

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

Applicant: Opticon Sensors Europe B.V.
Opaallaan 35, 2132 XV Hoofddorp, The Netherlands

Product Name: ESL Electronic Shelf Label

Brand Name: OPTICON

Model No.: EE-420R

Model Difference: N/A

FCC ID: Q2QEE420R

Report Number: E2/2017/90055

FCC Rule Part: §15.249

Issue Date: Nov. 15, 2017

Date of Test: Oct. 18, 2017 ~ Nov. 08, 2017

Date of EUT Received: Oct. 18, 2017

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Electronics & Communication Laboratory. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.

The test results of this report relate only to the tested sample identified in this report.

Prepared By: Yuri Tsai
Yuri Tsai / Clerk

Approved By: Jim Chang
Jim Chang / Asst. Manager



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Revision History

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1 GENERAL INFORMATION

1.1 Product Description

General:

| | |
|-------------------|-----------------------------|
| Product Name: | ESL Electronic Shelf Label |
| Brand Name: | OPTICON |
| Model No.: | EE-420R |
| Model Difference: | N/A |
| Hardware Version: | DVT |
| Software Version: | SW v1.53 |
| Power Supply: | 3.0Vdc from AAA batteries*2 |

Zigbee

| | |
|----------------------|---------------------------|
| Transmit Power | 87.27dBuV/m (Peak) |
| Operation Frequency: | 2405 ~ 2480MHz |
| Channel number: | 16 channels |
| Channel space: | 5MHz |
| Modulation Type: | DSSS |
| Antenna Designation: | Inverted F Antenna, -4dBi |

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1.2 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.249

ANSI C63.10:2013

Note:

1. All test items have been performed and record as per the above standards.

1.3 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory No.2, Keji 1st Rd.,
Guishan District, Taoyuan City, Taiwan 333 (TAF code 0513)

FCC Registration Number and Designation are: 735305 / TW0002

1.4 Special Accessories

There are no special accessories used while test was conducted.

1.5 Equipment Modifications

There was no modification incorporated into the EUT.

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2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is a placed on as turn table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz,. The CISPR Quasi-Peak and Average detector mode is employed according to §15.207. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

2.3.2 Radiated Emissions

The EUT is a placed on as turn table. For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made “while keeping the antenna in the ‘cone of radiation’ from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response.” is still within the 3dB illumination BW of the measurement antenna.

2.4 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

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2.5 Limitation

(1) Conducted Emission

Conducted Emission Limits is as following.

| Frequency (MHz) | Conducted Limit (dBuV) | |
|-----------------|------------------------|---------|
| | Quasi-Peak | Average |
| 0.15 – 0.5 | 66 - 56 | 56 - 46 |
| 0.5 – 5 | 56 | 46 |
| 5 - 30 | 60 | 50 |

(2) Radiated Emission

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following.

| Frequency (MHz) | Field strength of Fundamental | Field strength of Harmonics | Distance (m) |
|------------------|-------------------------------|-----------------------------|--------------|
| 902 – 928 | 50 mV/m (94dBuV/m) | 500 uV/m (54dBuV/m) | 3 |
| 2400 – 2483.5 | 50 mV/m (94dBuV/m) | 500 uV/m (54dBuV/m) | 3 |
| 5725 – 5875 | 50 mV/m (94dBuV/m) | 500 uV/m (54dBuV/m) | 3 |
| 24.0 – 24.25 GHz | 250 mV/m (107.95dBuV/m) | 2500 uV/m (67.95dBuV/m) | 3 |

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(3) Radiated Emission

Emission Radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50dB below the level of the fundamental or to the general radiated emission limits as below, whichever is the lesser attenuation.

| Frequency (MHz) | Field strength $\mu\text{V}/\text{m}$ | Distance (m) | Field strength at 3m $\text{dB}\mu\text{V}/\text{m}$ |
|-----------------|---------------------------------------|--------------|--|
| 1.705-30 | 30 | 30 | 69.54 |
| 30-88 | 100 | 3 | 40 |
| 88-216 | 150 | 3 | 43.5 |
| 216-960 | 200 | 3 | 46 |
| Above 960 | 500 | 3 | 54 |

(4) Radiated Emission

For frequencies above 1000MHz, the above field strength limits are based on average limits. The peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20dB under any condition of modulation.

- Remark:
1. Emission level in $\text{dB}\mu\text{V}/\text{m}=20 \log (\mu\text{V}/\text{m})$
 2. Measurement was performed at an antenna to the closed point of EUT distance of meters.
 3. Only spurious frequency is permitted to locate within the Restricted Bands specified in provision of ξ 15.205 and RSS-Gen ξ 8.10
 4. Emission spurious frequency which appearing within the Restricted Bands specified in provision of ξ 15.205, then the general radiated emission limits in ξ 15.209 apply.

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2.6 Configuration of Tested System

Fig. 2-1 Configuration of Conducted Tested System

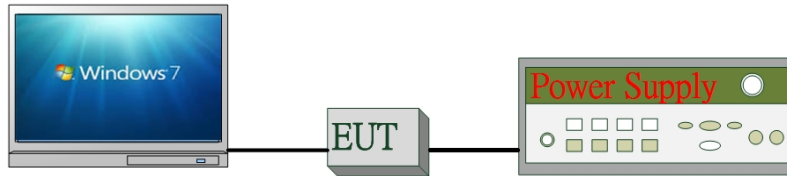


Fig. 2-2 Configuration Radiated Emission Tested System



Table 2-1 Equipment Used in Tested System

| Item | Equipment | Mfr/Brand | Model/Type No. | Series No. | Data Cable | Power Cord |
|------|-----------------|-----------|----------------|------------|------------|------------|
| 1. | Test Software | N/A | N/A | N/A | N/A | N/A |
| 2. | Notebook | Lenovo | L420 | LR-6MEX0 | Shielded | Unshielded |
| 3. | DC Power Supply | HOLA | DP-3003 | D7070035 | N/A | Unshielded |

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3 SUMMARY OF TEST RESULTS

| FCC Rules | Description Of Test | Result |
|------------------|----------------------------------|-----------|
| §15.207(a) | AC Power Line Conducted Emission | Compliant |
| §15.249(a)(d)(e) | Radiated Emission | Compliant |
| §15.215(c) | 20dB bandwidth Measurement | Compliant |

4 DESCRIPTION OF TEST MODES

4.1 Operated in 2405 ~ 2477MHz Band

16 channels are provided.

| Channel | Frequency | Channel | Frequency | Channel | Frequency | Channel | Frequency |
|---------|-----------|---------|-----------|---------|-----------|---------|-----------|
| 1 | 2405 MHz | 5 | 2425MHz | 9 | 2445 MHz | 13 | 2465 MHz |
| 2 | 2410 MHz | 6 | 2430 MHz | 10 | 2450 MHz | 14 | 2470 MHz |
| 3 | 2415 MHz | 7 | 2435 MHz | 11 | 2455 MHz | 15 | 2475 MHz |
| 4 | 2420 MHz | 8 | 2440 MHz | 12 | 2460 MHz | 16 | 2480 MHz |

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4.2 The Worst Test Modes and Channel Details

1. The EUT has been tested under operating condition.
2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

RADIATED EMISSION TEST:

| RADIATED EMISSION TEST (BELOW 1 GHz) | | | | |
|--------------------------------------|-------------------|----------------|------------|--------------|
| MODE | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION | ANTENNA PORT |
| 2.4G | 1 to 16 | 2,8,16 | DSSS | MAIN |
| RADIATED EMISSION TEST (ABOVE 1 GHz) | | | | |
| MODE | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION | ANTENNA PORT |
| 2.4G | 1 to 16 | 2,8,16 | DSSS | MAIN |

Note:

The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for Bluetooth LE Transmitter for channel Low, Mid and High, the worst case E2 position was reported.

ANTENNA PORT CONDUCTED MEASUREMENT:

| CONDUCTED TEST | | | | |
|----------------|-------------------|----------------|------------|--------------|
| MODE | AVAILABLE CHANNEL | TESTED CHANNEL | MODULATION | ANTENNA PORT |
| 2.4G | 1 to 16 | 2,8,16 | DSSS | MAIN |

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5 MEASUREMENT UNCERTAINTY

| Test Items | Uncertainty |
|---|-----------------------------|
| AC Power Line Conducted Emission | +/- 2.586 dB |
| 20dB & 99% Bandwidth | +/- 51.33 Hz |
| 100 kHz Bandwidth Of Frequency Band Edges | +/- 0.84 dB |
| Temperature | +/- 0.65 °C |
| Humidity | +/- 4.6 % |
| DC / AC Power Source | DC= +/- 0.13%, AC= +/- 0.2% |

Radiated Spurious Emission:

| | |
|--|----------------------------|
| Measurement uncertainty (Polarization : Vertical) | 9kHz – 30MHz: +/- 2.87 dB |
| | 30MHz - 180MHz: +/- 3.37dB |
| | 180MHz -417MHz: +/- 3.19dB |
| | 0.417GHz-1GHz: +/- 3.19dB |
| | 1GHz - 18GHz: +/- 4.04dB |
| | 18GHz - 40GHz: +/- 4.04dB |

| | |
|--|----------------------------|
| Measurement uncertainty (Polarization : Horizontal) | 9kHz – 30MHz: +/- 2.87 dB |
| | 30MHz - 167MHz: +/- 4.22dB |
| | 167MHz -500MHz: +/- 3.44dB |
| | 0.5GHz-1GHz: +/- 3.39dB |
| | 1GHz - 18GHz: +/- 4.08dB |
| | 18GHz - 40GHz: +/- 4.08dB |

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

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6 CONDUCTED EMISSION TEST

6.1 Standard Applicable:

Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

| Frequency range MHz | Limits dB(uV) | |
|------------------------|------------------|----------|
| | Quasi-peak | Average |
| 0.15 to 0.50 | 66 to 56 | 56 to 46 |
| 0.50 to 5 | 56 | 46 |
| 5 to 30 | 60 | 50 |

Note

- The lower limit shall apply at the transition frequencies
- The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

6.2 Measurement Equipment Used:

| Conducted Emission Test Site | | | | | |
|------------------------------|-------------|-----------------------|------------------|------------|------------|
| EQUIPMENT TYPE | MFR | MODEL NUMBER | SERIAL NUMBER | LAST CAL. | CAL DUE. |
| EMI Test Receiver | R&S | ESCI 7 | 100950 | 12/12/2016 | 12/11/2017 |
| Coaxial Cables | N/A | N30N30-1042-1 50cm | N/A | 08/30/2017 | 08/29/2018 |
| LISN | Schwarzbeck | NSLK 8127 | 8127-648 | 06/18/2017 | 06/17/2018 |
| Test Software | Farad | EZ-EMC | Ver. SGS-03A2 | N.C.R. | N.C.R. |

6.3 EUT Setup:

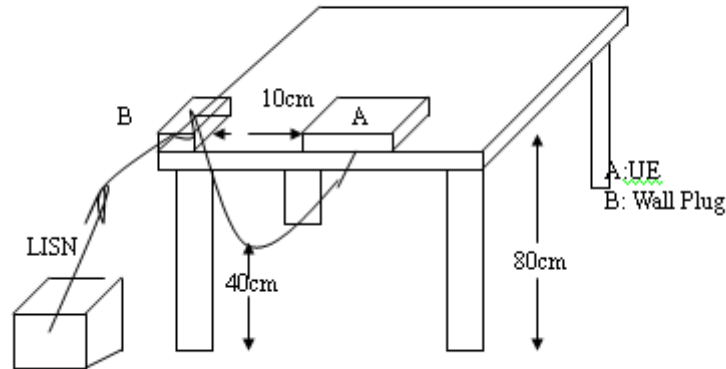
- The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
- The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
- The LISN was connected with 120Vac/60Hz power source.

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6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all phases of power being supplied by given UE are completed

6.6 Measurement Result:

N/A, This device is powered by battery.

