



## STC Test Report

**Date:** 2016-08-05

**Page 1 of 91**

**No.:** DMA000106

**Applicant:** Hip Shing Electronics Limited  
Units 1.2&3,20/F.,New Treasure Centre, 10., Ng Fong Street, San Po Kong, Kowloon, Hong Kong

**Manufacturer:** Dongguan Zhi Cheng Electronic Products Co., Ltd.  
No.11 Shangbao Road, 188 Industrial Zone, Pingshan, Tangxia, Dongguan, Guangdong, China

**Description of Sample(s):** Product: Internet/FM Digital Radio With Bluetooth and Spotify  
Brand Name: Como Audio  
Model Number: Solo  
FCC ID: BZAWDFB16SOLO

**Date Sample(s) Received:** 2016-07-26

**Date Tested:** 2016-07-29 to 2016-08-03

**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):** Bluetooth FHSS (GFSK/  $\pi/4$ -DQPSK/ 8DPSK)

LONG Yun Jian, Along  
Authorized Signatory

ElectroMagnetic Compatibility Department  
For and on behalf of

The Hong Kong Standards and Testing Centre Ltd.

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# STC Test Report

**Date: 2016-08-05**

**Page 2 of 91**

**No.: DMA000106**

## **CONTENT:**

Cover	Page 1 of 91
Content	Page 2 of 91
<b><u>1.0</u></b> <b><u>General Details</u></b>	
1.1 Test Laboratory	Page 3 of 91
1.2 Equipment Under Test [EUT] Description of EUT operation	Page 3 of 91
1.3 Date of Order	Page 3 of 91
1.4 Submitted Sample	Page 3 of 91
1.5 Test Duration	Page 3 of 91
1.6 Country of Origin	Page 3 of 91
1.7 RF Module Details	Page 4 of 91
1.8 Antenna Details	Page 4 of 91
<b><u>2.0</u></b> <b><u>Technical Details</u></b>	
2.1 Investigations Requested	Page 5 of 91
2.2 Test Standards and Results Summary	Page 5 of 91
2.3 Table for Test Modes	Page 6 of 91
<b><u>3.0</u></b> <b><u>Test Results</u></b>	
3.1 Emission	Page 7 –86 of 91
<b><u>Appendix A</u></b> List of Measurement Equipment	Page 87 of 91
<b><u>Appendix B</u></b> Photographs	Page 88-91 of 91

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## **STC Test Report**

**Date: 2016-08-05**

**Page 3 of 91**

**No.: DMA000106**

### **1.0 General Details**

#### **1.1 Test Laboratory**

The Hong Kong Standards and Testing Centre Ltd.  
EMC Laboratory  
10 Dai Wang Street, Taipo Industrial Estate, New Territories, Hong Kong  
Telephone: 852 2666 1888  
Fax: 852 2664 4353

#### **1.2 Equipment Under Test [EUT]**

##### **Description of Sample(s)**

Product: Internet/FM Digital Radio with Bluetooth and Spotify  
Manufacturer: Dongguan Zhi Cheng Electronic Products Co., Ltd.  
No.11 Shangbao Road, 188 Industrial Zone, Pingshan,  
Tangxia, Dongguan, Guangdong, China  
Brand Name: Como Audio  
Model Number: Solo  
Rating: 100-240Va.c. 50/60Hz

##### **1.2.1 Description of EUT Operation**

The Equipment Under Test (EUT) is a Internet/FM Digital Radio With Bluetooth and Spotify. The r.f. signal was modulated by IC and type of modulation was frequency hopping spread spectrum Modulation.

#### **1.3 Date of Order**

2016-07-26

#### **1.4 Submitted Sample(s):**

1 Sample

#### **1.5 Test Duration**

2016-07-29 to 2016-08-03

#### **1.6 Country of Origin**

China

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## **STC Test Report**

**Date: 2016-08-05**

**Page 4 of 91**

**No.: DMA000106**

### **1.7 RF Module Details**

Module Model Number:	BM153
Module FCC ID:	
Module Transmission Type:	Bluetooth V4.1
Modulation:	FHSS (GFSK / $\pi/4$ -DQPSK/ 8DPSK)
Data Rates:	1Mbps: GFSK 2 Mbps: $\pi/4$ -DQPSK 3 Mbps: 8DPSK
Frequency Range:	2400-2483.5MHz
Carrier Frequencies:	2402MHz – 2480MHz

Module Specification (specification provided by manufacturer)

### **1.8 Antenna Details**

Antenna Type:	Meander Line antenna
Antenna Gain:	2.12dBi

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## STC Test Report

Date: 2016-08-05

Page 5 of 91

No.: DMA000106

### 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)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Radiated Spurious Emissions	FCC 47CFR 15.209	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
AC Mains Conducted Emissions	FCC 47CFR 15.207	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Number of Hopping Frequency	FCC 47CFR 15.247 (b)(1)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20dB Bandwidth	FCC 47CFR 15.247(a)(2)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hopping Channel Separation	FCC 47CFR 15.247(a)(1)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Band-edge measurement (Radiated)	FCC 47CFR 15.247(d)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pseudorandom Hopping Algorithm	FCC 47CFR 15.247(a)(1)	N/A	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Time of Occupancy (Dwell Time)	FCC 47CFR 15.247(a)(1)(iii)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Antenna requirement	FCC 47CFR 15.203	N/A	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
RF Exposure	FCC 47CFR 15.247(i)	N/A	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Note: N/A – Not Applicable

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## STC Test Report

**Date: 2016-08-05**

**Page 6 of 91**

**No.: DMA000106**

### 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 / $\pi/4$ -DQPSK / 8DPSK	1MBps / 2MBps / 3MBps
Hopping Channel Separation	GFSK / $\pi/4$ -DQPSK / 8DPSK	1MBps / 2MBps / 3MBps
Number of Hopping Frequency	GFSK / $\pi/4$ -DQPSK / 8DPSK	1MBps / 2MBps / 3MBps
Time of Occupancy(Dwell Time)	8DPSK (DH1 / DH3 / DH5)	3MBps
Radiated Spurious Emissions	GFSK / $\pi/4$ -DQPSK / 8DPSK	1MBps / 2MBps / 3MBps
Band-edge compliance of Conducted Emission	GFSK / $\pi/4$ -DQPSK / 8DPSK	1MBps / 2MBps / 3MBps

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## STC Test Report

**Date: 2016-08-05**

**Page 7 of 91**

**No.: DMA000106**

### **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:	ANSI C63.10: 2013
Test Date:	2016-08-02
Mode of Operation:	Tx mode

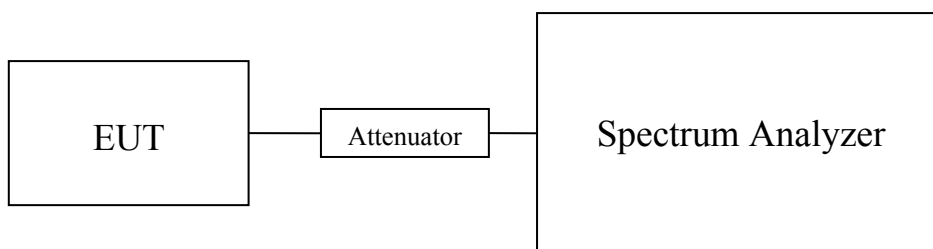
#### **Test Method:**

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 Watt.

#### **Spectrum Analyzer Setting:**

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

#### **Test Setup:**



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

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## STC Test Report

Date: 2016-08-05

Page 8 of 91

No.: DMA000106

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

The maximum peak output power shall not exceeded 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)
2402	0.000840

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2441	0.000790

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2480	0.000620

Results of Bluetooth Communication mode ( $\pi/4$ -DQPSK) (Fundamental Power): Pass

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2402	0.000760

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2441	0.000720

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2480	0.000500

Results of Bluetooth Communication mode (8 DPSK) (Fundamental Power): Pass

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2402	0.000770

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2441	0.000740

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2480	0.000540

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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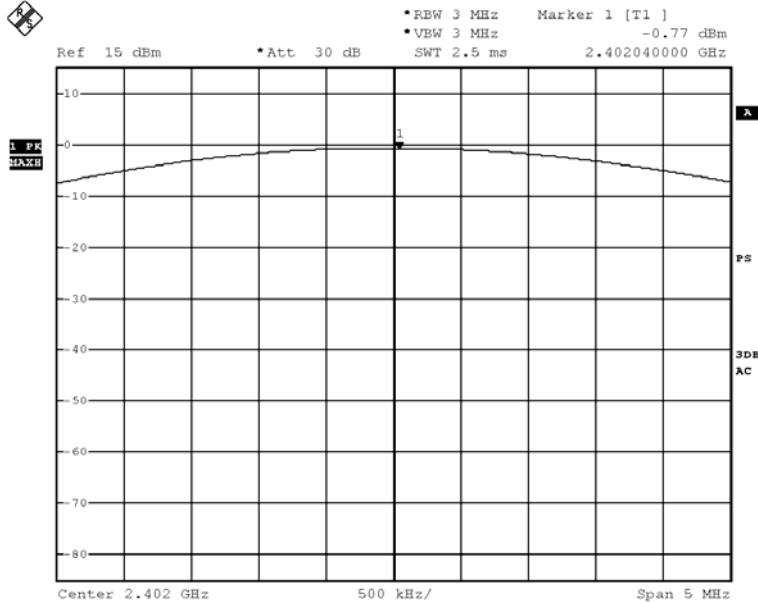


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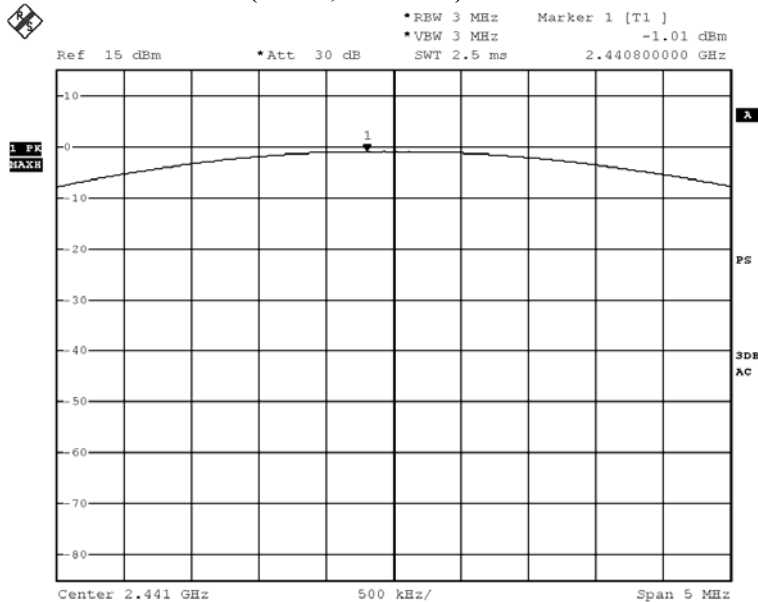
Date: 2016-08-05  
No.: DMA000106

Page 9 of 91

### Test plot of Maximum Peak Conducted Output Power : Bluetooth Communication mode (GFSK, 2402MHz)



### Bluetooth Communication mode (GFSK, 2441MHz)



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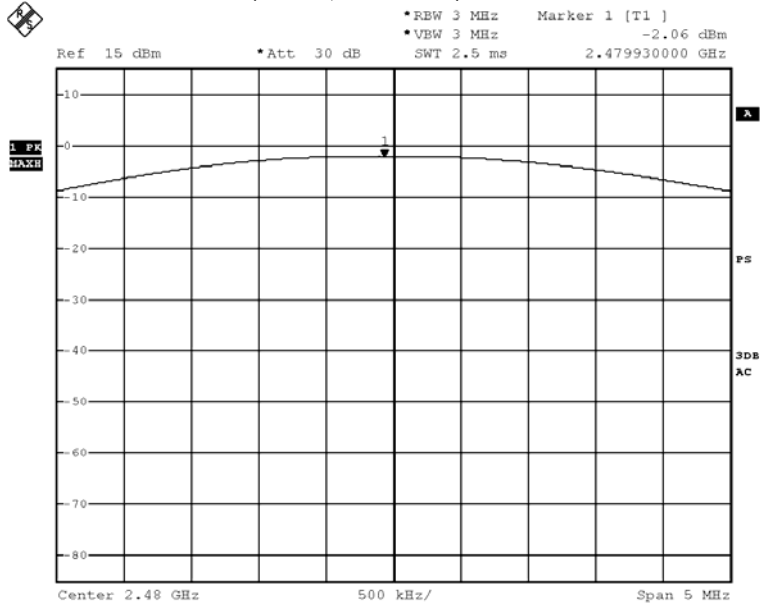


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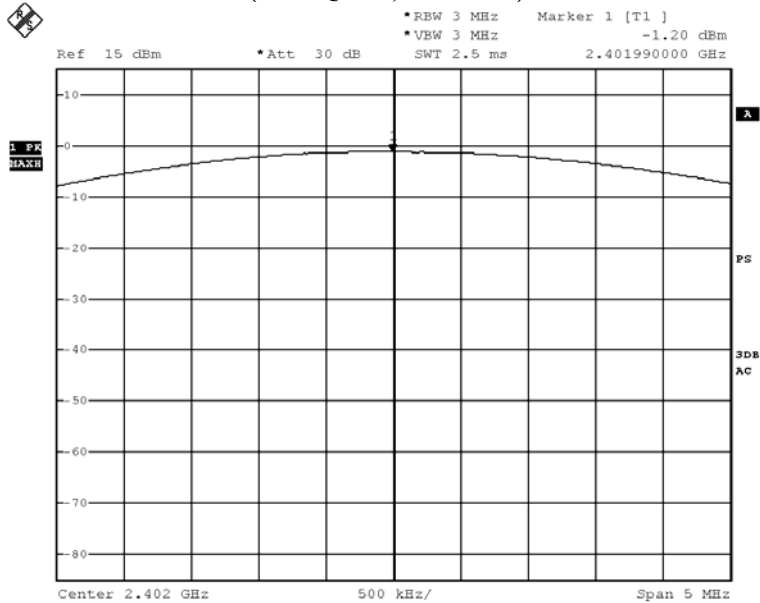
Date: 2016-08-05  
No.: DMA000106

Page 10 of 91

## Bluetooth Communication mode (GFSK, 2480MHz)



## Bluetooth Communication mode ( $\pi/4$ DQPSK, 2402MHz)



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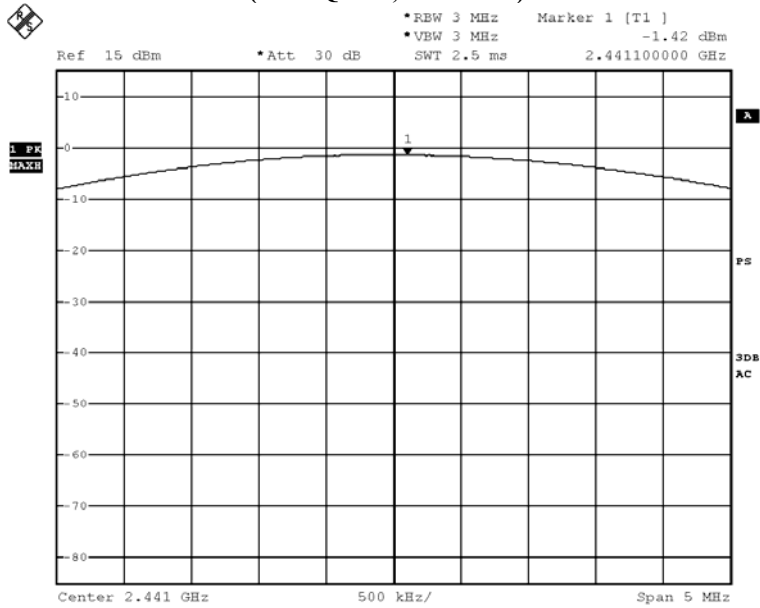


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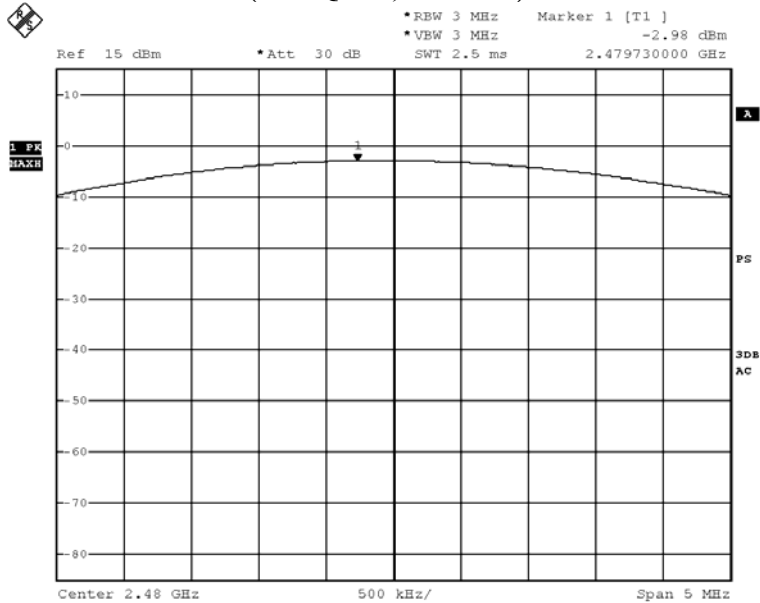
Date: 2016-08-05  
No.: DMA000106

Page 11 of 91

## Bluetooth Communication mode ( $\pi/4$ DQPSK, 2441MHz)



## Bluetooth Communication mode ( $\pi/4$ DQPSK, 2480MHz)



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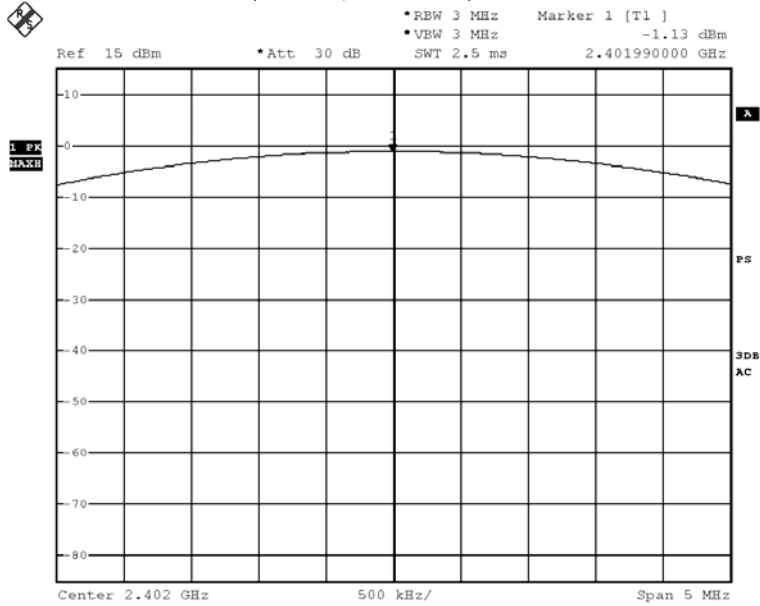


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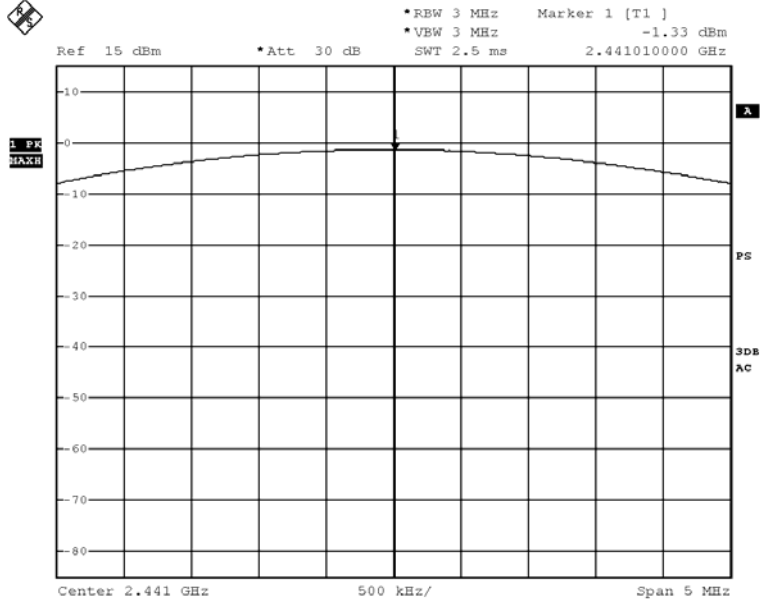
Date: 2016-08-05  
No.: DMA000106

Page 12 of 91

## Bluetooth Communication mode (8DPSK, 2402MHz)



## Bluetooth Communication mode (8DPSK, 2441MHz)



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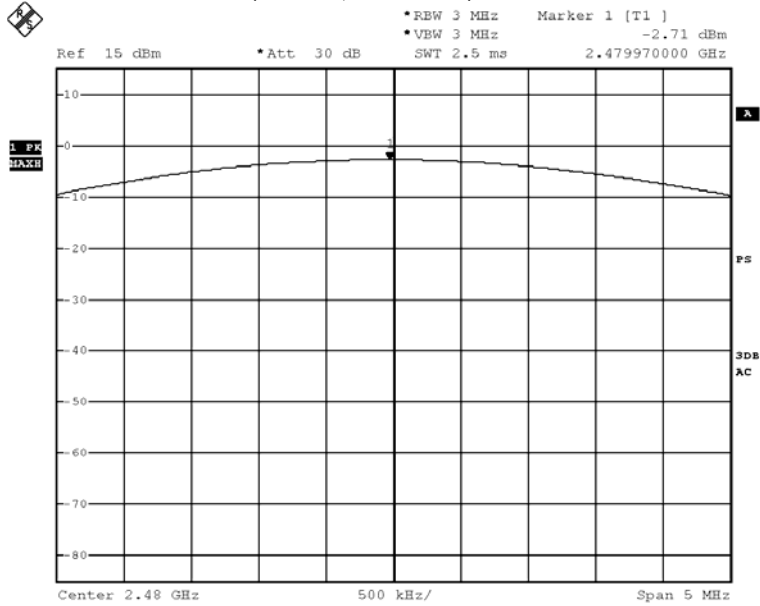


# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 13 of 91

## Bluetooth Communication mode (8DPSK, 2480MHz)



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## **STC Test Report**

**Date: 2016-08-05**

**Page 14 of 91**

**No.: DMA000106**

### **3.1.2 Radiated Spurious Emissions**

Test Requirement:	FCC 47CFR 15.209
Test Method:	ANSI C63.10: 2013
Test Date:	2016-08-02
Mode of Operation:	Tx mode / Bluetooth Communication 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 G/F of The Hong Kong Standards and Testing Centre Ltd. with a metal ground plane filed with the FCC pursuant to section 2.948 of the FCC rules, with Registration Number: 607756.

