



# TEST REPORT

|                                                                                                                                                                                                                           |                                                 |                                                        |                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|--------------------------------------------------------|---------------------------------------------------------|
| <b>KCTL Inc.</b><br>65, Sinwon-ro, Yeongtong-gu,<br>Suwon-si, Gyeonggi-do, 16677, Korea<br>TEL: 82-31-285-0894 FAX: 82-505-299-8311<br><a href="http://www.kctl.co.kr">www.kctl.co.kr</a>                                 |                                                 | Report No.:<br><b>KR18-SRF0085</b><br>Page (1) of (35) |                                                         |
| <b>1. Client</b><br>◦ Name : SMARTeLock CO., LTD.<br>◦ Address : B-402, Geumgang Penterium IT Tower, 215, Galmachi-ro,<br>Jungwon-gu, Seongnam-si, Gyeonggi-do, 13217,<br>Rep. of KOREA<br>◦ Date of Receipt : 2018-06-01 |                                                 |                                                        |                                                         |
| <b>2. Use of Report</b> : -                                                                                                                                                                                               |                                                 |                                                        |                                                         |
| <b>3. Name of Product and Model</b> : IN-Furniture Safe / ES100                                                                                                                                                           |                                                 |                                                        |                                                         |
| <b>4. Manufacturer and Country of Origin</b> : SMARTeLock CO., LTD. / Korea                                                                                                                                               |                                                 |                                                        |                                                         |
| <b>5. FCC ID</b> : 2AQAVES100                                                                                                                                                                                             |                                                 |                                                        |                                                         |
| <b>6. Date of Test</b> : 2018-06-18 to 2018-06-21                                                                                                                                                                         |                                                 |                                                        |                                                         |
| <b>7. Test Standards</b> : FCC Part 15 Subpart C, 15.247                                                                                                                                                                  |                                                 |                                                        |                                                         |
| <b>8. Test Results</b> : Refer to the test result in the test report                                                                                                                                                      |                                                 |                                                        |                                                         |
| Affirmation                                                                                                                                                                                                               | Tested by<br><br>Name : Seonjun Yun (Signature) |                                                        | Technical Manager<br><br>Name : Jongha Choi (Signature) |
|                                                                                                                                                                                                                           |                                                 |                                                        |                                                         |
| 2018-06-26                                                                                                                                                                                                                |                                                 |                                                        |                                                         |
| <b>KCTL Inc.</b>                                                                                                                                                                                                          |                                                 |                                                        |                                                         |
| As a test result of the sample which was submitted from the client, this report does not guarantee the whole product quality. This test report should not be used and copied without a written agreement by KCTL Inc.     |                                                 |                                                        |                                                         |

## REPORT REVISION HISTORY

| Date       | Revision          | Page No |
|------------|-------------------|---------|
| 2018-06-26 | Originally issued | -       |
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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------------------------------------------|

## 1. Client information

**Applicant:** SMARTeLock CO., LTD.  
**Address:** B-402, Geumgang Penterium IT Tower, 215, Galmachi-ro,  
 Jungwon-gu, Seongnam-si, Gyeonggi-do, 13217 Rep. of  
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**Telephone number:** +82 31 743 7277  
**Facsimile number:** +82 31 743 7276  
**Contact person:** Jaemin Lee / jmlee@esmartlock.com

**Manufacturer:** SMARTeLock CO., LTD.  
**Address:** B-402, Geumgang Penterium IT Tower, 215, Galmachi-ro,  
 Jungwon-gu, Seongnam-si, Gyeonggi-do, 13217 Rep. of  
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## 2. Laboratory information

### Address

#### KCTL Inc.

65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea

Telephone Number: 82 31 285 0894

Facsimile Number: 82 505 299 8311

FCC Site Designation No: KR0040, FCC Site Registration No: 687132

VCCI Registration No. : R-3327, G-198, C-3706, T-1849

Industry Canada Registration No. : 8035A-2

KOLAS NO.: KT231

### SITE MAP



### 3. Description of E.U.T.

#### 3.1 Basic description

|                         |                                                                                                                 |
|-------------------------|-----------------------------------------------------------------------------------------------------------------|
| Applicant               | SMARTeLock CO., LTD.                                                                                            |
| Address of Applicant    | B-402, Geumgang Penterium IT Tower, 215, Galmachi-ro, Jungwon-gu, Seongnam-si, Gyeonggi-do, 13217 Rep. of KOREA |
| Manufacturer            | SMARTeLock CO., LTD.                                                                                            |
| Address of Manufacturer | B-402, Geumgang Penterium IT Tower, 215, Galmachi-ro, Jungwon-gu, Seongnam-si, Gyeonggi-do, 13217 Rep. of KOREA |
| Type of equipment       | IN-Furniture Safe                                                                                               |
| Basic Model             | ES100                                                                                                           |
| Serial number           | N/A                                                                                                             |

#### 3.2 General description

|                             |                                                               |
|-----------------------------|---------------------------------------------------------------|
| Frequency Range             | 2 402 MHz ~ 2 480 MHz (Bluetooth Low Energy), 13.56 MHz (NFC) |
| Type of Modulation          | GFSK MHz (Bluetooth Low Energy), ASK (NFC)                    |
| The number of channels      | 40 ch (Bluetooth Low Energy), 1 ch (NFC)                      |
| Type of Antenna             | Chip Antenna (Bluetooth Low Energy), Loop Antenna (NFC)       |
| Antenna Gain                | 3.50 dBi                                                      |
| Transmit Power              | -3.47 dBm                                                     |
| Power supply                | DC 6 V                                                        |
| Product SW/HW version       | nRF51_ES100_HW11_V1.0.0 / V1.1                                |
| Radio SW/HW version         | nRF51_ES100_HW11_V1.0.0 / V1.1                                |
| Test SW Version             | Toggle button ON/OFF                                          |
| RF power setting in TEST SW | default                                                       |

Note : The above EUT information was declared by the manufacturer.

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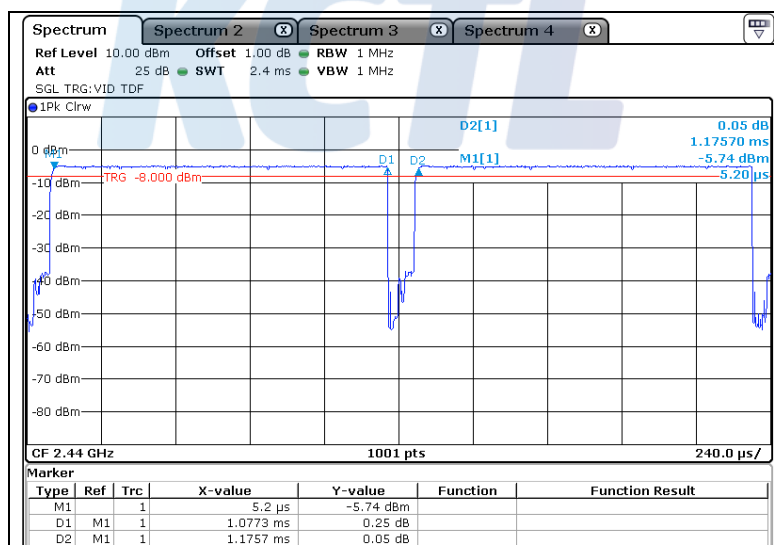
### 3.3 Test frequency

|                   | Frequency |
|-------------------|-----------|
| Lowest frequency  | 2 402 MHz |
| Middle frequency  | 2 440 MHz |
| Highest frequency | 2 480 MHz |

### 3.4 Test Voltage

| Mode            | Voltage |
|-----------------|---------|
| Nominal voltage | DC 6 V  |

