TEST REPORT

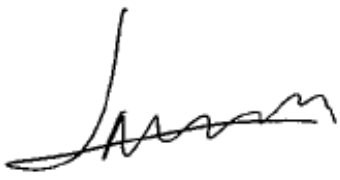
Applicant	Particle Industries, Inc
Address	126 Post St,4th floor, San Francisco, CA 94108 USA

Manufacturer or Supplier	Particle Industries, Inc
Address	126 Post St,4th floor, San Francisco, CA 94108 USA
Product	Electron LTE
Brand Name	Particle
Model	E402D
Additional Model & Model Difference	N/A
Date of tests	Nov. 26, 2018 ~ Dec. 13, 2018

The submitted sample of the above equipment has been tested for according to the requirements of the following standards:

☒ **FCC Part 15 Subpart B, Class B (sDoC)**
☒ **ICES-003 Issue 6:2016, Class B**

CONCLUSION: The submitted sample was found to COMPLY with the test requirement

Tested by Breeze Jiang Project Engineer / EMC Department	Approved by Madison Luo Supervisor / EMC Department
	 Date: April 2, 2019

Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch

No. 34, Chenwulu Section, Guantai Rd., Houjie Town, Dongguan City, Guangdong 523942, China

Tel.: +86 769 8998 2098
Fax: +86 769 8593 1080
Email: customerservice.dg@cn.bureauveritas.com

Table of Contents

RELEASE CONTROL RECORD 3
1 SUMMARY OF TEST RESULTS 4
1.1 MEASUREMENT UNCERTAINTY 4
2 GENERAL INFORMATION 5
2.1 GENERAL DESCRIPTION OF EUT 5
2.2 DESCRIPTION OF TEST MODES 6
2.3 DESCRIPTION OF SUPPORT UNITS 6
3 EMISSION TEST 7
3.1 CONDUCTED EMISSION MEASUREMENT 7
3.1.1 LIMITS OF CONDUCTED EMISSION MEASUREMENT 7
3.1.2 TEST INSTRUMENTS 7
3.1.3 TEST PROCEDURE 8
3.1.4 DEVIATION FROM TEST STANDARD 8
3.1.5 TEST SETUP 9
3.1.6 EUT OPERATING CONDITIONS 9
3.1.7 TEST RESULTS 10
3.2 RADIATED EMISSION MEASUREMENT 12
3.2.1 LIMITS OF RADIATED EMISSION MEASUREMENT 12
3.2.2 TEST INSTRUMENTS 14
3.2.3 TEST PROCEDURE 15
3.2.4 DEVIATION FROM TEST STANDARD 16
3.2.5 TEST SETUP 17
3.2.6 EUT OPERATING CONDITIONS 17
3.2.7 TEST RESULTS 18
4 PHOTOGRAPHS OF THE TEST CONFIGURATION 20
5 APPENDIX A – MODIFICATIONS RECORDERS FOR ENGINEERING CHANGES TO THE EUT BY THE LAB 22

RELEASE CONTROL RECORD

ISSUE NO.	REASON FOR CHANGE	DATE ISSUED
FS181126N009	Original release	April 2, 2019

Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch

No. 34, Chenwulu Section, Guantai Rd., Houjie Town, Dongguan City, Guangdong 523942, China

Tel.: +86 769 8998 2098
Fax: +86 769 8593 1080
Email: customerservice.dg@cn.bureauveritas.com

1 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

APPLIED STANDARD			
Standard Section	**Test Item**	**Result**	**Remark**
FCC Part 15 Subpart B, Class B (sDoC) ICES-003 Issue 6: 2016, Class B	Conducted test	PASS	Meets limits minimum passing margin is -30.46 dB at 0.76875 MHz
	Radiated Emission Test (30MHz ~ 1GHz)	PASS	Meets limits minimum passing margin is -13.22 dB at 120.312 MHz

Remark: Please refer to FCC part 2 2.1077 for sDoC compliance information requirement

1.1 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

MEASUREMENT	FREQUENCY	UNCERTAINTY
Conducted emission test	0.15MHz ~ 30MHz	+/-2.70 dB
Radiated emissions test	30MHz ~1000MHz	+/- 4.04 dB

2 GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

PRODUCT	Electron LTE
MODEL NO.	E402D
ADDITIONAL MODE	N/A
POWER SUPPLY	Li+ PIN /Battery connector: DC 3.7V from Li-ion Battery or VUSB PIN /USB connector :DC 5V from USB Host Unit
CABLE SUPPLIED	N/A
THE HIGHEST OPERATING FREQUENCY	Below 108MHz

NOTE:

1. For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.
2. For the test results, the EUT had been tested with all conditions. But only the worst case was showed in test report.
3. Please refer to the EUT photo document (Reference No.: 181126N009) for detailed product photo.

2.2 DESCRIPTION OF TEST MODES

The EUT was tested under the following modes. And the worst case was marked in bold and recorded in the report.

