Electromagnetic Emission

FCC MEASUREMENT REPORT

CERTIFICATION OF COMPLIANCE

FCC Part 15 Certification Measurement

PRODUCT	:	BLE Module
MODEL/Serial No.	:	BoT-nLE521 / Proto type
MULTIPLE MODEL	:	-
BRAND NAME	:	chipsen
FCC ID	:	2APB6-BOT-NLE521
APPLICANT	:	CHIPSEN. Co., Ltd B1 C-17,15, Gyeongin-ro 53-gil, Guro-gu, Seoul, South Korea Attn.: Jongwook Choi / Manager
MANUFACTURER	:	CHIPSEN. Co., Ltd B1 C-17,15, Gyeongin-ro 53-gil, Guro-gu, Seoul, South Korea
FACTORY	:	Dongwoo Electronic Co.,Ltd. 11-29, Gwaerang 6-gil, Jeongnan-myeon, Hwaseong-si, Gyeonggi-do, South Korea
EQUIPMENT CLASS	:	DTS (Part 15 Digital Transmission System)
TYPE OF MODULATION	:	FHSS (GFSK)
FREQUENCY CHANNEL	:	2 402 MHz to 2 480 MHz and Channel Spacing 2 MHz (40 Ch, BT 4.0 LE)
AIR DATE RATE	:	GFSK (1 Mbps)
ANTENNA TYPE	:	Chip Antenna (Integral)
ANTENNA GAIN	:	3.5 dBi max
RF POWER	:	1.36 mW
RULE PART(S)	:	FCC Part 15 Subpart C
FCC PROCEDURE	:	ANSI C63.10-2013
TEST REPORT No.	:	ETLT180307.0036
DATES OF TEST	:	March 21, 2018 to March 26, 2018
REPORT ISSUE DATE	:	April 03, 2018
TEST LABORATORY	:	ETL Inc. (FCC Designation Number : KR0022)

The BLE Module, Model BoT-nLE521 has been tested in accordance with the measurement procedures specified in ANSI C63.10-2013 at the ETL Test Laboratory and has been shown to be complied with the electromagnetic radiated emission limits specified in FCC Rule Part15 Subpart C section 15.247.
I attest to the accuracy of data. All measurement herein was performed by me or was made under my supervision and is correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.
The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Prepared by:
Seok Lyong, Choi (Test Engineer)
April 03, 2018

Reviewed by:
Kug Kyoung, Yoon (Chief Engineer)
April 03, 2018

ETL Inc.
Head office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea
Tel: 82-2-858-0786 Fax: 82-2-858-0788

Table of Contents

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

FCC MEASUREMENT REPORT

Scope – *Measurement and determination of electromagnetic emission (EME) of radio frequency devices including intentional radiators and/or unintentional radiators for compliance with the technical rules and regulations of the U.S Federal Communications Commission(FCC)*

General Information

Applicant Name	**: CHIPSEN. Co., Ltd**
Address	**: B1 C-17,15, Gyeongin-ro 53-gil, Guro-gu, Seoul, South Korea**
Attention	**: Jongwook Choi / Manager**

- **EUT Type** : BLE Module
- **Model Number** : BoT-nLE521
- **S/N** : Proto type
- **Modulation Technique** : FHSS (GFSK)
- **Frequency Channel** : 2 402 MHz to 2 480 MHz and Channel Spacing 2 MHz (40 Ch, BT 4.0 LE)
- **Air Data Rate** : GFSK (1 Mbps)
- **Antenna Type** : Chip Antenna (Integral)
- **Antenna Gain** : 3.5 dBi max
- **RF Power** : 1.36 mW
- **Environmental of Tests** : Temperature: (14.2 ± 10.9) °C
  Humidity: (58 ± 20) % R.H.
  Atmospheric Pressure: (102.1 ± 0.7) kPa
- **FCC Rule Part(s)** : FCC Part 15 Subpart C
- **Test Procedure** : ANSI C63.10-2013
- **EQUIPMENT CLASS** : DTS (Part 15 Digital Transmission System)
- **Place of Tests** : ETL Inc. Testing Lab. (FCC Designation Number : KR0022)

  Radiated Emission test 1;
  #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si,
  Gyeonggi-do, 445-882, Korea

  Radiated Emission test 2 and Conducted Emission test;
  #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

1. INTRODUCTION

The measurement test for radiated and conducted emission test was conducted at the ETL Inc. The site is constructed in conformance with the requirements of the ANSI C63.10-2013 and CISPR Publication 16. The ETL has site descriptions on file with the FCC for 3 m and 10 m site configurations. Detailed description of test facility was found to be in compliance with FCC Rules according to the ANSI C63.10-2013 and registered to the Federal Communications Commission (FCC Designation Number : KR0022).

The measurement procedure described in American National Standard for Method of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.10-2013) was used in determining radiated and conducted emissions from the CHIPSEN. Co., Ltd
Model: BoT-nLE521

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

2. PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the BLE Module (model: BoT-nLE521).

2.2 General Specification

Specification
Built in Antenna Bluetooth Smart (Bluetooth Low Energy) Module.
ARM® Cortex®-M4 32-bit processor with FPU, 64 MHz
Memory: 192 KB Flash / 24 KB RAM
Fully automatic LDO and DC/DC regulator system (Used LDO by Default)
Temperature Sensor
UART (CTS/RTS) with EasyDMA, SPI, and I2C data interfaces.
12-Bit 200 kbps ADC with - 8 configurable channels with programmable gain
Size: 15 mm x 8 mm x 1.8 mm
Operating Voltage: 1.7 V to 3.6 V
Operating Temperature: -40 °C to +85 °C
RoHS compliant
High Internal Frequency: X-tal → 32 MHz

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

3. DESCRIPTION OF TESTS

The tests documented in this report were performed in accordance with ANSI C63.10-2013 and FCC CFR 47 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057, 15.207, 15.209 and 15.247.

3.1 Radiated Emission Measurement

Radiated emission measurements were made in accordance with § 13 in ANSI C63.10-2013 "Measurement of Intentional radiators" The measurements were performed over the frequency range of 30 MHz to 40 GHz using antenna as the input transducer to a Spectrum analyzer or a Field Intensity Meter. The measurements were made with the detector set for "Peak, Quasi-peak, Average" within a bandwidth of 120 kHz and above 1 GHz is 1 MHz.

Preliminary measurements were made at 3 m using broadband antennas, and spectrum analyzer to determine the frequency producing the maximum emission in shielded room. Appropriate precaution was taken to ensure that all emission from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth and height with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 MHz to 1 000 MHz using Log-Bicon antenna. Above 1 GHz, linearly polarized double ridge horn antennas were used. Final measurements were made open site or SVSWR chamber at 3 m. The test equipment was placed on a styrofoam table. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. Each frequency found during pre-scan measurements was re-examined by manual. The EUT, support equipment and interconnecting cables were re-configured to the set-up producing the maximum emission for the frequency and were placed on top of a table height for below 1GHz is 0.8 m, and for above 1GHz is 1.5 m. nonmetallic 1.0 m x 1.5 m table. The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each emission. The turntable containing the system was rotated; the antenna height was varied 1 m to 4 m and stopped at the azimuth or height producing the maximum emission.

Varying the mode of operating frequencies of the EUT maximized each emission. The system was tested in all the three orthogonal planes and changing the polarity of the antenna. The worst-case emissions are recorded in the data tables. If necessary, the radiated emission measurement could be performed at a closer distance to ensure higher accuracy and the results were extrapolated to the specified distance using an inverse linear distance extrapolation factor (20 dB/decade) as per section 15.31(f).

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

3.2 Conducted Emission Measurement

Conducted emissions measurements were made in accordance with section § 13 in ANSI C63.10-2013 "measurement of intentional radiators" The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to a Spectrum Analyzer or a Test Receiver. The measurements were made with the detector set for "Peak" amplitude within a bandwidth of 9 kHz or for "quasi-peak" within a bandwidth of 9 kHz.

The line-conducted emission test is conducted inside a shielded anechoic chamber room with 1 m x 1.5 m x 0.8 m wooden table which is placed 0.4 m away from the vertical wall and 1.5 m away from the side wall of the chamber room. Two LISN are bonded to the shielded room. The EUT is powered from the LISN and the support equipment is powered from the other LISN. Power to the LISNs are filtered by a noise cut power line filters. All electrical cables are shielded by braided tinned steel tubing with inner ϕ 1.2 cm. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and these supply lines will be connected to the LISN. Non-inductive bundling to a 1 m length shortened all interconnecting cables more than 1 m. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the EMI Test Receiver to determine the frequency producing the maximum emission from the EUT. The frequency producing the maximum level was reexamined using to set Quasi-Peak mode by manual, after scanned by automatic Peak mode from 0.15 MHz to 30 MHz. The bandwidth of the spectrum analyzer was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission.

