CE EMC Test Report

Equipment	:	**Bluetooth 5.1 Nano BLE Data Module**
Model No.	:	**BL653µ**
Brand Name	:	**Laird Connectivity**
Applicant	:	**Laird Connectivity, Inc.**
Address	:	**W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA**
Standard	:	**EN 301 489-1 V2.2.3 (2019-11)** **EN 301 489-3 V2.1.1 (2019-03)** **EN 301 489-17 V3.2.4 (2020-09)**
Received Date	:	**Jun. 17, 2020**
Tested Date	:	**Aug. 27 ~ Oct. 18, 2020**

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:

Peter Lin / Supervisor

Eason Chang / Assistant Manager

Approved by:

Kent Chen / Assistant Manager

Testing Laboratory 2732

Table of Contents

1 GENERAL DESCRIPTION 6

1.1 Information 6
1.2 Test Equipment and Calibration Data 7
1.3 Testing Applied Standards 8
1.4 Deviation from Test Standard and Measurement Procedure 8
1.5 Measurement Uncertainty 9

2 TEST CONFIGURATION 10

2.1 Testing Condition 10
2.2 Testing Facility 10
2.3 The Worst Case Measurement Configuration 10
2.4 Local Support Equipment List 12
2.5 Test Setup Chart 12
2.6 Test Software and Operating Condition 14

3 EMISSION TEST RESULTS 15

3.1 Conducted Emissions from the AC mains power ports 15
3.2 Radiated Emissions 29

4 IMMUNITY TESTS 36

4.1 General Description 36
4.2 Performance Criteria Description 37
4.3 Electrostatic Discharge (ESD) 39
4.4 Radio Frequency Electromagnetic Field (RS) 43

5 PHOTOGRAPHS OF THE TEST CONFIGURATION 47

6 TEST LABORATORY INFORMATION 60

Release Record

Report No.	Version	Description	Issued Date
EH061704	Rev. 01	Initial issue	Nov. 24, 2020

Summary of Test Results

EN 301 489-1 Emission Tests				
Ref. Std. Clause	**Test Standard**	**Test Items**	**Measured**	**Result**
8.3/8.4	EN 55032:2015/AC:2016, Class B	Conducted Emissions from the DC mains power ports	Under limit -13.61dB @ 0.507MHz.	Pass
8.7	EN 55032:2015/AC:2016, Class B	Asymmetric Mode Conducted Emissions	Note[1]	N/A
8.2	EN 55032:2015/AC:2016, Class B	Radiated Emissions	Under limit -4.82dB @ 30.97MHz.	Pass
8.5	EN 61000-3-2:2014, Class A	Harmonic Current Emissions	Note[2]	N/A
8.6	EN 61000-3-3:2013	Voltage Fluctuations and Flicker	Note[2]	N/A

N/A means Not Applicable.
Note[1]: The EUT w/o telecom port.
Note[2]: The EUT consumes DC power, so the test is not required.

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

EN 301 489-1 Immunity Tests					
Ref. Std. Clause	**Test Standard**	**Description of Test**		**Pass Criterion**	**Result**
9.3	EN 61000-4-2:2009	Electrostatic Discharge (ESD)		B	Pass
9.2	EN 61000-4-3:2006/A1:2008/ A2:2010	Radio Frequency Electromagnetic Field (RS)		A	Pass
9.4	EN 61000-4-4:2012	Electrical Fast Transient/Burst (EFT)		Note[1]	N/A
9.8	EN 61000-4-5:2014+A1:2017	Surge		Note[2]	N/A
9.5	EN 61000-4-6:2014	Conducted Disturbances (CS)		Note[1]	N/A
9.7	EN 61000-4-11:2004+A1:2017	Voltage Dips	0% residual for 0.5 cycle	Note[2]	N/A
			0% residual for 1 cycle	Note[2]	N/A
			70% residual for 25 cycle	Note[2]	N/A
		Voltage Interruption	0% residual for 250 cycle	Note[2]	N/A

N/A means Not Applicable.
Note[1]: The EUT consumes DC power, and it is not intended to be used with cables longer than 3m. So this test is not carried out.
Note[2]: The EUT consumes DC power, so the test is not required.

Comments and Explanations:
None.

1 General Description

1.1 Information

1.1.1 Product Details

Model Name	Part Number	Remarks
BL653µ	453-00059	Chip Antenna
	453-00060	RF Trace Pin Antenna

1.1.2 Specification of the Equipment under Test (EUT)

EUT supports Radios application	NFC Bluetooth LE

1.1.3 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	Option 1: DC 5V from host Option 2: DC 3.3V from host Option 3: DC 1.7V from host

1.1.4 Antenna Details

Manufacturer	Model	Laird Part Number	Type	Connector	Gain (dBi)
Laird	NanoBlue	EBL2400A1-10 MH4L	PCB Dipole	IPEX MHF4	2
Laird	FlexPIFA	001-0022	PCB Dipole	IPEX MHF4	2
Mag.Layers	EDA-8709-2G4 C1-B27-CY	0600-00057	Dipole	IPEX MHF4	2
Laird	mFlexPIFA	EFA2400A3S-1 0MH4L	PIFA	IPEX MHF4	2
Laird	Laird NFC	0600-00061	NFC	N/A	--
Yageo	ANT1608LL14R 2400A	N/A	Chip Antenna	N/A	2

1.1.5 Accessories

N/A

1.2 Test Equipment and Calibration Data

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Test Date	Oct. 15, 2020				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Receiver	R&S	ESR3	101658	Dec. 12, 2019	Dec. 11, 2020
LISN	R&S	ENV216	101579	Mar. 12, 2020	Mar. 11, 2021
LISN (Support Unit)	SCHWARZBECK	Schwarzbeck 8127	8127-666	Dec. 20, 2019	Dec. 19, 2020
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Oct. 22, 2019	Oct. 21, 2020
50 ohm terminal (Support Unit)	NA	50	04	Jun. 05, 2020	Jun. 04, 2021
Measurement Software	AUDIX	e3	6.120210k	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emission below 1GHz				
Test Site	966 chamber 2 / (03CH02-WS)				
Test Date	Oct. 18, 2020				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Receiver	Agilent	N9038A	MY53290044	Sep. 15, 2020	Sep. 14, 2021
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 13, 2019	Nov. 12, 2020
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-523	Dec. 26, 2019	Dec. 25, 2020
Preamplifier	EMC	EMC02325	980194	Sep. 16, 2020	Sep. 15, 2021
LF cable 1M	EMC	EMCCFD400-NM-NM-1000	160501	Oct. 17, 2020	Oct. 16, 2021
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-003	Oct. 17, 2020	Oct. 16, 2021
LF cable 10M	EMC	CFD400-E	CFD400-001	Oct. 17, 2020	Oct. 16, 2021
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 / (03CH02-WS)				
Test Date	Oct. 15, 2020				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	Agilent	N9010A	MY53400091	Nov. 15, 2019	Nov. 14, 2020
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1095	Sep. 25, 2020	Sep. 24, 2021
Preamplifier	Agilent	83017A	MY53270014	Jul. 30, 2020	Jul. 29, 2021
RF Cable	EMC	EMC105-SM-SM-8000	180512	Oct. 17, 2020	Oct. 16, 2021
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16018/4	Oct. 17, 2020	Oct. 16, 2021
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	ESD				
Test Site	ESD room 1 / (ES01-WS)				
Tested Date	Aug. 27, 2020				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
ESD Generator	EMTest	Dito	V1248114239	Aug. 13, 2020	Aug. 12, 2021
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Immunity (80 MHz - 6 GHz)				
Test Site	RS room 1 / (RS01-WS)				
Tested Date	Sep. 11, 2020				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Signal Generator	R&S	SMB100A	103924HA	Oct. 18, 2019	Oct. 17, 2020
Power Sensor	R&S	NRP-Z91	101094-UL	Oct. 16, 2019	Oct. 15, 2020
Power Sensor	R&S	NRP-Z91	101095-KY	Oct. 16, 2019	Oct. 15, 2020
Power Amplifier	BONN	BLWA 0810-160/100D	107972A	N/A	N/A
Power Amplifier	BONN	BLMA 1060-100D	107972B	N/A	N/A
Antenna	SCHWARZBECK MESS-ELEKTRONIK	STLP 9149	9149-073	N/A	N/A
Antenna	R&S	HL046E	100076-Cd	N/A	N/A
Note: Calibration Interval of instruments listed above is one year.					

1.3 Testing Applied Standards

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

EN 301 489-1 V2.2.3 (2019-11)
EN 301 489-3 V2.1.1 (2019-03)
EN 301 489-17 V3.2.4 (2020-09)

1.4 Deviation from Test Standard and Measurement Procedure

None

1.5 Measurement Uncertainty

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 from the DC mains power ports	150kHz ~ 30MHz	±2.92 dB
Radiated Emissions	30MHz ~ 1GHz	±4.32 dB
	Above 1GHz	±4.57 dB

Note: The results of measurements of emissions shall reference the measurement uncertainty considerations contained in CISPR 16-4-2.

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
Conducted Emissions from the DC mains power ports	CO01-WS	26°C / 57%	Alex Tsai
Radiated Emissions	03CH02-WS	21°C / 62%	Rober Tsai
ESD	ES01-WS	24°C/49%/98kPa	JN Chen
RS	RS01-WS	25°C/61%/99kPa	JN Chen

2.2 Testing Facility

Test Laboratory	International Certification Corp.
Test Site	CO01-WS, 03CH02-WS, ES01-WS, RS01-WS
Address of Test Site	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

2.3 The Worst Case Measurement Configuration

Radiation Pretest Mode	
Pretest Mode	**Operating Description**
1	P/N: 453-00059 w/ Chip Ant. BT Link, EUT: Z-axis w/ NB 230V/50Hz
2	P/N: 453-00060 w/ Ant.: NanoBlue, BT Link, EUT: Z-axis w/ NB 230V/50Hz
3	P/N: 453-00060 w/ Ant.: FlexPIFA, BT Link, EUT: Z-axis w/ NB 230V/50Hz
4	P/N: 453-00060 w/ Ant.: EDA-8709-2G4C1-B27-CY, BT Link, EUT: Z-axis w/ NB 230V/50Hz
5	P/N: 453-00060 w/ Ant.: mFlexPIFA, BT Link, EUT: Z-axis w/ NB 230V/50Hz
6	P/N: 453-00060 w/ Ant.: Laird NFC, NFC Link, EUT: Z-axis w/ NB 230V/50Hz
7	P/N: 453-00060 w/ Ant.: EDA-8709-2G4C1-B27-CY, BT Link, EUT: Z-axis w/ NB 110V/60Hz
8	P/N: 453-00060 w/ Ant.: EDA-8709-2G4C1-B27-CY, Standby mode, EUT: Z-axis w/ NB 110V/60Hz
For **Pretest Mode 4** is the worst case and only its data was record in this test report.	

The Worst Test Configurations	
Conducted Emissions from the DC mains power ports	
Test Mode	**Operating Description**
1	P/N: 453-00060 w/ Ext An1(PCB Dipole), BT link to P/N: 453-00059 w/ Chip Ant., EUT: X-axis w/ NB 230V/50Hz
2	P/N: 453-00060 w/ Ext Ant2(PCB Dipole), BT link to P/N: 453-00059 w/ Chip Ant., EUT: X-axis w/ NB 110V/60Hz
3	P/N: 453-00060 w/ Ext Ant3(Dipole), BT link to P/N: 453-00059 w/ Chip Ant., EUT: X-axis w/ NB 230V/50Hz
4	P/N: 453-00060 w/ Ext Ant4(FlexPIFA), BT link to P/N: 453-00059 w/ Chip Ant., EUT: X-axis w/ NB 110V/60Hz
5	P/N: 453-00059 w/ Chip Ant., NFC link NFC Antenna, EUT: X-axis w/ NB 230V/50Hz
Radiated Emissions	
Test Mode ≤1GHz	**Operating Description**
1	P/N: 453-00060 w/ Ant.: EDA-8709-2G4C1-B27-CY, BT Link, EUT: Z-axis w/ NB 230V/50Hz
Test Mode >1GHz	**Operating Description**
1	P/N: 453-00060 w/ Ant.: EDA-8709-2G4C1-B27-CY, BT Link, EUT: Z-axis w/ NB 230V/50Hz
ESD & RS Tests	
Test Mode	**Operating Description**
1	P/N: 453-00060 w/ Ext An1(PCB Dipole), BT link to P/N: 453-00059 w/ Chip Ant.
2	P/N: 453-00060 w/ Ext Ant2(PCB Dipole), BT link to P/N: 453-00059 w/ Chip Ant.
3	P/N: 453-00060 w/ Ext Ant3(Dipole), BT link to P/N: 453-00059 w/ Chip Ant.
4	P/N: 453-00060 w/ Ext Ant4(FlexPIFA), BT link to P/N: 453-00059 w/ Chip Ant.
5	P/N: 453-00059 w/ Chip Ant., NFC link NFC Antenna
6	P/N: 453-00059 w/ Chip Ant., BT link to P/N: 453-00060 w/ Ext An1(PCB Dipole).

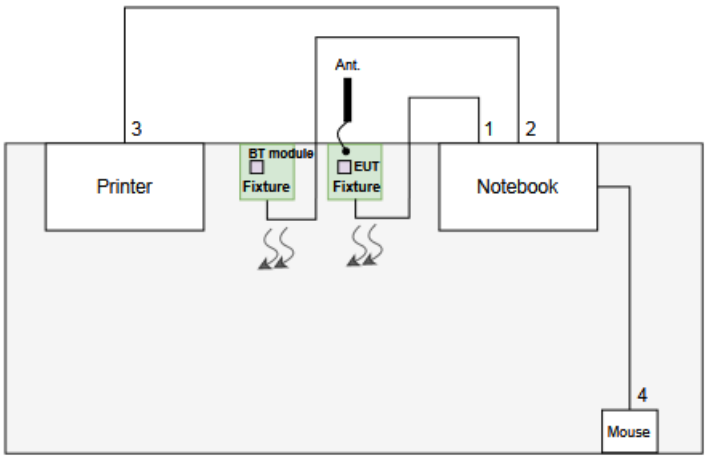
2.4 Local Support Equipment List

Support Equipment List (EMI)					
No.	**Equipment**	**Brand**	**Model**	**S/N**	**Remarks**
1	Notebook	DELL	Latitude E6440	8VXMD12	---
2	Mouse	DELL	MS111-L	2C3-00MM	---
3	Printer	EPSON	XP-30	QSDK002410	---
4	BT Module	Laird	BL653µ	---	Provided by applicant.
5	Fixture	Laird	DVD-BL653µ	---	Provided by applicant.
6	Tablet	SONY	SGP511TW/B	CB5126VXTX	---
7	USB 3.0 HDD	WD	WDBKXH5000 ABK	WX31AB210213	---

Support Equipment List (EMS)					
No.	**Equipment**	**Brand**	**Model**	**S/N**	**Remarks**
1	Notebook	DELL	Latitude E5430	6R4RWW1	---
2	BT Module	Laird	BL653µ	---	Provided by applicant.
3	Tablet	SONY	SGP511TW/B	CB5126VXTX	---
4	Fixture	---	---	---	Provided by applicant.

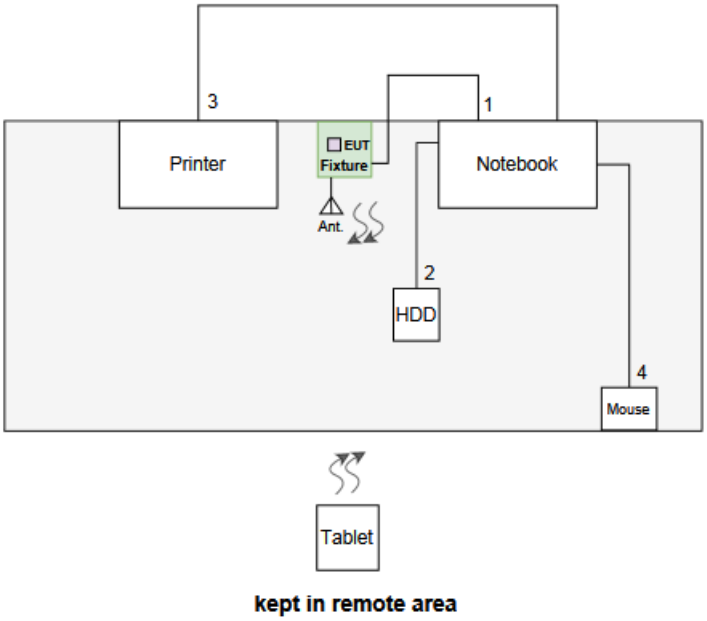
2.5 Test Setup Chart

Test Setup Diagram (EMI)



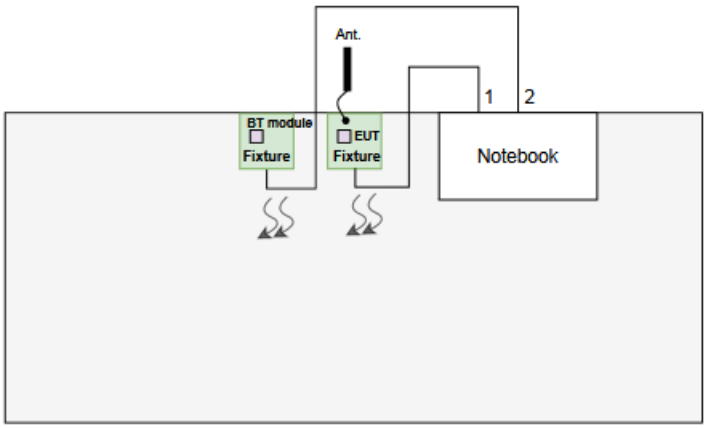
No.	Signal cable / Length (m)
1-2	USB, 1m shielded.
3-4	USB, 1.8m shielded.