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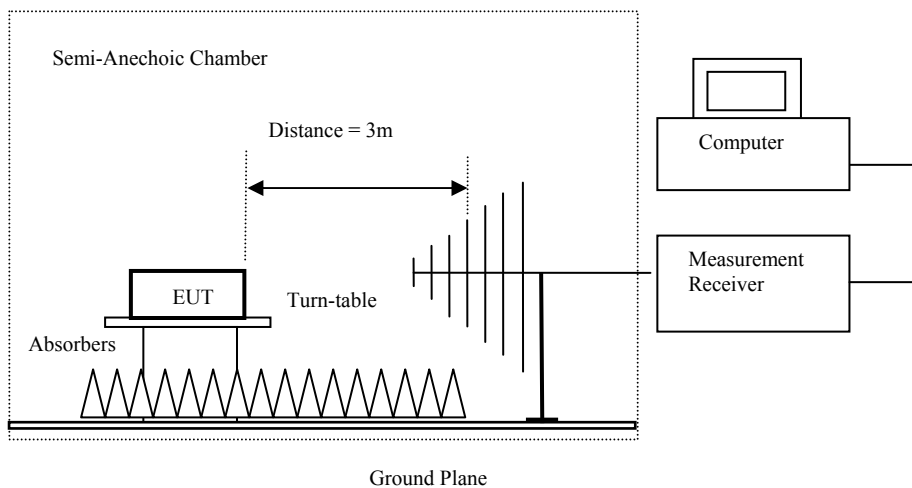
**Date: 2016-08-05**  
**No.: DMA000106**

**Page 15 of 91**

### **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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## STC Test Report

Date: 2016-08-05

Page 16 of 91

No.: DMA000106

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

Frequency Range [MHz]	Quasi-Peak Limits [ $\mu$ 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 (2402.0 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 (2402.0 MHz) (GFSK mode) (Above 1GHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
4804.0	16.0	41.5	57.5	74.0	16.5	Vertical
4804.0	12.3	42.4	54.7	74.0	19.3	Horizontal
7206.0	10.4	45.1	55.5	74.0	18.5	Vertical
7206.0	7.4	46.2	53.6	74.0	20.4	Horizontal
9608.0	7.2	48.0	55.2	74.0	18.8	Vertical
9608.0	4.2	48.8	53.0	74.0	21.0	Horizontal
12010.0	2.5	51.8	54.3	74.0	19.7	Vertical
12010.0	-0.1	52.4	52.3	74.0	21.7	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 17 of 91

No.: DMA000106

Result of Tx mode (2402.0 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
4804.0	0.8	41.5	42.3	54.0	11.7	Vertical
4804.0	-2.9	42.4	39.5	54.0	14.5	Horizontal
7206.0	-4.9	45.1	40.2	54.0	13.8	Vertical
7206.0	-7.7	46.2	38.5	54.0	15.5	Horizontal
9608.0	-8.0	48.0	40.0	54.0	14.0	Vertical
9608.0	-11.0	48.8	37.8	54.0	16.2	Horizontal
12010.0	-12.9	51.8	38.9	54.0	15.1	Vertical
12010.0	-15.2	52.4	37.2	54.0	16.8	Horizontal

Result of Tx mode (2441.0 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 (2441.0 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
4882.0	15.8	41.6	57.4	74.0	16.6	Vertical
4882.0	11.7	42.5	54.2	74.0	19.8	Horizontal
7323.0	1.6	53.2	54.8	74.0	19.2	Vertical
7323.0	6.4	46.3	52.7	74.0	21.3	Horizontal
9764.0	7	48.1	55.1	74.0	18.9	Vertical
9764.0	4.4	48.9	53.3	74.0	20.7	Horizontal
12205.0	3.1	51.6	54.7	74.0	19.3	Vertical
12205.0	1.0	52.5	53.5	74.0	20.5	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 18 of 91

No.: DMA000106

Result of Tx mode (2441.0 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
4882.0	0.6	41.6	42.2	54.0	11.8	Vertical
4882.0	-3.6	42.5	38.9	54.0	15.1	Horizontal
7323.0	-5.8	45.2	39.4	54.0	14.6	Vertical
7323.0	-8.7	46.3	37.6	54.0	16.4	Horizontal
9764.0	-8.1	48.1	40.0	54.0	14.0	Vertical
9764.0	-10.8	48.9	38.1	54.0	15.9	Horizontal
12205.0	-12.0	51.6	39.6	54.0	14.4	Vertical
12205.0	-14.1	52.5	38.4	54.0	15.6	Horizontal

Result of Tx mode (2480.0 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 (2480.0 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
4960.0	15.7	41.4	57.1	74.0	16.9	Vertical
4960.0	11.5	42.7	54.2	74.0	19.8	Horizontal
7440.0	9.8	45.6	55.4	74.0	18.6	Vertical
7440.0	5.7	46.5	52.2	74.0	21.8	Horizontal
9920.0	6.5	48.6	55.1	74.0	18.9	Vertical
9920.0	3.1	49.7	52.8	74.0	21.2	Horizontal
12400.0	2.5	51.7	54.2	74.0	19.8	Vertical
12400.0	-0.3	52.7	52.4	74.0	21.6	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 19 of 91

No.: DMA000106

Result of Tx mode (2480.0 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
4960.0	0.6	41.4	42.0	54.0	12.0	Vertical
4960.0	-3.7	42.7	39.0	54.0	15.0	Horizontal
7440.0	-5.5	45.6	40.1	54.0	13.9	Vertical
7440.0	-9.4	46.5	37.1	54.0	16.9	Horizontal
9920.0	-8.6	48.6	40.0	54.0	14.0	Vertical
9920.0	-12.1	49.7	37.6	54.0	16.4	Horizontal
12400.0	-12.8	51.7	38.9	54.0	15.1	Vertical
12400.0	-15.4	52.7	37.3	54.0	16.7	Horizontal

Result of Tx mode (2402.0 MHz) ( $\pi/4$ -DQPSK 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
<b>Emissions detected are more than 20 dB below the FCC Limits</b>						

Result of Tx mode (2402.0 MHz) ( $\pi/4$ -DQPSK mode) (Above 1GHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
4804.0	16.5	41.5	58.0	74.0	16.0	Vertical
4804.0	12.3	42.4	54.7	74.0	19.3	Horizontal
7206.0	10.7	45.1	55.8	74.0	18.2	Vertical
7206.0	8.5	46.2	54.7	74.0	19.3	Horizontal
9608.0	7.3	48.0	55.3	74.0	18.7	Vertical
9608.0	5.4	48.8	54.2	74.0	19.8	Horizontal
12010.0	3.4	51.8	55.2	74.0	18.8	Vertical
12010.0	1.2	52.4	53.6	74.0	20.4	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 20 of 91

No.: DMA000106

Result of Tx mode (2402.0 MHz) ( $\pi/4$ -DQPSK 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
4804.0	1.3	41.5	42.8	54.0	11.2	Vertical
4804.0	-2.9	42.4	39.5	54.0	14.5	Horizontal
7206.0	-4.6	45.1	40.5	54.0	13.5	Vertical
7206.0	-6.6	46.2	39.6	54.0	14.4	Horizontal
9608.0	-7.8	48.0	40.2	54.0	13.8	Vertical
9608.0	-9.9	48.8	38.9	54.0	15.1	Horizontal
12010.0	-11.9	51.8	39.9	54.0	14.1	Vertical
12010.0	-13.9	52.4	38.5	54.0	15.5	Horizontal

Result of Tx mode (2441.0 MHz) ( $\pi/4$ -DQPSK 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 (2441.0 MHz) ( $\pi/4$ -DQPSK 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
4882.0	16.0	41.6	57.6	74.0	16.4	Vertical
4882.0	11.9	42.5	54.4	74.0	19.6	Horizontal
7323.0	2.1	53.2	55.3	74.0	18.7	Vertical
7323.0	6.8	46.3	53.1	74.0	20.9	Horizontal
9764.0	7.5	48.1	55.6	74.0	18.4	Vertical
9764.0	4.8	48.9	53.7	74.0	20.3	Horizontal
12205.0	3.9	51.6	55.5	74.0	18.5	Vertical
12205.0	0.8	52.5	53.3	74.0	20.7	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 21 of 91

No.: DMA000106

Result of Tx mode (2441.0 MHz) ( $\pi/4$ -DQPSK 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
4882.0	0.9	41.6	42.5	54.0	11.5	Vertical
4882.0	-3.4	42.5	39.1	54.0	14.9	Horizontal
7323.0	-5.3	45.2	39.9	54.0	14.1	Vertical
7323.0	-8.3	46.3	38.0	54.0	16.0	Horizontal
9764.0	-7.6	48.1	40.5	54.0	13.5	Vertical
9764.0	-10.5	48.9	38.4	54.0	15.6	Horizontal
12205.0	-11.2	51.6	40.4	54.0	13.6	Vertical
12205.0	-14.3	52.5	38.2	54.0	15.8	Horizontal

Result of Tx mode (2480.0 MHz) ( $\pi/4$ -DQPSK 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 (2480.0 MHz) ( $\pi/4$ -DQPSK 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
4960.0	16.0	41.4	57.4	74.0	16.6	Vertical
4960.0	12.0	42.7	54.7	74.0	19.3	Horizontal
7440.0	9.6	45.6	55.2	74.0	18.8	Vertical
7440.0	5.8	46.5	52.3	74.0	21.7	Horizontal
9920.0	6.7	48.6	55.3	74.0	18.7	Vertical
9920.0	3.2	49.7	52.9	74.0	21.1	Horizontal
12400.0	3.4	51.7	55.1	74.0	18.9	Vertical
12400.0	0.5	52.7	53.2	74.0	20.8	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 22 of 91

No.: DMA000106

Result of Tx mode (2480.0 MHz) ( $\pi/4$ -DQPSK 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
4960.0	0.9	41.4	42.3	54.0	11.7	Vertical
4960.0	-3.2	42.7	39.5	54.0	14.5	Horizontal
7440.0	-5.7	45.6	39.9	54.0	14.1	Vertical
7440.0	-9.3	46.5	37.2	54.0	16.8	Horizontal
9920.0	-8.4	48.6	40.2	54.0	13.8	Vertical
9920.0	-12.0	49.7	37.7	54.0	16.3	Horizontal
12400.0	-11.9	51.7	39.8	54.0	14.2	Vertical
12400.0	-14.6	52.7	38.1	54.0	15.9	Horizontal

Result of Tx mode (2402.0 MHz) (8DPSK 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 (2402.0 MHz) (8DPSK mode) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
4804.0	16.3	41.5	57.8	74.0	16.2	Vertical
4804.0	12.4	42.4	54.8	74.0	19.2	Horizontal
7206.0	10.4	45.1	55.5	74.0	18.5	Vertical
7206.0	8.0	46.2	54.2	74.0	19.8	Horizontal
9608.0	7.6	48.0	55.6	74.0	18.4	Vertical
9608.0	5.1	48.8	53.9	74.0	20.1	Horizontal
12010.0	3.3	51.8	55.1	74.0	18.9	Vertical
12010.0	1.3	52.4	53.7	74.0	20.3	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 23 of 91

No.: DMA000106

Result of Tx mode (2402.0 MHz) (8DPSK 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
4804.0	1.2	41.5	42.7	54.0	11.3	Vertical
4804.0	-2.9	42.4	39.5	54.0	14.5	Horizontal
7206.0	-4.9	45.1	40.2	54.0	13.8	Vertical
7206.0	-7.2	46.2	39.0	54.0	15.0	Horizontal
9608.0	-7.5	48.0	40.5	54.0	13.5	Vertical
9608.0	-10.1	48.8	38.7	54.0	15.3	Horizontal
12010.0	-12.0	51.8	39.8	54.0	14.2	Vertical
12010.0	-13.8	52.4	38.6	54.0	15.4	Horizontal

Result of Tx mode (2441.0 MHz) (8DPSK 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 (2441.0 MHz) (8DPSK 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
4882.0	15.8	41.6	57.4	74.0	16.6	Vertical
4882.0	11.7	42.5	54.2	74.0	19.8	Horizontal
7323.0	2.0	53.2	55.2	74.0	18.8	Vertical
7323.0	7.0	46.3	53.3	74.0	20.7	Horizontal
9764.0	7.1	48.1	55.2	74.0	18.8	Vertical
9764.0	4.0	48.9	52.9	74.0	21.1	Horizontal
12205.0	3.7	51.6	55.3	74.0	18.7	Vertical
12205.0	0.6	52.5	53.1	74.0	20.9	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 24 of 91

No.: DMA000106

Result of Tx mode (2441.0 MHz) (8DPSK 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
4882.0	0.7	41.6	42.3	54.0	11.7	Vertical
4882.0	-3.5	42.5	39.0	54.0	15.0	Horizontal
7323.0	-5.4	45.2	39.8	54.0	14.2	Vertical
7323.0	-8.1	46.3	38.2	54.0	15.8	Horizontal
9764.0	-8.0	48.1	40.1	54.0	13.9	Vertical
9764.0	-11.2	48.9	37.7	54.0	16.3	Horizontal
12205.0	-11.4	51.6	40.2	54.0	13.8	Vertical
12205.0	-14.5	52.5	38.0	54.0	16.0	Horizontal

Result of Tx mode (2480.0 MHz) (8DPSK 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 (2480.0 MHz) (8DPSK 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
4960.0	16.0	41.4	57.4	74.0	16.6	Vertical
4960.0	11.0	42.7	53.7	74.0	20.3	Horizontal
7440.0	10.5	45.6	56.1	74.0	17.9	Vertical
7440.0	6.8	46.5	53.3	74.0	20.7	Horizontal
9920.0	7	48.6	55.6	74.0	18.4	Vertical
9920.0	3.8	49.7	53.5	74.0	20.5	Horizontal
12400.0	3.6	51.7	55.3	74.0	18.7	Vertical
12400.0	0.1	52.7	52.8	74.0	21.2	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 25 of 91

No.: DMA000106

Result of Tx mode (2480.0 MHz) (8DPSK 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
4960.0	0.9	41.4	42.3	54.0	11.7	Vertical
4960.0	-4.2	42.7	38.5	54.0	15.5	Horizontal
7440.0	-4.8	45.6	40.8	54.0	13.2	Vertical
7440.0	-8.3	46.5	38.2	54.0	15.8	Horizontal
9920.0	-8.1	48.6	40.5	54.0	13.5	Vertical
9920.0	-11.4	49.7	38.3	54.0	15.7	Horizontal
12400.0	-11.7	51.7	40.0	54.0	14.0	Vertical
12400.0	-15.0	52.7	37.7	54.0	16.3	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): 2.0dB  
(30MHz -1GHz): 4.9dB  
(1GHz -6GHz): 4.02dB  
(6GHz -26.5GHz): 4.03dB

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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## STC Test Report

Date: 2016-08-05

Page 26 of 91

No.: DMA000106

### 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 dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2390.0	11.5	36.8	48.3	74.0	25.7	Vertical
2390.0	8.8	36.4	45.2	74.0	28.8	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2390.0	1.1	36.8	37.9	54.0	16.1	Vertical
2390.0	-1.7	36.4	34.7	54.0	19.3	Horizontal

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

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2483.5	10.0	36.8	46.8	74.0	27.2	Vertical
2483.5	8.2	36.4	44.6	74.0	29.4	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2483.5	-0.2	36.8	36.6	54.0	17.4	Vertical
2483.5	-2.1	36.4	34.3	54.0	19.7	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 27 of 91

No.: DMA000106

### 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 ( $\pi/4$ -DQPSK Lowest)

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2390.0	11.1	36.8	47.9	74.0	26.1	Vertical
2390.0	9.2	36.4	45.6	74.0	28.4	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2390.0	0.7	36.8	37.5	54.0	16.5	Vertical
2390.0	-1.3	36.4	35.1	54.0	18.9	Horizontal

### Result: Band-edge Compliance of RF Radiated Emissions ( $\pi/4$ -DQPSK Highest)

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2483.5	10.0	36.8	46.8	74.0	27.2	Vertical
2483.5	7.8	36.4	44.2	74.0	29.8	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2483.5	-0.2	36.8	36.6	54.0	17.4	Vertical
2483.5	-2.5	36.4	33.9	54.0	20.1	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 28 of 91

No.: DMA000106

### 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 (8DPSK Lowest)

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2390.0	11.3	36.8	48.1	74.0	25.9	Vertical
2390.0	8.9	36.4	45.3	74.0	28.7	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2390.0	0.9	36.8	37.7	54.0	16.3	Vertical
2390.0	1.6	36.4	38.0	54.0	16.0	Horizontal

### Result: Band-edge Compliance of RF Radiated Emissions (8DPSK Highest)

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2483.5	10.0	36.8	46.8	74.0	27.2	Vertical
2483.5	8.0	36.4	44.4	74.0	29.6	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB $\mu$ V	Correction Factor dB/m	Field Strength dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Margin dB $\mu$ V/m	E-Field Polarity
2483.5	-0.2	36.8	36.6	54.0	17.4	Vertical
2483.5	-2.3	36.4	34.1	54.0	19.9	Horizontal

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## STC Test Report

Date: 2016-08-05

Page 29 of 91

No.: DMA000106

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

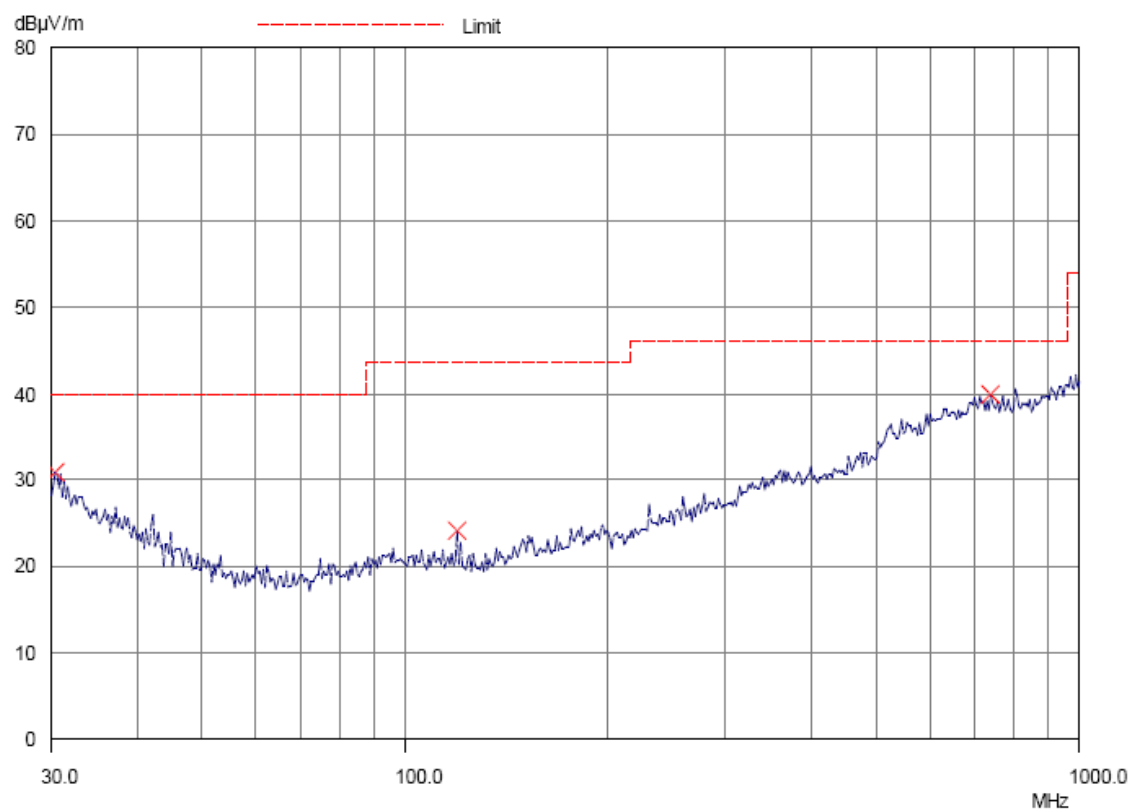
Frequency Range [MHz]	Quasi-Peak Limits [ $\mu$ V/m]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above960	500

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 Bluetooth Communication mode (2402MHz, GFSK) (30MHz – 1GHz): Pass

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

Horizontal



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## STC Test Report

Date: 2016-08-05

Page 30 of 91

No.: DMA000106

Result of Bluetooth Communication mode (2402MHz, GFSK) (30MHz – 1GHz): Pass

Radiated Emissions Quasi-Peak					
Emission Frequency MHz	E-Field Polarity	Level @3m dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Level @3m $\mu$ V/m	Limit @3m $\mu$ V/m
30.3	Horizontal	30.8	40.0	34.7	100
119.6	Horizontal	24.1	43.5	16.0	150
733.6	Horizontal	38.8	46.0	87.1	200

