

## ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT INTENTIONAL RADIATOR CERTIFICATION

**Product** : Smart High Line  
**Trade mark** : Bosch  
**Model/Type reference** : SAM, NAR  
**Serial Number** : N/A  
**FCC ID** : V8VCNE8415BSMHLR  
**Ratings** : DC 12V  
**Report Number** : EESZE07200009-1  
**Date** : Aug. 08, 2012  
**Regulations** : See below

Standards	Results
<input checked="" type="checkbox"/> 47 CFR FCC Part 15 Subpart C 15.247:2011	PASS

Prepared for  
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Date: Aug. 08, 2012

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*(Note: N/A means not applicable)*

## 1. GENERAL INFORMATION

**Applicant:** SKYPINE ELECTRONICS (SHENZHEN) CO., LTD.  
2/F. A incubation Building, Taohua Yuan High-Tech innovation Park, Baoan District, Shenzhen City, China

**Manufacturer:** SKYPINE ELECTRONICS (SHENZHEN) CO., LTD.  
2/F. A incubation Building, Taohua Yuan High-Tech innovation Park, Baoan District, Shenzhen City, China

**Product:** Smart High Line

**Trade mark:** Bosch

**Model/Type reference:** SAM, NAR

**FCC ID:** V8VCNE8415BSMHLR

**Sample Received Date:** Jul. 25, 2012

**Report Number:** EESZE07200009-1

**Date of Test:** Jul. 25, 2012 to Aug. 08, 2012

The above equipment was tested by Centre Testing International for compliance with the requirements set forth in the FCC Rules and Regulations Part 15, Subpart C and the measurement procedure according to ANSI C63.4:2003.

## 2. TEST SUMMARY

The complete list of measurements is given below:

No.	Test Item	Rule	Result
1	20dB Bandwidth	FCC 15.247(a)(1)	PASS
2	Carrier Frequency Separation	FCC15.247(a)(1)	PASS
3	Number of Hopping Frequency	FCC 15.247(a)(iii)	PASS
4	Time of Occupancy (Dwell Time)	FCC 15.247(a)(iii)	PASS
5	Maximum Peak Conducted Output Power	FCC 15.247(b)(1)	PASS
6	Band edge Emission	FCC 15.247(d)	PASS
7	Spurious RF Conducted Emission	FCC 15.247(d)	PASS
8	Radiated Emission	FCC 15.247(d)	PASS
9	Antenna Requirements *	FCC 15.203	PASS

\*: According to Section 15.203, 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 EUT has a built in antenna which is a short wire solder on the PCB, this is permanently attached antenna and meets the requirements of this section.

### 3. MEASUREMENT UNCERTAINTY

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

Measurement items	Uncertainty
Conducted Emission	2.6
Maximum Peak Conducted Output Power	0.22dB
Radiated Emissions / Band edge Emission	4.4 dB

### 4. PRODUCT INFORMATION

Items	Description
Intentional Transceiver	Intentional Transceiver
Modulation	Frequency Hopping Spread Spectrum (FHSS) 1. GFSK 2.π/4-DQPSK 3. 8DPSK
Data Rate (Mbps)	GFSK: 1 ; π/4-DQPSK: 2 ; 8DPSK: 3
Frequency Range	2402 ~ 2480 MHz
Channel Number	79 (at intervals of 1MHz)
Type	PCB Inverted-F Antenna
Connector	fixed on board
Gain	1.5dBi

### 5. SYSTEM TEST CONFIGURATION

#### 5.1 JUSTIFICATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, all cables were manipulated to produce worst case emissions. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance.

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

## 5.2 EUT EXERCISING SOFTWARE

The EUT exercise program CSR, (provided by client) used during testing was designed to exercise the various system components in a manner similar to a typical use.

The parameters of test software setting:

During the test, Channel and power controlling software provided by the applicant was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the application and is going to be fixed on the firmware of the end product.

Channel No.	Data rate	Modulation Type
1 to 79	1 Mbps / 2 Mbps / 3 Mbps	GFSK / π/4-DQPSK / 8DPSK

## 6. TABLE OF TEST MODE

Preliminary tests were performed the entire possible configuration in different modulation type and different data rate according to the following table to find the worst cases. And only one group of the worst - case data for each test item is shown in the report.

Test Items	Mode	Data Rate	Channel
20dB Bandwidth	GFSK / π/4-DQPSK / 8DPSK	1 Mbps / 2 Mbps / 3 Mbps	1 / 40 / 79
Carrier Frequency Separation	8DPSK	3 Mbps	1 and 2 / 40 and 41 / 78 and 79
Number of Hopping Frequency	8DPSK	3 Mbps	1 to 79
Time of Occupancy (Dwell Time)	GFSK / π/4-DQPSK / 8DPSK	1 Mbps / 2 Mbps / 3 Mbps	1 / 40 / 79
Maximum Peak Conducted Output Power	GFSK / π/4-DQPSK / 8DPSK	1 Mbps / 2 Mbps / 3 Mbps	1 / 40 / 79
Band edge Emission	GFSK / π/4-DQPSK / 8DPSK	1 Mbps / 2 Mbps / 3 Mbps	1 / 79
Spurious RF Conducted Emission	GFSK	1 Mbps	1 / 40 / 79
Radiated Emission	GFSK	1 Mbps	1 / 40 / 79

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## 7. TEST EQUIPMENT LIST

Equipment	Manufacturer	Model Number	Serial Number	Due Date
3M Chamber & Accessory Equipment	ETS-LINDGREN	FACT-3	3510	07/09/2013
Spectrum Analyzer	Agilent	E4440A	MY46185649	03/07/2013
TRILOG Broadband Antenna	schwarzbeck	VULB 9163	401	07/06/2013
Multi device Controller	ETS-LINGREN	2090	00057230	N/A
Horn Antenna	ETS-LINGREN	3117	00057407	07/06/2013
Microwave Preamplifier	Agilent	8449B	3008A02425	03/29/2013
Loop Antenna	ETS-LINDGERN	6502	71730	07/06/2013

## 8. SUPPORT EQUIPMENT LIST

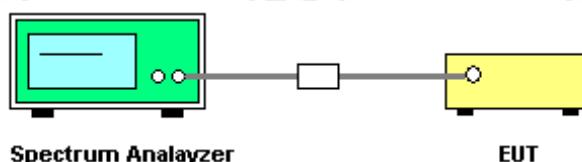
No special auxiliary equipment used.

## 9. 20DB BANDWIDTH MEASUREMENT

### 9.1 LIMITS

None

### 9.2 BLOCK DIAGRAM OF TEST SETUP



### 9.3 TEST PROCEDURE

1. The transmitter output (antenna port) was connected to the spectrum analyzer.
2. Set spectrum analyzer's RBW and VBW to applicable value with Peak in Max Hold.
3. A PEAK output reading was taken, a DISPLAY line was drawn 20 dB lower than PEAK level.
4. The 20dB bandwidth was determined from where the channel output spectrum intersected the display line.

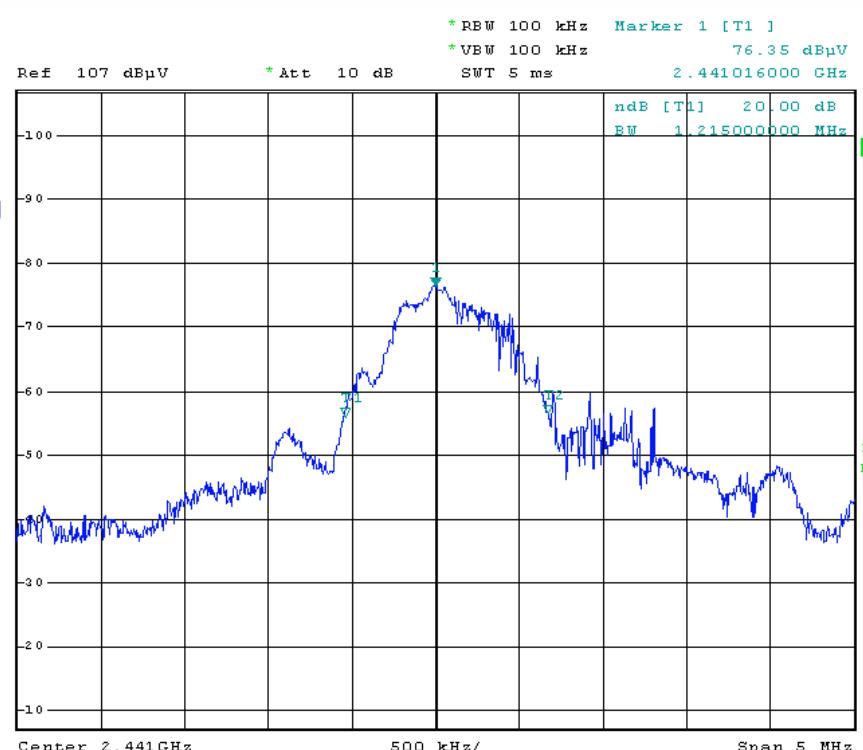
### 9.4 TEST RESULT

Worst case-- Modulation Type: 8DPSK Data Rate: 3Mbps

Channel	Frequency (MHz)	20 dB BW (MHz)	Result
CH1	2402	1.240	1.255MHz
CH40	2441	1.215	
CH79	2480	1.255	



Channel 1\_ 2402 MHz



Channel 40\_ 2441 MHz

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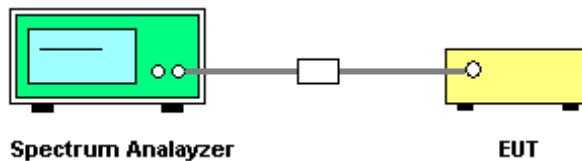
## 10. CARRIER FREQUENCY SEPARATION

### 10.1 LIMITS

Frequency hopping systems operating in the 2400-2483.5MHz 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 125mW.

As the system's 20 dB bandwidth is 1.255MHz, thus, Carrier Frequency Separation should be greater than 837 kHz.

### 10.2 BLOCK DIAGRAM OF TEST SETUP



### 10.3 TEST PROCEDURE

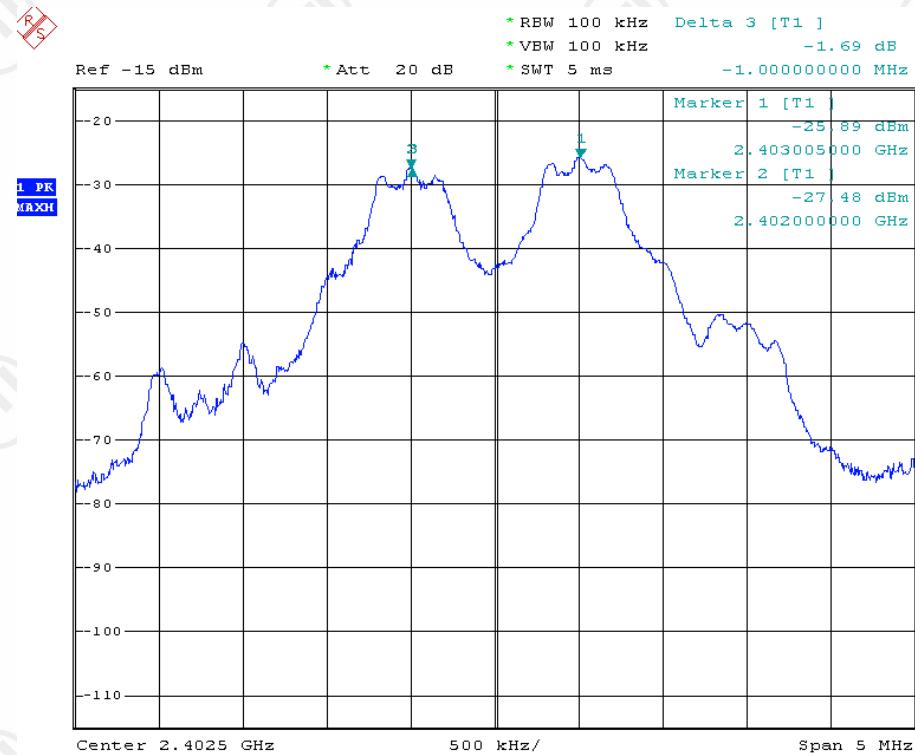
1. The transmitter output (antenna port) was connected to the spectrum analyzer.
2. Set spectrum analyzer's RBW and VBW to applicable value with Peak in Max Hold. The original channel's carrier frequency was taken.
3. Make EUT transmit in adjacent channel.
4. Use the delta marker button on spectrum analyzer to read the channel separation from the adjacent channel to original channel.