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7 Radiated Emission Test

7.1. Measurement Procedure

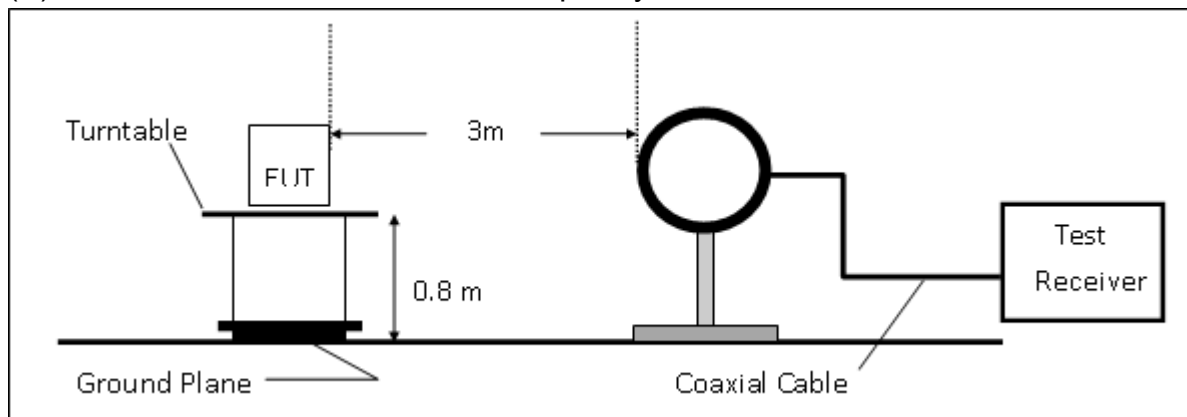
1. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 1.5m for frequency > 1GHz above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Set the spectrum analyzer as RBW=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
4. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
5. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.

| Band | Duty Cycle(%) | T(μs) | 1/T(kHz) | VBW Setting |
|------|---------------|-------|----------|-------------|
| 2.4G | 100 | - | - | 10 Hz |

6. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. Repeat above procedures until all frequency measured were complete.

7.2. Test SET-UP (Block Diagram of Configuration)

(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



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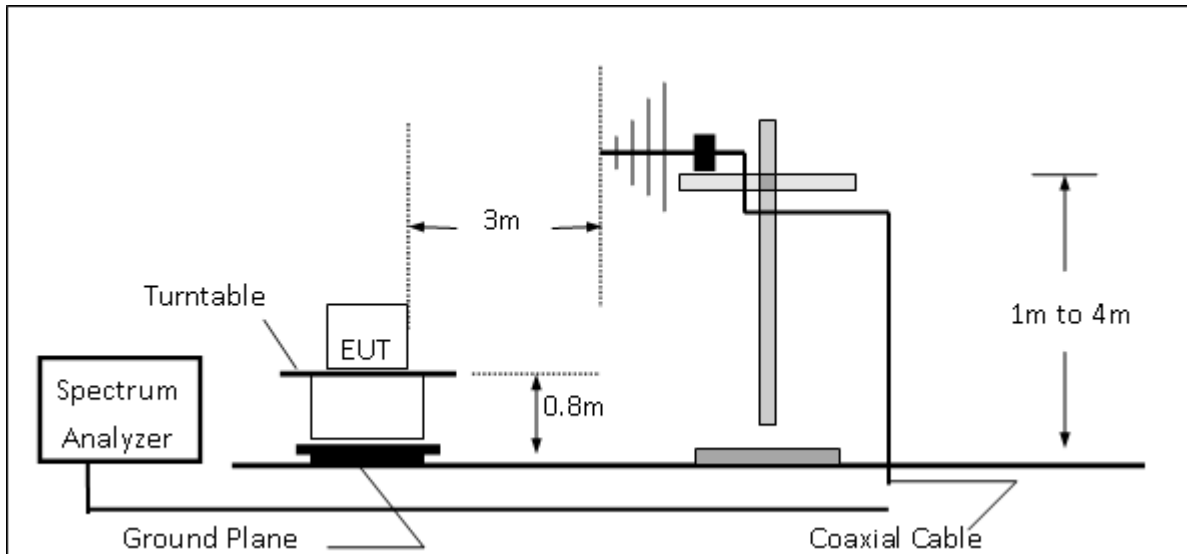
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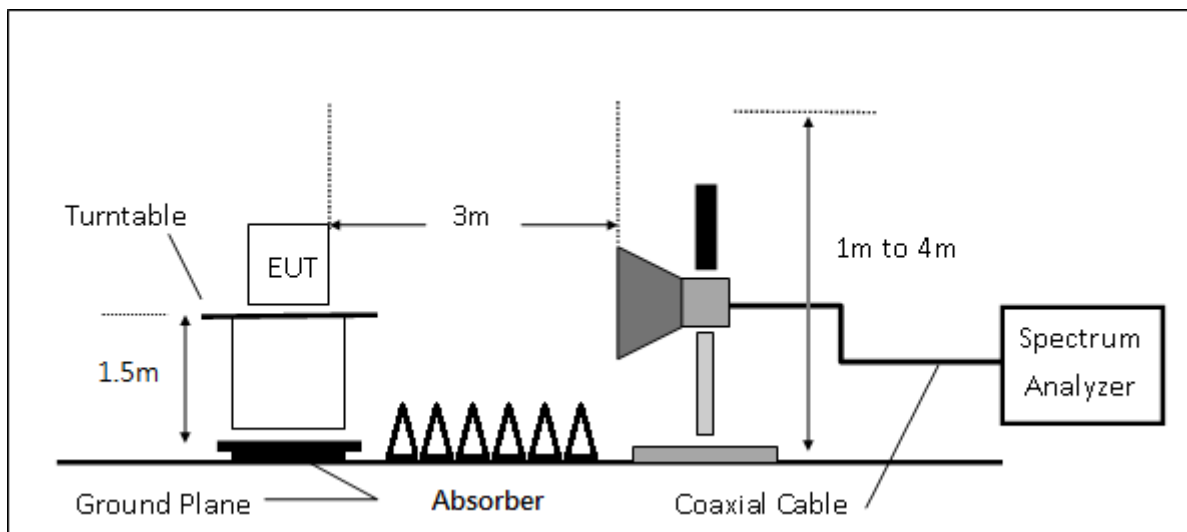
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(B) Radiated Emission Test Set-Up, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



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7.3. Measurement Equipment Used:

| 966 Chamber | | | | | |
|-------------------|-----------------|-----------------------------|---------------|------------|------------|
| EQUIPMENT TYPE | MFR | MODEL NUMBER | SERIAL NUMBER | LAST CAL. | CAL DUE. |
| EMI Test Receiver | R&S | ESU 40 | 100363 | 04/18/2017 | 04/17/2018 |
| Loop Antenna | ETS-Lindgren | 6502 | 00143303 | 12/23/2016 | 12/22/2017 |
| Broadband Antenna | TESEQ | CBL 6112D | 35240 | 08/05/2017 | 08/04/2018 |
| Horn Antenna | ETS-Lindgren | 3117 | 00143272 | 12/15/2016 | 12/16/2017 |
| Horn Antenna | Schwarzbeck | BBHA9170 | 185 | 08/01/2017 | 07/31/2018 |
| Pre Amplifier | EMC Instruments | EMC330 | 980096 | 12/12/2016 | 12/11/2017 |
| Pre Amplifier | EMC Instruments | EMC0011830 | 980199 | 12/12/2016 | 12/11/2017 |
| Pre Amplifier | R&S | SCU-18 | 10204 | 12/12/2016 | 12/11/2017 |
| Pre Amplifier | R&S | SCU-26 | 100780 | 12/12/2016 | 12/11/2017 |
| Coaxial Cable | Huber+Suhner | RG 214/U | 966Rx 9K-30M | 12/12/2016 | 12/11/2017 |
| Coaxial Cable | Huber+Suhner | RG 214/U SUCOFLEX 104 | 966Rx 30M-3G | 12/12/2016 | 12/11/2017 |
| Coaxial Cable | Huber+Suhner | SUCOFLEX 104 | 966Rx 1G-18G | 12/12/2016 | 12/11/2017 |
| Coaxial Cable | Huber+Suhner | mini 141-12 SUCOFLEX 104 | 966Rx 18G-40G | 12/12/2016 | 12/11/2017 |
| Coaxial Cable | Huber+Suhner | SUCOFLEX 104 | 966Tx 30M-18G | 12/12/2016 | 12/11/2017 |
| Coaxial Cable | Huber+Suhner | SUCOFLEX 102 | 966Tx 18G-40G | 12/12/2016 | 12/11/2017 |
| Attenuator | WOKEN | 218FS-10 | RF27 | 12/12/2016 | 12/11/2017 |
| Site NSA | SGS | 966 Chamber C | SAC-C | 03/02/2017 | 03/01/2018 |
| Site VSWR | SGS | 966 Chamber C | SAC-C | 03/02/2017 | 03/01/2018 |
| DC Power Supply | HOLA | DP-3003 | D7070035 | 05/04/2017 | 05/03/2018 |
| Controller | MF | MF-7802 | N/A | N.C.R. | N.C.R. |
| Antenna Master | MF | N/A | N/A | N.C.R. | N.C.R. |
| Turn Table | MF | N/A | N/A | N.C.R. | N.C.R. |
| Test Software | World-Pallas | Dr. E | V 3.0 Lite | N.C.R. | N.C.R. |

Note: N.C.R refers to Not Calibrated Required

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7.4. Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

| | | |
|-------|------------------------|--|
| Where | FS = Field Strength | CL = Cable Attenuation Factor (Cable Loss) |
| | RA = Reading Amplitude | AG = Amplifier Gain |
| | AF = Antenna Factor | |

Actual FS(dBµV/m) = SPA. Reading level(dBµV) + Factor(dB)

Factor(dB) = Antenna Factor(dBµV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

Note : “F” : denotes Fundamental Frequency. ; “H” : denotes Harmonic Frequency.
“E” : denotes Band Edge Frequency. ; “S” : denotes Spurious Frequency.

7.5. Measurement Result

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

Note: There is a comparison data of both open-field test site and semi-Anechoic, and test result came out very similar.

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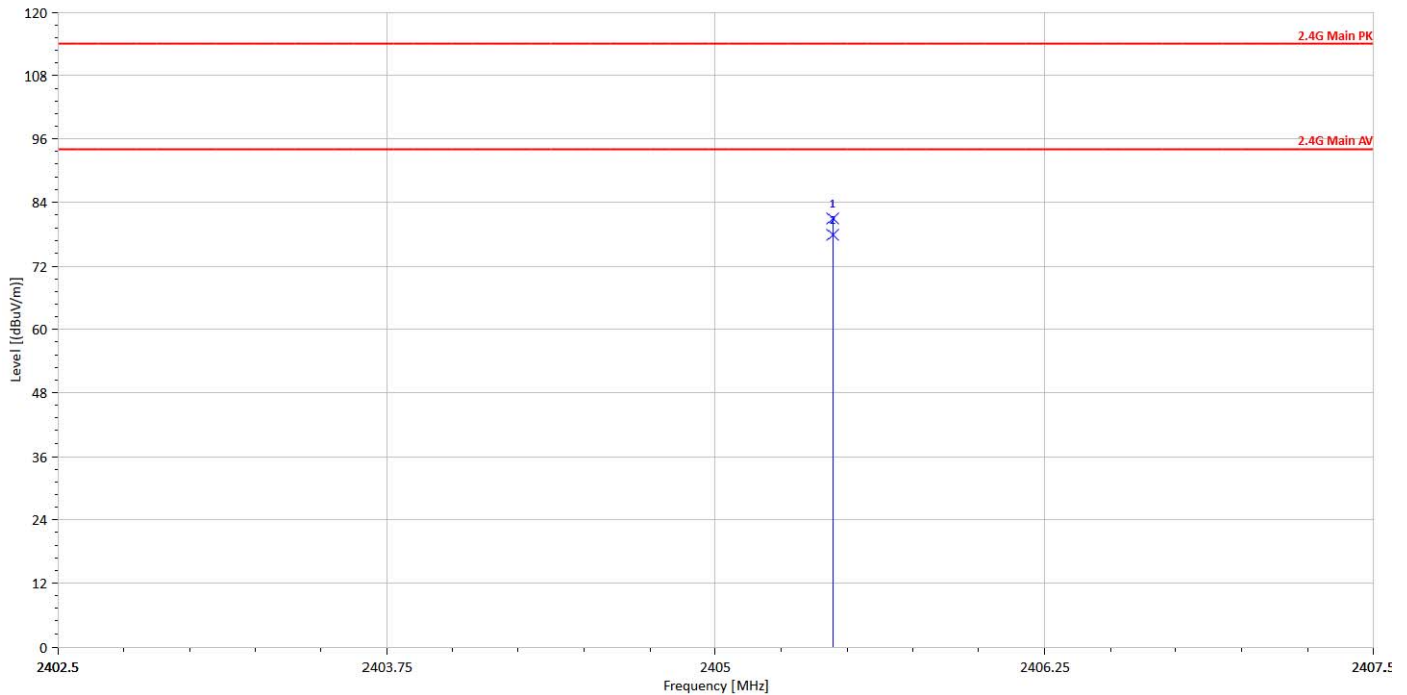
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Radiated Spurious Emission Measurement Result

| | | | |
|-------------------------|-------------|----------------------------|----------------|
| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2405 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | Main CH Low | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Vertical |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBuV | Factor dB | Actual FS dBuV/m | Limit @3m dBuV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 2405.45 | F | Peak | 79.95 | 1.03 | 80.98 | 114 | -33.02 |
| 2405.45 | F | Average | 76.82 | 1.03 | 77.85 | 94 | -16.15 |