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## STC Test Report

Date: 2016-08-05

Page 31 of 91

No.: DMA000106

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

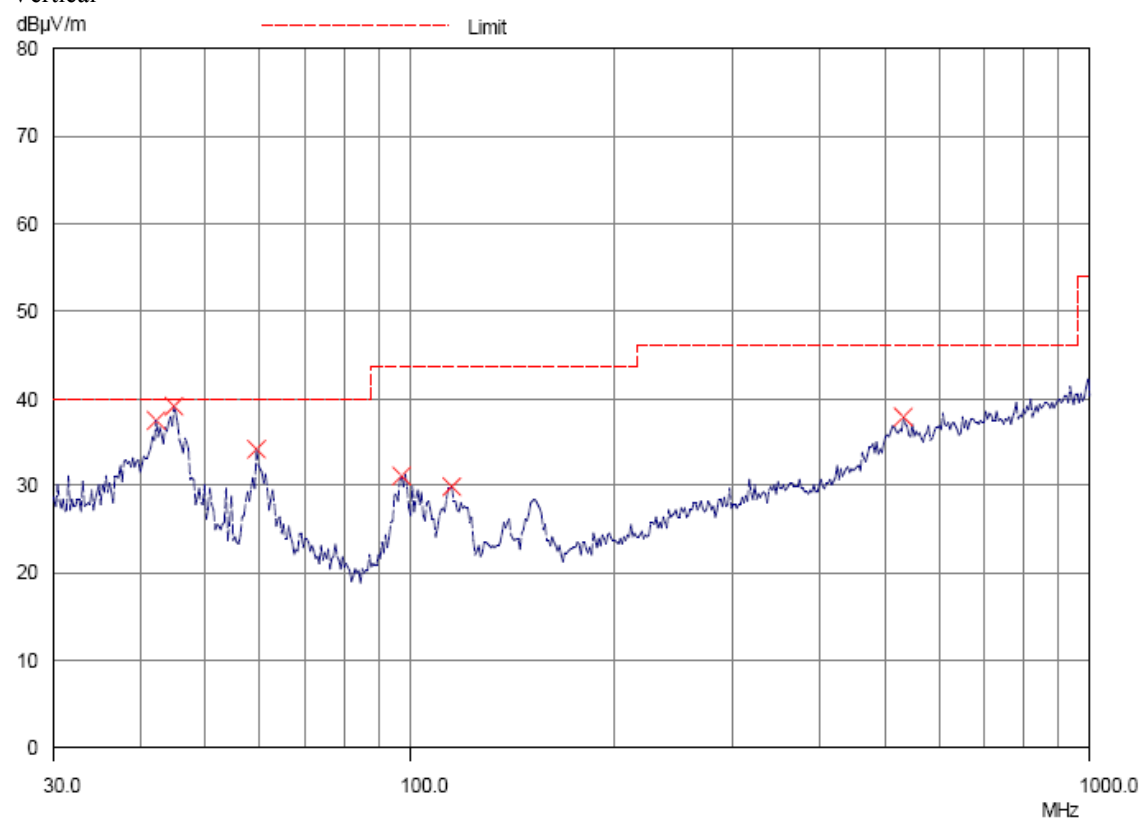
Frequency Range [MHz]	Quasi-Peak Limits [ $\mu\text{V}/\text{m}$ ]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above960	500

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 Bluetooth Communication mode (2402MHz, GFSK) (30MHz – 1GHz): Pass

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

Vertical



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## STC Test Report

Date: 2016-08-05

Page 32 of 91

No.: DMA000106

Result of Bluetooth Communication mode (2402MHz, GFSK) (30MHz – 1GHz): Pass

Radiated Emissions Quasi-Peak					
Emission Frequency MHz	E-Field Polarity	Level @3m dB $\mu$ V/m	Limit @3m dB $\mu$ V/m	Level @3m $\mu$ V/m	Limit @3m $\mu$ V/m
42.3	Vertical	35.5	40.0	59.6	100
45.0	Vertical	36.9	40.0	70.0	100
59.5	Vertical	34.2	40.0	51.3	100
97.0	Vertical	31.1	43.5	35.9	150
115.1	Vertical	29.9	43.5	31.3	150
530.6	Vertical	36.8	46.0	69.2	200

Remarks:

Calculated measurement uncertainty (30MHz – 1GHz): 4.9dB

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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## STC Test Report

**Date: 2016-08-05**

**Page 33 of 91**

**No.: DMA000106**

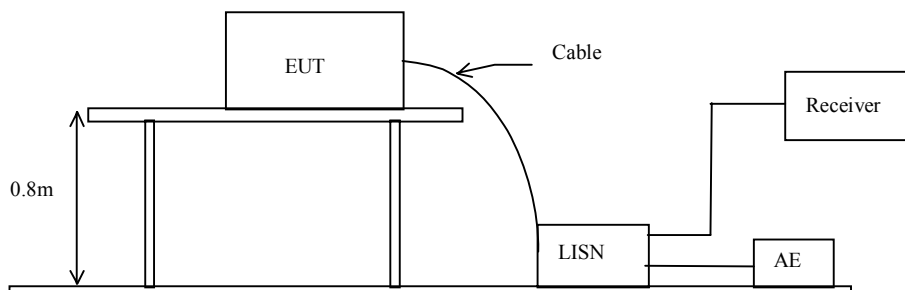
### **3.1.3 AC Mains Conducted Emissions (0.15MHz to 30MHz)**

Test Requirement:	FCC 47CFR 15.207
Test Method:	ANSI C63.10: 2013
Test Date:	2016-08-02
Mode of Operation:	Bluetooth Communication 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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## STC Test Report

**Date: 2016-08-05**

**Page 34 of 91**

**No.: DMA000106**

**Limit for Conducted Emissions (FCC 47 CFR 15.207):**

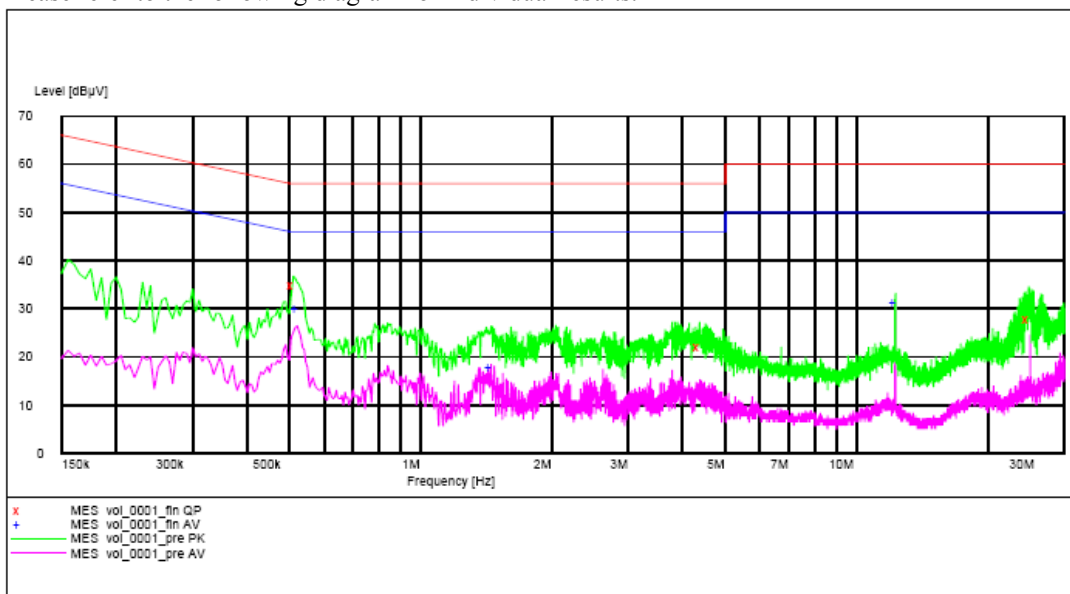
Frequency Range [MHz]	Quasi-Peak Limits [dB $\mu$ V]	Average [dB $\mu$ V]
0.15-0.5	66 to 56*	56 to 46*
0.5-5.0	56	46
5.0-30.0	60	50

\* 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 Bluetooth Communication mode (L): PASS**

Please refer to the following diagram for individual results.



Conductor Live or Neutral	Frequency MHz	Quasi-peak		Average	
		Level dB $\mu$ V	Limit dB $\mu$ V	Level dB $\mu$ V	Limit dB $\mu$ V
Live	0.510	34.7	56.0	-*-	-*-
Live	4.360	22.1	56.0	-*-	-*-
Live	24.870	27.9	60.0	-*-	-*-
Live	0.520	-*-	-*-	30.0	46.0
Live	1.450	-*-	-*-	17.9	46.0
Live	12.290	-*-	-*-	31.3	50.0

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# STC Test Report

**Date: 2016-08-05**

**Page 35 of 91**

**No.: DMA000106**

**Limit for Conducted Emissions (FCC 47 CFR 15.207):**

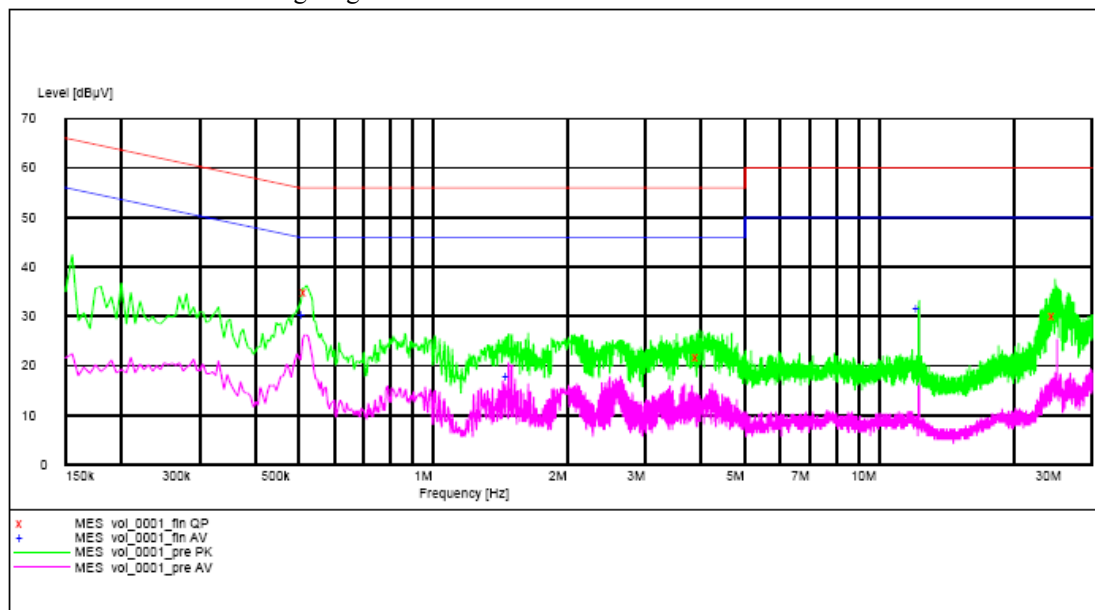
Frequency Range [MHz]	Quasi-Peak Limits [dBμV]	Average [dBμV]
0.15-0.5	66 to 56*	56 to 46*
0.5-5.0	56	46
5.0-30.0	60	50

\* 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 Bluetooth Communication 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	0.520	35.0	56.0	-*-	-*-
Neutral	3.940	21.8	56.0	-*-	-*-
Neutral	24.815	29.9	60.0	-*-	-*-
Neutral	0.515	-*-	-*-	30.3	46.0
Neutral	1.475	-*-	-*-	17.9	46.0
Neutral	12.290	-*-	-*-	31.6	50.0

Remarks:

Calculated measurement uncertainty (0.15MHz – 30MHz): 3.25dB

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

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## STC Test Report

**Date: 2016-08-05**  
**No.: DMA000106**

**Page 36 of 91**

### **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:**

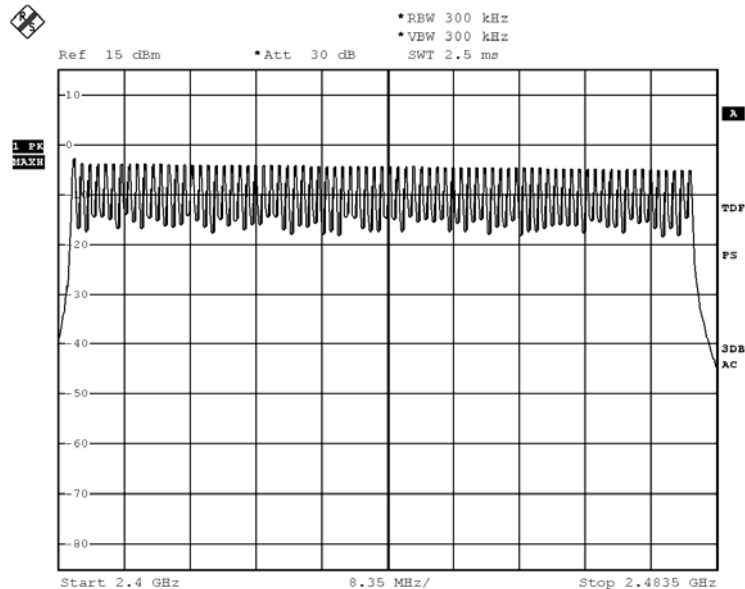
RBW = 300kHz, VBW  $\geq$  RBW, Sweep = Auto, Span = the frequency band of operation  
Detector = Peak, Trace = Max. hold

#### **Test Setup:**

As Test Setup of clause 3.1.1 in this test report.

#### **Measurement Data:**

##### **GFSK: 79 of 79 Channel**



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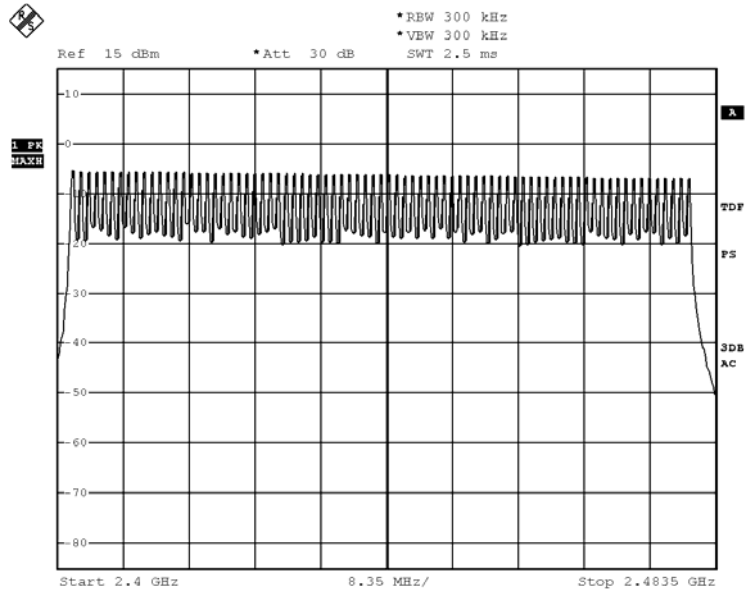


# STC Test Report

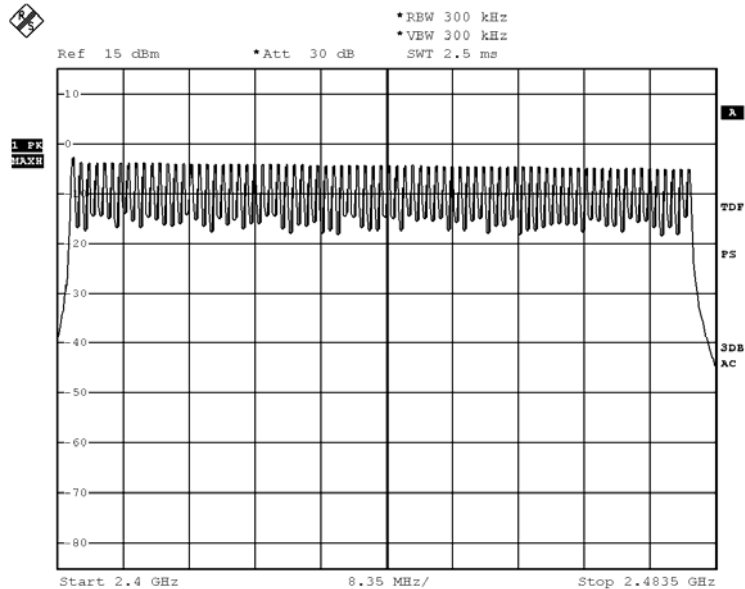
Date: 2016-08-05  
No.: DMA000106

Page 37 of 91

## $\pi/4$ -DQPSK: 79 of 79 Channel



## 8DPSK: 79 of 79 Channel



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## **STC Test Report**

**Date: 2016-08-05**  
**No.: DMA000106**

**Page 38 of 91**

### **3.1.5 20dB Bandwidth**

Test Requirement:	FCC 47CFR 15.247(a)(1)
Test Method:	ANSI C63.10: 2013
Test Date:	2016-08-01
Mode of Operation:	TX 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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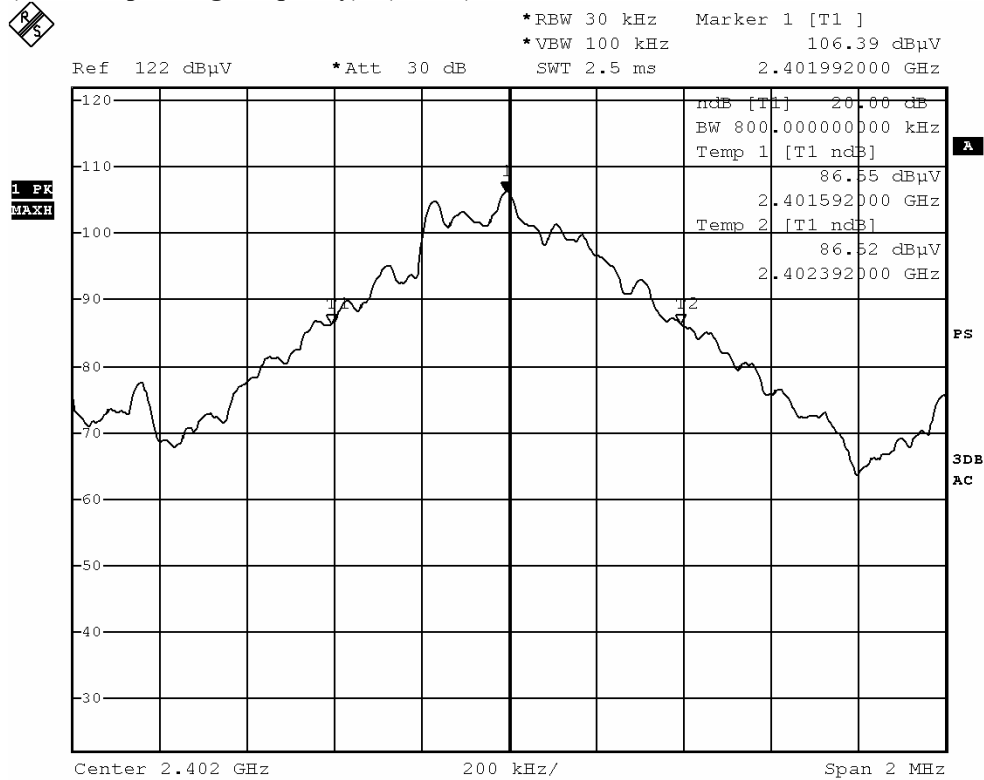
# STC Test Report

**Date: 2016-08-05**  
**No.: DMA000106**

**Page 39 of 91**

Fundamental Frequency [MHz]	20dB Bandwidth [kHz]	FCC Limits [MHz]
2402	800.0	Within 2400-2483.5

**(Lowest Operating Frequency) - (GFSK)**



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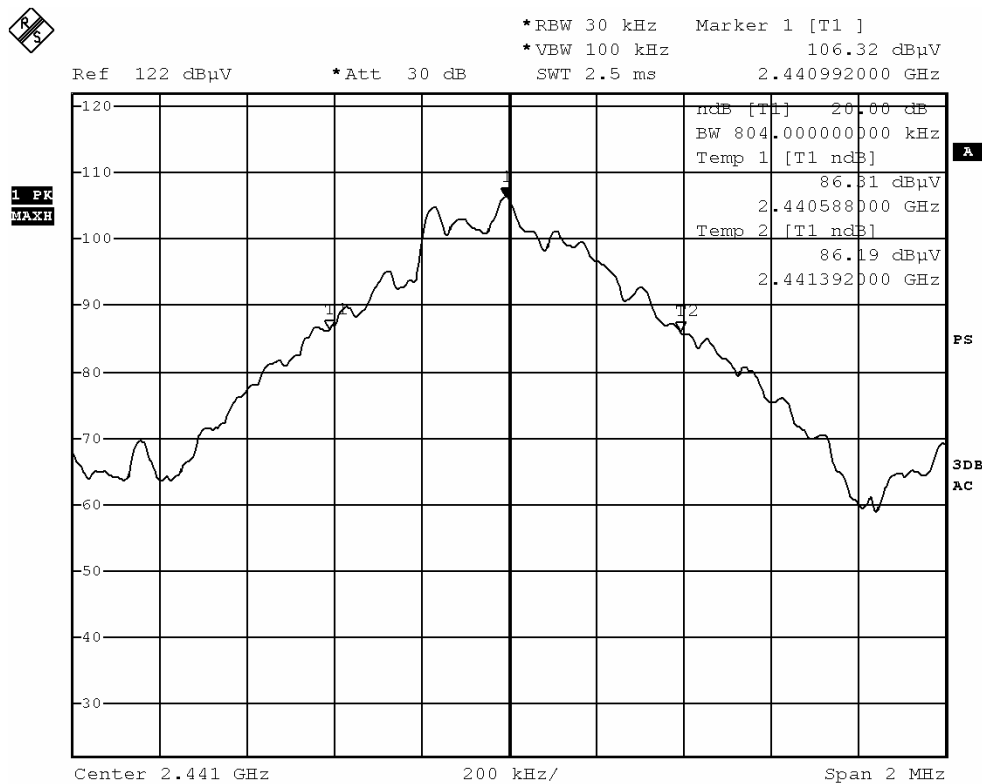
# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 40 of 91

Fundamental Frequency [MHz]	20dB Bandwidth [kHz]	FCC Limits [MHz]
2441	804.0	Within 2400-2483.5