◆ **FOR CONDUCTED EMISSIONS TEST:**

Test Mode	Test Voltage
Normal Working	**DC 5V from Adapter input AC 120V 60Hz**

◆ **FOR RADIATED EMISSIONS TEST:**

Test Mode	Test Voltage
Normal Working	DC 3.7V from Battery
Normal Working	**DC 5V from Adapter input AC 120V 60Hz**

2.3 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

NO.	PRODUCT	BRAND	MODEL NO.	SERIAL NO.	FCC ID
1	Adapter	N/A	DC 5V 1.5A	N/A	N/A

NO.	DESCRIPTION OF THE ABOVE SUPPORT UNITS
1	USB Line: Unshielded detachable 0.6m.

3 EMISSION TEST

3.1 CONDUCTED EMISSION MEASUREMENT

3.1.1 LIMITS OF CONDUCTED EMISSION MEASUREMENT

TEST STANDARD: FCC Part 15, Subpart B (Section: 15.107)

FREQUENCY (MHz)	Class A (dBuV)		Class B (dBuV)	
	Quasi-peak	Average	Quasi-peak	Average
0.15 - 0.5	79	66	66 - 56	56 - 46
0.50 - 5.0	73	60	56	46
5.0 - 30.0	73	60	60	50

NOTES: (1) The lower limit shall apply at the transition frequencies.
(2) The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.
(3) All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

3.1.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
EMI Test Receiver	Rohde&Schwarz	ESR7	101494	Mar. 21,18	Mar. 20,19
Artificial Mains Network	Rohde&Schwarz	ENV216	101173	Mar. 03,18	Mar. 02,19
Artificial Mains Network	Rohde&Schwarz	ESH3-Z5	100317	Apr. 11,18	Apr. 10,19
Voltage probe	SCHWARZBECK	TK 9421	TK 9421-176	Jan. 17,18	Jan. 16,19
Test software	ADT	ADT_Cond _V7.3.7	N/A	N/A	N/A

NOTE: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.
2. The test was performed in shielding room 553.

3.1.3 TEST PROCEDURE

The basic test procedure was in accordance with ANSI C63.4:2014 (section 7).

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.

b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels under (Limit – 20dB) were not recorded.

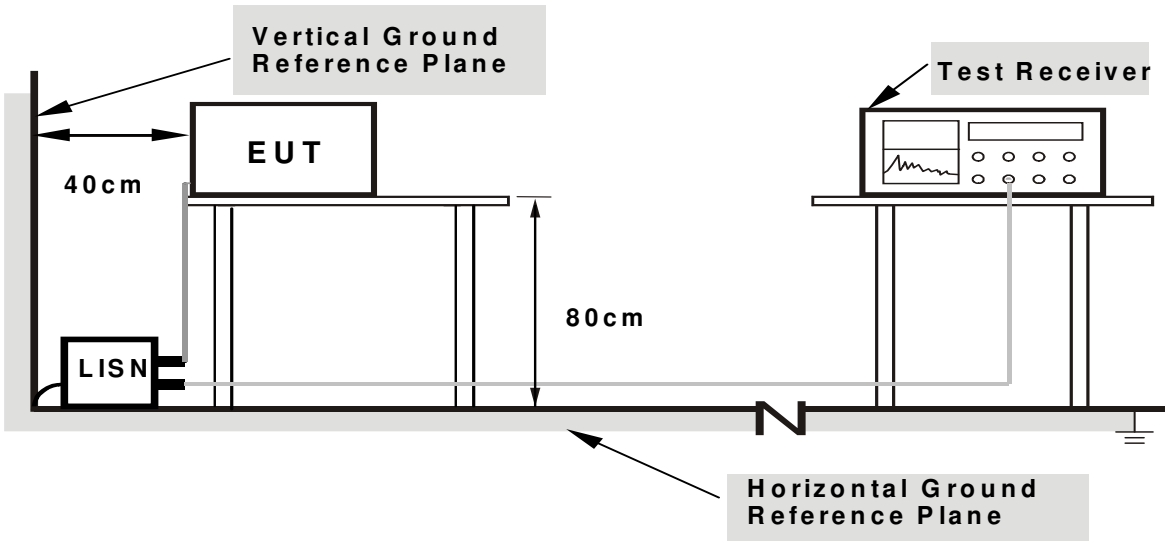
NOTE:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. "-": The Quasi-peak reading value also meets average limit and measurement with the average detector is unnecessary.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

3.1.4 DEVIATION FROM TEST STANDARD

No deviation.

3.1.5 TEST SETUP



Note: 1.Support units were connected to second LISN.
2.Both of LISNs (AMN) are 80cm from EUT and at least 80cm from other units and other metal planes support units.

3.1.6 EUT OPERATING CONDITIONS

a. Turned on the power of all equipment.