### 10.4 TEST RESULT

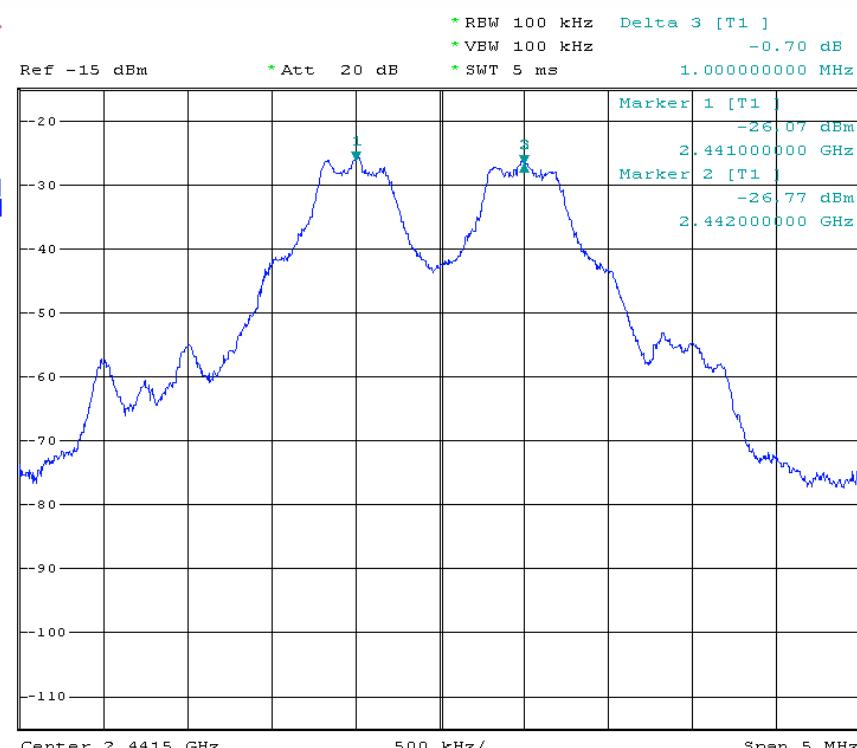
Worst case-- Modulation Type: 8DPSK Data Rate: 3Mbps

Carrier Frequency Separation: 1 MHz

Test Result: Pass



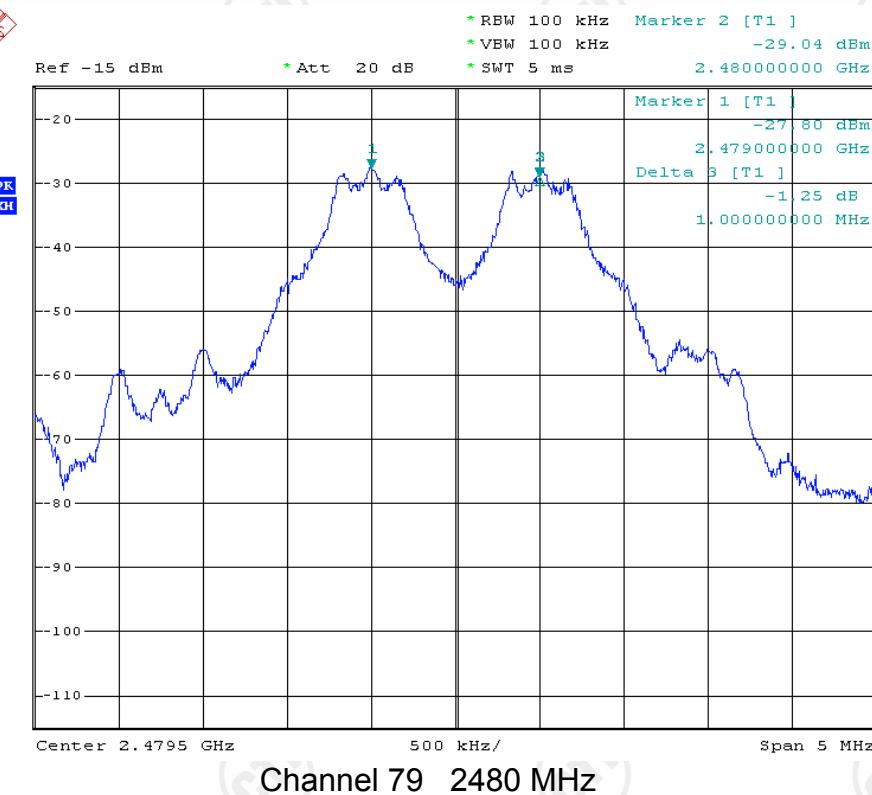
Channel 1\_ 2402 MHz



Channel 40\_ 2441 MHz

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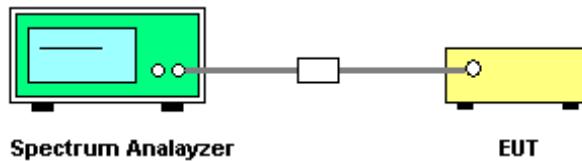


## 11. NUMBER OF HOPPING FREQUENCY

### 11.1 LIMITS

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

### 11.2 BLOCK DIAGRAM OF TEST SETUP



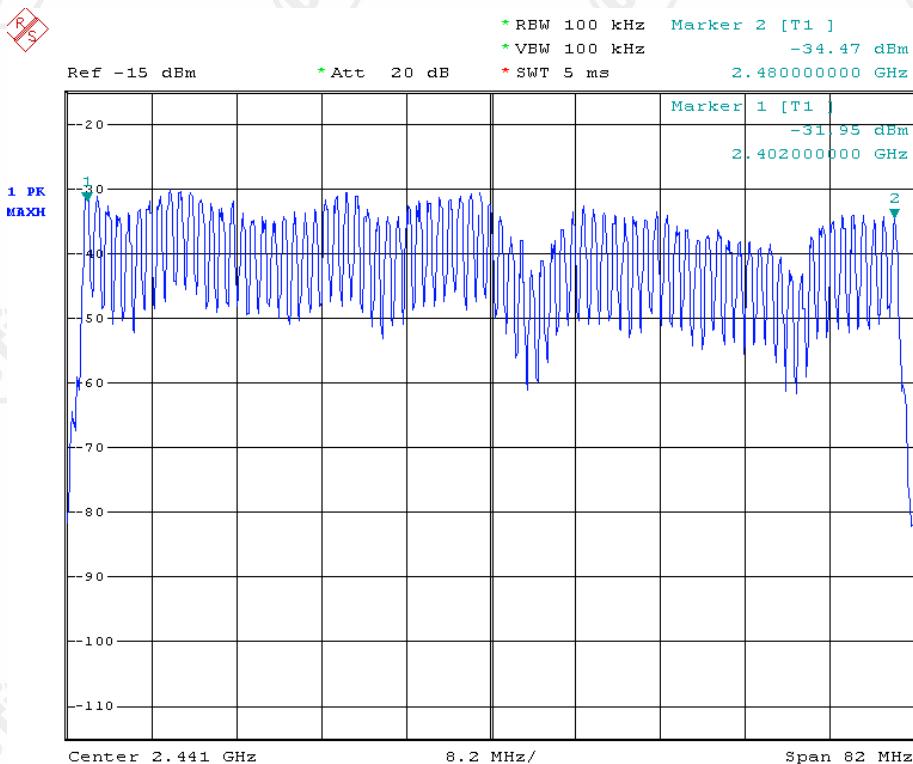
### 11.3 TEST PROCEDURE

1. The transmitter output (antenna port) was connected to the spectrum analyzer.
2. Set spectrum analyzer to Peak in Max Hold.
3. Make EUT work continually, till all operation channels were recorded.

### 11.4 TEST RESULT

Worst case-- Modulation Type: 8DPSK Data Rate: 3Mbps

Number of Hopping Frequency is 79, with frequency space = 1MHz.

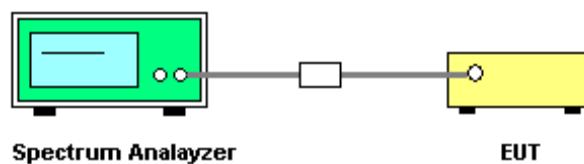


## 12. TIME OF OCCUPANCY (DWELL TIME)

### 13.1 LIMITS

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 channels employed.

### 12.2 BLOCK DIAGRAM OF TEST SETUP



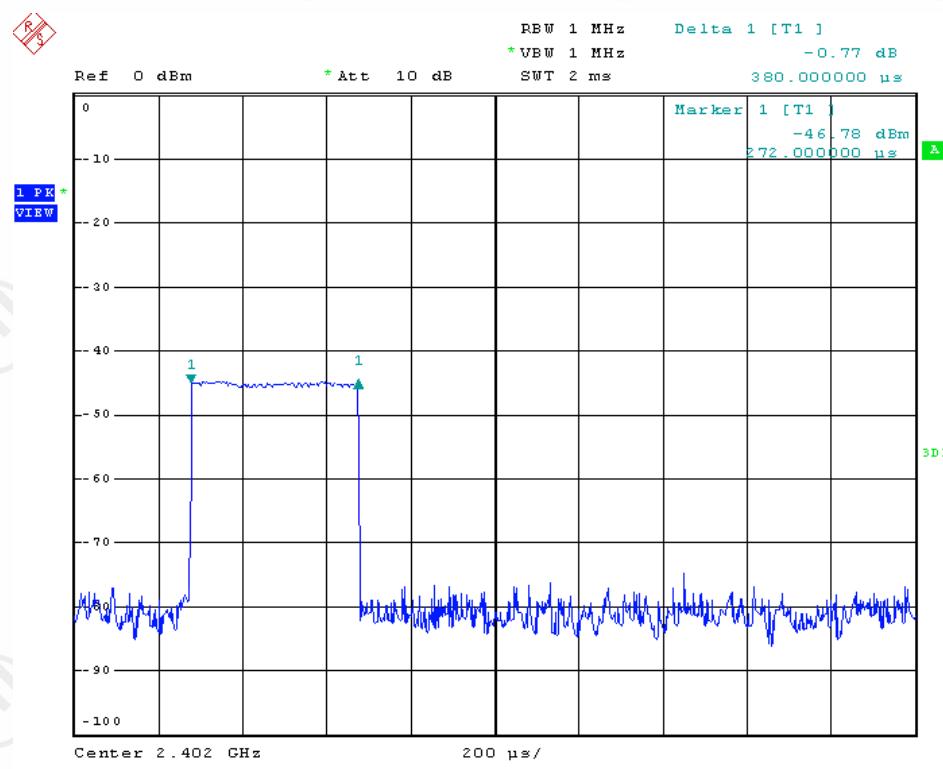
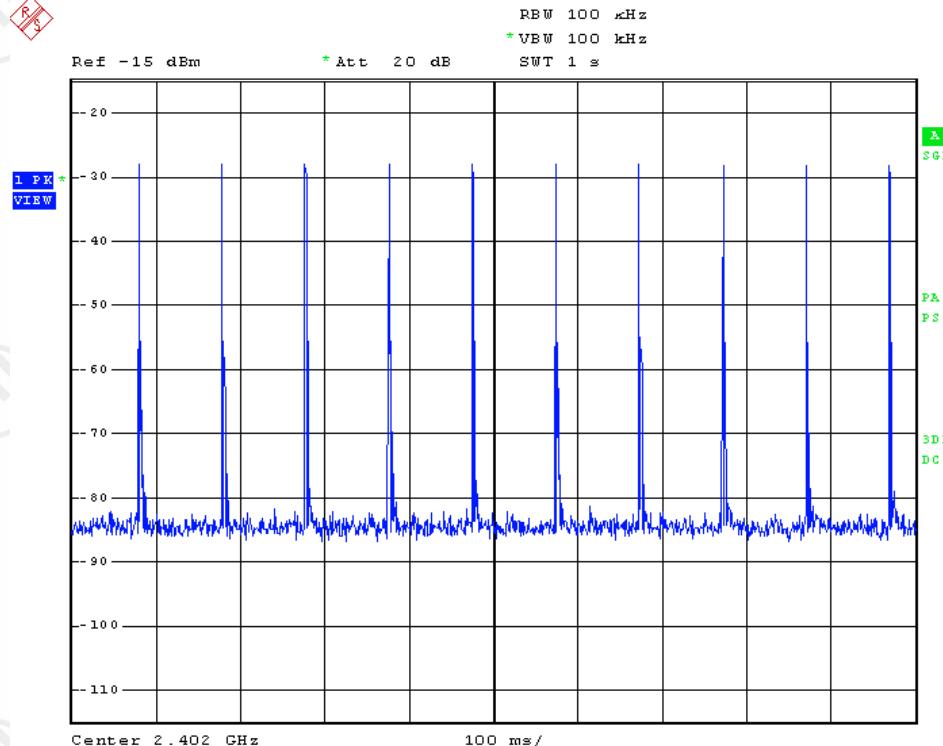
### 12.3 TEST PROCEDURE

1. The transmitter output (antenna port) was connected to the spectrum analyzer.
2. Set spectrum analyzer's RBW and VBW to applicable value with Peak in Max Hold.
3. Measured pulse time and Time separation.

