TEST REPORT

Application No.:	HKEM1807000552HS
Applicant:	Root Robotics, Inc.
Address of Applicant:	2067 Massachusetts Ave. 5th Floor,Cambridge, MA02140, USA
Equipment Under Test (EUT):	
EUT Name:	Root Robot
Model No.:	RT1
Trade Mark:	Root
Country of Origin:	China
Standard(s) :	ETSI EN 301 489-1 V2.1.1
	ETSI EN 301 489-17 V3.1.1
Date of Receipt:	2018-07-06, 2018-09-18, 2019-03-08
Date of Test:	2018-09-03 to 2019-01-12
Date of Issue:	2019-03-15
Test Result:	**Pass***

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

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The CE mark as shown below can be used, under the responsibility of the manufacturer, after completion of an EU Declaration of Conformity and compliance with all relevant EU Directives.

Ivan Toa
EMC Manager

The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS International Electrical Approvals or testing done by SGS International Electrical Approvals in connection with, distribution or use of the product described in this report must be approved by SGS International Electrical Approvals in writing.

Revision Record				
Version	**Chapter**	**Date**	**Modifier**	**Remark**
01		2019-03-15		*Original*

Authorized for issue by:				
Tested by		 **Cheng Wing Hong** **/Project Engineer**		Date: 2019-03-13
Checked by		 **Ivan Toa** **/Reviewer**		Date: 2019-03-15

2 Test Summary

Emission Part				
Item	**Standard**	**Method**	**Requirement**	**Result**
Conducted Emissions at Mains Terminals (150kHz-30MHz)	ETSI EN 301 489-1 V2.1.1 ETSI EN 301 489-17 V3.1.1	EN 55032:2015	Class B	N/A
Conducted Emissions at Telecommunication Port (150kHz-30MHz)	ETSI EN 301 489-1 V2.1.1 ETSI EN 301 489-17 V3.1.1	EN 55032:2015	Class B	N/A
Radiated Emissions (30MHz-1GHz)	ETSI EN 301 489-1 V2.1.1 ETSI EN 301 489-17 V3.1.1	EN 55032:2015	Class B	Pass
Radiated Emissions (above 1GHz)	ETSI EN 301 489-1 V2.1.1 ETSI EN 301 489-17 V3.1.1	EN 55032:2015	Class B	Pass
Harmonic Current Emission	ETSI EN 301 489-1 V2.1.1 ETSI EN 301 489-17 V3.1.1	EN 61000-3-2:2014	Class A	*N/A
Voltage Fluctuations and Flicker	ETSI EN 301 489-1 V2.1.1 ETSI EN 301 489-17 V3.1.1	EN 61000-3-3:2013	Clause 5 of EN 61000-3-3	*N/A

N/A: Not applicable, please refer to section 6.1, 6.3, 6.4, 7.3, 7.4, 7.5, 7.6 of this report for details.

*N/A: Not applicable, the EUT do not connect to AC mains directly.

Immunity Part				
Item	**Standard**	**Method**	**Requirement**	**Result**
Electrostatic Discharge	ETSI EN 301 489-1 V2.1.1 ETSI EN 301 489-17 V3.1.1	EN 61000-4-2:2009	4kV Contact Discharge 8kV Air Discharge	Pass
Electrical Fast Transients/Burst at Power Port	ETSI EN 301 489-1 V2.1.1 ETSI EN 301 489-17 V3.1.1	EN 61000-4-4:2012	1kV 5/50ns Tr/Td 5kHz Repetition Frequency	N/A
Surge at Power Port	ETSI EN 301 489-1 V2.1.1 ETSI EN 301 489-17 V3.1.1	EN 61000-4-5:2014	1.2/50μs Tr/Td 1kV Line to Line 2kV Line to Ground	N/A
Conducted Immunity at Power Port (150kHz-80MHz)	ETSI EN 301 489-1 V2.1.1 ETSI EN 301 489-17 V3.1.1	EN 61000-4-6:2014	3Vrms (emf),80%,1kHz Amp. Mod.	N/A
Voltage Dips and Interruptions	ETSI EN 301 489-1 V2.1.1 ETSI EN 301 489-17 V3.1.1	EN 61000-4-11:2004	0 % UT for 0.5per 0 % UT for 250per 70 % UT for 25per UT is Supply Voltage	N/A
Radiated Immunity (80MHz-6GHz)	ETSI EN 301 489-1 V2.1.1	EN 61000-4-3:2006 +A1:2008+A2:2010	3V/m, 80%, 1kHz Amp. Mod.	Pass

N/A: Not applicable, please refer to section 6.1, 6.3, 6.4, 7.3, 7.4, 7.5, 7.6 of this report for details.