### 3.5 Duty Cycle Correction Factor



Note<sub>1</sub>) : period : 1.18 ms, On time : 1.08 ms

Note<sub>2</sub>) :  $10 \log(1 / x) = 10 \log(1/0.92) = 0.36 \text{ dB}$ ,  $x = 1.08/1.18 = 0.92$  (92 %)

Note<sub>3</sub>) : It is a continuous transmission (duty cycle is less than 98 %)

## 4. Summary of test results

### 4.1 Standards & results

| FCC Rule Reference                                                                                                                                                                                                                                                                                                                                                                         | Parameter                                            | Report Section | Test Result                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|----------------|----------------------------|
| 15.203, 15.247(b)(4)                                                                                                                                                                                                                                                                                                                                                                       | Antenna Requirement                                  | 5.1            | C                          |
| 15.247(b)(3)                                                                                                                                                                                                                                                                                                                                                                               | Maximum Peak Output Power                            | 5.2            | C                          |
| 15.247(e)                                                                                                                                                                                                                                                                                                                                                                                  | Peak Power Spectral Density                          | 5.3            | C                          |
| 15.247(a)(2)                                                                                                                                                                                                                                                                                                                                                                               | 6 dB Channel Bandwidth                               | 5.4            | C                          |
| -                                                                                                                                                                                                                                                                                                                                                                                          | Occupied Bandwidth                                   | 5.4            | C                          |
| 15.247(d),15.205(a),15.209(a)                                                                                                                                                                                                                                                                                                                                                              | Spurious Emission,<br>Band Edge and Restricted bands | 5.5            | C                          |
| 15.207(a)                                                                                                                                                                                                                                                                                                                                                                                  | Conducted Emissions                                  | 5.6            | NA<br>(Note <sub>2</sub> ) |
| Note <sub>1</sub> ): C = Complies, NC = Not complies, NT = Not tested, NA = Not Applicable<br>Note <sub>2</sub> ): 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. |                                                      |                |                            |

Note: The general test methods used to test this device is ANSI C63.10:2013

### 4.2 Measurement Uncertainty

| Measurement Item             | Expanded Uncertainty<br>$U = kU_c$ ( $k = 2$ ) |                    |
|------------------------------|------------------------------------------------|--------------------|
| Conducted RF power           | 1.44 dB                                        |                    |
| Conducted Spurious Emissions | 1.52 dB                                        |                    |
| Radiated Spurious Emissions  | 30 MHz ~ 300 MHz:                              | +4.94 dB, -5.06 dB |
|                              |                                                | +4.93 dB, -5.05 dB |
|                              | 300 MHz ~ 1 000 MHz:                           | +4.97 dB, -5.08 dB |
|                              |                                                | +4.84 dB, -4.96 dB |
| Conducted Emissions          | 1 GHz ~ 25 GHz:                                | +6.03 dB, -6.05 dB |
|                              | 9 kHz ~ 150 kHz:                               | 3.75 dB            |
|                              | 150 kHz ~ 30 MHz:                              | 3.36 dB            |

## 5. Test results

### 5.1 Antenna Requirement

#### 5.1.1 Regulation

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.

And according to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### 5.1.2 Result

##### - Complied

The transmitter has permanently attached Chip Antenna (internal antenna) on PCB.

## 5.2 Maximum Peak Output Power

### 5.2.1 Regulation

According to §15.247(b)(3), For systems using digital modulation in the 902-928 MHz, 2 400-2 483.5 MHz, and 5 725-5 850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### 5.2.2 Measurement Procedure

These test measurement settings are specified in section 9.0 of 558074 D01 DTS Meas Guidance.

#### 5.2.2.1 PKPM1 Peak-reading power meter method

The maximum peak conducted output power may be measured using a broadband peak RF power meter.

The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

### 5.2.3 Test Result

#### - Complied

| Channel | Frequency<br>[MHz] | Result<br>[dBm] | Limit<br>[dBm] | Margin<br>[dB] | Average Power<br>[dBm] |
|---------|--------------------|-----------------|----------------|----------------|------------------------|
| Lowest  | 2 402              | -3.47           | 30.00          | 33.47          | -5.15                  |
| Middle  | 2 440              | -3.47           | 30.00          | 33.47          | -5.08                  |
| Highest | 2 480              | -7.08           | 30.00          | 37.08          | -9.34                  |

#### -NOTE:

1. We took the insertion loss of the cable loss into consideration within the measuring instrument. (Cable loss + Attenuator)
2. It was measured by peak power sensor.

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## 5.3 Peak Power Spectral Density

### 5.3.1 Regulation

According to §15.247(e), 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.

### 5.3.2 Measurement Procedure

These test measurement settings are specified in section 10.0 of 558074 D01 DTS Meas Guidance.

#### 5.3.2.1 Method PKPSD (peak PSD)

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance.

- 1) Set analyzer center frequency to DTS channel center frequency.
- 2) Set the span to 1.5 times the DTS bandwidth.
- 3) Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
- 4) Set the VBW  $\geq 3 \times \text{RBW}$ .
- 5) Detector = peak.
- 6) Sweep time = auto couple.
- 7) Trace mode = max hold.
- 8) Allow trace to fully stabilize.
- 9) Use the peak marker function to determine the maximum amplitude level within the RBW.
- 10) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### 5.3.3 Test Result

- Complied

| Channel | Frequency<br>[MHz] | Result<br>(RBW=3 kHz)<br>[dB m/3 kHz] | Limit<br>[dBm/3 kHz] | Margin<br>[dB] |
|---------|--------------------|---------------------------------------|----------------------|----------------|
| Lowest  | 2 402              | -17.05                                | 8.00                 | 25.05          |
| Middle  | 2 440              | -17.25                                | 8.00                 | 25.25          |
| Highest | 2 480              | -22.79                                | 8.00                 | 30.79          |

**-NOTE:**

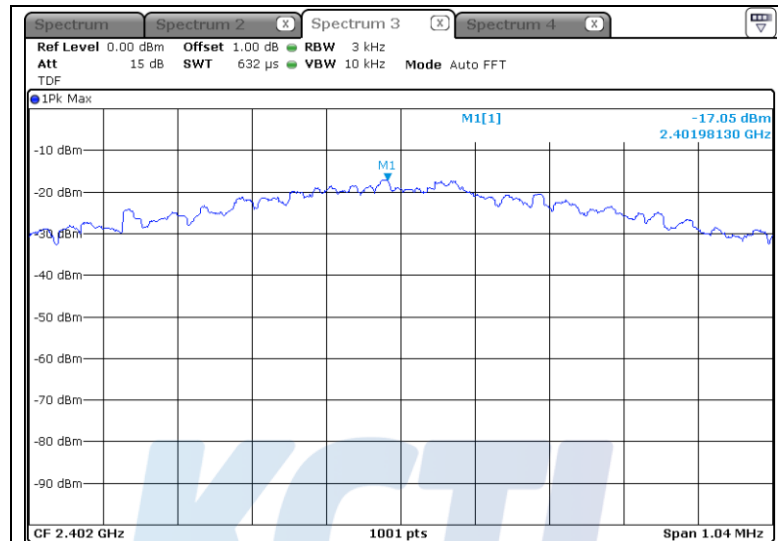
1. We took the insertion loss of the cable loss into consideration within the measuring instrument.

