TEST REPORT

Part 15 Subpart C 15.247

1. Applicant

Name	:	UnionNet Co., Ltd.
Address	:	278-2, Union Bldg., Seongsan-dong, Mapo-Gu, Seoul, Korea

2. Products

Name	:	Uni Reader Bluetooth Scanner
Model/Type	:	SP-2100
FCC ID	:	ONV-SP-2100
Manufacturer	:	UnionNet Co., Ltd.

3. Test Standard	:	FCC CFR 47 Part 15.247 Subpart C
Test Method	:	ANSI C63.4-2009
Test Result	:	Positive
Date of receipt	:	July 03, 2012
Date of Issue	:	July 20, 2012

Tested by	Approved by
Dong Hwa Shin	SungBum, Hong
Test Engineer:	Compliance Engineer:

Korea Standard Quality Laboratories
Testing Laboratories for EMC and Safety Compliance
www.ksqlab.com #102, Jangduk-Dong, Hwasung-City, Kyunggi-Do, KOREA

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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
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 Standard Quality Laboratories 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 Standard Quality Laboratories

2.1 Location

#102, Jangduk Dong, Hwasung City, Kyunggi Do, South Korea
(FCC Registered Test Site Number: 100384)

This test site is in compliance with ISO/IEC 17025 for general requirements for the competence of testing and calibration laboratories.

2.2 Test Date

Date of Test: July 10, 2012 ~ July 18, 2012

2.3 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

Power source	DC 3.7 V
Transmit Frequency	2402 ~ 2480 MHz (1 MHz step, 79 channels)
X-tal or Oscillator	X-tal: 26 MHz
Antenna Type	Integral (Chip Antenna, Gain: 0.5 dBi max.)
Type of Modulation	FHSS (GFSK)

3.2 Equipment Modifications

None.

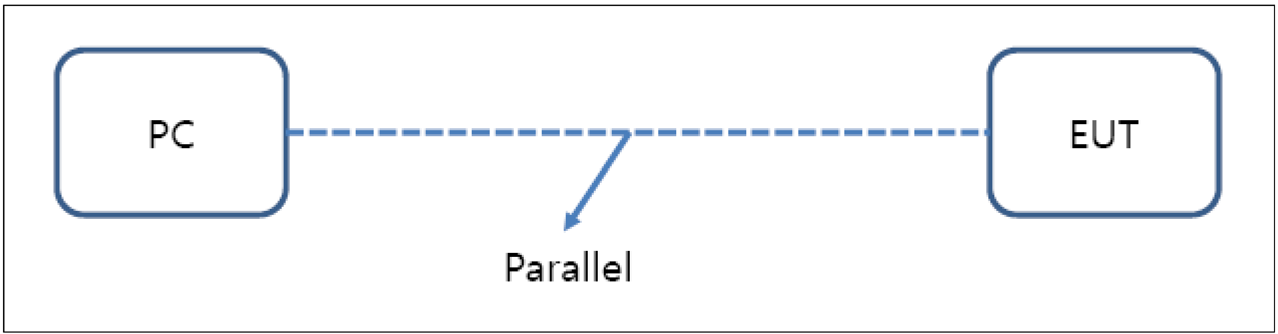
3.3 Submitted Documents

Block diagram
Schematic diagram
Antenna Specification
External photos
Test setup photos
Part List
Tune up Procedure
Label Location
User manual

4. MEASUREMENT CONDITIONS

4.1 Description of test configuration

The measurements were taken in continuous transmitting mode using the TEST MODE. For controlling the EUT as TEST MODE, the test program and the cable assembly were provided by the applicant.



[System Block Diagram of Test Configuration]

4.2 List of Peripherals

Equipment Type	Manufacturer	Model	S/N
Personal Computer**	FineMV	Br3658	-
-	-	-	-

** For control of the RF module via SPI interface in the EUT. For radiated spurious emission measurements, setting the EUT to TEST MODE.

The AC power line conducted emission measurement was performed while charging the battery and simultaneously transmitting the RF signal. for modulating the transmitter, a pseudo random bit sequence with a pattern type DH5 for GFSK was used.

4.3 Type of Used Cables

#	START		END		CABLE	
	NAME	I/O PORT	NAME	I/O PORT	LENGTH(m)	SHIELDED
1	PC	Parallel	EUT	-	1.0	YES
2						

5. TEST AND MEASUREMENT

Summary of Test Reaults

Requirement	CFR 47 Section	Report Section	Test Result
Antenna Requirement	15.203, 15.247(b)(4)	5.1	PASS
20dB Bandwidth	15.247(a)(1)	5.2	PASS
Maximum Peak Output Power	15.247(b)(1), (4)	5.3	PASS
Carrier Frequency Separation	15.247(a)(1)	5.4	PASS
Number of Hopping Channels	15.247(a)(iii), 15.247(b)(1)	5.5	PASS
Dwell Time	15.247(a)(iii)	5.6	PASS
Spurious Emission, Band Edge, and Restricted bands	15.247(d), 15.205(a), 15.209(a)	5.7	PASS
Conducted Emissions	15.207(a)	5.8	PASS
Receiver Spurious Emissions	-	5.9	PASS
RF Exposure	15.247(i), 1.1307(b)(1)	5.10	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 an integral Chip antenna. The directional gain of the antenna is 0.5 dBi.

5.2. 20dB BANDWIDTH

5.2.1 Regulation

According to §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

5.2.2. Test Condition

- Set RBW of Spectrum analyzer to 10 kHz, Span=3MHz, Sweep=auto
- The 20dB bandwidth is defined as the frequency range where the power is higher than the peak power minus 20dB . Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater

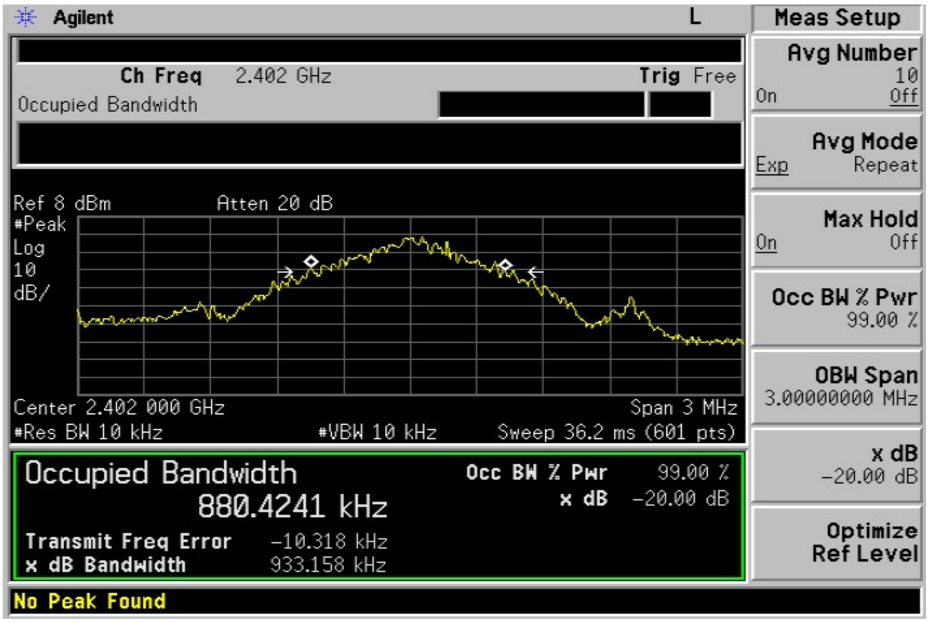
5.2.3. Test result : PASS

Table 1 : Measured values of the 20dB Bandwidth

Modulation	Frequency (MHz)	Result (kHz)	Verdict
GFSK	2402	933.16	Pass
	2441	929.17	Pass
	2480	932.21	Pass

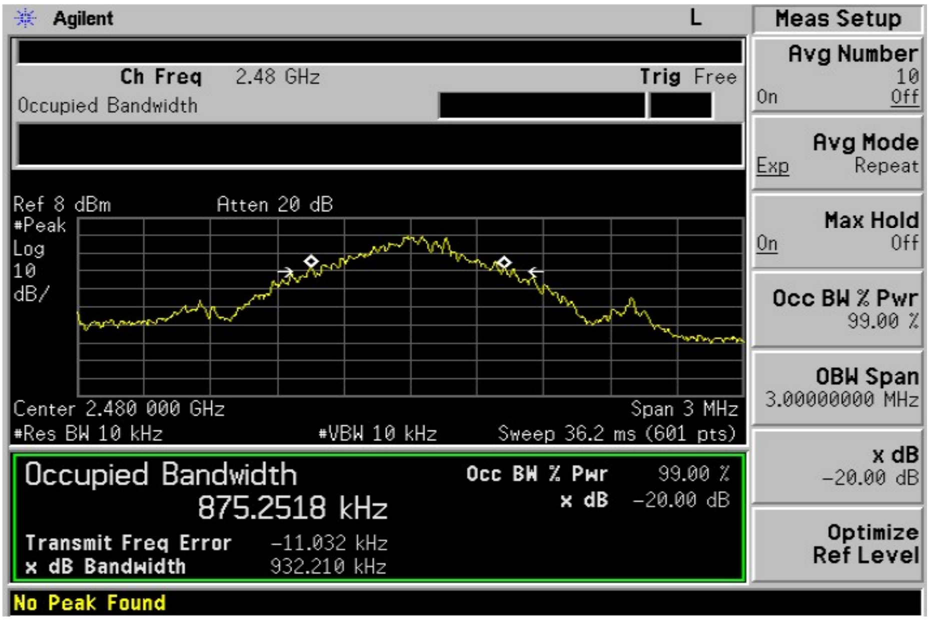
Figure 1. Plot of the 20dB Channel Bandwidth

Lowest Channel (2402 MHz)



Middle Channel (2441 MHz)

Highest Channel (2480 MHz)



5.3. MAXIMUM PEAK POWER

5.3.1 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.

