TEST REPORT

Date: 2011-01-28
Report No.: 60.870.11.003.01F

Applicant:	Acoustic Arc International Ltd. Unit 311B, 3/F, IC Development Centre, No.6 Science Park West Avenue, Hong Kong Science Park, Shatin, N.T. Hong Kong	
Description of Samples:	Model name:	2.4GHz Wireless Headphone System (Transmitter)
	Brand name:	aai
	Model no.:	DH1080
	FCCID:	VHC-AAI-DH1080-00
Date Samples Received:	2011-01-06	
Date Tested:	2011-01-06 to 2011-01-26	
Investigation Requested:	FCC Part 15 Subpart C, Section 15.247	
Conclusions:	The submitted product COMPLIED with the requirements of Federal Communications Commission [FCC] Rules and Regulations Part 15. The tests were performed in accordance with the standards described above and on Section 2.2 in this Test Report.	
Remarks:	----	

Checked by: Approved by:-

Nicolas Cheng	Jeff Pong
Assistant Project Manager	Project Manager
Wireless & Telecom Department	Wireless & Telecom Department

CONTENT:

1.0 General Details

1.1 Test Laboratory

EMC Laboratory registered by FCC with
FCC Registration Number: 538587

1.2 Applicant Details

Applicant

Acoustic Arc International Ltd.
Unit 311B, 3/F., IC Development Centre, No.6 Science Park West Avenue, Hong Kong Science Park, Shatin, N.T. Hong Kong

Manufacturer

Acoustic Arc International Ltd.
Unit 311B, 3/F., IC Development Centre, No.6 Science Park West Avenue, Hong Kong Science Park, Shatin, N.T. Hong Kong

1.3 Equipment Under Test [EUT]

Description of EUT

Product Description:	2.4G Wireless Headphone System (Transmitter)
Model No.:	DH1080
Brand Name:	aai
FCCID:	VHC-AAI-DH1080-00
Rating:	- DC 5.0V, 500mA powered by AC/DC power adaptor Or DC 3.7V build-in battery cell
Operated Frequency:	2406 -2472 MHz
No. of Operated Channel:	31
Accessories and Auxiliary Equipments:	- iPod - AC/DC power adaptor.
Antenna Type:	Integral
Manufacture of Antenna:	Acoustic Arc International Ltd.
Antenna Gain:	0dBi
Antenna Model:	N/A

General Operation of EUT

The Equipment Under Test (EUT) is a Transmitter of the Wireless Headphone System operated at 2.4GHz.

FHSS Operation Principle:

This module is controlled by microchip to generate Pseudorandom Frequency Hopping Sequence, this module support 31 hopping channels. Refer to section 4.5 of this report to have more detail of Pseudorandom Hopping Algorithm.

1.4 Related Submittal(s) Grants

This is a signal application subjected to Certificate Authorization.

2.0 Technical Details

2.1 Investigations Requested

Perform ElectroMagnetic Interference measurement in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15: 2009 and ANSI C63.4: 2003 for FCC Verification

2.2 Test Standards and Results Summary Tables

Test Condition	Test Requirement	Test Result	
		Pass	N/A
Number of Frequency Hopping	Section 15.247 (a1)	☒	☐
20dB Bandwidth Measurement	Section 15.247 (a1)	☒	☐
Hopping Channel Carrier Frequency Separation	Section 15.247 (a1)	☒	☐
Average Time of Occupancy	Section 15.247 (a1)	☒	☐
Pseudorandom Hopping Algorithm	Section 15.247 (a1)	☒	☐
Band Edge Measurement	Section 15.247	☒	☐
Maximum Output Power	Section 15.247 (b1)	☒	☐
Out of Band Emission	Section 15.247 (d)	☒	☐
Radiated Emission in Restricted Band	Section 15.247 (d)	☒	☐
Conducted Emission on AC Mains	Section 15.207	☒	☐
RF Exposure	Section 15.247 (i)	☒	☐
Antenna Requirement	Section 15.203	☒ See note 1	☐

Note 1 : The EUT uses a permanently attached antenna, which in accordance to Section 15.203, is considered sufficient to comply with the provisions of this section.

Remark: N/A - Not Applicable

3.0 Test Methodology

3.1 Radiated Emission

The sample was placed 0.8m above the ground plane on a standard emission test site *. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages.

*On a standard emission test site with a metal ground plane filed with the FCC pursuant to section 2.948 of the FCC rules, with Registration Number: 607756.

3.2 Field Strength Calculation

The field strength at 3 m was established by adding the meter reading of the spectrum analyzer to the factors associated with antenna correction factor, cable loss, preamplifiers and filter attenuation.

The equation is expressed as follow:

FS = R + System Factor
System Factor = AF + CF + FA – PA

Where FS = Net Field Strength in dBuV/m at 3 meters.
R = Reading of Spectrum Analyzer / Test Receiver in dBuV.
AF = Antenna Factor in dB.
CF = Cable Attenuation Factor in dB.
FA = Filter Attenuation Factor in dB.
PA = Preamplifier Factor in dB.

FA and PA are only be used for the measuring frequency above 1 GHz.

3.3 Conducted Emissions

The test was performed in accordance with ANSI C63.4: 2003, with the following: initial measurements were performed in peak and average detection modes on the live line of personal computer, any emissions recorded within 30dB of the relevant limit lines were re-measured using quasi-peak and average detection on the live and neutral lines with the worst case recorded in the table of results.

4.0 Test Results

4.1 Number of Hopping Frequency

Test Requirement:	FCC part 15 section 15.247 (a1)(iii)
Test Date:	2011-01-26
Mode of Operation:	Transmitting mode.
Detector Function:	Max Hold

Result: PASS

Measured Result :

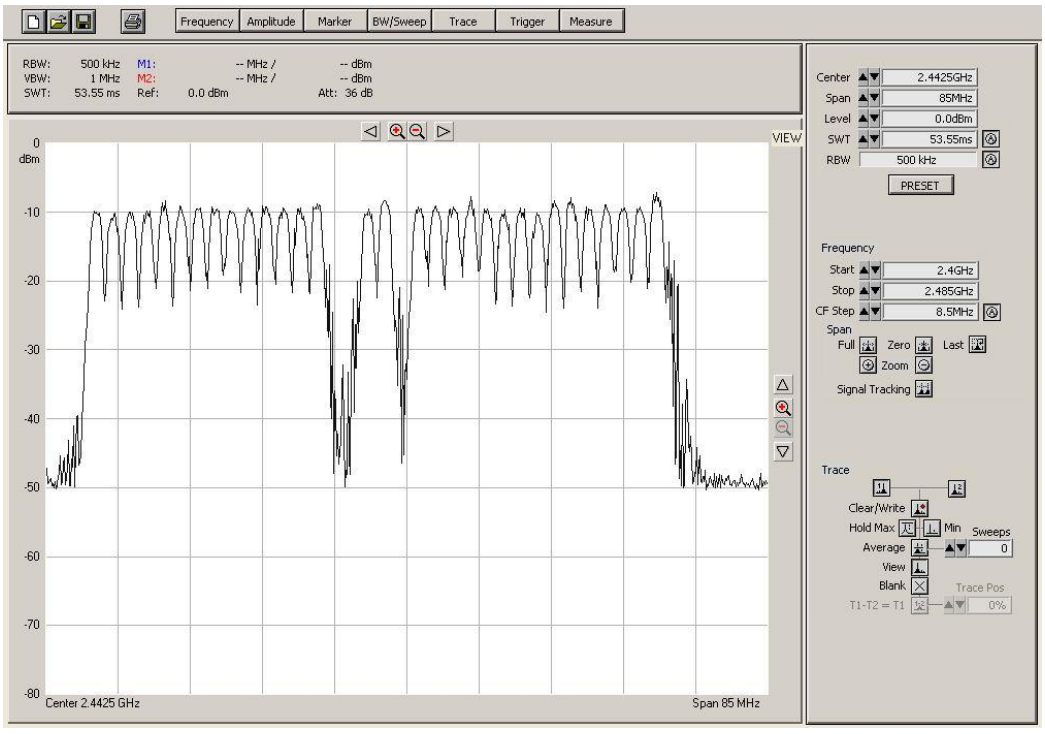
Operating Channel Frequency in sequence (MHz):