*N/A: Not applicable, the EUT do not connect to AC mains directly.

3 Contents

4 General Information

4.1 Details of E.U.T.

	Power supply:	AC 230V ~ 50/60Hz to DC 5V Adaptor no.: IECC-05 DC 3.6V (Rechargeable battery x 1)
	Cable:	100 cm unshielded USB cable
	Function:	Bluetooth
	Modulation Type:	GFSK
	Frequency Range:	Bluetooth: 2402MHz to 2480MHz

4.2 Description of Support Units

The EUT has been tested with companion device (iPhone 7) which is provided lab

4.3 Measurement Uncertainty

No.	Item	Measurement Uncertainty
1	Conduction emission	±2.71dB (150kHz to 30MHz)
2	Radiated emission	±5.26dB (30MHz-1GHz)
3	Radiated Immunity	±1.85dB
4	Conducted Immunity	±1.30dB
5	ESD	±6 %
6	EFT (Electrical Fast Transients)	±5 %
7	Surge Immunity	±5 %
8	Voltage Dips and Interruptions	±4 %

Remark:

The Ulab (lab Uncertainty) is less than Ucispr (CISPR Uncertainty), so the test results

– compliance is deemed to occur if no measured disturbance level exceeds the disturbance limit;

– non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit.

4.4 Test Location

All tests were performed at:
SGS IECC Limited (Member of the SGS Group (SGS SA))
No. 16-B, Yip Wo Street, On Lok Tsuen, Fanling, N.T., Hong Kong
Tel: +852 2305 2570 Fax: +852 2756 4480
No tests were sub-contracted.

4.5 Deviation from Standards

None

4.6 Abnormalities from Standard Conditions

None

4.7 Monitoring of EUT for All Immunity Test

Visual: Monitored the working status of the EUT
Audio: Monitored the sound of EUT

5 Equipment List

Radiated Emission			
Equipment	**Manufacturer**	**Model / Serial No.**	**Calibration Due**
EMI Test Receiver 9kHz to 3.6GHz	Rohde & Schwarz	ESR3 / 102326	2019/08/12
Signal Generator	Rohde & Schwarz	SMT 03 / 832939/017	2019/05/22
Antenna (30-300 MHz)	Schwarzbeck	BBA9106, VHA9103	2020/01/29
Log-periodic Antennas (300MHz-1000MHz)	Schwarzbeck	UHALP9107	2020/01/29
Antenna (30-1000 MHz)	Schaffner	CBL6111C / 2791	2019/10/26
Antenna Mast System	Schwarzbeck	AM9104 / -	--
Turntable with Controller	Drehtisch	DT312 / -	--

Conducted Emission			
Equipment	**Manufacturer**	**Model / Serial No.**	**Calibration Due**
Test Receiver	Rohde & Schwarz	ESHS 30 / 839667/002	2019/09/17
Signal Generator	Rohde & Schwarz	SMT03 / 832939/017	2019/05/22
Artificial Mains Network (LISN)	Schwarzbeck	NSLK 8127 / 8127312	2019/05/22
Impulse Limiter	Rohde & Schwarz	ESH-3-Z2 / 357881052	2019/10/07

Harmonics / Flicker			
Equipment	**Manufacturer**	**Model / Serial No.**	**Calibration Due**
AC Power Source	California Instruments	5001iX-CTS-400-413 / 72753	2019/05/22
Compliance and Test System	California Instruments	PACS-1 / 59355	2019/05/22