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

3.3 FCC Part 15.205 Restricted Bands of Operations

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110 [1]0.495 - 0.505 2.173 5 - 2.190 5 4.125 - 4.128 4.177 25 - 4.177 75 4.207 25 - 4.207 75 6.215 - 6.218 6.267 75 - 6.268 25 6.311 75 - 6.312 25 8.291 - 8.294 8.362 - 8.366 8.376 25 - 8.386 75 8.414 25 - 8.414 75 12.29 - 12.293 12.519 75 - 12.520 25 12.576 75 - 12.577 25 13.36 - 13.41	16.42 - 16.423 16.694 75 - 16.695 25 16.804 25 - 16.804 75 25.5 - 25.67 37.5 - 38.25 73 - 74.6 74.8 - 75.2 108 - 121.94 123 - 138 149.9 - 150.05 156.524 75 - 156.525 25 156.7 - 156.9 162.012 5 - 167.17 167.72 - 173.2 240 - 285 322 - 335.4	399.9 - 410 608 - 614 960 - 1 240 1 300 - 1 427 1 435 - 1 626.5 1 645.5 - 1 646.5 1 660 - 1 710 1 718.8 - 1 722.2 2 200 - 2 300 2 310 - 2 390 2 483.5 - 2 500 2 690 - 2 900 3 260 - 3 267 3 332 - 3 339 3 345.8 - 3 358 3 600 - 4 400	4.5 - 5.15 5.35 - 5.46 7.25 - 7.75 8.025 - 8.5 9.0 - 9.2 9.3 - 9.5 10.6 - 12.7 13.25 - 13.4 14.47 - 14.5 15.35 - 16.2 17.7 - 21.4 22.01 - 23.12 23.6 - 24.0 31.2 - 31.8 36.43 - 36.5 ([2])

[1] Until February 1, 1999, this restricted band shall be 0.490 MHz - 0.510 MHz.
[2] Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1 000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

3.4 Antenna connection requirement

(1) 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

4. TEST CONDITION

4.1 Test Configuration

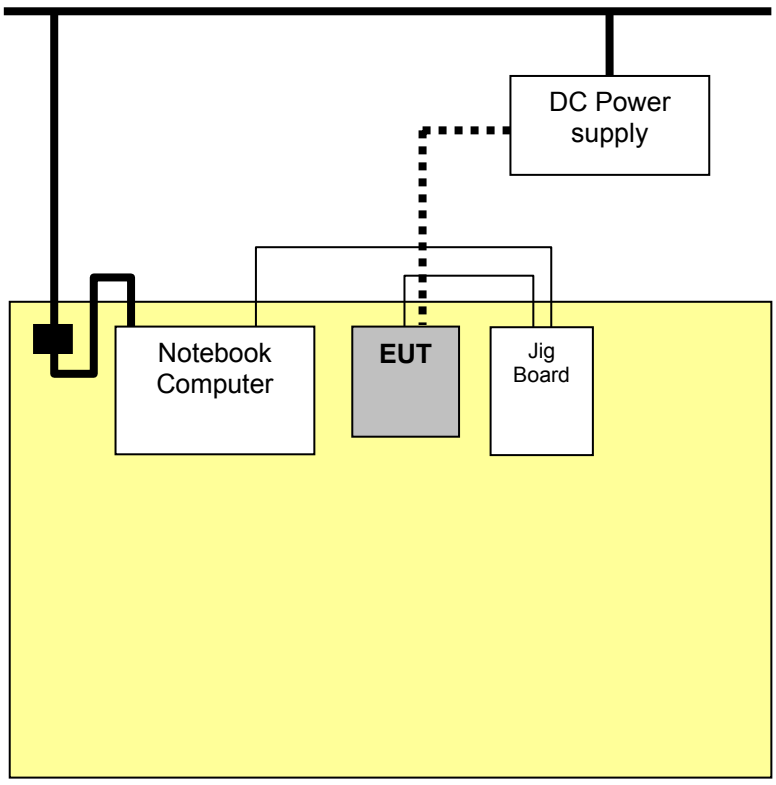
The device was configured for testing in a typical fashion (as a customer would normally use it). During the tests, the following conditions and configurations were used.

* This test was applied to X, Y, Z. and the worst result were investigated and reported.

4.2 Description of Test modes

BLE Module that has the control software.

4.3 The setup drawing(s)



: Signal Line
: Power Line
: Adapter
: DC Line

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

4.4 Support Equipment Used

Description	Model Name	Serial No.	Manufacturer
Notebook Computer	CQ35	CND9322TYH	HEWLET-PACKARD COMPANY
Adapter (for Notebook Computer)	PPP009C	F220881413024952	CHICONY POWER TECHNOLOGY (Chong Qlng) CO., LTD.
DC POWER SUPPLY	DP30-03A	16110016	TOYO TECH

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5. TEST RESULTS

5.1 Summary of Test Results

The measurement results were obtained with the EUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum emission of the EUT are reported.

47 CFR Part 15, Subpart C	Measurement Required	Result
15.247(a)(2)	6 dB Bandwidth	**Pass**
15.247(b)(3)	Maximum Peak Output Power	**Pass**
15.247(d)	Bandwidth of Frequency Band Edges	**Pass**
15.247(e)	Power Spectral Density	**Pass**
15.209(a)	Spurious Emissions	**Pass**
15.207	Conducted Emissions	**Pass ***
15.203	Antenna connection requirement	Integral antenna which is permanently attached and cannot be replaced.
1.1307(b)(1)	RF Exposure	**Pass**

***** This test was tested at DC Power Supply (EUT was connected DC Power Supply).

The data collected shows that the **CHIPSEN. Co., Ltd / BLE Module / BoT-nLE521** complied with technical requirements of above rules part 15.207, 209 and 15.247 Limits.

The equipment is not modified anything, mechanical or circuits to improve EMI status during a measurement. No EMI suppression device(s) was added and/or modified during testing.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.2 6 dB Bandwidth

EUT	BLE Module / BoT-nLE521
Limit apply to	FCC Part 15.247(a)(2)
Test Date	March 21, 2018
Environmental of Test	(23.0 ± 0.0) °C, (47 ± 0) % R.H., (101.6 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

Limit

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

Test Data

Frequency [MHz]	6 dB Bandwidth [kHz]	Limit
2 402	0.697	> 500 kHz
2 440	0.693	
2 480	0.699	

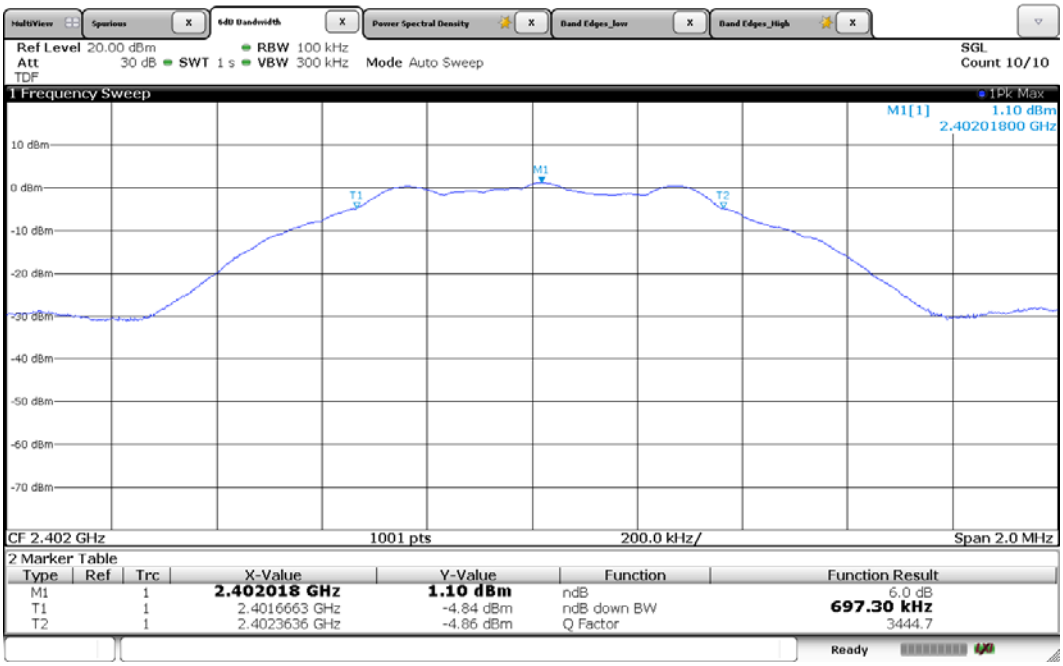
NOTES:

1. Measure frequency separation of relevant channel using spectrum analyzer.
2. RBW 100 kHz, VBW 300 kHz, Sweep 1s.
3. Please see the measured plot in next page.

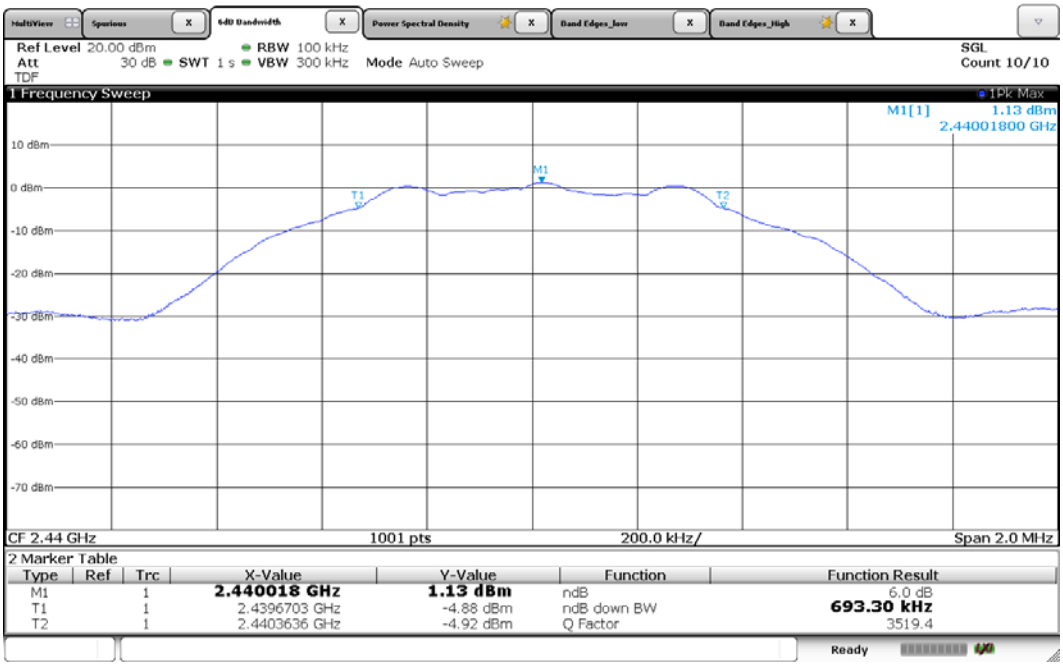
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of 6 dB Bandwidth

[2 402 MHz]

