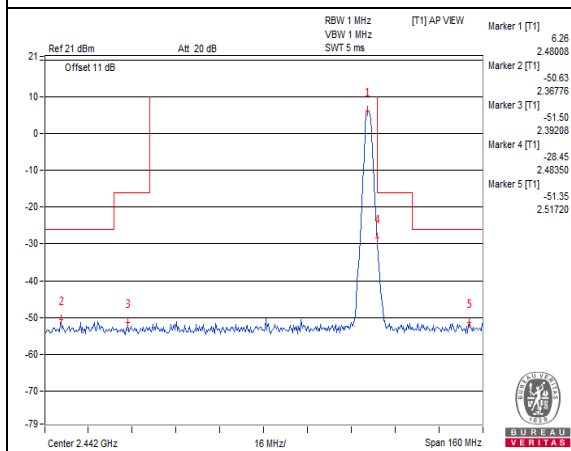
Measurement uncertainty: $\pm 3.93\text{dB}$

Vnormal Channel 19



Measurement uncertainty: $\pm 3.93\text{dB}$

Vnormal Channel 39



Measurement uncertainty: $\pm 3.93\text{dB}$

4.5 Antenna Power Measurement

4.5.1 Limits of Antenna Power

Modulation System	Frequency Band Used	Antenna Power (Max.)	EIRP (Max.)	
			Omni-Directional Case	Directional Case
DS	2400 – 2483.5 MHz	10 mW/MHz	12.14 dBm/MHz (16.368 mW/MHz)	22.14 dBm/MHz (163.68 mW/MHz)
OFDM (Note 1)	2400 – 2483.5 MHz	10 mW/MHz	12.14 dBm/MHz (16.368 mW/MHz)	22.14 dBm/MHz (163.68 mW/MHz)
OFDM (Note 2)	2400 – 2483.5 MHz	5 mW/MHz	9.14d Bm/MHz (8.20 mW/MHz)	19.14 dBm/MHz (82.03 mW/MHz)
Other than the above	2400 – 2483.5 MHz	10 mW/MHz	12.14 dBm/MHz	22.14 dBm/MHz

Note:

1. Occupied bandwidth is less than 26MHz
2. Occupied bandwidth is more that 26MHz and less than 38MHz
3. The half-power beam width for directional antenna shall be 360/A degrees or less, where A is a ratio which causes the EIRP concerned to exceed the omnidirectional EIRP upper limit.
4. Tolerance of antenna power shall be +20% (upper value) and –80% (lower value).

4.5.2 Test Setup



4.5.3 Test Results

Environmental Conditions		25 deg.C, 60% RH	
Channel Number	Frequency (MHz)	Conducted RF Output Power Density (mW)	
		Normal Voltage	Max. Limit (mW)
		3.80Vdc	
0	2402	5.023	10
19	2440	4.955	10
39	2480	4.932	10
Rated power		6.00mW	
Tolerance of antenna power		1.20mW ~ 7.20mW	
Measurement uncertainty		$\pm 1.11\text{dB}$	

Loop antenna with 3.83dBi gain

Environmental Conditions		25 deg.C, 60% RH	
Channel Number	Frequency (MHz)	Radiated RF Output Power Density (mW)	
		Normal Voltage	Max. Limit (mW)
		3.80Vdc	
0	2402	12.133	16.368
19	2440	11.969	16.368
39	2480	11.913	16.368
Measurement uncertainty		$\pm 1.11\text{dB}$	

Note: The value of radiated RF output densities are "calculated" values.

