

FCC 15B Test Report

Equipment : Bluetooth 5.0 Module w/Integrated PCB

(Refer to item 1.1.1 for more details)

Model No. : BL651 : Laird **Brand Name**

Applicant : Laird Technologies

Address : W66N220 Commerce Court, Cedarburg,

Wisconsin 53012, USA

Standard : FCC Part 15, Subpart B, Class B

> ICES-003 Issue 6 ANSI C63.4:2014

Received Date : May 28, 2018

Tested Date : Jun. 04 ~ Jun. 06, 2018

We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by: Approved by:

Kent Chen / Assistant Manager

Testing Laboratory

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Report Version: Rev. 01

Peter Lin / Supervisor



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Release Record

Report No.	Version	Description	Issued Date
FD852803	Rev. 01	Initial issue	Aug. 22, 2018

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Summary of Test Results

FCC Part 15, Subpart B Emission Tests							
Ref. Std. Clause	Test Standard	Test Items	Measured	Result			
15.107	FCC Part 15, Subpart B, Class B	Conducted Emissions	-15.13dB AV @ 4.292MHz.	Pass			
15.109	FCC Part 15, Subpart B, Class B	Radiated Emissions	-3.65dB PK@ 68.80MHz.	Pass			

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1. General Description

1.1 Information

1.1.1 Product Details

The following models are provided to this EUT.

Brand Name Model Name		Product Name	Description
		Bluetooth 5.0 Module w/Integrated PCB Antenna	Printed PCB Antenna
Laird	BL651	Bluetooth 5.0 Module w/External Antenna	MHF4 Connector Type Antenna

1.1.2 Specification of the Equipment under Test (EUT)

Operating Frequency	2402 MHz ~ 2480 MHz
Modulation Type	Bluetooth 5.0 LE: GFSK

1.1.3 Antenna Details

Ant. No.	Manufacturer	Model	Laird Part Number	Туре	Connector	Gain (dBi)	Remarks
1	Laird	NanoBlue	EBL2400A1- 10MH4L	PCB Dipole	IPEX MHF4	2	MHF4 Connector Type Antenna
2	Laird	FlexPIFA	001-0022	PIFA	IPEX MHF4	2	MHF4 Connector Type Antenna
3	Mag.Layers	EDA-8709- 2G4C1-B27-CY	0600-00057	Dipole	IPEX MHF4	2	MHF4 Connector Type Antenna
4	Laird	mFlexPIFA	EFA2400A3S- 10MH4L	PIFA	IPEX MHF4	2	MHF4 Connector Type Antenna
5	Laird	PCB printed antenna	NA	Printed PCB	N/A	0	Printed PCB Antenna

1.1.4 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	DC 1.8V & DC 3.3V from host
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1.1.5 Accessories

N/A

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1.2 The Equipment List

Test Item	Conducted Emission							
Test Site	Conduction room 1 / (Conduction room 1 / (CO01-WS)						
Tested Date	Jun. 06, 2018							
Instrument	Manufacturer	Manufacturer Model No. Serial No. Calibration Date Calibration Until						
Receiver	R&S	ESR3	101657	Jan. 05, 2018	Jan. 04, 2019			
LISN	SCHWARZBECK	Schwarzbeck 8127	8127-667	Nov. 13, 2017	Nov. 12, 2018			
LISN (Support Unit)	SCHWARZBECK	Schwarzbeck 8127	8127-666	Nov. 24, 2017	Nov. 23, 2018			
RF Cable-CON	EMC	EMCCFD300-BM-B M-6000	50821	Dec. 18, 2017	Dec. 17, 2018			
50 ohm terminal (Support Unit)	NA	50	04	May 22, 2018	May 21, 2019			
Measurement Software	AUDIX	e3	6.120210k	NA	NA			
Note: Calibration Inte	Note: Calibration Interval of instruments listed above is one year.							

