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EMI TEST REPORT

Device Under Test : ZigBee Module

Model Number : ZBM-2400

Client : Chilin Eletronics Co. Ltd.

FCC ID: CO9ZBM2400

IC: 10396A-ZBM2400



This Test report applied to above tested sample only.
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 Taiwan. R.O.C.



Applicant : Chilin Eletronics Co., Ltd.

3F No.4, Lane 81, Chien-I Road, Chung-Ho Dist.
 New Taipei City, Taiwan, R.O.C.

Manufacturer : Chilin Eletronics Co., Ltd.

Trade Name : Chilin

EUT Description : ZigBee Module

Model Number : ZBM-2400

Measurement Description Used :

FCC 47 CFR, Part 15 Subpart C (Oct. 2011); C63.4(2003); KDB558074 D01
 and
 Canada RSS-Gen i3 and RSS-210 i8 (Dec. 2010) Test site no. 10479A-1

Summary of Test Data

Name of Test	FCC Part. No.	IC RSS-210	Results
Antenna Requirement	15.203	RSS-Gen_7.1.4	Complied
Radiated Emission	15.247 (d)	RSS-210_2.2	Complied
Emission Bandwidth	15.247 (a)(2)	RSS-210_A8.2 (a)	Complied
Output Power Requirement	15.247 (b)	RSS-210_A8.4 (4)	Complied
Power Density Requirement	15.247 (e)	RSS-210_A8.2 (b)	Complied
Spurious Emissions	15.247 (d)	RSS-210_A8.5	Complied
Maximum Unwanted Emission Levels	15.247 (d)	RSS-210_2.2	Complied
Conducted Emission	15.207	RSS-Gen_7.2.2	----

Test Conditions: Temperature: 26°C.. Humidity: 55%

Date of Issue : July 25, 2012

Date of Test : May 08-July 24, 2012

Test Officer : Shin-Yen Du

Technical Manager : Ming-Hong Ko

Shin-Yen Du

Ko Ming Hong



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1. GENERAL INFORMATION

1.1. INSTRUMENT Under Test (EUT)

Type	: ZigBee Module
Model Number	: ZBM-2400 Ver 1.0
Manufacturer	: Chilin Eletronics Co., Ltd. 3F No.4, Lane 81, Chien-I Road, Chung-Ho Dist, New Taipei City, Taiwan, R.O.C.

1.2. Product Description

The ZBM-2400 is a 2.4GHz transceiver module that can receive signal from transmitter and then retransmit the signal to other ZigBee modules act as a repeater. Due to this ZigBee function, its transmission can be lower than other structures. Most application is for wireless master/secondary clock system transmission.

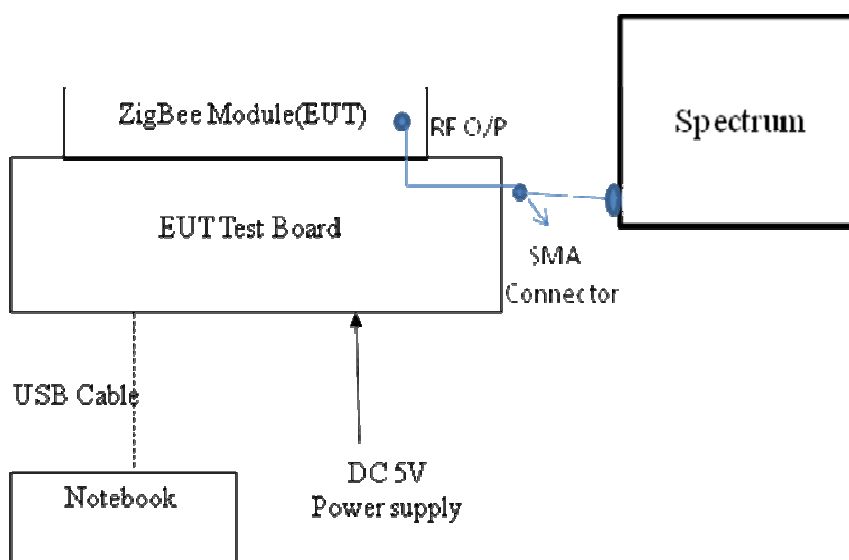


Photo of ZBM-2400



1.3 System Test Description

The applicant provides a channel and continuous mode selection application on the notebook. We can select the Low (2405MHz) Mid(2440MHz) and High(2480MHz) channel respectively before we do the testing. After channel selection we remove the notebook for test. The EUT was tested with a 5V DC power supply. Auxiliary equipment : 1. Notebook Acer Aspire 5100 2. DC Power Supply MRL TH009N.



Configuration of System

1.4 Restricted Bands of Operation

According to 15.205, the Restricted bands of operation listed as follows.

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
¹ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(²)
13.36-13.41			

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

² Above 38.6



2. ANTENNA REQUIREMENT

2.1 Standard Applicable

According to 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.

And according to 15.247 (b), if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

2.2 Antenna Description

Antenna type: Chip Antenna

Antenna gain: 2 dBi typ.

	In	mm		
L	0.276 ± 0.008	7.00 ± 0.20		
W	0.079 ± 0.008	2.00 ± 0.20		
T	0.047 +.004/-0.008	1.20 +0.1/-0.2		
a	0.020 ± 0.012	0.50 ± 0.30		

Antenna Mechanical Dimintions



3. RADIATED EMISSION MEASUREMENT

3.1. Standard Applicable

For unintentional radiator, the radiated emission shall comply with 15.109(a).

For intentional radiators, according to 15.247 (a), operation under this provision is limited to frequency hopping and direct sequence spread spectrum, and the out band emission shall be comply with 15.247 (c). Radiated Band Edge Tests follow KDB 558074 D01.

3.2 Measurement Description

Set up the EUT in the Chamber on a 80cm high wooden 360 degree turn table. The distance between EUT and receiving antenna is 3M. Set the EMI receiver RBW to 120kHz for below 1GHz emission measurement and set the EMI receiver RBW to 1MHz for above 1GHz. Execute pre-scan for V and H measurement to find the maximum emission when antenna tower raising from 1M to 4 M and evaluate all three orthogonal planes . After determine the the maximum emission position then execute the emission measurement. Please refer to Configuration of Measurement below. After evaluate the test results, horizontal emissions were larger than vertical emissions for low, middle and high channel. The Band Edge emission horizontal results please refer to page 24. Radiated Band Edge Emission in 2310 to 2390 MHz is very low, on the other hand, Radiated Band Edge Emission in 2483.5 to 2500 MHz is about 50dB below the carrier.

3.3 Measurement Instrument

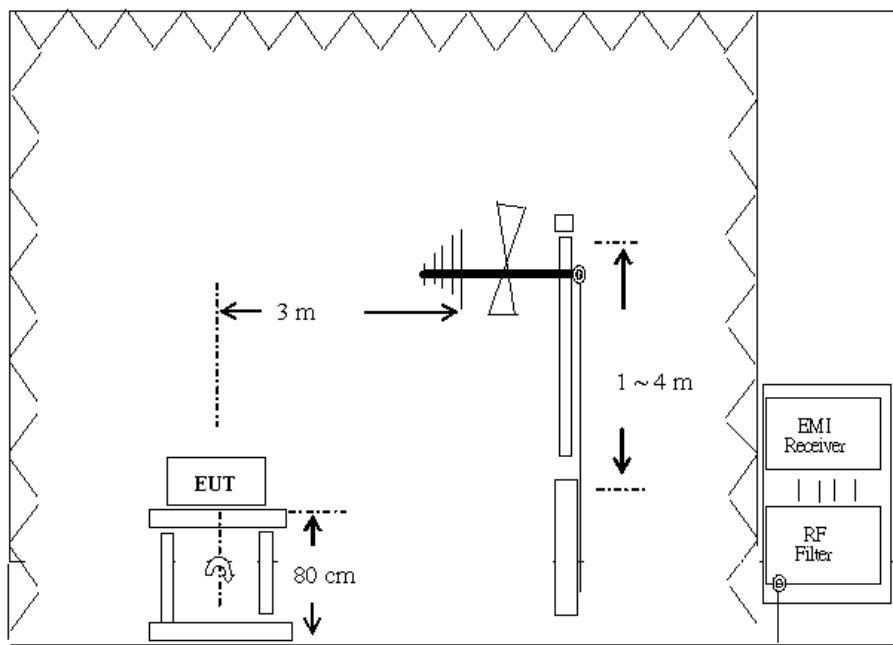
The following test Measurement Instruments are used during the radiated emission tests:

Type	Manufacturer	Model No.	Last Cal.	Cal. Interval
EMI Receiver	HP	8546A	2012.06.25	1 Year
Horn Antenna	EMCO	3115	2012.06.08	1 Year
Horn Antenna	EMCO	3116	2012.05.14	1 Year
BiLog Antenna	EMCO	3142B	2012.06.05	1 Year



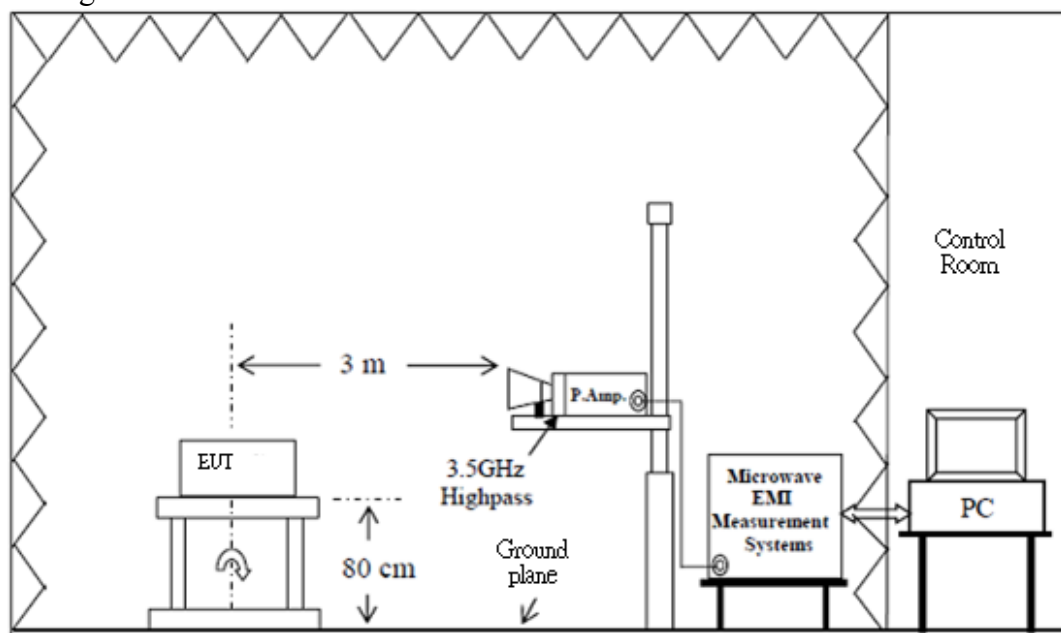
3.4. Block Diagram of Test Setup

Configuration of Measurement under 3.5GHz



- Note :
1. 30~1000MHz testing Biconilog Antenna is used °
 2. 1GHz~3.5GHz testing 3115 Horn Antenna is used °

Configuration of Measurement above 3.5GHz



Note: 3.5GHz~18GHz testing 3116 Horn Antenna is used °



3.5. Radiation Limit

FREQUENCY MHz	DISTANCE Meters	FIELD STRENGTHS LIMITS	
		$\mu\text{V/m}$	$\text{dB}\mu\text{V/m}$
30 ~ 88	3	100	40.0
88 ~ 216	3	150	43.5
216 ~ 960	3	200	46.0
above 960	3	500	54.0

- Remark : (1) Emission level ($\text{dB}\mu\text{V/m}$) = $20 \log$ Emission level ($\mu\text{V/m}$)
 (2) The tighter limit applies at the edge between two frequency bands.
 (3) Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.

3.6. RF exposure evaluation

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.



3.7. TEST DATA OF RADIATED EMISSION

Tx Freq. : 2405MHz

Tx/Rx Mode

Harmonic	Frequency (MHz)	Peak@3m (dBμV/m)		Limit (dBμV/m)	Margin (dB)		Results
		Hor.	Ver.		Hor.	Ver.	
2	4810	---	---	---	---	---	---
3	7215	---	---	---	---	---	---
4	9620	---	---	---	---	---	---
5	12025	---	---	---	---	---	---
6	14430	---	---	---	---	---	---
7	16835	---	---	---	---	---	---
8	19240	---	---	---	---	---	---
9	21645	---	---	---	---	---	---
10	24050	---	---	---	---	---	---

Out of Band Emissions

Freq. (MHz)	Polari. (H/V)	I.R. (dBμV)	C.F. (dB)	Reading@3m (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Results
51.8	H	42.1	-18.2	23.9	40.0	-16.1	Pass
141.6	H	39.3	-17.6	21.7	43.5	-21.8	Pass
226.4	H	36.2	-13.8	22.4	46.0	-23.6	Pass
304.0	H	34.5	-11.4	23.1	46.0	-22.9	Pass
311.3	H	33.5	-11.1	22.4	46.0	-23.6	Pass
350.1	H	32.6	-9.9	22.7	46.0	-23.3	Pass
51.8	V	57.3	-18.2	39.1	40.0	-0.9	Pass
144.0	V	37.0	-17.4	19.6	43.5	-23.9	Pass
211.9	V	31.5	-14.4	17.1	43.5	-26.4	Pass
304.0	V	32.0	-11.4	20.6	46.0	-25.4	Pass
311.3	V	31.6	-11.1	20.5	46.0	-25.5	Pass
---	---	---	---	---	---	---	---
Uncertainty : ±4.3dB							

- Note : 1. Out of Band Immisions meet the limits , Please refer to section 3.7 Charts .
 2. --- means that the emission under test system background noise .
 3. Reading@3m = I.R.(Instrument Reading)+C.F.(Cal. Factor) .
 4. Cal Factor =Antenna factor+Cable loss-Preamplifier gain .
 5. Margin= Reading@3m -Limit .