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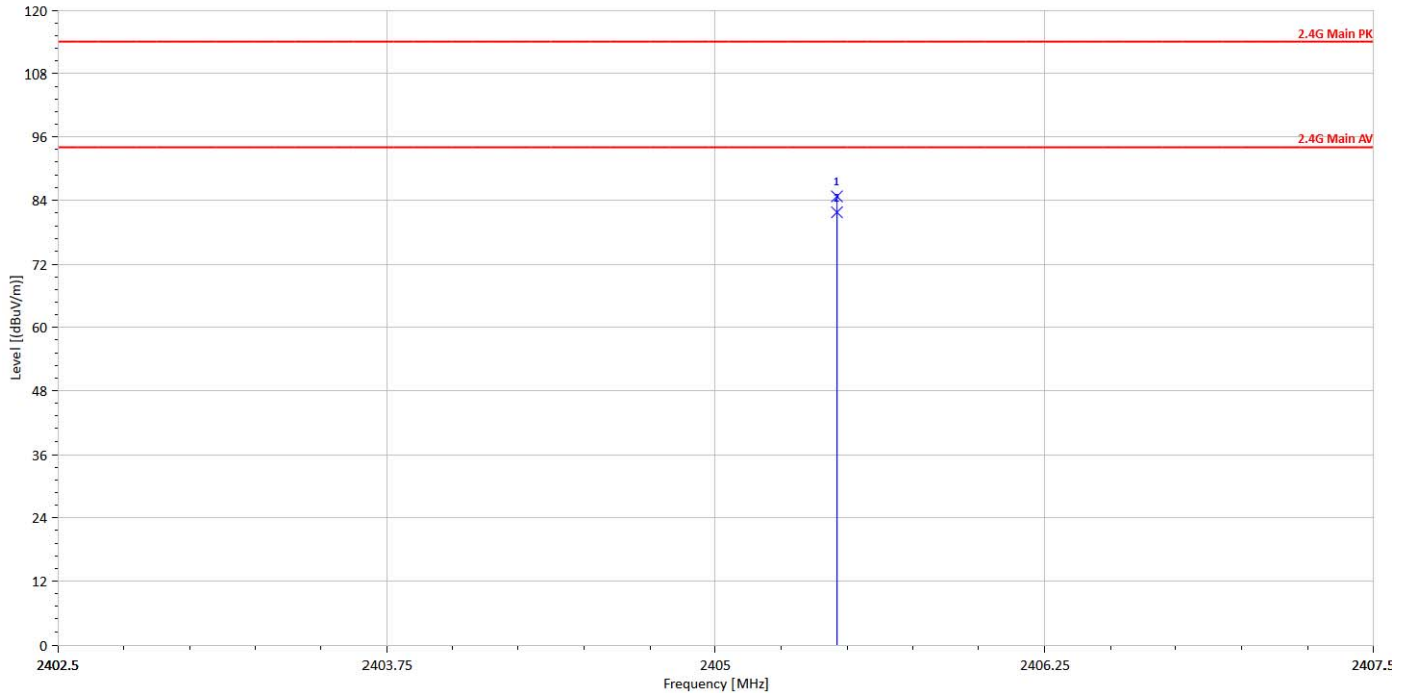
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| | | | |
|-------------------------|-------------|----------------------------|----------------|
| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2405 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | Main CH Low | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Horizontal |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 2405.46 | F | Peak | 83.78 | 1.03 | 84.81 | 114 | -29.19 |
| 2405.46 | F | Average | 80.74 | 1.03 | 81.77 | 94 | -12.23 |

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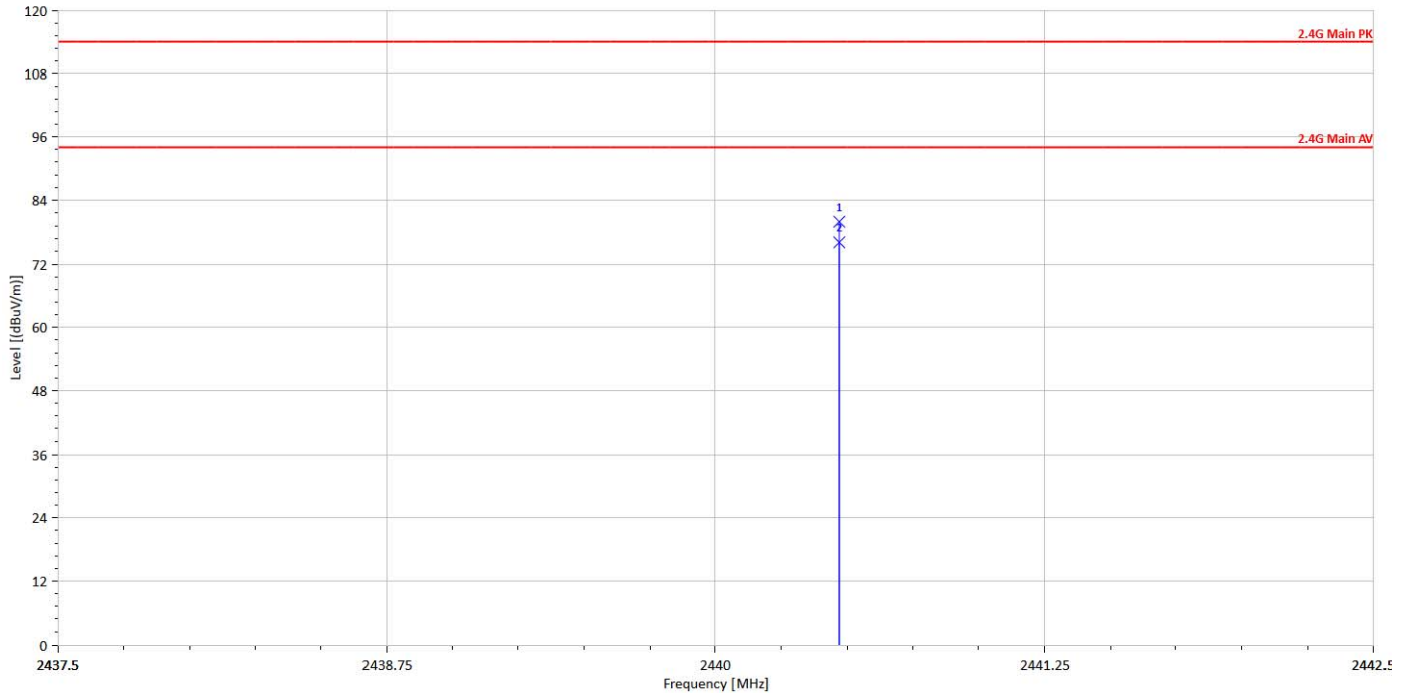
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| | | | |
|-------------------------|-------------|----------------------------|----------------|
| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2440 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | Main CH Mid | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Vertical |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 2440.47 | F | Peak | 79.13 | 0.84 | 79.97 | 114 | -34.03 |
| 2440.47 | F | Average | 75.19 | 0.84 | 76.03 | 94 | -17.97 |

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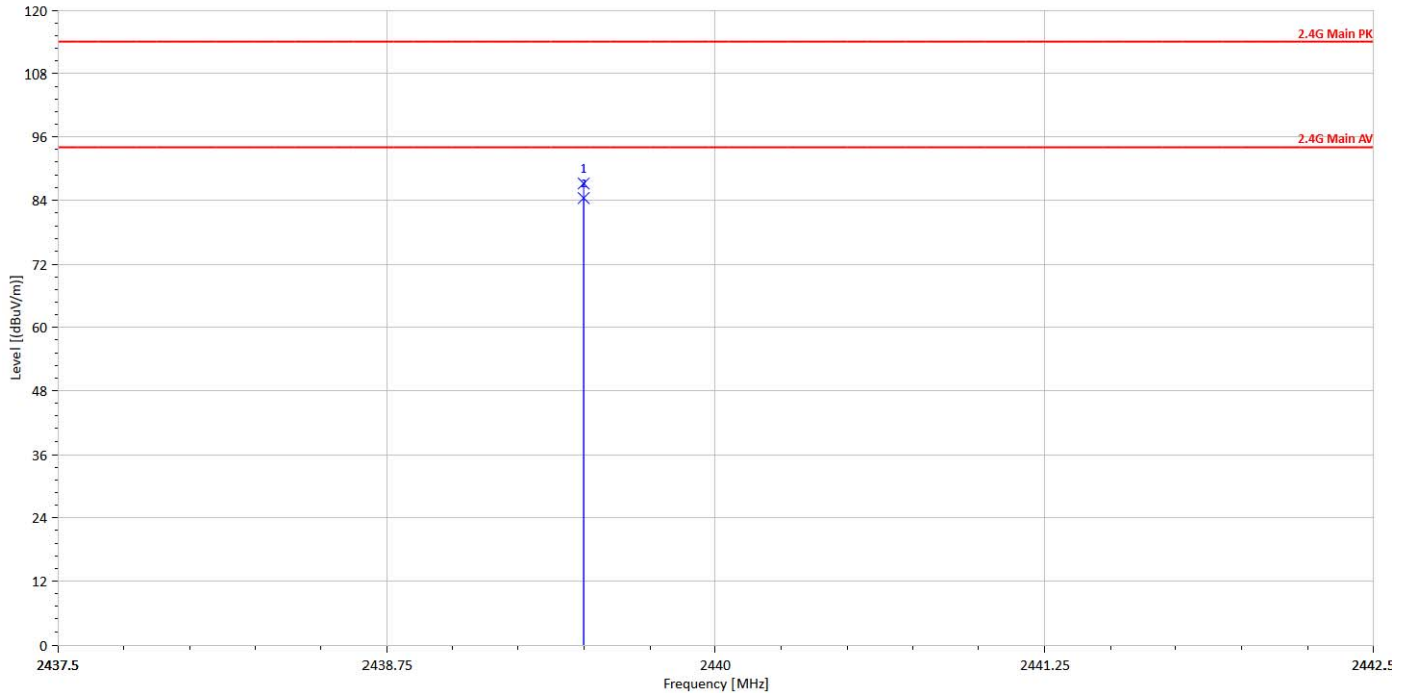
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| | | | |
|-------------------------|-------------|----------------------------|----------------|
| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2440 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | Main CH Mid | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Horizontal |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 2439.50 | F | Peak | 86.42 | 0.85 | 87.27 | 114 | -26.73 |
| 2439.50 | F | Average | 83.64 | 0.85 | 84.49 | 94 | -9.51 |