Test Item	Radiated Emission below 1GHz							
Test Site	966 chamber 2 / (03CH02-WS)							
Tested Date	Jun. 04, 2018							
Instrument	Manufacturer	Manufacturer Model No. Serial No. Calibration Date Calibration Until						
Receiver	Agilent	N9038A	MY53290044	Sep. 26, 2017	Sep. 25, 2018			
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 13, 2017	Nov. 12, 2018			
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-523	Nov. 10, 2017	Nov. 09, 2018			
Preamplifier	EMC	EMC02325	980194	Sep. 25, 2017	Sep. 24, 2018			
LF cable 1M	EMC	EMCCFD400-NM-N M-1000	16051	Dec. 06, 2017	Dec. 05, 2018			
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-003	Dec. 06, 2017	Dec. 05, 2018			
LF cable 10M	EMCC	CFD400-E	CFD400-001	Dec. 06, 2017	Dec. 05, 2018			
Measurement Software	AUDIX	e3	6.120210g	NA	NA			
Note: Calibration Interval of instruments listed above is one year.								

Test Item	Radiated Emission above 1GHz							
Test Site	966 chamber 2 / (03C	966 chamber 2 / (03CH02-WS)						
Tested Date	Jun. 06, 2018	Jun. 06, 2018						
Instrument	Manufacturer	Manufacturer Model No. Serial No. Calibration Date Calibration Until						
Spectrum Analyzer	Agilent	N9010A	MY53400091	Nov. 15, 2017	Nov. 14, 2018			
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1095	Sep. 22, 2017	Sep. 21, 2018			
Preamplifier	Agilent	83017A	MY39501309	Sep. 25, 2017	Sep. 24, 2018			
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16140/4	Dec. 06, 2017	Dec. 05, 2018			
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16018/4	Dec. 06, 2017	Dec. 05, 2018			
Measurement Software	MA I NA I NA I NA							
Note: Calibration Inter	rval of instruments liste	d above is one year.						

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1.3 Testing Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

FCC Part 15, Subpart B, Class B ICES-003 Issue 6 ANSI C63.4:2014

1.4 Measurement Uncertainty

CISPR 16-4-2 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)

Measurement Uncertainty					
Test Item Frequency Uncertainty					
Conducted Emissions	150kHz ~ 30MHz	±2.90 dB			
Dedicted Essissions	30MHz ~ 1GHz	±3.87 dB			
Radiated Emissions	Above 1GHz	±5.60 dB			

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2. Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
AC Conduction	CO01-WS	23°C / 58%	Alex Tsai
Radiated Emissions	03CH02-WS	23-24°C / 58-61%	Alex Tsai

FCC site registration No.: 933633IC site registration No.: 10807A-2

2.2 The Worst Case Measurement Configuration

The EUT supports two DC voltage options, DC 1.8V & DC 3.3V. Both options were assessed and **DC 3.3V** was found to be the worst case and was selected for the final test.

Radiation below 1GHz Pretest Mode		
Pretest Mode	Pretest Mode Operating Description	
1	BT Link, EUT: X-axis, Ant: EDA-8709-2G4C1-B27-CY	
2	BT Link, EUT: Y-axis, Ant: EDA-8709-2G4C1-B27-CY	
3	BT Link, EUT: Z-axis, Ant: EDA-8709-2G4C1-B27-CY	
4	BT Link, EUT: Y-axis, Ant: FlexPIFA	
5	BT Link, EUT: Y-axis, Ant: mFlexPIFA	
6	BT Link, EUT: Y-axis, Ant: NanoBlue	
7	BT Link, EUT: Y-axis, Ant: PCB printed antenna	
For Pretest Mode 2 is the worst case and only its data was record in this test report.		