2406 ; 2408 ; 2410 ; 2412 ; 2414 ; 2416 ; 2418 ; 2420 ; 2422 ; 2424 ; 2426 ; 2428 ; 2430 ; 2432 ; 2438 ; 2440 ;2444 ; 2446 ; 2448 ; 2450 ; 2452 ; 2454 ; 2456 ; 2458 ; 2460 ; 2462 ; 2464 ; 2466 ; 2468 ; 2470 ; 2472

Limit for Number of Hopping Channel [Section 15.247 (a1)(iii)]

At least 15 non-overlapping channels of each sequence for 2400-2483.5MHz.

Figure 1 – Result data graph shows the number of operation channels:



4.2 20dB Bandwidth Measurement

Test Requirement:	FCC part 15 section 15.247 (a1)
Test Date:	2011-01-26
Mode of Operation:	Transmitting mode.
Detector Function:	Max Hold

Test Setup:

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency. Once the reference level is established, the equipment is conditioned with typical modulating signal to produce the worst-case (i.e. the widest) bandwidth.

Channel	Measured frequency (MHz)	20dB Bandwidth (MHz)
Lowest	2.406	1.53
Middle	2.440	1.60
Highest	2.472	1.61

This result is used for checking the hopping channel carrier frequencies separation.

Figure 2 – Result data graph shows 20 dB bandwidth, CF = 2.406GHz, BW = 1.53MHz

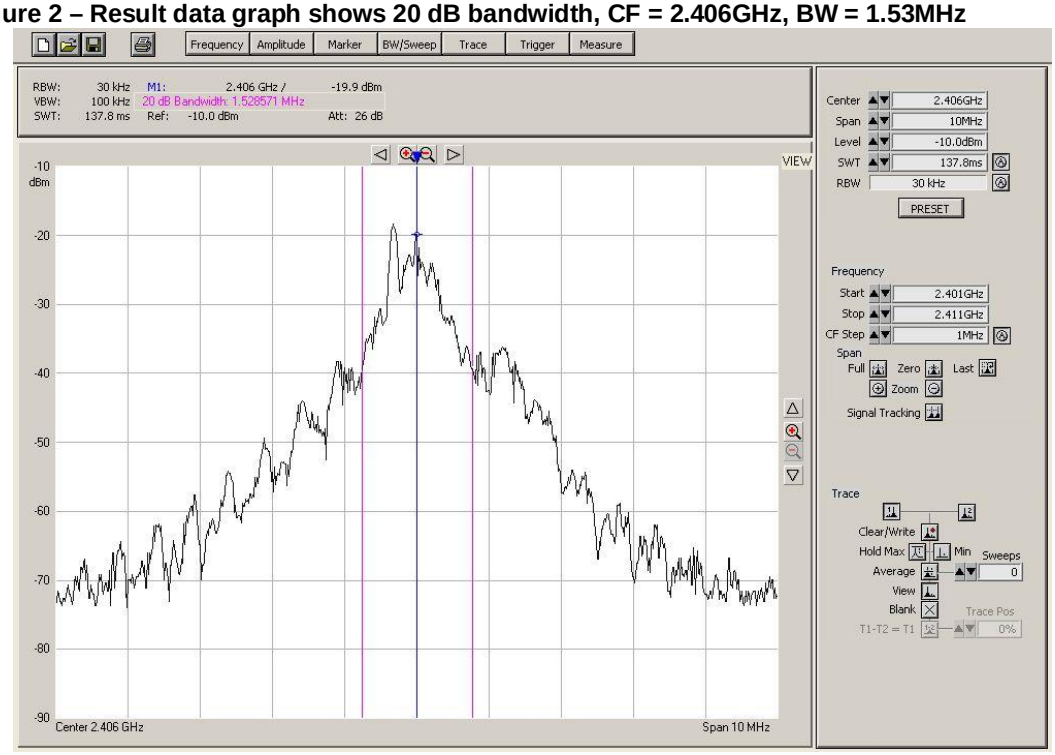