Electrostatic Discharge			
Equipment	**Manufacturer**	**Model No**	**Cal Due Date**
ESD Generator	TESEQ AG	NSG 437	2019-04-15

Radiated Immunity			
Equipment	**Manufacturer**	**Model / Serial No.**	**Calibration Due**
RF Amplifier 80 - 1000MHz, 175Watts	Milmega	80RF1000-175 / 1048909	2019/10/14
RF Amplifier 0.8 – 2.7GHz, 55Watts	Milmega	AS0827-55 / 1052118	2019/10/14
Antenna	Schwarzbeck	VULP9118E / 9118E908	2019/05/17
Antenna	Schwarzbeck	STLP9149 / 9149-179	2019/05/17
Signal Generator	Rohde & Schwarz	SMT03 / 827786/015	2019/05/17
Dual Directional Coupler 80 - 1000MHz, 200Watts	Amplifier Research	DC6080A / 0339242	2021/01/29
RF Power head with USB interface, 9kHz - 2.7GHz	Dare	RPR1006A / 06D00705SNO-95	2019/08/12
RF Power head with USB interface, 9kHz - 2.7GHz	Dare	RPR1006A / 06D00705SNO-96	2019/08/12
Signal Generator	Rohde & Schwarz	SMB100A SIGNAL GENERATOR	2019/08/12
2.5 - 6GHz Power Amplifier	Rohde & Schwarz	BBA150-E30	2019/10/14

EFT, Surge, Voltage Dips and Interruption Tests			
Equipment	**Manufacturer**	**Model / Serial No.**	**Calibration Due**
EMC Test System	TESEQ	NSG 3060 / 4120	2019/06/27
Single phase CDN	TESEQ	CDN3061-C16 / 5060	2019/06/27
Power source	TESEQ	INA 6501 / 1016	2019/06/27

Conducted Immunity Test			
Equipment	**Manufacturer**	**Model / Serial No.**	**Calibration Due**
Signal Generator	Rohde & Schwarz	SMX / 828758/035	2019/05/22
Amplifier	AMPLIFIER RESEARCH	75A250 / 21955	2019/10/14
Millivoltmeter	Rohde & Schwarz	URV5 / 892679/041	2019/05/15
EM Injection Clamp	F.C.C.	F-203I-23mm / 491	2019/05/09
Coupling-Decoupling Unit	Schaffner	CDN M016 / 21257	2019/05/23

6 Emission Test Results

6.1 Conducted Emissions at Mains Terminals (150kHz-30MHz)

Test Requirement: ETSI EN 301 489-1 V2.1.1
Test Method: EN 55032:2015
Test Date: Not Applicable

Remark:
The EUT is not connected AC mains.

6.2 Radiated Emissions (30MHz-1GHz)

Test Requirement:	ETSI EN 301 489-1 V2.1.1
Test Method:	EN 55032:2015
Frequency Range:	30MHz to 1GHz
Measurement Distance:	3m
Limit:	
30MHz-230MHz	40 dB(μV/m) quasi-peak
230MHz-1GHz	47 dB(μV/m) quasi-peak
Detector:	Peak for pre-scan (120kHz resolution bandwidth) 30M to 1000MHz