Test Setup Diagram (EMI-for NFC link mode only)

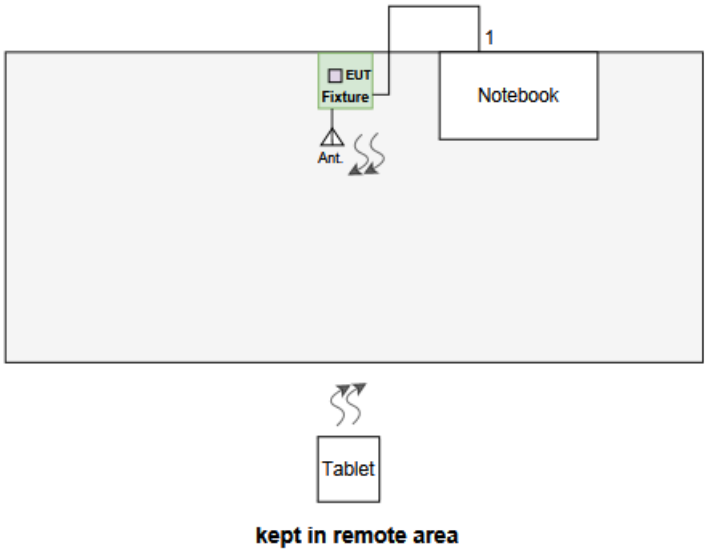


No.	Signal cable / Length (m)
1	USB, 1m shielded.
2	USB, 0.5m shielded.
3-4	USB, 1.8m shielded.

Test Setup Diagram (EMS)



No.	Signal cable / Length (m)
1-2	USB, 1.5m shielded.

Test Setup Diagram (EMS-for NFC link mode only)	
	
No.	**Signal cable / Length (m)**
1	USB, 1.5m shielded.

2.6 Test Software and Operating Condition

<EMI>

a. To enable 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 “KM player.exe” to play colorbar video.

BT link

e. The support notebook executed “UwTerminal.exe” to give command for BT link to secondary device.

NFC link

f. The support notebook executed “WinEMC.exe” to read and wrote data from USB 3.0 HDD.

g. The support tablet was able to communicate with EUT if they were close to each other.

<EMS>

BT link

a. The support notebook executed “UwTerminal.exe” to give command for BT link to secondary device.

NFC link

b. The support tablet was able to communicate with EUT if they were close to each other.

BT PER link

c. The support notebook executed “UwTerminal.exe” to observe packet error rate below 10%.

3 Emission Test Results

3.1 Conducted Emissions from the AC mains power ports

3.1.1 Limits of Conducted Emissions from the AC mains power ports

Frequency Range	Limits values (dBµV)			
	Class A		Class B	
	Quasi-Peak	Average	Quasi-Peak	Average
0,15 MHz to 0,5 MHz	79	66	66 to 56 *	56 to 46 *
> 0,5 MHz to 5 MHz	73	60	56	46
> 5 MHz to 30 MHz	73	60	60	50

Note 1: "*" Decreasing linearly with the logarithm of the frequency.
Note 2: If the limits for the average detector are met when using the quasi-peak detector, then the limits for the measurements with the average detector are considered to be met.
Note 3: The higher value measured with and without the outer conductor screen of the antenna terminal connected to earth is considered.

3.1.2 Test Procedures

a. The EUT was placed on a desk 0.8 meters height from the metal ground plane and 0.4 meter from the conducting wall of the shielding room and it was kept at least 0.8 meters from any other grounded conducting surface.

b. A thickness of ≤ 0.15m insulation should be placed between local AE and associated cabling and the RGP.

c. Connect EUT to the power mains through a line impedance stabilization network (LISN).

d. All the support units are connecting to the other LISN.

e. The LISN provides 50 ohm coupling impedance for the measuring instrument.

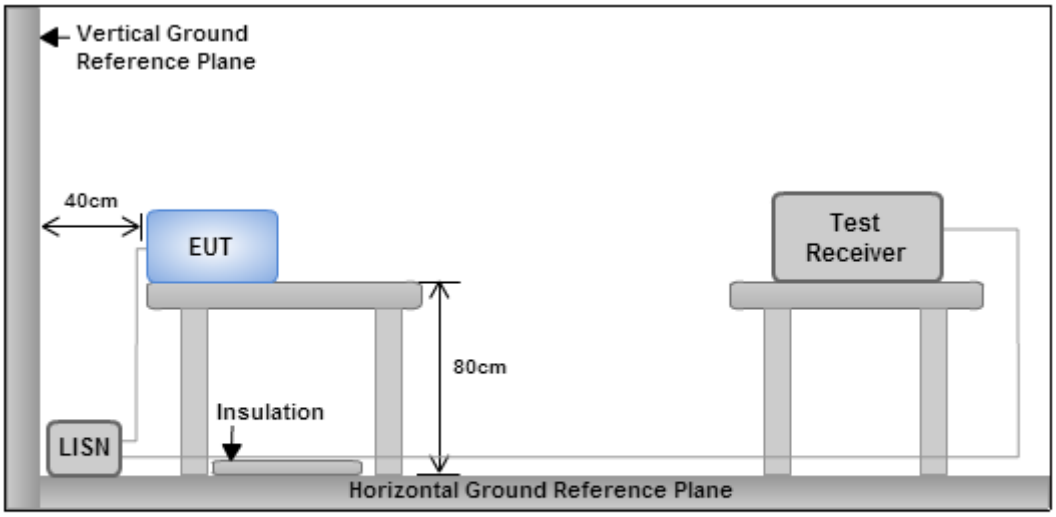
f. The CISPR states that a 50 ohm, 50 microhenry LISN should be used.

g. Both sides of AC line were checked for maximum conducted interference.

h. The frequency range from 150 kHz to 30 MHz was searched.

i. Set the test-receiver system to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

3.1.3 Test Setup

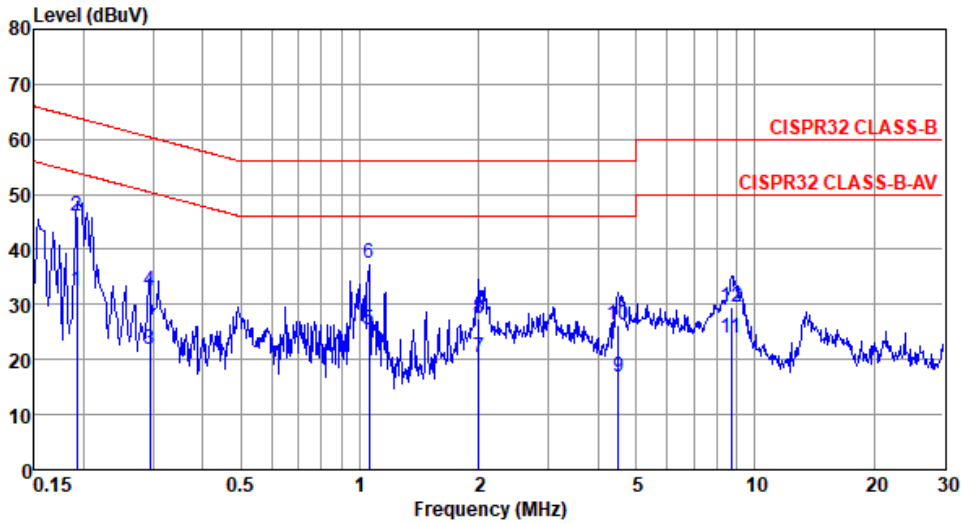


Note: 1. Support units were connected to second LISN.

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

3.1.4 Test Result of Conducted Emissions from the AC mains power ports

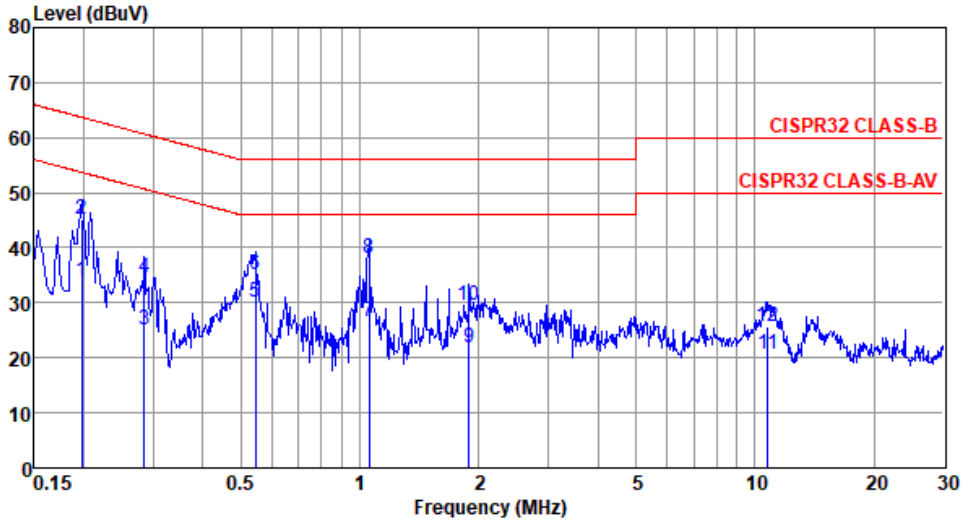
Power Phase	Line	Test Mode	1



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.192	32.54	53.93	-21.39	22.85	9.63	0.06	Average
2*	0.192	46.08	63.93	-17.85	36.39	9.63	0.06	QP
3	0.294	21.97	50.41	-28.44	12.27	9.63	0.07	Average
4	0.294	32.57	60.41	-27.84	22.87	9.63	0.07	QP
5	1.054	25.49	46.00	-20.51	15.74	9.63	0.12	Average
6	1.054	37.53	56.00	-18.47	27.78	9.63	0.12	QP
7	2.001	20.26	46.00	-25.74	10.44	9.64	0.18	Average
8	2.001	27.40	56.00	-28.60	17.58	9.64	0.18	QP
9	4.501	16.84	46.00	-29.16	6.88	9.66	0.30	Average
10	4.501	26.29	56.00	-29.71	16.33	9.66	0.30	QP
11	8.729	24.02	50.00	-25.98	13.97	9.68	0.37	Average
12	8.729	29.58	60.00	-30.42	19.53	9.68	0.37	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

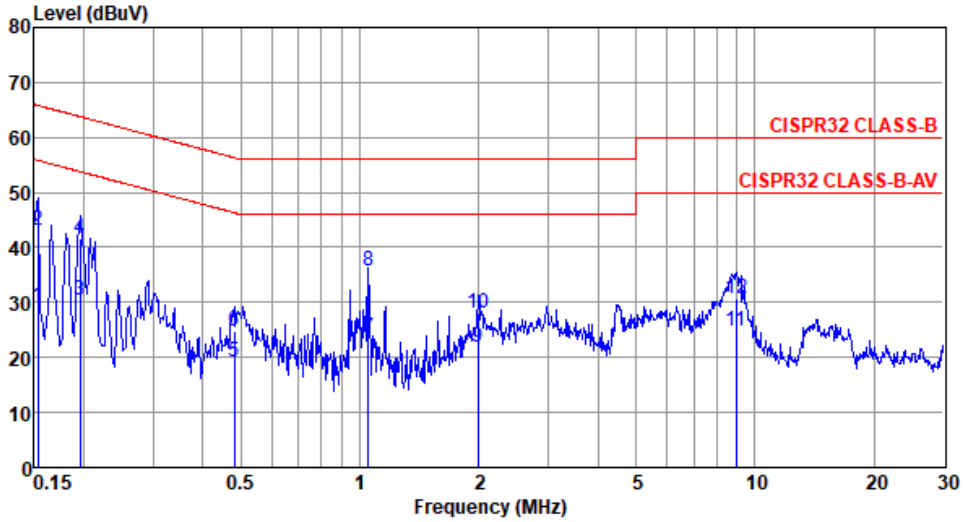
Power Phase	Neutral	Test Mode	1



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.198	34.02	53.71	-19.69	24.31	9.65	0.06	Average
2	0.198	45.18	63.71	-18.53	35.47	9.65	0.06	QP
3	0.285	25.08	50.68	-25.60	15.36	9.65	0.07	Average
4	0.285	34.60	60.68	-26.08	24.88	9.65	0.07	QP
5*	0.544	29.98	46.00	-16.02	20.24	9.65	0.09	Average
6	0.544	35.04	56.00	-20.96	25.30	9.65	0.09	QP
7	1.054	26.49	46.00	-19.51	16.72	9.65	0.12	Average
8	1.054	38.13	56.00	-17.87	28.36	9.65	0.12	QP
9	1.893	21.91	46.00	-24.09	12.07	9.66	0.18	Average
10	1.893	29.54	56.00	-26.46	19.70	9.66	0.18	QP
11	10.790	20.68	50.00	-29.32	10.51	9.74	0.43	Average
12	10.790	25.54	60.00	-34.46	15.37	9.74	0.43	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

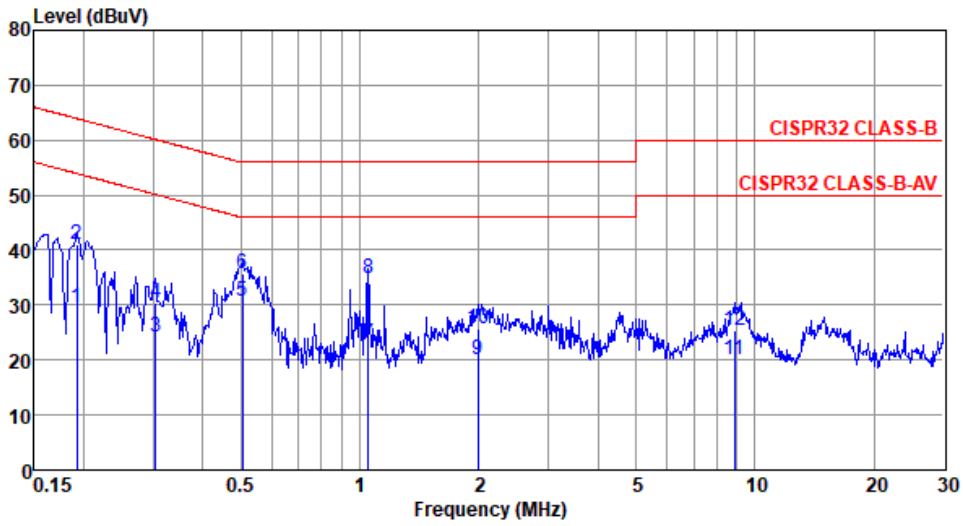
Power Phase	Line	Test Mode	2



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.153	29.16	55.82	-26.66	19.47	9.64	0.05	Average
2	0.153	42.97	65.82	-22.85	33.28	9.64	0.05	QP
3	0.195	30.39	53.80	-23.41	20.70	9.63	0.06	Average
4	0.195	41.53	63.80	-22.27	31.84	9.63	0.06	QP
5	0.481	19.30	46.32	-27.02	9.58	9.63	0.09	Average
6	0.481	24.85	56.32	-31.47	15.13	9.63	0.09	QP
7	1.049	23.63	46.00	-22.37	13.88	9.63	0.12	Average
8*	1.049	35.72	56.00	-20.28	25.97	9.63	0.12	QP
9	1.991	21.79	46.00	-24.21	11.97	9.64	0.18	Average
10	1.991	28.00	56.00	-28.00	18.18	9.64	0.18	QP
11	8.964	24.81	50.00	-25.19	14.74	9.69	0.38	Average
12	8.964	30.76	60.00	-29.24	20.69	9.69	0.38	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

