EMC TEST REPORT
No. JSH007040579-001

Applicant	:	Element Products, Inc. 5155 West 123rd Place, Broomfield, CO, 80020, US
Manufacturer	:	Modulestek Inc. No.208, Zhengkang 1st St., Taoyuan City, Taoyuan County 33043, Taiwan
Equipment	:	BAM for the iRobot Create
Type/Model	:	10542B

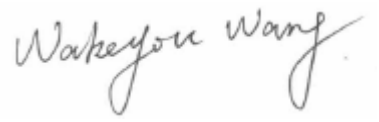
SUMMARY

The equipment complies with the requirements according to the following standard(s):

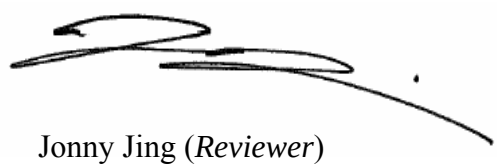
47CFR Part 15 (2006): Radio Frequency Devices
ANSIC63.4 (2003): American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

Date of issue: June 19, 2007

Tested by: Reviewed by:



Wakeyou Wang (*Projector Engineer*)



Jonny Jing (*Reviewer*)

Description of Test Facility

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Content

1. General Information

1.1 Applicant Information

Applicant:	Element Products, Inc. 5155 West 123rd Place, Broomfield, CO, 80020, US
Name of contact:	Mr. Benwirz
Tel: Fax:	303 466 2750 303 466 4798
Manufacturer:	Modulestek Inc. No.208, Zhengkang 1st St., Taoyuan City, Taoyuan County 33043, Taiwan

1.2 Identification of the EUT

Equipment:	BAM for the iRobot Create
Type/model:	10542B
FCC ID:	U9N10542B

1.3 Technical specification

Operation Frequency Band:	2.4GHz ~ 2.4835 GHz
Modulation:	FHSS
Antenna Designation:	Chip antenna, Non-User Replaceable (Fixed)
Gain of Antenna:	0.5dBi max.
Rating :	5.0 Vdc @ 100mA (max)
Description of EUT:	The EUT is a Bluetooth adapter enables wireless communication between Bluetooth host and device which this adapter connected with.
Channel Description:	There are 79 channels named channel 0 to channel 78. Channel 0 corresponds to carrier frequency 2402MHz and channel 78 corresponds to 2480MHz. The rating channel spacing is 1MHz.

1.4 Mode of operation during the test / Test peripherals used

While performing “dwell time” test, three packet settings were observed separately, namely Packet Type 4, Packet Size 27; Packet Type 11, Packet Size 183; Packet Type 15, Packet Size 339.
For other tests, if hopping mode is necessary, Packet Type 15, Packet Size 339 which with the biggest packet as the client’s description was setting to get the worst test results.

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2. Test Specification

2.1 Instrument list

Equipment	Type	Manu.	Internal no.	Cal. Date	Due date
Test Receiver	ESIB 26	R&S	EC 3045	2006-7-1	2007-6-30
Ultra-broadband antenna	HL 562	R&S	EC 3046-1	2006-7-1	2007-6-30
Horn antenna	HF 906	R&S	EC 3049	2006-7-1	2007-6-30
Signal generator	SMR 20	R&S	EC 3044-1	2006-8-22	2007-8-21
Power meter	PM2002	AR	EC3043-7	2007-1-23	2008-1-22
Power sensor	PH2000	AR	EC3043-8	2007-1-23	2008-1-22
Semi-anechoic chamber	-	Albatross project	EC 3048	2006-7-1	2007-6-30
Pre-amplifier	Pre-amp 18	R&S	EC 3222	2006-7-1	2007-6-30
Pre-amplifier	Pre-amp 40	Beijing Radio 2	-	2007-3-4	2008-3-3
Horn antenna	K638A	Beijing Radio 2	-	2007-3-4	2008-3-3
A.M.N.	ESH2-Z5	R&S	EC 3119	2007-1-23	2008-1-22
Test Receiver	ESCS 30	R&S	EC 2107	2007-1-23	2008-1-22

