FCC Part 15
EMI TEST REPORT

of

E.U.T. ： IVY SMART JEWELRY
Model ： SMIVYBS1
FCC ID ： 2AKET-SMIVYBS1

for

APPLICANT : SMARTFUTURE PTE LTD

ADDRESS : #06-01, 178 PAYA LEBAR ROAD, SINGAPORE 409030

Test Performed by

ELECTRONICS TESTING CENTER, TAIWAN
NO. 34. LIN 5. DINGFU VIL., LINKOU DIST.,
NEW TAIPEI CITY, TAIWAN, 24442, R.O.C.
Tel : (02)26023052 Fax : (02)26010910
http://www.etc.org.tw ; e-mail: emc@etc.org.tw

Report Number : 17-02-RBF-015

TEST REPORT CERTIFICATION

Applicant	: SMARTFUTURE PTE LTD #06-01, 178 PAYA LEBAR ROAD, SINGAPORE 409030
Manufacturer	: Dawning Leading Technology Inc. No.118,Chung-Hua Rd.,Chu-Nan,Miao-Li 35053, Taiwan,R.O.C

Description of EUT

a) Type of EUT	: IVY SMART JEWELRY
b) Trade Name	: IVY
c) Model No.	: SMIVYBS1
d) Serial Model	: SMIVYBS2, SMIVYBS3, SMIVYBS4, SMIVYBS5, SMIVYPS1, SMIVYPS2, SMIVYPS3, SMIVYPS4, SMIVYPS5, SMIVYCS1, SMIVYCS2, SMIVYCS3, SMIVYCS4, SMIVYCS5, SMIVYRS1, SMIVYRS2, SMIVYRS3,SMIVYRS4, SMIVYRS5, SMIVYPUS1, SMIVYPUS2, SMIVYPUS3, SMIVYPUS4, SMIVYPUS5
e) Power Supply	: DC 3V

Regulation Applied : FCC Rules and Regulations Part 15 Subpart C

I HEREBY CERTIFY THAT: The data shown in this report were made in accordance with the procedures given in ANSI C63.10-2013, and the energy emitted by the device was founded to be within the limits applicable. I assume full responsibility for accuracy and completeness of these data.

Note: 1. The result of the testing report relate only to the item tested.
2. The testing report shall not be reproduced expect in full, without the written approval of ETC

Summary of Tests

Test	Results
Radiated Emission	**Pass**
Conducted Emission	**N/A**
Emission Bandwidth	**Pass**
Output Power	**Pass**
100 kHz Bandwidth of Band Edges	**Pass**
Power Density	**Pass**
Out-of-Band Conducted Emission	**Pass**
Duty Cycle	**N/A**

Date Test Item Received	:	*Feb. 10, 2017*
Date Test Campaign Completed	:	*Feb. 21, 2017*
Date of Issue	:	*Mar. 09, 2016*

Test Engineer : Kazuma Ho

(Kazuma Ho , Engineer)

Approve & Authorized Signer : S S Liou

S. S. Liou, Section Manager
EMC Dept. II of ELECTRONICS
TESTING CENTER, TAIWAN

EMC TESTING DEPARTMENT II
財團法人台灣電子檢驗中心
電磁相容試驗二部
ELECTRONICS TESTING CENTER, TAIWAN E.T.C.

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1 GENERAL INFORMATION

1.1 Product Description

a) Type of EUT : IVY SMART JEWELRY

b) Trade Name : IVY

c) Model No. : SMIVYBS12

d) Serial Model : SMIVYBS2, SMIVYBS3, SMIVYBS4, SMIVYBS5, SMIVYPS1, SMIVYPS2, SMIVYPS3, SMIVYPS4, SMIVYPS5, SMIVYCS1, SMIVYCS2, SMIVYCS3, SMIVYCS4, SMIVYCS5, SMIVYRS1, SMIVYRS2, SMIVYRS3,SMIVYRS4, SMIVYRS5, SMIVYPUS1, SMIVYPUS2, SMIVYPUS3, SMIVYPUS4, SMIVYPUS5

e) Power Supply : DC 3V

f) ModelDifference : PCB is exactly the same as SMIVYBS1 in all serial models and only accessory colors are different.

1.2 Characteristics of Device

The EUT is a wireless device with Bluetooth BLE.

1.3 Test Methodology

Both conducted and radiated emissions were performed according to the procedures illustrated in ANSI C63.10-2013. Other required measurements were illustrated in separate sections of this test report for details. For RF test the measurement procedure was refered to FCC KDB 558074 D01 DTS Meas Guidance v03r05.

Measurement Software

Software	Version	Note
e3	Version 6.100618b	Radiated Emission Test
e3	Version 6.100421	Conducted Emission Test

1.4 Test Facility

Location of the Test site: No.34, Lin 5, Dingfu Vil., Linkou Dist., New Taipei City, Taiwan 24442, R.O.C.

Designation Number: TW2628.

2 PROVISIONS APPLICABLE

2.1 Definition

Unintentional radiator:
A device that intentionally generates and radio frequency energy for use within the device, or that sends radio frequency signals by conduction to associated equipment via connecting wiring, but which is not intended to emit RF energy by radiation or induction.

Class A Digital Device:
A digital device which is marketed for use in commercial or business environment; exclusive of a device which is market for use by the general public, or which is intended to be used in the home.

Class B Digital Device :
A digital device which is marketed for use in a residential environment notwithstanding use in a commercial, business of industrial environment. Example of such devices that are marketed for the general public.

Note : A manufacturer may also qualify a device intended to be marketed in a commercial, business, or industrial environment as a Class B digital device, and in fact is encouraged to do so, provided the device complies with the technical specifications for a Class B Digital Device. In the event that a particular type of device has been found to repeatedly cause harmful interference to radio communications, the Commission may classify such a digital device as a Class B Digital Device, Regardless of its intended use.

Intentional radiator:
A device that intentionally generates and emits radio frequency energy by radiation or induction.

2.2 Requirement for Compliance

(1) Conducted Emission Requirement

Except for Class A digital devices, for equpment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150kHz to 30MHz shall not exceed the limits in the following table, as measured using a 50μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the band edges.

Frequency MHz	Quasi Peak dBμV	Average dBμV
0.15 - 0.5	66-56*	56-46*
0.5 - 5.0	56	46
5.0 - 30.0	60	50

* Decreases with the logarithm of the frequency

(2) Radiated Emission Requirement

For unintentional device, according to §15.109(a), except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency MHz	Distance Meters	Radiated dBμV/m	Radiated μV/m
30 - 88	3	40.0	100
88 - 216	3	43.5	150
216 - 960	3	46.0	200
Above 960	3	54.0	500

For intentional device, according to §15.209(a), the general requirement of field strength of radiated emissions from intentional radiators at a distance of 3 meters shall not exceed the above table.

(3) Antenna Requirement

For intentional device, according to §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.

(4) Bandwidth Requirement

For direct sequence system, according to 15.247(a)(2), the minimum 6dB bandwidth shall be at least 500 kHz.

(5) Output Power Requirement

For direct sequence system, according to 15.247(b), the maximum peak output power of the transmitter shall not exceed 1 Watt. If transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(6) 100 kHz Bandwidth of Frequency Band Edges Requirement

According to 15.247(c), if any 100 kHz bandwidth outside these frequency bands, the radio frequency power that is produced by the modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 kHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in §15.209(a), whichever results in the lesser attenuation.

(7) Power Density Requirement

According to 15.247(d), for direct sequence systems, the transmitted power density averaged over any 1 second interval shall not be greater than 8 dBm in any 3 kHz bandwidth within these bands.

2.3 Restricted Bands of Operation

Only spurious emissions are permitted in any of the frequency bands listed below :

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42-16.423	399.9-410	4.5-5.15
0.495 - 0.505 **	16.69475 - 16.69525	608-614	5.35-5.46
2.1735 - 2.1905	16.80425 - 16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475 - 156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2655-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3360-4400	Above 38.6
13.36-13.41			

** : Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz

2.4 Labeling Requirement

The device shall bear the following statement in a conspicuous location on the device :

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions : (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

2.5 User Information

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual.

The Federal Communications Commission Radio Frequency Interference Statement includes the following paragraph.

This equipment has been tested and found to comply with the limits for a Class B Digital Device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.

-- Increase the separation between the equipment and receiver.

-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-- Consult the dealer or an experienced radio / TV technician for help.

3. SYSTEM TEST CONFIGURATION

3.1 Justification

For both radiated and conducted emissions below 1 GHz, the system was configured for testing in a typical fashion as a customer would normally use it. The peripherals other than EUT were connected in normally standing by situation. Measurement was performed under the condition that a computer program was exercised to simulate data communication of EUT, and the transmission rate was set to maximum allowed by EUT. Three highest emissions were verified with varying placement of the cables connected to EUT to maximize the emission from EUT.

For conducted and radiated spurious emissions, whichever RF channel is operated, the digital circuits function identically. As the reason, measurement of radiated emissions from digital circuits is only performed with channel 1 by transmitting mode.

For portable device, the EUT was pretested in three orthogonal plans: put on table horizontally, stands vertically and side up vertically. The worst case was chosen for final test.

3.2 Devices for Tested System

Device	Manufacture	Model / FCC ID.	Description
IVY SMART JEWELRY *	Dawning Leading Technology Inc.	SMIVYBS1 / 2AKET-SMIVYBS1	---

Remark “*” means equipment under test.

4 RADIATED EMISSION MEASUREMENT

4.1 Applicable Standard

For unintentional radiator, the radiated emission shall comply with §15.109(a).
For intentional radiators, according to §15.247 (a), operation under this provision is limited to frequency hopping and direct sequence spread spectrum, and the out band emission shall be comply with §15.247 (d)

4.2 Measurement Procedure

A. Preliminary Measurement For Portable Devices

For portable devices, the following procedure was performed to determine the maximum emission axis of EUT:

1. With the receiving antenna is H polarization, rotate the EUT in turns with three orthogonal axes to determine the axis of maximum emission.
2. With the receiving antenna is V polarization, rotate the EUT in turns with three orthogonal axes to determine the axis of maximum emission.
3. Compare the results derived from above two steps. So, the axis of maximum emission from EUT was determined and the configuration was used to perform the final measurement.

B. Final Measurement

1. Setup the configuration per figure 1 and 2 for frequencies measured below and above 1 GHz respectively. Turn on EUT and make sure that it is in normal function.
2. For emission frequencies measured below 1 GHz, a pre-scan is performed in a shielded chamber to determine the accurate frequencies of higher emissions will be checked on a open test site. As the same purpose, for emission frequencies measured above 1 GHz, a pre-scan also be performed with a 1 meter measuring distance before final test.
3. For emission frequencies measured below and above 1 GHz, set the spectrum analyzer on a 100 kHz and 1 MHz resolution bandwidth respectively for each frequency measured in step 2.
4. The search antenna is to be raised and lowered over a range from 1 to 4 meters in horizontally polarized orientation. Position the highness when the highest value is indicated on spectrum analyzer, then change the orientation of EUT on test table over a range from 0° to 360° with a speed as slow as possible, and keep the azimuth that highest emission is indicated on the spectrum analyzer. Vary the antenna position again and record the highest value as a final reading. A RF test receiver is also used to confirm emissions measured.