Figure 3 – Result data graph shows 20 dB bandwidth, CF = 2.440GHz, BW = 1.6MHz

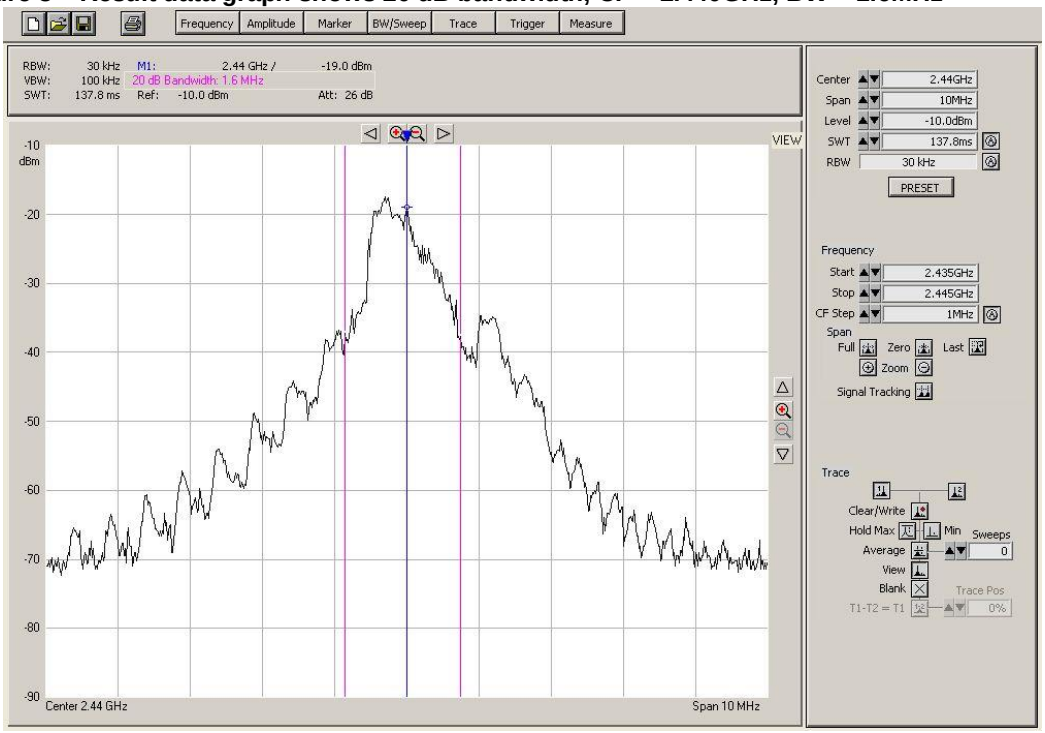
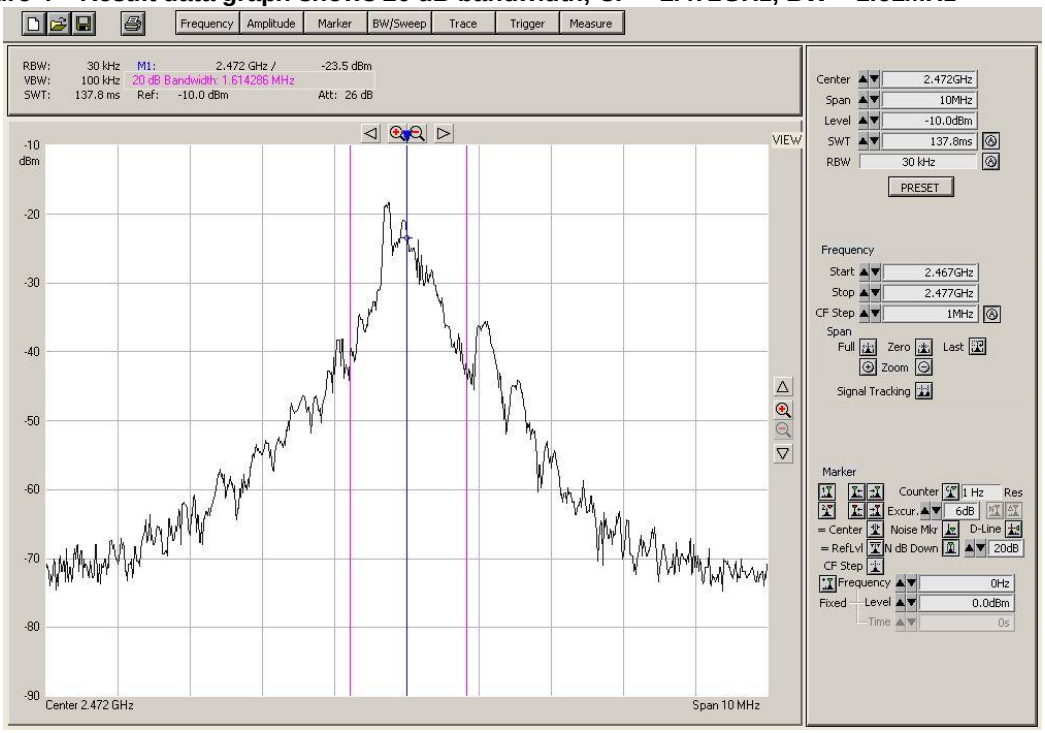


Figure 4 – Result data graph shows 20 dB bandwidth, CF = 2.472GHz, BW = 1.61MHz



4.3 Hopping Channel Carrier Frequency Separation

Test Requirement:	FCC part 15 section 15.247 (a1)
Test Date:	2011-01-26
Mode of Operation:	Transmitting mode.
Detector Function:	Max Hold

Result: PASS

Measured Result :

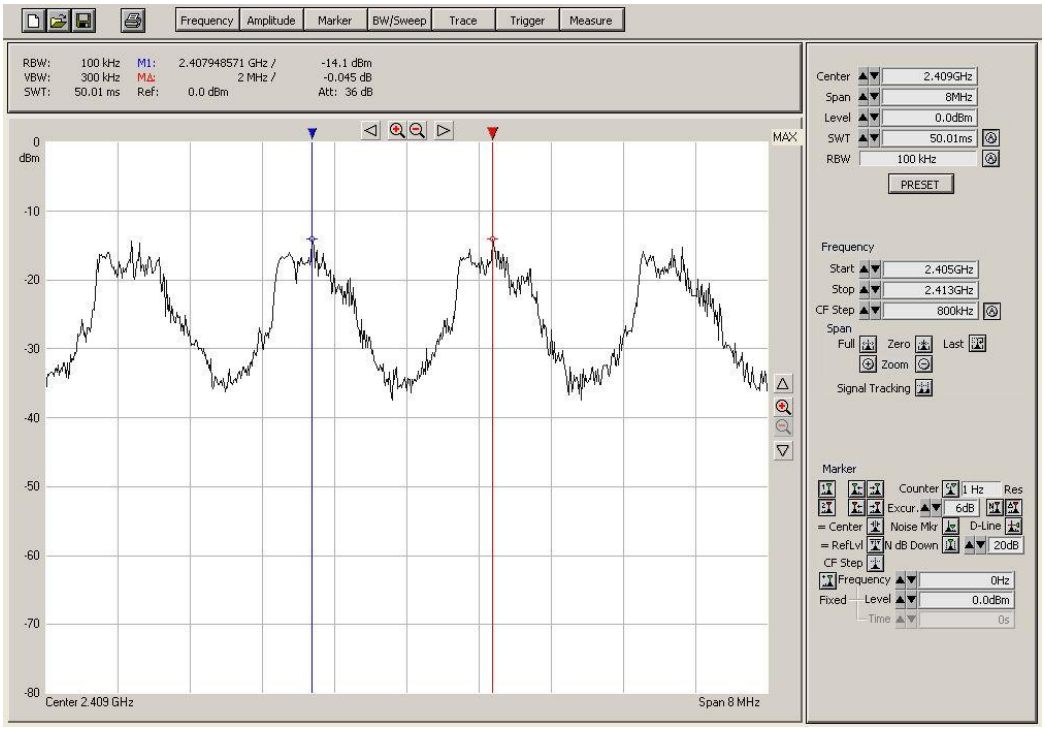
Refer to the delta marker, the frequency separation between two adjacent channels is 2 MHz, therefore, the requirement of channel separated by a two-third of the 20dB bandwidth of the hopping channel is applied.

According to the test result shown in section 4.2, the maximum 20dB bandwidth is 1.61 MHz, so the hopping channel separation of this EUT is found to comply with the requirement.

Limits for Hopping Channel Separation [Section 15.247 (a1)]:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5MHz band may have hopping channel carrier frequencies that are separated by 25KHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater.

