

# TEST REPORT

of

FCC Part 15 Subpart C §15.247

FCC ID: ZNFHBSFL7

Equipment Under Test : LG STEREO Headset  
Model Name : HBS-FL7  
Variant Model Name : HBS-PFL7  
Applicant : LG Electronics USA, Inc.  
Manufacturer : GoerTek  
Date of Receipt : 2019.05.07  
Date of Test(s) : 2019.05.08 ~ 2019. 05.23  
Date of Issue : 2019.06.11

In the configuration tested, the EUT complied with the standards specified above.

Tested By:

  
\_\_\_\_\_  
Murphy Kim

Date:

2019.06.11

Technical  
Manager:

  
\_\_\_\_\_  
Jungmin Yang

Date:

2019.06.11

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A4(210 mm x 297 mm)

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## 1. General Information

### 1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)

- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- Designation number: KR0150

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Phone No. : +82 31 688 0901

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### 1.2. Details of Applicant

Applicant : LG Electronics USA, Inc.

Address : 1000 Sylvan Ave, Englewood Cliffs, New Jersey, United States 07632

Contact Person : Han, Kyung-Su

Phone No. : +1 201 266 2215

### 1.3. Details of Manufacturer

Company : GoerTek

Address : No.268 Dongfang Road, High-Tech Industry Development District, Weifang, Shandong, P.R.C

### 1.4. Description of EUT

|                      |       |                                   |
|----------------------|-------|-----------------------------------|
| Kind of Product      |       | LG STEREO Headset                 |
| Model Name           |       | HBS-FL7                           |
| Variant Model Name   |       | HBS-PFL7                          |
| Power Supply         |       | DC 3.7 V                          |
| Frequency Range      |       | 2 402 MHz ~ 2 480 MHz (Bluetooth) |
| Modulation Technique |       | GFSK, $\pi$ /4DQPSK, 8DPSK        |
| Number of Channels   |       | 79 channel (Bluetooth)            |
| Antenna Type         |       | FPC antenna                       |
| Antenna Gain         | Left  | -3.58 dB i                        |
|                      | Right | -3.36 dB i                        |

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## 1.5. Test Equipment List

| Equipment           | Manufacturer                | Model                                | S/N                       | Cal. Date     | Cal. Interval | Cal. Due      |
|---------------------|-----------------------------|--------------------------------------|---------------------------|---------------|---------------|---------------|
| Signal Generator    | R&S                         | SMR40                                | 100272                    | Jun. 12, 2018 | Annual        | Jun. 12, 2019 |
| Signal Generator    | R&S                         | SMBV100A                             | 255834                    | Jun. 15, 2018 | Annual        | Jun. 15, 2019 |
| Spectrum Analyzer   | R&S                         | FSV30                                | 103210                    | Dec. 05, 2018 | Annual        | Dec. 05, 2019 |
| Spectrum Analyzer   | Agilent                     | N9020A                               | MY53421758                | Sep. 21, 2018 | Annual        | Sep. 21, 2019 |
| Bluetooth Tester    | TESCOM                      | TC-3000C                             | 3000C000296               | Jun. 12, 2018 | Annual        | Jun. 12, 2019 |
| Directional Coupler | KRYTAR                      | 152613                               | 122660                    | Jun. 14, 2018 | Annual        | Jun. 14, 2019 |
| High Pass Filter    | Wainwright Instrument GmbH  | WHK3.0/18G-10SS                      | 344                       | May 27, 2018  | Annual        | May 27, 2019  |
| High Pass Filter    | Wainwright Instrument GmbH  | WHNX7.5/26.5G-6SS                    | 15                        | Jun. 11, 2018 | Annual        | Jun. 11, 2019 |
| Low Pass Filter     | Mini-Circuits               | NLP-1200+                            | V 8979400903-2            | Feb. 19, 2019 | Annual        | Feb. 19, 2020 |
| Power Sensor        | R&S                         | NRP-Z81                              | 100748                    | Jun. 12, 2018 | Annual        | Jun. 12, 2019 |
| DC Power Supply     | R&S                         | HMP2020                              | 019258024                 | Nov. 06, 2018 | Annual        | Nov. 06, 2019 |
| Preamplifier        | H.P.                        | 8447F                                | 2944A03909                | Aug. 07, 2018 | Annual        | Aug. 07, 2019 |
| Preamplifier        | Agilent                     | 8449B                                | 3008A01932                | Feb. 22, 2019 | Annual        | Feb. 22, 2020 |
| Preamplifier        | MITEQ Inc.                  | JS44-18004000-35-8P                  | 1546891                   | May 13, 2019  | Annual        | May 13, 2020  |
| Loop Antenna        | Schwarzbeck Mess-Elektronik | FMZB 1519                            | 1519-039                  | Aug. 23, 2017 | Biennial      | Aug. 23, 2019 |
| Bilog Antenna       | Schwarzbeck Mess-Elektronik | VULB 9163                            | 01126                     | Mar. 26, 2018 | Biennial      | Mar. 26, 2020 |
| Horn Antenna        | R&S                         | HF906                                | 100326                    | Feb. 14, 2018 | Biennial      | Feb. 14, 2020 |
| Horn Antenna        | Schwarzbeck Mess-Elektronik | BBHA 9170                            | BBHA9170431               | Sep. 10, 2018 | Biennial      | Sep. 10, 2020 |
| Test Receiver       | R&S                         | ESU26                                | 100109                    | Jan. 31, 2019 | Annual        | Jan. 31, 2020 |
| Turn Table          | Innco systems GmbH          | DS 1200 S                            | N/A                       | N.C.R.        | N/A           | N.C.R.        |
| Controller          | Innco systems GmbH          | CONTROLLER<br>CO3000-4P              | CO3000/963/383<br>30516/L | N.C.R.        | N/A           | N.C.R.        |
| Antenna Mast        | Innco systems GmbH          | MA4640-XP-ET                         | MA4640/536/383<br>30516/L | N.C.R.        | N/A           | N.C.R.        |
| Anechoic Chamber    | SY Corporation              | L x W x H<br>(9.6 m x 6.4 m x 6.6 m) | N/A                       | N.C.R.        | N/A           | N.C.R.        |
| Coaxial Cable       | SUCOFLEX                    | 104 (3 m)                            | MY3258414                 | Jan. 04, 2019 | Semi-annual   | Jul. 04, 2019 |
| Coaxial Cable       | SUCOFLEX                    | 104 (10 m)                           | MY3145814                 | Jan. 04, 2019 | Semi-annual   | Jul. 04, 2019 |
| Coaxial Cable       | Rosenberger                 | LA1-C006-1500                        | 131014 01/20              | Feb. 28, 2019 | Semi-annual   | Aug. 28, 2019 |
| Coaxial Cable       | Rosenberger                 | LA1-C006-1500                        | 131014 05/20              | Feb. 28, 2019 | Semi-annual   | Aug. 28, 2019 |
| Coaxial Cable       | Rosenberger                 | LA1-C006-1500                        | 131014 10/20              | Feb. 28, 2019 | Semi-annual   | Aug. 28, 2019 |

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## 1.6. Declaration by the Manufacturer

- Adaptive Frequency Hopping is supported and use at least 20 channels.

## 1.7. Information about the FHSS characteristics:

### 1.7.1. Pseudorandom Frequency Hopping Sequence

The channel is represented by a pseudo-random hopping sequence hopping through the 79 RF channels. The hopping sequence is unique for the piconet and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies. The nominal hop rate is 1 600 hops/s.

### 1.7.2. Equal Hopping Frequency Use

The channels of this system will be used equally over the long-term distribution of the hopsets.

### 1.7.3. Example of a 79 hopping sequence in data mode:

02, 05, 31, 24, 20, 10, 43, 36, 30, 23, 40, 06, 21, 50, 44, 09, 71, 78, 01, 13, 73, 07, 70, 72, 35, 62, 42, 11, 41, 08, 16, 29, 60, 15, 34, 61, 58, 04, 67, 12, 22, 53, 57, 18, 27, 76, 39, 32, 17, 77, 52, 33, 56, 46, 37, 47, 64, 49, 45, 38, 69, 14, 51, 26, 79, 19, 28, 65, 75, 54, 48, 03, 25, 66, 05, 16, 68, 74, 59, 63, 55

### 1.7.4. System Receiver Input Bandwidth

Each channel bandwidth is 1 MHz.

The system receivers have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

### 1.7.5. Equipment Description

15.247(a)(1) that the Rx input bandwidths shift frequencies in synchronization with the transmitted signals.

15.247(g): In accordance with the Bluetooth Industry Standard, the system is designed to comply with all of the regulations in Section 15.247 when the transmitter is presented with a continuous data (or information) system.

15.247(h): In accordance with the Bluetooth Industry Standard, the system does not coordinate its channels selection/ hopping sequence with other frequency hopping systems for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

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## 1.8. Summary of Test Results

The EUT has been tested according to the following specifications:

| APPLIED STANDARD: FCC Part15 Subpart C |                                                                         |                   |
|----------------------------------------|-------------------------------------------------------------------------|-------------------|
| Section                                | Test Item                                                               | Result            |
| 15.205(a)<br>15.209<br>15.247(d)       | Transmitter Radiated Spurious Emissions and Conducted Spurious Emission | Complied          |
| 15.247(a)(1)                           | 20 dB Bandwidth                                                         | Complied          |
| 15.247(b)(1)                           | Maximum Peak Conducted Output Power                                     | Complied          |
| 15.247(a)(1)                           | Carrier Frequency Separation                                            | Complied          |
| 15.247(a)(1)(iii)                      | Number of Hopping Frequencies                                           | Complied          |
| 15.247(a)(1)(iii)                      | Time of Occupancy (Dwell Time)                                          | Complied          |
| 15.207                                 | AC Power Line Conducted Emission                                        | N/A <sup>1)</sup> |

### Note;

1) The AC power line test was not performed because the EUT does not operate while charging.

