



STC Test Report

Date: 2016-03-01

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No.: DM122135

Applicant:

Acoustic Arc International Ltd.
110-112, 1/F., Philips Electronics Building, 5 Science Park
East Avenue, Hong Kong Science Park, Shatin,
New Territories, Hong Kong

Manufacturer:

ShengHai Electronics (Shenzhen) Ltd.
Block 17&18, Hui Ming Ying Industry, Yan Chuan,
Songgang, Baoan County, Shenzhen, China 518105

Description of Sample(s):

Product: 2.4GHz Digital Wireless Headphone
Brand Name: Geemarc
Model Number: CL7400
FCC ID: VHC-AAI-DH1250-00

Date Sample(s) Received:

2015-12-29

Date Tested:

2016-01-07 to 2016-03-01

Investigation Requested:

Perform ElectroMagnetic Interference measurement in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15: 2015 and ANSI C63.10: 2013 for FCC Certification.

Conclusion(s):

The submitted product COMPLIED with the requirements of Federal Communications Commission [FCC] Rules and Regulations Part 15. The tests were performed in accordance with the standards described above and on Section 2.2 in this Test Report.

Remark(s):



LONG Yun Jian, Along
Authorized Signatory
ElectroMagnetic Compatibility Department
For and on behalf of
STC (Dongguan) Company Limited

STC (Dongguan) Company Limited

68 Fumin Nan Road, Dalang, Dongguan, China. (Zip Code : 523 770)
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1.0 General Details

1.1 Test Laboratory

STC (Dongguan) Company Limited
EMC Laboratory
68 Fumin Nan Road, Dalang, Dongguan, Guangdong, China

Telephone: (86 769) 81119888
Fax: (86 769) 81116222

1.2 Equipment Under Test [EUT] Description of Sample(s)

Product: 2.4GHz Digital Wireless Headphone
Manufacturer: ShengHai Electronics (Shenzhen) Ltd.
Block 17&18, Hui Ming Ying Industry, Yan Chuan,
Songgang, Baoan County, Shenzhen, China 518105
Brand Name: Geemarc
Model Number: CL7400
Rating: Input: 100-240Va.c. 50/60Hz 0.2A;
Output: 6.0Vd.c. 0.6A.

The AC/DC adaptor was provided by the applicant with following details:
Brand name: N/A; Model no.: K05S060 060U

1.2.1 Description of EUT Operation

The Equipment Under Test (EUT) is a 2.4GHz Digital Wireless Headphone. The r.f. signal was modulated by IC and type of modulation was frequency hopping spread spectrum Modulation.

1.3 Date of Order

2015-12-29

1.4 Submitted Sample(s):

1 Sample

1.5 Test Duration

2016-01-07 to 2016-03-01

1.6 Country of Origin

China

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1.7 RF Module Details

Module Model Number:	DH1250
Module FCC ID:	
Module Transmission Type:	JX120-TH05B
Modulation:	FHSS (GFSK)
Data Rates:	1MBps: GFSK
Frequency Range:	2400-2483.5MHz
Carrier Frequencies:	2406MHz – 2472MHz

Module Specification (specification provided by manufacturer)

1.8 Antenna Details

Antenna Type:	Integral antenna
Antenna Gain:	0dBi

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2.0 Technical Details

2.1 Investigations Requested

Perform Electromagnetic Interference measurements in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15: 2015 Regulations and ANSI C63.10: 2013 for FCC Certification.

2.2 Test Standards and Results Summary Tables

EMISSION Results Summary						
Test Condition	Test Requirement	Test Method	Class / Severity	Test Result		
				Pass	Fail	N/A
Maximum Peak Conducted Output Power	FCC 47CFR 15.247(b)(1)	FCC Pubic Notice DA 00-705	N/A	☒	☐	☐
Radiated Spurious Emissions	FCC 47CFR 15.209	ANSI C63.10: 2013	N/A	☒	☐	☐
AC Mains Conducted Emissions	FCC 47CFR 15.207	ANSI C63.10: 2013	N/A	☒	☐	☐
Number of Hopping Frequency	FCC 47CFR 15.247 (b)(1)	FCC Pubic Notice DA 00-705	N/A	☒	☐	☐
20dB Bandwidth	FCC 47CFR 15.247(a)(2)	FCC Pubic Notice DA 00-705	N/A	☒	☐	☐
Hopping Channel Separation	FCC 47CFR 15.247(a)(1)	FCC Pubic Notice DA 00-705	N/A	☒	☐	☐
Band-edge measurement (Radiated)	FCC 47CFR 15.247(d)	FCC Pubic Notice DA 00-705	N/A	☒	☐	☐
Pseudorandom Hopping Algorithm	FCC 47CFR 15.247(a)(1)	N/A	N/A	☒	☐	☐
Time of Occupancy (Dwell Time)	FCC 47CFR 15.247(a)(1)(iii)	FCC Pubic Notice DA 00-705	N/A	☒	☐	☐
Antenna requirement	FCC 47CFR 15.203	N/A	N/A	☒	☐	☐
RF Exposure	FCC 47CFR 15.247(i)	N/A	N/A	☒	☐	☐

Note: N/A – Not Applicable

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2.3 Table for Test Modes

Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate in the table below is the worst case rate with respect to the specific test item.

Investigation has been done on all the possible configurations for searching the worst cases.

The device was realized by test software.

The following table is a list of the test modes shown in this test report.

Test Items	Mode	Data Rate
Maximum Peak Conducted Output Power	GFSK	1MBps
Hopping Channel Separation	GFSK	1MBps
Number of Hopping Frequency	GFSK	1MBps
Time of Occupancy(Dwell Time)	GFSK	1MBps
Radiated Spurious Emissions	GFSK	1MBps
Band-edge compliance of Conducted Emission	GFSK	1MBps

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3.0 Test Results

3.1 Emission

3.1.1 Maximum Peak Conducted Output Power

Test Requirement:	FCC 47CFR 15.247(b)(1)
Test Method:	FCC Pubic Notice DA 00-705
Test Date:	2016-02-29
Mode of Operation:	Tx mode

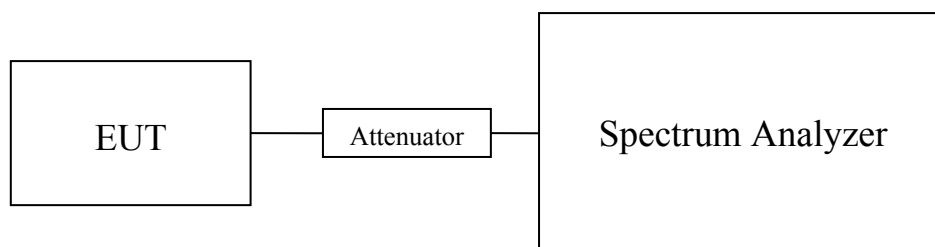
Test Method:

A temporary antenna connector was soldered to the RF output. The RF output of the EUT was connected to the spectrum analyzer. All the attenuation or cable loss will be added to the measured maximum output power. The results are recorded in dBm.

Spectrum Analyzer Setting:

RBW = 3 MHz, VBW = 3MHz, Sweep = Auto, Span = 10MHz
Detector = Peak, Trace = Max. hold

Test Setup:



Note: a temporary antenna connector was soldered to the RF output.

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Limits for Maximum Peak Conducted Output Power [FCC 47CFR 15.247]:

The maximum peak output power shall not exceed the following limits:
For frequency hopping systems employing at least 75 hopping channels: 1 Watt
For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 Watts
For Digital Transmission systems in 2400-2483.5 MHz Band: 1 Watt

Results of Bluetooth Communication mode (GFSK) (Fundamental Power): Pass

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2406	0.01026

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2444	0.00944

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2472	0.00836

Calculated measurement uncertainty : 30MHz to 1GHz 1.7dB
1GHz to 18GHz 1.7dB

Remark:

1. All test data for each data rate were verified, but only the worst case was reported.
2. The EUT is programmed to transmit signals continuously for all testing.

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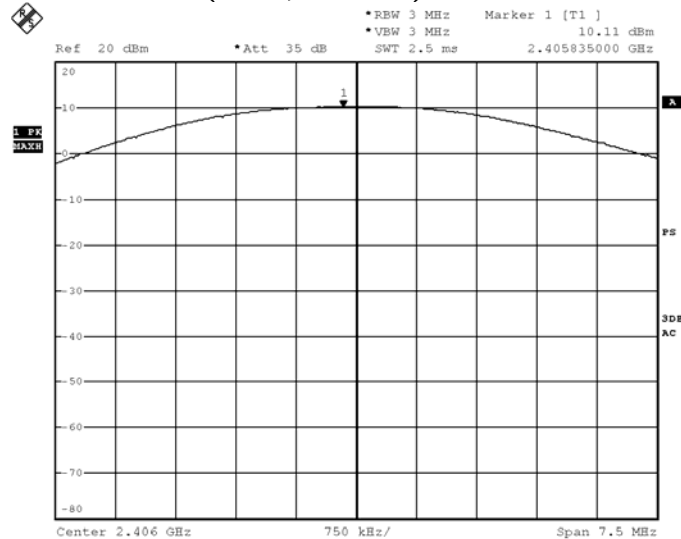
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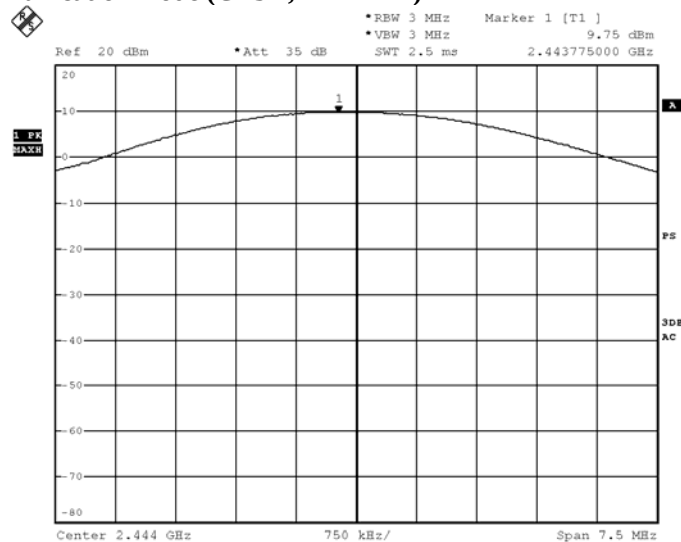
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Test plot of Maximum Peak Conducted Output Power :
Bluetooth Communication mode (GFSK, 2406MHz)



