KOREA EMC LABORATORY

Certificate of Compliance

Test Report No.	**KEL06-F01047**		
Applicant	**SAMSUNG ELECTRONICS CO., LTD.**		
Applicant Address	#416 Metan-Dong, Yeongtong-Gu, Suwon-City, Gyunggi-Do, Korea.		
Manufacturer	Oriental Integrated Electronics Co., Ltd.		
Manufacturer Address	81-34, Dodang-Dong, Wonmi-Ku, Bucheon-City, Kyonggi-Do, Korea		
Device Under Test	**Home Gateway**		
FCC ID	**A3L-HHG3004H2**	**Model No.:**	**HHG-3004H2**
Date of incoming	Jan 31, 2006		
Date of Issue	April 5, 2006		
Location of Testing	**KOREA EMC LABORATORY** 390 Bora-dong, Giheung-gu, Yongin-si, Gyeonggi-do, Republic of Korea 446-904		
Test Procedure	**ANSI C63.4 / 2003**		
Test Specification	**47CFR, Part 15 Subpart C**		
Equipment Class	**DSS - Part 15 Spread Spectrum Transmitter**		
Test Result	The above-mentioned device has been tested and passed.		

Tested & Reported by: *Chang-Min, Moon*	**Approved by**: *Su-Gil, Moon*
April 6, 2006	S. G. MOON *April 6, 2006*
Signature *Date*	*Signature* *Date*

Other Aspects	
Abbreviations	**· OK, Pass = passed · Fail = failed · N/A = not applicable**

☞ **•This test report is not permitted to copy partly without our permission.**
•This test result is dependent on only equipment to be used.
•This test result is based on a single evaluation of one sample of the above mentioned.
• We certify that this test report has been based on the measurement standard that is traceable to the national or International standards.

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1. GENERAL

These tests were performed using the test procedure outlined in ANSI C63.4, 2003 for intentional radiators, and in accordance with the limits set forth in FCC Part 15.247 for Spread Spectrum Transmitter. The EUT (Equipment Under Test) has been shown to be capable of compliance with the applicable technical standards.

We attest to the accuracy of data. All measurements reported herein were performed by KOREA EMC LABORATORY and were made under Chief Engineer's supervision.
We assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

2. TEST SITE

KOREA EMC LABORATORY

2.1 Location

390 Bora-dong, Giheung-gu, Yongin-si, Gyeonggi-do, Republic of Korea 446-904

The Open Field Radiated and Indoor Line Conducted sites are constructed and calibrated to meet the FCC Requirements in documents ANSI C63.4-2003.
Korea EMC Laboratory was refilled in FCC in April 13, 2005. (Registration Number: 90751).

2.2 List of Test and Measurement Instruments

Description	Manufacturer	Model #	Serial #	
Spectrum Analyzer	Advantest	R3273	110600584	☒
Spectrum Analyzer	H.P	8560E	3517A01551	☒
Modulation Analyzer	H.P	8901B	3438A05241	
Audio Analyzer	H.P	8903B	3011A08331	
Frequency Counter	EIP Microwave	28B	9205-004723	
CDMA Mobile StationTest Set	H.P	8924C	US37261566	
Digital Oscilloscope	Tecktronics	TDS380	B011855	
Digital Multimeter	Fluke	8842A	6585251	
Test Receiver	Rohde&Schwarz	ESVS10	825120/006	☒
Test Receiver	Rohde&Schwarz	ESCS30	100054	☒
Signal Generator	H.P	E4421A	US37230495	
Function Generator	H.P	33120A	US36030957	
Dual Directional Coupler	H.P	778D	14903	
L.I.S.N(for E.U.T)	SCHWARZBECK	NSLK8128	8128144	☒
L.I.S.N(for Peripheral)	Kyoritsu	KNW-407	8-8833-14	☒
Pre-amplifier	H.P	87405A	2944A06481	☒
Pre-amplifier	H.P	8449B	3008A00121	☒
Power Meter	Agilent	E4416A	GB41290751	☒
Power Sensor	Agilent	E9323A	US40410488	☒
Active Loop Antenna	EMCO	6507	1435	
Bi-Log Antenna	Schwarzbeck	VULB9160	3121	☒
Bi-Log Antenna	Schwarzbeck	VULB9160	3141	☒
Double Ridge Horn Antenna	AH System Inc	SAS-571	500	☒
DC Power Supply	H.P	E3611A	KR41808575	
Temperature/Humidity Chamber	HANYOUNG	HY-LTH2	A33-051216	
Temperature/Humidity Chamber	HANYOUNG	HY-LTH-3	A34-970616	
Attenuator	H.P	8498A	1801A04842	
Attenuator	H.P	8491A	30907	

2.3 Test Date

Date of Application : Jan 31, 2006

Date of Test : Jan 31, 2006 ~ April 5, 2006

2.4 Test Environment

See each test item's description.

3. DESCRIPTION OF THE EQUIPMENT UNDER TEST

The product specification described herein was obtained from the product data sheet or user's manual.

3.1 Rating and Physical Characteristics

Type / Model No.	Home Gateway / HHG-3004H2
Power source	AC Adaptor
Local Oscillator or X-Tal	X-Tal: 25 MHz,16 MHz,10 MHz
Transmit Frequency	2405 ~ 2475 MHz (5MHz Step, 15 channels)
Antenna Type	Reverse Polarity Dipole antenna (50Ω, 5.5dBi)
Type of Modulation	OQPSK (DSSS)
Rated Output power	4dBm
External Ports	- WAN Port 1EA - LAN Port 4EA - Serial Port 1EA - AC Adaptor Jack Model: PL-ADT/A Input: AC 100~240V, 50~60Hz, 0.3A Output: DC 12.5V, 0.8A

3.2 Equipment Modifications

None.

3.3 Submitted Documents

Block diagram

Schematic diagram

Antenna Specification

Part List

User manual

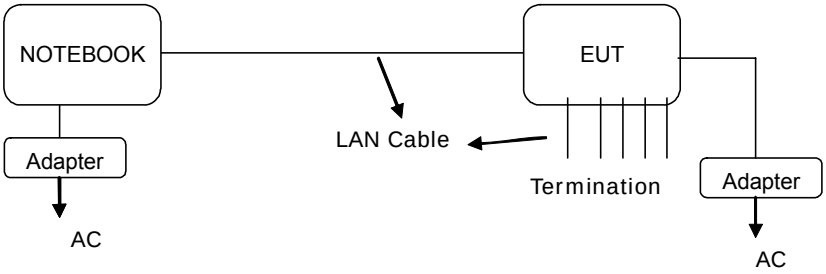
4. MEASUREMENT CONDITIONS

4.1 Description of test configuration

The EUT exercise Zigbee Module Control (Switch Use for Channel select) used during radiated and conducted testing was designed to exercise the various system components in a manner similar to typical use. The EUT was connected to Notebook with LAN Cable and could communicate with EUT & Notebook. PLC Function was tested in state of normal operating mode.

The RF Module operating mode/system were as follows:

- Transmitting mode (ch1: 2405MHz, CH8: 2440MHz, CH15: 2475MHz)



4.2 List of Peripherals

Equipment Type	Manufacture	Model	Cable Description
Notebook	Sambo Computer	Dreambook	1.5m, Shielded, Serial Cable 1.5m, unshielded, LAN Cable 5 EA
AC Adapter	-	-	1.8m, Non-Shielded, Power Line Cable

4.3 Uncertainty

- Conducted Emission Test

The measurement uncertainty (with a 95% confidence level) for this test was ±2.07dB

- Radiated Emission Test

The measurement uncertainty (with a 95% confidence level) for this test was ±5.05dB.

5. TEST AND MEASUREMENTS

Summary of Test Results

Requirement	CFR 47 Section	Report Section	Test Result
Antenna Requirement	15.203, 15.247(b)(4)	5.1	PASS
Maximum Peak Output Power	15.247(b)	5.2	PASS
6dB Bandwidth	15.247(a)(2)	5.3	PASS
Out of Band Emissions & Band Edge	15.205 15.209 15.247(d)	5.4	PASS
Power Spectral Density	15.247(e)	5.5	PASS
Conducted Emissions	15.207	5.6	PASS
RF Exposure	15.247(i), 1.1307(b)(1)	5.7	PASS

5.1 ANTENNA REQUIREMENT

5.1.1 Regulation

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. 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.