2.2 Test Standard

47CFR Part 15 (2006)
ANSI C63.4: 2003

2.3 Test Summary

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TEST ITEM	REFERANCE	RESULT
Hopping channel separation	15.247(a)(1)	Pass
Maximum peak output power	15.247(b)(1)	Pass
Power spectrum density	15.247(e)	NA
Spurious emission	15.205, 15.209	Pass
Emission outside the frequency band	15.247(d)	Pass
Power line conducted emission	15.207	Pass
Channel number of hopping system	15.247(a)(1)(iii)	Pass
Average time of occupancy in any channel	15.247(a)(1)(iii)	Pass

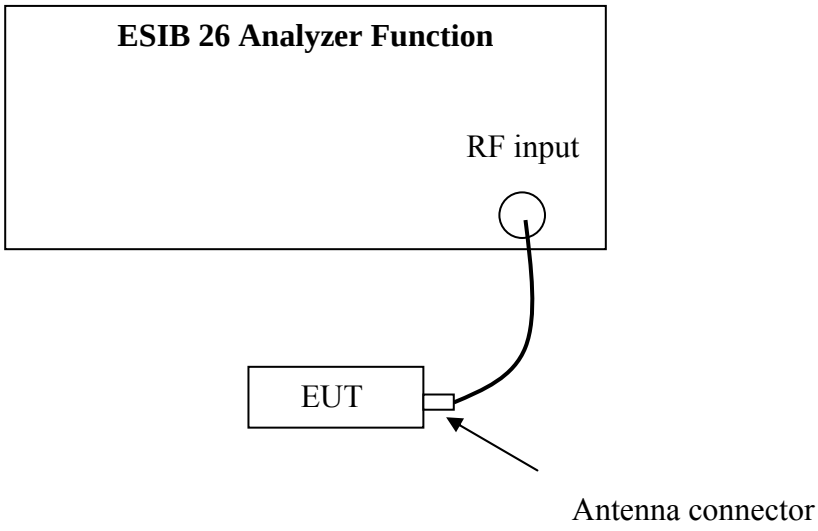
3. Hopping channel separation

Test result: PASS

3.1 Limit

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 125mW.

3.2 Test Configuration



3.3 Test Procedure and test setup

Hopping Channel separation per FCC § 15.247(a)(1) is measured using the ESIB 26 analyzer function with the resolutions bandwidth set at 100kHz, the video bandwidth set at 300kHz, and the SPAN>>RBW. The test was performed at 3 channels (lowest, middle and highest channel).

3.4 Test Protocol

Temperature : 22°C
Relative Humidity : 43%

Channel	Channel Frequency(GHz)	20 dB Bandwidth (kHz) **B**	Channel Separation with adjacent channel (kHz) **S**	Margin (kHz) **M**
0(lowest)	2.402	998	1012	14
39(middle)	2.441	998	1010	12
78(highest)	2.480	998	1010	12

Remark: **M = S -B**

3.5 Measurement uncertainty

The measurement uncertainty is ±100Hz.

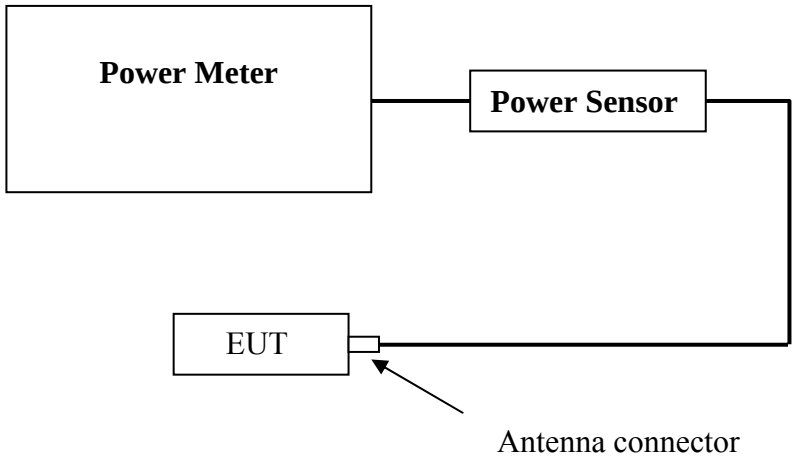
4. Maximum peak output power

Test result: Pass

4.1 Test limit

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

4.2 Test Configuration



4.3 Test procedure and test setup

The power output per FCC § 15.247(b)(1) was measured on the EUT using a power meter via power sensor. The test was performed at 3 channels (lowest, middle and highest channel).