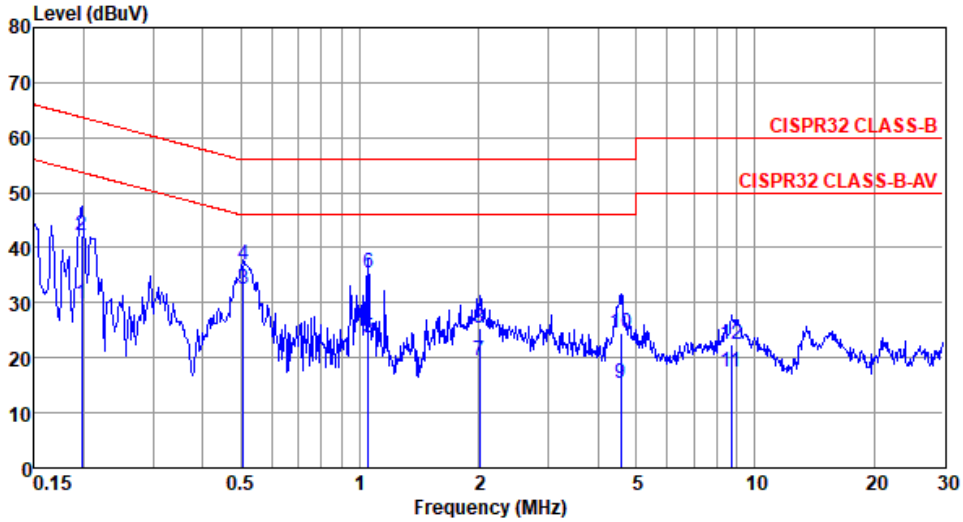
Power Phase	Neutral	Test Mode	2



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.192	29.58	53.93	-24.35	19.87	9.65	0.06	Average
2	0.192	41.09	63.93	-22.84	31.38	9.65	0.06	QP
3	0.303	24.09	50.15	-26.06	14.37	9.65	0.07	Average
4	0.303	30.52	60.15	-29.63	20.80	9.65	0.07	QP
5*	0.505	30.73	46.00	-15.27	20.99	9.65	0.09	Average
6	0.505	35.81	56.00	-20.19	26.07	9.65	0.09	QP
7	1.049	23.02	46.00	-22.98	13.25	9.65	0.12	Average
8	1.049	34.71	56.00	-21.29	24.94	9.65	0.12	QP
9	1.991	20.17	46.00	-25.83	10.33	9.66	0.18	Average
10	1.991	25.64	56.00	-30.36	15.80	9.66	0.18	QP
11	8.869	20.17	50.00	-29.83	10.07	9.72	0.38	Average
12	8.869	25.38	60.00	-34.62	15.28	9.72	0.38	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

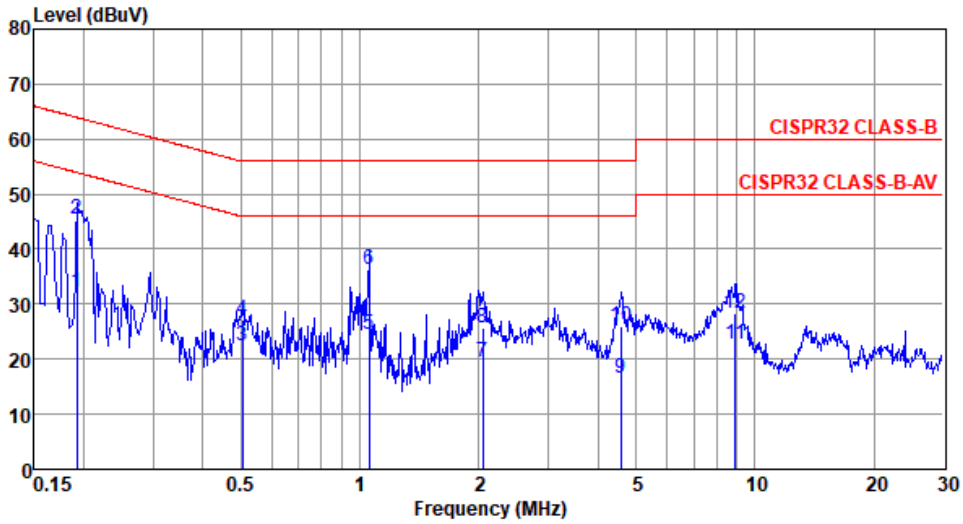
Power Phase	Line	Test Mode	3



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.198	29.81	53.71	-23.90	20.12	9.63	0.06	Average
2	0.198	42.23	63.71	-21.48	32.54	9.63	0.06	QP
3*	0.507	32.39	46.00	-13.61	22.67	9.63	0.09	Average
4	0.507	36.98	56.00	-19.02	27.26	9.63	0.09	QP
5	1.049	23.66	46.00	-22.34	13.91	9.63	0.12	Average
6	1.049	35.29	56.00	-20.71	25.54	9.63	0.12	QP
7	2.012	19.51	46.00	-26.49	9.69	9.64	0.18	Average
8	2.012	25.27	56.00	-30.73	15.45	9.64	0.18	QP
9	4.574	15.23	46.00	-30.77	5.27	9.66	0.30	Average
10	4.574	24.44	56.00	-31.56	14.48	9.66	0.30	QP
11	8.729	17.54	50.00	-32.46	7.49	9.68	0.37	Average
12	8.729	22.33	60.00	-37.67	12.28	9.68	0.37	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

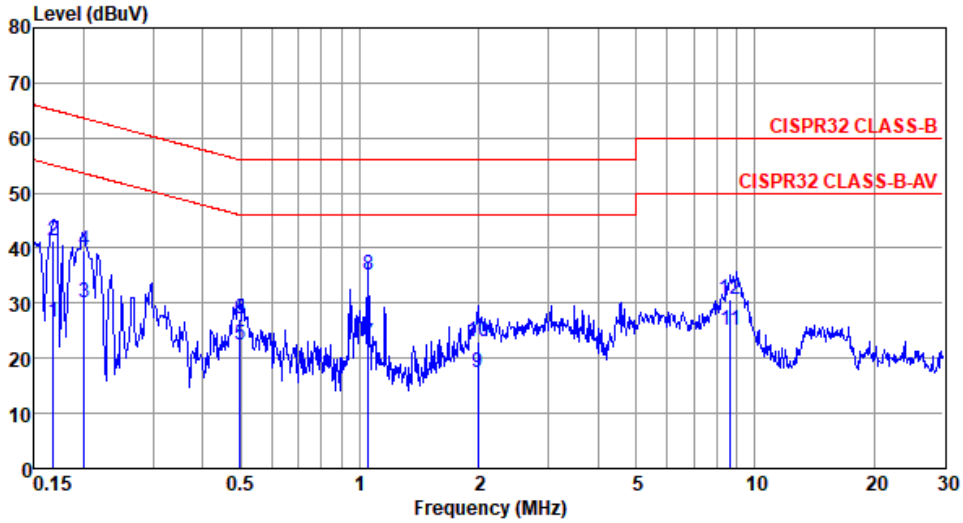
Power Phase	Neutral	Test Mode	3



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.192	32.20	53.93	-21.73	22.49	9.65	0.06	Average
2*	0.192	45.42	63.93	-18.51	35.71	9.65	0.06	QP
3	0.505	22.55	46.00	-23.45	12.81	9.65	0.09	Average
4	0.505	27.08	56.00	-28.92	17.34	9.65	0.09	QP
5	1.054	24.36	46.00	-21.64	14.59	9.65	0.12	Average
6	1.054	36.39	56.00	-19.61	26.62	9.65	0.12	QP
7	2.044	19.52	46.00	-26.48	9.68	9.66	0.18	Average
8	2.044	25.79	56.00	-30.21	15.95	9.66	0.18	QP
9	4.574	16.56	46.00	-29.44	6.58	9.68	0.30	Average
10	4.574	26.06	56.00	-29.94	16.08	9.68	0.30	QP
11	8.916	22.82	50.00	-27.18	12.72	9.72	0.38	Average
12	8.916	28.34	60.00	-31.66	18.24	9.72	0.38	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

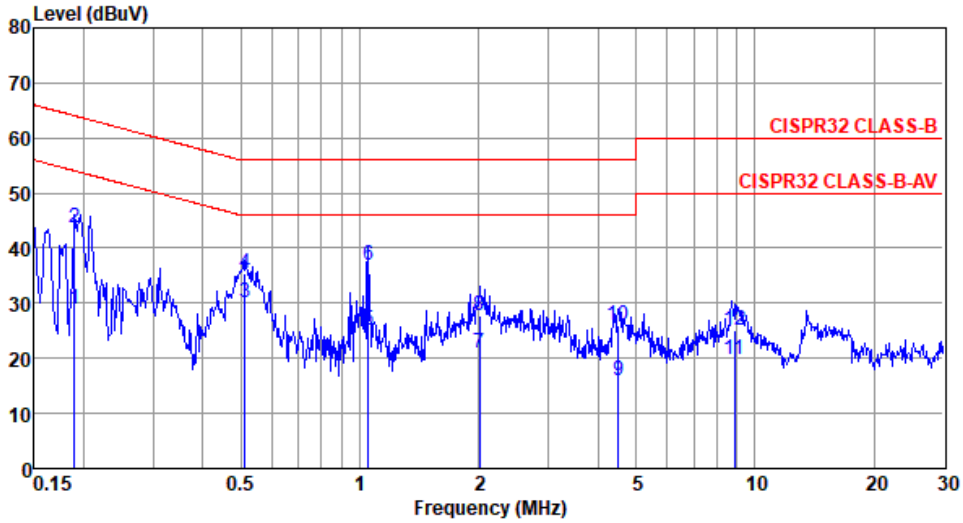
Power Phase	Line	Test Mode	4



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.168	26.64	55.08	-28.44	16.95	9.64	0.05	Average
2	0.168	41.29	65.08	-23.79	31.60	9.64	0.05	QP
3	0.201	30.20	53.58	-23.38	20.51	9.63	0.06	Average
4	0.201	39.61	63.58	-23.97	29.92	9.63	0.06	QP
5	0.497	22.42	46.05	-23.63	12.70	9.63	0.09	Average
6	0.497	27.22	56.05	-28.83	17.50	9.63	0.09	QP
7	1.049	22.85	46.00	-23.15	13.10	9.63	0.12	Average
8*	1.049	35.09	56.00	-20.91	25.34	9.63	0.12	QP
9	1.991	17.32	46.00	-28.68	7.50	9.64	0.18	Average
10	1.991	23.15	56.00	-32.85	13.33	9.64	0.18	QP
11	8.683	25.06	50.00	-24.94	15.01	9.68	0.37	Average
12	8.683	30.57	60.00	-29.43	20.52	9.68	0.37	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

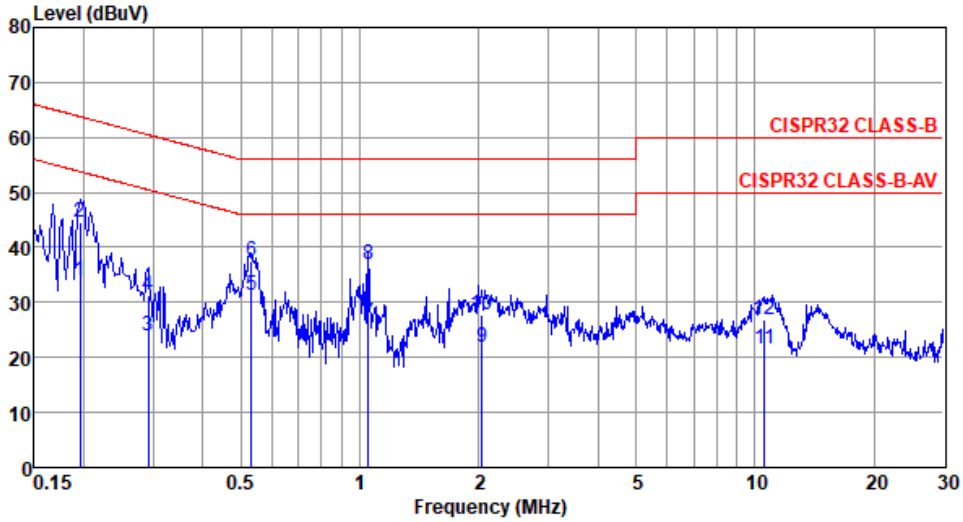
Power Phase	Neutral	Test Mode	4



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.189	28.79	54.06	-25.27	19.08	9.65	0.06	Average
2	0.189	43.56	64.06	-20.50	33.85	9.65	0.06	QP
3*	0.513	30.18	46.00	-15.82	20.44	9.65	0.09	Average
4	0.513	35.45	56.00	-20.55	25.71	9.65	0.09	QP
5	1.049	25.05	46.00	-20.95	15.28	9.65	0.12	Average
6	1.049	36.83	56.00	-19.17	27.06	9.65	0.12	QP
7	2.012	21.00	46.00	-25.00	11.16	9.66	0.18	Average
8	2.012	27.80	56.00	-28.20	17.96	9.66	0.18	QP
9	4.501	16.02	46.00	-29.98	6.04	9.68	0.30	Average
10	4.501	25.94	56.00	-30.06	15.96	9.68	0.30	QP
11	8.869	19.84	50.00	-30.16	9.74	9.72	0.38	Average
12	8.869	25.01	60.00	-34.99	14.91	9.72	0.38	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

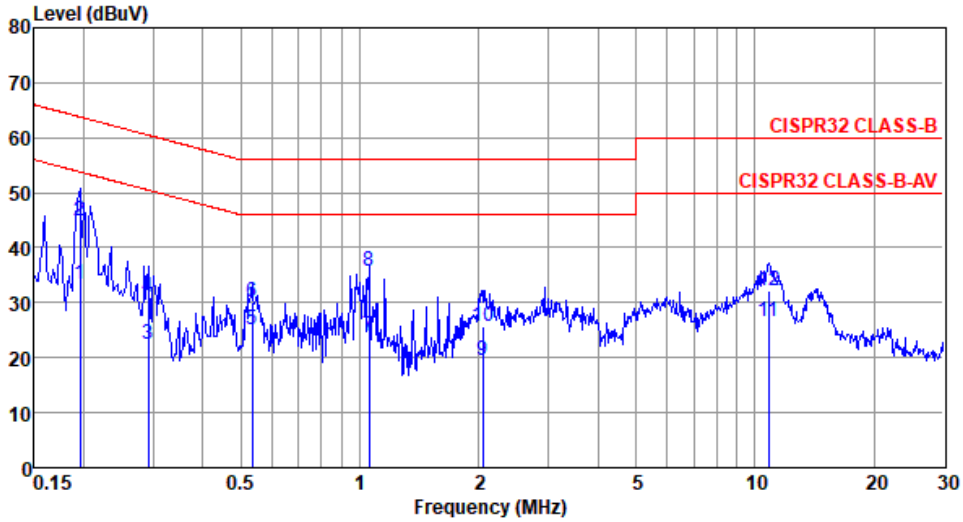
Power Phase	Line	Test Mode	5



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.195	34.04	53.80	-19.76	24.35	9.63	0.06	Average
2	0.195	44.62	63.80	-19.18	34.93	9.63	0.06	QP
3	0.291	24.01	50.50	-26.49	14.31	9.63	0.07	Average
4	0.291	31.43	60.50	-29.07	21.73	9.63	0.07	QP
5*	0.532	31.28	46.00	-14.72	21.56	9.63	0.09	Average
6	0.532	37.37	56.00	-18.63	27.65	9.63	0.09	QP
7	1.049	26.17	46.00	-19.83	16.42	9.63	0.12	Average
8	1.049	36.98	56.00	-19.02	27.23	9.63	0.12	QP
9	2.033	21.93	46.00	-24.07	12.11	9.64	0.18	Average
10	2.033	27.71	56.00	-28.29	17.89	9.64	0.18	QP
11	10.564	21.61	50.00	-28.39	11.50	9.69	0.42	Average
12	10.564	26.73	60.00	-33.27	16.62	9.69	0.42	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