And according to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.1.2 Result: PASS

The transmitter has a Reverse Polarity Unique Dipole Antenna.

The directional gain of the antenna is typically 5.5 dBi.

5.2 MAXIMUM PEAK OUTPUT POWER

5.2.1 Regulation

According to §15.247(b)(1), for frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

According to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.2.2 Test Procedure

The Maximum Peak Output power was measured with a Power Meter connected to the antenna port. Power was measured by removing the antenna and measuring across a antenna port using a Peak & Average Power Meter model E4416A (supported by 5MHz Bandwidth power measurement).

5.2.3 Test Results: PASS

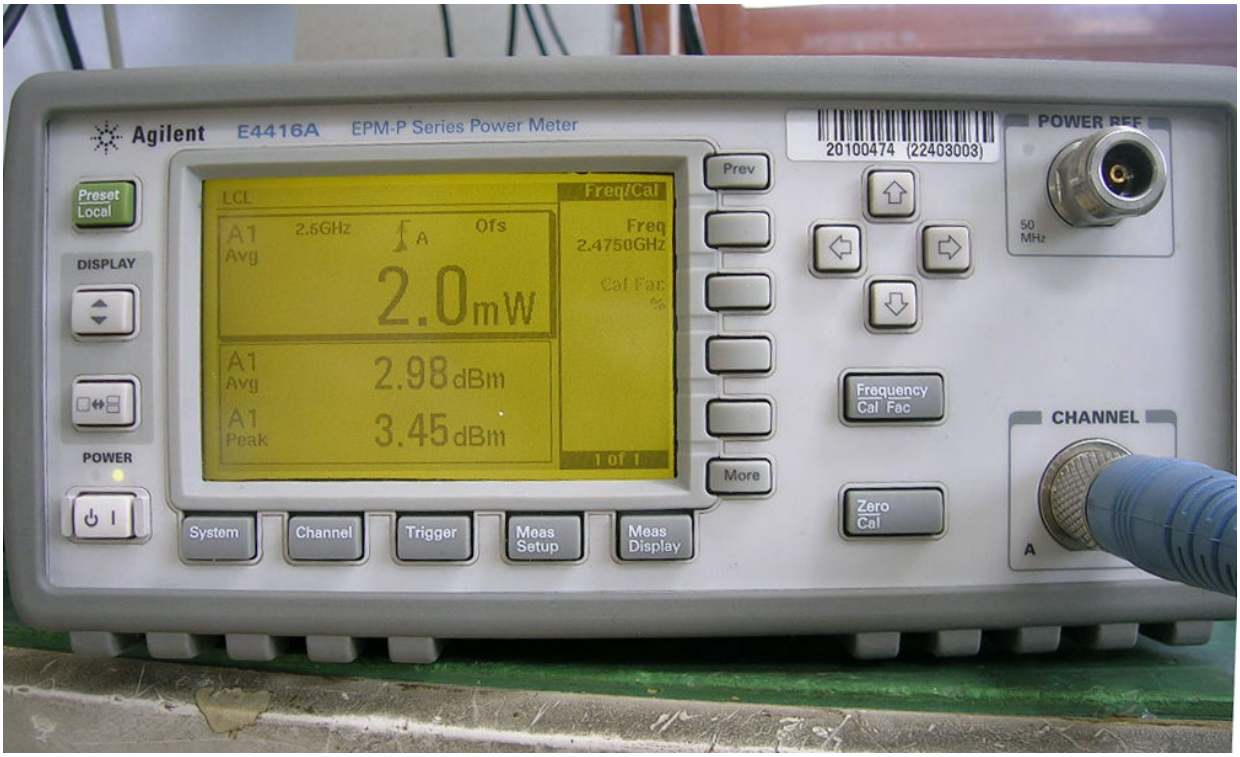
Measured values of the Maximum Peak Output Power (Conducted)

Operating Frequency	Peak	Average	Limit
2405 MHz	3.79dBm	3.34dBm	1 W (30dBm)
2440 MHz	3.68dBm	3.21dBm	1 W (30dBm)
2475 MHz	3.45dBm	2.98dBm	1 W (30dBm)

Lowest Channel (operating at 2405 MHz)

Middle Channel (operating at 2440 MHz)

Highest Channel (operating at 2475 MHz)



5.3 6dB BANDWIDTH

5.3.1 Regulation

According to §15.247(a)(2), System using digital modulation techniques may operate in the 902–928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6dB bandwidth shall be at least 500kHz.

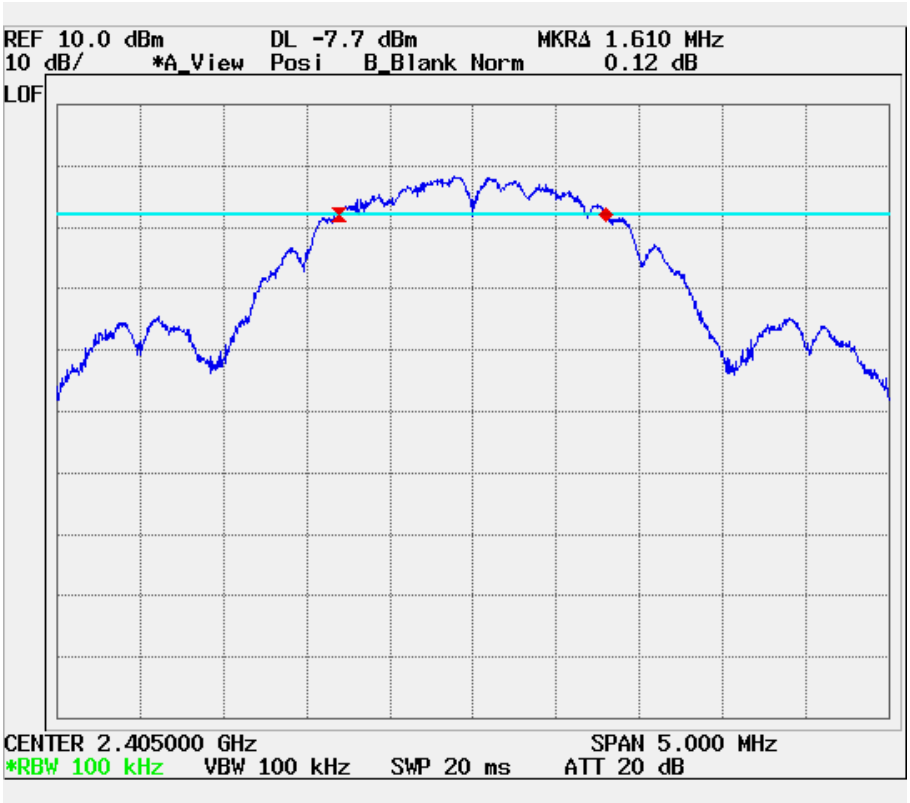
5.3.2 Test Procedure

The minimum 6dB bandwidth was measured with a spectrum analyzer connected to the antenna port.