Tx Freq. : 2440MHz Tx/Rx Mode

Harmonic	Frequency (MHz)	Peak@3m (dBμV/m)		Limit (dBμV/m)	Margin (dB)		Results
		Hor.	Ver.		Hor.	Ver.	
2	4880	---	---	---	---	---	---
3	7320	46.5	46.3	54.0	-7.5	-7.7	Pass
4	9760	---	---	---	---	---	---
5	12200	---	---	---	---	---	---
6	14640	---	---	---	---	---	---
7	17080	---	---	---	---	---	---
8	19520	---	---	---	---	---	---
9	21960	---	---	---	---	---	---
10	24400	---	---	---	---	---	---

Out of Band Immision

Freq. (MHz)	Polari. (H/V)	I.R. (dBμV)	C.F. (dB)	Reading@3m (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Results
51.8	H	42.7	-18.2	24.5	40.0	-15.5	Pass
141.6	H	38.6	-17.6	21.0	43.5	-22.5	Pass
304.0	H	33.5	-11.4	22.1	46.0	-23.9	Pass
335.6	H	32.2	-10.3	21.9	46.0	-24.1	Pass
342.8	H	31.9	-10.1	21.8	46.0	-24.2	Pass
350.1	H	31.9	-9.9	22.0	46.0	-24.0	Pass
37.3	V	39.7	-10.7	29.0	40.0	-11.0	Pass
54.3	V	55.5	-18.3	37.2	40.0	-2.8	Pass
144.0	V	36.8	-17.4	19.4	43.5	-24.1	Pass
304.0	V	31.7	-11.4	20.3	46.0	-25.7	Pass
---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---
Uncertainty : ±4.3dB							

- Note : 1. Out of Band Immisions meet the limits , Please refer to section 3.7 Charts .
 2. --- means that the emission under test system background noise .
 3. Reading@3m =I.R.(Instrument Reading)+C.F.(Cal. Factor) .
 4. Cal Factor =Antenna factor+Cable loss-Preamplifier gain .
 5. Margin= Reading@3m -Limit .



Tx Freq. : 2480MHz Tx/Rx Mode

Harmonic	Frequency (MHz)	Peak@3m (dBμV/m)		Limit (dBμV/m)	Margin (dB)		Results
		Hor.	Ver.		Hor.	Ver.	
2	4960	---	---	---	---	---	---
3	7440	---	48.5	54.0	---	-5.5	Pass
4	9920	---	---	---	---	---	---
5	12400	---	---	---	---	---	---
6	14880	---	---	---	---	---	---
7	17360	---	---	---	---	---	---
8	19840	---	---	---	---	---	---
9	22320	---	---	---	---	---	---
10	24800	---	---	---	---	---	---

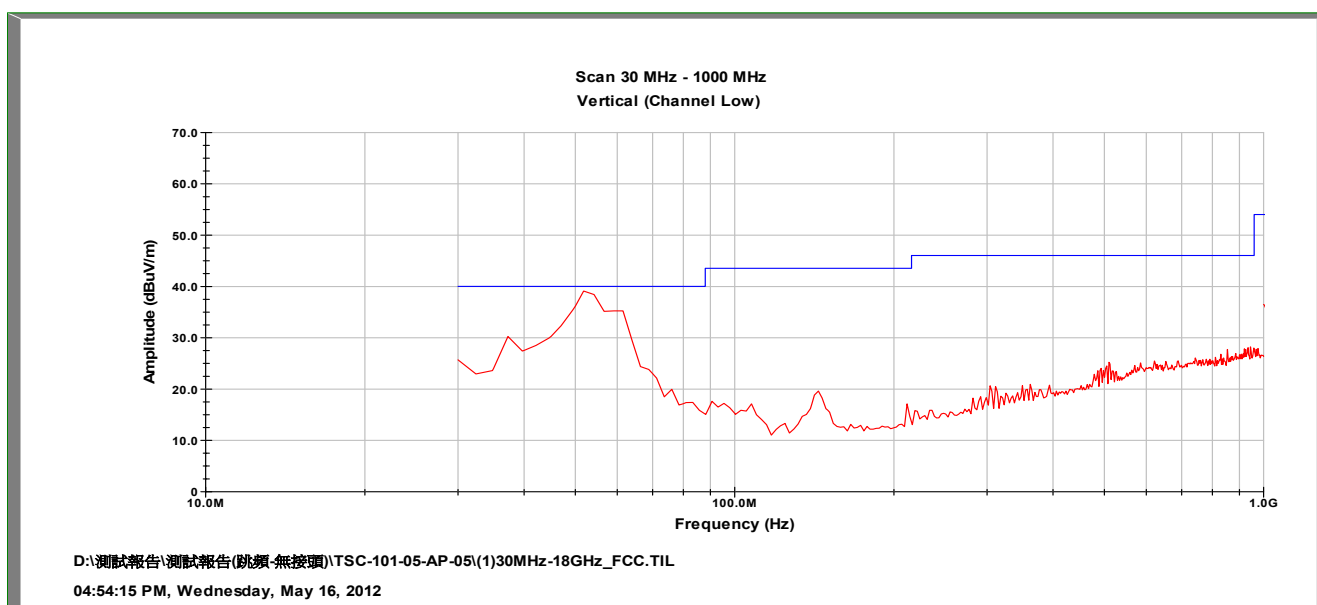
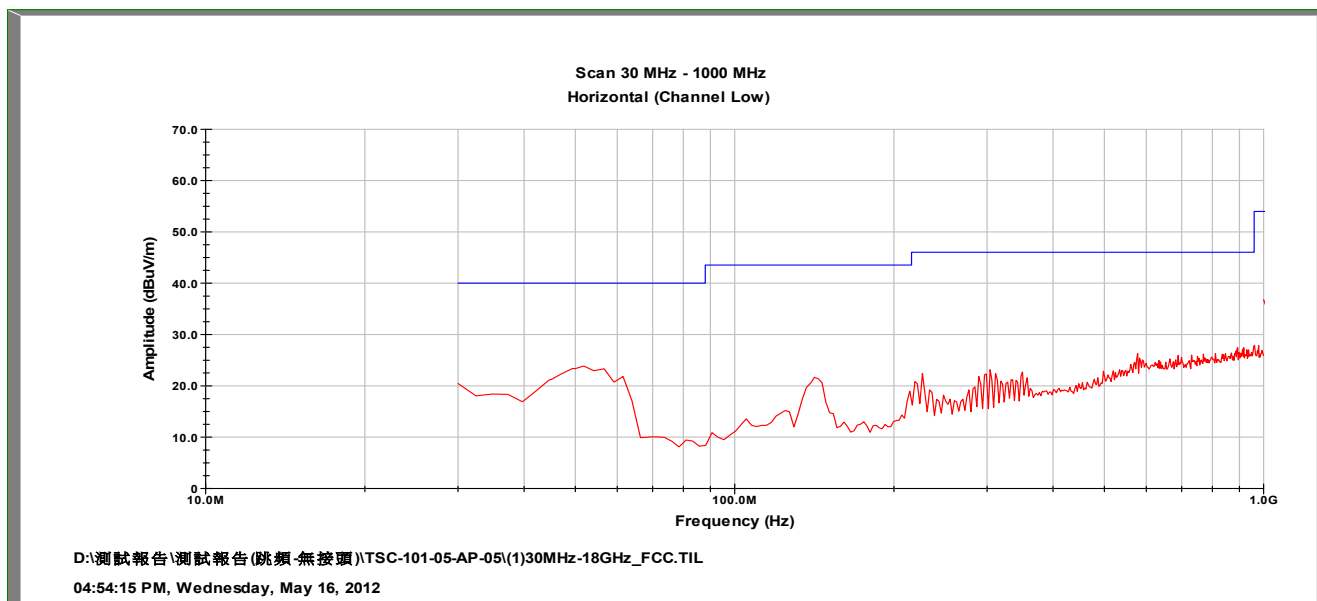
Out of Band Immision

Freq. (MHz)	Polari. (H/V)	I.R. (dBμV)	C.F. (dB)	Reading@3m (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Results
49.4	H	43.5	-17.8	25.7	40.0	-14.3	Pass
141.6	H	39.2	-17.6	21.6	43.5	-21.9	Pass
214.3	H	34.7	-14.3	20.4	43.5	-23.1	Pass
304.0	H	33.5	-11.4	22.1	46.0	-23.9	Pass
342.8	H	31.3	-10.1	21.2	46.0	-24.8	Pass
350.1	H	31.7	-9.9	21.8	46.0	-24.2	Pass
37.3	V	40.2	-10.7	29.5	40.0	-10.5	Pass
51.8	V	57.4	-18.2	39.2	40.0	-0.8	Pass
141.6	V	36.0	-17.6	18.4	43.5	-25.1	Pass
306.4	V	32.3	-11.3	21.0	46.0	-25.0	Pass
---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---
Uncertainty : ±4.3dB							

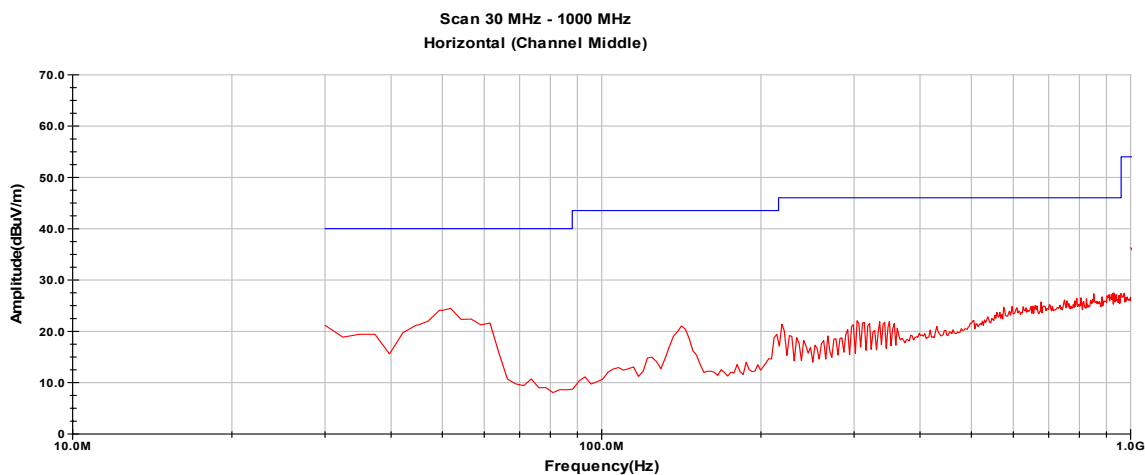
- Note : 1. Out of Band Immisions meet the limits , Please refer to section 3.7 Charts .
 2. --- means that the emission under test system background noise .
 3. Reading@3m =I.R.(Instrument Reading)+C.F.(Cal. Factor) .
 4. Cal Factor =Antenna factor+Cable loss-Preamplifier gain .
 5. Margin= Reading@3m -Limit .



3.8 Charts of Test Data

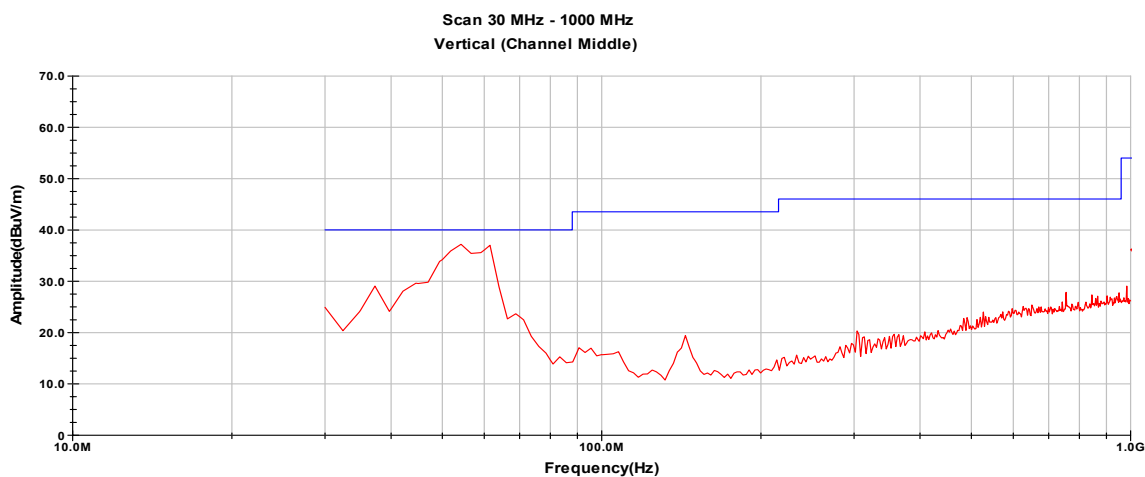


RADIATED EMISSION under 1GHz (Tx Freq.2405MHz)



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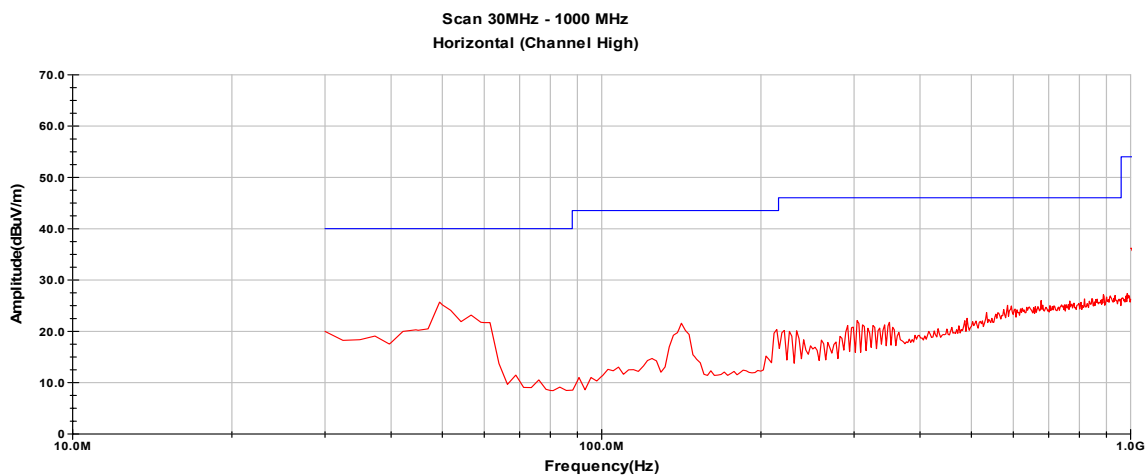
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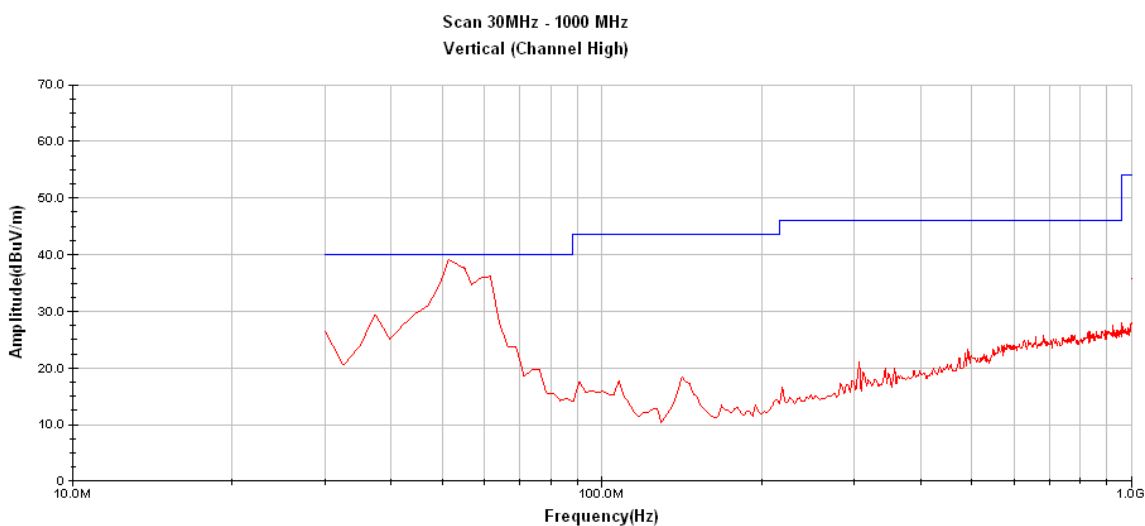
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RADIATED EMISSION under 1GHz (Tx Freq.2440MHz)



