# Electromagnetic Emission

# FCC MEASUREMENT REPORT

## CERTIFICATION OF COMPLIANCE

### FCC Part 15 Certification Measurement

| | | |
|---|---|---|
| **PRODUCT** | : | Level1 Cubico Kids Coding |
| **MODEL/Serial No.** | : | LV1-CUBICO / Proto type |
| **MULTIPLE MODEL** | : | - |
| **BRAND NAME** | : | SIGONGmedia |
| **FCC ID** | : | 2ALAL-LV1-CUBICO |
| **APPLICANT** | : | Sigongmedia Co., Ltd.<br>225-20, Pangyoyeok-ro, Bundang-gu, Seongnam-si,<br>Gyeonggi-do, 13494, South Korea<br>Attn.: Jihye, Kim / Manager |
| **MANUFACTURER** | : | Sigongmedia Co., Ltd.<br>225-20, Pangyoyeok-ro, Bundang-gu, Seongnam-si,<br>Gyeonggi-do, 13494, 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) |
| **ANTENNA TYPE** | : | PCB Pattern Antenna (Integral) |
| **ANTENNA GAIN** | : | 0 dBi max |
| **RF POWER** | : | 0.82 mW |
| **RULE PART(S)** | : | FCC Part 15 Subpart C |
| **FCC PROCEDURE** | : | ANSI C63.10-2013 |
| **TEST REPORT No.** | : | ETLT170227.0031 |
| **DATES OF TEST** | : | March 16, 2017 to March 18, 2017 |
| **REPORT ISSUE DATE** | : | March 24, 2017 |
| **TEST LABORATORY** | : | ETL Inc. (FCC Designation Number : KR0022) |

The Level1 Cubico Kids Coding, Model LV1-CUBICO 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)
March 24, 2017

Reviewed by:
Kug Kyoung, Yoon (Chief Engineer)
March 24, 2017

**ETL Inc.**
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*The test report merely corresponds to the test sample(s).*
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# 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** | **: Sigongmedia Co., Ltd.** |
| **Address** | **: 225-20, Pangyoyeok-ro, Bundang-gu, Seongnam-si, Gyeonggi-do, 13494, South Korea** |
| **Attention** | **: Jihye, Kim / Manager** |

- **EUT Type** : Level1 Cubico Kids Coding
- **Model Number** : LV1-CUBICO
- **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)
- **Antenna Type** : PCB Pattern Antenna (Integral)
- **Antenna Gain** : 0 dBi max
- **RF Power** : 0.82 mW
- **Environmental of Tests** : Temperature: (17.7 ± 7.5) °C
  Humidity: (40 ± 5) % R.H.
  Atmospheric Pressure: (102.1 ± 0.2) 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



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# 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 Sigongmedia Co., Ltd.
Model: LV1-CUBICO



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# 2. PRODUCT INFORMATION

## 2.1 Equipment Description

The Equipment Under Test (EUT) is the Level1 Cubico Kids Coding (model: LV1-CUBICO).

The model LV1-CUBICO is basic model that was tested.

## 2.2 General Specification

| Item | Specification |
|---|---|
| Bluetooth | 4.0 (40 CH) |
| Dimension (Package) | 373 mm x 313 mm x 88 mm |
| Dimension (Coding tray) | 297 mm x 77 mm x 32 mm |
| Weight (Package) | 2 900 g |
| Weight (Coding tray) | 186 g |
| Battery | AAA 1.5 V x 2 EA |
| Operation Temperature | (20 ± 25) °C |
| High Internal Frequency | X-tal → 16 MHz |



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# 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.



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## 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 $\phi$ 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.



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



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# 4. TEST CONDITION

## 4.1 Test Configuration

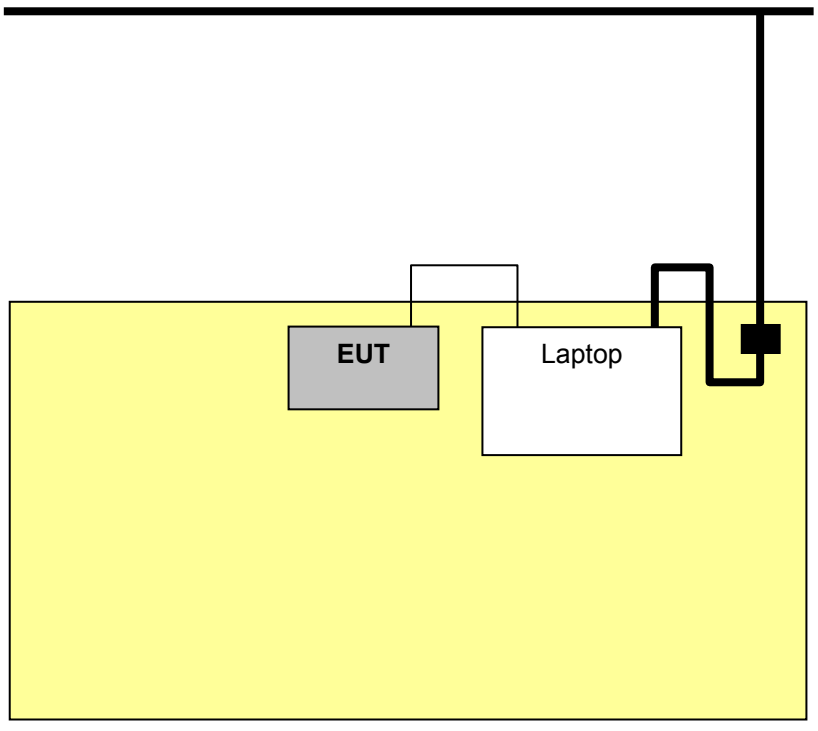
The device was configured for testing in a typical fashion (as a customer would normally use it). During the tests, the following conditions and configurations were used.

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

## 4.2 Description of Test modes

Level1 Cubico Kids Coding that has the control software.

## 4.3 The setup drawing(s)




: Signal Line

: Power Line

: Adapter



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# 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 | **N/A *** |
| 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 not applied. EUT uses only battery power. (Battery type: DC 1.5 V 'AAA' type battery 2 EA)

The data collected shows that the **Sigongmedia Co., Ltd. / Level1 Cubico Kids Coding / LV1-CUBICO** complied with technical requirements of above rules part 15.209 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.



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## 5.2 6 dB Bandwidth

| | |
|---|---|
| EUT | Level1 Cubico Kids Coding / LV1-CUBICO |
| Limit apply to | FCC Part 15.247(a)(2) |
| Test Date | March 17, 2017 |
| Environmental of Test | (23.8 ± 0.1) °C, (40 ± 0) % R.H., (102.3 ± 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 | 0.510 | > 500 kHz |
| 2 440 | 0.509 | |
| 2 480 | 0.506 | |

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.