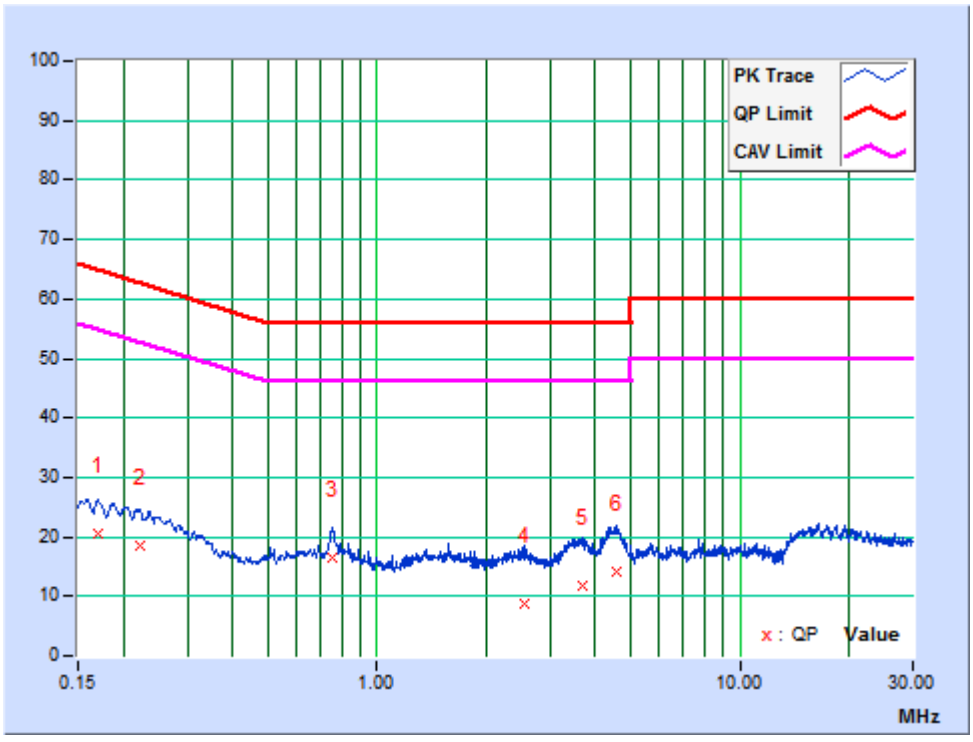
b. EUT was operated according to the type description in manufacturer's specifications or the User's Manual.

3.1.7 TEST RESULTS

TEST MODE	Normal Working	**6DB BANDWIDTH**	9 kHz
TEST VOLTAGE	DC 5V from Adapter input AC 120V 60Hz	**PHASE**	Line (L)
ENVIRONMENTAL CONDITIONS	22deg. C, 46% RH	**TESTED BY**	Dragon

No	Freq.	Corr. Factor	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
	[MHz]	(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.17025	9.61	11.05	0.63	20.66	10.24	64.95	54.95	-44.29	-44.71
2	0.22151	10.29	8.36	-1.13	18.65	9.16	62.76	52.76	-44.11	-43.60
3	0.75075	10.17	6.41	1.49	16.58	11.66	56.00	46.00	-39.42	-34.34
4	2.53500	9.97	-1.28	-4.55	8.69	5.42	56.00	46.00	-47.31	-40.58
5	3.70050	9.78	2.16	-2.79	11.94	6.99	56.00	46.00	-44.06	-39.01
6	4.54875	10.04	4.24	-2.55	14.28	7.49	56.00	46.00	-41.72	-38.51

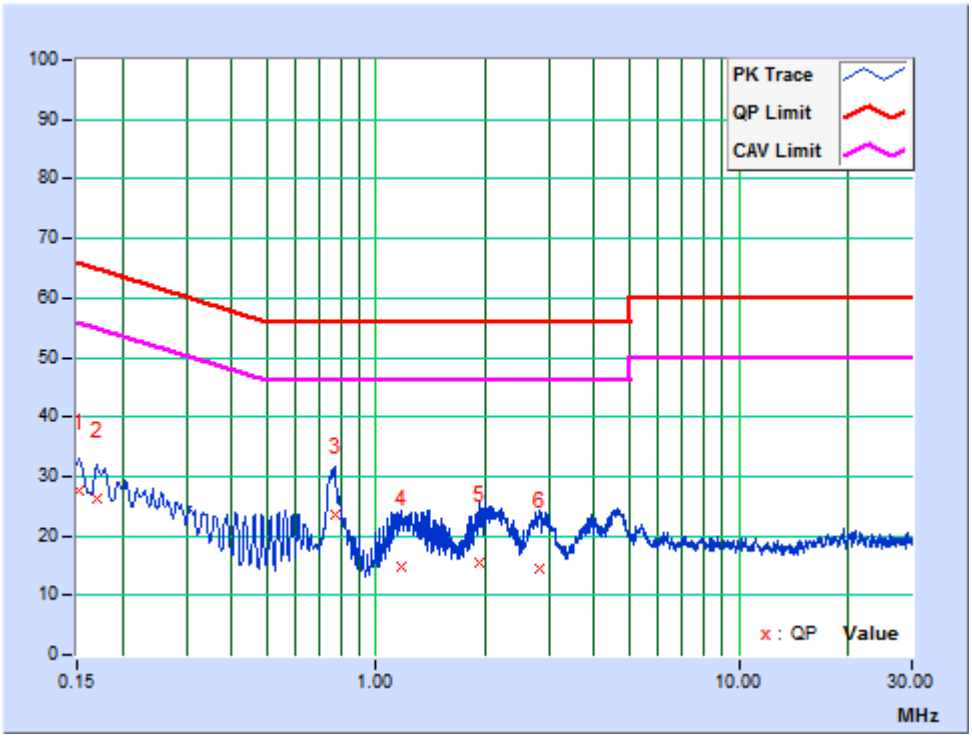
REMARKS: The emission levels of other frequencies were very low against the limit.