Radiation above 1GHz Pretest Mode		
Pretest Mode	Pretest Mode Operating Description	
1	BT Link, EUT: X-axis, Ant: EDA-8709-2G4C1-B27-CY	
2	BT Link, EUT: Y-axis, Ant: EDA-8709-2G4C1-B27-CY	
3	BT Link, EUT: Z-axis, Ant: EDA-8709-2G4C1-B27-CY	
4	BT Link, EUT: Y-axis, Ant: FlexPIFA	
5	BT Link, EUT: Y-axis, Ant: mFlexPIFA	
6	BT Link, EUT: Y-axis, Ant: NanoBlue	
7	BT Link, EUT: Y-axis, Ant: PCB printed antenna	
For Pretest Mode 2 is the worst case and only its data was record in this test report.		

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The Determined Worst Case Configurations			
Conducted Emissions			
Test Mode	Operating Description		
1	BT Link, EUT: Y-axis, Ant: EDA-8709-2G4C1-B27-CY		
Radiated Emissions			
Test Mode ≤ 1GHz	Operating Description		
1	BT Link, EUT: Y-axis, Ant: EDA-8709-2G4C1-B27-CY		
Test Mode > 1GHz	Operating Description		
1	BT Link, EUT: Y-axis, Ant: EDA-8709-2G4C1-B27-CY		

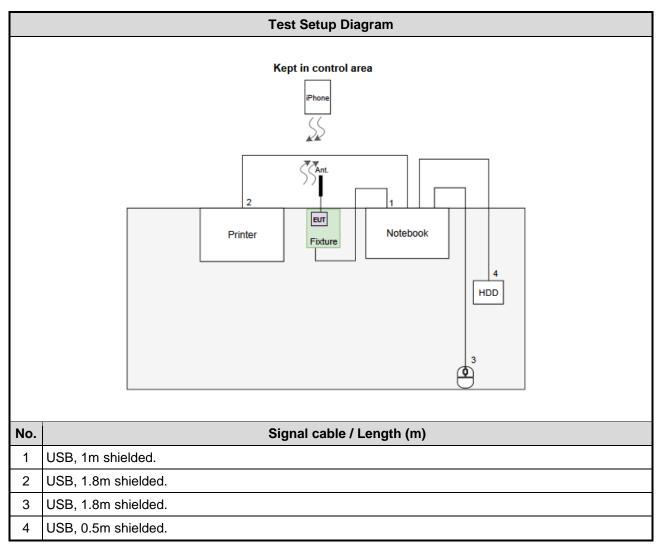
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2.3 Local Support Equipment List

Support Equipment List					
No.	Equipment	Brand	Model	S/N	Remarks
1	Notebook	DELL	Latitude E6440	8VXMD12	
2	Printer	EPSON	XP-30	QSDK002410	
3	USB 3.0 HDD	WD	WDBKXH5000 ABK	WX31AB210213	
4	Mouse	DELL	MS111-L	2C3-00MM	
5	iPhone	Apple	A1530	6FRC6	
6	Fixture	Laird	DVK-BL652-A1		Provided by applicant.

2.4 Test Setup Chart



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2.5 Test Software and Operating Condition

- a. Enabled all function of test system.
- b. The support notebook executed "WinEMC.exe" to send "H" patterns to its monitor and the monitor displayed them.
- c. The support notebook executed "WinEMC.exe" to send "H" patterns to the printer.
- d. The support notebook executed "WinEMC.exe" to read and wrote data from HDD.
- e. The support iPhone executed "nRF Toolbox" application for BT link.

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3. Emission Tests Results

3.1 Conducted Emissions

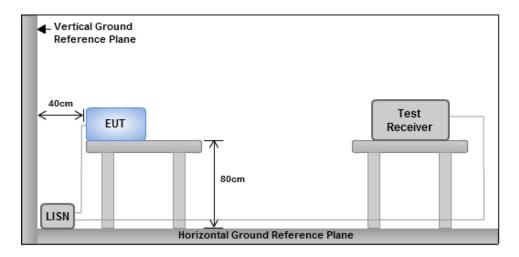
3.1.1 Limits of Conducted Emissions

Conducted Emissions Limit				
Frequency Emission (MHz) Quasi-Peak Average				
0,15 to 0,5	66 - 56 *	56 - 46 *		
0,5 to 5	56	46		
5 to 30	60	50		
Note 1: * Decreases with the logarithm of the frequency.				