5. Repeat step 4 until all frequencies need to be measured were complete.
6. Repeat step 5 with search antenna in vertical polarized orientations.
7. Check the three frequencies of highest emission with varying the placement of cables (if any) associated with EUT to obtain the worse case and record the result.

Figure 1 : Frequencies measured below 1 GHz configuration

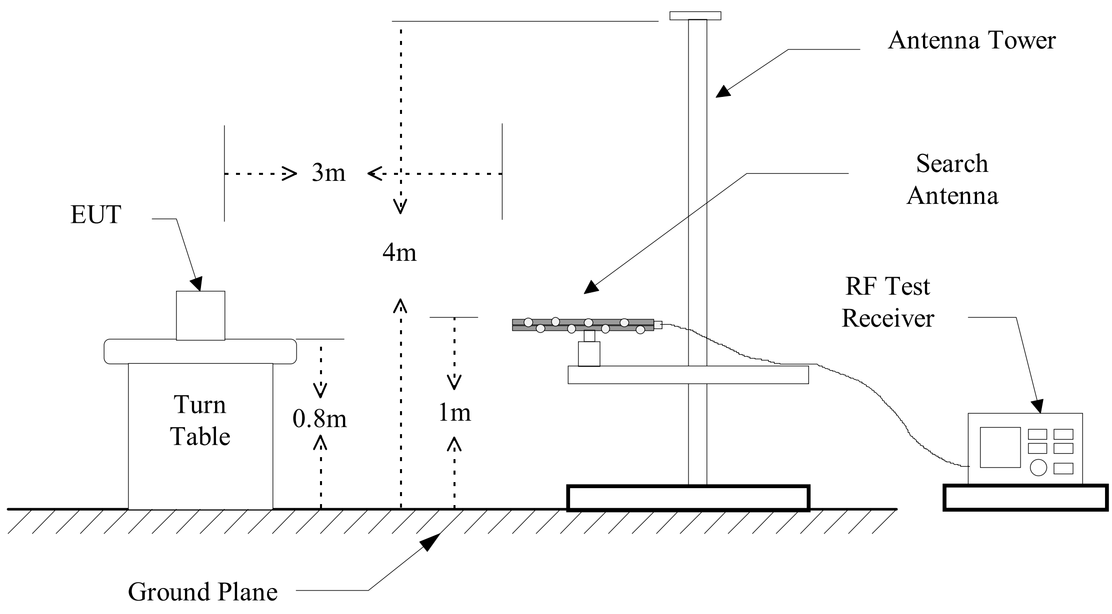
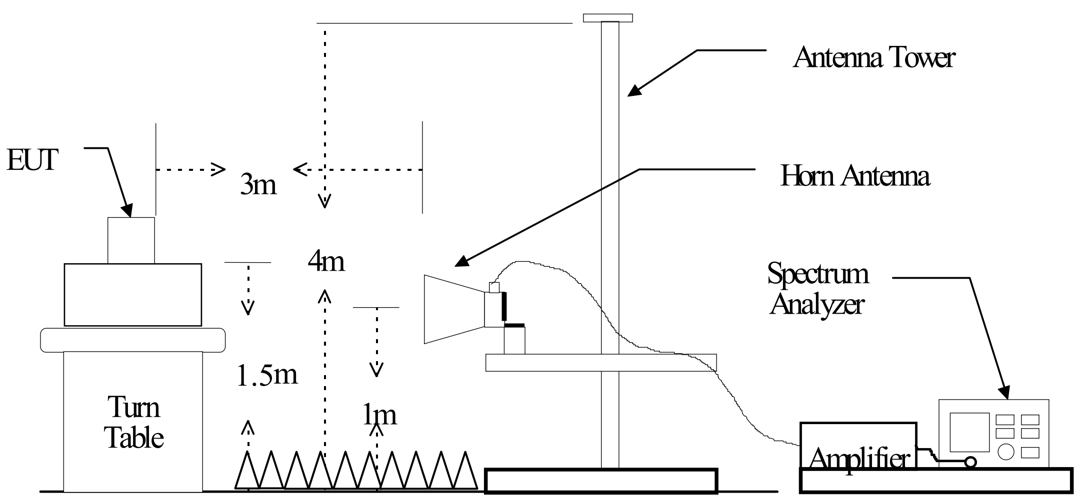


Figure 2 : Frequencies measured above 1 GHz configuration



4.3 Measuring Instrument

The following instrument are used for radiated emissions measurement:

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
EMI Test Receiver	Rohde & Schwarz	ESCI	2016/09/07	2017/09/06
Double Ridged Antenna	EMCO	3115	2016/10/05	2017/10/04
Double Ridged Guide Horn Antenna	EMCO	3116	2016/10/05	2017/10/04
Log-periodic Antenna	EMCO	3146	2016/07/05	2017/07/04
Biconical Antenna	EMCO	3110B	2016/07/05	2017/07/04
Amplifier	HP	8449B	2016/10/14	2017/10/13
Amplifier	HP	8447D	2016/09/26	2017/09/25
Amplifier	HP	83051A	2016/07/18	2017/07/17

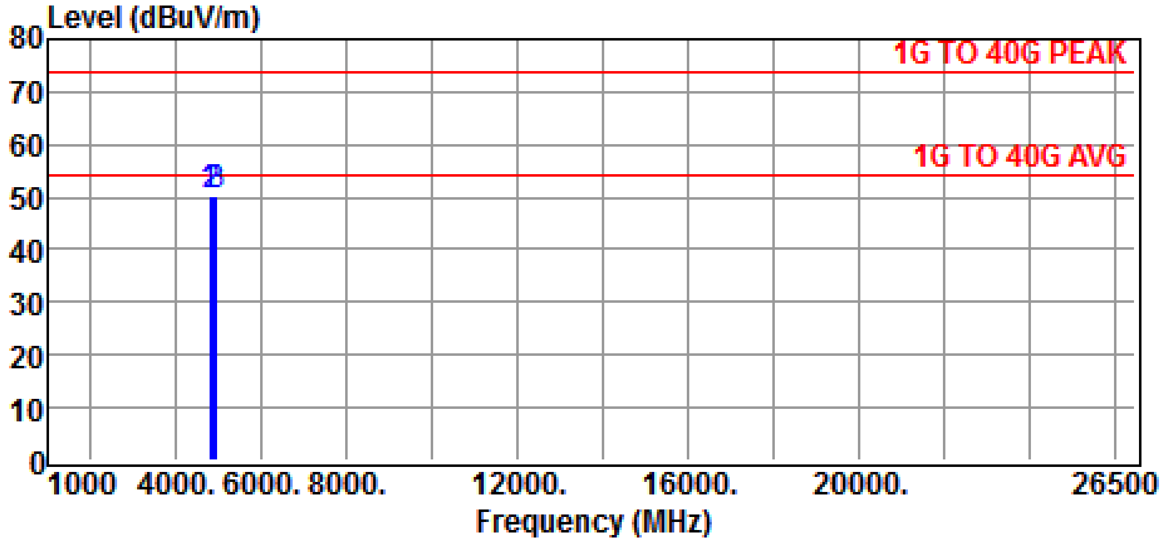
Measuring instrument setup in measured frequency band when specified detector function is used :

Frequency Band (MHz)	Instrument	Function	Resolution bandwidth	Video Bandwidth
30 to 1000	RF Test Receiver	Quasi-Peak	120 kHz	N/A
	Spectrum Analyzer	Peak	100 kHz	100 kHz
Above 1000	Spectrum Analyzer	Peak	1 MHz	1 MHz
	Spectrum Analyzer	Average	1 MHz	10 Hz or $\geq$ 1/T (Note 1)

Note 1:
VBW = 10 Hz, when the duty cycle is no less than 98%.
VBW $\geq$ 1/T, when duty cycle is less than 98% where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

4.4 Radiated Emission Data

4.4.1 RF Portion

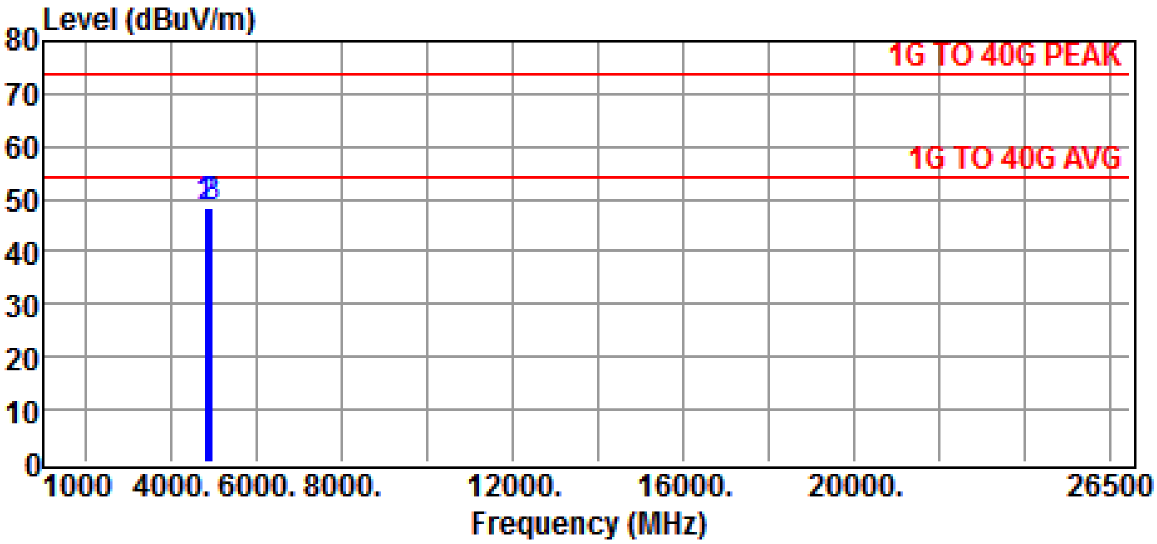


Site	:CHAMBER#2	Date	:2017-02-21
Limit	:1G TO 40G PEAK	Ant. Pol.	:HORIZONTAL
EUT	:IVY SMART JEWELRY	Model	:SMIVYBS1
Power Rating	:DC3V Battery	Temp.	:21˚C
Engineer	: Kazuma Ho	Humi.	:53 %
Test Mode	:BLE		
Test Mode	: EUT put on table horizontally (worst case)		

Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits (AVG) dBμV/m	Over limit dB	Detector
4804.0000	49.08	1.25	50.33	54.00	-3.67	Peak
4880.0000	48.94	1.47	50.41	54.00	-3.59	Peak
4960.0000	48.75	1.74	50.49	54.00	-3.51	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit – Result
4. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.