TEST MODE	Normal Working	6DB BANDWIDTH	9 kHz
TEST VOLTAGE	DC 5V from Adapter input AC 120V 60Hz	PHASE	Neutral (N)
ENVIRONMENTAL CONDITIONS	22deg. C, 46% RH	TESTED BY	Dragon

No	Freq.	Corr. Factor	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
	[MHz]	(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15225	9.72	17.95	2.79	27.67	12.51	65.88	55.88	-38.21	-43.37
2	0.17011	10.34	15.86	1.38	26.20	11.72	64.96	54.96	-38.75	-43.23
3	**0.76875**	**9.97**	**13.65**	**5.57**	**23.62**	**15.54**	**56.00**	**46.00**	**-32.38**	**-30.46**
4	1.17824	9.67	5.03	-1.33	14.70	8.34	56.00	46.00	-41.30	-37.66
5	1.92031	10.24	5.20	2.08	15.44	12.32	56.00	46.00	-40.56	-33.68
6	2.81850	10.05	4.43	0.81	14.48	10.86	56.00	46.00	-41.52	-35.14

REMARKS: The emission levels of other frequencies were very low against the limit.



3.2 RADIATED EMISSION MEASUREMENT

3.2.1 LIMITS OF RADIATED EMISSION MEASUREMENT

TEST STANDARD: FCC Part 15, Subpart B (Section: 15.109)
ICES-003 for below 1GHz (Class A: section 6.2.1 Table 4; Class B: section 6.2.1Table 5); for above 1GHz (Class A: section 6.2.2 Table 6; Class B: section 6.2.2 Table 7)

Emissions radiated outside of the specified bands, shall be according to the general radiated limits as following:

Radiated Emissions Limits at 10 meters (dBμV/m)				
Frequencies (MHz)	**FCC 15B/ ICES-003, Class A**	**FCC 15B / ICES-003, Class B**	**CISPR 22, Class A**	**CISPR 22, Class B**
30-88	39	29.5	40	30
88-216	43.5	33.1		
216-230	46.4	35.6		
230-960			47	37
960-1000	49.5	43.5		

Radiated Emissions Limits at 3 meters (dBμV/m)		
Frequencies (MHz)	**FCC 15B / ICES-003, Class A**	**FCC 15B / ICES-003, Class B**
30-88	49.5	40
88-216	54	43.5
216-230	56.9	46
230-960		
960-1000	60	54
1000-3000	Avg: 60 Peak: 80	Avg: 54 Peak: 74
Above 3000		

FREQUENCY RANGE OF RADIATED MEASUREMENT
(For unintentional radiators)

Highest frequency generated or Upper frequency of measurement used in the device or on which the device operates or tunes (MHz)	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: (1) The lower limit shall apply at the transition frequencies.

(2) Emission level (dBuV/m) = 20 log Emission level (uV/m).

(3) All emanation from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

3.2.2 TEST INSTRUMENTS

FREQUENCY RANGE BELOW 1GHz

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
EMI Test Receiver	Rohde&Schwarz	ESCI 3	101418	Jan. 02,18	Jan. 01,19
EMI Test Receiver	Rohde&Schwarz	ESR7	101564	Jan. 18,18	Jan. 17,19
Trilog-Broadband Antenna	SCHWARZBECK	VULB 9168	9168-555	Nov. 10, 18	Nov. 09, 19
Trilog-Broadband Antenna	SCHWARZBECK	VULB 9168	9168-554	Dec. 10, 18	Dec. 09, 19
Preamplifier	EMCI	EMC1135	980378	Mar. 19,18	Mar. 18,19
Preamplifier	EMCI	EMC1135	980423	Mar. 19,18	Mar. 18,19
10m Semi-anechoic Chamber	CHANGLING	21.4m*12.1m* 8.8m	NSEMC006	Feb. 10,18	Feb. 09,19
Test Software	ADT	ADT_Radiated _V8.7.07	N/A	N/A	N/A

NOTES: 1. The test was performed in 10m Chamber.

2. The calibration interval of the above test instruments is 12 months. And the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

3. The FCC Site Registration No. is 749762.

FREQUENCY RANGE ABOVE 1GHz

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
Horn Antenna	ETS-Lindgren	3117	00085519	Dec. 10, 18	Dec. 09, 19
Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170242	May 05,18	May 04,19
Signal and Spectrum Analyzer	Rohde&Schwarz	FSV40	101003	Apr. 21,18	Apr. 20,19
Broadband Preamplifier (1~18GHz)	SCHWARZBECK	BBV9718	266	Apr. 18,18	Apr. 18,19
Pre-Amplifier (18GHz-40GHz)	EMCI	EMC 184045	980102	Nov. 08,18	Nov. 07,19
Test Software	ADT	ADT_Radiated _V8.7.07	N/A	N/A	N/A

NOTES: 1. The test was performed in 10m Chamber.

2. The calibration interval of the above test instruments is 12 months. And the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

3. The FCC Site Registration No. is 749762.

3.2.3 TEST PROCEDURE

<Frequency Range below 1GHz>

The basic test procedure was in accordance with ANSI C63.4:2014 (section 12).

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 10 meter semi-anechoic chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The height of antenna is varied from 1 meter to 4 meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1GHz.