5.3.2 Test Condition

- Set RBW of Spectrum analyzer to 1 MHz
- The Maximum Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt.

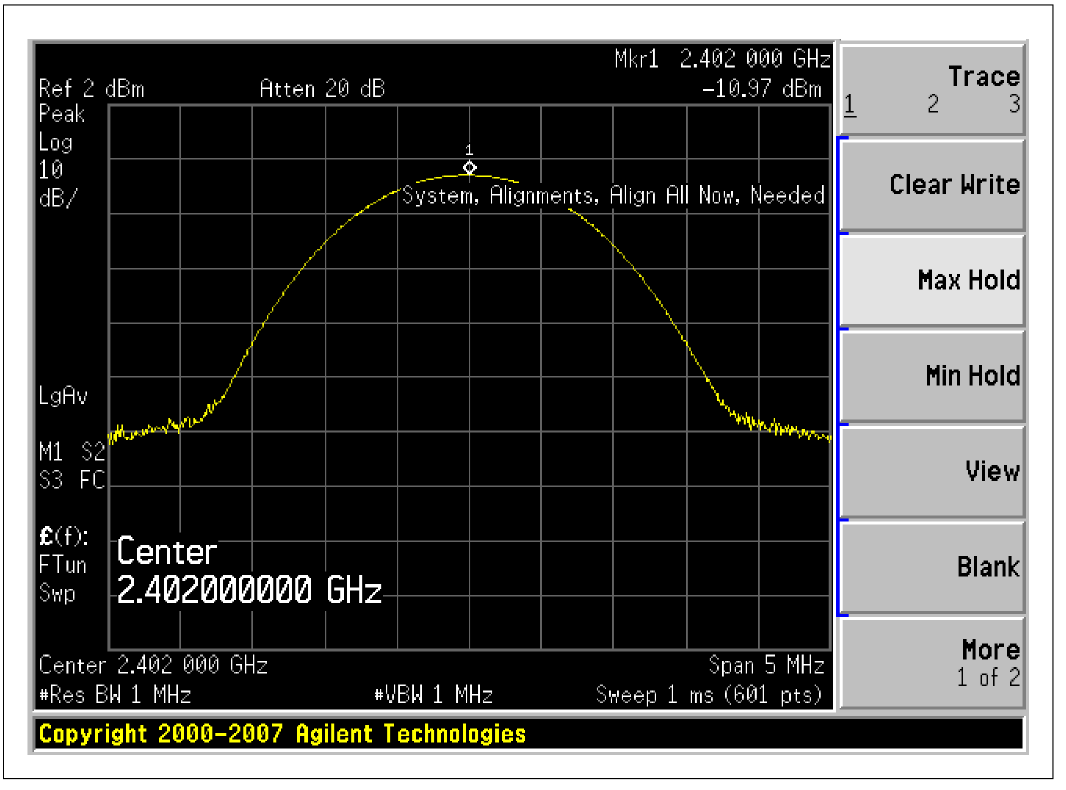
5.3.3 Test result : PASS

Table 2 : Measured values of the Maximum Peak Output Power(Conducted)

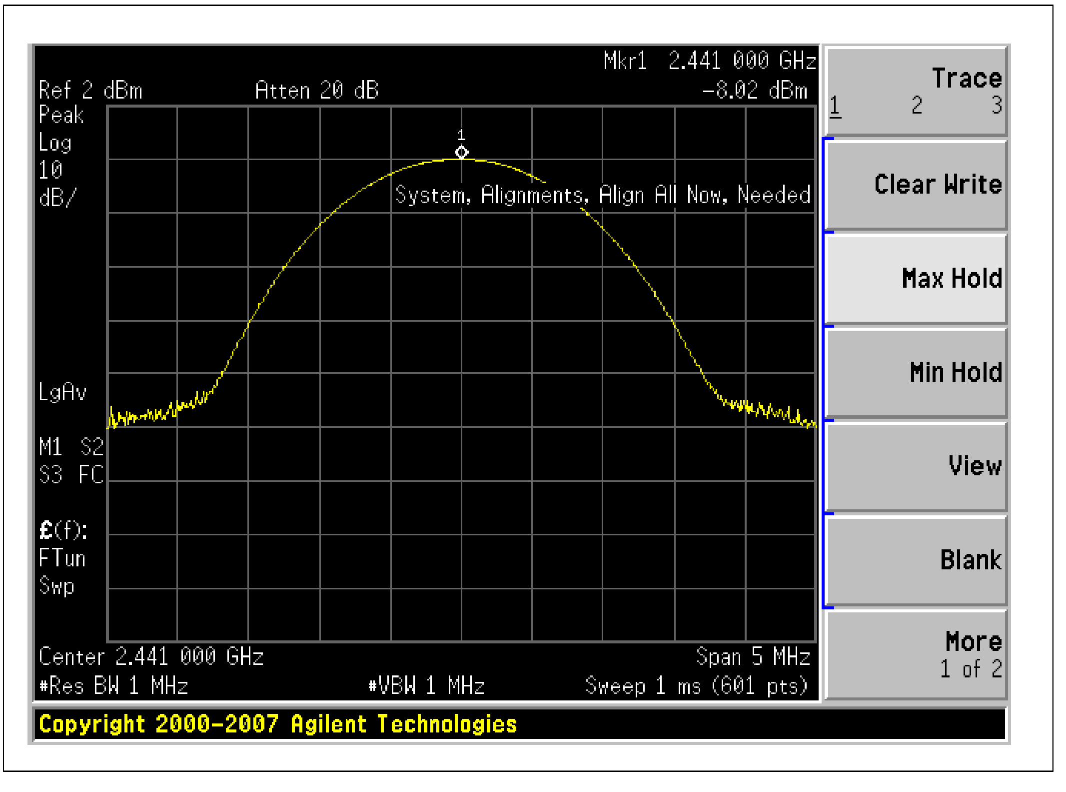
Modulation	Frequency (MHz)	Reading Power (dBm)	Output Power (W)	Limit (W)	Verdict
GFSK	2402	-10.97	0.00008	1	Pass
	2441	-8.02	0.00015	1	Pass
	2480	-5.96	0.00025	1	Pass

Figure 2. Plot of the Maximum Peak Output Power(Conducted)

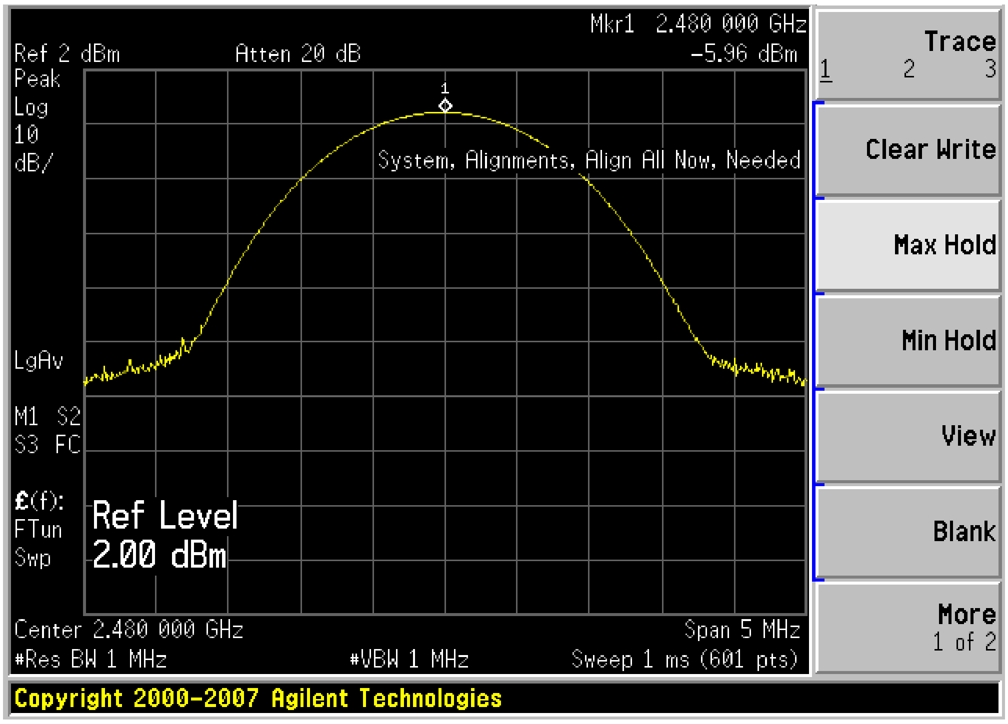
Lowest Channel (2402 MHz)



Middle Channel (2441 MHz)



Highest Channel (2480 MHz)