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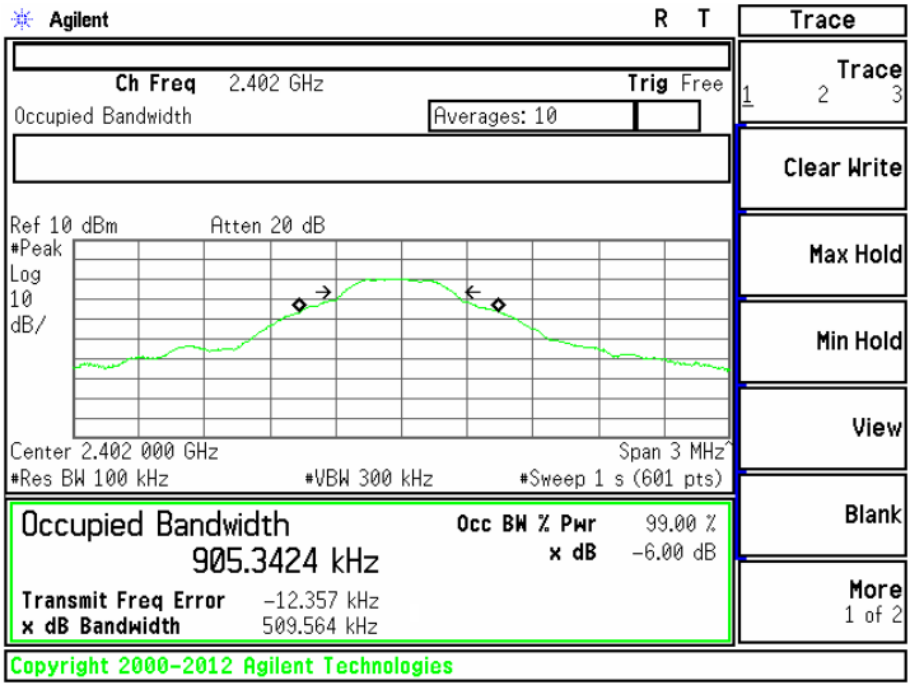
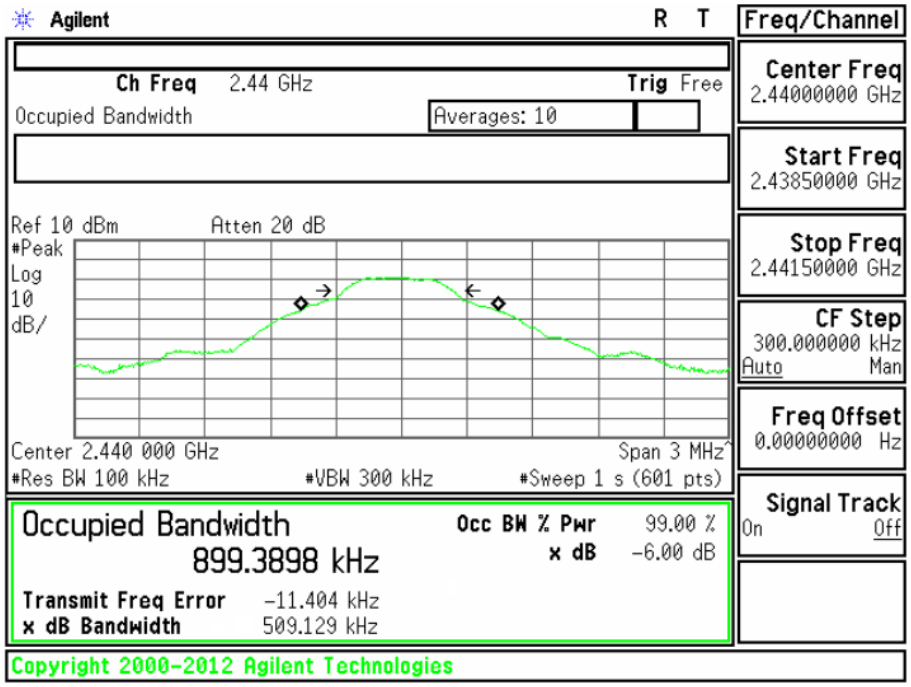
## Plots of 6 dB Bandwidth

[2 402 MHz]




[2 440 MHz]



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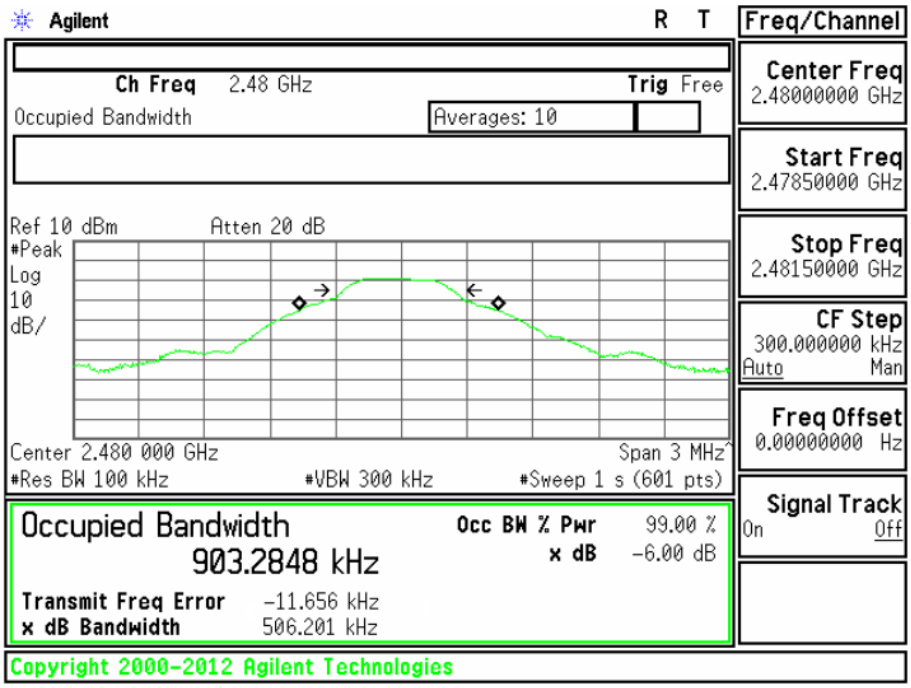
[2 480 MHz]



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## 5.3 Maximum Peak Conducted Output Power

| | |
|---|---|
| EUT | Level1 Cubico Kids Coding / LV1-CUBICO |
| Limit apply to | FCC Part 15.247(b)(3) |
| Test Date | March 17, 2017 |
| Environmental of Test | (23.5 ± 0.2) °C, (39 ± 0) % R.H., (102.3 ± 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 | -1.41 | < 30.00 dBm (1 W) |
| 2 440 | -0.84 | |
| 2 480 | -0.93 | |



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## Plots of Output Power

[2 402 MHz]

[2 440 MHz]

[2 480 MHz]

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## 5.4 Bandwidth of Frequency Band Edges

| | |
|---|---|
| EUT | Level1 Cubico Kids Coding / LV1-CUBICO |
| Limit apply to | FCC Part 15.247(d) |
| Test Date | March 18, 2017 |
| Environmental of Test | (23.5 ± 1.7) °C, (36 ± 1) % R.H., (102.0 ± 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.