## 1.9. Test Procedure(s)

The measurement procedures described in the American National Standard of Procedure for Compliance Testing of unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074 D01 15.247 Meas Guidance v05r02 were used in the measurement of the DUT.

## 1.10. Sample Calculation

Where relevant, the following sample calculation is provided:

### 1.10.1. Conducted Test

Offset value (dB) = Directional coupler (dB) + Cable loss (dB)

### 1.10.2. Radiation Test

Field strength level (dB $\mu$ V/m) = Measured level (dB $\mu$ V) + Antenna factor (dB) + Cable loss (dB) - Amplifier gain (dB)

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### 1.11. Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Uncertainty figures are valid to a confidence level of 95 %.

| Parameter                          | Uncertainty (dB) |
|------------------------------------|------------------|
| RF Output Power                    | $\pm 0.40$ dB    |
| Conducted Spurious Emission        | $\pm 0.76$ dB    |
| Occupied Bandwidth                 | $\pm 9.66$ kHz   |
| Radiated Emission, 9 kHz to 30 MHz | $\pm 3.59$ dB    |
| Radiated Emission, below 1 GHz     | $\pm 5.88$ dB    |
| Radiated Emission, above 1 GHz     | $\pm 5.94$ dB    |

### 1.12. Test Report Revision

| Revision | Report Number        | Date of Issue | Description |
|----------|----------------------|---------------|-------------|
| 0        | F690501/RF-RTL013936 | 2019.06.11    | Initial     |

### 1.13. Information of Variant Model

| Model Name | Information                                                                |
|------------|----------------------------------------------------------------------------|
| HBS-FL7    | - Basic Model                                                              |
| HBS-PFL7   | - Same to basic mode, but variant model name is made for marketing purpose |

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## 1.14. Descriptions of Test Mode

Preliminary tests were performed in different data rates and recorded the RF output power in the following table:

### 1.14.1. Left

| Operation Mode | Data Rate (Mbps) | Channel | Frequency (MHz) | RF Output Power (dB m) |
|----------------|------------------|---------|-----------------|------------------------|
| GFSK           | 1                | Low     | 2 402           | 9.43                   |
|                |                  | Middle  | 2 441           | <b><u>9.48</u></b>     |
|                |                  | High    | 2 480           | 9.37                   |
| $\pi/4$ DQPSK  | 2                | Low     | 2 402           | 9.34                   |
|                |                  | Middle  | 2 441           | <b><u>9.41</u></b>     |
|                |                  | High    | 2 480           | 9.36                   |
| 8DPSK          | 3                | Low     | 2 402           | 9.34                   |
|                |                  | Middle  | 2 441           | <b><u>9.44</u></b>     |
|                |                  | High    | 2 480           | 9.30                   |

#### Note;

1. For transmitter radiated spurious emissions, conducted spurious emission, carrier frequency separation and number of hopping frequencies, GFSK / DH5 and 8DPSK / 3DH5 are tested as worst condition.
2. For 20 dB bandwidth and maximum peak conducted output power, GFSK / DH5,  $\pi/4$ DQPSK / 2DH5 and 8DPSK / 3DH5 are tested as worst condition.
3. For Time of Occupancy, GFSK / DH1, DH3, DH5 and 8DPSK / 3DH1, 3DH3, 3DH5 are tested as worst condition.

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### 1.14.2. Right

| Operation Mode | Data Rate (Mbps) | Channel | Frequency (MHz) | RF Output Power (dB m) |
|----------------|------------------|---------|-----------------|------------------------|
| GFSK           | 1                | Low     | 2 402           | <b><u>9.05</u></b>     |
|                |                  | Middle  | 2 441           | 8.92                   |
|                |                  | High    | 2 480           | 8.68                   |
| $\pi/4$ DQPSK  | 2                | Low     | 2 402           | <b><u>8.98</u></b>     |
|                |                  | Middle  | 2 441           | 8.86                   |
|                |                  | High    | 2 480           | 8.65                   |
| 8DPSK          | 3                | Low     | 2 402           | <b><u>8.99</u></b>     |
|                |                  | Middle  | 2 441           | 8.85                   |
|                |                  | High    | 2 480           | 8.62                   |

#### Note;

1. For transmitter radiated spurious emissions, conducted spurious emission, carrier frequency separation and number of hopping frequencies, GFSK / DH5 and 8DPSK / 3DH5 are tested as worst condition.
2. For 20 dB bandwidth and maximum peak conducted output power, GFSK / DH5,  $\pi/4$ DQPSK / 2DH5 and 8DPSK / 3DH5 are tested as worst condition.
3. For Time of Occupancy, GFSK / DH1, DH3, DH5 and 8DPSK / 3DH1, 3DH3, 3DH5 are tested as worst condition.

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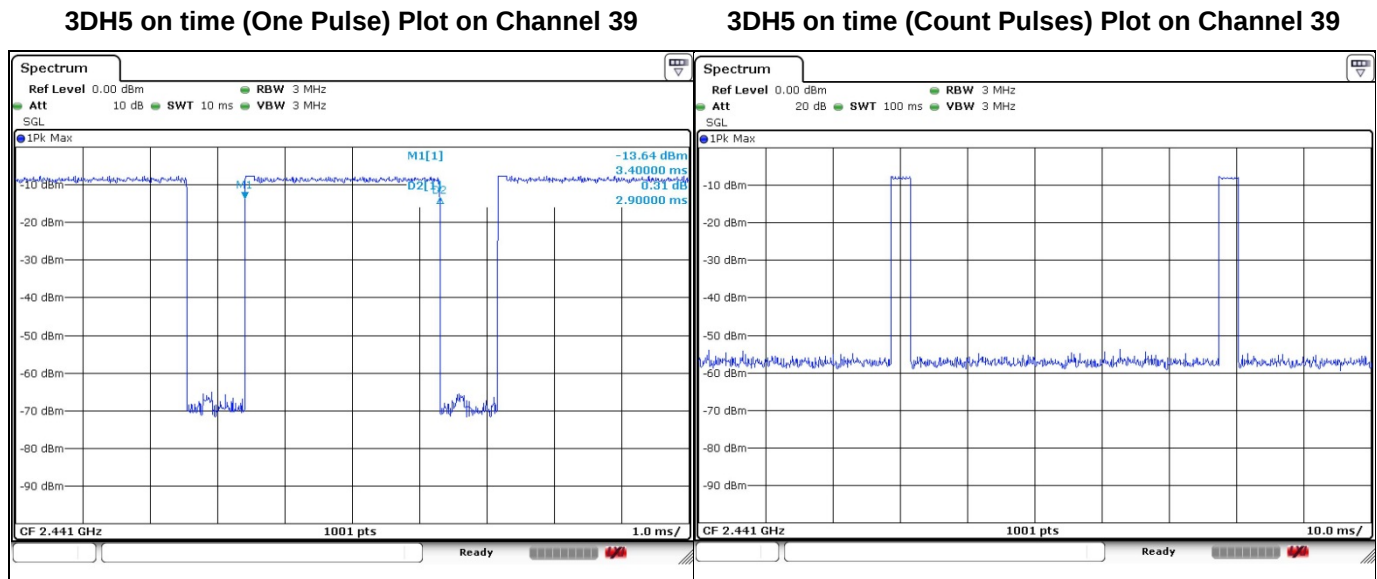
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## 1.15. Duty Cycle Correction Factor of EUT

According to KDB 558074 D01 15.247 Meas Guidance v05r02, 9, as a “duty cycle correction factor”, pulse averaging with 20 log (worst case dwell time / 100 ms) has to be used for average result.