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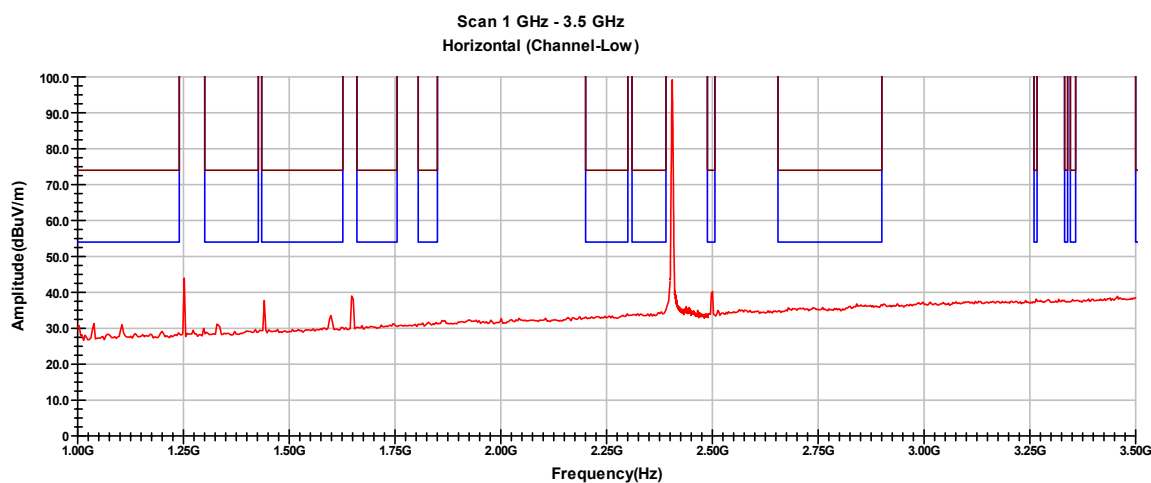
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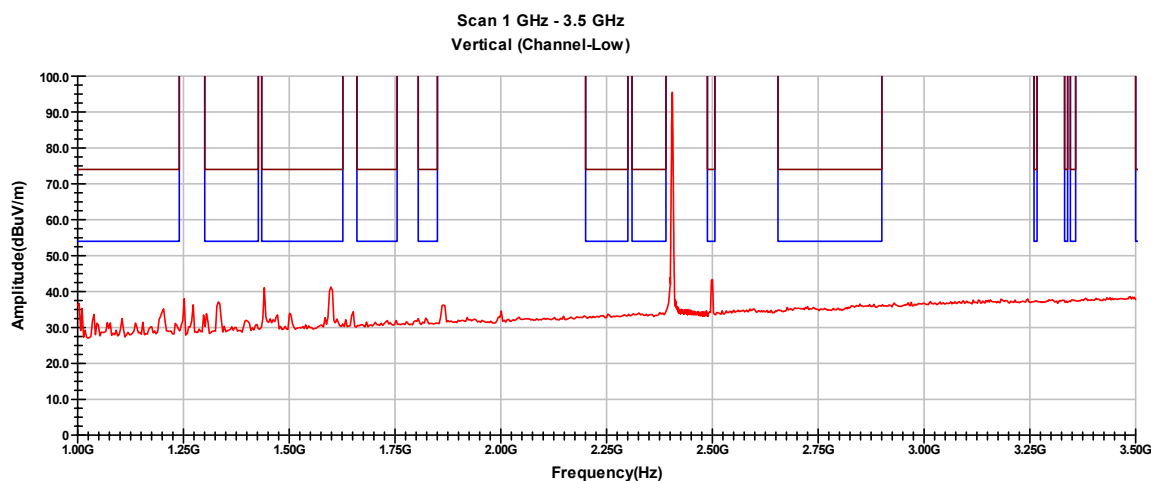
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RADIATED EMISSION under 1GHz (Tx Freq. 2480MHz)



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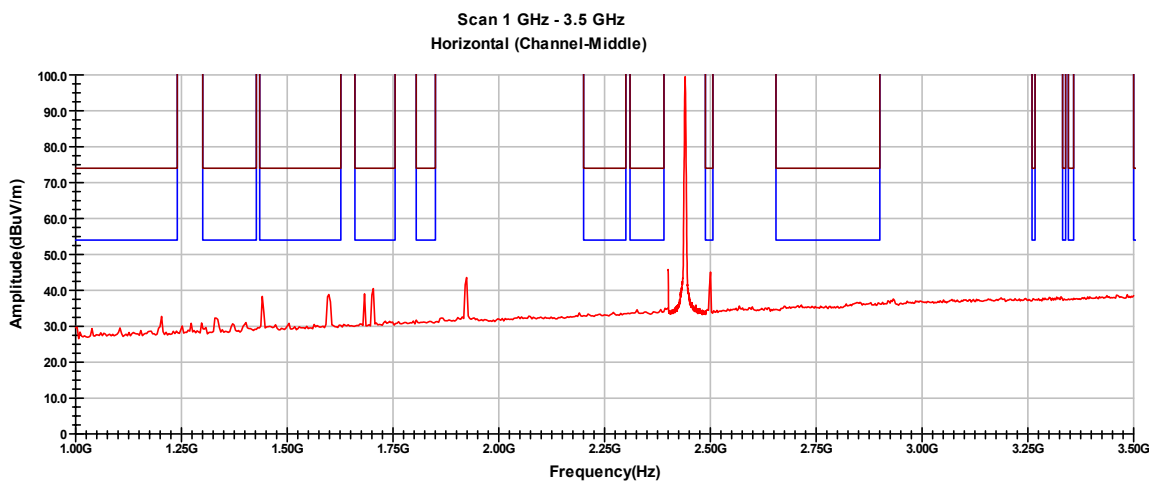
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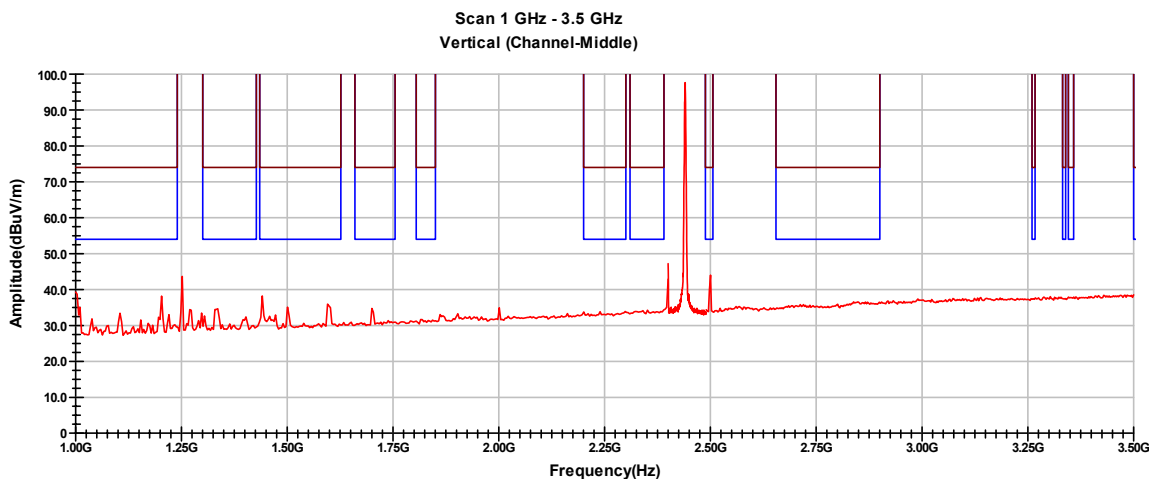
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1 ~ 3.5GH RADIATED EMISSION (Tx Freq.2405MHz)



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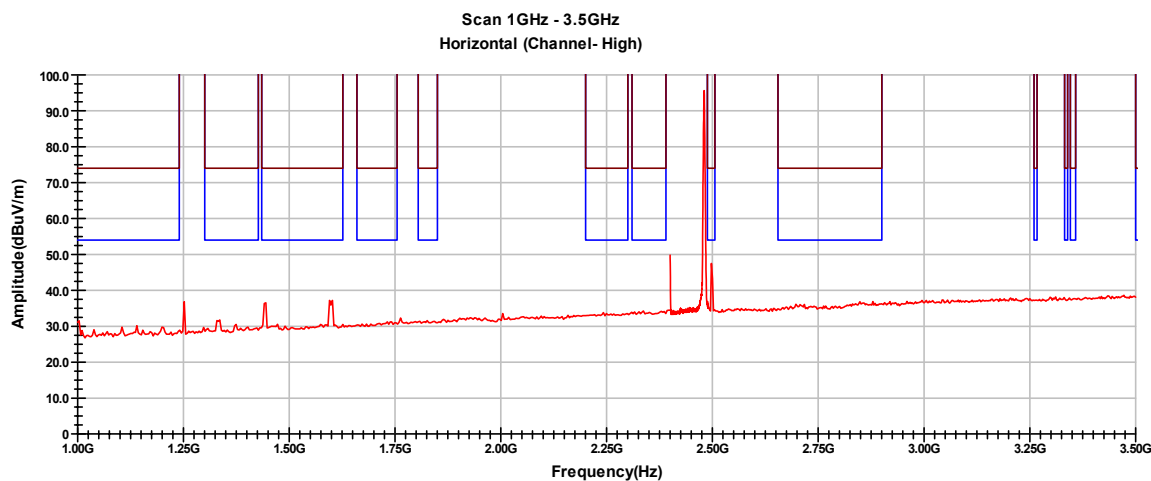
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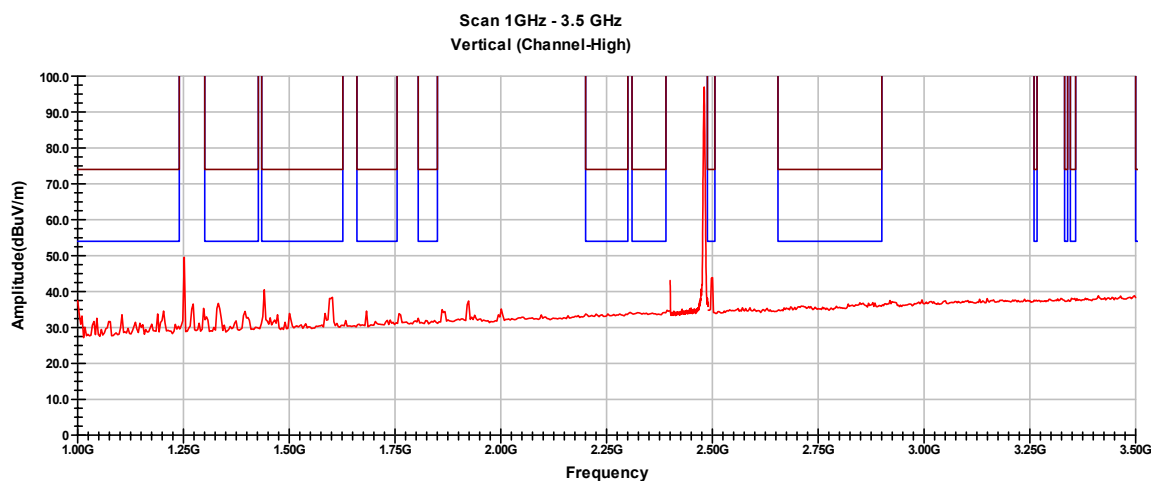
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1 ~ 3.5GHz RADIATED EMISSION (Tx Freq.2440MHz)



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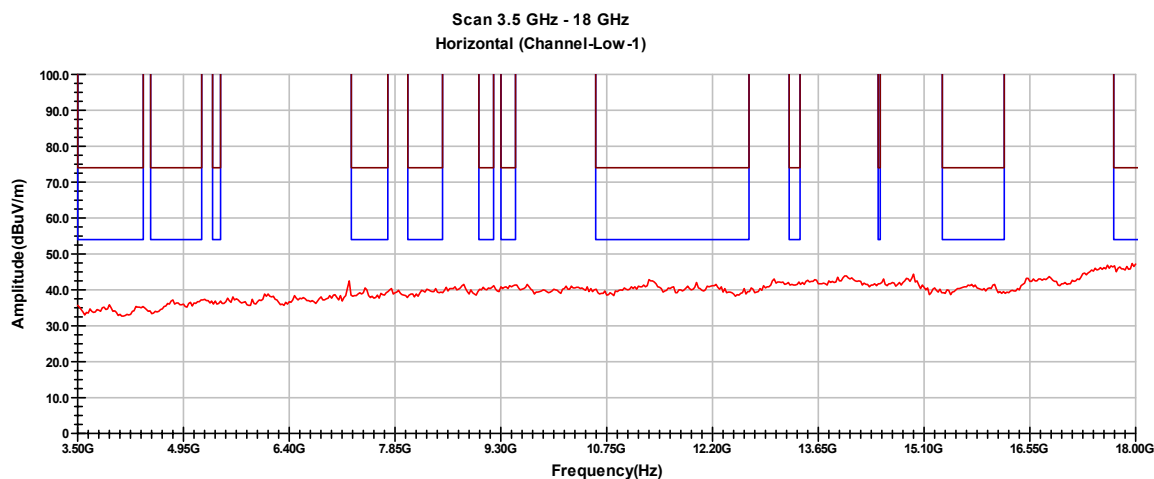
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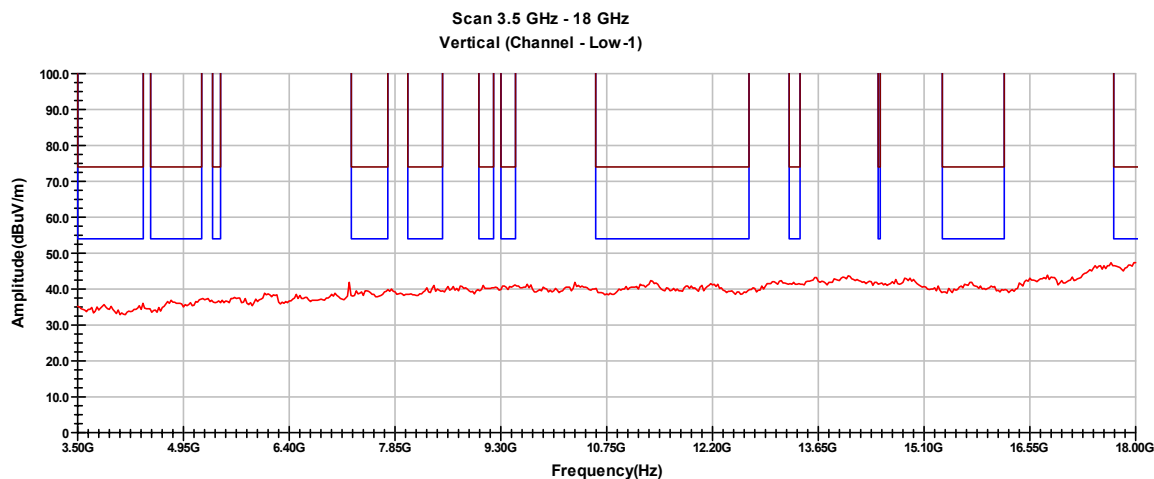
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1 ~ 3.5GHz RADIATED EMISSION (Tx Freq.2480MHz)