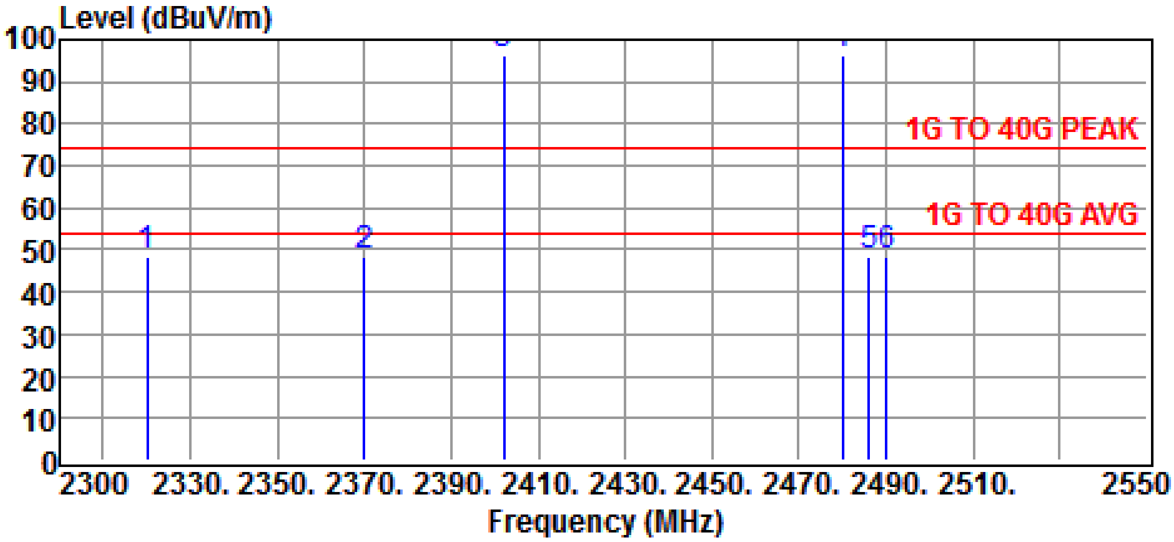
Site	:CHAMBER#2	Date	:2017-02-21
Limit	:1G TO 40G PEAK	Ant. Pol.	:VERTICTAL
EUT	:IVY SMART JEWELRY	Model	:SMIVYBS1
Power Rating	:DC3V Battery	Temp.	:21˚C
Engineer	: Kazuma Ho	Humi.	:53 %
Test Mode	:BLE		
Test Mode	: EUT put on table horizontally (worst case)		

Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits (AVG) dBμV/m	Over limit dB	Detector
4804.0000	47.17	1.25	48.42	54.00	-5.58	Peak
4880.0000	47.00	1.47	48.47	54.00	-5.53	Peak
4960.0000	46.77	1.74	48.51	54.00	-5.49	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit – Result
4. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.

4.4.2 Radiated Eimssion of Restricted bands

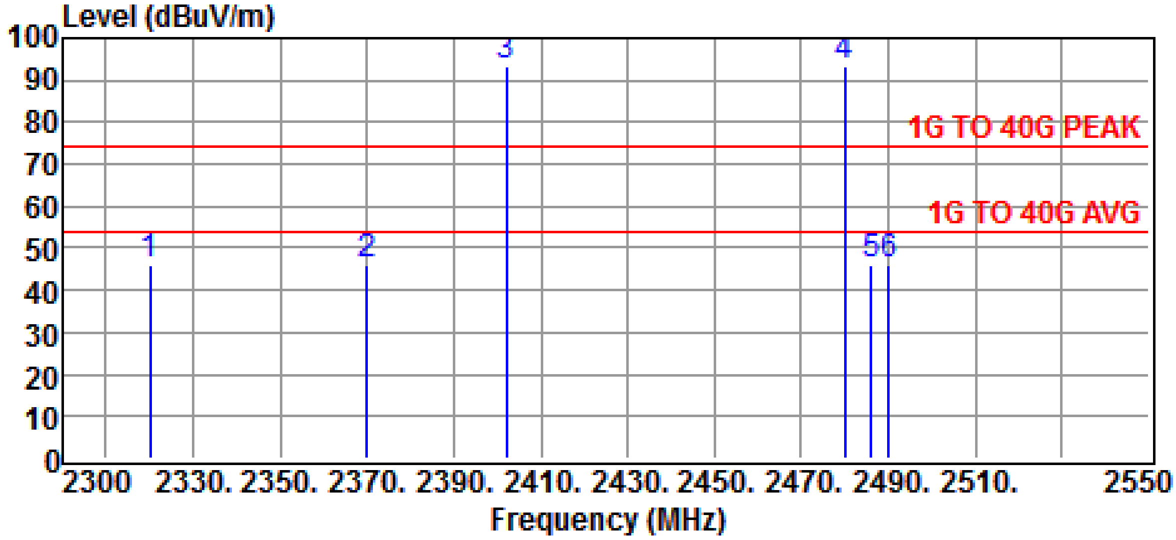


Site	:CHAMBER#2	Date	:2017-02-21
Limit	:1G TO 40G PEAK	Ant. Pol.	:HORIZONTAL
EUT	:IVY SMART JEWELRY	Model	:SMIVYBS1
Power Rating	:DC3V Battery	Temp.	:21˚C
Engineer	: Kazuma Ho	Humi.	:53 %
Test Mode	:BLE		
Test Mode	: EUT put on table horizontally (worst case)		

Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits (AVG) dBμV/m	Over limit dB	Detector
2320.0000	54.38	-5.76	48.62	54.00	-5.38	Peak
2370.0000	54.28	-5.63	48.65	54.00	-5.35	Peak
2402.0000	101.92	-5.61	96.31	---	---	Peak
2480.0000	101.79	-5.40	96.39	---	---	Peak
2486.0000	54.11	-5.40	48.71	54.00	-5.29	Peak
2490.0000	54.05	-5.36	48.69	54.00	-5.31	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit – Result
4. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.



Site	:CHAMBER#2	Date	:2017-02-21
Limit	:1G TO 40G PEAK	Ant. Pol.	:VERTICAL
EUT	:IVY SMART JEWELRY	Model	:SMIVYBS1
Power Rating	:DC3V Battery	Temp.	:21˚C
Engineer	: Kazuma Ho	Humi.	:53 %
Test Mode	:BLE		
Test Mode	: EUT put on table horizontally (worst case)		

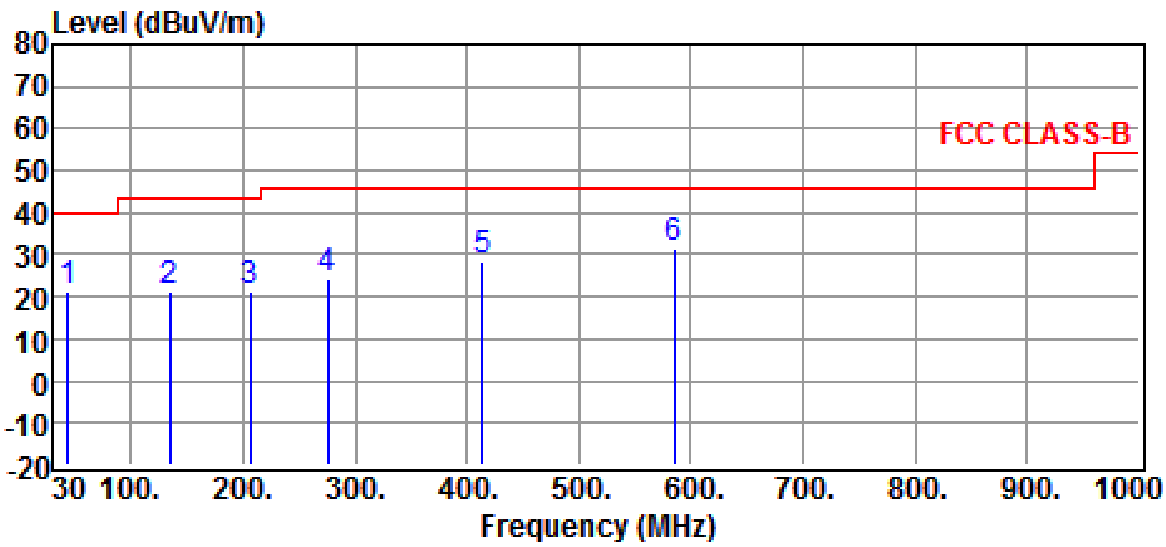
Freq MHz	Reading dBµV	Correction Factor dB	Result dBµV/m	Limits (AVG) dBµV/m	Over limit dB	Detector
2320.0000	51.87	-5.76	46.11	54.00	-7.89	Peak
2370.0000	51.78	-5.63	46.15	54.00	-7.85	Peak
2402.0000	98.86	-5.61	93.25	---	---	Peak
2480.0000	98.70	-5.40	93.30	---	---	Peak
2486.0000	51.53	-5.40	46.13	54.00	-7.87	Peak
2490.0000	51.56	-5.36	46.20	54.00	-7.80	Peak

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss - Amplifier Gain (if any)
3. The margin value=Limit – Result
4. Peak measurements are compared to the average limit - as peak measurements are below the average limit, they also comply with the peak limit.

4.4.3 Other Emission

a) Emission frequencies below 1 GHz

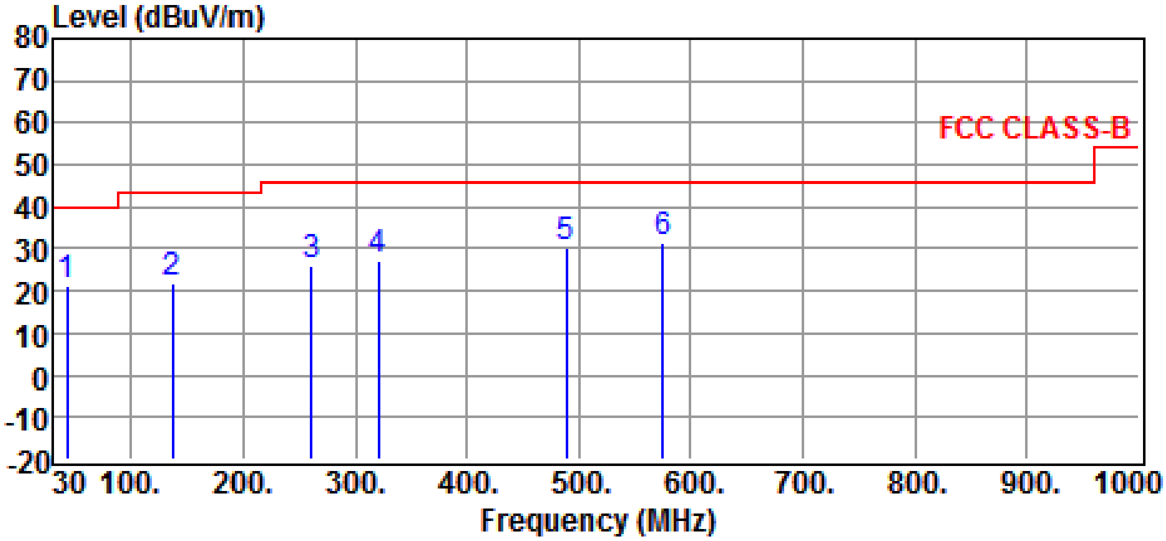


Site	:CHAMBER#2	Date	:2017-02-13
Limit	:FCC CLASS-B	Ant. Pol.	:HORIZONTAL
EUT	:IVY SMART JEWELRY	Model	:SMIVYBS1
Power Rating	:DC3V Battery	Temp.	:22˚C
Engineer	: Kazuma Ho	Humi.	:58 %
Test Mode	:Operation Mode		
Test Mode	: EUT put on table horizontally (worst case)		

Freq MHz	Reading dBμV	Correction Factor dB	Result dBμV/m	Limits dBμV/m	Over limit dB	Detector
44.5500	28.31	-7.01	21.30	40.00	-18.70	QP
134.7600	28.66	-7.34	21.32	43.50	-22.18	QP
206.5400	28.76	-7.21	21.55	43.50	-21.95	QP
276.3800	29.14	-4.57	24.57	46.00	-21.43	QP
414.1200	30.05	-1.33	28.72	46.00	-17.28	QP
584.8400	30.81	0.95	31.76	46.00	-14.24	QP