NOTE:

1. The resolution bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. Emission level(dBuV/m)=Raw Value(dBuV) + Correction Factor(dB/m)
3. Correction Factor(dB/m) = Antenna Factor (dB/m) + Cable Factor (dB) (if the raw value not contains the amplifier);
4. Correction Factor(dB/m) = Antenna Factor (dB/m) + Cable Factor (dB) – Amplifier Gain(dB) (if the raw value contains the amplifier).
5. Margin value = Emission level – Limit value.

<Frequency Range above 1GHz>

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 10 meters Semi-anechoic chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz

NOTE:

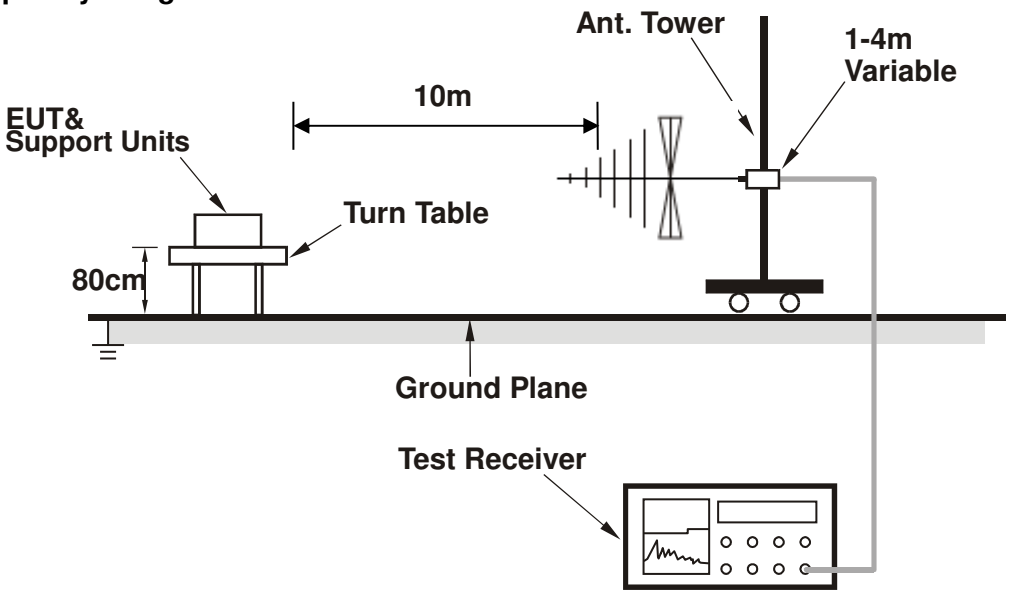
1. The resolution bandwidth is 1MHz and video bandwidth of test receiver/spectrum analyzer is 3MHz for Peak detection at frequency above 1GHz. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz for Average detection (AV) at frequency above 1GHz.
2. For measurement of frequency above 1000 MHz, the EUT was set 3 meters away from the receiver antenna.
3. Emission level(dBuV/m)=Raw Value(dBuV) + Correction Factor(dB/m)
4. Correction Factor(dB/m) = Antenna Factor (dB/m) + Cable Factor (dB) (if the raw value not contains the amplifier);
5. Correction Factor(dB/m) = Antenna Factor (dB/m) + Cable Factor (dB) – Amplifier Gain(dB) (if the raw value contains the amplifier)
6. Margin value = Emission level – Limit value.

3.2.4 DEVIATION FROM TEST STANDARD

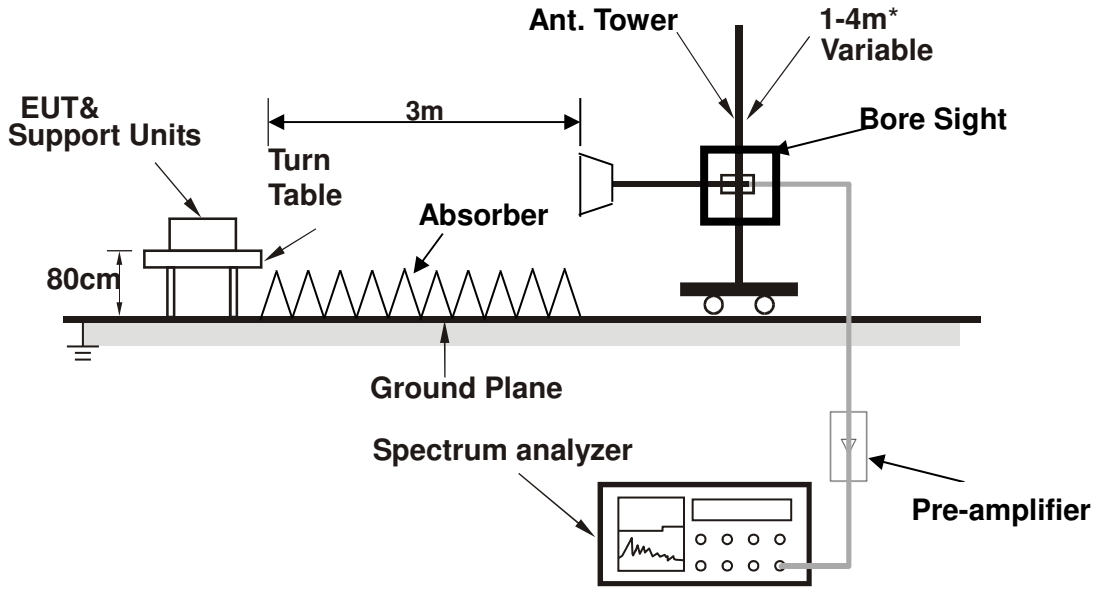
No deviation.