6.2.1 E.U.T. Operation

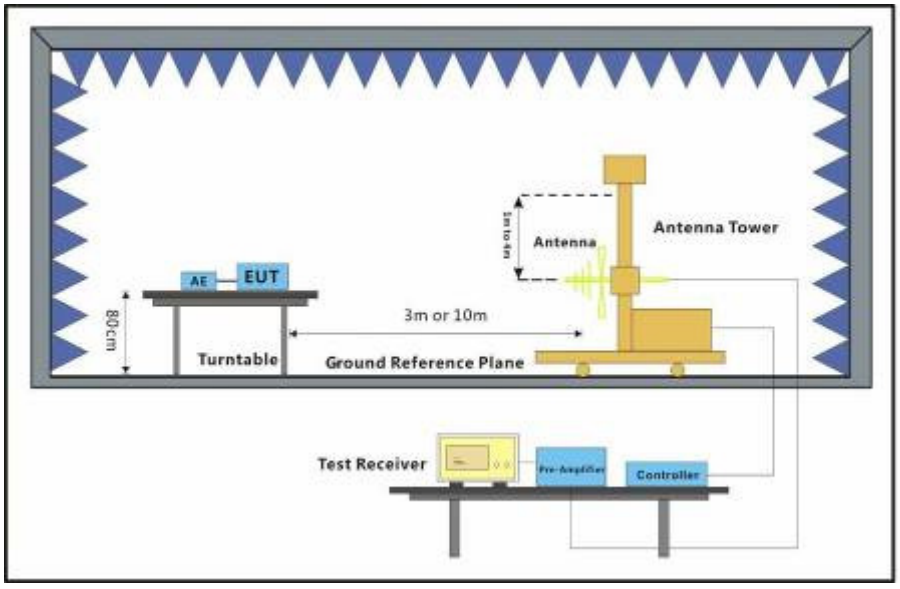
Operating Environment:

Temperature: 24 °C Humidity: 57 % RH

Pretest these mode to find the worst case: a:Bluetooth Playing_Keep the EUT communication with the companion device.
b:Idle_Keep the EUT standby.

The worst case for final test: a:Bluetooth Playing _Keep the EUT communication with the companion device.