## (Middle Operating Frequency) - (GFSK)



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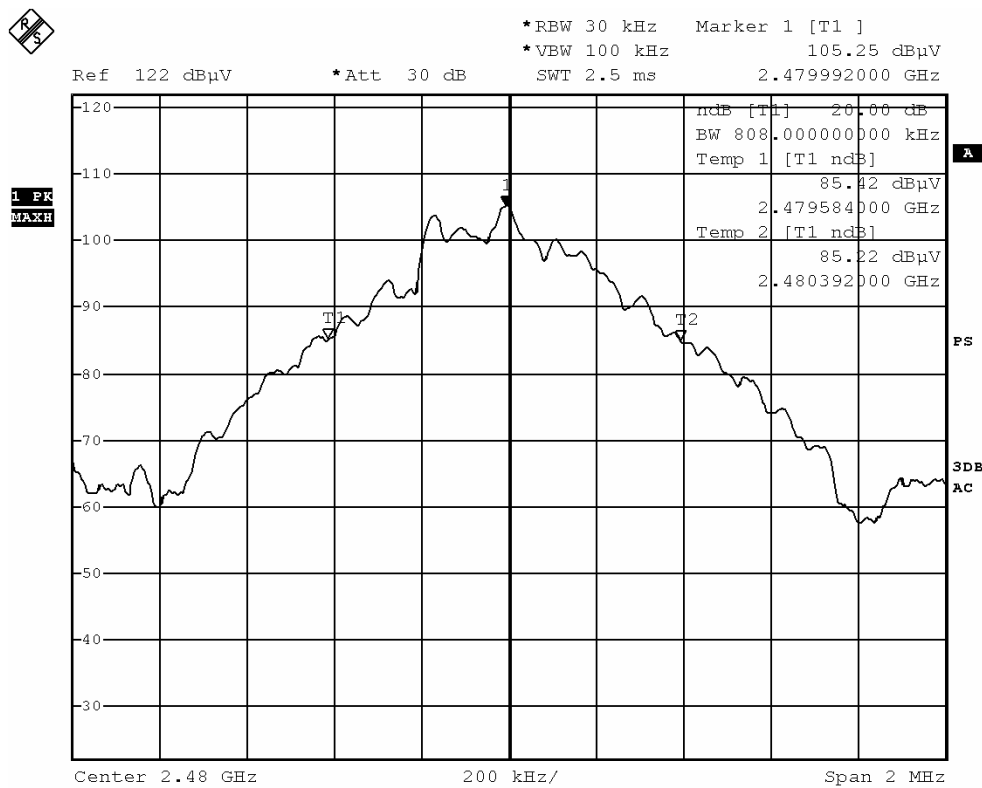
# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 41 of 91

Fundamental Frequency [MHz]	20dB Bandwidth [kHz]	FCC Limits [MHz]
2480	808.0	Within 2400-2483.5

## (Highest Operating Frequency) - (GFSK)



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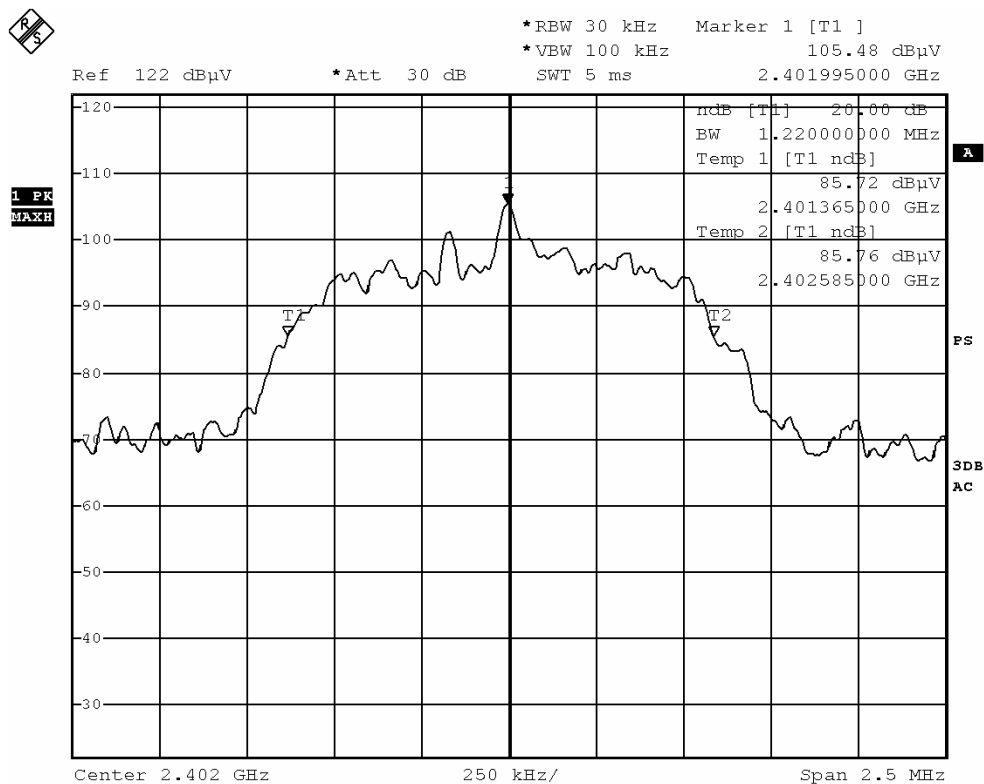
# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 42 of 91

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2402	1.220	Within 2400-2483.5

## (Lowest Operating Frequency) - ( $\pi/4$ -DQPSK)



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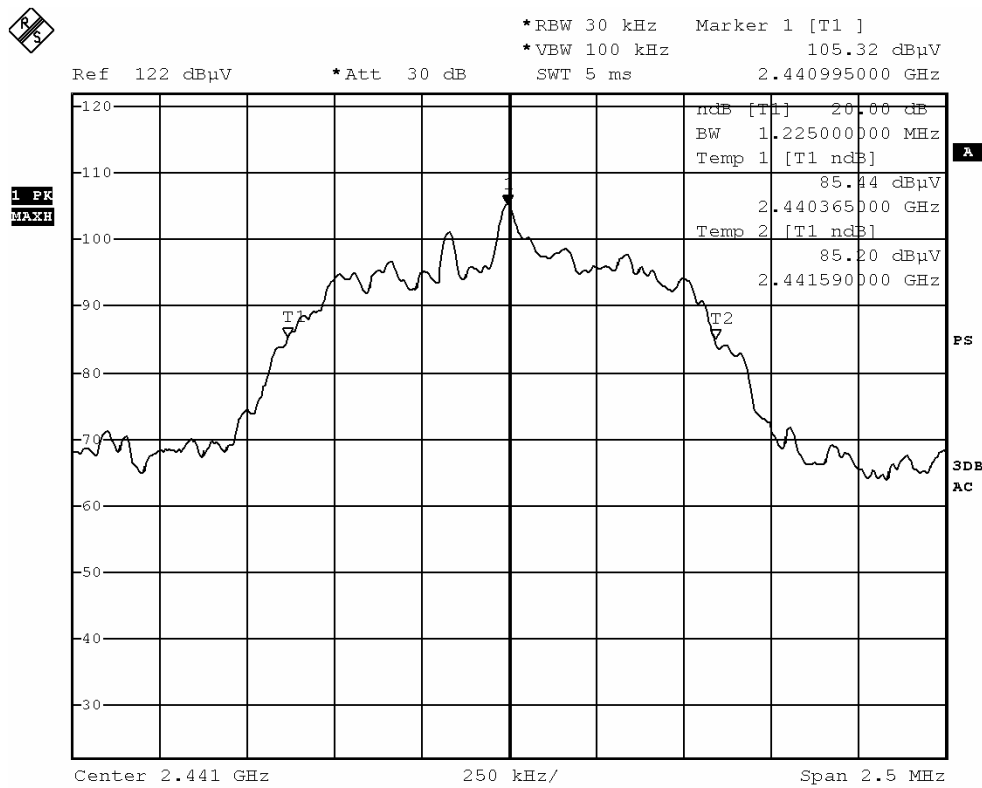
# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 43 of 91

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	1.225	Within 2400-2483.5

## (Middle Operating Frequency) - ( $\pi/4$ -DQPSK)



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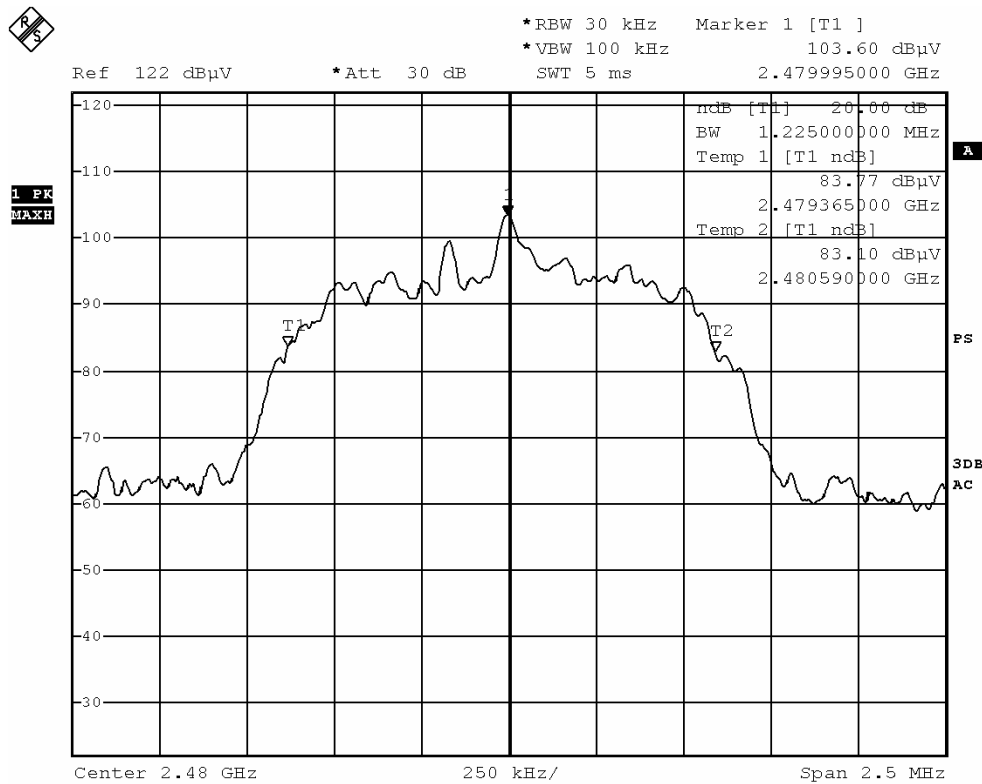
# STC Test Report

**Date: 2016-08-05**  
**No.: DMA000106**

**Page 44 of 91**

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	1.225	Within 2400-2483.5

**(Highest Operating Frequency) - ( $\pi/4$  -DQPSK)**



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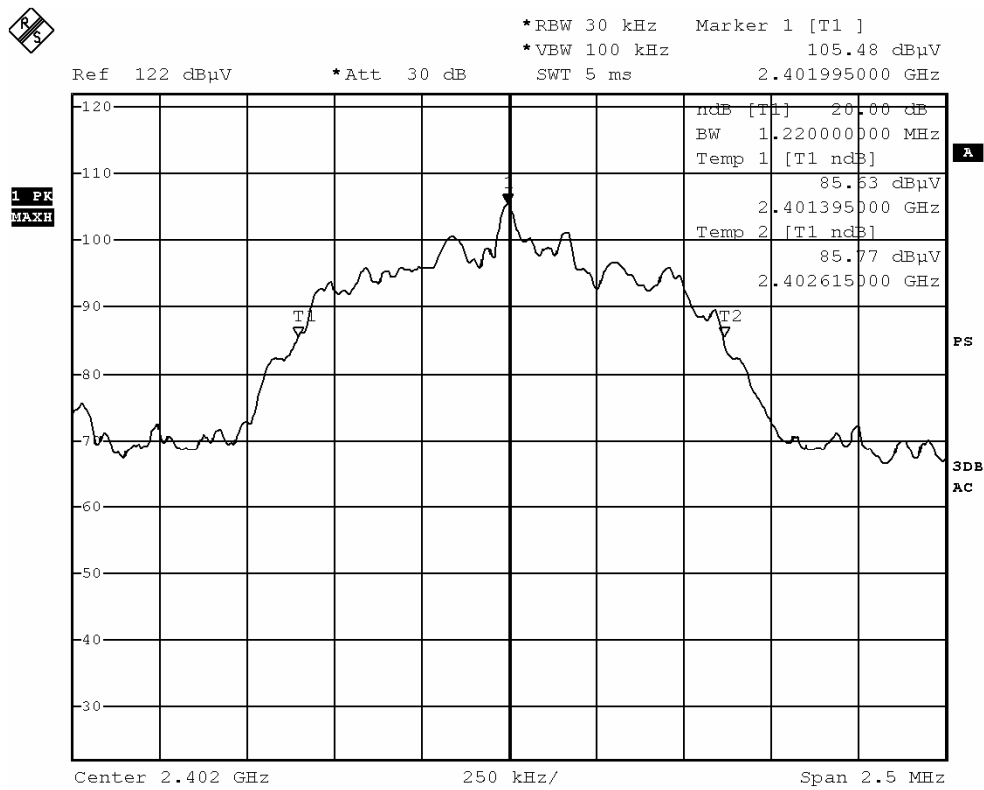
# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 45 of 91

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2402	1.220	Within 2400-2483.5

## (Lowest Operating Frequency) - (8DPSK)



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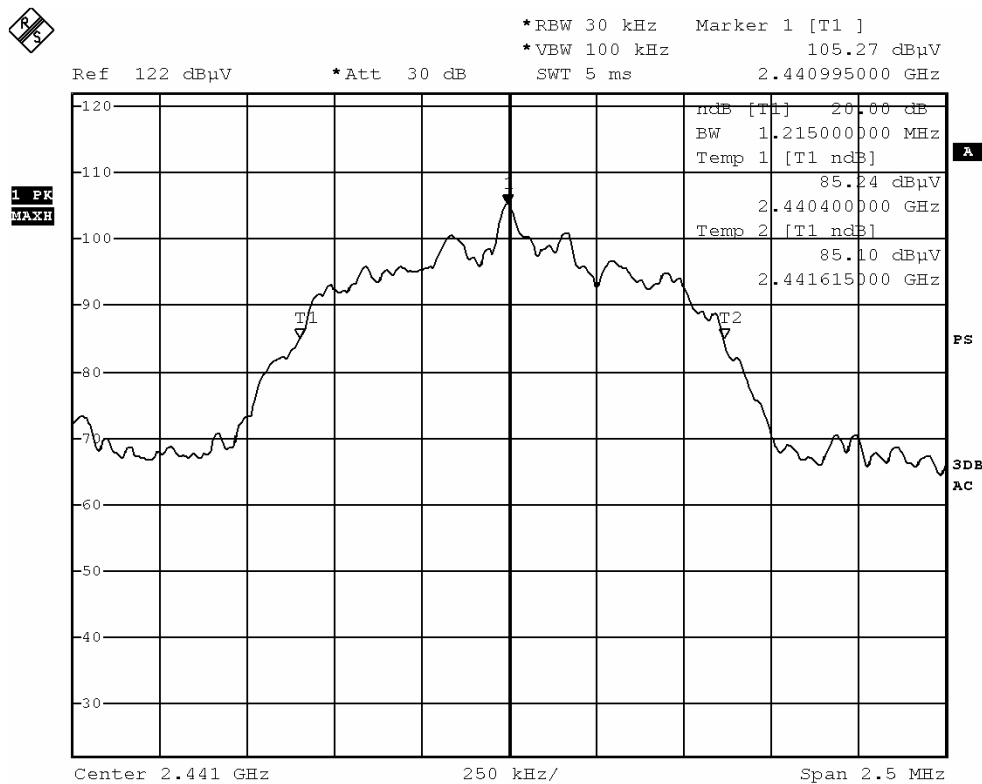
# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 46 of 91

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	1.215	Within 2400-2483.5

## (Middle Operating Frequency) - (8DPSK)



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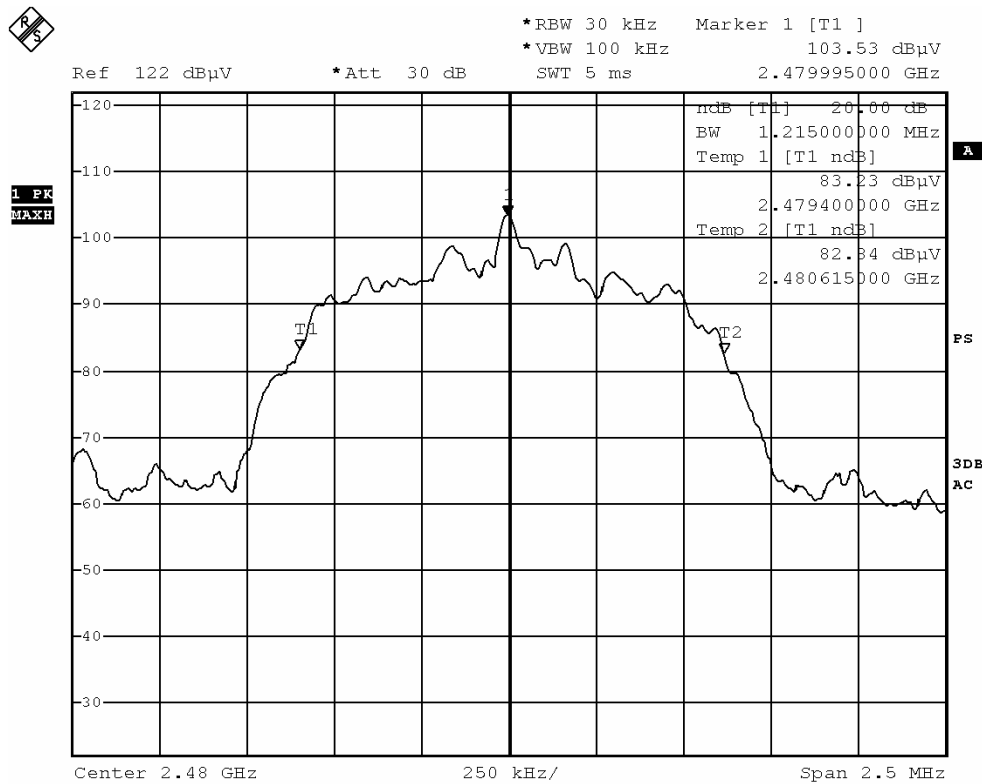
# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 47 of 91

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	1.215	Within 2400-2483.5

## (Highest Operating Frequency) - (8DPSK)



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## **STC Test Report**

**Date: 2016-08-05**

**Page 48 of 91**

**No.: DMA000106**

### **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 = 1.225MHz \* 2/3 = 817kHz

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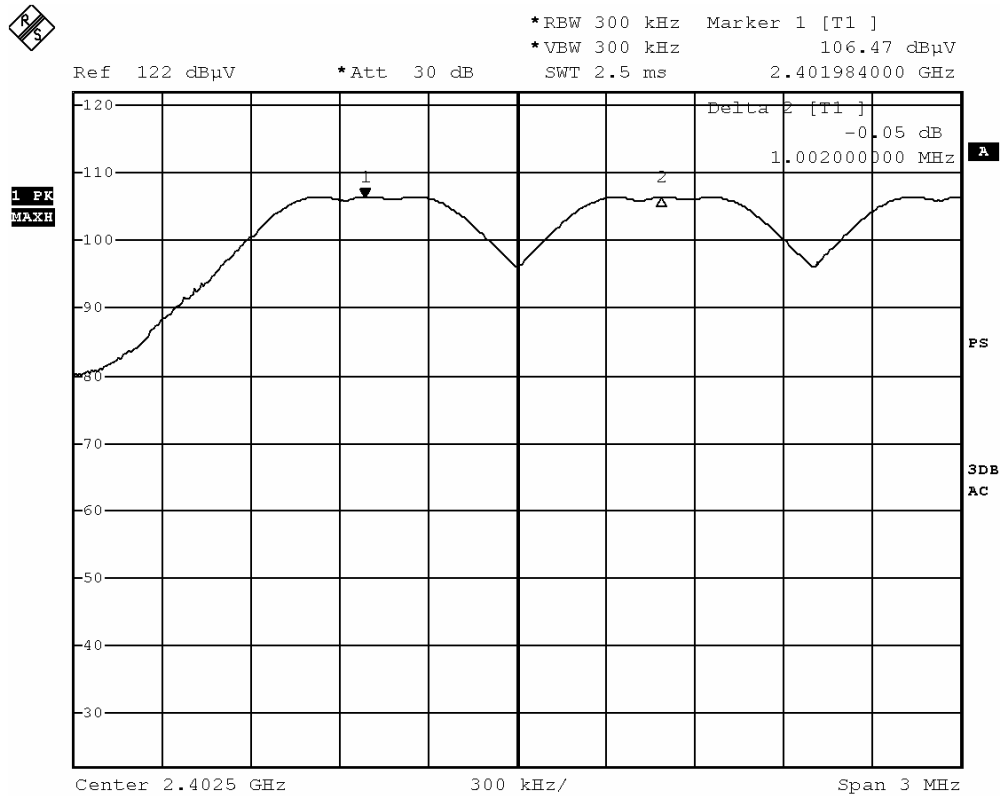


# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 49 of 91

Channel separation = 1MHz (>817kHz) (Lowest) (GFSK)



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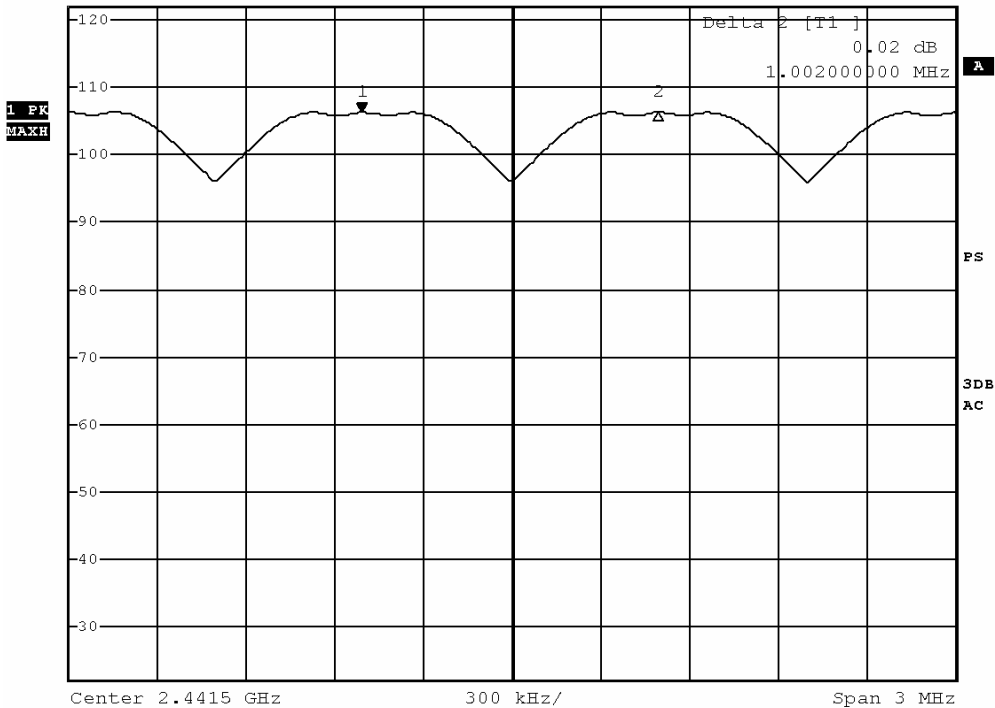
Page 50 of 91