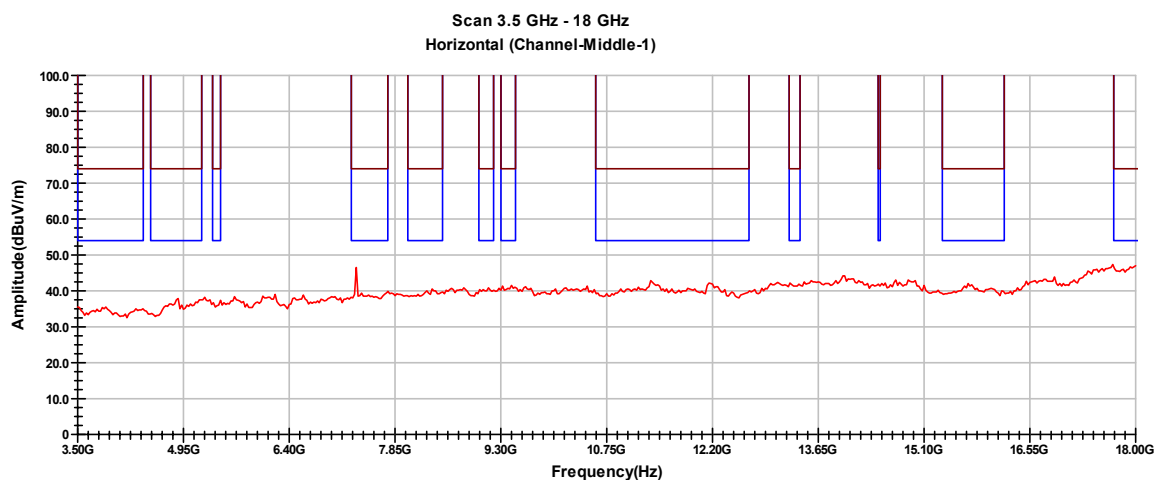


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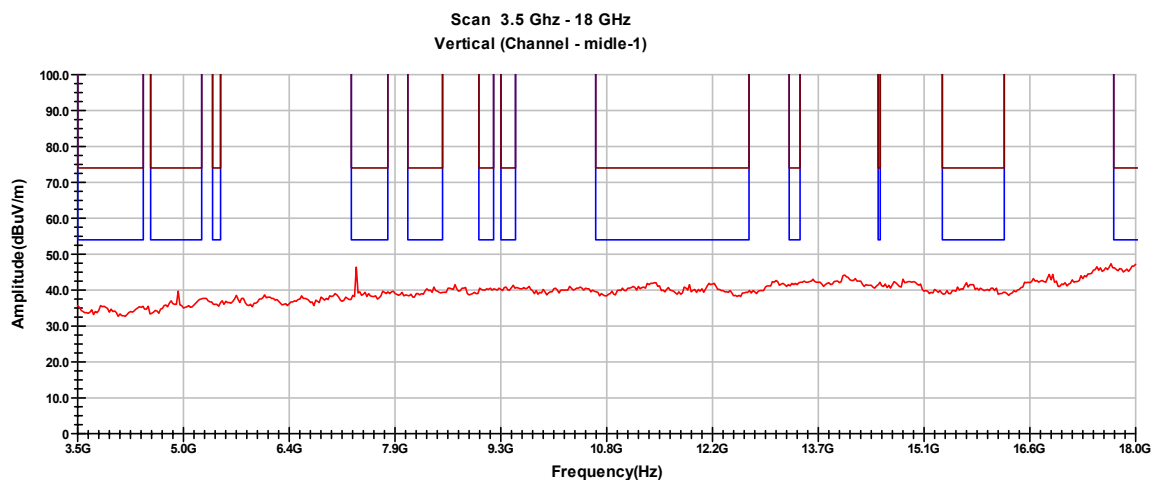
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3.5 ~ 18GH RADIATED EMISSION (Tx Freq.2405MHz)



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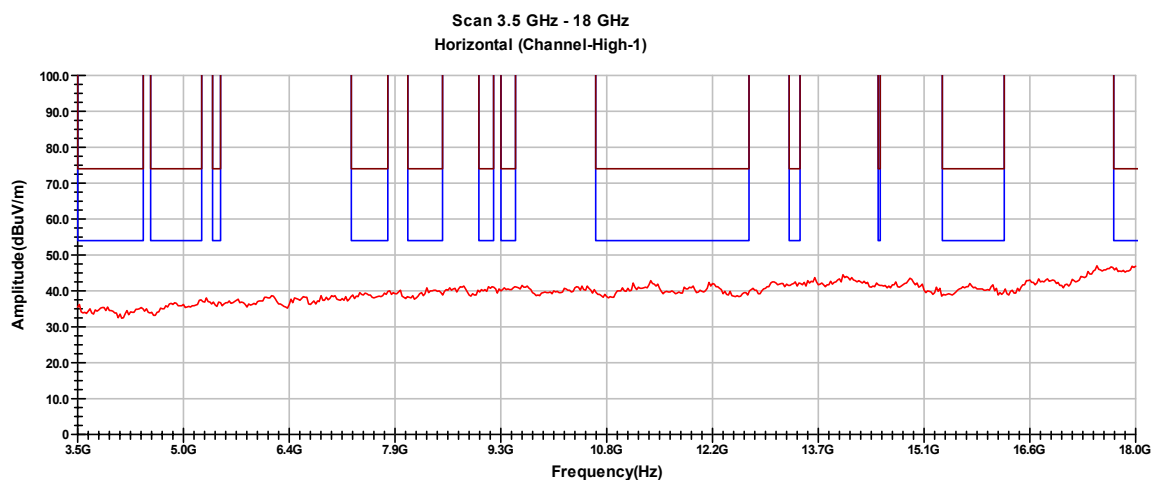
10:57:34 AM, Tuesday, May 22, 2012



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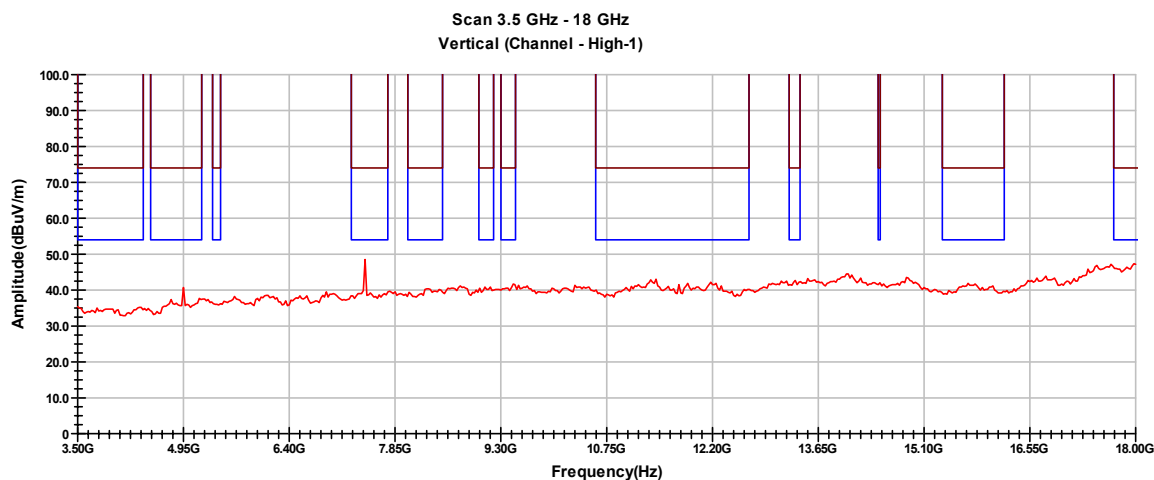
10:57:34 AM, Tuesday, May 22, 2012

3.5 ~ 18GHz RADIATED EMISSION (Tx Freq.2440MHz)



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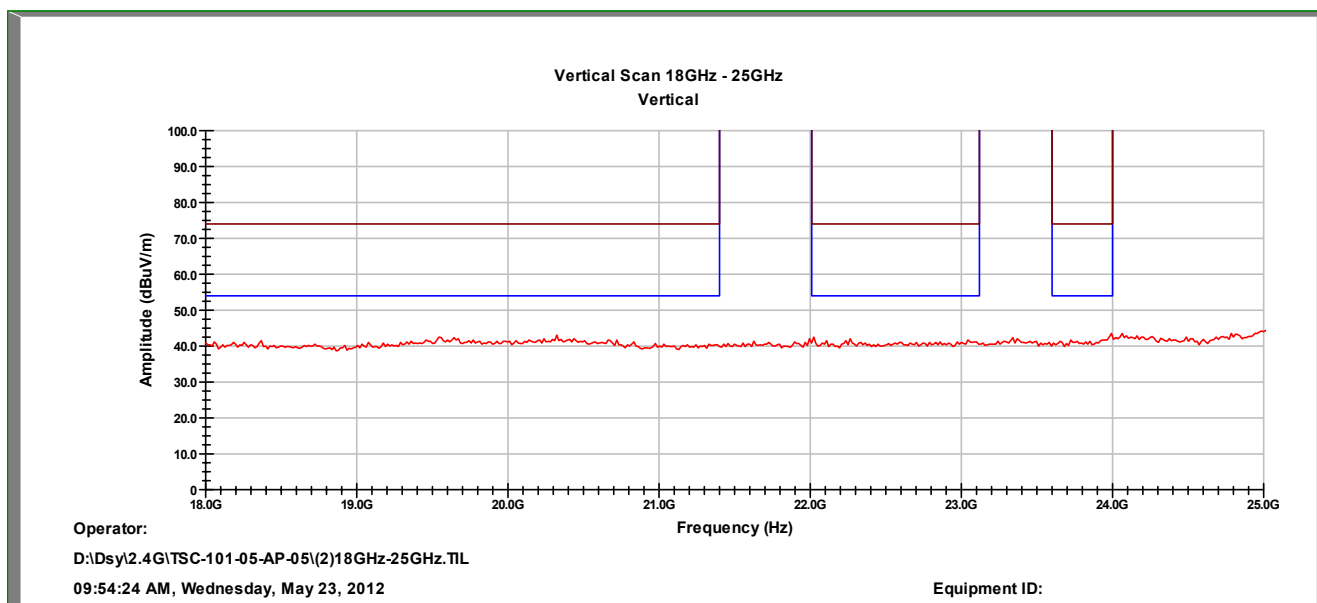
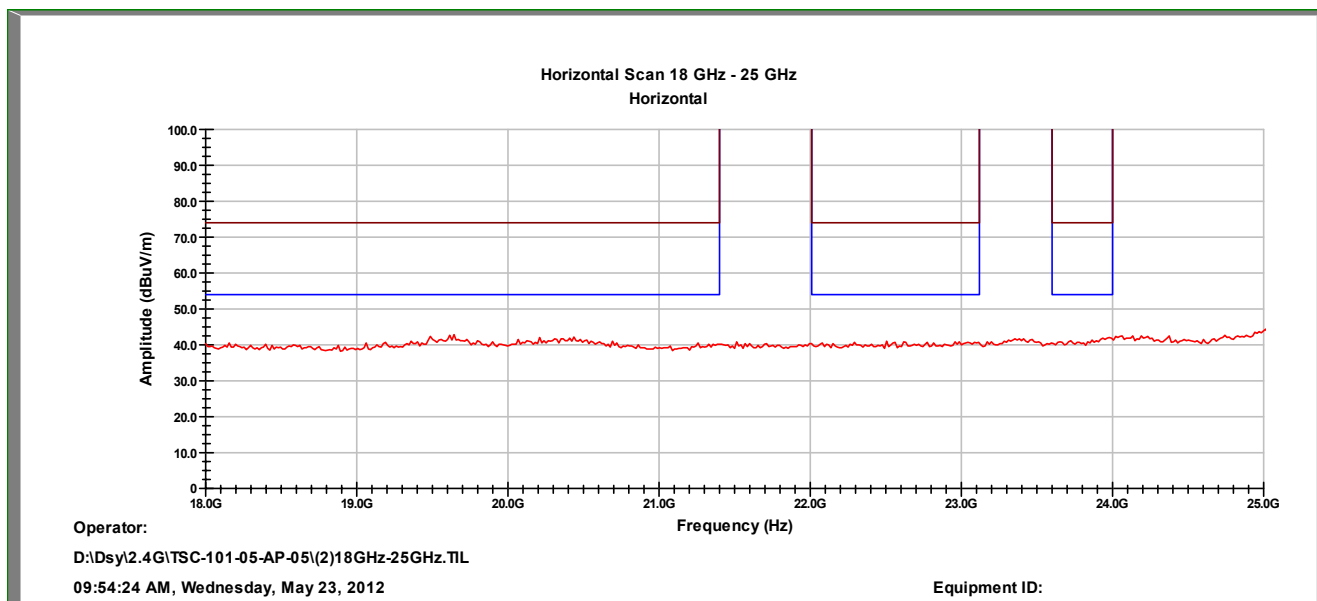
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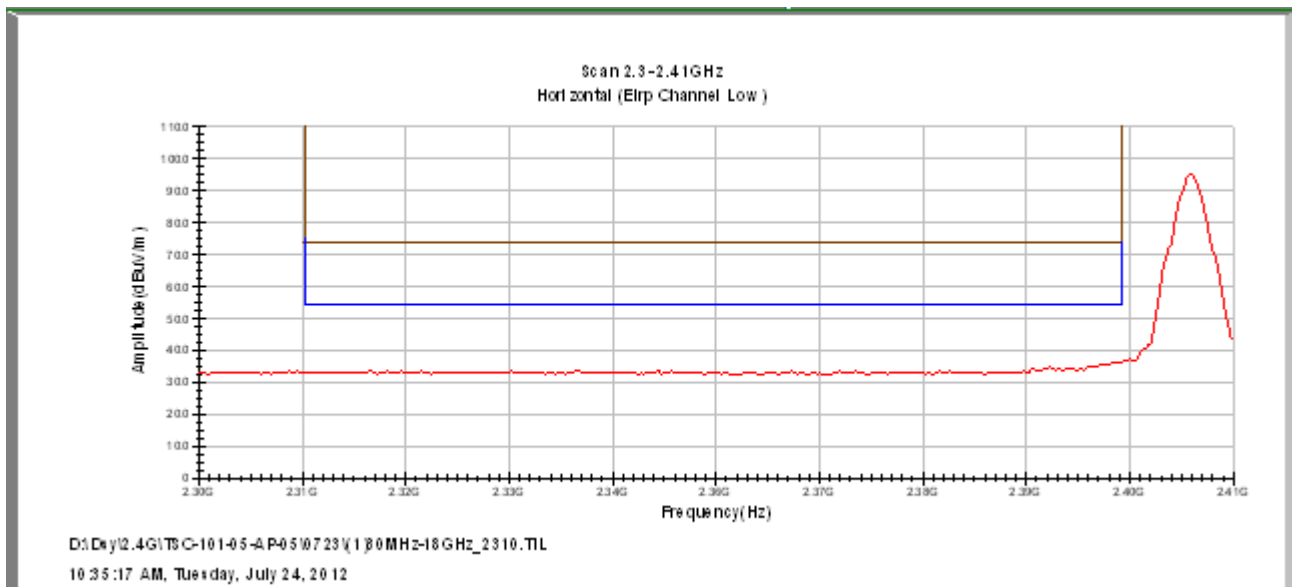
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10:57:34 AM, Tuesday, May 22, 2012