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss
3. The margin value=Limit - Result



Site	:CHAMBER#2	Date	:2017-02-13
Limit	:FCC CLASS-B	Ant. Pol.	:VERTICAL
EUT	:IVY SMART JEWELRY	Model	:SMIVYBS1
Power Rating	:DC3V Battery	Temp.	:22˚C
Engineer	: Kazuma Ho	Humi.	:58 %
Test Mode	:Operation Mode		
Test Mode	: EUT put on table horizontally (worst case)		

Freq MHz	Reading dBµV	Correction Factor dB	Result dBµV/m	Limits dBµV/m	Over limit dB	Detector
42.6100	28.18	-6.83	21.35	40.00	-18.65	QP
136.7000	28.94	-7.23	21.71	43.50	-21.79	QP
260.8600	30.98	-4.94	26.04	46.00	-19.96	QP
321.0000	30.38	-3.06	27.32	46.00	-18.68	QP
488.8100	30.46	-0.35	30.11	46.00	-15.89	QP
575.1400	30.93	0.79	31.72	46.00	-14.28	QP

Note :

1. Result = Reading + Corrected Factor
2. Corrected Factor = Antenna Factor + Cable Loss
3. The margin value=Limit - Result

b) Emission frequencies above 1 GHz

Radiated emission frequencies above 1 GHz to 26.5 GHz were too low to be measured with a pre-amplifier of 35 dB.

c) Emission frequencies below 30MHz (9kHz - 30MHz)

According to exploratory test no any obvious emission were detected from 9kHz to 30MHz. Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30 m open are test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 937606.

4.5 Field Strength Calculation

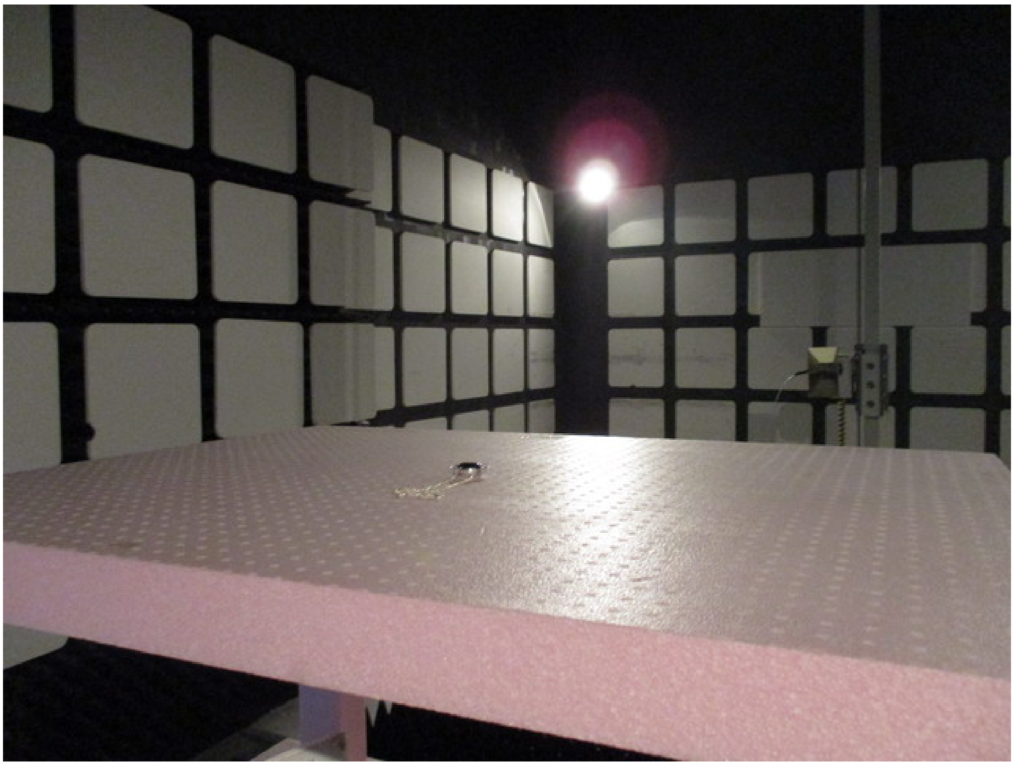
The field strength is calculated by adding the Antenna Factor, High Pass Filter Loss(if used) and Cable Loss, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation calculation is as follows:

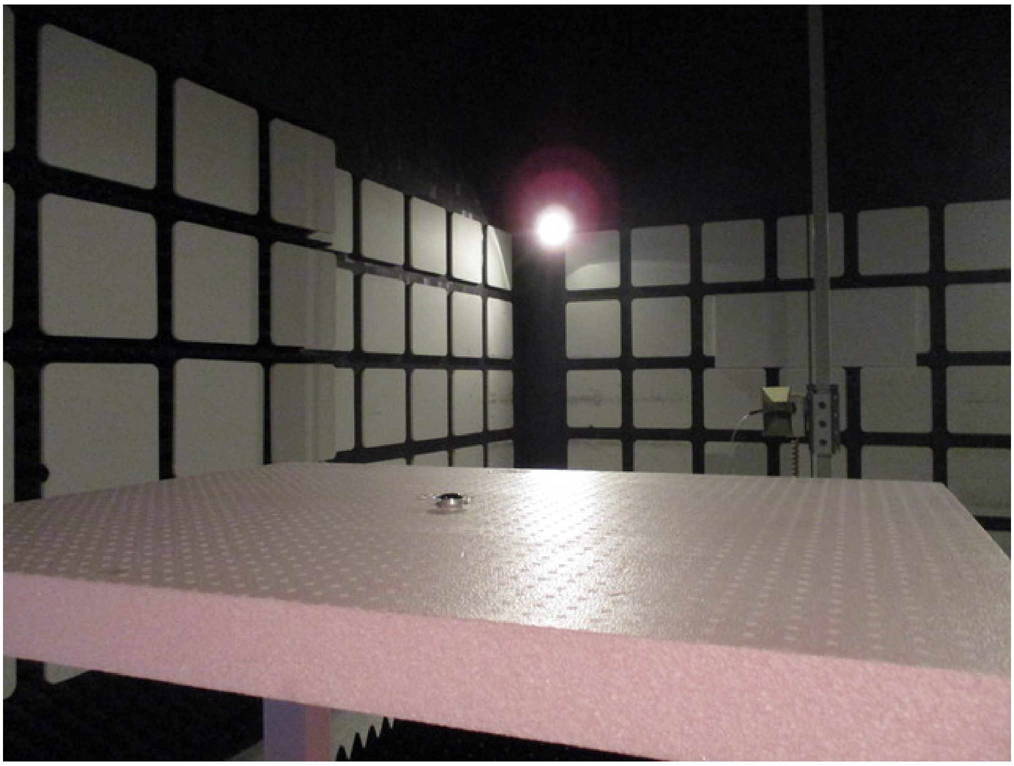
Result = Reading + Corrected Factor

where

Corrected Factor = Antenna FACTOR + Cable Loss + High Pass Filter Loss - Amplifier Gain

4.6 Photos of Radiation Measuring Setup





5 CONDUCTED EMISSION MEASUREMENT

5.1 Description

This EUT is excused from investigation of conducted emission, for it is powered by DC battery only. According to §15.207 (d), measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines.

6 ANTENNA REQUIREMENT

6.1 Standard Applicable

For intentional device, according to §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.
And according to §15.247 (b)(4), if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

6.2 Antenna Construction and Directional Gain

The antenna is integrated on the main PCB and installed inside the houseing, no consideration of replacement.
Please refer to the construction Photo for details.

7 EMISSION BANDWIDTH MEASUREMENT

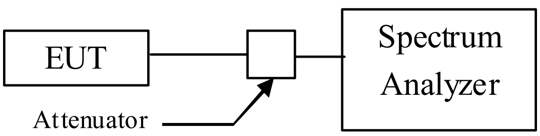
7.1 Standard Applicable

According to 15.247(a)(2), for direct sequence system, the minimum 6dB bandwidth shall be at least 500 kHz.

7.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value. The settings of spectrum analyzer is as followings.
   1) Set RBW = 100 kHz.
   2) Set the video bandwidth (VBW) ≥ 3 x RBW.
   3) Detector = Peak.
   4) Trace mode = max hold.
   5) Sweep = auto couple.
   6) Allow the trace to stabilize.
   7) 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.
3. Repeat above procedures until all frequencies measured were complete.

Figure 4: Measurement configuration.



7.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

7.4 Measurement Data

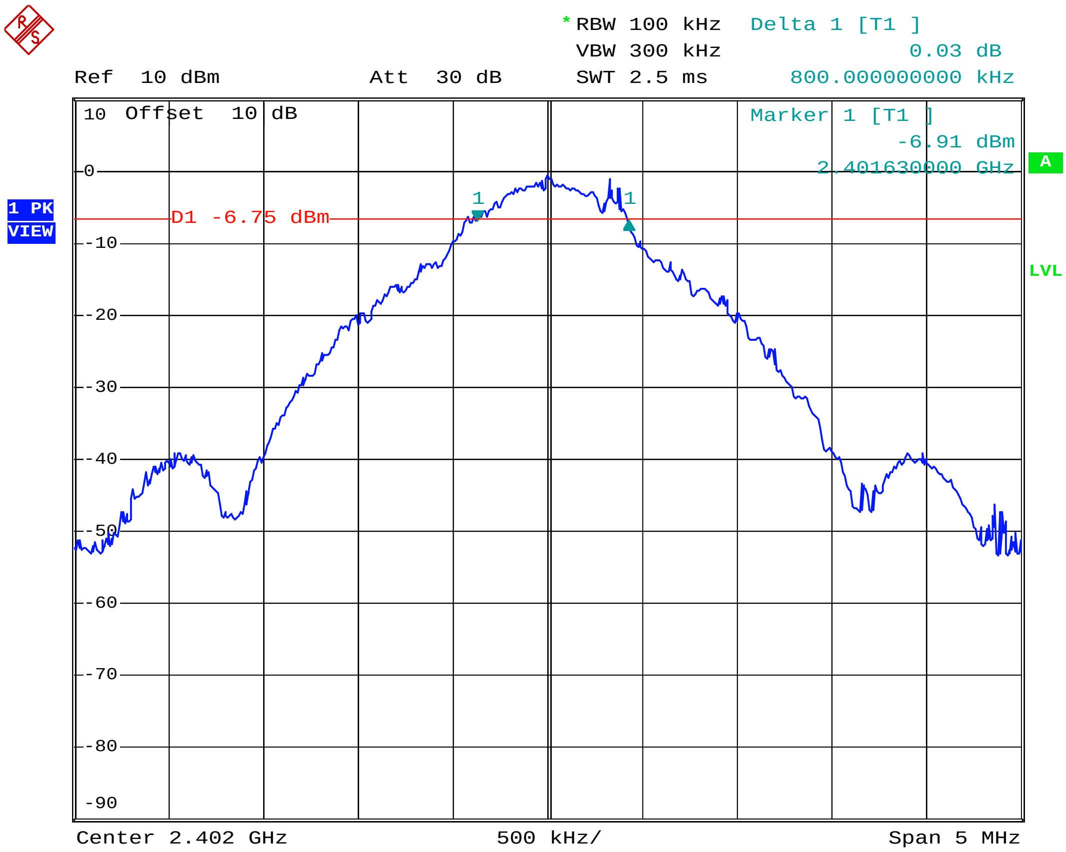
Test Date : Feb. 18, 2017 Temperature : 21 °C Humidity : 65 %

