EMC / EMI Test Report

As per

CISPR 32:2015 / EN 55032:2015, CISPR 24:2010/EN 55024:2010, FCC Part 15 Subpart B:2017 & ICES-003:2016

Emissions & Immunity for

Multimedia Class B Equipment

on the

BeagleBone Blue, A2

Issued by:

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Testing produced for

See Appendix A for full client & EUT details.

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Report Scope

This report addresses the EMC verification testing and test results of the **BeagleBone**, Model: **Blue, Rev. A2**, herein referred to as EUT (Equipment Under Test). The EUT was tested for emissions and immunity compliance against the following standards:

EN 55032:2015/CISPR 32:2015

EN 55024:2010/CISPR 24:2010

FCC Part 15 Subpart B:2017

ICES-003:2016

Radiated emissions, and immunity testing was evaluated on the EUT. Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

For a more detailed list of the standards and the revision used, see the "Applicable Standards, Specifications and Methods" section of this report.

This report does not imply product endorsement by any government, accreditation agency, or TÜV SÜD Canada Inc.

Opinions or interpretations expressed in this report, if any, are outside the scope of TÜV SÜD Canada Inc. accreditations. Any opinions expressed do not necessarily reflect the opinions of TÜV SÜD Canada Inc., unless otherwise stated.

Summary

The results contained in this report relate only to the item(s) tested.

Equipment Under Test (EUT)	BeagleBone Blue, A2
EUT passed all tests performed	Yes
Testing conducted by	Glen Westwell

For testing dates, see 'Testing Environmental Conditions and Dates'.

Test Results Summary

Standard/ Method	Description	Criteria	Class / Level	Result
EN 55032/ CISPR 32 FCC 15 - ICES 003	Power Line Conducted Emissions	N/A	Class B	N/A
EN 55032/ CISPR 32 FCC 15 - ICES 003	Radiated Emissions	N/A	Class B	Pass
EN 61000-3-2	Power Line Harmonic Emissions	N/A	Class A	N/A
EN 61000-3-3	Flicker Emissions	N/A	--	N/A
EN 55024/ EN 61000-4-2	Electro-Static Discharge	B	±4kV Contact ±8kV Air	Pass
EN 55024/ EN 61000-4-3	Radiated Field Immunity	A	3 V/m, 80 MHz – 1 GHz	Pass
EN 55024/ EN 61000-4-4	Electrical Fast Transients (Bursts)	B	±1kV - Mains ±0.5kV - I/O	N/A
EN 55024/ EN 61000-4-5	Surge Immunity	B	±1kV Line - Line ±2kV Line - Ground	N/A
EN 55024/ EN 61000-4-6	Conducted RF Immunity	A	3 Vrms, 150 kHz – 80 MHz	N/A
EN 55024/ EN 61000-4-8	Power Frequency Magnetic Field	A	1 A/m (3 A/m Tested)	Pass
EN 55024/ EN 61000-4-11	Voltage Dips and Interrupts	B/C	Various	N/A
Overall Result				**Pass**

If the product as tested complies with the specification or requirement, the EUT is deemed to comply and is issued a 'PASS' grade. If not, 'FAIL' grade is issued.

Notes, Justifications, or Deviations

The following justifications for tests not performed or deviations from the above listed specifications apply:

Client has stated that this equipment is consider a DC device and that the EUT is not intended to be used with a AC/DC power adaptor as part of their system.
The following tests are therefore not applicable for a DC powered device:

- Conducted Emissions
- Power Line Harmonics Emissions
- Flicker Emissions
- Electrical Fast Transients (Bursts)
- Surge Immunity
- Conducted RF Immunity
- Voltage Dips and Interrupts

The client has indicated that the EUT / PCB will be ESD Sensitive and is marked with the ESD Sensitive marking on the silk screen of the PCB.

A later revision of the standard may have been substituted in place of the previous dated referenced revision. The year of the specification used is listed under applicable standards. Using the later revision accomplishes the goal of ensuring compliance to the intent of the previous specification, while allowing the laboratory to incorporate the extensions and clarifications made available by a later revision.

Sample Calculation(s)

Radiated Emission Test

Margin = Limit – (Received Signal + Antenna Factor + Cable Loss – Pre-Amp Gain)
Margin = 50dBµV/m – (50dBµV + 10dB + 2.5dB – 20dB)
Margin = 7.5 dB (pass)

Power Line Conducted Emission Test

Margin = Limit – (Received Signal + Attenuation Factor + Cable Loss + LISN Factor)
Margin = 73.0dBµV – (50dBµV + 10dB + 2.5dB + 0.5dB)
Margin = 10.0 dB (pass)

Applicable Standards, Specifications and Methods

ANSI C63.4:2014	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
CFR47 FCC Part 15 Subpart B:2017	Code of Federal Regulations - Radio Frequency Devices
ICES-003, Issue 6 2016	Information Technology Equipment (ITE) - Limits and Methods of Measurement
EN55032:2015/ CISPR32:2015	Electromagnetic Compatibility of Multimedia Equipment – Emission Requirements
EN55024:2010/ CISPR24:2010	Information Technology Equipment - Immunity Characteristics - Limits and Methods of Measurement
CISPR 16-2-3:2010/A2:2014	Specification for Radio Disturbance and Immunity Measuring Apparatus and Methods - Part 2-3: Methods of Measurement of Disturbances and Immunity - Radiated Disturbance Measurements
IEC/EN 61000-3-2:2014	Limits for Harmonic Current Emissions (equipment input current ≤ 16A per phase)
IEC/EN 61000-3-3:2013	Limitation of Voltage Changes, Voltage Fluctuations and Flicker in Public Low-Voltage Supply Systems, for equipment with rated current ≤ 16A per phase and not subject to conditional connection.
IEC 61000-4-2:2008 EN 61000-4-2:2009	Testing and Measurement Techniques - Electrostatic Discharge Immunity Test
IEC/EN 61000-4-3:2006/ A2:2010	Testing and Measurement Techniques - Radiated, Radio-Frequency, Electromagnetic Field Immunity Test
IEC/EN 61000-4-4:2004	Testing and Measurement Techniques - Electrical Fast Transient/Burst Immunity Test
IEC 61000-4-5:2005 EN 61000-4-5:2006	Testing and Measurement Techniques - Surge Immunity Test
IEC 61000-4-6:2008 EN 61000-4-6:2009	Testing and Measurement Techniques - Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields
IEC 61000-4-8:2009 EN 61000-4-8:2010	Testing and Measurement Techniques - Power Frequency Magnetic Field Immunity Test
IEC/EN 61000-4-11:2004	Testing and Measurement Techniques - Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests
ISO 17025:2005	General Requirements for the Competence of Testing and Calibration Laboratories

Document Revision Status

Revision 0, March 7, 2017
Initial Release

Definitions and Acronyms

The following definitions and acronyms are applicable in this report.
See also ANSI C63.14.

AM – Amplitude Modulation
CDN – Coupling Decoupling Network
EFT – Electrical Fast Transients
ESD – Electro-Static Discharge
HCP – Horizontal Coupling Plane
VCP – Vertical Coupling Plane
LISN – Line Impedance Stabilization Network
NCR – No Calibration Required
NSA – Normalized Site Attenuation
N/A – Not Applicable
RF – Radio Frequency

AE – Associated Equipment. Equipment needed to exercise and/or monitor the operation of the EUT.

Class A Device – A device that is marketed for use in a commercial, industrial or business environment. A 'Class A' device should not be marketed for use by the general public. A 'Class A' device should contain a warning notice in the user manual stating that it could cause radio interference. For example: "**Warning**: Operation of this equipment in a residential environment could cause radio interference."

Class B Device – A device that is marketed for use in a residential environment and may also be used in a commercial, business or industrial environments. NOTE: A residential environment is an environment where the use of broadcast radio and television receivers may be expected within a distance of 10m of the device concerned.

EMC – Electro-Magnetic Compatibility. The ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

EMI – Electro-Magnetic Immunity. The ability to maintain a specified performance when the equipment is subjected to disturbance (unwanted) signals of specified levels.

EUT – Equipment Under Test. A device or system being evaluated for compliance that is representative of a product to be marketed.

ITE – Information Technology Equipment. Has a primary function of entry, storage, display, retrieval, transmission, processing, switching, or control of data and/or telecommunication messages and which may be equipped with one or more ports typically for information transfer.

Antenna Port – Port, other than a broadcast receiver tuner port, for connection of an antenna used for intentional transmission and/or reception of radiated RF energy.

Broadcast Receiver Tuner Port – Port intended for the reception of a modulated RF signal carrying terrestrial, satellite and/or cable transmissions of audio and/or video broadcast and similar services.

Optical Fiber Port – Port at which an optical fiber is connected to an equipment.

Signal/Control Port – Port intended for the interconnection of components of a EUT, or between a EUT and local AE and used in accordance with relevant functional specifications (for example for the maximum length of cable connected to it).
(Examples include: RS-232, USB, HDMI, Fire Wire)

Wired Network Port – Point of connection for voice, data and signaling transfers intended to interconnect widely dispersed systems by direct connection to a single-user or multi-user communication network.
(Examples include: CATV, PSTN, ISDN, xDSL, LAN and similar networks)

EMC Test Plan – An EMC test plan established prior to testing. See 'Appendix A – EUT & Client Provided Details'.

Testing Facility

Testing for EMC on the EUT was carried out at TÜV SÜD Canada testing lab near Toronto, Ontario. The testing lab has a calibrated 3m semi-anechoic chamber which allows measurements on a EUT that has a maximum width or length of up to 2m and a height of up to 3m. The chamber is equipped with a turntable that is capable of testing devices up to 3300lb in weight. This facility is capable of testing products that are rated for 120Vac and 240Vac single phase, or devices that are rated for a 208Vac 3 phase input. DC capability is also available for testing. The chamber is equipped with a mast that controls the polarization and height of the antenna. Control of the mast occurs in the control room adjoining the shielded chamber. Radiated emission measurements are performed using a BiLog antenna and a Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN and using the Vertical Ground plane if applicable.