3.2.5 TEST SETUP

<Frequency Range below 1GHz>



<Frequency Range above 1GHz>



* depends on the EUT height and the antenna 3dB beamwidth both, refer to section 7.3 of CISPR 16-2-3

3.2.6 EUT OPERATING CONDITIONS

a. Turned on the power of all equipment.

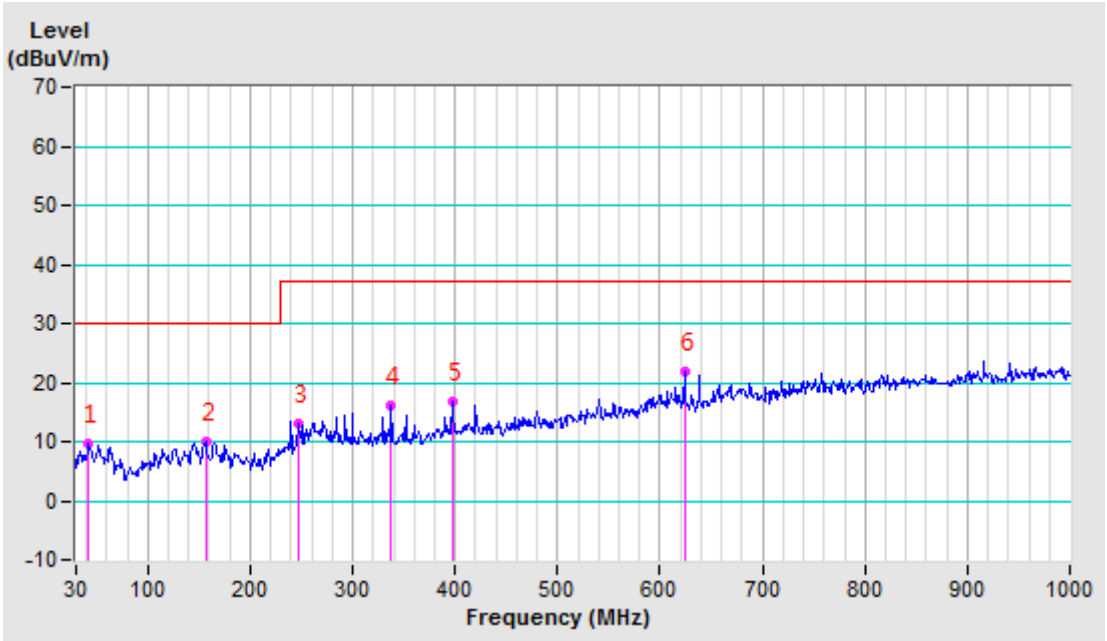
b. EUT was operated according to the type description in manufacturer's specifications or the User's Manual.

3.2.7 TEST RESULTS

TEST MODE	Normal Working	FREQUENCY RANGE	30-1000MHz
TEST VOLTAGE	DC 5V from Adapter input AC 120V 60Hz	DETECTOR FUNCTION & RESOLUTION BANDWIDTH	Quasi-Peak, 120kHz
ENVIRONMENTAL CONDITIONS	21.0deg. C, 59.0% RH	TESTED BY: Luke	

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 10 M								
No.	Freq. (MHz)	Correction Factor (dB/m)	Raw Value (dBuV)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (cm)	Table Angle (Degree)
1	42.368	-22.54	32.13	9.59	30.00	-20.41	400	23
2	156.343	-21.92	31.88	9.96	30.00	-20.04	400	287
3	247.401	-22.49	35.67	13.18	37.00	-23.82	400	307
4	337.490	-19.77	35.86	16.09	37.00	-20.91	200	296
5	397.509	-18.19	34.92	16.73	37.00	-20.27	200	255
6	624.246	-13.26	35.24	21.98	37.00	-15.02	200	58