Channel separation = 1MHz (>817kHz) (Mid) (GFSK)



\*RBW 300 kHz Marker 1 [T1 ]  
\*VBW 300 kHz 106.28 dBμV

Ref 122 dBμV \*Att 30 dB SWT 2.5 ms 2.440990000 GHz



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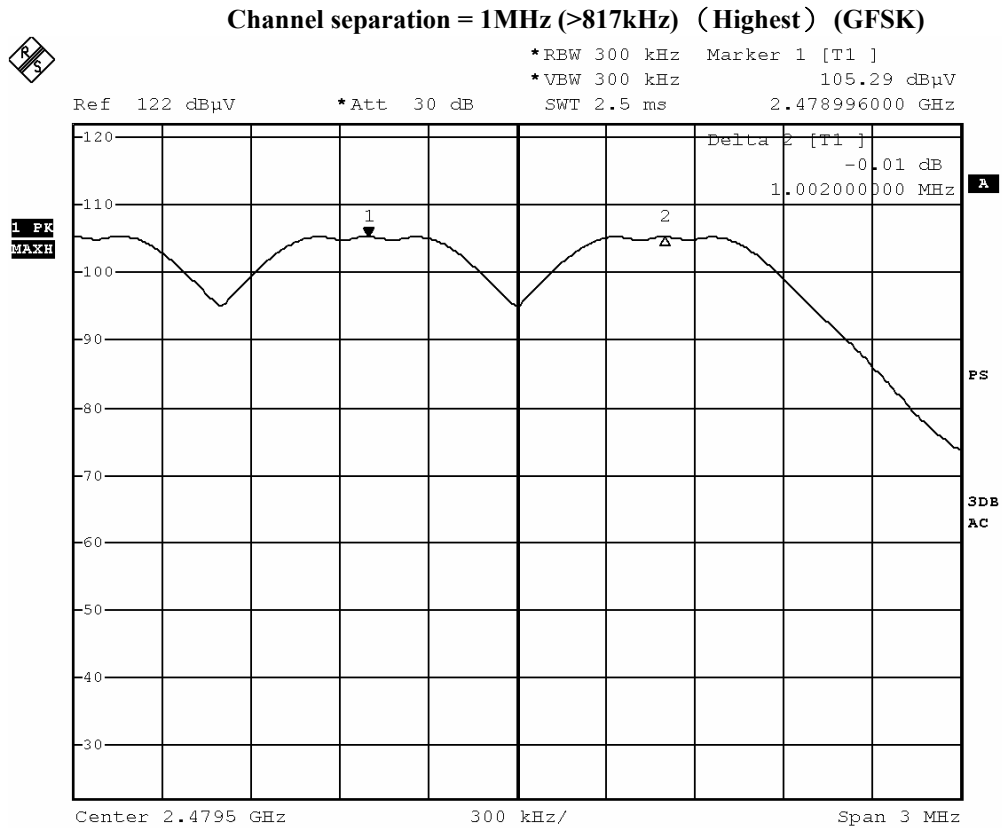
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# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 51 of 91



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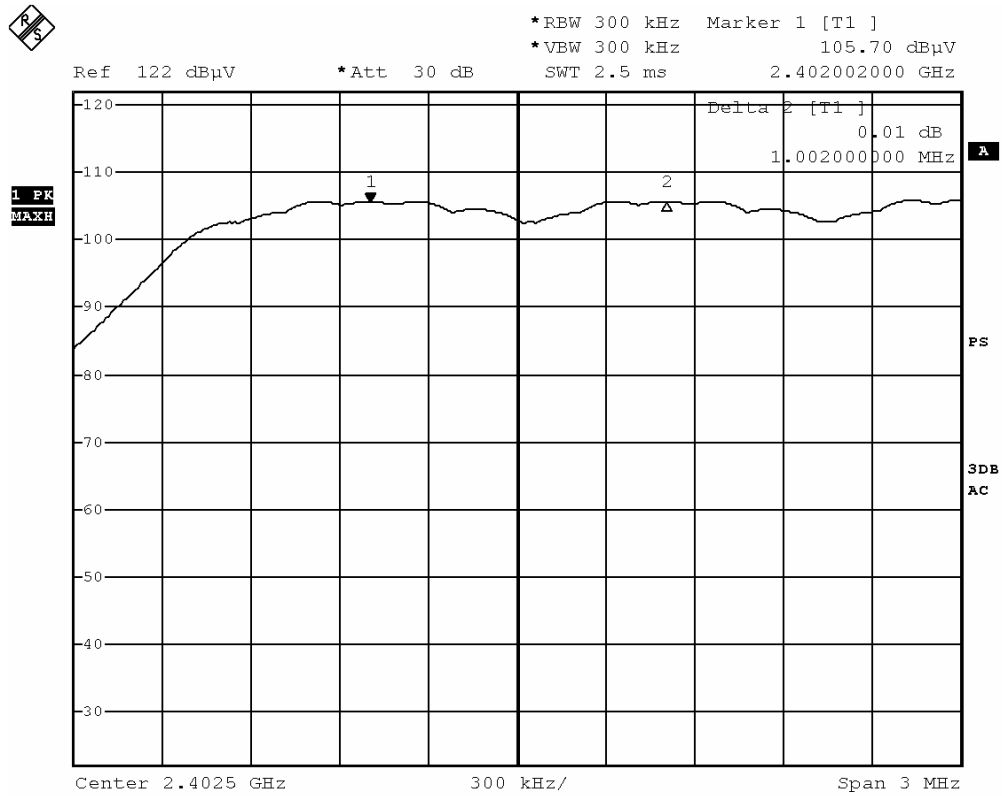


# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 52 of 91

Channel separation = 1MHz (>817kHz) (Lowest) ( $\pi/4$  DQPSK)



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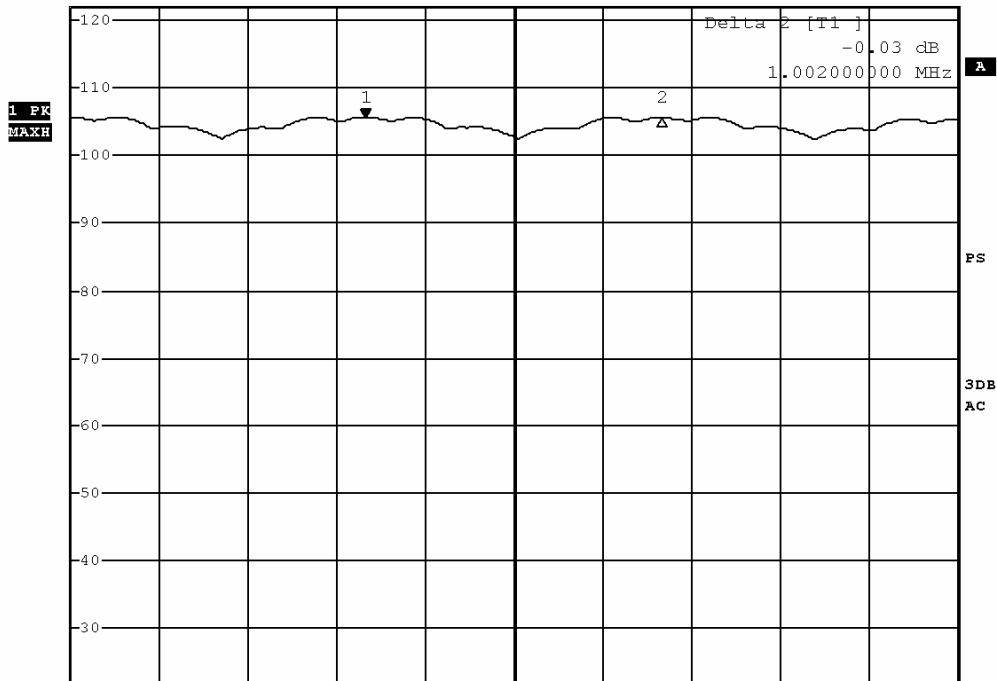
Page 53 of 91

Channel separation = 1MHz (>817kHz) (Mid) ( $\pi/4$  DQPSK)



\*RBW 300 kHz Marker 1 [T1 ]  
\*VBW 300 kHz 105.64 dB $\mu$ V

Ref 122 dB $\mu$ V \*Att 30 dB SWT 2.5 ms 2.440996000 GHz



Center 2.4415 GHz 300 kHz/ Span 3 MHz

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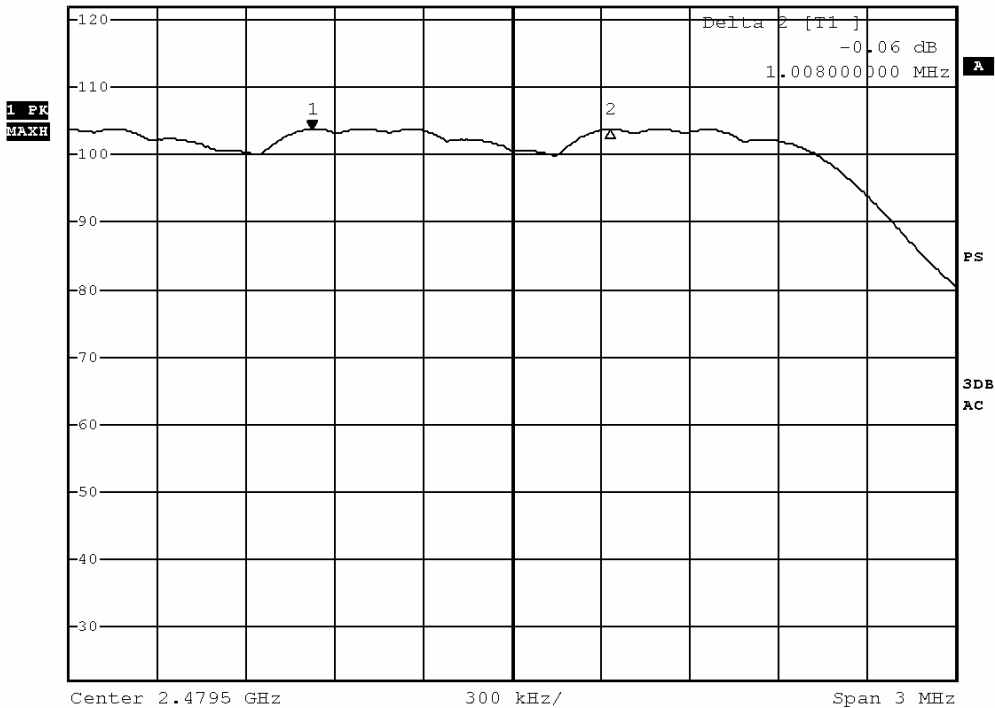
Page 54 of 91

Channel separation = 1MHz (>817kHz) (Highest) ( $\pi/4$  DQPSK)



\*RBW 300 kHz Marker 1 [T1 ]  
\*VBW 300 kHz 103.85 dB $\mu$ V

Ref 122 dB $\mu$ V \*Att 30 dB SWT 2.5 ms 2.478822000 GHz



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No.: DMA000106

Page 55 of 91

Channel separation = 1MHz (>817kHz) (Lowest) (8DPSK)



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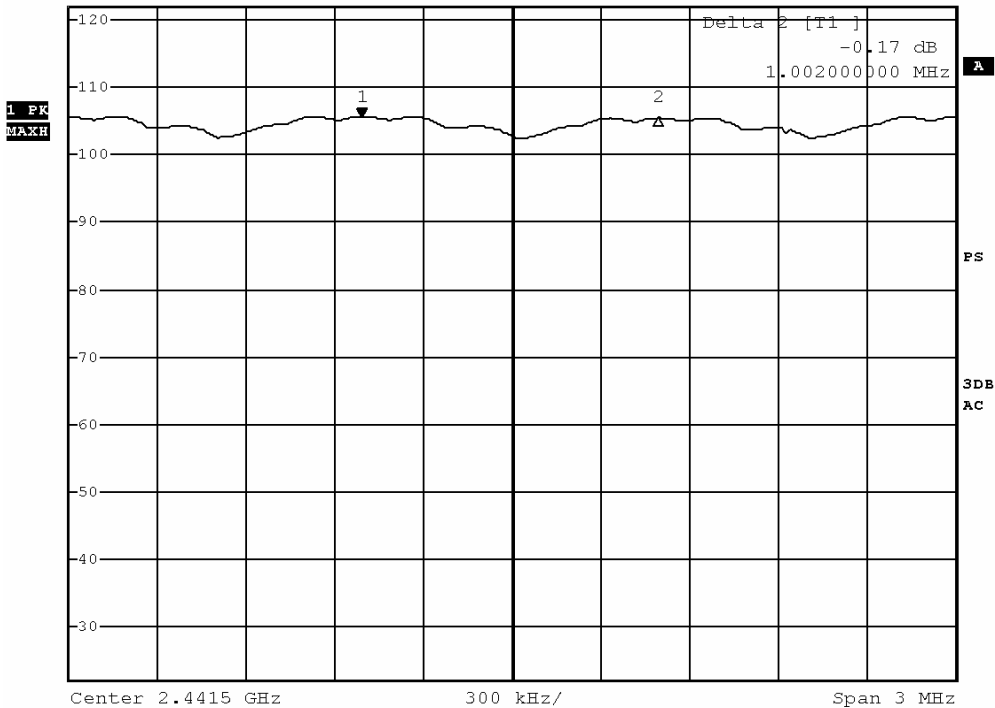
Page 56 of 91

Channel separation = 1MHz (>817kHz) (Mid) (8DPSK)



\*RBW 300 kHz Marker 1 [T1 ]  
\*VBW 300 kHz 105.66 dBμV

Ref 122 dBμV \*Att 30 dB SWT 2.5 ms 2.440990000 GHz



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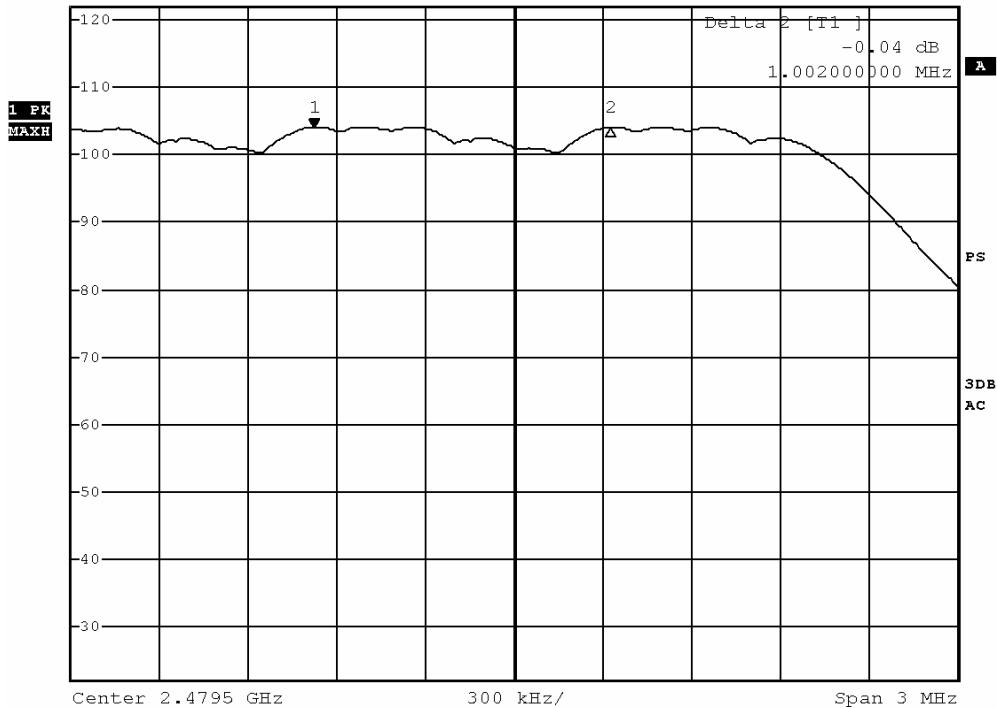
Page 57 of 91

Channel separation = 1MHz (>817kHz) (Highest) (8DPSK)



\*RBW 300 kHz Marker 1 [T1 ]  
\*VBW 300 kHz 104.10 dBμV

Ref 122 dBμV \*Att 30 dB SWT 2.5 ms 2.478822000 GHz



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# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 58 of 91

### 3.1.7 Band-edge Compliance of RF Conducted Emissions Measurement:

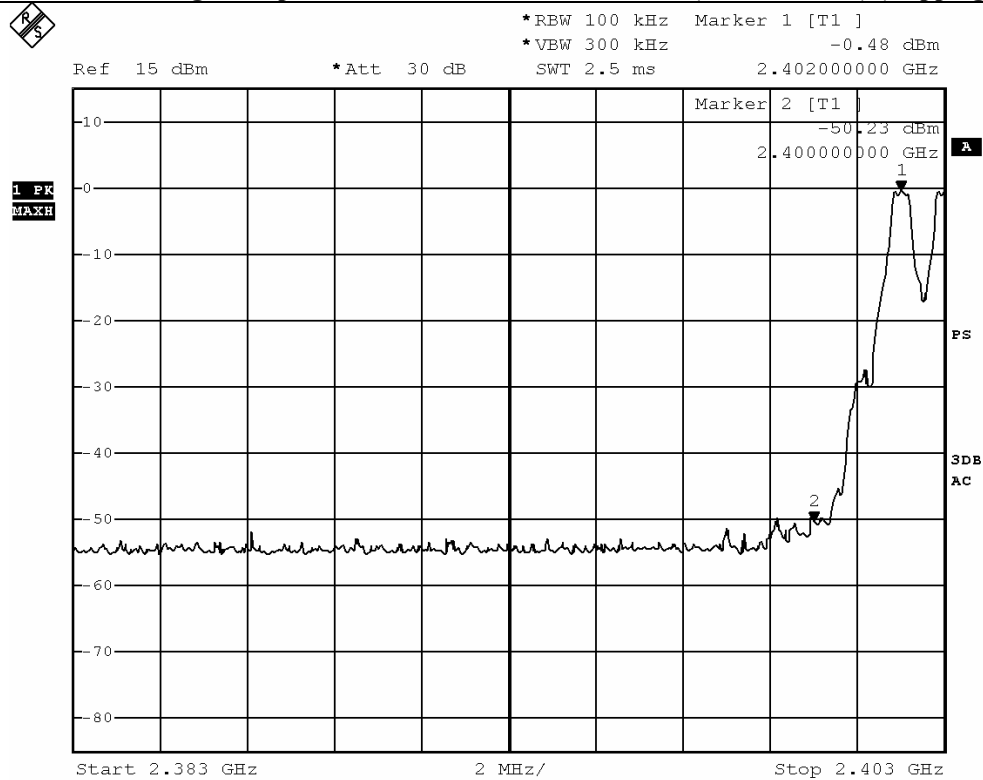
#### Limit :

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 [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	49.75

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





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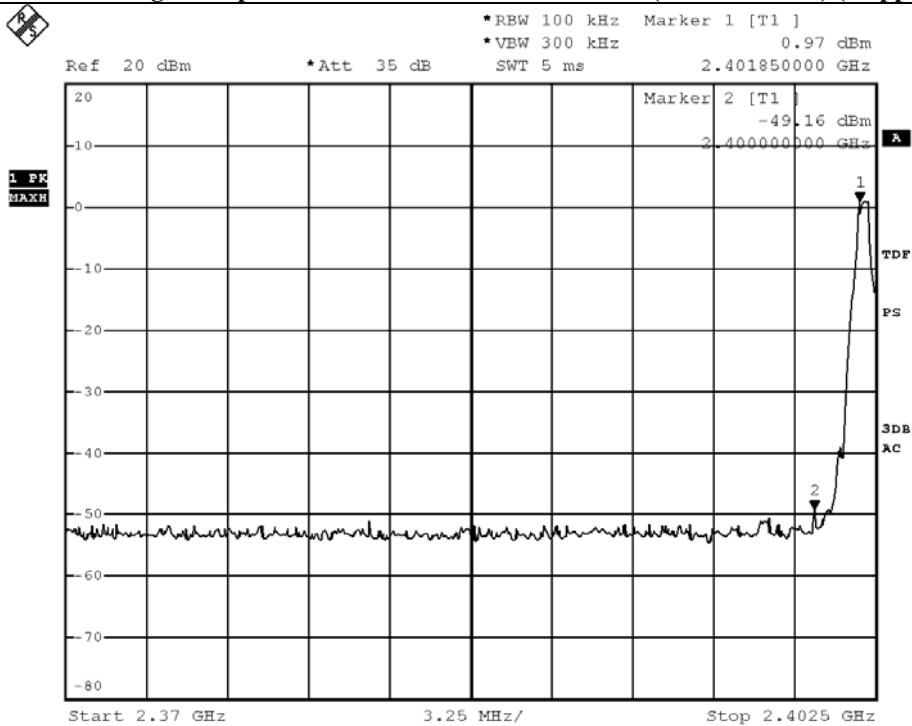
Date: 2016-08-05  
No.: DMA000106