5.4 CARRIER FREQUENCY SEPARATION

5.4.1 Regulation

According to §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

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

5.4.2 Test Condition

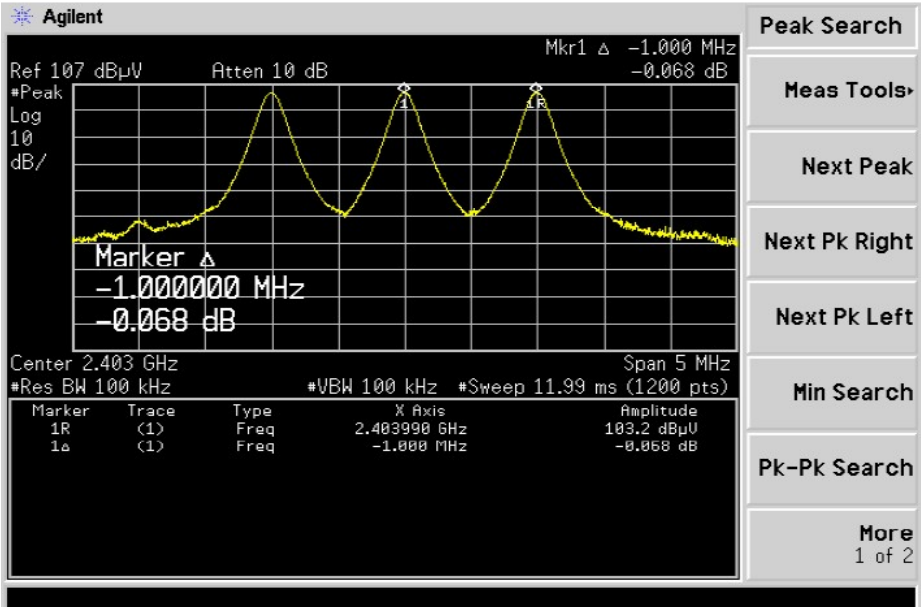
- Set RBW of Spectrum analyzer to 30 kHz, Span=3MHz, Sweep=auto
- Frequency hopping system shall have hopping channel carrier frequencies separated by minimum of 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

5.4.3 Test result : PASS

Table 3 : Measured values of the Carrier Frequency Separation

Modulation	Operating frequency (MHz)	frequency separation (kHz)	Limit (frequency separation)	Verdict
GFSK	2402	1069	≥ 25 kHz or 20 dB bandwidth, whichever is greater	Pass

Figure 3. Plot of the Carrier Frequency Separation



5.5. NUMBER OF HOPPING CHANNELS

5.5.1 Regulation

According to §15.247(a)(1)(iii), frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

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.

5.5.2 Test Condition

- Set RBW of Spectrum analyzer to 100 kHz
- Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

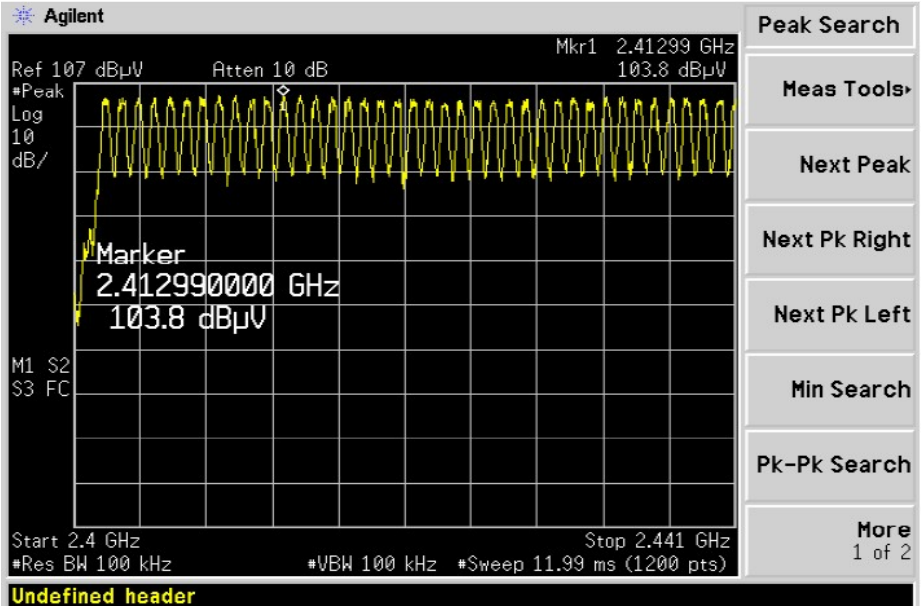
5.5.3 Test result : PASS

Table 4 : Measured values of the Number of Hopping Channels

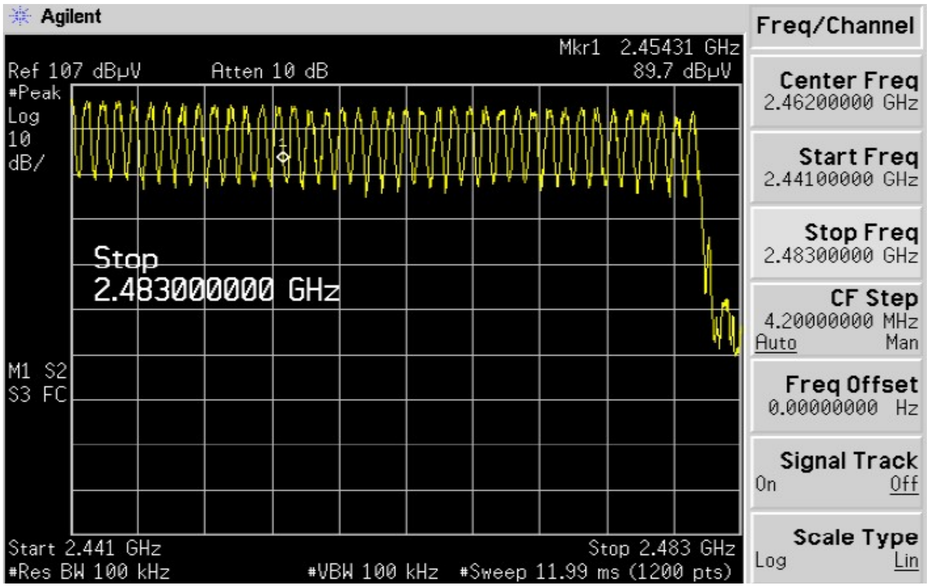
Modulation	Operating frequency (MHz)	Result (channel)	Limit (channel)	Verdict
GFSK	2402 ~ 2480MHz	79	15	Pass

Figure 4. Plot of the Number of Hopping Channels

2402 ~ 2441 MHz



2441 ~ 2480 MHz



5.6 DWELL TIME

5.6.1 Regulation

According to §15.247(a)(1)(iii), frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

5.6.2 Test Condition

- Set RBW of Spectrum analyzer to 3 MHz, sweep time is 4.0 ms
- Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. 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. Since the Bluetooth technology uses 79 channels this period is calculated to be 31.6 seconds.

5.6.3 Test result : PASS

A period time = 0.4 (ms) * 79 = 31.6 (s)

CH Low: DH1 time slot = 0.405 (ms) * (1600/(2*79)) * 31.6 = 129.6 (ms)

DH3 time slot = 1.675 (ms) * (1600/(4*79)) * 31.6 = 268.0 (ms)

DH5 time slot = 2.925 (ms) * (1600/(6*79)) * 31.6 = 312.0 (ms)

CH Mid: DH1 time slot = 0.405 (ms) * (1600/(2*79)) * 31.6 = 129.6 (ms)

DH3 time slot = 1.675 (ms) * (1600/(4*79)) * 31.6 = 268.0 (ms)

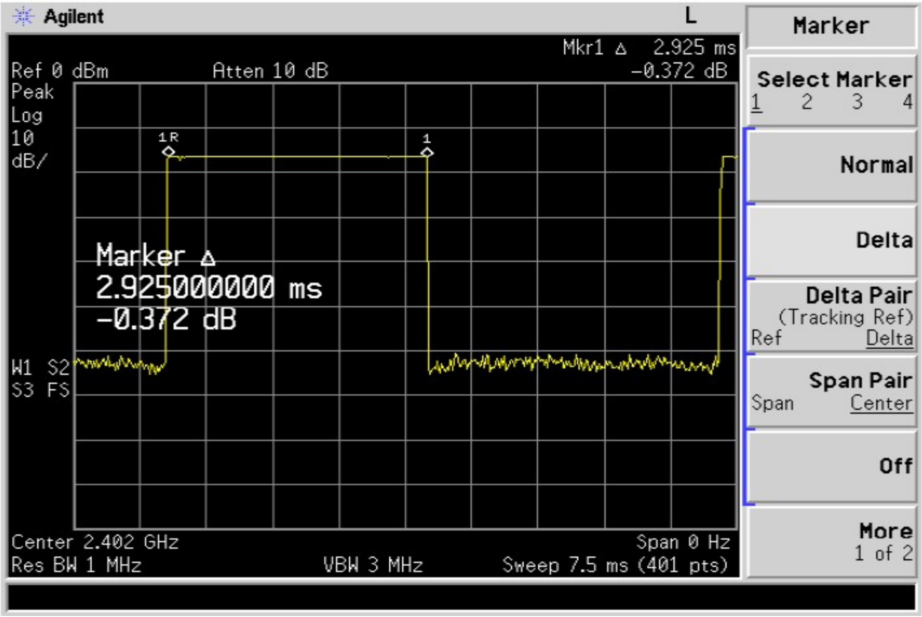
DH5 time slot = 2.906 (ms) * (1600/(6*79)) * 31.6 = 309.9 (ms)

CH High: DH1 time slot = 0.416 (ms) * (1600/(2*79)) * 31.6 = 133.12 (ms)