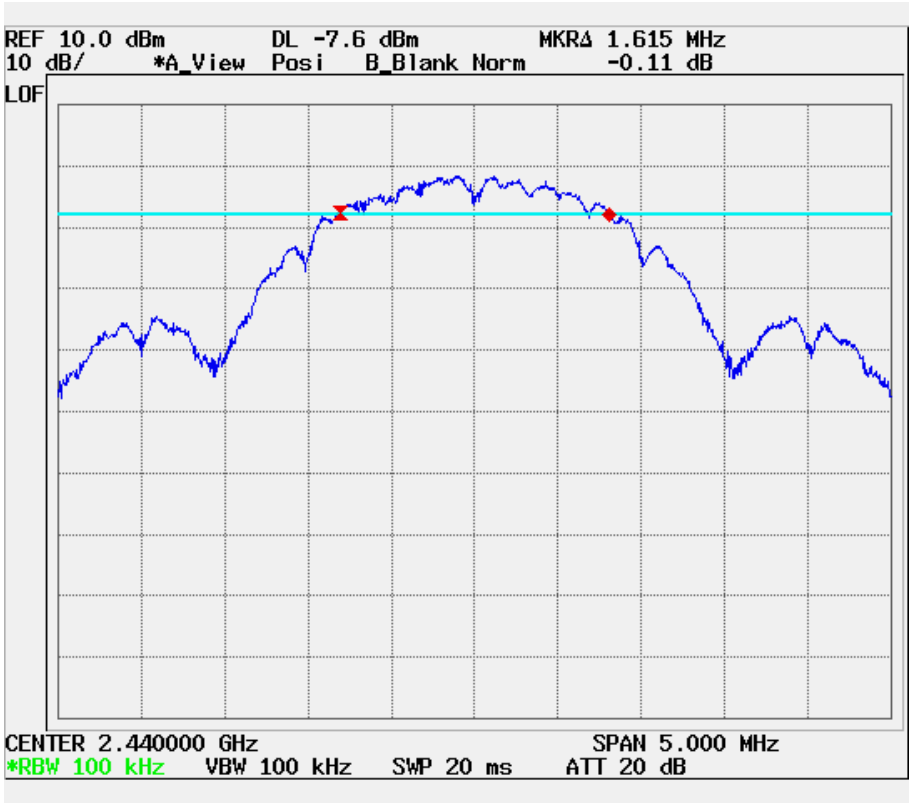
5.3.3 Test Results: PASS

Measured values of the 6dB Bandwidth (Conducted)		
Operating frequency	6dB bandwidth	Limit
2405 MHz	1610 kHz	> 500 kHz
2440 MHz	1615 kHz	> 500 kHz
2475 MHz	1610 kHz	> 500 kHz

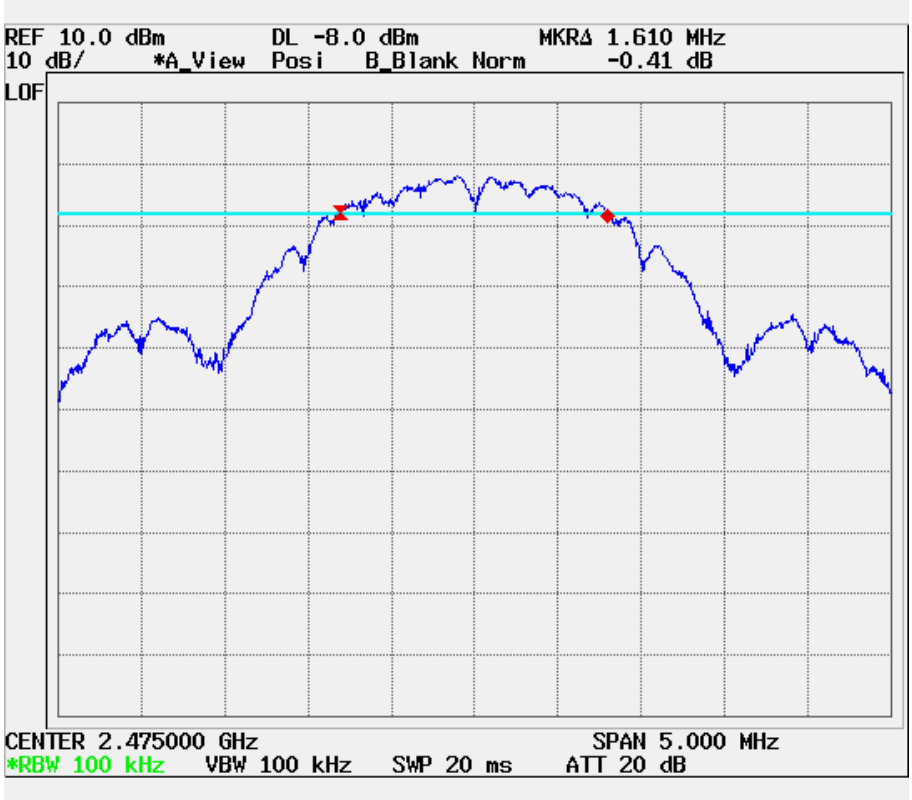
Lowest Channel (operating at 2405 MHz)



Middle Channel (operating at 2440 MHz)



Highest Channel (operating at 2475 MHz)



5.4 Out of Band Emissions & Band Edge

5.4.1 Regulation

According to §15.247(d), 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 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)).

According to §15.209(a), for an intentional device, the general requirement of field strength of radiated emissions from intentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency (MHz)	Field strength (μV/m @ 3m)	Field strength (dBμV/m @ 3m)
30–88	100	40.0
88–216	150	43.5
216–960	200	46.0
Above 960	500	54.0

According to §15.109(a), for an unintentional device, except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the above table.

** The emission limits shown in the above table are based on measurement instrumentation employing a CISPR quasi-peak detector and above 1000 MHz are based on the average value of measured emissions.

5.4.2 Test Procedure

1) Spurious RF Conducted Emissions:

The Out of Band Emissions was measured with a spectrum analyzer connected to the antenna port.

At RBW=100kHz, VBW=300kHz, spurious emission in the frequency range 30MHz-25GHz which was out of 2400-2483.5MHz was lower 20dB than radio frequency power.

2) Spurious Radiated Emissions:

The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters.

The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360˚.

The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 25 to 1000 MHz using the Bi-Log antenna, and from 1000 MHz to 18000 MHz using the horn antenna.

To obtain the final measurement data, the EUT was arranged on a turntable situated on a 4 × 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.

Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

The presence of ambient signals was verified by turning the EUT off. In case an ambient signal was detected, the measurement bandwidth was reduced temporarily and verification was made that an additional adjacent peak did not exist. This ensures that the ambient signal does not hide any emissions from the EUT.

The field strength is calculated by adding the Antenna Factor, Cable factor, & preamplifier.

The basic equation with a sample calculation is as follow:

Final Test Level = Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

5.4.3 Test Results: PASS

Out of band emissions & Band Edge (Conducted)				
Channel	Frequency [MHz]	Result [dBc]	Limit [dBc]	Margin [dB]
1	2405	44.1	20.0	24.1
8	2440	53.3	20.0	33.3
15	2475	44.9	20.0	24.9

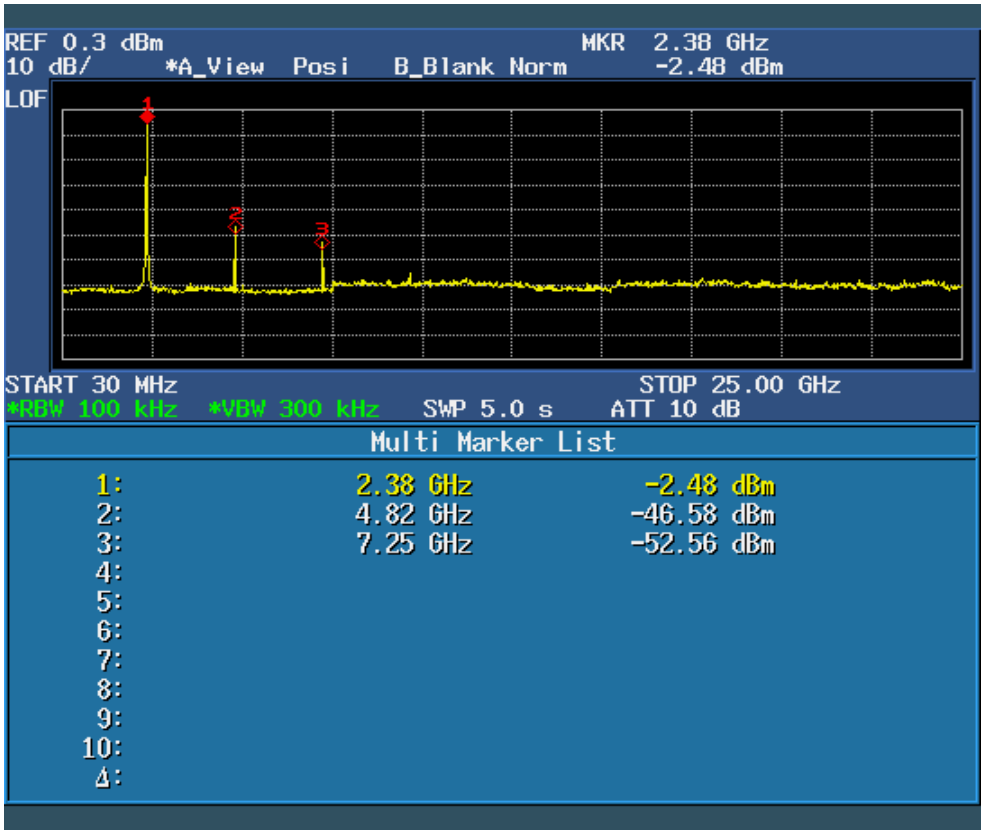
*Please refer to graph as below:

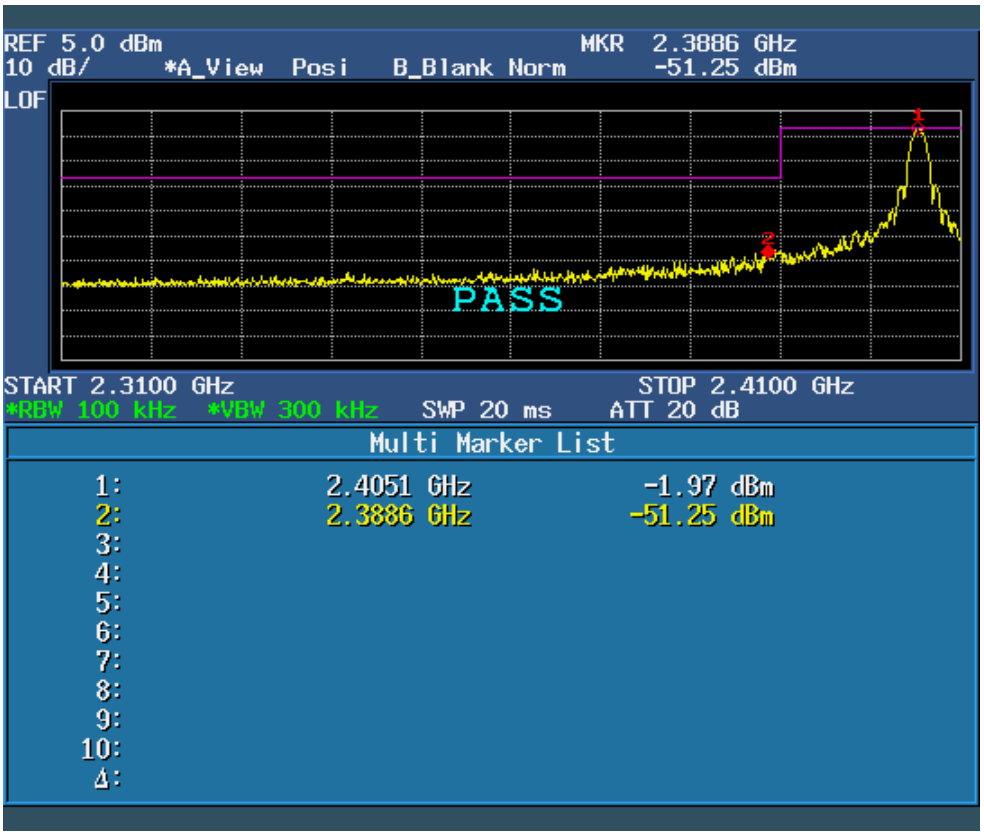
Out of band emissions & Band Edge (Radiated)					
Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Field Strength [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-peak data, emissions below 1000 MHz					
33.460	120	V	27.1	40.0	12.9
125.014	120	V	38.1	43.5	5.4
143.314	120	V	34.5	43.5	9.0
199.982	120	V	31.8	43.5	11.7
250.007	120	H	44.1	46.0	1.9
399.995	120	H	36.5	46.0	9.5
499.964	120	V	41.4	46.0	4.6
667.118	120	H	44.1	46.0	1.9
797.641	120	V	37.4	46.0	8.6
933.977	120	V	42.8	46.0	3.2
AVERAGE data, emissions above 1000 MHz					
2389.20	1000	H	37.3	54.0	16.7
2483.98	1000	H	43.7	54.0	10.3
4809.29	1000	H	42.2	54.0	11.8
4879.25	1000	H	41.8	54.0	12.2
4950.49	1000	H	41.4	54.0	12.6
PEAK data, emissions above 1000 MHz					
2389.60	1000	H	61.3	74.0	12.7
2483.65	1000	H	67.8	74.0	6.2
4809.29	1000	H	60.6	74.0	13.4
4879.25	1000	H	60.9	74.0	13.1
4950.49	1000	H	59.4	74.0	14.6

NOTE: The spectrum was scanned from 30 MHz to 18 GHz. All emissions not reported were more than 20 dB below the specified limit or in the noise floor. The measured data in the above table include the spurious radiated emissions that do not fall in the restricted bands.

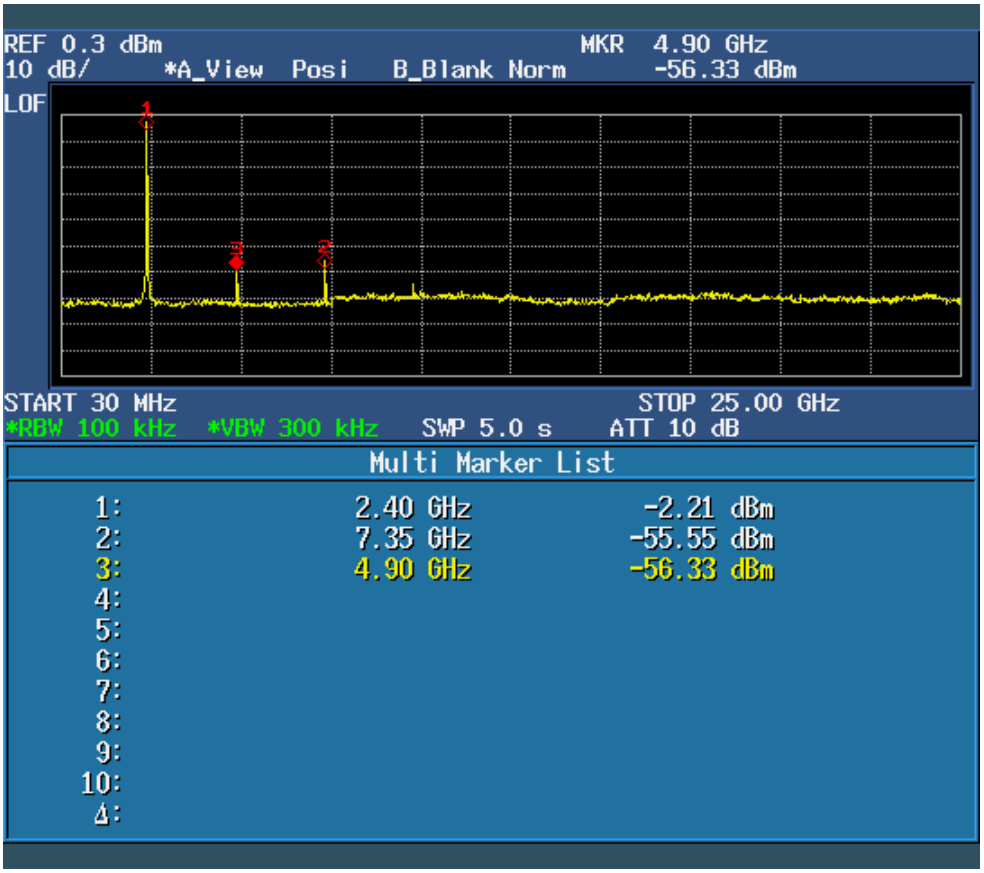
RF antenna port emissions (Conducted)

Lowest Channel (operating at 2405 MHz)