Mode: Bluetooth BLE

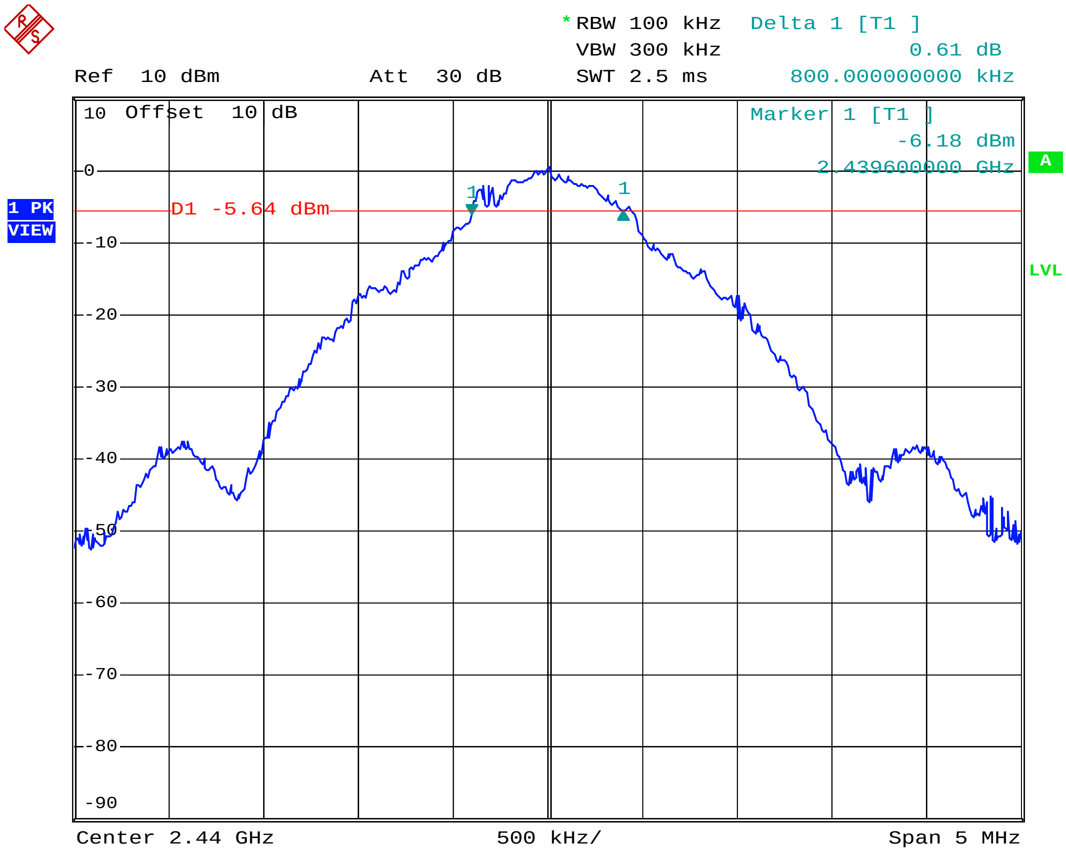
a) Channel Low: 6 dB Emission Bandwidth is 0.800 MHz
b) Channel Mid: 6 dB Emission Bandwidth is 0.800 MHz
c) Channel High: 6 dB Emission Bandwidth is 0.800 MHz

Note : The expanded uncertainty: frequency $\times 1.65 \times 10^{-6}$ (1 GHz $<$ f $\leq$ 18 GHz).

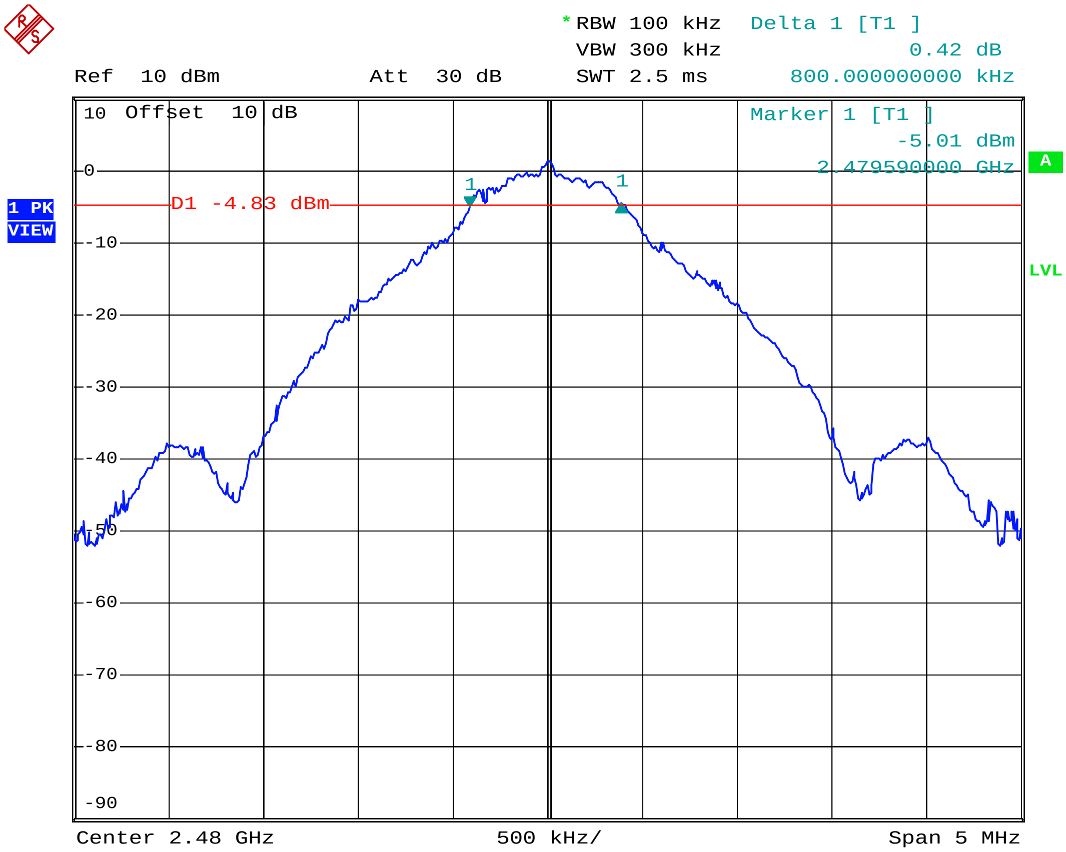
Mode: Bluetooth BLE / Channel Low



Mode: Bluetooth BLE / Channel Mid



Mode: Bluetooth BLE / Channel High



8 OUTPUT POWER MEASUREMENT

8.1 Standard Applicable

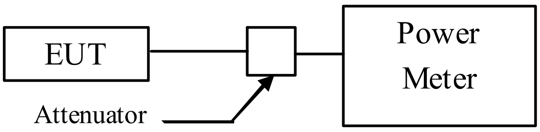
For direct sequence system, according to 15.247(b), the maximum peak output power of the transmitter shall not exceed 1 Watt. If transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

8.2 Measurement Procedure

Measurement Procedure:
9.1.2 PKPM1 Peak power meter method

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 5 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable.
3. Record the readings on the instrument and add a compensat factor of the attenuator.
4. Repeat above procedures until all frequencies measured were complete.

Figure 5: Output power and measurement configuration.



8.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
POWER METER +SENSOR	ANRITSU	ML2487A +MA2491A	2016/05/12	2017/05/11
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

8.4 Measurement Data

Test Date : Feb. 18, 2017 Temperature : 21 °C Humidity : 65 %

Measurement Procedure:

9.1.2 PKPM1 Peak power meter method

Output Peak Power		dBm	mW
Bluetooth BLE	Channel Low:2402MHz	-0.14	0.968
	Channel Mid:2440MHz	1.26	1.337
	Channel High:2480MHz	1.05	1.274

Note : The expanded uncertainty: 2dB.

9 100 kHz BANDWIDTH OF BAND EDGES MEASUREMENT

9.1 Standard Applicable

According to 15.247(c), if any 100 kHz bandwidth outside these frequency bands, the radio frequency power that is produced by the modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 kHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in §15.209(a), whichever results in the lesser attenuation.

9.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
3. Set both RBW of spectrum analyzer to 100kHz and VBW to 1 MHz with a convenient frequency span including 100kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

9.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

9.4 Measurement Data

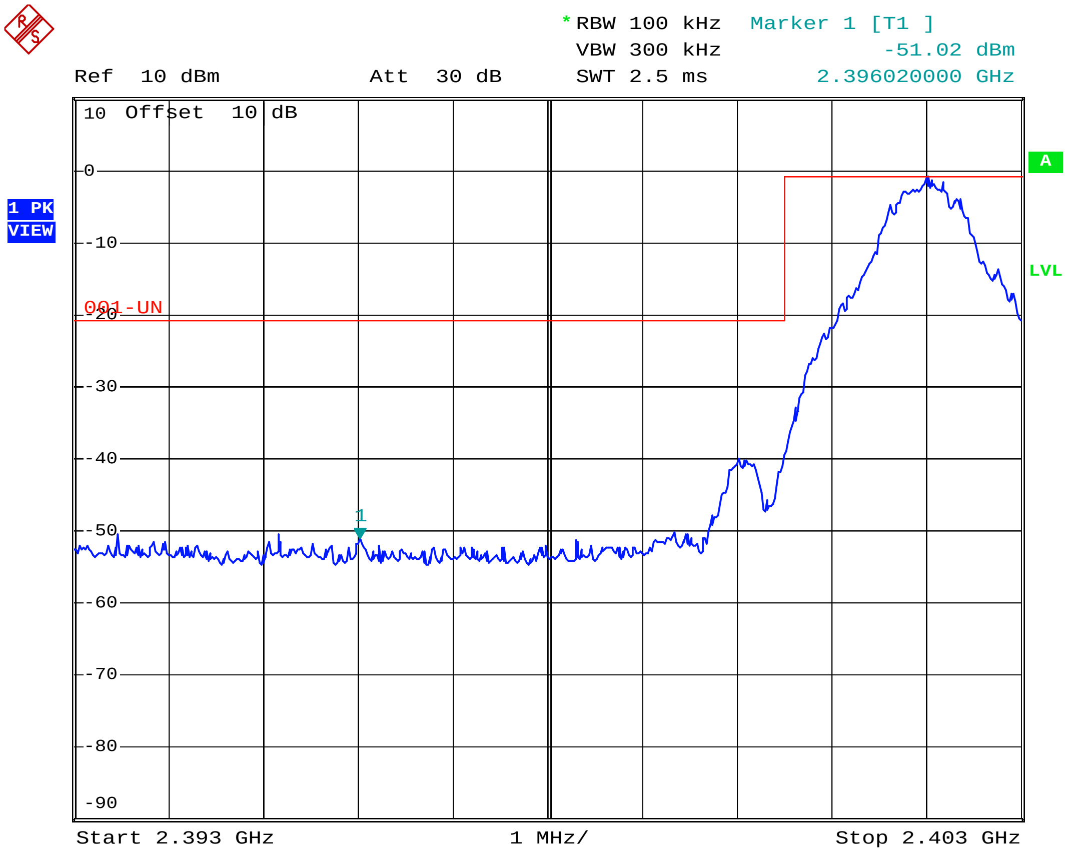
Test Date : Feb. 18, 2017 Temperature : 21 °C Humidity : 65 %