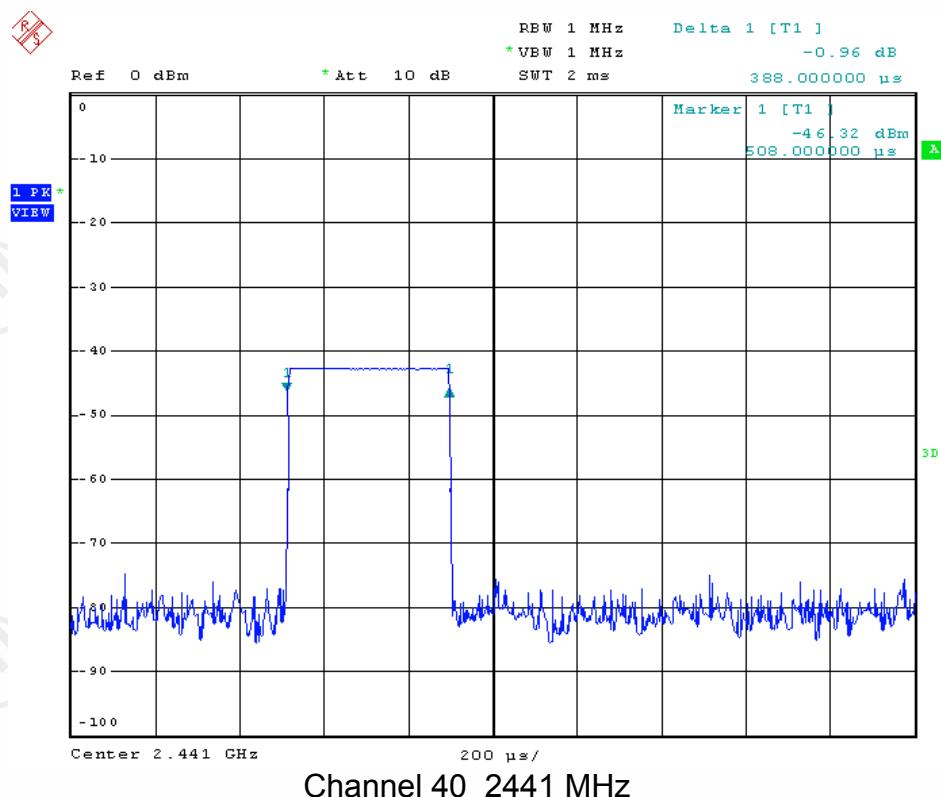
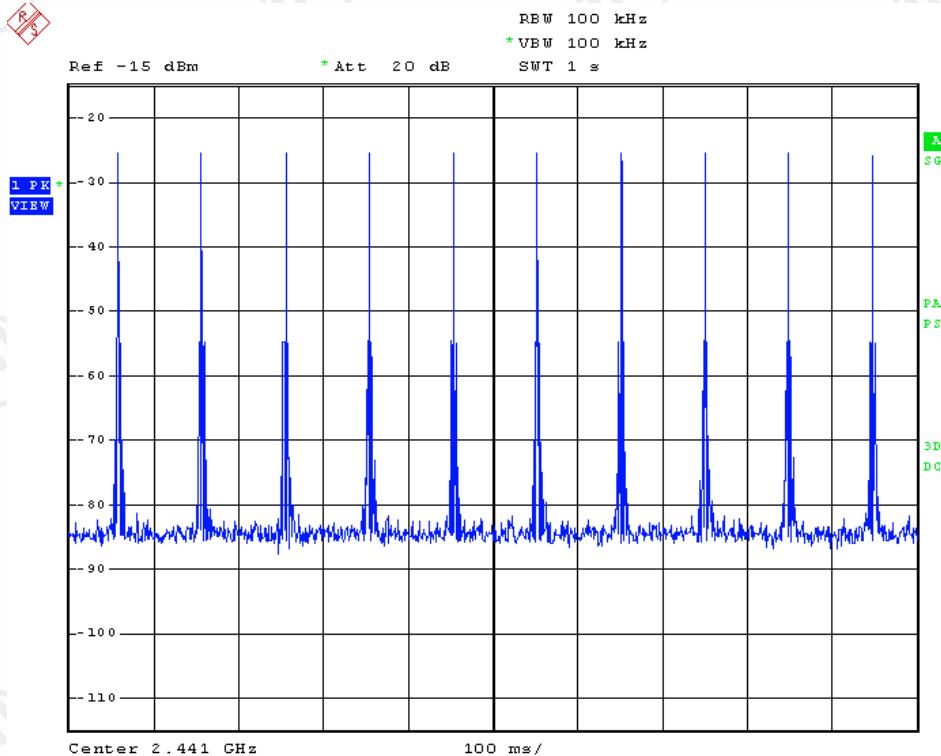
### 12.4 TEST RESULT

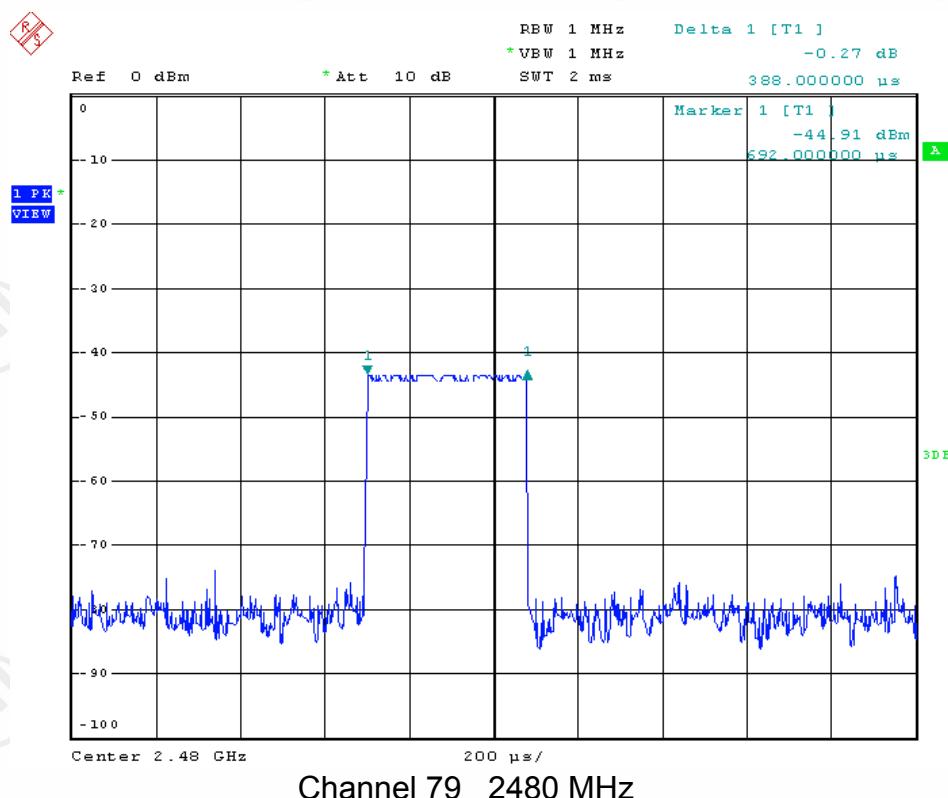
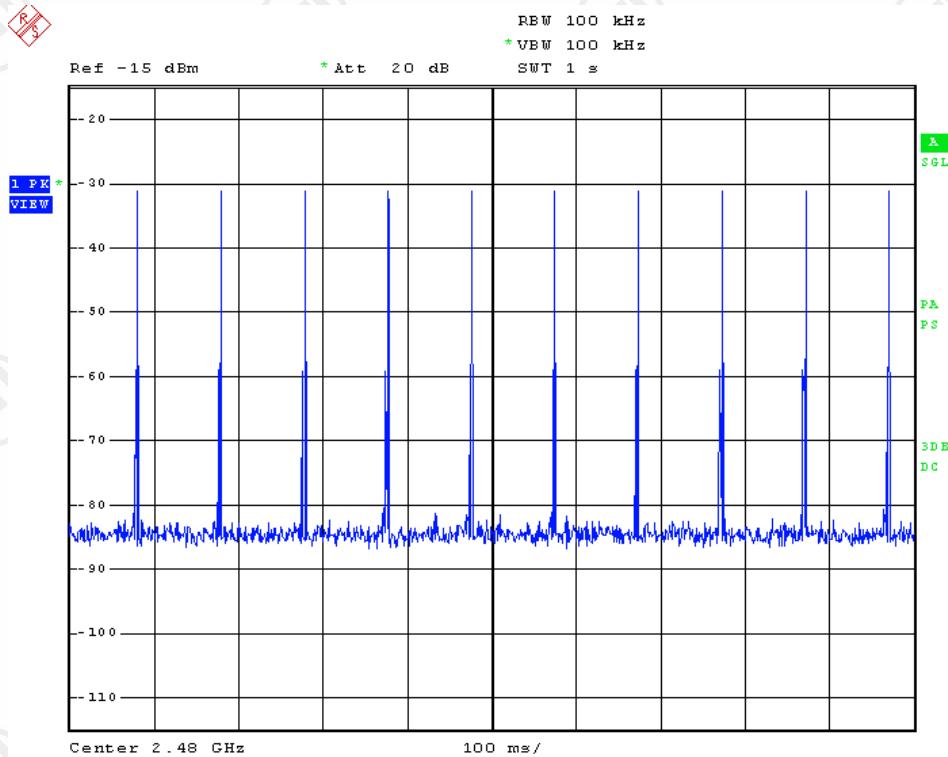
Worst case-- Modulation Type: 8DPSK Data Rate: 3Mbps

Channel _ Freq. (MHz)	Pulse Wide (ms)	Number of Hopping Pulses in 0.4s*channel number	Dwell Time (s)	Limit (s)	Result (Pass / Fail)
CH0 _ 2402	0.380	316	0.120	0.4	Pass
CH39 _ 2441	0.388	316	0.123	0.4	Pass
CH78 _ 2480	0.388	316	0.123	0.4	Pass



Channel 1\_ 2402 MHz



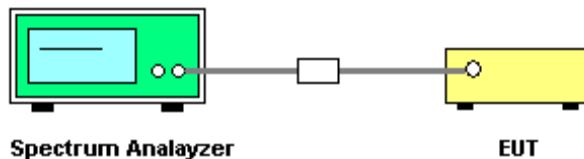


## 13. MAXIMUM PEAK CONDUCTED OUTPUT POWER MEASUREMENT

## 13.1 LIMITS

The limit for peak output power is 0.125Watt (21dBm).

## 13.2 BLOCK DIAGRAM OF TEST SETUP



### 13.3 TEST PROCEDURE

1. The transmitter output (antenna port) was connected to the spectrum analyzer.
2. Set spectrum analyzer's RBW and VBW to applicable value with Peak in Max Hold.
3. Record the channel power directly from the spectrum analyzer.