3.1.2 Test Procedures

- a. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
- b. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
- c. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.

3.1.3 Test Setup



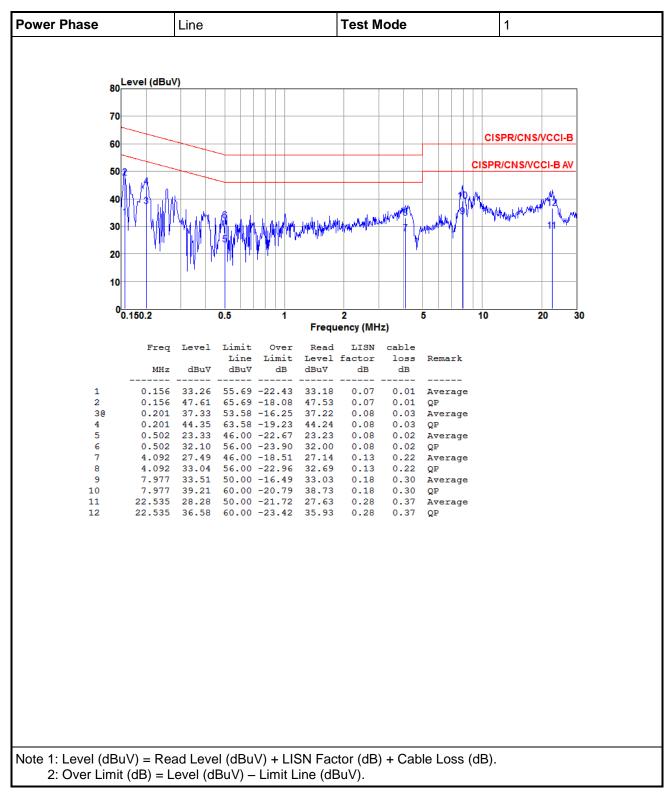
Note: 1. Support units were connected to second LISN.

Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

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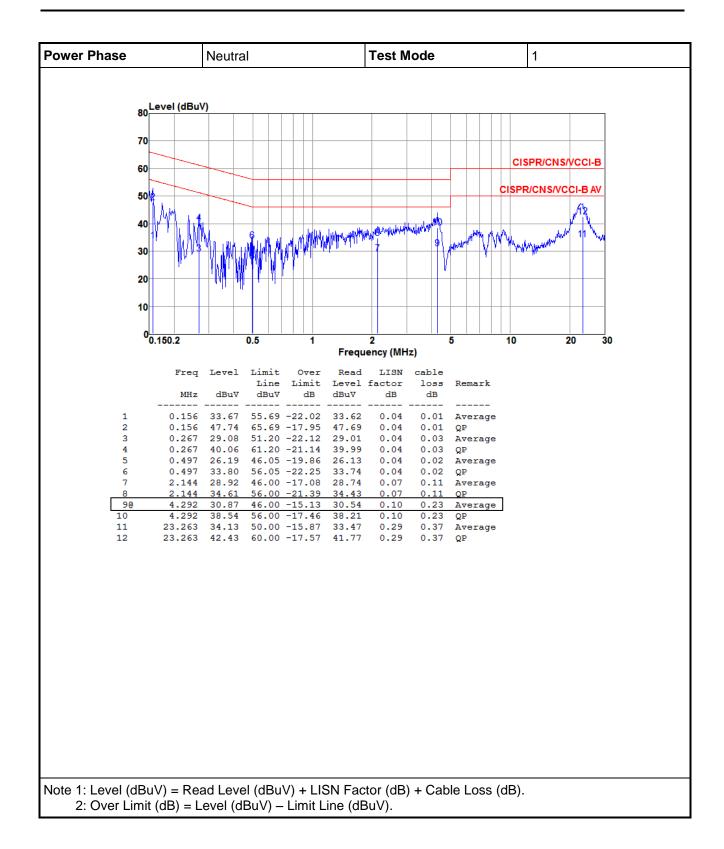