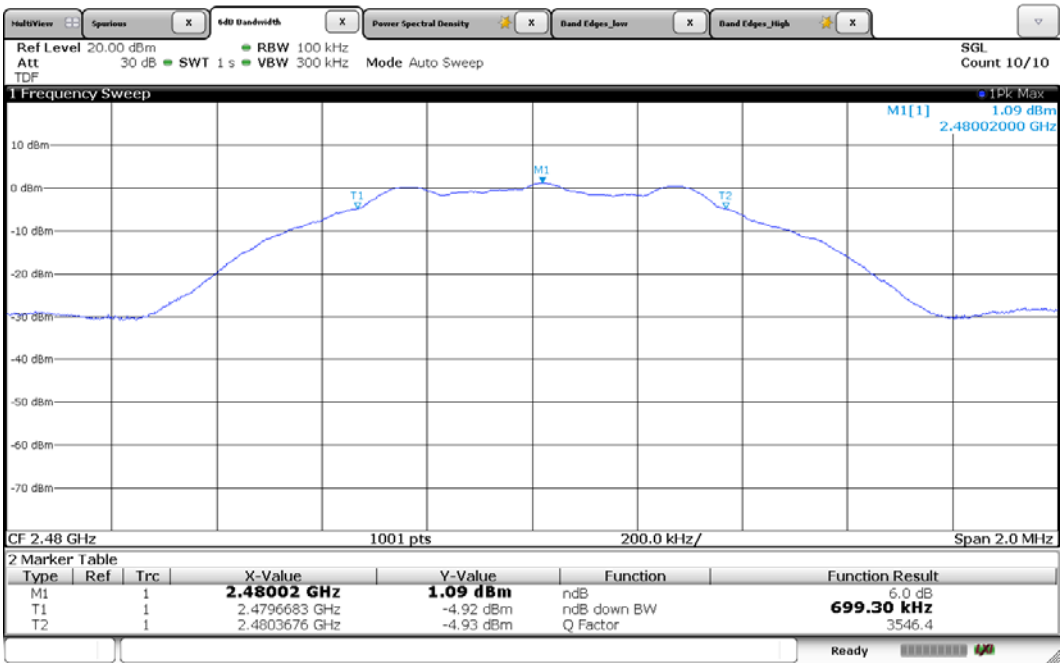


[2 440 MHz]



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

[2 480 MHz]



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.3 Maximum Peak Conducted Output Power

EUT	BLE Module / BoT-nLE521
Limit apply to	FCC Part 15.247(b)(3)
Test Date	March 21, 2018
Environmental of Test	(23.2 ± 0.0) °C, (47 ± 0) % R.H., (101.6 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

Limit

The maximum peak conducted output power of the intentional radiator shall not exceed the following:

For frequency hopping systems operating in the 2 400.0 MHz - 2 483.5 MHz band: 1 Watt

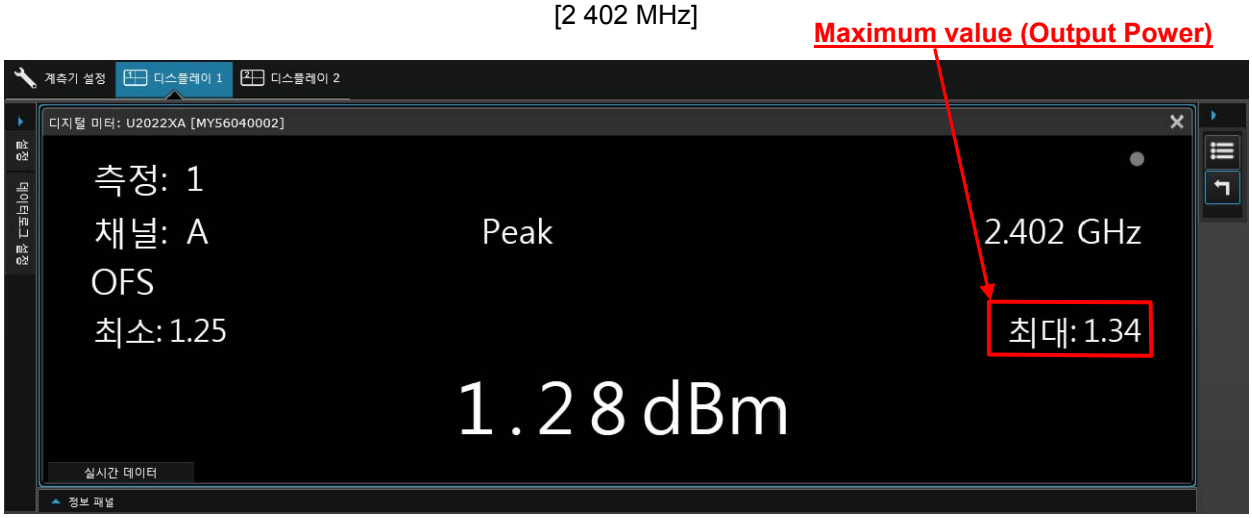
Test Data

Frequency [MHz]	Output Power [dBm]	Limit
2 402	1.34	< 30.00 dBm (1 W)
2 440	1.33	
2 480	1.33	

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of Output Power

[2 402 MHz]



[2 440 MHz]

[2 480 MHz]

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.4 Bandwidth of Frequency Band Edges

EUT	BLE Module / BoT-nLE521
Limit apply to	FCC Part 15.247(d)
Test Date	March 22, 2018
Environmental of Test	(23.3 ± 1.8) °C, (42 ± 3) % R.H., (101.4 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

Limit

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

Test Results

- Refer to see the measured plot in next page.

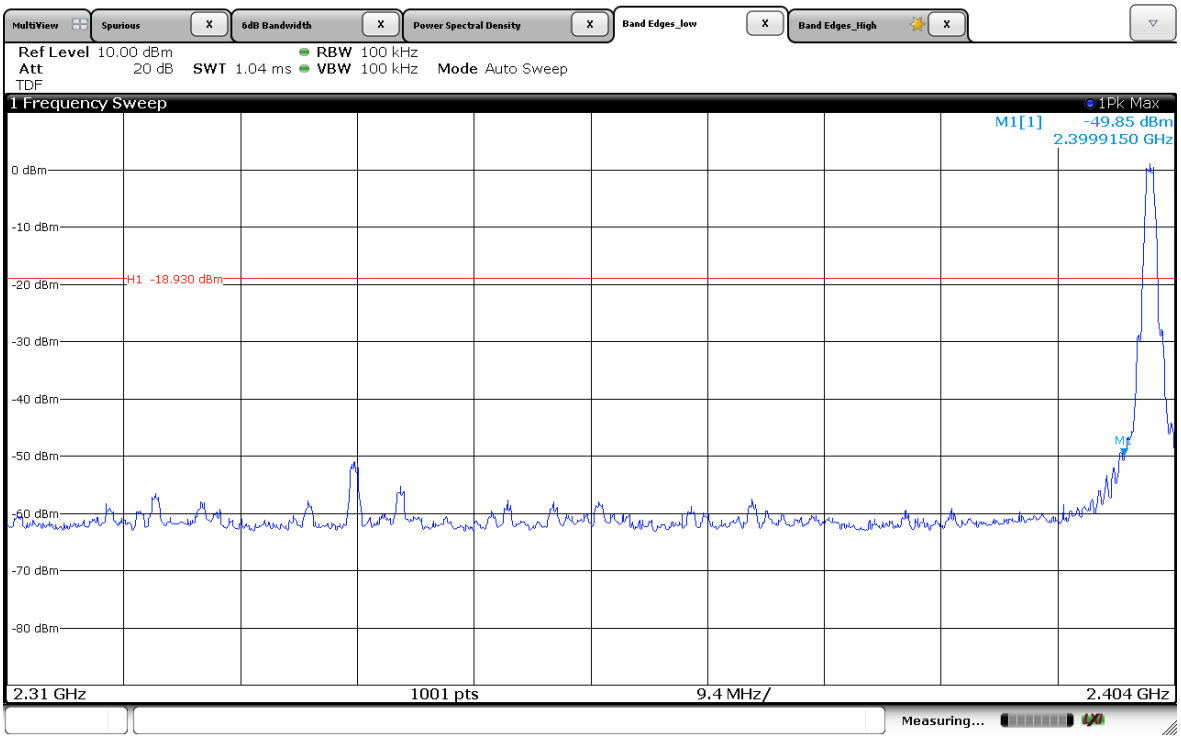
NOTES:

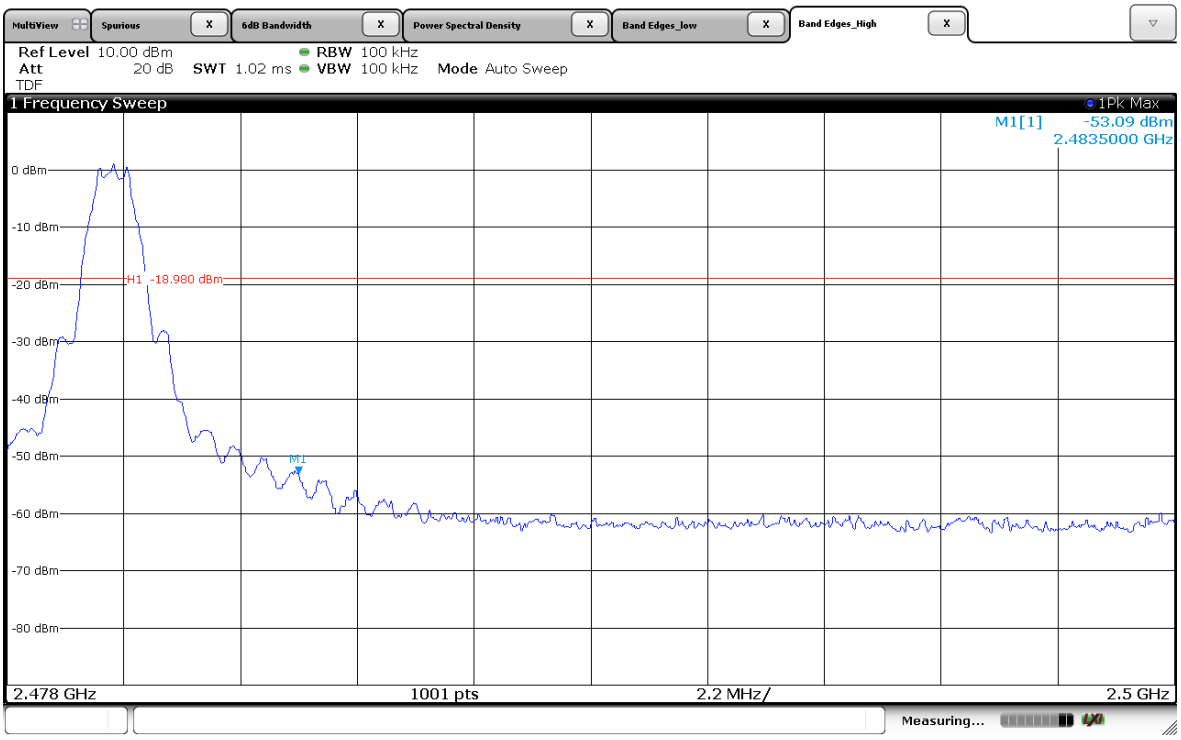
1. The test was performed to make a direct field strength measurement at the band edge frequencies.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of Bandwidth of Frequency Band Edges