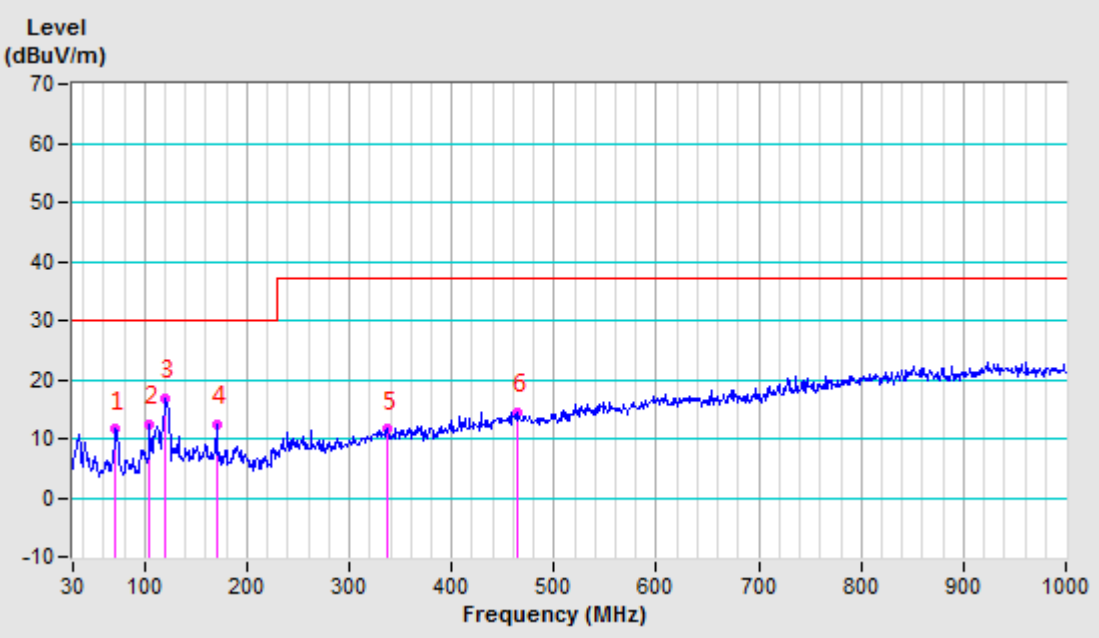
REMARKS: 1. Peak detector quick scan is showed on the graph and final quasi-peak detector data is measured corresponding to relevant limit and recorded in the data table.
2. Negative sign (-) in the margin column signify levels below the limit.
3. Frequency range scanned: 30MHz to 1000MHz.
4. Only emissions significantly above equipment noise floor are reported.



TEST MODE	Normal Working	FREQUENCY RANGE	30-1000MHz
TEST VOLTAGE	DC 5V from Adapter input AC 120V 60Hz	DETECTOR FUNCTION & RESOLUTION BANDWIDTH	Quasi-Peak, 120kHz
ENVIRONMENTAL CONDITIONS	21.0deg. C, 59.0% RH	TESTED BY: Luke	

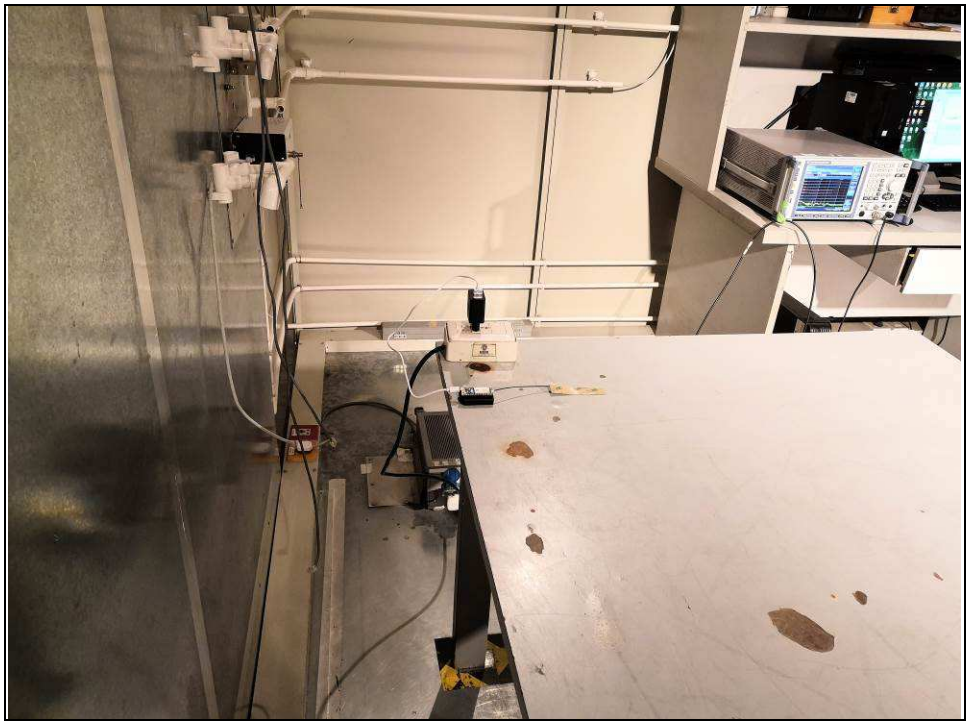
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 10 M								
No.	Freq. (MHz)	Correction Factor (dB/m)	Raw Value (dBuV)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (cm)	Table Angle (Degree)
1	71.809	-25.22	36.76	11.54	30.00	-18.46	100	338
2	105.033	-24.48	36.83	12.35	30.00	-17.65	100	338
3	**120.312**	**-23.13**	**39.91**	**16.78**	**30.00**	**-13.22**	**100**	**338**
4	170.221	-21.70	34.18	12.48	30.00	-17.52	100	341
5	336.584	-18.39	29.97	11.58	37.00	-25.42	100	344
6	464.727	-15.67	30.21	14.54	37.00	-22.46	300	88

REMARKS: 1. Peak detector quick scan is showed on the graph and final quasi-peak detector data is measured corresponding to relevant limit and recorded in the data table.
2. Negative sign (-) in the margin column signify levels below the limit.
3. Frequency range scanned: 30MHz to 1000MHz.
4. Only emissions significantly above equipment noise floor are reported.