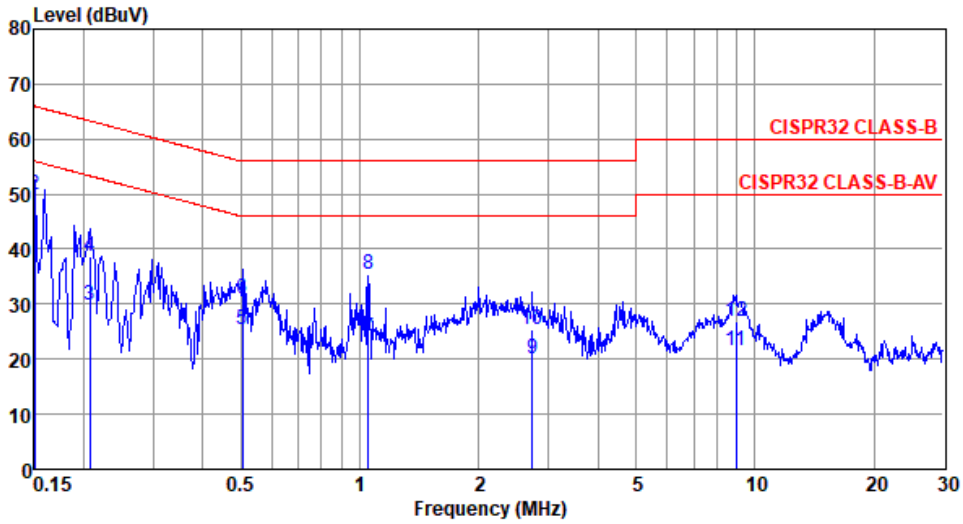
Power Phase	Neutral	Test Mode	5



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.195	33.39	53.80	-20.41	23.68	9.65	0.06	Average
2*	0.195	44.93	63.80	-18.87	35.22	9.65	0.06	QP
3	0.291	22.29	50.50	-28.21	12.57	9.65	0.07	Average
4	0.291	30.88	60.50	-29.62	21.16	9.65	0.07	QP
5	0.535	24.99	46.00	-21.01	15.25	9.65	0.09	Average
6	0.535	30.02	56.00	-25.98	20.28	9.65	0.09	QP
7	1.054	23.81	46.00	-22.19	14.04	9.65	0.12	Average
8	1.054	35.62	56.00	-20.38	25.85	9.65	0.12	QP
9	2.044	19.34	46.00	-26.66	9.50	9.66	0.18	Average
10	2.044	25.56	56.00	-30.44	15.72	9.66	0.18	QP
11	10.847	26.49	50.00	-23.51	16.32	9.74	0.43	Average
12	10.847	32.16	60.00	-27.84	21.99	9.74	0.43	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

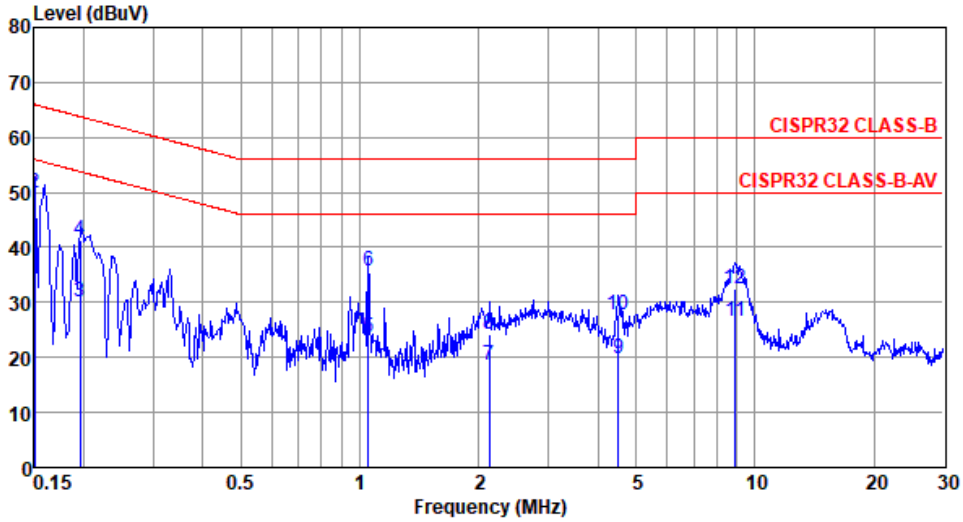
Power Phase	Line	Test Mode	6



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.150	37.19	56.00	-18.81	27.50	9.64	0.05	Average
2*	0.150	49.81	66.00	-16.19	40.12	9.64	0.05	QP
3	0.207	29.72	53.32	-23.60	20.03	9.63	0.06	Average
4	0.207	38.61	63.32	-24.71	28.92	9.63	0.06	QP
5	0.505	25.24	46.00	-20.76	15.52	9.63	0.09	Average
6	0.505	31.05	56.00	-24.95	21.33	9.63	0.09	QP
7	1.049	23.87	46.00	-22.13	14.12	9.63	0.12	Average
8	1.049	35.36	56.00	-20.64	25.61	9.63	0.12	QP
9	2.736	20.18	46.00	-25.82	10.31	9.64	0.23	Average
10	2.736	25.48	56.00	-30.52	15.61	9.64	0.23	QP
11	8.964	21.60	50.00	-28.40	11.53	9.69	0.38	Average
12	8.964	26.75	60.00	-33.25	16.68	9.69	0.38	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

Power Phase	Neutral	Test Mode	6



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.150	35.75	56.00	-20.25	26.04	9.66	0.05	Average
2*	0.150	50.02	66.00	-15.98	40.31	9.66	0.05	QP
3	0.195	30.14	53.80	-23.66	20.43	9.65	0.06	Average
4	0.195	41.38	63.80	-22.42	31.67	9.65	0.06	QP
5	1.049	23.71	46.00	-22.29	13.94	9.65	0.12	Average
6	1.049	35.69	56.00	-20.31	25.92	9.65	0.12	QP
7	2.121	18.73	46.00	-27.27	8.88	9.66	0.19	Average
8	2.121	24.08	56.00	-31.92	14.23	9.66	0.19	QP
9	4.501	19.71	46.00	-26.29	9.73	9.68	0.30	Average
10	4.501	27.75	56.00	-28.25	17.77	9.68	0.30	QP
11	8.916	26.57	50.00	-23.43	16.47	9.72	0.38	Average
12	8.916	32.42	60.00	-27.58	22.32	9.72	0.38	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

3.2 Radiated Emissions

3.2.1 Limit of Radiated Emissions

Frequency Range (MHz)	Class A		Class B	
	10m	3m	10m	3m
	Quasi-peak limits (dBμV/m)			
30 to 230	40	50	30	40
230 to 1000	47	57	37	47
Note 1: The lower limit shall apply at the transition frequency. Note 2: Additional provisions may be required for cases where interference occurs.				

Frequency range (GHz)	Class A (3 m)		Class B (3 m)	
	Average limit (dBμV/m)	Peak limit (dBμV/m)	Average limit (dBμV/m)	Peak limit (dBμV/m)
1 to 3	56	76	50	70
3 to 6	60	80	54	74
Note 1: The lower limit shall apply at the transition frequency. Note 2: Additional provisions may be required for cases where interference occurs.				

For an unintentional radiator is shown in the table below.

The highest internal source of an EUT is defined as the highest frequency generated or used within the EUT or on which the EUT operates or tunes.	Upper frequency of measurement range
Below 108 MHz	1 GHz
108 MHz to 500 MHz	2 GHz
500 MHz to 1 GHz	5 GHz
Above 1 GHz	5 times the highest frequency or 6 GHz, whichever is less.

3.2.2 Test Procedures

a. The EUT was placed on a rotatable table top with a height of 0.8 meters which is placed on the ground plane.

b. A thickness of ≤ 0.15m insulation should be placed between local AE and associated cabling and the RGP.

c. The EUT received DC power source from the outlet socket under the turntable. All support equipment power received from another socket under the turntable.

d. The EUT and local AE shall be arranged in the most compact practical arrangement within the test volume. The central point of the arrangement shall be positioned at the centre of the turntable. The measurement distance is the shortest horizontal distance between an imaginary circular periphery just encompassing this arrangement and calibration point of the antenna.

e. The table was rotated 360 degrees to determine the position of the highest radiation.

f. The antenna is a half wave dipole and its height is varied between one meter and four meters above ground to find the maximum value of the field strength both horizontal polarization and vertical polarization of the antenna are set to make the measurement.

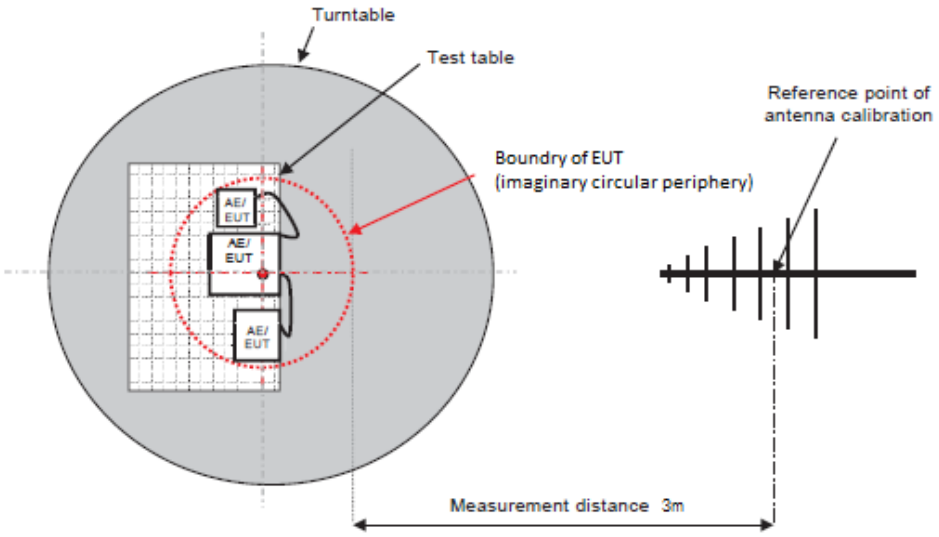
g. For each suspected emission the EUT was arranged to its worst case and then tune the antenna tower (from 1 to 4 meters) and turn table (from 0 to 360 degrees) to find the maximum reading.

h. Set the test-receiver system to Peak Detect Function and specified bandwidth with Maximum Hold Mode.

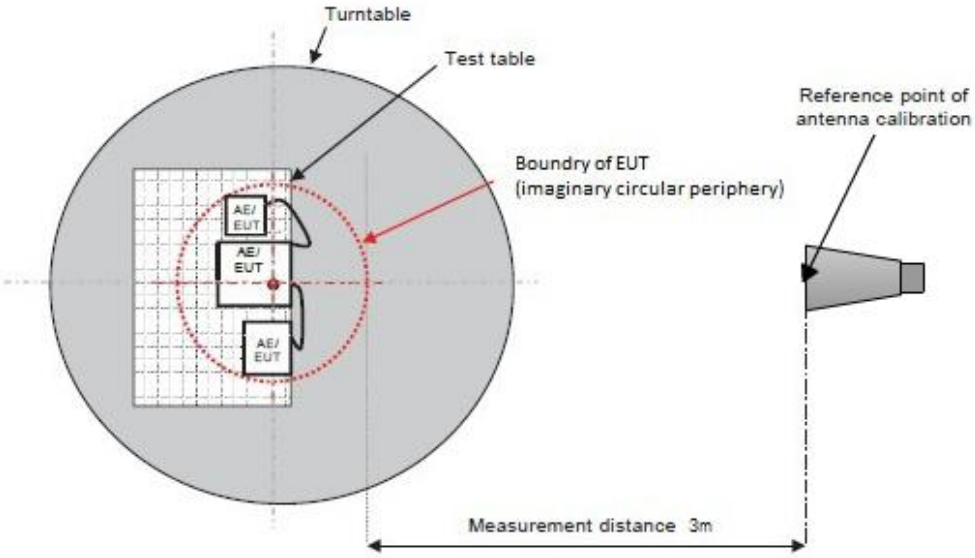
i. If the emission level of the EUT in peak mode was 2 dB lower than the limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 2 dB margin will be repeated one by one using the quasi-peak method and reported.

3.2.3 Test Setup

Radiated Emissions below 1GHz

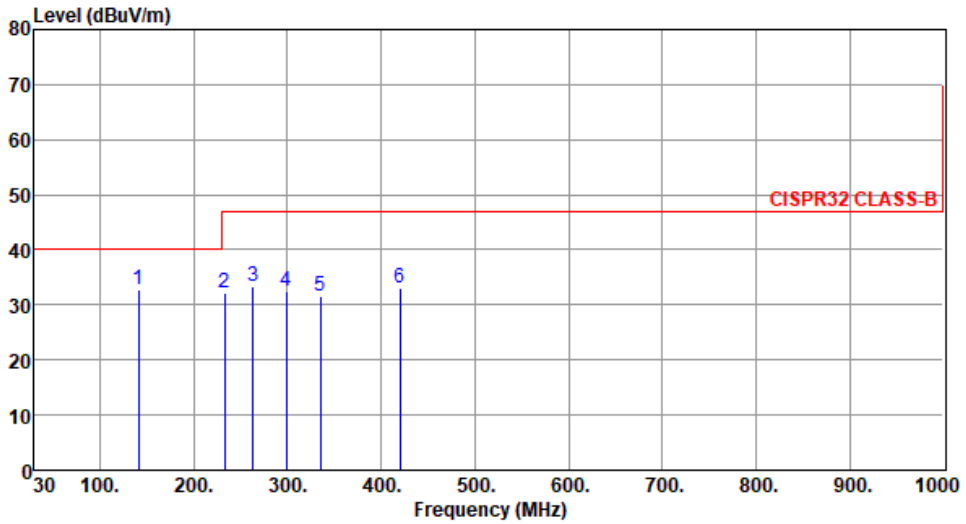


Radiated Emissions above 1GHz



3.2.4 Radiated Emissions (Below 1GHz)

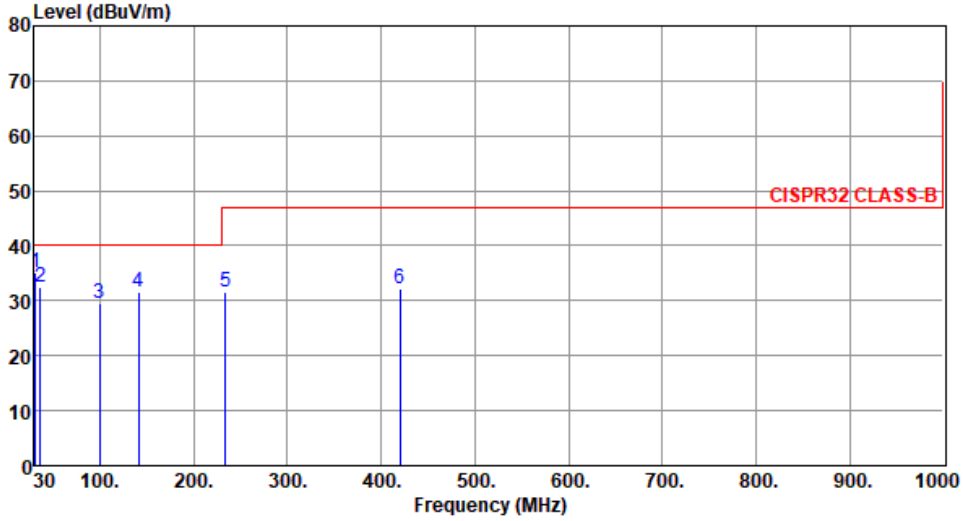
Polarization	Horizontal	Test Mode	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	141.55	32.62	40.00	-7.38	40.87	-8.25	Peak	---	---
2	232.73	32.12	47.00	-14.88	41.09	-8.97	Peak	---	---
3	263.00	33.33	47.00	-13.67	41.73	-8.40	Peak	---	---
4	298.69	32.36	47.00	-14.64	39.78	-7.42	Peak	---	---
5	335.55	31.67	47.00	-15.33	37.95	-6.28	Peak	---	---
6	419.94	32.94	47.00	-14.06	37.01	-4.07	Peak	---	---

Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB).
2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Polarization	Vertical	Test Mode	1

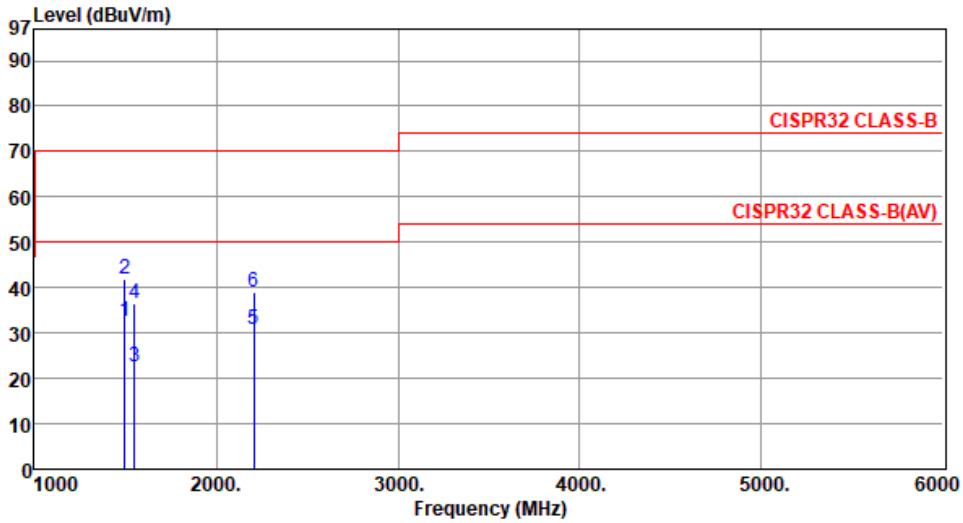


	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	30.97	35.18	40.00	-4.82	44.17	-8.99	Peak	---	---
2	36.79	32.40	40.00	-7.60	41.12	-8.72	Peak	---	---
3	99.84	29.43	40.00	-10.57	42.66	-13.23	Peak	---	---
4	141.55	31.46	40.00	-8.54	39.71	-8.25	Peak	---	---
5	233.70	31.45	47.00	-15.55	40.35	-8.90	Peak	---	---
6	419.94	32.03	47.00	-14.97	36.10	-4.07	Peak	---	---

Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB).
2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

3.2.5 Radiated Emissions (Above 1GHz)

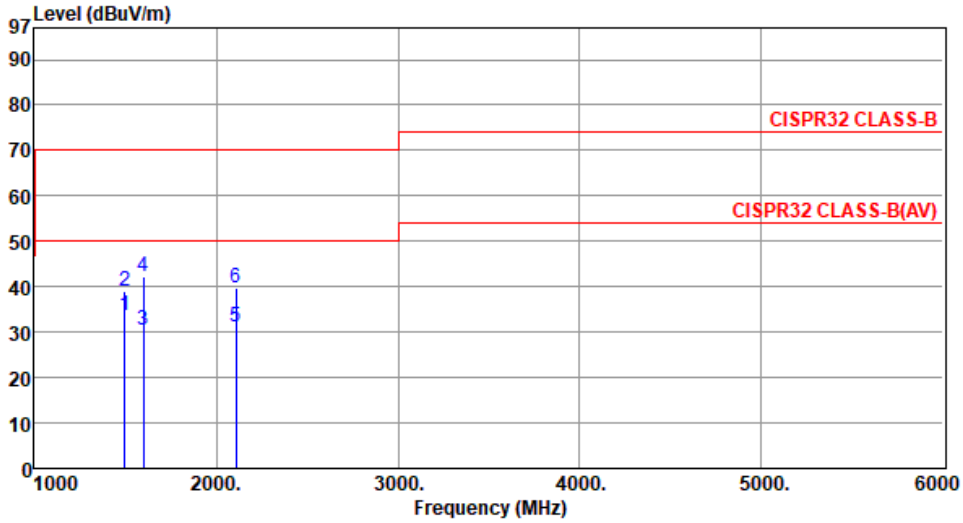
Polarization	Horizontal	Test Mode	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1499.00	32.51	50.00	-17.49	40.01	-7.50	Average	100	168
2	1499.00	41.77	70.00	-28.23	49.27	-7.50	Peak	100	168
3	1549.00	22.66	50.00	-27.34	30.32	-7.66	Average	100	262
4	1549.00	36.42	70.00	-33.58	44.08	-7.66	Peak	100	262
5	2206.00	30.95	50.00	-19.05	35.11	-4.16	Average	100	102
6	2206.00	39.09	70.00	-30.91	43.25	-4.16	Peak	100	102

Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB).
2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Polarization	Vertical	Test Mode	1



	Freq. MHz	Emission level dBuV/m	Limit dBuV/m	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg
1	1499.00	33.60	50.00	-16.40	41.10	-7.50	Average	100	120
2	1499.00	38.95	70.00	-31.05	46.45	-7.50	Peak	100	120
3	1598.00	30.39	50.00	-19.61	38.10	-7.71	Average	100	180
4	1598.00	42.24	70.00	-27.76	49.95	-7.71	Peak	100	180
5	2108.00	30.98	50.00	-19.02	36.17	-5.19	Average	100	223
6	2108.00	39.60	70.00	-30.40	44.79	-5.19	Peak	100	223

Note 1: Emission level (dBuV/m) = SA reading (dBuV) + Factor (dB).
2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

4 Immunity Tests

4.1 General Description

Product Standard: EN 301 489-1, EN 301 489-3, EN 301 489-17		
Basic Standard	**Spec. Requirement**	**Performance Criteria**
EN 61000-4-2 (ESD)	Contact Discharge: ± 4 kV Air Discharge: ± 8 kV	B
EN 61000-4-3 (RS)	80 MHz to 6000 MHz 3 V/m, 1 kHz Sine Wave 80%, AM Modulation	A

4.2 Performance Criteria Description

EN 301 489-3		
Criteria	**During test**	**After test**
A	Operate as intended No loss of function No unintentional responses	Operate as intended No loss of function No degradation of performance No loss of stored data or user programmable functions
B	May show loss of function No unintentional responses	Operate as intended Lost function(s) shall be self-recoverable No degradation of performance No loss of stored data or user programmable functions

4.3 Performance Criteria Description

EN 301 489-17		
Criteria	**During test**	**After test (i.e. as a result of the application of the test)**
A	Shall operate as intended. (see note). Shall be no loss of function. Shall be no unintentional transmissions.	Shall operate as intended. Shall be no degradation of performance Shall be no loss of function. Shall be no loss of critical stored data.
B	May be loss of function.	Functions shall be self-recoverable. Shall operate as intended after recovering. Shall be no loss of critical stored data.
C	May be loss of function.	Functions shall be recoverable by the operator. Shall operate as intended after recovering. Shall be no loss of critical stored data.
Note: Operate as intended during the test allows a level of degradation in accordance with clause 6.2.2. ***Clause 6.2.2 Minimum performance level*** *For equipment that supports a PER or FER, the minimum performance level shall be a PER or FER less than or equal to 10%.* *For equipment that does not support a PER or FER, the minimum performance level shall be no loss of wireless transmission function needed for the intended use of the equipment.*		

EN 301 489-17 Performance Criteria	
CT	The performance criteria A shall apply. Tests shall be repeated with the EUT in standby mode (if applicable) to ensure that unintentional transmission does not occur. In systems using acknowledgement signals, it is recognized that an ACKnowledgement (ACK) or Not ACKnowledgement (NACK) transmission may occur, and steps should be taken to ensure that any transmission resulting from the application of the test is correctly interpreted.
TT	The performance criteria B shall apply, except for voltage dips of 100 ms and voltage interruptions of 5 000 ms duration, for which performance criteria C shall apply. Tests shall be repeated with the EUT in standby mode (if applicable) to ensure that unintentional transmission does not occur. In systems using acknowledgement signals, it is recognized that an acknowledgement (ACK) or not-acknowledgement (NACK) transmission may occur, and steps should be taken to ensure that any transmission resulting from the application of the test is correctly interpreted.
CR	The performance criteria A shall apply. Where the EUT is a transceiver, under no circumstances, shall the transmitter operate unintentionally during the test. In systems using acknowledgement signals, it is recognized that an ACK or NACK transmission may occur, and steps should be taken to ensure that any transmission resulting from the application of the test is correctly interpreted.
TR	The performance criteria B shall apply, except for voltage dips of 100 ms and voltage interruptions of 5 000 ms duration for which performance criteria C shall apply. Where the EUT is a transceiver, under no circumstances, shall the transmitter operate unintentionally during the test. In systems using acknowledgement signals, it is recognized that an ACK or NACK transmission may occur, and steps should be taken to ensure that any transmission resulting from the application of the test is correctly interpreted.

4.4 Special Conditions for EMC Measurements

4.4.1 Special Conditions for Emission Measurements

EN 301 489-3

The provisions of EN 301 489-1, clause 7.1 shall apply.

EN 301 489-17

No special conditions.

4.4.2 Special Conditions for Immunity Measurements

EN 301 489-3

Reference to clauses in EN 301 489-1	Special product-related conditions, additional to or modifying the test conditions in EN 301 489-1, clause 9
9.2.2: Test method; Radio frequency electromagnetic field	The test shall be performed over the range 80 MHz to 2 700 MHz with the exception of the exclusion bands defined in clause 4.6. Where the EUT is subject to EMC Immunity testing under a Harmonised Standard of a Directive other than the Directive 2014/53/EU [i.3] then the modulating signal frequency specified in that Harmonised Standard may be used. If this alternative modulating frequency is used, then the applicable Directive, Harmonised Standard & modulating frequency shall be noted in the test report.
9.5.2: Test method; Radio frequency, common mode	Where the EUT is subject to EMC Immunity testing under a Harmonised Standard of a Directive other than the Directive 2014/53/EU [i.3] then the modulating signal frequency specified in that Harmonised Standard may be used. If this alternative modulating frequency is used, then the applicable Directive, Harmonised Standard & modulating frequency shall be noted in the test report.

EN 301 489-17

No special conditions.

4.5 Electrostatic Discharge (ESD)

4.5.1 Test Specification of Electrostatic Discharge (ESD)

Basic Standard	EN 61000-4-2
Discharge Voltage	Contact Discharge: ± 2 kV / ± 4 kV Air Discharge: ± 2 kV / ± 4 kV / ± 8 kV
Discharge Impedance	330 ohm / 150 pF
Number of Discharge	Air Discharge: minimum 20 times at each test point Contact Discharge: minimum 20 times at each test point
Discharge Mode	Single Discharge
Discharge Period	1 second minimum

4.5.2 Test Procedures

a. In the case of air discharge testing the climatic conditions shall be within the following ranges:
- ambient temperature: 15°C to 35°C;
- relative humidity : 30% to 60%;
- atmospheric pressure : 86 kPa (860 mbar) to 106 kPa (1060 mbar).

b. Test programs and software shall be chosen so as to exercise all normal modes of operation of the EUT. The use of special exercising software is encouraged, but permitted only where it can be shown that the EUT is being comprehensively exercised.

c. The test voltage shall be increased from the minimum to the selected test severity level, in order to determine any threshold of failure. The final severity level should not exceed the product specification value in order to avoid damage to the equipment.

d. The test shall be performed with both air discharge and contact discharge. On preselected points at least 10 single discharges (in the most sensitive polarity) shall be applied on air discharge. On preselected points at least 10 single discharges (in the most sensitive polarity) shall be applied on contact discharge.

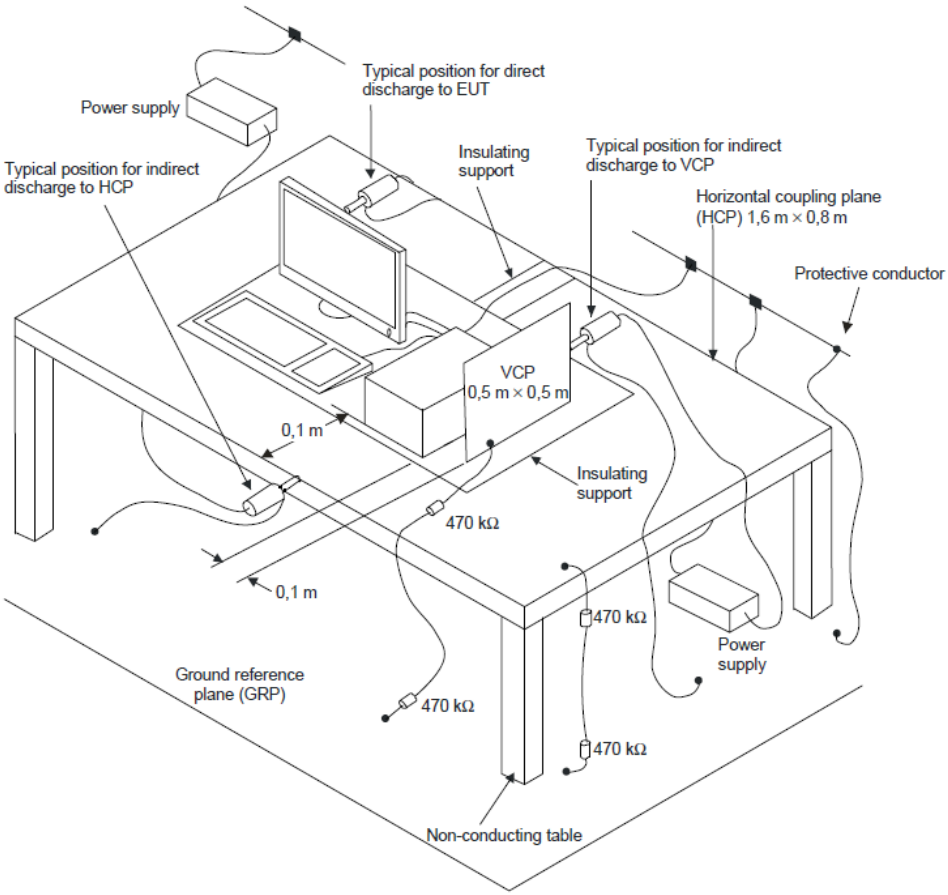
e. For the time interval between successive single discharges an initial value of one second is recommended. Longer intervals may be determined whether a system failure has occurred.

f. In the case of contact discharges, the tip of the discharge electrode shall touch the EUT before the discharge switch is operated.

g. In the case of painted surface covering a conducting substrate, the following procedure shall be adopted:
- If the coating is not declared to be an insulating coating by the equipment manufacturer, then the pointed tip of the generator shall penetrate the coating so as to make contact with the conducting substrate.
- Coating declared as insulating by the manufacturer shall only be submitted to the air discharge.
- The contact discharge test shall not be applied to such surfaces.

h. In the case of air discharges, the round discharge tip of the discharge electrode shall be approached as fast as possible (without causing mechanical damage) to touch the EUT. After each discharge, the ESD generator (discharge electrode) shall be removed from the EUT. The generator is then retriggered for a new single discharge. This procedure shall be repeated until the discharges are completed. In the case of an air discharge test, the discharge switch, which is used for contact discharge, shall be closed.

4.5.3 Test Setup



The test setup shall consist of a non-conductive table, (0.8 ± 0.08) m high, standing on the ground reference plane.

A horizontal coupling plane (HCP), (1.6 ± 0.02) m × (0.8 ± 0.02) m, shall be placed on the table. The EUT and its cables shall be isolated from the coupling plane by an insulating support (0.5 ± 0.05) mm in thickness.

4.5.4 Test Result of Electrostatic Discharge (ESD)

Test Mode	1, 2, 4, 5, 6				
Indirect Application					
Test Voltage (kV)	**Polarity**	**Test Point**	**Horizontal Coupling Plane (HCP)**	**Vertical Coupling Plane (VCP)**	**Performance Criteria**
2, 4	+/-	At front, rear, left and right side	Note	Note	A

Note: There was no abnormal situation during the test compared with initial operation.

Test Mode	3				
Direct Application					
Test Voltage (kV)	**Polarity**	**Test Point**	**Contact Discharge**	**Air Discharge**	**Performance Criteria**
2, 4	+/-	1	N/A	Note 1	A
8	+/-	1	N/A	Note 2	B
Indirect Application					
Test Voltage (kV)	**Polarity**	**Test Point**	**Horizontal Coupling Plane (HCP)**	**Vertical Coupling Plane (VCP)**	**Performance Criteria**
2, 4	+/-	At front, rear, left and right side	Note 1	Note 1	A

Note:
1) There was no abnormal situation during the test compared with initial operation.
2) Data loss is occurred in BT transmitting during the test. After the test, the equipment continued to operate as intended without operator intervention.

4.5.5 Test Point Photo

Mode 3

4.6 Radio Frequency Electromagnetic Field (RS)

4.6.1 Test Specification of Radio Frequency Electromagnetic Field (RS)

Basic Standard	EN 61000-4-3
Frequency Range	80 MHz ~ 6000 MHz
Field Strength	3 V/m
Modulation	1 kHz Sine Wave, 80%, AM Modulation
Frequency Step	1 % of preceding frequency value
Polarity of Antenna	Horizontal and Vertical
Antenna Height	1.5 m
Antenna Distance	80 MHz ~ 1000 MHz: 3 m 1000 MHz ~ 6000 MHz: 1 m
Dwell Time	3 seconds

4.6.2 Test Procedures

a. The test level shall be 3 V/m (measured unmodulated). The test signal shall be amplitude modulated to a depth of 80 % by a sinusoidal audio signal of 1000 Hz. If the wanted signal is modulated at 1000 Hz, then an audio signal of 400 Hz shall be used.

b. The test shall be performed over the frequency range 80 MHz to 6000 MHz with the exception of the exclusion band for transmitters, receivers and duplex transceivers, as appropriate.

c. For receivers and transmitters the stepped frequency increments shall be 1 % frequency increment of the momentary used frequency, unless specified otherwise in the part of EN 301 489 series [i.13] dealing with the relevant type of radio equipment.

d. Further product related spot frequency tests may be specified in the relevant part of EN 301 489 series [i.13] dealing with the particular type of radio equipment.

e. Responses on receivers occurring at discrete frequencies, which are narrow band responses, shall be disregarded from the test.

f. The frequencies selected and used during the test shall be recorded in the test report.

g. When testing at frequencies above 1 GHz, the test distance shall be 1 m when using the independent windows method. Compliance with the field uniformity requirement shall be verified for the selected test distance.

h. The alternative method for frequencies above 1 GHz divides the calibration area into a suitable array of 0,5 m × 0,5 m windows such that the whole area to be occupied by the face of the EUT is covered. The field uniformity shall be independently calibrated over each window.

i. During the test, at each frequency the forward power shall be applied to the field-generating antenna. The test shall be repeated with the field-generating antenna repositioned to illuminate each of the required windows in turn.