BMP
Date: 1.MAR.2016 11:20:14

Bluetooth Communication mode (GFSK, 2444MHz)



BMP
Date: 1.MAR.2016 11:21:09

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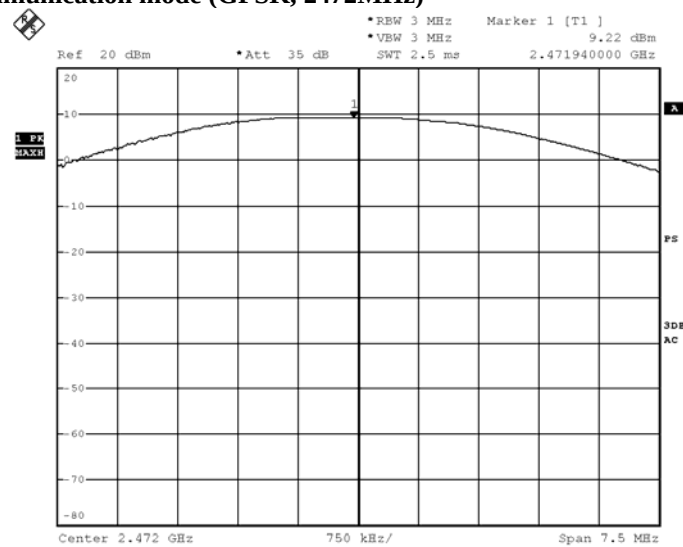
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Bluetooth Communication mode (GFSK, 2472MHz)



BMP

Date: 1.MAR.2016 11:23:11

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3.1.2 Radiated Spurious Emissions

Test Requirement:	FCC 47CFR 15.209
Test Method:	ANSI C63.10: 2013
Test Date:	2016-01-07 to 2016-01-27
Mode of Operation:	Tx mode

Test Method:

For emission measurements at or below 1 GHz, the sample was placed 0.8m above the ground plane of semi-anechoic Chamber*. For emission measurements above 1 GHz, the sample was placed 1.5m above the ground plane of semi-anechoic Chamber*. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages.

- *: Semi-anechoic chamber located on the STC (Dongguan) Company Ltd. 68 Fumin Nan Road, Dalang, Dongguan, Guangdong, PRC with a metal ground plane filed with the FCC pursuant to section 2.948 of the FCC rules, with Registration Number: 629686.

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Spectrum Analyzer Setting:

9KHz – 30MHz (Pk & Av)

RBW: 10kHz
VBW: 30kHz
Sweep: Auto
Span: Fully capture the emissions being measured
Trace: Max. hold

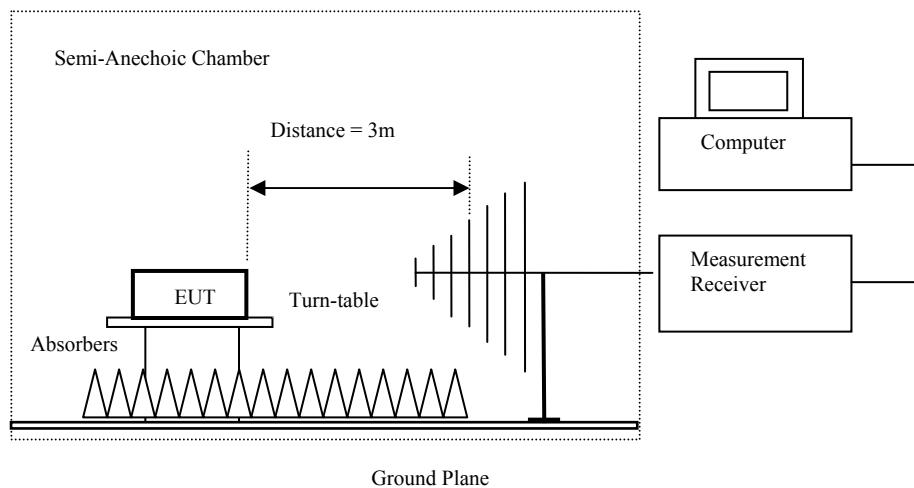
30MHz – 1GHz (QP)

RBW: 120kHz
VBW: 120kHz
Sweep: Auto
Span: Fully capture the emissions being measured
Trace: Max. hold

Above 1GHz (Pk & Av)

RBW: 1MHz
VBW: 3MHz
Sweep: Auto
Span: Fully capture the emissions being measured
Trace: Max. hold

Test Setup:



- Absorbers placed on top of the ground plane are for measurements above 1000MHz only.
- Measurements between 30MHz to 1000MHz made with Bi-log antennas, above 1000MHz horn antennas are used, 9kHz to 30MHz loop antennas are used.

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Limits for Radiated Emissions [FCC 47 CFR 15.209 Class B]:

Frequency Range [MHz]	Quasi-Peak Limits [μV/m]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above 960	500

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Result of Tx mode (2406.0 MHz) (GFSK mode) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level dBμV	Correction Factor dB/m	Field Strength dBμV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2406.0 MHz) (GFSK mode) (Above 1GHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
4812.0	18.1	41.5	59.6	74.0	14.4	Vertical
4812.0	15.0	42.4	57.4	74.0	16.6	Horizontal
7218.0	11.6	45.1	56.7	74.0	17.3	Vertical
7218.0	7.3	46.2	53.5	74.0	20.5	Horizontal
9624.0	7.6	48.0	55.6	74.0	18.4	Vertical
9624.0	4.5	48.8	53.3	74.0	20.7	Horizontal
12030.0	3.2	51.8	55.0	74.0	19.0	Vertical
12030.0	1.0	52.4	53.4	74.0	20.6	Horizontal

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Result of Tx mode (2406.0 MHz) (GFSK mode) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4812.0	3.8	41.5	45.3	54.0	8.7	Vertical
4812.0	0.8	42.4	43.2	54.0	10.8	Horizontal
7218.0	-2.5	45.1	42.6	54.0	11.4	Vertical
7218.0	-4.2	46.2	42.0	54.0	12.0	Horizontal
9624.0	-6.6	48.0	41.4	54.0	12.6	Vertical
9624.0	-7.2	48.8	41.6	54.0	12.4	Horizontal
12030.0	-10.7	51.8	41.1	54.0	12.9	Vertical
12030.0	-10.3	52.4	42.1	54.0	11.9	Horizontal

Result of Tx mode (2444.0 MHz) (GFSK mode) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2444.0 MHz) (GFSK mode) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4888.0	16.9	41.6	58.5	74.0	15.5	Vertical
4888.0	13.8	42.5	56.3	74.0	17.7	Horizontal
7332.0	3.7	53.2	56.9	74.0	17.1	Vertical
7332.0	7.2	46.3	53.5	74.0	20.5	Horizontal
9776.0	7.6	48.1	55.7	74.0	18.3	Vertical
9776.0	3.6	48.9	52.5	74.0	21.5	Horizontal
12220.0	3.6	51.6	55.2	74.0	18.8	Vertical
12220.0	0.6	52.5	53.1	74.0	20.9	Horizontal

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Result of Tx mode (2444.0 MHz) (GFSK mode) (Above 1GHz): Pass

Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4888.0	3.1	41.6	44.7	54.0	9.3	Vertical
4888.0	0.3	42.5	42.8	54.0	11.2	Horizontal
7332.0	-2.0	45.2	43.2	54.0	10.8	Vertical
7332.0	-4.2	46.3	42.1	54.0	11.9	Horizontal
9776.0	-6.1	48.1	42.0	54.0	12.0	Vertical
9776.0	-7.6	48.9	41.3	54.0	12.7	Horizontal
12220.0	-9.5	51.6	42.1	54.0	11.9	Vertical
12220.0	-10.7	52.5	41.8	54.0	12.2	Horizontal

Result of Tx mode (2472.0 MHz) (GFSK mode) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2472.0 MHz) (GFSK mode) (Above 1GHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4944.0	16.9	41.4	58.3	74.0	15.7	Vertical
4944.0	13.0	42.7	55.7	74.0	18.3	Horizontal
7416.0	10.2	45.6	55.8	74.0	18.2	Vertical
7416.0	7.7	46.5	54.2	74.0	19.8	Horizontal
9888.0	6.9	48.6	55.5	74.0	18.5	Vertical
9888.0	3.9	49.7	53.6	74.0	20.4	Horizontal
12360.0	3.1	51.7	54.8	74.0	19.2	Vertical
12360.0	-0.02	52.7	52.7	74.0	21.3	Horizontal

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Result of Tx mode (2472.0 MHz) (GFSK mode) (Above 1GHz): Pass

Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4944.0	3.1	41.4	44.5	54.0	9.5	Vertical
4944.0	-0.1	42.7	42.6	54.0	11.4	Horizontal
7416.0	-3.6	45.6	42.0	54.0	12.0	Vertical
7416.0	-4.3	46.5	42.2	54.0	11.8	Horizontal
9888.0	-7.1	48.6	41.5	54.0	12.5	Vertical
9888.0	-7.5	49.7	42.2	54.0	11.8	Horizontal
12360.0	-9.4	51.7	42.3	54.0	11.7	Vertical
12360.0	-11.0	52.7	41.7	54.0	12.3	Horizontal

Remarks:

- * Denotes restricted band of operation.
Measurements were made using a peak detector. Any emission less than 1000MHz and falling within the restricted bands of FCC Rules Part 15 Section 15.205 and the limits of FCC Rules Part 15 Section 15.209 were applied.

Correction Factor included Antenna Factor and Cable Attenuation.

Calculated measurement uncertainty: (9kHz - 30MHz): 3.3dB
(30MHz - 1GHz): 4.6dB
(1GHz - 26GHz): 4.4dB

Emissions in the vertical and horizontal polarizations have been investigated and the worst-case test results are recorded in this report.