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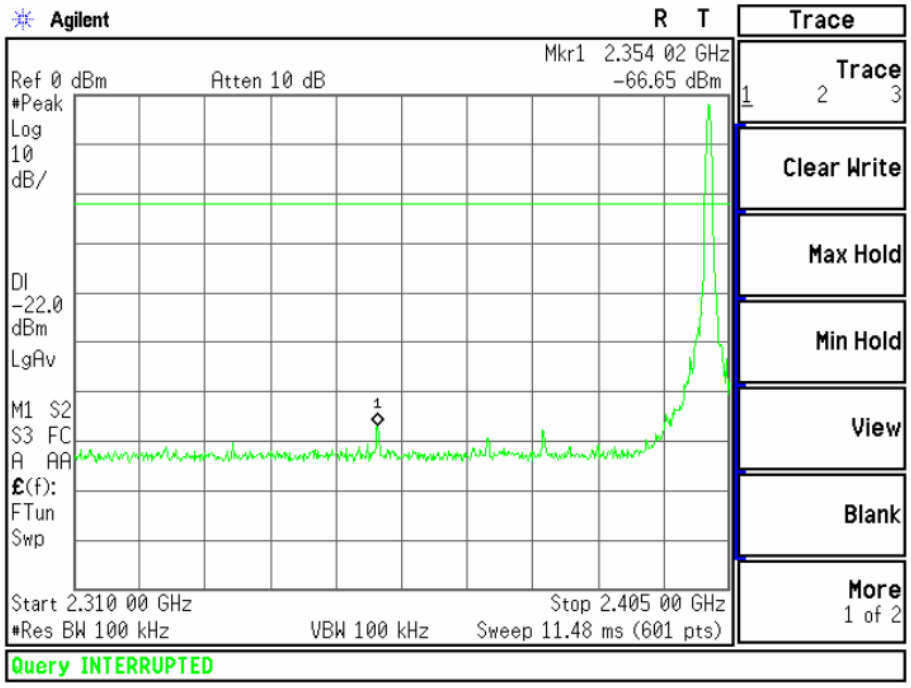
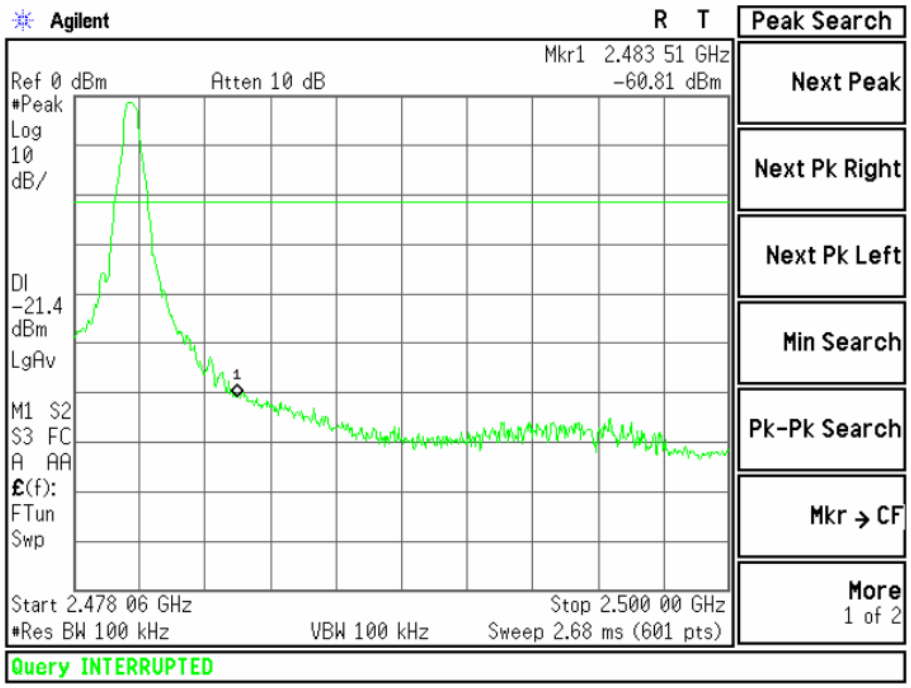
## Plots of Bandwidth of Frequency Band Edges

### Conducted



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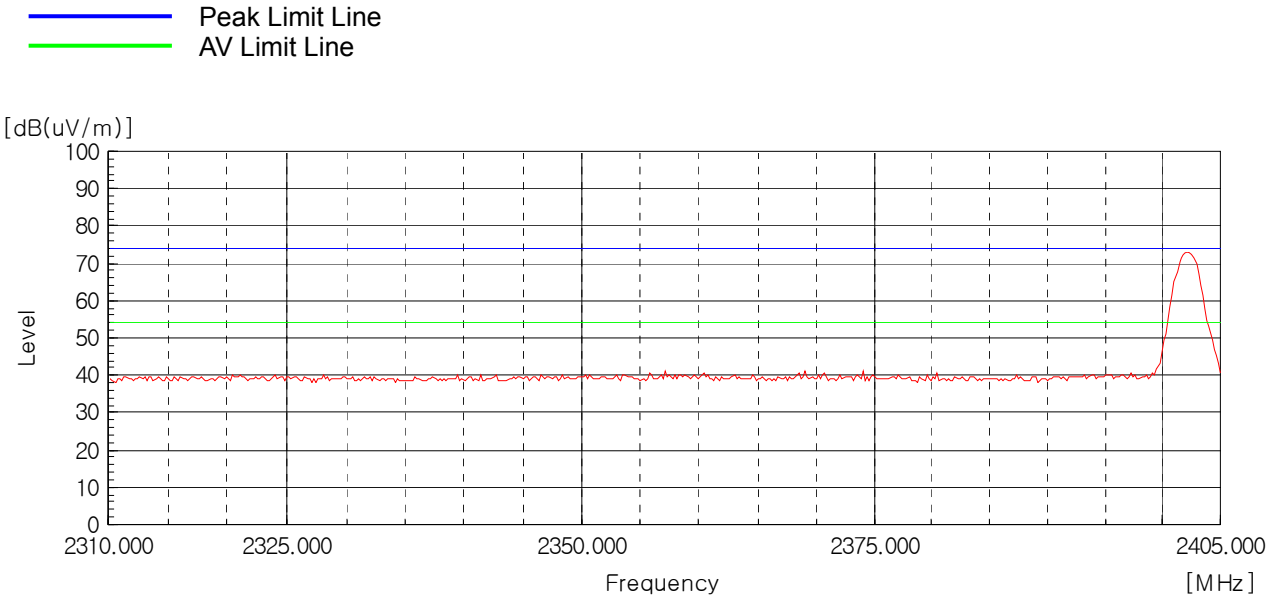
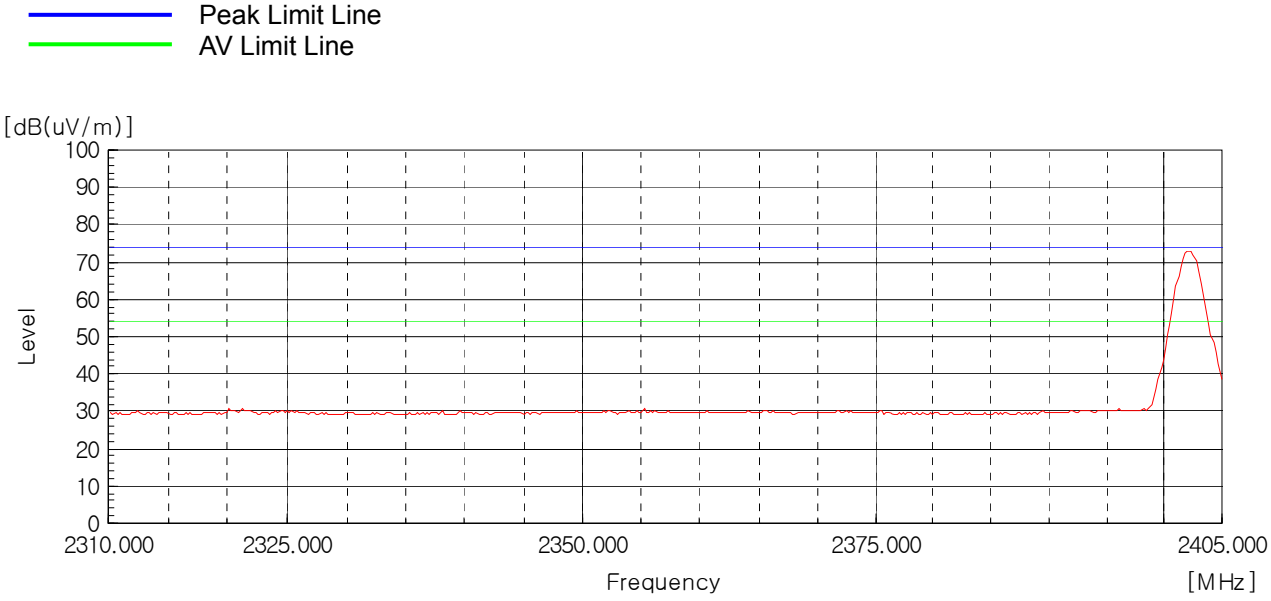
**Radiated**