### 1.15.1. Left



In AFH mode, the minimum hopping frequencies are 20, to get the longest dwell time 3DH5 packet is observed;  
the period to have 3DH5 packet completing one hopping sequence is  $2.90 \text{ ms} \times 20 \text{ channels} = 58.00 \text{ ms}$

There cannot be 2 complete hopping sequences within 100 ms period, considering the random hopping behavior, maximum 2 hops can be possibly observed within the period.  $[100 \text{ ms} / 58.00 \text{ ms}] = 2 \text{ hops}$

Thus, the maximum possible ON time:

$$2.90 \text{ ms} \times 2 = 5.80 \text{ ms}$$

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time:

$$20 \times \log (5.80 \text{ ms} / 100 \text{ ms}) = -24.73 \text{ dB}$$

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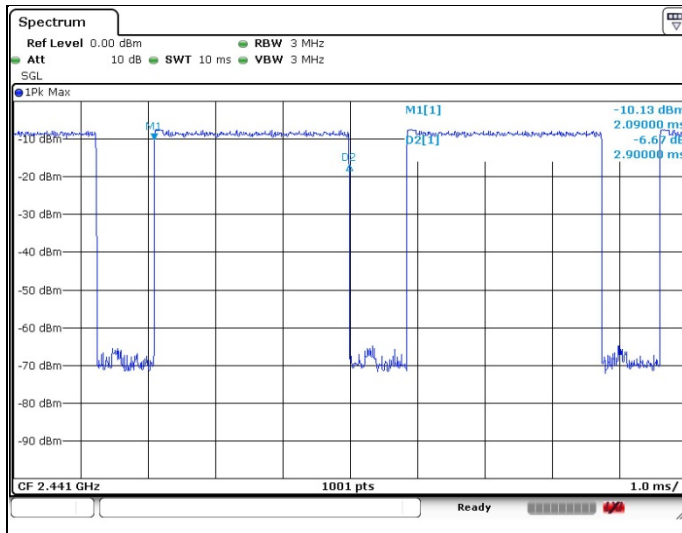
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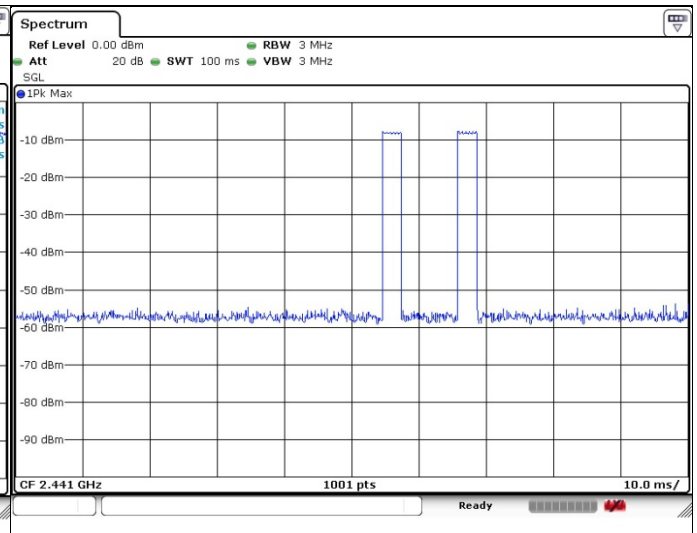
A4(210 mm x 297 mm)

## 1.15.2. Right

3DH5 on time (One Pulse) Plot on Channel 39



3DH5 on time (Count Pulses) Plot on Channel 39



In AFH mode, the minimum hopping frequencies are 20, to get the longest dwell time 3DH5 packet is observed;  
the period to have 3DH5 packet completing one hopping sequence is  $2.90 \text{ ms} \times 20 \text{ channels} = 58.00 \text{ ms}$

There cannot be 2 complete hopping sequences within 100 ms period, considering the random hopping behavior, maximum 2 hops can be possibly observed within the period.  $[100 \text{ ms} / 58.00 \text{ ms}] = 2 \text{ hops}$

Thus, the maximum possible ON time:

$$2.90 \text{ ms} \times 2 = 5.80 \text{ ms}$$

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time:

$$20 \times \log(5.80 \text{ ms} / 100 \text{ ms}) = -24.73 \text{ dB}$$

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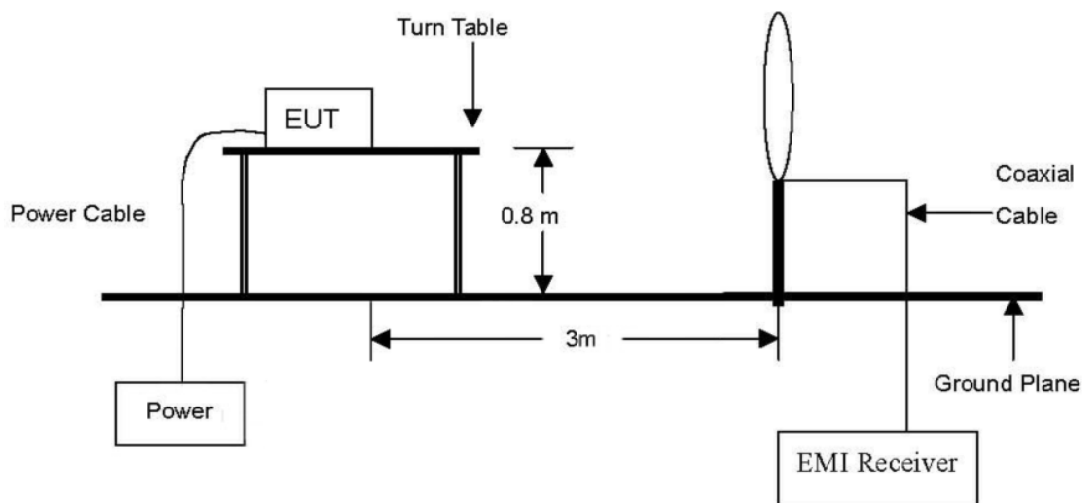
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## 2. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

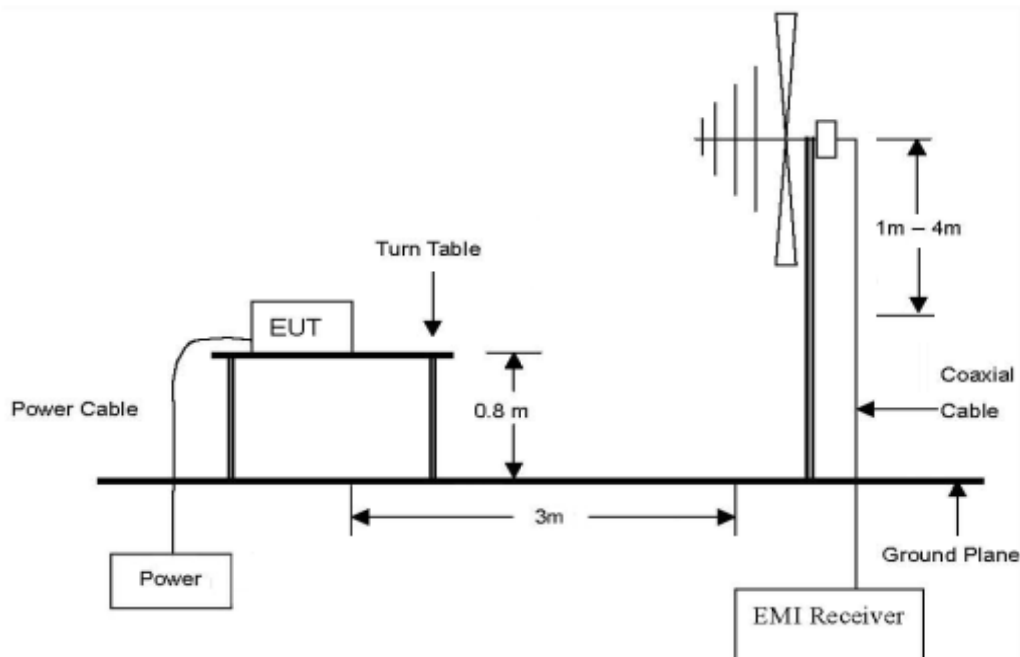
### 2.1. Test Setup

#### 2.1.1. Transmitter Radiated Spurious Emissions

The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz.



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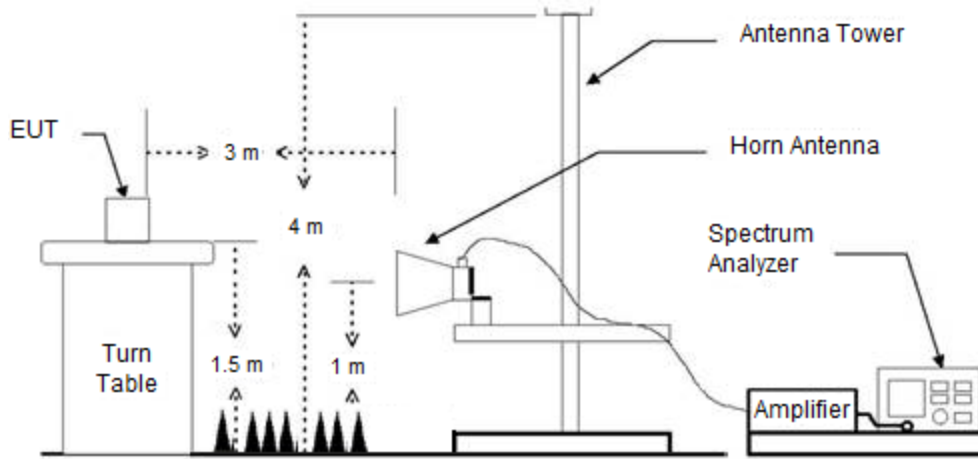
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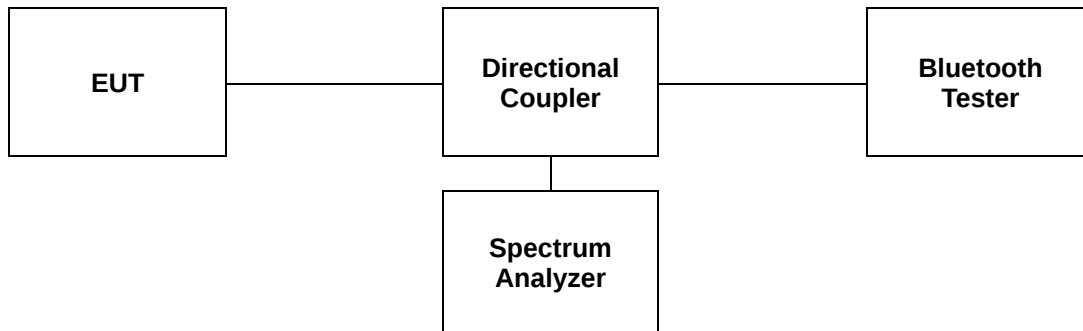
The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated from 1 GHz to the 10<sup>th</sup> harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.



