

FCC - TEST REPORT

Report Number : 60.790.16.717.01 Date of Issue: June 2, 2016

Model : SH002

Product Type : VerveLoop+

Applicant : Binatone Electronics International Ltd.

Address : Floor 23A, 9 Des Voeux Road West, Sheung Wan, Hong Kong
China

Production Facility : Charter Media (Dongguan) Co., Ltd.

Address : Dabandi Industrial Zone, Daning District, Humen Town,
Dongguan City, Guangdong Province 523930, P. R. China

Test Result : **Positive** **Negative**

Total pages including
Appendices : 27

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1 Table of Contents

| | | |
|-----|--|----|
| 1 | Table of Contents..... | 2 |
| 2 | Details about the Test Laboratory..... | 3 |
| 3 | Description of the Equipment Under Test..... | 4 |
| 4 | Summary of Test Standards..... | 5 |
| 5 | Summary of Test Results..... | 6 |
| 6 | General Remarks..... | 7 |
| 7 | Test Setups..... | 8 |
| 8 | Systems test configuration..... | 9 |
| 9 | Technical Requirement..... | 10 |
| 9.1 | Conducted Emission..... | 10 |
| 9.2 | Conducted peak output power..... | 13 |
| 9.3 | Power spectral density..... | 15 |
| 9.4 | 6 dB Bandwidth and 99% Occupied Bandwidth..... | 16 |
| 9.5 | Spurious RF conducted emissions..... | 18 |
| 9.6 | Band edge testing..... | 22 |
| 9.7 | Spurious radiated emissions for transmitter..... | 24 |
| 10 | Test Equipment List..... | 26 |
| 11 | System Measurement Uncertainty..... | 27 |

2 Details about the Test Laboratory

Details about the Test Laboratory

Test Site 1

Company name: TÜV SÜD Hong Kong Ltd.
3/F, West Wing, Lakeside 2,
10 Science Park West Avenue,
Science Park, Shatin, Hong Kong

Test Site 2

Company name: Hong Kong Productivity Council
LG1, HKPC Building,
78 Tat Chee Avenue,
Kowloon, Hong Kong

FCC Registration Number: 90656

IC Registration Number: 4780A

3 Description of the Equipment Under Test

| | |
|-------------------------------|---|
| Product: | VerveLoop+ |
| Model no.: | SH002 |
| Options and accessories: | Nil |
| Rating: | DC3.7V Supplied by Li-ion Rechargeable Battery DC5.0V Charged by the mini-USB port |
| RF Transmission Frequency: | 2402MHz-2480MHz |
| No. of Operated Channel: | 40 |
| Modulation: | GFSK |
| Antenna Type: | Chip antenna |
| Antenna Gain: | 1.6dBi |
| Description of the EUT: | The Equipment Under Test (EUT) is Bluetooth Headphones operated at 2.4GHz |

4 Summary of Test Standards

| Test Standards | |
|--|--|
| FCC Part 15 Subpart C 10-1-2015 Edition | PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators |
| RSS-247 Issue 1 2015 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices |

5 Summary of Test Results

| Technical Requirements | | | | |
|---------------------------|--------------------------|--|------------|-------------|
| FCC Part 15 Subpart C | | | | |
| Test Condition | | | Pages | Test Result |
| §15.207 | RSS-GEN A7.2.4 | Conducted emission AC power port | 10 | Pass |
| §15.247(b)(1) | RSS-247 Clause 5.4(2) | Conducted peak output power | 13 | Pass |
| §15.247(e) | RSS-247 Clause 5.2(2) | Power spectral density | 15 | Pass |
| §15.247(a)(2) | RSS-247 Clause 5.2(1) | 6dB bandwidth | 16 | Pass |
| §15.247(a)(1) | RSS-247 Clause 5.1(1) | 20dB bandwidth and 99% Occupied Bandwidth | -- | N/A |
| §15.247(a)(1) | RSS-247 Clause 5.1(2) | Carrier frequency separation | -- | N/A |
| §15.247(a)(1)(iii) | RSS-247 Clause 5.1(4) | Number of hopping frequencies | -- | N/A |
| §15.247(a)(1)(iii) | RSS-247 Clause 5.1(4) | Dwell Time | -- | N/A |
| §15.247(d) | RSS-247 Clause 5.5 | Spurious RF conducted emissions | 18 | Pass |
| §15.247(d) | RSS-247 Clause 5.5 | Band edge | 22 | Pass |
| §15.247(d) & §15.209 & | & RSSGEN 7.2.5 | Spurious radiated emissions for transmitter | 24 | Pass |
| §15.203 | RSSGEN 7.1.2 | Antenna requirement | See note 1 | Pass |

Note 1: N/A=Not Applicable.

Note 2: The EUT uses a Chip antenna, which gain is 1.6dBi. In accordance to §15.203, it is considered sufficiently to comply with the provisions of this section.

6 General Remarks

Remarks

This submittal(s) (test report) is intended for FCC ID: VLJ-SH002, IC: 4522A-SH002 complies with Section 15.207, 15.209, 15.247 of the FCC Part 15, Subpart C, RSS 247 and RSS-Gen rules.

This report is for the BT 4.0 part.

SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

□ - **Not** Performed

The Equipment Under Test

■ - **Fulfills** the general approval requirements.

□ - **Does not** fulfill the general approval requirements.

Sample Received Date: May 9, 2016

Testing Start Date: May 9, 2016

Testing End Date: May 28, 2016

- TÜV SÜD HONG KONG LTD. -

Reviewed by:

Prepared by:



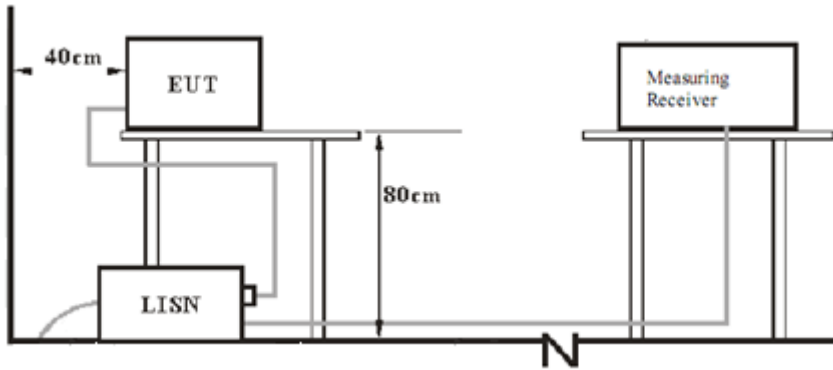
Phoebe Hu
EMC Project Manager



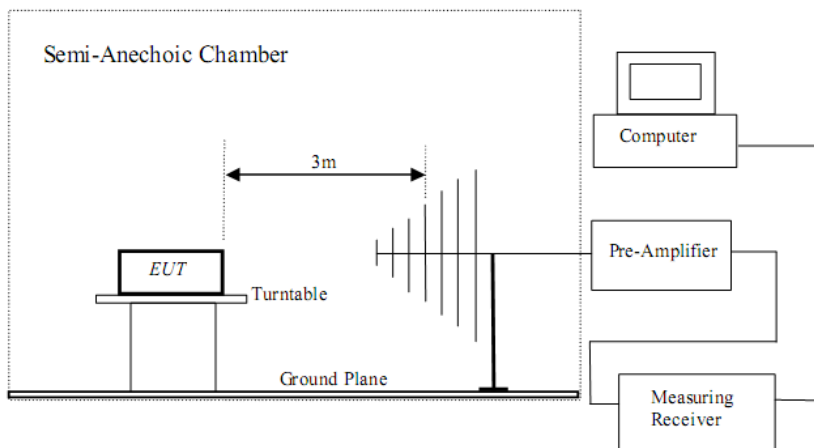
Felix Li
Senior EMC Project Engineer

7 Test Setups

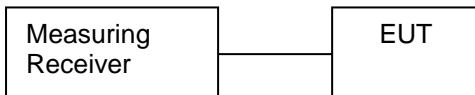
7.1 AC Power Line Conducted Emission test setups



7.2 Radiated test setups



7.3 Conducted RF test setups



8 Systems test configuration

Auxiliary Equipment Used during Test:

| DESCRIPTION | MANUFACTURER | MODEL NO.(SHIELD) | S/N(LENGTH) |
|-------------|--------------|-------------------|-------------|
| PC | Lenovo | X220 | --- |

Test software: Blue test 3.0, which used to control the EUT in continues transmitting mode

9 Technical Requirement

9.1 Conducted Emission

Test Method

1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. A EMI test receiver is used to test the emissions from both sides of AC line

Limit

| Frequency MHz | QP Limit dB μ V | AV Limit dB μ V |
|------------------|------------------------|------------------------|
| 0.150-0.500 | 66-56* | 56-46* |
| 0.500-5 | 56 | 46 |
| 5-30 | 60 | 50 |

Decreasing linearly with logarithm of the frequency

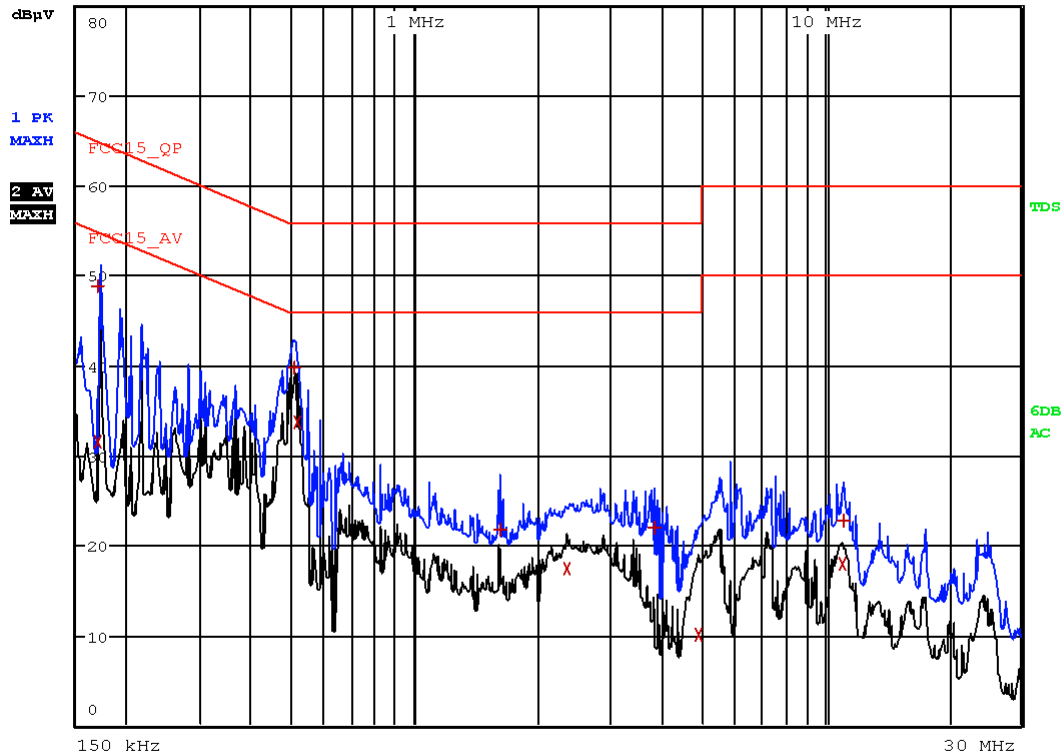
Conducted Emission

Product Type : VerveLoop+
 M/N : SH002
 Operating Condition : Charging & BT
 Test Specification : Live
 Comment : AC 120V/60Hz