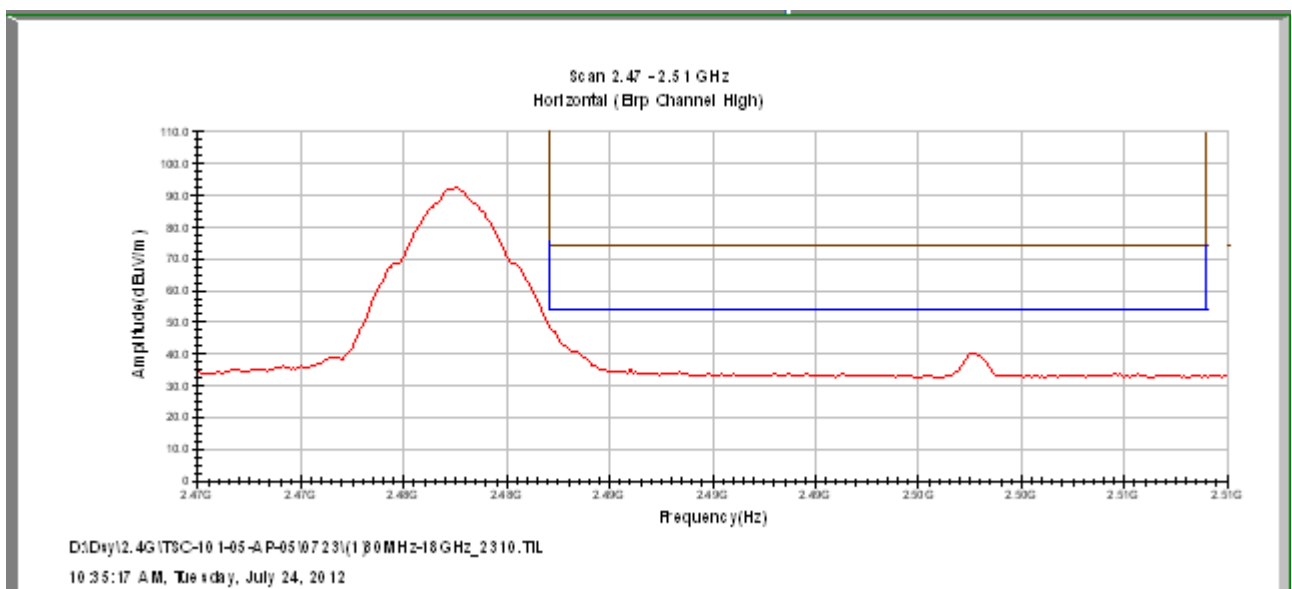
3.5 ~ 18GHz RADIATED EMISSION (Tx Freq.2480MHz)



18 ~ 25GHz RADIATED EMISSION (Tx Freq.2405, 2440, 2480MHz)



Radiated Band Edge Emission (2310 to 2390 MHz)



Radiated Band Edge Emission (2483.5 to 2500 MHz)

[The carrier above is 2.48GHz.(the horizontal deviation is 4MHz, carrier=2470+2.5x4=2.48GHz)]



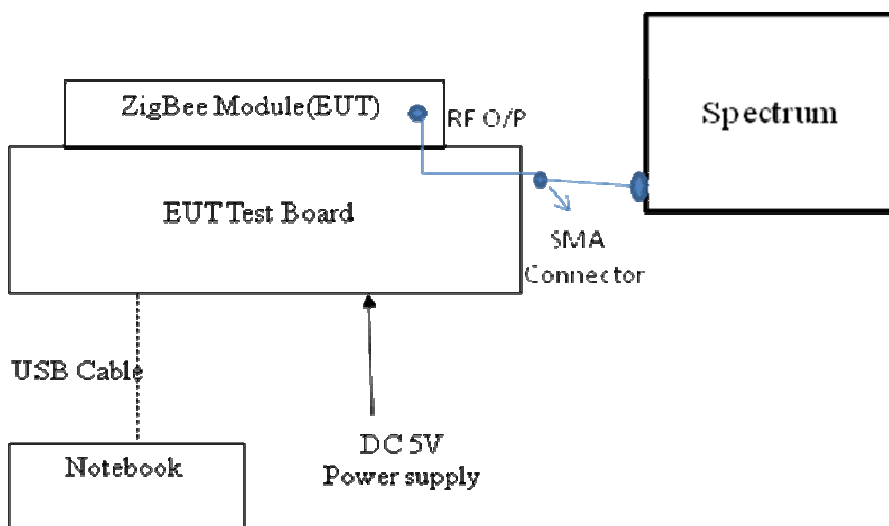
4 EMISSION BANDWIDTH MEASUREMENT

4.1 Standard Applicable

According to 15.247(a)(2), system using digital modulation techniques, the minimum 6dB bandwidth shall be at least 500 kHz.

4.2 Measurement Description

The Spetrum analyzer set up please refer to the Charts below.



Configuration of Measurement

4.3 Measurement Instrument

Type	Manufacturer	Model No.	Last Cal.	Cal. Interval
Spectrum Analyzer	HP	8593E	2012.05.14	1 Year



4.4 Measurement Data

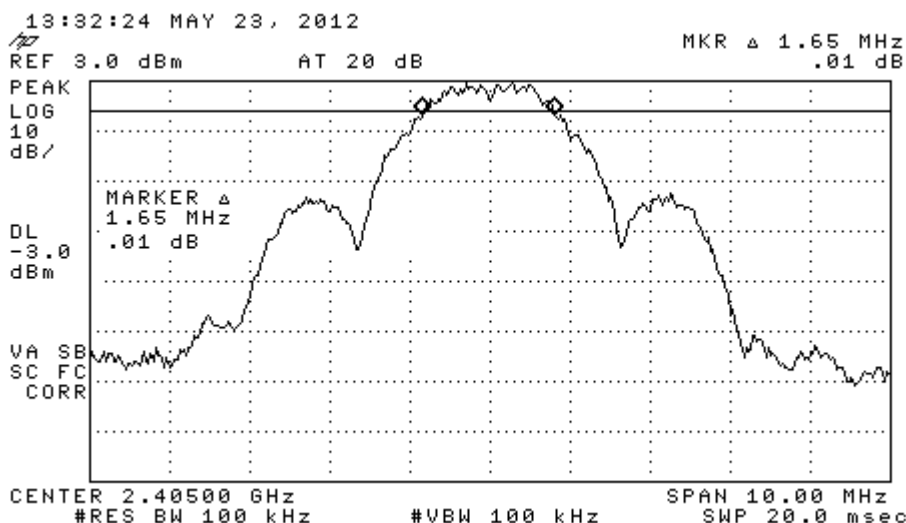
Channel	Freq.	6dB BW	Limit
	(MHz)	(kHz)	(kHz)
Low	2405	1650	> 500
Mid	2440	1630	> 500
High	2480	1630	> 500

Uncertainty: Amplitude $\pm 2.5\text{dB}$
 Freq. $\pm 1 \times 10^{-7}/\text{year}$

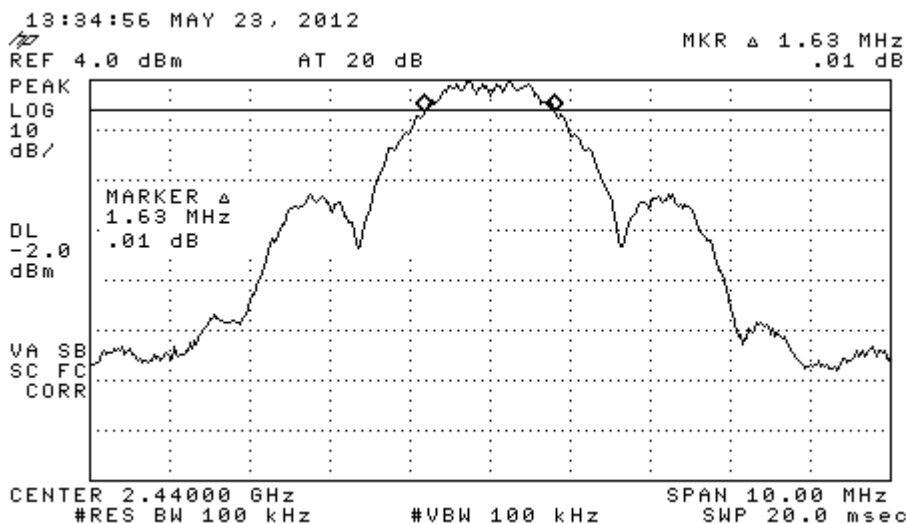
Channel	Freq.	99% BW
	(MHz)	(kHz)
Low	2405	2587
Mid	2440	2587
High	2480	2587

Uncertainty: Amplitude $\pm 2.5\text{dB}$
 Freq. $\pm 1 \times 10^{-7}/\text{year}$

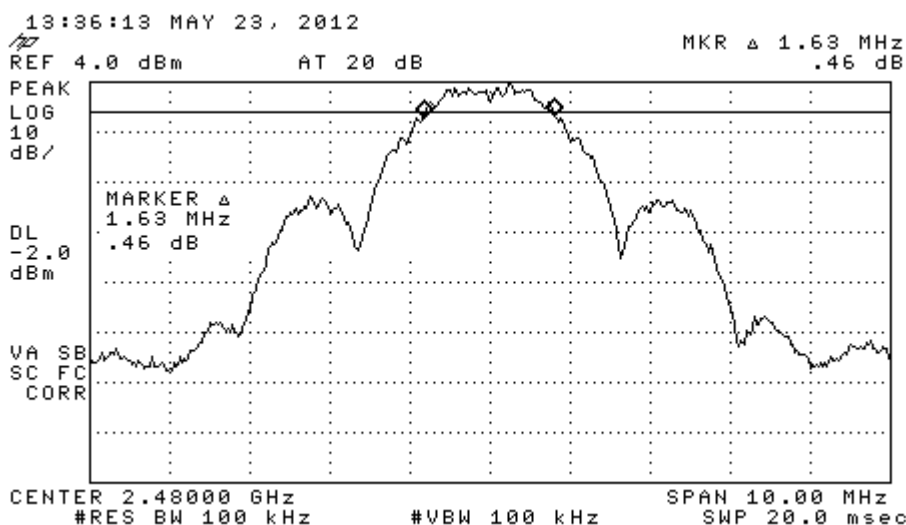
Note: Please refer to Charts below



RL



RL

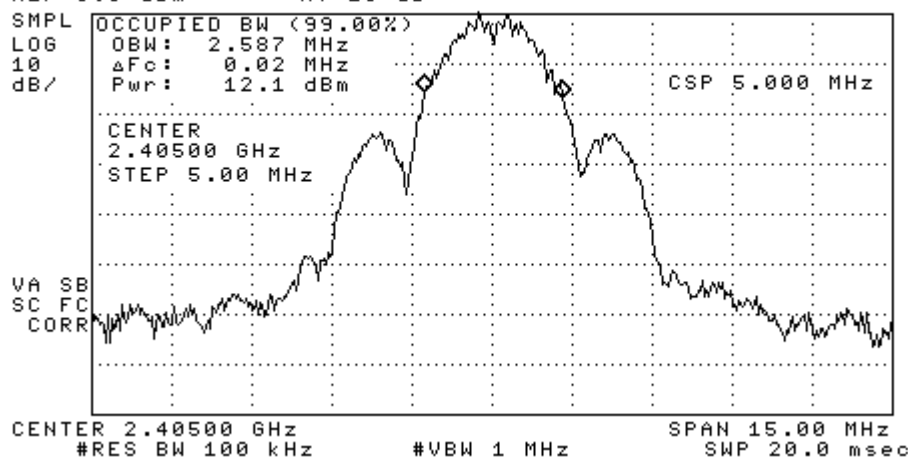


RL



14:09:34 MAY 23, 2012

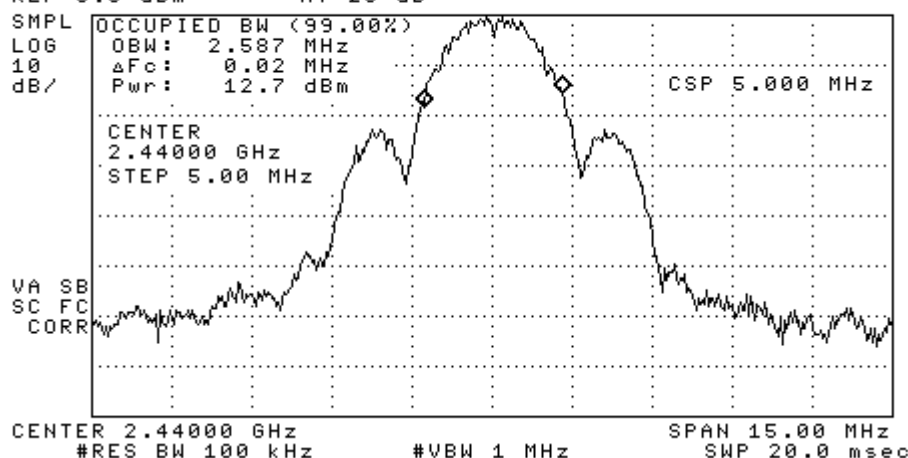
REF 3.0 dBm AT 20 dB



RL

14:06:43 MAY 23, 2012

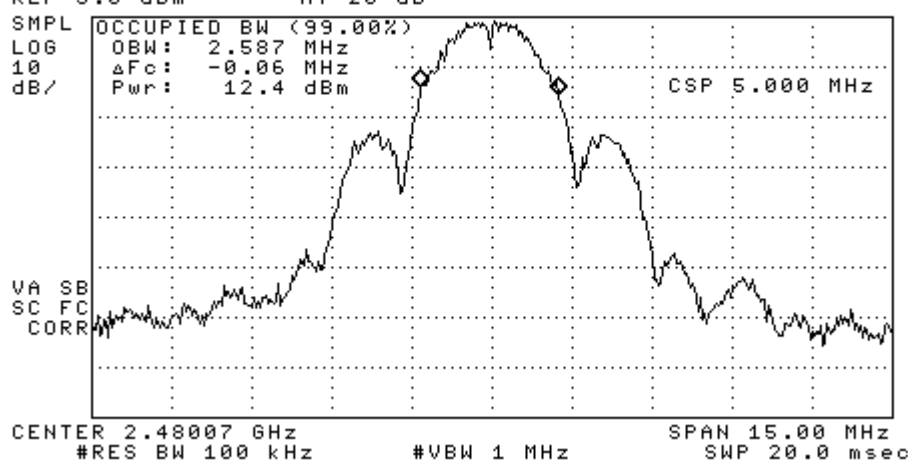
REF 3.0 dBm AT 20 dB



RL

14:03:17 MAY 23, 2012

REF 3.0 dBm AT 20 dB



RL



5 Maximum Peak Conducted Output Power Measurement

5.1 Standard Applicable

For direct sequence system, according to 15.247(b), the maximum peak output power of the transmitter shall not exceed 1 Watt. If transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.2 Measurement Description

The Configuration of Measurement Please refer to P.28 in this test report.