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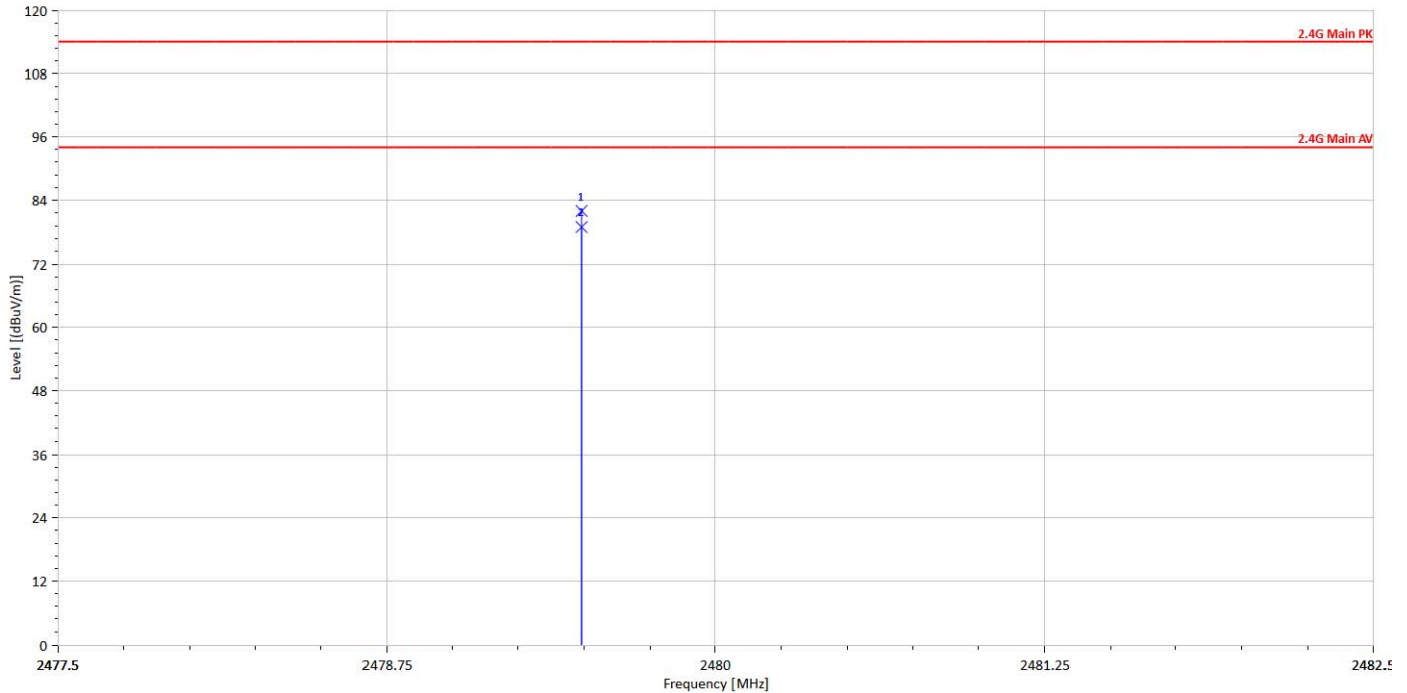
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|-------------------------|--------------|----------------------------|----------------|
| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2480 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | Main CH High | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Vertical |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 2479.49 | F | Peak | 80.86 | 1.17 | 82.03 | 114 | -31.97 |
| 2479.49 | F | Average | 77.79 | 1.17 | 78.96 | 94 | -15.04 |

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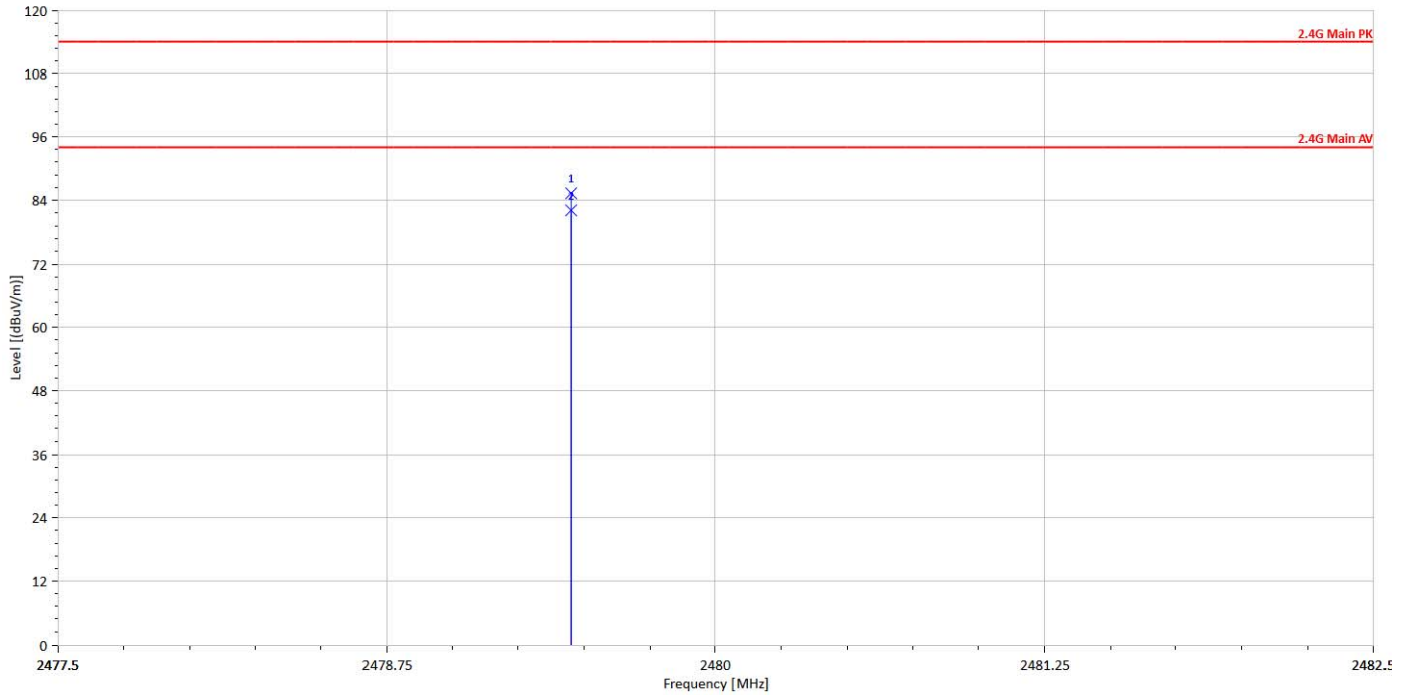
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| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2480 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | Main CH High | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Horizontal |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 2479.45 | F | Peak | 84.23 | 1.17 | 85.40 | 114 | -28.60 |
| 2479.45 | F | Average | 80.97 | 1.17 | 82.14 | 94 | -11.86 |

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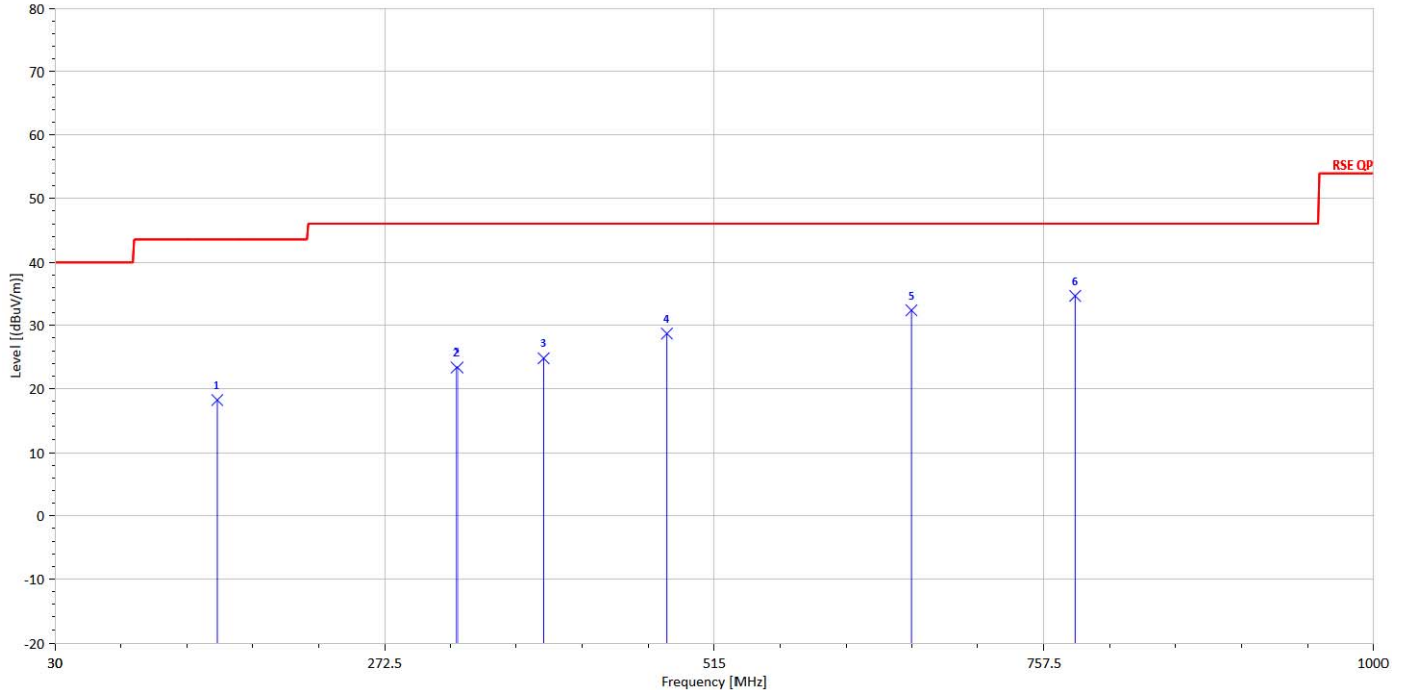
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Radiated Spurious Emission Measurement Result

Operation Mode : 2.4G Test Date : 2017/10/26
 Fundamental Frequency : 2405 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : TX CH LOW Test Engineer : Enzo
 EUT Pol. : E2 Measurement Antenna Pol. : Vertical



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 149.31 | S | Peak | 34.96 | -16.73 | 18.23 | 43.5 | -25.27 |
| 325.85 | S | Peak | 35.47 | -12.05 | 23.42 | 46 | -22.58 |
| 389.87 | S | Peak | 34.91 | -10.03 | 24.88 | 46 | -21.12 |
| 480.08 | S | Peak | 36.47 | -7.81 | 28.67 | 46 | -17.33 |
| 660.50 | S | Peak | 37.88 | -5.50 | 32.38 | 46 | -13.62 |
| 780.78 | S | Peak | 39.10 | -4.43 | 34.67 | 46 | -11.33 |

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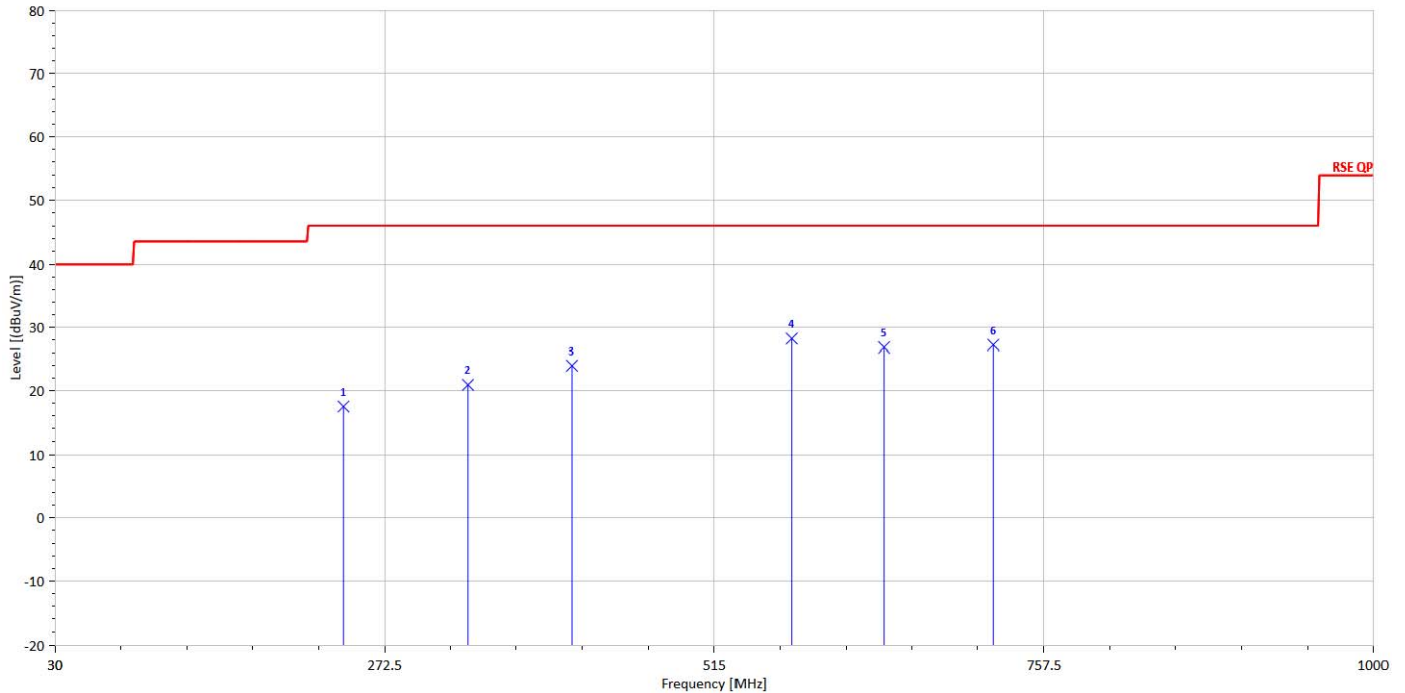
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| | | | |
|-------------------------|-----------|----------------------------|----------------|
| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2405 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | TX CH LOW | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Horizontal |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 242.43 | S | Peak | 32.69 | -15.16 | 17.53 | 46 | -28.47 |
| 333.61 | S | Peak | 32.85 | -11.88 | 20.97 | 46 | -25.03 |
| 410.24 | S | Peak | 33.16 | -9.16 | 24.00 | 46 | -22.00 |
| 572.23 | S | Peak | 34.42 | -6.21 | 28.21 | 46 | -17.79 |
| 640.13 | S | Peak | 32.21 | -5.37 | 26.84 | 46 | -19.16 |
| 720.64 | S | Peak | 32.06 | -4.83 | 27.23 | 46 | -18.77 |