4.6 Spurious Emissions for Receiver

4.6.1 Limits of Spurious Emissions for Receiver

Frequencies (MHz)	Limit
Below 1GHz	$\leq 4\text{nW}$ (-54dBm)
Above 1GHz	$\leq 20\text{nW}$ (-47dBm)

4.6.2 Test Setup

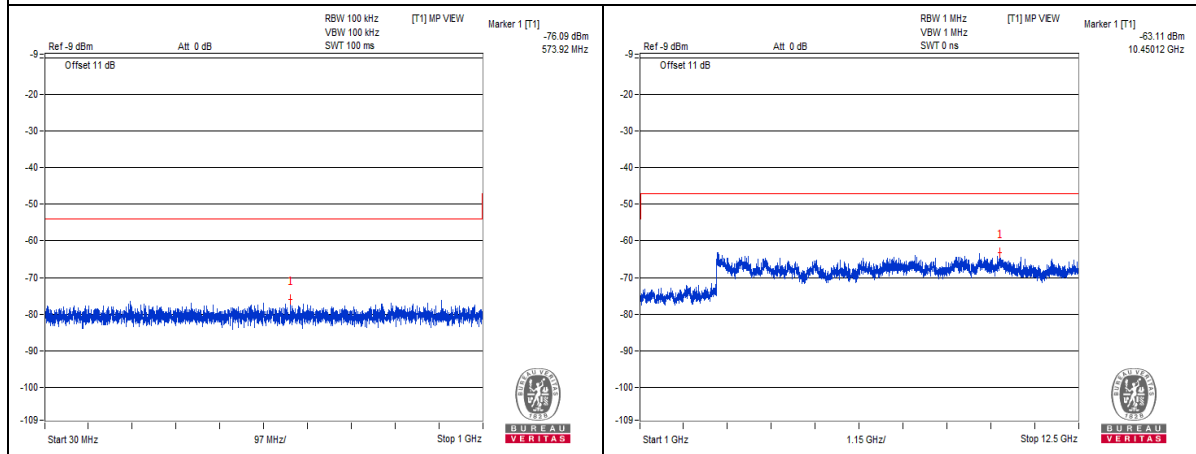


4.6.3 Test Result

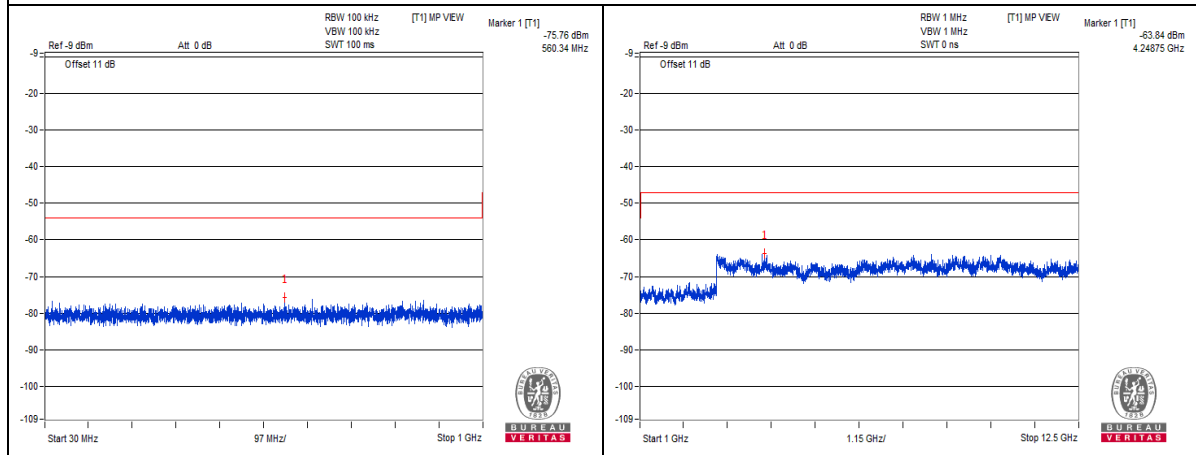
Environmental Conditions		25 deg.C, 60% RH					
Test Channel		CH0 (2402MHz)		CH19 (2440MHz)		Limit	Result
Test Condition	Frequency Range	Frequency (MHz)	Measured Value	Frequency (MHz)	Measured Value		
V _{normal}	Below 1GHz	573.920	0.024604nW	560.340	0.026546nW	4nW/100kHz	PASS
	Above 1GHz	10450.120	0.488652nW	4248.750	0.413048nW	20nW/MHz	PASS
Test Channel		CH39(2480MHz)				Limit	Result
Test Condition	Frequency Range	Frequency (MHz)		Measured Value			
V _{normal}	Below 1GHz	861.040		0.02355nW		4nW/100kHz	PASS
	Above 1GHz	9265.620		0.583445nW		20nW/MHz	PASS

Note: 1. The worst value in each frequency range v.s. each channel has been marked by boldface.
2. The spectrum plots are attached on the following pages.