6.2.2 Test Setup Diagram



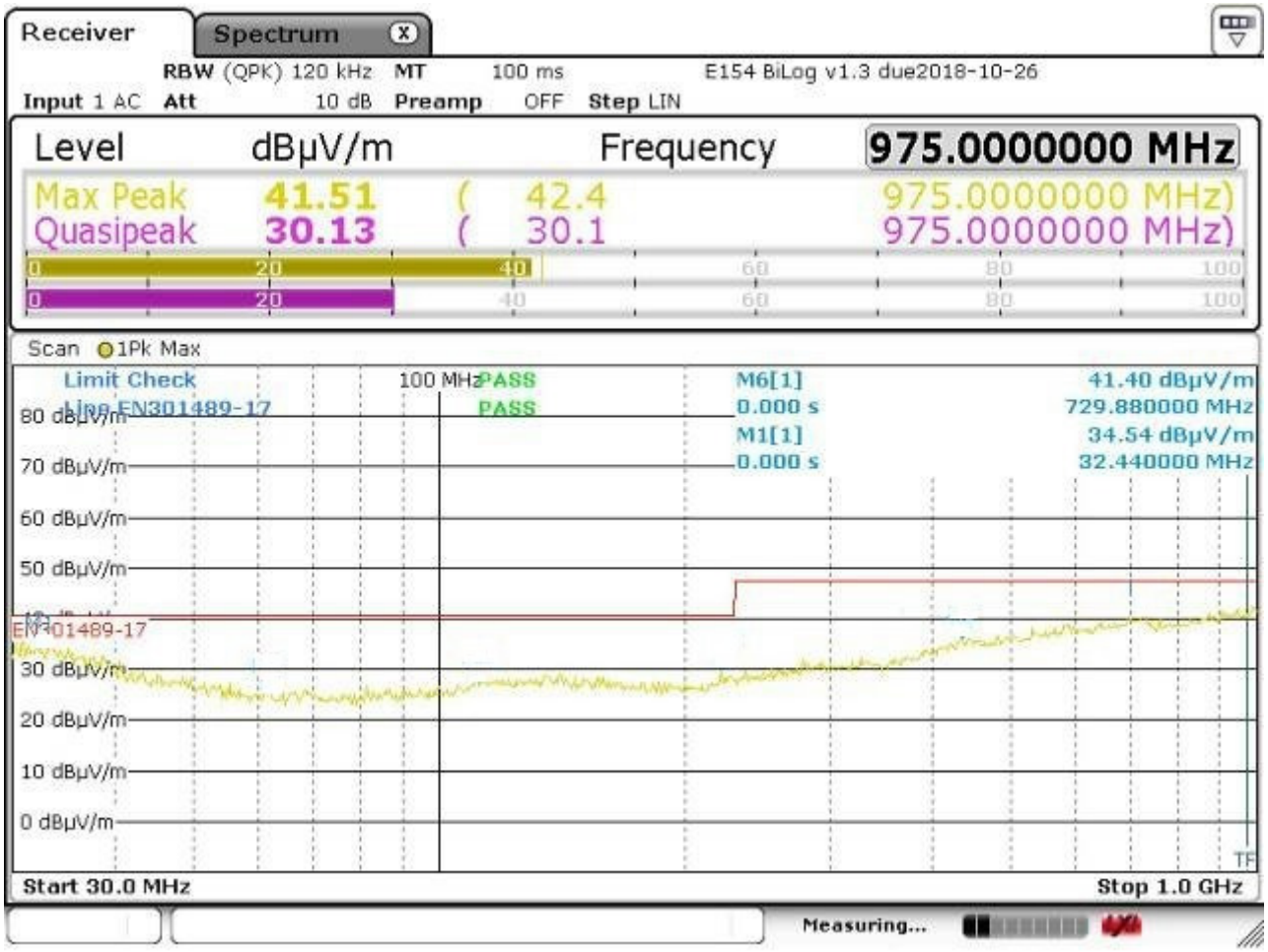
6.2.3 Measurement Data

An initial pre-scan was performed in the chamber using the spectrum analyser in peak detection mode. Quasi-peak measurements were conducted based on the peak sweep graph. The EUT was measured by BiConiLog antenna with 2 orthogonal polarities.

Vertical / Horizontal:

Quasi-peak measurement:

Bluetooth Playing mode



Frequency (MHz)	Antenna Polarization	Correction Factor (dB/m)	Receiver QP Reading (dBµV)	Emission Level (dBµV/m)	Limit (dBµV/m)	Over Limit (dB)
34.990	V	13.7	8.5	22.2	40	-17.8
61.350	H	12.7	6.3	19.0	40	-21.0
153.630	H	14.5	7.1	21.6	40	-18.4
240.020	V	12.7	7.9	20.6	47	-26.4
361.300	H	15.9	6.2	22.1	47	-24.9
721.490	H	23.5	8.0	31.5	47	-15.5

1. All readings are Quasi-Peak values.

2. Correction Factor = Antenna Factor + Cable Loss.

3. No Emission is detected above 1GHz

6.3 Harmonics Test Results

Test Requirement:	EN 61000-3-2
Test Method:	EN 61000-3-2
Frequency Range	100Hz to 2kHz
Test Date:	Not Applicable

Remark:

The EUT is not connected AC mains.

6.4 Flicker Test Results

Test Requirement:	EN 61000-3-3
Test Method:	EN 61000-3-3
Test Date:	Not Applicable

Remark:

The EUT is not connected AC mains.

7 Immunity Test Results

7.1 Performance Criteria Description in ETSI EN 301 489-1 V2.1.1

Criterion A The equipment shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the equipment if used as intended.

Criterion B After the test, the equipment shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed, after the application of the phenomena below a performance level specified by the manufacturer, when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance.

During the test, degradation of performance is allowed. However, no change of operating state or stored data is allowed to persist after the test.

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

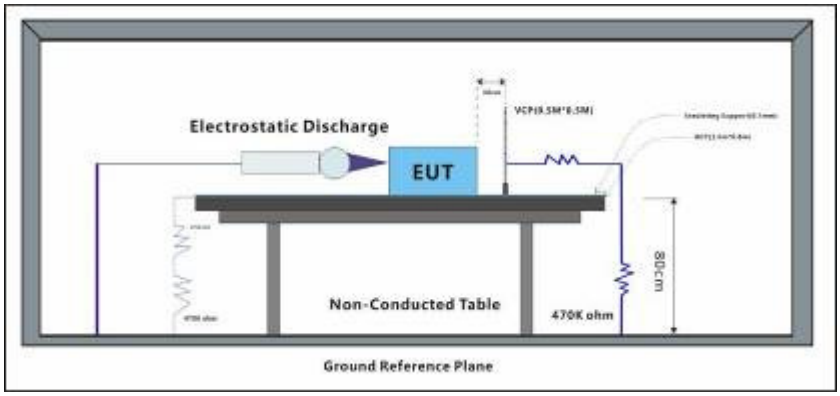
Criterion C Loss of function is allowed, provided the function is self-recoverable, or can be restored by the operation of the controls by the user in accordance with the manufacturer's instructions.