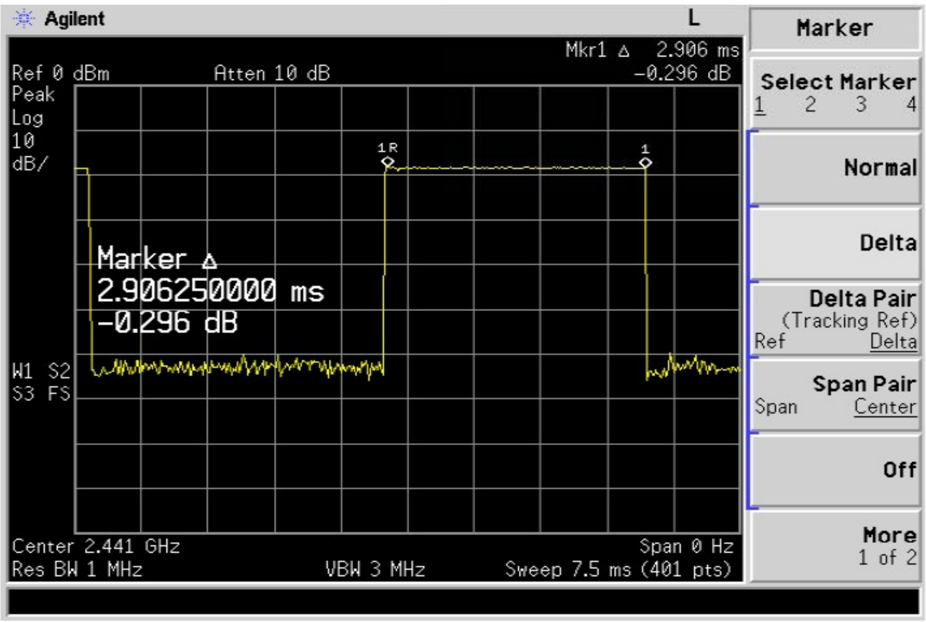
DH3 time slot = 1.662 (ms) * (1600/(4*79)) * 31.6 = 265.92 (ms)

DH5 time slot = 2.906 (ms) * (1600/(6*79)) * 31.6 = 309.97 (ms)

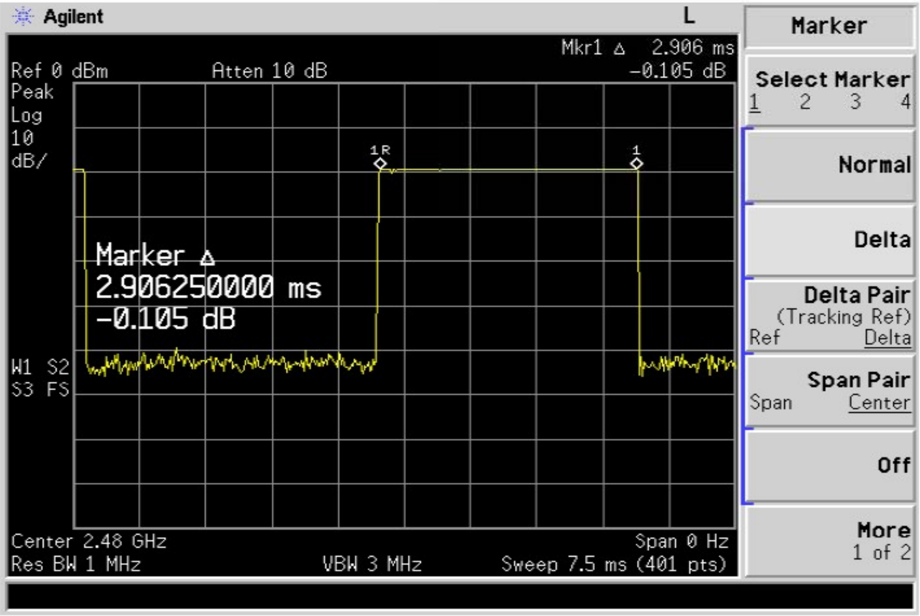
CH-Low_ DH5



CH-Mid_ DH5



CH-High_ DH5


Agilent
L
Marker
Mkr1 Δ 2.906 ms
-0.105 dB
Ref 0 dBm
Atten 10 dB
Peak
Log
10
dB/
Select Marker
1 2 3 4
Normal
Delta
Marker Δ
2.906250000 ms
-0.105 dB
Delta Pair
(Tracking Ref)
Ref Delta
W1 S2
S3 FS
Span Pair
Span Center
Off
Center 2.48 GHz
Span 0 Hz
Res BW 1 MHz
VBW 3 MHz
Sweep 7.5 ms (401 pts)
More
1 of 2

5.7 SPURIOUS EMISSIONS, BAND EDGE, AND RESTRICTED BANDS

5.7.1 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:

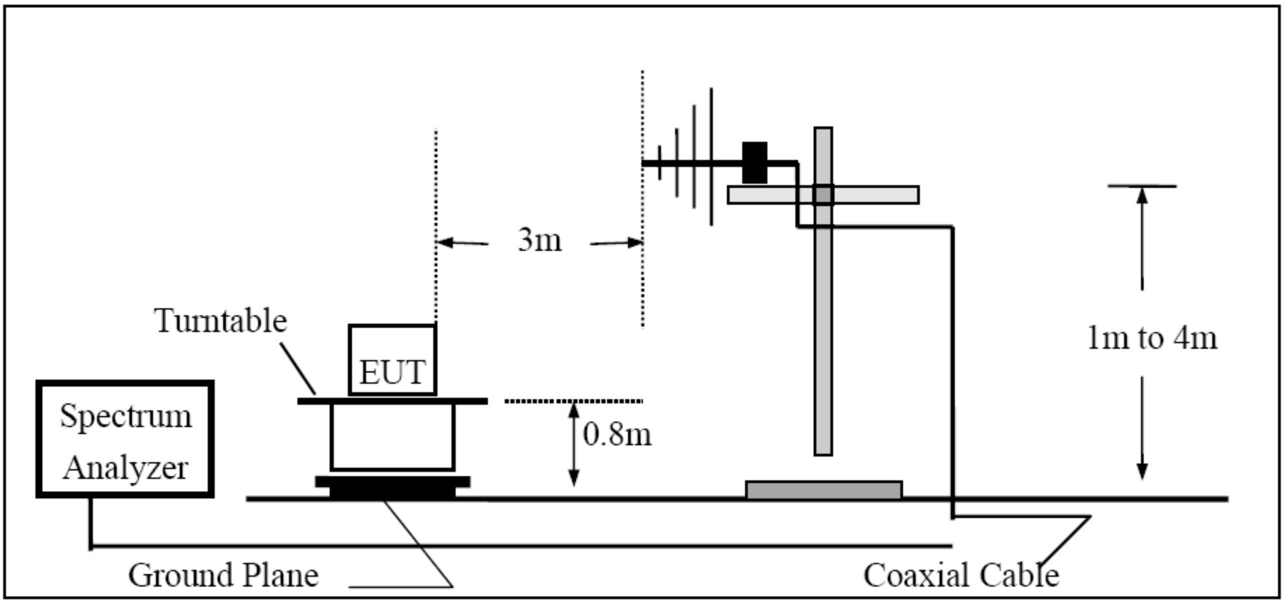
Frequency (MHz)	Field strength (μV/m @ 3m)	Field strength (dBμV/m @ 3m)
30–88	100	40.0
88–216	150	43.5
216–960	200	46.0
Above 960	500	54.0

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.

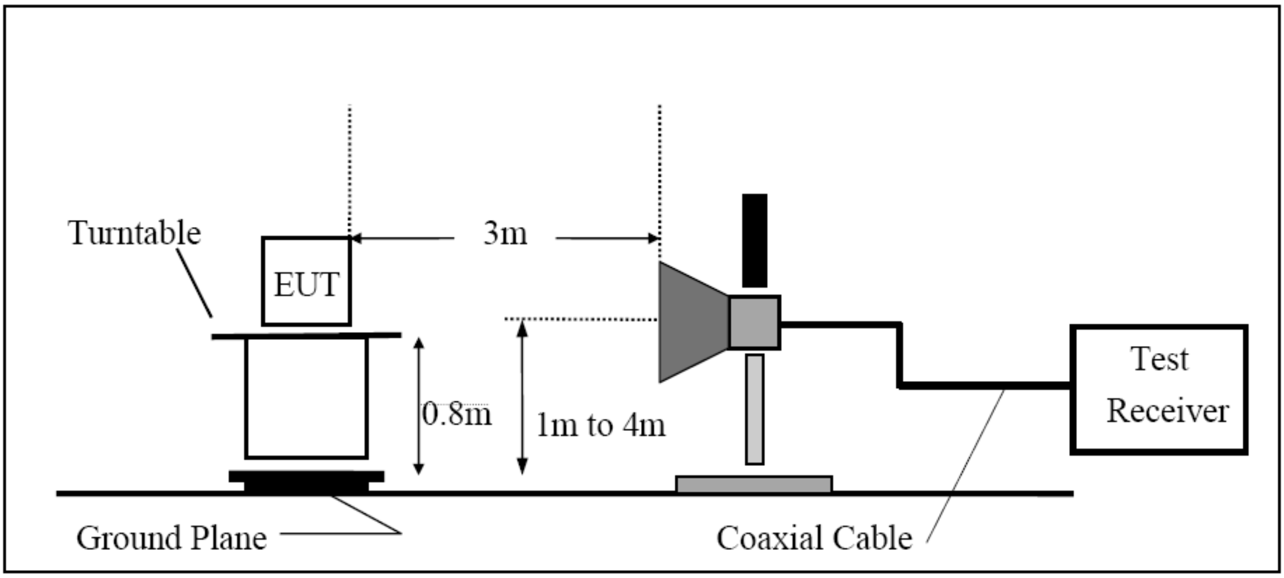
** The emission limits shown in the above table are based on measurement instrumentation employing a CISPR quasi-peak detector and above 1000 MHz are based on the average value of measured emissions.

