Shenzhen CTL Testing Technology Co., Ltd.
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TEST REPORT

EN62311:2008

Report Reference No. ..... :	**CTL1906244051-WH**	
Compiled by: (position+printed name+signature)	Happy Guo (File administrators)	
Tested by: (position+printed name+signature)	Nice Nong (Test Engineer)	
Approved by: (position+printed name+signature)	Ivan Xie (Manager)	

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..... :	**EN62311:2008**
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**

EMF TEST REPORT

Test Report No. :	CTL1906244051-WH	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, Chinas.

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-WH	Tracy Qi

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1 TEST SUMMARY

1.1 Test Standards

EN62311: Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz – 300 GHz)

Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0Hz to 300GHz) (Official Journal L 197 of 30 July 1999).

1.2 Test Facility

1.2.1 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 22/EN 55022 requirements.

1.2.2 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.

1.3 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 acc. 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 acc. 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 Items	Measurement Uncertainty	Notes
Occupied Channel Bandwidth	±2%	(1)
Transmitter power conducted	0.57 dB	(1)
Transmitter power Radiated	2.20 dB	(1)
Conducted spurious emission	1.60 dB	(1)
Radiated spurious emission	2.20 dB	(1)
Temperature	±1℃	(1)
Humidity	±3%	(1)
DC and low frequency voltages	±1.5%	(1)
Time	±2%	(1)
Duty cycle	±2%	(1)

Note 1: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=1.96.

2 GENERAL INFORMATION

2.1 Environmental conditions

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

Temperature	Normal Temperature:	25°C
	High Temperature:	55°C
	Low Temperature:	-20°C
Voltage	Normal Voltage	5.00V
	High Voltage	5.75V
	Low Voltage	4.25V
Other	Relative Humidity	55 %
	Air Pressure	101 kPa

2.2 General Description of EUT

Product Name:	Beaglebone AI
Model/Type reference:	Beaglebone AI
Power supply:	DC 5.0V
Bluetooth:	
Version:	Supported Bluetooth 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
2.4GHz 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			
5GHz 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.

3 Method of measurement

Limit

Basic restriction for electric, magnetic and electromagnetic fields (0Hz to 300GHz)

Frequency range	Magnetic flux density (mT)	Current density (mA/m^2)	Whole body average SAR(W/kg)	Localised SAR (head and trunk)(W/kg)	Localised SAR (limbs) (W/kg)	Power density, S (W/m^2)
0Hz	40	--	--	--	--	--
>0-1Hz	--	8	--	--	--	--
1-4Hz	--	8/f	--	--	--	--
4-1000Hz	--	2	--	--	--	--
1000Hz-100kHz	--	f/500	--	--	--	--
100kHz-10MHz	--	f/500	0.08	2	4	--
10MHz-10GHz	--	--	0.08	2	4	--
10-300GHz	--	--	--	--	--	10

Notes:
1. f is the frequency in Hz.
2. The basic restriction on the current density is intended to protect against acute exposure effects on central nervous system tissues in the head and trunk of the body and includes a safety factor. The basic restrictions for ELF fields are based on established adverse effects on the central nervous system. Such acute effects are essentially instantaneous and there is no scientific justification to modify the basic restrictions for exposure of short duration. However, since the basic restriction refers to adverse effects on the central nervous system, this basic restriction may permit higher current densities in body tissues other than the central nervous system under the same exposure conditions.
3. Because of electrical inhomogeneity of the body, current densities should be averaged over a cross section of 1cm2 perpendicular to the current direction.
4. For frequencies up to 100 kHz, peak current density values can be obtained by multiplying the rms value by $\sqrt{2}$(=1.414). For pulses of duration t_p the equivalent frequency to apply in the basic restrictions should be calculated as=1/ ($2t_p$)
5. For frequencies up to 100kHz and for pulsed magnetic fields, the maximum current density associated with the pulses can be calculated from the rise/fall times and the maximum rate of change of magnetic flux density. The induced current density can then be compared with the appropriate basic restriction.
6. All SAR values are to be averaged over any six-minute period.
7. Localised SAR averaging mass is any 10g of contiguous tissue; the maximum SAR so obtained should be the value used for the estimation of exposure. These 10g of tissue are intended to be a mass of contiguous tissue with nearly homogeneous electrical properties. In specifying a contiguous mass of tissue, it is recognised that this concept can be used in computational dosimetry but may present difficulties for direct physical measurements. A simple geometry such as cubic tissue mass can be used provided that the calculated dosimetric quantities have conservation values relative to the exposure guidelines.
8. For pulses of duration tp the equivalent frequency to apply in the basic restrictions should be calculated as=1/($2t_p$). Additionally, for pulsed exposures, in the frequency range 0,3 to 10GHz and for localised exposure of the head, in order to limit and avoid auditory effects caused by thermoelastic expansion, an additional basic restriction is recommended. This is that SA should not exceed 2mJ kg-1 averaged over 10g of tissue.