RBW 9 kHz
 MT 1 s
 PREAMP OFF

Att 0 dB AUTO



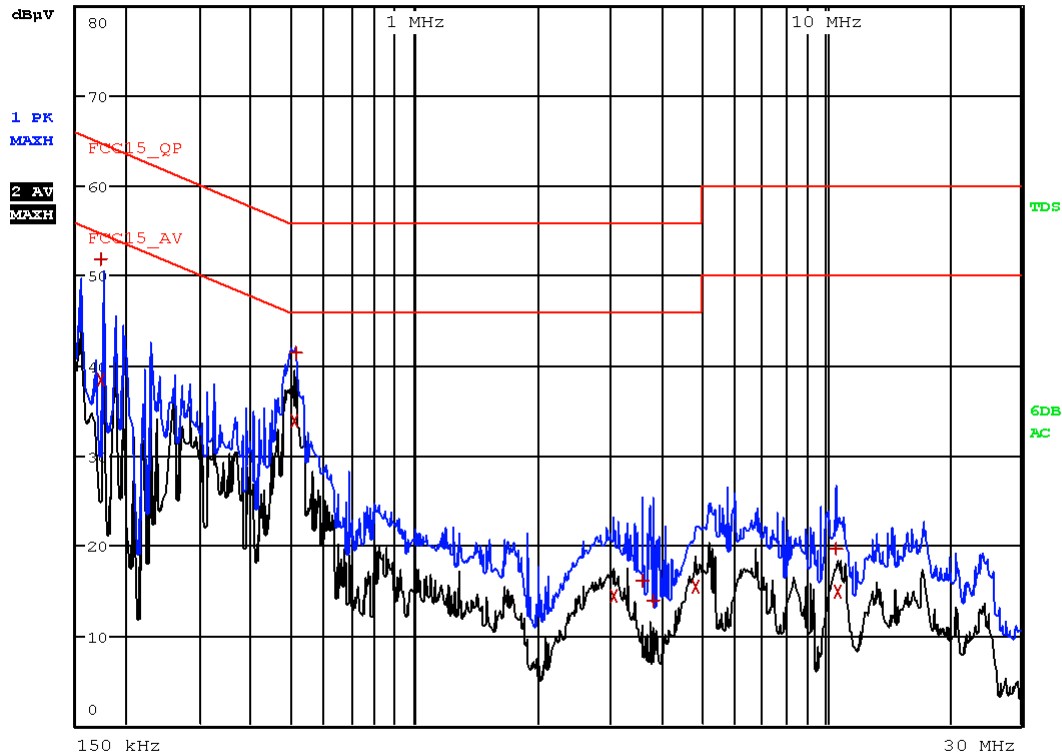
| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|-------|------------------|--------------|------------|----------------|
| 1 | 170.00000000 kHz | 48.88 | Quasi Peak | -16.08 |
| 2 | 170.00000000 kHz | 31.56 | Average | -23.40 |
| 1 | 506.00000000 kHz | 39.75 | Quasi Peak | -16.25 |
| 2 | 514.00000000 kHz | 33.75 | Average | -12.25 |
| 1 | 1.614000000 MHz | 21.73 | Quasi Peak | -34.27 |
| 2 | 2.338000000 MHz | 17.32 | Average | -28.68 |
| 1 | 3.834000000 MHz | 21.86 | Quasi Peak | -34.14 |
| 2 | 4.914000000 MHz | 9.98 | Average | -36.02 |
| 2 | 11.050000000 MHz | 17.88 | Average | -32.12 |
| 1 | 11.070000000 MHz | 22.74 | Quasi Peak | -37.26 |

Conducted Emission

Product Type : VerveLoop+
 M/N : SH002
 Operating Condition : Charging & BT
 Test Specification : Neutral
 Comment : AC 120V/60Hz



RBW 9 kHz
 MT 1 s
 Att 0 dB AUTO PREAMP OFF



| Trace | Frequency | Level (dBµV) | Detector | Delta Limit/dB |
|-------|-------------------|--------------|------------|----------------|
| 1 | 174.000000000 kHz | 51.77 | Quasi Peak | -12.99 |
| 2 | 174.000000000 kHz | 38.39 | Average | -16.38 |
| 2 | 506.000000000 kHz | 33.81 | Average | -12.19 |
| 1 | 510.000000000 kHz | 41.48 | Quasi Peak | -14.52 |
| 2 | 3.042000000 MHz | 14.41 | Average | -31.59 |
| 1 | 3.598000000 MHz | 15.99 | Quasi Peak | -40.01 |
| 1 | 3.806000000 MHz | 13.83 | Quasi Peak | -42.17 |
| 2 | 4.842000000 MHz | 15.41 | Average | -30.59 |
| 1 | 10.682000000 MHz | 19.63 | Quasi Peak | -40.37 |
| 2 | 10.738000000 MHz | 14.90 | Average | -35.10 |

9.2 Conducted peak output power

Test Method

1. Use the following spectrum analyzer settings:
Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel
RBW > the 20 dB bandwidth of the emission being measured, VBW ≥ RBW,
Sweep = auto, Detector function = peak, Trace = max hold
2. Add a correction factor to the display.
3. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power

Limits

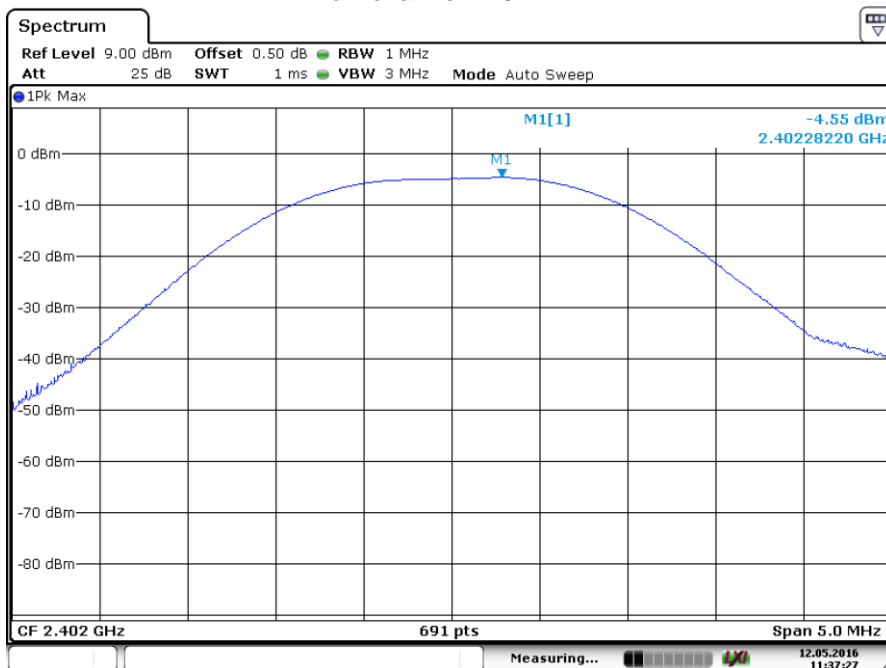
| Frequency Range MHz | Limit W | Limit dBm |
|------------------------|------------|--------------|
| 2400-2483.5 | ≤1 | ≤30 |