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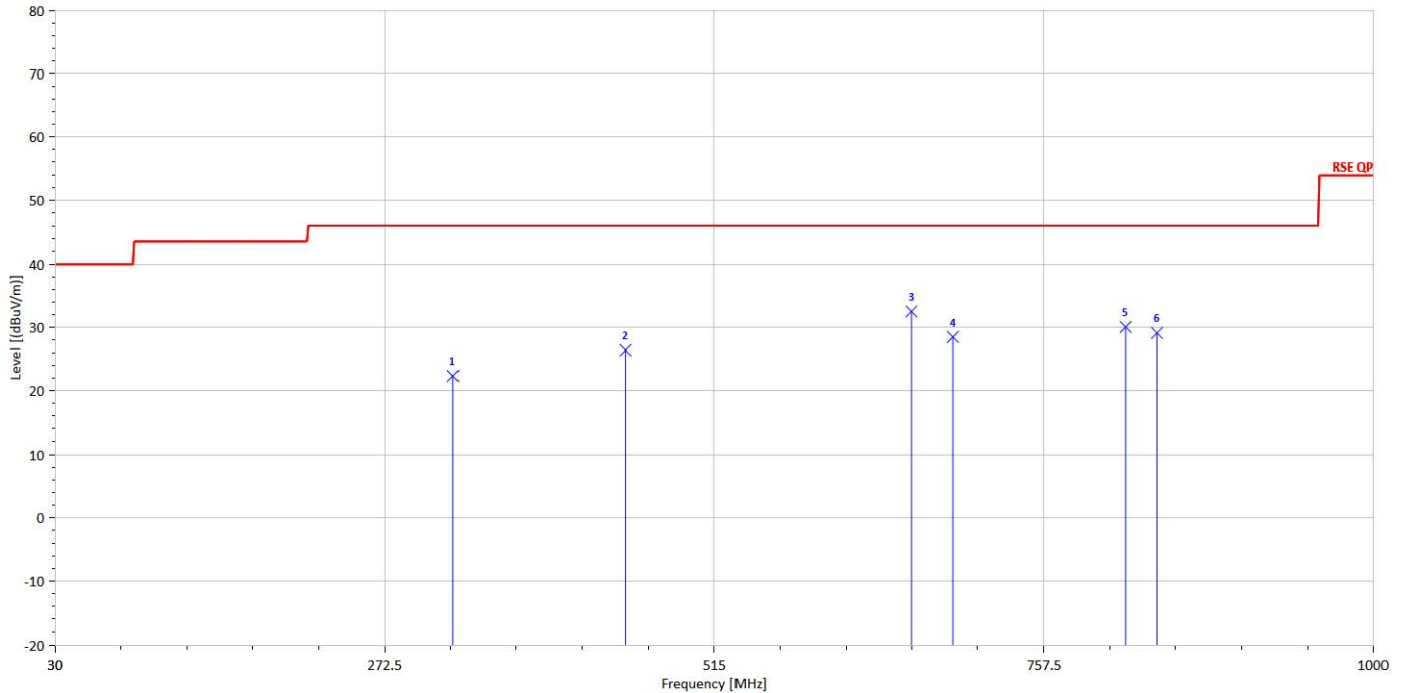
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Operation Mode : 2.4G Test Date : 2017/10/26
 Fundamental Frequency : 2440 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : TX CH MID Test Engineer : Enzo
 EUT Pol. : E2 Measurement Antenna Pol. : Vertical



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 322.94 | S | Peak | 34.36 | -11.99 | 22.37 | 46 | -23.63 |
| 450.01 | S | Peak | 35.05 | -8.64 | 26.41 | 46 | -19.59 |
| 660.50 | S | Peak | 38.01 | -5.50 | 32.51 | 46 | -13.49 |
| 690.57 | S | Peak | 33.97 | -5.52 | 28.45 | 46 | -17.55 |
| 817.64 | S | Peak | 33.14 | -3.10 | 30.04 | 46 | -15.96 |
| 840.92 | S | Peak | 32.03 | -2.94 | 29.09 | 46 | -16.91 |

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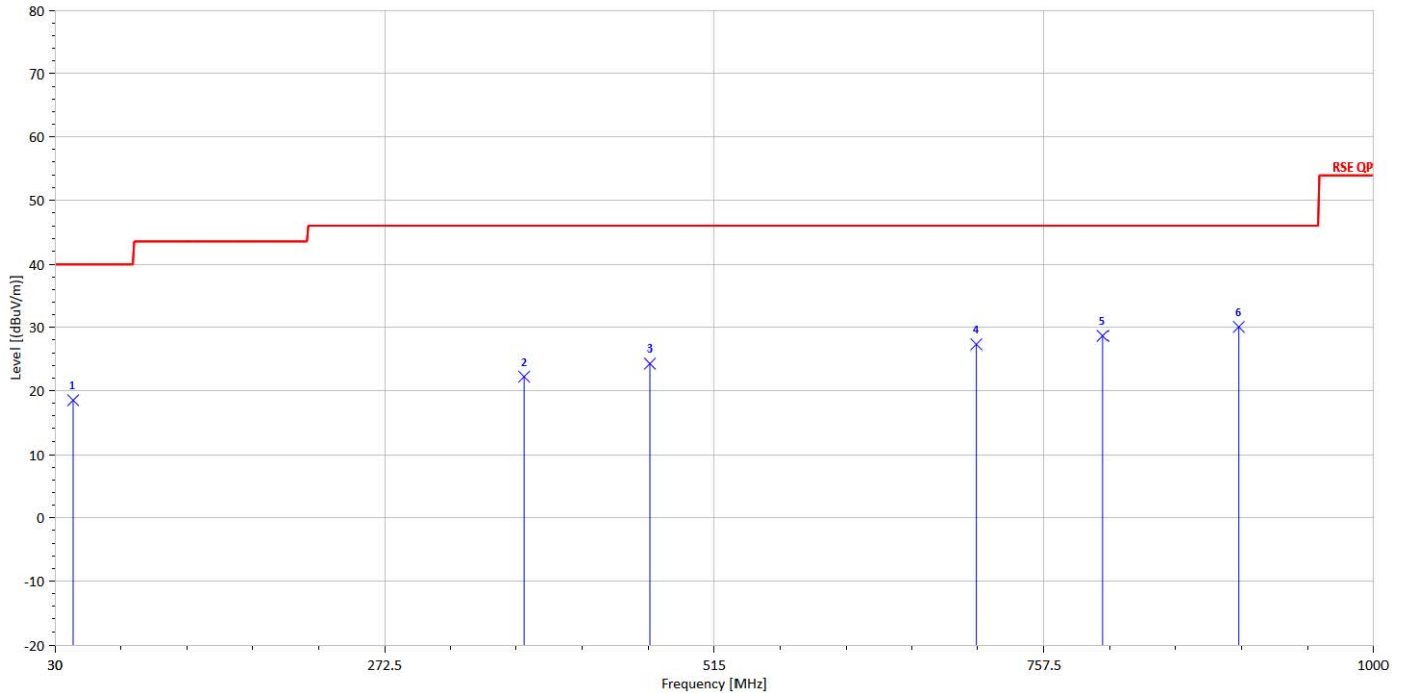
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Operation Mode : 2.4G Test Date : 2017/10/26
 Fundamental Frequency : 2440 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : TX CH MID Test Engineer : Enzo
 EUT Pol. : E2 Measurement Antenna Pol. : Horizontal



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 43.58 | S | Peak | 33.87 | -15.35 | 18.52 | 40 | -21.48 |
| 375.32 | S | Peak | 32.80 | -10.53 | 22.27 | 46 | -23.73 |
| 467.47 | S | Peak | 32.08 | -7.73 | 24.35 | 46 | -21.65 |
| 708.03 | S | Peak | 32.42 | -5.15 | 27.28 | 46 | -18.72 |
| 801.15 | S | Peak | 32.11 | -3.49 | 28.62 | 46 | -17.38 |
| 901.06 | S | Peak | 32.13 | -2.09 | 30.04 | 46 | -15.96 |

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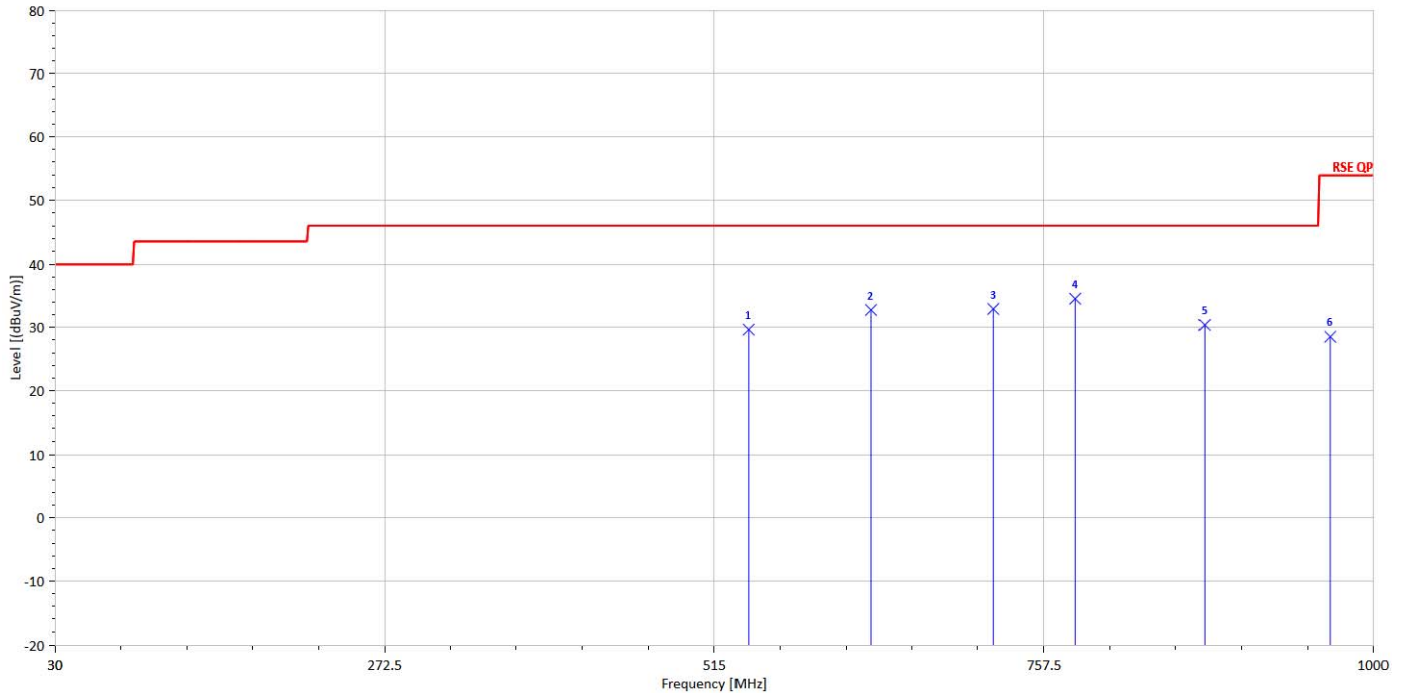
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|-------------------------|------------|----------------------------|----------------|
| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2480 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | TX CH HIGH | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Vertical |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 540.22 | S | Peak | 36.80 | -7.19 | 29.62 | 46 | -16.38 |
| 630.43 | S | Peak | 38.68 | -5.94 | 32.74 | 46 | -13.26 |
| 720.64 | S | Peak | 37.73 | -4.83 | 32.90 | 46 | -13.10 |
| 780.78 | S | Peak | 38.97 | -4.43 | 34.53 | 46 | -11.47 |
| 875.84 | S | Peak | 33.16 | -2.80 | 30.36 | 46 | -15.64 |
| 968.35 | S | Peak | 30.02 | -1.55 | 28.47 | 54 | -25.53 |