Reference levels for electric, magnetic and electromagnetic fields (0Hz to 300GHz,unperturbed rms values)

Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field (uT)	Equivalent plane wave power density S_{eq}(W/m^2)
0-1Hz	--	3.2×10^4	4×10^4	--
1-8Hz	10000	$3.2\times10^4/f^2$	$4\times10^4/f^2$	--
8-25Hz	10000	4000/f	5000/f	--
0.025-0.8KHz	250/f	4/f	5/f	--
0.8-3KHz	250/f	5	6.25	--
3-150KHz	87	5	6.25	--
0.15-1MHz	87	0.73/f	0.92/f	--
1-10MHz	$87/f^{1/2}$	0.73/f	0.92/f	--
10-400MHz	28	0.073	0.092	2
400-2000MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$0.0046f^{1/2}$	f/200
2-300GHz	61	0.16	0.20	10

Notes: 1. As indicated in the frequency range column.

2. For frequencies between 100kHz and 10GHz, S_{eq}, E^2, H^2 and B^2 are to be averaged over any six-minute period.

3. For frequencies exceeding 10GHz, S_{eq}, E^2, H^2 and B^2 are to be averaged over any $68/f^{1.05}$-minute period (.in GHz).

4. No E-field value is provided for frequencies <1Hz, which are effectively static electric fields. For most people the annoying perception of surface electric charges will not occur at field strengths less than 20kV/m. Spark discharges causing stress or annoyance should be avoided.

EMF Assessment Model

Predication of EMF limit at a given distance
Equation from page 26 of EN 62311, Edition 2008

$$E=\eta_0 H=\frac{\sqrt{30PG(\theta,\phi)}}{r}$$

Where:
E: E-field strength (V/m)
P: power input to antenna (Watt)
G: is the antenna gain relative to an isotropic antenna;
θ,ϕ: are elevation and azimuth angles to point of investigation;
r: is the distance from observation point to the antenna;
η_0: is the characteristic impedance of free space.

Test Result

From the maximum EUT RF output power, the minimum mobile separation distance, r=20cm.

Bluetooth:

Test Frequency (MHz)	Minimum Separation Distance (cm)	Max.Output Power (dBm)	Max.Output Power (W)	Antenna Gain (Nemeric)	E-field strength Limit (V/m)	E-field strength At 20 cm (V/m)
2402	20	7.67	0.0058	1.4125	2.4890	61
2441	20	3.51	0.0022	1.4125	1.5418	61
2480	20	3.81	0.0024	1.4125	1.5960	61

BLE:

Test Frequency (MHz)	Minimum Separation Distance (cm)	Max.Output Power (dBm)	Max.Output Power (W)	Antenna Gain (Nemeric)	E-field strength Limit (V/m)	E-field strength At 20 cm (V/m)
2402	20	2.28	0.0017	1.4125	1.3382	61
2440	20	2.15	0.0016	1.4125	1.3183	61
2480	20	1.65	0.0015	1.4125	1.2446	61

2.4GHz WIFI:

Test Frequency (MHz)	Minimum Separation Distance (cm)	Max.Output Power (dBm)	Max.Output Power (W)	Antenna Gain (Nemeric)	E-field strength Limit (V/m)	E-field strength At 20 cm (V/m)
2412	20	15.89	0.0388	1.4125	6.4125	61
2442	20	15.00	0.0316	1.4125	5.7880	61
2472	20	14.88	0.0308	1.4125	5.7086	61

5GHz WIFI:

Test Frequency (MHz)	Minimum Separation Distance (cm)	Max.Output Power (dBm)	Max.Output Power (W)	Antenna Gain (Nemeric)	E-field strength Limit (V/m)	E-field strength At 20 cm (V/m)
5180	20	7.54	0.0057	1.4125	2.4521	61
5320	20	7.50	0.0056	1.4125	2.4408	61
5500	20	7.35	0.0054	1.4125	2.3990	61
5700	20	7.25	0.0053	1.4125	2.3715	61
5745	20	3.01	0.0020	1.4125	1.4556	61
5785	20	2.59	0.0018	1.4125	1.3869	61
5825	20	2.19	0.0017	1.4125	1.3244	61

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