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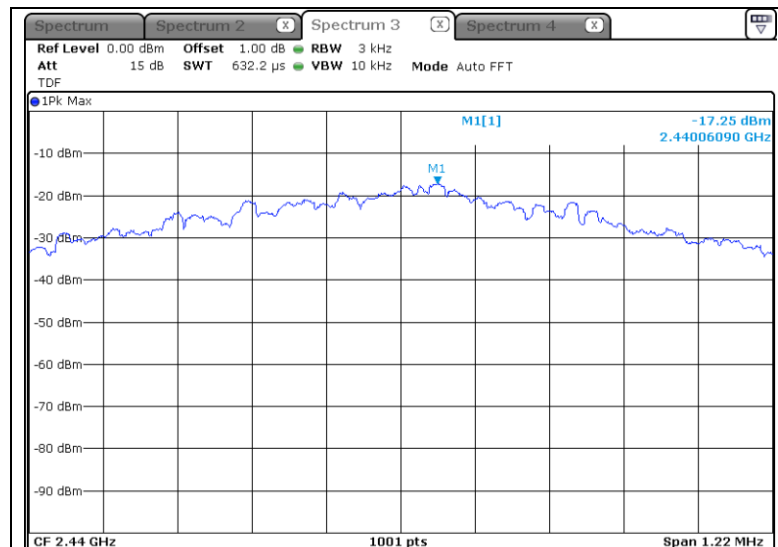
### 5.3.4 Test Plot

Figure 1. Plot of the Power Density

Lowest Channel (2 402 MHz)



Middle Channel (2 440 MHz)



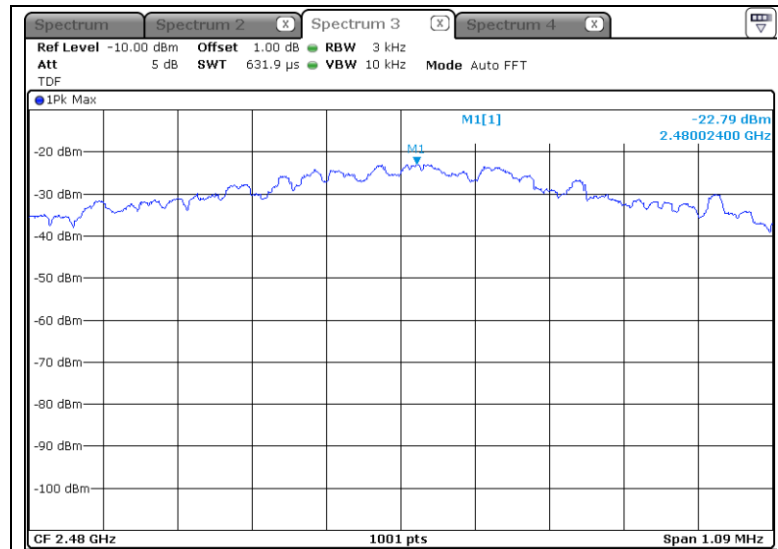
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Highest Channel (2 480 MHz)



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## 5.4 6 dB Bandwidth(DTS Channel Bandwidth)

### 5.4.1 Regulation

According to §15.247(a)(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2 400–2 483.5 MHz, and 5 725–5 850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

### 5.4.2 Measurement Procedure

These test measurement settings are specified in section 8.0 of 558074 D01 DTS Meas Guidance.

#### 5.4.2.1 DTS Channel Bandwidth Measurement Procedure-Option 2

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 x RBW, peak detector with maximum hold) is implemented by the instrumentation function.

When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

### 5.4.3 Test Result

- Complied

| Channel | Frequency<br>[MHz] | 6 dB Bandwidth<br>[MHz] | Min. Limit<br>[MHz] | Occupied<br>Bandwidth<br>(99 % BW) [MHz] |
|---------|--------------------|-------------------------|---------------------|------------------------------------------|
| Lowest  | 2 402              | 0.69                    | 0.50                | 1.74                                     |
| Middle  | 2 440              | 0.81                    | 0.50                | 1.77                                     |
| Highest | 2 480              | 0.73                    | 0.50                | 1.77                                     |

-NOTE:

1. We took the insertion loss of the cable loss into consideration within the measuring instrument.

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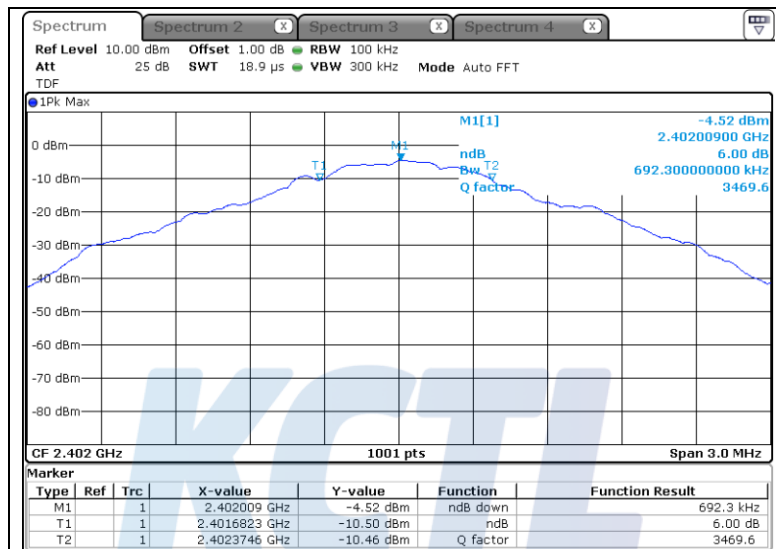
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### 5.4.4 Test Plot

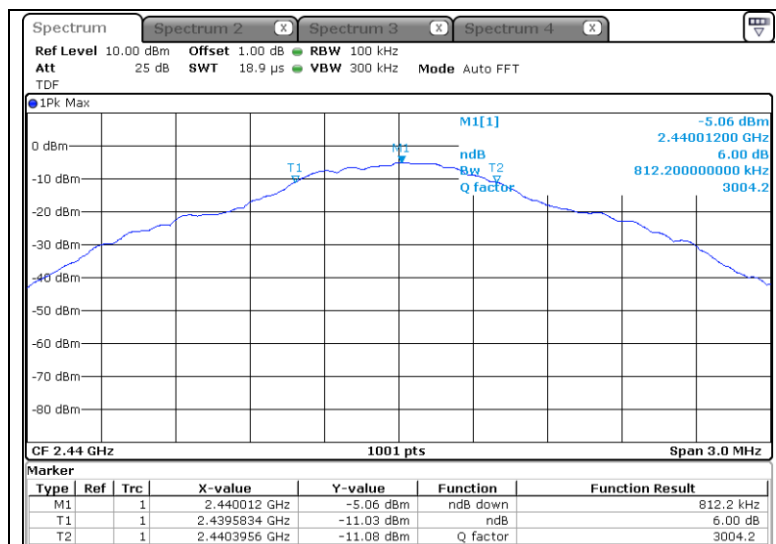
Figure 2. Plot of the 6dB Bandwidth & Occupied Bandwidth

#### - 6 dB Bandwidth

Lowest Channel (2 402 MHz)



Middle Channel (2 440 MHz)