Mode: Bluetooth BLE

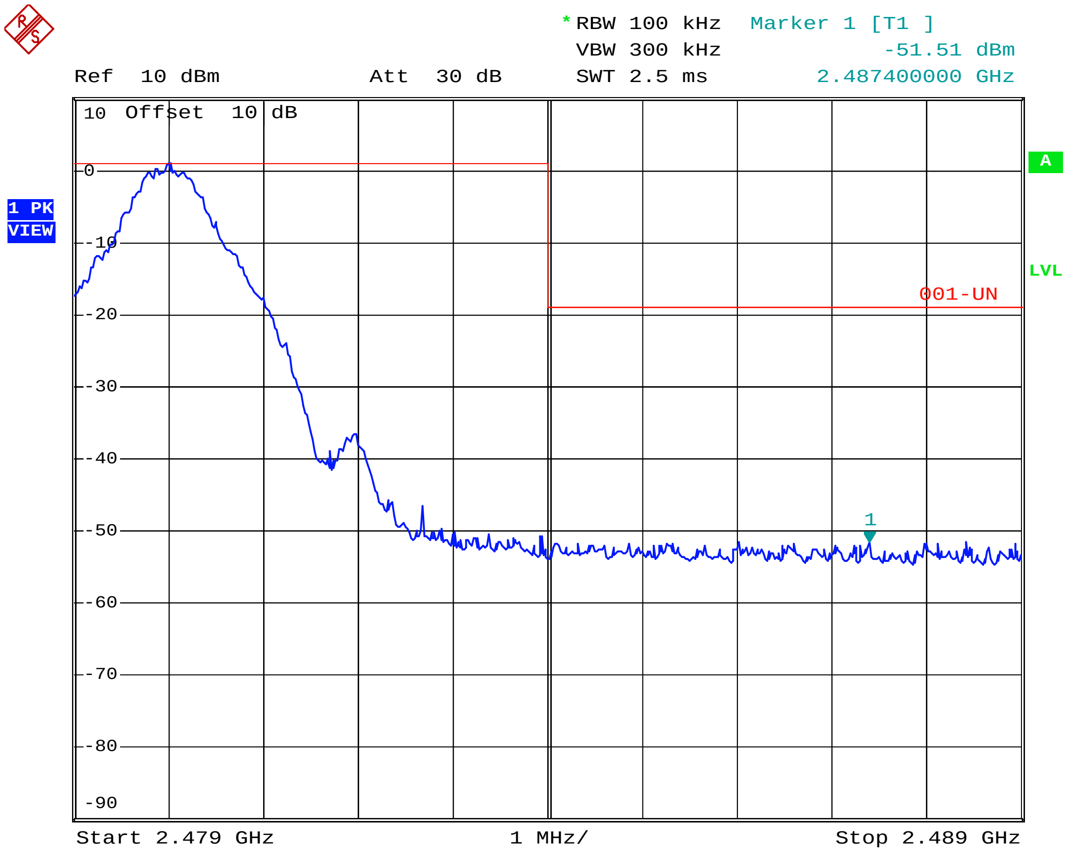
a) Lower Band Edge : All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.
b) Upper Band Edge : All emissions in this 100kHz bandwidth are attenuated more than 20dB from the carrier.

Note : The expanded uncertainty: 2dB.

Bluetooth BLE / Channel Low



Bluetooth BLE / Channel High



10 POWER DENSITY MEASUREMENT

10.1 Standard Applicable

According to 15.247(d), for direct sequence systems, the transmitted power density averaged over any 1 second interval shall not be greater than 8 dBm in any 3 kHz bandwidth within these bands.

10.2 Measurement Procedure

Measurement Method: PKPSD

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 5 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set EUT to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
3. Set analyzer center frequency to DTS channel center frequency.
4. Set the span to 1.5 times the DTS bandwidth.
5. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
6. Set the VBW ≥ 3 x RBW.
7. Detector = peak.
8. Sweep time = auto couple.
9. Trace mode = max hold.
10. Allow trace to fully stabilize.
11. Use the peak marker function to determine the maximum amplitude level within the RBW.
12. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
13. Repeat above procedures until all measured frequencies were complete.

10.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

10.4 Measurement Data

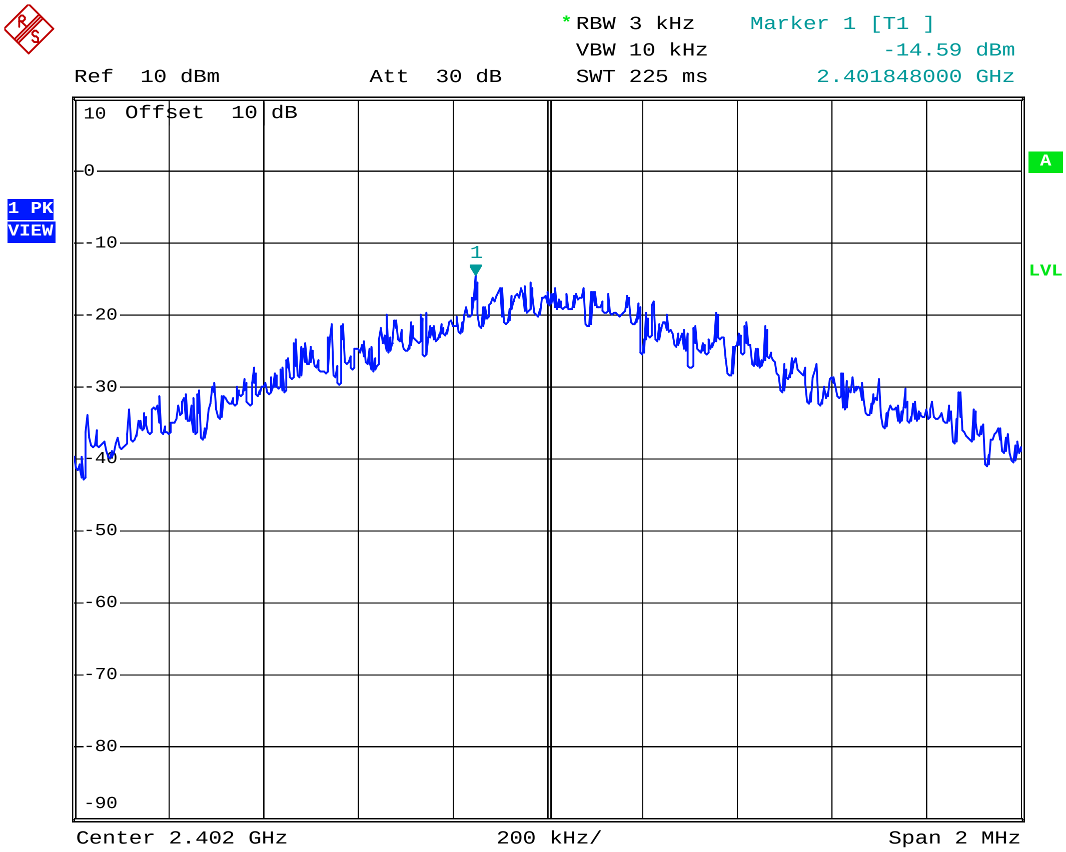
Test Date : Feb. 18, 2017 Temperature : 21 °C Humidity : 65 %

Mode: Bluetooth BLE

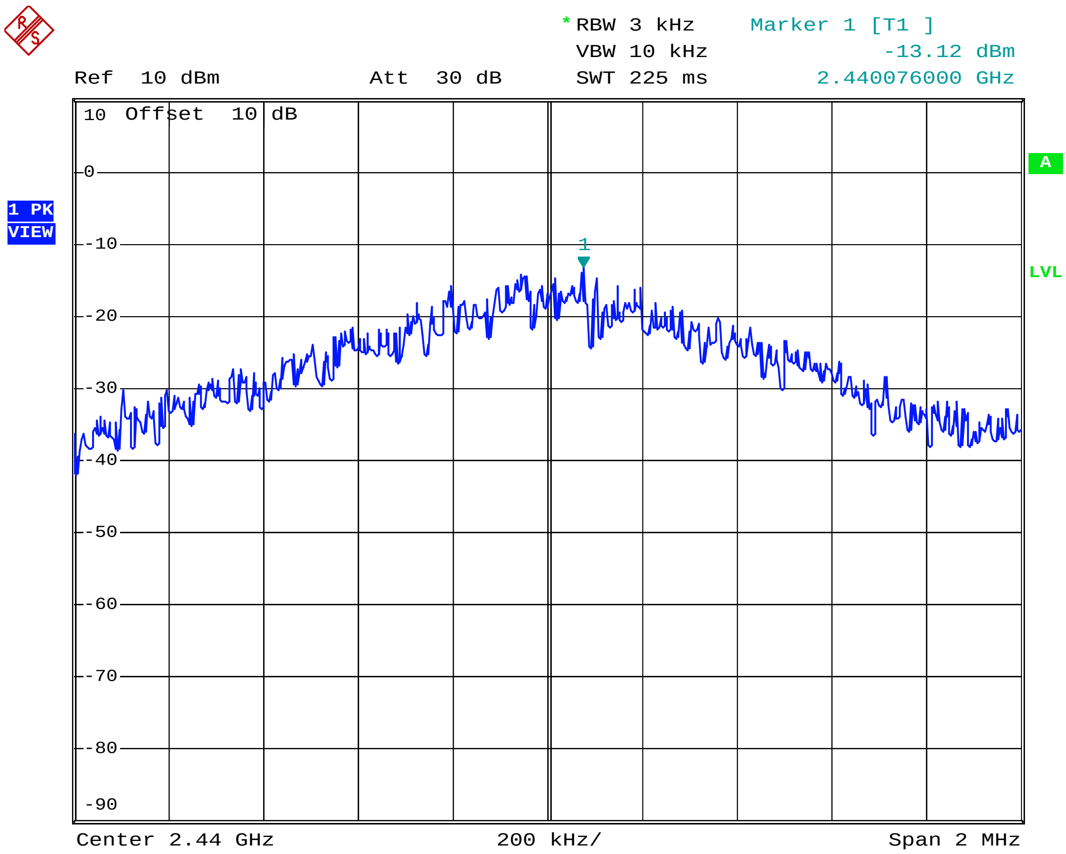
a) Channel Low: Maximun PSD is -14.59 dBm
b) Channel Mid: Maximun PSD is -13.12 dBm
c) Channel High: Maximun PSD is -13.15 dBm

Note : The expanded uncertainty: 2dB.