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Limits for Radiated Emissions [FCC 47 CFR 15.209 Class B]:

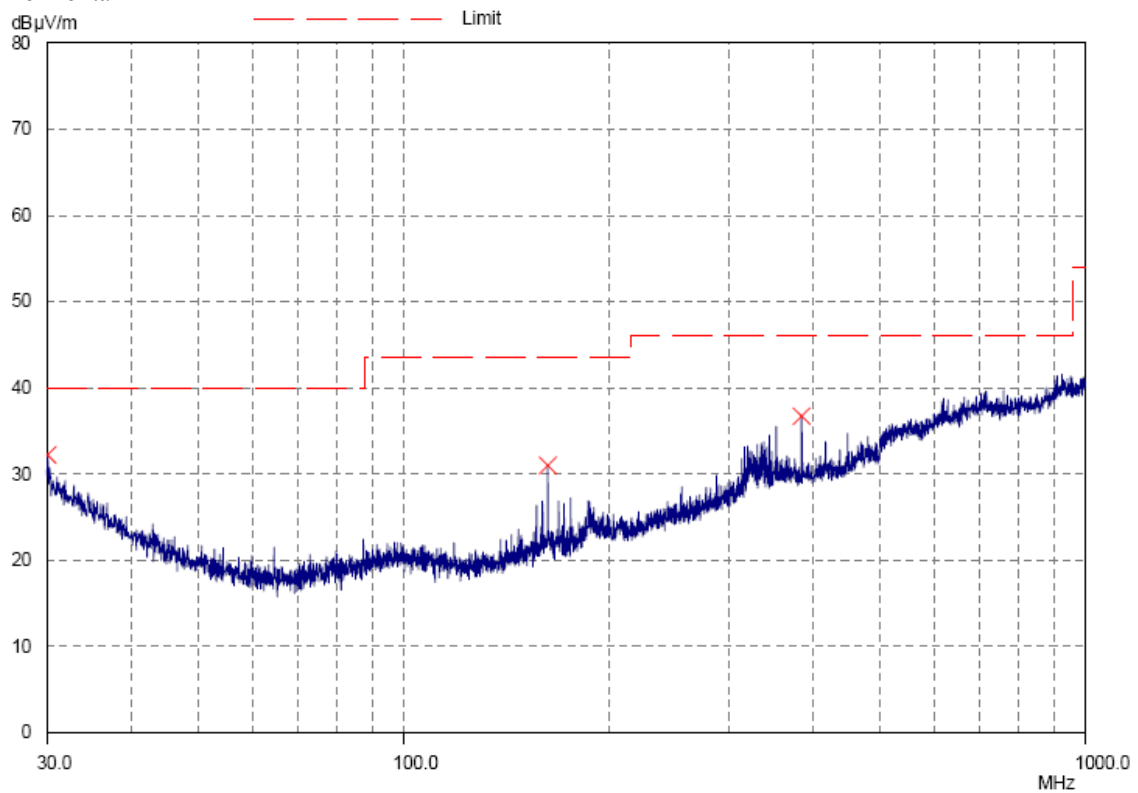
Frequency Range	Quasi-Peak Limits
[MHz]	[$\mu\text{V/m}$]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above960	500

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Result of TX mode (2406MHz) (30MHz – 1GHz): Pass

Please refer to the following table for result details(The data is the worst cases)

Horizontal



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Result of TX mode (2406MHz) (30MHz – 1GHz): Pass

Radiated Emissions Quasi-Peak					
Emission Frequency MHz	E-Field Polarity	Level @3m dBμV/m	Limit @3m dBμV/m	Level @3m μV/m	Limit @3m μV/m
30.1	Horizontal	30.2	40.0	32.4	100
162.8	Horizontal	30.9	43.5	35.1	150
384.0	Horizontal	36.7	46.0	68.4	200

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Limits for Radiated Emissions [FCC 47 CFR 15.209 Class B]:

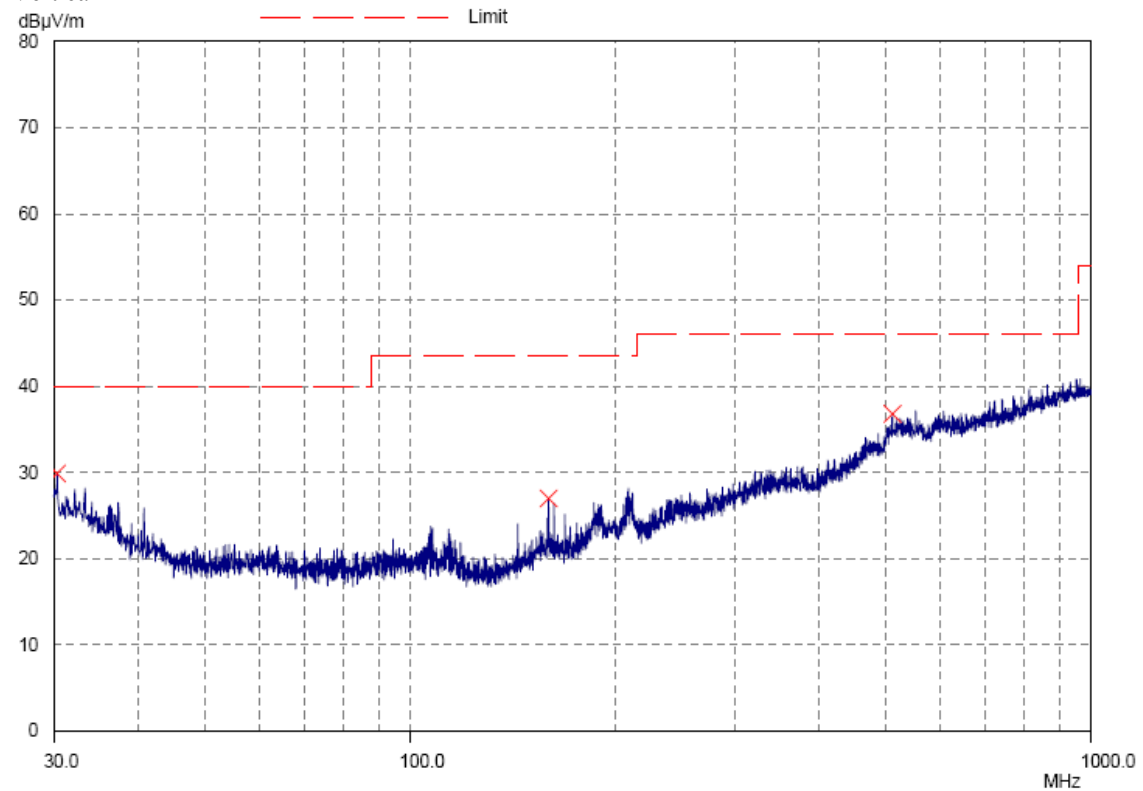
Frequency Range	Quasi-Peak Limits
[MHz]	[μ V/m]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above960	500

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Result of TX mode (2406MHz) (30MHz – 1GHz): Pass

Please refer to the following table for result details(The data is the worst cases)

Vertical



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Result of TX mode (2406MHz) (30MHz – 1GHz): Pass

Radiated Emissions					
Quasi-Peak					
Emission Frequency MHz	E-Field Polarity	Level @3m dB μ V/m	Limit @3m dB μ V/m	Level @3m μ V/m	Limit @3m μ V/m
30.3	Vertical	29.8	40.0	30.9	100
160.0	Vertical	26.9	43.5	22.1	150
511.9	Vertical	36.7	46.0	68.4	200

Remarks:

Calculated measurement uncertainty (30MHz – 1GHz): 4.6dB

Emissions in the vertical and horizontal polarizations have been investigated and the worst-case test results are recorded in this report.

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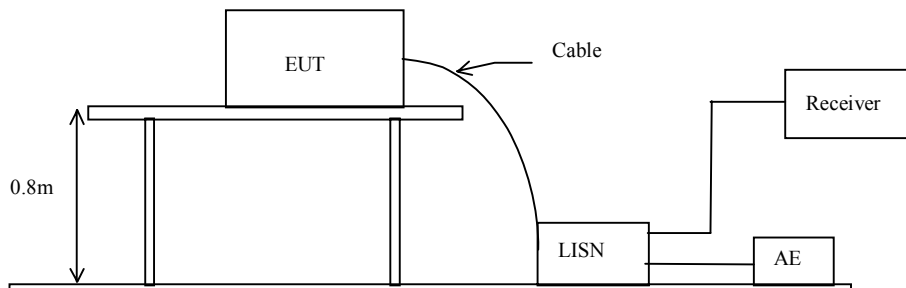
3.1.3 AC Mains Conducted Emissions (0.15MHz to 30MHz)

Test Requirement:	FCC 47CFR 15.207
Test Method:	ANSI C63.10: 2013
Test Date:	2016-01-07
Mode of Operation:	TX mode
Test Voltage:	120Va.c. 60Hz

Test Method:

The test was performed in accordance with ANSI C63.10: 2013, with the following: an initial measurement was performed in peak and average detection mode on the live line, any emissions recorded within 30dB of the relevant limit line were re-measured using quasi-peak and average detection on the live and neutral lines with the worst case recorded in the table of results.