Conducted peak output power

BT 4.0 Bluetooth Mode GFSK modulation Test Result

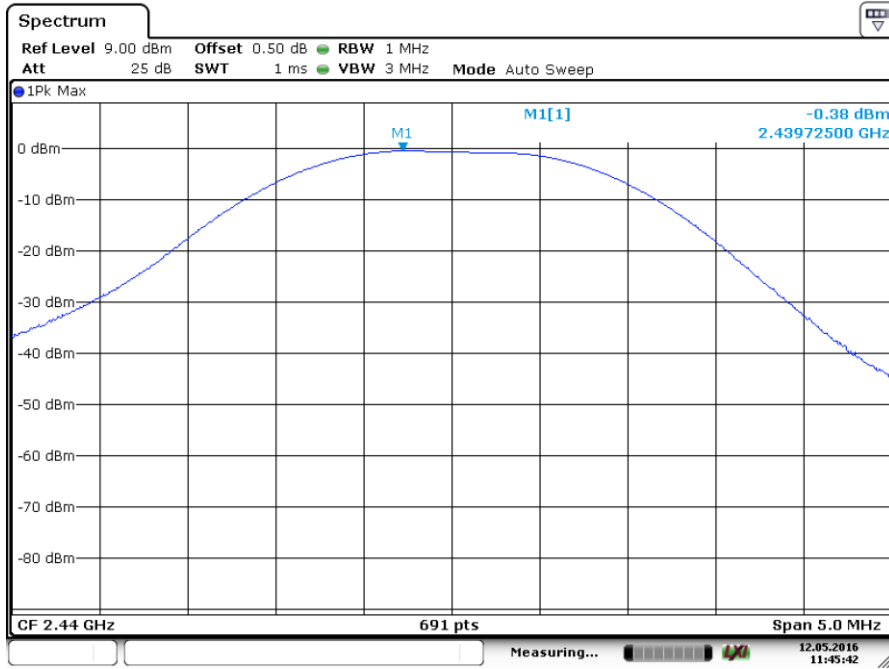
| Frequency MHz | Conducted Peak Output Power dBm | Result |
|------------------------|---------------------------------------|--------|
| Low channel 2402MHz | -4.55 | Pass |
| Middle channel 2440MHz | -0.38 | Pass |
| High channel 2480MHz | -0.02 | Pass |

Low channel 2402MHz



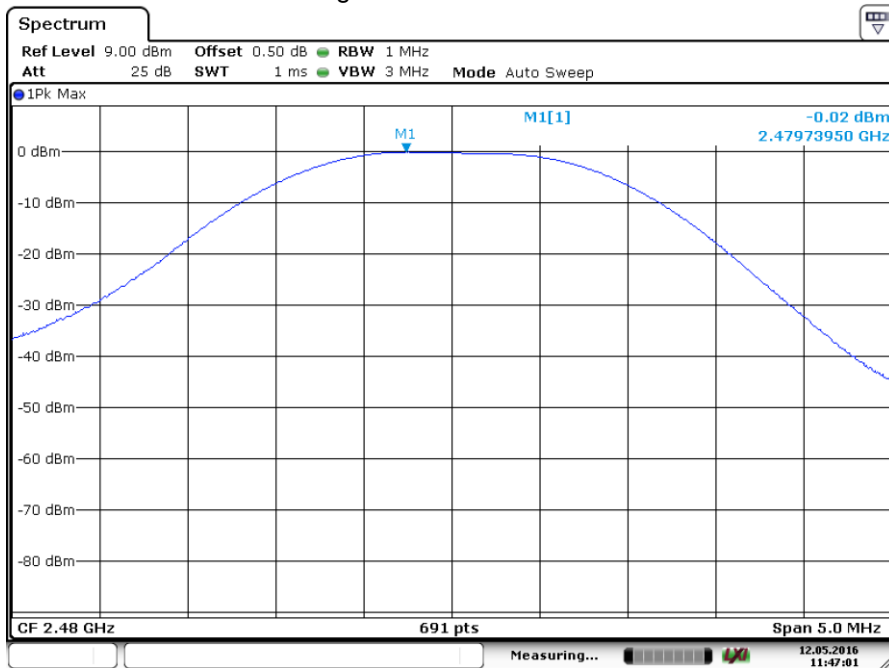
Date: 12.MAY.2016 11:37:27

Middle channel 2440MHz



Date: 12.MAY.2016 11:45:42

High channel 2480MHz



Date: 12.MAY.2016 11:47:01

9.3 Power spectral density

Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

1. Set analyzer center frequency to DTS channel center frequency.
RBW=3kHz,VBW≥3RBW,Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold
2. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
3. Repeat above procedures until other frequencies measured were completed

Limit

Limit [dBm]

≤8

BT 4.0 Bluetooth Mode GFSK modulation Test Result

| Frequency MHz | Power spectral density | Limit dBm | Result |
|------------------|---------------------------|--------------|--------|
| 2402 | -20.66 | 8 | Pass |
| 2440 | -16.29 | 8 | Pass |
| 2480 | -15.78 | 8 | Pass |

9.4 6 dB Bandwidth and 99% Occupied Bandwidth

Test Method

1. Use the following spectrum analyzer settings:
RBW=100K, VBW≥3RBW, Sweep = auto, Detector function = peak, Trace = max hold
2. Use the automatic bandwidth measurement capability of an instrument, may be employed using the X dB bandwidth mode with X set to 6 dB, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.
3. Allow the trace to stabilize, record the X dB Bandwidth value.

Limit

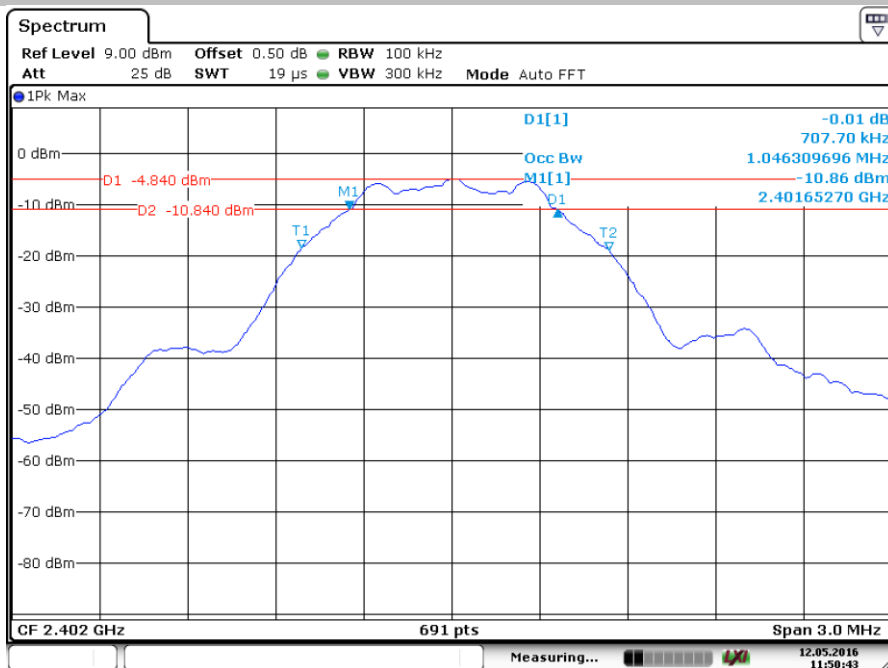
Limit [kHz]