3.1.4 Test Result of Conducted Emissions



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3.2 Radiated Emissions

3.2.1 Limits of Radiated Emissions

According to FCC Part 15, Subpart B §15.109, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency of Emission (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)
Below 1.705	30
1.705-108	1000
108-500	2000
500-1000	5000
Above 1000	5th harmonic of the highest frequency or 40 GHz, whichever is lower

Note: According to FCC Part 15, Subpart B §15.33: For an unintentional radiator is shown in the table above.

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3.2.2 Test Procedures

Measuring below 1 GHz:

- a. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at a height of 0.8 m test table above the ground plane.
- b. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
- c. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

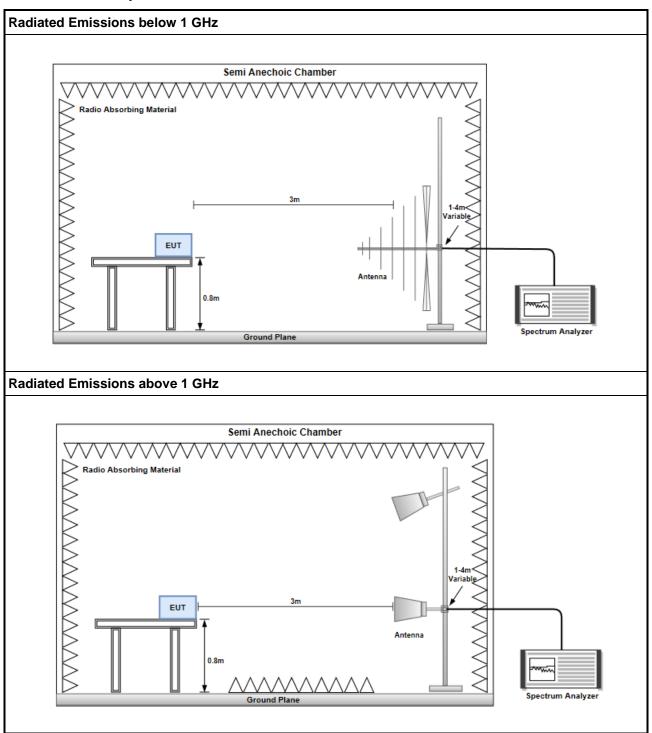
Measuring above 1 GHz:

- a. Same test set up as below 1GHz radiated testing.
- b. The EUT was set 3 meters from the interference-receiving antenna which was mounted on the top of a variable height antenna tower.
- c. There should be absorber placed between the EUT and Antenna and its located size should let the test site meet CISPR16-1-4 requirement.
- d. The table was rotated 360 degrees to determine the position of the highest radiation.
- e. Set the test-receiver system to Peak Detect Function and specified bandwidth with Maximum Hold Mode.
- f. Set the Horn Antenna at 1m height, then run the turn table to get the maximum noise reading from Horizontal and Vertical polarity separately.
- g. When EUT locating on the turn-table, the Horn Antenna must be raised up and descended down, then turning around the turn-table to get the maximum noise reading of the Horizontal and Vertical polarity separately. Note the maximum raise up height is same as the top of EUT.
- h. If emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