Calibrations and Accreditations

The 3m semi-anechoic chamber is registered with Federal Communications Commission (FCC, CA6844), Industry Canada (IC, 6844A-3) and Voluntary Control Council for Interference (VCCI, R-4023, G-506, C-4498, and T-1246). This chamber was calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. The NSA data is kept on file at TÜV SÜD Canada. For radiated susceptibility testing, a 16 point field calibration has been performed on the chamber. The field uniformity data is kept on file at TÜV SÜD Canada. TÜV SÜD Canada Inc. is accredited to ISO 17025 by A2LA with Testing Certificate #2955.02. The laboratory's current scope of accreditation listing can be found as listed on the A2LA website. All measuring equipment is calibrated on an annual or bi-annual basis as listed for each respective test.

Testing Environmental Conditions and Dates

Following environmental conditions were recorded in the facility during time of testing:

Date	Test	Initials	Temperature (ºC)	Humidity (%)	Pressure (kPa)
7th Feb to 7th March 2017	Radiated Emissions	GW	21 – 24	40 – 51	98.0 – 102.0
8th Feb 2017	Electro-Static Discharge	GW	21 – 24	40 – 51	98.0 – 102.0
7th Feb 2017	Radiated Field Immunity	GW	21 – 24	40 – 51	98.0 – 102.0
7th Feb 2017	Power Frequency Magnetic Field	GW	21 – 24	40 – 51	98.0 – 102.0

Detailed Test Result Section

Radiated Emissions

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard and measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

Limits & Method

The limits and method are as defined in ANSI C63.4 and CISPR 32, EN55032, 47 CFR FCC Part 15 Section 15.109(g), and ICES-003 Issue 6 Section 6.2:

CLASS B

Frequency Range[a]	Quasi-Peak Limits - 10m[b]	Quasi-Peak Limits - 3m[b]
30 MHz – 230 MHz	30 dBµV/m	40 dBµV/m
230 MHz – 1 GHz	37 dBµV/m	47 dBµV/m

CISPR 32 / EN 55032,

Frequency Range[a]	Average Limit - 3m[c]	Peak Limit - 3m[d]
1 GHz – 3 GHz	50 dBµV/m	70 dBµV/m
3 GHz – 6 GHz	54 dBµV/m	74 dBµV/m

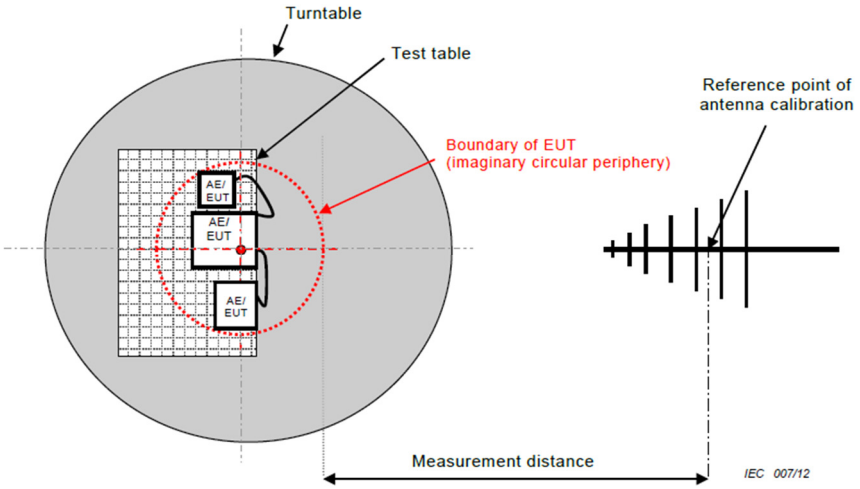
FCC Part 15 Subpart B,

Frequency Range[a]	Average Limit - 3m[c]	Peak Limit - 3m[d]
1 GHz and Up	54 dBµV/m	74 dBµV/m

[a]The frequency range scanned is in accordance to CISPR 32 Table 1 and FCC Part 15 Section 15.33(b).
[b]Limit is with a resolution bandwidth of 120 kHz, a video bandwidth at least three times greater than the resolution bandwidth, and using a Quasi-Peak detector.
[c]Limit is with a resolution bandwidth of 1 MHz and using an Average detector.
[d]Limit is with a resolution bandwidth of 1 MHz, a video bandwidth at least three times greater than the resolution bandwidth, and using a Peak detector.

Based on ANSI C63.4 Section 4.2 and CISPR 32 Annex C.3, if the Peak detector measurements do not exceed the Quasi-Peak limits, where defined, then the EUT is deemed to have passed the requirements.

Typical Radiated Emissions Setup



Note: In accordance with CISPR 32 Annex C, testing was performed at a 3 meter test distance.

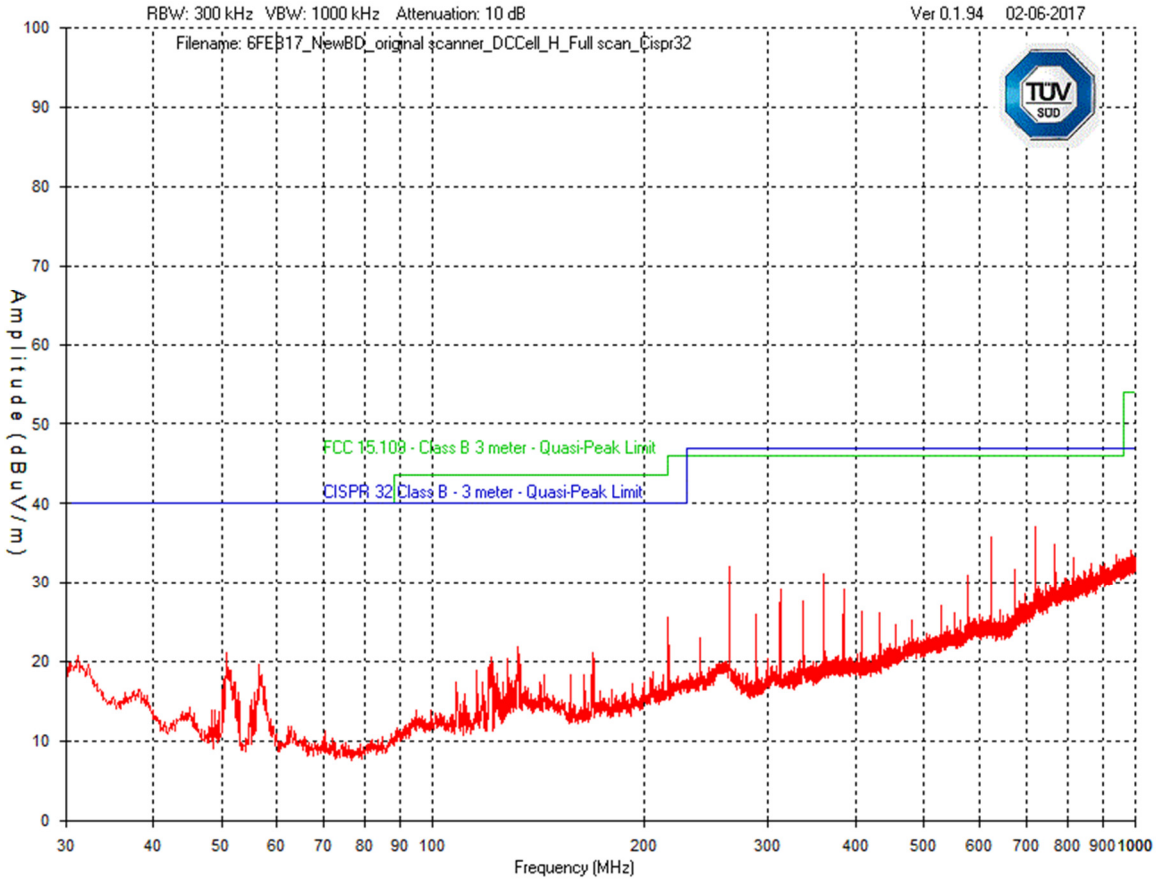
Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is ±4.25dB for 30MHz – 1GHz and ±4.93dB for 1GHz – 18GHz with a 'k=2' coverage factor and a 95% confidence level.