4.4 Test protocol

Temperature : 22°C
Relative Humidity : 43%

Channel	Reading of power meter (dBm) **R**	Cable loss (dB) **L**	Corrected Reading (dBm) **C**	Limit (dBm)
0(lowest)	7.82	1.32	9.14	30
39(middle)	7.71	1.32	9.03	30
78(highest)	7.79	1.32	9.11	30

Remark: **C = R+ L**

4.5 Measurement uncertainty

The measurement uncertainty is ±1dB.

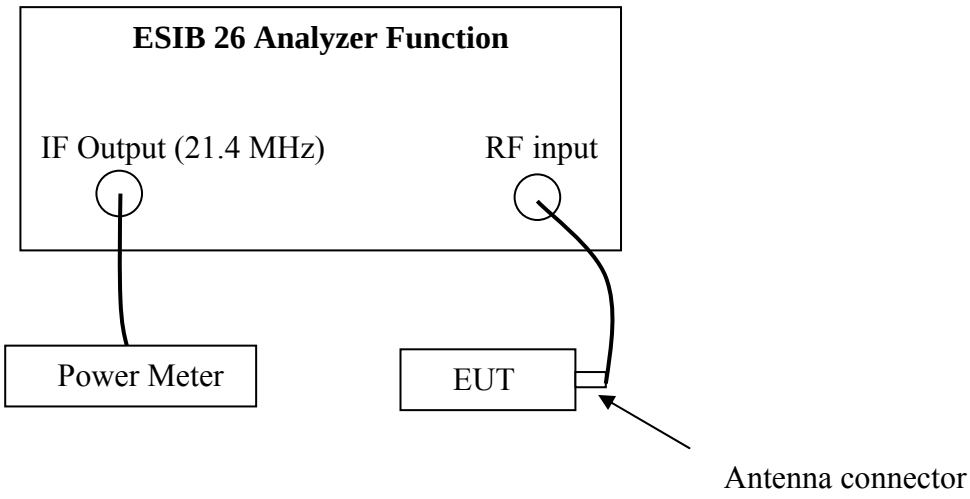
5. Power spectrum density

Test result: **NA**

5.1 Test limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

5.2 Test Configuration



5.3 Test procedure and test setup

The power output per FCC §15.247(e) is measured using the ESIB 26 analyzer function with a power meter connected to IF output (21.4MHz) port. Under spectral measurement mode, catch the frequency point with maximum power spectrum. Then set the span to be 0 and the resolutions bandwidth to be 3 kHz. After calibration, it is found that the power spectral density equals the reference level of analyzer plus the reading of power meter.
The test was performed at 3 channels (lowest, middle and highest channel).

5.4 Test Protocol

Temperature : °C

Relative Humidity : %

Channel	Channel Frequency(GHz)	Maximum power spectral density (dBm/3kHz)	Limit (dBm/3kHz)
-	-	-	-
-	-	-	-
-	-	-	-

5.5 Measurement uncertainty

The measurement uncertainty is ±1dB/3kHz.