Test Setup:



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Limit for Conducted Emissions (FCC 47 CFR 15.207):

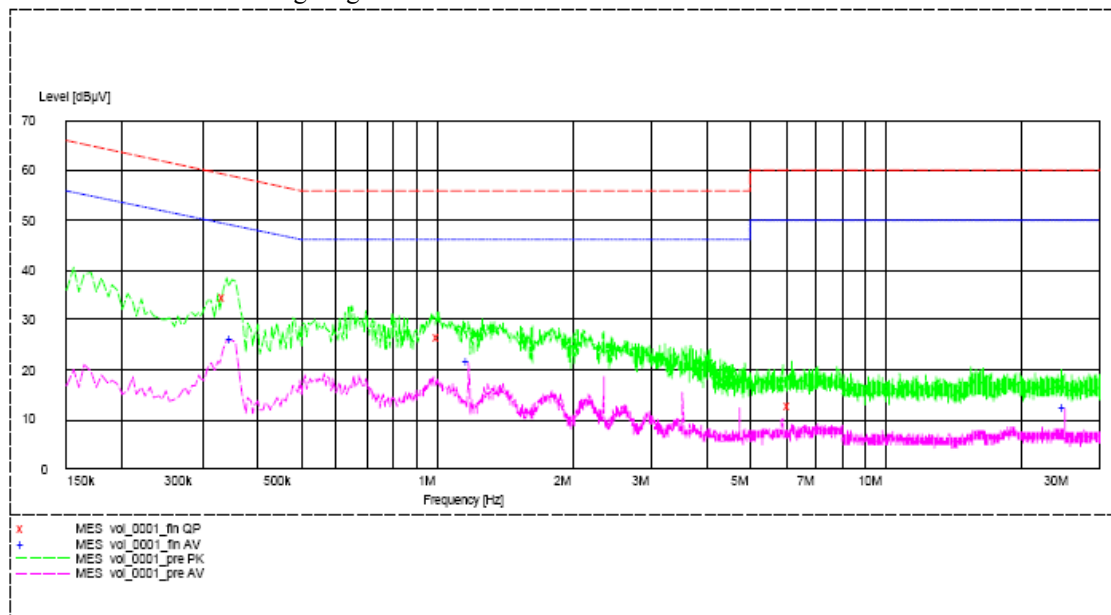
Frequency Range [MHz]	Quasi-Peak Limits [dBμV]	Average [dBμV]
0.15-0.5	66 to 56*	56 to 46*
0.5-5.0	56	46
5.0-30.0	60	50

* Decreases with the logarithm of the frequency.

Limits for Conducted Emissions Test, please refer to limit lines (Quasi-Peak and Average) in the following diagram.

Result of TX mode (L): PASS

Please refer to the following diagram for individual results.



Conductor Live or Neutral	Frequency MHz	Quasi-peak		Average	
		Level dBμV	Limit dBμV	Level dBμV	Limit dBμV
Live	0.340	34.6	59.0	-*-	-*-
Live	1.015	26.4	56.0	-*-	-*-
Live	6.160	12.8	60.0	-*-	-*-
Live	0.350	-*-	-*-	26.3	49.0
Live	1.180	-*-	-*-	21.6	46.0
Live	25.060	-*-	-*-	12.6	50.0

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Limit for Conducted Emissions (FCC 47 CFR 15.207):

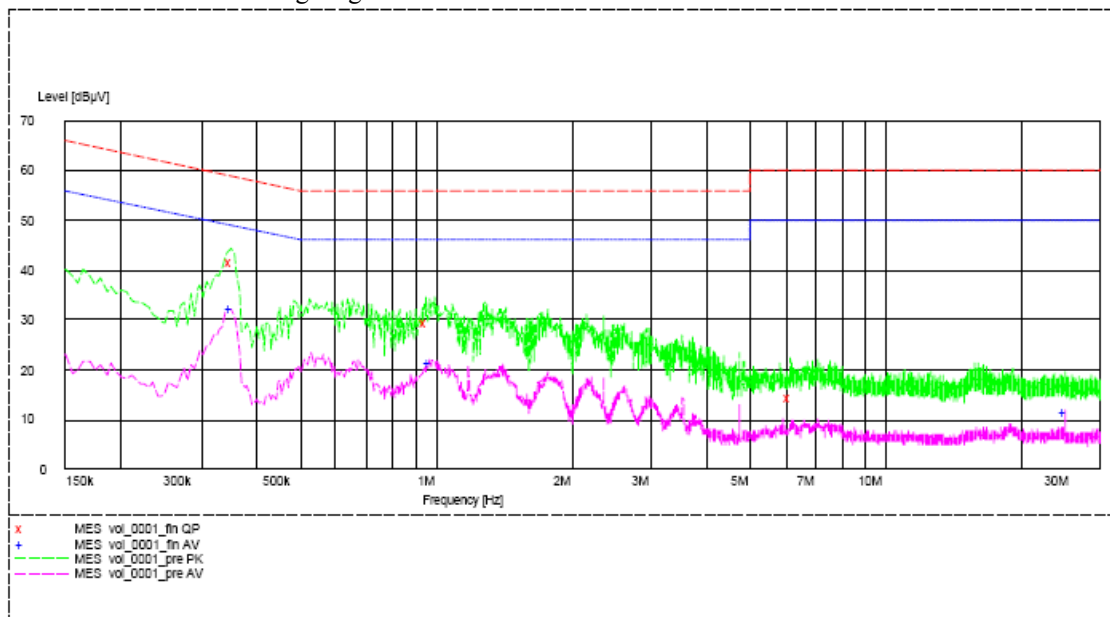
Frequency Range [MHz]	Quasi-Peak Limits [dBμV]	Average [dBμV]
0.15-0.5	66 to 56*	56 to 46*
0.5-5.0	56	46
5.0-30.0	60	50

* Decreases with the logarithm of the frequency.

Limits for Conducted Emissions Test, please refer to limit lines (Quasi-Peak and Average) in the following diagram.

Result of TX mode (N): PASS

Please refer to the following diagram for individual results.



Conductor Live or Neutral	Frequency MHz	Quasi-peak		Average	
		Level dBμV	Limit dBμV	Level dBμV	Limit dBμV
Neutral	0.350	41.6	59.0	-*-	-*-
Neutral	0.955	29.4	56.0	-*-	-*-
Neutral	6.150	14.3	60.0	-*-	-*-
Neutral	0.350	-*-	-*-	32.5	49.0
Neutral	0.965	-*-	-*-	21.3	46.0
Neutral	25.060	-*-	-*-	11.7	50.0

Remarks:

Calculated measurement uncertainty (0.15MHz – 30MHz): 3.2dB

-*- Emission(s) that is far below the corresponding limit line.

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3.1.4 Number of Hopping Frequency

Limit of Number of Hopping Frequency

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels

Test Method:

The RF output of the EUT was connected to the spectrum analyzer by a low loss cable.

Spectrum Analyzer Setting:

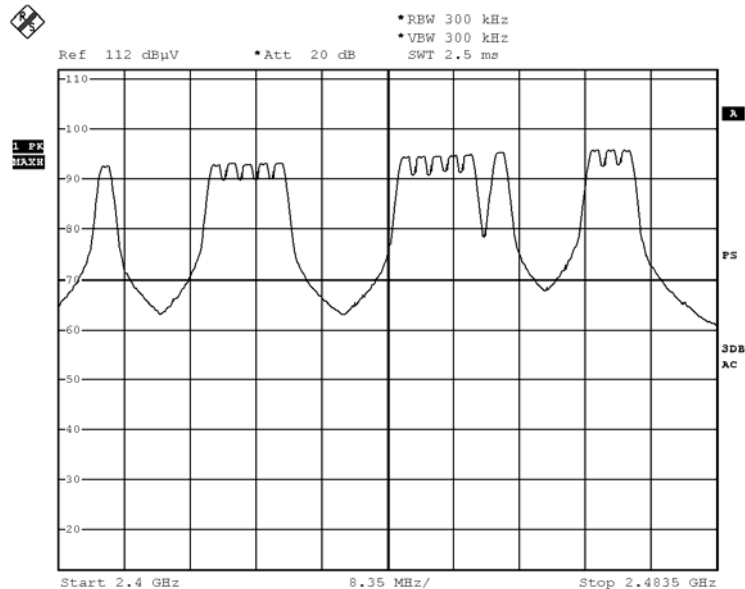
RBW = 1MHz, VBW $\geq$ RBW, Sweep = Auto, Span = the frequency band of operation
Detector = Peak, Trace = Max. hold

Test Setup:

As Test Setup of clause 3.1.1 in this test report.

Measurement Data:

GFSK: 15 of 15 Channel



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3.1.5 20dB Bandwidth

Test Requirement:	FCC 47CFR 15.247(a)(1)
Test Method:	ANSI C63.10: 2013
Test Date:	2016-01-25
Mode of Operation:	Communication mode

Remark:

The result has been done on all the possible configurations for searching the worst cases.

Test Method:

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency. Once the reference level is established, the equipment is conditioned with typical modulating signal to produce the worst-case (i.e. the widest) bandwidth.

Test Setup:

As Test Setup of clause 3.1.1 in this test report.

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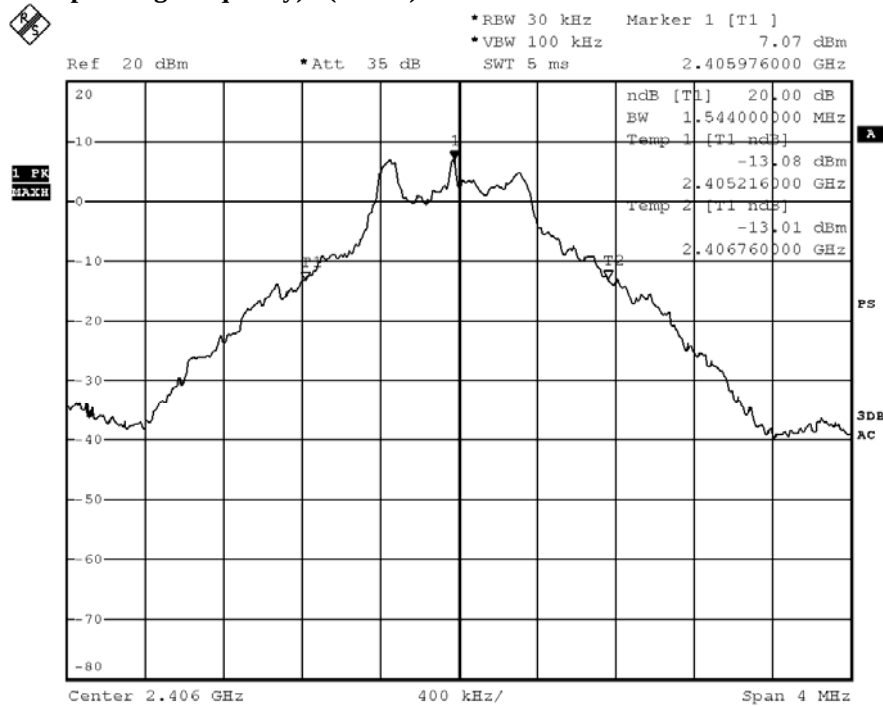
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Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2406	1.544	Within 2400-2483.5