Figure 5 – Result data graph shows the channel separation:



4.4 Average Time of Channel Occupancy

Test Requirement:	FCC part 15 section 15.247 (a1)(iii)
Test Date:	2011-01-26
Mode of Operation:	Transmitting mode.
Detector Function:	Zero span, Sweep time 1s

Result : PASS

Measured Result :

Figure 6 shows, each transmission only 15 channels will be used.

Observe time = 15 channels × 0.4s = 6s

Figure 6a shows 17 pulses within 1s

Figure 7 shows One set of pulses = 3.84ms

Therefore, the average channel occupancy times (ms)

= 3.84ms x 17 x 6

So, total transmitting time is 0.392s. (<0.4s).

Limits for Average Time of Occupancy [Section 15.247 (a1)(iii)]:

The average time of occupancy on any channel shall not be greater than 0.4 second within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Figure 6 – Result data graph shows total 15 channels are used.

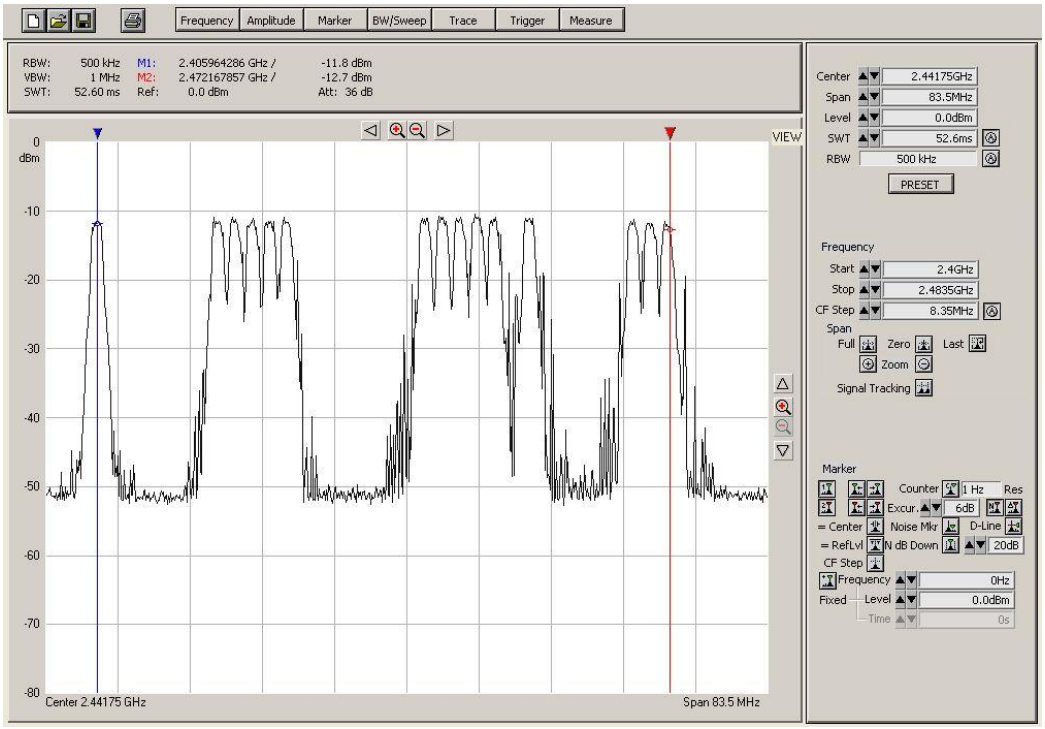


Figure 6a – Result data graph shows total 17 pulses with 1s.

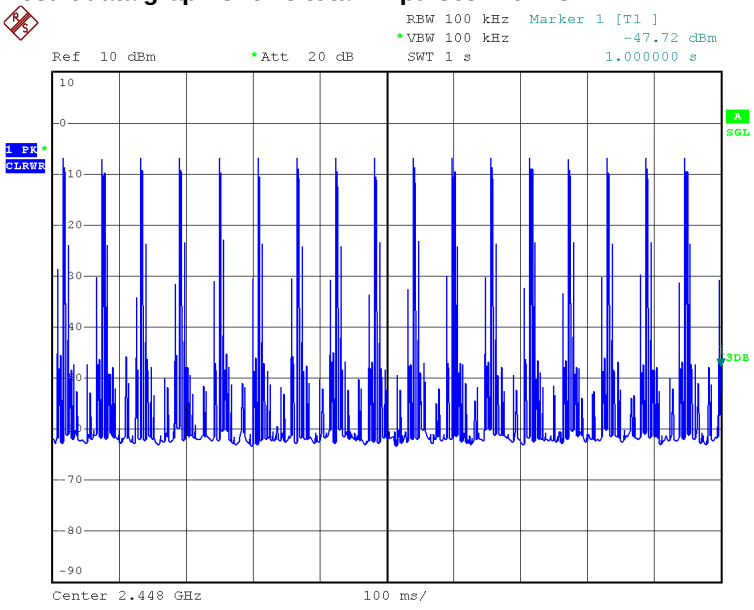
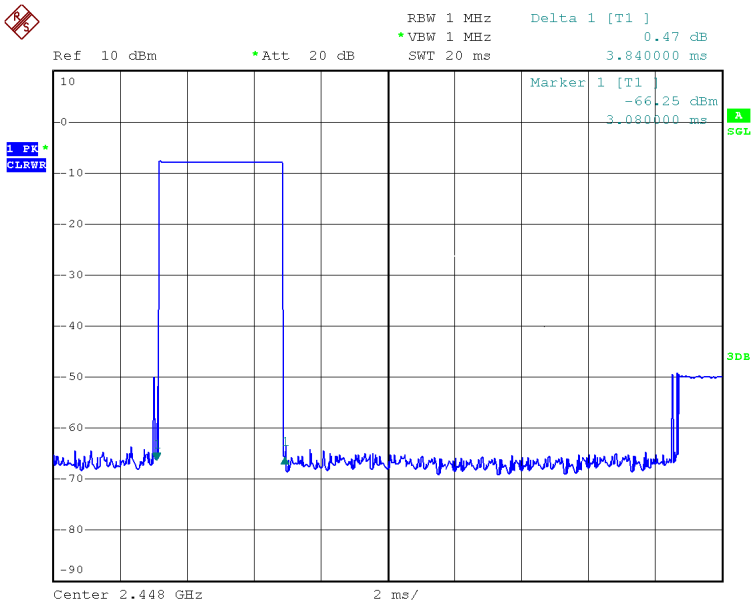


Figure 7 – Result data graph zooms into detail, one pulse period is 3.84ms.



4.5 Pseudorandom Hopping Algorithm

Pseudorandom Frequency Hopping

DH1080 uses FHSS technology with 31 hopping frequencies. Each channel frequency is selected from a pseudorandom ordered list of hopping frequencies, from 2406MHz to 2472MHz with separating in 2 MHz apart from each of the channels. A single data frame is transmitted on each frequency location before skipping to the next hopping frequency in the list.

There is one step to make the receiver to shift the frequency the frequencies in synchronization with transmitter signal. When simultaneously press CH/ID button both Tx module and ID_LED blinks by 0.25s on/off, ID_Learning process will continue 15s, and Rx module longer than 3s, the ID_Learning will be enable, so the receiver will be able to shift the receiving frequencies in synchronization with the transmitter signals.