Functions, and/or information stored in non-volatile memory, or protected by a battery backup, shall not be lost.

7.2 Electrostatic Discharge

Test Requirement:	ETSI EN 301 489-1 V2.1.1
Test Method:	EN 61000-4-2:2009
Performance Criterion:	B
Discharge Impedance:	330Ω/150pF
Number of Discharge:	Minimum 10 times at each test point
Discharge Mode:	Single Discharge
Discharge Period:	1 second minimum

7.2.1 Test Setup Diagram



7.2.2 E.U.T. Operation

Operating Environment:

Temperature: 21 °C Humidity: 59 % RH Atmospheric Pressure: 1010 mbar

Test mode: a: Bluetooth Playing_Keep the EUT communication with the companion device.
b: Idle_Keep the EUT standby.

7.2.3 Test Results:

Observations: Test Point:

1. All insulated enclosure and seams.
2. All accessible metal parts of the enclosure.
3. All side

Discharge type	Level (kV)	Polarity	Test Point	Result / Observations
Air Discharge	2,4,8	+	1	A
Air Discharge	2,4,8	-	1	A
Contact Discharge	4	+	2	B#
Contact Discharge	4	-	2	B#
Horizontal Coupling	4	+	3	A
Horizontal Coupling	4	-	3	A
Vertical Coupling	4	+	3	A
Vertical Coupling	4	-	3	A

Results:

A: No degradation in the performance of the EUT was observed.

B#: During discharge 4kV directly applied to the connector shell (metallic), the EUT auto disconnected the Bluetooth connection during test, it can be restored by operation by end user in accordance with the user manual. The performance level is specified by the manufacturer, when the equipment is used as intended.

Therefore, EUT met the manufacturer specified performance level.

7.3 Electrical Fast Transients/Burst at Power Port

Test Requirement: ETSI EN 301 489-1 V2.1.1
Test Method: EN 61000-4-4:2012

Remark:
The EUT is not connected AC mains.

7.4 Surge at Power Port

Test Requirement: ETSI EN 301 489-1 V2.1.1
Test Method: EN 61000-4-5:2014

Remark:
The EUT is not connected AC mains.

7.5 Conducted Immunity at Power Port (150kHz-80MHz)

Test Requirement: ETSI EN 301 489-1 V2.1.1
Test Method: EN 61000-4-6:2014

Remark:
The EUT is not connected AC mains.

7.6 Voltage Dips and Interruptions

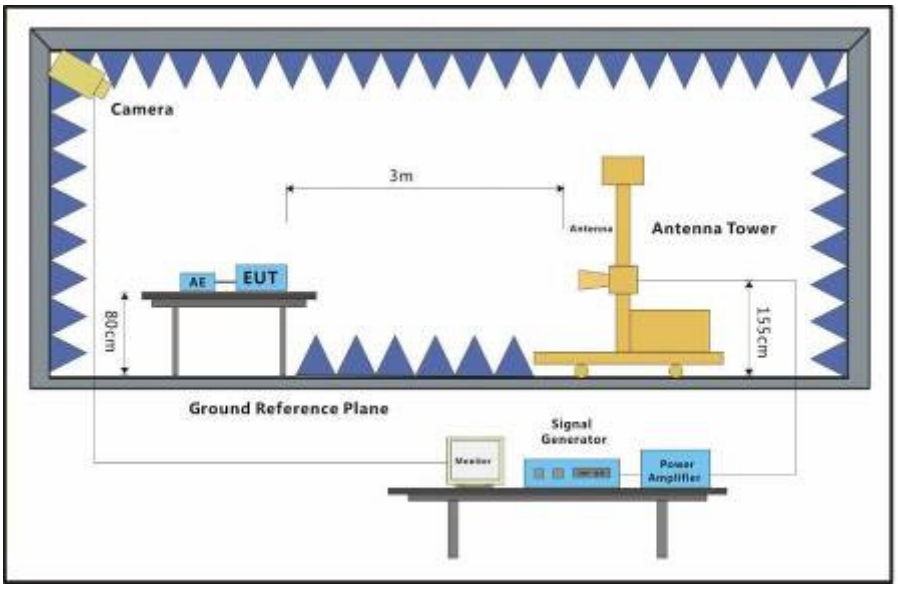
Test Requirement: ETSI EN 301 489-1 V2.1.1
Test Method: EN 61000-4-11:2004

Remark:
The EUT is not connected AC mains.