(Lowest Operating Frequency) - (GFSK)



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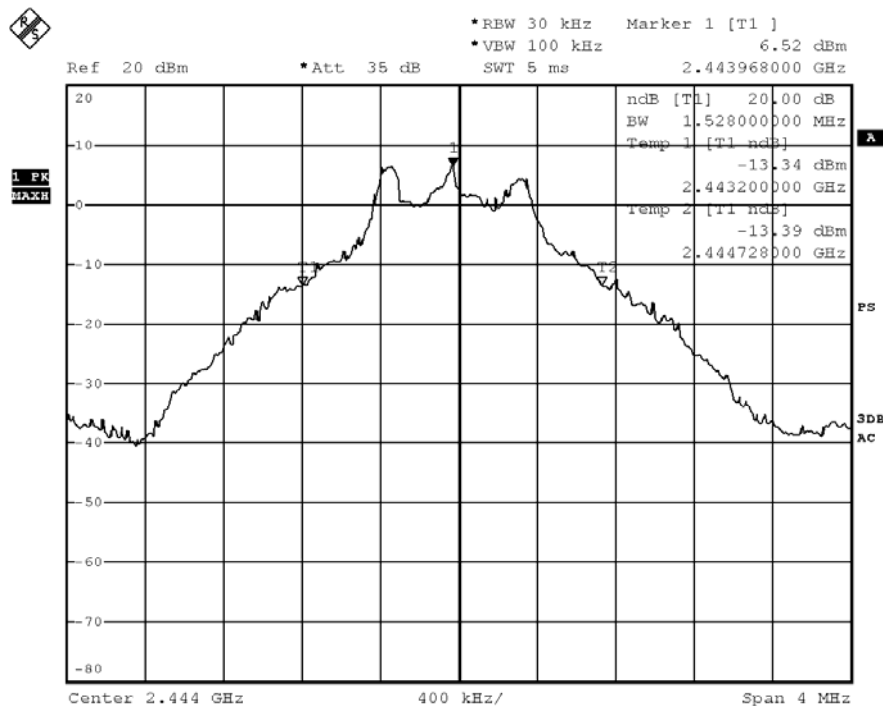
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Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2444	1.528	Within 2400-2483.5

(Middle Operating Frequency) - (GFSK)



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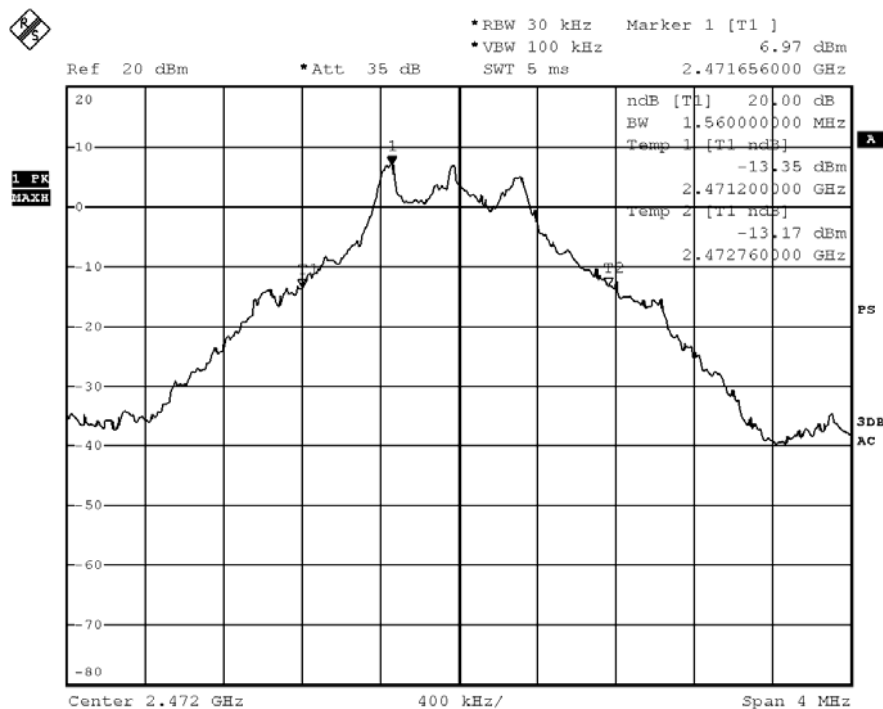
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Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2472	1.560	Within 2400-2483.5

(Highest Operating Frequency) - (GFSK)



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3.1.6 Hopping Channel Separation

Requirements:

Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Limit:

The measured maximum bandwidth * 2/3 = 1.56MHz * 2/3 = 1040kHz

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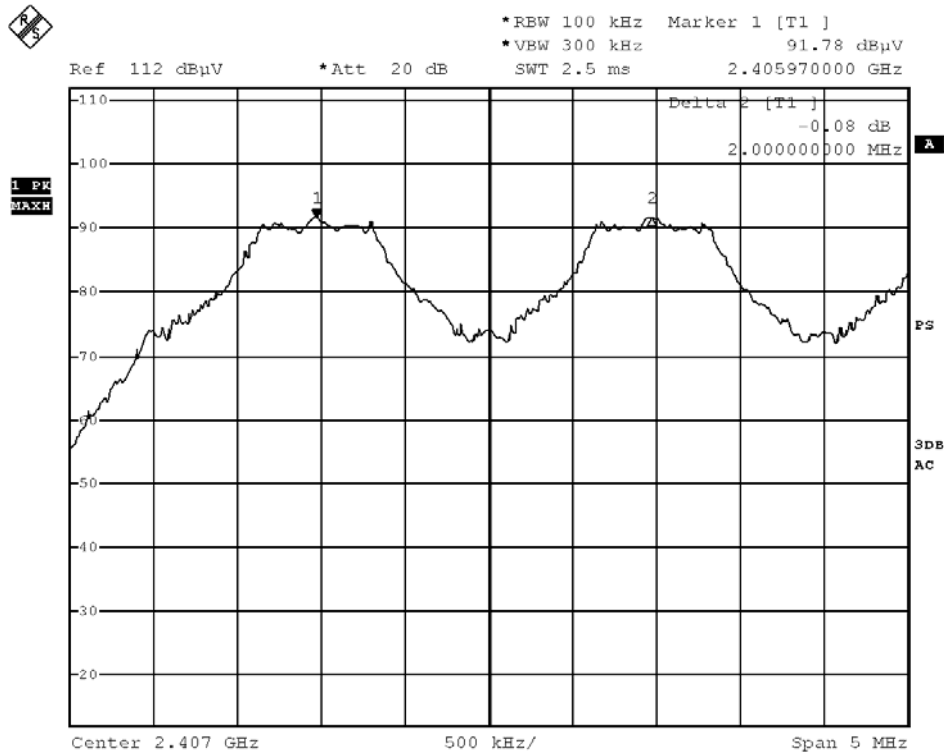
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Channel separation = 1MHz (>1040kHz) (Lowest) (GFSK)



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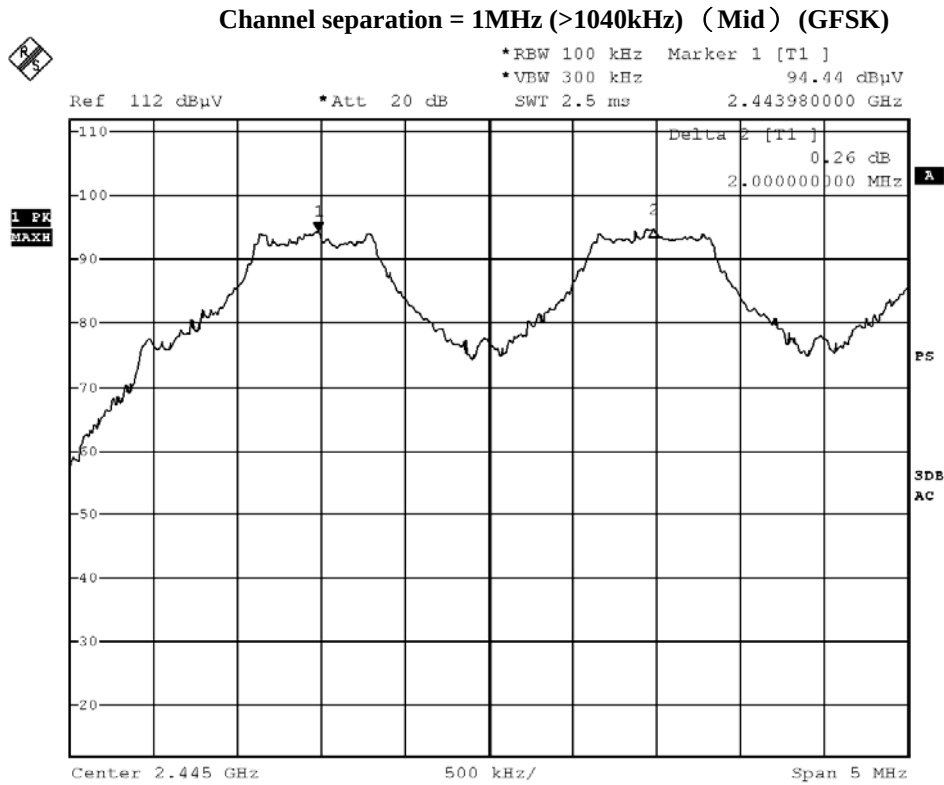