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### 2.1.2. Conducted Spurious Emissions



### 2.2. Limit

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 emission 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 §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<br>(MHz) | Field Strength<br>( $\mu\text{V/m}$ ) | Measurement Distance<br>(Meters) |
|--------------------|---------------------------------------|----------------------------------|
| 0.009-0.490        | 2 400/F(kHz)                          | 300                              |
| 0.490-1.705        | 24 000/F(kHz)                         | 30                               |
| 1.705-30.0         | 30                                    | 30                               |
| 30-88              | 100**                                 | 3                                |
| 88-216             | 150**                                 | 3                                |
| 216-960            | 200**                                 | 3                                |
| Above 960          | 500                                   | 3                                |

\*\* Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 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.

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## 2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10-2013.

### 2.3.1. Test Procedures for emission below 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum Hold Mode.

### 2.3.2. Test Procedures for emission from above 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site below 1 GHz and 1.5 meter above the ground at a 3 meter anechoic chamber test site above 1 GHz. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a bi-log antenna, a horn antenna and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

#### 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. For frequency above 1 GHz, set spectrum analyzer detector to peak, and resolution bandwidth is 1 MHz and video bandwidth is 3 MHz.
3. Definition of DUT Axis.  
Definition of the test orthogonal plan for EUT was described in the test setup photo.  
The test orthogonal plan of EUT is X – axis during radiation test.

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### 2.3.3. Test Procedures for Conducted Spurious Emissions

#### 2.3.3.1. Band-edge Compliance of RF Conducted Emissions

The transmitter output was connected to the spectrum analyzer.

Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.

RBW  $\geq$  100 kHz

VBW = 300 kHz

Sweep = auto

Detector function = peak

Trace = max hold

#### 2.3.3.2. Spurious RF Conducted Emissions

The transmitter output was connected to the spectrum analyzer.

RBW = 1 MHz

VBW = 3 MHz

Sweep = auto

Detector function = peak

Trace = max hold

#### 2.3.3.3. TDF function

- For plots showing conducted spurious emissions from 9 kHz to 25 GHz, all path loss of wide frequency range was investigated and compensated to spectrum analyzer as TDF function.

So, the reading values shown in plots were final result.

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## 2.4. Test Results

Ambient temperature : (23 ± 1) °C  
Relative humidity : 47 % R.H.

### 2.4.1. Radiated Spurious Emission below 1 000 MHz

The frequency spectrum from 9 kHz to 1 000 MHz was investigated. All reading values are peak values.

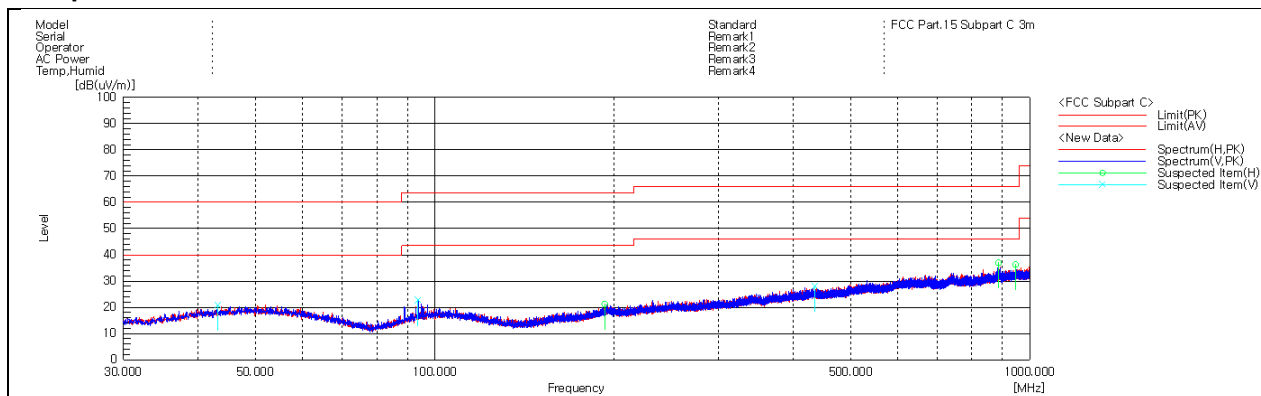
#### 2.4.1.1. Left

| Radiated Emissions |                |             | Ant  | Correction Factors |               | Total           | Limit          |             |
|--------------------|----------------|-------------|------|--------------------|---------------|-----------------|----------------|-------------|
| Frequency (MHz)    | Reading (dBμV) | Detect Mode | Pol. | AF (dB/m)          | AMP + CL (dB) | Actual (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| 886.43             | 30.90          | Peak        | H    | 22.03              | -21.69        | 31.24           | 46.00          | 14.76       |
| 947.54             | 29.70          | Peak        | H    | 22.42              | -21.40        | 30.72           | 46.00          | 15.28       |

#### Remark;

- Spurious emissions for all channels and modes were investigated and almost the same below 1 GHz.
- Reported spurious emissions are in **BDR / DH5 / Middle channel** as worst case among other modes.
- Radiated spurious emission measurement as below.  
(Actual = Reading + AF + AMP + CL)
- According to §15.31(o), emission levels are not report much lower than the limits by over 20 dB.

#### - Test plot



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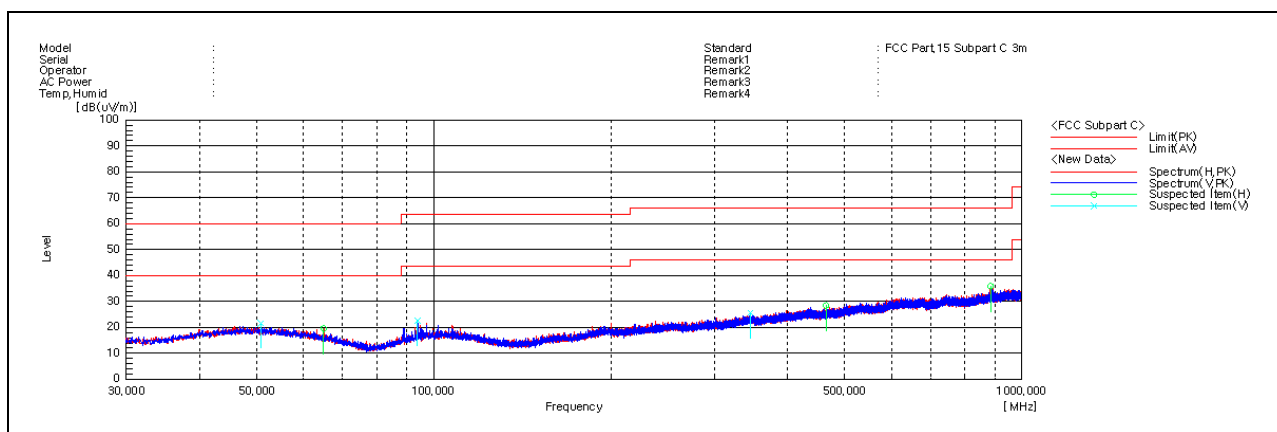
### 2.4.1.2. Right

| Radiated Emissions |                      |             | Ant  | Correction Factors |               | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|---------------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP + CL (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| 884.77             | 30.10                | Peak        | H    | 22.00              | -21.66        | 30.44                 | 46.00                | 15.56       |
| Above 900.00       | Not detected         | -           | -    | -                  | -             | -                     | -                    | -           |

#### Remark;

- Spurious emissions for all channels and modes were investigated and almost the same below 1 GHz.
- Reported spurious emissions are in **BDR / DH5 / Low channel** as worst case among other modes.
- Radiated spurious emission measurement as below.  
(Actual = Reading + AF + AMP + CL)
- According to §15.31(o), emission levels are not report much lower than the limits by over 20 dB.

#### - Test plot



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## 2.4.2. Radiated Spurious Emission above 1 000 MHz

The frequency spectrum above 1 000 MHz was investigated. All reading values are peak values.

