Shenzhen CTL Testing Technology Co., Ltd.
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TEST REPORT

ETSI EN 301 489-1 V2.1.1 (2017-02)& ETSI EN 301 489-3 V2.1.1 (2019-03) & ETSI EN 301 489-17 V3.1.1 (2017-02)

Report Reference No. .....: **CTL1906244051-WE**

Compiled by: (position+printed name+signature)	Happy Guo (File administrators)	Happy Guo
Tested by: (position+printed name+signature)	Nice Nong (Test Engineer)	Nice Nong
Approved by: (position+printed name+signature)	Ivan Xie (Manager)	Ivan Xie

Product Name.....:	Beaglebone AI
Model/Type reference .....:	Beaglebone AI
List Model(s).....:	N/A
Trade Mark.....:	N/A
Applicant's name .....:	**BeagleBoard.org Foundation**
Address of applicant .....:	4467 Ascot Court Oakland Township, Michigan, US 48306
Test Firm .....:	**Shenzhen CTL Testing Technology Co., Ltd.**
Address of Test Firm .....:	Floor 1-A, Baisha Technology Park, No.3011, Shahexi Road, Nanshan District, Shenzhen, China 518055
Test specification.....:	
Standard.....:	**ETSI EN 301 489-1 V2.1.1 (2017-02)** **ETSI EN 301 489-3 V2.1.1 (2019-03)** **ETSI EN 301 489-17 V3.1.1 (2017-02)**
TRF Originator .....:	Shenzhen CTL Testing Technology Co., Ltd.
Master TRF .....:	Dated 2011-01
Date of receipt of test item.....:	Jun. 26, 2019
Date of sampling.....:	Jun. 26, 2019
Date of Test Date.....:	Jun. 26, 2019–Jul. 08, 2019
Data of Issue.....:	Jul. 09, 2019
Result.....:	**Pass**

TEST REPORT

Test Report No. :	CTL1906244051-WE	Jul. 09, 2019 Date of issue

Equipment under Test	:	Beaglebone AI
Model /Type	:	Beaglebone AI
Listed Models	:	N/A
Applicant	:	**BeagleBoard.org Foundation**
Address	:	4467 Ascot Court Oakland Township, Michigan, US 48306
Manufacturer	:	**Embest Technology Co., Ltd**
Address	:	Tower B 4/F, Shanghai Building, Nanshan Yungu Innovation Industry Park, Liuxian Ave. No.1183, Taoyuan St., Nanshan District, Shenzhen, China.

Test result	Pass *

* In the configuration tested, the EUT complied with the standards specified page 5.

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the issuing testing laboratory.

** Modified History **

Revision	Description	Issued Data	Report No.	Remark
Version 1.0	Initial Test Report Release	2019-07-09	CTL1906244051-WE	Tracy Qi

Contents

1 TEST SUMMARY

1.1 Test Standards

The tests were performed according to following standards:

ETSI EN 301 489-1 V2.1.1 (2017-02)-ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU and the essential requirements of article 6 of Directive 2014/30/EU

ETSI EN 301 489-3 V2.1.1 (2019-03) —ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 3: Specific conditions for Short-Range Devices (SRD) operating on frequencies between 9 kHz and 246 GHz; Harmonised Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU

ETSI EN 301 489-17 V3.1.1 (2017-02)-ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for Broadband Data Transmission Systems; Harmonised Standard covering the essential requirements of article 3.1(b) of Directive 2014/53/EU

1.2 Test Description

ETSI EN 301 489-1/ Requirements		
Conducted Emission(AC Mains)	ETSI EN301 489-1 V2.1.1 Clause 7.1	PASS
Radiated Emission	ETSI EN301 489-1 V2.1.1 Clause 7.1	PASS
Conducted Emission(Telecommunication Ports)	ETSI EN301 489-1 V2.1.1 Clause 7.1	PASS
Harmonic Current Emissions	ETSI EN301 489-1 V2.1.1 Clause 7.1	N/A_{note1}
Voltage Fluctuations and Flicker	ETSI EN301 489-1 V2.1.1 Clause 7.1	N/A_{note1}
Electrostatic Discharge	ETSI EN301 489-1 V2.1.1 Clause 7.2	PASS
RF Electromagnetic Field	ETSI EN301 489-1 V2.1.1 Clause 7.2	PASS
Fast Transients Common Mode	ETSI EN301 489-1 V2.1.1 Clause 7.2	N/A_{note1}
Surges	ETSI EN301 489-1 V2.1.1 Clause 7.2	N/A_{note1}
RF Common Mode 0,15 MHz to 80 MHz	ETSI EN301 489-1 V2.1.1 Clause 7.2	N/A_{note1}
Transients and Surges	ETSI EN301 489-1 V2.1.1 Clause 7.2	N/A_{note1}
Voltage Dips and Interruptions	ETSI EN301 489-1 V2.1.1 Clause 7.2	N/A_{note1}

Note1: This test is suitable for devices with an adapter.

1.3 Test Facility

1.3.1 Address of the test laboratory

Shenzhen CTL Testing Technology Co., Ltd.
Floor 1-A, Baisha Technology Park, No. 3011, Shahexi Road, Nanshan, Shenzhen 518055 China

There is one 3m semi-anechoic chamber and two line conducted labs for final test. The Test Sites meet the requirements in documents ANSI C63.4 and CISPR 32/EN 55032 requirements.

1.3.2 Laboratory accreditation

The test facility is recognized, certified, or accredited by the following organizations:

CNAS-Lab Code: L7497

Shenzhen CTL Testing Technology Co., Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC 17025: 2005 General Requirements) for the Competence of Testing and Calibration Laboratories.

A2LA-Lab Cert. No. 4343.01

Shenzhen CTL Testing Technology Co., Ltd, EMC Laboratory has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

IC Registration No.: 9518B

CAB identifier: CN0041

The 3m alternate test site of Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements with Registration No.: 9518B on Jan. 22, 2019.

FCC-Registration No.: 399832

Designation No.: CN1216

Shenzhen CTL Testing Technology Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration 399832, December 08, 2017.

1.4 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report according to CISPR 16 - 4 "Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements" and is documented in the Shenzhen CTL Testing Technology Co., Ltd. quality system according to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result
in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for CTL laboratory is reported:

Test	Range	Measurement Uncertainty	Notes
Radiated Emission	30~1000MHz	±3.53dB	(1)
Radiated Emission	1~12.75GHz	±4.32dB	(1)
Conducted Emission	0.15~30MHz	±2.66dB	(1)

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

Harmonic Current Emission
The measurement uncertainty is evaluated as ± 1.2 %.

Voltage Fluctuations and Flicker
The measurement uncertainty is evaluated as ± 1.5 %.

Electrostatic Discharge
As what is concluded in the document from Note1 of clause 7.6.3 of ISO/IEC 17025: 2017, the requirements for measurement uncertainty in ESD testing are deemed to have been satisfied, and the testing is reported in accordance with the relevant ESD standards. The immunity test signal from the ESD system meet the required specifications in IEC 61000-4-2 through the calibration report with the calibrated uncertainty for the waveform of voltage and timing as being 1.63% and 2.76%.

RF Electromagnetic Field
As what is concluded in the document from Note1 of clause 7.6.3 of ISO/IEC 17025: 2017, the requirements for measurement uncertainty in RS testing are deemed to have been satisfied, and the testing is reported in accordance with the relevant RS standards. The immunity test signal from the RS system meet the required specifications in IEC 61000-4-3 through the calibration for the uniform field strength and monitoring for the test level with the uncertainty evaluation report for the electrical filed strength as being 2.72 dB.

Fast Transients Common Mode
As what is concluded in the document from Note1 of clause 7.6.3 of ISO/IEC 17025: 2017, the requirements for measurement uncertainty in EFT/Burst testing are deemed to have been satisfied, and the testing is reported in accordance with the relevant EFT/Burst standards. The immunity test signal from the EFT/Burst system meet the required specifications in IEC 61000-4-4 through the calibration report with the calibrated uncertainty for the waveform of voltage. Frequency and timing as being 1.63% and 2.76%.

Surges
As what is concluded in the document from Note1 of clause 7.6.3 of ISO/IEC 17025: 2017, the requirements for measurement uncertainty in Surge testing are deemed to have been satisfied, and the testing is reported in accordance with the relevant Surge standards. The immunity test signal from the Surge system meet the required specifications in IEC 61000-4-5 through the calibration report with the calibrated uncertainty for the waveform of voltage and timing as being 1.63% and 2.76%.

RF Common Mode
As what is concluded in the document from Note1 of clause 7.6.3 of ISO/IEC 17025: 2017, the requirements for measurement uncertainty in CS testing are deemed to have been satisfied, and the testing is reported in accordance with the relevant CS standards. The immunity test signal from the CS system meet the required specifications in IEC 61000-4-6 through the calibration for unmodulated signal and monitoring for the test level with the uncertainty evaluation report for the injected modulated signal level through CDN and EM Clamp/Direct Injection as being 3.72 dB and 2.78 dB.