## 13.4 TEST RESULT

Worst case-- Modulation Type: GFSK Data Rate: 1Mbps

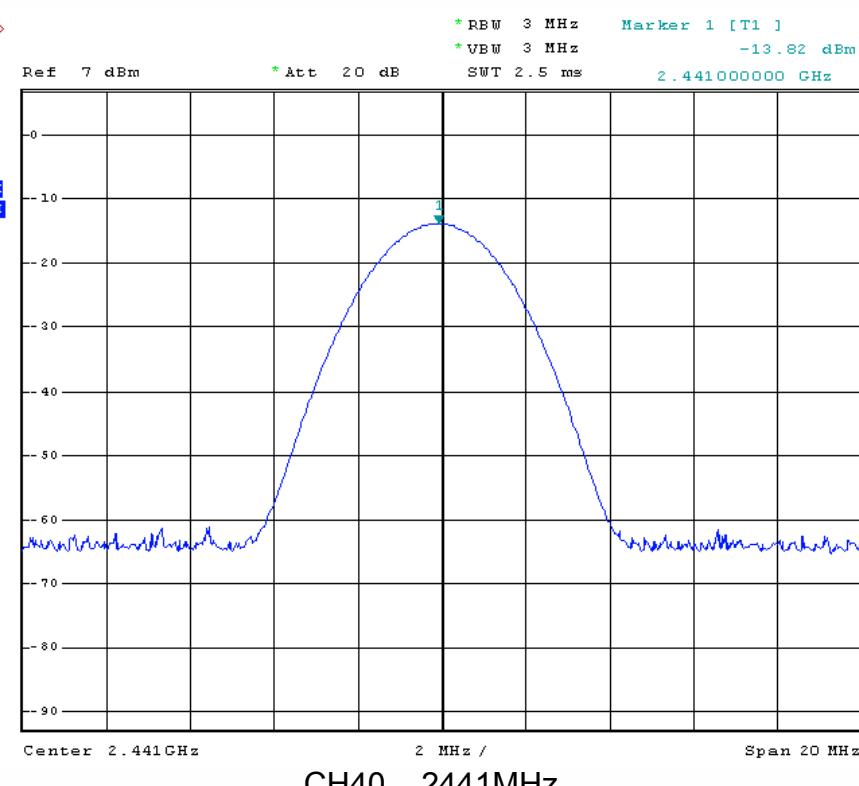
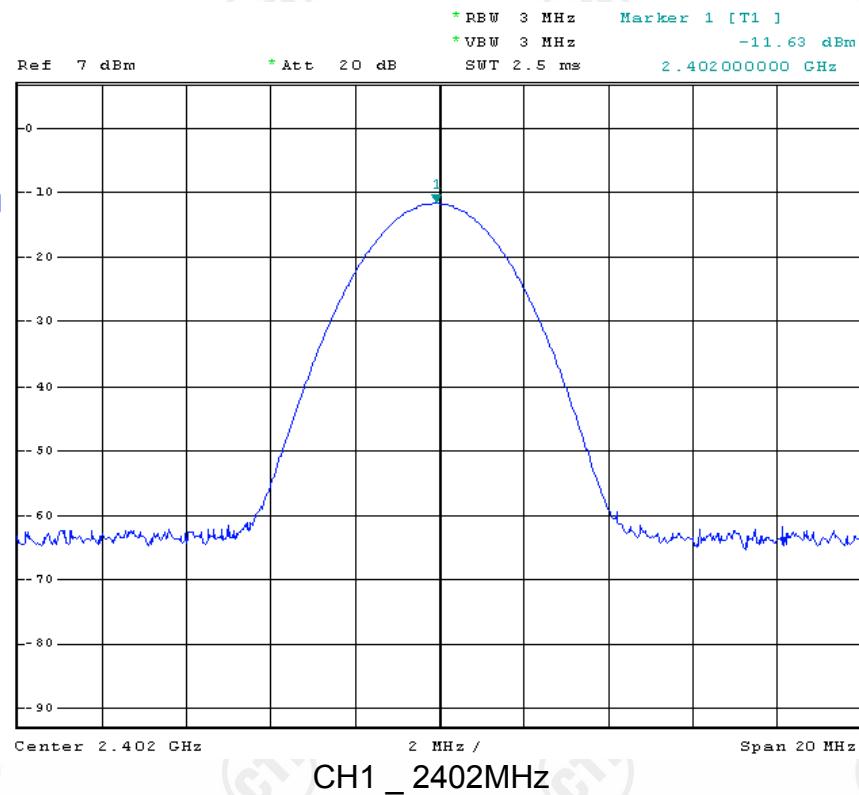
Channel _ Freq. (MHz)	Reading Power (dBm)	Factor (dB)	Measured Power (dBm)	Limit (dBm)	Result (Pass / Fail)
CH1_2402	-11.63	11.8	0.17	21	Pass
CH40_2441	-13.82	11.8	-2.02	21	Pass
CH79_2480	-13.94	11.8	-2.14	21	Pass

### Remark:

Factor= Cable loss + Attenuator

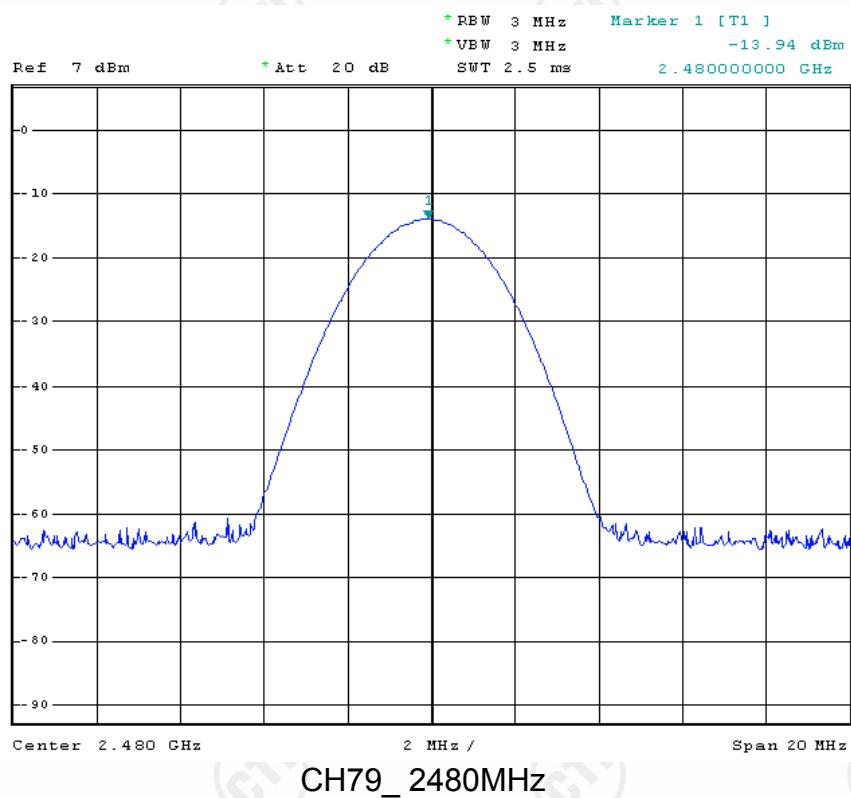
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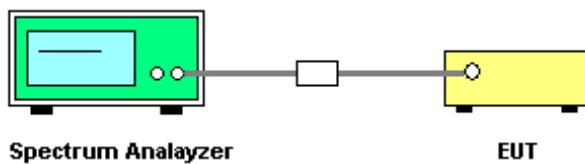


## 14. BAND EDGE EMISSION MEASUREMENT

### 14.1 LIMITS (FCC 's requirement)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

### 14.2 BLOCK DIAGRAM OF TEST SETUP



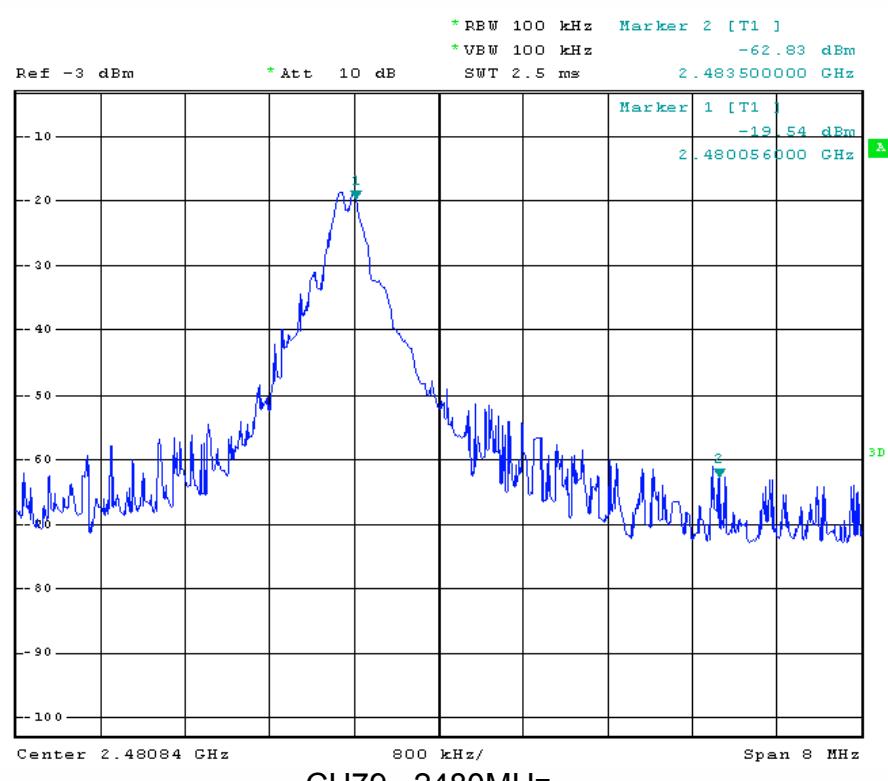
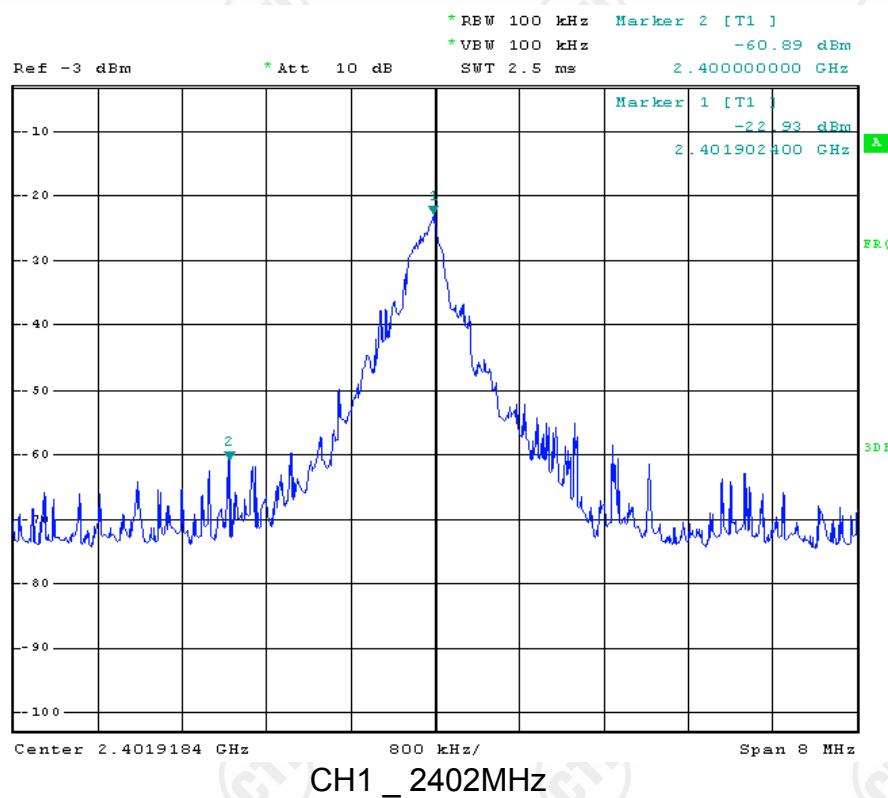
### 14.3 TEST PROCEDURE

1. The transmitter output (antenna port) was connected to the spectrum analyzer.
2. Set spectrum analyzer's RBW and VBW to applicable value with Peak in Max Hold.
3. Record the emission drops at the band-edge relative to the highest fundamental emission level.
4. Use the marker-delta method to determine band-edge compliance as required.

### 14.4 TEST RESULT

Worst case-- Modulation Type: GFSK Data Rate: 1Mbps

Channel Frequency (MHz)	Fundamental Emission (dB $\mu$ V/m)	Delta (dB)	Final Emission (dB $\mu$ V/m)		Limit (dB $\mu$ V/m)		Result (Pass / Fail)
			PK	PK	PK	AV	
CH1_2402	88.63	---	---	---	---	---	---
2400.0	---	37.96	50.67	74	54	Pass	
CH79_2480	86.10	---	---	---	---	---	---
2483.5	---	43.29	42.81	74	54	Pass	