6. Spurious emission

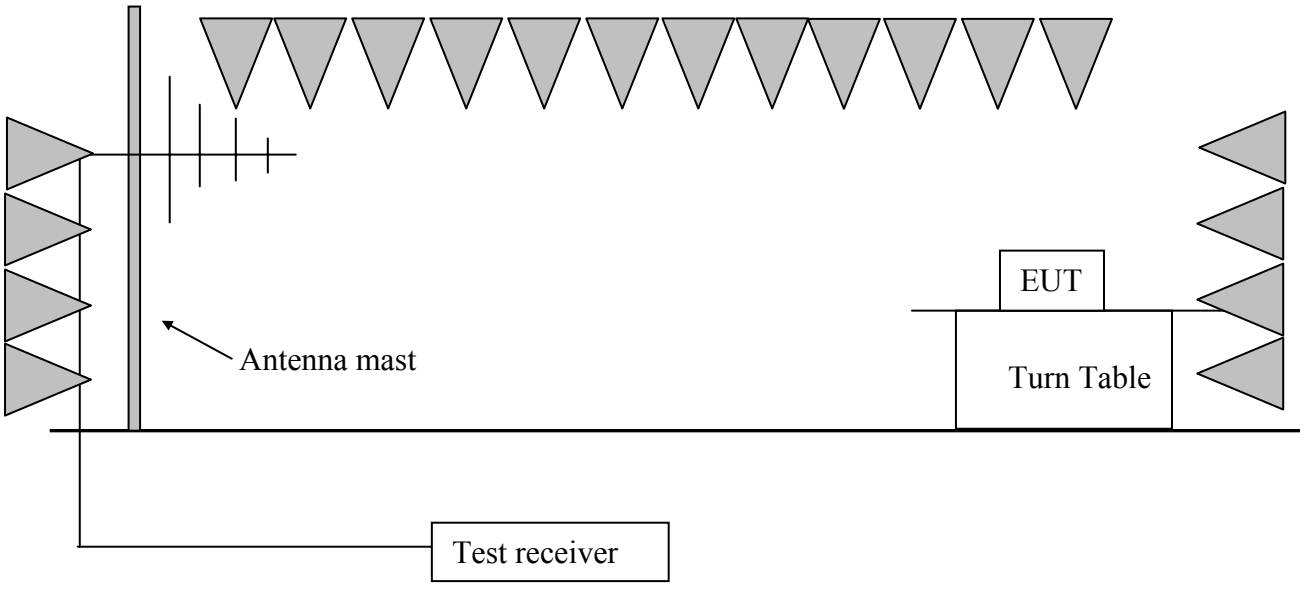
Test result: PASS

6.1 Test limit

The spurious emission shall test through the 10th harmonic. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) showed as below:

Frequency (MHz)	Field Strength (dBuV/m)	Measurement Distance (m)
30 - 88	40.0	3
88 - 216	43.5	3
216 - 960	46.0	3
Above 960	54.0	3

6.2 Test Configuration



6.3 Test procedure and test setup

The measurement was applied in a semi-anechoic chamber. While testing for spurious emission higher than 1GHz, the pre-amplifier is equipped just at the output terminal of the antenna.
The EUT and simulators were placed on a 0.8m high wooden turntable above the horizontal metal ground plane. The turn table rotated 360 degrees to determine the position of the maximum emission level. The EUT was set 3 meters away from the receiving antenna which was mounted on an antenna mast. The antenna moved up and down between from 1meter to 4 meters to find out the maximum emission level.

6.4 Test protocol

For QP test below 1GHz:

Antenna	Frequency (MHz)	Correct Factor (dB/m)	Receiver Reading (dBuV)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	98.04	10.95	16.85	27.80	43.50	15.70
H	142.75	11.28	17.22	28.50	43.50	15.00
H	255.49	12.09	11.51	33.60	46.00	12.40
V	35.83	10.17	27.03	37.20	40.00	12.80
V	101.92	11.04	16.76	27.80	43.50	15.70
V	496.53	13.21	16.39	29.60	46.00	16.40

Remark: 1.Correct Factor = Antenna Factor + Cable Loss
2. Corrected Reading = Receiver Reading + Correct Factor
3. Margin = limit - Corrected Reading

For PK test above 1GHz:

Antenna	Frequency (MHz)	Correct Factor (dB/m)	Receiver Reading (dBuV)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	4883.77	4.80	43.60	48.40	74.00	25.60
H	6723.45	5.00	42.50	47.50	74.00	26.50
H	6961.92	4.80	40.10	44.90	74.00	29.10
V	2226.45	2.30	48.40	50.70	74.00	23.30
V	4917.84	4.80	52.10	56.90	74.00	17.10
V	6246.49	5.50	42.00	47.50	74.00	26.50