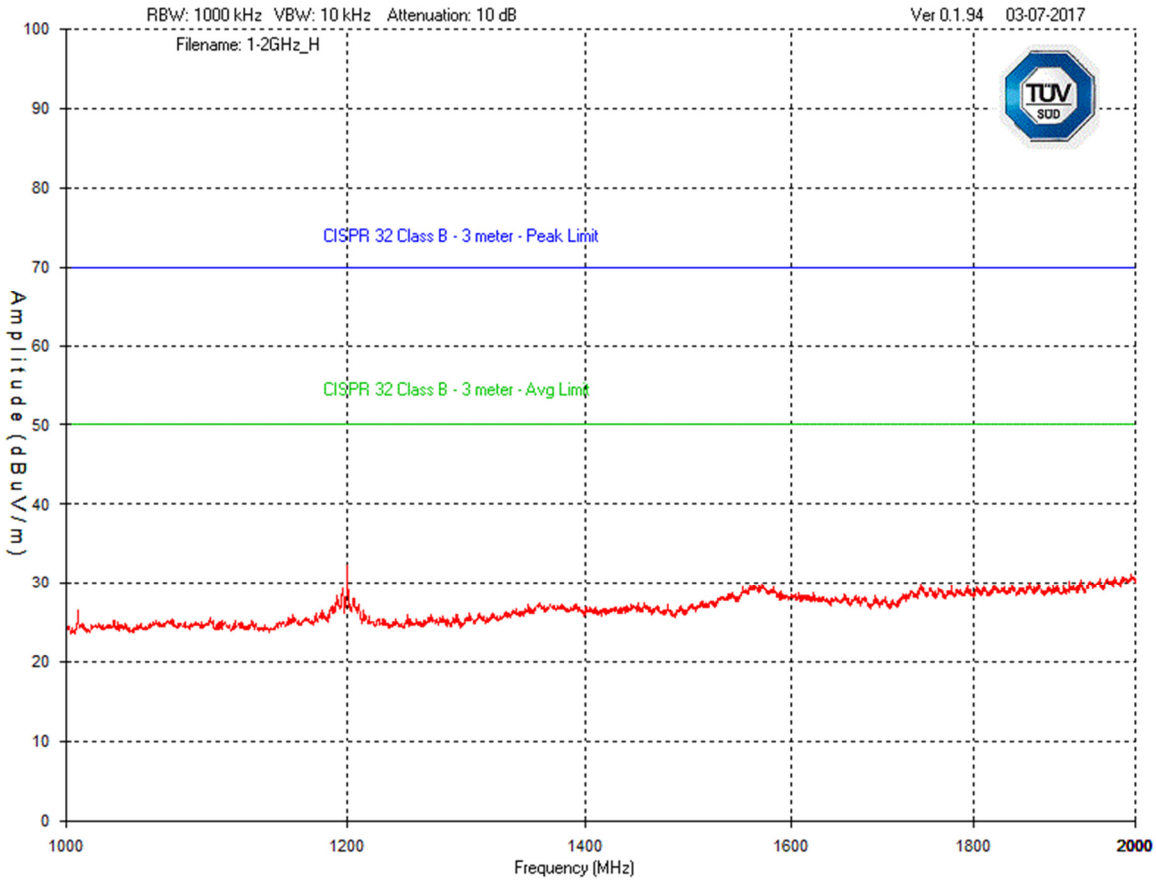
Preliminary Graphs

The graphs shown below are maximized peak measurement graphs measured with a resolution bandwidth greater than or equal to the final required detector over a full 0-360°. This peaking process is done as a worst-case measurement and enables the detection of frequencies of concern for final measurement. For final measurements with the appropriate detector, where applicable, please refer to the tables under Final Measurements.

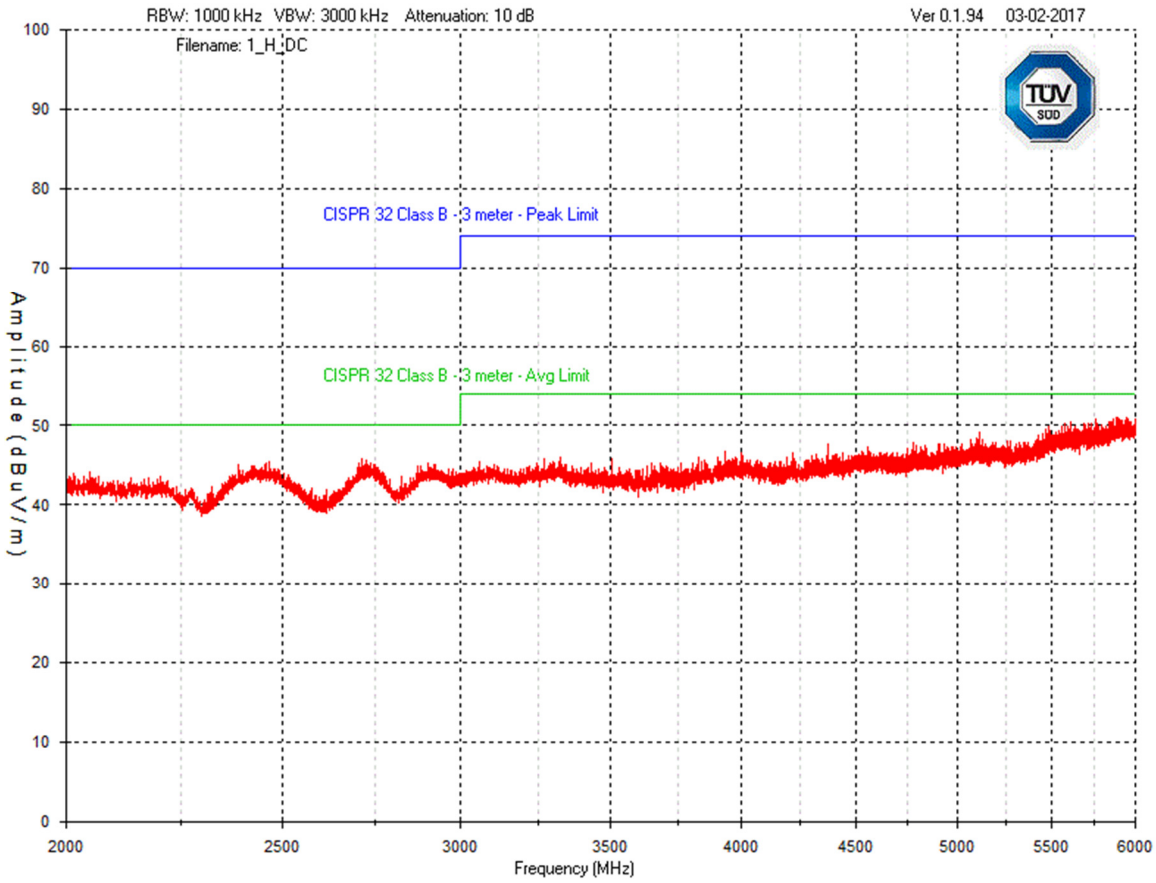
In accordance with FCC Part 15, Subpart A, Section 15.33 and CISPR 32 Table 1, the EUT was scanned to a minimum of a 1 GHz. For devices containing clocks higher than 108 MHz, they were scanned above 1 GHz to meet the requirements of FCC Part 15 Section 15.33 and CISPR 32.



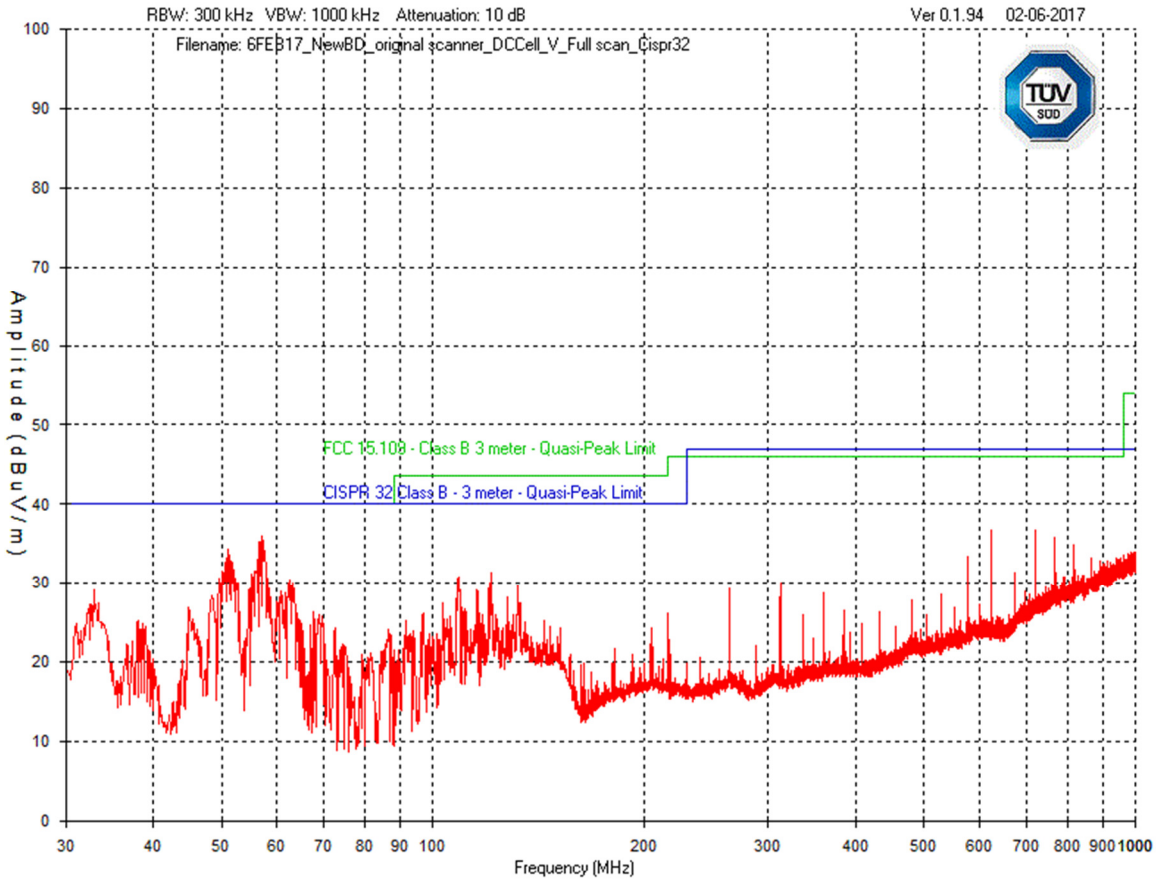
Horizontal – Peak Emissions Graph
Battery Mode – 30MHz - 1GHz