5.7.2 Test Setup Layout

5.7.2.1 Radiated Emission Test Set-Up, Frequency Below 1000MHz



5.7.2.2 Radiated Emission Test Set-UP Frequency Over 1000MHz



5.7.3 Test Procedure

1) Band-edge Compliance of RF Conducted Emissions

1. Set the spectrum analyzer as follows:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation
RBW ≥ 1% of the span
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

2. Allow the trace to stabilize. Set the marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is greater than that at the band-edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.
3. Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit.

2) Spurious RF Conducted Emissions:

1. Set the spectrum analyzer as follows:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

2. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.

3) Spurious Radiated Emissions:

1. The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters for above 30 MHz, and at 1 meter distance for below 30 MHz.
2. 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°.

3. The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 kHz to 30 MHz using the loop antenna, from 30 to 1000 MHz using the Trilog broadband antenna, and from 1 GHz to tenth harmonic of the highest fundamental frequency using the horn antenna.
4. 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.
5. 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.
6. The EUT is situated in three orthogonal planes (if appropriate)
7. 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.
8. If the emission on which a radiated measurement must be made is located at the edge of the authorized band of operation, then the alternative “marker-delta” method may be employed.

4) Marker-Delta Method at the edge of the authorized band of operation:

1. Perform an in-band field strength measurement of the fundamental emission using the RBW and detector function as the above Spurious Radiated Emissions test procedure.
2. Choose a spectrum analyzer span that encompasses both the peak of the fundamental emission and the band-edge emission under investigation. Set the analyzer RBW to 1% of the total span (but never less than 30 kHz) with a video bandwidth equal to or greater than the RBW. Record the peak levels of the fundamental emission and the relevant band-edge emission (i.e., run several sweeps in peak hold mode). Observe the stored trace and measure the amplitude delta between the peak of the fundamental and the peak of the band-edge emission. This is not a field strength measurement; it is only a relative measurement to determine the amount by which the emission drops at the band-edge relative to the highest fundamental emission level.
3. Subtract the delta measured in step (2) from the field strengths measured in step (1). The resultant field strengths (CISPR QP, average, or peak, as appropriate) are then used to determine band-edge compliance as required by Section 15.205.
4. The above "delta" measurement technique may be used for measuring emissions that are up to two "standard" bandwidths away from the band-edge, where a "standard" bandwidth is the bandwidth specified by C63.4 for the frequency being measured. For example, for band-edge measurements in the restricted band that begins at 2483.5 MHz, C63.4 specifies a measurement bandwidth of at least 1 MHz. Therefore you may use the "delta" technique for measuring emissions up to 2 MHz removed from the band-edge. Radiated emissions that are removed by more than two “standard” bandwidths must be measured as the above Spurious Radiated Emissions test procedure.

5.7.4 Test Results: PASS

Band-edge compliance of RF conducted/radiated emissions was shown in the Figure 6 and Figure 7

NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

Spurious RF conducted emissions were shown in the Figure 8

NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

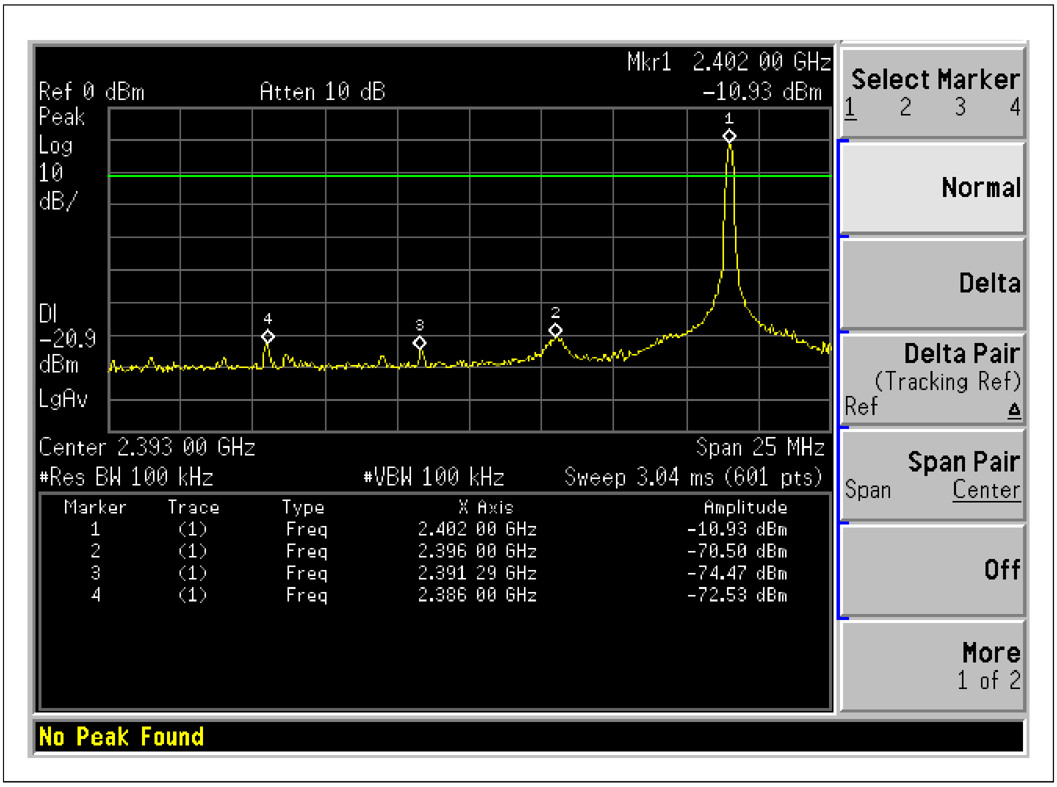
Table 6 : Measured values of the Field strength of spurious emission (Transmit mode)

Frequency (MHz)		Detect Mode	Polarization (V/H)	Turn Table (degree)	Measured Value (dBμV)	Antenna Factor + Cable Loss (dB/m)	Amplifier Gain (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Average/Peak/Quasi-peak data, emissions below 30 MHz										
			No Spurious Radiated Emissions Found							
Quasi-peak data, emissions below 1000 MHz										
			No Spurious Radiated Emissions Found							
Peak/Average data, emissions above 1000 MHz										
CH 0 (2402MHz)	4804	Peak	V	108	27.32	40.3	-23.2	44.42	74	29.58
	4804	Average	V	108	20.69	40.3	-23.2	37.79	54	16.21
	4804	Peak	H	37	28.42	40.3	-23.2	45.52	74	28.48
	4804	Average	H	37	19.74	40.3	-23.2	36.84	54	17.16
CH 39 (2441MHz)	4882	Peak	V	287	26.36	40.7	-23.2	43.46	74	30.54
	4882	Average	V	287	20.64	40.7	-23.2	37.74	54	16.26
	4882	Peak	H	41	25.18	40.7	-23.2	42.28	74	31.72
	4882	Average	H	41	19.86	40.7	-23.2	36.96	54	17.04
CH 78 (2480MHz)	4960	Peak	V	133	27.35	41.2	-23.2	44.45	74	29.55
	4960	Average	V	133	21.34	41.2	-23.2	38.44	54	15.56
	4960	Peak	H	85	26.69	41.2	-23.2	43.79	74	30.21
	4960	Average	H	85	20.54	41.2	-23.2	37.64	54	16.36

1. Margin (dB) = Limit − Emission Level
2. H = Horizontal, V = Vertical Polarization

Figure 6. Plot of the Band Edge (Conducted)

Lowest Channel (2402 MHz)



Middle Channel (2480 MHz)