### 2.4.2.1. Left

#### Operating Mode: GFSK (1 Mbps)

##### A. Low Channel (2 402 MHz)

| Radiated Emissions |                |             | Ant. | Correction Factors |         |         | Total           | Limit          |             |
|--------------------|----------------|-------------|------|--------------------|---------|---------|-----------------|----------------|-------------|
| Frequency (MHz)    | Reading (dBμV) | Detect Mode | Pol. | AF (dB/m)          | CL (dB) | DF (dB) | Actual (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| *2 310.00          | 24.93          | Peak        | V    | 27.82              | 10.56   | -       | 63.31           | 74.00          | 10.69       |
| *2 310.00          | -              | -           | -    | -                  | -       | -24.73  | 38.58           | 54.00          | 15.42       |
| *2 373.70          | 27.36          | Peak        | V    | 27.95              | 10.63   | -       | 65.94           | 74.00          | 8.06        |
| *2 373.70          | -              | -           | -    | -                  | -       | -24.73  | 41.21           | 54.00          | 12.79       |
| *2 390.00          | 25.05          | Peak        | V    | 27.98              | 10.65   | -       | 63.68           | 74.00          | 10.32       |
| *2 390.00          | -              | -           | -    | -                  | -       | -24.73  | 38.95           | 54.00          | 15.05       |

| Radiated Emissions |                |             | Ant. | Correction Factors |             |         | Total           | Limit          |             |
|--------------------|----------------|-------------|------|--------------------|-------------|---------|-----------------|----------------|-------------|
| Frequency (MHz)    | Reading (dBμV) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| Above 1 000.00     | Not detected   | -           | -    | -                  | -           | -       | -               | -              | -           |

##### B. Middle Channel (2 441 MHz)

| Radiated Emissions |                |             | Ant. | Correction Factors |             |         | Total           | Limit          |             |
|--------------------|----------------|-------------|------|--------------------|-------------|---------|-----------------|----------------|-------------|
| Frequency (MHz)    | Reading (dBμV) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| Above 1 000.00     | Not detected   | -           | -    | -                  | -           | -       | -               | -              | -           |

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## C. High Channel (2 480 MHz)

| Radiated Emissions |                      |             | Ant. | Correction Factors |         |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|---------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| *2 483.50          | 26.01                | Peak        | V    | 28.00              | 10.74   | -       | 64.75                 | 74.00                | 9.25        |
| *2 483.50          | -                    | -           | -    | -                  | -       | -24.73  | 40.02                 | 54.00                | 13.98       |
| *2 490.69          | 28.22                | Peak        | V    | 28.00              | 10.75   | -       | 66.97                 | 74.00                | 7.03        |
| *2 490.69          | -                    | -           | -    | -                  | -       | -24.73  | 42.24                 | 54.00                | 11.76       |
| *2 500.00          | 27.23                | Peak        | V    | 28.00              | 10.75   | -       | 65.98                 | 74.00                | 8.02        |
| *2 500.00          | -                    | -           | -    | -                  | -       | -24.73  | 41.25                 | 54.00                | 12.75       |

| Radiated Emissions |                      |             | Ant. | Correction Factors |             |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|-------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| Above 1 000.00     | Not detected         | -           | -    | -                  | -           | -       | -                     | -                    | -           |

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### Operating Mode: 8DPSK (3 Mbps)

Low Channel (2 402 MHz)

| Radiated Emissions |                      |             | Ant. | Correction Factors |         |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|---------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| *2 310.00          | 25.11                | Peak        | V    | 27.82              | 10.56   | -       | 63.49                 | 74.00                | 10.51       |
| *2 310.00          | -                    | -           | -    | -                  | -       | -24.73  | 38.76                 | 54.00                | 15.24       |
| *2 377.88          | 26.89                | Peak        | V    | 27.96              | 10.63   | -       | 65.48                 | 74.00                | 8.52        |
| *2 377.88          | -                    | -           | -    | -                  | -       | -24.73  | 40.75                 | 54.00                | 13.25       |
| *2 390.00          | 25.33                | Peak        | V    | 27.98              | 10.65   | -       | 63.96                 | 74.00                | 10.04       |
| *2 390.00          | -                    | -           | -    | -                  | -       | -24.73  | 39.23                 | 54.00                | 14.77       |

| Radiated Emissions |                      |             | Ant. | Correction Factors |             |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|-------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| Above 1 000.00     | Not detected         | -           | -    | -                  | -           | -       | -                     | -                    | -           |

Middle Channel (2 441 MHz)

| Radiated Emissions |                      |             | Ant. | Correction Factors |             |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|-------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| Above 1 000.00     | Not detected         | -           | -    | -                  | -           | -       | -                     | -                    | -           |

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## High Channel (2 480 MHz)

| Radiated Emissions |                      |             | Ant. | Correction Factors |         |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|---------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| *2 483.50          | 26.29                | Peak        | V    | 28.00              | 10.74   | -       | 65.03                 | 74.00                | 8.97        |
| *2 483.50          | -                    | -           | -    | -                  | -       | -24.73  | 40.30                 | 54.00                | 13.70       |
| *2 488.90          | 27.44                | Peak        | V    | 28.00              | 10.75   | -       | 66.19                 | 74.00                | 7.81        |
| *2 488.90          | -                    | -           | -    | -                  | -       | -24.73  | 41.46                 | 54.00                | 12.54       |
| *2 500.00          | 27.13                | Peak        | V    | 28.00              | 10.75   | -       | 65.88                 | 74.00                | 8.12        |
| *2 500.00          | -                    | -           | -    | -                  | -       | -24.73  | 41.15                 | 54.00                | 12.85       |

| Radiated Emissions |                      |             | Ant. | Correction Factors |             |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|-------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| Above 1 000.00     | Not detected         | -           | -    | -                  | -           | -       | -                     | -                    | -           |

## Remark;

1. "\*" means the restricted band.
2. Measuring frequencies from 1 GHz to the 10<sup>th</sup> harmonic of highest fundamental frequency.
3. Radiated emissions measured in frequency above 1 000 MHz were made with an instrument using peak/average detector mode.
4. Actual = Reading + AF + CL + (DF) or Reading + AF + AMP + CL + (DF).
5. According to § 15.31(o), emission levels are not reported much lower than the limits by over 20 dB.
6. The maximized peak measured value complies with the average limit, to perform an average measurement is unnecessary.

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### 2.4.2.2. Right

#### Operating Mode: GFSK (1 Mbps)

Low Channel (2 402 MHz)

| Radiated Emissions |                      |             | Ant. | Correction Factors |         |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|---------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| *2 310.00          | 25.24                | Peak        | H    | 27.82              | 10.56   | -       | 63.62                 | 74.00                | 10.38       |
| *2 310.00          | -                    | -           | -    | -                  | -       | -24.73  | 38.89                 | 54.00                | 15.11       |
| *2 369.30          | 26.66                | Peak        | H    | 27.94              | 10.62   | -       | 65.22                 | 74.00                | 8.78        |
| *2 369.30          | -                    | -           | -    | -                  | -       | -24.73  | 40.49                 | 54.00                | 13.51       |
| *2 390.00          | 26.00                | Peak        | H    | 27.98              | 10.65   | -       | 64.63                 | 74.00                | 9.37        |
| *2 390.00          | -                    | -           | -    | -                  | -       | -24.73  | 39.90                 | 54.00                | 14.10       |

| Radiated Emissions |                      |             | Ant. | Correction Factors |             |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|-------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| Above 1 000.00     | Not detected         | -           | -    | -                  | -           | -       | -                     | -                    | -           |

Middle Channel (2 441 MHz)

| Radiated Emissions |                      |             | Ant. | Correction Factors |             |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|-------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| Above 1 000.00     | Not detected         | -           | -    | -                  | -           | -       | -                     | -                    | -           |

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## High Channel (2 480 MHz)

| Radiated Emissions |                      |             | Ant. | Correction Factors |         |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|---------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| *2 483.50          | 25.70                | Peak        | H    | 28.00              | 10.74   | -       | 64.44                 | 74.00                | 9.56        |
| *2 483.50          | -                    | -           | -    | -                  | -       | -24.73  | 39.71                 | 54.00                | 14.29       |
| *2 495.22          | 27.94                | Peak        | H    | 28.00              | 10.75   | -       | 66.69                 | 74.00                | 7.31        |
| *2 495.22          | -                    | -           | -    | -                  | -       | -24.73  | 41.96                 | 54.00                | 12.04       |
| *2 500.00          | 25.59                | Peak        | H    | 28.00              | 10.75   | -       | 64.34                 | 74.00                | 9.66        |
| *2 500.00          | -                    | -           | -    | -                  | -       | -24.73  | 39.61                 | 54.00                | 14.39       |

| Radiated Emissions |                      |             | Ant. | Correction Factors |             |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|-------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| Above 1 000.00     | Not detected         | -           | -    | -                  | -           | -       | -                     | -                    | -           |

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A4(210 mm x 297 mm)

### Operating Mode: 8DPSK (3 Mbps)

Low Channel (2 402 MHz)

| Radiated Emissions |                      |             | Ant. | Correction Factors |         |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|---------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| *2 310.00          | 25.17                | Peak        | H    | 27.82              | 10.56   | -       | 63.55                 | 74.00                | 10.45       |
| *2 310.00          | -                    | -           | -    | -                  | -       | -24.73  | 38.82                 | 54.00                | 15.18       |
| *2 337.51          | 27.41                | Peak        | H    | 27.88              | 10.58   | -       | 65.87                 | 74.00                | 8.13        |
| *2 337.51          | -                    | -           | -    | -                  | -       | -24.73  | 41.14                 | 54.00                | 12.86       |
| *2 390.00          | 26.88                | Peak        | H    | 27.98              | 10.65   | -       | 65.51                 | 74.00                | 8.49        |
| *2 390.00          | -                    | -           | -    | -                  | -       | -24.73  | 40.78                 | 54.00                | 13.22       |

| Radiated Emissions |                      |             | Ant. | Correction Factors |             |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|-------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| Above 1 000.00     | Not detected         | -           | -    | -                  | -           | -       | -                     | -                    | -           |