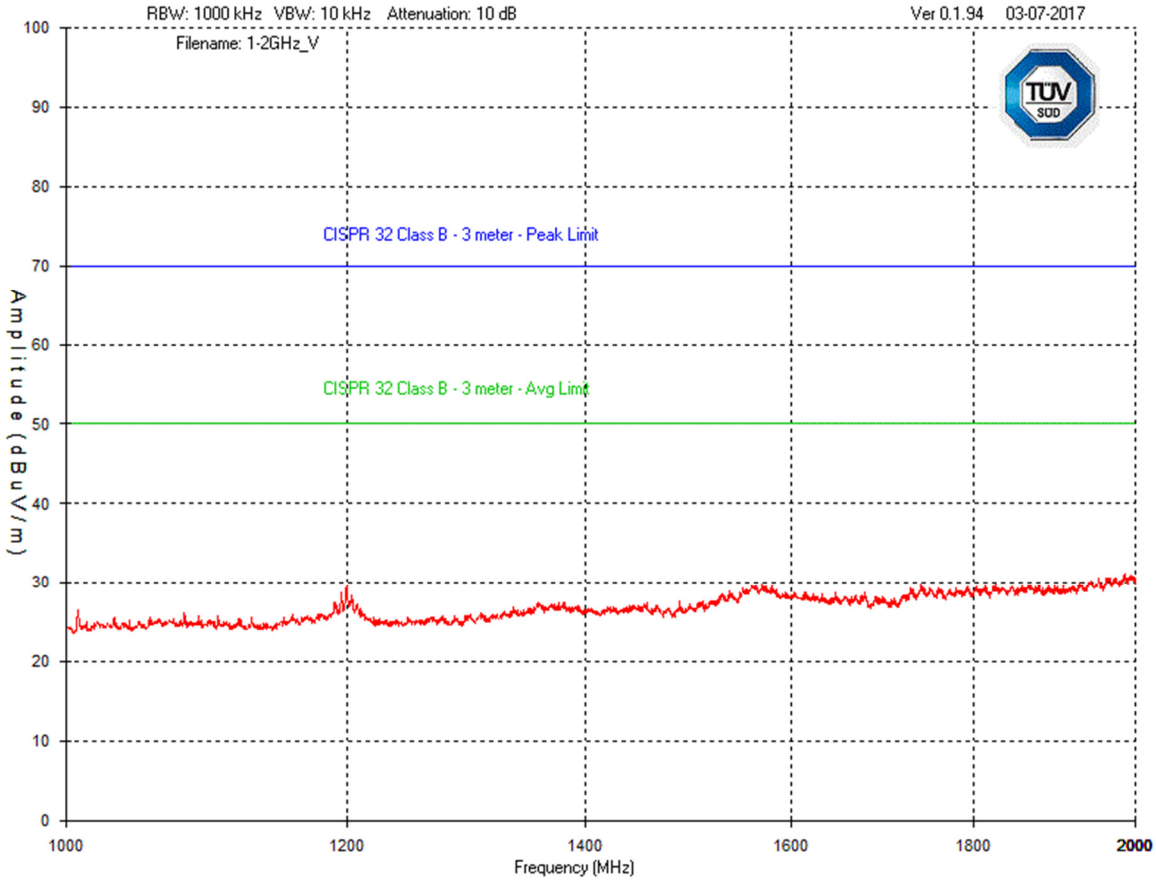
Horizontal – Peak Emissions Graph
Battery Mode –1GHz - 2GHz



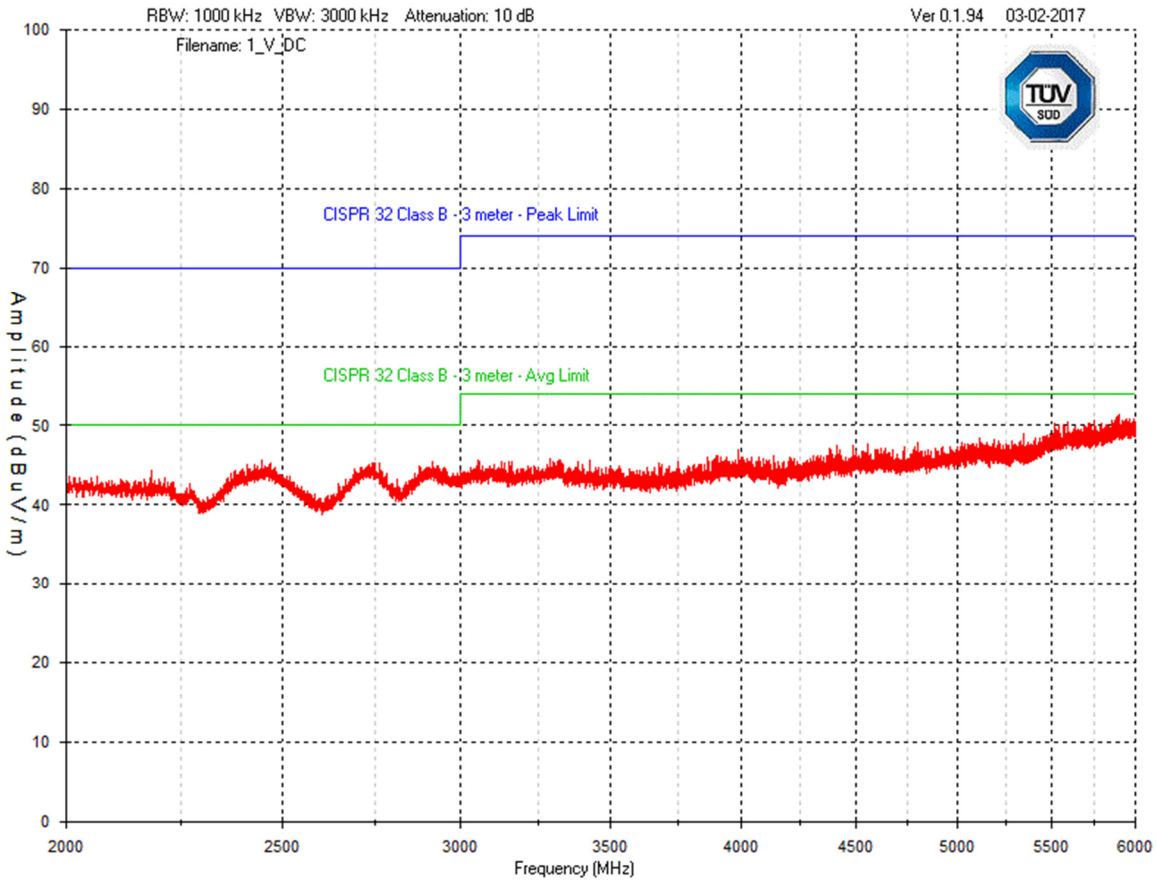
Horizontal – Peak Emissions Graph
Battery Mode – 2GHz - 6GHz



Vertical – Peak Emissions Graph
Battery Mode – 30MHz - 1GHz



Vertical – Peak Emissions Graph
Battery Mode – 1GHz - 2GHz



Vertical – Peak Emissions Graph
Battery Mode – 2GHz - 6GHz

Final Measurements

The worst-case measurement as listed in the table below appeared at a vertical antenna height of 120 cm and a table azimuth of 240 degrees, as pictured in Appendix B.

- All detected emissions are reported.
- Emissions above 1 GHz are measured using a peak detector and are all below the average limit. No emission were detected above 1GHz.

Quasi-Peak Emissions Table

Product Category			**Class B – CISPR 32**							
Supply			**6-12V DC Cell**							
Frequency (MHz)	**Detector Peak/QP**	**Received Signal (dBµV)**	**Antenna Factor (dB/m)**	**Atten Factor (dB)**	**Cable Factor (dB)**	**Pre-Amp (dB)**	**Level (dBµV/m)**	**QP Limit (dBµV/m)**	**QP Margin (dB)**	**Pass/ Fail**
Horizontal Antenna Polarization										
720.08	PEAK	43.6	20.9	3	2.0	-32.3	37.2	47.0	9.8	Pass
624.05	PEAK	45.0	19.6	3	1.8	-33.5	35.9	47.0	11.1	Pass
768.19	PEAK	40.2	21.1	3	2.1	-31.6	34.8	47.0	12.2	Pass
216.13	PEAK	45.2	11.2	3	0.9	-34.7	25.6	40.0	14.4	Pass
264.14	PEAK	49.9	12.9	3	1.1	-34.7	32.2	47.0	14.8	Pass
672.07	PEAK	40.0	20.1	3	1.7	-33.1	31.7	47.0	15.3	Pass
Vertical Antenna Polarization										
50.86	QP	38.9	7.7	3	0.4	-34.5	15.5	40.0	24.5	Pass
120.88	PEAK	54.5	7.8	3	0.6	-34.6	31.3	40.0	8.7	Pass
108.73	PEAK	53.2	8.5	3	0.6	-34.5	30.8	40.0	9.2	Pass
49.63	PEAK	53.8	7.8	3	0.4	-34.5	30.5	40.0	9.5	Pass
62.46	PEAK	54.3	7.3	3	0.4	-34.5	30.5	40.0	9.5	Pass
720.08	PEAK	43.3	20.9	3	2.0	-32.3	36.9	47.0	10.1	Pass

Note:
Peak = Peak measurement
QP = Quasi-Peak measurement

See 'Appendix B – EUT, Peripherals, and Test Setup Photos' for photos showing the test set-up for the highest radiated emission.

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Spectrum Analyzer	ESU 40	Rohde & Schwarz	Jan. 6, 2016	Jan. 6, 2018	GEMC 233
BiLog Antenna	3142-C	ETS	Oct. 5, 2016	Oct. 5, 2018	GEMC 8
Attenuator 3 dB	612-03-1	Meca Electronics, Inc	NCR	NCR	GEMC 222
Pre-Amp 9 kHz – 1 GHz	CPA9231A	Chase	Oct 12, 2016	Oct 12, 2018	GEMC 6403
Horn Antenna 2 – 18 GHz	WBH218HN	Q-par	Feb. 12, 2016	Feb. 12, 2018	GEMC 6375
Pre-Amp 1 – 26.5 GHz	HP 8449B	HP	Nov. 27, 2015	Nov. 27, 2017	GEMC 189
RF Cable 7m	LMR-400-7M-50Ω-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 10m	LMR-400-10M-50Ω-MN-MN	LexTec	NCR	NCR	GEMC 27
RF Cable 0.5m	LMR-400-0.5M-50Ω-MN-MN	LexTec	NCR	NCR	GEMC 31
Emissions Software	0.1.94	Global EMC	NCR	NCR	GEMC 58

CISPR32-FCC_RE-B_Rev1

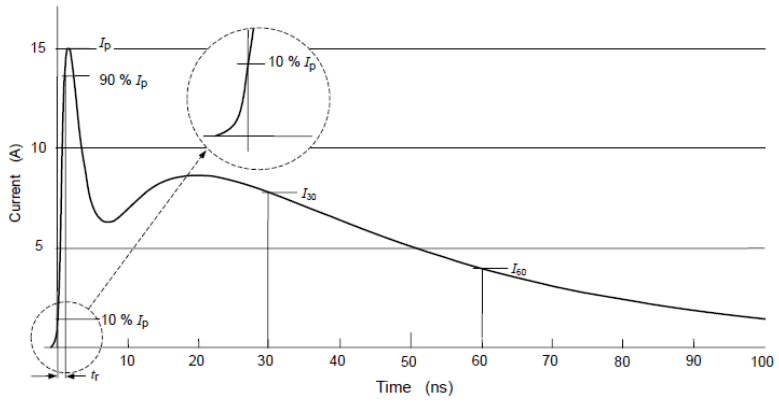
Electro-Static Discharge

Purpose

The purpose of this immunity test is to apply a static electricity discharge from the operator to the EUT or create a nearby discharge field. An example of this discharge can be seen in low humidity conditions when a person touches an object and creates a small spark. This spark could potentially be harmful to the operation of the EUT. The contact method, with related reduced voltages, has been shown to be roughly equivalent to air discharges in severity and due to its reproducibility, contact is the preferred test method. Air discharge is used where contact discharge cannot be applied since the discharge point is significantly insulated and the insulation cannot be easily broken through. This test ensures a minimum level of immunity which is likely to occur in a normal usage environment. This test does not guarantee that the EUT will not be exposed to higher discharge levels which could cause it to fail.