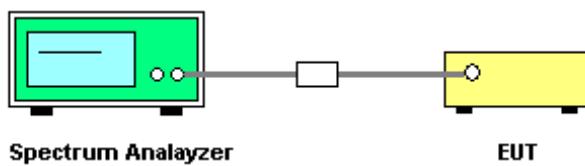


## 15. SPURIOUS RF CONDUCTED EMISSIONS MEASUREMENT

### 15.1 LIMITS

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

### 15.2 BLOCK DIAGRAM OF TEST SETUP



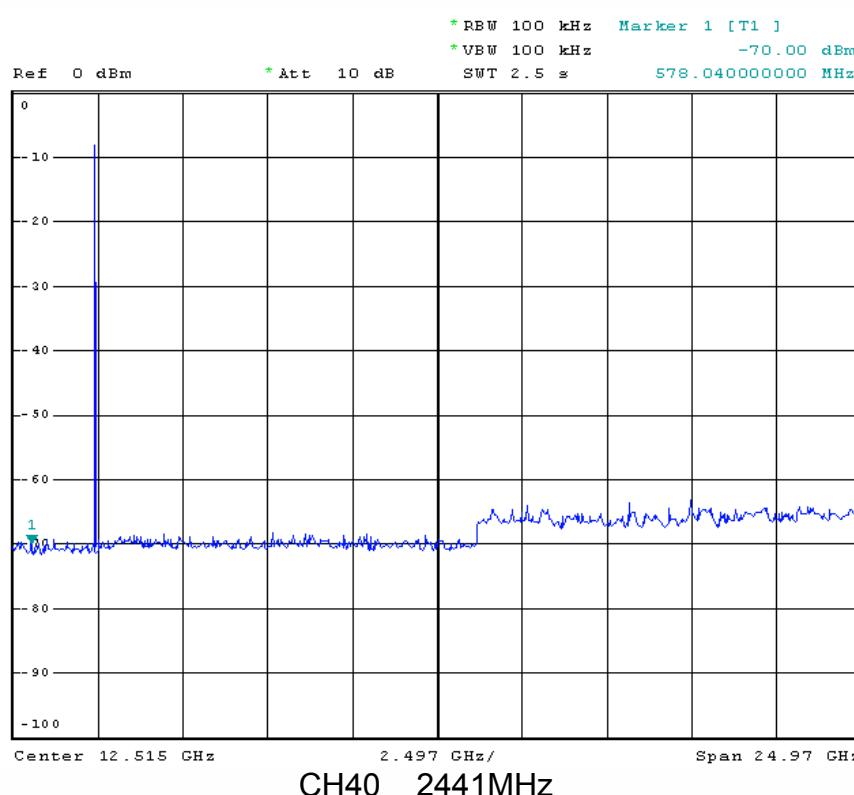
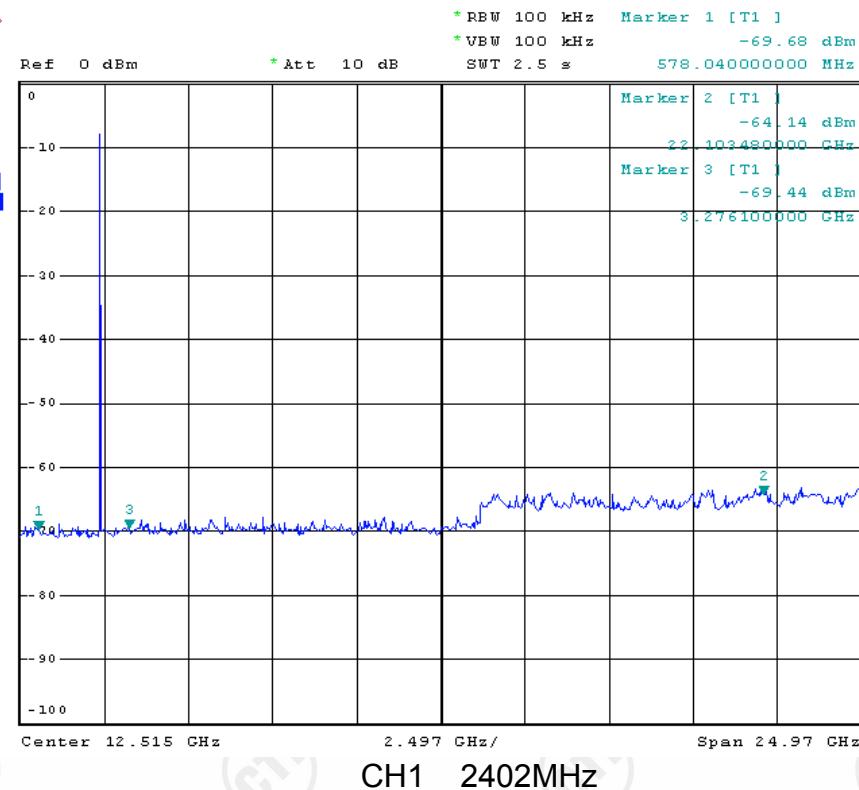
### 15.3 TEST PROCEDURE

1. The transmitter output (antenna port) was connected to the spectrum analyzer.
2. Set spectrum analyzer's RBW and VBW to applicable value with Peak in Max Hold.
3. Record the peak level of the in-band emission and all spurious emissions from the lowest frequency generated in the EUT up through the 10th harmonic.

### 15.4 TEST RESULT

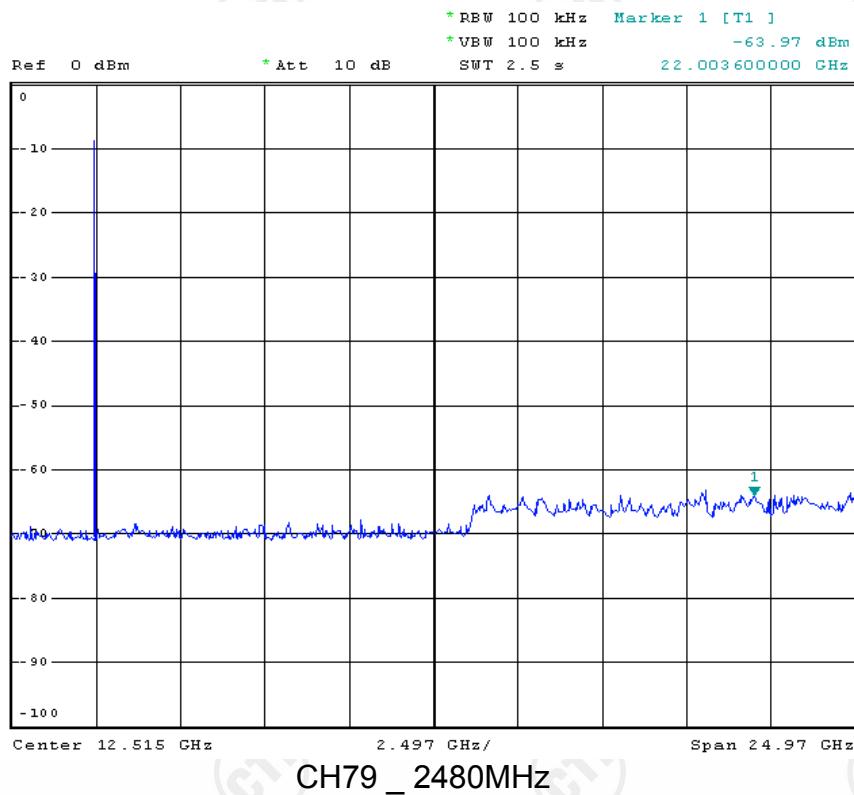
Worst case-- Modulation Type: GFSK Data Rate: 1Mbps

Please see the following plots.



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## 16. RADIATED EMISSIONS MEASUREMENT

### 16.1 LIMITS

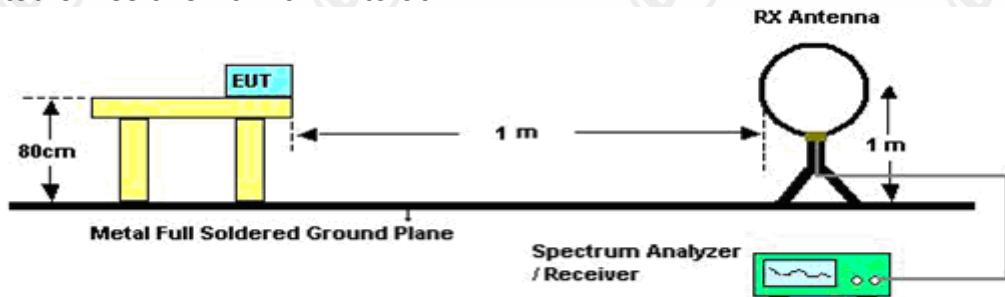
The field strength of any emissions, which appear outside of operating frequency band and restricted band specified on FCC 15.205(a) and RSS-210 2.7, shall not exceed the general radiated emission limits as below.

Frequency (MHz)	Field strength ( $\mu$ V/m)	Distance (m)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

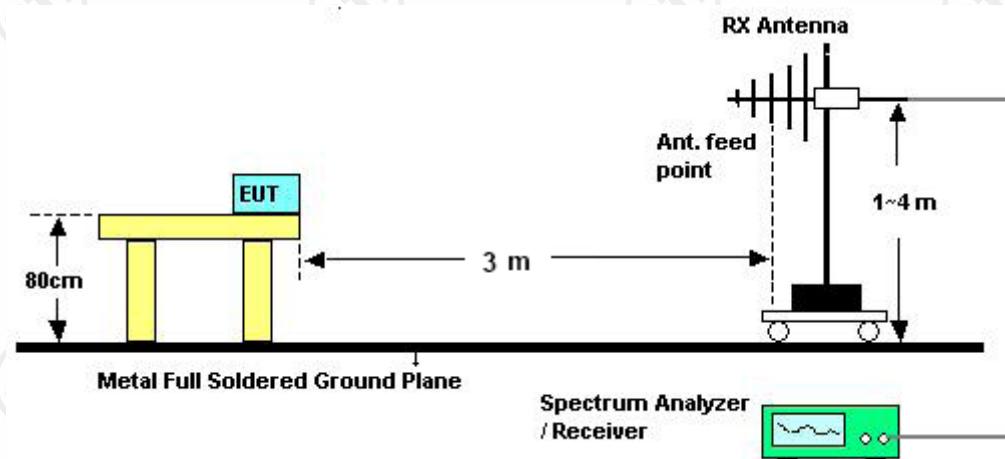
**Note:** the tighter limit applies at the band edges.

### 16.2 BLOCK DIAGRAM OF TEST SETUP

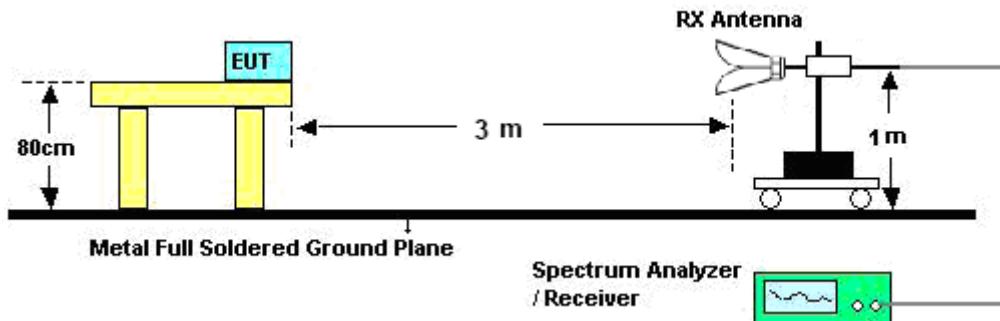
For radiated emissions from 9kHz to 30MHz



For radiated emissions from 30 - 1000MHz



For radiated emissions from 1GHz to 25GHz



### 16.3 TEST PROCEDURE

#### Below 30MHz

- The EUT is placed on a turntable 0.8 meters above the ground in the chamber, 1 meter away from the antenna (loop antenna). The maximum values of the field strength are recorded by adjusting the polarizations of the test antenna and rotating the turntable.
- For each suspected emission, the EUT was arranged to its worst case and then turn table was turned from 0 degrees to 360 degrees to find the maximum reading.
- The test frequency analyzer system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

#### 30MHz ~ 1GHz:

- The EUT was placed on the non-conductive turntable 0.8 m above the ground at a chamber.
- Set the spectrum analyzer/receiver in Peak detector, Max Hold mode, and 120 kHz RBW. Record the maximum field strength of all the pre-scan process in the full band when the antenna is varied between 1~4 m in both horizontal and vertical, and the turntable is rotated from 0 to 360 degrees.
- For each frequency whose maximum record was higher or close to limit, measure its QP value: vary the antenna's height and rotate the turntable from 0 to 360 degrees to find the height and degree where EUT radiated the maximum emission, then set the test frequency analyzer/receiver to QP Detector and specified bandwidth with Maximum Hold Mode, and record the maximum value.

#### Above 1GHz:

- The EUT was placed on the non-conductive turntable 0.8 m above the ground at a chamber.
- Set the spectrum analyzer/receiver in Peak detector, Max Hold mode, and 1MHz RBW. Record the maximum field strength of all the pre-scan process in the full band when the antenna is varied in both horizontal and vertical, and the turntable is rotated from 0 to 360 degrees.

c. For each frequency whose maximum record was higher or close to limit, measure its AV value: rotate the turntable from 0 to 360 degrees to find the degree where EUT radiated the maximum emission, then set the test frequency analyzer/receiver to AV value and specified bandwidth with Maximum Hold Mode, and record the maximum value.

#### 16.4 TEST RESULT

##### A. Below 30MHz:

No emissions were found higher than the background below 30MHz and background is lower than the limit, so it deems to compliance with the limit without recorded.