Conducted





Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

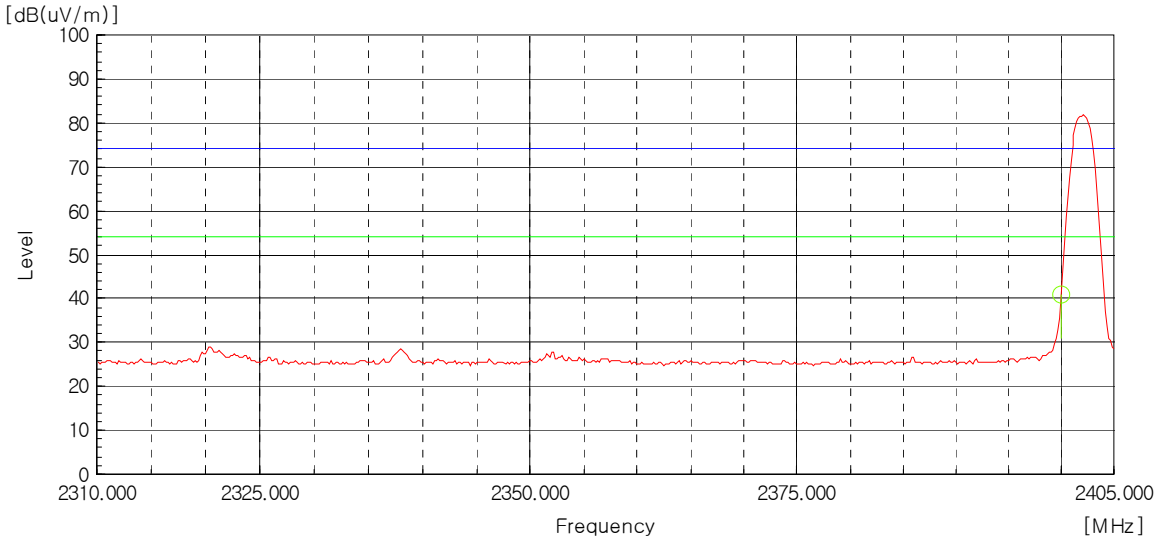
Radiated

Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 310 MHz - 2 390 MHz), Worst case (Low, Vertical)

Peak Limit Line
AV Limit Line

AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 310 MHz - 2 390 MHz), Worst case (Low, Vertical)

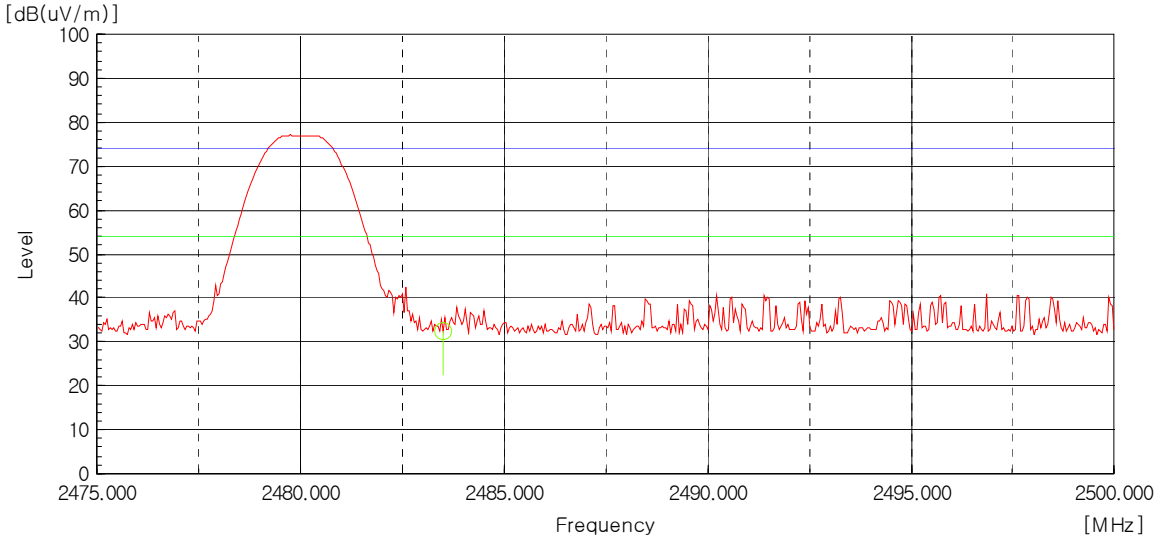
Peak Limit Line
AV Limit Line



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

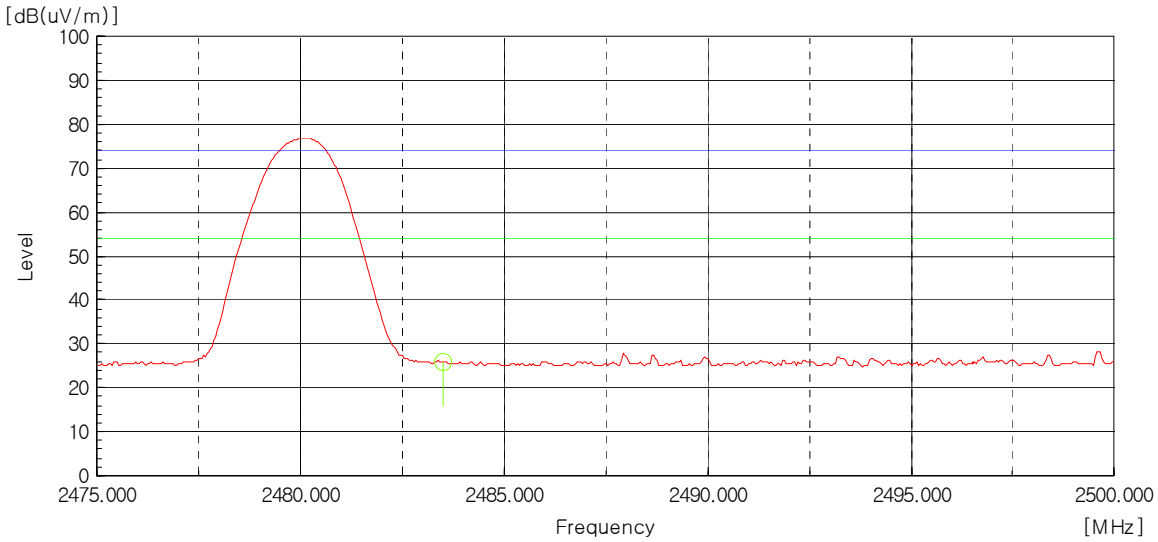
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 483.5 MHz - 2 500 MHz), Worst case (High, Vertical)

Peak Limit Line
AV Limit Line



AV Detector: RBW: 1 MHz, VBW: 10 Hz (2 483.5 MHz - 2 500 MHz), Worst case (High, Vertical)

Peak Limit Line
AV Limit Line



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.5 Power Spectral Density

EUT	BLE Module / BoT-nLE521
Limit apply to	FCC Part 15.247(e)
Test Date	March 21, 2018
Environmental of Test	(23.2 ± 0.0) °C, (46 ± 0) % R.H., (101.6 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Data

Frequency [MHz]	PSD [dBm]	Limit
2 402	-14.29	8.00 dBm
2 440	-14.32	
2 480	-14.40	

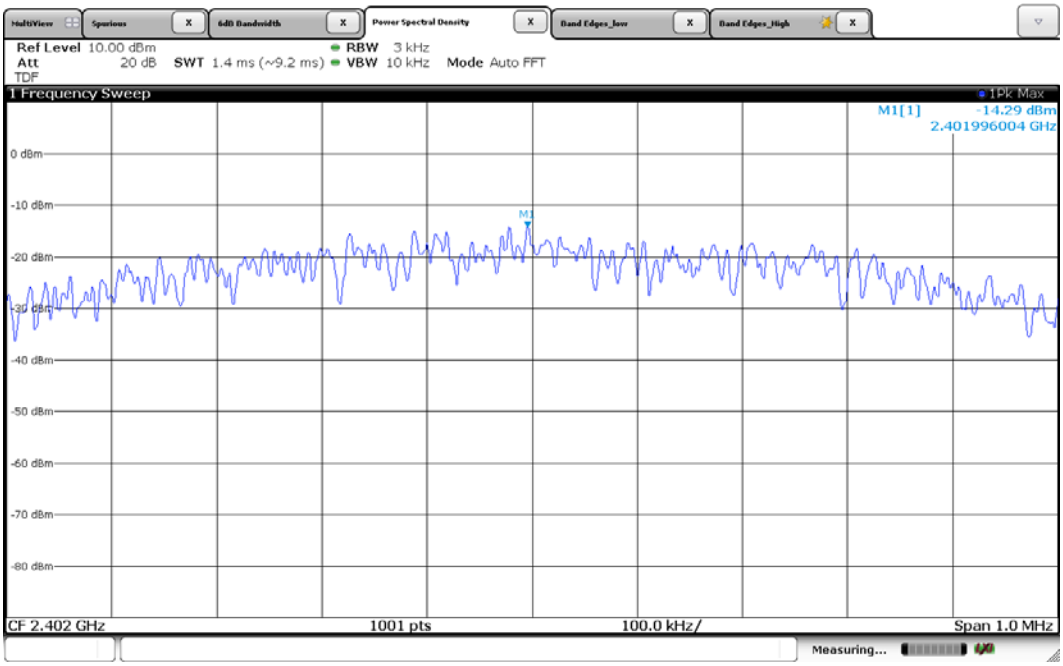
NOTES:

1. Measure power spectral density of relevant channel using spectrum analyzer.
2. RBW 3 kHz, VBW 10 kHz, span(=6 dB bandwidth x 1.5), Sweep time (= auto couple).
3. Please see the measured plot in next page.