The system will generate a pseudorandom ordered list base on:

1. A 16 bit Random ID for pairing

2. The audio formats are 16 bit per sample, and sampling frequency are 8, 32, 44.1 and 48 kHz

Frequency use is equally used on average.

Frequency list (in MHz):

Sequence 1: 2406 ; 2420 ; 2422 ; 2424 ; 2426 ; 2428 ; 2444 ; 2446 ; 2448 ; 2450 ; 2452 ; 2456 ; 2468 ; 2470 ; 2472
Sequence 2: 2406 ; 2408 ; 2410 ; 2412 ; 2414 ; 2416 ; 2418 ; 2420 ; 2422 ; 2424 ; 2426 ; 2428 ; 2430 ; 2438 ; 2446
Sequence 3: 2432 ; 2440 ; 2448 ; 2450 ; 2452 ; 2454 ; 2456 ; 2458 ; 2460 ; 2462 ; 2464 ; 2466 ; 2468 ; 2470 ; 2472
Sequence 4: 2406 ; 2408 ; 2410 ; 2412 ; 2414 ; 2416 ; 2418 ; 2426 ; 2454 ; 2462 ; 2464 ; 2466 ; 2468 ; 2470 ; 2472

Requirement for Pseudorandom Hopping Algorithm [Section 15.247 (a1)]:

The channel frequencies shall be selected from a pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on average by the transmitter.

4.6 Band Edge Measurement

Test Requirement:	FCC part 15 section 15.247
Test Date:	2011-01-20
Mode of Operation:	Transmitting mode.
Detector Function:	Max Hold

Result: PASS

Measured Result :

Refer to the figure 8 and 9, it shows the frequency of lower band edge and upper band edge is 2.406 GHz and 2.472GHz separately.

Limits of Band Edge for Carrier Frequencies Operated within the Bands [Section 15.247]:

The carrier frequencies should operate within 2400-2483.5MHz.

Figure 8 – Result data graph shows the frequency of lowest channel.

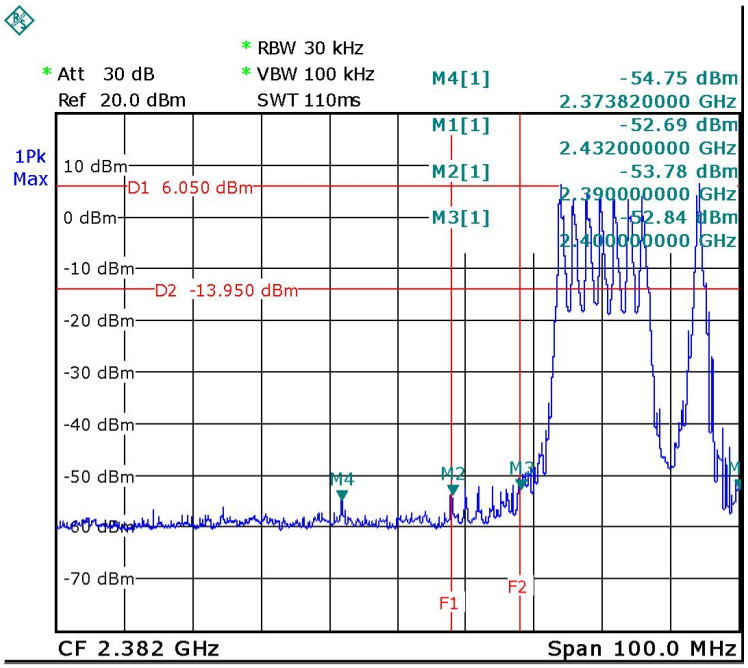
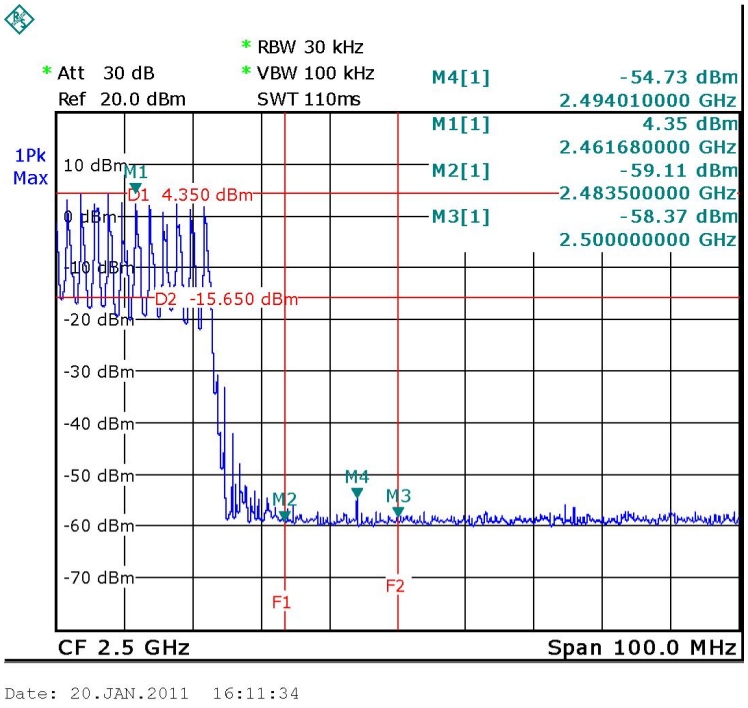


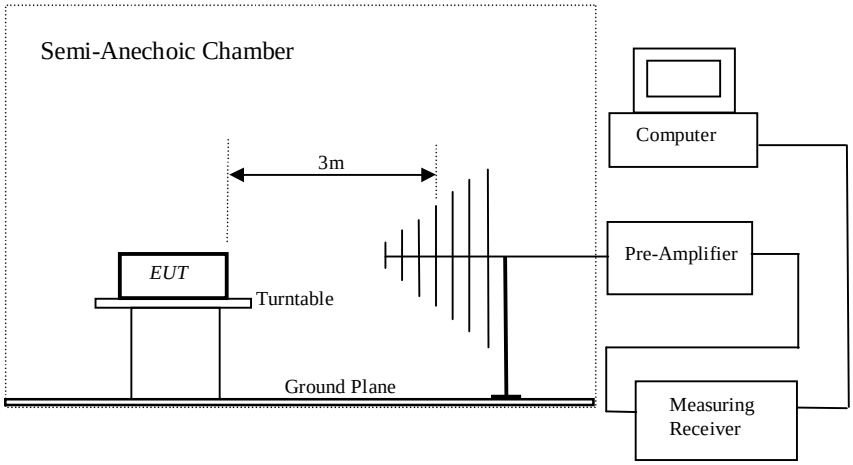
Figure 9 – Result data graph shows the frequency of highest channel.