Voltage Dips and Interruption
As what is concluded in the document from Note1 of clause 7.6.3 of ISO/IEC 17025: 2017, the requirements for measurement uncertainty in DIP testing are deemed to have been satisfied, and the testing is reported in accordance with the relevant DIP standards. The immunity test signal from the DIP system meet the required specifications in IEC 61000-4-11 through the calibration report with the calibrated uncertainty for the waveform of voltage and timing as being 1.63% and 2.76%.

Transients and Surges
As what is concluded in the document from Note1 of clause 7.6.3 of ISO/IEC 17025: 2017, the requirements for measurement uncertainty in Transients and Surges testing are deemed to have been satisfied, and the testing is reported in accordance with the relevant DIP standards. The immunity test signal from the Transients and Surges system meet the required specifications in ISO 7637-2 through the calibration report with the calibrated uncertainty for the waveform of voltage and timing as being 1.60% and 2.60%.

2 GENERAL INFORMATION

2.1 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature:	15°C -35°C
Relative Humidity	35%-55 %
Air Pressure	101KPa

2.2 General Description of EUT

Product Name:	Beaglebone AI
Model/Type reference:	Beaglebone AI
Power supply:	DC 5.0V
Bluetooth:	
Version:	Supported BR\EDR
Modulation:	GFSK, π/4DQPSK, 8DPSK
Operation frequency:	2402MHz~2480MHz
Channel number:	79
Channel separation:	1MHz
Antenna type:	Internal Antenna
Antenna gain:	1.5dBi
Bluetooth:	
Supported type:	Supported bluetooth low Energy
Modulation:	GFSK
Operation frequency:	2402MHz to 2480MHz
Channel number:	40
Channel separation:	2 MHz
Antenna type:	Internal Antenna
Antenna gain:	1.5dBi
2.4G WIFI:	
Supported type:	802.11b/802.11g/802.11n(H20)/802.11n(H40)
Modulation:	802.11b: DSSS 802.11g/802.11n(H20)/802.11n(H40): OFDM
Operation frequency:	802.11b/802.11g/802.11n(H20): 2412MHz~2472MHz 802.11n(H40): 2422MHz~2462MHz
Channel number:	802.11b/802.11g/802.11n(H20): 13 802.11n(H40): 9
Channel separation:	5MHz
Antenna type:	Internal Antenna
Antenna gain:	1.5dBi

5G WIFI:				
Supported type:	20MHz system	40MHz system	80MHz system	160MHz system
	802.11a 802.11n 802.11ac	802.11n 802.11ac	802.11ac	N/A
Operation frequency:	5180MHz-5240MHz 5260MHz-5320MHz 5500MHz-5700MHz 5745MHz-5825MHz	5190MHz-5230MHz 5270MHz-5310MHz 5510MHz-5670MHz 5755MHz-5795MHz	5210MHz 5290MHz 5530MHz 5610MHz 5775MHz	N/A
Modulation:	OFDM	OFDM	OFDM	N/A
Channel number:	24	11	5	N/A
Channel separation:	20MHz	40MHz	80MHz	N/A
Antenna type:	Internal Antenna			
Antenna gain:	1.5dBi			

Note: For more detailed features description, please refer to the manufacturer's specifications or the User's Manual.

2.3 Description of Test Modes

The EUT was tested under typical operating condition. The applicant provides drivers to make it work in general use, and software can obtain data form it to see if it works intended during testing.

2.4 Equipments Used during the Test

Radiated Emission(chamber 1)						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1	ULTRA-BROADBAND ANTENNA	Sunol Sciences Corp.	JB1 Antenna	A061713	2019/05/24	2020/05/23
2	EMI Test Receiver	ROHDE & SCHWARZ	ESCI	1166.5950.03	2019/05/24	2020/05/23
3	Horn Antenna	Sunol Sciences Corp	DRH-118	A062013	2019/05/24	2020/05/23

Conducted Emission						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1	EMI Test Receiver	ROHDE & SCHWARZ	ESCI	1166.5950.03	2019/05/24	2020/05/23
2	LISN	ROHDE & SCHWARZ	ESH2-Z5	860014/010	2019/05/24	2020/05/23
3	Limitator	HP	VTSD 9561f	N/A	2019/05/24	2020/05/23

Harmonic Current/ Voltage Fluctuation and Flicker						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1	Purified Power Source	MToni	PHF 5010	N/A	2019/05/24	2020/05/23
2	Harmonic And Flicker Analyzer	Voltech	PM6000	N/A	2019/05/24	2020/05/23

Electrostatic Discharge						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1	ESD Simulator	TESEQ AG	NSG 437	1058	2019/05/24	2020/05/23

Electrical Fast Transient/Surge/Dips						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1	Ultra Compact Simulator	HAEFELY	ECOMPACT4	174887	2019/05/24	2020/05/23

Conducted Susceptibility（CS）:						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1	Conducted Disturbances test system	SCHLODER	CDG 6000	N/A	2019/05/24	2020/05/23
2	Amplifier	SCHLODER	4N100W-6DB	N/A	2019/05/24	2020/05/23
3	EM CLAMP	LÜTHI	EM101	335625	2019/05/24	2020/05/23

4	CDN	SCHLODER	CDN M2+M3	A2210225/ 2013	2019/05/24	2020/05/23

Power Frequency Magnetic Field Susceptibility						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1	MAGNETIC COIL	HTEC Instruments Ltd.	HPFMF	154402	2019/05/24	2020/05/23

RF Field Strength Susceptibility						
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1	SIGNAL GENERATOR	HEWLETT PACKARD	8648C	3642U01765	2019/05/24	2020/05/23
2	Power Amplifier	AR	150W1000M3	309401	2019/05/24	2020/05/23
3	Power Meter	Agilent	E4419B	GB43317877	2019/05/24	2020/05/23
4	Directional Coupler	EMtrace	DDC-0210-150W	N/A	2019/05/24	2020/05/23
5	Test Antenna-Bi-Log	Schwarzbeck	VULB 9118 E	N/A	2019/05/24	2020/05/23

The calibration interval is 1 year.

3 TEST CONDITIONS AND RESULTS

3.1 EMC EMISSION TEST

3.1.1 Conducted Emission (AC Mains)

LIMIT

FREQUENCY (MHz)	Class A (dBuV)		Class B (dBuV)	
	Quasi-peak	Average	Quasi-peak	Average
0.15 -0.5	79.00	66.00	66 - 56 *	56 - 46 *
0.50 -5.0	73.00	60.00	56.00	46.00
5.0 -30.0	73.00	60.00	60.00	50.00

Note: (1)The tighter limit applies at the band edges.

(2)The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

TEST PROCEDURE

a) The EUT was placed 0.4 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.

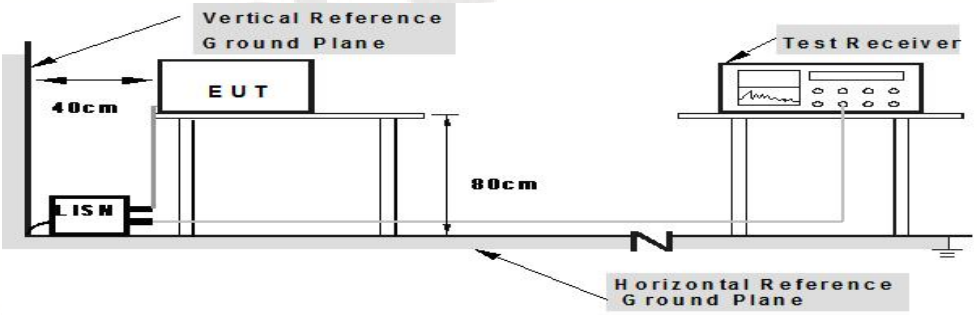
b) Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.

c) I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.

d) LISN at least 80 cm from nearest part of EUT chassis.

e) For the actual test configuration, please refer to the related Item –EUT Test Photos.