Page 59 of 91

### Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	50.13

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



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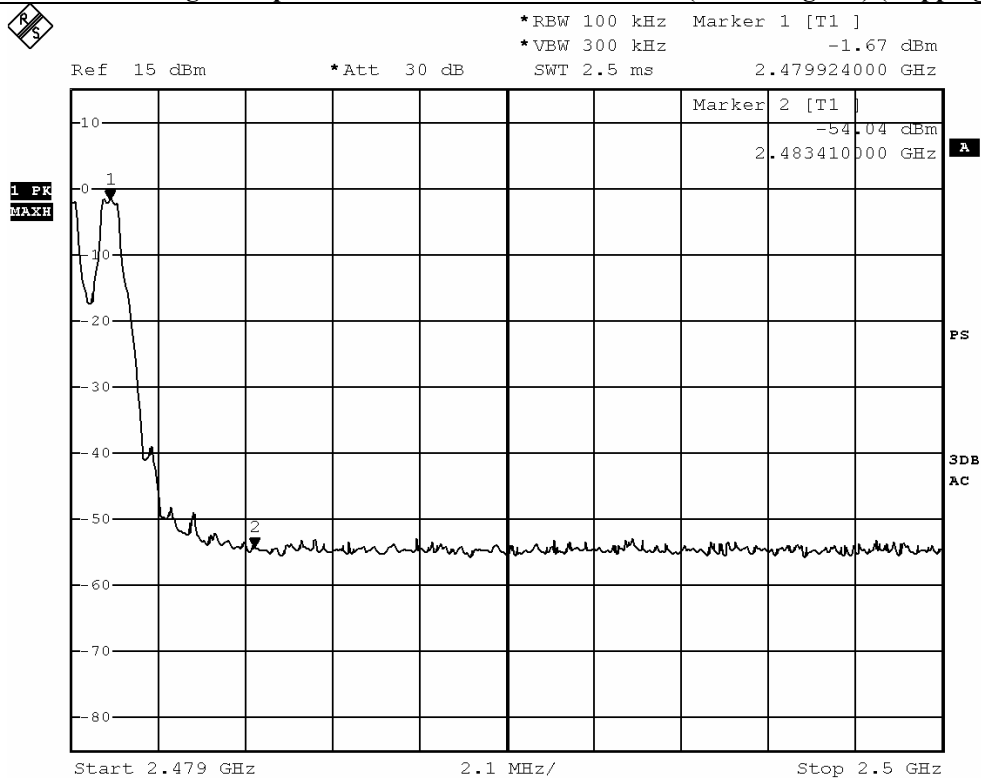
Date: 2016-08-05  
No.: DMA000106

Page 60 of 91

## Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
Highest Fundamental (2480) - 2483.5	52.37

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



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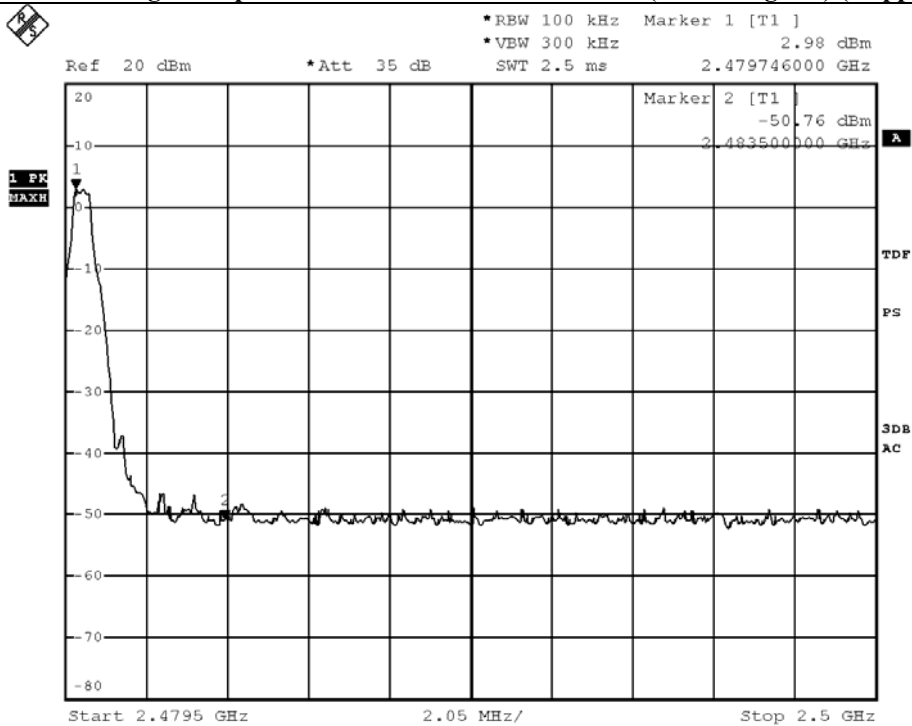
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**No.: DMA000106**

**Page 61 of 91**

**Band-edge Compliance of RF Conducted Emissions Measurement:**

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
Highest Fundamental (2480) - 2483.5	53.74

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



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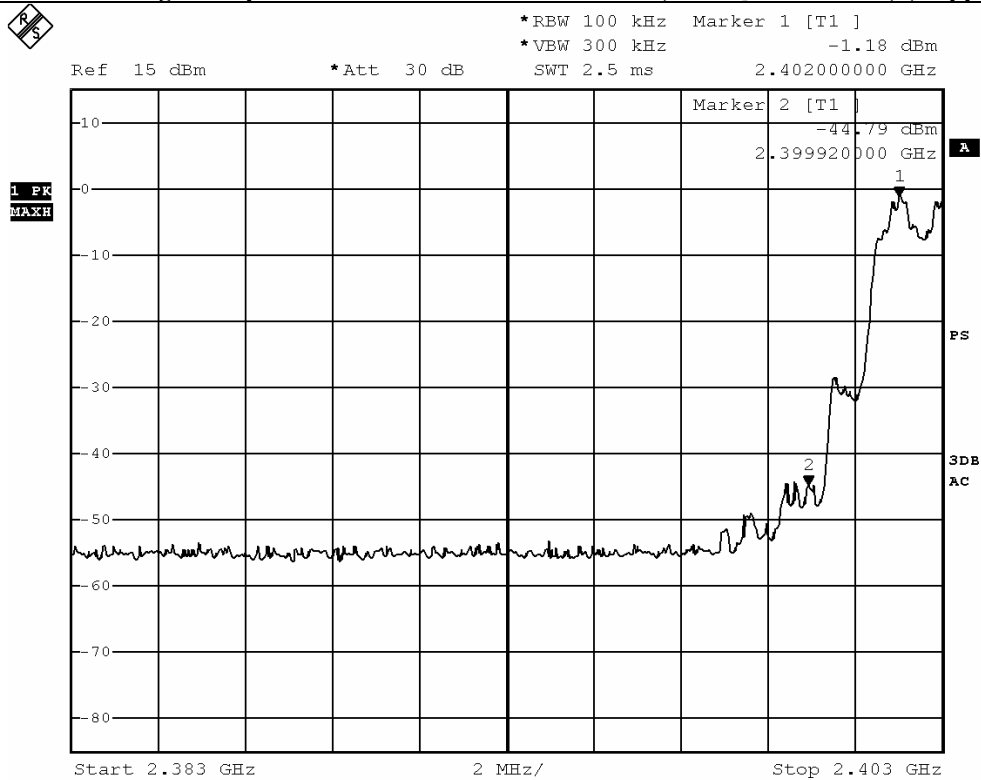
Date: 2016-08-05  
No.: DMA000106

Page 62 of 91

### Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	43.61

### Band-edge Compliance of RF Conducted Emissions ( $\pi/4$ DQPSK Lowest) (Hopping on)



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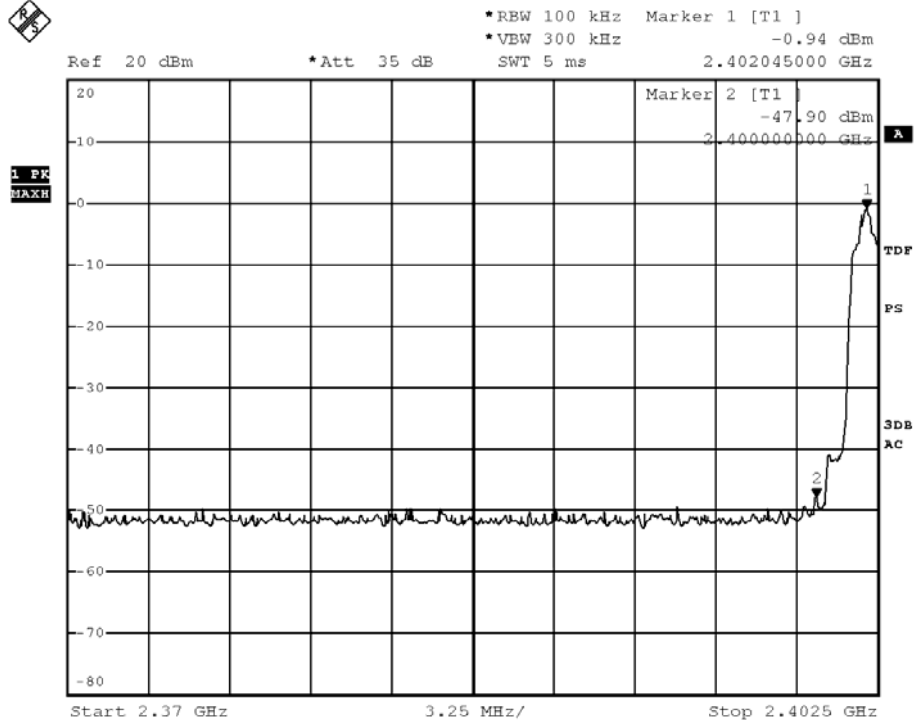
Date: 2016-08-05  
No.: DMA000106

Page 63 of 91

### Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	46.96

### Band-edge Compliance of RF Conducted Emissions ( $\pi/4$ DQPSK Lowest) (Hopping off)



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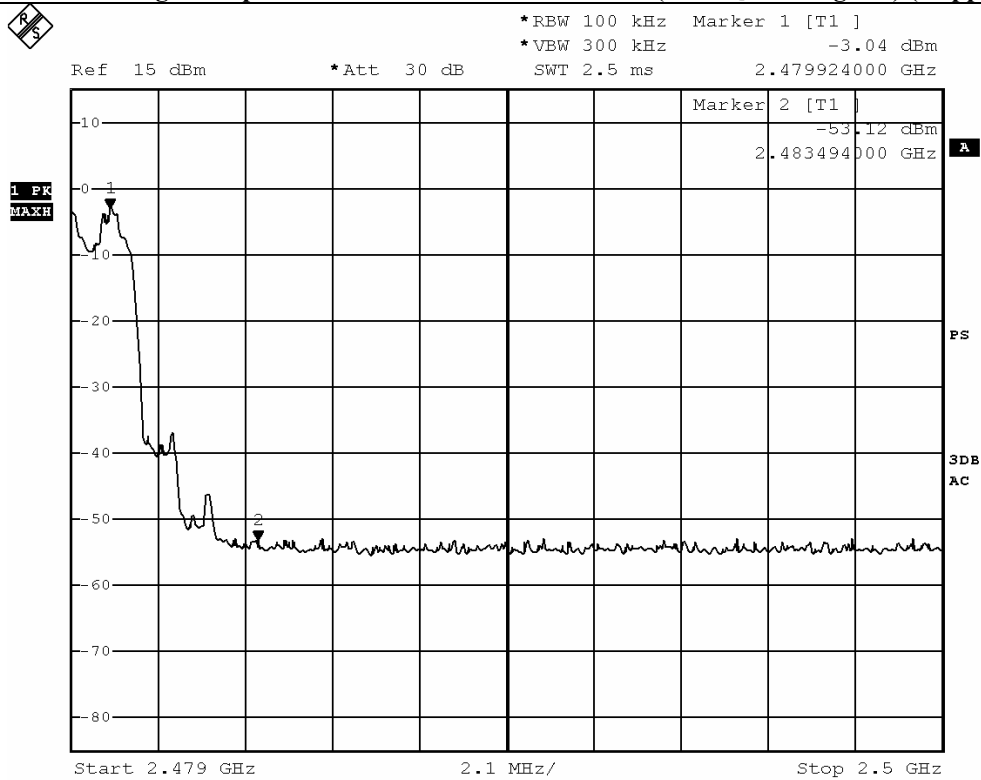
Date: 2016-08-05  
No.: DMA000106

Page 64 of 91

## Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
Highest Fundamental (2480) - 2483.5	50.08

## Band-edge Compliance of RF Conducted Emissions ( $\pi/4$ DQPSK Highest) (Hopping on)



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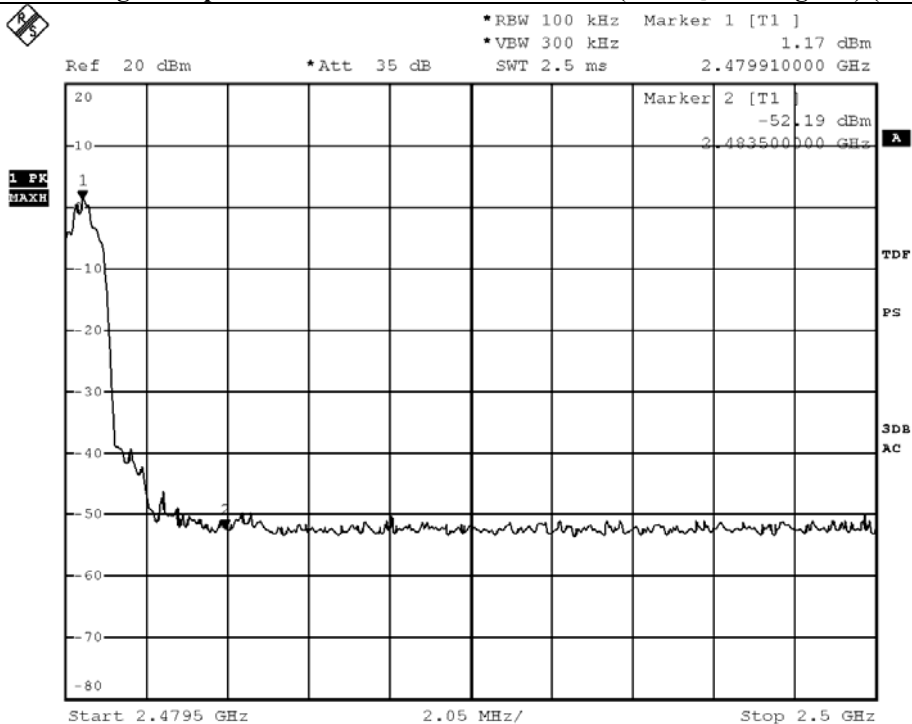
Date: 2016-08-05  
No.: DMA000106

Page 65 of 91

### Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
Highest Fundamental (2480) - 2483.5	53.36

### Band-edge Compliance of RF Conducted Emissions ( $\pi/4$ DQPSK Highest) (Hopping off)



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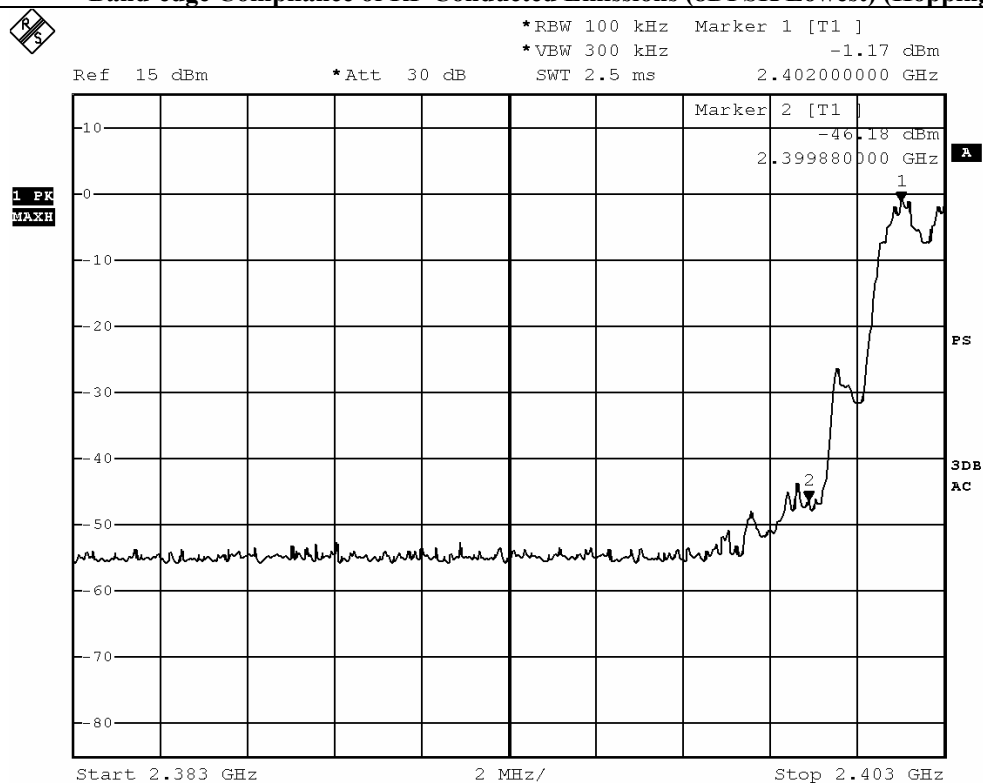
Page 66 of 91

No.: DMA000106

### Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	45.01

### Band-edge Compliance of RF Conducted Emissions (8DPSK Lowest) (Hopping on)



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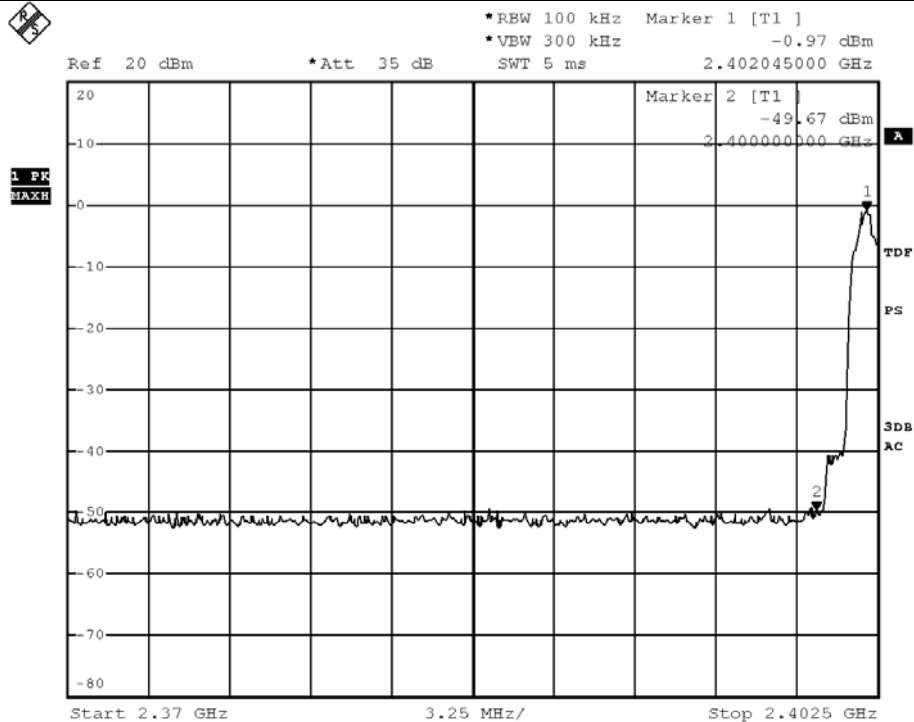
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No.: DMA000106

Page 67 of 91

### Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2402)	48.70

### Band-edge Compliance of RF Conducted Emissions (8DPSK Lowest) (Hopping off)



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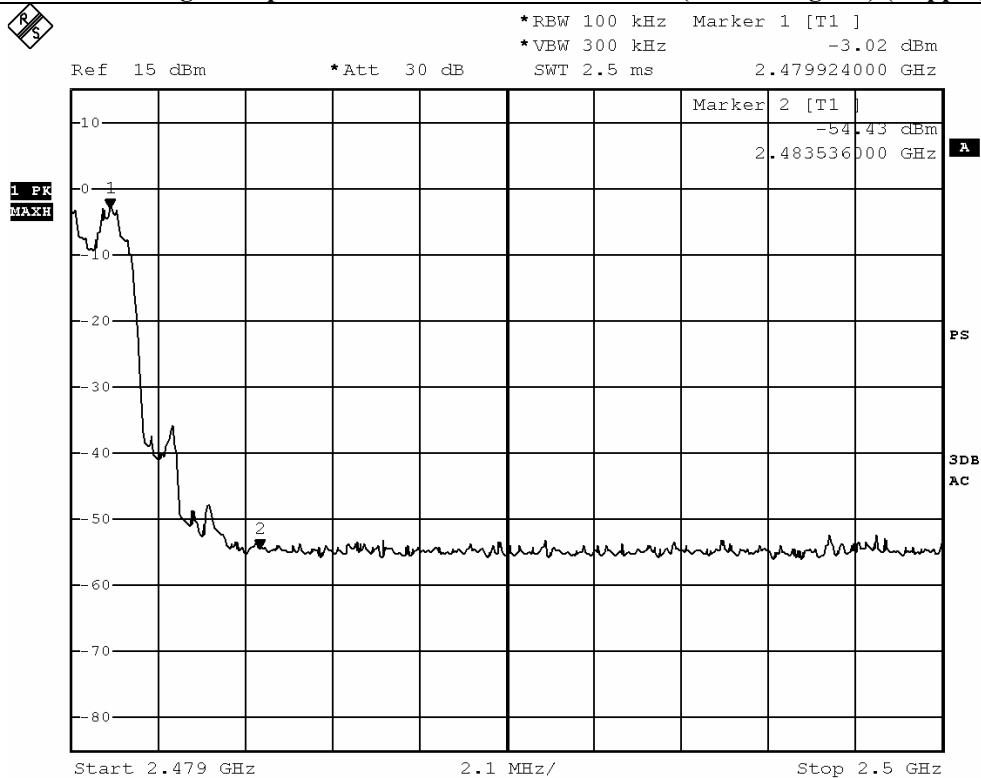
Date: 2016-08-05  
No.: DMA000106

Page 68 of 91

## Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
Highest Fundamental (2480) - 2483.5	51.41

## Band-edge Compliance of RF Conducted Emissions (8DPSK Highest) (Hopping on)



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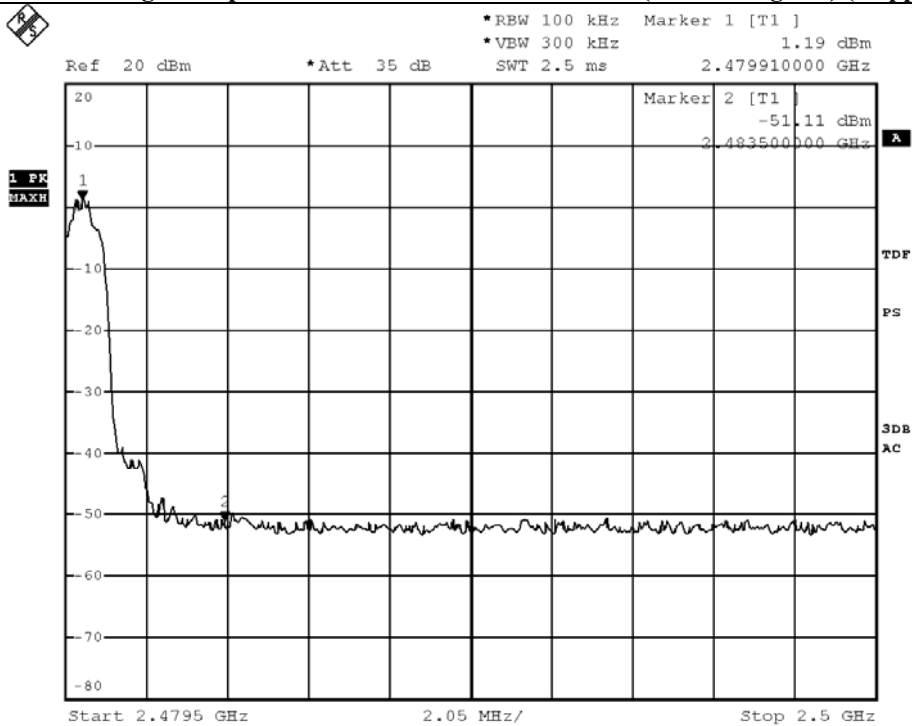
Date: 2016-08-05  
No.: DMA000106