4.6.3 Exclusion bands

EN 301 489-3

- Transmitters

The exclusion band shall be those frequencies specified in the relevant radio standard as the operating frequency band and the Out of Band domain.

Where this is not so specified the exclusions bands shall be as below:

For transmitters operating, or intended to operate, in a channelized frequency band, the exclusion band is five times (i.e. ±250 %) the maximum operating channel width (OCW) allowed for that service, centred around the operating frequency.

For wide band transmitters, i.e. transmitters in a non-channelized frequency band, the exclusion band is twice the intended operating frequency band centred around the centre frequency of the intended operating frequency band.

The exclusion band shall only apply when the EUT is in transmit mode of operation.

- Receivers

The exclusion band is based on an extension value.

The lower limit of the exclusion band is the lower edge of the Operating Channel (OC) minus the extension value, or zero, whichever is the greater.

The upper limit is the upper edge of the OC plus the extension value.

The extension value is given in below table. The OC is defined in the relevant radio standard.

Receiver operating frequency fo	Extension value
< 300 kHz	300 kHz
300 kHz to < 30 MHz	3 MHz
30 MHz to < 1 GHz	15 MHz, or 5 % × fo, whichever is greater
1 GHz to < 6 GHz	100 MHz
≥ 6 GHz	5 % × fo

NOTE: The receiver exclusion band frequency range aligns as far as possible with the blocking test frequency range defined in ETSI EN 300 220-1.

- Duplex and multi-mode equipment

In the case of EUT tested with a simultaneous transmit and receive mode, the exclusion band used shall be the combination of the exclusion band for the transmitter and the exclusion band for the receiver. I.e. both exclusion bands shall be applied.

In the case of transmitters capable of operating on more than one frequency band, testing shall be carried out on each band separately.

In the case of receivers operating on more than one frequency, the exclusion band used shall be the combination of the exclusion bands for each frequency, i.e. an exclusion band for each frequency shall be applied.

NOTE: Where the frequencies are in the same operational frequency band, the result will usually be an enlarged single exclusion band. Where the frequencies are widely spaced, e.g. in different bands, the result will be to create multiple separate exclusion bands.

EN 301 489-17

The frequencies on which the transmitter part of the EUT is intended to operate shall be excluded from radiated emission measurements when performed in transmit mode of operation.

There shall be no frequency exclusion band applied to emission measurements of the receiver part of transceivers or the stand alone receiver under test, and/or associated ancillary equipment.

The exclusion band for immunity testing of equipment operating in the 2,4 GHz band shall be:

- lower limit of exclusion band = lowest allocated band edge frequency -120 MHz, i.e. 2 280 MHz;
- upper limit of exclusion band = highest allocated band edge frequency +120 MHz, i.e. 2 603,5MHz.

The exclusion band for immunity testing of equipment operating in the 5 GHz Wi-Fi band shall be:

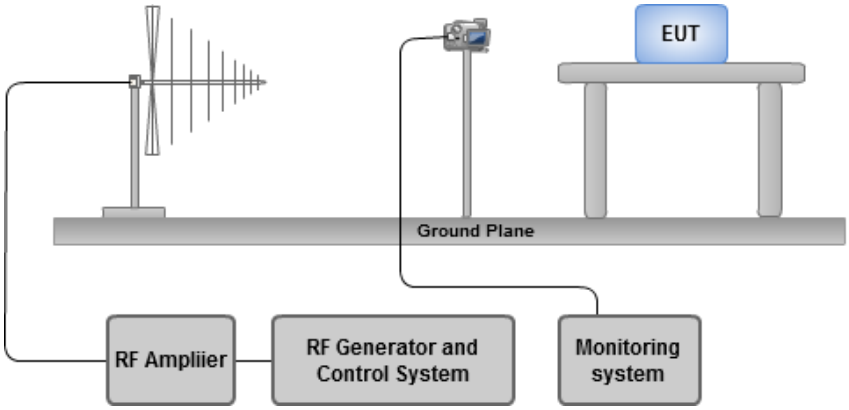
- lower limit of exclusion band = lowest allocated band edge frequency -270 MHz, i.e. 4 880 MHz;
- upper limit of exclusion band = highest allocated band edge frequency +270 MHz, i.e. 5 995 MHz.

The exclusion band for immunity testing of equipment operating in the 5,8 GHz band shall be:

- lower limit of exclusion band = lowest allocated band edge frequency -270 MHz, i.e. 5 455 MHz;
- as the immunity requirements have an upper frequency range of 6 GHz and any upper edge exclusion band would be greater than this for the 5,8 GHz band. The above frequency shall also be regarded as the upper end of the test range.

NOTE: These receiver exclusion band ranges align with the relevant blocking test ranges.

4.6.4 Test Setup



Note: The procedure defined in this part requires the generation of electromagnetic fields within which the test sample is placed and its operation observed. To generate fields that are useful for simulation of actual (field) conditions may require significant antenna drive power and the resultant high field strength levels. To comply with local regulations and to prevent biological hazards to the testing personnel, it is recommended that these tests be carried out in a shielded enclosure or semi-anechoic chamber.

4.6.5 Test Result of Radio Frequency Electromagnetic Field (RS)

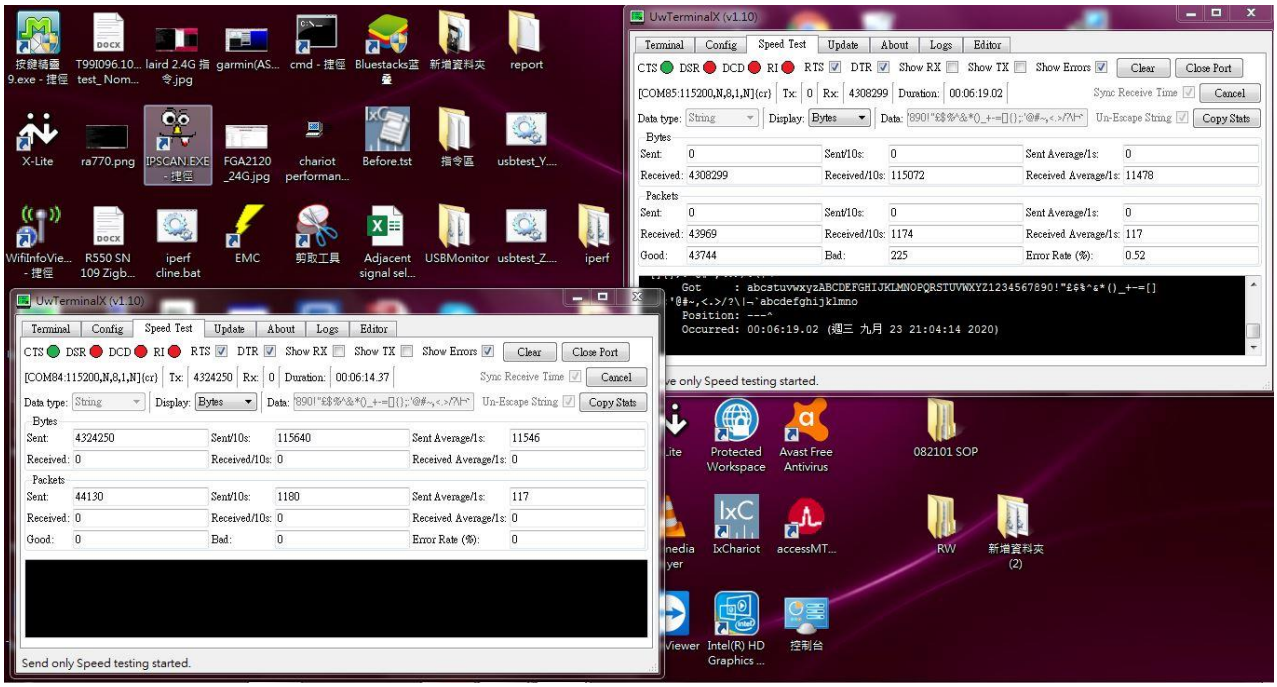
Test Mode	1, 2, 3, 4, 6				
Frequency Range (MHz)	Azimuth	Polarity	Test Field Strength (V/m)	Observation	Performance Criteria
80 - 6000	0	V&H	3	Note 1, 2	A
80 - 6000	90	V&H	3	Note 1, 2	A
80 - 6000	180	V&H	3	Note 1, 2	A
80 - 6000	270	V&H	3	Note 1, 2	A

Note:
1) There was no abnormal situation during the test compared with initial operation.
2) The PER shall be less than or equal to 10%.

Test Mode	5				
Frequency Range (MHz)	Azimuth	Polarity	Test Field Strength (V/m)	Observation	Performance Criteria
80 - 6000	0, 90, 180, 270	V&H	3	Note	A

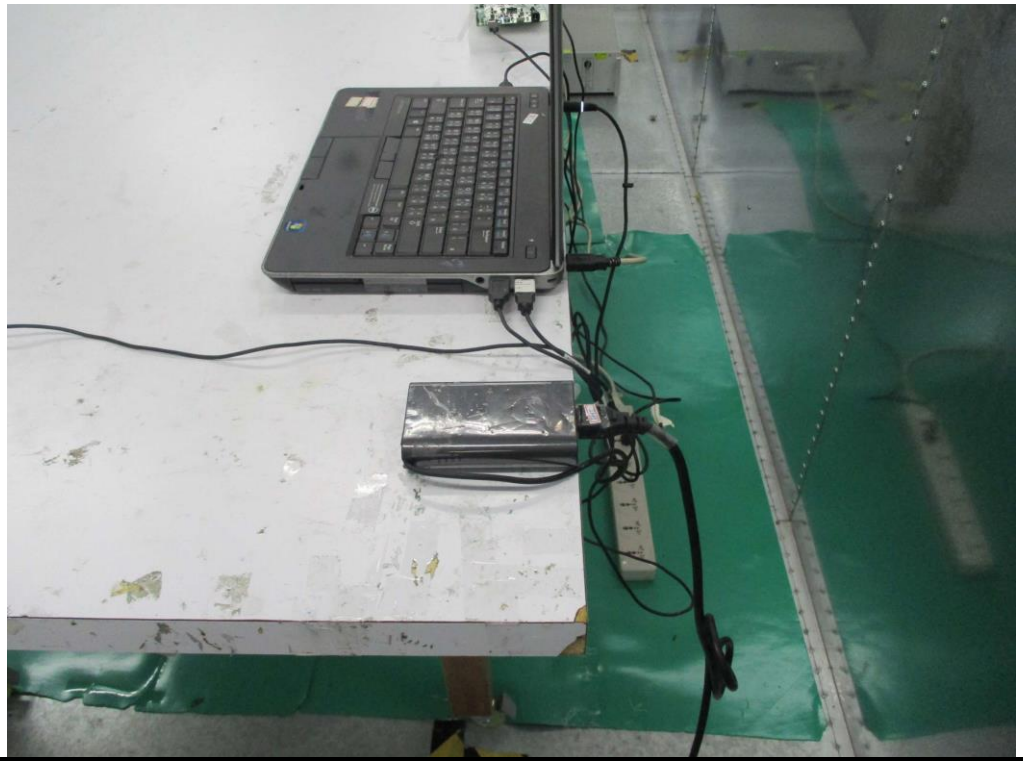
Note: There was no abnormal situation during the test compared with initial operation.

Test Mode	BT PER mode



5 Photographs of the Test Configuration

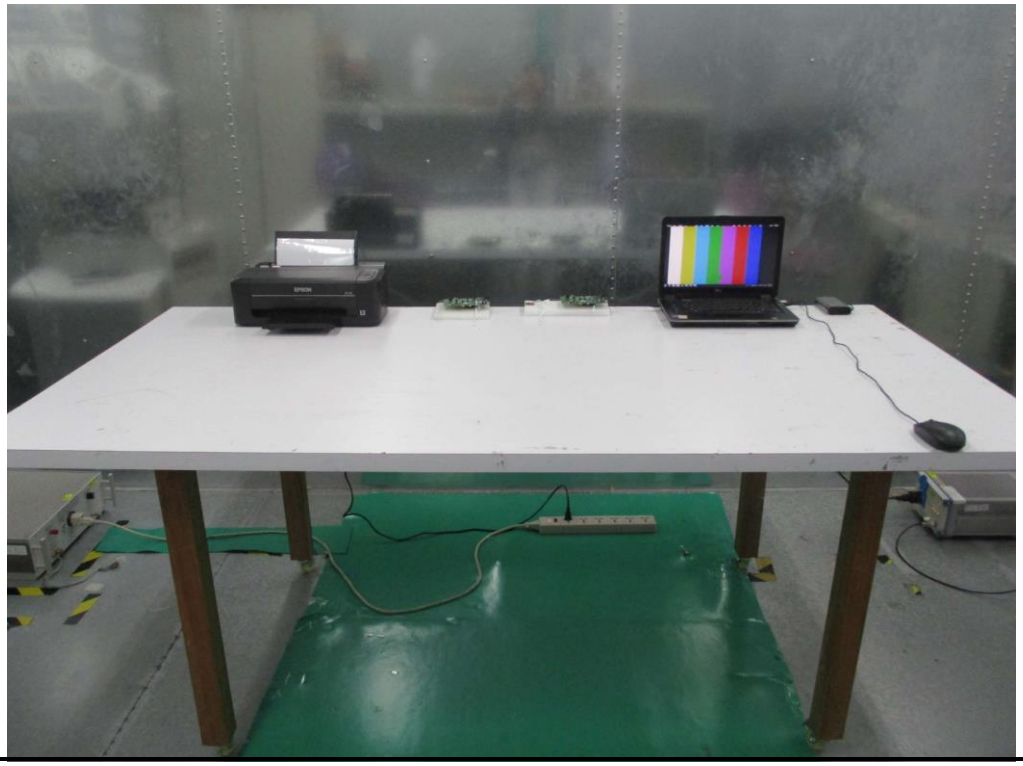
Conducted Emissions from the AC mains power ports (Mode 1)



Conducted Emissions from the AC mains power ports (Mode 2)

Conducted Emissions from the AC mains power ports (Mode 3)

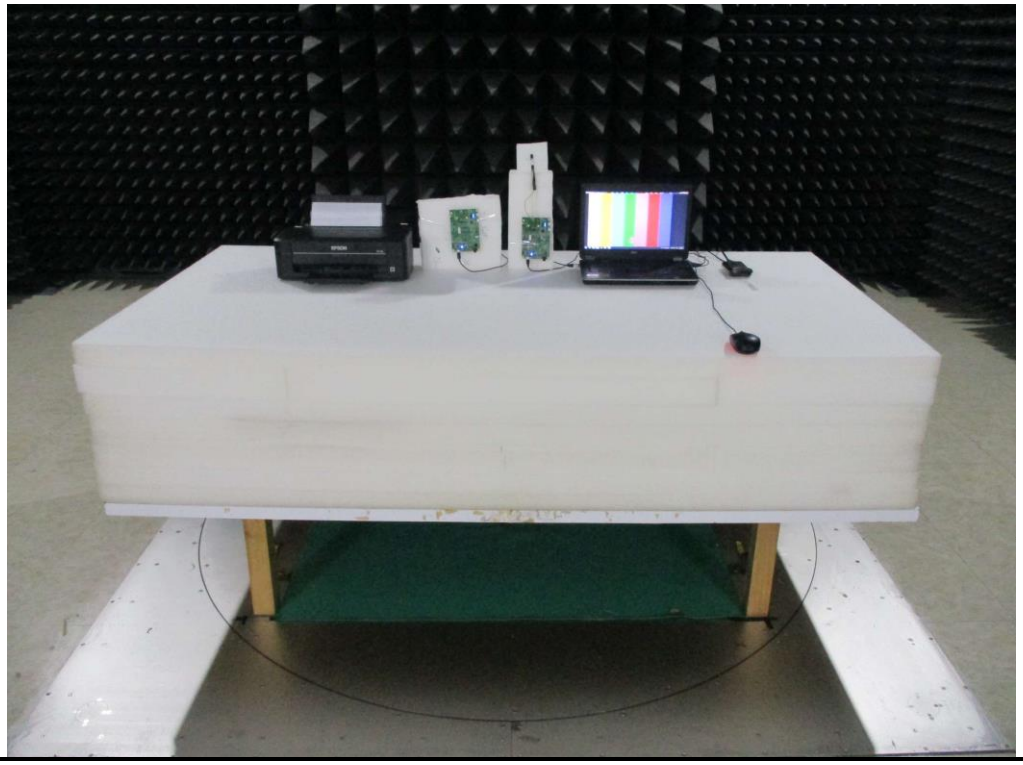
Conducted Emissions from the AC mains power ports (Mode 4)