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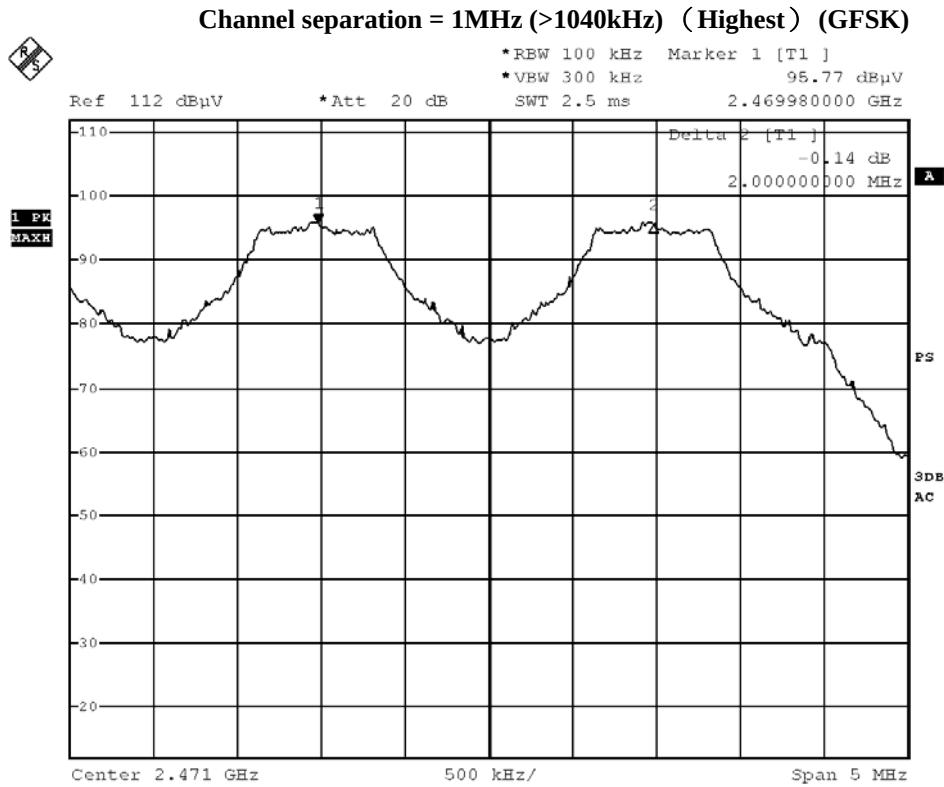


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3.1.7 Band-edge Compliance of RF Conducted Emissions Measurement:

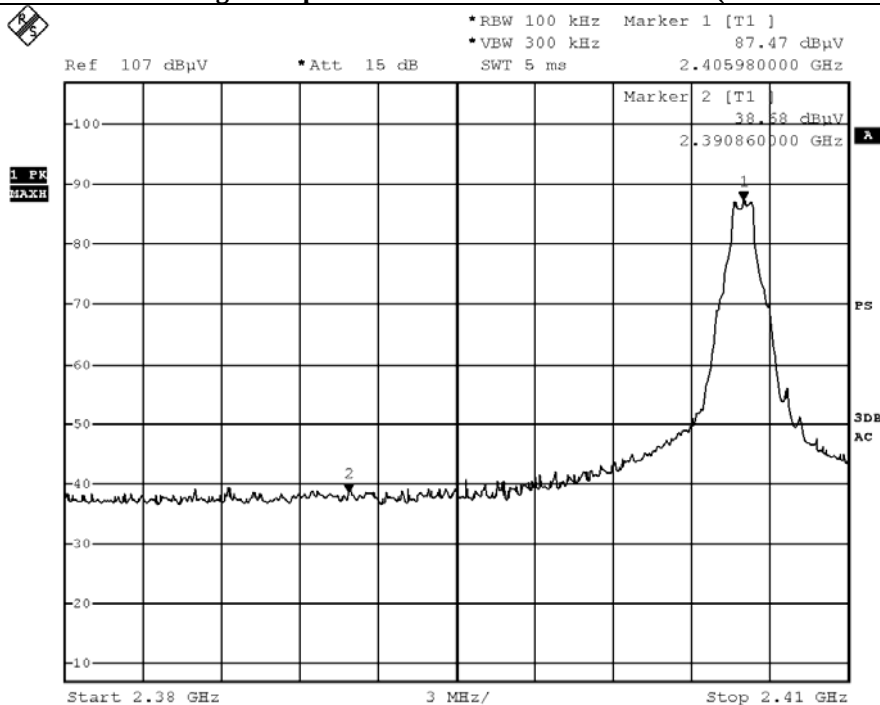
Limit :

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. According to the test method DA 00-705.

Remark: Emissions under the fixed frequency mode and hopping mode have been investigated, the worst-case measurement results were recorded in the test report

Frequency Range	Radiated Emission Attenuated below the Fundamental
[MHz]	[dB]
2400 – Lowest Fundamental (2406)	48.89

Band-edge Compliance of RF Conducted Emissions (GFSK Lowest)



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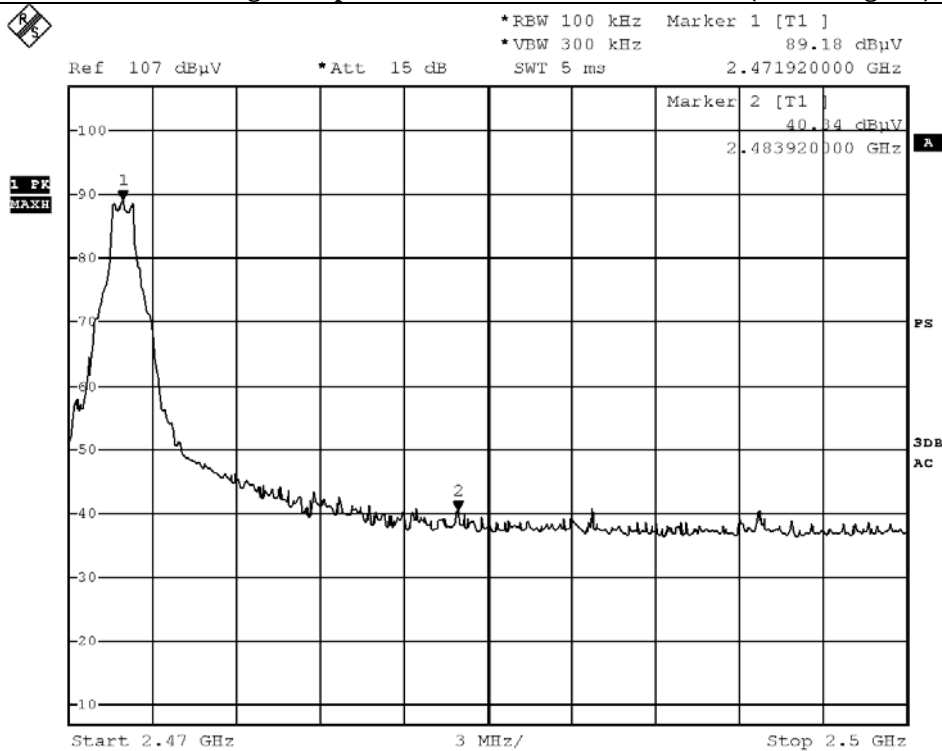
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Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
Highest Fundamental (2472) - 2483.5	48.84

Band-edge Compliance of RF Conducted Emissions (GFSK Highest)



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Band-edge Compliance of RF Radiated Emissions Measurement:

Limit :

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)).

Result: Band-edge Compliance of RF Radiated Emissions (GFSK Lowest)

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2390.0	31.7	36.8	68.5	74.0	5.5	Vertical
2390.0	30.1	36.4	66.5	74.0	7.5	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2390.0	14.5	36.8	51.3	54.0	2.7	Vertical
2390.0	14.3	36.4	50.7	54.0	3.3	Horizontal

Result: Band-edge Compliance of RF Radiated Emissions (GFSK Highest)

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2483.5	28.6	36.8	65.4	74.0	8.6	Vertical
2483.5	28.2	36.4	64.6	74.0	9.4	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dBμV/m	E-Field Polarity
2483.5	13.4	36.8	50.2	54.0	3.8	Vertical
2483.5	13.3	36.4	49.7	54.0	4.3	Horizontal

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3.1.8 Time of Occupancy (Dwell Time)

Requirements:

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channel employed.

No requirements for Digital Transmission System.

Measurement Data: Number of RF channel: 15
Observed duration of occupancy: $0.4 \times 15 = 6\text{s}$
Period observed: 6s
burst: 0.00372s

Time of occupancy: $104 \times 0.00372 = 0.38688\text{s}$

See fig. A and B.

Remark: The Occupancy Time of the Lowest, Middle and Highest operating frequency has been examined and the worst case test result is recorded in this test report.

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Fig. A Pulse Train(2406)

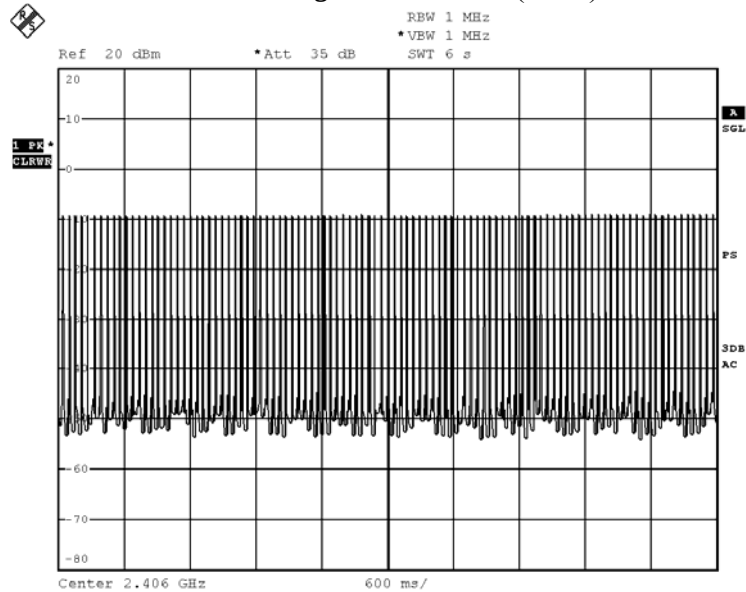
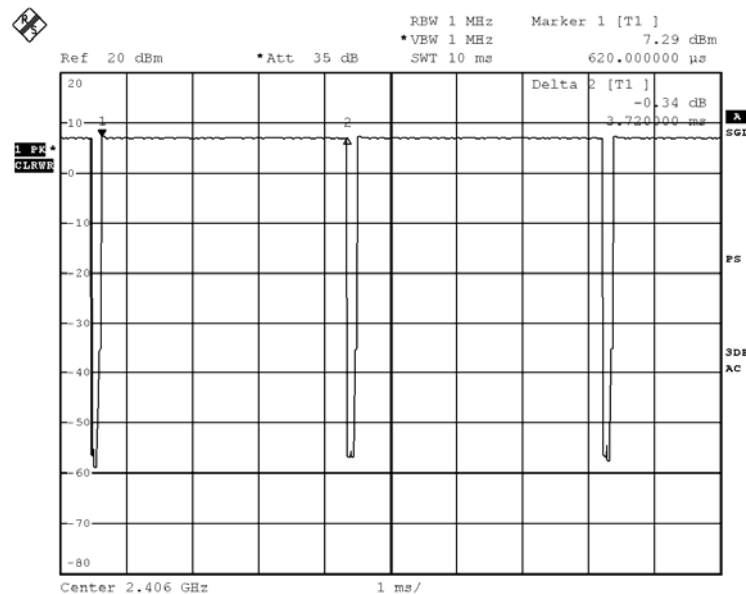