Remark: 1.Correct Factor = Antenna Factor + Cable Loss - Gain of Preamplifier
2. Corrected Reading = Receiver Reading + Correct Factor
3. Limit of PK = limit of AV + 20 = 54 + 20 = 74 dBuV/m
4. Margin = limit - Corrected Reading

For AV test above 1GHz:

Antenna	Frequency (MHz)	Correct Factor (dB/m)	Receiver Reading (dBuV)	Corrected Reading (dBuV/m)	Limit (dBuV/m)	Margin (dB)
H	4883.77	4.80	*	*	54.00	*
H	6723.45	5.00	*	*	54.00	*
H	6961.92	4.80	*	*	54.00	*
V	2226.45	2.30	*	*	54.00	*
V	4917.84	4.80	*	*	54.00	*
V	6246.49	5.50	*	*	54.00	*

Remark: 1.Correct Factor = Antenna Factor + Cable Loss - Gain of Preamplifier
2. Corrected Reading = Receiver Reading + Correct Factor
3. Margin = limit - Corrected Reading.
If margin>30dB, it would be marked as *.

6.5 Measurement uncertainty

The measurement uncertainty describes the overall uncertainty of the given measured value during the operation of the EUT.
Measurement uncertainty of radiated emission is: ± 5.31dB
The measurement uncertainty is given with a confidence of 95%, k=2.
The measurement uncertainty is traceable to internal procedure TI-036.

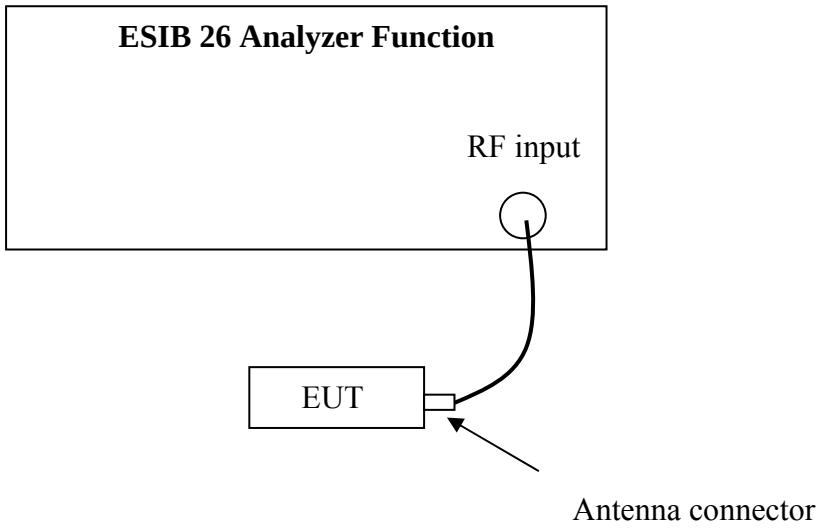
7. Emission outside the frequency Band

Test result: **PASS**

7.1 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.

7.2 Test Configuration



7.3 Test procedure and test setup

The Emission outside the frequency Band per FCC §15.247(d) is measured using the ESIB 26 analyzer function with the resolutions bandwidth set at 100kHz, the video bandwidth set at 300kHz, and the SPAN>>RBW.

7.4 Test protocol

Highest level outside the band edge (dBm)	Highest emission within the band edge (dBm)	Delta (dBm)	Limit
-25.11 (frequency lower than 2.4GHz)	8.23	33.34	≥ 20dB
-31.42 (frequency higher than 2.4835GHz)	8.21	39.63	≥ 20dB

7.5 Measurement uncertainty

The measurement uncertainty is ±1dB.