≥500

BT 4.0 Bluetooth Mode GFSK modulation Test Result

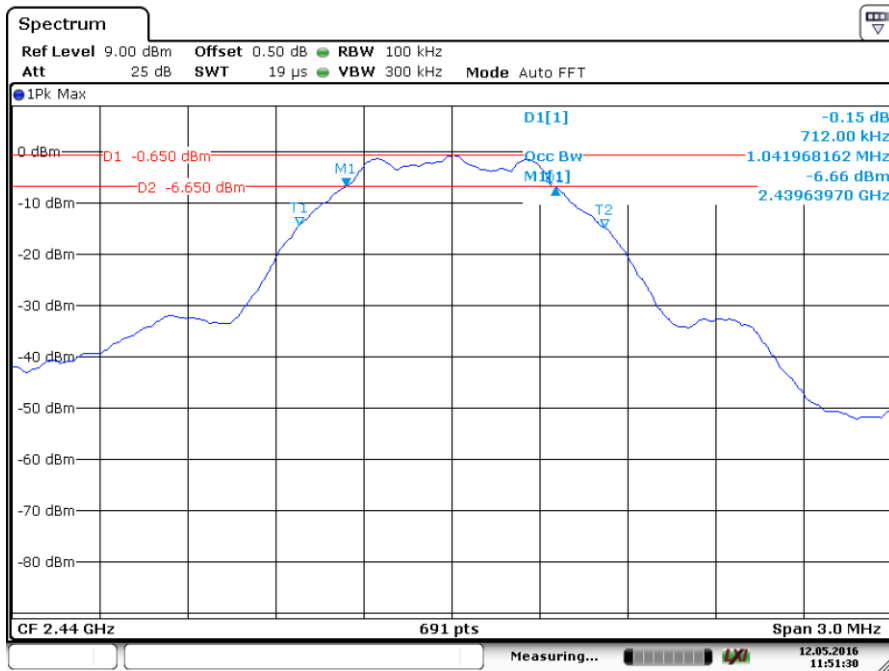
| Frequency MHz | 6 dB Bandwidth kHz | Limit kHz | Result |
|------------------|-----------------------|--------------|--------|
| 2402 | 707.7 | 500 | Pass |
| 2440 | 712.0 | 500 | Pass |
| 2480 | 712.0 | 500 | Pass |

6 dB Bandwidth

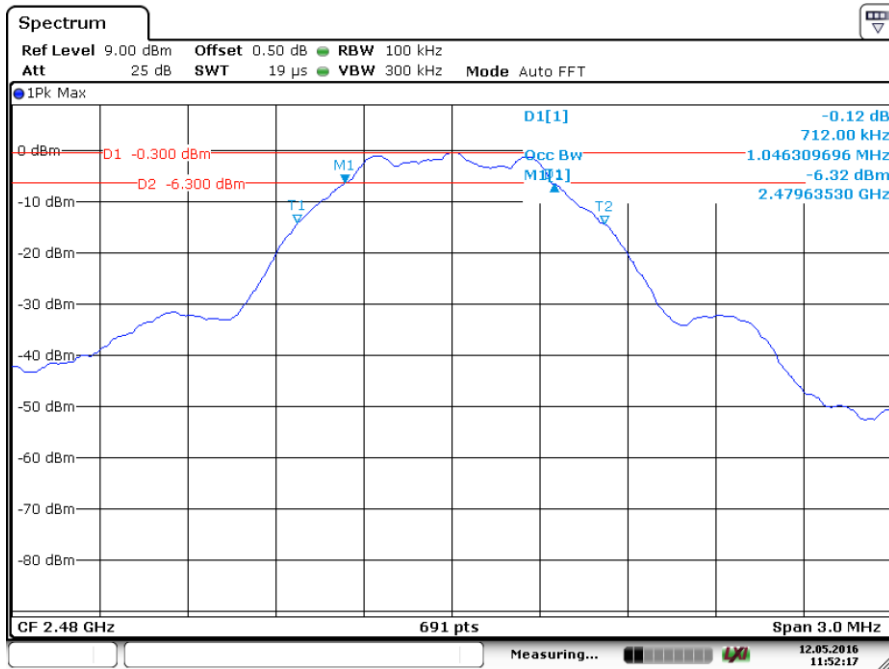


Date: 12.MAY.2016 11:50:43

6 dB Bandwidth



Date: 12.MAY.2016 11:51:30



Date: 12.MAY.2016 11:52:17

9.5 Spurious RF conducted emissions

Test Method

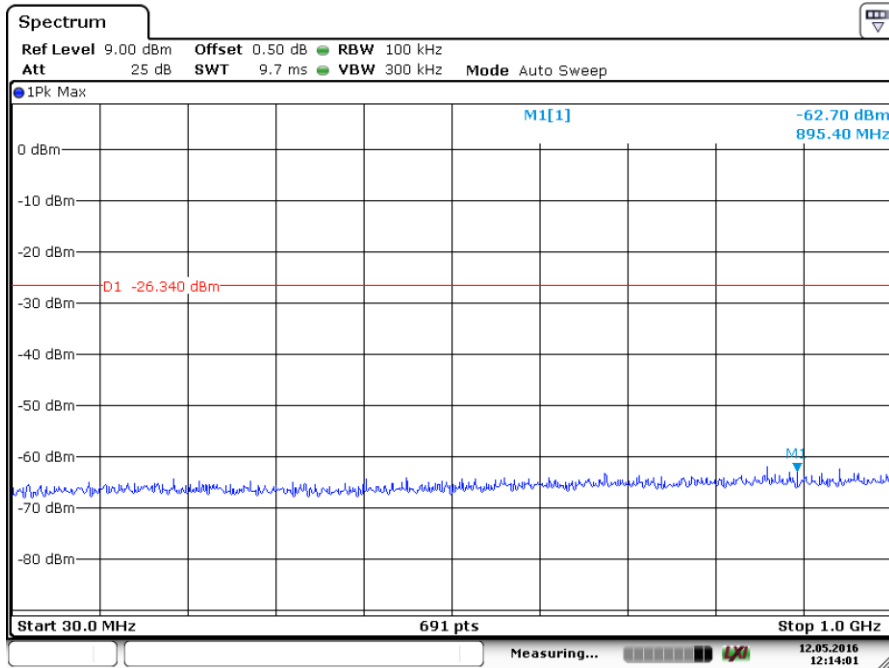
1. Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz, VBW \geq RBW, Sweep = auto, Detector function = peak, Trace = max hold
2. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
3. The level displayed must comply with the limit specified in this Section. Submit these plots.
4. Repeat above procedures until all frequencies measured were complete.