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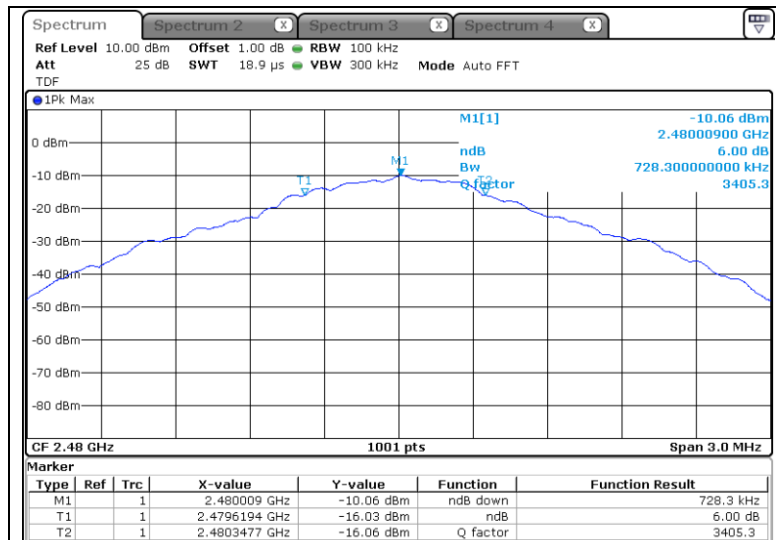
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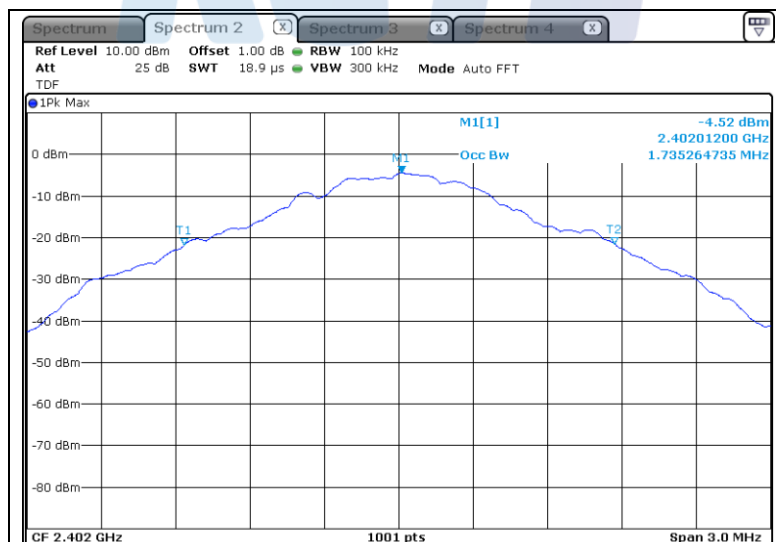
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### Highest Channel (2 480 MHz)



### - OBW

### Lowest Channel (2 402 MHz)



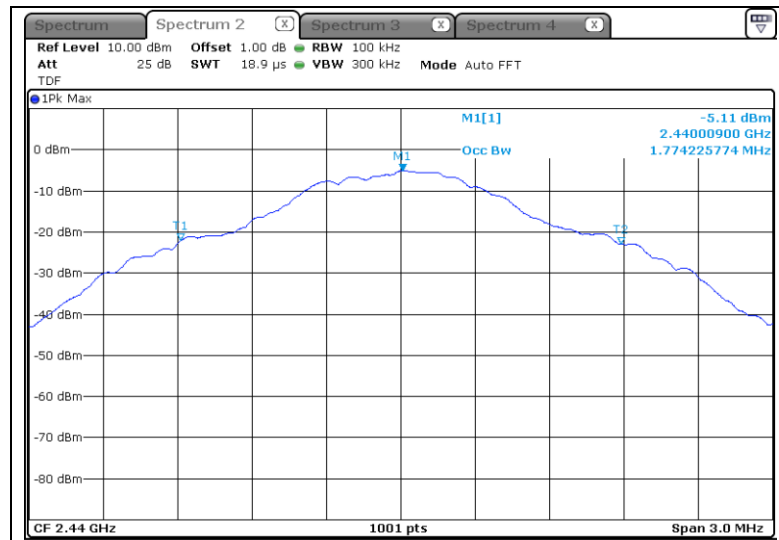
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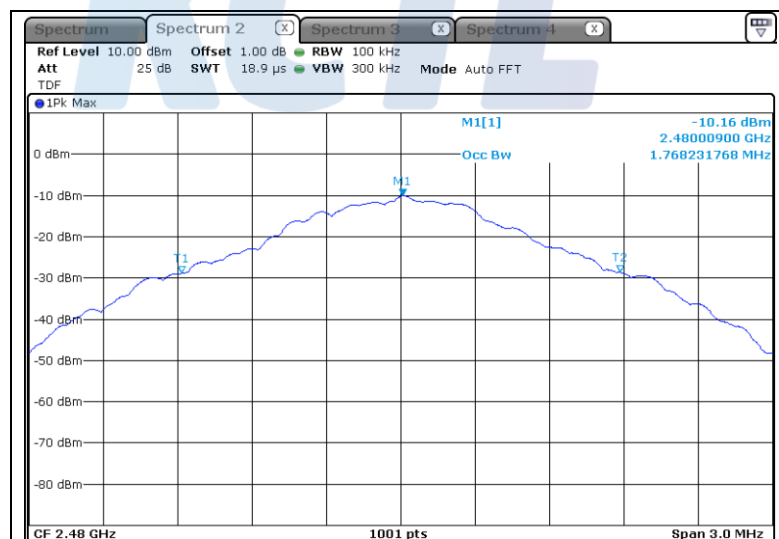
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### Middle Channel (2 440 MHz)



### Highest Channel (2 480 MHz)



## 5.5 Spurious Emission, Band Edge, and Restricted bands

### 5.5.1 Regulation

According to §15.247(d), 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)).

According to §15.209(a), 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:

| Frequency (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      | 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 54–72 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §15.231 and 15.241.

According to § 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

| MHz                   | MHz                     | MHz               | GHz           |
|-----------------------|-------------------------|-------------------|---------------|
| 0.009 - 0.110         | 16.42 - 16.423          | 399.9 - 410       | 4.5 - 5.15    |
| 0.495 - 0.505         | 16.694 75 - 16.695 25   | 608 - 614         | 5.35 - 5.46   |
| 2.173 5 - 2.190 5     | 16.804 25 - 16.804 75   | 960 - 1 240       | 7.25 - 7.75   |
| 4.125 - 4.128         | 25.5 - 25.67            | 1 300 - 1 427     | 8.025 - 8.5   |
| 4.177 25 - 4.177 75   | 37.5 - 38.25            | 1 435 - 1 626.5   | 9.0 - 9.2     |
| 4.207 25 - 4.207 75   | 73 - 74.6               | 1 645.5 - 1 646.5 | 9.3 - 9.5     |
| 6.215 - 6.218         | 74.8 - 75.2             | 1 660 - 1 710     | 10.6 - 12.7   |
| 6.267 75 - 6.268 25   | 108 - 121.94            | 1 718.8 - 1 722.2 | 13.25 - 13.4  |
| 6.311 75 - 6.312 25   | 123 - 138               | 2 200 - 2 300     | 14.47 - 14.5  |
| 8.291 - 8.294         | 149.9 - 150.05          | 2 310 - 2 390     | 15.35 - 16.2  |
| 8.362 - 8.366         | 156.524 75 - 156.525 25 | 2 483.5 - 2 500   | 17.7 - 21.4   |
| 8.376 25 - 8.386 75   | 156.7 - 156.9           | 2 690 - 2 900     | 22.01 - 23.12 |
| 8.414 25 - 8.414 75   | 162.012 5 - 167.17      | 3 260 - 3 267     | 23.6 - 24.0   |
| 12.29 - 12.293        | 167.72 - 173.2          | 3 332 - 3 339     | 31.2 - 31.8   |
| 12.519 75 - 12.520 25 | 240 - 285               | 3 345.8 - 3 358   | 36.43 - 36.5  |
| 12.576 75 - 12.577 25 | 322 - 335.4             | 3 600 - 4 400     | Above 38.6    |
| 13.36 - 13.41         |                         |                   |               |

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

## 5.5.2 Measurement Procedure

### 5.5.2.1 Band-edge Compliance of RF Conducted Emissions

#### 5.5.2.1.1 Reference Level Measurement

Establish a reference level by using the following procedure:

- 1) Set instrument center frequency to DTS channel center frequency.
- 2) Set the span to  $\geq 1.5$  times the DTS bandwidth.
- 3) Set the RBW = 100 kHz.
- 4) Set the VBW  $\geq 3 \times$  RBW.
- 5) Detector = peak.
- 6) Sweep time = auto couple.
- 7) Trace mode = max hold.
- 8) Allow trace to fully stabilize.
- 9) Use the peak marker function to determine the maximum PSD level.