Page 69 of 91

### Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
Highest Fundamental (2480) - 2483.5	52.30

### Band-edge Compliance of RF Conducted Emissions (8DPSK Highest) (Hopping off)



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## STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 70 of 91

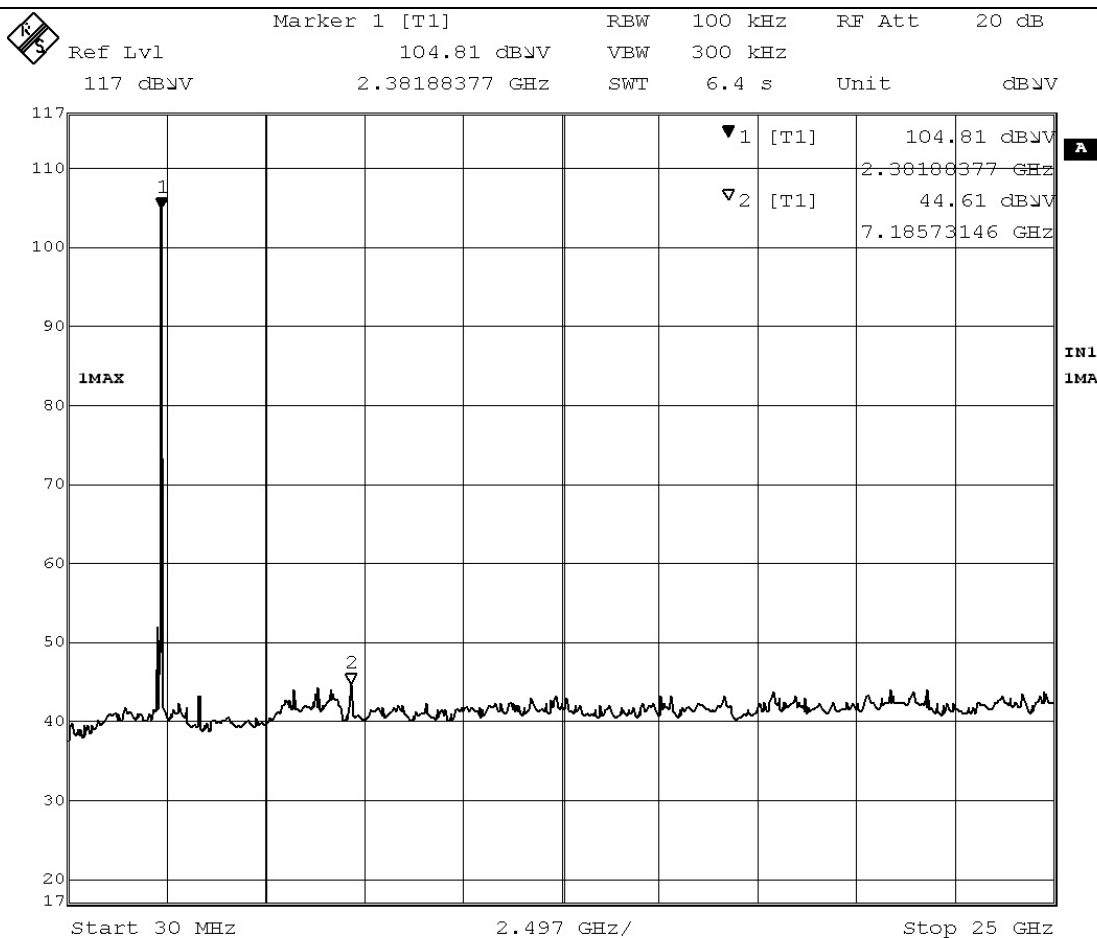
### Band-edge Compliance of RF Conducted Emissions Measurement:

#### 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

### Band-edge Compliance of RF Conducted Emissions (GFSK 2402)



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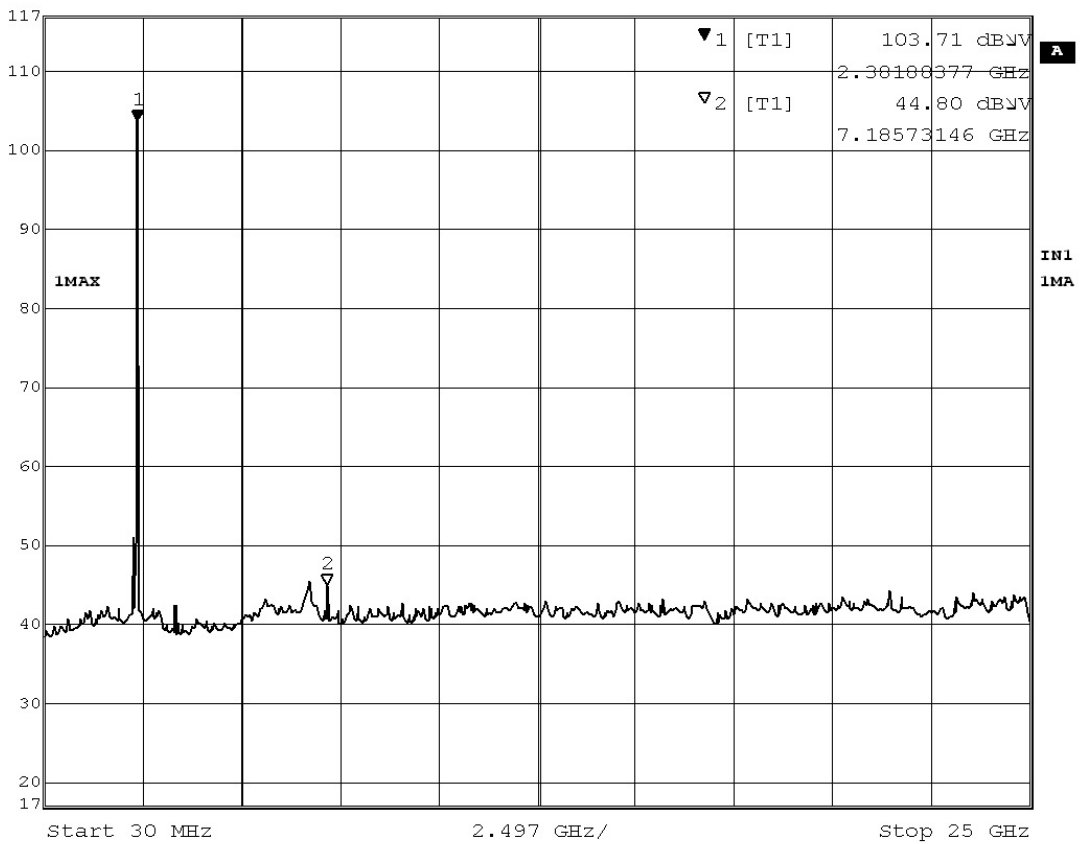
# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 71 of 91

## Band-edge Compliance of RF Conducted Emissions ( $\pi/4$ -DQPSK 2402)

	Marker 1 [T1]	RBW	100 kHz	RF Att	20 dB
	Ref Lvl	103.71 dB $\mu$ V	VBW	300 kHz	
	117 dB $\mu$ V	2.38188377 GHz	SWT	6.4 s	Unit



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## STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 73 of 91

### 3.1.8 Time of Occupancy (Dwell Time)

#### Requirements:

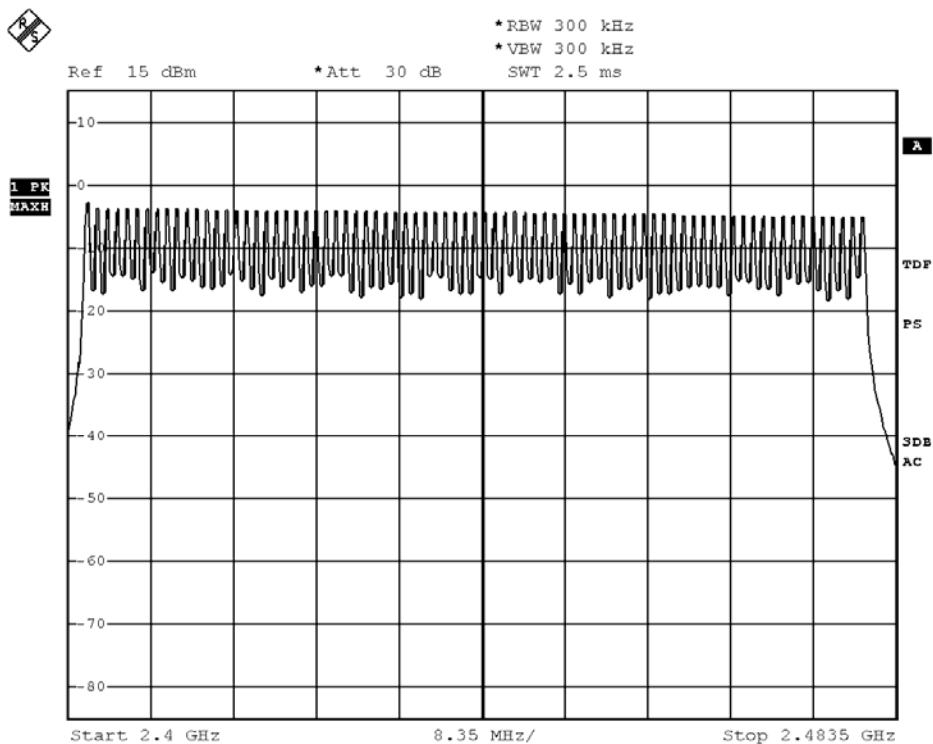
The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channel employed.  
No requirements for Digital Transmission System.

**Dwell Time = Pulse Duration \* hop rate / number of channel \* observation duration**

**Observed duration: 0.4s x 79 = 31.6s**

#### Measurement Data:

**Channel Occupied in 8DPSK: 79 of 79 Channel**



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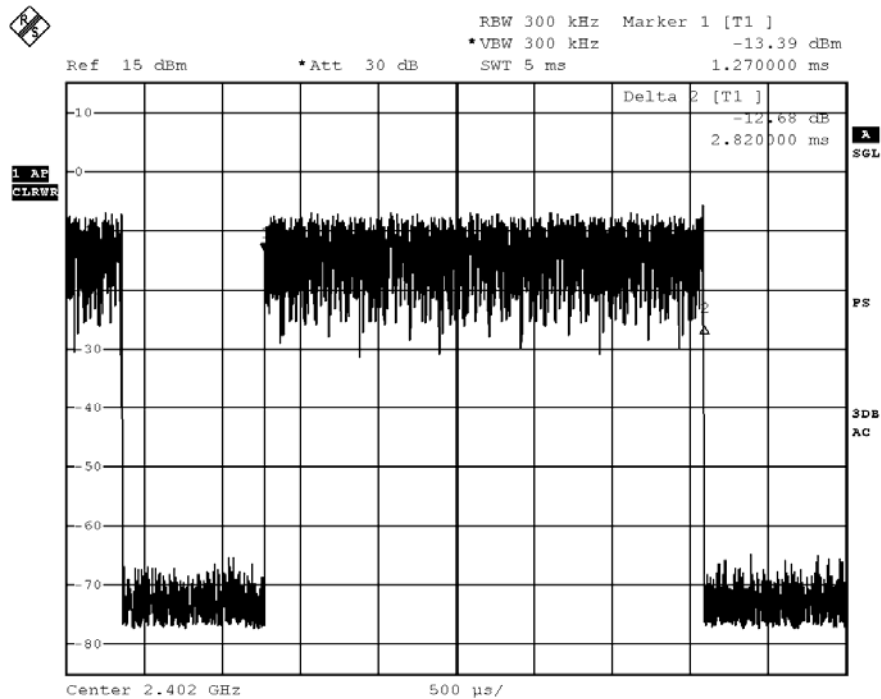
Date: 2016-08-05  
No.: DMA000106

Page 74 of 91

### DH5 Packet:

DH5 Packet permit maximum  $1600/79/6 = 3.37$  hops per second in each channel (5 time slots RX, 1 time slot TX). The Dwell time is the time duration of the pulse times  $3.37 \times 31.6 = 106.6$  within 31.6 seconds

**Fig. A**  
**[Pulse duration of Lowest Channel]**



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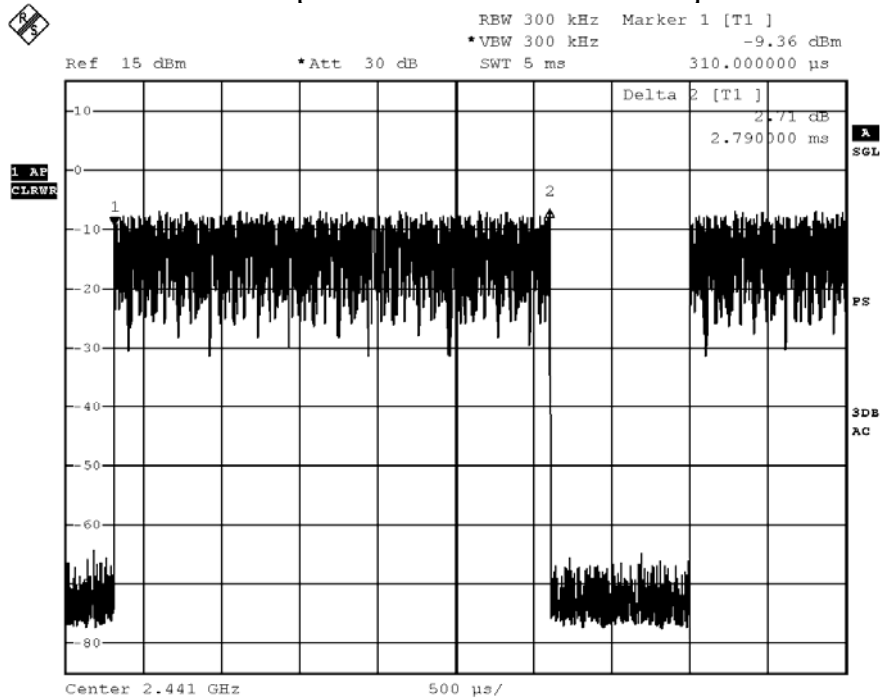


# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 75 of 91

**Fig. B**  
**[Pulse duration of Middle Channel]**



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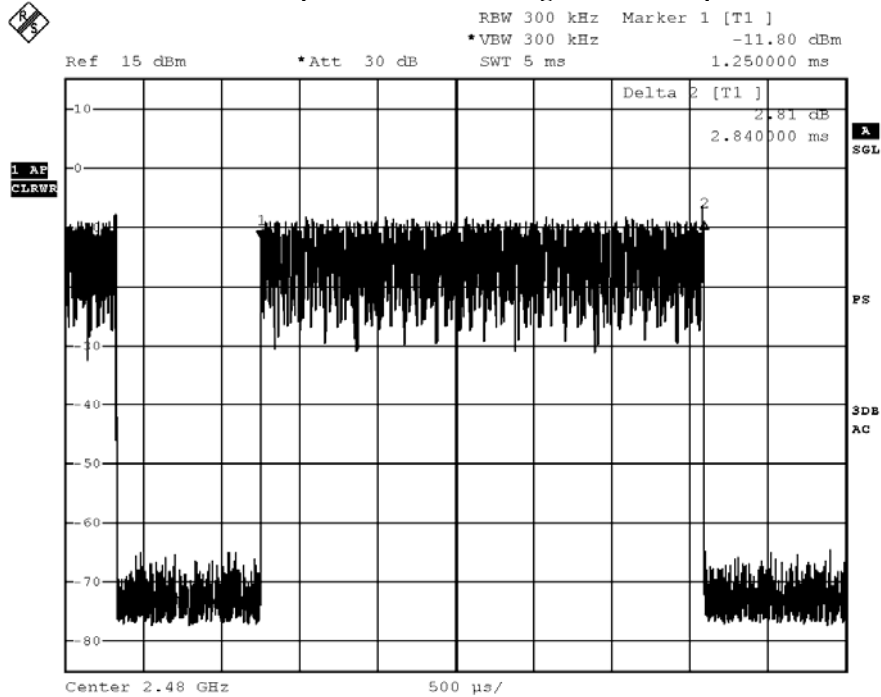


# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 76 of 91

Fig. C  
[Pulse duration of Highest Channel]



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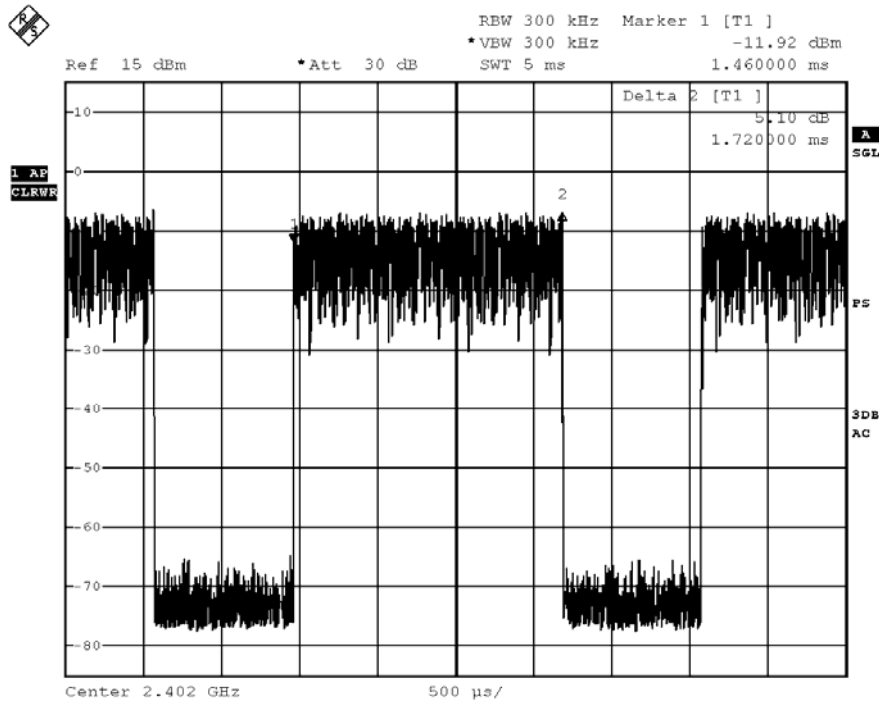
Date: 2016-08-05  
No.: DMA000106

Page 77 of 91

### DH3 Packet:

DH3 Packet permit maximum  $1600/79/4 = 5.06$  hops per second in each channel (3 time slots RX, 1 time slot TX). The Dwell time is the time duration of the pulse times  $5.06 \times 31.6 = 160$  within 31.6 seconds

**Fig. D**  
**[Pulse duration of Lowest Channel]**



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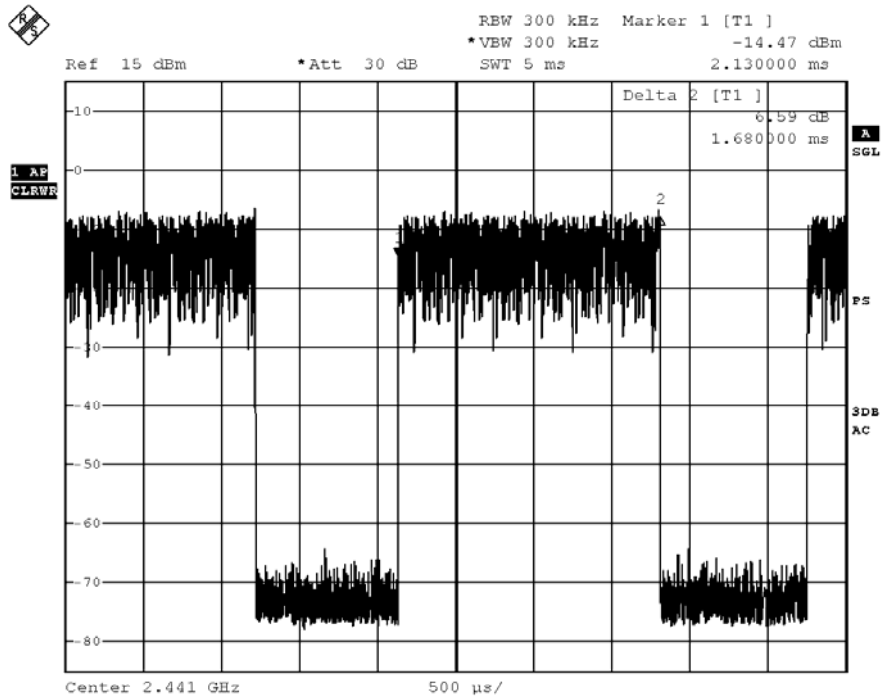


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Date: 2016-08-05  
No.: DMA000106