4.7 Maximum Output Power

Test Requirement:	FCC part 15 section 15.247 (a1)
Test Method:	ANSI C63.4:2003
Test Date:	2011-01-19
Mode of Operation:	Transmitting mode.
Detector Function:	Peak
Measurement BW:	RBW 3MHz ; VBW 3MHz

Test Setup:



Result : PASS

Frequency (MHz)	Output Power		Max. Output Power (mW)
	(dBuV/m)	(V/m)	
Lowest Channel : 2406	**100.22**	**0.103**	**3.16**
Middle Channel : 2440	**100.27**	**0.103**	**3.19**
Highest Channel : 2472	**99.79**	**0.098**	**2.86**
Limit	**116.20**	**0.645**	**125.0**

Calculate the transmitter's peak power using the following equation:

$$E = \frac{\sqrt{30PG}}{d}$$

Where:E is the measured maximum fundamental field strength in V/m, utilizing a RBW ≥ the 20 dB bandwidth of the emission, VBW > RBW, peak detector function. Follow the procedures in C63.4-2003 with respect to maximizing the emission.

G is the numeric gain of the transmitting antenna with reference to an isotropic radiator.
This antenna gain declared by manufacture is 0dBi, antenna is PCB integrated in the actual use. 0dBi logarithmic terms convert to numeric result is nearly 1. So, we apply G =1.0.

d is the distance in meters from which the field strength was measured.

P is the power in watts for which you are solving:

$$P = \frac{(E*d)^2}{30G}$$

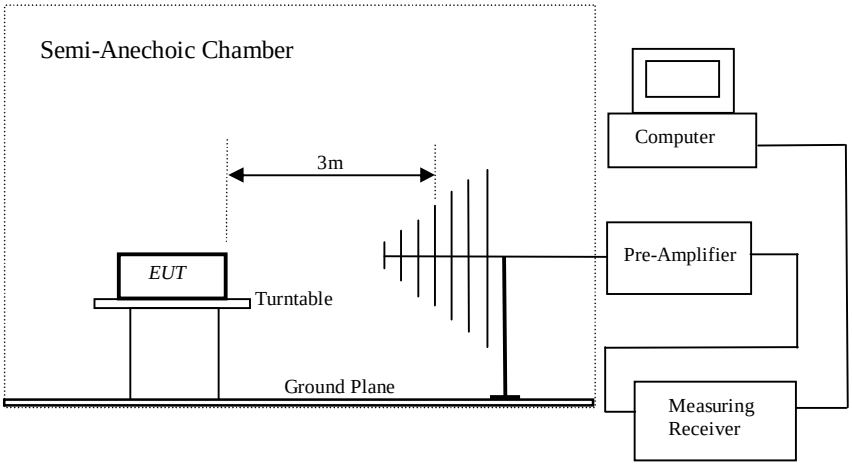
Limits for Maximum Output Power [Section 15.247 (a1)(iii)]:

For frequency hopping systems employing at least 75 hopping channels: 1 Watt
For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 Watts

4.8 Out of Band Emissions and Emissions in Restricted Bands

Test Requirement:	FCC part 15 section 15.247 (d)
Test Method:	ANSI C63.4:2003
Test Date:	2011-01-19
Mode of Operation:	Transmitting mode.
Detector Function:	Peak
Measurement BW:	RBW 100KHz ; VBW 300KHz

Test Setup:



Result : PASS

Out of Frequency Band Emissions:

For out of band emissions that are close to or exceed 20dB attenuation requirement, and emission falls into restricted band, radiated emission was performed in order to show compliance with the general radiated emission requirement.

Result Summary:

Refer to Figure 10 to 11 for the emission data graph, result shows that the significant emissions detected are with more than 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power.

Limits for Out of Frequency Band Emission [Section 15.247 (d)]:

In any 100kHz 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 100kHz bandwidth within the band that contains the highest level of the desired power. Attenuation below the general limits specified in Section 15.209(a) is not required.

Limit for Radiated Emission Falling in Restricted Bands [Section 15.209]:

Frequency (MHz)	Field Strength [μV/m]	Field Strength [dBμV/m]
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
Above 960	500	54.0

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.

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Result : PASS

All Emission and Emissions Fall into Restricted Band were recorded as below:

Radiated Emissions							
	Emissions Frequency	**E-Field Polarity**	**Reading**	**System Factor**	**Field strength at 3m**	**Limit**	**Delta to Limit**
	MHz		**dBuV/m**	**dB**	**dBuV/m**	**dBuV/m**	**dBuV/m**
	Lowest Channel						
PK	*4811.08	V	43.35	5.24	48.59	74.00	-25.41
AV		V	40.41	5.24	45.65	54.00	-8.35
PK	*4811.76	H	42.32	5.24	47.56	74.00	-26.44
AV		H	39.44	5.24	44.68	54.00	-9.32
	Middle Channel						
PK	*4880.26	V	43.52	5.46	48.98	74.00	-25.02
AV		V	41.22	5.46	46.68	54.00	-7.32
PK	*4880.02	H	42.43	5.46	47.89	74.00	-26.11
AV		H	39.29	5.40	44.69	54.00	-9.31
	Highest Channel						
PK	*4944.18	V	44.64	5.68	50.32	74.00	-23.68
AV		V	43.02	5.68	48.70	54.00	-5.30
PK	*4944.34	H	43.22	5.68	48.90	74.00	-25.10
AV		H	41.23	5.68	46.91	54.00	-7.09
	Spurious Emissions						
QP	42.13	V	51.19	-17.15	34.04	40.00	-5.96
QP	197.33	V	47.55	-14.02	33.53	43.50	-9.97
QP	345.25	V	45.23	-10.42	34.81	46.00	-11.19
QP	546.53	V	41.48	-6.28	35.20	46.00	-10.80
QP	565.93	V	40.31	-5.96	34.35	46.00	-11.65
QP	614.43	V	40.74	-5.43	35.31	46.00	-10.69
QP	296.75	H	45.29	-11.13	34.16	46.00	-11.84
QP	345.25	H	49.45	-10.42	39.03	46.00	-6.97
QP	369.50	H	46.41	-10.09	36.32	46.00	-9.68
QP	393.75	H	44.28	-9.80	34.48	46.00	-11.52
QP	418.00	H	42.11	-9.40	32.71	46.00	-13.29
QP	890.88	H	38.25	-3.85	34.40	46.00	-11.60

Refer to Figure 10 to 13 shows the worst case channel's emission data graph from 30MHz-26GHz.

Result Summary:

1) Communication mode: All other emissions are more than 20dB below FCC part 15.209 limit.

2) No further spurious emissions found between 30 MHz and lowest internal used/generated frequency and from 30MHz to 1GHz.