7.7 Radiated Immunity (80MHz-6GHz)

Test Requirement: ETSI EN 301 489-1 V2.1.1
Test Method: EN 61000-4-3:2006 +A1:2008+A2:2010
Performance Criterion: A
Frequency Range: 80MHz to 6GHz
Antenna Polarisation: Vertical and Horizontal
Modulation: 1kHz,80% Amp. Mod,1% increment

7.7.1 Test Setup Diagram



7.7.2 E.U.T. Operation

Operating Environment:
Temperature: 21 °C Humidity: 59 % RH Atmospheric Pressure: 1010 mbar
Test mode: a: Bluetooth Playing_Keep the EUT communication with the companion device.
b: Idle_Keep the EUT standby.

7.7.3 Test Results:

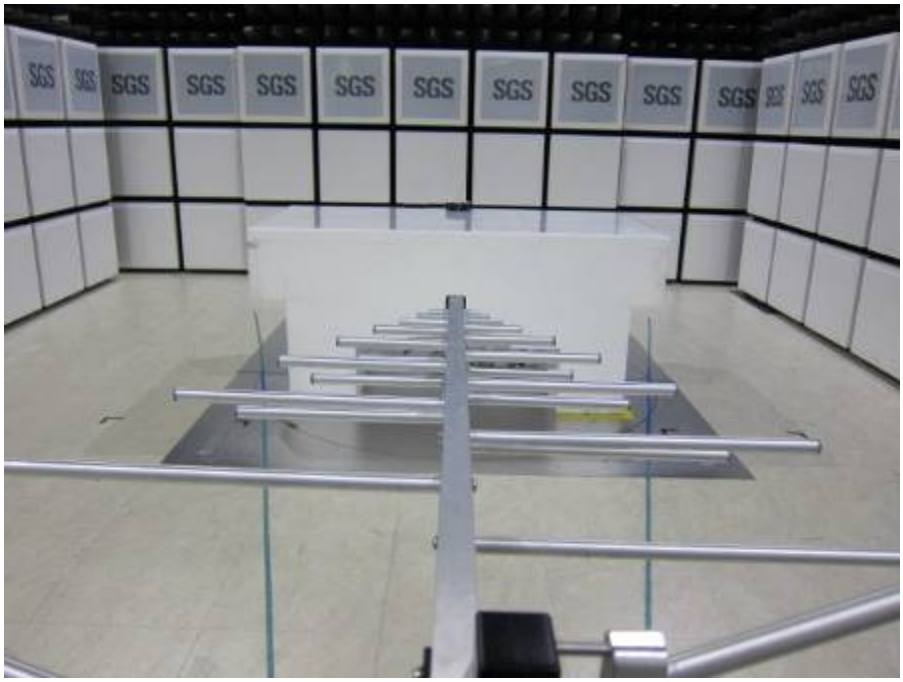
Frequency	Level (V/m)	EUT Face	Dwell time	Result / Observations
80MHz-6GHz	3	Front	2s	A
80MHz-6GHz	3	Back	2s	A
80MHz-6GHz	3	Left	2s	A
80MHz-6GHz	3	Right	2s	A

Results:

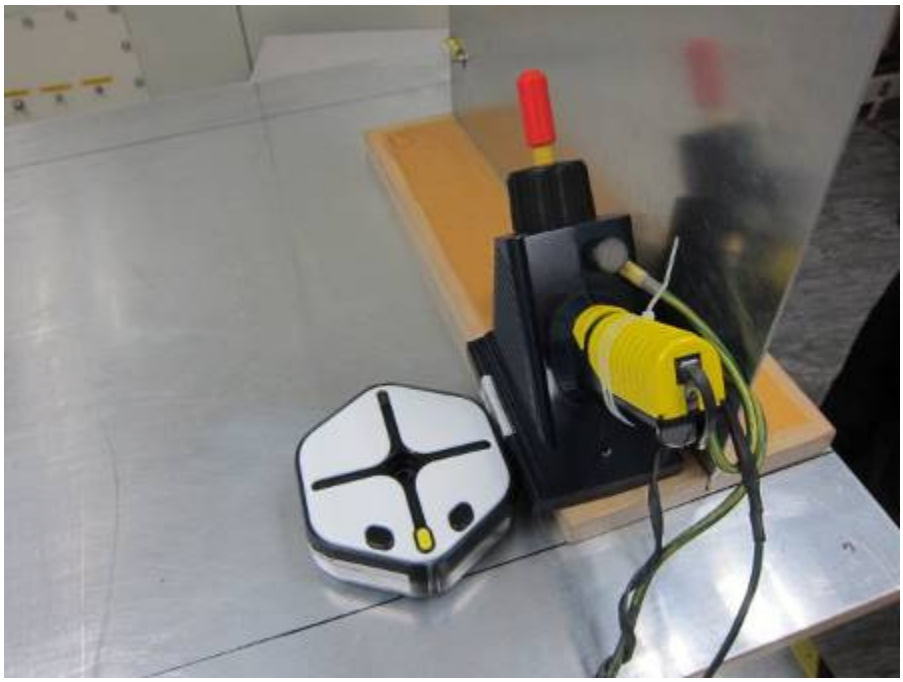
A: No degradation in the performance of the EUT was observed.

8 Photographs

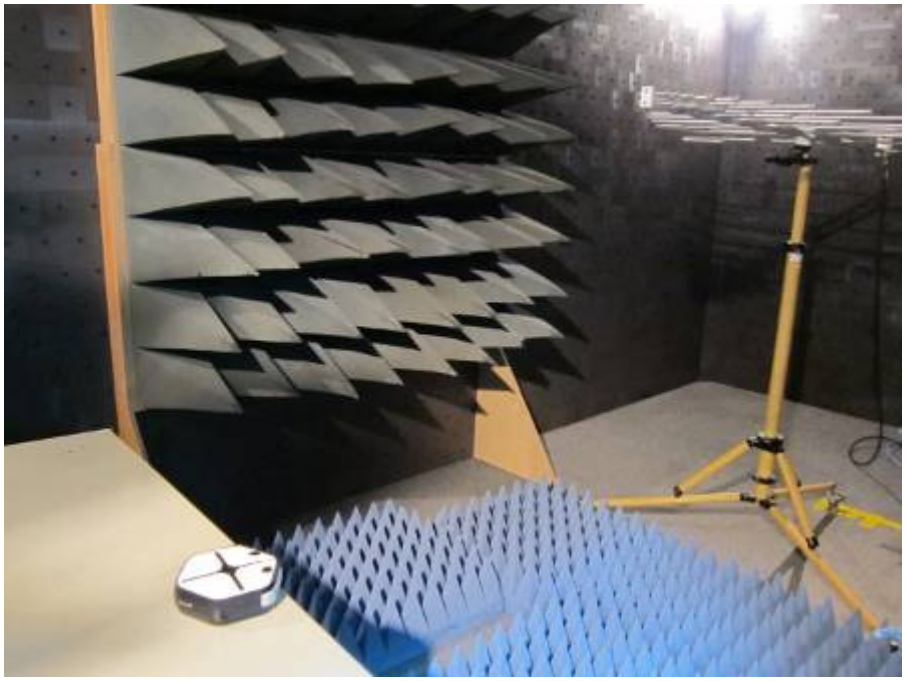
8.1 Radiated Emissions (30MHz-1GHz) Test Setup



8.2 Electrostatic Discharge Test Setup



8.3 Radiated Immunity (80MHz-6GHz) Test Setup



8.4 EUT Constructional Details

- End of the Report -