Fig B Single Pulse(2406)



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Fig. A Pulse Train(2444)

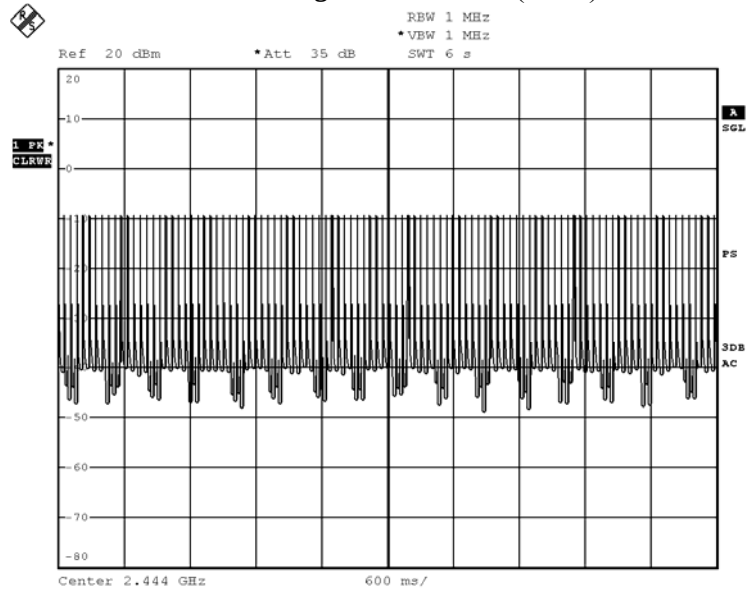
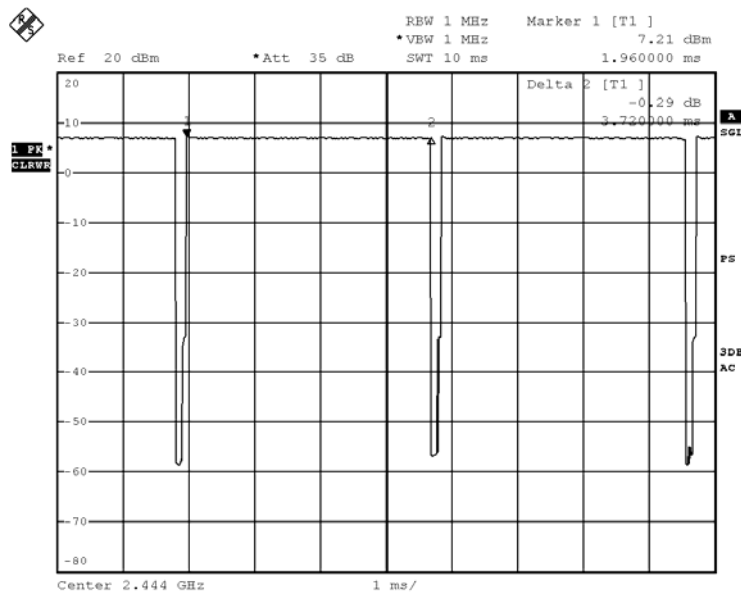


Fig B Single Pulse(2444)



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Fig. A Pulse Train(2472)

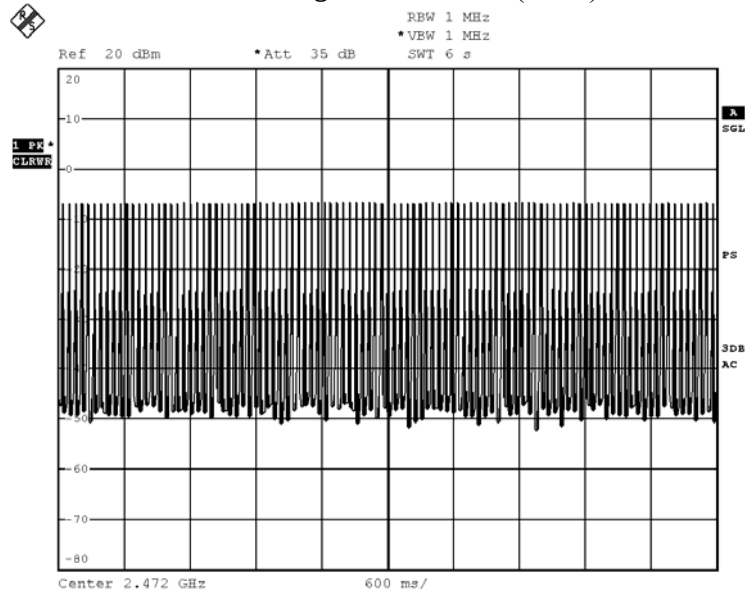
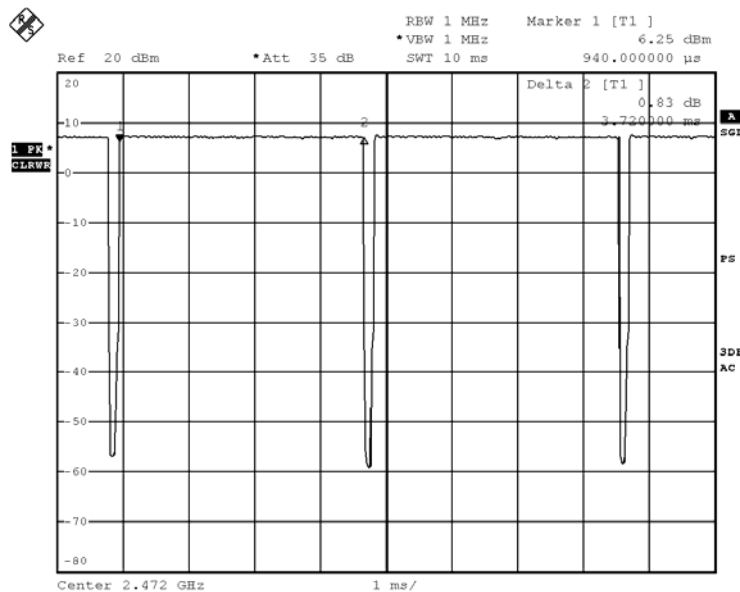


Fig B Single Pulse(2472)



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3.1.9 Channel Centre Frequency

Requirements:

Frequency hopping system in the 2400-2483.5MHz band shall use at least 15 (Channel 1 to 15) non-overlapping channels.

The EUT operates in according with the Bluetooth system specification within the 2400 - 2483.5 MHz frequency band.

RF channels for Bluetooth systems are spaced 2 MHz and are ordered in channel number k. In order to comply with out-of-band regulations, a lower frequency guard band of 2.0 MHz and a higher frequency guard band of 3.5MHz is used.

The operating frequencies of each channel are as follows:

First RF channel start from 2400MHz + 6MHz guard band = 2406MHz

Frequency of RF Channel = 2406+k MHz, k = 2,4,6,8....66 (Channel separation = 2MHz)

Sequence 1: 2406, 2420, 2422, 2424, 2426, 2428, 2444, 2446, 2448, 2450, 2452, 2456, 2468, 2470, 2472 MHz

Sequence 2: 2406, 2408, 2410, 2412, 2414, 2416, 2418, 2420, 2422, 2424, 2426, 2428, 2430, 2438, 2446 MHz

Sequence 3: 2432, 2440, 2448, 2450, 2452, 2454, 2456, 2458, 2460, 2462, 2464, 2466, 2468, 2470, 2472 MHz

Sequence 4: 2406, 2408, 2410, 2412, 2414, 2416, 2418, 2426, 2454, 2462, 2464, 2466, 2468, 2470, 2472 MHz

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3.1.10 Pseudorandom Hopping Algorithm

Requirements:

The channel frequencies shall be selected from a pseudorandom ordered list of hopping frequencies. Each frequency must be used equally by the transmitter.

EUT Pseudorandom Hopping Algorithm

The EUT is a Bluetooth device, the Pseudo-random hopping pattern; hopping characteristics and algorithm are based on the Bluetooth specification.

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3.1.11 Antenna Requirement

Test Requirements: § 15.203

Test Specification:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Test Results:

This is Integral antenna. There is no external antenna, the antenna gain = 0dBi. User is unable to remove or changed the Antenna.

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3.1.12 RF Exposure

Test Requirement: FCC 47CFR 15.247(i)
Test Date: 2016-03-01
Mode of Operation: Tx mode

Test Method:

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

Test Results:

The EUT complied with the requirement(s) of this section.
EUT meets the requirements of these sections as proven through MPE calculation
The MPE calculation for EUT @ 20cm
Based on the highest P = 10.26 mW

$$\begin{aligned} P_d &= PG / 4\pi R^2 = (10.26 \times 1) / 12.566 \times (20)^2 \\ &= (10.26) / 12.566 \times 400 = 10.26 / 5026.4 \\ &= 0.00204 \text{ mW/cm}^2 \end{aligned}$$

where:

- *Pd = power density in mW/cm²
- * G = Antenna numeric gain (1.0); Log G = g/10 (g = 0dBi).
- * P = Conducted RF power to antenna (2.582mW).
- * R = Minimum allowable distance.(20 cm)

- *The power density Pd = 0.00204mW/cm² is less than 1 mW/cm² (listed MPE limit)
- *The SAR evaluation is not needed (this is a desk top device, R> 20 cm)
- * The EUT(antenna) must be 0.2 meters away from the General Population.