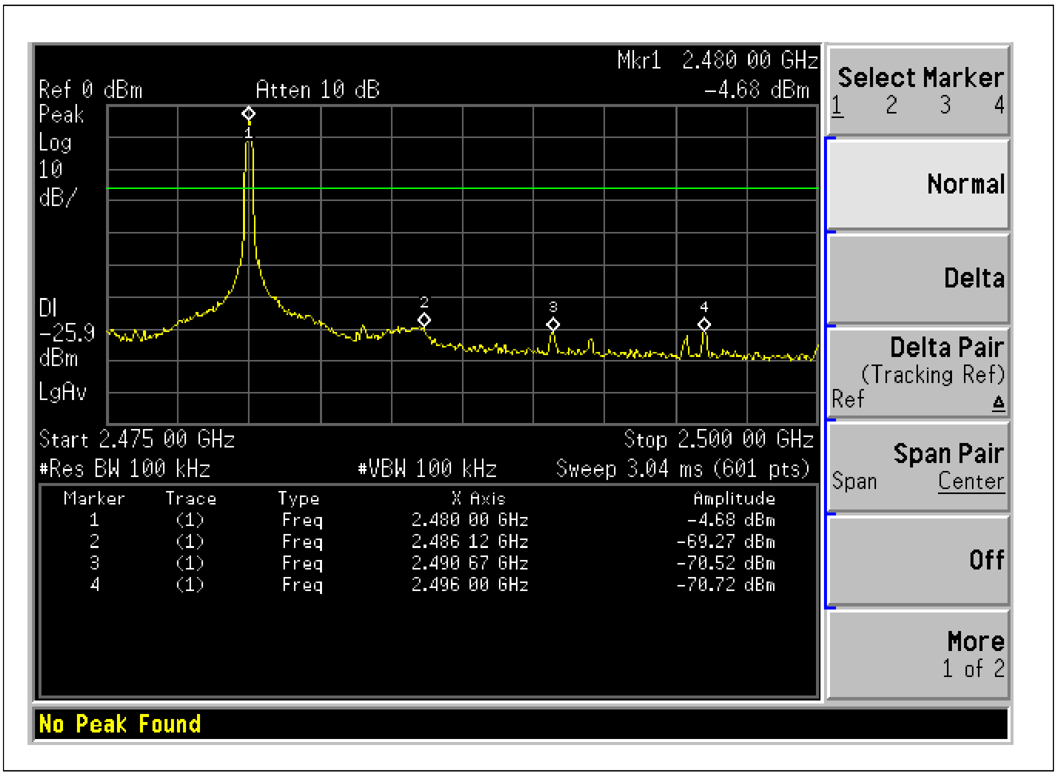
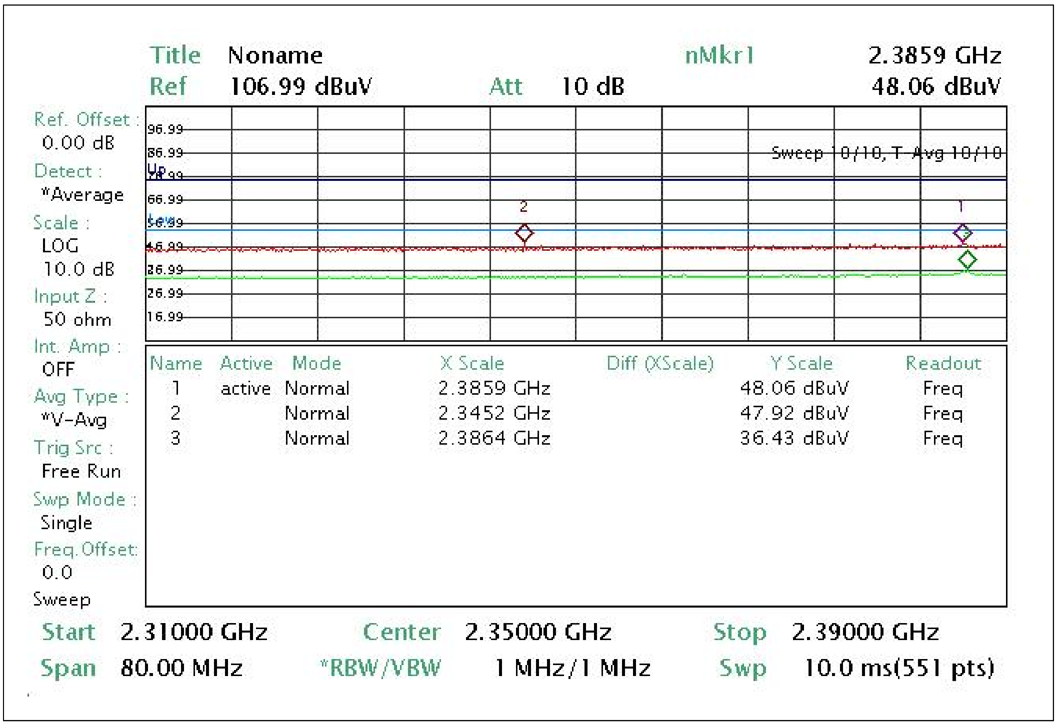


Figure 7. Plot of the Band Edge (Radiated)

Peak
Average

Lowest Channel (2402 MHz)



Highest Channel (2480 MHz)

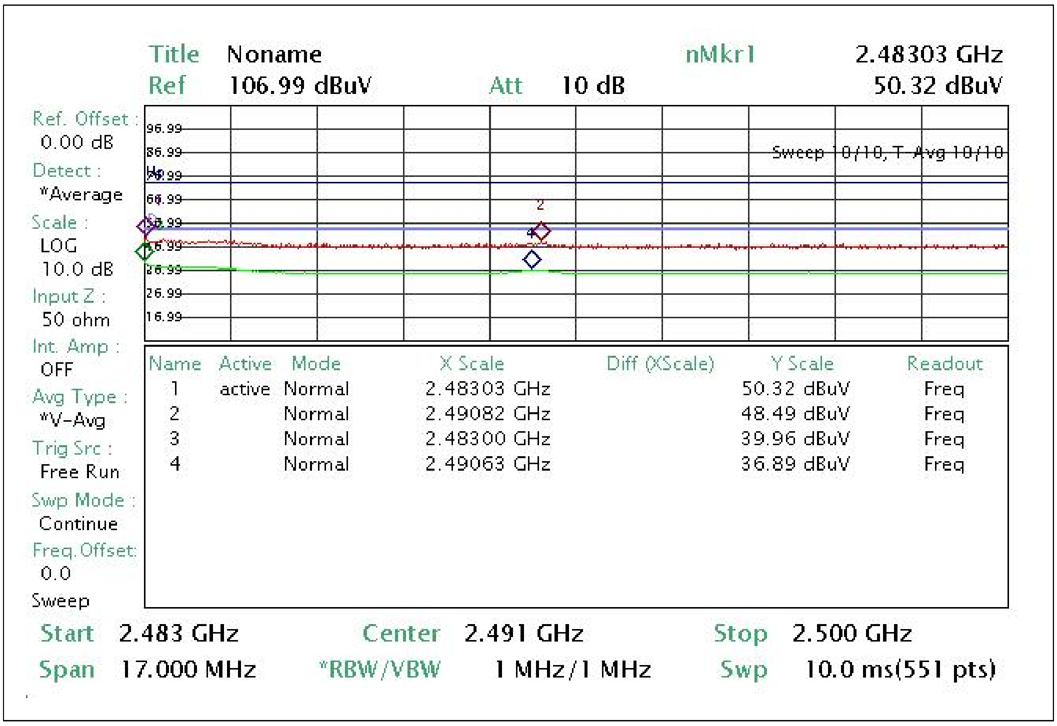
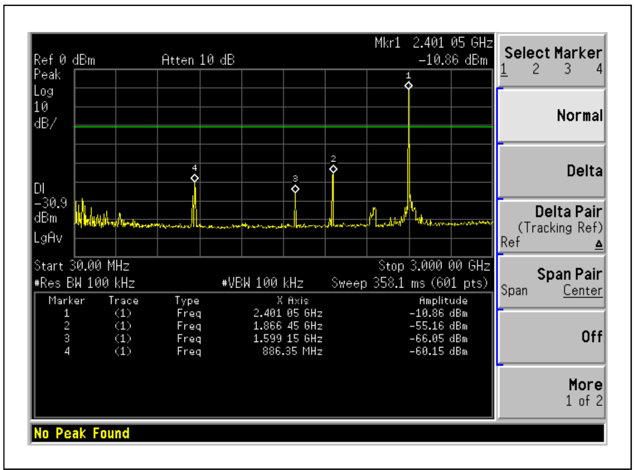
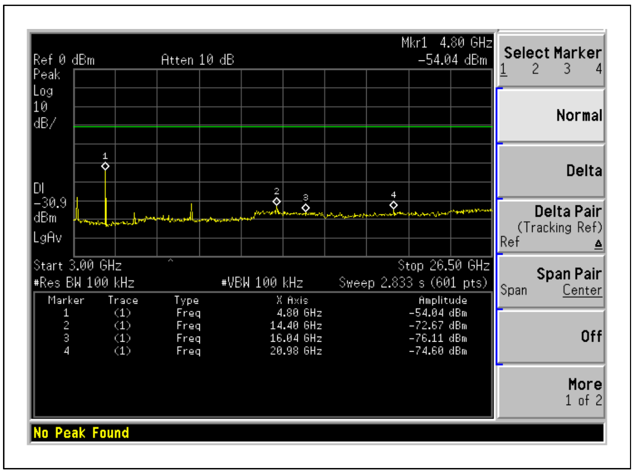


Figure 8. Plot of the Spurious RF conducted emissions

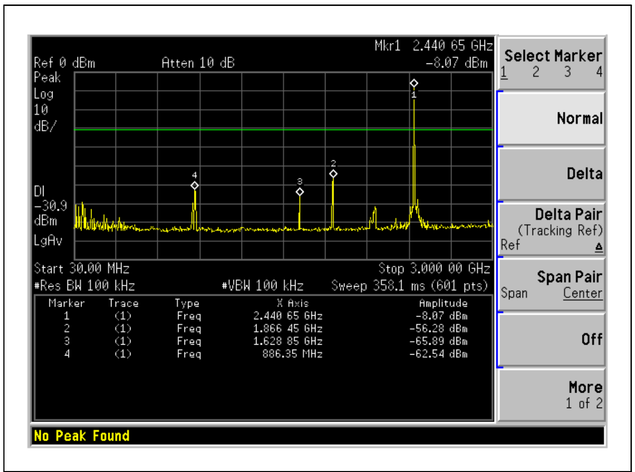
Lowest Channel (2402 MHz) : 30MHz ~ 3GHz