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 from other units and other metal planes

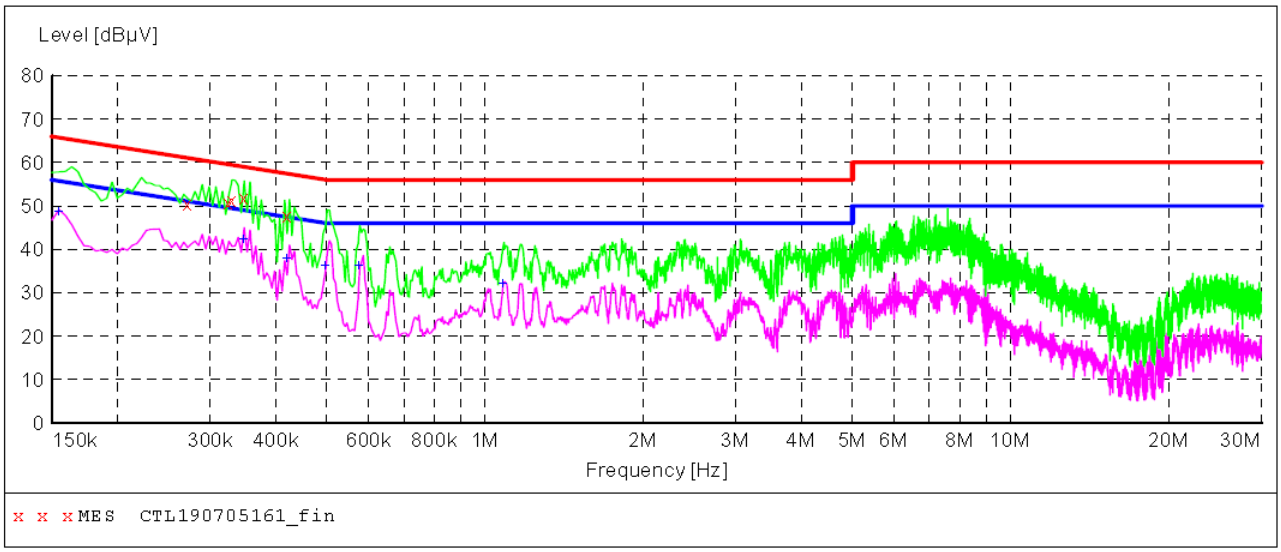
TEST RESULTS

------Passed------

Please refer to the below test data:

Line:	L

SCAN TABLE: "Voltage (9K-30M)FIN"
Short Description: 150K-30M Voltage



MEASUREMENT RESULT: "CTL190705161_fin"

2019-7-5 04:38??

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.271500	50.40	11.2	61	10.7	QP	L1	GND
0.325500	50.90	11.2	60	8.7	QP	L1	GND
0.330000	51.40	11.2	60	8.1	QP	L1	GND
0.348000	51.80	11.2	59	7.2	QP	L1	GND
0.420000	47.90	11.2	57	9.5	QP	L1	GND

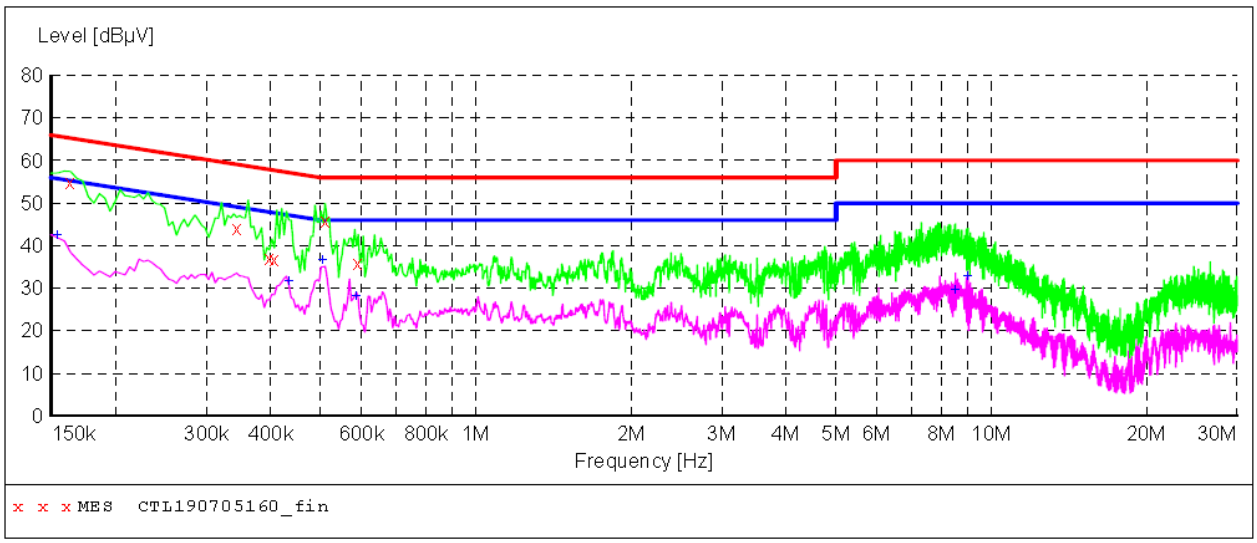
MEASUREMENT RESULT: "CTL190705161_fin2"

2019-7-5 04:38??

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.154500	48.70	11.2	56	7.1	AV	L1	GND
0.348000	42.30	11.2	49	6.7	AV	L1	GND
0.420000	37.70	11.2	47	9.7	AV	L1	GND
0.496500	36.20	11.2	46	9.9	AV	L1	GND
0.577500	36.10	11.2	46	9.9	AV	L1	GND
1.081500	32.10	11.3	46	13.9	AV	L1	GND

Line:	N

SCAN TABLE: "Voltage (9K-30M)FIN"
Short Description: 150K-30M Voltage



MEASUREMENT RESULT: "CTL190705160_fin"

2019-7-5 04:34??

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.163500	54.80	11.2	65	10.5	QP	N	GND
0.343500	44.20	11.2	59	14.9	QP	N	GND
0.397500	37.00	11.2	58	20.9	QP	N	GND
0.406500	36.80	11.2	58	20.9	QP	N	GND
0.510000	45.90	11.2	56	10.1	QP	N	GND
0.591000	36.00	11.2	56	20.0	QP	N	GND

MEASUREMENT RESULT: "CTL190705160_fin2"

2019-7-5 04:34??

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.154500	42.70	11.2	56	13.1	AV	N	GND
0.433500	31.70	11.2	47	15.5	AV	N	GND
0.505500	36.80	11.2	46	9.2	AV	N	GND
0.586500	28.30	11.2	46	17.7	AV	N	GND
8.515500	29.70	11.1	50	20.3	AV	N	GND
9.024000	33.00	11.1	50	17.0	AV	N	GND

3.1.2 Conducted Emission (Telecommunication ports)

LIMIT

LIMITS OF CONDUCTED COMMON MODE AT TELECOMMUNICATION PORTS

FREQUENCY (MHz)	Voltage limits dB(μV)		Current limits dB(μA)	
	Quasi-peak	Average	Quasi-peak	Average
0,15 to 0,5	84 to 74	74 to 64	40 to 30	30 to 20
0,5 to 30	74	64	30	20
NOTE 1 The limits decrease linearly with the logarithm of the frequency in the range 0,15 MHz to 0,5 MHz. NOTE 2 The current and voltage disturbance limits are derived for use with an impedance stabilization network (ISN) which presents a common mode (asymmetric mode) impedance of 150 Ω to the telecommunication port under test (conversion factor is 20 log10 150 / I = 44 dB).				

TEST PROCEDURE

a) The EUT was placed 0.4 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.

b) ISN bonded to the ground reference plane 0,8 m away from the EUT and Other units of the equipment under test shall be at least 0,8 m from the ISN.

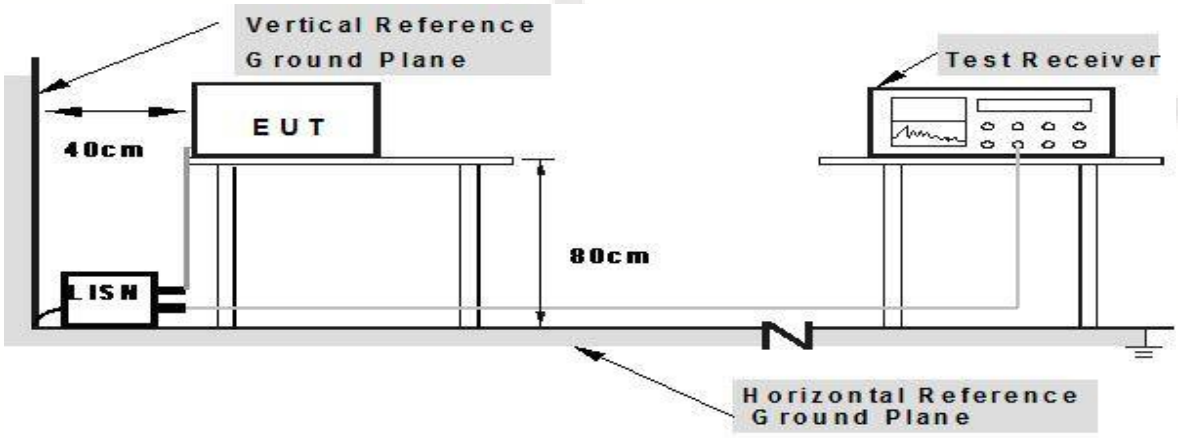
c) Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.

d) I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.

e) LISN at least 80 cm from nearest part of EUT chassis.

f) For the actual test configuration, please refer to the related Item –EUT Test Photos.