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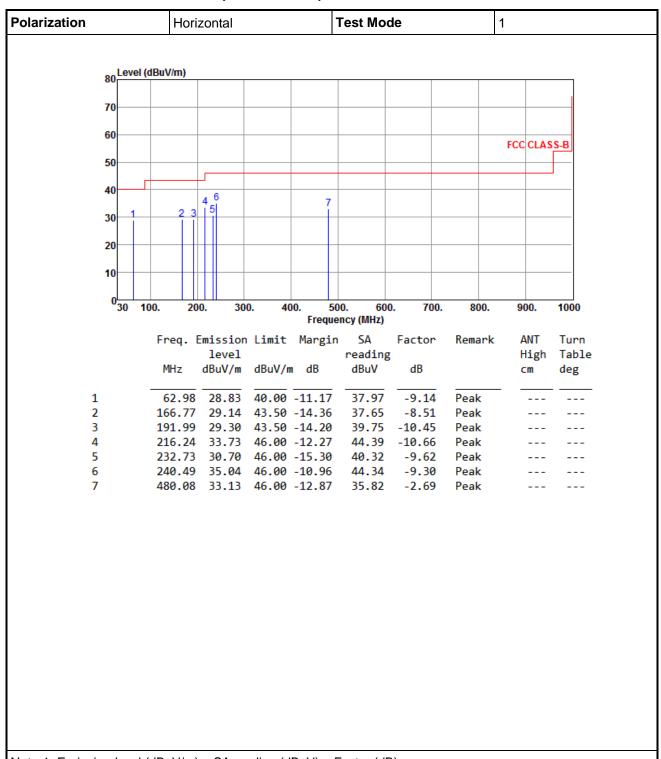
3.2.3 Test Setup



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3.2.4 Radiated Emissions (Below 1GHz)

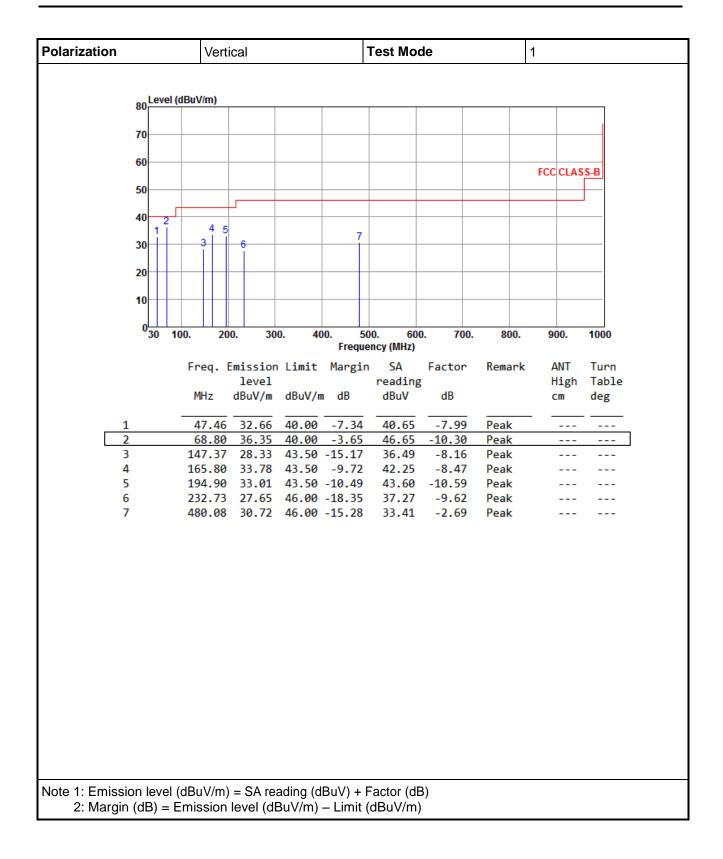


Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB)

2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m)