Middle Channel (2 441 MHz)

| Radiated Emissions |                      |             | Ant. | Correction Factors |             |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|-------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| Above 1 000.00     | Not detected         | -           | -    | -                  | -           | -       | -                     | -                    | -           |

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High Channel (2 480 MHz)

| Radiated Emissions |                      |             | Ant. | Correction Factors |         |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|---------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| *2 483.50          | 25.77                | Peak        | H    | 28.00              | 10.74   | -       | 64.51                 | 74.00                | 9.49        |
| *2 483.50          | -                    | -           | -    | -                  | -       | -24.73  | 39.78                 | 54.00                | 14.22       |
| *2 496.59          | 27.34                | Peak        | H    | 28.00              | 10.75   | -       | 66.09                 | 74.00                | 7.91        |
| *2 496.59          | -                    | -           | -    | -                  | -       | -24.73  | 41.36                 | 54.00                | 12.64       |
| *2 500.00          | 26.82                | Peak        | H    | 28.00              | 10.75   | -       | 65.57                 | 74.00                | 8.43        |
| *2 500.00          | -                    | -           | -    | -                  | -       | -24.73  | 40.84                 | 54.00                | 13.16       |

| Radiated Emissions |                      |             | Ant. | Correction Factors |             |         | Total                 | Limit                |             |
|--------------------|----------------------|-------------|------|--------------------|-------------|---------|-----------------------|----------------------|-------------|
| Frequency (MHz)    | Reading (dB $\mu$ V) | Detect Mode | Pol. | AF (dB/m)          | AMP+CL (dB) | DF (dB) | Actual (dB $\mu$ V/m) | Limit (dB $\mu$ V/m) | Margin (dB) |
| Above 1 000.00     | Not detected         | -           | -    | -                  | -           | -       | -                     | -                    | -           |

#### Remark;

1. "\*" means the restricted band.
2. Measuring frequencies from 1 GHz to the 10<sup>th</sup> harmonic of highest fundamental frequency.
3. Radiated emissions measured in frequency above 1 000 MHz were made with an instrument using peak/average detector mode.
4. Actual = Reading + AF + CL + (Duty Factor) or Reading + AF + AMP + CL + (Duty Factor).
5. According to § 15.31(o), emission levels are not reported much lower than the limits by over 20 dB.
6. The maximized peak measured value complies with the average limit, to perform an average measurement is unnecessary.

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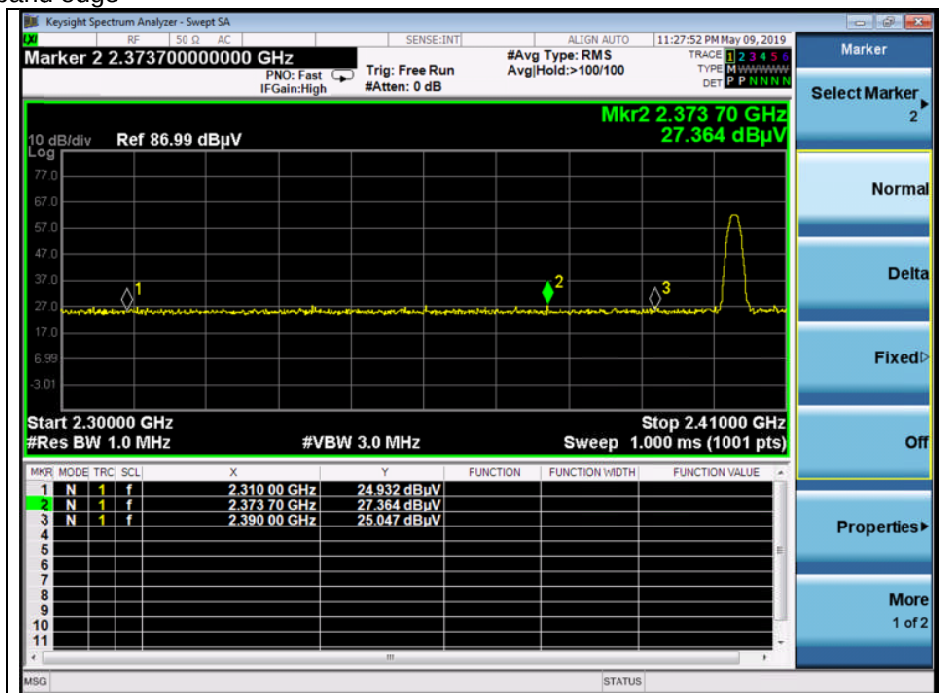
A4(210 mm x 297 mm)

## - Test plots

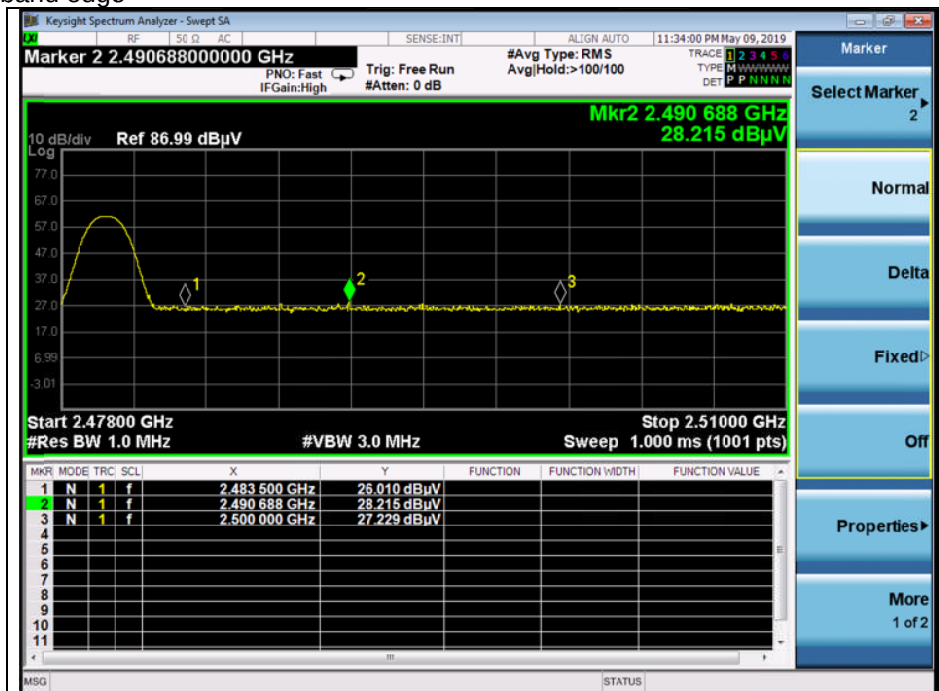
### 2.4.2.3. Left

#### Operating Mode: GFSK (1 Mbps)

#### Low channel band edge



#### High channel band edge



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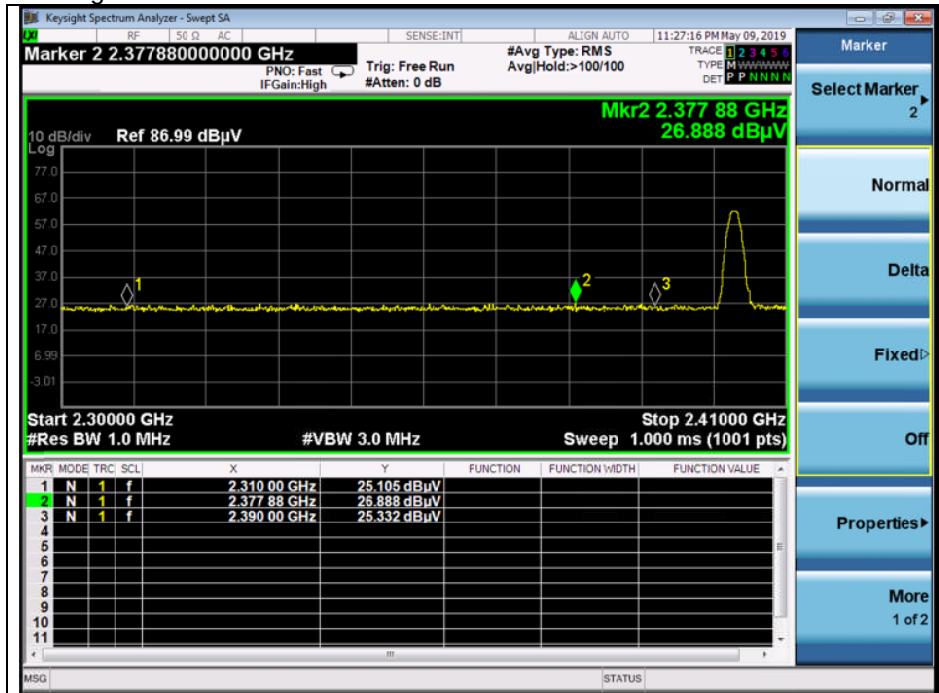
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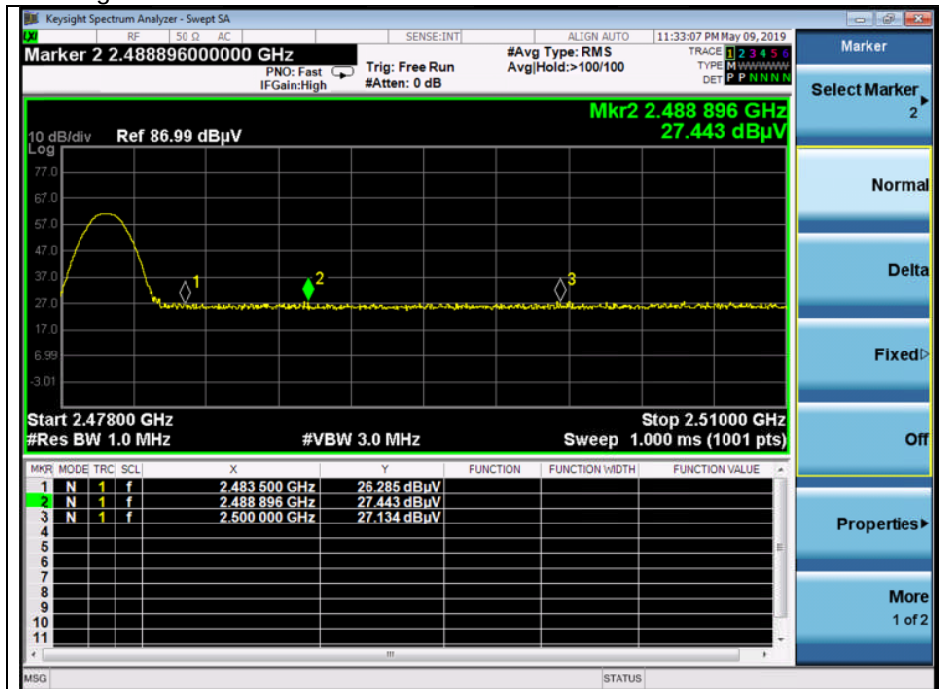
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A4(210 mm x 297 mm)