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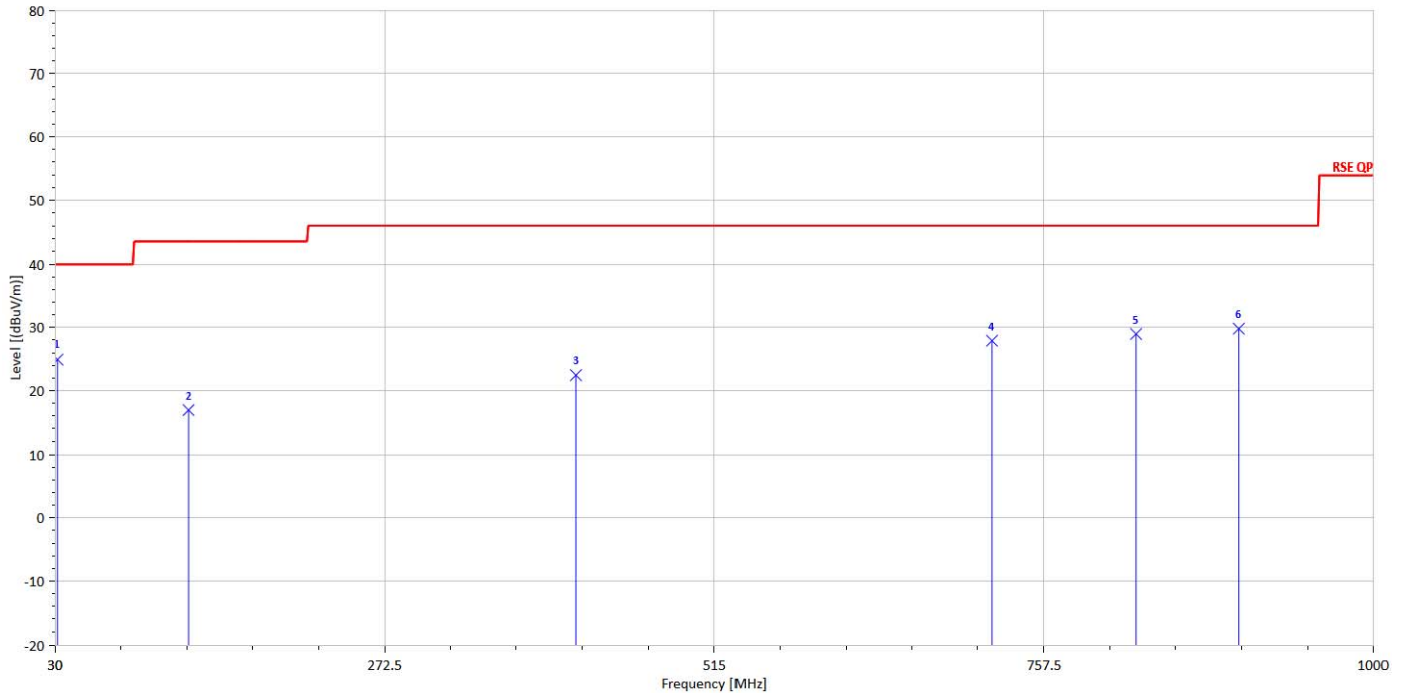
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| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2480 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | TX CH HIGH | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Horizontal |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 31.94 | S | Peak | 33.21 | -8.22 | 24.99 | 40 | -15.01 |
| 127.97 | S | Peak | 32.58 | -15.62 | 16.96 | 43.5 | -26.54 |
| 413.15 | S | Peak | 31.90 | -9.39 | 22.52 | 46 | -23.48 |
| 719.67 | S | Peak | 32.80 | -4.95 | 27.85 | 46 | -18.15 |
| 825.40 | S | Peak | 31.83 | -2.91 | 28.92 | 46 | -17.08 |
| 901.06 | S | Peak | 31.85 | -2.09 | 29.76 | 46 | -16.24 |

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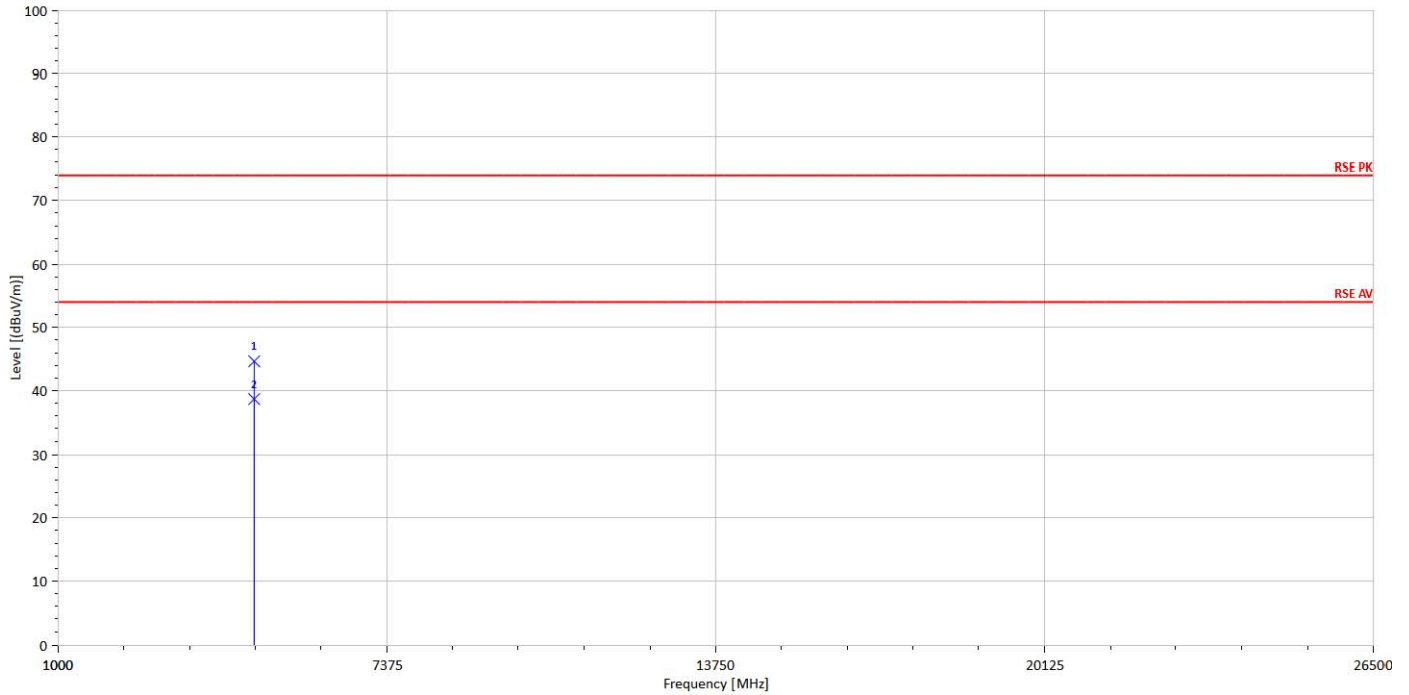
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|-------------------------|-----------|----------------------------|----------------|
| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2405 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | TX CH LOW | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Vertical |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 4810.00 | H | Peak | 37.04 | 7.67 | 44.72 | 74 | -29.28 |
| 4810.00 | H | Average | 31.05 | 7.66 | 38.71 | 54 | -15.29 |

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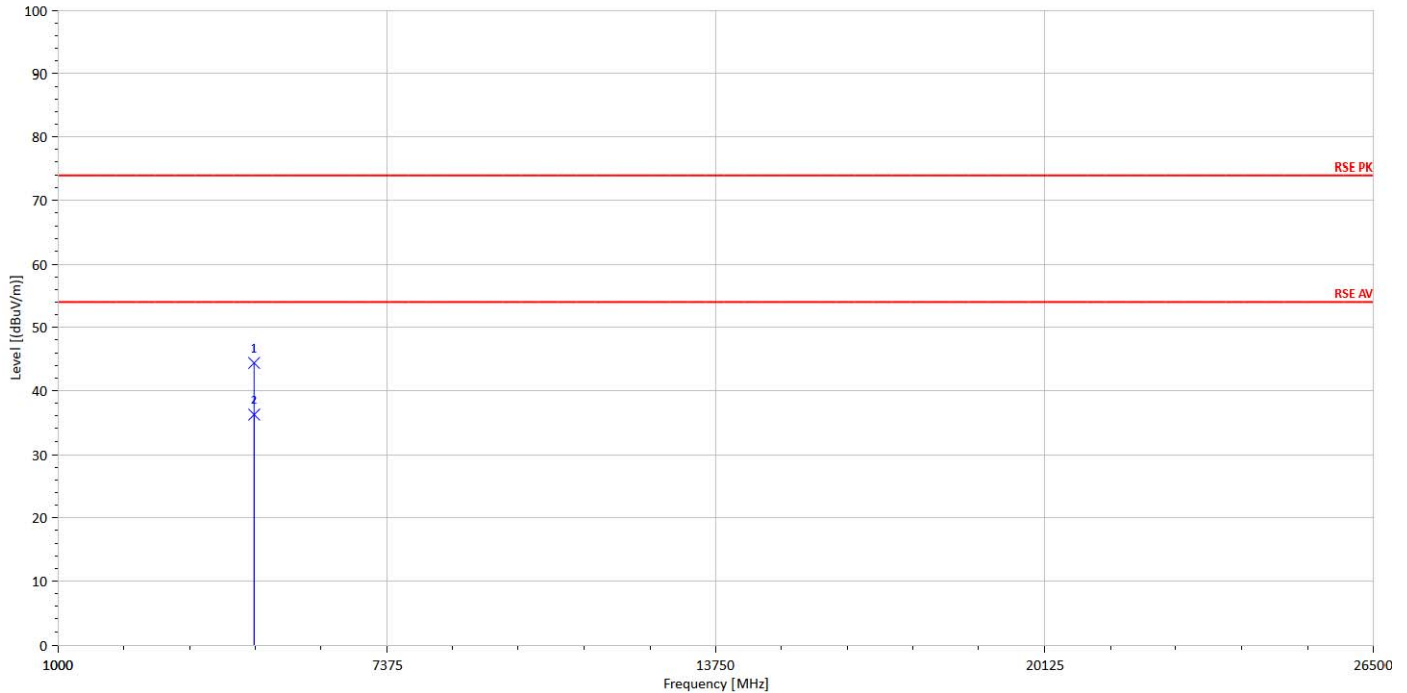
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| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2405 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | TX CH LOW | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Horizontal |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 4808.00 | H | Peak | 36.79 | 7.67 | 44.46 | 74 | -29.54 |
| 4810.00 | H | Average | 28.56 | 7.67 | 36.23 | 54 | -17.77 |