TEST SETUP

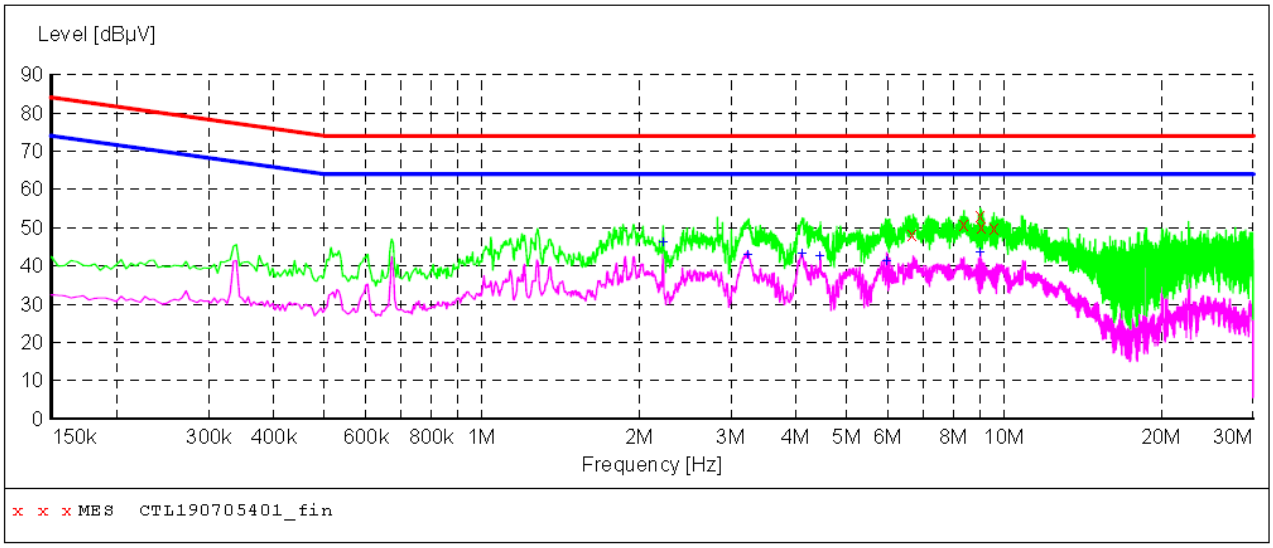


Note: 1.Support units were connected to second LISN.
2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes

TEST RESULTS

Line:	LAN

SCAN TABLE: "Voltage (9K-30M)NETF"
Short Description: 150K-30M Voltage



MEASUREMENT RESULT: "CTL190705401_fin"

2019-7-5 06:59??

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
6.670500	48.20	19.4	74	25.8	QP	NET	GND
8.380500	50.80	19.6	74	23.2	QP	NET	GND
9.019500	53.10	19.6	74	20.9	QP	NET	GND
9.060000	50.20	19.6	74	23.8	QP	NET	GND
9.613500	49.90	19.6	74	24.1	QP	NET	GND

MEASUREMENT RESULT: "CTL190705401_fin2"

2019-7-5 06:59??

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
2.224500	46.50	19.5	64	17.5	AV	NET	GND
3.241500	43.20	19.5	64	20.8	AV	NET	GND
4.105500	43.30	19.4	64	20.7	AV	NET	GND
4.443000	42.70	19.4	64	21.3	AV	NET	GND
5.964000	41.50	19.4	64	22.5	AV	NET	GND
9.019500	43.50	19.6	64	20.5	AV	NET	GND

3.1.3 Radiated Emission

LIMIT

LIMITS OF RADIATED EMISSION MEASUREMENT (Below 1000MHz)

FREQUENCY (MHz)	Class B(at 10m)	Class B (at 3m)
	dBuV/m	dBuV/m
30 – 230	30	40
230 – 1000	37	47

LIMITS OF RADIATED EMISSION MEASUREMENT(Above 1000MHz)

FREQUENCY (MHz)	Class A (at 10m) dBuV/m		Class B (at 3m) dBuV/m	
	Peak	Avg	Peak	Avg
1000-3000	76	56	70	50
3000-6000	80	60	74	54

Notes: (1)The limit for radiated test was performed according to as following:
ETSI EN 301 489-1/EN 55022
(2)The tighter limit applies at the band edges.

TEST PROCEDURE

a) The EUT was placed on the top of a rotating table 3 meters away from the receiver antenna and 0.8 meters above the ground at a 9X9X6 anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b) The height of the equipment shall be 0.8 m; the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

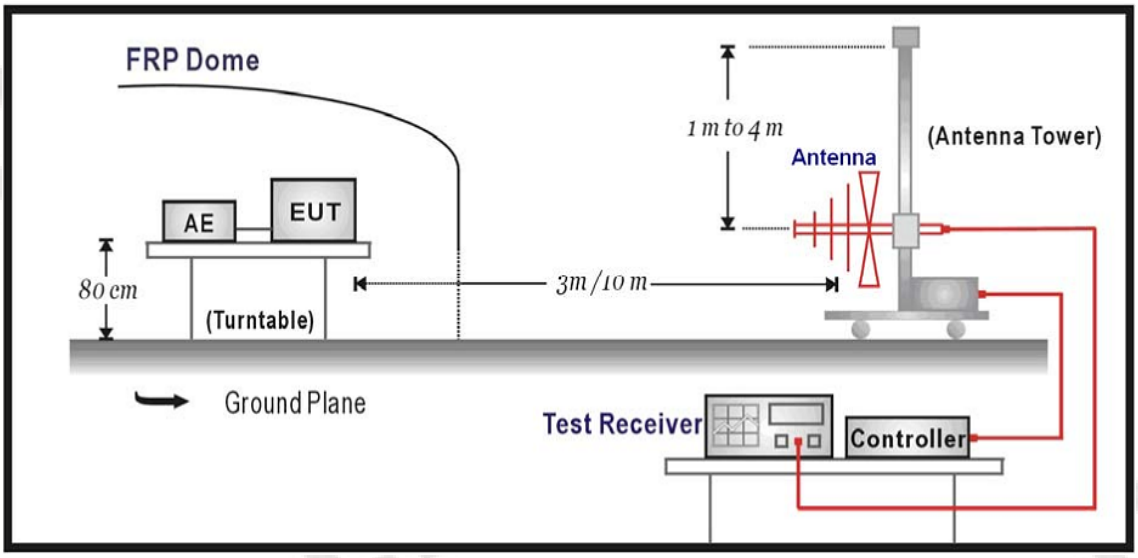
c) The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak/Average detector mode re-measured.

d) If the Peak Mode measured value compliance with and lower than Quasi Peak/Average Mode Limit, the EUT shall be deemed to meet QP/AV Limits and then no additional QP/AV Mode measurement performed.

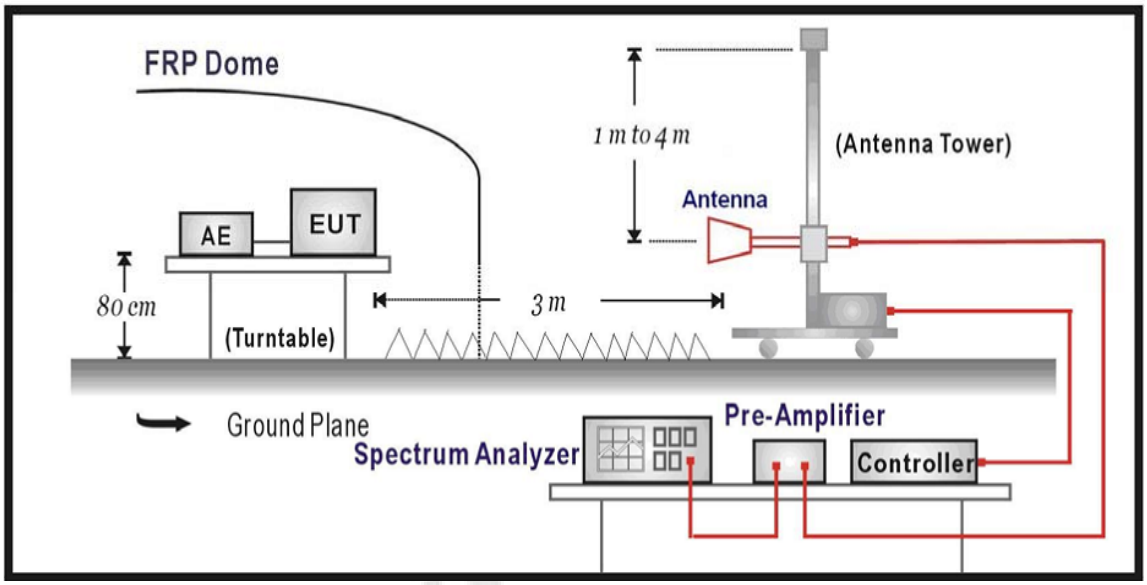
e) For the actual test configuration, please refer to the related Item –EUT Test Photos.