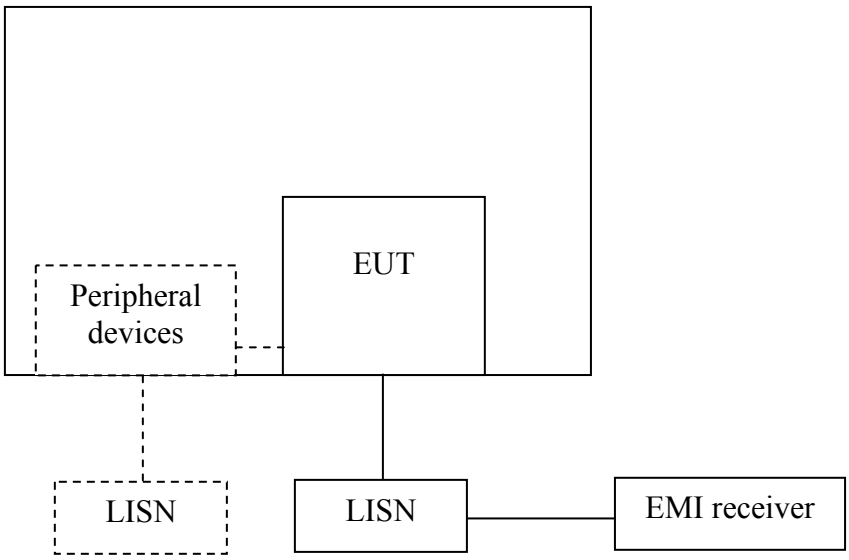
8. Power line conducted emission

Test result: **Pass**

8.1 Limit

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	QP	AV
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.		

8.2 Test configuration



☒ For table top equipment, wooden support is 0.8m height table

☐ For floor standing equipment, wooden support is 0.1m height rack.

8.3 Test procedure and test set up

The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a 50Ω/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50Ω/50uH coupling impedance with 50Ω termination.
Both sides (Line and Neutral) of AC line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4: 2003 on conducted measurement.
The bandwidth of the test receiver is set at 9 kHz.

8.4 Test protocol

Power line: L

Freq	Correct Factor (dB)	Receiver Reading (dBuV)		Corrected Reading (dBuV)		Limit (dBuV)		Margin (dB)	
		QP	AV	QP	AV	QP	AV	QP	AV
0.15	3	*	*	*	*	*	*	*	*
0.20	3	*	35.55	*	38.55	*	53.68	*	15.13
0.40	3	*	29.79	*	32.79	*	47.86	*	15.07
0.47	3	*	29.34	*	32.34	*	46.60	*	14.26
16.78	3	*	28.76	*	31.76	*	50.00	*	18.24
30.00	3	*	*	*	*	*	*	*	*

Remark: 1. Correction Factor (dB) = LISN Factor (dB) + Cable Loss (dB).
2. Margin (dB) = Limit - Corrected Reading.
If margin>20dB, it would be marked as *.

Power line: N

Freq	Correct Factor (dB)	Receiver Reading (dBuV)		Corrected Reading (dBuV)		Limit (dBuV)		Margin (dB)	
		QP	AV	QP	AV	QP	AV	QP	AV
0.15	3	*	*	*	*	*	*	*	*
0.20	3	49.77	43.91	52.77	46.91	63.68	53.68	10.91	6.77
0.26	3	*	*	*	*	*	*	*	*
10.32	3	*	*	*	*	*	*	*	*
18.31	3	37.63	30.84	40.63	33.84	60.00	50.00	19.37	16.16
30.00	3	*	*	*	*	*	*	*	*

Remark: 1. Correction Factor (dB) = LISN Factor (dB) + Cable Loss (dB).
2. Margin (dB) = Limit - Corrected Reading.
If margin>20dB, it would be marked as *.

8.5 Measurement Uncertainty

The measurement uncertainty describes the overall uncertainty of the given measured value during the operation of the EUT.
Measurement uncertainty at mains terminal: ± 1.99dB
The measurement uncertainty is given with a confidence of 95%, k=2.
The measurement uncertainty is traceable to internal procedure TI-036.