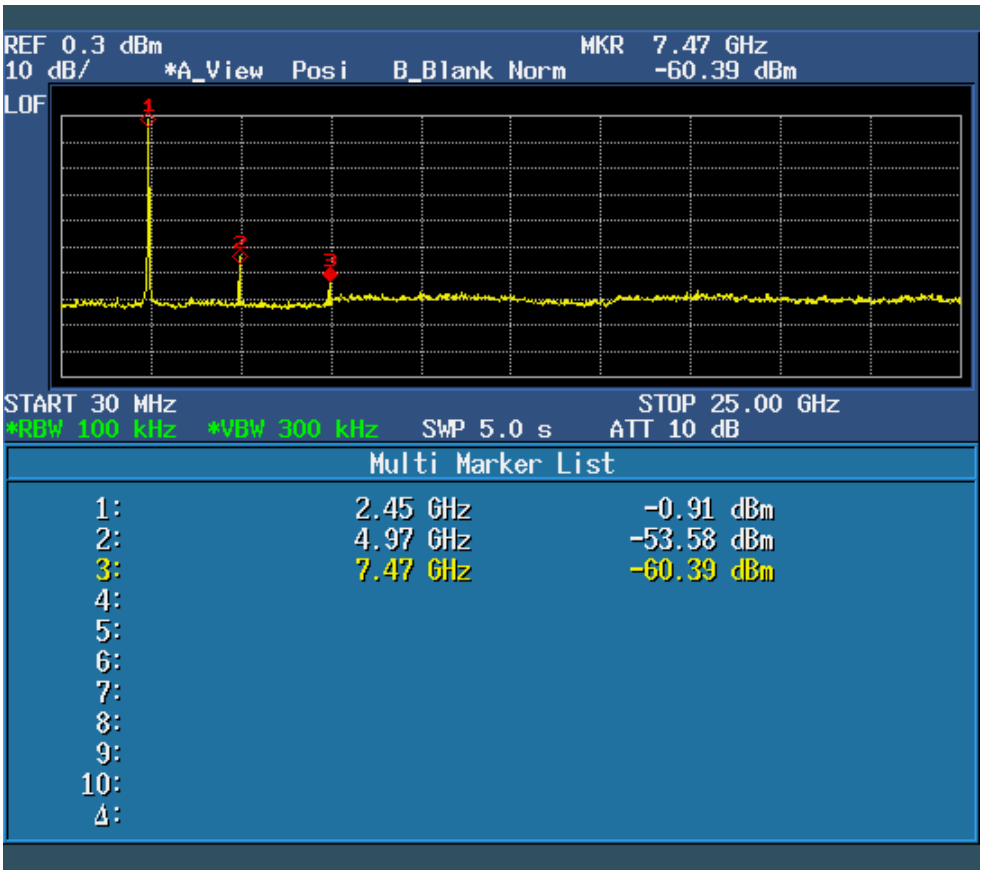


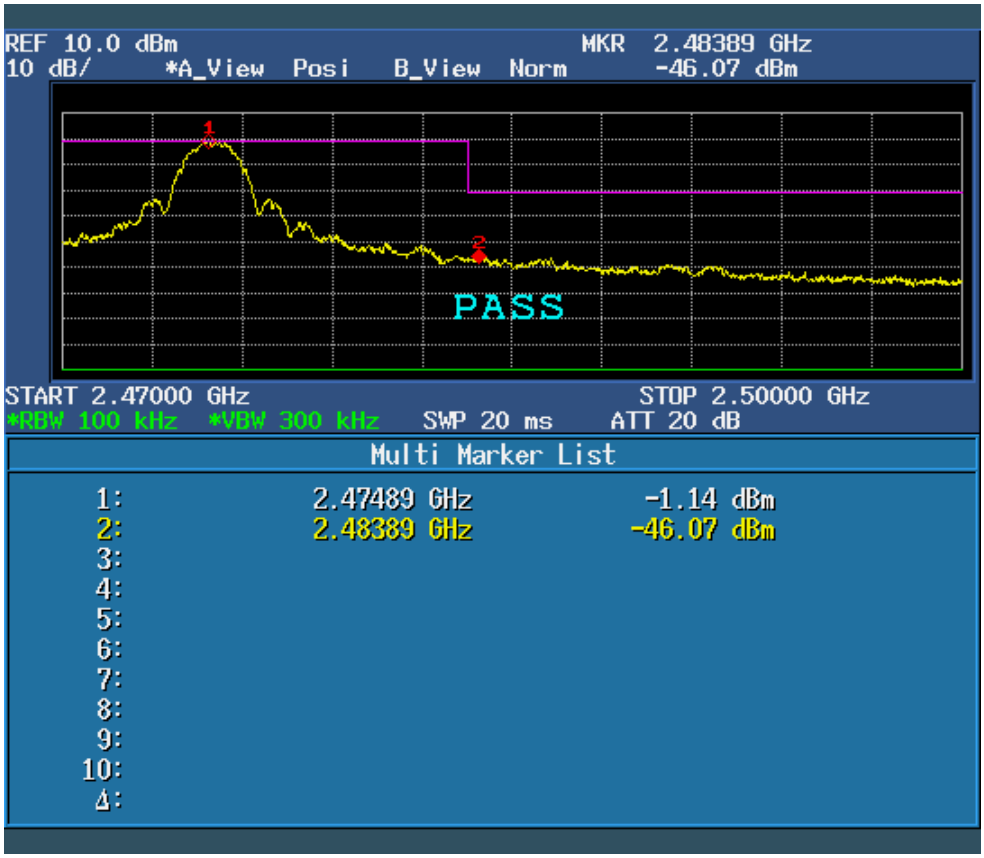


Middle Channel (operating at 2440 MHz)



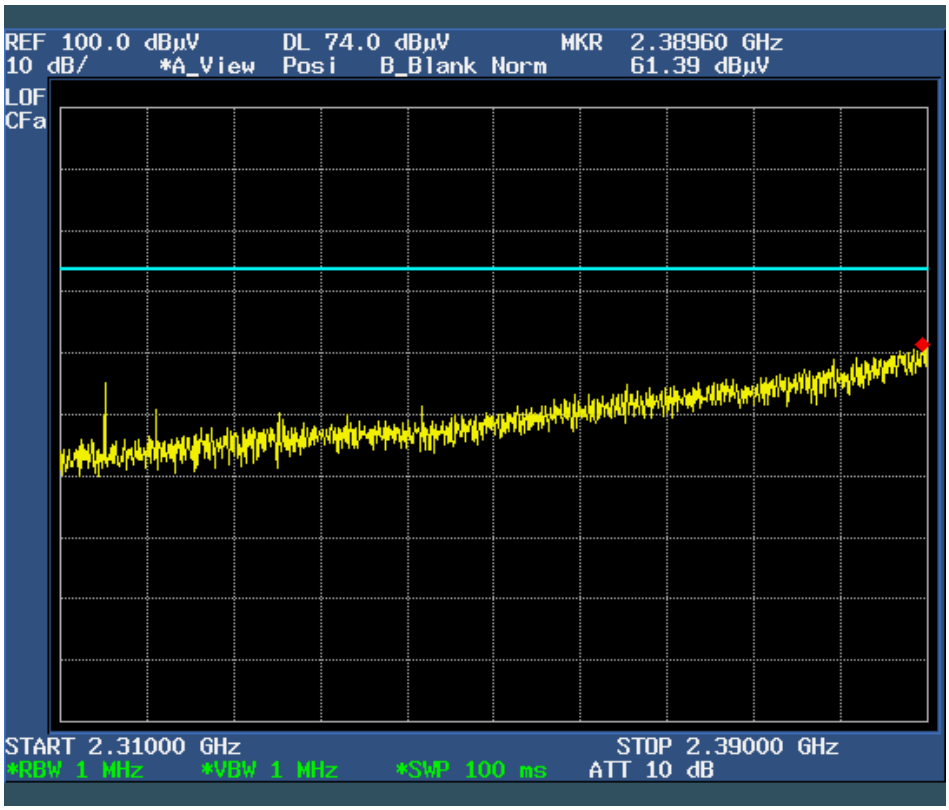
Highest Channel (operating at 2475 MHz)