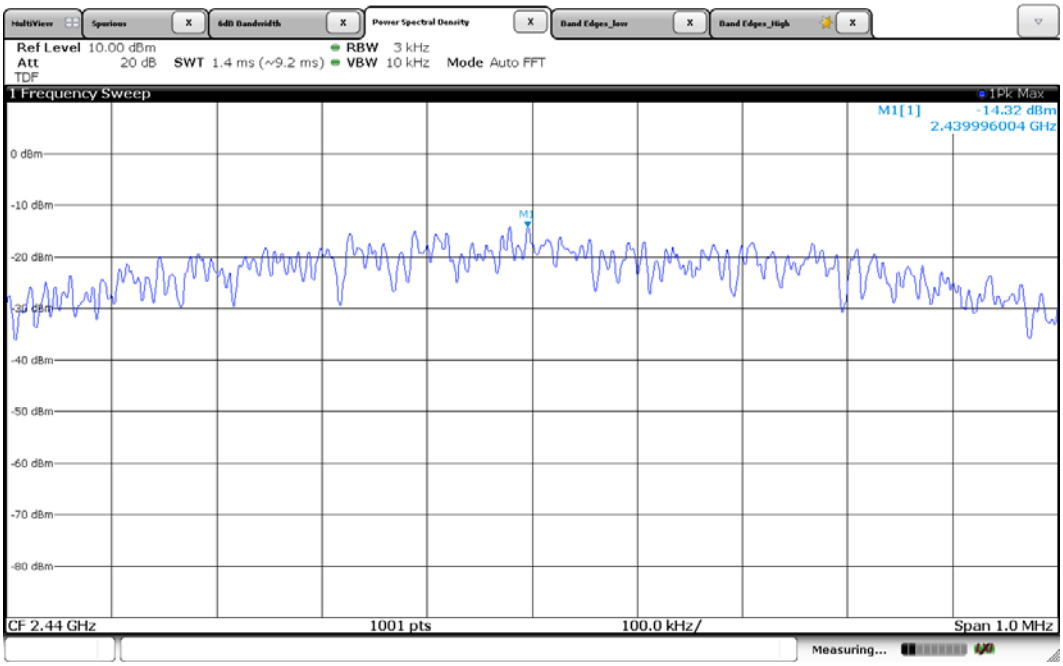
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Plots of Power Spectral Density

[2 402 MHz]

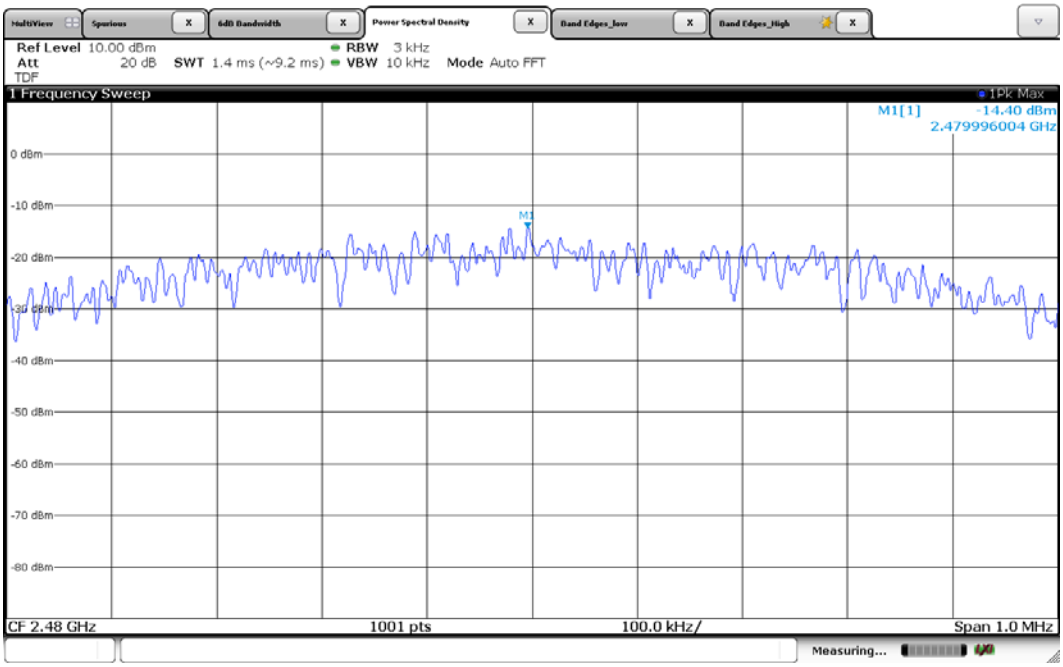


[2 440 MHz]



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

[2 480 MHz]



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.6 Spurious Emissions

EUT	BLE Module / BoT-nLE521
Limit apply to	FCC Part 15.209
Operating Condition	Low CH, Middle CH, High CH Transmission
Result	Passed

Limit

Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequencies [MHz]	Field Strength [μV/m]	Measurement Distance [m]
0.009 - 0.490	2 400/F(kHz)	300
0.490 - 1.705	24 000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

* Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 MHz - 72 MHz, 76 MHz - 88 MHz, 174 MHz - 216 MHz or 470 MHz - 806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

Test Results

- Refer to see the measured plot in next page.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Radiated Emissions Test data

- 9 kHz to 1 GHz

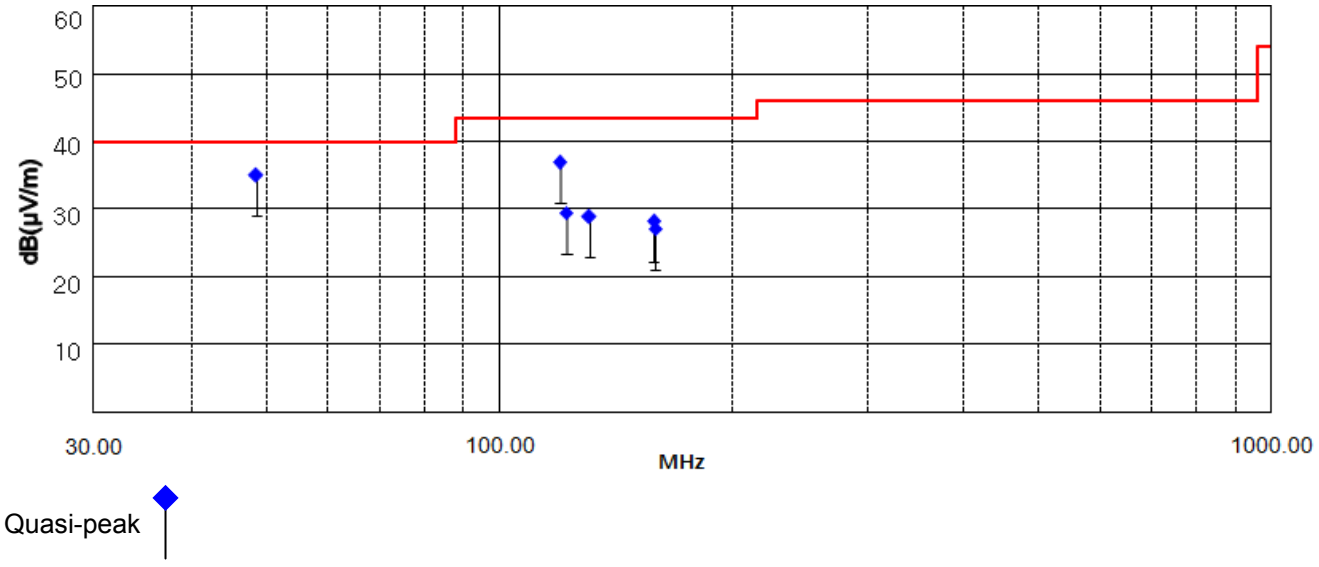
Test Date	March 26, 2018
Environmental of Test	(5.7 ± 2.4) °C, (69 ± 5) % R.H., (102.5 ± 0.1) kPa

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.
Detector mode: CISPR Quasi-Peak mode (100 Hz, 9 kHz) (6 dB Bandwidth: 120 kHz)

Frequency [MHz]	Reading [dB(μV)]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB(μV)]	Height [cm]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
48.55	54.31	V	13.22	-32.50	100	35.03	40.00	4.97
120.06	59.77	V	9.28	-32.11	106	36.94	43.50	6.56
122.44	52.54	V	9.09	-32.09	107	29.54	43.50	13.96
131.17	52.55	V	8.39	-32.00	107	28.94	43.50	14.56
158.74	51.73	V	8.27	-31.75	109	28.25	43.50	15.25
159.48	50.56	V	8.29	-31.74	109	27.11	43.50	16.39

NOTES:

1. * H : Horizontal polarization, ** V : Vertical polarization
2. The cable loss value was included the Amp. Gain.
3. Result = Reading + Antenna factor + Cable loss
4. Margin = Limit - Result
5. The measurement was performed for the frequency range above 9 kHz according to FCC Part 15.209.