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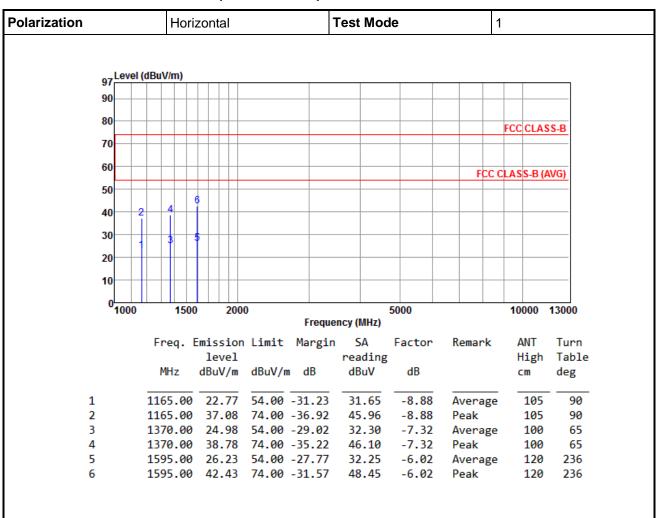




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3.2.5 Radiated Emissions (Above 1GHz)

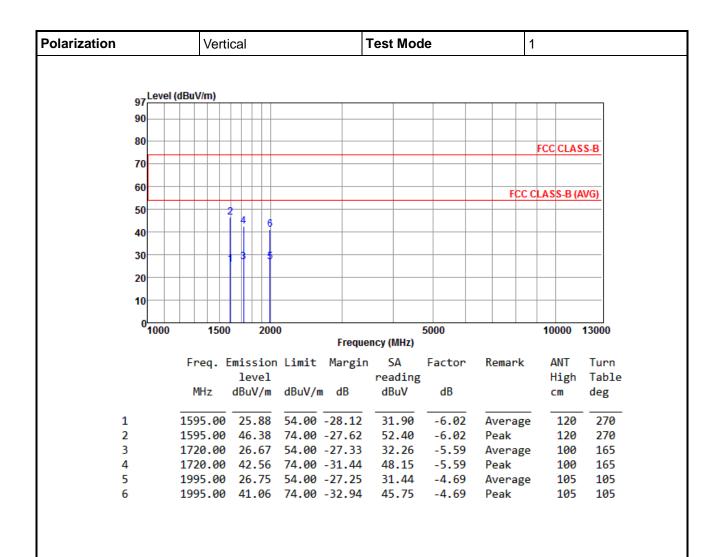


Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB)

2: Margin (dB) = Emission level (dBuV/m) - Limit (dBuV/m)

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Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB)

2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m)

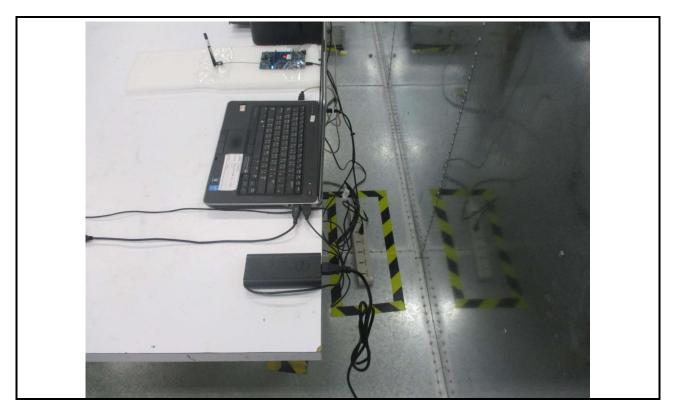
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4. Photographs of the Test Configuration