#### 5.5.2.1.2 Emissions Level Measurement

- 1) Set the center frequency and span to encompass frequency range to be measured.
- 2) Set the RBW = 100 kHz.
- 3) Set the VBW  $\geq 3 \times$  RBW.
- 4) Detector = peak.
- 5) Ensure that the number of measurement points  $\geq$  span/RBW
- 6) Sweep time = auto couple.
- 7) Trace mode = max hold.
- 8) Allow trace to fully stabilize.
- 9) Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b). Report the three highest emissions relative to the limit.

### 5.5.2.2 Conducted Spurious Emissions

Set the spectrum analyzer as follows:

- 1) 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.

- 2) RBW = 100 kHz
- 3) VBW  $\geq$  RBW
- 4) Sweep = auto
- 5) Detector function = peak
- 6) Trace = max hold
- 7) Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
- 8) Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

### 5.5.2.3 Radiated Spurious Emissions

- 1) The preliminary and final radiated measurements were performed to determine the frequency producing the maximum emissions in at a 10m semi-anechoic chamber. The EUT was tested at a distance 3 meters.
- 2) The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360°.
- 3) The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 kHz to 30 MHz using the loop antenna, and from 30 to 1 000 MHz using the Bi-Log antenna, and from 1 000 MHz to 26 500 MHz using the horn antenna.
- 4) Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.
- 5) The 0.8m height is for below 1 G testing, and 1.5m is for above 1G testing.

#### Note

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1 GHz.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Average detection (AV) at frequency above 1 GHz. (Detector = RMS, Averaging type = power)  
In case of duty cycle less than 98%, a duty cycle correction factor has to be added to the measurement result.

|                                                                                                                                                                                                          |                                                             |                                                                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <p><b>KCTL Inc.</b><br/> 65, Sinwon-ro, Yeongtong-gu,<br/> Suwon-si, Gyeonggi-do, 16677, Korea<br/> TEL: 82-31-285-0894 FAX: 82-505-299-8311<br/> <a href="http://www.kctl.co.kr">www.kctl.co.kr</a></p> | <p>Report No.:<br/> KR18-SRF0085<br/> Page (25) of (35)</p> |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------|

- KDB 414788

#### RADIATED EMISSION TEST SITES FOR MEASUREMENTS FROM 9 kHz TO 30 MHz

The test site requirements of Section 15.31(d) apply for part 15 device radiated emission measurements at frequencies below 30 MHz. Site validation requirements for radiated emission measurements below 30 MHz have not been established. However, ANSI C63 standards provide general criteria for test sites used to make measurements in the 9 kHz to 30 MHz frequency range. For example, Subclause 5.2 of ANSI C63.10-2013 states that “radiated emission test sites below 30 MHz shall be free from metal objects, buried pipes, and any objects that can affect radiated measurements. An alternative test site that can demonstrate equivalence to a test site as described in the preceding sentence shall be accepted for the purposes of this standard.”

Therefore, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30 MHz if characterized so that the measurements correspond to those obtained at an open-field test site. Site characterization shall be obtained by other means such as performing measurements at an alternative test site and comparing to measurement results obtained at an open-field test site. Statistical analysis of the measurement data from several similar devices may be required to show correlation between the measurements from the alternative test site and the open-field test site. Test laboratories wishing to make radiated emission measurements below 30 MHz using other than an open-field site must document evidence of correlation between the alternative site and an open-field test site and make it available to the Commission upon request and for review during a laboratory accreditation assessment.

For Part 18 equipment, Section 2.1 of FCC Measurement Procedure MP-5 also permits the use of test sites other than an open-field test site only if it can be shown that the results obtained at such a location are correlated with those made at an open-field test site. Sufficient tests shall be made to demonstrate that the alternative test site produces results that correlate with the results of tests made at an open-field test site.

### 5.5.3 Test Result

#### - Complied

1. Conducted Spurious Emissions was shown in figure 3.  
Note: We took the insertion loss of the cable into consideration within the measuring instrument.
2. Measured value of the Field strength of spurious Emissions (Radiated)
3. It tested x,y and z – 3 axis each, mentioned only worst case data at this report.

#### - Below 1 GHz data (worst-case)

##### Lowest Channel (2 402 MHz)

| Frequency<br>[MHz]                             | Receiver<br>Bandwidth<br>[kHz] | Pol.<br>[V/H] | Reading<br>[dB(μV)] | Cable<br>Loss<br>[dB] | Amp<br>Gain<br>[dB] | Antenna<br>Factor<br>[dB] | Factor<br>[dB] | Result<br>[dB(μV/m)] | Limit<br>[dB(μV/m)] | Margin<br>[dB] |
|------------------------------------------------|--------------------------------|---------------|---------------------|-----------------------|---------------------|---------------------------|----------------|----------------------|---------------------|----------------|
| <b>Quasi-Peak DATA. Emissions below 30 MHz</b> |                                |               |                     |                       |                     |                           |                |                      |                     |                |
| Not detected                                   |                                |               |                     |                       |                     |                           |                |                      |                     |                |
| <b>Quasi-Peak DATA. Emissions below 1 GHz</b>  |                                |               |                     |                       |                     |                           |                |                      |                     |                |
| 35.21                                          | 120                            | H             | 35.80               | 1.18                  | -29.6               | 12.52                     | -15.90         | 19.90                | 40.00               | 20.10          |
| 189.81                                         | 120                            | H             | 36.00               | 3.03                  | -29.6               | 10.77                     | -15.80         | 20.20                | 43.50               | 23.30          |
| 216.97                                         | 120                            | H             | 36.70               | 3.25                  | -29.59              | 10.54                     | -15.80         | 20.90                | 46.00               | 25.10          |
| 244.13                                         | 120                            | H             | 37.50               | 3.46                  | -29.54              | 11.58                     | -14.50         | 23.00                | 46.00               | 23.00          |
| 271.17                                         | 120                            | H             | 38.80               | 3.67                  | -29.19              | 12.52                     | -13.00         | 25.80                | 46.00               | 20.20          |
| 705.24                                         | 120                            | V             | 29.10               | 6.22                  | -28.7               | 21.18                     | -1.30          | 27.80                | 46.00               | 18.20          |