The Spectrum analyzer set up please refer to the Charts below. KDB 558074 D01 5.2.1.2 Measurement Procedure PK2 is followed.

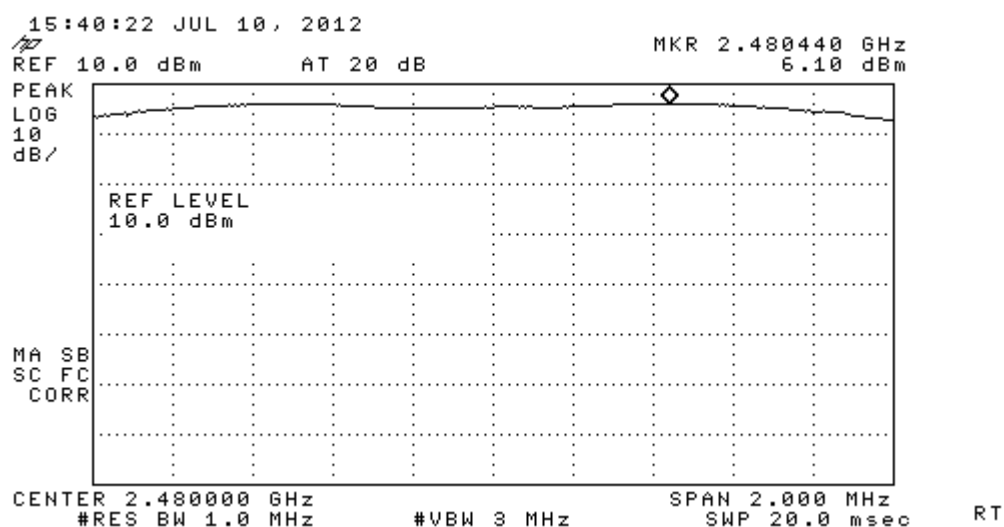
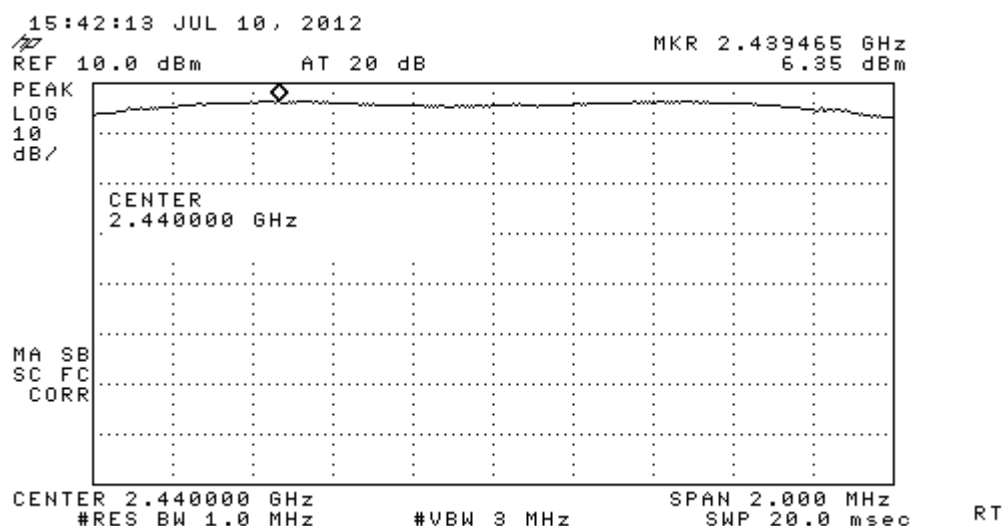
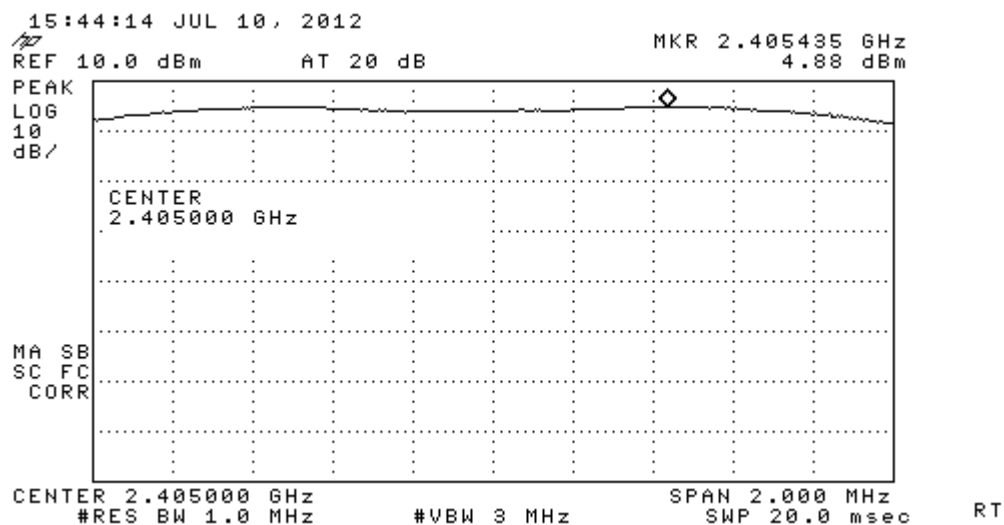
5.3 Measurement Instrument

Type	Manufacturer	Model No.	Last Cal.	Cal. Interval
Spectrum Analyzer	HP	8593E	2012.05.14	1 Year

5.4 Measurement Data

Channel	Freq.	Cable loss	Max. peak power	Limit
	(MHz)	(dB)	(dBm)	(dBm)
Low	2405	0.5	5.4	30
Mid	2440	0.5	6.9	30
High	2480	0.5	6.6	30

Uncertainty: Amplitude $\pm 2.5\text{dB}$
Freq. $\pm 1 \times 10^{-7}/\text{year}$





6 POWER DENSITY MEASUREMENT

6.1 Standard Applicable

§15.247(e) specifies a conducted power spectral density (PSD) limit of 8 dBm in any 3 kHz band segment within the fundamental EBW during any time interval of continuous transmission. The same method as used to determine the conducted output power shall be used to determine the power spectral density. The the peak PSD procedure was used.

6.2 Measurement Description

The Configuration of Measurement Please refer to P.28 in this test report.

The Spetrum analyzer set up please refer to the Charts below. Set the span to 5-30% (2MHz) greater than EBW (1.63-1.65MHz).

6.3 Measurement Instrument

Type	Manufacturer	Model No.	Last Cal.	Cal. Interval
Spectrum Analyzer	Agilent	N9020A	2012.05.06	1 Year

6.4 Measurement Data

Channel	Freq.	Peak power spectral density	Limit
	(MHz)	(dBm)	(dBm)
Low	2405	-4.10	8
Mid	2440	-2.29	8
High	2480	-2.36	8

Uncertainty: Amplitude $\pm 2.5\text{dB}$
Freq. $\pm 1 \times 10^{-7}/\text{year}$





7 SPURIOUS EMISSION

7.1 Standard Applicable

According to 12.247 (c) , 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 15.205(c)).

7.2 Measurement Description

The Configuration of Measurement Please refer to P.28 in this test report.

The Spetrum analyzer set up please refer to the Charts below.

7.3 Measurement Instrument

Type	Manufacturer	Model No.	Last Cal.	Cal. Interval
Spectrum Analyzer	HP	8593E	2012.05.14	1 Year

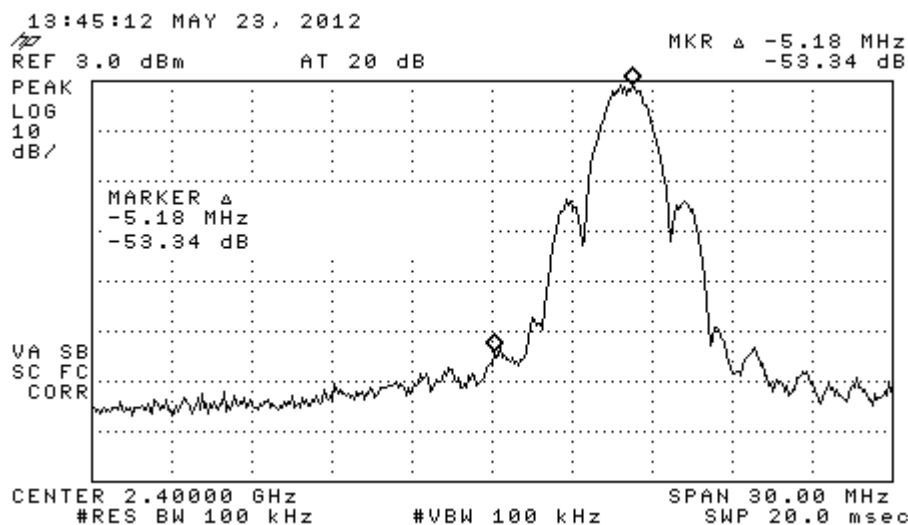
7.4 Measurement Data

Channel	Freq.	Reading	Limit
	(MHz)	(dB)	(dB)
Low	2405	-53.34	< -20
Mid	2440	-47.56	< -20
High	2480	-46.29	< -20

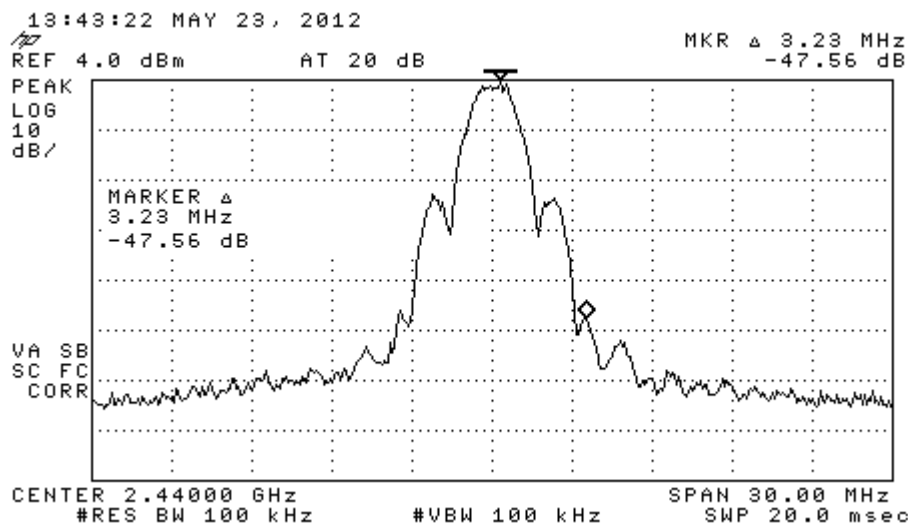
Uncertainty: Amplitude $\pm 2.5\text{dB}$

Freq. $\pm 1 \times 10^{-7}/\text{year}$

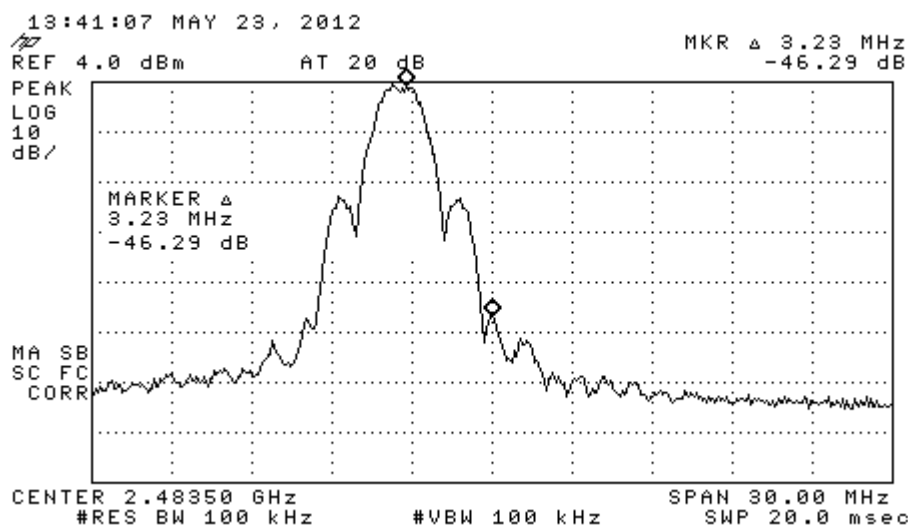
Note: Please refer to Charts below



RL



RL



RT



8. Maximum Unwanted Emission Levels

8.1 Standard Applicable

According to 15.247(d) specifies that in any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions:

If the peak output power procedure is used to measure the fundamental emission power to demonstrate compliance to 15.247(b)(3) requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum measured in-band peak PSD level.