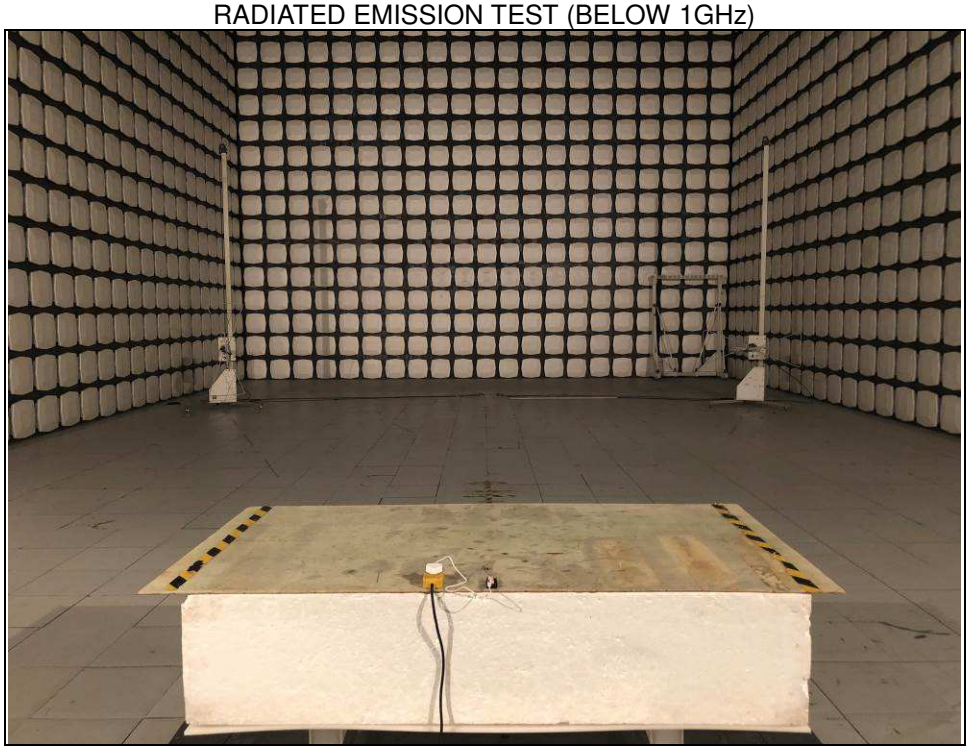


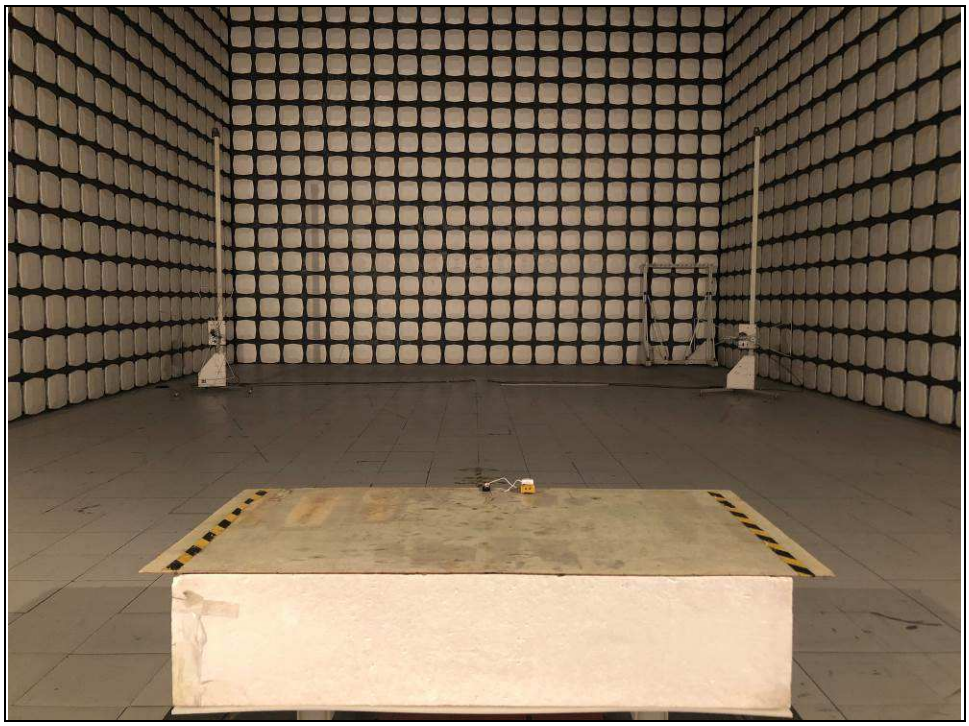
4 PHOTOGRAPHS OF THE TEST CONFIGURATION

CONDUCTED EMISSION TEST



RADIATED EMISSION TEST (BELOW 1GHz)





5 APPENDIX A – MODIFICATIONS RECORDERS FOR ENGINEERING CHANGES TO THE EUT BY THE LAB

No any modifications were made to the EUT by the lab during the test.

---END---