Note. Factor = Cable loss + Amp gain + Antenna factor

### - Above 1 GHz data

#### Lowest Channel (2 402 MHz)

| Frequency<br>[MHz]                         | Receiver<br>Bandwidth<br>[kHz] | Pol.<br>[V/H] | Reading<br>[dB(μV)] | Cable<br>Loss<br>[dB] | Amp<br>Gain<br>[dB] | Antenna<br>Factor<br>[dB] | Factor<br>[dB] | DCCF<br>[dB] | Result<br>[dB(μV/m)] | Limit<br>[dB(μV/m)] | Margin<br>[dB] |
|--------------------------------------------|--------------------------------|---------------|---------------------|-----------------------|---------------------|---------------------------|----------------|--------------|----------------------|---------------------|----------------|
| <b>Peak DATA. Emissions above 1 GHz</b>    |                                |               |                     |                       |                     |                           |                |              |                      |                     |                |
| 1 886.95                                   | 1 000                          | V             | 75.70               | 3.32                  | -59.61              | 27.35                     | -28.94         | -            | 46.76                | 74.00               | 27.24          |
| 2 386.12 <sup>1)</sup>                     | 1 000                          | V             | 75.83               | 3.70                  | -59.22              | 28.53                     | -26.99         | -            | 48.85                | 74.00               | 25.15          |
| 4 804.21 <sup>1,2)</sup>                   | 1 000                          | V             | 75.50               | 5.34                  | -61.68              | 32.80                     | -23.54         | -            | 51.96                | 74.00               | 22.04          |
| 7 207.02 <sup>2)</sup>                     | 1 000                          | V             | 75.42               | 6.71                  | -63.19              | 35.91                     | -20.57         | -            | 54.85                | 74.00               | 19.15          |
| 21 435.86                                  | 1 000                          | V             | 47.72               | 11.90                 | -49.30              | 44.90                     | 7.50           | -            | 55.23                | 74.00               | 18.77          |
| 25 967.16                                  | 1 000                          | H             | 45.88               | 13.60                 | -46.57              | 45.70                     | 12.73          | -            | 58.61                | 74.00               | 15.39          |
| <b>Average DATA. Emissions above 1 GHz</b> |                                |               |                     |                       |                     |                           |                |              |                      |                     |                |
| 2 386.12 <sup>1)</sup>                     | 1 000                          | V             | 56.36               | 3.70                  | -59.22              | 28.53                     | -26.99         | 0.36         | 29.37                | 54.00               | 24.27          |
| 4 804.21 <sup>1,2)</sup>                   | 1 000                          | V             | 72.53               | 5.34                  | -61.68              | 32.80                     | -23.54         | 0.36         | 48.99                | 54.00               | 4.65           |

Note. Factor = Cable loss + Amp. Gain + Antenna factor

<sup>1)</sup> Restricted band

<sup>2)</sup> Harmonic

#### Middle Channel (2 440 MHz)

| Frequency<br>[MHz]                         | Receiver<br>Bandwidth<br>[kHz] | Pol.<br>[V/H] | Reading<br>[dB(μV)] | Cable<br>Loss<br>[dB] | Amp<br>Gain<br>[dB] | Antenna<br>Factor<br>[dB] | Factor<br>[dB] | DCCF<br>[dB] | Result<br>[dB(μV/m)] | Limit<br>[dB(μV/m)] | Margin<br>[dB] |
|--------------------------------------------|--------------------------------|---------------|---------------------|-----------------------|---------------------|---------------------------|----------------|--------------|----------------------|---------------------|----------------|
| <b>Peak DATA. Emissions above 1 GHz</b>    |                                |               |                     |                       |                     |                           |                |              |                      |                     |                |
| 1 784.06                                   | 1 000                          | V             | 73.87               | 3.22                  | -60.02              | 26.94                     | -29.86         | -            | 44.01                | 74.00               | 29.99          |
| 3 395.08                                   | 1 000                          | H             | 76.65               | 4.39                  | -60.01              | 30.77                     | -24.85         | -            | 51.80                | 74.00               | 22.20          |
| 4 879.97 <sup>1,2)</sup>                   | 1 000                          | V             | 75.05               | 5.39                  | -61.24              | 32.84                     | -23.01         | -            | 52.04                | 74.00               | 21.96          |
| 7 320.69 <sup>1,2)</sup>                   | 1 000                          | V             | 73.68               | 6.76                  | -63.11              | 36.02                     | -20.33         | -            | 53.35                | 74.00               | 20.65          |
| 23 175.70                                  | 1 000                          | H             | 47.52               | 12.50                 | -49.04              | 45.10                     | 8.56           | -            | 56.09                | 74.00               | 17.91          |
| 26 179.66                                  | 1 000                          | V             | 45.91               | 13.70                 | -46.73              | 45.70                     | 12.67          | -            | 58.58                | 74.00               | 15.42          |
| <b>Average DATA. Emissions above 1 GHz</b> |                                |               |                     |                       |                     |                           |                |              |                      |                     |                |
| 4 879.97 <sup>1,2)</sup>                   | 1 000                          | V             | 70.19               | 5.39                  | -61.24              | 32.84                     | -23.01         | 0.36         | 47.18                | 54.00               | 6.46           |
| 7 320.69 <sup>1,2)</sup>                   | 1 000                          | V             | 64.79               | 6.76                  | -63.11              | 36.02                     | -20.33         | 0.36         | 44.46                | 54.00               | 9.18           |

Note. Factor = Cable loss + Amp. Gain + Antenna factor

<sup>1)</sup> Restricted band

<sup>2)</sup> Harmonic

### Highest Channel (2 480 MHz)

| Frequency<br>[MHz]                         | Receiver<br>Bandwidth<br>[kHz] | Pol.<br>[V/H] | Reading<br>[dB(μV)] | Cable<br>Loss<br>[dB] | Amp<br>Gain<br>[dB] | Antenna<br>Factor<br>[dB] | Factor<br>[dB] | DCCF<br>[dB] | Result<br>dB(μV/m) | Limit<br>dB(μV/m) | Margin<br>[dB] |
|--------------------------------------------|--------------------------------|---------------|---------------------|-----------------------|---------------------|---------------------------|----------------|--------------|--------------------|-------------------|----------------|
| <b>Peak DATA. Emissions above 1 GHz</b>    |                                |               |                     |                       |                     |                           |                |              |                    |                   |                |
| 1 987.58                                   | 1 000                          | H             | 77.67               | 3.41                  | -59.25              | 27.75                     | -28.09         | -            | 49.58              | 74.00             | 24.42          |
| 2 485.39 <sup>1)</sup>                     | 1 000                          | V             | 75.04               | 3.77                  | -59.10              | 28.72                     | -26.61         | -            | 48.43              | 74.00             | 25.57          |
| 4 959.68 <sup>1,2)</sup>                   | 1 000                          | V             | 74.46               | 5.44                  | -60.80              | 32.88                     | -22.48         | -            | 51.98              | 74.00             | 22.02          |
| 7 439.17 <sup>1,2)</sup>                   | 1 000                          | V             | 66.55               | 6.81                  | -63.01              | 36.14                     | -20.06         | -            | 46.49              | 74.00             | 27.51          |
| 21 537.06                                  | 1 000                          | H             | 49.18               | 12.00                 | -49.48              | 45.00                     | 7.52           | -            | 56.70              | 74.00             | 17.30          |
| 26 393.22                                  | 1 000                          | H             | 46.23               | 13.70                 | -46.79              | 45.60                     | 12.51          | -            | 58.74              | 74.00             | 15.26          |
| <b>Average DATA. Emissions above 1 GHz</b> |                                |               |                     |                       |                     |                           |                |              |                    |                   |                |
| 2 485.39 <sup>1)</sup>                     | 1 000                          | V             | 56.83               | 3.77                  | -59.10              | 28.72                     | -26.61         | 0.36         | 30.22              | 54.00             | 23.42          |
| 4 959.68 <sup>1,2)</sup>                   | 1 000                          | V             | 70.44               | 5.44                  | -60.80              | 32.88                     | -22.48         | 0.36         | 47.96              | 54.00             | 5.68           |
| 7 439.17 <sup>1,2)</sup>                   | 1 000                          | V             | 64.24               | 6.81                  | -63.01              | 36.14                     | -20.06         | 0.36         | 44.18              | 54.00             | 9.46           |