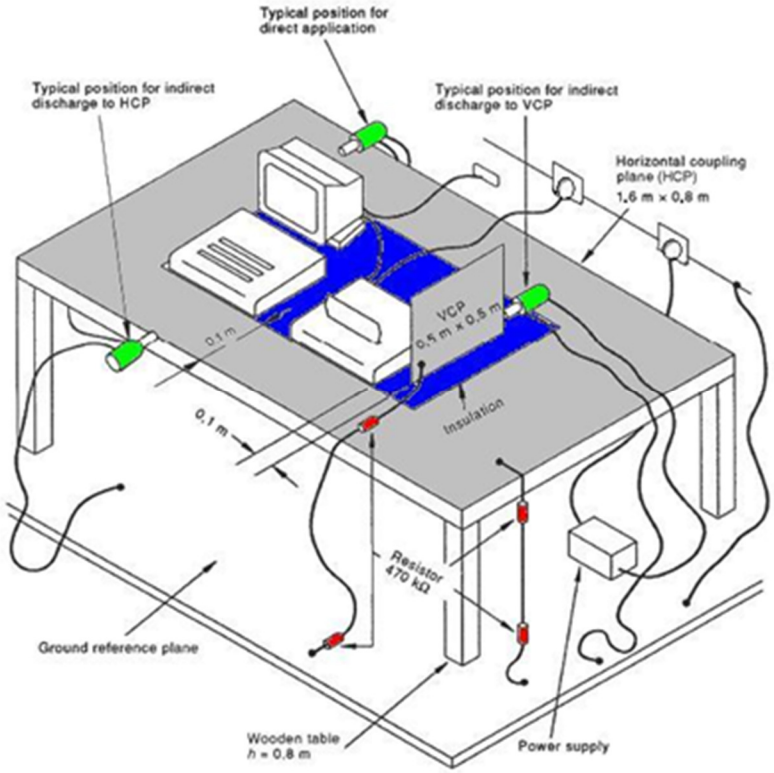
Application Level Requirement

This test is performed in accordance with the methodology defined in IEC 61000-4-2. Ten hits in the positive and negative polarity are applied at each defined discharge point on the EUT. These are called direct discharges, regardless of contact or air being applied. Horizontal Coupling Plane (HCP) and Vertical Coupling Plane (VCP) discharges are also applied and these are called indirect discharges. A typical test setup representation is shown on the following page. A photograph of the actual test setup is shown in Appendix B. See the results table under Test Results for the actual EUT discharge points.



A level of ±4kV contact or ±8kV air, where applicable, is applied to each defined discharge point. For air discharge testing, the test is applied at the lower test levels first. Performance Criteria level B as defined in "Appendix A – EUT & Client Provided Details" is applied to this test. However, all anomalies, if any, are noted.

Typical ESD Setup



Application Level Accuracy

Contact discharge: ±15% for the first peak current, ±5% for the output voltage and ±25% for the rise time as measured at the discharge electrode tip of ESD generator.

Test Results

The EUT passed the requirements. The EUT was tested with the DC cell power applied. The LED and “heart beat” pattern was monitored and verified operational. The EUT met Criteria B as defined in "Appendix A – EUT & Client Provided Details". No anomalies were observed.

Location	Test Voltage	Discharge Type	Pass / Fail
1. HCP	±4kV	Contact	Pass
2. VCP	±4kV	Contact	Pass
3. USB connector	±4kV	Contact	Pass
4. Micro-USB connector	±4kV	Contact	Pass
5. Micro-SD holder (underside of pcb)	±4kV	Contact	Pass
6. DC Cell connector	±8kV	Air Discharge (attempt)	Pass

Figure 1 – ESD Discharge Locations

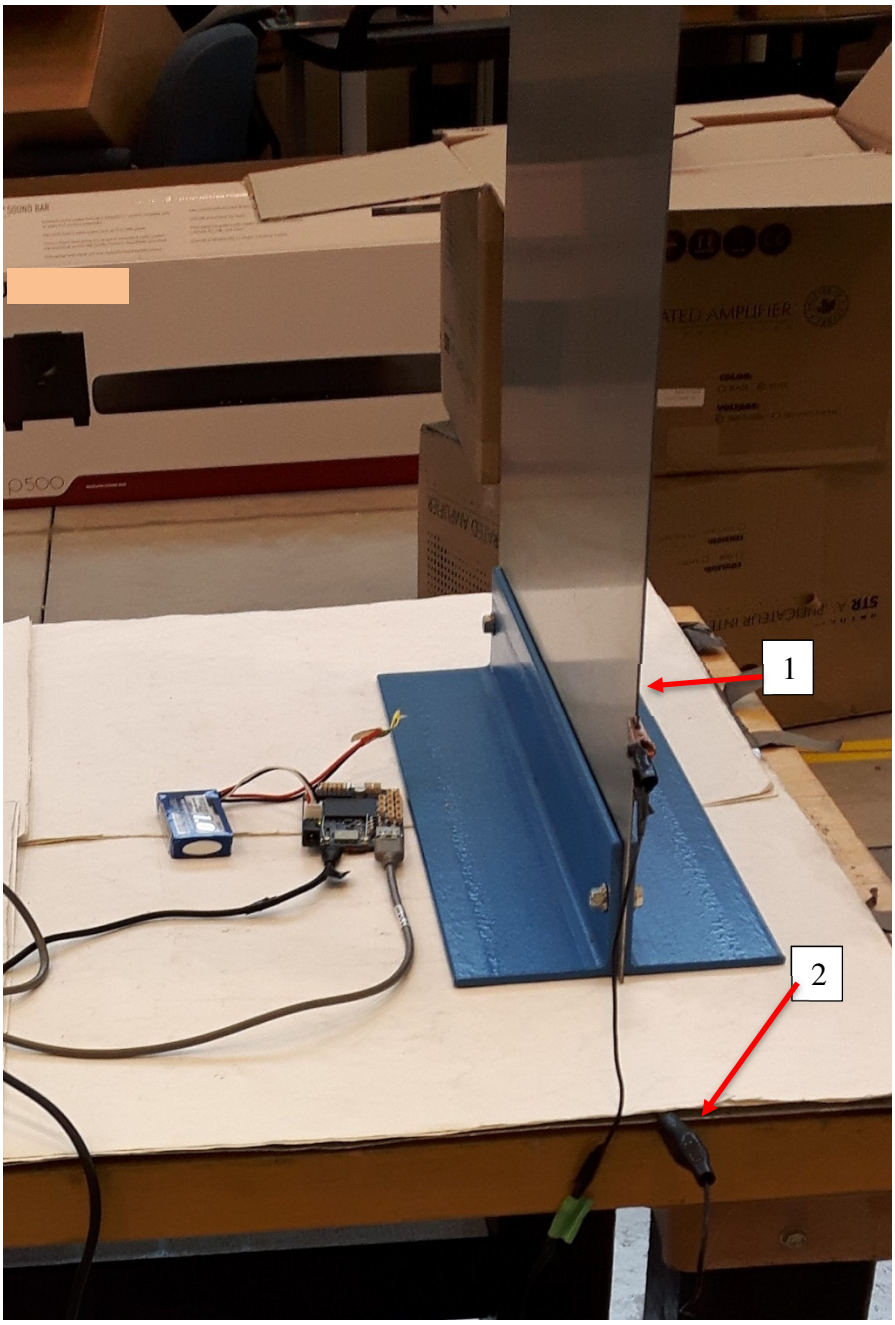
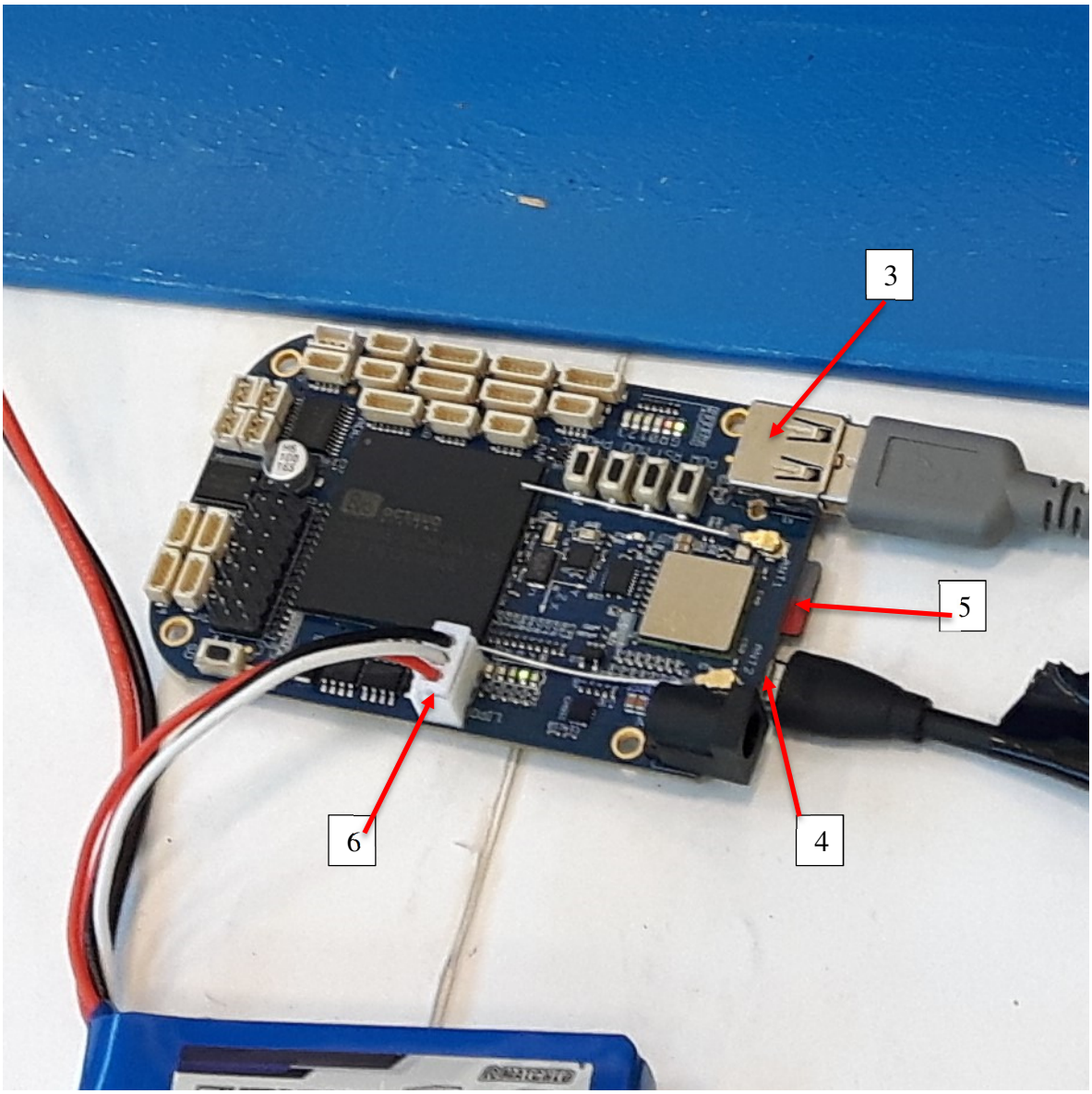