Limit

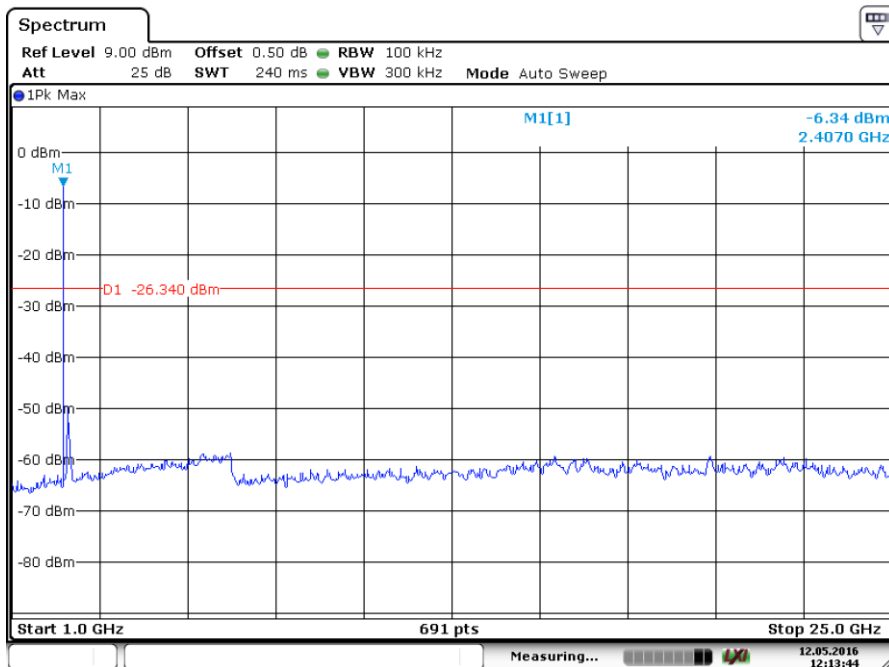
| Frequency Range MHz | Limit (dBc) |
|------------------------|-------------|
| 30-25000 | -20 |