##### B. 30MHz ~ 1GHz:

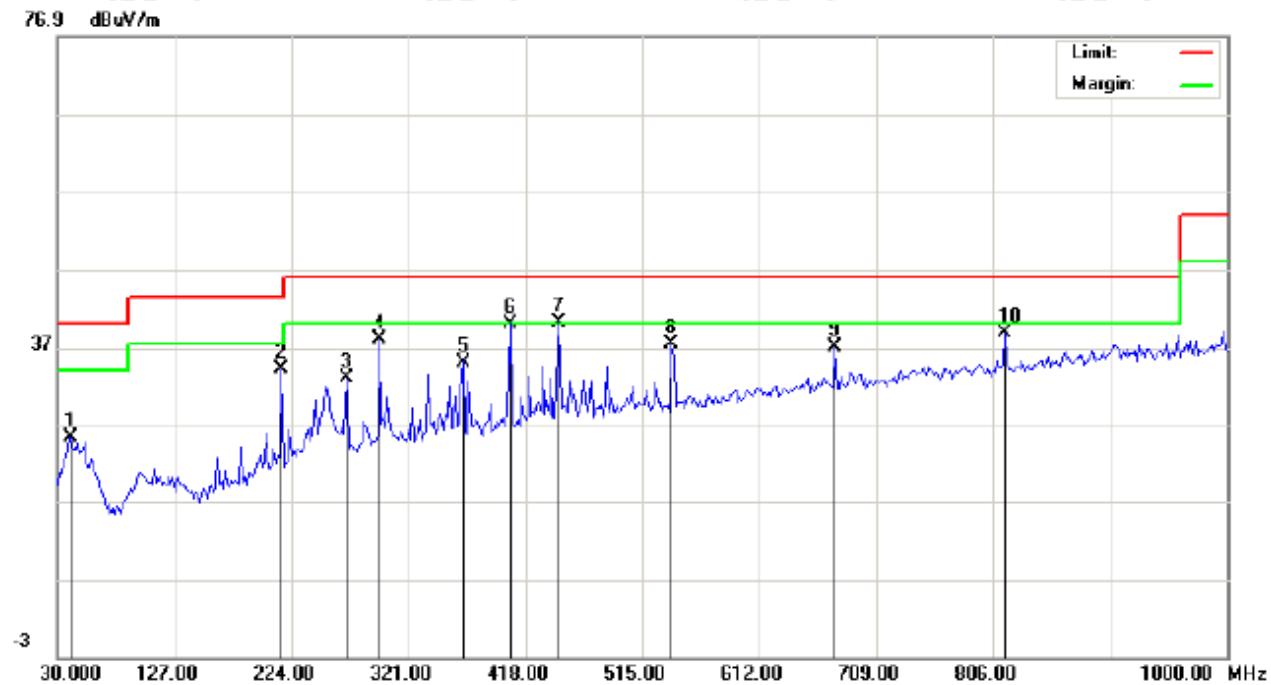
The test data of low channel, middle channel and high channel are almost same in frequency bands 30MHz to 1GHz, and the data of middle channel are chosen as representative in below:



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H:

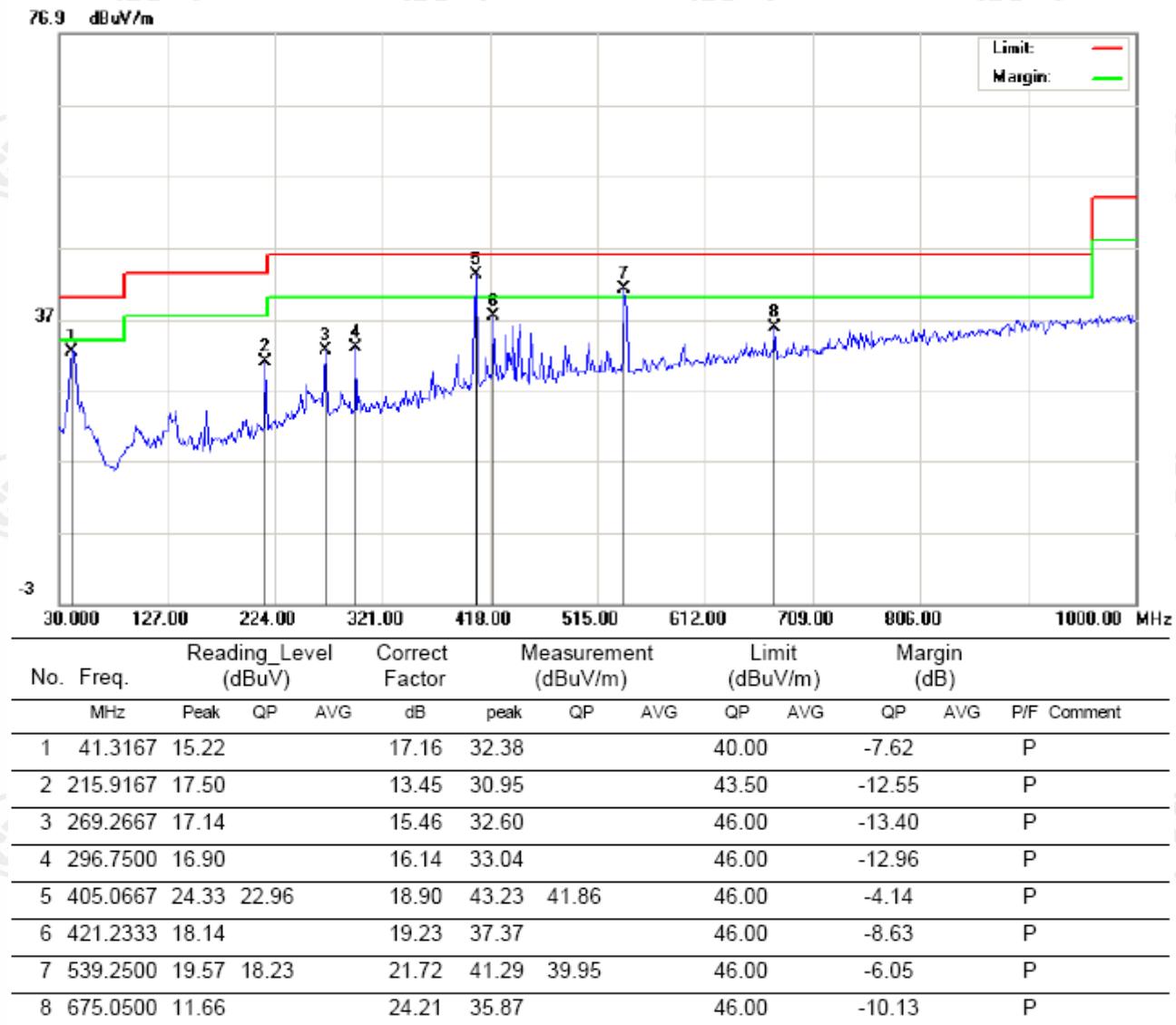


No.	Freq.	Reading Level (dBuV)			Correct Factor			Measurement (dBuV/m)			Limit (dBuV/m)		Margin (dB)	
		MHz	Peak	QP	Avg	dB	peak	QP	Avg	QP	Avg	QP	Avg	P/F
1	41.3167	8.33				17.16	25.49			40.00		-14.51		P
2	215.9167	20.74				13.45	34.19			43.50		-9.31		P
3	269.2667	17.47				15.46	32.93			46.00		-13.07		P
4	296.7500	21.88				16.14	38.02			46.00		-7.98		P
5	366.2667	17.01				18.09	35.10			46.00		-10.90		P
6	405.0667	21.11				18.90	40.01			46.00		-5.99		P
7	445.4833	20.37				19.74	40.11			46.00		-5.89		P
8	539.2500	15.75				21.72	37.47			46.00		-8.53		P
9	675.0500	12.71				24.21	36.92			46.00		-9.08		P
10	815.7000	12.64				26.22	38.86			46.00		-7.14		P

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V:



**C. Above 1GHz:**

Test Results-(Measurement Distance: 3m)_Channel low							
Frequency (MHz)	Measurement value			Limit		Antenna	Result
	PK (dB $\mu$ V/m)	AV factor (dB)	AV (dB $\mu$ V/m)	PK (dB $\mu$ V/m)	AV (dB $\mu$ V/m)	(H/V)	(P/F)
1423.000	25.36	---	---	74	54	H	P
2402.000*	88.63	---	---	---	---	H	P
4052.500	24.36	---	---	74	54	H	P
7412.000	33.20	---	---	74	54	H	P
12612.50	39.63	---	---	74	54	H	P
16192.50	47.21	---	---	74	54	H	P
17910.00	47.99	---	---	74	54	H	P
<hr/>							
1425.500	26.30	---	---	74	54	V	P
2402.000*	85.36	---	---	---	---	V	P
6787.500	31.23	---	---	74	54	V	P
11488.00	38.96	---	---	74	54	V	P
13292.50	43.21	---	---	74	54	V	P
16800.00	47.98	---	---	74	54	V	P

\*: fundamental frequency

Test Results-(Measurement Distance: 3m)_Channel middle							
Frequency (MHz)	Measurement value			Limit		Antenna	Result
	PK (dB $\mu$ V/m)	AV factor (dB)	AV (dB $\mu$ V/m)	PK (dB $\mu$ V/m)	AV (dB $\mu$ V/m)	(H/V)	(P/F)
1395.500	26.32	---	---	74	54	H	P
2441.000*	85.63	---	---	---	---	H	P
7587.000	33.02	---	---	74	54	H	P
8321.000	33.99	---	---	74	54	H	P
11236.50	37.12	---	---	74	54	H	P
14452.00	44.02	---	---	74	54	H	P
16811.00	46.38	---	---	74	54	H	P
<hr/>							
1498.500	25.33	---	---	74	54	V	P
2441.000*	83.66	---	---	---	---	V	P
4778.500	27.56	---	---	74	54	V	P
7045.000	32.63	---	---	74	54	V	P
13688.50	43.23	---	---	74	54	V	P
15597.50	47.02	---	---	74	54	V	P

\*: fundamental frequency

Test Results-(Measurement Distance: 3m)_Channel high							
Frequency (MHz)	Measurement value			Limit		Antenna	Result
	PK (dB $\mu$ V/m)	AV factor (dB)	AV (dB $\mu$ V/m)	PK (dB $\mu$ V/m)	AV (dB $\mu$ V/m)	(H/V)	(P/F)
1436.000	25.85	---	---	74	54	H	P
2480.000*	86.10	---	---	---	---	H	P
6997.500	31.36	---	---	74	54	H	P
13254.50	43.63	---	---	74	54	H	P
14921.50	46.23	---	---	74	54	H	P
17465.00	47.21	---	---	74	54	H	P
<hr/>							
1437.500	26.99	---	---	74	54	V	P
2480.000*	82.06	---	---	---	---	V	P
5584.000	28.32	---	---	74	54	V	P
7135.000	32.02	---	---	74	54	V	P
11874.00	37.21	---	---	74	54	V	P
14562.50	45.02	---	---	74	54	V	P
16895.50	47.23	---	---	74	54	V	P

\*: fundamental frequency

Remark:

According to the emissions below 18GHz, the data curve is lower than the limit, and the data between 18GHz to 25GHz will be lower than the limit, so they are not recorded in the report.

## Declaration for Bluetooth

### 1. Output power and channel separation of a Bluetooth device in the different operating modes:

The different operating modes (data-mode, acquisition-mode) of a Bluetooth device has no influence on the output power and the channel spacing. There is only one transmitter which is driven by identical input parameters concerning these two parameters.

Only a different hopping sequence will be used. For this reason the check of these RF parameters in one op-mode is sufficient.

### 2. Frequency range of a Bluetooth device:

Hereby we declare that the maximum frequency of this device is: 2402 – 2480 MHz. This is according to the Bluetooth Core Specification (+ critical errata) for devices which will be operated in the USA.

This was checked during the Bluetooth Qualification tests (Test Case: TRM/CA/04-E). Other frequency ranges (e.g. for Spain, France, Japan) which are allowed according the Core Specification are not supported by this device.

### 3 Co-ordination of the hopping sequence in data mode to avoid simultaneous occupancy by multiple transmitters:

Bluetooth units which want to communicate with other units must be organized in a structure called piconet. This piconet consist of max. 8 Bluetooth units. One unit is the master the other seven are the slaves. The master co-ordinates frequency occupation in this piconet for all units. As the master hop sequence is derived from its BD address which is unique for each Bluetooth device, additional masters intending to establish new piconets will always use different hop sequences.

### 4. Example of a hopping sequence in data mode:

Example of a 79 hopping sequence in data mode:

40, 21, 44, 23, 42, 53, 46, 55, 48, 33, 52, 35, 50, 65, 54, 67, 56, 37, 60, 39, 58, 69, 62, 71, 64, 25, 68, 27, 66, 57, 70, 59, 72, 29, 76, 31, 74, 61, 78, 63, 01, 41, 05, 43, 03, 73, 07, 75, 09, 45, 13, 47, 11, 77, 15, 00, 64, 49, 66, 53, 68, 02, 70, 06, 01, 51, 03, 55, 05, 04

### 5. Equally average use of frequencies in data mode and behaviour for short transmissions:

The generation of the hopping sequence in connection mode depends essentially on two input values:

1. LAP/UAP of the master of the connection
2. Internal master clock

The LAP (lower address part) are the 24 LSB's of the 48 BD\_ADDRESS. The BD\_ADDRESS is an unambiguous number of every Bluetooth unit. The UAP (upper address part) are the 24 MSB's of the 48 BD\_ADDRESS.

The internal clock of a Bluetooth unit is derived from a free running clock which is never adjusted and is never turned off. For synchronisation with other units only offset are used. It has no relation to the time of the day. Its resolution is at least half the RX/TX slot length of 312.5  $\mu$ s. The clock has a cycle of about one day (23h30). In most case it is implemented as 28 bit counter. For the deriving of the hopping sequence the entire LAP (24 bits), 4 LSB's (4 bits) (Input 1) and the 27 MSB's of the clock (Input 2) are used. With this input values different mathematical procedures (permutations, additions, XOR- operations) are performed to generate the sequence. This will be done at the beginning of every new transmission.

Regarding short transmissions the Bluetooth system has the following behaviour: The first connection between the two devices is established, a hopping sequence was generated. For transmitting the wanted data the complete hopping sequence was not used. The connection ended.