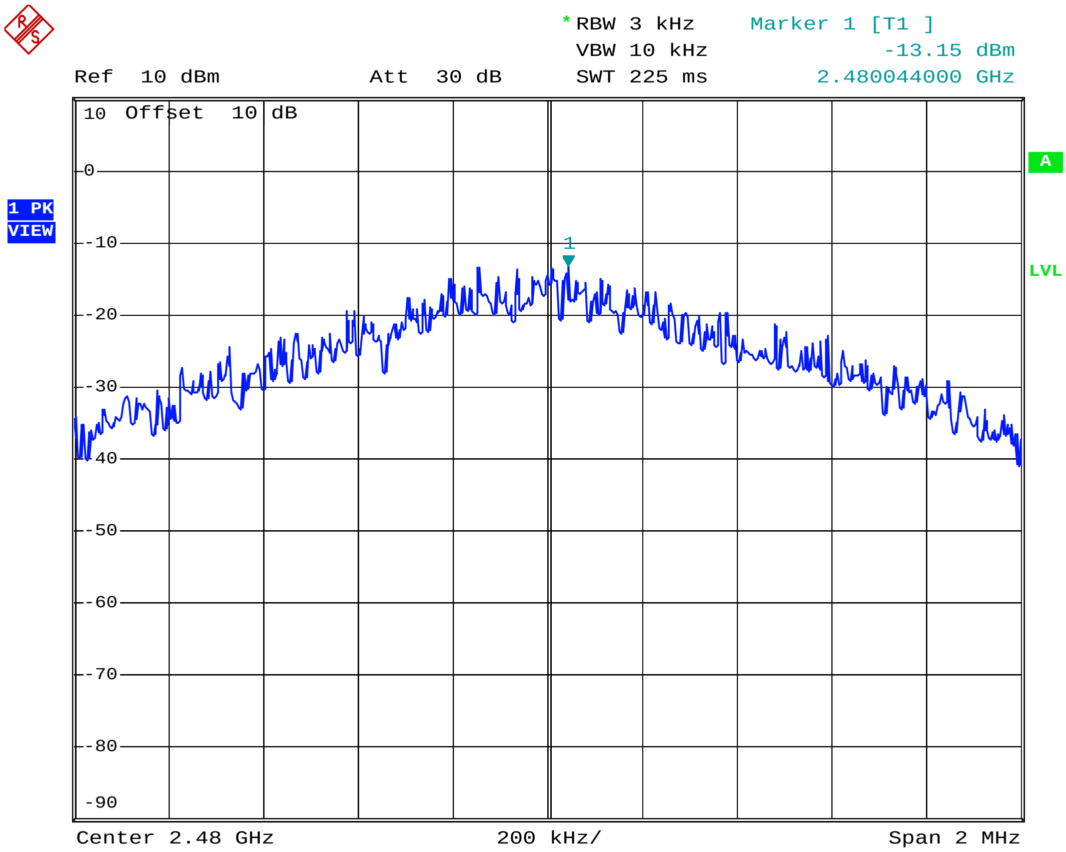
Bluetooth BLE / Channel Low



Bluetooth BLE / Channel Mid



Bluetooth BLE / Channel High



11. OUT-OF-BAND CONDUCTED EMISSION MEASUREMENT

11.1 Standard Applicable

According to 15.247(c), 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. Attenuation below the general limits specified in Section 15.209(a) is not required.

11.2 Measurement Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in figure 4 without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
3. Use the following spectrum analyzer settings:
   Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
   RBW = 100 kHz
   VBW ≥ RBW
   Sweep = auto
   Detector function = peak
   Trace = max hold.
4. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. Plot the result on the screen of spectrum analyzer.
5. Repeat above procedures until all measured frequencies were complete.

11.3 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

11.4 Measurement Data

Test Date : Feb. 18, 2017 Temperature : 21 °C Humidity : 65 %

A. Bluetooth BLE

Mode: Channel Low, Mid, High

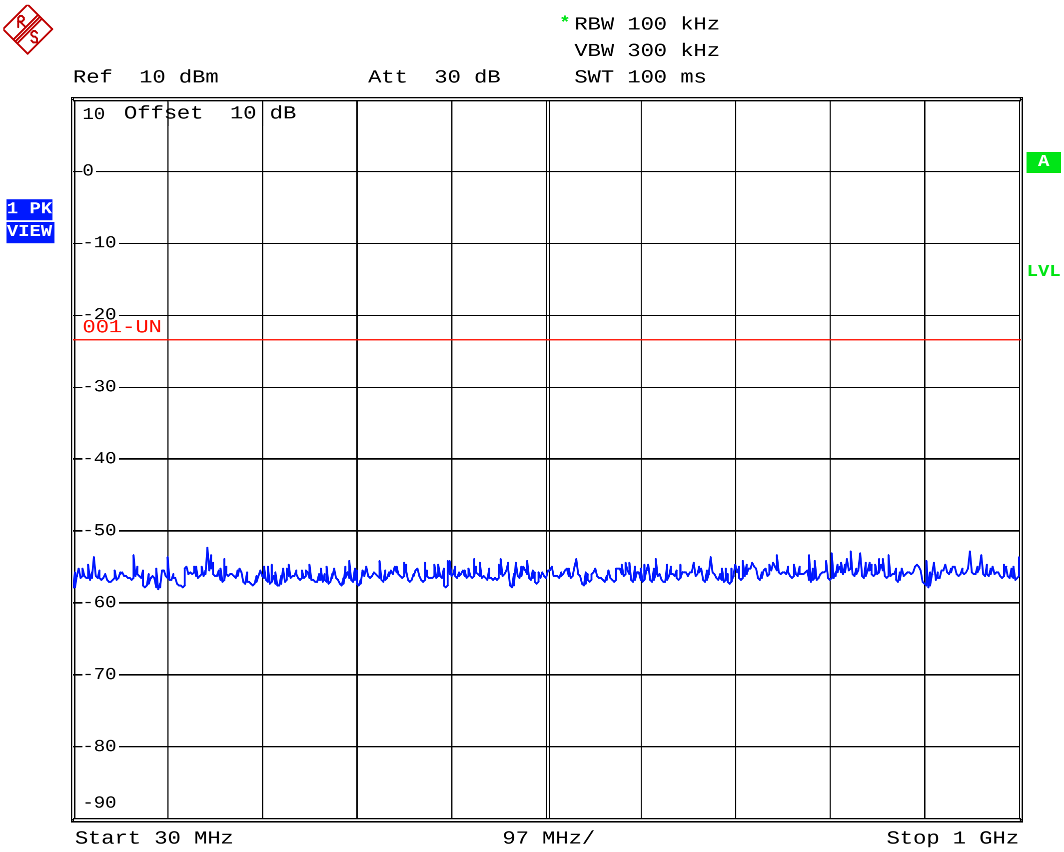
(a) 30 MHz to 1 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.

(b) 1 GHz to 26.5 GHz frequency band: All emissions are attenuated more than 20dB from the carrier.

Note : The expanded uncertainty: 2dB.