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




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



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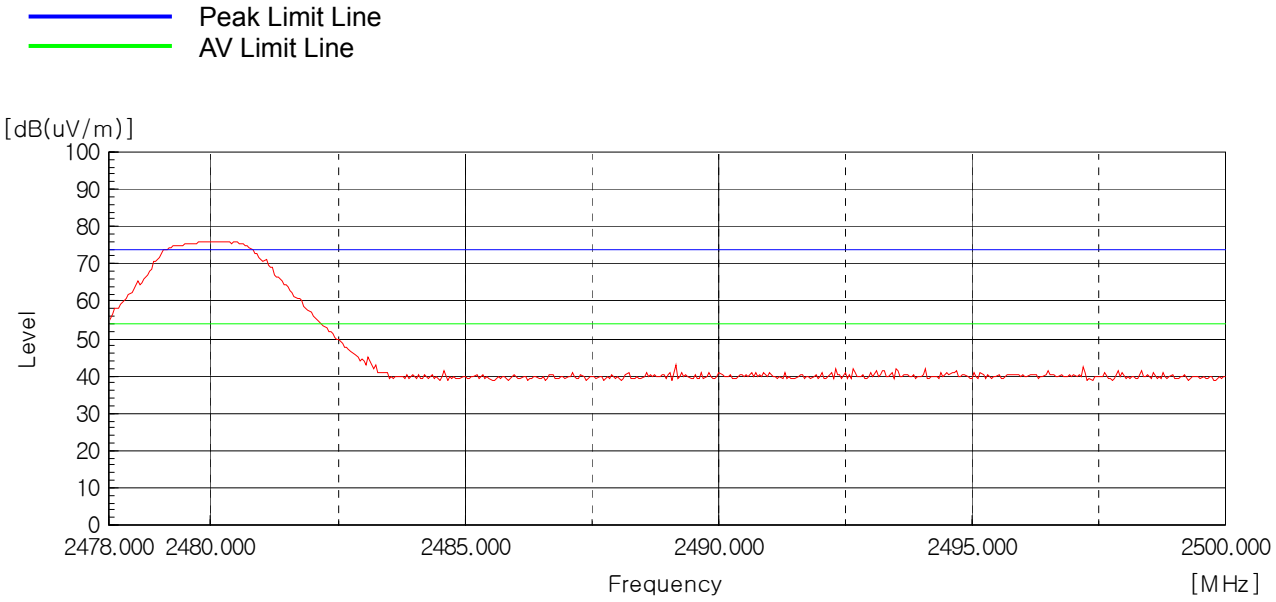
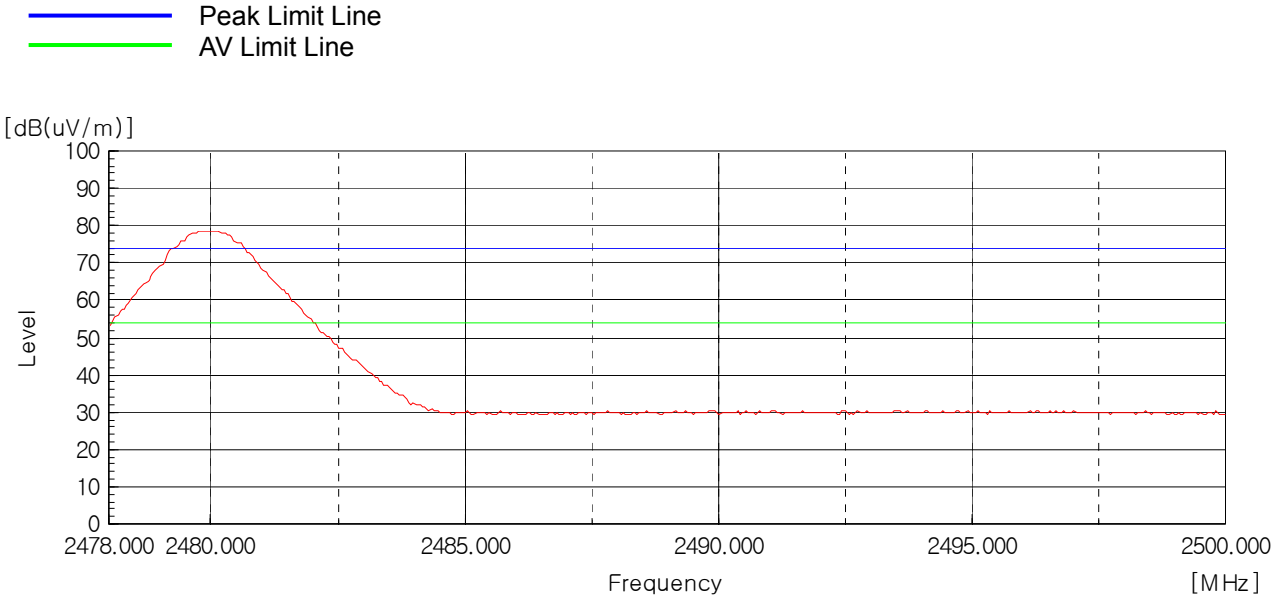
Peak Detector: RBW: 1 MHz, VBW: 1 MHz (2 483.5 MHz - 2 500 MHz), Worst case (High, Horizontal)




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



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## 5.5 Power Spectral Density

| | |
|---|---|
| EUT | Level1 Cubico Kids Coding / LV1-CUBICO |
| Limit apply to | FCC Part 15.247(e) |
| Test Date | March 17, 2017 |
| Environmental of Test | (23.9 ± 0.0) °C, (40 ± 0) % R.H., (102.3 ± 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 | -12.65 | 8.00 dBm |
| 2 440 | -12.08 | |
| 2 480 | -12.05 | |

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.