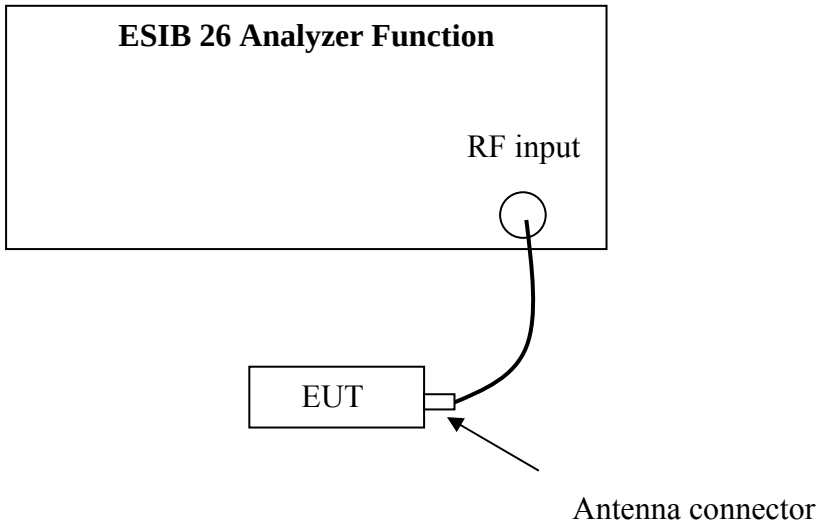
9. Channel Number of hopping system

Test result: **PASS**

9.1 Limit

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

9.2 Test Configuration



9.3 Test procedure and test setup

The channel number per FCC §15.247(a)(1)(iii) is measured using the ESIB 26 analyzer function with the resolutions bandwidth set at 100kHz, the video bandwidth set at 300kHz, and the SPAN>>RBW.
The RF passband of the EUT was divided into 3 appropriate bands to test.

9.4 Test protocol

Channel Number	Limit
79	≥15

9.5 Measurement uncertainty

The measurement uncertainty is ±1dB.

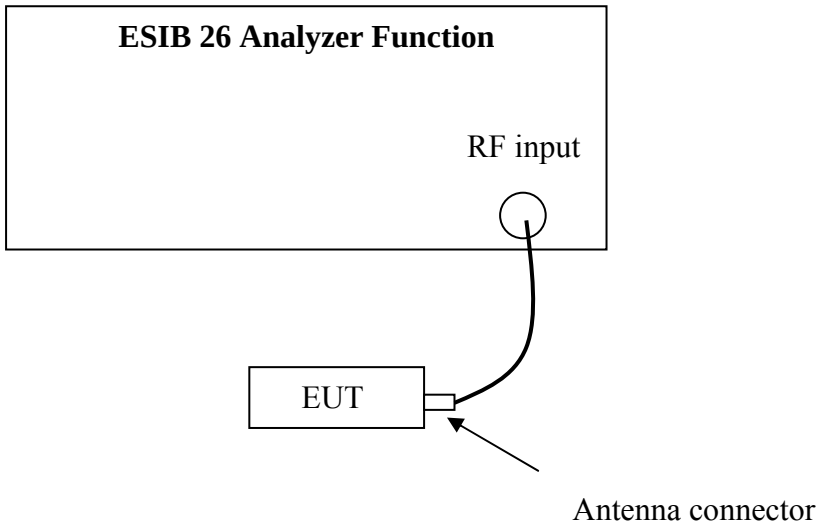
10. Average time of occupancy in any channel

Test result: **PASS**

10.1 Limit

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.

10.2 Test Configuration



10.3 Test procedure and test setup

Average time of occupancy in any channel per FCC § 15.247(a)(1)(iii) is measured using the ESIB 26 analyzer function with the resolutions bandwidth set at 100kHz, the video bandwidth set at 300kHz, and the SPAN set to be 0Hz to test in time domain. The test is performed at the middle channel.

10.4 Test protocol

Packet	Observed period (s) **P**	Time of occupancy for single hopping (ms) **O**	Interval between two hopping (ms) **I**	Average time of occupancy (s) **T**	Limit (s)
Packet Type 4, Packet Size 27	31.6	0.46	100.20	0.15	≤0.4
Packet Type 11 Packet Size 183	31.6	1.80	198.92	0.29	≤0.4
Packet Type 15, Packet Size 339	31.6	3.05	294.59	0.33	≤0.4

Remark: 1. There are 79 channels in all. So the observed period P = 0.4 * 79 = 31.6 s.
2. Average time of occupancy **T = O / I * P** (Base on fact that any interval between two hopping is same which can be referred from test data).

10.5 Measurement uncertainty

The measurement uncertainty is ± 10μs.