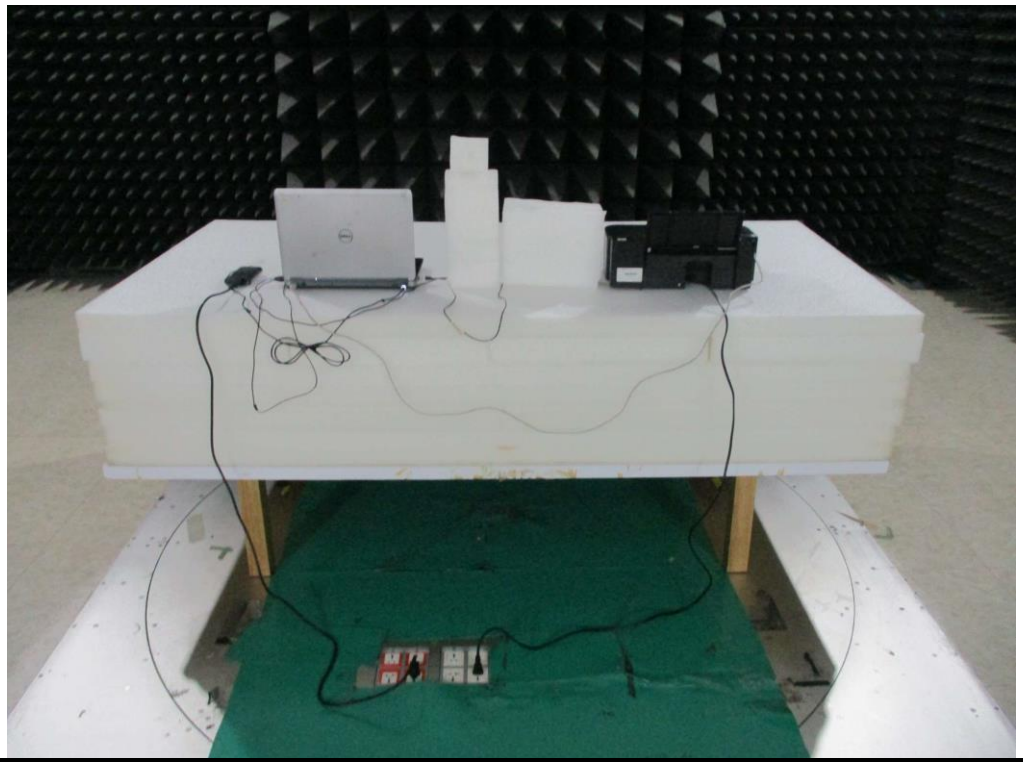


Conducted Emissions from the AC mains power ports (Mode 5)

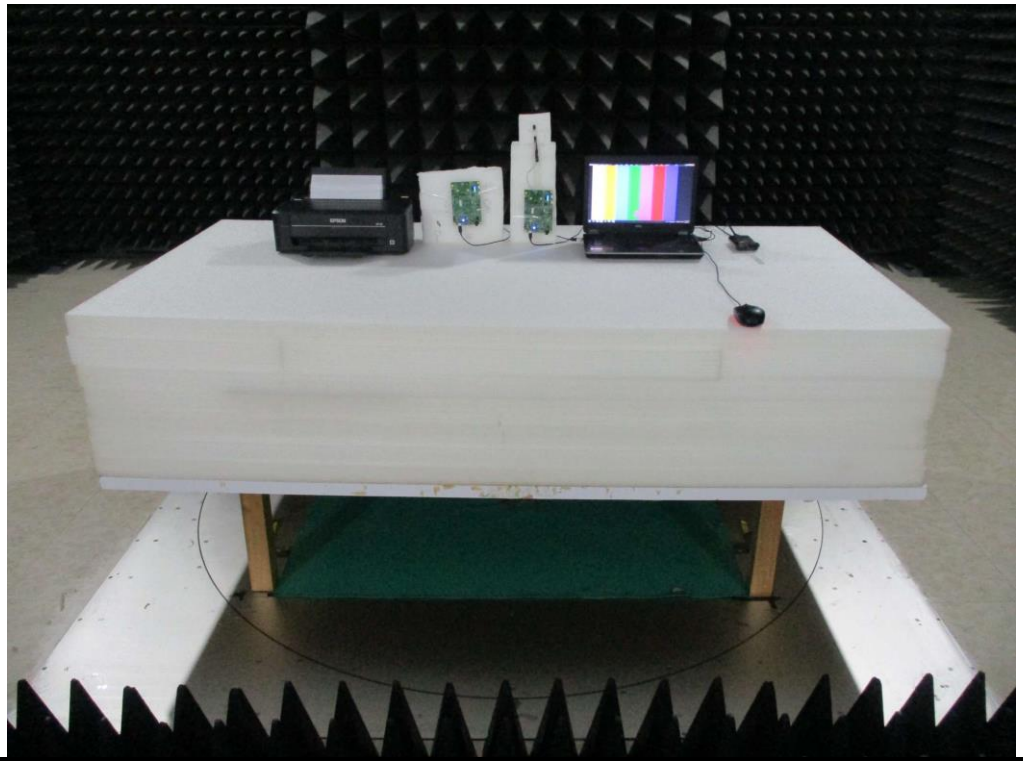
Conducted Emissions from the AC mains power ports (Mode 6)

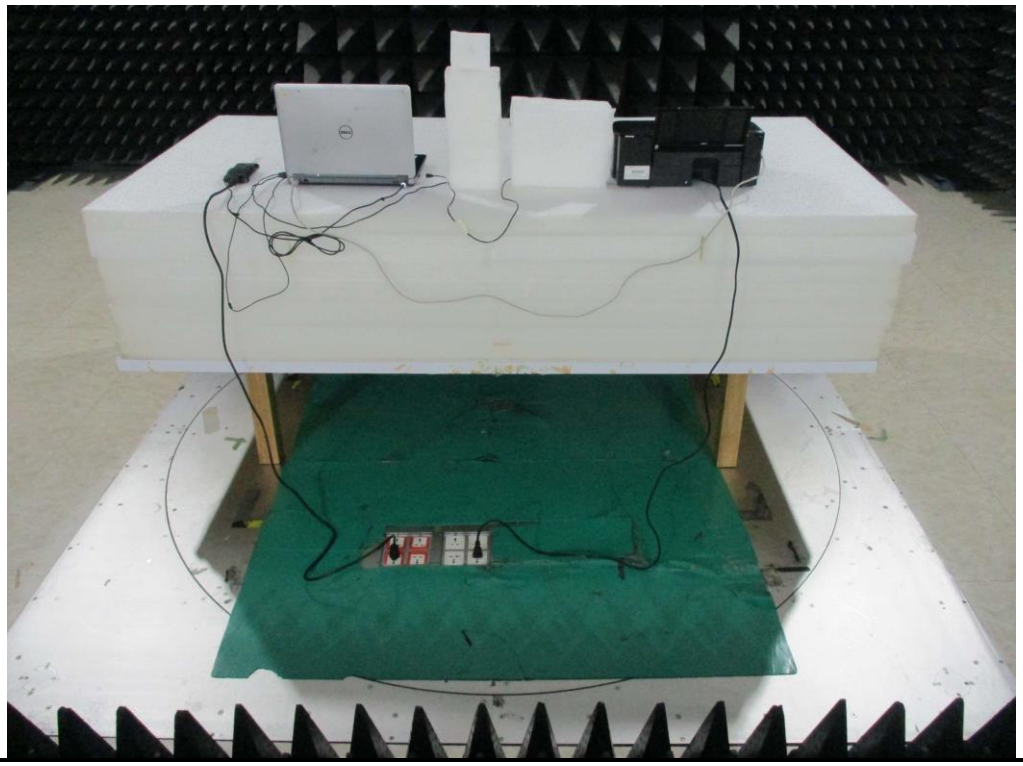
Radiated Emissions below 1GHz test



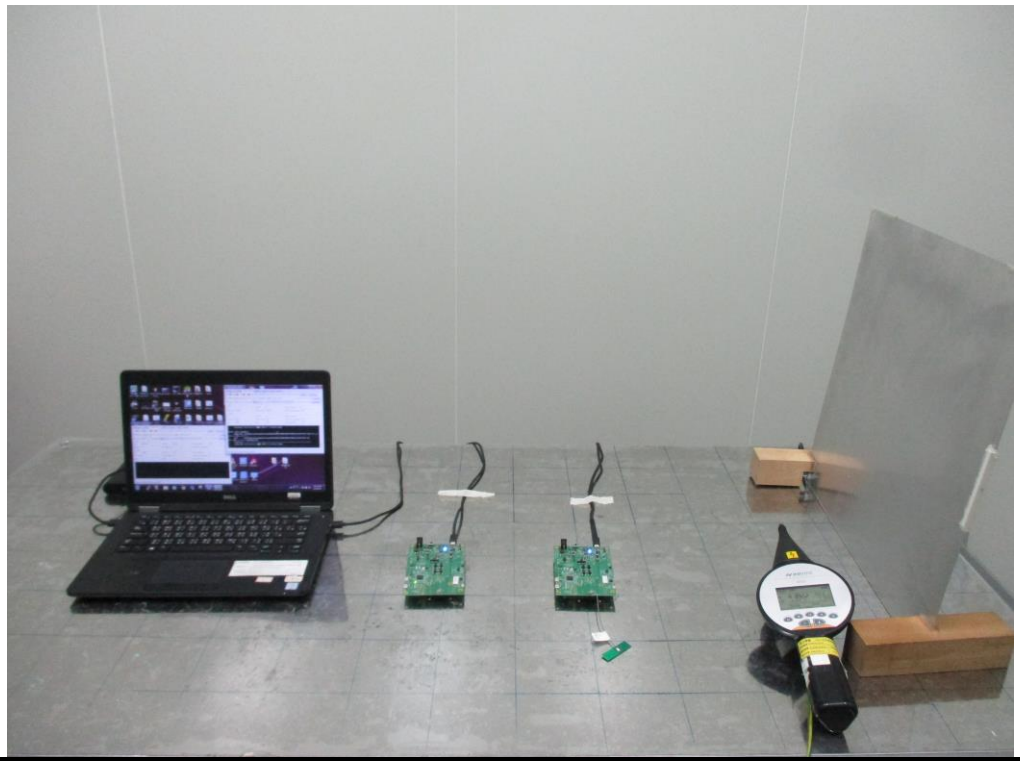


Radiated Emissions above 1GHz test

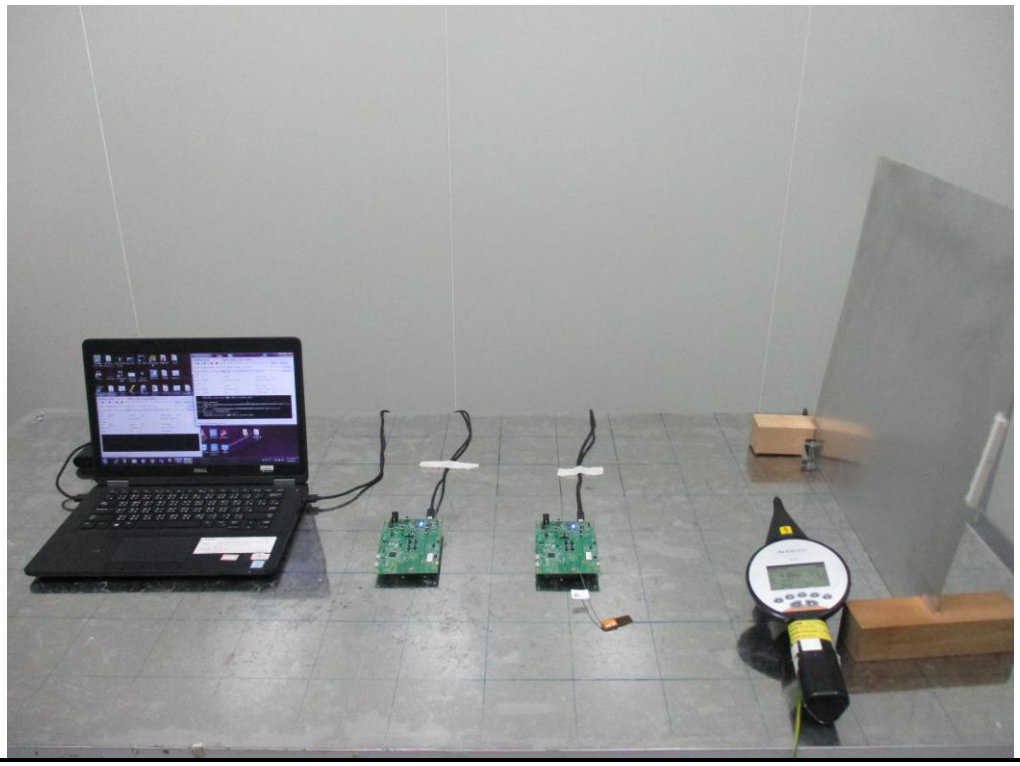




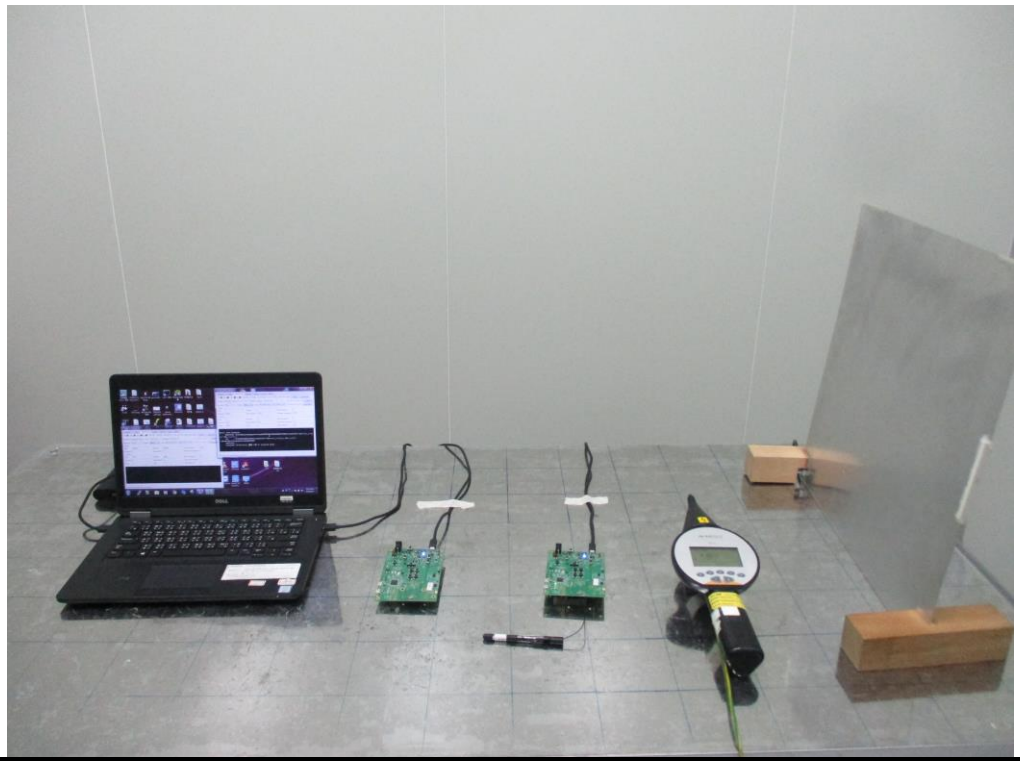
ESD Test (Mode 1, 6)



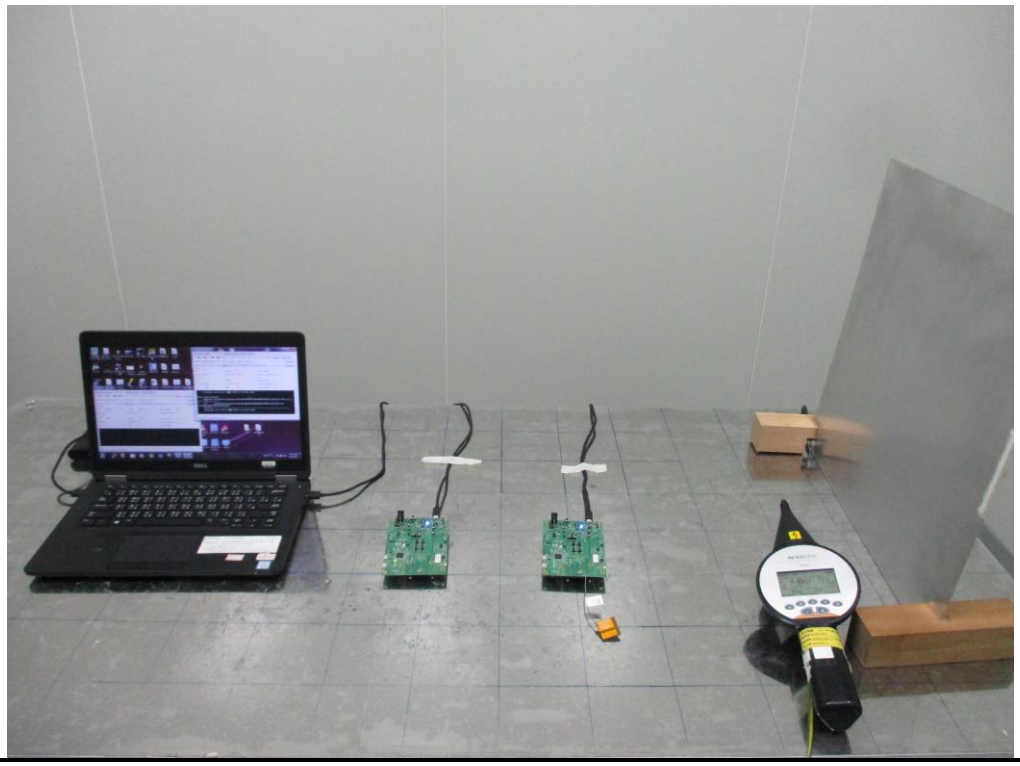
ESD Test (Mode 2)