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Appendix A

List of Measurement Equipment

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EMD004	LISN	ROHDE & SCHWARZ	ESH3-Z5	100102	2015.3.24	2016.3.24
EMD022	EMI Test Receiver	ROHDE & SCHWARZ	ESCS30	100314	2015.3.24	2016.3.24
EMD035	EMI Test Receiver	ROHDE & SCHWARZ	ESCI	100441	2015.3.24	2016.3.24
EMD036	EMI Test Receiver	ROHDE & SCHWARZ	ESIB 26	100388	2015.3.24	2016.3.24
EMD041	TWO-LINE V-NETWORK	ROHDE & SCHWARZ	ENV216	100261	2015.3.24	2016.3.24
EMD061	Biconilog Antenna	ETS.LINDGREN	3142C	00060439	2014.11.29	2016.11.29
EMD062	Double-Ridged Waveguide (1GHz – 18GHz)	ETS.LINDGREN	3117	00075933	2014.11.15	2016.11.15
EMD084	MULTI-DVICE CONTROLLER	ETS.LINDGREN	2090	00060107	N/A	N/A
EMD088	Video Contol Unit	ETS.LINDGREN	Y21953A	2601073	N/A	N/A
EMD093	Monitor	ViewSonic	VA9036	Q8X064201876	N/A	N/A
EMD102	Intelligent Frequency	Ainuo Instrument Co., Ltd	AN97005SS	79707454	N/A	N/A
EMD103	Intelligent Frequency	Ainuo Instrument Co., Ltd	AN97005SS	79707455	N/A	N/A
EMD105	FACT-3 EMC Chamber	ETS.LINDGREN	FACT-3	3803	N/A	N/A
EMD106	Shielding Room #1	ETS.LINDGREN	RFD-100	3802	N/A	N/A
EMD111	Power meter	ROHDE & SCHWARZ	NRVD	102051	2015.3.24	2016.3.24
	100V Insertion Unit	ROHDE & SCHWARZ	URV5-Z4	100464	2015.3.24	2016.3.24
EMD113	Pre-Amplifier	ROHDE & SCHWARZ	N/A	1129588	2015.3.24	2016.3.24
EMD124	Loop Antenna	ETS-Lindgren	6502	00104905	2014.04.28	2016.04.28
EMD131	Standard Gain Horn Antenna (18GHz – 26.5GHz)	Chengdu AINFO Inc.	JXTXLB-42-15-C-KF	J2021100721001	2015.04.09	2017.04.09
RE01	RF cable	N/A	N/A	N/A	2014-9-28	2016-9-27
RE02	RF cable	N/A	N/A	N/A	2014-9-28	2016-9-27

Remarks:-

N/A Not Applicable or Not Available

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Appendix B

Photographs of EUT

Front View of the product



Rear View of the product



Inside View of the product



Inner Circuit Top View



Inner Circuit Bottom View



Inner Circuit Top View



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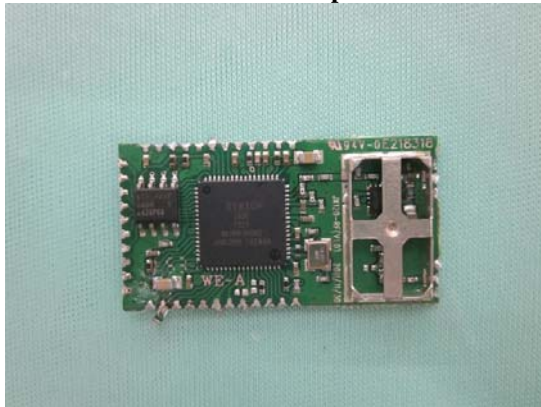
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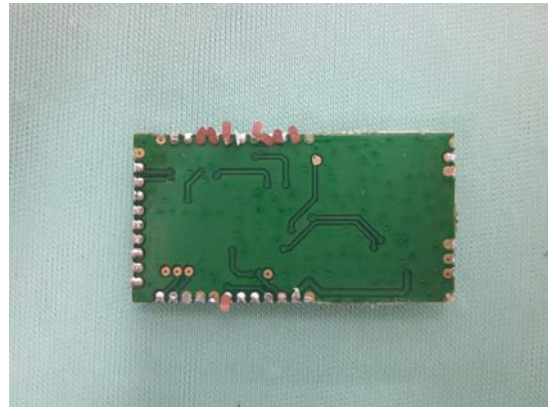
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Photographs of EUT

Inner Circuit Top View



Inner Circuit Bottom View



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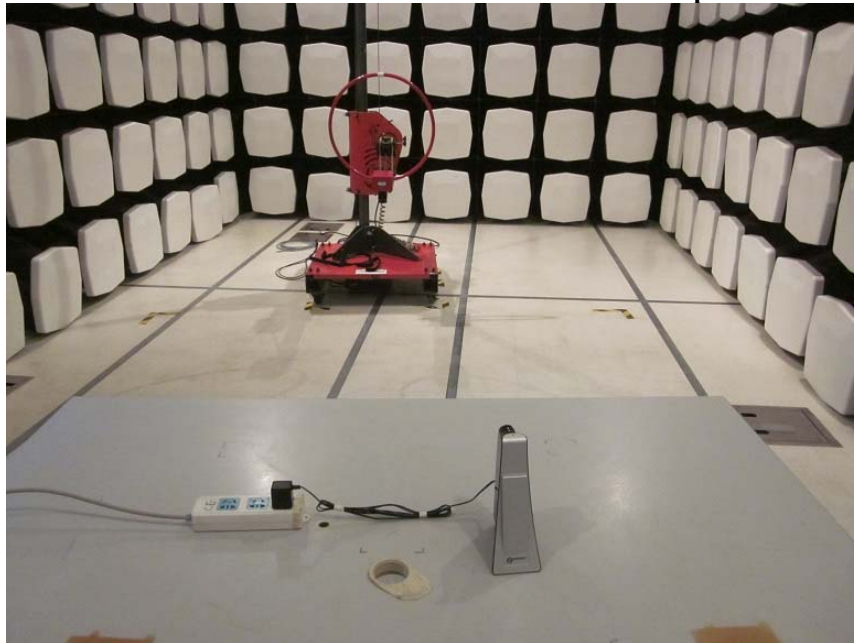
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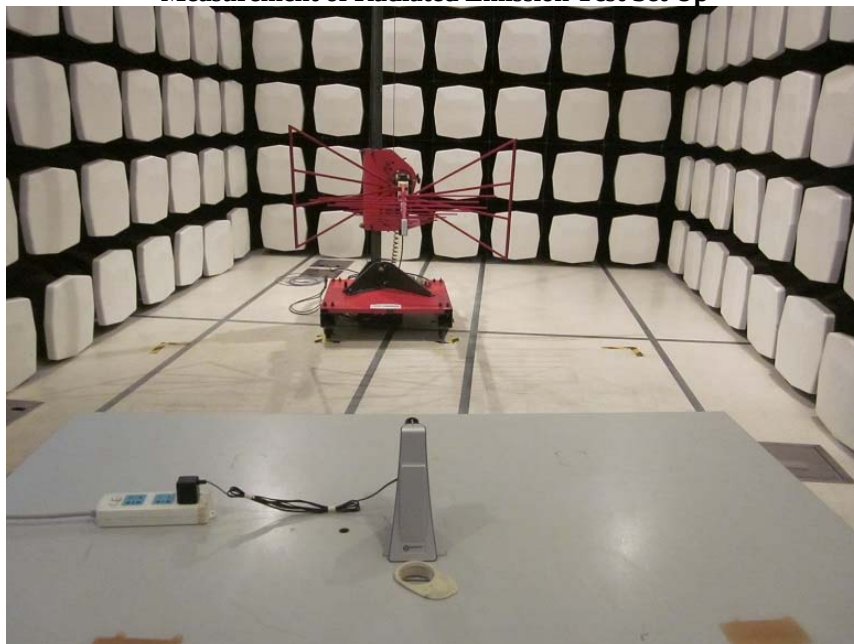
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Photographs of EUT

Measurement of Radiated Emission Test Set Up



Measurement of Radiated Emission Test Set Up



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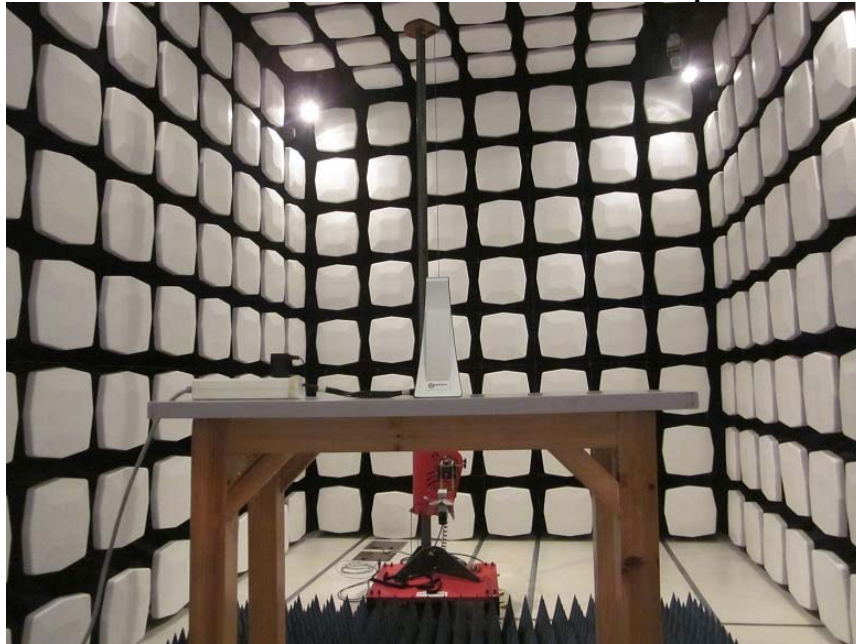
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Photographs of EUT

Measurement of Radiated Emission Test Set Up



Measurement of Conducted Emission Test Set Up



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