## Operating Mode: 8DPSK (3 Mbps) Low channel band edge



## High channel band edge



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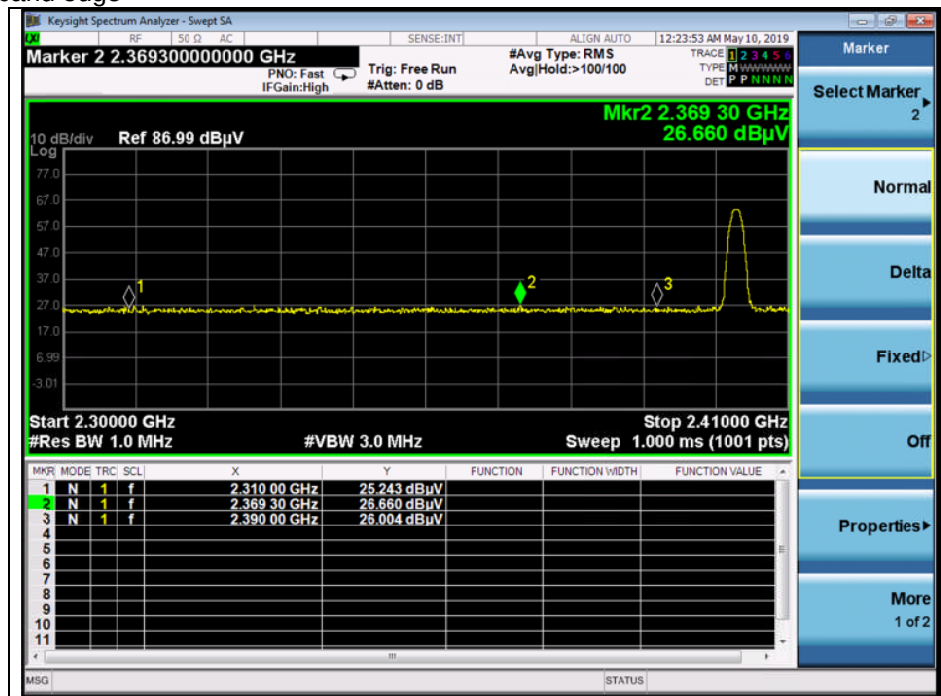
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A4(210 mm x 297 mm)

## 2.4.2.4. Right

Operating Mode: GFSK (1 Mbps)  
Low channel band edge



High channel band edge



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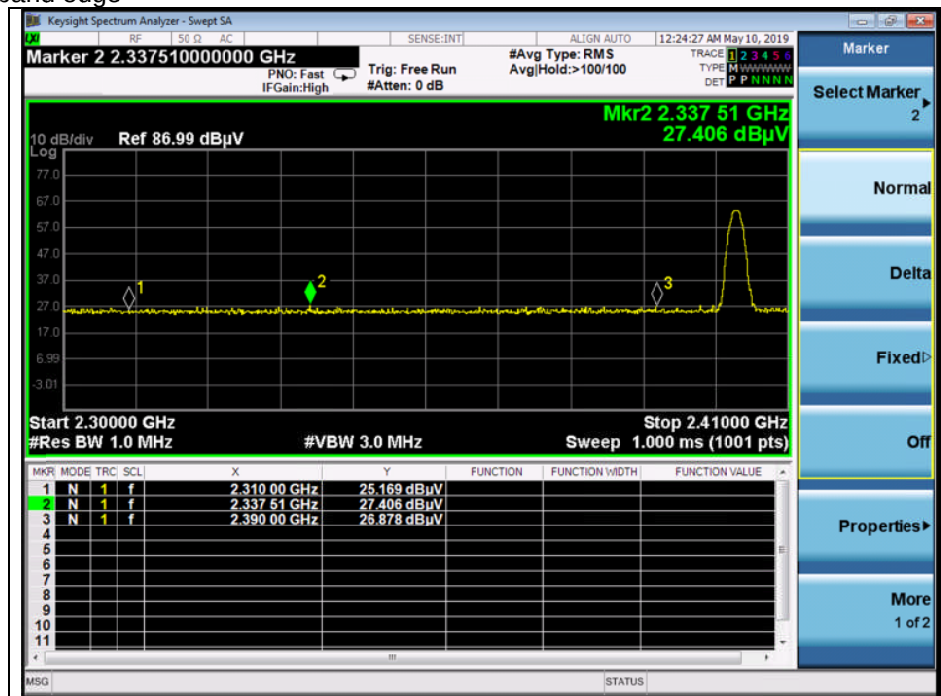
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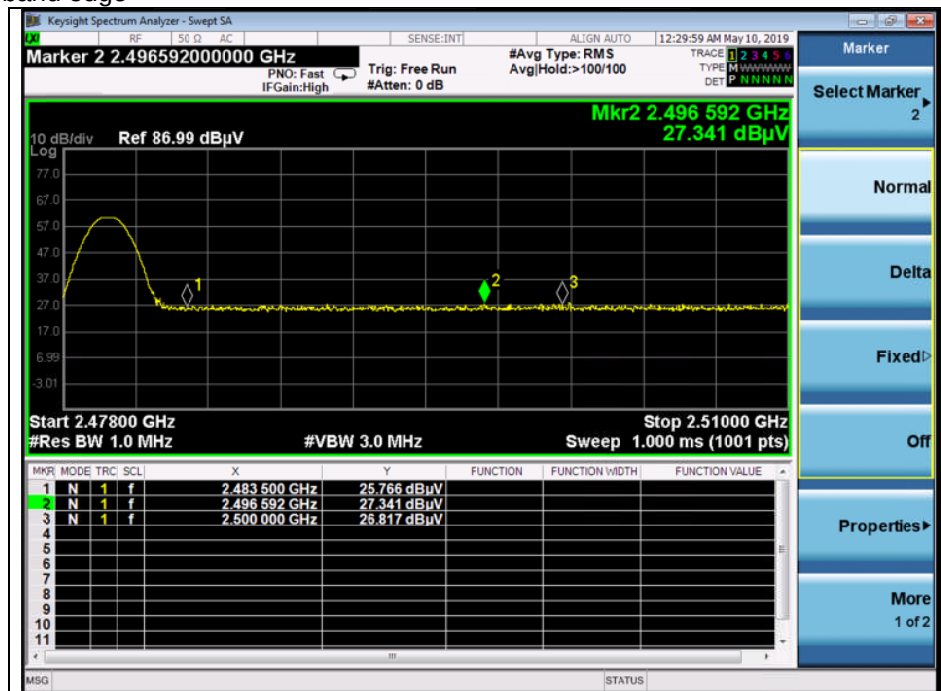
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A4(210 mm x 297 mm)