TEST SETUP

Below 1GHz



Above 1GHz



TEST RESULTS

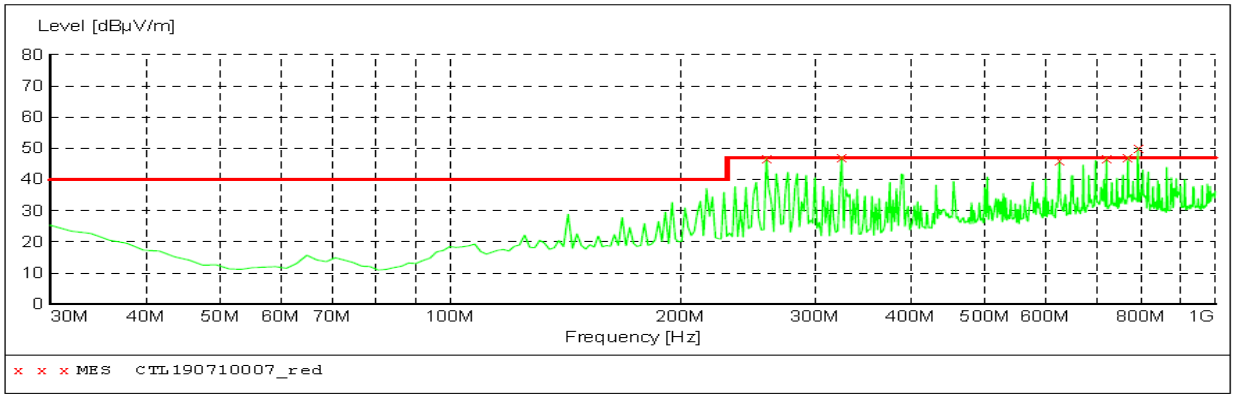
------Passed------

Please refer to the below test data:

Polarization:	Horizontal

SWEEP TABLE: "test (30M-1G)"

Short Description:			Field Strength		
Start Frequency	Stop Frequency	Detector	Meas. Time	IF Bandw.	Transducer
30.0 MHz	1.0 GHz	MaxPeak	300.0 ms	120 kHz	JB1



MEASUREMENT RESULT: "CTL190710007_red"

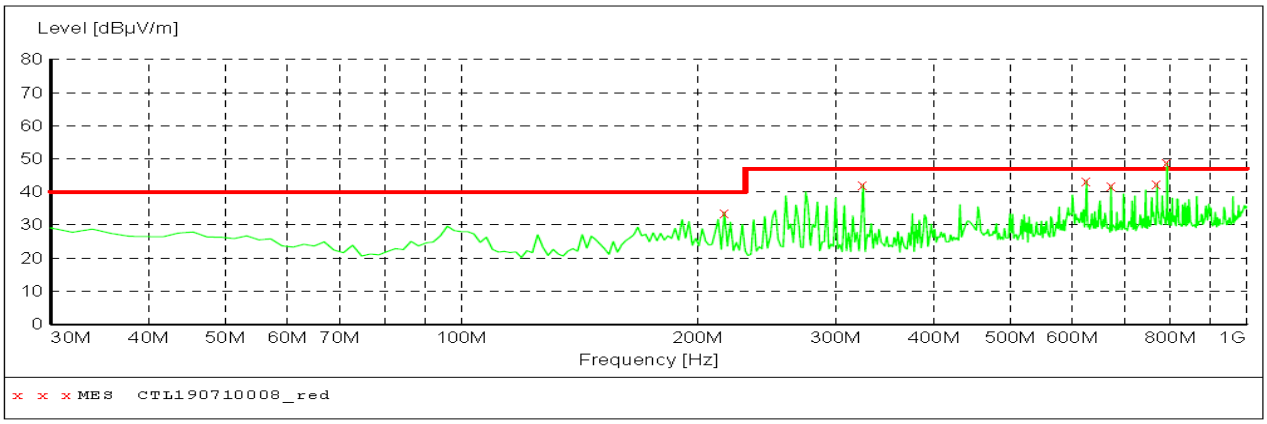
2019-7-10 10:15

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
258.920000	46.80	14.8	47.0	0.2	QP	0.0	0.00	HORIZONTAL
324.880000	46.10	16.7	47.0	0.9	QP	0.0	0.00	HORIZONTAL
625.580000	46.10	23.4	47.0	0.9	QP	0.0	0.00	HORIZONTAL
720.640000	46.80	24.5	47.0	0.2	QP	0.0	0.00	HORIZONTAL
769.140000	46.50	25.2	47.0	0.5	QP	0.0	0.00	HORIZONTAL
792.420000	46.20	25.5	47.0	0.8	QP	0.0	0.00	HORIZONTAL

Polarization:	Vertical

SWEEP TABLE: "test (30M-1G)"

Short Description:			Field Strength		
Start Frequency	Stop Frequency	Detector	Meas. Time	IF Bandw.	Transducer
30.0 MHz	1.0 GHz	MaxPeak	300.0 ms	120 kHz	JB1



MEASUREMENT RESULT: "CTL190710008_red"

2019-7-10 10:22

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Azimuth deg	Polarization
216.240000	33.70	14.4	40.0	6.3	QP	0.0	0.00	VERTICAL
324.880000	42.20	16.7	47.0	4.8	QP	0.0	0.00	VERTICAL
625.580000	43.40	23.4	47.0	3.6	QP	0.0	0.00	VERTICAL
672.140000	41.70	23.9	47.0	5.3	QP	0.0	0.00	VERTICAL
769.140000	42.40	25.2	47.0	4.6	QP	0.0	0.00	VERTICAL
792.420000	45.80	25.5	47.0	1.2	QP	0.0	0.00	VERTICAL

Note Above 1-6GHz have been tested and found no emission except floor noise

3.2 EMC IMMUNITY TEST

3.2.1 Immunity Performance criteria

A. General Requirements (ETSI EN 301489-1):

The performance criteria criteria are used to take a decision on whether radio equipment passes or fails immunity tests.

For the purpose of the present document four categories of performance criteria apply:

- Performance criteria for continuous phenomena applied to transmitters and receivers
- Performance criteria for transient phenomena applied to transmitters and receivers
- Performance criteria for equipment which does not provide a continuous communication link
- Performance criteria for ancillary equipment tested on a stand alone basis

(1) Performance criteria for continuous phenomena applied to transmitters and receivers
If no further details are given in the relevant part of ETSI EN 301 489 series [i.13] dealing with the particular type of radio equipment, the following general performance criteria for continuous phenomena shall apply.

During and after the test, the equipment shall continue to operate as intended. No degradation of performance or loss of function is allowed below a permissible performance level specified by the manufacturer when the equipment is used as intended. In some cases this permissible performance level may be replaced by a permissible loss of performance.

During the test the EUT shall not unintentionally transmit or change its actual operating state and stored data.

If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be deduced from the product description and documentation and what the user may reasonably expect from the equipment if used as intended.

(2) Performance criteria for transient phenomena applied to transmitters and receivers
If no further details are given in the relevant part of ETSI EN 301 489 series [i.13] dealing with the particular type of radio equipment, the following general performance criteria for transient phenomena shall apply.

For surges applied to symmetrically operated wired network ports intended to be connected directly to outdoor lines the following criteria applies:

f) For products with only one symmetrical port intended for connection to outdoor lines, loss of function is allowed, provided the function is self-recoverable, or can be restored by the operation of the controls by the user in accordance with the manufacturer's instructions. A SW reboot is not allowed. Information stored in non-volatile memory, or protected by a battery backup, shall not be lost.

g) For products with more than one symmetrical port intended for connection to outdoor lines, loss of function on the port under test is allowed, provided the function is self-recoverable. A SW reboot is not allowed. Information stored in non-volatile memory, or protected by a battery backup, shall not be lost.

For all other ports the following applies:

h) After the test, the equipment shall continue to operate as intended. No degradation of performance or loss of function is allowed below a permissible performance level specified by the manufacturer, when the equipment is used as intended. In some cases this permissible performance level may be replaced by a permissible loss of performance.

i) During the EMC exposure to an electromagnetic phenomenon, a degradation of performance is, however, allowed. No change of the actual mode of operation (e.g. unintended transmission) or stored data is allowed.

j) If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be deduced from the product description and documentation and what the user may reasonably expect from the equipment if used as intended.