The second connection will be established. A new hopping sequence is generated. Due to the fact that the Bluetooth clock has a different value, because the period between the two transmission is longer (and it cannot be shorter) than the minimum resolution of the clock (312.5  $\mu$ s). The hopping sequence will always differ from the first one.

## **6. Receiver input bandwidth and behaviour for repeated single or multiple packets:**

The input bandwidth of the receiver is 1 MHz. In every connection one Bluetooth device is the master and the other one is the slave. The master determines the hopping sequence (see chapter 5). The slave follows this sequence. Both devices shift between RX and TX time slot according to the clock of the master.

Additionally the type of connection (e.g. single or multislots packet) is set up at the beginning of the connection. The master adapts its hopping frequency and its TX/RX timing according to the packet type of the connection. Also the slave of the connection will use these settings.

Repeating of a packet has no influence on the hopping sequence. The hopping sequence generated by the master of the connection will be followed in any case. That means, a repeated packet will not be send on the same frequency, it is send on the next frequency of the hopping sequence.

## **7. Dwell time in data mode**

The dwell time of 0.3797s within a 30 second period in data mode is independent from the packet type (packet length). The calculation for a 30 second period is as follows:

Dwell time = time slot length \* hop rate / number of hopping channels \*30s

Example for a DH1 packet (with a maximum length of one time slot) Dwell time =  $625 \mu\text{s} * 1600 \text{ 1/s} / 79 * 30\text{s} = 0.3797\text{s}$  (in a 30s period) For multislot packet the hopping is reduced according to the length of the packet.

Example for a DH5 packet (with a maximum length of five time slots Dwell time =  $5 * 625 \text{ s} * 1600 * 1/5 * 1/\text{s} / 79 * 30\text{s} = 0.3797\text{s}$  (in a 30s period).

This is according the Bluetooth Core Specification V 1.0B (+ critical errata) for all Bluetooth devices. Therefor all Bluetooth devices comply with the FCC dwell time requirement in data mode. This was checked during the Bluetooth Qualification tests. The Dwell time in hybrid mode is measured and stated in the test report.

## 8. Channel Separation in hybrid mode

The nominal channel spacing of the Bluetooth system is 1Mhz independent of the operating mode.

The maximum “initial carrier frequency tolerance” which is allowed for Bluetooth is  $f_{center} = 75 \text{ kHz}$ .

This was checked during the Bluetooth Qualification tests (Test Case: TRM/CA/07-E) for three frequencies (2402, 2441, 2480 MHz). Additionally an example for the channel separation is given in the test report

## 9. Derivation and examples for a hopping sequence in hybrid mode

For the generation of the inquiry and page hop sequences the same procedures as described for the data mode are used (see chapter 5), but this time with different input vectors:

- For the inquiry hop sequence, a predefined fixed address is always used. This results in the same 32 frequencies used by all devices doing an inquiry but every time with a different start frequency and phase in this sequence.
- For the page hop sequence, the device address of the paged unit is used as input vector. This results in the use of a subset of 32 frequencies which is specific for that initial state of the connection establishment between the two units. A page to different devices would result in a different subset of 32 frequencies.

So it is ensured that also in hybrid mode the frequency use equally averaged.

Example of a hopping sequence in inquiry mode:

48, 50, 09, 13, 52, 54, 41, 45, 56, 58, 11, 15, 60, 62, 43, 47, 00, 02, 64, 68, 04, 06, 17, 21, 08, 10, 66, 70, 12, 14, 19, 23

Example of a hopping sequence in paging mode:

08, 57, 68, 70, 51, 02, 42, 40, 04, 61, 44, 46, 63, 14, 50, 48, 16, 65, 52, 54, 67, 18, 58, 56, 20, 53, 60, 62, 55, 06, 66, 64

## **10. Receiver input bandwidth and synchronisation in hybrid mode:**

The receiver input bandwidth is the same as in the data mode (1 MHz). When two Bluetooth devices establish contact for the first time, one device sends an inquiry access code, the other device is scanning for this inquiry access code. If two devices have been connected previously and want to start a new transmission, a similar procedure takes place. The only difference is, instead of the inquiry access code, an special access code, derived from the BD\_ADDRESS of the paged device will be, will be sent by the master of this connection.

Due to the fact that both units have been connected before (in the inquiry procedure) the paging unit has timing and frequency information about the page scan of the paged unit. For this reason the time to establish the connection is reduced considerable.

## **11. Spread rate / data rate of the direct sequence signal**

The Spread rate / Data rate in inquiry and paging mode can be defined via the access code. The access code is the only criterion for the system to check if there is a valid transmission or not. If you regard the presence of a valid access code as one bit of information, and compare it with the length of the access code of 68 bits, the Spread rate / Data rate will be 68/1.

## **12 Spurious emission in hybrid mode**

The dwell time in hybrid mode is shorter than in data mode. For this reason the spurious emissions average level in data mode is worst case. The spurious emissions peak level is the same for both modes.

## **13. Peak power spectral density measurement**

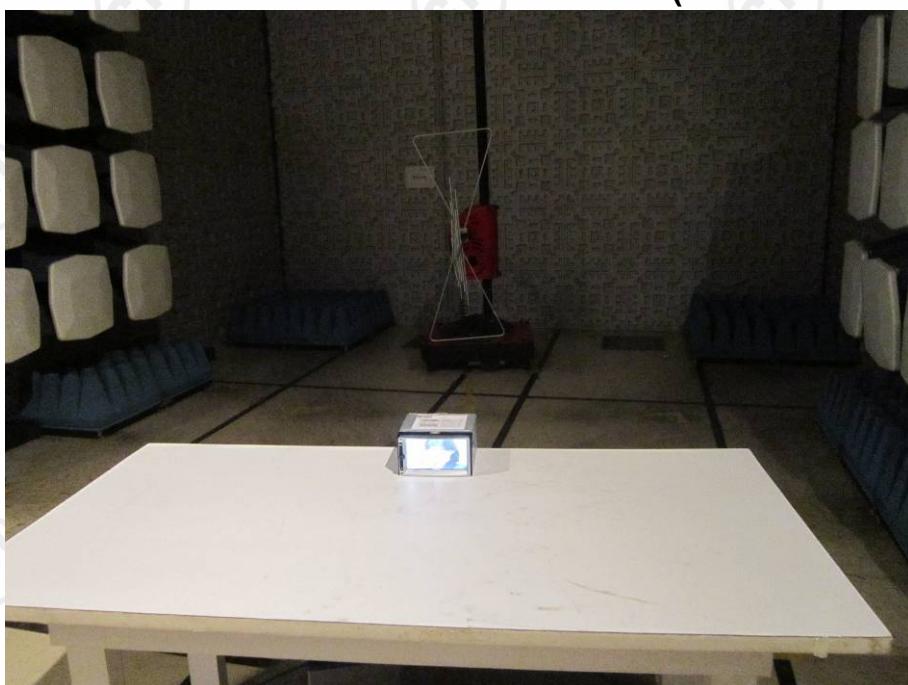
Since the transmitter is only active for some milliseconds on one channel you would get a result with many interruptions if using a sweep time of e.g. 1s as stated in the FCC rules. Therefore a fast sweep in maxhold function is used instead and the EUT is activated several times until the measurement curve has stabilized.