## Operating Mode: 8DPSK (3 Mbps) Low channel band edge



## High channel band edge



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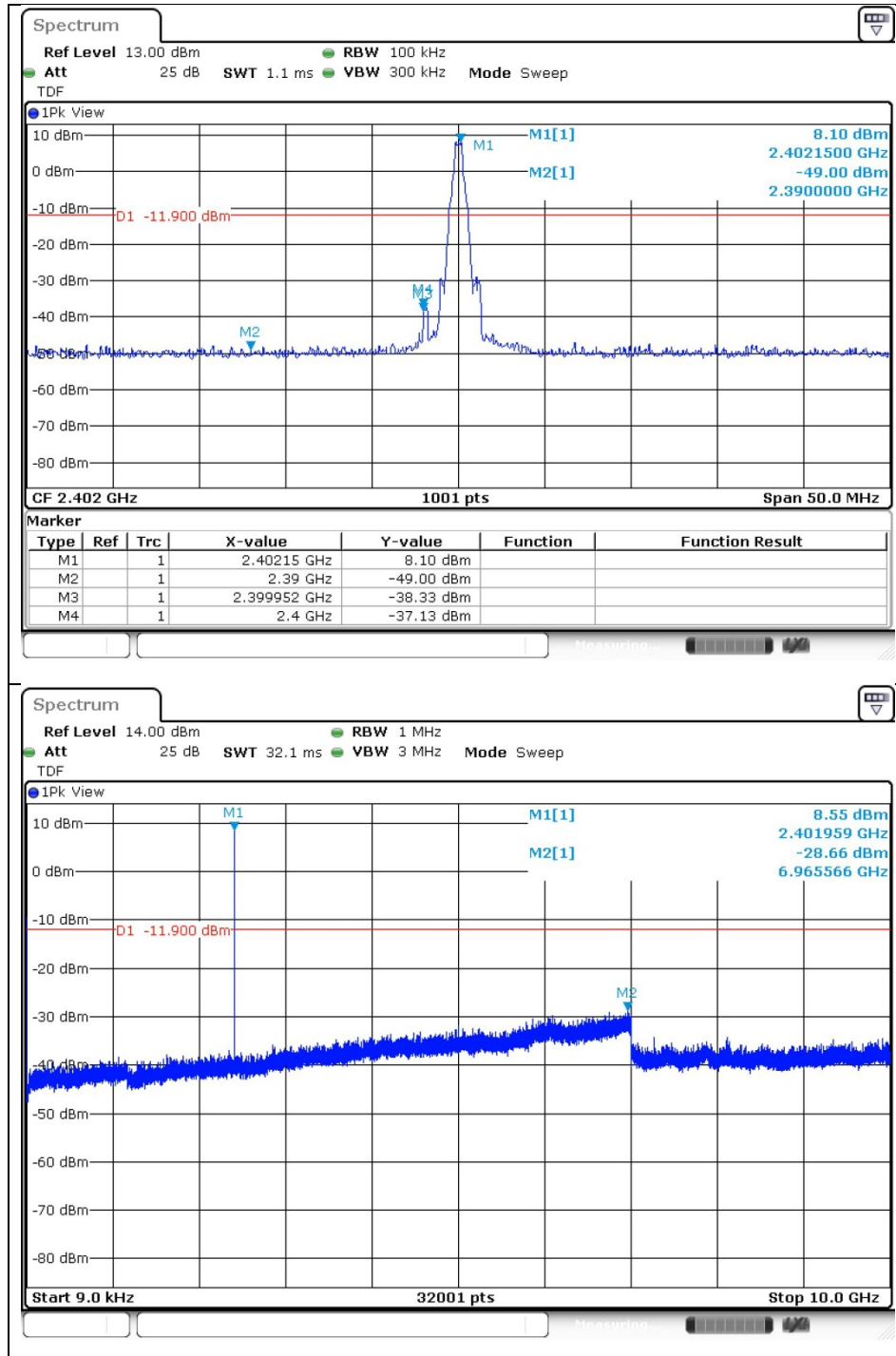
A4(210 mm x 297 mm)

## 2.4.3. Plot of Conducted Spurious Emissions

### 2.4.3.1. Left

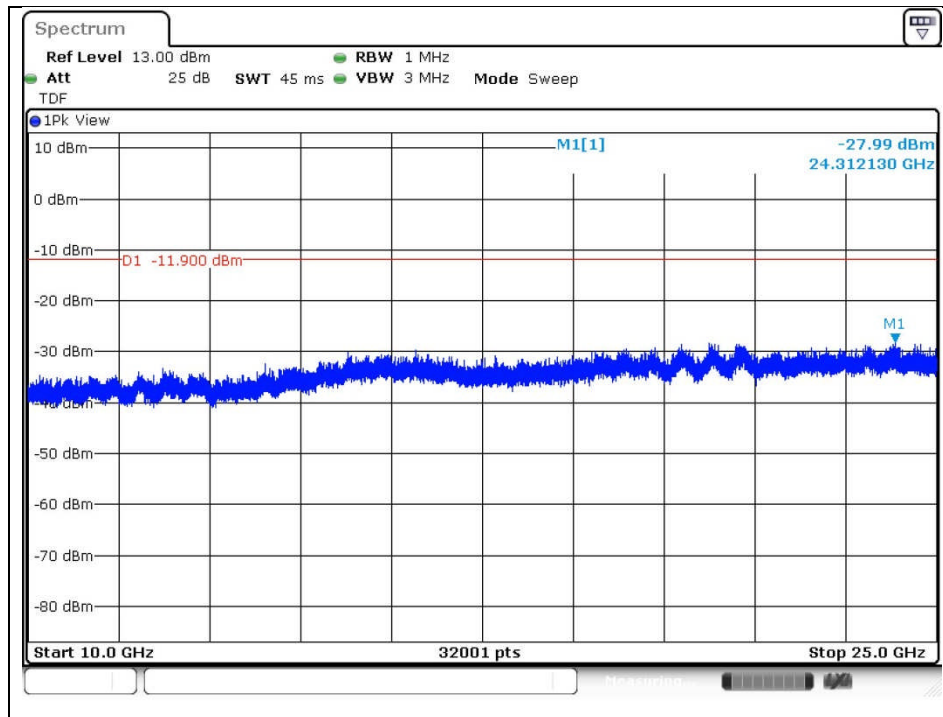
Operating Mode: GFSK (1 Mbps)

Low channel



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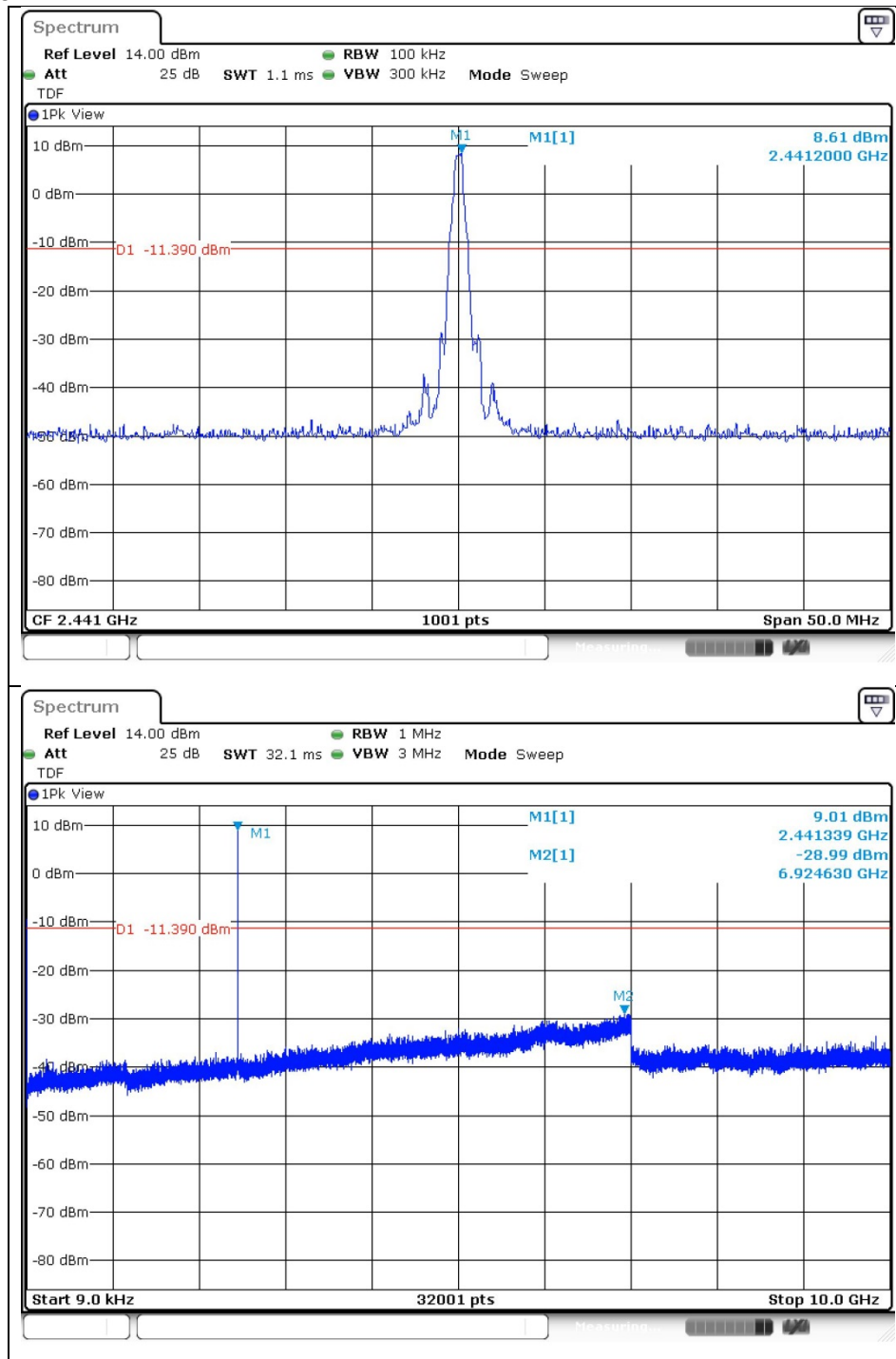
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## Middle channel



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