(3) Performance criteria for equipment which does not provide a continuous communication link

For radio equipment which does not provide a continuous communication link, the performance criteria described in clauses 6.1 and 6.2 are not appropriate, in these cases the manufacturer shall declare, for inclusion in the test report, his own specification for an acceptable level of performance or degradation of performance during and/or after the immunity tests. The performance specification shall be included in the product description and documentation. The related specifications set out in clause 5.3 have also to be taken into account.

The performance criteria specified by the manufacturer shall give the same degree of immunity protection as called for in clauses 6.1 and 6.2.

(4) Performance criteria for ancillary equipment tested on a stand alone basis

If ancillary equipment is intended to be tested on a stand alone basis, the performance criteria described in clauses 6.1 and 6.2 are not appropriate, in these cases the manufacturer shall declare, for inclusion in the test report, his own specification for an acceptable level of performance or degradation of performance during and/or after the immunity tests. The performance specification shall be included in the product description and documentation. The related specifications set out in clause 5.3 have also to be taken into account.

The performance criteria specified by the manufacturer shall give the same degree of immunity protection as called for in clauses 6.1 and 6.2.

B. EN301489-17

General performance criteria

• Performance criteria A for immunity tests with phenomena of a continuous nature;

• Performance criteria B for immunity tests with phenomena of a transient nature;

• Performance criteria C for immunity tests with power interruptions exceeding a certain time.

The equipment shall meet the minimum performance criteria as specified in the following.

Criteria	During test	After test
A	Shall operate as intended. (see note 1). Shall be no loss of function. Shall be no unintentional transmissions.	Shall operate as intended. Shall be no degradation of performance (see note 3) Shall be no loss of function. Shall be no loss of stored data or user programmable functions.
B	May show loss of function (one or more). May show degradation of performance (see note 2). Shall be no unintentional transmissions.	Functions shall be self-recoverable. Shall operate as intended after recovering. Shall be no degradation of performance (see note 3) Shall be no loss of stored data or user programmable functions.
C	May be loss of function (one or more).	Functions shall be recoverable by the operator. Shall operate as intended after recovering. Shall be no degradation of performance (see note 3).
NOTE 1: Operate as intended during the test allows a level of degradation not below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance.		

If the minimum performance level or the permissible performance degradation is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.

NOTE 2:
Degradation of performance during the test is understood as a degradation to a level not below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance.

If the minimum performance level or the permissible performance degradation is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.

NOTE 3:
No degradation of performance after the test is understood as no degradation below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance. After the test no change of actual operating data or user retrievable data is allowed.

If the minimum performance level or the permissible performance degradation is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.

Performance criteria for Continuous phenomena applied to Transmitters (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.

Performance criteria for Transient phenomena applied toTransmitters (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.

Performance criteria for Continuous phenomena applied to Receivers (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.

Performance criteria for Transient phenomena applied to Receivers (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.

3.2.2 Electrostatic Discharge

TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-2
Discharge Impedance:	330 ohm / 150 pF
Required Performance	B
Discharge Voltage:	Air Discharge:2kV/4kV/8kV (Direct) Contact Discharge:2kV/4kV (Direct/Indirect)
Polarity:	Positive & Negative
Number of Discharge:	Air Discharge: min. 10 times at each test point Contact Discharge: min. 200 times in total
Discharge Period:	1 second minimum

TEST PROCEDURE

The test generator necessary to perform direct and indirect application of discharges to the EUT in the following manner:

a) Contact discharge was applied to conductive surfaces and coupling planes of the EUT. During the test, it was performed with single discharges. For the single discharge time between successive single discharges was at least 1 second. The EUT shall be exposed to at least 200 discharges, 100 each at negative and positive polarity, at a minimum of four test points. One of the test points shall be subjected to at least 50 indirect discharges to the center of the front edge of the horizontal coupling plane. The remaining three test points shall each receive at least 50 direct contact discharges.

If no direct contact test points are available, then at least 200 indirect discharges shall be applied in the indirect mode. Test shall be performed at a maximum repetition rate of one discharge per second.

Vertical Coupling Plane (VCP):

The coupling plane, of dimensions 0.5m x 0.5m, is placed parallel to, and positioned at a distance 0.1m from, the EUT, with the Discharge Electrode touching the coupling plane. The four faces of the EUT will be performed with electrostatic discharge.

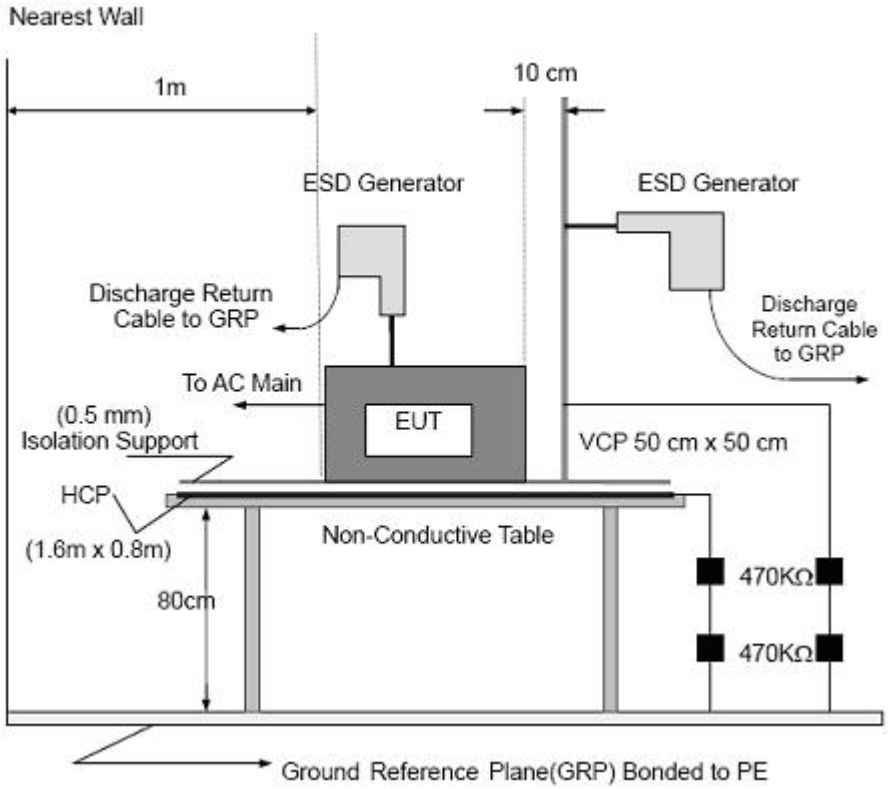
Horizontal Coupling Plane (HCP):

The coupling plane is placed under to the EUT. The generator shall be positioned vertically at a distance of 0.1m from the EUT, with the Discharge Electrode touching the coupling plane. The four faces of the EUT will be performed with electrostatic discharge.

b) Air discharges at insulation surfaces of the EUT. It was at least ten single discharges with positive and negative at the same selected point.

c) For the actual test configuration, please refer to the related Item –EUT Test Photos.

TEST SETUP



Note:

TABLE-TOP EQUIPMENT

The configuration consisted of a wooden table 0.8 meters high standing on the Ground Reference Plane. The GRP consisted of a sheet of aluminum at least 0.25mm thick, and 2.5 meters square connected to the protective grounding system. A Horizontal Coupling Plane (1.6m x 0.8m) was placed on the table and attached to the GRP by means of a cable with 940k total impedance. The equipment under test, was installed in a representative system as described in section 7 of IEC /EN 61000-4-2, and its cables were placed on the HCP and isolated by an insulating support of 0.5mm thickness. A distance of1-meter minimum was provided between the EUT and the walls of the laboratory and any other metallic structure.

FLOOR-STANDING EQUIPMENT

The equipment under test was installed in a representative system as described in section 7 of IEC/EN 61000-4-2, and its cables were isolated from the Ground Reference Plane by an insulating support of0.1-meter thickness. The GRP consisted of a sheet of aluminum that is at least 0.25mm thick, and 2.5meters square connected to the protective grounding system and extended at least 0.5 meters from the EUT on all sides.