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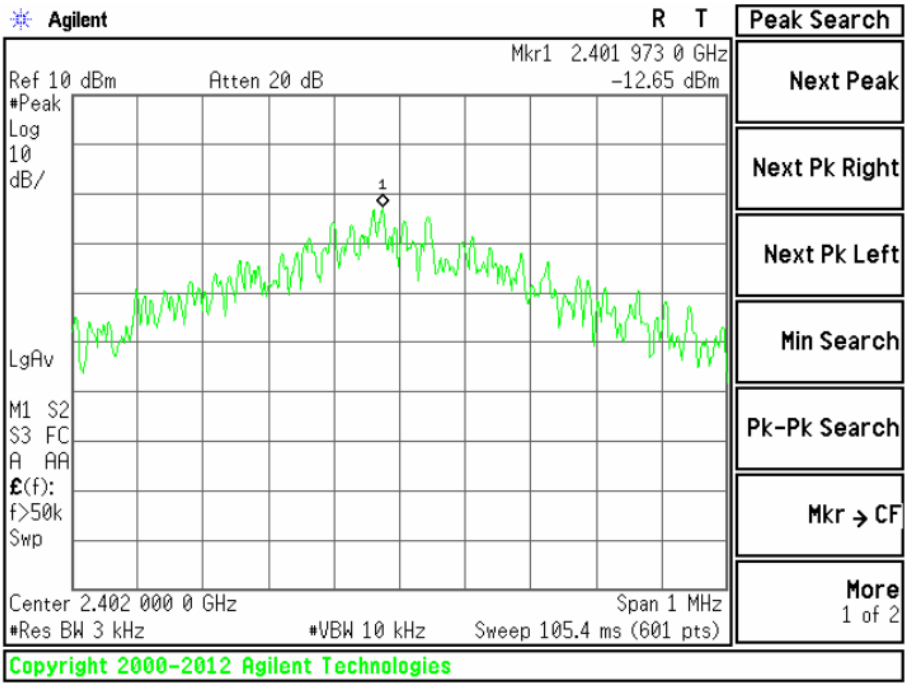
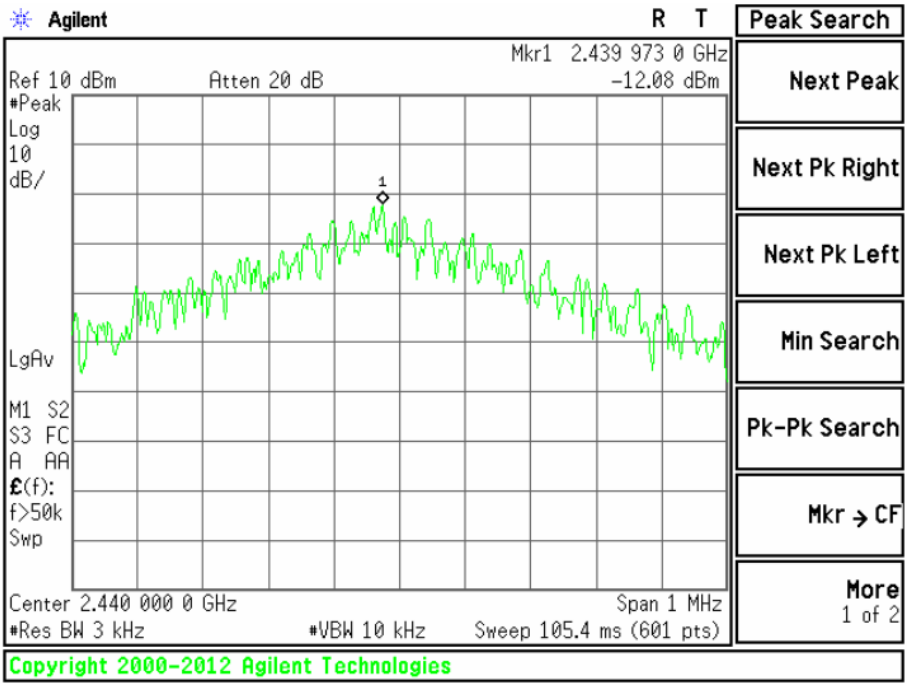
## Plots of Power Spectral Density

[2 402 MHz]




[2 440 MHz]



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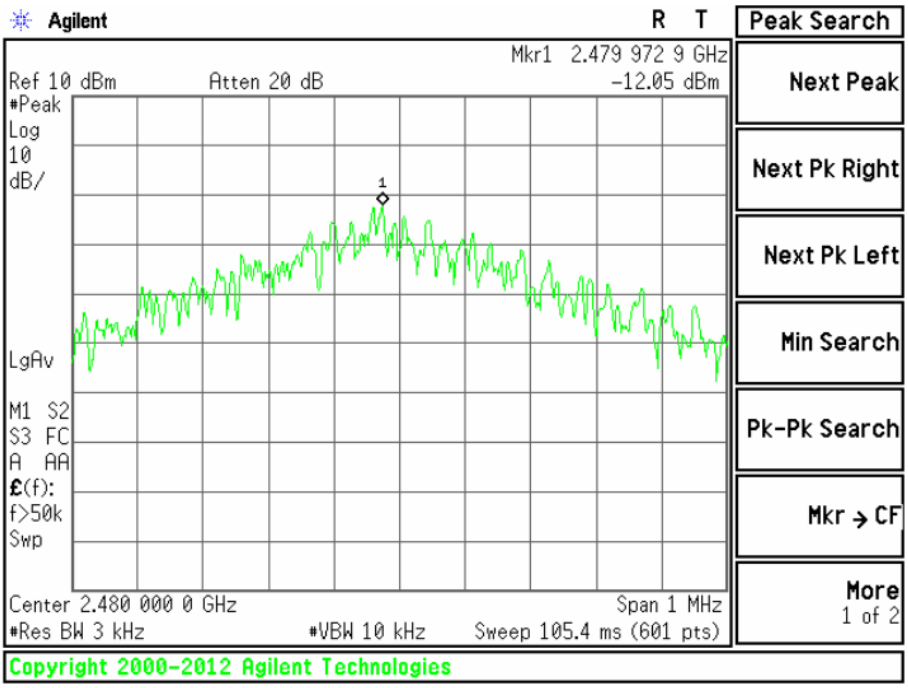
[2 480 MHz]



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## 5.6 Spurious Emissions

| | |
|---|---|
| EUT | Level1 Cubico Kids Coding / LV1-CUBICO |
| 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.