Remarks:

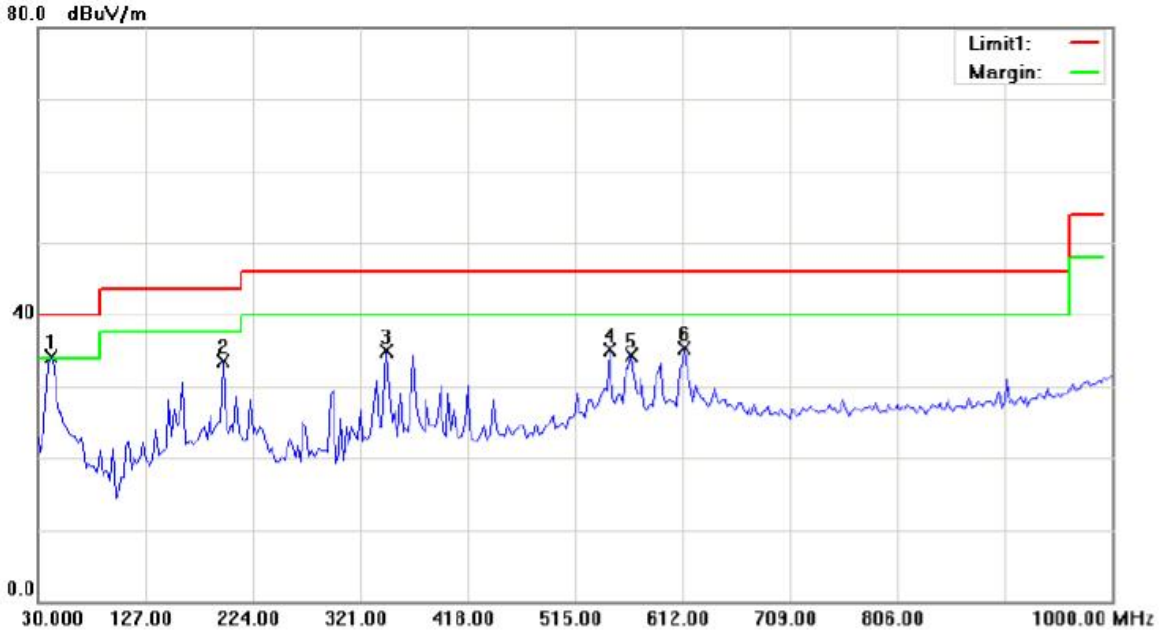
1. " * " Radiated emissions which fall in the restricted bands as defined in Section 15.205(a).

2. Emission level with more than 20dB below the FCC required limit is not mentioned in table.

3. Delta to Limit = Field strength (dBµV/m) – Limit (dBµV/m).

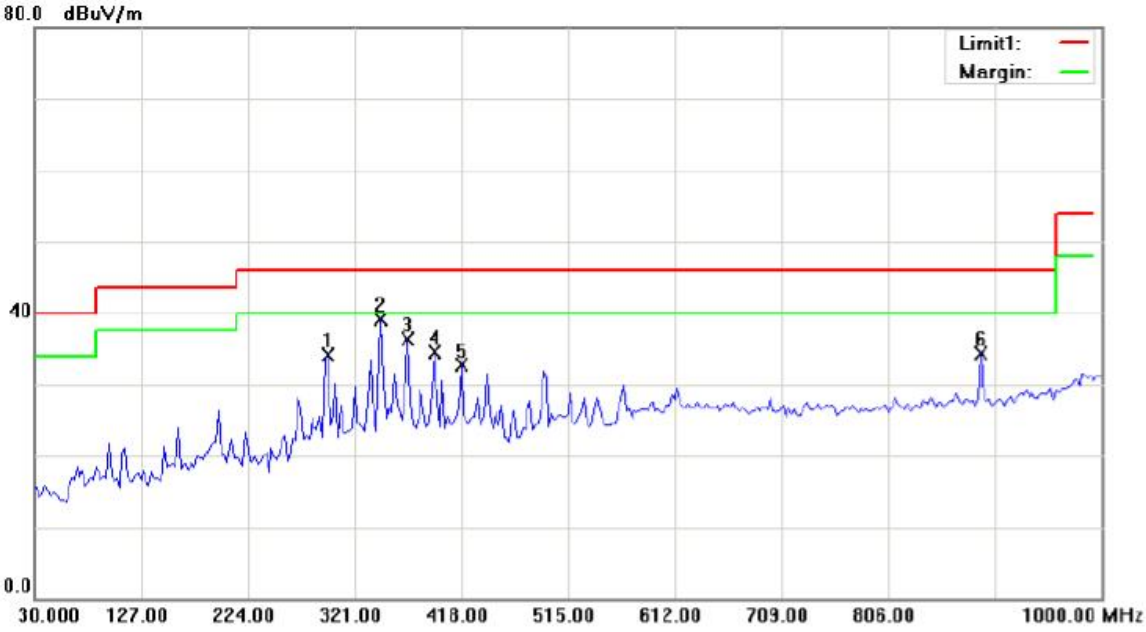
4. Calculated measurement uncertainty: 9kHz -30MHz: 1.8dB.
30MHz -1GHz: 5.2dB.
1GHz -18GHz: 5.1dB.

Figure 10 – Radiated emission data graph (Vertical polarization, 30MHz-1GHz)



Remark: Only background noise was measured from 1GHz-26GHz excluding the operation frequency relational.

Figure 11 – Radiated emission data graph (Horizontal polarization, 30MHz-1GHz)



Remark: Only background noise was measured from 1GHz-26GHz excluding the operation frequency relational.

4.9 Conducted Emissions (0.15MHz to 30MHz)

Test Requirement:	FCC part 15 Section 15.207 Class B
Test Method:	ANSI C63.4:2003
Test Date:	2011-01-18
Mode of Operation:	-Transmitting with Charging mode
Detector Function:	CISPR Quasi Peak
Measurement BW:	100 kHz
Worst Case Channel:	1

Results: PASS

- Refer Figure 14-15 for the result data graph.

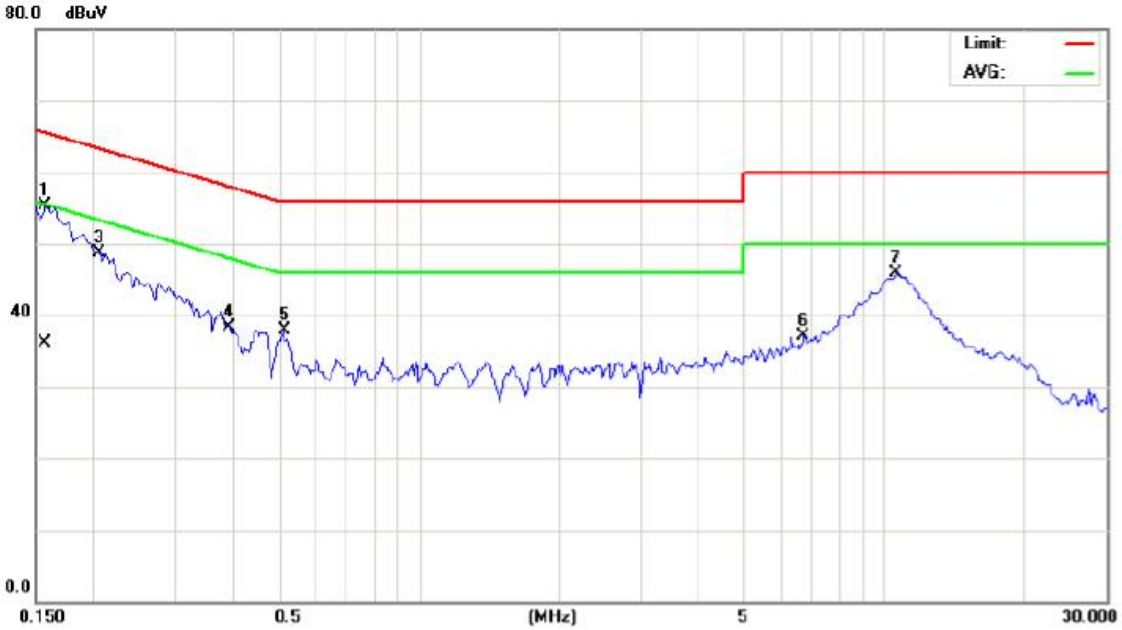
Limits for Conducted Emission [Section 15.207]:

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

* Decreases with the logarithm of the frequency.