Page 78 of 91

**Fig. E**  
**[Pulse duration of Middle Channel]**



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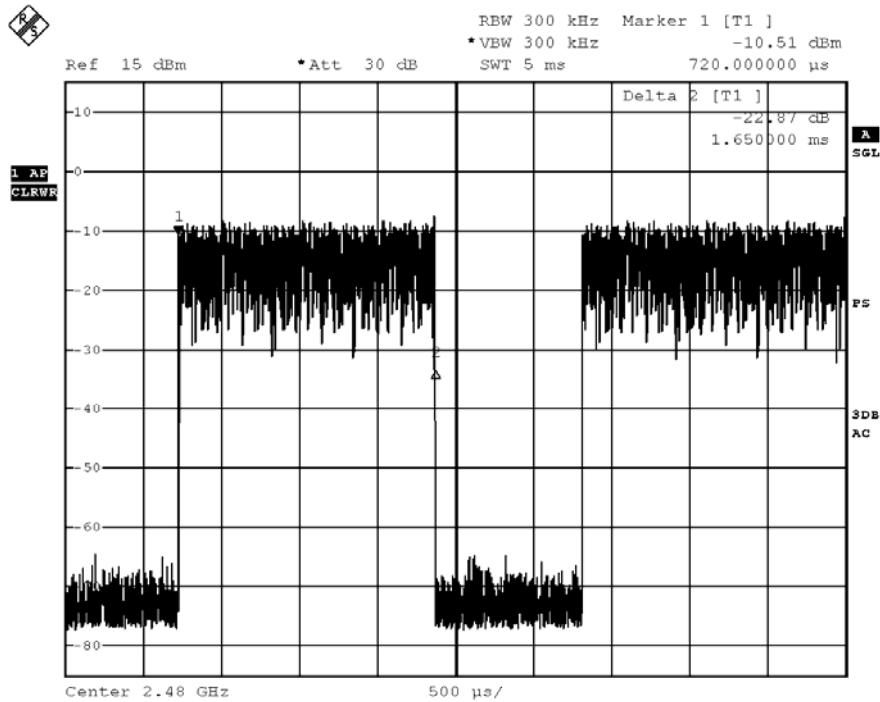


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Date: 2016-08-05  
No.: DMA000106

Page 79 of 91

**Fig. F**  
**[Pulse duration of Highest Channel]**



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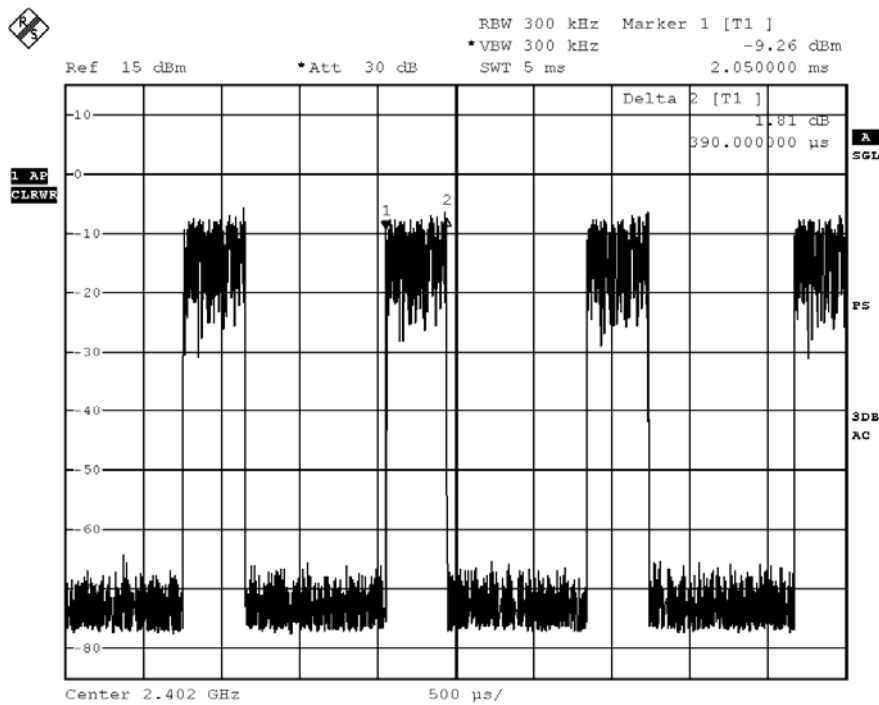
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No.: DMA000106

Page 80 of 91

## DH1 Packet:

DH1 Packet permit maximum  $1600/79/2 = 10.12$  hops per second in each channel (3 time slots RX, 1 time slot TX). The Dwell time is the time duration of the pulse times  $10.12 \times 31.6 = 320$  within 31.6 seconds

**Fig. G**  
**[Pulse duration of Lowest Channel]**



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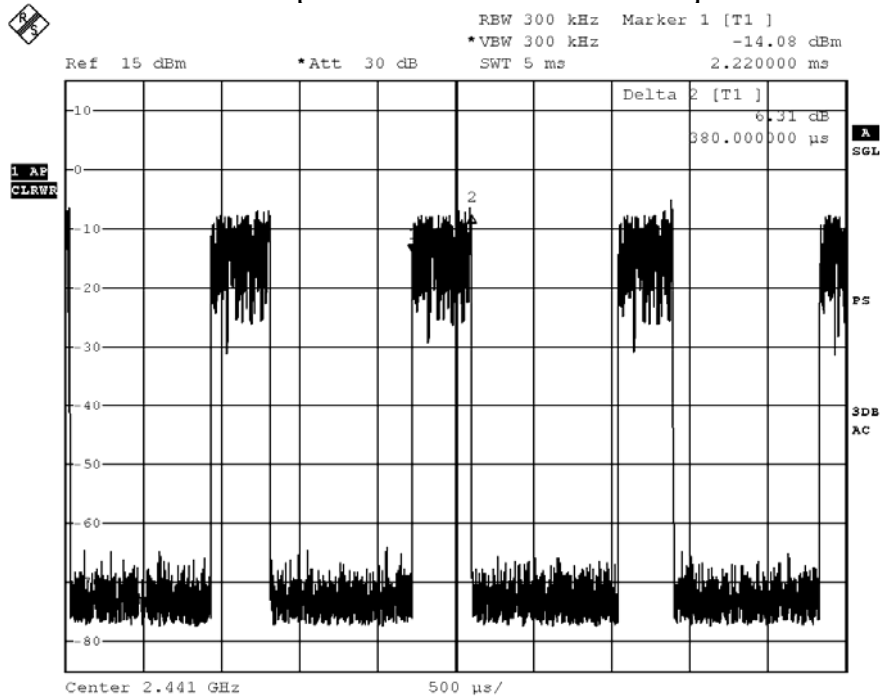


# STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 81 of 91

Fig. H  
[Pulse duration of Middle Channel]



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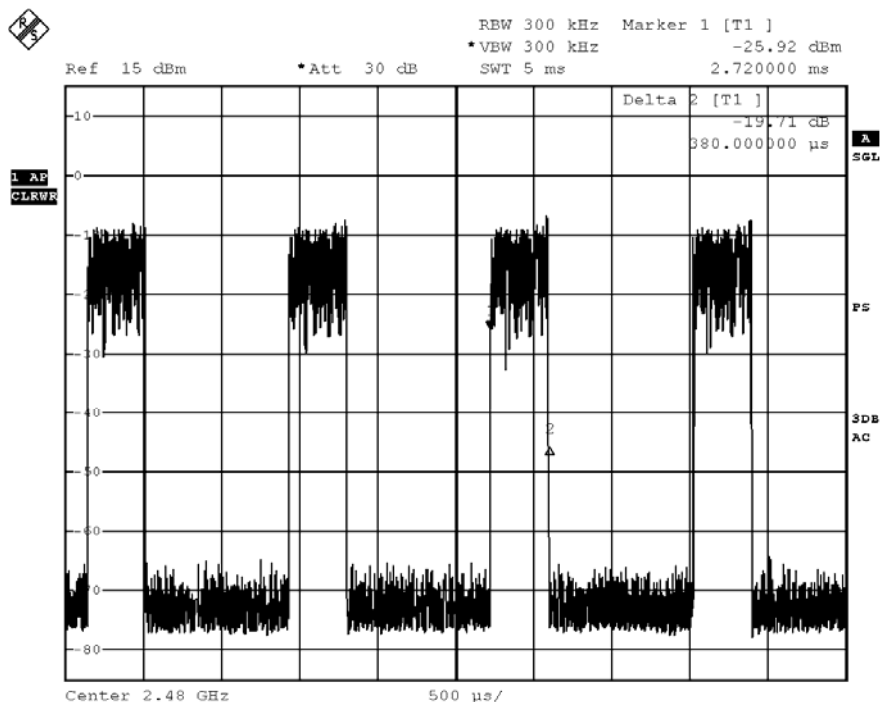
## STC Test Report

Date: 2016-08-05

Page 82 of 91

No.: DMA000106

**Fig. I**  
[Pulse duration of Highest Channel]



**Time of occupancy (Dwell Time):**

Data Packet	Frequency (MHz)	Pulse Duration (ms)	Dwell Time (s)	Limits (s)	Test Results
DH5	2402	2.82	0.267	0.400	Complies
DH5	2441	2.79	0.264	0.400	Complies
DH5	2480	2.84	0.269	0.400	Complies
DH3	2402	1.72	0.272	0.400	Complies
DH3	2441	1.68	0.265	0.400	Complies
DH3	2480	1.65	0.261	0.400	Complies
DH1	2402	0.39	0.123	0.400	Complies
DH1	2441	0.38	0.120	0.400	Complies
DH1	2480	0.38	0.120	0.400	Complies

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## **STC Test Report**

**Date: 2016-08-05**  
**No.: DMA000106**

**Page 83 of 91**

### **3.1.9 Channel Centre Frequency**

**Requirements:**

Frequency hopping system in the 2400-2483.5MHz band shall use at least 79 (Channel 1 to 79) 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 1 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 + 2MHz guard band = 2402MHz

Frequency of RF Channel = 2402+k MHz, k = 1,...,79 (Channel separation = 1MHz)

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## **STC Test Report**

**Date: 2016-08-05**

**Page 84 of 91**

**No.: DMA000106**

### **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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## **STC Test Report**

**Date: 2016-08-05**

**Page 85 of 91**

**No.: DMA000106**

### **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 Meander Line antenna. There is no external antenna, the antenna gain = 2.12dBi. User is unable to remove or changed the Antenna.

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## STC Test Report

**Date: 2016-08-05**

**Page 86 of 91**

**No.: DMA000106**

### **3.1.12 RF Exposure**

Test Requirement: FCC 47CFR 15.247(i)  
Test Date: 2016-08-03  
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 = 0.84 mW

$$\begin{aligned} P_d &= PG / 4\pi R^2 = (0.84 \times 1.63) / 12.566 \times (20)^2 \\ &= (1.369) / 12.566 \times 400 = 1.369 / 5026.4 \\ &= 0.000272 \text{ mW/cm}^2 \end{aligned}$$

where:

- \*Pd = power density in mW/cm<sup>2</sup>
- \* G = Antenna numeric gain (1.63); Log G = g/10 ( g = 2.12dBi ).
- \* P = Conducted RF power to antenna (0.84 mW).
- \* R = Minimum allowable distance.(20 cm)

- \*The power density Pd = 0.000344 mW/cm<sup>2</sup> is less than 1 mW/cm<sup>2</sup> (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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## STC Test Report

Date: 2016-08-05

Page 87 of 91

No.: DMA000106

### Appendix A

#### List of Measurement Equipment

##### Radiated Emission

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM299	Double-Ridged Waveguide Horn Antenna	ETS-Lindgren	3115	00114120	2016/04/27	2018/04/27
EM215	MULTIDEVICE CONTROLLER	EMCO	2090	00024676	N/A	N/A
EM216	MINI MAST SYSTEM	EMCO	2075	00026842	N/A	N/A
EM217	ELECTRIC POWERED TURNTABLE	EMCO	2088	00029144	N/A	N/A
EM218	ANECHOIC CHAMBER	ETS-Lindgren	FACT-3	--	2016/04/24	2017/04/24
EM355	Biconilog Antenna	ETS-Lindgren	3143B	00094856	2016/03/03	2018/03/03
EM229	EMI Test Receiver	R&S	ESIB40	100248	2016/06/01	2017/06/01
EM181	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB7	100072	2016/06/01	2017/06/01
EM145	EMI Test Receiver	R & S	ESCS 30	830245/021	2016/06/01	2017/06/01
EM353	LOOP ANTENNA	ETS LINDGREN	6502	00206533	2016/03/16	2018/03/16
EM302	Precision Omnidirectional Dipole (1 – 6GHz)	Seibersdorf Laboratories	POD 16	161806/L	2016/05/11	2018/05/11
EM303	Precision Omnidirectional Dipole (6 – 18GHz)	Seibersdorf Laboratories	POD 618	6181908/L	2016/05/11	2018/05/11

##### Line Conducted

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM119	LISN	R & S	ESH3-Z5	0831.5518.52	2015/10/22	2016/10/22
EM145	EMI Test Receiver	R & S	ESCS 30	830245/021	2016/06/01	2017/06/01
EM179	IMPULSE LIMITER	ROHDE & SCHWARZ	ESH3-Z2	357-8810.52/54	2016/01/11	2017/01/11
EM154	SHIELDING ROOM	SIEMENS MATSUSHITA COMPONENTS	N/A	803-740-057-99A	2012/02/03	2017/02/03
N/A	mEASUREMENT AND EVALUATION SOFTWARE	ROHDE & SCHWARZ	esib-k1	v1.20	n/a	n/a

Remarks:-

N/A Not Applicable or Not Available

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## STC Test Report

Date: 2016-08-05  
No.: DMA000106

Page 88 of 91

### Appendix B

#### Photographs of EUT

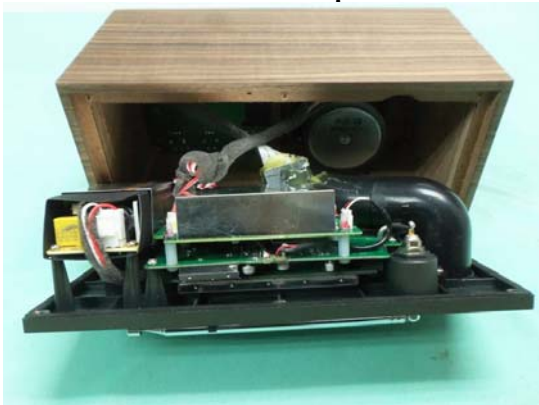
Front View of the product



Rear View of the product



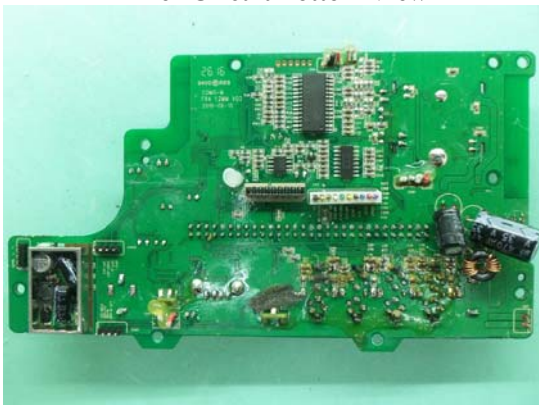
Inside View of the product



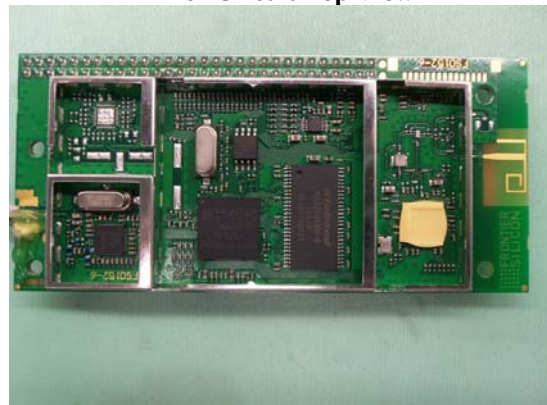
Inner Circuit Top View



Inner Circuit Bottom View



Inner Circuit Top View



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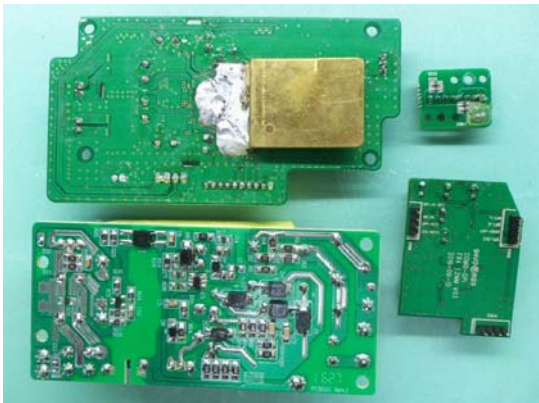
Page 89 of 91

## Photographs of EUT

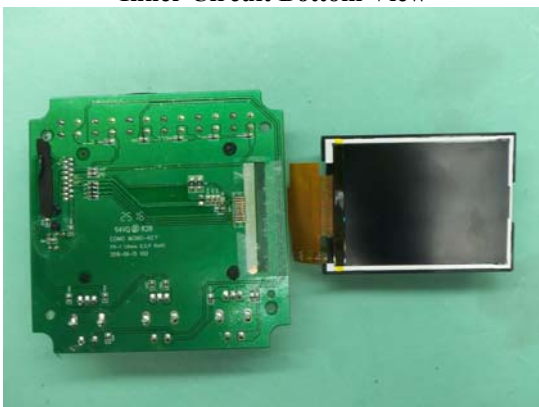
**Inner Circuit Bottom View**



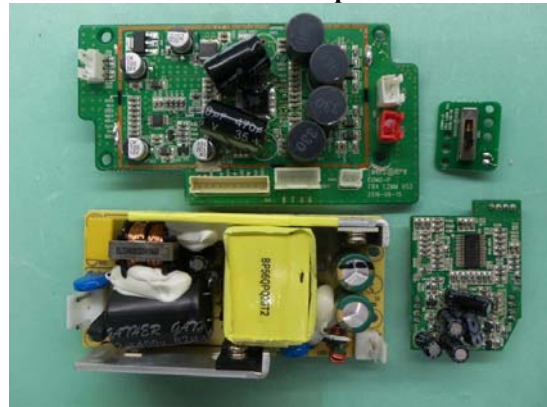
**Inner Circuit Bottom View**



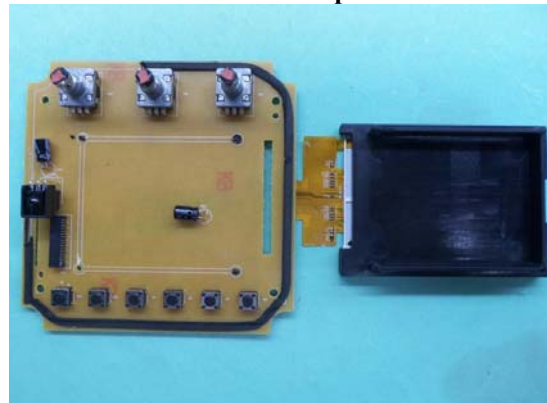
**Inner Circuit Bottom View**



**Inner Circuit Top View**



**Inner Circuit Top View**



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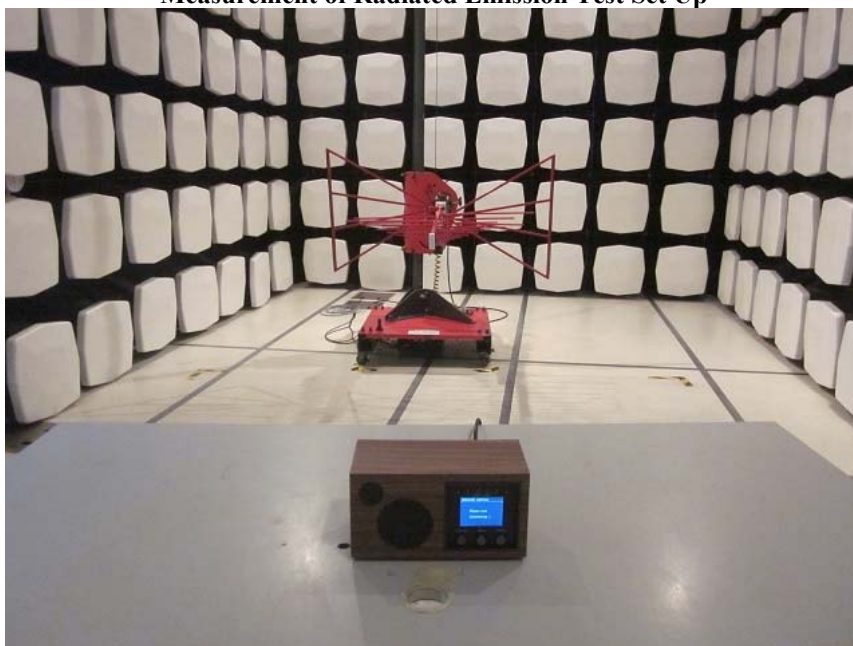
Page 90 of 91

### Photographs of EUT

Measurement of Radiated Emission Test Set Up



Measurement of Radiated Emission Test Set Up



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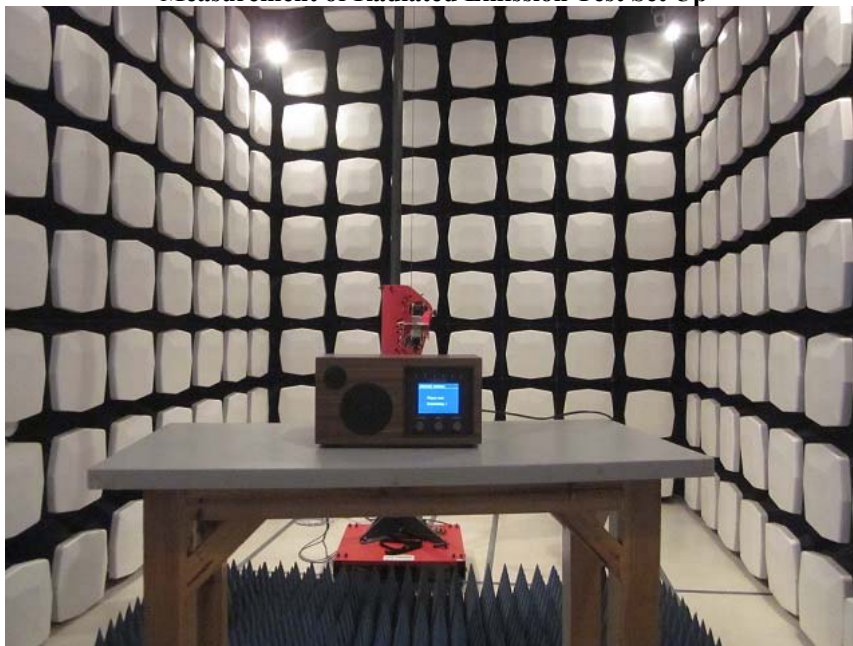
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Date: 2016-08-05  
No.: DMA000106

Page 91 of 91

### Photographs of EUT

**Measurement of Radiated Emission Test Set Up**



**Measurement of Conducted Emission Test Set Up**



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