Spurious RF conducted emissions

BT4.0 GFSK Modulation:
2402MHz

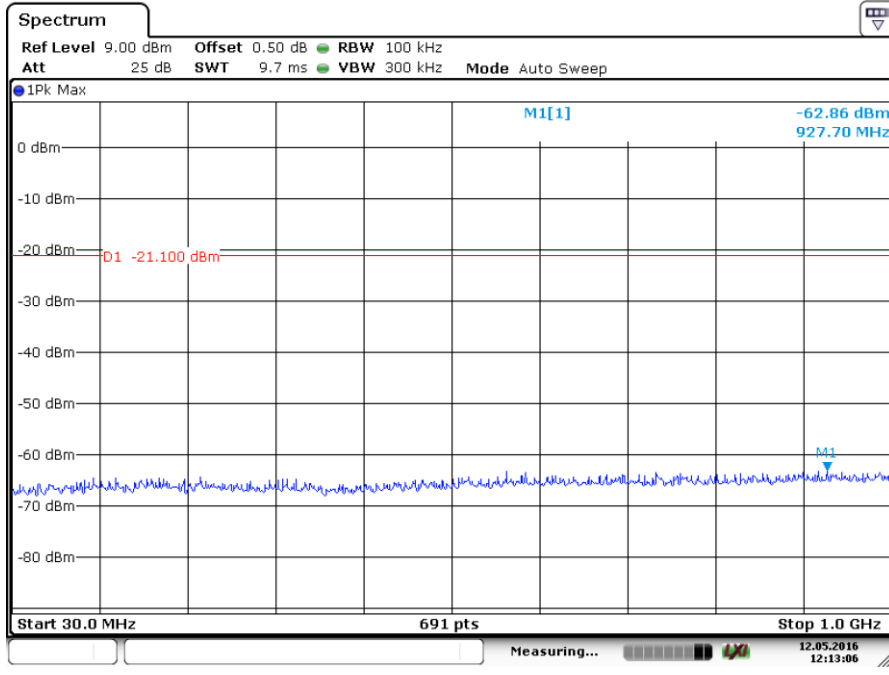


Date: 12.MAY.2016 12:14:01

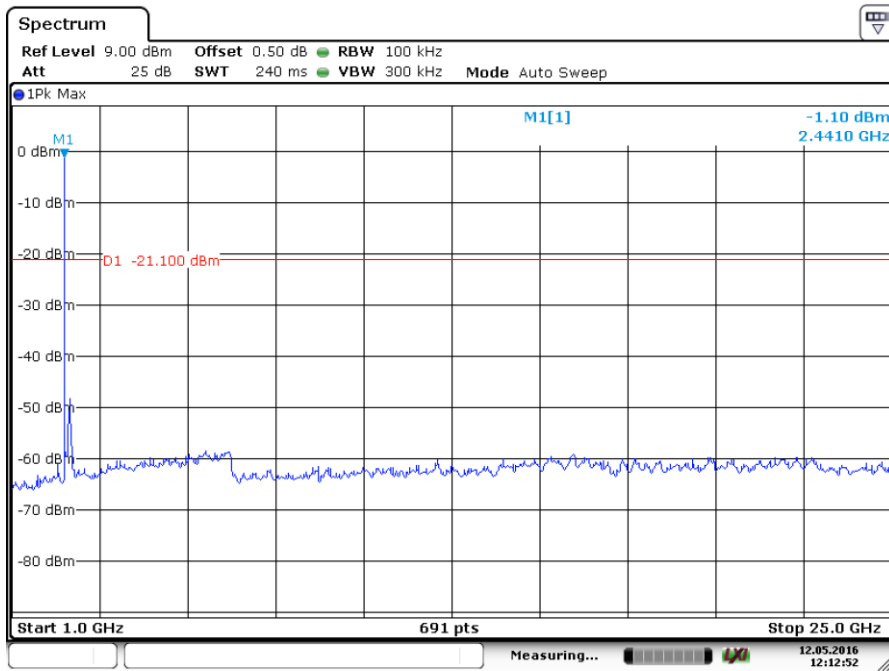


Date: 12.MAY.2016 12:13:44

2440MHz

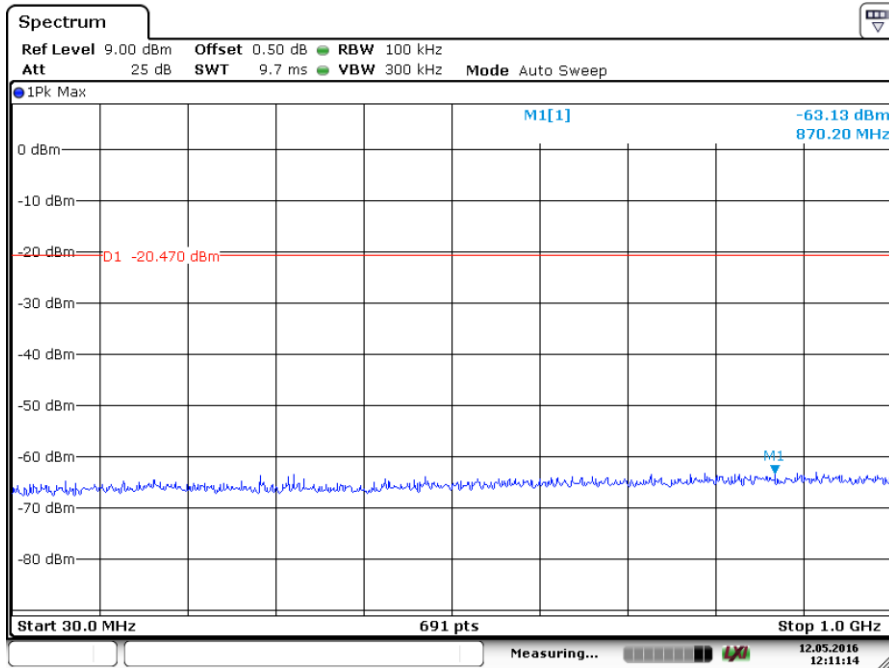


Date: 12.MAY.2016 12:13:07

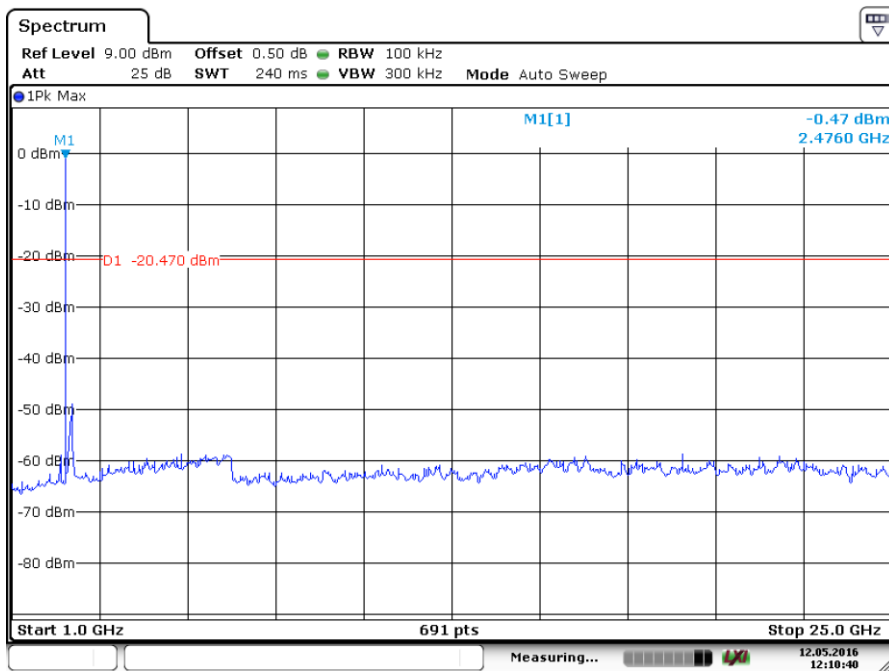


Date: 12.MAY.2016 12:12:52

2480MHz



Date: 12.MAY.2016 12:11:14



Date: 12.MAY.2016 12:10:40

9.6 Band edge testing

Test Method

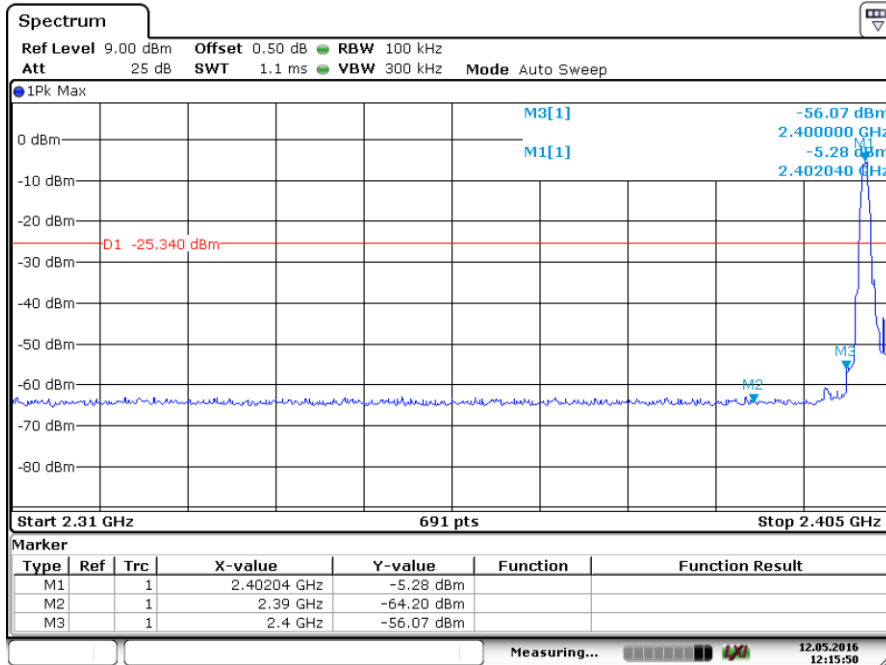
- 1 Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 kHz, VBW \geq RBW, Sweep = auto, Detector function = peak, Trace = max hold
- 2 Allow the trace to stabilize, use the peak and delta measurement to record the result.
- 3 The level displayed must comply with the limit specified in this Section. .
- 4 Repeat the test at the hopping off and hopping on mode, submit all the plots.

Limit:

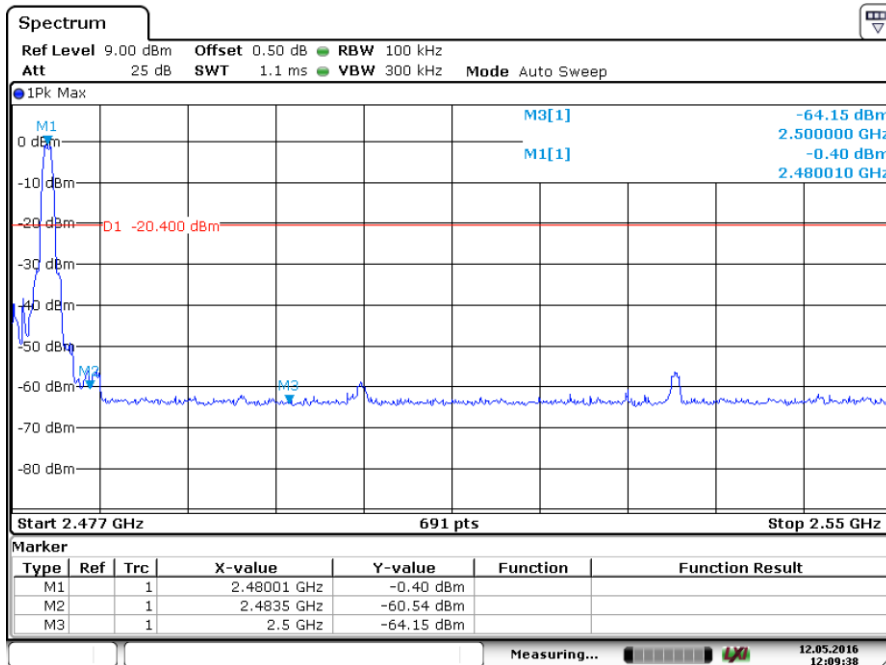
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits.