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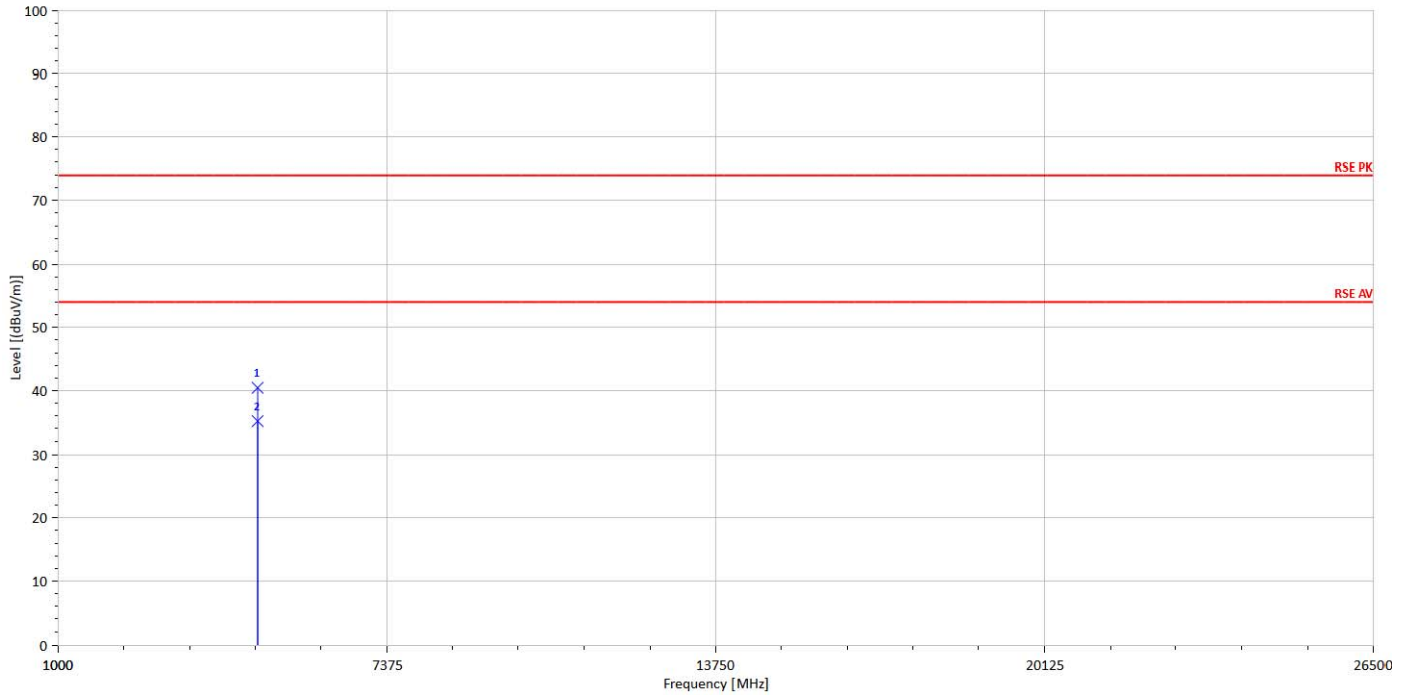
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Operation Mode : 2.4G Test Date : 2017/10/26
 Fundamental Frequency : 2440 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : TX CH MID Test Engineer : Enzo
 EUT Pol. : E2 Measurement Antenna Pol. : Vertical



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 4878.00 | H | Peak | 32.65 | 7.86 | 40.51 | 74 | -33.49 |
| 4878.00 | H | Average | 27.34 | 7.86 | 35.20 | 54 | -18.80 |

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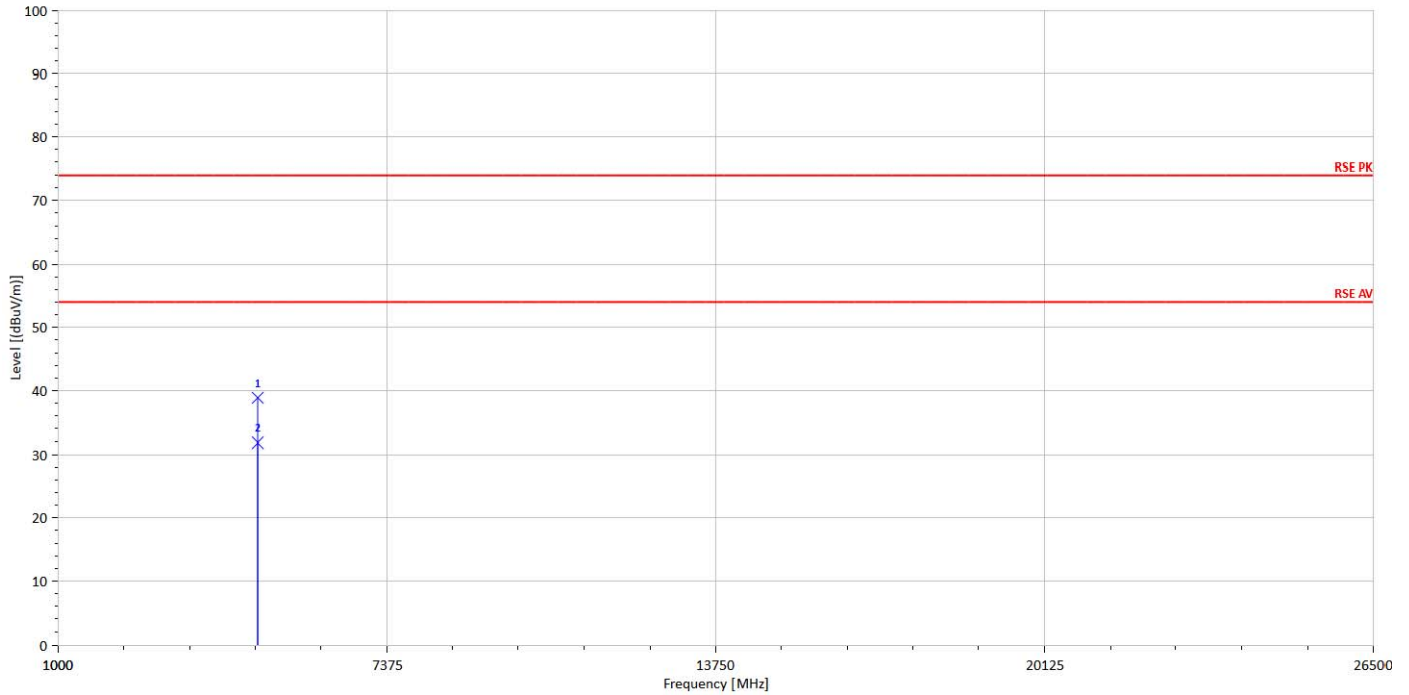
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Operation Mode : 2.4G Test Date : 2017/10/26
 Fundamental Frequency : 2440 MHz Temp. / Humi. : 22.7deg_C/57RH
 Operation Band : TX CH MID Test Engineer : Enzo
 EUT Pol. : E2 Measurement Antenna Pol. : Horizontal



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 4880.00 | H | Peak | 31.14 | 7.78 | 38.92 | 74 | -35.08 |
| 4880.00 | H | Average | 24.05 | 7.78 | 31.83 | 54 | -22.17 |

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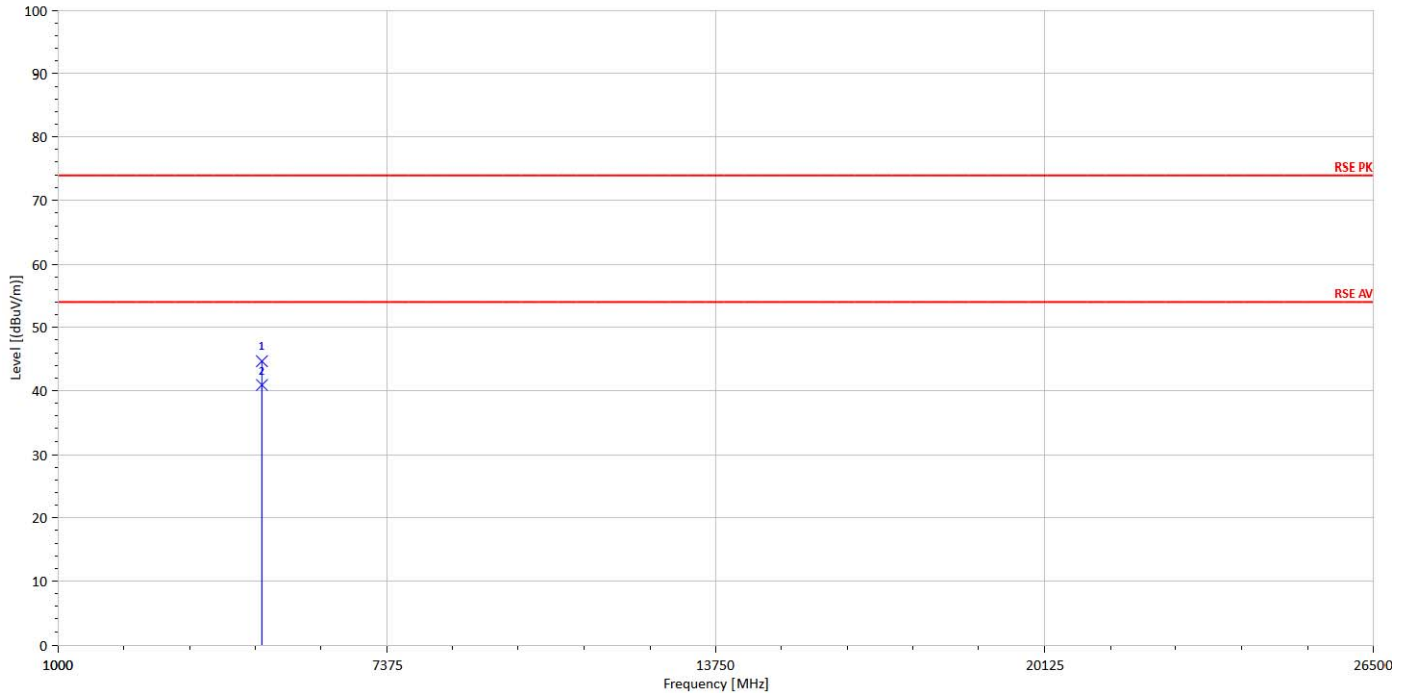
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| | | | |
|-------------------------|------------|----------------------------|----------------|
| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2480 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | TX CH HIGH | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Vertical |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 4962.00 | H | Peak | 37.06 | 7.68 | 44.74 | 74 | -29.26 |
| 4962.00 | H | Average | 33.27 | 7.68 | 40.95 | 54 | -13.05 |

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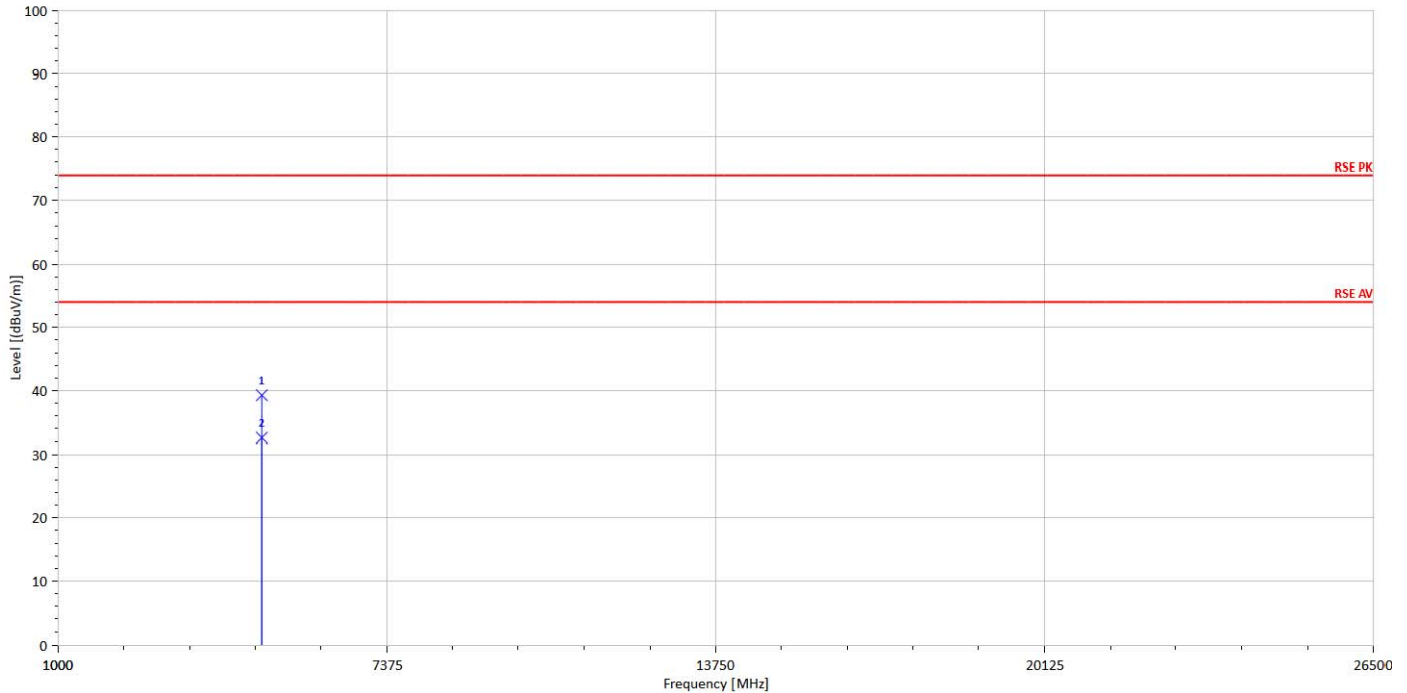
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| Operation Mode : | 2.4G | Test Date : | 2017/10/26 |
| Fundamental Frequency : | 2480 MHz | Temp. / Humi. : | 22.7deg_C/57RH |
| Operation Band : | TX CH HIGH | Test Engineer : | Enzo |
| EUT Pol. : | E2 | Measurement Antenna Pol. : | Horizontal |