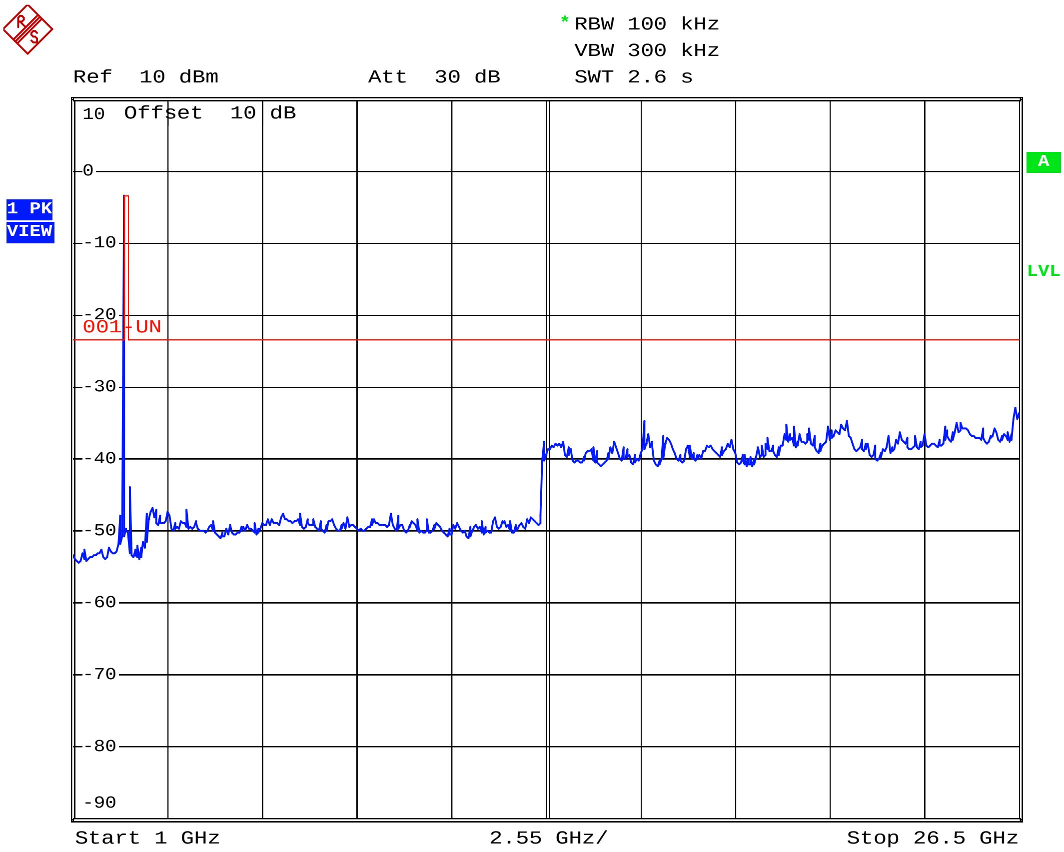
Bluetooth BLE

30 MHz to 1 GHz / Channel Low



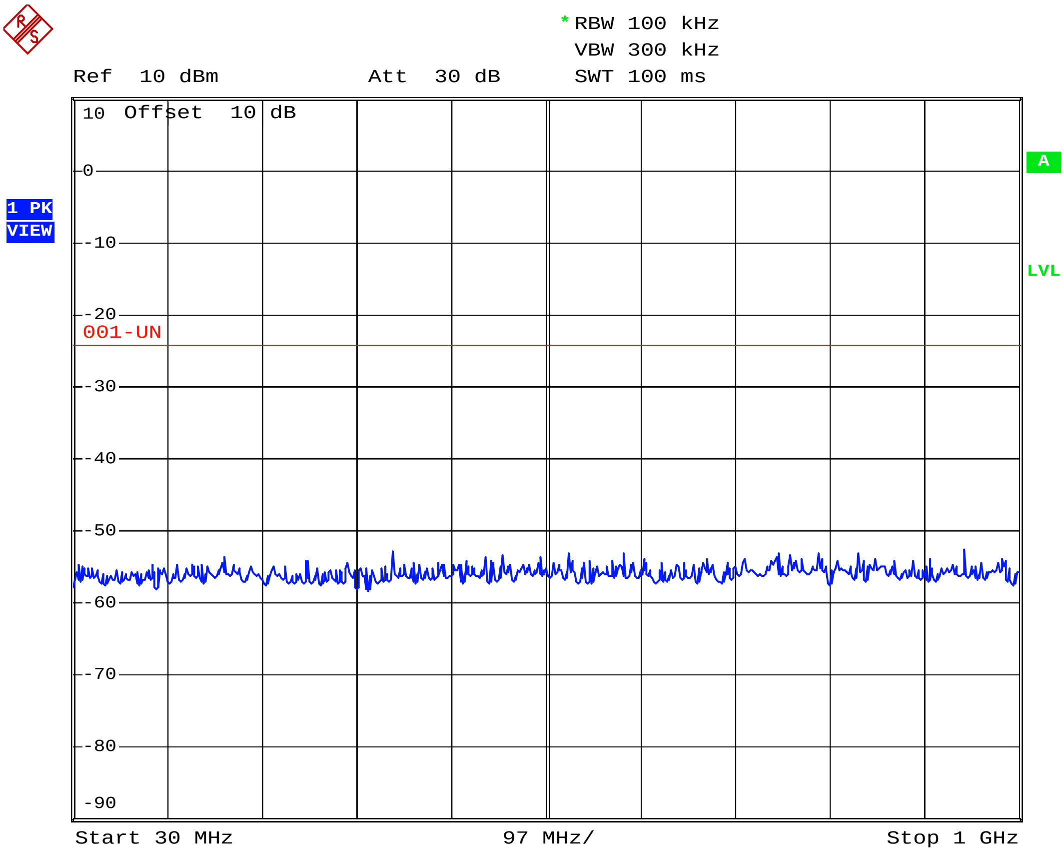
Bluetooth BLE

Above 1 GHz / Channel Low



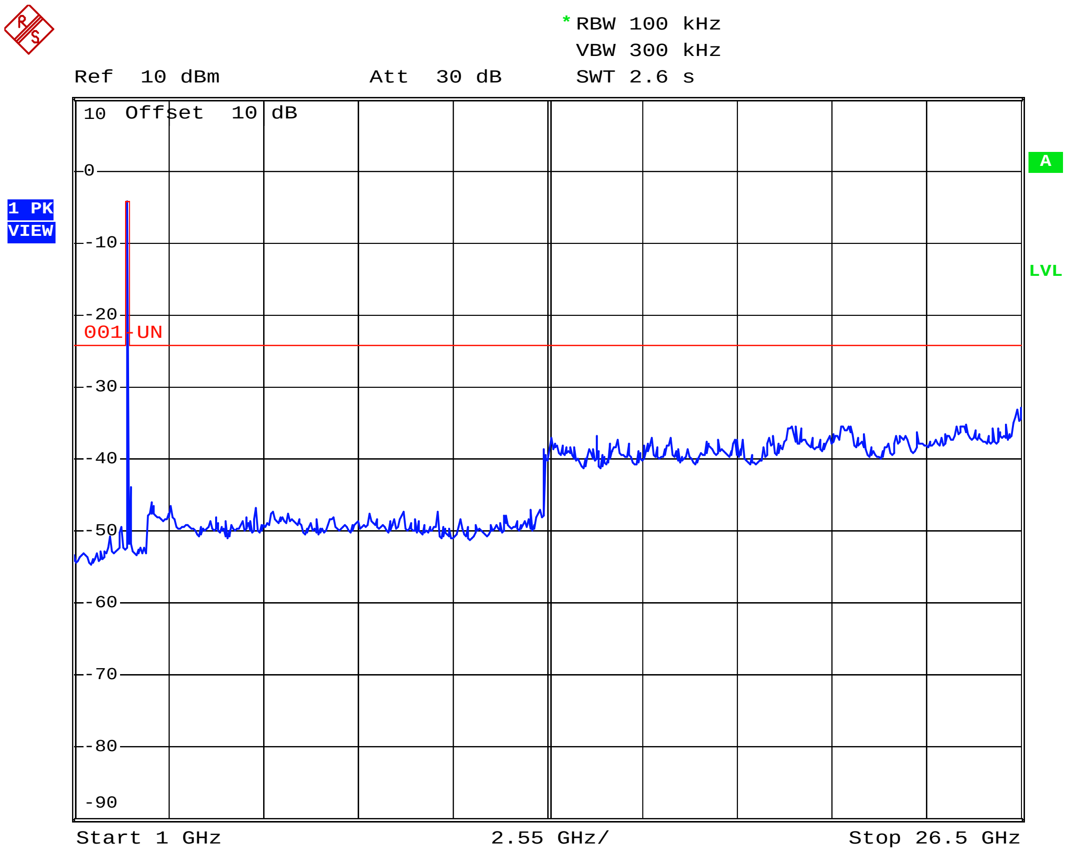
Bluetooth BLE

30 MHz to 1 GHz / Channel Mid



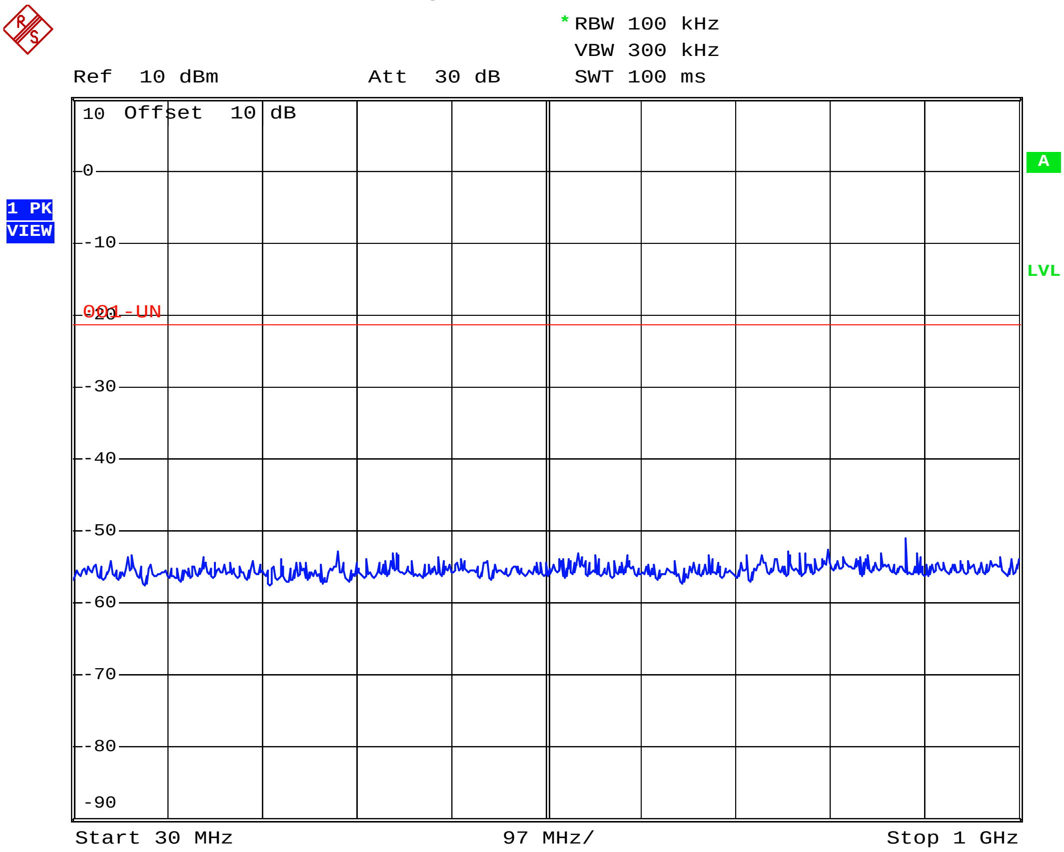
Bluetooth BLE

Above 1 GHz / Channel Mid



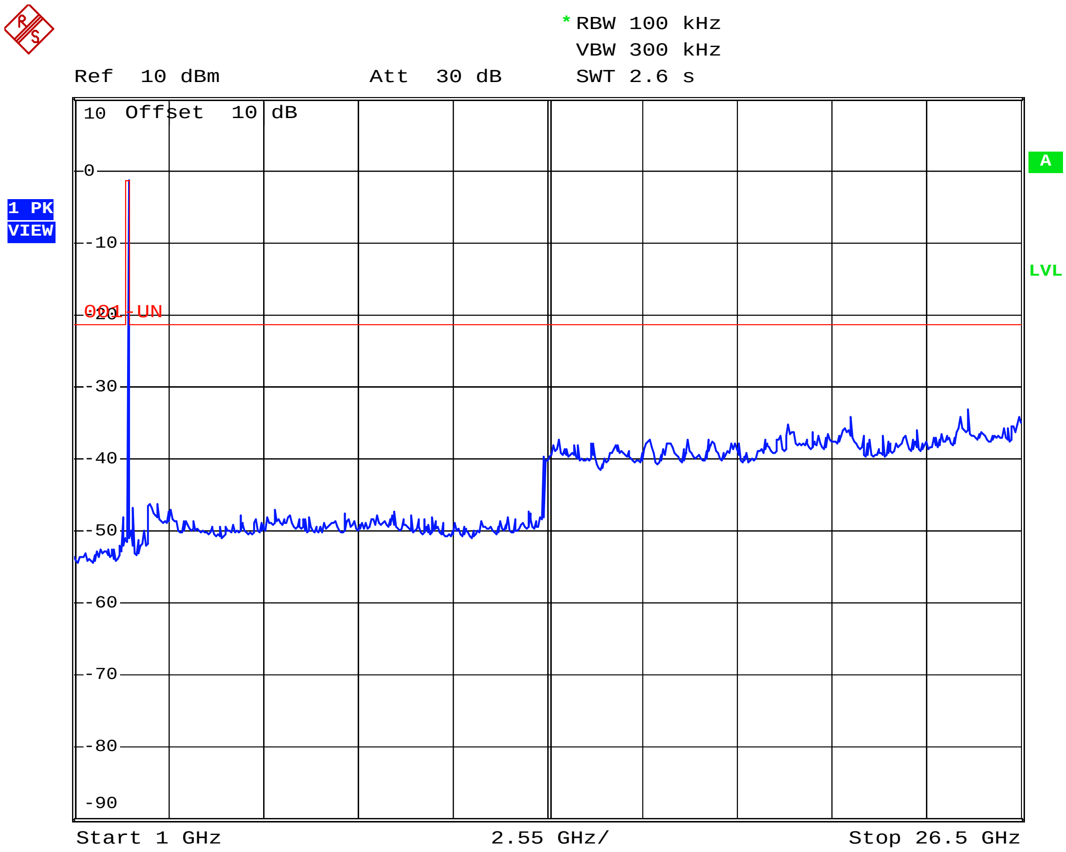
Bluetooth BLE

30 MHz to 1 GHz / Channel High



Bluetooth BLE

Above 1 GHz / Channel High



12. DYTY CYCLE

12.1 Standard Applicable

None. Referency only.

12.2 Measurement Equipment

Equipment	Manufacturer	Model No.	Calibration Date	Next Cal. Date
Spectrum Analyzer	Rohde & Schwarz	FSP40	2016/10/03	2017/10/02
Attenuator	MINI-CIRCUITS	BW-S10W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S20W2+	2016/09/30	2017/09/29
Attenuator	MINI-CIRCUITS	BW-S30W2+	2016/09/30	2017/09/29

12.3 Measurement Data

Test Date : Feb. 18, 2017 Temperature : 21 °C Humidity : 65 %

Duty Cycle Calculation

Period = 1.2ms
Transmission duration (T) = 1.1ms
Duty Cycle (%) = (1.1 / 1.2) * 100 % = 91.7 %

The duty cycle is less than 98%. For the average measurement of the radiated emission test, the VBW setting is >1/T where the T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

1/T = 1 / 1.1ms = 9.09kHz

Hense the VBW setting for the average measurement is 10kHz.

Refer to the following page for data plots..

Bluetooth BLE