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## Radiated Emissions Test data

### - 9 kHz to 1 GHz

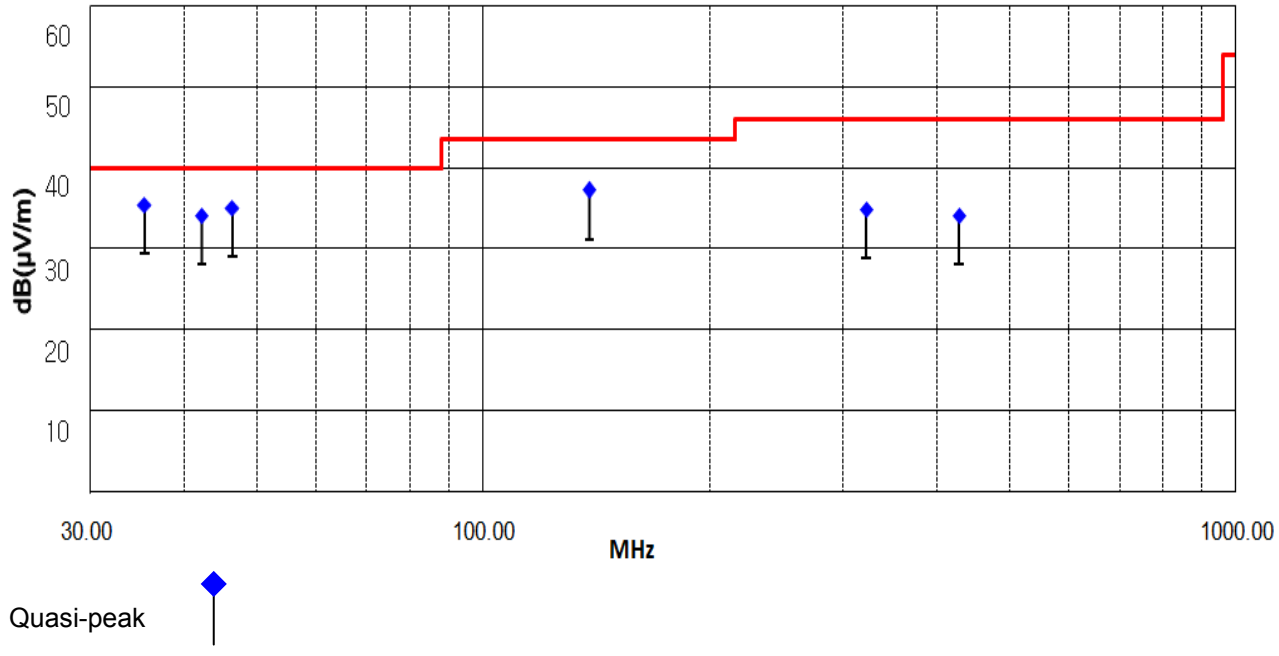
| | |
|---|---|
| Test Date | March 16, 2017 |
| Environmental of Test | (12.5 ± 2.3) °C, (43 ± 2) % R.H., (102.0 ± 0.1) kPa |

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] |
|---|---|---|---|---|---|---|---|---|
| 35.45 | 54.12 | V | 12.13 | -30.85 | 100 | 35.40 | 40.00 | 4.60 |
| 42.27 | 51.87 | V | 12.98 | -30.75 | 100 | 34.10 | 40.00 | 5.90 |
| 46.36 | 52.49 | V | 13.17 | -30.66 | 105 | 35.00 | 40.00 | 5.00 |
| 138.40 | 54.62 | V | 12.23 | -29.65 | 107 | 37.20 | 43.50 | 6.30 |
| 322.98 | 48.53 | H | 14.09 | -27.82 | 393 | 34.80 | 46.00 | 11.20 |
| 429.02 | 44.45 | V | 16.59 | -26.94 | 132 | 34.10 | 46.00 | 11.90 |

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 value = Limit - Result
5. The measurement was performed for the frequency range above 9 kHz according to FCC Part 15.209.



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**- Above 1 GHz (1 GHz to 25 GHz)**

| | |
|---|---|
| Test Date | March 16, 2017 |
| Environmental of Test | (12.1 ± 1.8) °C, (40 ± 2) % R.H., (102.1 ± 0.0) kPa |

1. Low CH (2 402 MHz)

| Frequency [MHz] | Reading [dB(μV)] | | Polarity (*H/**V) | Ant. Factor [dB/m] | Cable - Amp. Gain [dB] | Result [dB(μV/m)] | | Limit [dB(μV/m)] | | Margin [dB] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Peak | Average | | | | Peak | Average | Peak | Average | Peak | Average |
| 10 619.46 | 41.58 | 28.88 | H | 40.21 | -23.99 | 57.80 | 45.10 | 73.97 | 53.97 | 16.17 | 8.87 |
| 10 983.06 | 42.14 | 28.24 | V | 40.75 | -23.89 | 59.00 | 45.10 | 73.97 | 53.97 | 14.97 | 8.87 |
| 14 242.00 | 40.10 | 26.40 | V | 42.17 | -21.17 | 61.10 | 47.40 | 73.97 | 53.97 | 12.87 | 6.57 |
| 14 874.93 | 40.08 | 26.88 | H | 41.47 | -20.55 | 61.00 | 47.80 | 73.97 | 53.97 | 12.97 | 6.17 |
| 16 881.46 | 40.96 | 27.56 | V | 40.92 | -19.38 | 62.50 | 49.10 | 73.97 | 53.97 | 11.47 | 4.87 |
| 17 312.40 | 38.34 | 26.24 | V | 42.89 | -19.73 | 61.50 | 49.40 | 73.97 | 53.97 | 12.47 | 4.57 |

2. Middle CH (2 440 MHz)

| Frequency [MHz] | Reading [dB(μV)] | | Polarity (*H/**V) | Ant. Factor [dB/m] | Cable - Amp. Gain [dB] | Result [dB(μV/m)] | | Limit [dB(μV/m)] | | Margin [dB] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Peak | Average | | | | Peak | Average | Peak | Average | Peak | Average |
| 10 723.51 | 40.91 | 28.61 | H | 40.37 | -23.78 | 57.50 | 45.20 | 73.97 | 53.97 | 16.47 | 8.77 |
| 11 388.16 | 45.08 | 28.98 | H | 40.20 | -23.88 | 61.40 | 45.30 | 73.97 | 53.97 | 12.57 | 8.67 |
| 14 856.52 | 40.29 | 26.59 | V | 41.52 | -20.61 | 61.20 | 47.50 | 73.97 | 53.97 | 12.77 | 6.47 |
| 14 891.37 | 40.18 | 26.88 | V | 41.42 | -20.50 | 61.10 | 47.80 | 73.97 | 53.97 | 12.87 | 6.17 |
| 16 883.59 | 41.22 | 27.62 | V | 40.94 | -19.36 | 62.80 | 49.20 | 73.97 | 53.97 | 11.17 | 4.77 |
| 17 311.68 | 38.45 | 26.35 | H | 42.89 | -19.74 | 61.60 | 49.50 | 73.97 | 53.97 | 12.37 | 4.47 |



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3. High CH (2 480 MHz)

| Frequency [MHz] | Reading [dB(μV)] | | Polarity (*H/**V) | Ant. Factor [dB/m] | Cable - Amp. Gain [dB] | Result [dB(μV/m)] | | Limit [dB(μV/m)] | | Margin [dB] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Peak | Average | | | | Peak | Average | Peak | Average | Peak | Average |
| 11 077.33 | 41.47 | 28.97 | H | 40.66 | -24.23 | 57.90 | 45.40 | 73.97 | 53.97 | 16.07 | 8.57 |
| 11 387.06 | 41.88 | 29.18 | V | 40.20 | -23.88 | 58.20 | 45.50 | 73.97 | 53.97 | 15.77 | 8.47 |
| 14 821.06 | 39.52 | 26.82 | V | 41.61 | -20.73 | 60.40 | 47.70 | 73.97 | 53.97 | 13.57 | 6.27 |
| 14 915.33 | 40.27 | 26.47 | H | 41.35 | -20.42 | 61.20 | 47.40 | 73.97 | 53.97 | 12.77 | 6.57 |
| 16 868.00 | 40.59 | 27.59 | V | 40.81 | -19.50 | 61.90 | 48.90 | 73.97 | 53.97 | 12.07 | 5.07 |
| 17 339.33 | 38.25 | 25.95 | H | 42.98 | -19.63 | 61.60 | 49.30 | 73.97 | 53.97 | 12.37 | 4.67 |