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

- Above 1 GHz (1 GHz to 25 GHz)

Test Date	March 26, 2018
Environmental of Test	(7.9 ± 3.8) °C, (72 ± 6) % R.H., (102.6 ± 0.1) kPa

1. Low CH (2 402 MHz)

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable - AMP Loss [dB]	Height [cm]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average					Peak	Average	Peak	Average	Peak	Average
1 196.46	68.71	56.88	H	24.97	-49.56	150	44.12	32.29	73.97	53.97	29.85	21.68
5 291.42	50.35	37.21	V	31.68	-43.91	150	38.12	24.98	73.97	53.97	35.85	28.99
11 154.63	45.44	32.28	H	40.54	-38.48	150	47.50	34.34	73.97	53.97	26.47	19.63
13 774.32	43.78	30.74	V	42.03	-36.47	150	49.34	36.30	73.97	53.97	24.63	17.67
19 727.61	41.84	29.05	V	37.51	-31.87	150	47.48	34.69	73.97	53.97	26.49	19.28
21 374.24	42.86	29.85	V	37.81	-30.68	150	49.99	36.98	73.97	53.97	23.98	16.99

2. Middle CH (2 440 MHz)

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable - AMP Loss [dB]	Height [cm]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average					Peak	Average	Peak	Average	Peak	Average
1 199.51	69.72	56.64	H	24.97	-49.55	150	45.14	32.06	73.97	53.97	28.83	21.91
5 291.51	50.34	37.21	V	31.68	-43.91	150	38.11	24.98	73.97	53.97	35.86	28.99
10 869.24	45.48	32.26	V	40.58	-38.45	150	47.61	34.39	73.97	53.97	26.36	19.58
14 411.79	44.23	30.78	V	42.39	-35.90	150	50.72	37.27	73.97	53.97	23.25	16.70
19 078.38	42.28	29.24	V	37.54	-32.29	150	47.53	34.49	73.97	53.97	26.44	19.48
23 194.31	42.81	29.94	H	38.06	-29.43	150	51.44	38.57	73.97	53.97	22.53	15.40

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

3. High CH (2 480 MHz)

Frequency [MHz]	Reading [dB(μV)]		Polarity (*H/**V)	Ant. Factor [dB/m]	Cable - AMP Loss [dB]	Height [cm]	Result [dB(μV/m)]		Limit [dB(μV/m)]		Margin [dB]	
	Peak	Average					Peak	Average	Peak	Average	Peak	Average
1 120.37	68.84	56.70	H	24.88	-49.78	150	43.94	31.80	73.97	53.97	30.03	22.17
5 291.77	50.26	37.36	H	31.68	-43.91	150	38.03	25.13	73.97	53.97	35.94	28.84
10 742.46	45.44	32.22	V	40.39	-38.54	150	47.29	34.07	73.97	53.97	26.68	19.90
14 396.25	44.19	30.75	V	42.37	-35.92	150	50.64	37.20	73.97	53.97	23.33	16.77
21 159.44	42.86	29.74	V	37.70	-30.79	150	49.77	36.65	73.97	53.97	24.20	17.32
21 411.58	42.92	29.86	V	37.83	-30.66	150	50.09	37.03	73.97	53.97	23.88	16.94

NOTES:

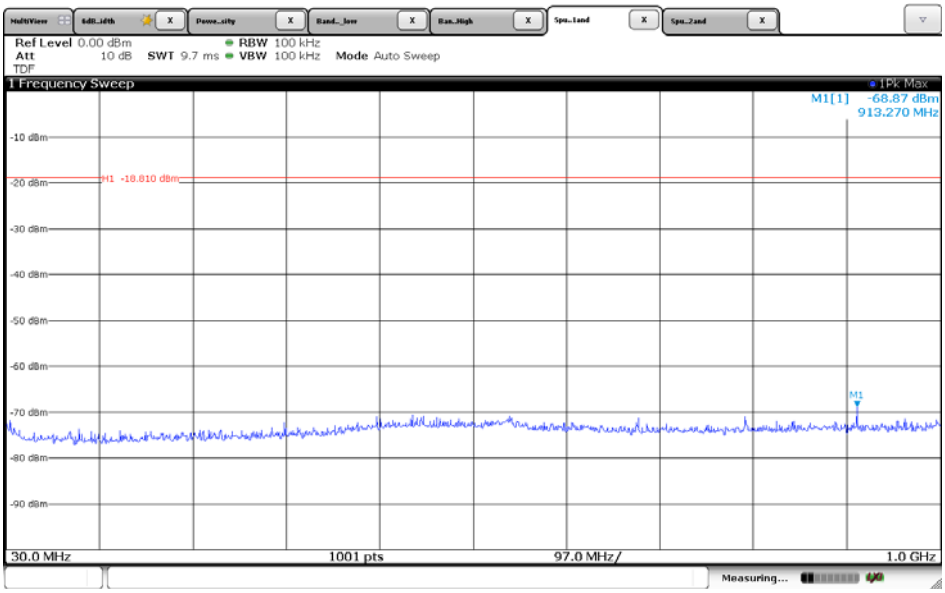
1. * H : Horizontal polarization , ** V : Vertical polarization
2. Factor = Antenna factor + Cable loss + Preamp
3. Result = Reading + Factor
4. Margin = Limit - Result
5. Measuring frequencies from 1GHz to the 10^{th} harmonic of highest fundamental frequency.
6. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded(ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
7. Spectrum setting:
   a. Peak Setting 1 GHz to 10^{th} harmonics of fundamental, RBW = 1 MHz, VBW = 1 MHz, Sweep = Auto
   b. AV Setting 1 GHz to 10^{th} harmonics of fundamental, RBW = 1 MHz, VBW = 10 kHz, Sweep = Auto

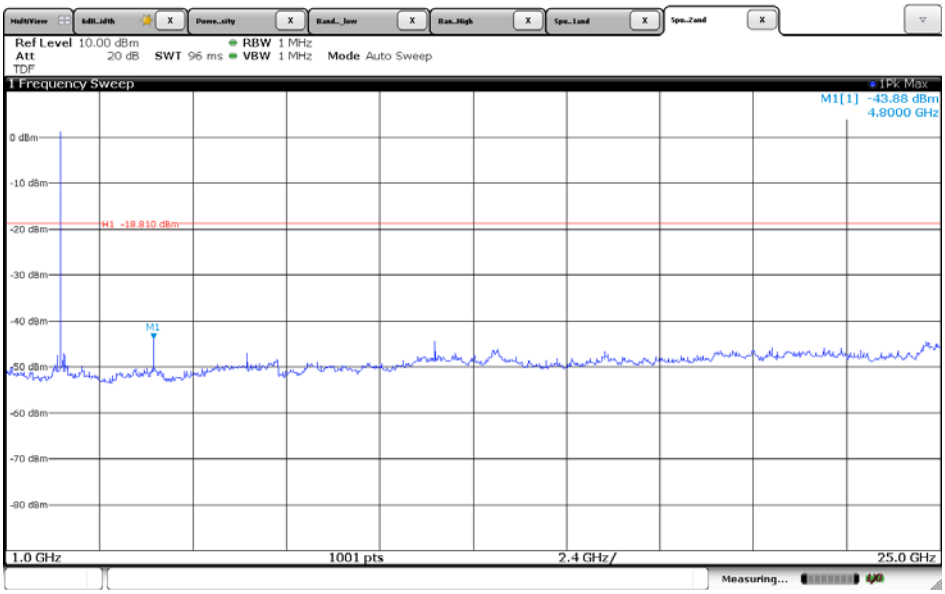
Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Test Date	March 21, 2018
Environmental of Test	(23.3 ± 0.0) °C, (46 ± 0) % R.H., (101.6 ± 0.0) kPa

Plots of Spurious Emissions (Conducted Measurement)

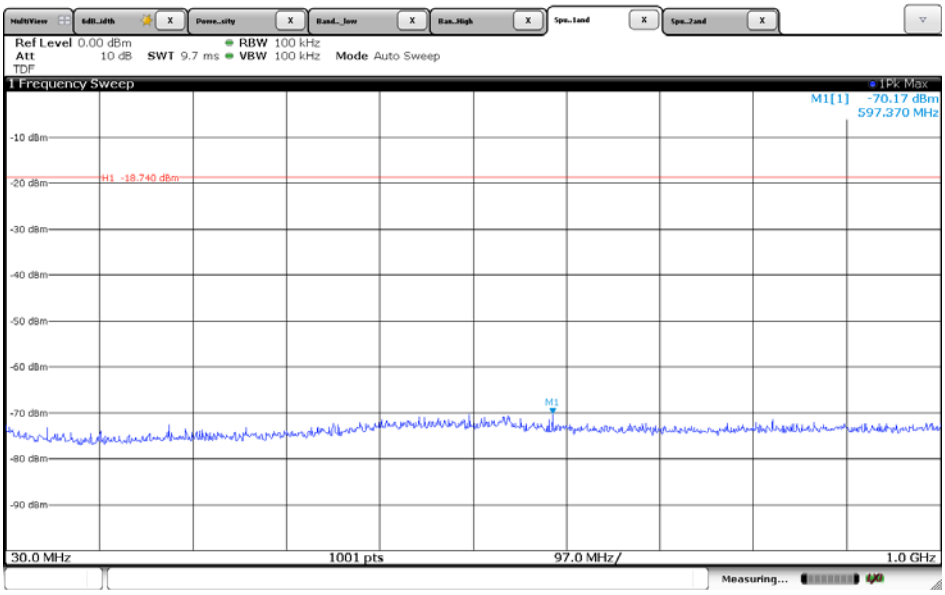
[CH Low]