Conducted Emission Test

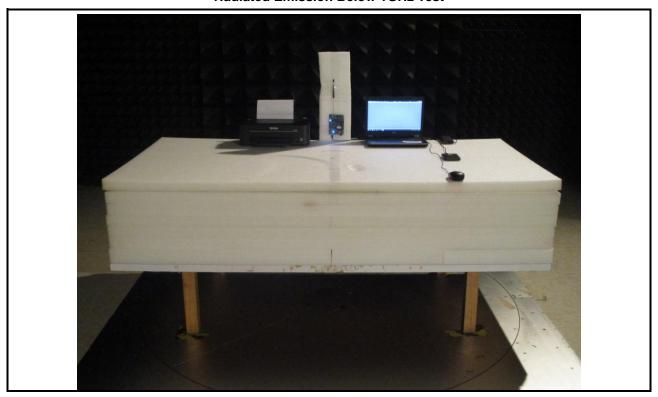


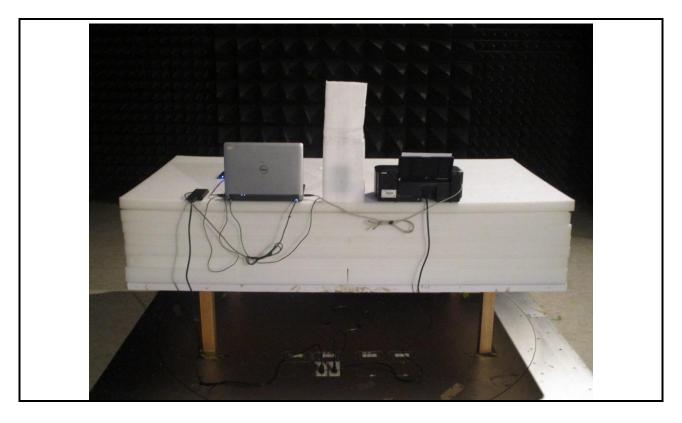


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Radiated Emission Below 1GHz Test

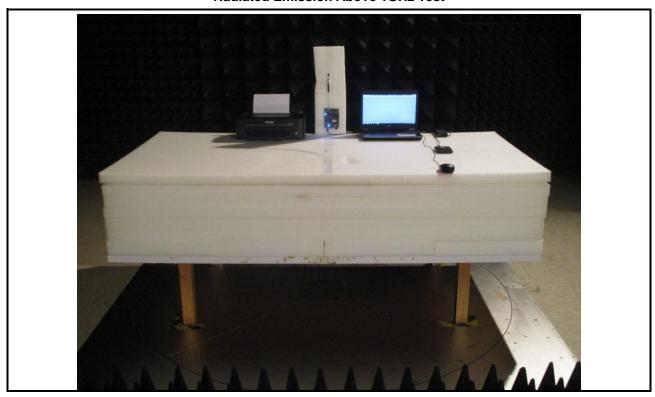


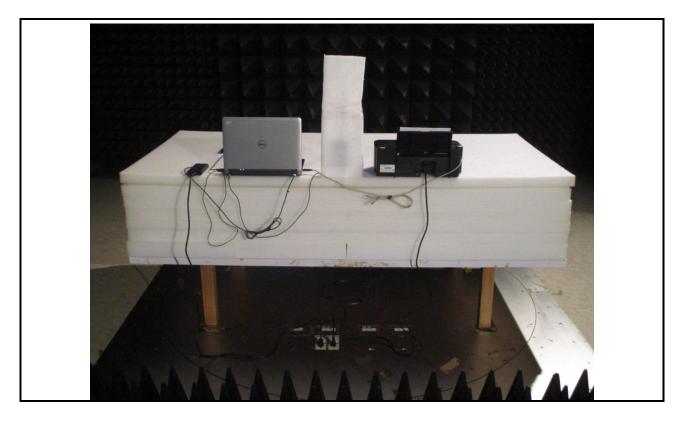


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Radiated Emission Above 1GHz Test





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5. Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website http://www.icertifi.com.tw.

Linkou

Tel: 886-2-2601-1640

No. 30-2, Ding Fwu Tsuen, Lin Kou District, New Taipei City, Taiwan,

R.O.C.

Kwei Shan

Tel: 886-3-271-8666

No. 3-1, Lane 6, Wen San 3rd
St., Kwei Shan District, Tao Yuan
City 333, Taiwan, R.O.C.

Kwei Shan Site II

Tel: 886-3-271-8640

No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

If you have any suggestion, please feel free to contact us as below information

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Email: ICC_Service@icertifi.com.tw

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