**Note: Other harmonics are lower than background noise.**

NOTES:

1. * H : Horizontal polarization, ** V : Vertical polarization
2. Factor = Antenna factor + Cable loss - Amp. Gain
3. Result = Reading + Factor
4. Margin value = Limit - Result
5. Measuring frequencies from 1 GHz 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



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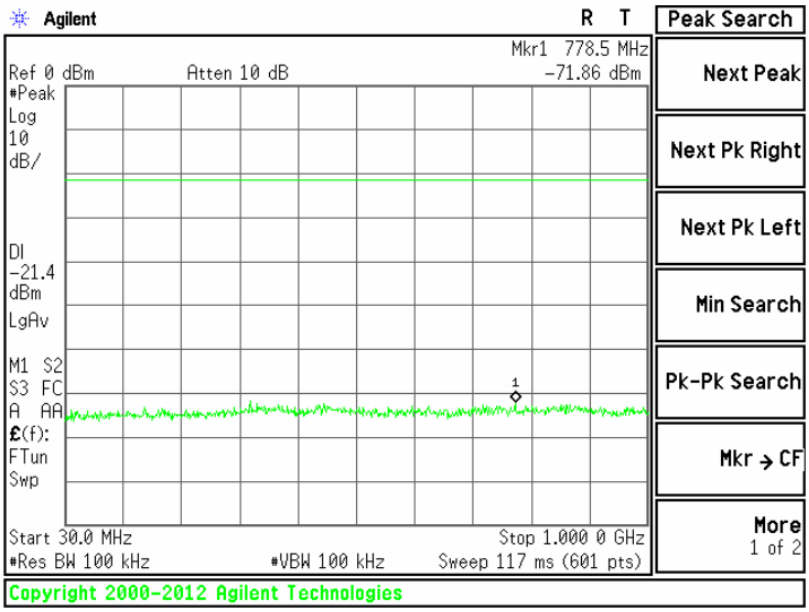
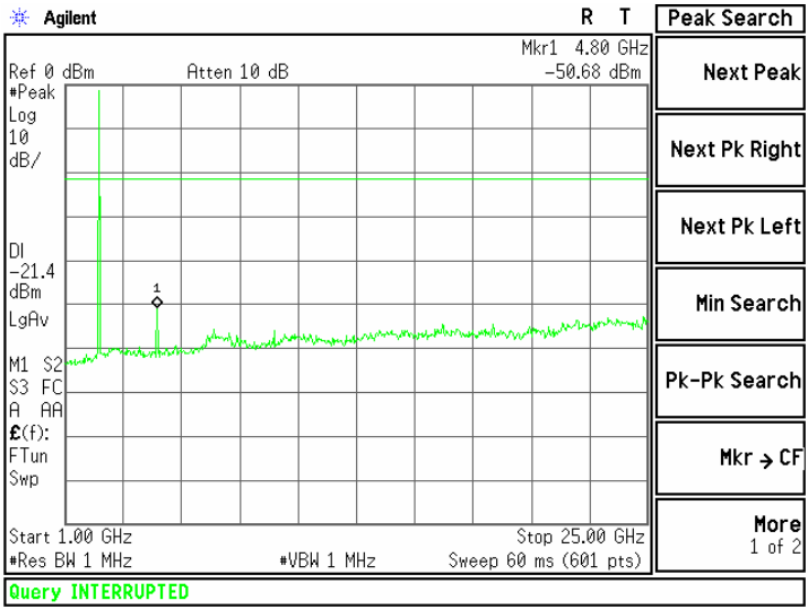
## Plots of Spurious Emissions (Conducted Measurement)

| | |
|---|---|
| Test Date | March 17, 2017 |
| Environmental of Test | (23.2 ± 0.5) °C, (38 ± 1) % R.H., (102.3 ± 0.0) kPa |

[CH Low]



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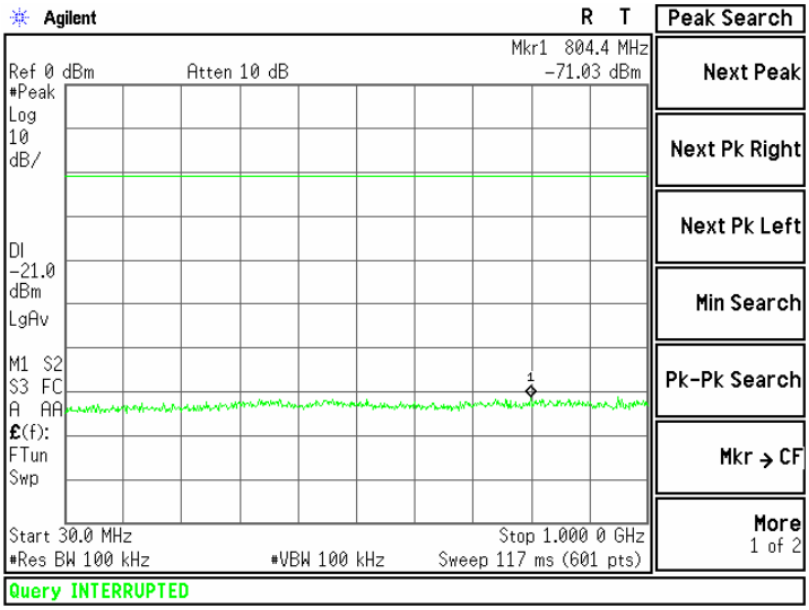
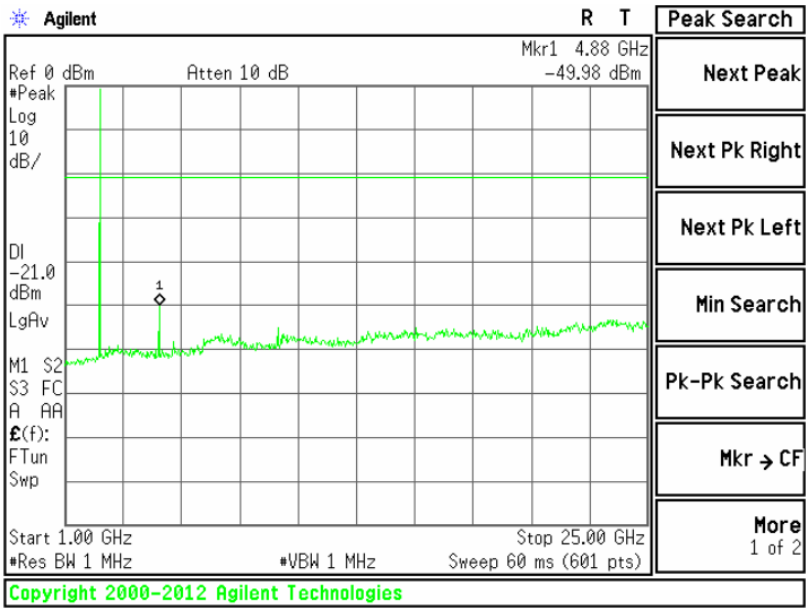
[CH Mid]