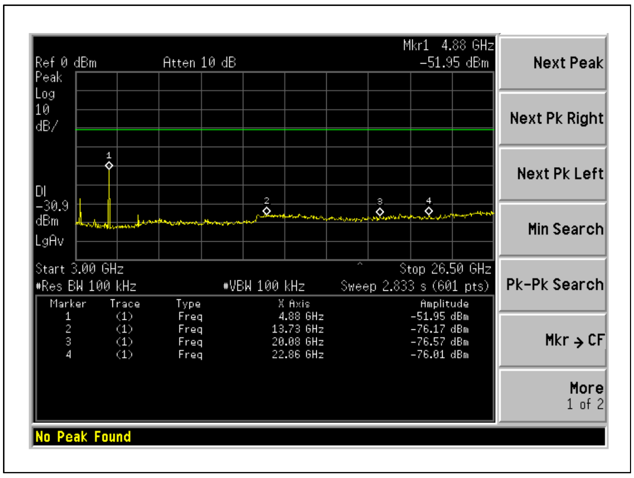
Lowest Channel (2402 MHz) : 3GHz ~ 26.5GHz



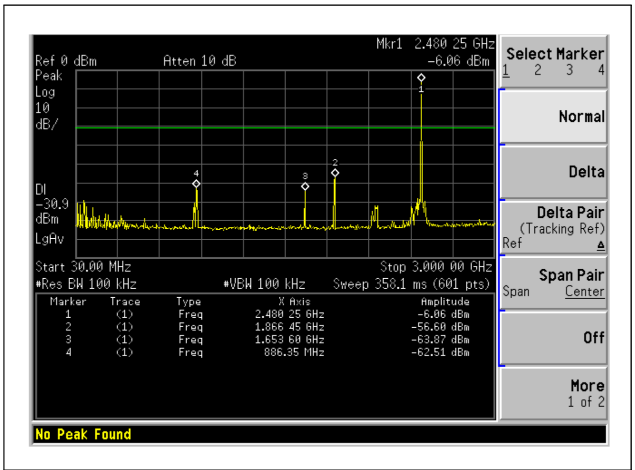
Middle Channel (2441 MHz) : 30MHz ~ 3GHz



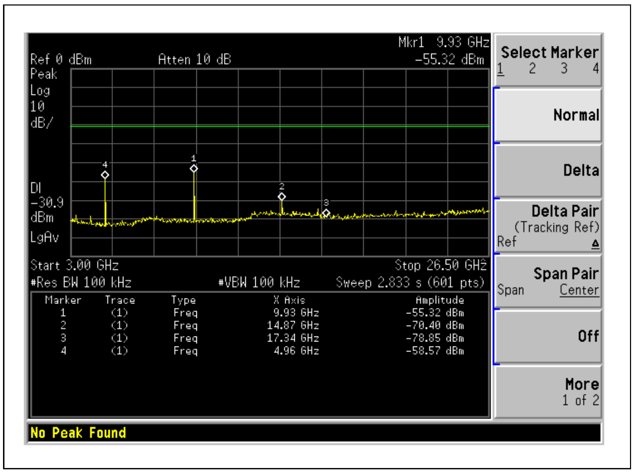
Middle Channel (2441 MHz) : 3GHz ~ 26.5GHz



Highest Channel (2480 MHz) : 30MHz ~ 3GHz



Highest Channel (2480 MHz) : 3GHz ~ 26.5GHz



5.8 AC POWER LINE CONDUCTED EMISSIONS

5.8.1 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.

5.8.2 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 final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.
5. 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.

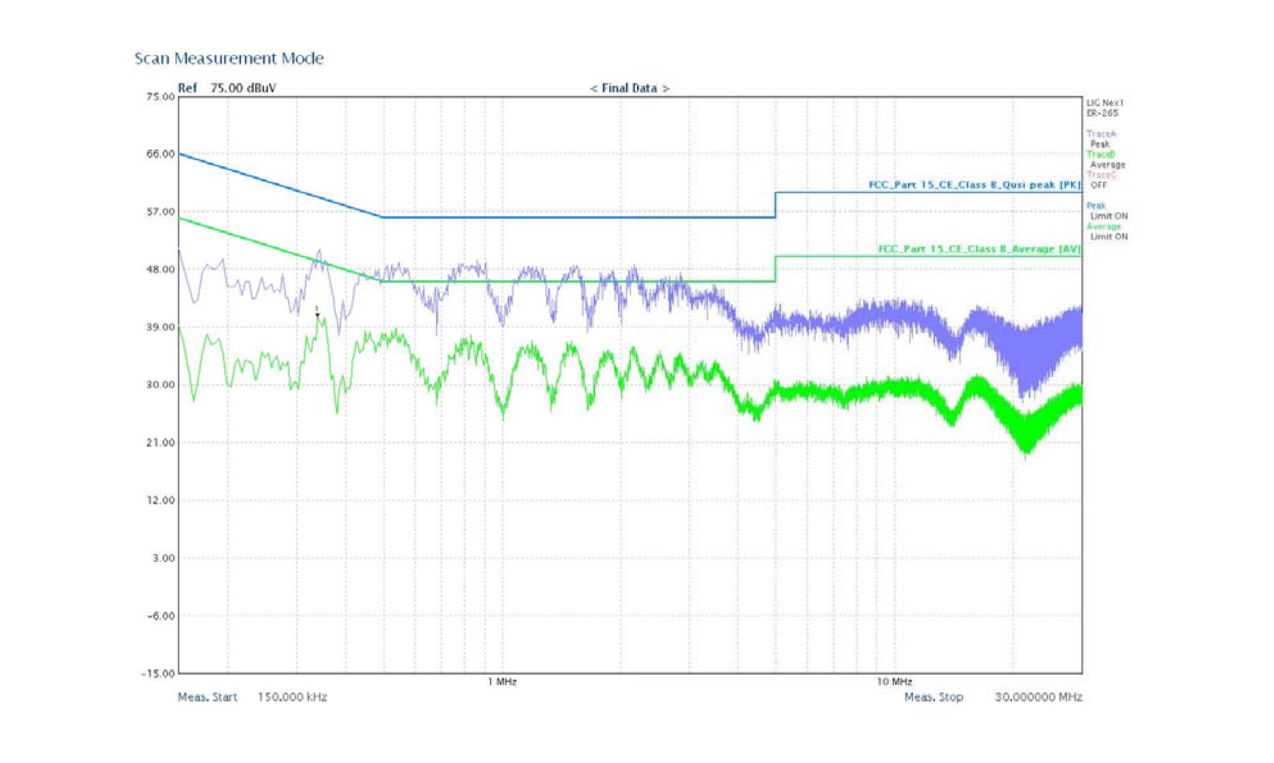
5.8.3 Test Results: PASS

Margin (dB) = Limit − Emission Level
[Emission Level = Measured Value + CF + CL]

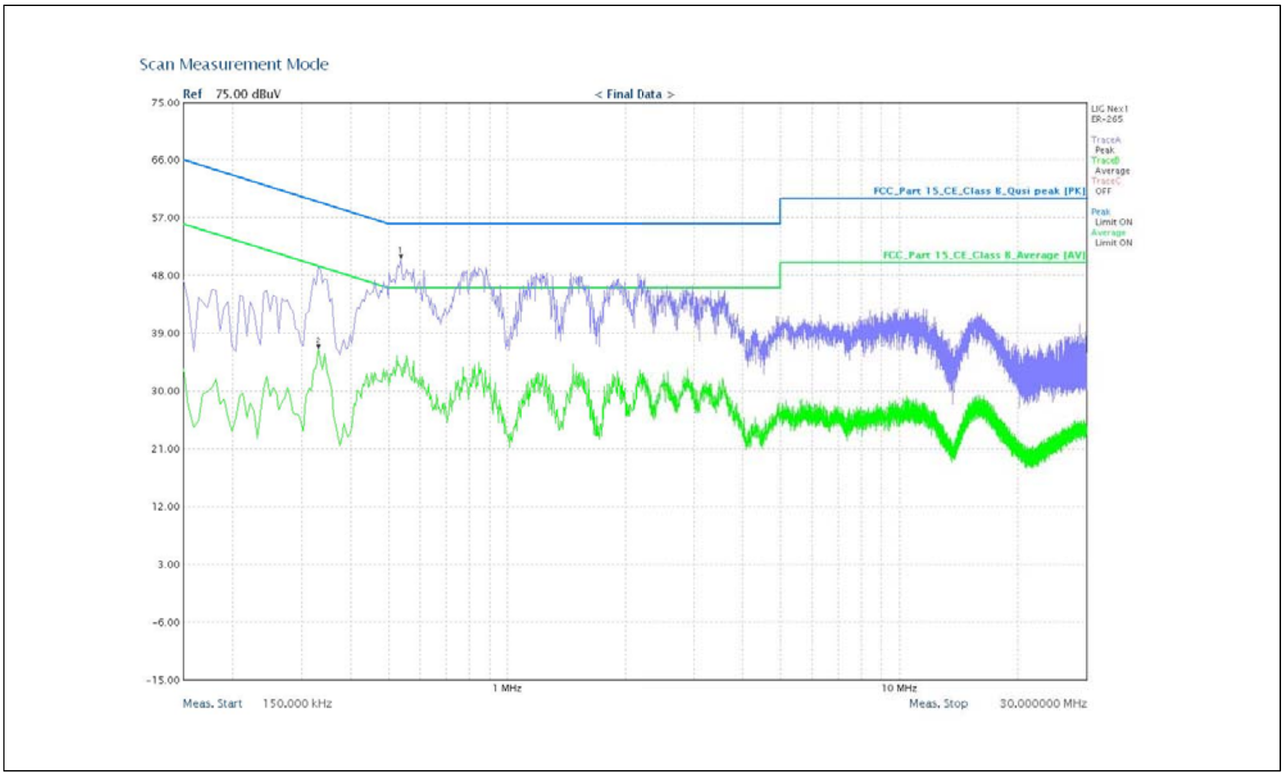
Line Conducted Emission				CISPR 22 Class B		
Frequency (MHz)	Amplitude (dBuV)	Phase Hot/Neutral	Detector QP/AV/PK	Applicable Limit		Quasi-peak Margin (dB)
				Quasi-peak (dBuV)	Average (dBuV)	
0.34	51.06	H	QP	59.12	49.12	8.06
0.33	49.43	N	QP	59.45	49.45	10.02
0.86	49.34	H	QP	56.00	46.00	6.66
0.53	50.59	N	QP	56.00	46.00	5.41
0.90	49.08	H	QP	56.00	46.00	6.92
0.88	49.28	N	QP	56.00	46.00	6.72
2.16	48.73	H	QP	56.00	46.00	7.27
2.15	48.27	N	QP	56.00	46.00	7.73
2.85	47.67	N	QP	56.00	46.00	8.33
2.97	46.40	H	QP	56.00	46.00	9.60
8.84	43.62	H	QP	60.00	50.00	16.38
8.42	42.59	N	QP	60.00	50.00	17.41
10.22	43.52	H	QP	60.00	50.00	16.48
9.87	42.82	N	QP	60.00	50.00	17.18
29.71	42.44	H	QP	60.00	50.00	17.56
16.74	40.83	N	QP	60.00	50.00	19.17