TEST RESULTS

------Passed------

Please refer to the below test data:

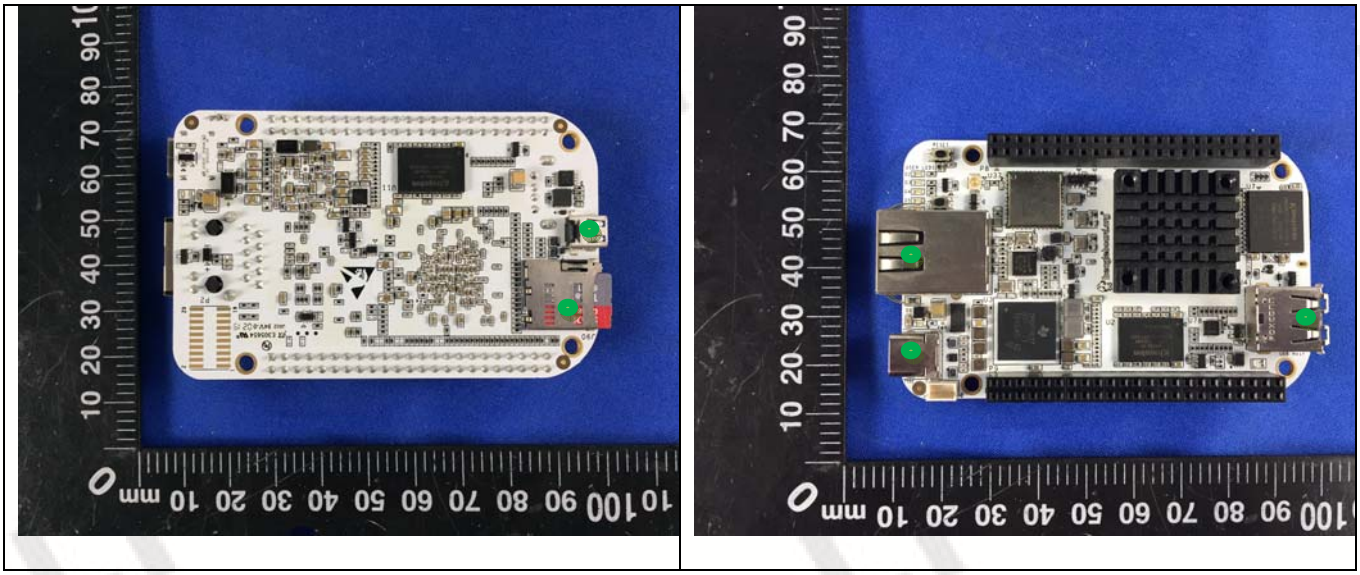
Direct discharge				
Type of discharge	Discharge voltage (KV)	Observations Performance	Criteria Level	Result
Contact discharge	±2	A	B	Pass
	±4	B	B	
Air discharge	±2	N/A	N/A	N/A
	±4	N/A	N/A	
	±8	N/A	N/A	
Indirect discharge				
Type of discharge	Discharge voltage (KV)	Observations Performance	Criteria Level	Result
HCP (6 sides)	±2	A	B	Pass
	±4	A	B	
VCP (4 sides)	±2	A	B	
	±4	A	B	

Note1: The EUT loss communication link a while and it can self-recoverable after test.

Note2: EUT samples belong to the development board products, so only indirect contact and direct contact are done.

Description of Discharge Point

Remark: CD point- Green AD point – Red



3.2.3 RF Electromagnetic Field

TEST SPECIFICATION

Basic Standard:	IEC/EN 61000-4-3
Required Performance	A
Frequency Range:	80 MHz - 6000 MHz
Field Strength:	3 V/m
Modulation:	1kHz Sine Wave, 80%, AM Modulation
Frequency Step:	1 % of fundamental
Polarity of Antenna:	Horizontal and Vertical
Test Distance:	3 m
Antenna Height:	1.5 m
Dwell Time:	at least 3 seconds

TEST PROCEDURE

The EUT and support equipment, which are placed on a table that is 0.8 meter above ground and the testing was performed in a fully-anechoic chamber. The testing distance from antenna to the EUT was 3 meters. The other condition as following manner:

a) The field strength level was 3V/m.

b) The frequency range is swept from 80 MHz to 6000 MHz with the signal 80% amplitude modulated with a 1 kHz sine wave. The rate of sweep did not exceed 1.5x 10-3 decade/s. Where the frequency range is swept incrementally, the step size was 1% of fundamental.

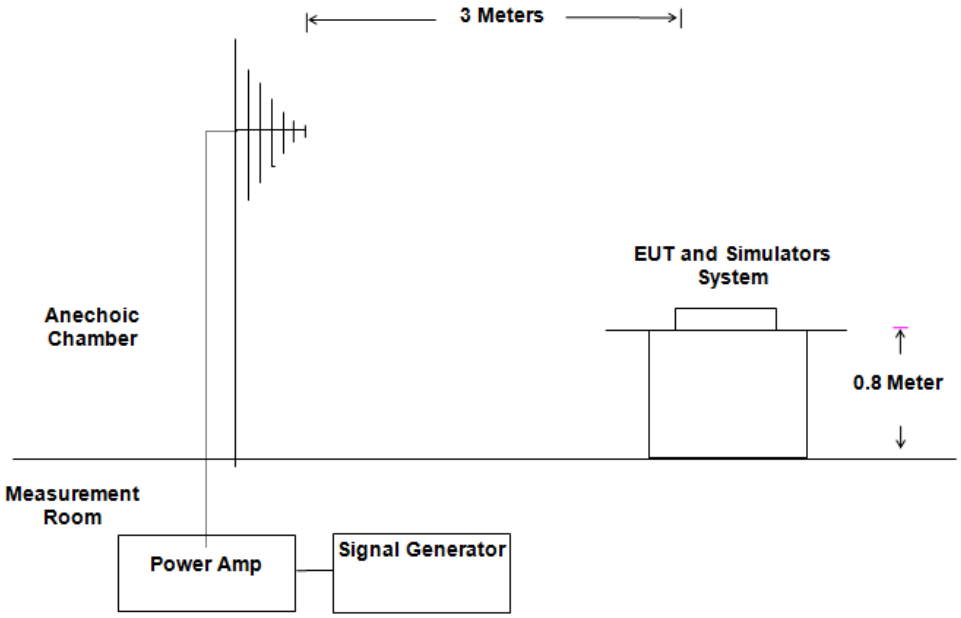
c) Sweep Frequency 900 MHz, with the Duty Cycle:1/8 and Modulation: Pulse 217 Hz(if applicable)

d) The dwell time at each frequency shall be not less than the time necessary for the EUT to be able to respond.

e) The test was performed with the EUT exposed to both vertically and horizontally polarized fields on each of the four sides.

f) For the actual test configuration, please refer to the related Item –EUT Test Photos.

TEST SETUP



Note:

TABLE-TOP EQUIPMENT

The EUT installed in a representative system as described in section 7 of IEC/EN 61000-4-3 was placed on a non-conductive table 0.8 meters in height. The system under test was connected to the power and signal wire according to relevant installation instructions.

FLOOR-STANDING EQUIPMENT

The EUT installed in a representative system as described in section 7 of IEC/EN 61000-4-3 was placed on a non-conductive wood support 0.1 meters in height. The system under test was connected to the power and signal wire according to relevant installation instructions.

TEST RESULTS

------Passed------

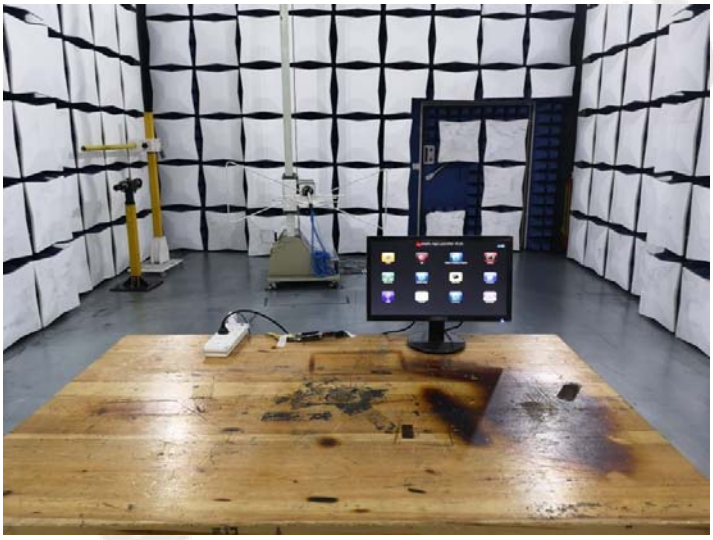
Please refer to the below test data:

Frequency Range (MHz)	RF Field Position	R.F. Field Strength	Azimuth	Observations Performance	Perform. Criteria	Result
80~6000	H / V	3 V/m (rms) AM Modulated 1000Hz, 80%	Front	A	A	PASS
			Rear			
			Left			
			Right			
			Above			
			Below			

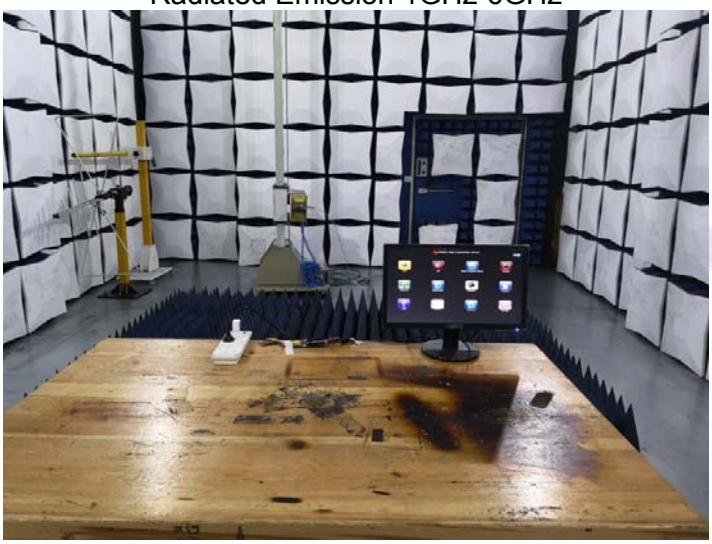
Note1: The EUT can maintain communication link and not operate unintentionally during the test also can operate without any loss of user control functions after test.