Note. Factor = Cable loss + Amp. Gain + Antenna factor

<sup>1)</sup> Restricted band

<sup>2)</sup> Harmonic

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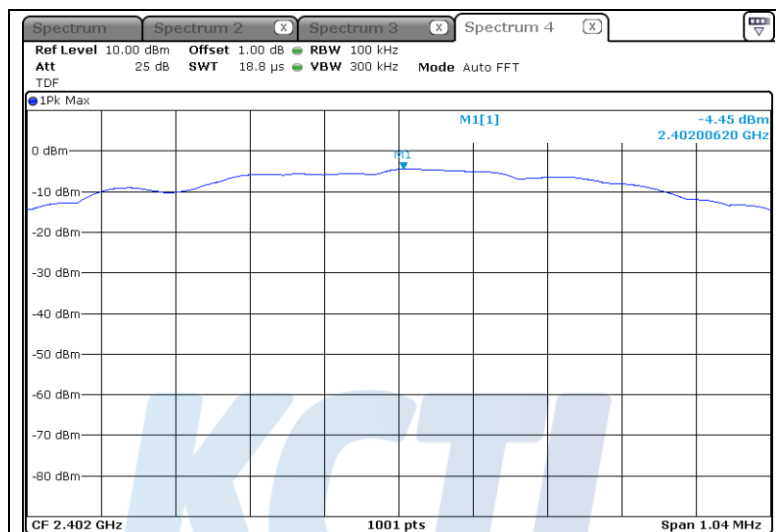
# KCTL

### 5.5.5 Test Plot

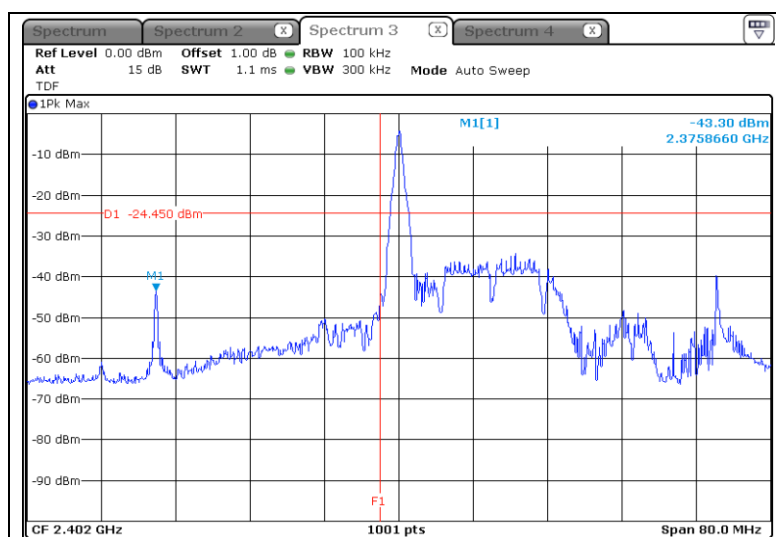
Figure 5. Plot of the Band-edge & Conducted Spurious Emissions (Conducted)

Lowest Channel (2 402 MHz)

#### Reference



#### Band-edge



Result of 2 400.0 MHz

## KCTL Inc.

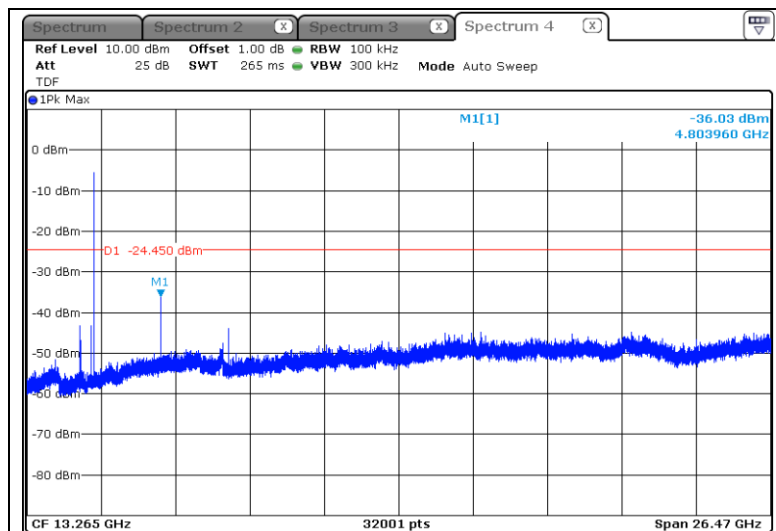
65, Sinwon-ro, Yeongtong-gu,  
Suwon-si, Gyeonggi-do, 16677, Korea  
TEL: 82-31-285-0894 FAX: 82-505-299-8311  
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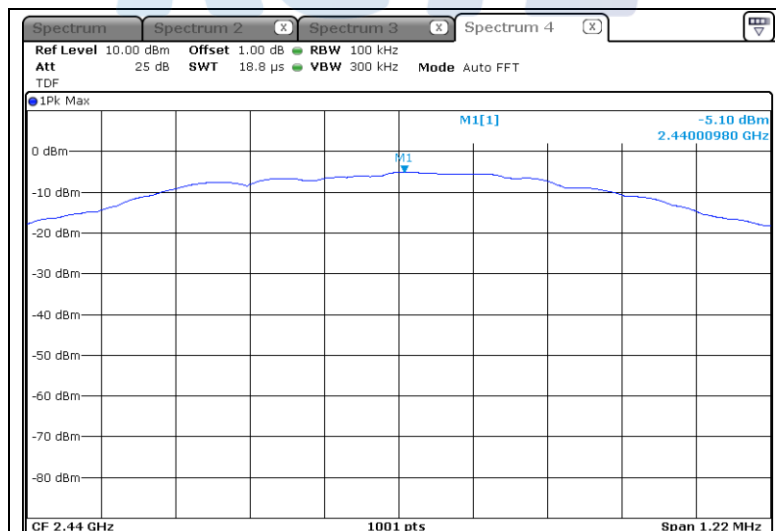
# KCTL

### Conducted Spurious Emissions



Middle Channel (2 440 MHz)

### Reference



## KCTL Inc.

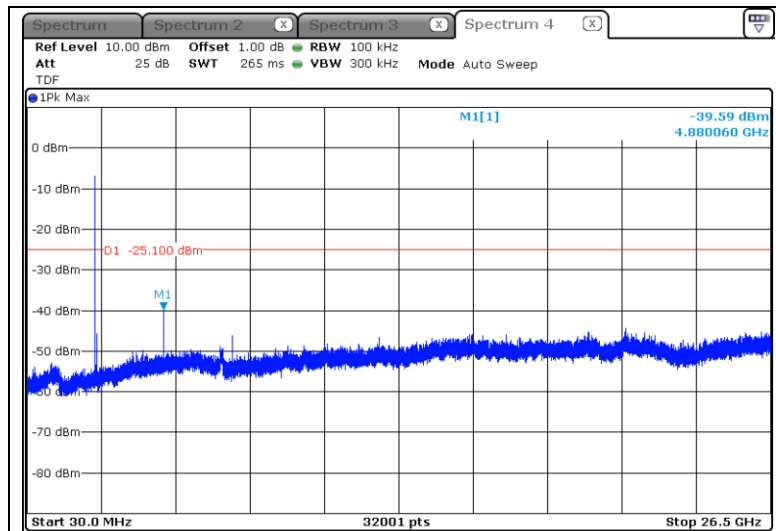
65, Sinwon-ro, Yeongtong-gu,  
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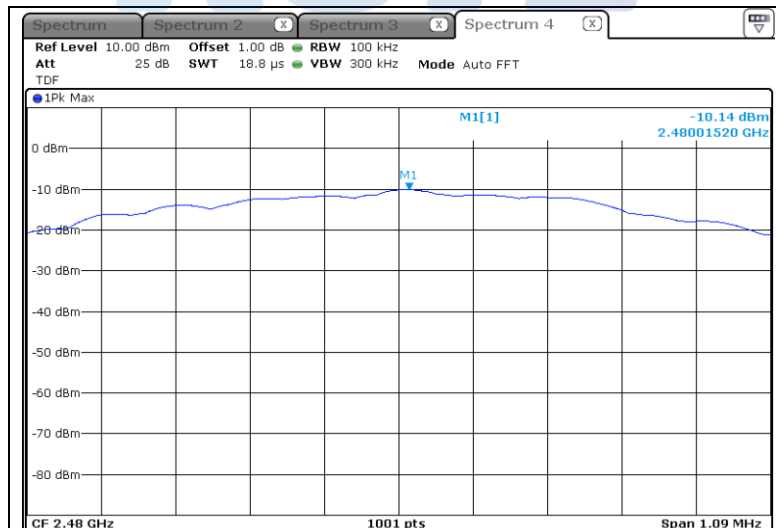
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### Conducted Spurious Emissions