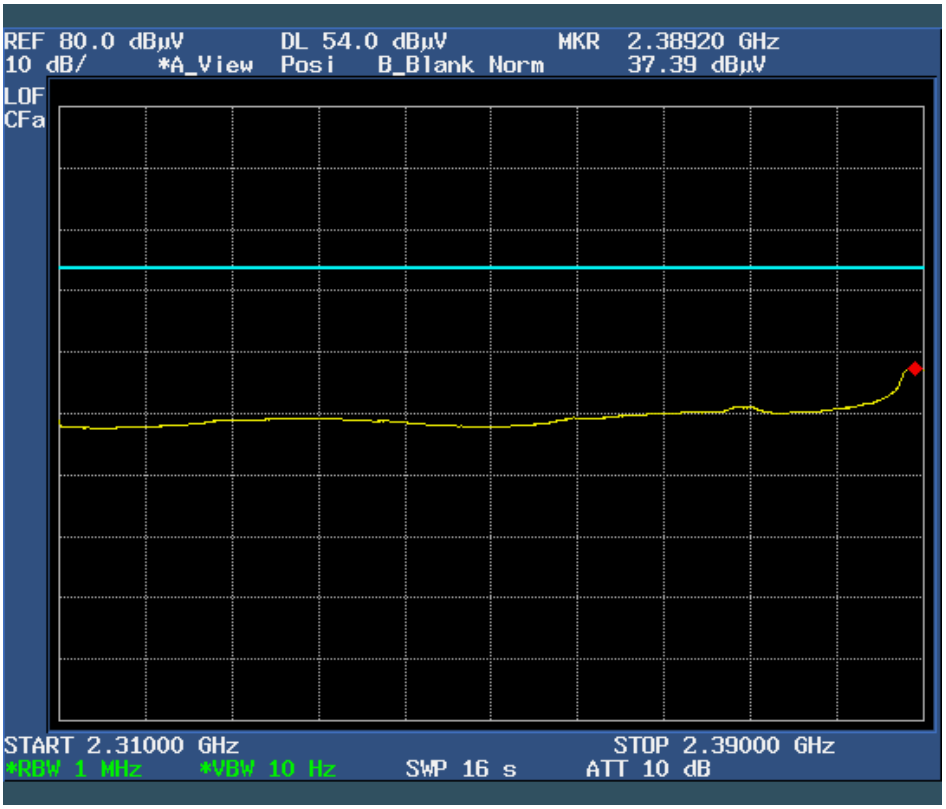


Band Edge (Radiated)

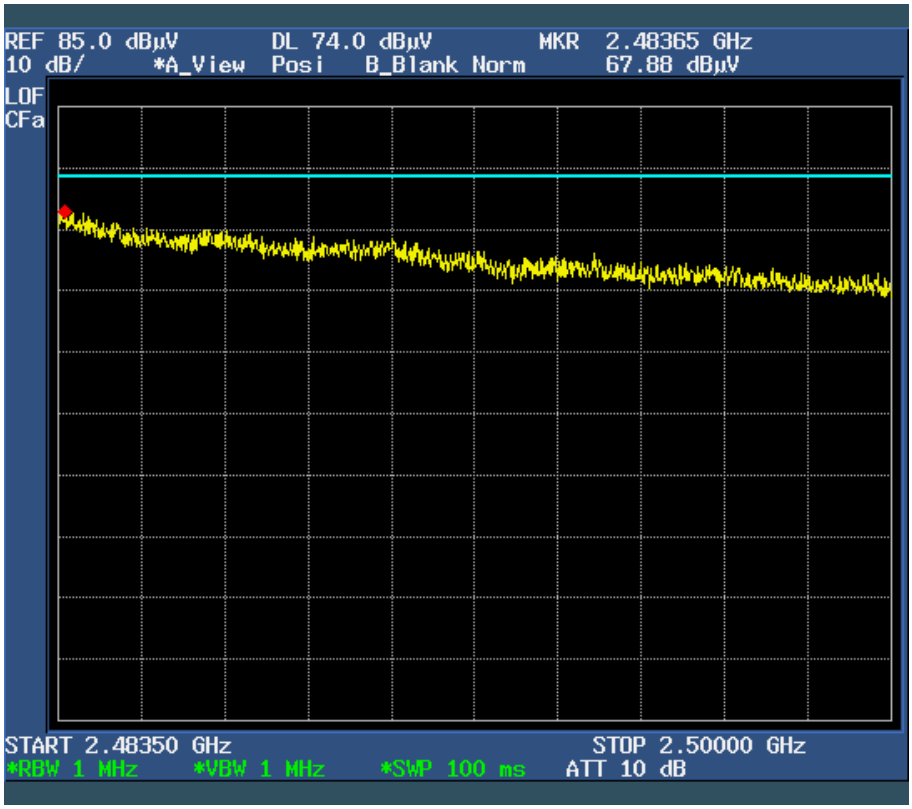
Lowest Channel (operating at 2405 MHz) PEAK



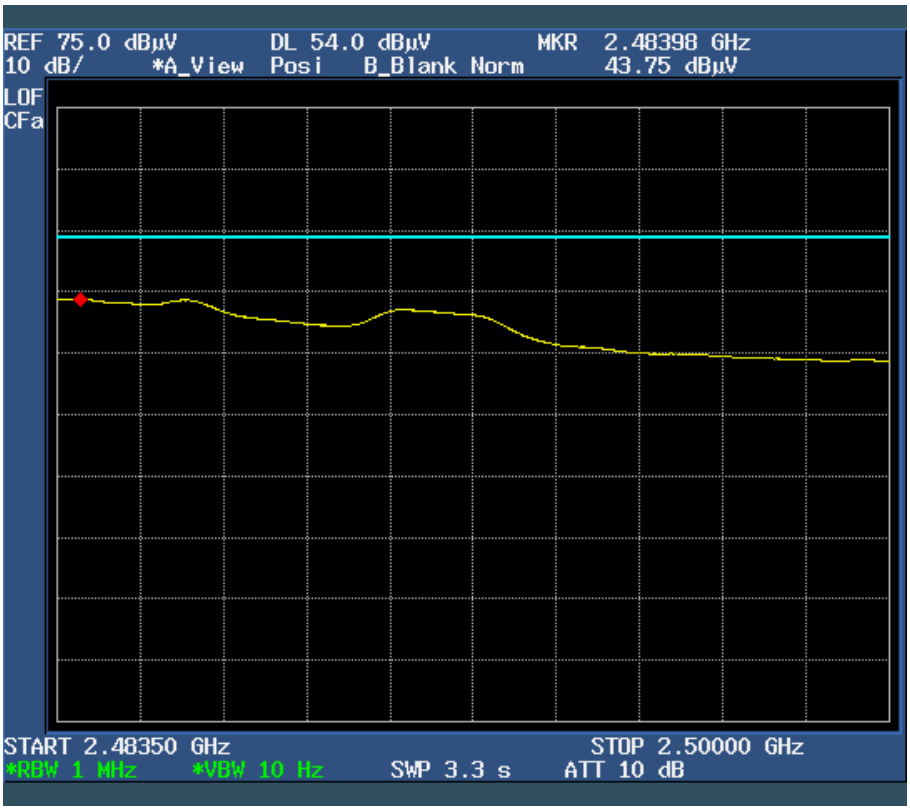
Lowest Channel (operating at 2405 MHz) AVERAGE