Remarks:
Calculated measurement uncertainty: ±2.8dB

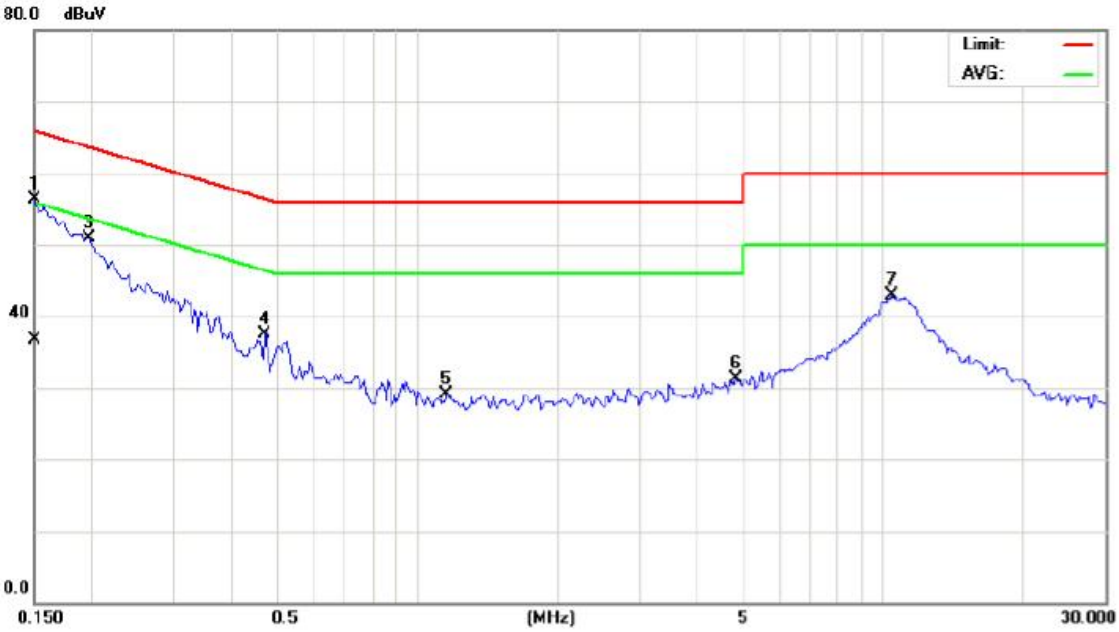
Figure 14– Result data graph shows the conducted emission (Live).



Refer to the following page for the result details:

Frequency (MHz)	Detector (QP/AV)	Phase	Result (dBµV)	Limit (dBµV)	Margin
0.158	QP	L	55.21	65.58	-10.37
	AV	L	36.03	55.58	-19.55
0.205	QP	L	48.73	63.41	-14.68
0.393	QP	L	38.38	57.99	-19.61
0.513	QP	L	37.94	56.00	-18.06
6.731	QP	L	37.14	60.00	-22.86
10.609	QP	L	45.81	60.00	-14.19

Figure 15– Result data graph shows the conducted emission (Neutral).



Refer to the following page for the result details:

Frequency (MHz)	Detector (QP/AV)	Phase	Result (dBµV)	Limit (dBµV)	Margin
0.150	QP	N	56.29	66.00	-9.71
	AV	N	36.78	56.00	-19.22
0.197	QP	N	50.98	63.74	-12.76
0.470	QP	N	37.56	56.51	-18.95
1.154	QP	N	29.10	56.00	-26.90
4.830	QP	N	31.21	56.00	-24.79
10.402	QP	N	42.83	60.00	-17.17

5.0 RF Exposure Compliance Requirement

Test Requirement:	FCC part 15 section 15.247 (i)
Test Method:	FCC part 15 section 1.1307 (b1) OET Bulletin 65, Edition 01-01

Results: PASS

Systems operation under the provision of this section shall be operated in a manner that ensures the public is not exposed to radio frequency energy levels in excess of the Commission's guideline,

The EUT is considered as a mobile device according to OET Bulletin 65, Edition 01-01, therefore distance to human body of min. 20cm is determined.

Frequency Band:	2.407.5GHz ~2.475GHz
Device Category:	☐ Portable (< 20cm separation) ☒ Mobile (>20cm separation) ☐ Others :
Exposure Classification:	☐ Occupational/ Controlled exposure ☒ General Population / Uncontrolled exposure
Max. Output Power	3.19mW
Antenna Gain	0dBi (Numeric gain:1)
Evaluation Applied:	☒ MPE Evaluation ☐ SAR Evaluation

MPE calculation:

The radiated (EIRP) = 3.19 mW

The power density at 20cm from the antenna : = EIRP / $4\pi R^2$
= 0.00063mW / cm^2

Limits for General Population/Uncontrolled Exposure [OET Bulletin 65, Edition 01-01]:

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Averaging Time $\|E\|^2$, $\|H\|^2$ or S (minutes)
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
1500-100,000	--	--	1.0	30

6.0 List of Measurement Equipment

Radiated Emission and Out of Band Emissions

Description	Manufacturer	Model no.	Serial no.	CAL due
Test Receiver	R & S	ESCI	100382	26 May 2011
Spectrum Analyzer	Agilent	E4408B	US39240143	26 Nov 2011
Spectrum Analyzer	R & S	FS300	101335	21 Jul 2011
Antenna	Schwarbeck	VULB9106	9160-3232	08 Jun 2011
Antenna	ETS	3115	00075789	27 May 2011
Amplifier	Agilent	8449B	3008A02274	26 May 2011
Test Cable	Huber+Suhner	SUCOFLEX_8	313794/4	12 Apr 2011
Controller	CT	SC100	N/A	N/A

Conducted Emission

Description	Manufacturer	Model no.	Serial no.	CAL due
Test Receiver	R & S	ESCS30	8333641017	27 May 2011
LISN	R & S	ENV216	100087	26 May 2011
LISN	EMCO	3816/2	00052765	26 May 2011
50ohm Terminator	SHX	TF2-3G-A	08122901	26 May 2011
Test Cable	N/A	C_17	N/A	31 Mar 2011

N/A Not Applicable or Not Available