| Freq. MHz | Note F/H/E/S | Detector Mode PK/QP/AV | Spectrum Reading Level dBµV | Factor dB | Actual FS dBµV/m | Limit @3m dBµV/m | Margin dB |
|--------------|-----------------|------------------------------|-----------------------------------|--------------|------------------------|------------------------|--------------|
| 4960.00 | H | Peak | 31.64 | 7.69 | 39.32 | 74 | -34.68 |
| 4960.00 | H | Average | 24.89 | 7.69 | 32.58 | 54 | -21.42 |

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8 20 dB Bandwidth Measurement

8.1 Measurement Procedure

1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. Set ETU normal operating mode.
3. Set SPA Center Frequency = fundamental frequency, RBW = 100kHz, VBW = 300kHz, Span = 5MHz.
4. Set SPA Max hold. Mark peak, -20dB.

8.2 Test SET-UP (Block Diagram of Configuration)

Refer to section 7.2 for the plot.

8.3 Measurement Equipment Used:

| Conducted Emission Test Site | | | | | |
|------------------------------|-----------|--------------------|---------------|------------|------------|
| EQUIPMENT TYPE | MFR | MODEL NUMBER | SERIAL NUMBER | LAST CAL. | CAL DUE. |
| Spectrum Analyzer | KEYSIGHT | N9010A | MY51440113 | 06/20/2017 | 06/19/2018 |
| Power Meter | Anritsu | ML2496A | 1326001 | 06/23/2017 | 06/22/2018 |
| Power Sensor | Anritsu | MA2411B | 1315048 | 06/23/2017 | 06/22/2018 |
| Power Sensor | Anritsu | MA2411B | 1315049 | 06/23/2017 | 06/22/2018 |
| Coaxial Cable 30cm | WOKEN | 00100A1F1A1 95C | RF01 | 12/12/2016 | 12/11/2017 |
| DC Block | PASTERNAK | PE8210 | RF29 | 12/12/2016 | 12/11/2017 |
| Splitter | RF-LAMBAD | RFLT2W1G18 G | RF35 | 12/12/2016 | 12/11/2017 |
| Attenuator | WOKEN | 218FS-10 | RF23 | 12/12/2016 | 12/11/2017 |
| DC Power Supply | Agilent | E3640A | MY53140006 | 05/02/2017 | 05/01/2018 |

8.4 Measurement Results:

| Frequency (MHz) | 20dB Bandwidth (kHz) |
|-----------------|----------------------|
| 2405 | 2826 |
| 2475 | 2830 |
| 2480 | 2837 |

Refer to attached data chart.

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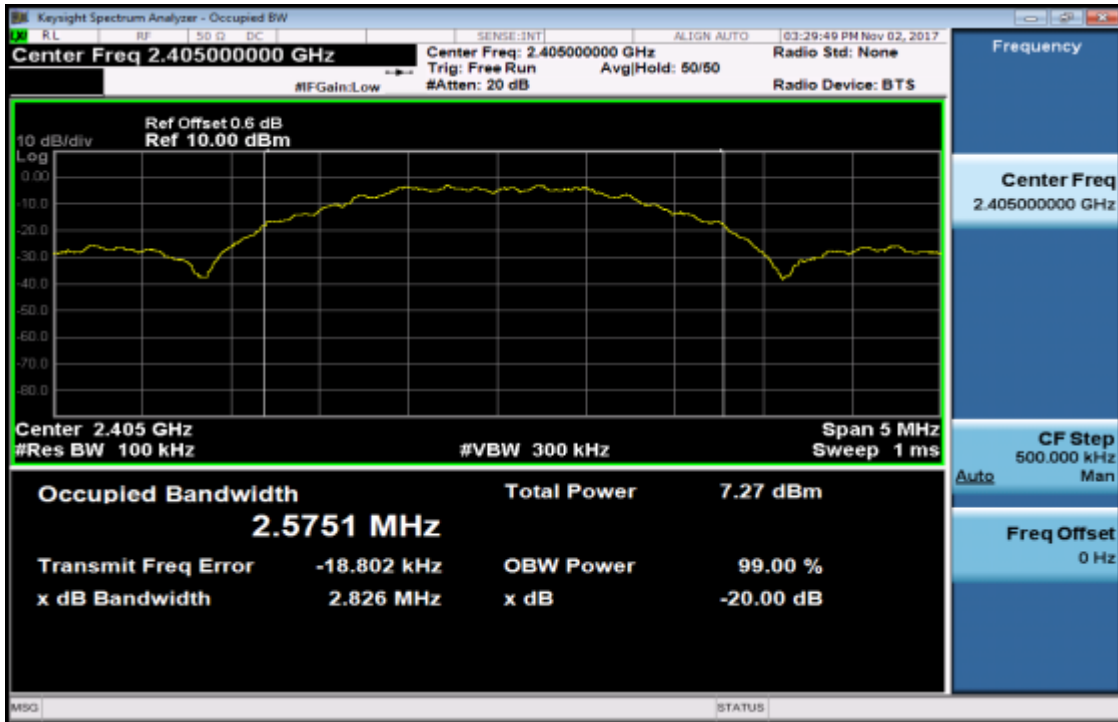
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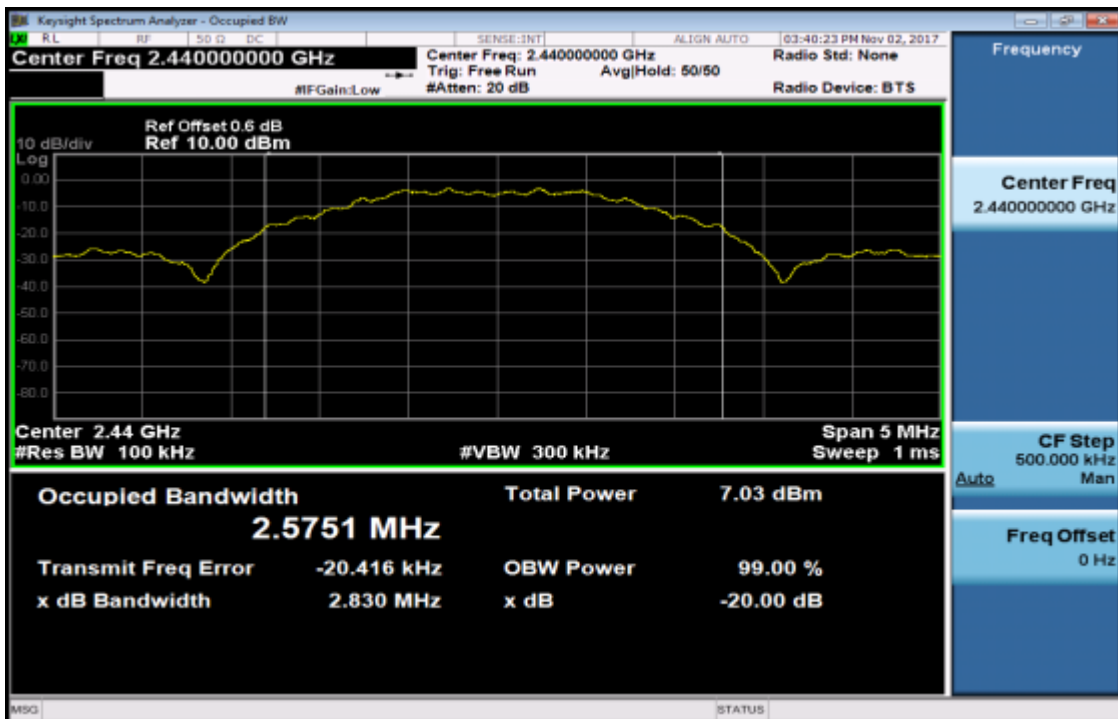
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2405MHz



2440MHz



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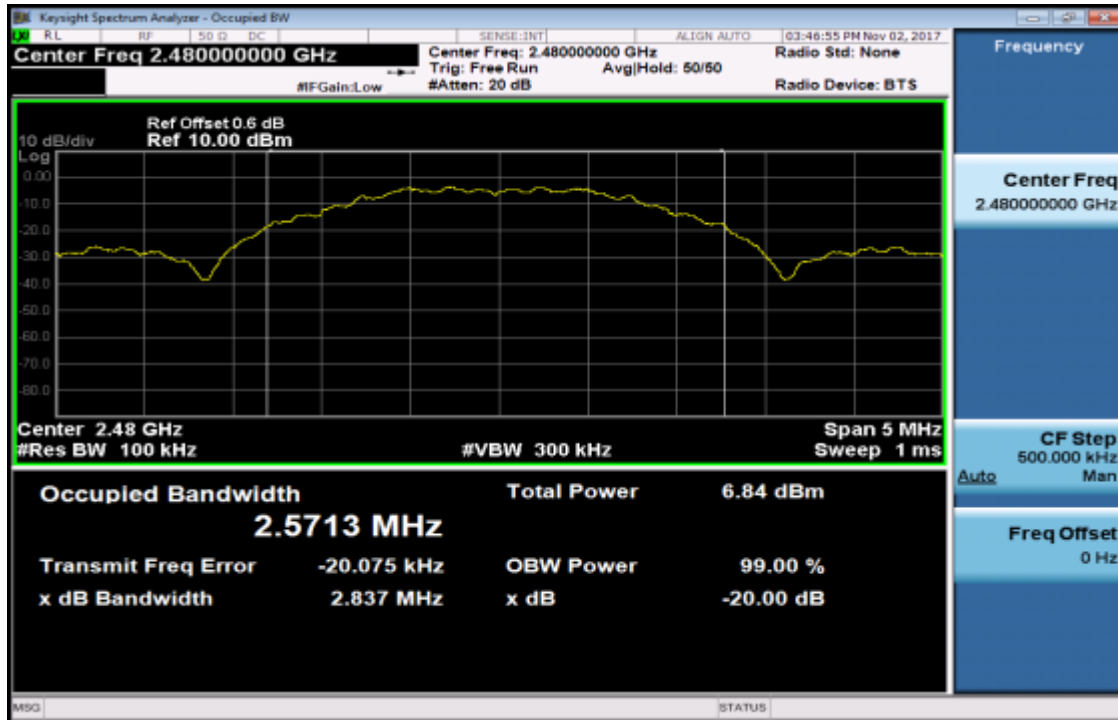
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2480MHz



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9 Antenna Requirement

9.1 Standard Applicable:

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

9.2 Antenna Connected Construction:

An embedded-in antenna design is used.

The antenna is designed as permanently attached and no consideration of replacement. Please see EUT photo and antenna spec. for details.

The antenna gain is less than 6dBi. Therefore, it is not necessary to reduce maximum output power limit.

~ End of Report ~

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