Highest Channel (operating at 2475 MHz) PEAK



Highest Channel (operating at 2475 MHz) AVERAGE



5.5 PEAK POWER SPECTRAL DENSITY

5.5.1 Regulation

According to §15.247(e), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

5.5.2 Test Procedure

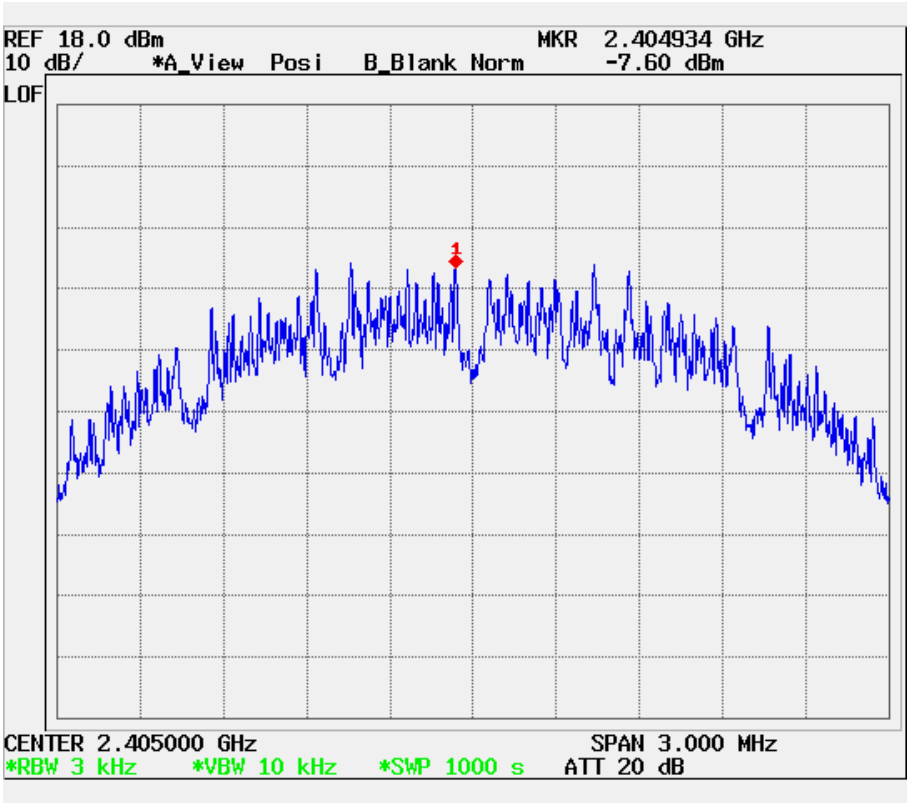
The Power Spectral Density was measured with a spectrum analyzer connected to the antenna port.

At RBW=3kHz, VBW=10kHz, SPAN=3MHz, Sweep time= (SPAN/3kHz)=1000sec

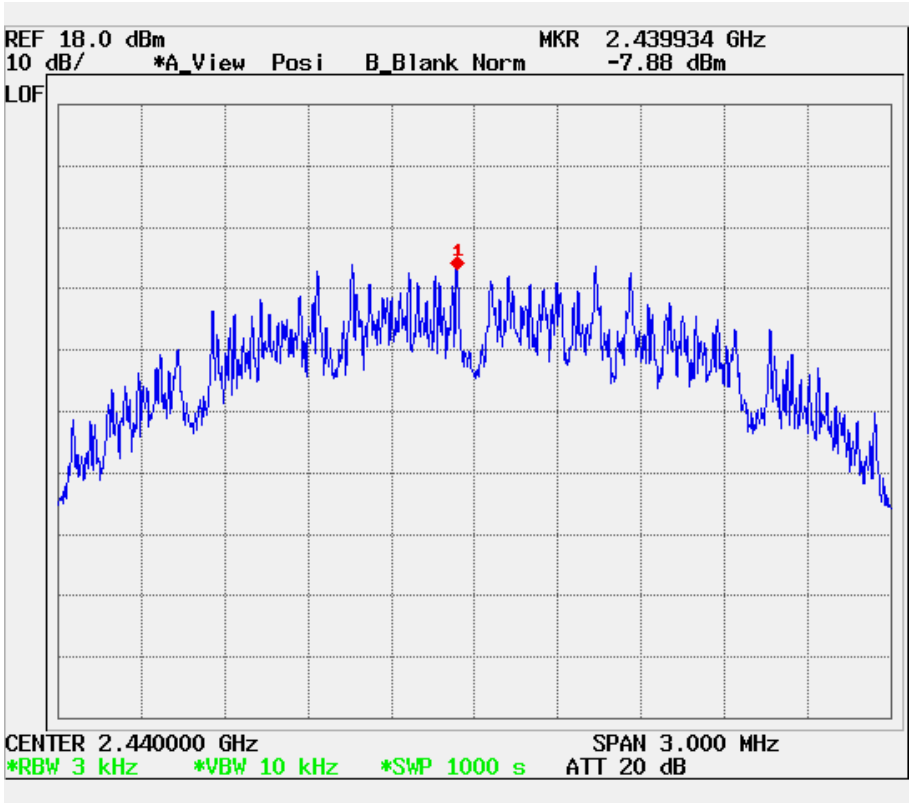
5.5.3 Test Results: PASS

Measured values of the Peak Power Spectral Density (Conducted)		
Operating frequency	PSD	Limit
2405 MHz	- 7.60 dBm	8.0 dBm
2440 MHz	- 7.88 dBm	8.0 dBm
2475 MHz	- 8.61 dBm	8.0 dBm

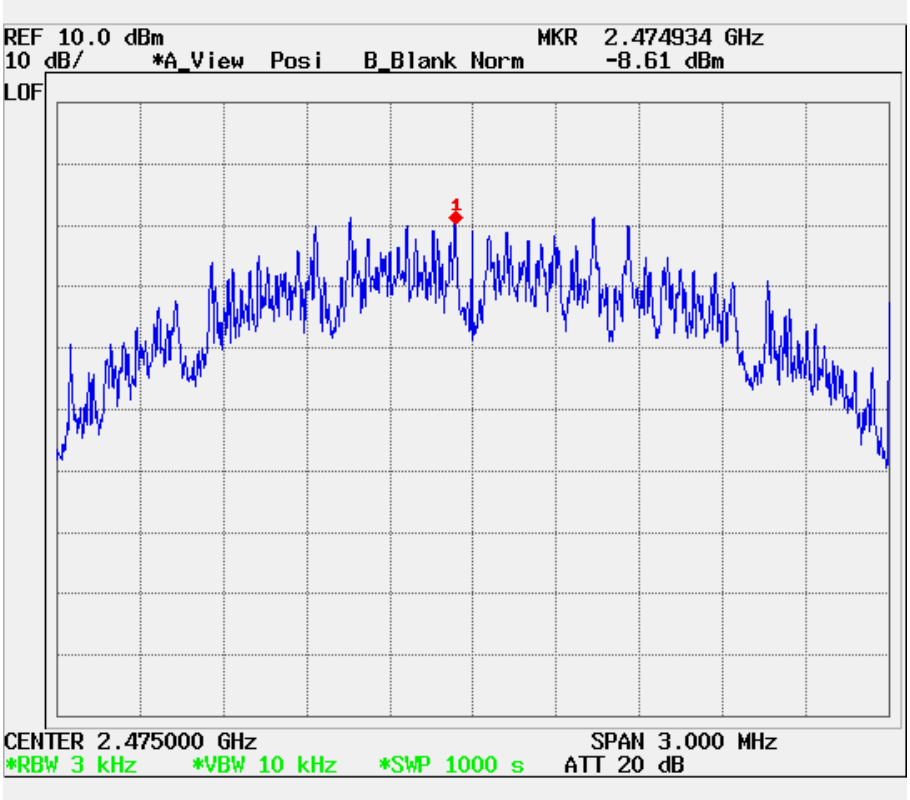
Lowest Channel (operating at 2405 MHz)



Middle Channel (operating at 2440 MHz)



Highest Channel (operating at 2475 MHz)



5.6 CONDUCTED EMISSIONS

5.6.1 Regulation

According to §15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50μH/50Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Qausi-peak	Average
0.15 – 0.5	66 to 56 *	56 to 46 *
0.5 – 5	56	46
5 – 30	60	50

* Decreases with the logarithm of the frequency.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

5.6.2 Test Procedure

1. The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5m away from the side wall of the shielded room.
2. Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50μH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.
3. Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
4. The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASI-PEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.
5. The measuring level is calculated by adding the Correction Factor, Cable Loss.
   The basic equation with a sample calculation is as follow:
   Final Test Level = Receiver Reading + Correction Factor + Cable Factor