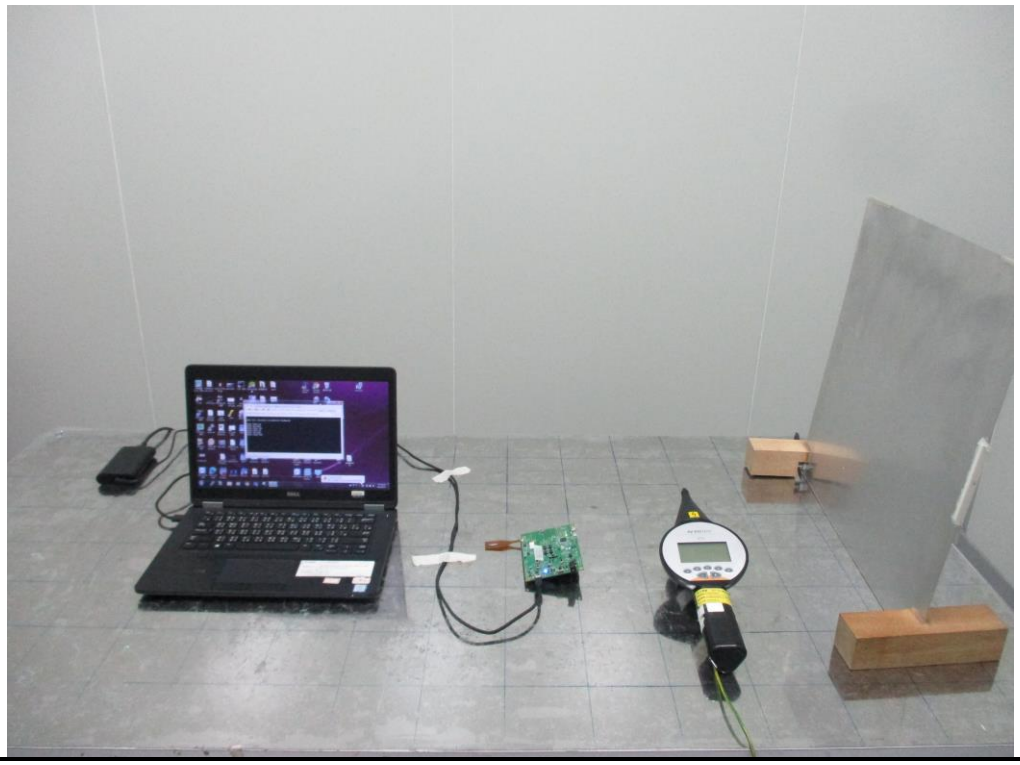
ESD Test (Mode 3)



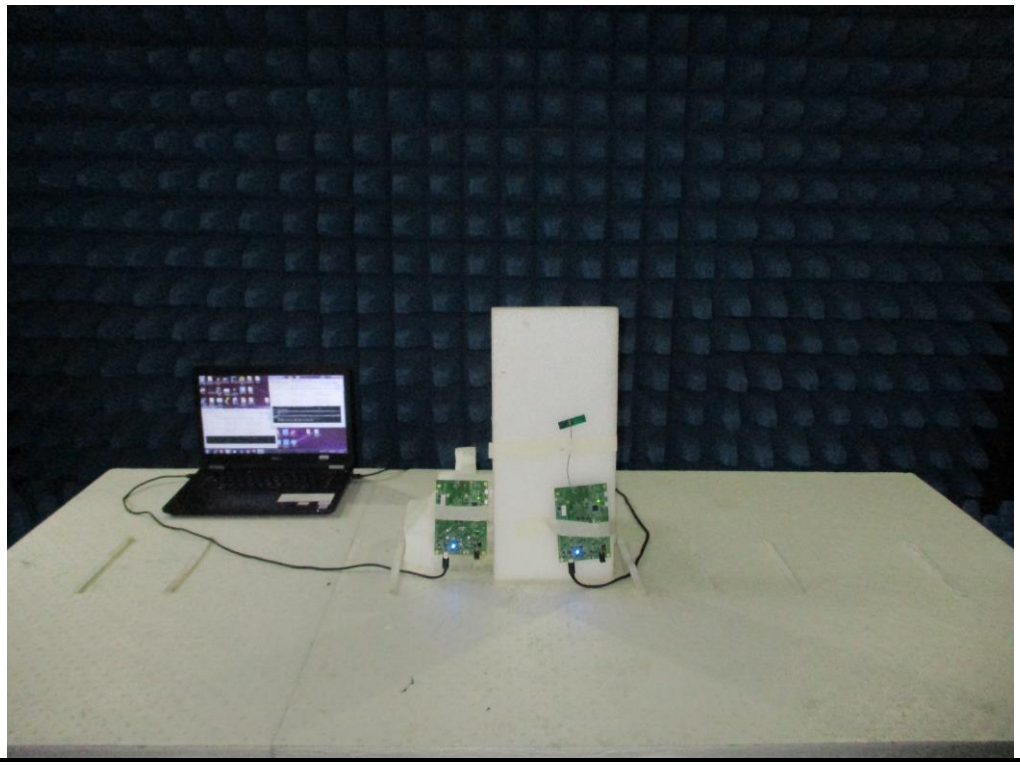
ESD Test (Mode 4)



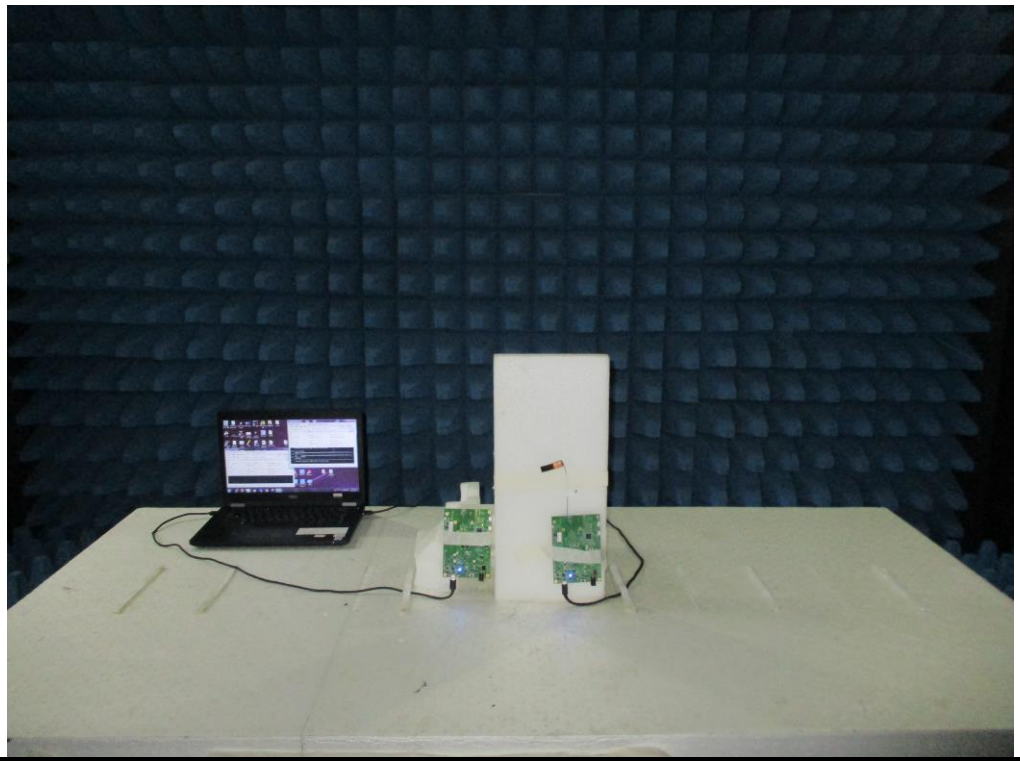
ESD Test (Mode 5)



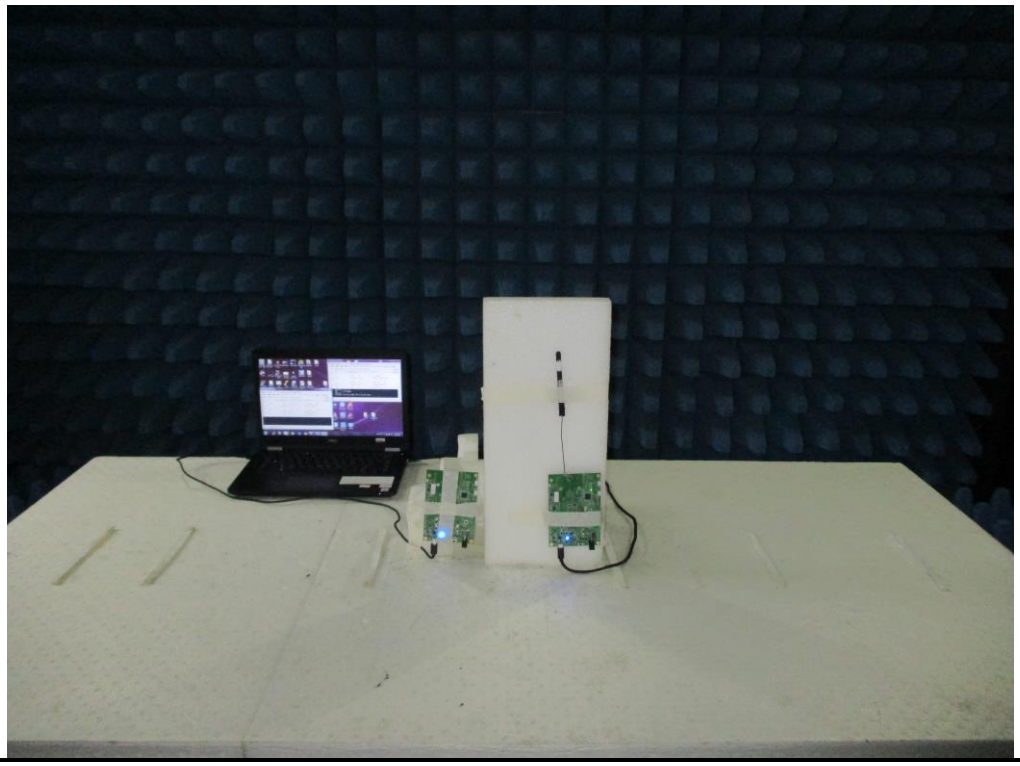
RS Test (Mode 1, 6)



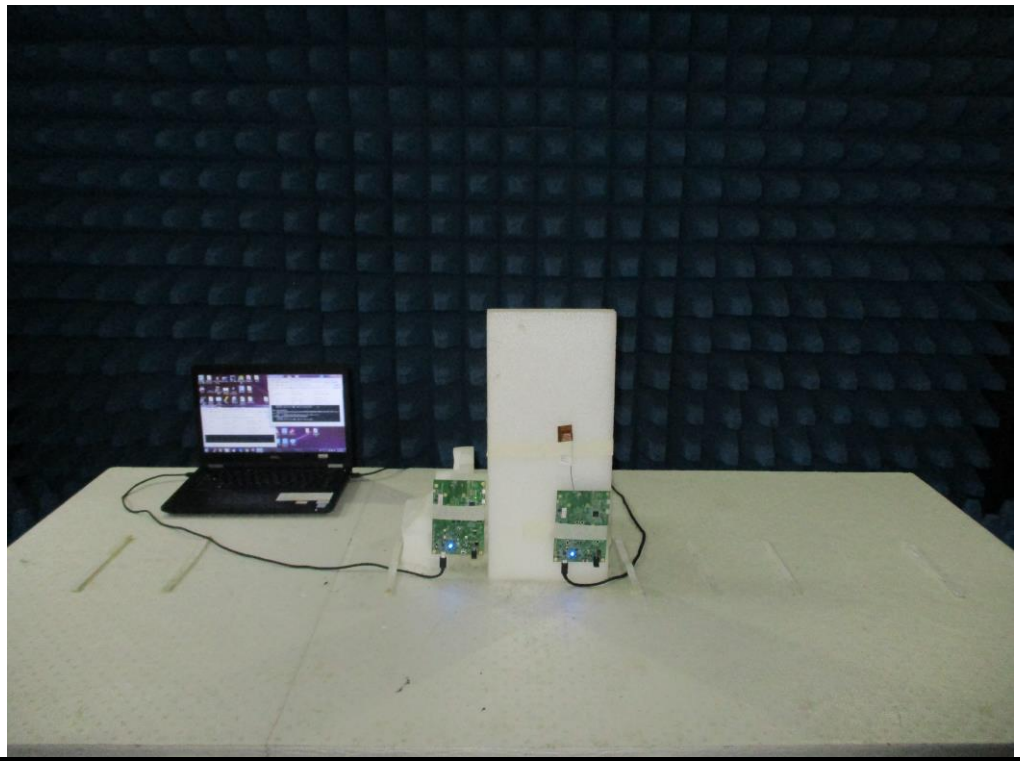
RS Test (Mode 2)



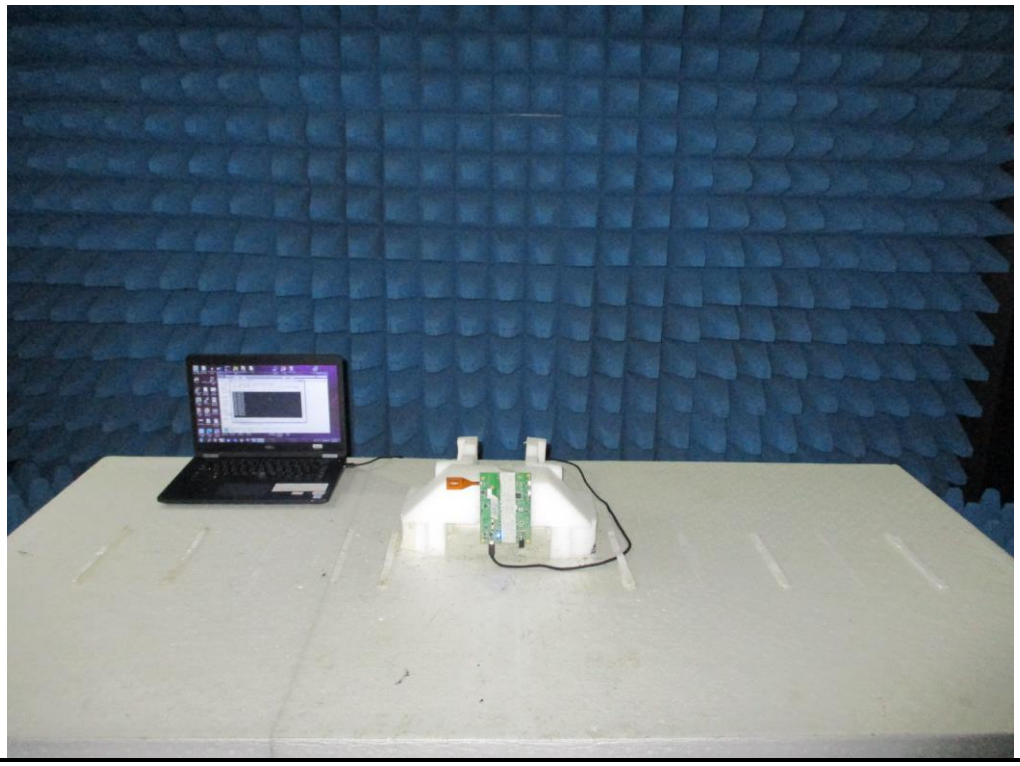
RS Test (Mode 3)



RS Test (Mode 4)



RS Test (Mode 5)



6 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	**Kwei Shan**	**Kwei Shan Site II**
Tel: 886-2-2601-1640	Tel: 886-3-271-8666	Tel: 886-3-271-8640
No. 30-2, Ding Fwu Tsuen, Lin Kou District, New Taipei City, Taiwan, R.O.C.	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.	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

Tel: 886-3-271-8666
Fax: 886-3-318-0155
Email: ICC_Service@icertifi.com.tw

═END═