Band edge testing

BT4.0 GFSK Modulation Test Result



Date: 12.MAY.2016 12:15:50



Date: 12.MAY.2016 12:09:38

9.7 Spurious radiated emissions for transmitter

Test Method

1. The EUT is placed on a turntable, which is 0.8m above ground plane.
2. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
3. Use the following spectrum analyzer settings:
Span = wide enough to fully capture the emission being measured, RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz, VBW \geq RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Follow the guidelines in ANSI C63.4-2009 with respect to maximizing the emission by rotating the EUT, adjusting the measurement antenna height and polarization, etc.
The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, submit this data. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
5. Set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the duty cycle per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a "duty cycle correction factor", derived from $20\log(\text{duty cycle}/100 \text{ ms})$, in an effort to demonstrate compliance with the 15.209 limit. Submit this data.

Limit

The radio emission outside the operating frequency band 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. Radiated emissions which fall in the restricted bands, as defined in section 15.205, must comply with the radiated emission limits specified in section 15.209.

| Frequency MHz | Field Strength uV/m | Field Strength dB μ V/m | Detector |
|------------------|------------------------|--------------------------------|----------|
| 30-88 | 100 | 40 | QP |
| 88-216 | 150 | 43.5 | QP |
| 216-960 | 200 | 46 | QP |
| 960-1000 | 500 | 54 | QP |
| Above 1000 | 500 | 54 | AV |
| Above 1000 | 5000 | 74 | PK |

Spurious radiated emissions for transmitter

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

The only worse case (which is subject to the maximum EIRP, GFSK mode) test result is listed in the report.

Transmitting spurious emission test result as below:

BT4.0 GFSK Modulation 2402MHz Test Result

| Frequency band | Frequency | Emission Level | Polarization | Limit | Detector | Margin | Result |
|----------------|-----------|----------------|--------------|--------|----------|--------|--------|
| | MHz | dBuV/m | | dBuV/m | | dBuV/m | |
| 1000-25000MHz | *4804 | 41.49 | H | 74 | PK | 32.51 | Pass |
| | *7206 | 41.45 | H | 74 | PK | 32.55 | Pass |
| | *4804 | 35.76 | V | 74 | PK | 38.24 | Pass |
| | *7206 | 39.24 | V | 74 | PK | 34.76 | Pass |

BT4.0 GFSK Modulation 2440MHz Test Result

| Frequency band | Frequency | Emission Level | Polarization | Limit | Detector | Margin | Result |
|----------------|-----------|----------------|--------------|--------|----------|--------|--------|
| | MHz | dBuV/m | | dBuV/m | | dBuV/m | |
| 1000-25000MHz | *4880 | 44.86 | H | 74 | PK | 29.14 | Pass |
| | *7320 | 40.19 | H | 74 | PK | 33.81 | Pass |
| | *4880 | 38.33 | V | 74 | PK | 35.67 | Pass |
| | *7320 | 40.53 | V | 74 | PK | 33.47 | Pass |

BT4.0 GFSK Modulation 2480MHz Test Result

| Frequency band | Frequency | Emission Level | Polarization | Limit | Detector | Margin | Result |
|----------------|-----------|----------------|--------------|--------|----------|--------|--------|
| | MHz | dBuV/m | | dBuV/m | | dBuV/m | |
| 30-1000MHz | -- | -- | H | 43.5 | PK | -- | Pass |
| | -- | -- | V | 46 | PK | -- | Pass |
| 1000-25000MHz | *4960 | 44.29 | H | 74 | PK | 29.71 | Pass |
| | *7440 | 39.69 | H | 74 | PK | 34.31 | Pass |
| | *4960 | 39.39 | V | 74 | PK | 34.61 | Pass |
| | *7440 | 40.08 | V | 74 | PK | 33.92 | Pass |

Remark:

- (1) "*" means the emission(s) appear within the restrict bands shall follow the requirement of section 15.205.

10 Test Equipment List

Site 2:

| DESCRIPTION | MANUFACTURER | MODEL NO. | SERIAL NO. | CAL. DUE DATE |
|---|--------------|------------------------|----------------------|---------------|
| Test Receiver | R & S | ESU26 | 100050 | 12-Feb-2017 |
| Bi-conical Antenna | R & S | HK116 | 100242 | 07-Dec-2016 |
| Log Periodic Antenna | R & S | HL223 | 841516/020 | 01-Sep-2017 |
| Coaxial cable (50ohm) | Rosenberger | RTK081-05S- 05S-10m | LA2-001-10M / 001 | 01-Sep-2017 |
| Microwave amplifier (0.5-26.5GHz, 25dB gain) | HP | 83017A | 3123A00437 | 10-Jun-2016 |
| High Pass Filter (cutoff freq. =1000MHz) | Trilithic | 23042 | 9829213 | 17-Jul-2016 |
| Horn Antenna | EMCO | 3115 | 9002-3351 | 28-Oct-2017 |
| Active Loop Antenna | EMCO | 6502 | 9107-2651 | 26-Aug-2017 |
| RF Voltage Probe | Schwarzbeck | TK9416 | None | 10-Feb-2017 |
| LISN | R&S | ESH3-Z5 | 849876/027 | 15-Jun-2016 |
| Double Shield Cable | Radiall | RG142 | Nil | 14-Sep-2017 |
| Pulse Limiter | R&S | ESH3-Z2 | Nil | 04-Jun-2016 |

11 System Measurement Uncertainty

For a 95% confidence level, the measurement expanded uncertainties for defined systems, in accordance with the recommendations of ISO 17025 were:

| System Measurement Uncertainty | | |
|--------------------------------|--------------------------------------|----------------------|
| Items | | Extended Uncertainty |
| Radiated Emissions | Level accuracy | ±4.68 dB |
| | 30 to 200 MHz | ±5.73 dB |
| | 200 to 1000 MHz 1000 to 25000 MHz | ±5.57 dB |
| Conducted Emissions | Level accuracy 9 kHz to 30 MHz | ±3.16 dB |
| Conducted RF Test | | ≤ 1 dB |