Highest Channel (2 480 MHz)

### Reference



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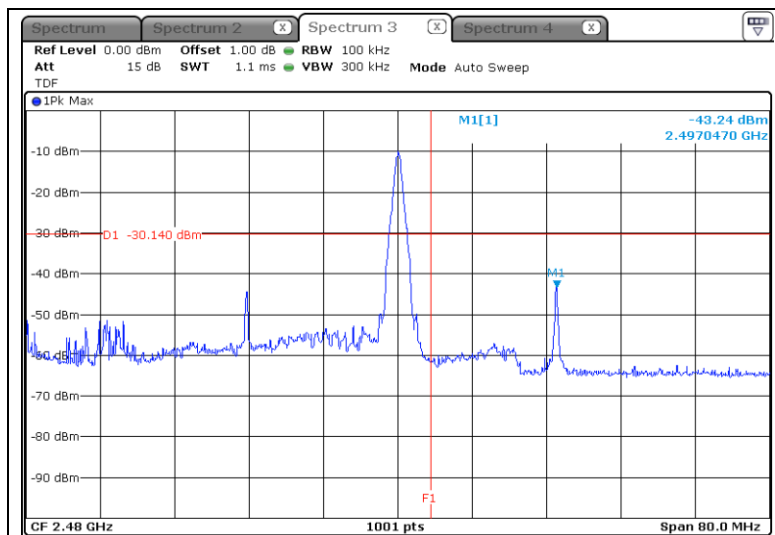
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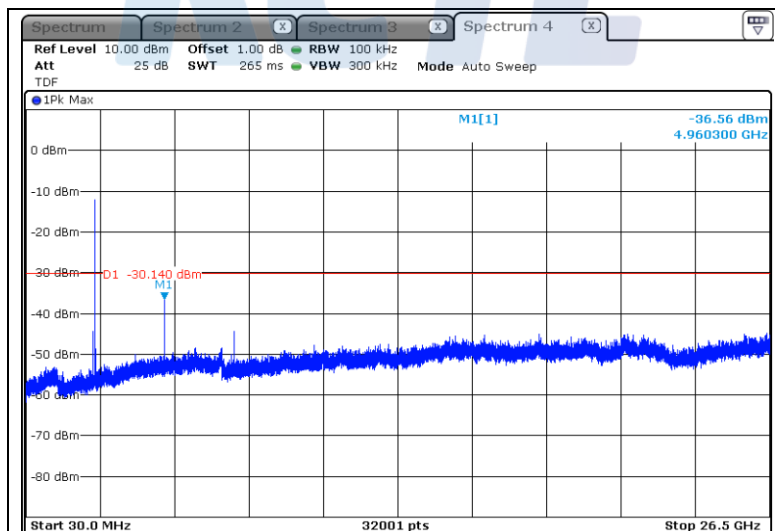
# KCTL

### Band-edge



Result of 2 483.5 MHz

### Conducted Spurious Emissions



## 5.6 Conducted Emission

### 5.6.1 Regulation

According to §15.207(a), 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 Ω 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 frequency ranges.

| Frequency of emission (MHz) | Conducted limit (dBµV) |            |
|-----------------------------|------------------------|------------|
|                             | 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.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

### 5.6.2 Measurement Procedure

- 1) The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5m away from the side wall of the shielded room.
- 2) Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50µH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.
- 3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
- 4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment in the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.
- 5) The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASI-PEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

### 5.6.3 Test Result

**Result: NA : 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.**

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## 6. Test equipment used for test

|   | Equipment Name          | Manufacturer    | Model No.                                     | Serial No.  | Next Cal. Date |
|---|-------------------------|-----------------|-----------------------------------------------|-------------|----------------|
| ■ | SPECTRUM ANALYZER       | R&S             | FSV40                                         | 100988      | 19.01.05       |
| ■ | DC Power Supply         | AGILENT         | E3632A                                        | KR75304571  | 19.05.14       |
| ■ | SIGNAL GENERATOR        | R&S             | SMR40                                         | 100007      | 19.05.15       |
| ■ | WIDEBAND POWER SENSOR   | R&S             | NRP-Z81                                       | 257566      | 19.01.05       |
| ■ | Attenuator              | R&S             | DNF<br>Dämpfungsglied<br>10 dB in<br>N-50 Ohm | 0003        | 19.01.31       |
| ■ | Vector Signal Generator | R&S             | SMBV100A                                      | 257566      | 19.01.05       |
| ■ | Loop Antenna            | R&S             | HFH2-Z2                                       | 892665/035  | 19.01.25       |
| ■ | EMI Test Receiver       | R&S             | ESC17                                         | 100732      | 18.08.24       |
| ■ | Amplifier               | SONOMA          | 310N                                          | 284608      | 18.08.24       |
| ■ | Antenna Mast            | MA4000-EP       | Innco Systems                                 | 303         | -              |
| ■ | Turn Table              | DT2000          | Innco Systems                                 | 79          | -              |
| ■ | Antenna Mast            | Innco Systems   | MA4640-XP-ET                                  | -           | -              |
| ■ | Turn Table              | DT2000          | Innco Systems                                 | 79          | -              |
| ■ | Bi-Log Antenna          | SCHWARZBECK     | VULB9163                                      | 440         | 19.10.23       |
| ■ | ATTENUATOR              | HP              | 8491A                                         | MY52461848  | 19.10.23       |
| ■ | Horn Antenna            | ETS.lindgren    | 3117                                          | 00155757    | 18.10.20       |
| ■ | Horn Antenna            | ETS.lindgren    | 3116                                          | 86632       | 19.04.20       |
| ■ | Amplifier               | L-3 Narda-MITEQ | AMF-7D-01001800-22-10P                        | 2003683     | 19.05.15       |
| ■ | Amplifier               | L-3 Narda-MITEQ | JS44-18004000-33-8P                           | 2000997     | 18.08.09       |
| ■ | High Pass Filter        | WT              | WT-A1698-HS                                   | WT160411001 | 19.05.14       |
| ■ | Cable Assembly          | Radiall         | 2301762000PJ                                  | 1724.66     | -              |
| ■ | Cable Assembly          | RadiAll         | 2301761768000PJ                               | 17.30.38    | -              |
| ■ | Cable Assembly          | Gigalane        | RF-400                                        | -           | -              |