5.6.3 Test Results: **PASS**

Measured values of the Conducted Emissions				
Freq (MHz)	Polarity (H/N)	Level (Q.P/A.V) (dBuV)	LIMIT (Q.P/A.V) (dBuV)	Margin (Q.P/A.V) (dB)
0.150	L1	16.7	65.9	49.2
0.199	L1	53.8	64.6	10.8
0.300	L1	45.6	61.6	16.0
0.401	L1	40.0	58.8	18.8
0.502	L1	39.1	56.0	16.9
0.703	L1	35.9	56.0	20.1
1.004	L1	35.1	56.0	20.9
1.507	L1	36.8	56.0	19.2
2.096	L2	46.8 / 39.6	56.0 / 46.0	9.2 / 6.4
4.074	L2	39.6	56.0	16.4
5.996	L2	34.9	60.0	25.1
8.782	L2	27.0	60.0	33.0
14.272	L2	25.0	60.0	35.0
18.916	L2	20.1	60.0	39.9

Line - PE

Korea EMC Laboratory
Conducted Emission

EUT:
Manuf:
Op Cond:
Operator:
Test Spec:
Comment: L1

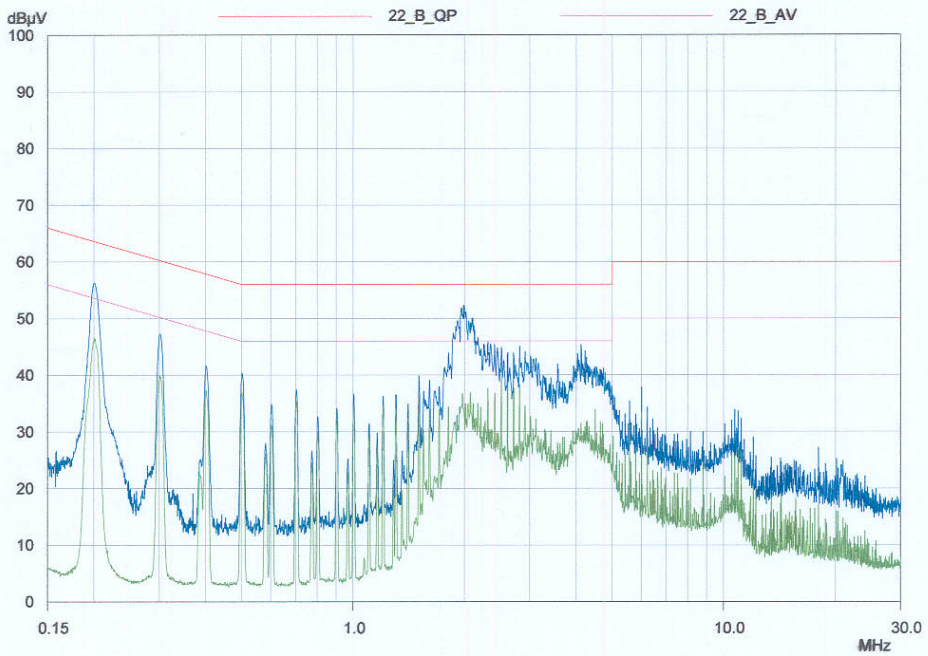
Result File: L-1.dat :

Scan Settings (1 Range)

Frequencies			Receiver Settings					
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
150kHz	30MHz	0.2%	9kHz	PK+AV	20msec	Auto	OFF	60dB

Final Measurement:

Detector:	X QP
Meas Time:	2sec
Peaks:	8
Acc Margin:	25 dB



Neutral - PE

Korea EMC Laboratory
Conducted Emission

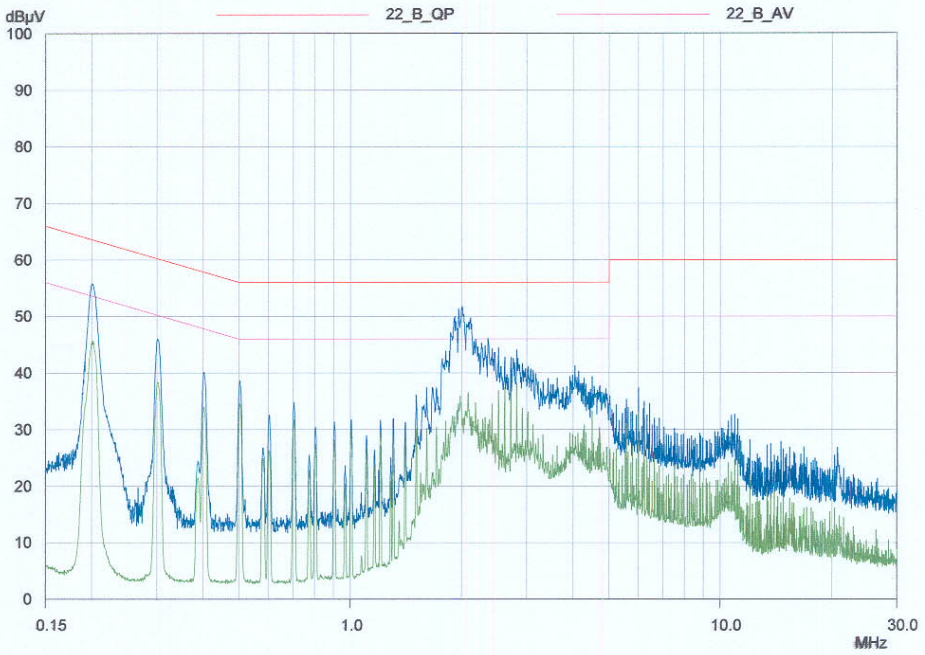
EUT:
Manuf:
Op Cond:
Operator:
Test Spec:
Comment: L2

Result File: L-2.dat :

Scan Settings (1 Range)

Frequencies			Receiver Settings					
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp	OpRge
150kHz	30MHz	0.2%	9kHz	PK+AV	20msec	Auto	OFF	60dB

Final Measurement: Detector: X QP
Meas Time: 2sec
Peaks: 8
Acc Margin: 25 dB



5.7 RF Exposure

5.7.1 Regulation

According to §15.247(i), 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. See § 1.1307(b)(1) of this Chapter.

Limits for Maximum Permissive Exposure: According to §1.1310 and §2.1093, RF exposure is calculated.

Frequency Range	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm^2]	Averaging Time [minute]
Limits for General Population/Uncontrolled Exposure				
0.3 ~ 1.34	614	1.63	*(100)	30
1.34 ~ 30	824/f	2.19/f	*(180/f^2)	30
30 ~ 300	27.5	0.073	0.2	30
300 ~ 1500	/	/	f/1500	30
1500 ~ 15000	/	/	1.0	30

f = frequency in MHz, * = Plane-wave equivalent power density

MPE (Maximum Permissive Exposure) Prediction

Predication of MPE limit at a given distance: Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

$$\left(\Rightarrow R = \sqrt{PG/4\pi S}\right)$$

S = power density [mW/cm^2]
P = power input to antenna [mW]
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna [cm]

EUT: Maximum peak output power = 3.79[dBm] (= 2.4 [mW]) & Antenna gain = 5.5[dBi](=3.54 numeric)	
100mW, at 20cm from an antenna 6 [dBi]	S = PG/4πR² = 100 × 3.98 / (4 × π × 400) = 0.0792 [mW/cm^2] < 1.0 [mW/cm^2]
2.4mW, at 20cm from the antenna 5.5 [dBi]	S = PG/4πR² = 0.00169 [mW/cm^2] < 1.0 [mW/cm^2]
2.4mW, at 5cm from the antenna 5.5 [dBi]	S = PG/4πR² = 0.027 [mW/cm^2] < 1.0 [mW/cm^2]
2.4mW, at 1cm from the antenna 5.5 [dBi]	S = PG/4πR² = 0.676 [mW/cm^2] < 1.0 [mW/cm^2]

NOTE: The antenna used for the EUT is a reverse polarity dipole antenna. The calculated values of MPE for the EUT show that MPE is safe beyond 1 cm from the antenna.

5.7.2 RF Exposure Compliance Issue

The EUT is categorically excluded from routine environmental because it operates at very low power level. The equipment is deemed to comply with the SAR or MPE limits without testing due to this very low power level. The maximum RF EIRP power output from the EUT is less than 9mW. If the entire RF power was absorbed by 1 gram of tissue (not possible considering typical RF circuits), the SAR limit of 1.6mW/g would still not be exceed. Therefore no warning labels, no RF exposure warnings in the manual or other protection measures are required for the EUT.