8.2 Measurement Description

Configuration of System please refer to page 6.

Set up the spectrum according to KDB 558074 D1 requirement.

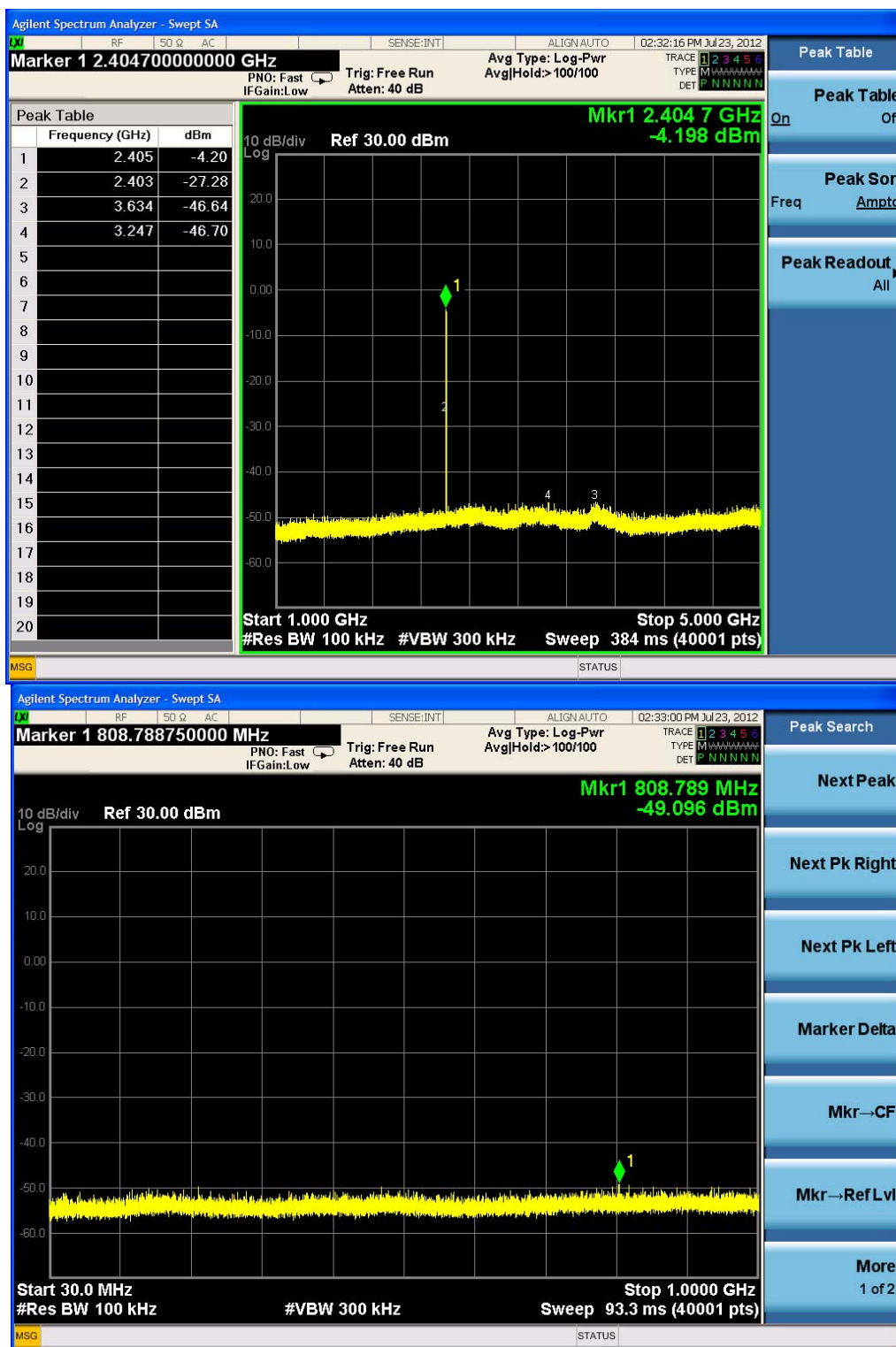
8.3 Measurement Instrument

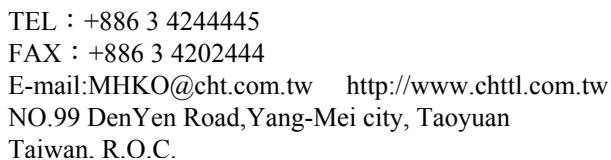
Type	Manufacturer	Model No.	Last Cal.	Cal. Interval
Spectrum Analyzer	Agilent	N9020A	2012.05.06	1 Year

8.4 Measurement Data

All Non-Restricted Frequency Bands and Restricted Frequency Bands were more than 20dB below the carrier. Please refer to the charts below for Low, Mid and High CH respectively.

Uncertainty: Amplitude $\pm 2.5\text{dB}$ Freq. $\pm 1 \times 10^{-7}/\text{year}$



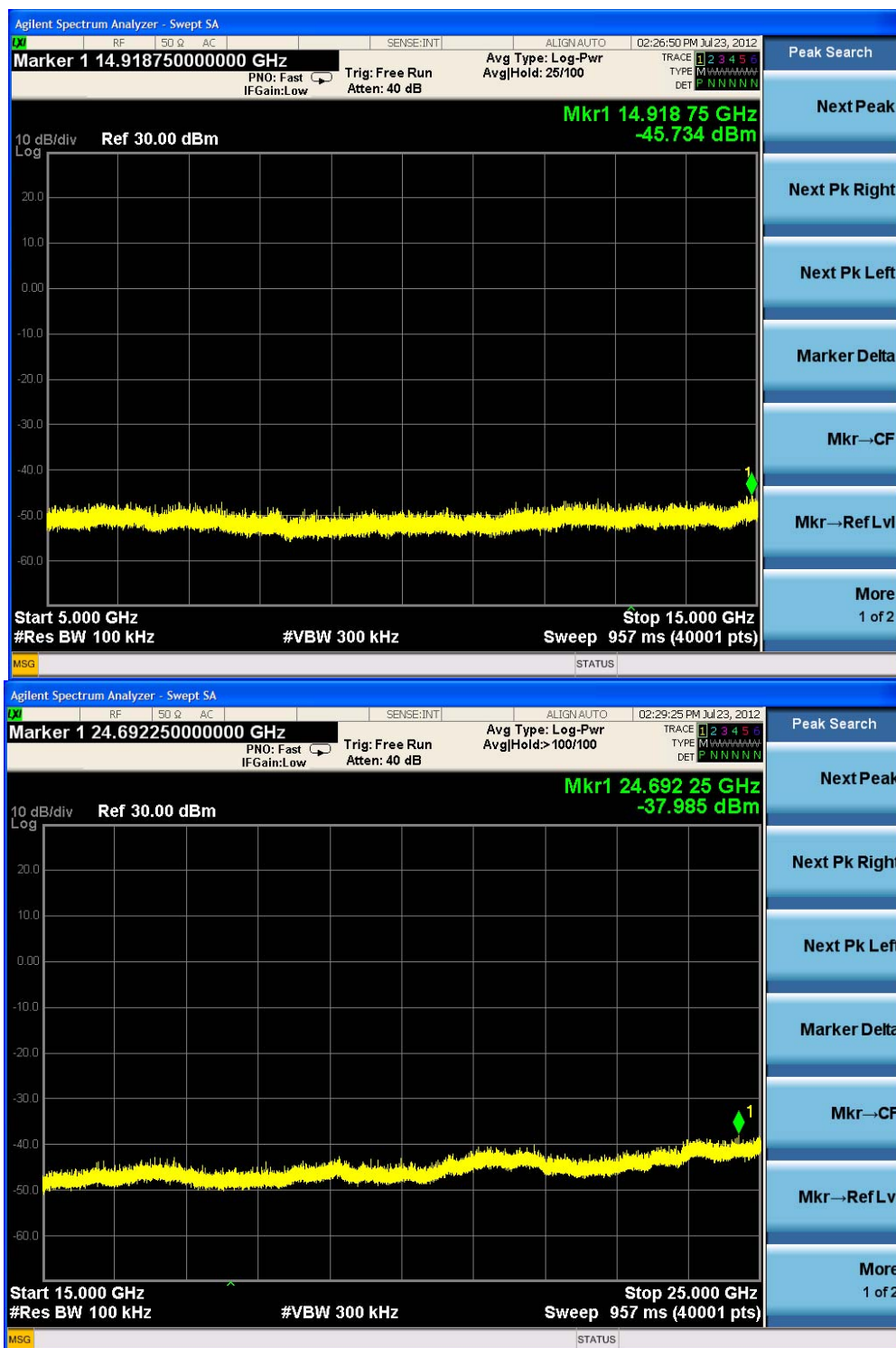






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Taiwan. R.O.C.

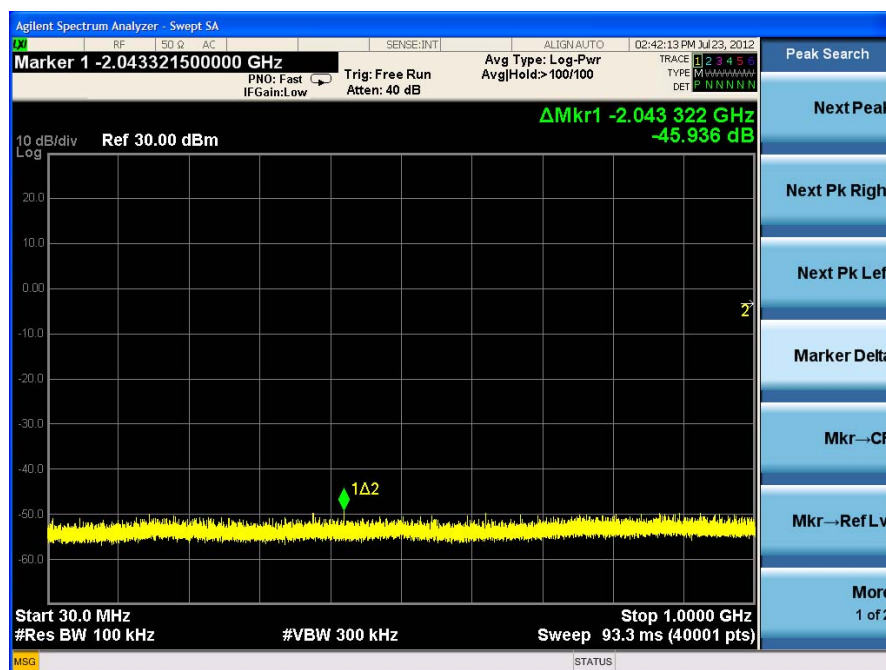
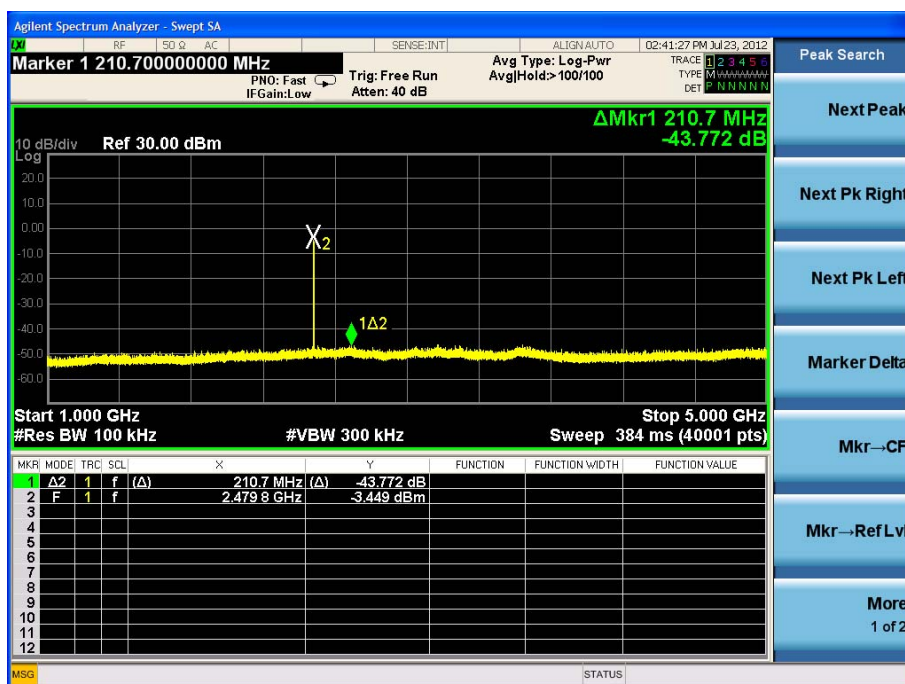


Mid CH



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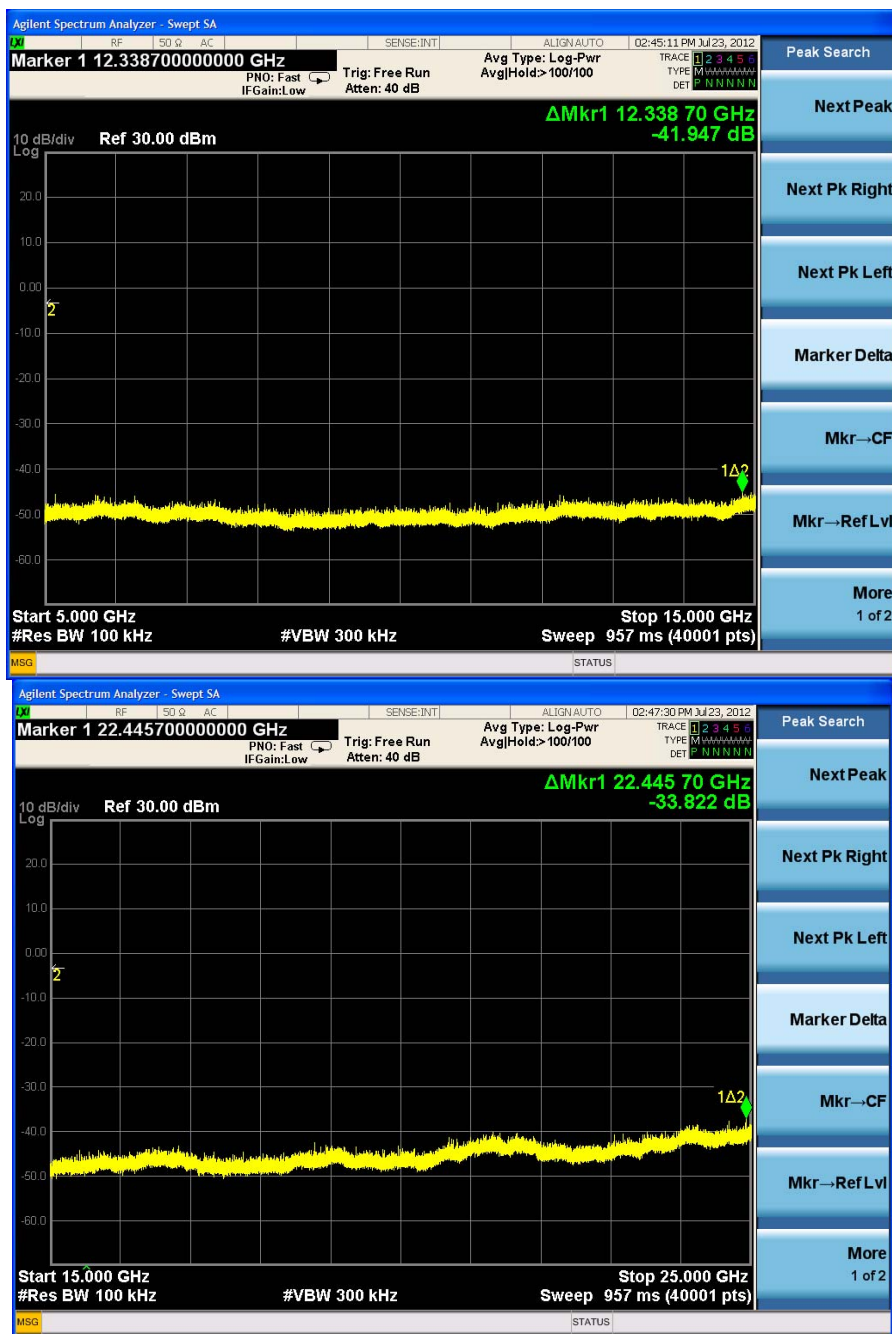
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High CH



9. Duty Cycle Measurement

9.1 Standard Applicable

According to KDB 558074 D01, when average power is used to demonstrate compliance to the pertinent limit, the power averaging is permitted only during the ‘on-time’ of the EUT transmitter. Duty cycle power reduction attributable to transmitter ‘off-time’ is not permitted. Thus, whenever possible, the EUT must be configured to transmit continuously (i.e., $\geq 98\%$ duty cycle) when average power measurements are used to demonstrate compliance to the limits.