4 TEST SETUP PHOTOS

Radiated Emission 30MHz-1GHz

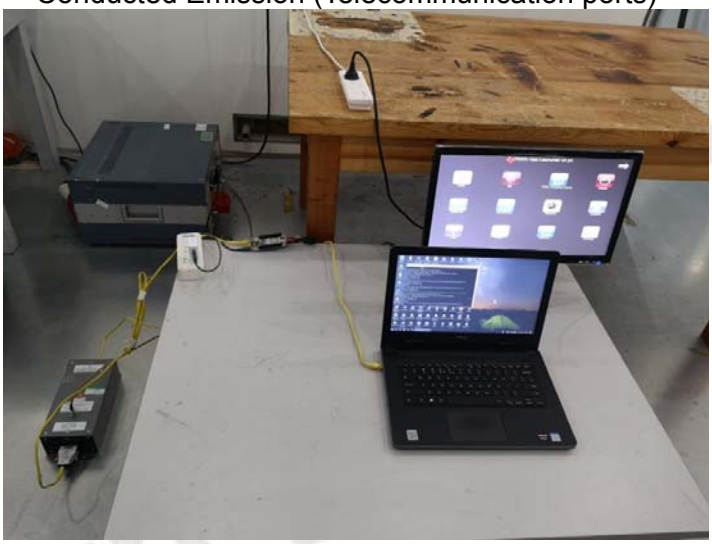


Radiated Emission 1GHz-6GHz



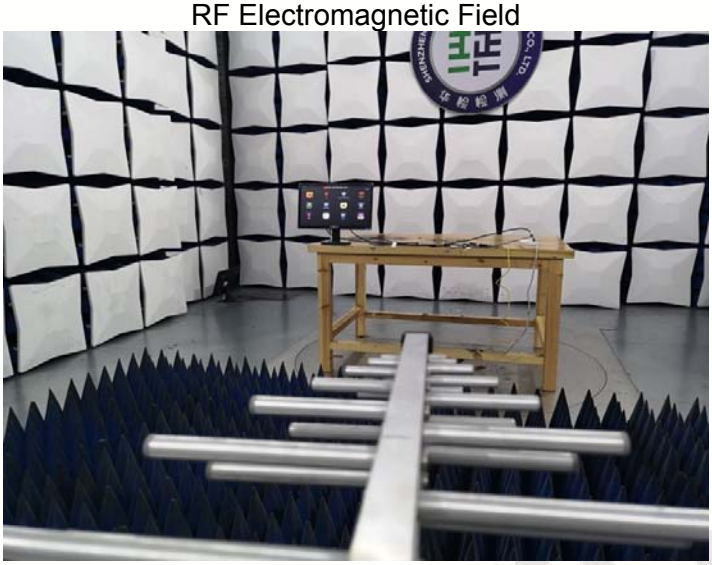
Conducted disturbance (AC main)

Conducted Emission (Telecommunication ports)

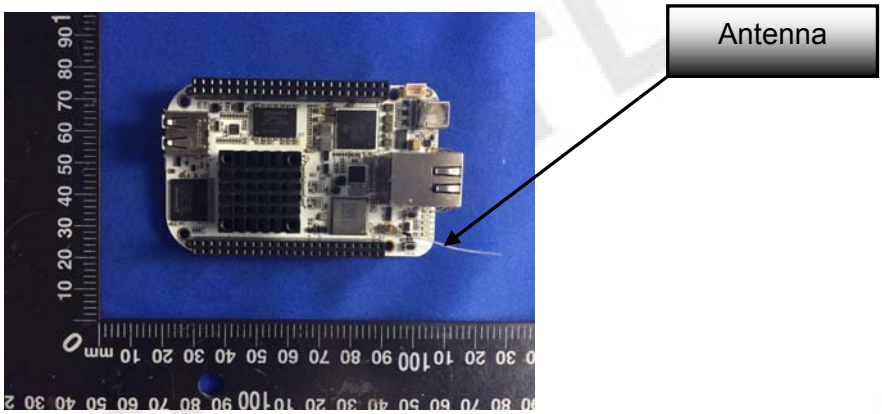


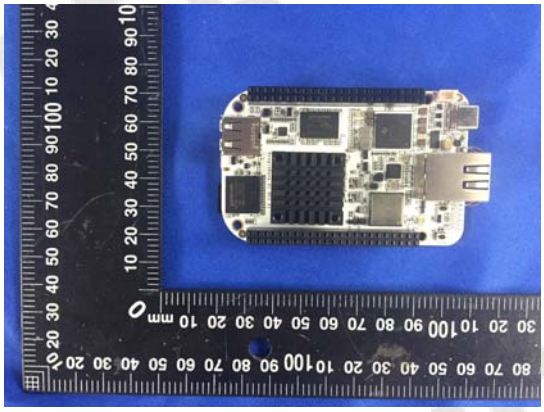
Electrostatic Discharge

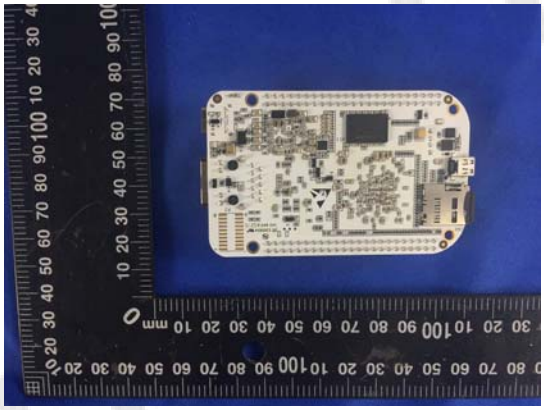
RF Electromagnetic Field

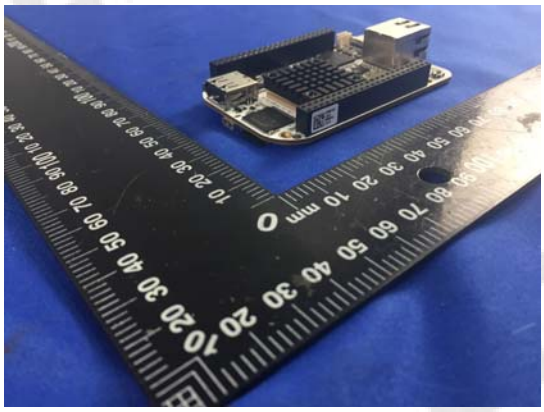


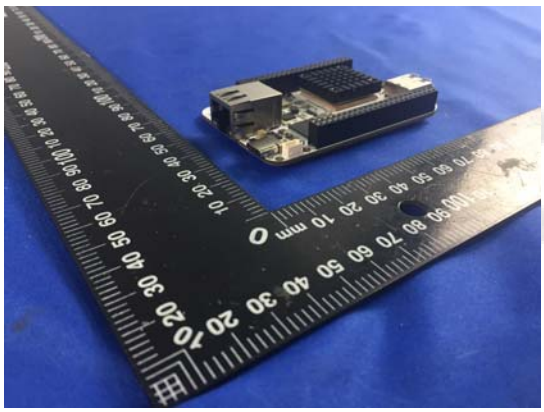
5 PHOTOS OF THE EUT

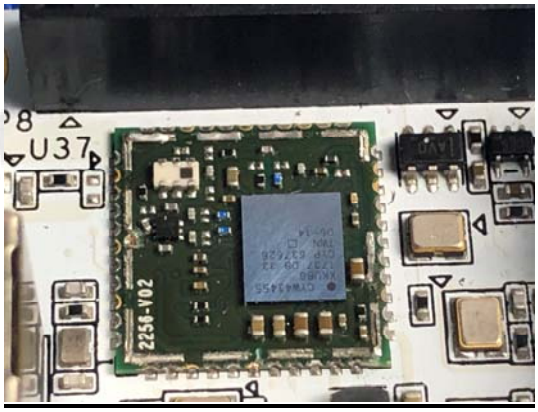












********** End of Report **********