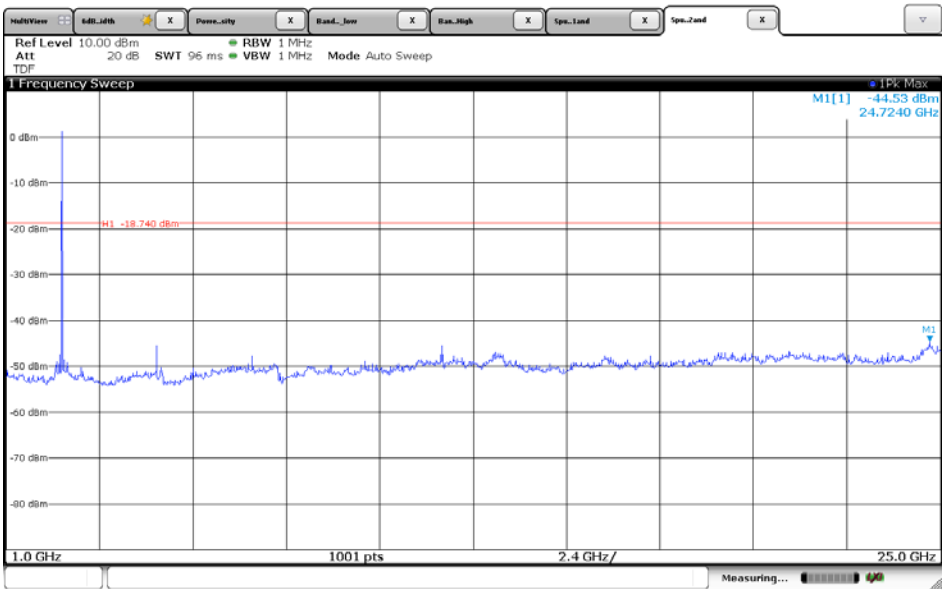




Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

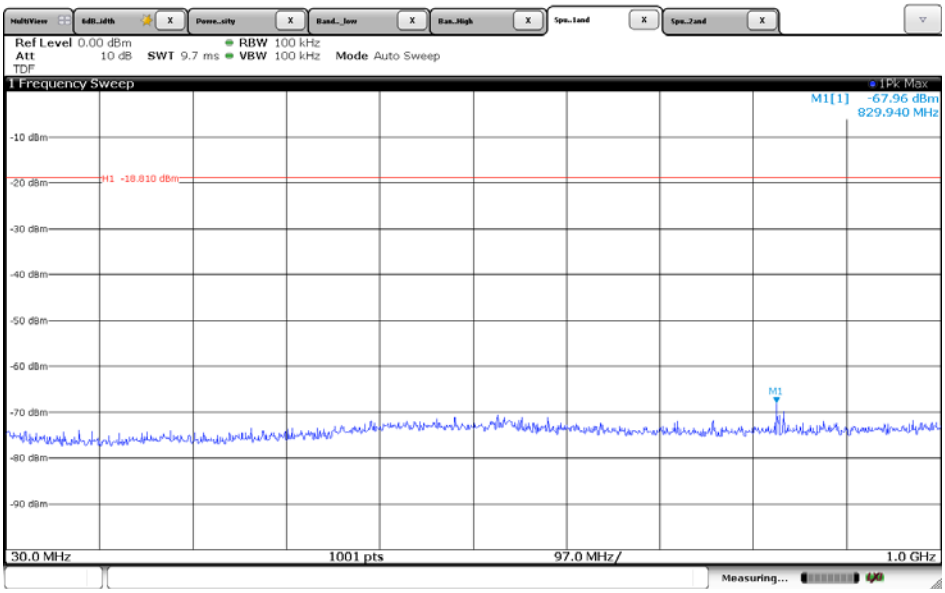
[CH Mid]

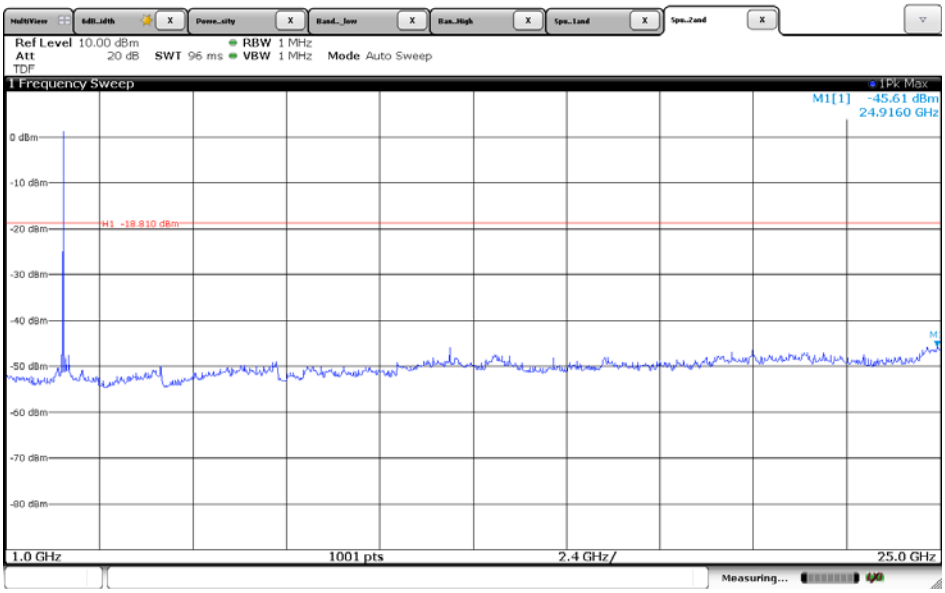




Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

[CH High]





Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.7 Conducted Emissions Measurement

EUT	BLE Module / BoT-nLE521
Limit apply to	FCC Part 15.207
Test Date	March 23, 2018
Environmental of Test	(24.0 ± 0.2) °C, (39 ± 1) % R.H., (102.1 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed by 11.10 dB

Limit

For an intentional radiator 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 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/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 boundary between the frequencies ranges.

Frequency of Emission [MHz]	Conducted limit [dB(μV)]	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 *	56 to 46 *
0.5 - 5	56	46
5 - 30	60	50

* Decreases with the logarithm of the frequency.

Test Results

- Refer to see the measured plot in next page.

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

Conducted Emission Test Data

The following data and graph shows the highest levels of conducted emissions on both polarizations of hot and neutral line.
Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 9 kHz)

NOTES:

1. **Please see the measured data and graph in next page.**
2. **The Level (Result) value was included the reading, LISN factor and cable loss.**
3. **Delta (Margin) value = Limit - Level (Result)**
4. **Measurement were performed at the AC Power Inlet in the frequency band of 150 kHz ~ 30 MHz according to the FCC Part 15.207.**
5. **If the Quasi-Peak limit is met when using a Peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the Quasi-Peak detector receiver is unnecessary.**
6. **If the average limit is met when using a Quasi-peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the average detector receiver is unnecessary.**

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

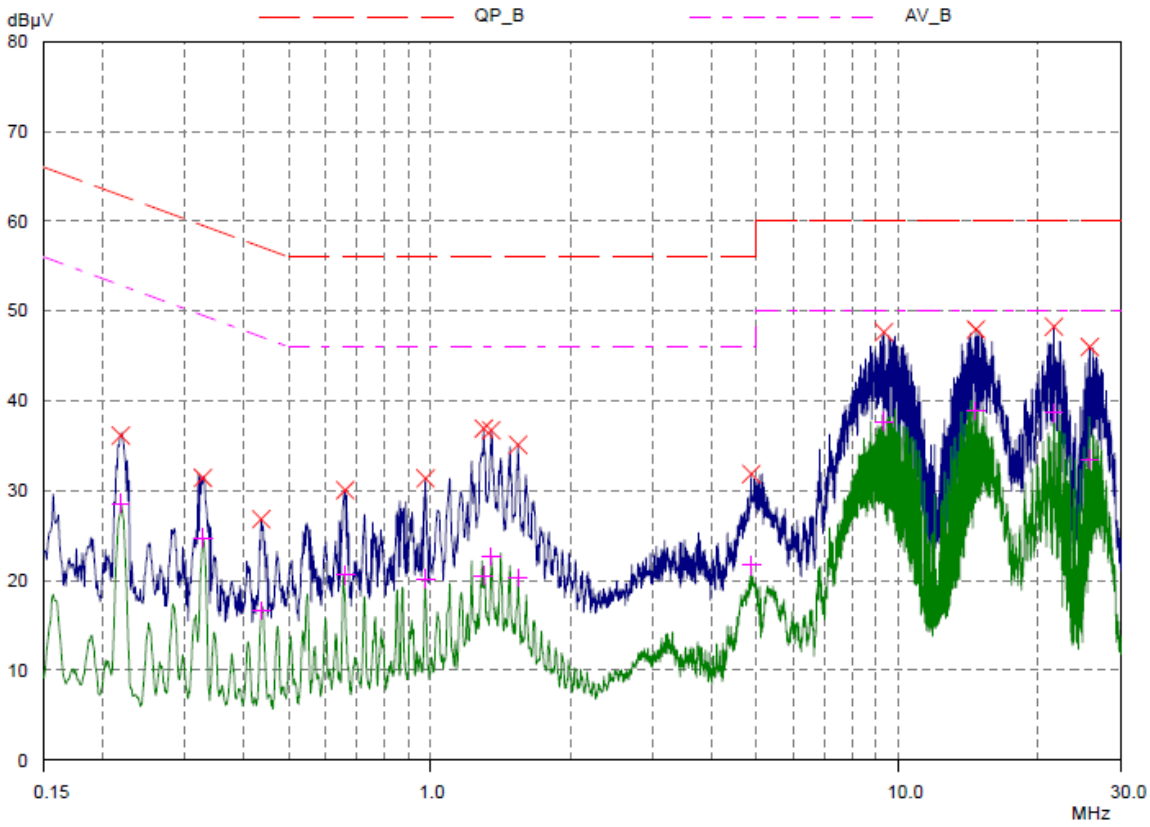
Line: HOT

ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180307.0036
Manuf:
Op Cond:
Operator:
Test Spec:
Comment: H

Prescan Measurement:
Detectors: X PK / + AV
Meas Time: see scan settings
Peaks: 16
Acc Margin: 10 dB



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180307.0036
Manuf:
Op Cond:
Operator:
Test Spec:
Comment: H

Prescan Measurement: Detectors: X PK / + AV
Meas Time: see scan settings
Peaks: 16
Acc Margin: 10 dB

Peak Search Results

Frequency MHz	PK Level dBµV	PK Limit dBµV	PK Delta dB
0.219	36.11	62.86	26.75
0.328	31.40	59.50	28.10
0.437	26.80	57.12	30.32
0.66	30.03	56.00	25.97
0.981	31.35	56.00	24.65
1.305	36.89	56.00	19.11
1.355	36.71	56.00	19.29
1.545	35.08	56.00	20.92
4.87	31.83	56.00	24.17
9.355	47.64	60.00	12.36
14.72	47.94	60.00	12.06
21.58	48.25	60.00	11.75
25.73	45.97	60.00	14.03

Frequency MHz	AV Level dBµV	AV Limit dBµV	AV Delta dB
0.219	28.53	52.86	24.33
0.328	24.75	49.50	24.75
0.437	16.64	47.12	30.48
0.66	20.56	46.00	25.44
0.981	20.16	46.00	25.84
1.305	20.50	46.00	25.50
1.355	22.67	46.00	23.33
1.545	20.29	46.00	25.71
4.87	21.66	46.00	24.34
9.355	37.69	50.00	12.31
14.72	38.90	50.00	11.10
21.58	38.68	50.00	11.32
25.73	33.49	50.00	16.51