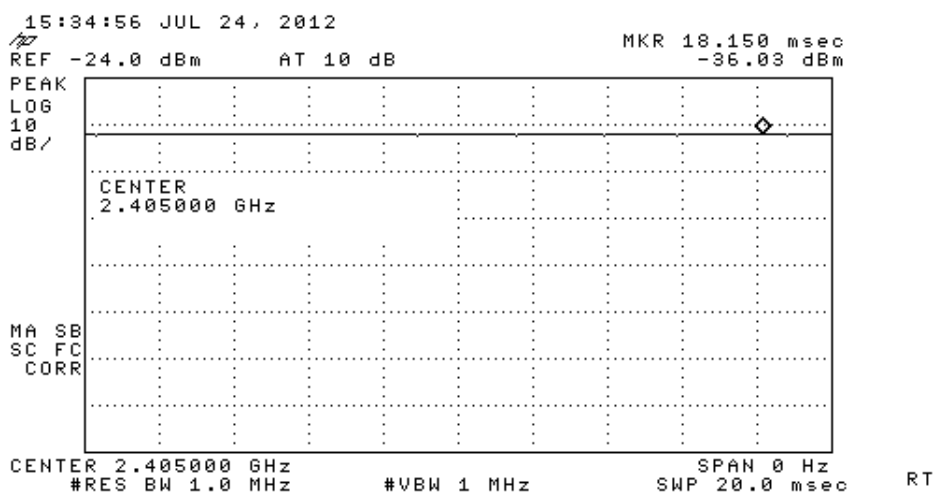
9.2 Measurement Description

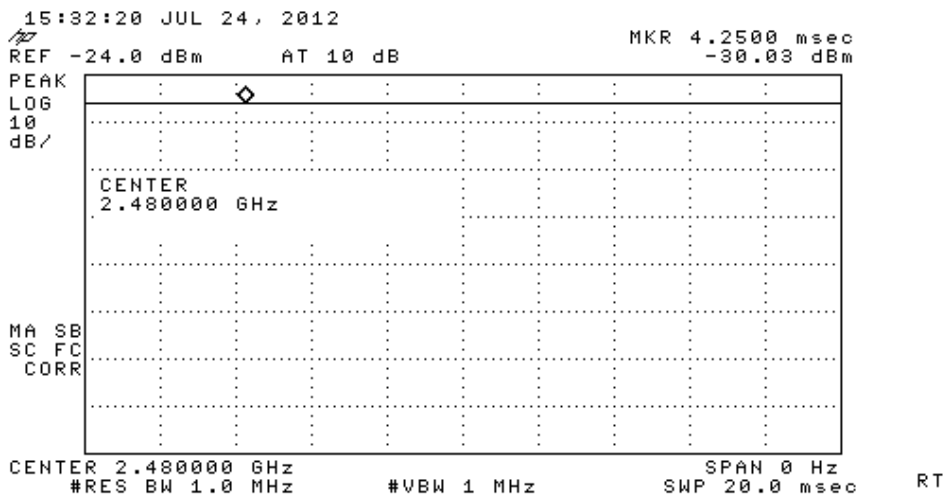
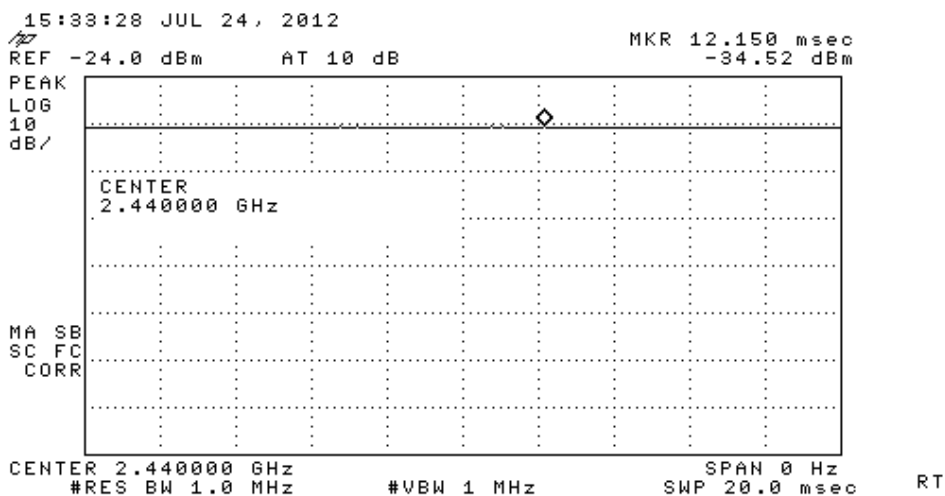
The EUT was configured to transmit continuously (100% duty cycle), There is no power reduction attributable to transmitter.

9.3 Measurement Instrument

Type	Manufacturer	Model No.	Last Cal.	Cal. Interval
Spectrum Analyzer	HP	8593E	2012.05.14	1 Year

9.4 Measurement Data





10. Conducted Emission Measurement

DC Power Supply MRL TH009N was used in the test. Please refer to the Configuration of System on page 6.



11. PHOTOGRAPHS



EUT Top View



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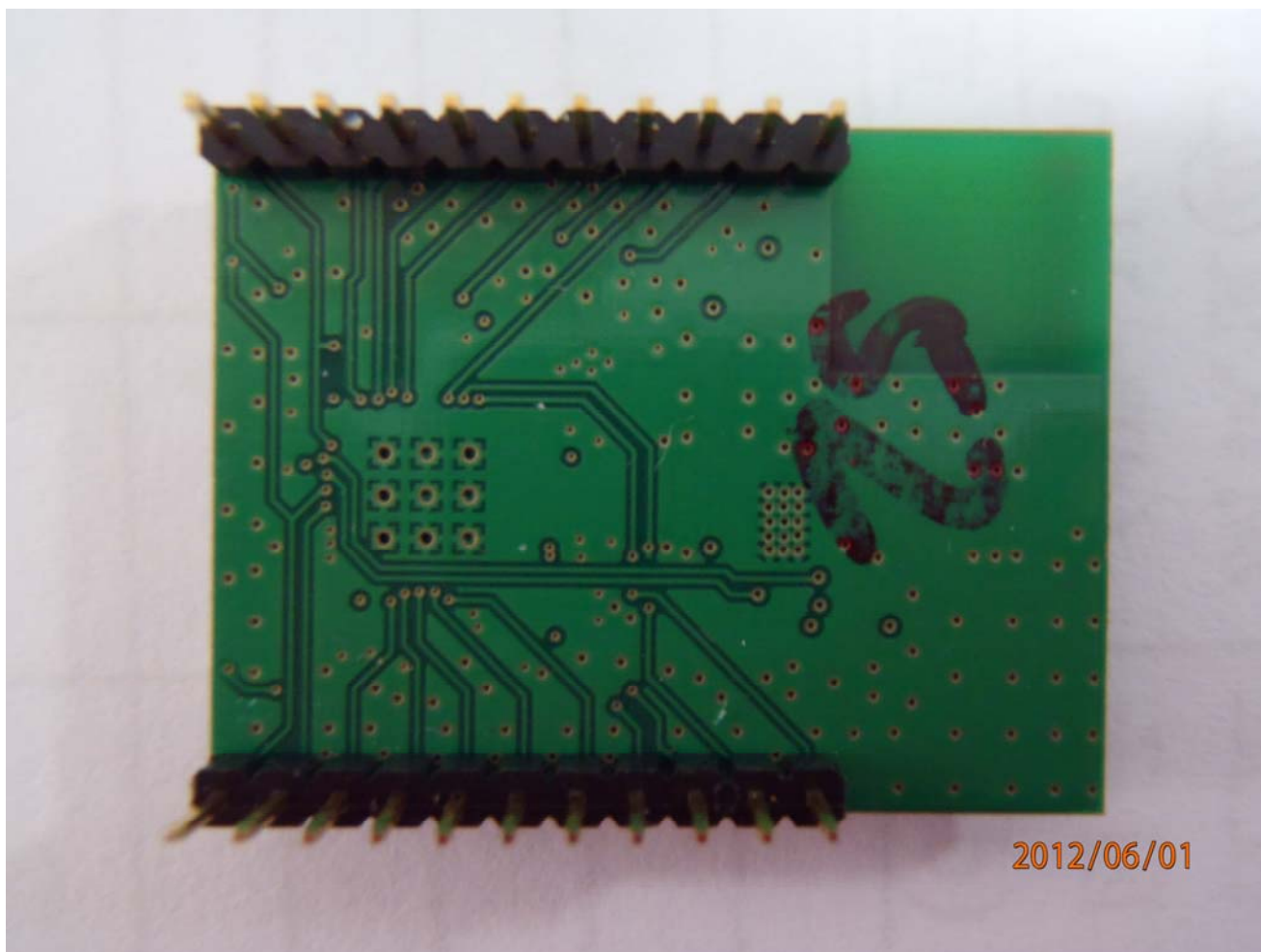
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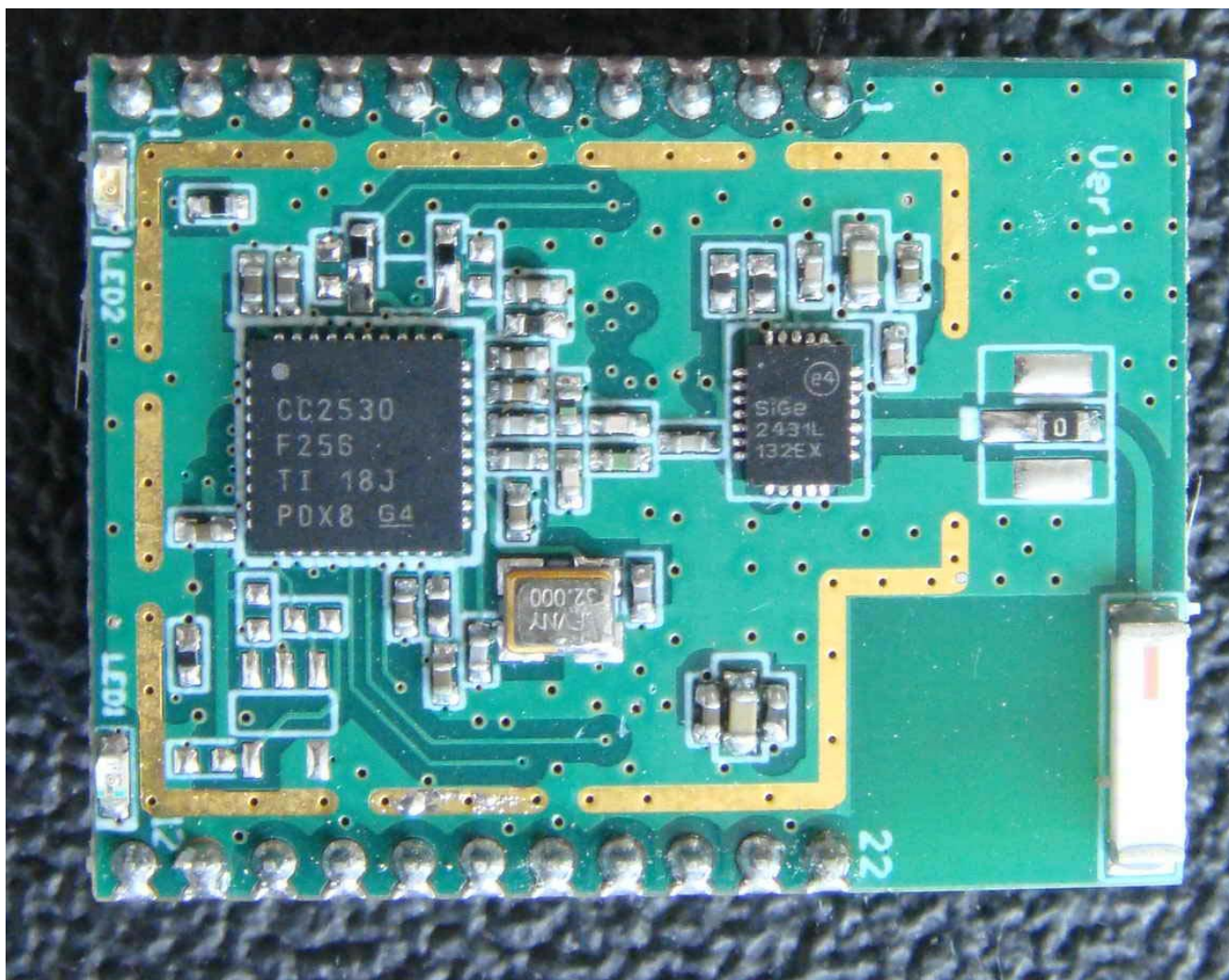


EUT Bottom View



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EUT Inside Shielding



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EUT on Test Board