Figure 2 – ESD Discharge Locations



Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Minizap ESD Simulator	Minizap	Thermo Electron Corp	Feb. 10, 2015	Feb. 10, 2017	GEMC 1
ESD HCP	80CM x 160CM	Global EMC	NCR	NCR	GEMC 50
ESD VCP	50CM x 50CM	Global EMC	NCR	NCR	GEMC 51
ESD 470K A	2x470kΩ 100CM	Global EMC	NCR	NCR	GEMC 52
ESD 470K B	2x470kΩ 100CM	Global EMC	NCR	NCR	GEMC 53

IEC61000-4-2_ESD_Rev4

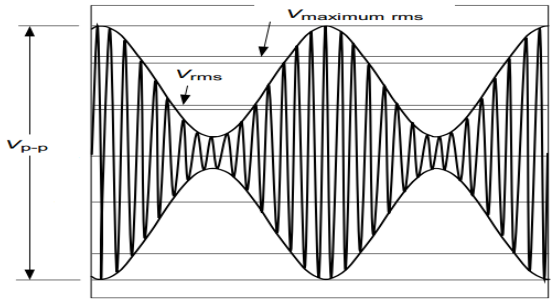
Radiated Field Immunity

Purpose

The EUT will likely be exposed to intentional sources of electromagnetic radiation during its regular application. Sources of such radiation can be cellular phones, FM radio, television, remote car alarms, garage door openers, and other broadcast transmissions. These sources of radiation are licensed or certified for broadcast and therefore, the EUT should be immune to their RF energy. This test assesses the immunity of the EUT to the applicable field strength test level. This test, however, does not guarantee that the EUT will not be exposed to higher level fields during its operation, which may cause it to fail.

Application Level Requirement

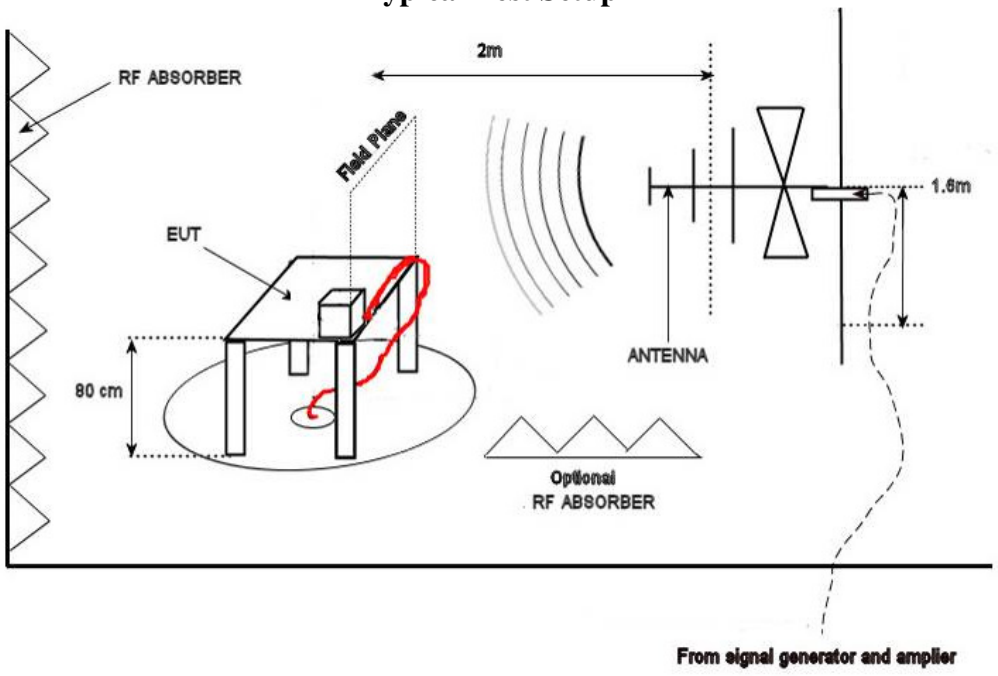
This test is performed in accordance with the methodology defined in IEC 61000-4-3. The immunity test is performed over the frequency range of 80MHz to 1.0GHz. As the frequency range is swept incrementally, the step size used is calculated at 1% of the preceding frequency value, rounded down to the nearest kHz. Known clock frequencies, local oscillators, etc. are analyzed separately, where applicable, and these are defined in "Appendix A – EUT & Client Provided Details". The field uniformity is calibrated at 3V/m and a modulation of 80% AM 1kHz sine wave is applied during the application of the RF energy at each frequency.



Modulated RF-signal 80 % AM

The RF field is applied in both horizontal and vertical antenna polarization and four sides of the EUT are subjected to this RF field. The dwell time used for each frequency is 3 seconds. Forward power is monitored and records are kept on file at TUV SUD Canada Inc. An isotropic field probe is also placed in near proximity of the EUT to verify the application of the RF field. Performance Criteria Level A as defined in "Appendix A – EUT & Client Provided Details" is applied to this test.

Typical Test Setup



Application Level Accuracy

As per IEC 61000-4-3, the RF field is specified as 0dB to +6dB for at least 12 of the 16 calibration points. For a 10 V/m field, this allows for the EUT to be subjected to a field of 10 V/m to 20 V/m with at least 75% coverage at this level.

Test Results

The EUT passed the requirements. The EUT met Criteria A as defined in "Appendix A – EUT & Client Provided Details". No anomalies were observed.

Input Voltage and Frequency	6-12V (7.4V) DC Cell	
Frequency Range and Field Strength	80MHz – 1GHz 3V/m (80% AM)	
Sweep Step	1% of Fundamental	
Dwell Time	3 sec.	
Clock Frequencies Analyzed Separately		
Clock	**Frequency Inspected**	**Dwell Time**
Clock	400 MHz	60 sec
Clock	1 GHz	60 sec
Result	**Pass**	

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Signal Generator	SMHU	Rohde & Schwarz	Feb. 1, 2017	Feb. 1, 2019	GEMC 155
BiLog Antenna	3142-C	ETS	Oct. 5, 2016	Oct. 5, 2018	GEMC 8
Power Amplifier	250W1000B	AR	NCR	NCR	GEMC 192
Power Amplifier	20S1G4	AR	NCR	NCR	GEMC 185
Field Probe	FL 7018	AR	Sept. 21, 2016	Sept. 21, 2018	GEMC 164
Field Monitor	FM 7004	AR	NCR	NCR	GEMC 13
Immunity Software	V221	Global EMC	NCR	NCR	GEMC 57

IEC61000-4-3_RadiatedImmunity_Rev4

Power Frequency Magnetic Field

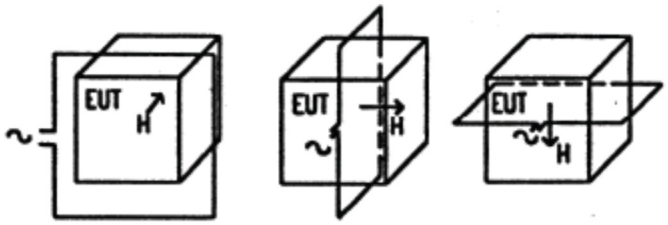
Purpose

A magnetic field with the frequency of the power line is generated around the EUT. In practice, the EUT will be subjected to power frequency magnetic fields from nearby power lines, transformers, or devices such as televisions or monitors. Since the EUT is usually used in conjunction with other electrical equipment, it is subjected to the steady state magnetic fields. These are magnetic fields that the device is exposed to under normal operating conditions. These fields have lower field strengths compared to typical transient magnetic fields.