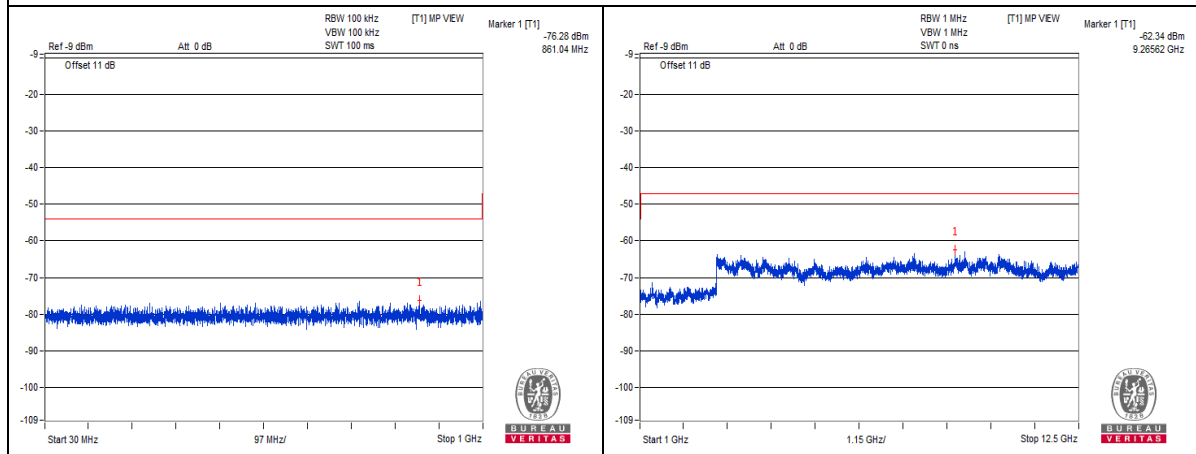
Vnormal



Channel 0



Channel 19



Channel 39

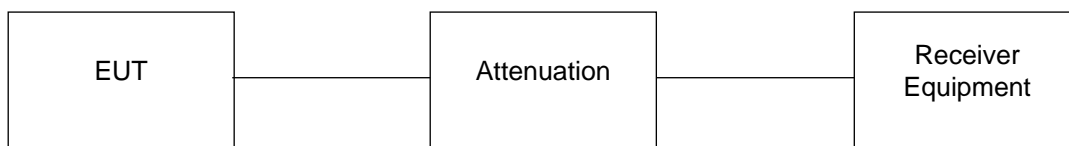
Measurement uncertainty: $\pm 3.93\text{dB}$

4.7 Interference Prevention Function

4.7.1 Limits of Interference Prevention Function

Radio equipment used mainly on the same premises and automatically transmits or receives identification code.

4.7.2 Test Setup



4.7.3 Test Results

ENVIRONMENTAL CONDITIONS	25 deg.C, 60% RH
Link Mode	Test Result
Bluetooth LE	Pass

5 Photographs of the Test Configuration



Appendix - Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Lin Kou EMC/RF Lab

Tel: 886-2-26052180

Fax: 886-2-26051924

Hsin Chu EMC/RF/Telecom Lab

Tel: 886-3-6668565

Fax: 886-3-6668323

Hwa Ya EMC/RF/Safety Lab

Tel: 886-3-3183232

Fax: 886-3-3270892

Email: service.adt@tw.bureauveritas.com

Web Site: www.bureauveritas-adt.com

The address and road map of all our labs can be found in our web site also.

--- END ---