Figure 9. Plot of the AC Power Line Conducted Emissions

Line – PE(Peak and Average detector used)



Neutral – PE(Peak and Average detector used)



5.9 RECEIVER SPURIOUS EMISSIONS

5.9.1 Regulation

The following receiver spurious emission limits shall be complied with:

(a) If a radiated measurement is made, all spurious emissions shall comply with the limits of Table 1. The resolution bandwidth of the spectrum analyzer shall be 100 kHz for spurious emission measurements below 1.0 GHz, and 1.0 MHz for measurements above 1.0 GHz.

Spurious Emission Limit for Receivers

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

* Use quasi-peak below 1000 MHz and averaging meter above 1000 MHz.

5.9.2 Test Results: PASS

Table 8 : Measured values of the Receiver Spurious Emissions

Frequency (MHz)		Detect Mode	Polarization (V/H)	Turn Table (degree)	Measured Value (dBμV)	Antenna Factor + Cable Loss (dB/m)	Amplifier Gain (dB)	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)
Quasi-peak data, emissions below 1000 MHz										
			No Spurious Radiated Emissions Found							
Peak/Average data, emissions above 1000 MHz										
CH 0 (2402MHz)	2403.5	Peak	V	224	36.65	40.3	-23.2	53.75	74	20.25
	2403.5	Average	V	224	24.27	40.3	-23.2	41.37	54	12.63
	2403.5	Peak	H	64	35.41	40.3	-23.2	52.51	74	21.49
	2403.5	Average	H	64	25.17	40.3	-23.2	42.27	54	11.73
CH 39 (2441MHz)	2442.5	Peak	V	321	35.77	40.7	-23.2	52.87	74	21.13
	2442.5	Average	V	321	24.38	40.7	-23.2	41.48	54	12.52
	2442.5	Peak	H	53	35.51	40.7	-23.2	52.61	74	21.39
	2442.5	Average	H	53	24.75	40.7	-23.2	41.85	54	12.15
CH 78 (2480MHz)	2481.5	Peak	V	29	36.34	41.2	-23.2	53.44	74	20.56
	2481.5	Average	V	29	25.32	41.2	-23.2	42.42	54	11.58
	2481.5	Peak	H	175	35.74	41.2	-23.2	52.84	74	21.16
	2481.5	Average	H	175	25.12	41.2	-23.2	42.22	54	11.78

1. Margin (dB) = Limit − Emission Level
2. H = Horizontal, V = Vertical Polarization

5.10 RF EXPOSURE

5.10.1 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: RF exposure is calculated.

Frequency Range	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm²]	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/f²)	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

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

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

S = power density [mW/cm²]
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=0.25 [mW](= -6 dBm)& Antenna gain=0.73 [mW](= 0.5 [dBi])	
100 mW, at 20 cm from an antenna 6 [dBi]	S = PG/4πR² = 100 × 3.98 / (4 × π × 400) = 0.079 2 [mW/cm²] < 1.0 [mW/cm²]
0.25 mW, at 20 cm from the antenna 0.5 [dBi]	S = PG/4πR² = 0.00012 [mW/cm²] < 1.0 [mW/cm²]
0.25 mW, at 2.5 cm from the antenna 0.5 [dBi]	S = PG/4πR² = 0.0032 [mW/cm²] < 1.0 [mW/cm²]

5.10.2 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. SAR data was not submitted because the output power of the EUT was below the low thresholds in the July 02 TCB Exclusion List: for portable transmitters,

Low threshold [($60/f_{GHz} \approx 25$) mW, d < 2.5 cm, ($120/f_{GHz} \approx 50$) mW, d $\geq$ 2.5 cm], and

High threshold [($900/f_{GHz} \approx 370$) mW, d < 20 cm], where f_{GHz}: 2.44, d: distance to a person's body

APPENDIX

TEST EQUIPMENT USED FOR TESTS

No.	Description	Manufacturer	Model No.	Specifications	Next Cal. Data	Used equipment
1	EMI Test Receiver	LIG Nex1	LSA-265	3Hz~26.5GHz	12.12.18	■
2	Dipole ANT	ElectroMetrics	TDA-30/1-4	30~1GHz	13.03.23	□
3	Biconical ANT	ElectroMetrics	BIA-30S	30~300MHz	13.03.23	■
4	Log periodic ANT	ElectroMetrics	LPA-30	0.2~1GHz	13.03.23	■
5	Bilog Antenna	Schaffner-Chase EMC Ltd.	CBL6140A	50V, 5A	13.05.07	■
6	Turn Table	KEI	KEI-TURN	1500×1000×800	N/A	□
7	Turn Table	KEI	KEI-TURN	1500×1000×800	N/A	■
8	Loop ANT.	Com-Power	AL-130	9kHz~30MHz	13.03.24	■
9	Spectrum Analyzer	LIG Nex1	ISA-265	1kHz~26.5GHz	13.05.20	□
10	Function Generator	Agilent	33120A	15MHz sine&square	13.06.09	□
11	Frequency Counter	HP	5350B	10Hz~20GHz	13.06.09	□
12	Modulation Analyzer	Agilent	8901B	10MHz~1.3GHz	13.06.09	□
13	Audio Analyaer	Agilent	8903B	20Hz~100kHz	13.06.09	□
14	Attenuator	Agilent	8494B	0~11dB, 18GHz	13.06.09	□
15	Attenuator	Agilent	8496B	0~110dB, 18GHz	13.06.09	□
16	Attenuator	Agilent	8495B	0~70dB, 18GHz	13.06.09	□
17	Attenuator	TAE SUNG	SMA-1	6dB	12.09.02	□
18	Attenuator	TAE SUNG	SMA-2	6dB	12.09.02	□
19	Power Meter	Agilent	E4418B	100kHz~110GHz, 0.0001uW~25100mW	13.06.09	■
20	Power Sensor	HP	8485A	50MHz~26.5GHz	13.06.09	■
21	Vibration Tester	Gana	GNV-400	10~60Hz, 0~4mm	12.09.09	□
22	RF Cable	Gigalane	SMS-LL280-SMS -1.5M	1.5m	N/A	■
23	Temp & Humidity Chamber	Seoksan Tech	SE-CT-02	-40~150℃, 30~98%	13.06.09	■
24	Signal Generator	Leader Electronics	3220	100kHz~1.3GHz	13.06.09	■
25	Oscilloscope	Tektronix	TDS-350	200MHz	12.09.02	□
26	Drop Tester	Self-made	KSQ-01	150cm	N/A	□
27	Pre Amplifier	GTC	GA-1825A	0.1~18GHz	13.06.09	■
28	Continuous operation tester	GTC	CT-100	Local Control	N/A	□
29	CW Generator	HP	83711B	1~20GHz	13.06.09	■
30	POWER DIVIDER	Agilent	11636B	26.5GHz	13.06.09	□
31	Power Sensor	Agilent	8482B	100kHz ~ 4.2GHz	13.06.09	□
32	Attenuator	Winswell	53-30-33	dc-2.5GHz, 500W	13.06.09	□
33	DC Power Supply	Hanil	HPS-505A	50V, 5A	13.09.02	□
34	Slidacs	Hanchang	5KV	5kW, 300V	12.09.02	□
35	Termination	Kwang Yeok	KYTE-NJ-150W	150W	12.09.02	□
36	Band-limited filter	MITECH	KSQ-02	600Ω	12.09.02	□
37	Signal Generator	WILTRON	6759B	10MHz ~ 26.5GHz	12.09.02	□
38	Digital Multimeter	DONG HWA	DM-300A	AC/DC 500V Max,320mA Max	12.09.02	■
39	Horn ANT.	SCHWARZBECK	BBHA 9120D	700MHz ~ 18GHz	12.09.23	■
40	DC Power Supply	ALINCO	DM-340MW	15V, 30A	12.09.02	■
41	Spectrum Analyzer	ROHDE&SCHWARZ	FSV30	1kHz~30GHz	12.08.27	■

APPENDIX

1. EUT photo