Application Level Requirement

This test is performed in accordance with the methodology defined in IEC 61000-4-8. Three orthogonal axis of the EUT are subjected to the field within the magnetic loop. The transient magnetic field, if applicable, is tested for 1 minute while the steady state magnetic field is tested for 15 minutes. The frequencies applied are 50 Hz and 60 Hz. A magnetic field strength of 3 A/m is applied to the EUT in each orthogonal axis. Performance Criteria Level A as defined in "Appendix A – EUT & Client Provided Details" is applied to this test.

Typical Setup Diagram



Application Level Accuracy

As per IEC 61000-4-8, the field over the area that the EUT occupies within the loop must be calibrated to be within ±3dB. For a field strength of 3 A/m, this means that the empty calibrated field strength can be between 2.1 A/m and 4.2 A/m over the area that the EUT occupies.

Test Results

The EUT passed the requirements. The EUT was powered with a 6-12Vdc (7.4V) cell and a 60Hz field was applied. The EUT met Criteria A as defined in "Appendix A – EUT & Client Provided Details". No anomalies were observed.

Test Equipment List

Equipment	Model No.	Manufacturer	Last Calibration Date	Next Calibration Date	Asset #
Magnetic Loop	F-1000-4-8/9/10-L-1M	FCC	NCR	NCR	GEMC 22
Immunity Generator	EMC Pro Plus	Keytek Thermo Corp.	Dec. 19, 2016	Dec. 19, 2018	GEMC 4
Immunity Software	CEWare 32 V4.1	Thermo Fisher Scientific	NCR	NCR	GEMC 182
Clamp Meter	365	Fluke	Nov. 23, 2016	Nov. 23, 2017	GEMC 260

IEC61000-4-8_MagneticImmunity_Rev3

Appendix A – EUT & Client Provided Details

Client Provided Details

Client Details	
Organization / Address	BeagleBoard.org Foundation 4467 Ascot Ct, Oakland Twp, MI 48306
Contact	Jason Kridner
Phone	586-764-1992
Email	jkridner@beagleboard.org

EUT (Equipment Under Test) Details	
EUT Name (for report title)	BeagleBone
EUT Model / SN (if known)	Blue
EUT revision	New product A2
Software version	2017-01-22
Equipment category	Single board computer
EUT is powered using	Battery
Input voltage range(s) (V)	6-12V
Frequency range(s) (Hz)	
Rated input current (A)	
Nominal power consumption (W)	0.35
Number of power supplies in EUT	4
Transmits RF energy? (describe)	Yes WiFi and Bluetooth 2.4GHz

Cont.

Basic EUT functionality description	Development board
High level block diagram of EUT (attachment)	
Modes of operation	Running test program
Step by step instructions for setup and operation	* Connect microUSB cable, microSD and USB scanner to EUT * Connect 12V power supply or battery to power EUT * Wait 1-2 minutes for EUT boot, hear tone from barcode scanner * Observe LEDs R (red) and G (green) illuminated while LED 0 (blue) flashes in a "heartbeat" pattern
Customer to setup EUT on site?	No
EUT response time (ms)	N/A
EUT setup time (min)	2+ minutes
Frequency of all clocks present in EUT	24MHz oscillator, 32kHz oscillator, 1GHz processor clock (internal to OSD3358), 400MHz DDR clock (internal to OSD3358), 2.4GHz WiFi clock (internal to WL1835 module), 48MHz USB clock (internal to OSD3358)
I/O cable description Specify length and type	3 ft microUSB cable, USB barcode scanner
Available connectors on EUT	microUSB client, USB host, microSD, 6-16V DC power jack, battery connector
Peripherals required to exercise EUT Ex. Signal generator	12V power supply, microSD card, microUSB cable, battery, USB barcode scanner
Dimensions of product	L 90mm W 60mm H 10mm
Method of monitoring EUT and description of failure for immunity.	EUT will illuminate LEDs R and G and provide a "heartbeat" pattern on LED 0. Depending on the level of failure: 1 - Device will recover with no interruptions to LED pattern. Mitigation: none. 2 - Device will reset and return to LED pattern with no user interaction. Mitigation: none. 3 - Device will reset and fail to boot. Mitigation: requires re-flashing of eMMC contents with software image.

General EUT Description

The BeagleBone Blue Development Platform is a low-cost, community-supported development platform with all the capability of today's desktop machines, without the bulk, expense, or noise for developers and hobbyists.
It is powered with a 6-12Vdc Cell and contains a USB, micro-USB and micro-SD ports.

This device contains an FCC approved radio module (2.4 GHz), FCC ID: Z64-WL18SBMOD, IC ID: 4511-WL18SBMOD. It is also CE Mark approved.

EUT Configuration and Set up

Please see Appendix B for a test setup pictures of the unit running in normal conditions.

- Cables were connected as per manufacturer's specification.
- A USB scanner device was used as functional equipment.
- The micro-SD flash memory card was used to initialize the EUT and perform a functional test routine.
- The EUT was power with a 6-12Vdc (7.4Vdc) Cell.

Modifications for Compliance

The following modifications were made during testing for the sample to achieve compliance with the testing requirements:

- None. The EUT provided met the requirements without need for modification.

Criteria Description

Performance Criterion A: During and after the test, the equipment shall continue to operate as intended as specified by the manufacturer.

Performance Criterion B: After the test, the equipment shall continue to operate as intended as specified by the manufacturer. During testing, temporary degradation, or loss of function or performance which is self-recovering is allowed.

Performance Criterion C: During testing, temporary degradation, or loss of function or performance which is self-recoverable or restorable by the operation of controls.