## APPENDIX 1 PHOTOGRAPHS OF TEST SETUP

### TEST SETUP OF RADIATED EMISSION (Below 30MHz)



### TEST SETUP OF RADIATED EMISSION (30MHz~1GHz)



### TEST SETUP OF RADIATED EMISSION (Above1GHz)



## APPENDIX 2 PHOTOGRAPHS OF EUT



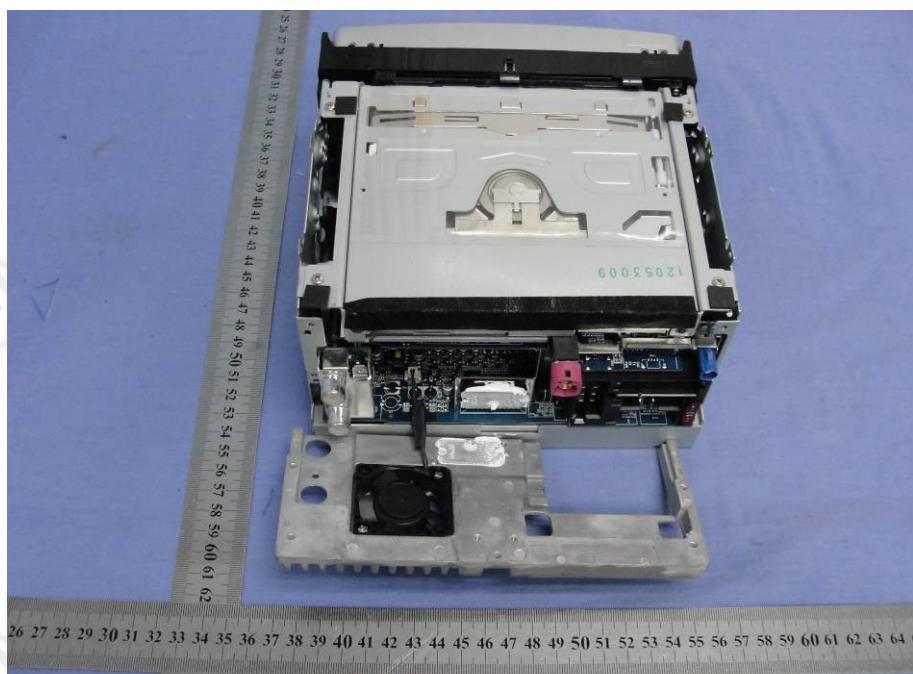
View of EUT-1



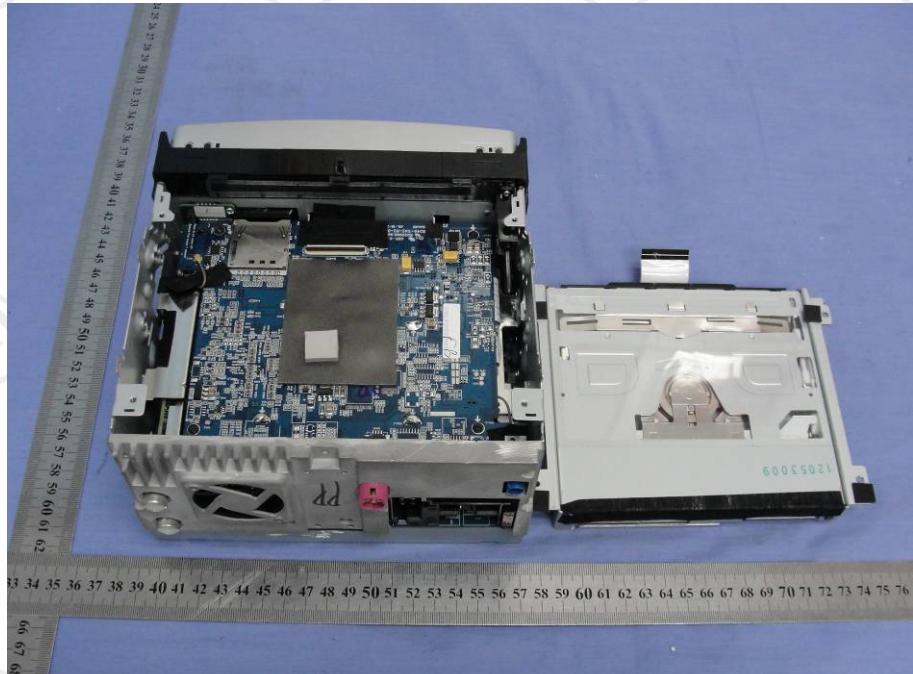
View of EUT-2



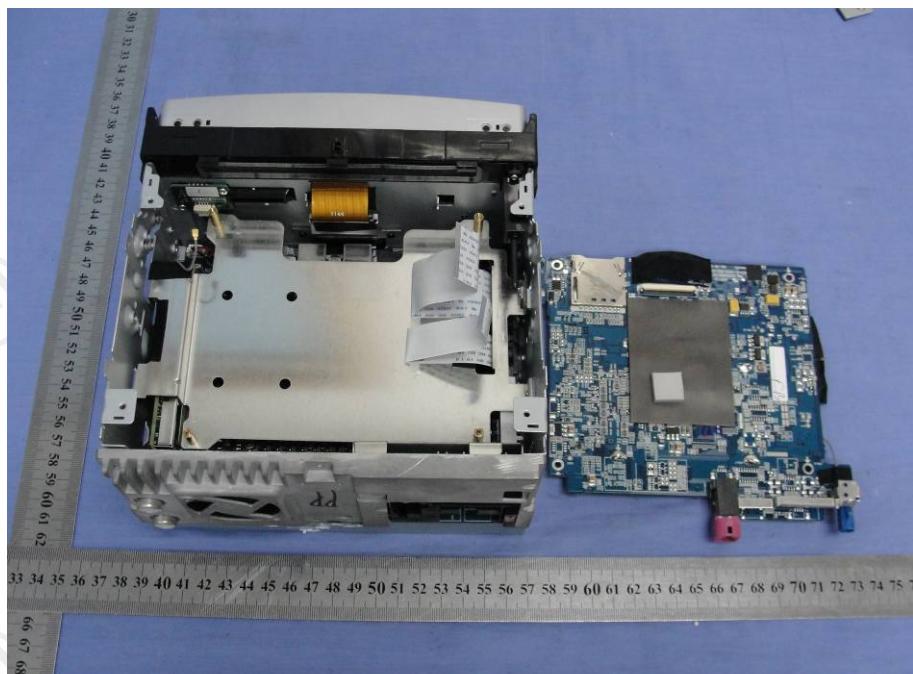
View of EUT-3



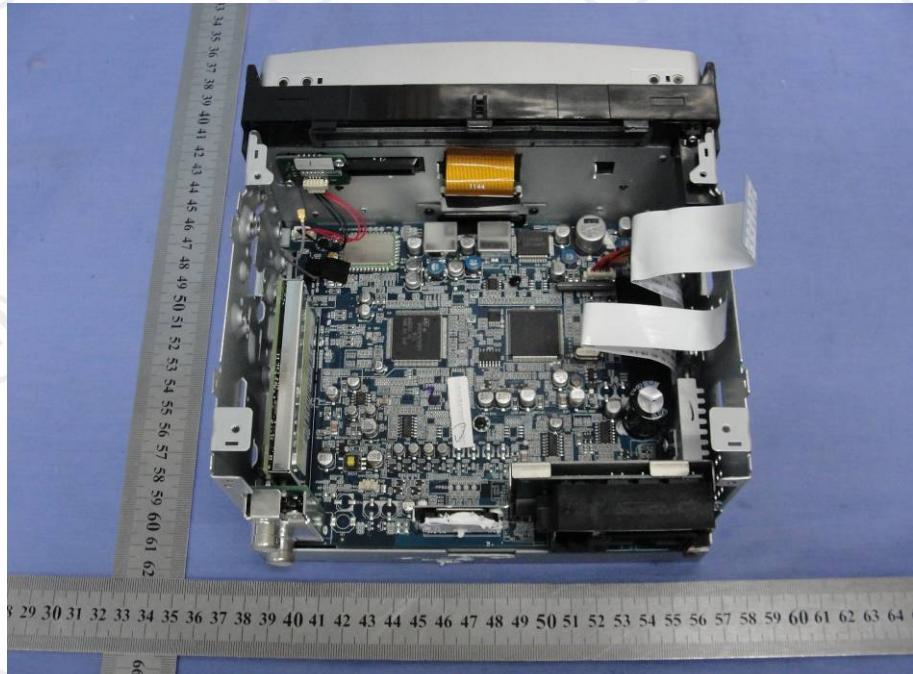
View of EUT-4



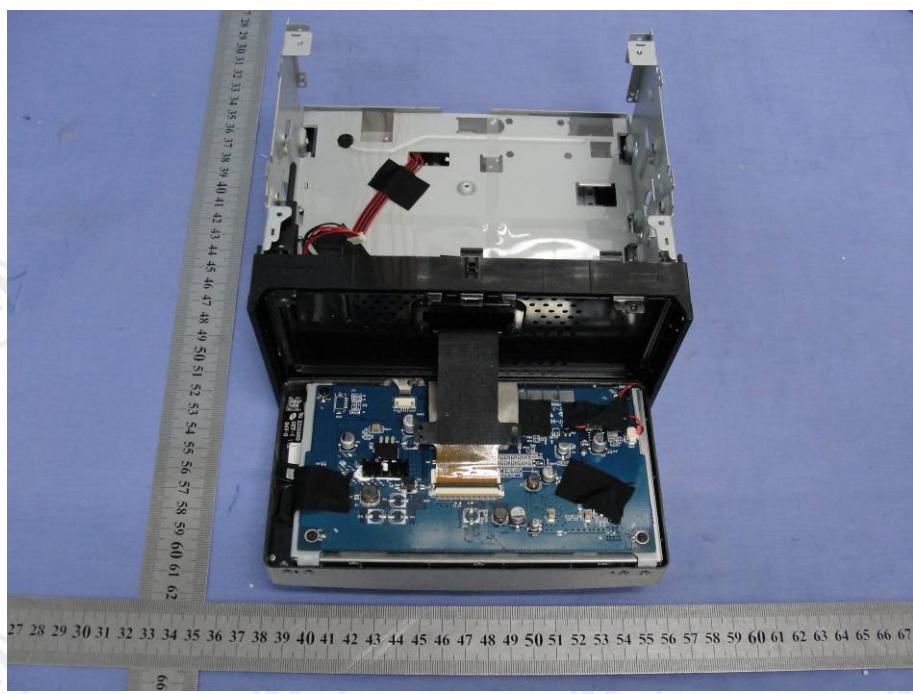
View of EUT-5



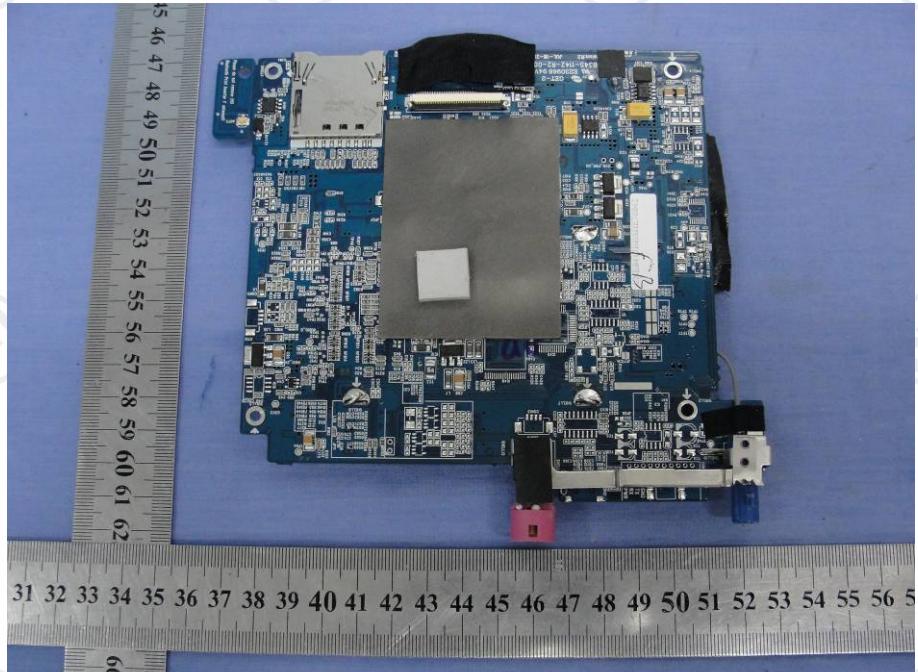
View of EUT-6



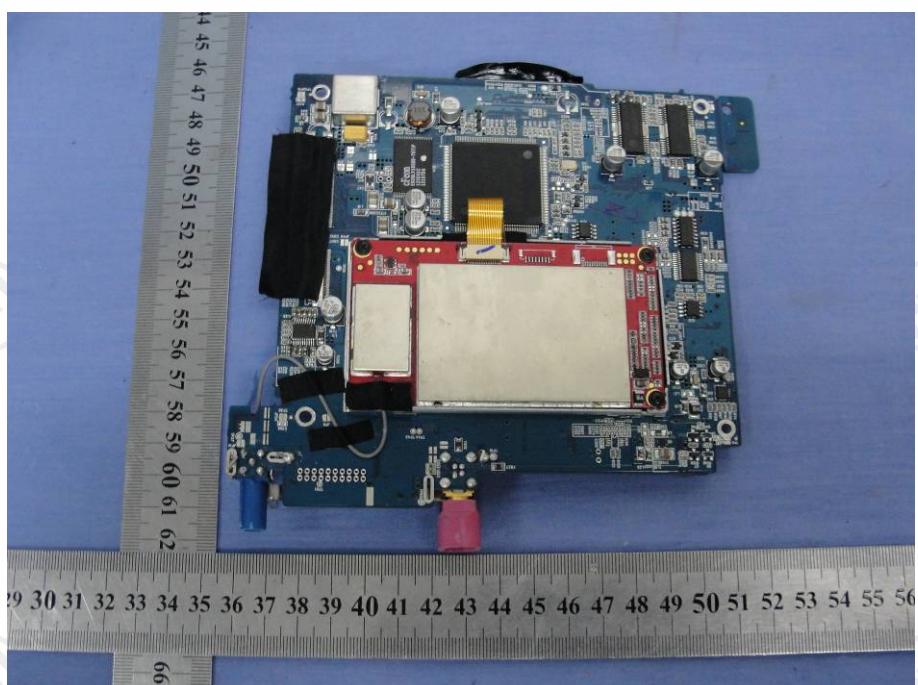
View of EUT-7



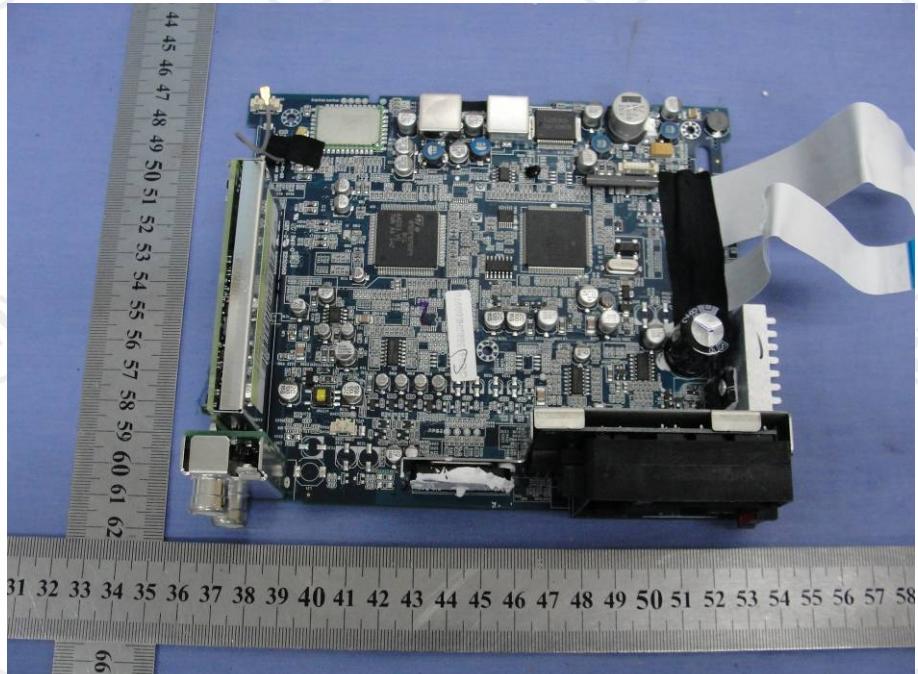
View of EUT-8



View of EUT-9



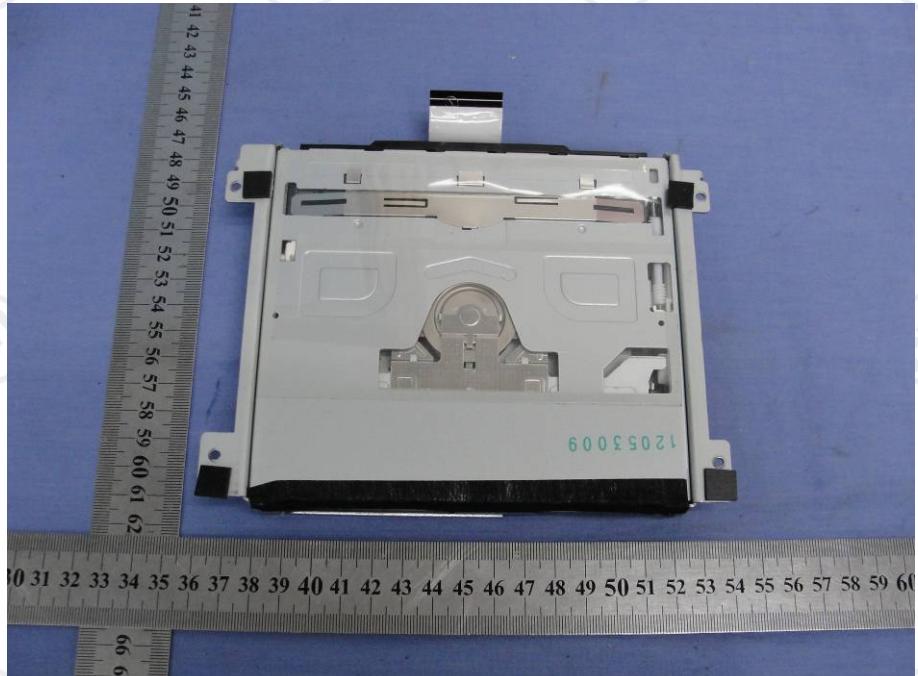
View of EUT-10



View of EUT-11



View of EUT-12



View of EUT-13

\*\*\* End of report \*\*\*

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