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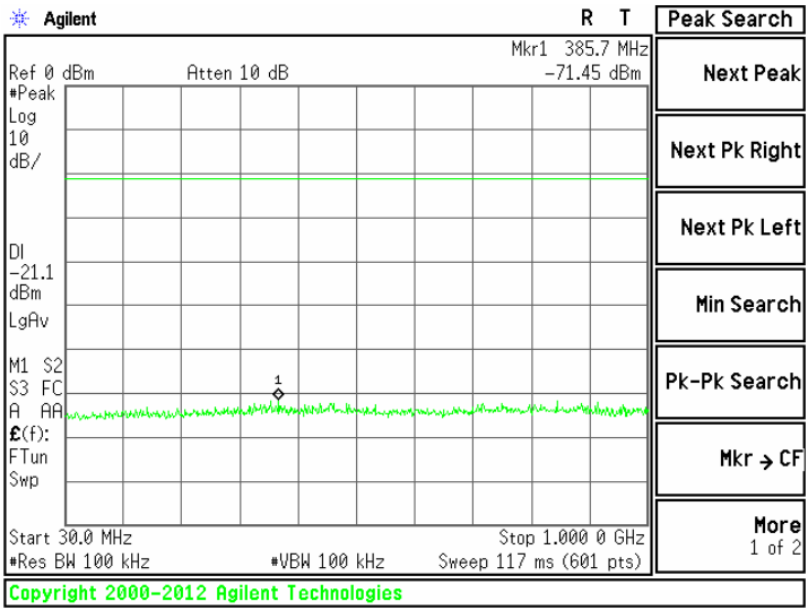
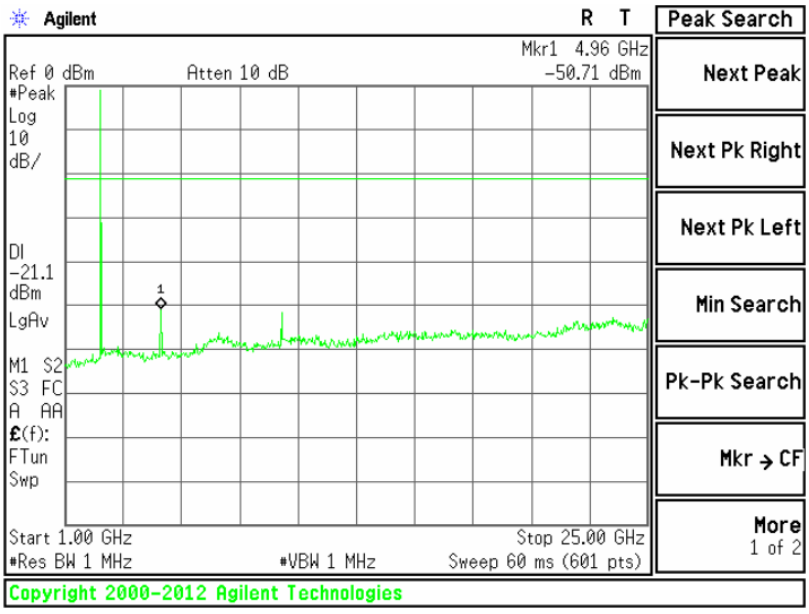
[CH High]



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## 5.7 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 (**0.89 mW**) lower than the threshold given and derived as above, where

**= 0.89 (mW) / 5 (mm) * √2.480 (GHz) = 0.28 < 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 | -1.41 | -3.0 | ± 2.00 | -1.0 | 0.79 | 5 | 0.24 | 3.00 |
| 2 440 | -0.84 | -2.5 | ± 2.00 | -0.5 | 0.89 | 5 | 0.28 | 3.00 |
| **2 480** | **-0.93** | **-2.5** | **± 2.00** | **-0.5** | **0.89** | **5** | **0.28** | **3.00** |



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# 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 : @ 17 311.68 MHz

| | | |
|---|---|---|
| Limit | = | 53.97 dB(μV/m) (Average) |
| Reading | = | 26.35 dB(μV) |
| Antenna Factor + (Cable loss – Amp. Gain) | | = 42.89 + (-19.74) = 23.15 dB(μV/m) |
| Total | | = 49.50 dB(μV/m) |
| Margin | = | 53.97 – 49.50 = 4.47 dB |
| | | = 4.47 dB below Limit |



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# 7. List of test equipments used for measurements

| Test Equipment | | Model | Mfg. | Serial No. | Cal. Date | Cal. Due Date |
|---|---|---|---|---|---|---|
| ☒ | EMI Test Receiver | ESCI7 | R&S | 100851 | 16.09.01 | 17.09.01 |
| ☒ | PSA Series Spectrum Analyzer | E4440A | Agilent | US40420382 | 16.09.05 | 17.09.05 |
| ☒ | EMI Test Receiver | ESPI3 | R&S | 100478 | 16.09.01 | 17.09.01 |
| ☒ | Attenuator | BW-S10-2W263+ | Mini-Circuits | NONE | 17.03.15 | 18.03.15 |
| ☒ | USB Wideband Power Sensor | U2022XA | Agilent | MY56040002 | 16.09.07 | 17.09.07 |
| ☒ | LogBicon Antenna(FCC) | VULB9160 | Schwarzbeck | 3164 | 15.06.08 | 17.06.08 |
| ☒ | Loop Antenna | 6502 | EMCO | 00033743 | 16.09.05 | 18.09.05 |
| ☒ | Horn Antenna(FCC) | BBHA 9120D | Schwarzbeck | 826 | 16.03.23 | 18.03.23 |
| ☒ | Horn Antenna | BBHA 9170 | Schwarzbeck | 9170-440 | 15.09.03 | 17.09.03 |
| ☒ | AMPLIFIER | TK-PA18 | TESTEK | 120020 | 16.09.01 | 17.09.01 |
| ☒ | AMPLIFIER | 310N | SONOMA INSTRUMENT | 284750 | 16.09.02 | 17.09.02 |
| ☒ | AMPLIFIER | JS44-18004000-45-8P | MITEQ Inc. | 1568695 | 16.09.02 | 17.09.02 |
| ☒ | Highpass Filter | WHKX3.0/18G-6SS | Wainwright Instrument | 15 | 17.03.14 | 18.03.14 |
| ☒ | Highpass Filter | WHNX6-4740-6000-26500-40CC | WAINWRIGHT INSTRUMENT GmbH | 1 | 16.09.02 | 17.09.02 |
| ☒ | Band Reject Filter | WRCGV 2402/2480-2382/2500-52/10SS | Wainwright Instrument | 2R | 17.02.01 | 18.02.01 |
| ☒ | 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 | HD2000 | HD GmbH | C/125 | N/A | N/A |
| ☒ | Antenna Master | MA4000 | AUDIX | N/A | N/A | N/A |



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