Appendix B – EUT, Peripherals, and Test Setup Photos

Figure 1 – EUT Close Up – Front

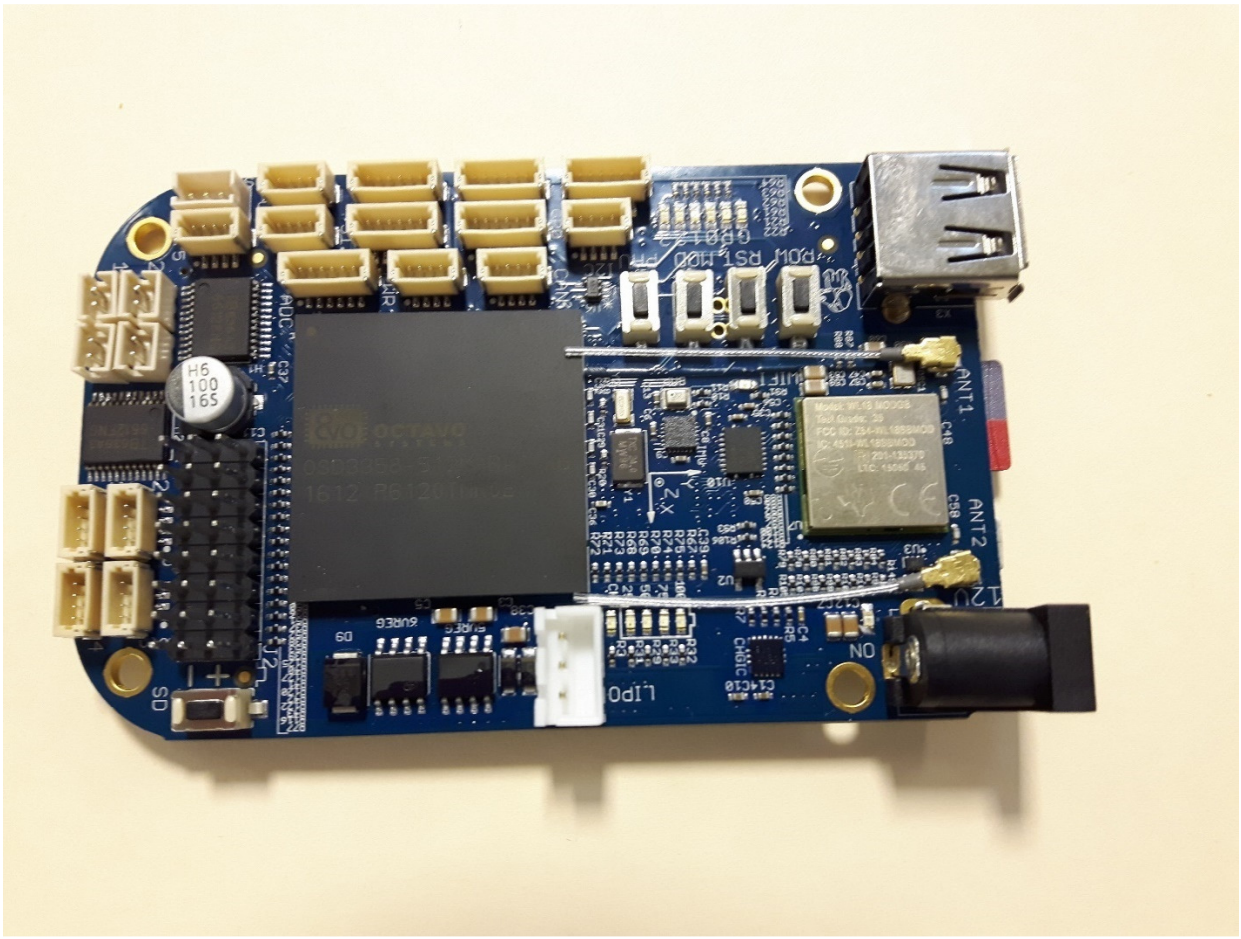


Figure 2 – EUT Close Up – Back

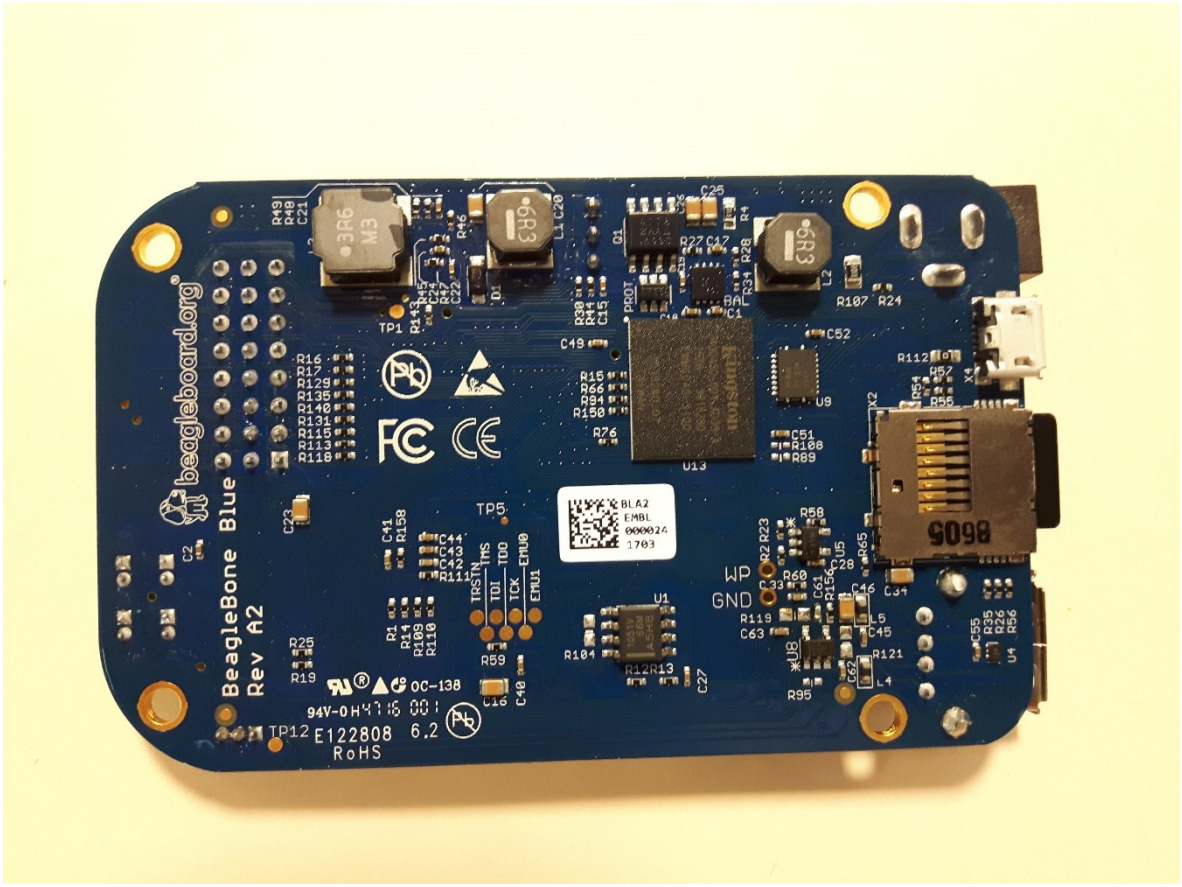


Figure 3 – Radiated Emissions Setup – Photo 1
30MHz – 1GHz

Figure 4 – Radiated Emissions Setup – Photo 2
1-2GHz

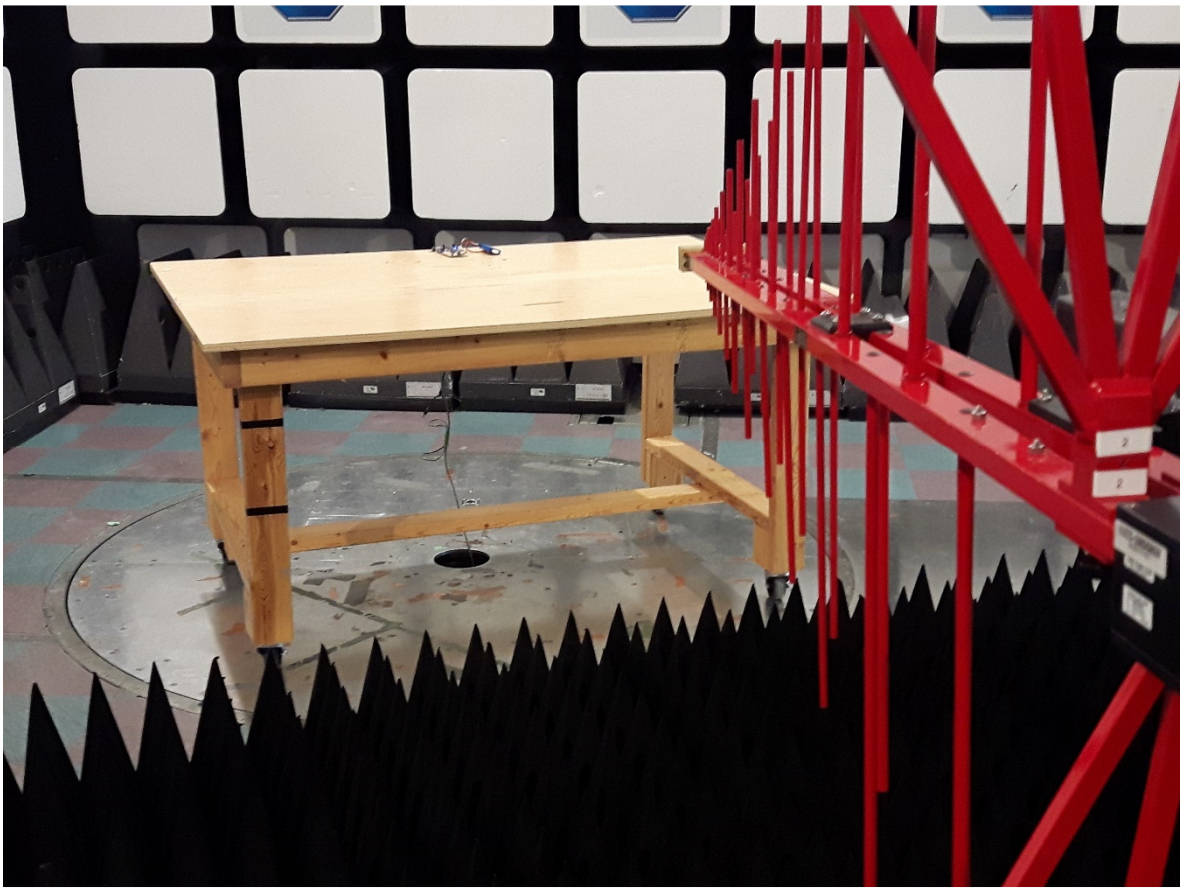


Figure 5 – Radiated Emissions Setup – Photo 3
2-6GHz

Figure 6 – Electro-Static Discharge Setup

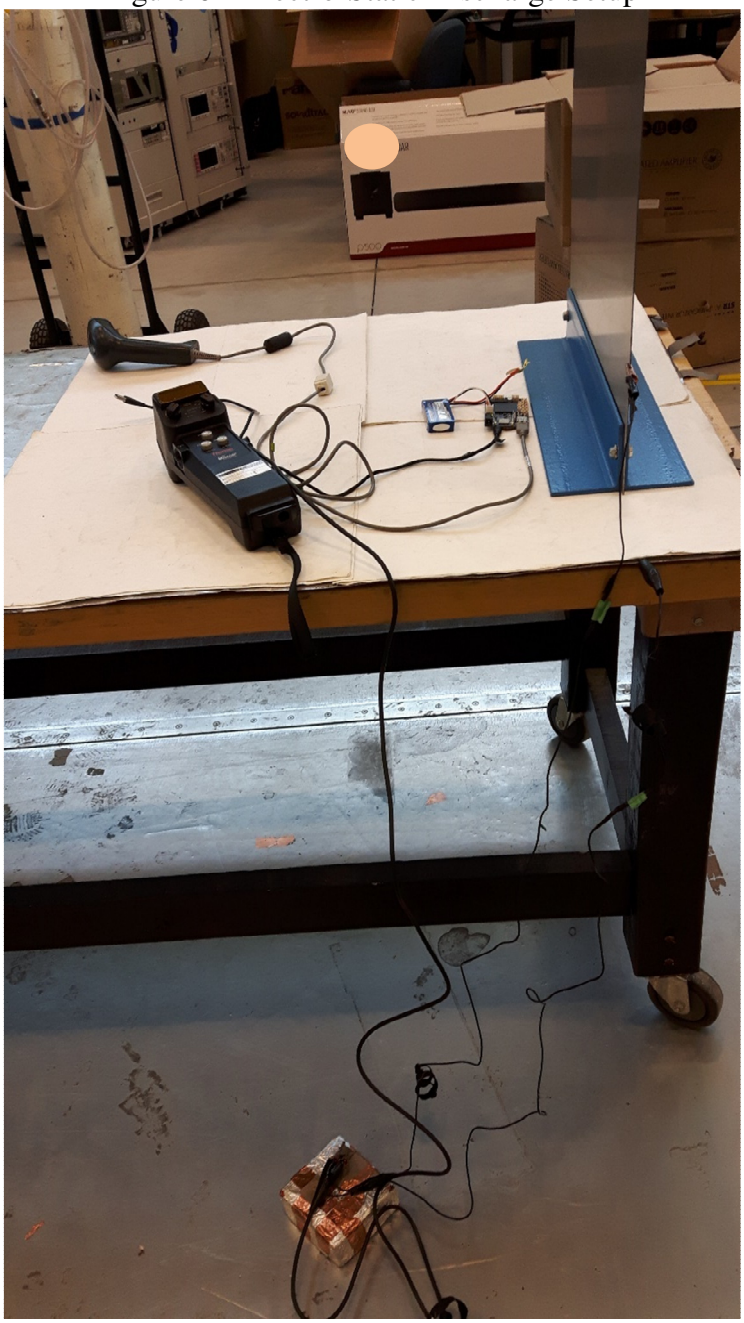


Figure 7 – Radiated Immunity Setup

Figure 8 – Power Frequency Magnetic Field Setup