* limit exceeded

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

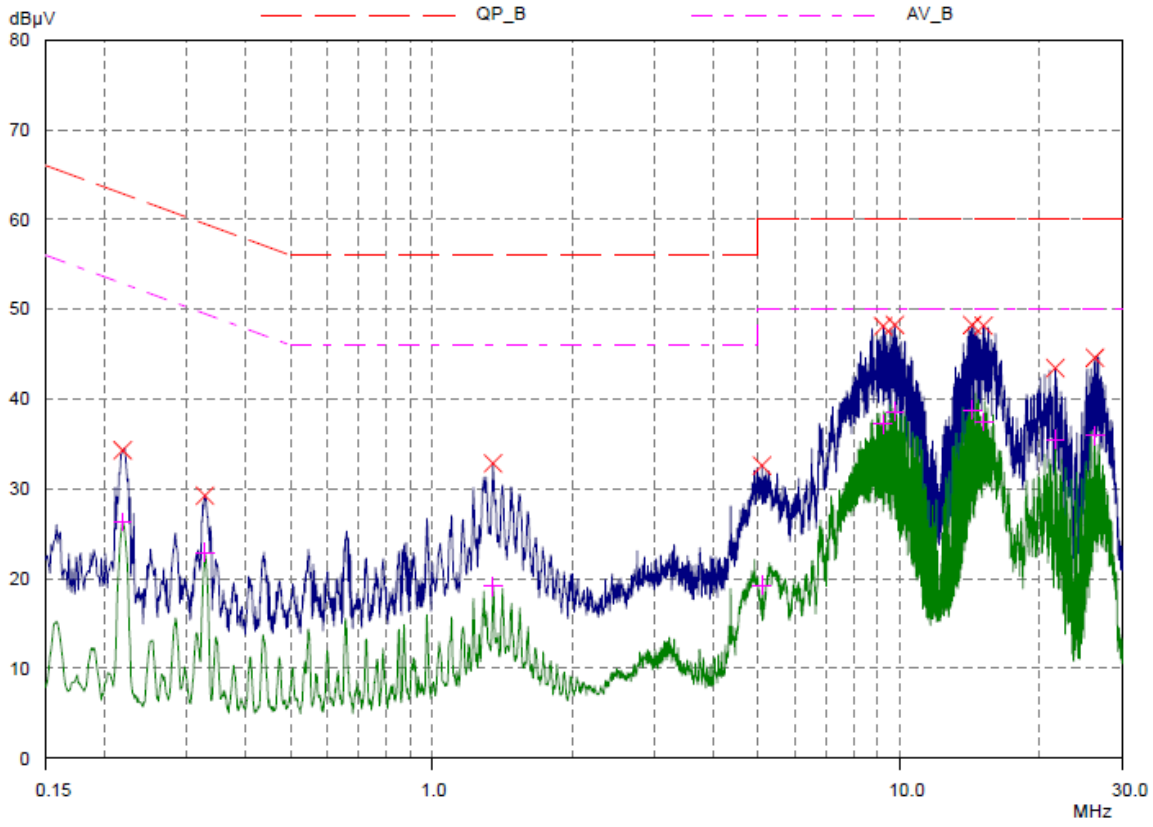
Line: Neutral

ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180307.0036
Manuf:
Op Cond:
Operator:
Test Spec:
Comment: N

Prescan Measurement:
Detectors: X PK / + AV
Meas Time: see scan settings
Peaks: 16
Acc Margin: 10 dB



Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180307.0036
Manuf:
Op Cond:
Operator:
Test Spec:
Comment: N

Prescan Measurement: Detectors: X PK / + AV
Meas Time: see scan settings
Peaks: 16
Acc Margin: 10 dB

Peak Search Results

Frequency MHz	PK Level dBµV	PK Limit dBµV	PK Delta dB
0.219	34.26	62.86	28.60
0.328	29.22	59.50	30.28
1.355	32.82	56.00	23.18
5.09	32.58	60.00	27.42
9.255	48.09	60.00	11.91
9.785	48.26	60.00	11.74
14.32	48.23	60.00	11.77
15.15	48.15	60.00	11.85
21.58	43.42	60.00	16.58
26.22	44.58	60.00	15.42

Frequency MHz	AV Level dBµV	AV Limit dBµV	AV Delta dB
0.219	26.32	52.86	26.54
0.328	22.86	49.50	26.64
1.355	19.14	46.00	26.86
5.09	19.24	50.00	30.76
9.255	37.16	50.00	12.84
9.785	38.56	50.00	11.44
14.32	38.79	50.00	11.21
15.15	37.45	50.00	12.55
21.58	35.50	50.00	14.50
26.22	35.89	50.00	14.11

* limit exceeded

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

5.8 Radio Frequency Exposure

Standard Applicable:

According to §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

This is a Portable device with its physical nature to be used nearby, the distance between radiating structure and human is less than 20 cm.

As per KDB 447498 D01, The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] *
[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

f (GHz) is the RF channel transmit frequency in GHz
Power and distance are rounded to the nearest mW and mm before calculation
The result is rounded to one decimal place for comparison

Measurement Result:

This is a portable device and the Max peak output power is (**1.41 mW**) lower than the threshold given and derived as above, where

= 1.41 (mW) / 5 (mm) * √2.480 (GHz) = 0.44 < 3.00

As the result of calculation result indicates, the RF exposure generating from given transmitter (transmitter employed digital modulation) can be excluded from SAR measurement, and is deemed compliant with RF exposure as per FCC.

Frequency [MHz]	Output Power [dBm]	Target power [dBm]	Allowed tolerance [dB]	Max tune up power [dBm]	Max tune up power [mW]	Separation distance [mm]	RF exposure	Limit
2 402	1.34	-0.5	± 2.00	1.5	1.41	5	0.44	3.00
2 440	1.33	-0.5	± 2.00	1.5	1.41	5	0.44	3.00
2 480	**1.33**	**-0.5**	**± 2.00**	**1.5**	**1.41**	**5**	**0.44**	**3.00**

ex) Target power[dBm] = Max tune up power[dBm] – Allowed tolerance[dB]

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

6. SAMPLE CALCULATION

Sample Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor.
The basic equation with a sample calculation is as follows:

FS = RA + AF + CF

Where FS = Field Strength
RA = Receiver Amplitude
AF = Antenna Factor
CF = Cable Attenuation Factor - Preamplifier Factor

dB(μV) = 20 $\log_{10}$ (μV) : Equation
dB(μV) = dBm + 107

Example : @ 48.55 MHz

Limit = 40.00 dB(μV/m)

Reading = 54.31 dB(μV)

Antenna Factor + (Cable Loss - Amp Gain) = 13.22 + (-32.50) = -19.28 dB(μV/m)

Total = 54.31 + (-19.28) = 35.03 dB(μV/m)

Margin = 40.00 – 35.03 = 4.97 dB

= 4.97 dB below Limit

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

7. List of test equipments used for measurements

Test Equipment		Model	Mfg.	Serial No.	Cal. Date	Cal. Due Date
☒	EMI Test Receiver	ESCI7	ROHDE & SCHWARZ.	100851	17.08.31	18.08.31
☒	EMI Test Receiver	ESCS30	ROHDE & SCHWARZ.	100087	18.03.12	19.03.12
☒	Spectrum Analyzer	FSW43	ROHDE & SCHWARZ.	103794	17.09.05	18.09.05
☒	PSA Series Spectrum Analyzer	E4440A	Agilent	US40420382	17.09.01	18.09.01
☒	EMI Test Receiver	ESPI3	R&S	100478	17.08.31	18.08.31
☒	Two-Line V-Network	ENV216	R&S	101715	18.03.12	19.03.12
☒	Two-Line V-Network	ENV216	R&S	102055	18.03.12	19.03.12
☒	Attenuator	BW-S10-2W263+	Mini-Circuits	NONE	18.03.14	19.03.14
☒	Wideband Power Sensor	U2022XA	Agilent	MY56040002	17.09.05	18.09.05
☒	DC Power Supply	SDP 60-5D	SM Techno	605DOD 002	18.03.12	19.03.12
☒	DC Power Supply	DP30-03A	TOYO TECH	16110016	18.03.13	19.03.13
☒	Bi-Log Antenna (FCC)	VULB9163	Schwarzbeck	01069	17.02.17	19.02.17
☒	Loop Antenna	6502	EMCO	00033743	16.09.05	18.09.05
☒	Horn Antenna (FCC)	BBHA 9120D	Schwarzbeck	277	16.10.12	18.10.12
☒	Horn Antenna	BBHA 9170	Schwarzbeck	BBHA9170440	17.12.04	19.12.04
☒	Amplifier	TK-PA18	TESTEK	120020	17.09.01	18.09.01
☒	Amplifier	TK-PA18H	TESTEK	170010-L	18.03.12	19.03.12
☒	Amplifier	BLWA 0310-1	BONN Elektronik	045672	18.01.31	19.01.31
☒	Amplifier	JS44-18004000-45-8P	MITEQ Inc.	1568695	17.09.05	18.09.05
☒	Highpass Filter	WHKX3.0 /18G-6SS	Wainwright Instrument	15	18.03.13	19.03.13
☒	Highpass Filter	WHNX6-4740-6000 -26500-40CC	WAINWRIGHT INSTRUMENT GmbH	1	17.09.04	18.09.04
☒	Band Reject Filter	WRCGV 2402/2480-2382/2500-52/10SS	Wainwright Instrument	2R	17.08.31	18.08.31
☒	Turn-Table	TT 1.35 SI	SES	-	N/A	N/A
☒	Antenna Master	AM 4.5	SES	-	N/A	N/A
☒	Turn-Table	DS1200-S	Innco Systems Gmbh	2740311	N/A	N/A
☒	Controller	HD 2000	HD GmbH	C/125	N/A	N/A
☒	Antenna Master	MA4000	AUDIX	N/A	N/A	N/A

Head Office: #371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea Tel : 82-2-858-0786 Fax : 82-2-858-0788
Open site: #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea