

EMC TEST REPORT

Product name: Single Board Computer
Model: ODROID-C1
Standards: EN 55022:2010
EN 55024:2010
EN 61000-3-2:2006 + A1:2009 + A2:2009
EN 61000-3-3:2008

Applicant: Hardkernel Co., LTD.
Test Report No.: UCSCE-1412-204

UCS Co., Ltd.

EMC TEST REPORT

Report Number		UCSCE-1412-204		
Applicant	Company Name	Hardkernel Co., LTD.		
	Address	704 25, Simin-daero 248beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, Korea		
Product	Product Name	Single Board Computer		
	Model No.	ODROID-C1		
	Manufacturer	Hardkernel Co., LTD.		
	Serial No.	-	Country of origin	Korea
Other	Receipt Date	2014.12.10	Receipt Number	UCS-R-2014-886
	Issued Date	2014.12.23	Tested Date	2014.12.19 ~ 2014.12.22
Standard	EN 55022:2010 EN 55024:2010 EN 61000-3-2:2006 + A1:2009 + A2:2009 EN 61000-3-3:2008			
Tested by	K. S. Yoon  (Sign)			
Approved by	Y. M. Choi  (Sign)			
UCS Co., Ltd.				
#702, AnyangMegavally, 268 Hagui-ro, Dongan-gu, Anyang-si, Gyeonggi-do, 431-767 Korea. Tel : +82-31-420-5680, Fax : +82-31-420-5685				
o This is certified that the above mentioned products have been tested for the sample provided by client. o No part of this document may not be duplicated or reproduced by any means without the express written permission of UCS Co., Ltd.				

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Revision History

Issued Report No.	Issued Date	Revisions	Effect Section
UCSCE-1412-204	23-Dec-2014	Initial Issue	All

1. Applicant Information

Applicant Name : Hardkernel Co., LTD.
Address : 704 25, Simin-daero 248beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, Korea
Manufacturer : Hardkernel Co., LTD.
Address : 704 25, Simin-daero 248beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, Korea
Country of Origin : Korea

2. EUT (Equipment under test) Information

Product Name : Single Board Computer
Model : ODROID-C1

Clock : 12 MHz, 24 MHz, 25 MHz, 32.768 kHz
Operating system : Xubuntu 14.04 (linux) or Android 4.4.X
Size : PCB 85 x 56 mm
Weight : 40 g
CPU : Amlogic S805 Quad
Processor : 1.5 GHz Quad Core Cortex-A5
Graphics processor : Mali-450 MP2
System memory : 1 024 MB
Network : 10 / 100 / 1 000 Base-TX (1 Port)
USB : Host 2.0 4 Port, Device 2.0 1 Port is not support on Linux (USB Storage Possible / ADB)
Storage : microSD, microSDHC up to 32 GB, eMMC 8 GB / 16 GB / 32 GB / 64 GB (Accessory)
Video output : HDMI 1.4a supports up to 1 920 x 1 080 resolution
Operating temperature : 5 °C ~ 35 °C
Input Rating : DC 5 V, < 10 W (2 A @ 5 V)

* Product specification information described herein was obtained from product data sheet or user's manual.

3. Laboratory Information

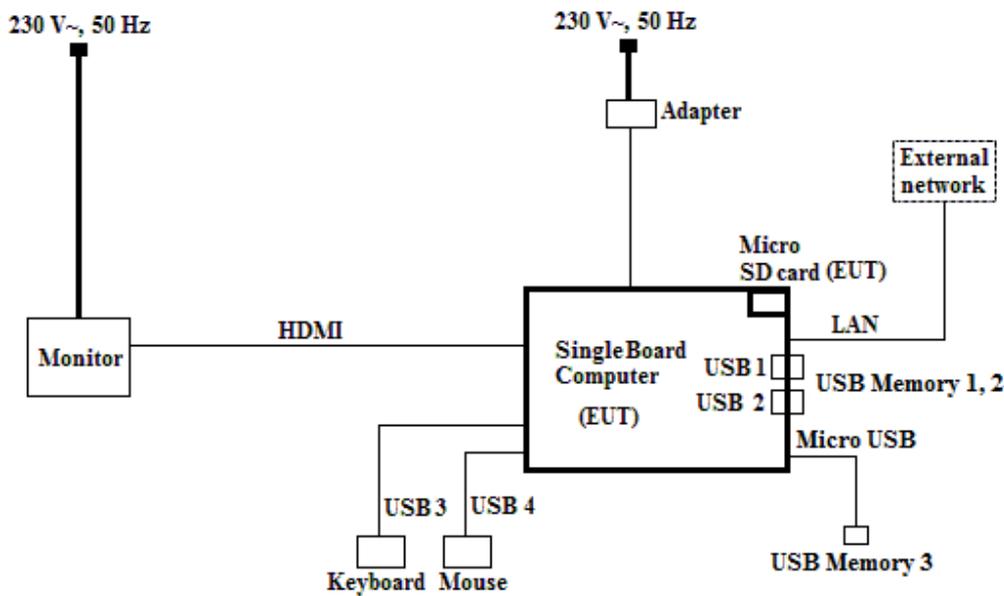
Laboratory Name : UCS Co., Ltd.
Location : 35-13, Hwalcho-gil, 109beon-gil, Hwaseong-si, Gyeonggi-do, 445-150 Korea.

4. Test Configuration and Condition

4.1 EUT operating condition

- After connecting a peripherals to the EUT, observed with video playback and ping test continuously during the test.
- Input power condition during the measurements was 230 V~, 50 Hz. (Adapter - Output: DC 5 V)
- At the request of the applicant tested using the Adapter but is not EUT.

4.2 EUT test configuration diagram



4.3 Peripheral equipments list for test

Equipment Name	Model	Serial Number	Manufacturer
Single Board Computer	ODROID-C1	-	Hardkernel Co., LTD.
Micro SD card	-	-	San Disk
Adapter	SA-A136	-	WEIHAI SUNIN ELECTRONICS CO., LTD.
Mouse	N910U	K9P90900022	DONGGUAN KUNYING COMPUTER PRODUCTS CO., LTD.
Keyboard	KB212-B	-	Dell Inc.
Monitor	LT23B350	ZWL6HMCC806181L	SAMSUNG
USB Memory 1	Cruzer Edge	-	San Disk
USB Memory 2	-	-	-
USB Memory 3	-	-	-

4.4 Cable connections

Start		End		Cable	
Name	I/O Port	Name	I/O Port	Length	Spec.
Single Board Computer (EUT)	DC in	Adapter	DC out	1.6	Unshielded
	Card slot	Micro SD card	Card slot	-	-
	Video out	Monitor	Video in	0.8	Shielded
	USB 1, 2	USB memory 1, 2	USB	-	-
	USB 3	Keyboard	-	1.5	Unshielded
	USB 4	Mouse	-	1.6	Unshielded
	Micro USB	USB Memory 3	USB	0.2	Shielded
	LAN	External network	LAN	3.0	Unshielded

4.5 Information of the instruction for class A ITE

- Class A equipment shall be included the following warning in the instructions for use.

WARNING

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4.6 EUT modifications

None

5. Summary of Test Results

5.1 Summary of test results

Standard	Test Item	Results
EN 55022:2010	Conducted disturbance at the mains ports	Met Class A / Pass
	Conducted disturbance at the telecommunication ports	Met Class A / Pass
	Radiated disturbance	Met Class A / Pass
EN 61000-3-2:2006 + A1:2009 + A2:2009	Harmonics current emissions	Met / Pass
EN 61000-3-3:2008	Voltage changes, Voltage fluctuations and flicker	Met / Pass
EN 55024:2010	Electrostatic discharge	Met Criterion A and B / Pass
	Radiated RF electromagnetic field immunity	Met Criterion A / Pass
	Electrical fast transient/burst immunity	Met Criterion A / Pass
	Surge immunity	Met Criterion A / Pass
	Conducted disturbance induced by RF fields immunity	Met Criterion A / Pass
	Magnetic field immunity	N/A (See Note)
	Voltage dips and short interruptions	Met Criterion A and C / Pass

* Note: The EUT does not contain devices susceptible to magnetic fields, so the test was not performed.

5.2 Performance of criteria

Performance criterion A

During and after the test the EUT shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed below a minimum performance level specified by the manufacturer when the EUT 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 EUT if used as intended.

Performance criterion B

After the test, the EUT 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 EUT 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 EUT if used as intended.

Performance criterion C

During and after testing, a temporary loss of function is allowed, provided the function is selfrecoverable, or can be restored by the operation of the controls or cycling of the power to the EUT 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.

6. Test Results

6.1 Conducted disturbance

Test Standard	EN 55022:2010, Class A
Tested Date	2014.12.19
Input Ratings	230 V~, 50 Hz
Test result	Met Class A / Pass

6.1.1 Limit

Mains ports

Frequency [MHz]	Class A [dB μ V]		Class B [dB μ V]	
	Quasi-Peak	Average	Quasi-Peak	Average
0.15 ~ 0.5	79	66	66 ~ 56*	56 ~ 46*
0.5 ~ 5	73	60	56	46
5 ~ 30	73	60	60	50

* The limit decreases linearly with the logarithm of frequency.

Telecommunication ports

Frequency [MHz]	Class A [dB μ V]		Class B [dB μ V]	
	Quasi-Peak	Average	Quasi-Peak	Average
0.15 ~ 0.5	97 ~ 87*	84 ~ 74*	84 ~ 74*	74 ~ 64*
0.5 ~ 30	87	74	74	64

* The limit decreases linearly with the logarithm of frequency.

6.1.2 Test set-up and procedure

The mains terminal disturbance voltage was measured with the equipment under test (EUT) in a shield room.

The EUT was connected to an artificial mains network (LISN) placed on the floor.

The EUT was placed on non-metallic table 0.8 m above the metallic, grounded floor.

The distance to other metallic surface was at least 0.8 m.

Amplitude measurements were performed with a quasi-peak detector and an average detector.

6.1.3 Test equipment used

Equipment	Model	Serial No.	Vendor	Next Cal. Date	Use
Test Receiver	ESPI3	101171	ROHDE & SCHWARZ	2015.08.08	□
Test Receiver	ESR7	101120	ROHDE & SCHWARZ	2015.01.03	■
LISN	NSLK 8127	8127518	SCHWARZBECK	2015.08.28	■
LISN	L3-32	1220X20311	PMM	2015.08.29	□
ISN	ISN T800	30813	TESEQ	2015.02.11	■
ISN	ISN T8-Cat6	29709	TESEQ	2015.02.11	□

6.1.4 Test set-up photos (Mains ports)

[Front]



[Rear]



6.1.5 Test set-up photos (Telecommunication ports)

[Front]



[Rear]



6.1.6 Test data (Mains ports)

- Test Frequency rang : 150 kHz ~ 30 MHz
- Bandwidth : 9 kHz
- Temperature : (16.7 ± 0.4) °C
- Humidity : (22.55 ± 0.55) % R.H.

Frequency [MHz]	Factor		Line	Quasi-Peak			Average		
	LISN [dB]	Cable [dB]		Limit [dB μ V]	Reading [dB μ V]	Results [dB μ V]	Limit [dB μ V]	Reading [dB μ V]	Results [dB μ V]
0.15	0.03	0.03	N	79.00	44.74	44.80	66.00	-	-
0.27	0.04	0.03	H	79.00	48.77	48.84	66.00	-	-
0.34	0.04	0.04	H	79.00	48.96	49.04	66.00	-	-
1.63	0.05	0.10	H	73.00	52.60	52.75	60.00	-	-
6.10	0.11	0.29	H	73.00	51.30	51.69	60.00	-	-
25.43	0.46	0.59	N	73.00	48.51	49.55	60.00	-	-

* Remark: "H": Hot line, "N": Neutral line

* Average mode was not recorded, because Quasi-Peak values were under the Average limit.

6.1.7 Test data (Telecommunication ports)

- Test Frequency rang : 150 kHz ~ 30 MHz
- Bandwidth : 9 kHz

- Temperature : (17.0 ± 0.5) °C
- Humidity : (22.15 ± 0.75) % R.H.

[10 Mbps]

Frequency [MHz]	Factor		Quasi-peak			Average		
	ISN [dB]	Cable [dB]	Limit [dBμV]	Reading [dBμV]	Result [dBμV]	Limit [dBμV]	Reading [dBμV]	Result [dBμV]
0.17	10.13	0.03	95.96	27.21	37.37	82.96	-	-
0.29	9.95	0.04	91.52	34.39	44.38	78.52	-	-
0.33	9.92	0.04	90.45	34.81	44.77	77.45	-	-
1.58	9.64	0.10	87.00	54.31	64.05	74.00	-	-
3.35	9.58	0.16	87.00	54.35	64.09	74.00	-	-
6.05	9.55	0.28	87.00	49.04	58.87	74.00	-	-

* Average mode was not recorded, because Quasi-Peak values were under the Average limit.

[100 Mbps]

Frequency [MHz]	Factor		Quasi-peak			Average		
	ISN [dB]	Cable [dB]	Limit [dBμV]	Reading [dBμV]	Result [dBμV]	Limit [dBμV]	Reading [dBμV]	Result [dBμV]
0.17	10.13	0.03	95.96	29.50	39.66	82.96	-	-
0.20	10.03	0.03	94.61	29.72	39.78	81.61	-	-
0.29	9.95	0.04	91.52	35.47	45.46	78.52	-	-
0.62	9.74	0.06	87.00	44.99	54.79	74.00	-	-
1.63	9.64	0.10	87.00	54.77	64.50	74.00	-	-
3.38	9.58	0.17	87.00	53.53	63.27	74.00	-	-

* Average mode was not recorded, because Quasi-Peak values were under the Average limit.

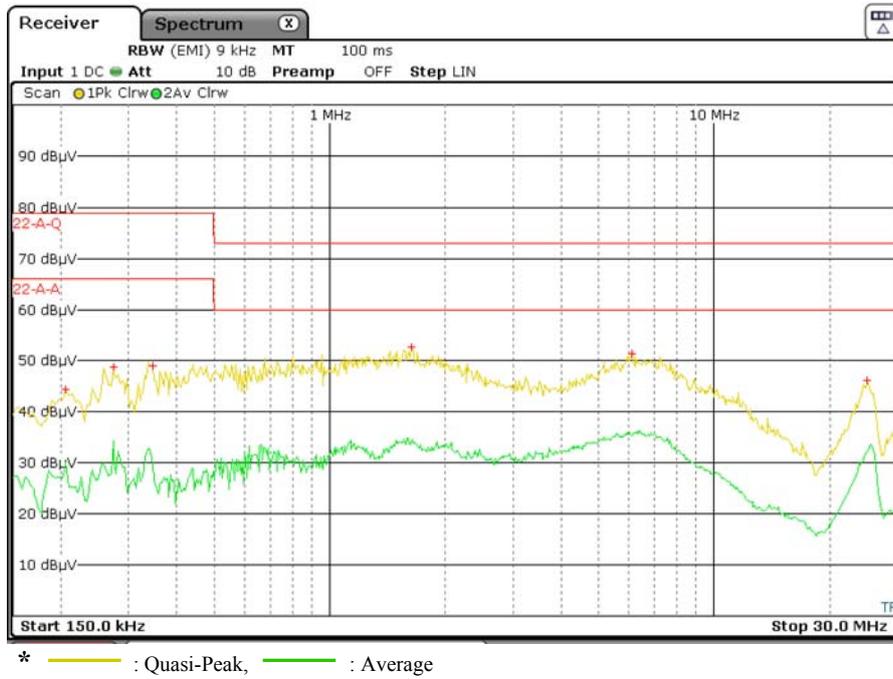
[1 000 Mbps]

Frequency [MHz]	Factor		Quasi-peak			Average		
	ISN [dB]	Cable [dB]	Limit [dB μ V]	Reading [dB μ V]	Result [dB μ V]	Limit [dB μ V]	Reading [dB μ V]	Result [dB μ V]
0.17	10.13	0.03	95.96	31.04	41.20	82.96	-	-
0.27	9.97	0.03	92.12	33.21	43.21	79.12	-	-
0.33	9.92	0.04	90.45	35.15	45.11	77.45	-	-
0.60	9.75	0.06	87.00	43.84	53.64	74.00	-	-
1.16	9.67	0.08	87.00	51.56	61.31	74.00	-	-
2.88	9.59	0.15	87.00	54.50	64.23	74.00	-	-

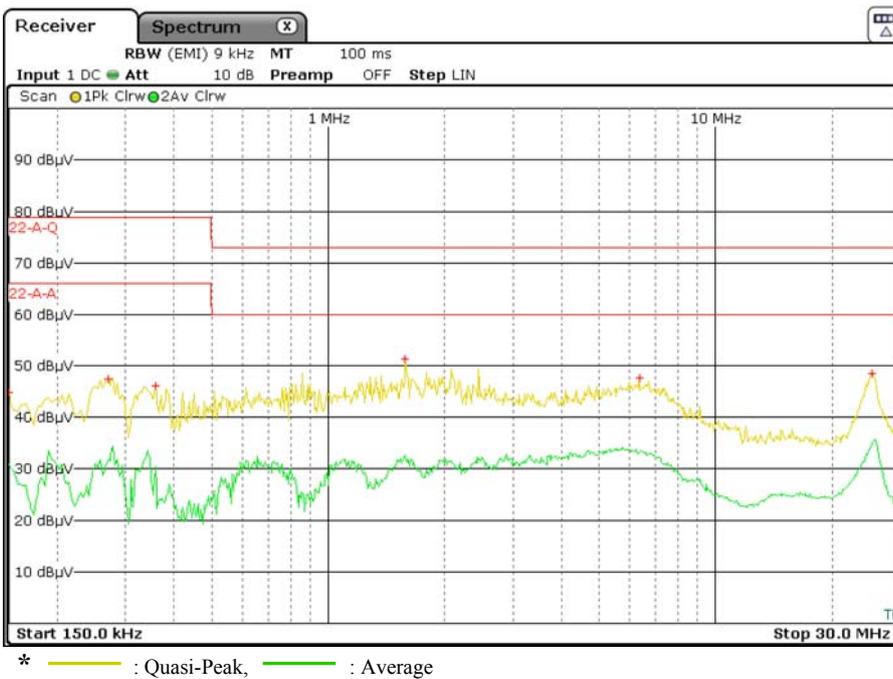
* Average mode was not recorded, because Quasi-Peak values were under the Average limit.

6.1.8 Test graph (Mains ports)

[Hot line]

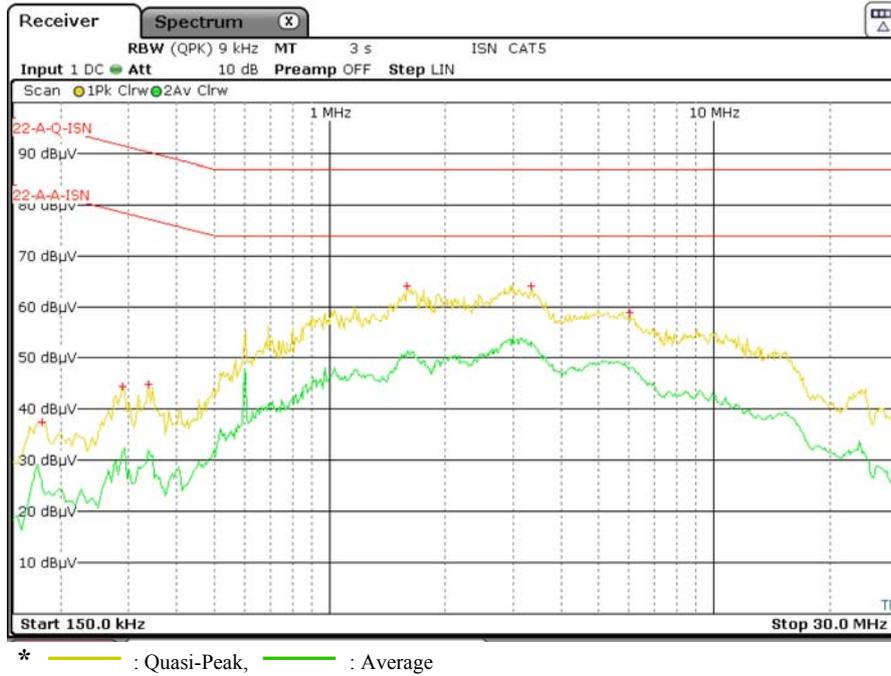


[Neutral line]

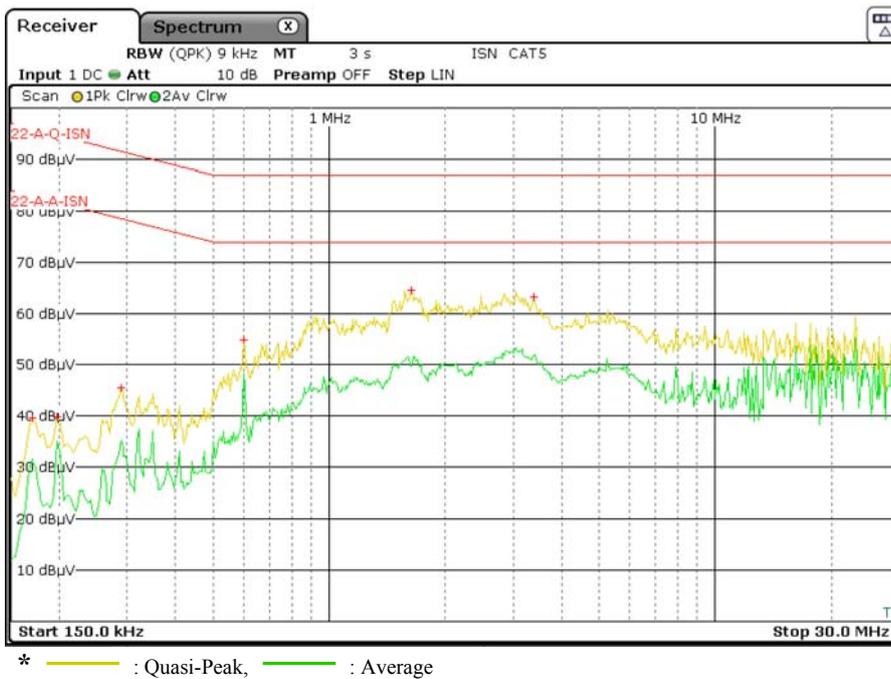


6.1.9 Test graph (Telecommunication ports)

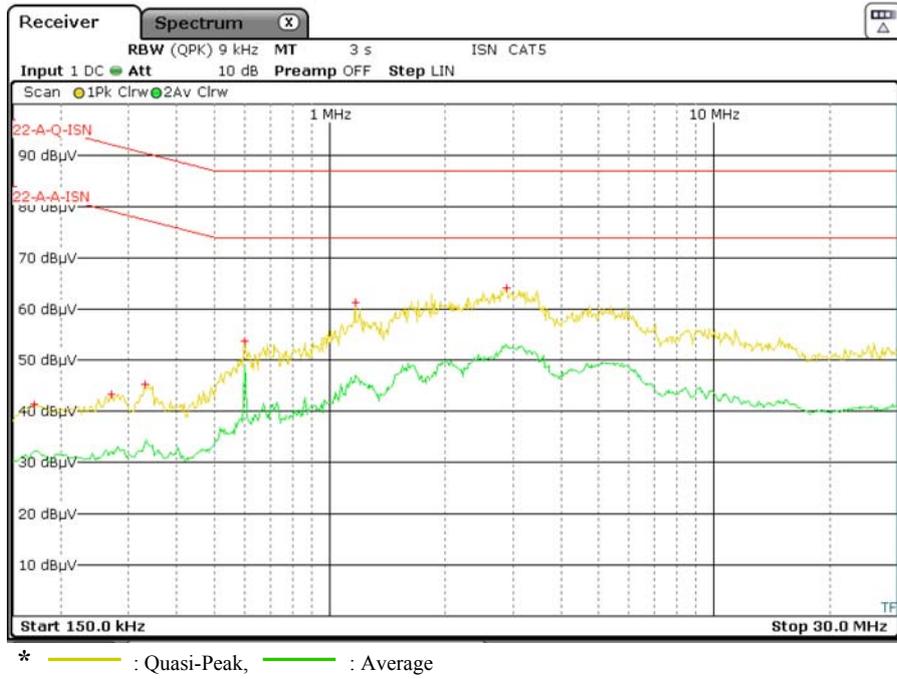
[10 Mbps]



[100 Mbps]



[1 000 Mbps]



6.2 Radiated disturbance (Below 1 GHz)

Test Standard	EN 55022:2010, Class A		
Tested Date	2014.12.19		
Input Ratings	230 V~, 50 Hz		
Temperature	(11.7 ± 0.3) °C	Humidity	(18.45 ± 0.75) % R.H.
Test result	Met Class A / Pass		

6.2.1 Limit

Frequency [MHz]	Class A [dBμV/m] @ 10 m	Class B [dBμV/m] @ 10 m
30 ~ 230	40	30
230 ~ 1 000	47	37

6.2.2 Test set-up and procedure

A pretest was performed at 3 m distance in a semi-anechoic chamber for searching correct frequency.

The final test was done at a 10 m open area test site with a quasi-peak detector.

EUT was placed on a non-metallic table height of 0.8 m above the reference ground plane.

Cables were folded back and forth forming a bundle 0.3 m to 0.4 m long and were hanged at a 0.4 m height to the ground plane.

Cables connected to EUT were fixed to cause maximum emission. Test was made with the antenna positioned in both the horizontal and vertical planes of polarization.

The measurement antenna was varied in height above the conducting ground plane to obtain the maximum.

6.2.3 Used test equipments

Equipment	Model	Serial No.	Vendor	Next Cal. Date	Use
Test Receiver	ESPI3	101171	ROHDE & SCHWARZ	2015.08.08	■
Test Receiver	ESR7	101120	ROHDE & SCHWARZ	2015.01.03	□
BI-LOG ANT	VULB 9163	691	SCHWARZBECK	2016.02.28	■
BI-LOG ANT	HLP-3003C	130526	TDK RF Solutions Inc.	2016.04.02	□
Antenna Master	act-a400	20090812002	Audix Coporation	-	■
Turn Table	act-t450	2009814072	Audix Coporation	-	■
AMPLIFIER	310N	291723	SONOMA	2015.08.28	■
Controller	act	CT-0131	Audix Coporation	-	■
10 m OATS	-	-	Semitec	-	■

6.2.4 Test set-up photos

[Front]



[Rear]



6.2.5 Test data

- Frequency Range : 30 MHz ~ 1 000 MHz
 - Bandwidth : 120 kHz
 - Distance : 10 m

Freq. [MHz]	Reading [dBμV]	Antenna Polarity [H/V]	Height [m]	Antenna Factor [dB/m]	Cable Loss [dB]	Amp. Gain [dB]	Results [dBμV/m]	Limit [dBμV/m]	Margin [dB]
143.50	41.35	V	1.00	7.84	4.34	31.67	21.86	40.00	-18.14
236.43	46.13	V	1.00	12.06	5.83	31.61	32.41	47.00	-14.59
244.44	49.00	V	1.00	12.38	5.93	31.61	35.70	47.00	-11.30
518.25	27.10	H	4.00	17.62	9.45	31.84	22.33	47.00	-24.67
743.15	32.30	H	4.00	20.65	11.79	31.88	32.86	47.00	-14.14
961.34	27.30	H	4.00	22.65	13.80	30.73	33.02	47.00	-13.98

* Remark: "H": Horizontal, "V": Vertical

* **Results [dBμV/m]** = Reading [dBμV] + Antenna Factor [dB/m] + Cable Loss [dB] – Amp. Gain [dB]

* **Margin [dB]** = Results [dBμV/m] – Limit [dBμV/m]

6.3 Radiated disturbance (Above 1 GHz)

Test Standard	EN 55022:2010, Class A		
Tested Date	2014.12.19		
Input Ratings	230 V~, 50 Hz		
Temperature	(12.05 ± 1.15) °C	Humidity	(41.65 ± 1.05) % R.H.
Test result	Met Class A / Pass		

6.3.1 Limit

Frequency [GHz]	Class A [dBμV] @ 3 m		Class B [dBμV] @ 3 m	
	Peak	Average	Peak	Average
1 ~ 3	76	56	70	50
3 ~ 6	80	60	74	54

6.3.2 Test set-up and procedure

The final test was done at a 3 m chamber with a peak and average detector.

EUT was placed on a non-metallic table height of 0.8 m above the reference ground plane.

Cables were folded back and forth forming a bundle 0.3 m to 0.4 m long and were hanged at a 0.4 m height to the ground plane.

Cables connected to EUT were fixed to cause maximum emission.

Test was made with the antenna positioned in both the horizontal and vertical planes of polarization.

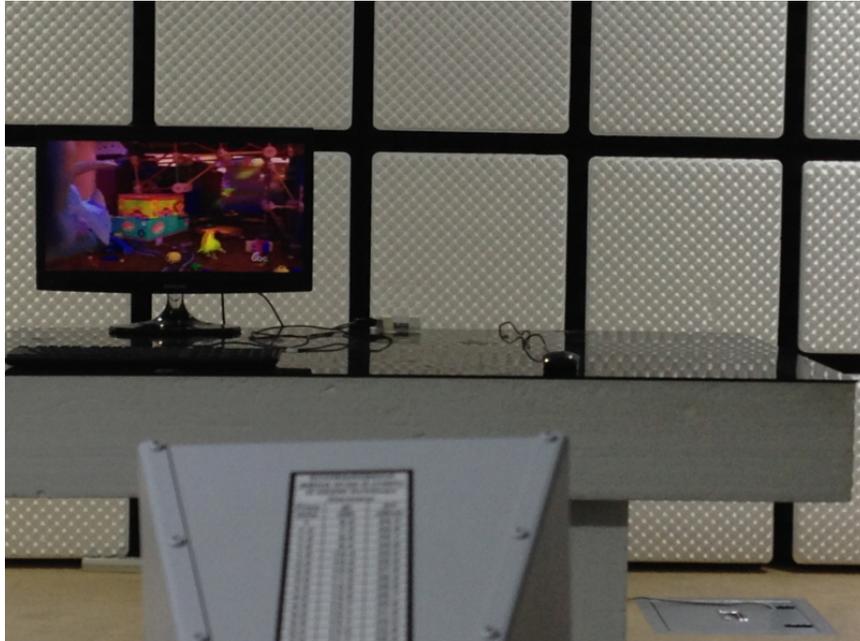
The measurement antenna was varied in height above the conducting ground plane to obtain the maximum signal strength.

6.3.3 Test equipment used

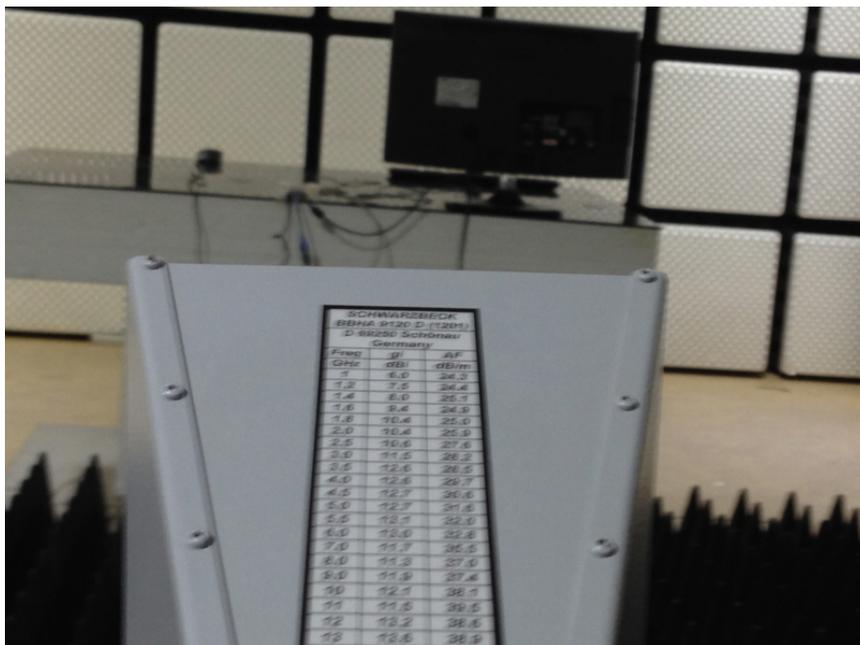
Equipment	Model	Serial No.	Vendor	Next Cal. Date	Use
Spectrum Analyzer	FSP13	100640	ROHDE & SCHWARZ	2015.01.03	□
Test Receiver	ESR7	101120	ROHDE & SCHWARZ	2015.01.03	■
HORN ANTENNA	BBHA 9120D	768	Schwarzbeck	2015.12.11	■
Antenna Mast	-	-	Audix Coporation	-	■
Turn Table	act-t300	-	Audix Coporation	-	■
Microwave Preamplifier	8449B	3008A02014	Agilent	2015.03.10	■
Controller	EM 1000	060558	Audix Corporation	-	■

6.3.4 Test set-up photos

[Front]



[Rear]



6.3.5 Test data

- Frequency Range : 1 000 MHz ~ 6 000 MHz
 - Bandwidth : 1 MHz
 - Distance : 3 m

[Peak]

Freq. [MHz]	Reading [dB μ V]	Antenna Polarity [H/V]	Height [m]	Antenna Factor [dB/m]	Cable Loss [dB]	Amp. Gain [dB]	Results [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
1 215.00	58.60	V	1.00	24.46	9.48	36.71	55.83	76.00	-20.17
1 330.00	58.14	V	1.00	24.57	9.04	36.56	55.19	76.00	-20.81
3 300.00	50.92	V	1.00	28.69	10.55	35.19	54.97	80.00	-25.03
4 535.00	46.02	V	1.00	30.52	8.27	34.47	50.34	80.00	-29.66
5 185.00	45.73	V	1.00	31.79	8.38	34.32	51.58	80.00	-28.42
5 755.00	47.10	H	1.00	32.40	8.77	34.33	53.94	80.00	-26.06

* Remark: "H": Horizontal, "V": Vertical

* Max. clock frequency: 1.5 GHz

* **Results [dB μ V/m]** = Reading [dB μ V] + Antenna Factor [dB/m] + Cable Loss [dB] – Amp. Gain [dB]

* **Margin [dB]** = Results [dB μ V/m] – Limit [dB μ V/m]

[Average]

Freq. [MHz]	Reading [dB μ V]	Antenna Polarity [H/V]	Height [m]	Antenna Factor [dB/m]	Cable Loss [dB]	Amp. Gain [dB]	Results [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
1 215.00	42.06	V	1.00	24.46	9.48	36.71	39.29	56.00	-16.71
1 330.00	42.70	V	1.00	24.57	9.04	36.56	39.75	56.00	-16.25
3 300.00	34.70	V	1.00	28.69	10.55	35.19	38.75	60.00	-21.25
4 535.00	34.38	V	1.00	30.52	8.27	34.47	38.70	60.00	-21.30
5 185.00	34.73	V	1.00	31.79	8.38	34.32	40.58	60.00	-19.42
5 755.00	34.56	H	1.00	32.40	8.77	34.33	41.40	60.00	-18.60

* Remark: "H": Horizontal, "V": Vertical

* Max. clock frequency: 1.5 GHz

* **Results [dB μ V/m]** = Reading [dB μ V] + Antenna Factor [dB/m] + Cable Loss [dB] – Amp. Gain [dB]

* **Margin [dB]** = Results [dB μ V/m] – Limit [dB μ V/m]

6.4 Harmonics current emissions

Test Standard	EN 61000-3-2:2006 + A1:2009 + A2:2009		
Tested Date	2014.12.19		
Input Ratings	230 V~, 50 Hz		
Temperature	(21.6 ± 0.4) °C	Humidity	(39.05 ± 0.55) % R.H.
Test result	Met / Pass		

6.4.1 Test setup and procedure

The equipment is supplied in series with shunt(s) Rms or current transformer(s) from a source having the same Nominal voltage and frequency as the rated supply voltage and frequency of the Measurements shall be made under Normal load, or conditions for adequate heat discharge, and underequipment.

Normal operating conditions. User's operation controls or automatic programmers shall be set to produce the maximum harmonic component, for each successive harmonic component in turn. For the purpose of harmonic current limitation, equipment is classified as follows:

Class A : Equipment not specified in one of the three other Classes shall be considered as Class A equipment.

- Balanced three-phase equipment;
- Household appliances, excluding equipment identified as class D;
- Tools, excluding portable tools;
- Dimmers for incandescent lamps;
- Audio equipment.

Class B:

- portable tools;
- arc welding equipment which is not professional equipment.

Class C:

- lighting equipment.

Class D: Equipment having a specified power according to 6.2.2 less than or equal to 600 W, of the following types:

- personal computers and personal computer monitors;
- television receivers.

6.4.2 Used test equipments

Equipment	Model	Serial No.	Vendor	Next Cal. Date	Use
Hamonics/Flicker	5001IX-208-150/300	S59160	C.I.	2015.10.13	■

6.4.3 Test set-up photos

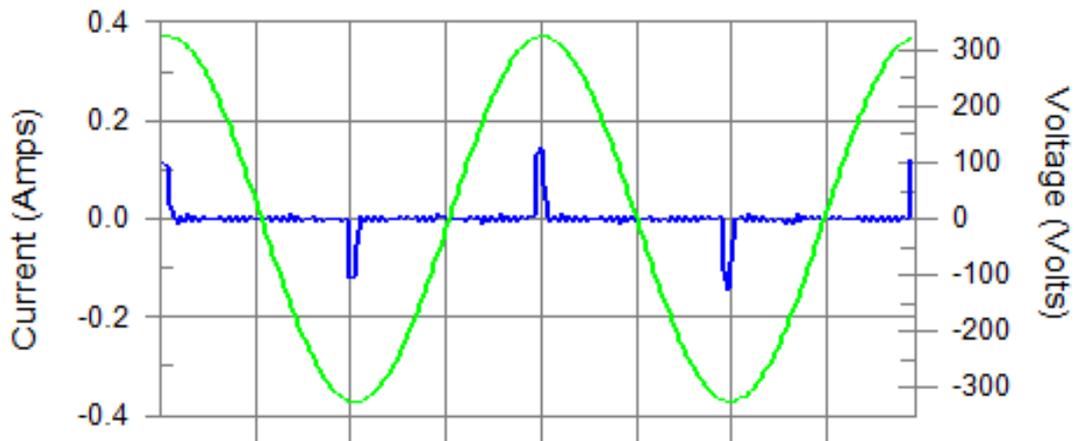


6.4.4 Test data

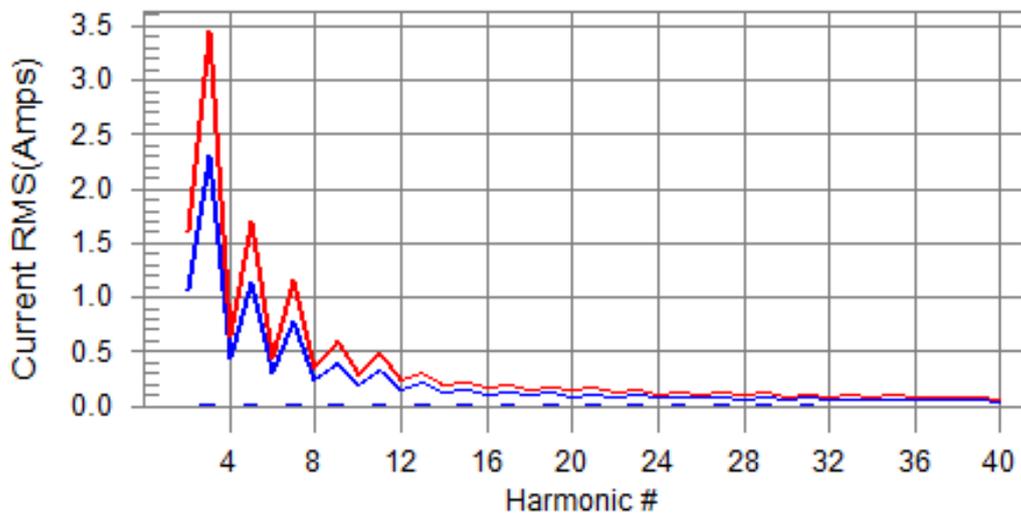
Harmonics – Class-A per Ed. 4.0 (2014)(Run time)

Test Result: Pass Source qualification: Normal

Current & voltage waveforms



Harmonics and Class A limit line European Limits



Test result: Pass Worst harmonic was #19 with 4.4% of the limit.

Current Test Result Summary (Run time)

Test Result: Pass Source qualification: Normal
 THC(A): 0.022 I-THD(%): 278.7 POHC(A): 0.000 POHC Limit(A): 0.251
 Highest parameter values during test:
 V_RMS (Volts): 229.98 Frequency(Hz): 50.00
 I_Peak (Amps): 0.165 I_RMS (Amps): 0.027
 I_Fund (Amps): 0.008 Crest Factor: 6.450
 Power (Watts): 1.9 Power Factor: 0.347

Harm#	Harms(avg)	100%Limit	%of Limit	Harms(max)	150%Limit	%of Limit	Status
2	0.000	1.080	N/A	0.000	1.620	N/A	Pass
3	0.008	2.300	0.3	0.008	3.450	0.2	Pass
4	0.000	0.430	N/A	0.000	0.645	N/A	Pass
5	0.008	1.140	0.7	0.008	1.710	0.5	Pass
6	0.000	0.300	N/A	0.000	0.450	N/A	Pass
7	0.008	0.770	1.0	0.008	1.155	0.7	Pass
8	0.000	0.230	N/A	0.000	0.345	N/A	Pass
9	0.007	0.400	1.8	0.008	0.600	1.3	Pass
10	0.000	0.184	N/A	0.000	0.276	N/A	Pass
11	0.007	0.330	2.1	0.007	0.495	1.4	Pass
12	0.000	0.153	N/A	0.000	0.230	N/A	Pass
13	0.007	0.210	3.1	0.007	0.315	2.1	Pass
14	0.000	0.131	N/A	0.000	0.197	N/A	Pass
15	0.006	0.150	4.1	0.006	0.225	2.8	Pass
16	0.000	0.115	N/A	0.000	0.173	N/A	Pass
17	0.006	0.132	4.3	0.006	0.198	2.9	Pass
18	0.000	0.102	N/A	0.000	0.153	N/A	Pass
19	0.005	0.118	4.4	0.005	0.178	3.0	Pass
20	0.000	0.092	N/A	0.000	0.138	N/A	Pass
21	0.005	0.107	N/A	0.005	0.161	N/A	Pass
22	0.000	0.084	N/A	0.000	0.125	N/A	Pass
23	0.004	0.098	N/A	0.004	0.147	N/A	Pass
24	0.000	0.077	N/A	0.000	0.115	N/A	Pass
25	0.004	0.090	N/A	0.004	0.135	N/A	Pass
26	0.000	0.071	N/A	0.000	0.107	N/A	Pass
27	0.003	0.083	N/A	0.003	0.125	N/A	Pass
28	0.000	0.066	N/A	0.000	0.099	N/A	Pass
29	0.003	0.078	N/A	0.003	0.116	N/A	Pass
30	0.000	0.061	N/A	0.000	0.092	N/A	Pass
31	0.002	0.073	N/A	0.002	0.109	N/A	Pass
32	0.000	0.058	N/A	0.000	0.086	N/A	Pass
33	0.002	0.068	N/A	0.002	0.102	N/A	Pass
34	0.000	0.054	N/A	0.000	0.081	N/A	Pass
35	0.001	0.064	N/A	0.002	0.096	N/A	Pass
36	0.000	0.051	N/A	0.000	0.077	N/A	Pass
37	0.001	0.061	N/A	0.001	0.091	N/A	Pass
38	0.000	0.048	N/A	0.000	0.073	N/A	Pass
39	0.001	0.058	N/A	0.001	0.087	N/A	Pass
40	0.000	0.046	N/A	0.000	0.069	N/A	Pass



Voltage Source Verification Data (Run time)

Test Result: Pass Source qualification: Normal

Highest parameter values during test:

Voltage (Vrms): 229.98	Frequency(Hz): 50.00
I_Peak (Amps): 0.165	I_RMS(Amps): 0.027
I_Fund (Amps): 0.008	Crest Factor: 6.450
Power(Watts): 1.9	Power Factor: 0.347

Harm#	Harmonics V-rms	Limit V-rms	% of Limit	Status
2	0.032	0.460	6.87	OK
3	0.470	2.070	22.73	OK
4	0.014	0.460	3.13	OK
5	0.010	0.920	1.12	OK
6	0.015	0.460	3.23	OK
7	0.050	0.690	7.25	OK
8	0.006	0.460	1.36	OK
9	0.118	0.460	25.67	OK
10	0.009	0.460	1.89	OK
11	0.070	0.230	30.45	OK
12	0.013	0.230	5.76	OK
13	0.031	0.230	13.43	OK
14	0.004	0.230	1.73	OK
15	0.015	0.230	6.49	OK
16	0.011	0.230	4.73	OK
17	0.006	0.230	2.75	OK
18	0.015	0.230	6.62	OK
19	0.011	0.230	4.71	OK
20	0.013	0.230	5.60	OK
21	0.009	0.230	3.94	OK
22	0.005	0.230	2.09	OK
23	0.006	0.230	2.71	OK
24	0.003	0.230	1.42	OK
25	0.006	0.230	2.62	OK
26	0.005	0.230	2.04	OK
27	0.003	0.230	1.22	OK
28	0.004	0.230	1.68	OK
29	0.008	0.230	3.29	OK
30	0.004	0.230	1.80	OK
31	0.005	0.230	2.32	OK
32	0.002	0.230	0.98	OK
33	0.006	0.230	2.74	OK
34	0.003	0.230	1.18	OK
35	0.004	0.230	1.83	OK
36	0.003	0.230	1.29	OK
37	0.006	0.230	2.67	OK
38	0.003	0.230	1.13	OK
39	0.005	0.230	2.17	OK
40	0.009	0.230	3.87	OK

6.5 Voltage changes, Voltage fluctuations and flicker

Test Standard	EN 61000-3-3:2008		
Tested Date	2014.12.19		
Input Ratings	230 V~, 50 Hz		
Temperature	(21.7 ± 0.5) °C	Humidity	(38.15 ± 0.75) % R.H.
Test result	Met / Pass		

6.5.1 Test set-up and procedure

EUT was connected to the power analyzer system.

Measurement was performed to obtain the desired flicker parameters.

The measuring time depends on which parameters are to be measured.

Plt = 2 h

Pst = 10 min

Controls and automatic programs shall be set to produce the most unfavorable sequence of voltage changes, using only those combinations of controls and programs are mentioned by the manufacturer in the instruction manual.

6.5.2 Used test equipments

Equipment	Model	Serial No.	Vendor	Next Cal. Date	Use
Hamonics/Flicker	5001IX-208-150/300	S59160	C.I.	2015.10.13	■

6.5.3 Test set-up photos



6.5.4 Test data

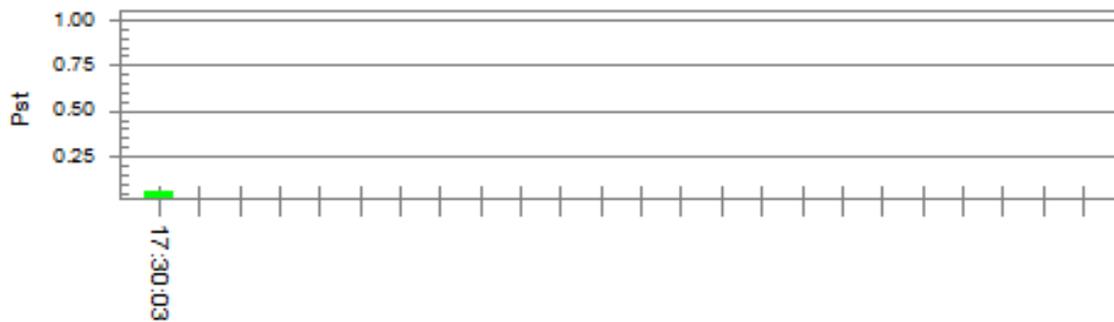
Flicker Test Summary per EN/IEC61000-3-3 (Run time)

Test Result: Pass

Status: Test Completed

Pst_t and limit line

European Limits



Plt and limit line



Parameter values recorded during the test:

Vrms at the end of test (Volt):	229.95		
Highest dt (%):	0.00	Test limit (%):	N/A
T-max (mS):	0	Test limit (mS):	500.0
Highest dc (%):	0.00	Test limit (%):	3.30
Highest dmax (%):	0.00	Test limit (%):	4.00
Highest Pst (10 min. period):	0.064	Test limit:	1.000
Highest Plt (2 hr. period):	0.028	Test limit:	0.650

6.6 Electrostatic discharge

Test Standard	EN 61000-4-2:2009, Criteria: B		
Test Level	HCP/VCP/Contact: ± 4 kV Air: ± 2 kV, ± 4 kV, ± 8 kV		
Discharge Impedance	330 Ω / 150 pF		
Test Time	at least 25 times for each adapting point		
Tested Date	2014.12.19		
Input Ratings	230 V~, 50 Hz		
Temperature	(21.9 \pm 0.7) $^{\circ}$ C	Humidity	(39.9 \pm 0.7) % R.H.
Atmospheric pressure	102.7 kPa		
Test Result	Met criterion A and B / Pass		

6.6.1 Test set-up and procedure

A ground reference plane was located on the floor, and connected to earth via a low Impedance connection.

The return cable of the ESD generator was connected to the reference plane.

In case of floor standing equipment, EUT was placed on the reference plane on 0.1 m of insulating Support.

In case of table top equipment, EUT was placed on a wooden table 0.8 m above the reference grounded floor.

A horizontal coupling plane (HCP) was placed on the table, and Connected to the reference plane via a 470 kohm resistor located in each end (0.5 mm insulating support between EUT and HCP).

In both cases a vertical coupling plane (VCP) of 0.5 m x 0.5 m was located 0.1 m from the EUT's sides.

The VCP was connected to the reference plane in the same matter as the HCP.

6.6.2 Used test equipments

Equipment	Model	Serial No.	Vendor	Next Cal. Date	Use
ESD Simulator	ESS-2000	4010C63927	NoiseKen	2015.08.28	■
HAEFELY TEST AG	ONYX 16	177897	HAEFELY TECHNOLOGY	2015.04.04	□
HCP	-	-	-	-	■
VCP	-	-	-	-	■

6.6.3 Test set-up photos



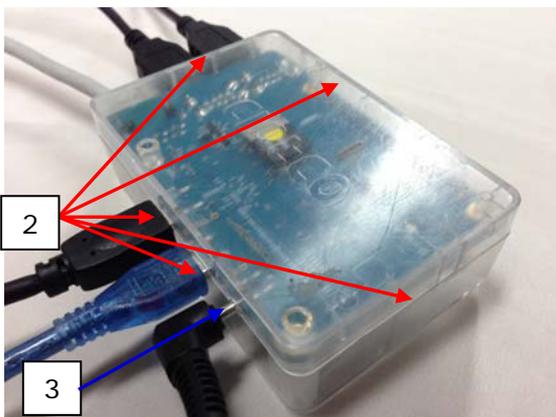
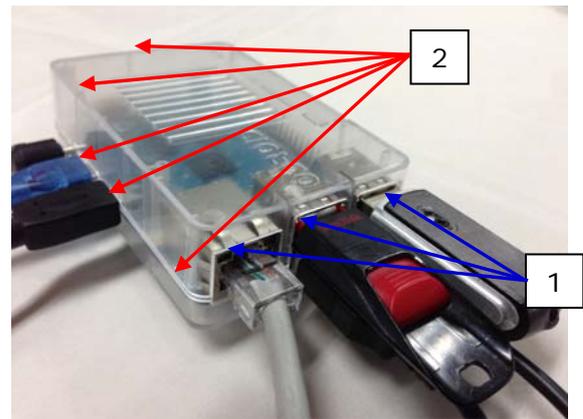
6.6.4 Test data

Location	Applied Level (±)	Criteria	Results
VCP	4 kV	B	A (See note 1)
HCP	4 kV	B	

Location (EUT)	Applied Level (±)	Method	Criteria	Results
(1) USB, LAN Part	4 kV	Contact	B	A (See note 1)
(2) HDMI, Micro USB, Cover Part	2 kV, 4 kV, 8 kV	Air	B	
(3) Power port Part	4 kV	Contact	B	B (See note 2)

* Note 1: There was no deviation from normal operation condition.

* Note 2: The flicker was observed on the monitor during the test, but return to normal operating condition after the test.



6.7 Radiated RF electromagnetic field immunity

Test Standard	EN 61000-4-3:2006 + A1:2008 + A2:2010, Criteria: A		
Tested Frequency	80 MHz ~ 1.0 GHz		
Test Level/Modulation	3 V/m (AM 80 %, 1 kHz)		
Distance	3 m		
Dwell Time	3 s		
Step Size	log 1 % step		
Tested Date	2014.12.19		
Input Ratings	230 V~, 50 Hz		
Temperature	(24.15 ± 0.55) °C	Humidity	(39.9 ± 1.1) % R.H.
Atmospheric pressure	102.5 kPa		
Test Result	Met criterion A / Pass		

6.7.1 Test set-up and procedure

The test was performed at 3 m full anechoic chamber.

For floor standing equipment, the EUT was standing on the floor.

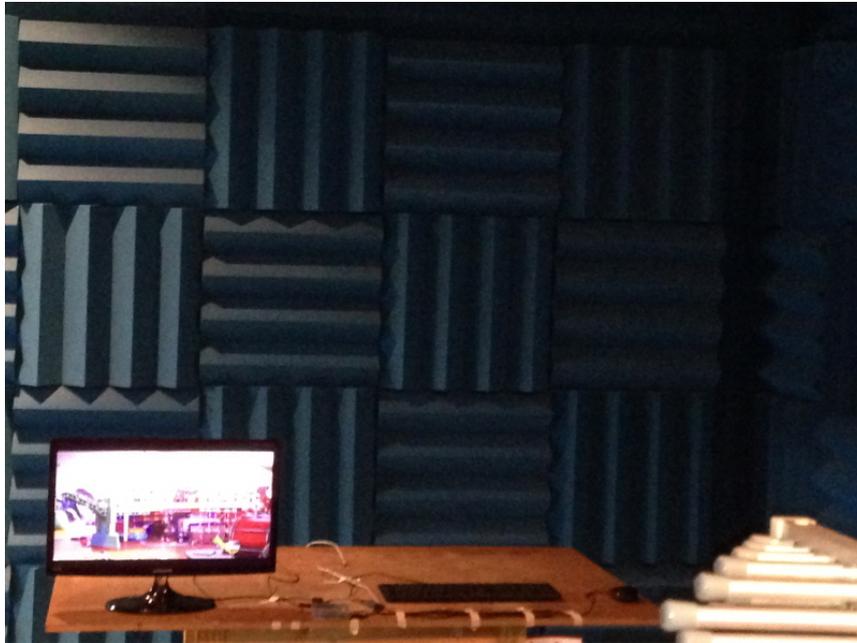
For tabletop equipment, the EUT was located on a wooden table 0.8 m above the floor.

The EUT was tested all sides, horizontal and vertical polarization.

6.7.2 Used test equipments

Equipment	Model	Serial No.	Vendor	Next Cal. Date	Use
SIGNAL GENERATOR	SMC100A	101441	ROHDE & SCHWARZ	2015.08.28	■
EMP Series Power Meter	E4419B	MY45104421	Agilent	2015.08.28	■
E-SERIES AVG POWER SENSOR	E9304A	MY41499023	Agilent	2015.08.28	■
RF AMPLIFIER	25A250AM1	0331227	AMPLIFRER RESEARCH	-	□
RF AMPLIFIER	30S1G3M1	0331152	AMPLIFRER RESEARCH	-	□
RF AMPLIFIER	150W1000M1	0331746	AMPLIFRER RESEARCH	-	■
Horn Antenna	AT4002A	0330909	AMPLIFRER RESEARCH	-	□
LOG-PER ANTENNA	VULP 9118 E	855	SCHWARZBECK	-	■

6.7.3 Test set-up photos



6.7.4 Test data

Location (EUT)	Antenna Polarization	Results	Results
Front Side	Horizontal	A	A
	Vertical	A	A
Rear Side	Horizontal	A	A
	Vertical	A	A
Left Side	Horizontal	A	A
	Vertical	A	A
Right Side	Horizontal	A	A
	Vertical	A	A

* There was no deviation from normal operation condition.

6.8 Electric fast transient/burst immunity

Test Standard	EN 61000-4-4:2012, Criteria: B		
Coupling	Coupling Decoupling Network		
Test Level	AC Mains: ± 1 kV Peak, Signal: ± 0.5 kV Peak		
Repetition Freq.	5 kHz, Tr / Th = 5 / 50 ns		
Coupling Time	60 s		
Tested Date	2014.12.22		
Input Ratings	230 V~, 50 Hz		
Temperature	$(20.55 \pm 0.65) ^\circ\text{C}$	Humidity	$(46.5 \pm 1.1) \% \text{ R.H.}$
Atmospheric pressure	102.2 kPa		
Test Result	Met criterion A / Pass		

6.8.1 Test set-up and procedure

A ground reference plane was located on the floor.

EFT generator was connected to reference ground plane via low impedance connection.

For floor standing equipment, EUT was placed on a 0.1 m wooden table.

For tabletop equipment, EUT was placed on a 0.1 m above the ground reference plane.

Test generator and coupling/decoupling network was placed on, and bounded to, the ground reference plane.

When using the coupling clamp, the minimum distance between the coupling plates and all other conductive surfaces, except the ground reference plane beneath the coupling clamp, Shall be 0.5 m.

6.8.2 Used test equipments

Equipment	Model	Serial No.	Vendor	Next Cal. Date	Use
EMC IMMUNITY TEST	EMCPRO PLUS	0906221	ThermoFisher Scientific	2015.08.28	■
Capacitive Clamp	CCL	0904227	ThermoFisher Scientific	2015.08.29	■

6.8.3 Test set-up photos



6.8.4 Test data

EFT Coupling Point	Level (±)	Criteria	Results
L	1 kV	B	A
N	1 kV	B	A
L - N	1 kV	B	A
LAN	0.5 kV	B	A

* There was no deviation from normal operation condition.

6.9 Surge immunity

Test Standard	EN 61000-4-5:2006, Criteria: B		
Coupling	Coupling Decoupling Network		
Test Level	AC Mains (Line to Line): $\pm (0.5, 1)$ kV		
Surge Pulse Shape	Tr/Th = 1.2/50 μ s (8/20 μ s)		
Number of surge/time	1 time / 1 min, total 5 times		
Tested Date	2014.12.22		
Input Ratings	230 V~, 50 Hz		
Temperature	(19.7 \pm 0.9) °C	Humidity	(43.45 \pm 1.15) % R.H.
Atmospheric pressure	102.2 kPa		
Test Result	Met criterion A / Pass		

6.9.1 Test set-up and procedure

A ground reference plane was located on the floor. SURGE generator was connected to reference ground plane via low impedance connection. For floor standing equipment, EUT was placed on a 0.1 m wooden table.

For table top equipment, EUT was placed on a wooden table (0.1 m) above the reference plane.

6.9.2 Used test equipments

Equipment	Model	Serial No.	Vendor	Next Cal. Date	Use
EMC IMMUNITY TEST	EMCPRO PLUS	0906221	ThermoFisher Scientific	2015.08.28	■
I/O Lin Coupler/Decoupler	CM-I/OCD	0906226	ThermoFisher Scientific	-	□
Telecom coupler/Decoupler	CM-TELCD	0905226	ThermoFisher Scientific	-	□

6.9.3 Test set-up photos



6.9.4 Test data

Coupling Point	Level (\pm)	Criteria	Results
L to N	0.5 kV, 1 kV	B	A

* There was no deviation from normal operation condition.

* The EUT does not have the signal ports that may connect directly to outdoor cables.

6.10 Conducted disturbance induced by RF fields immunity

Test Standard	EN 61000-4-6:2009, Criteria: A		
Tested Frequency	150 kHz ~ 80 MHz		
Test Level/Modulation	3 V (AM 80 %, 1 kHz)		
Coupling Method	AC Mains: M2, Signal: EM Clamp		
Dwell Time	3 s		
Step Size	log 1 % step		
Tested Date	2014.12.22		
Input Ratings	230 V~, 50 Hz		
Temperature	(20.3 ± 0.7) °C	Humidity	(42.3 ± 0.6) % R.H.
Atmospheric pressure	102.4 kPa		
Test Result	Met criterion A / Pass		

6.10.1 Test set-up and procedure

A ground reference plane was located on the floor

The test was performed on a ground reference plane on a 0.1 m wooden table.

This test were performed using CDN for mains, clamp for signal and injection probe.

The frequency range was swept from 150 kHz to 100 MHz. This frequency range was modulated with 1 kHz sine wave at 80 %.

The signal generators provided the modulated frequency at a 1 % step size

The power and all network cable, I/O cables longer than 3 m length were tested

6.10.2 Used test equipments

Equipment	Model	Serial No.	Vendor	Next Cal. Date	Use
CDN M2	FCC-801-M2-16A	091165	FCC	2015.08.28	■
CDN M3	FCC-801-M3-16A	091994	FCC	2015.08.28	□
EM INJECTION CLAMP	F-203I-23mm	091199	FCC	2015.01.02	■
Continuous Wave Simulator	CWS 500N1	P1247105423	EM Test	2015.02.20	■
Coaxial Fixed Attenuator	ATT6/75	P1306112966	EM Test	2015.02.20	■

6.10.3 Test set-up photos



6.10.4 Test data

Coupling Point	Coupling Method	Criteria	Results
AC Mains	CDN (M2)	A	A
LAN	EM Clamp	A	A

* There was no deviation from normal operation condition.

6.11 Voltage dips and short interruptions

Test Standard	EN 61000-4-11:2004, Criterion : B or C		
Number of reduction	3 T		
Duration	10 s		
Phase	Zero crossing (0°, 180°)		
Tested Date	2014.12.22		
Input Ratings	100-240 V~, 50 Hz		
Temperature	(21.0 ± 0.4) °C	Humidity	(43.45 ± 1.05) % R.H.
Atmospheric pressure	(102.35 ± 0.05) kPa		
Test result	Met criterion A and C / Pass		

6.11.1 Test set-up and procedure

The dips/interruption test is only applicable to AC mains.

The dips/interruptions were applied at zero crossing

6.11.2 Used test equipments

Equipment	Model	Serial No.	Vendor	Next Cal. Date	Use
EMC IMMUNITY TEST	EMCPRO PLUS	0906221	ThermoFisher Scientific	2015.08.28	■

6.11.3 Test set-up photos



6.11.4 Test data

Test	Test Level (% U _T)	Periods	Criteria	Results
Voltage dips	> 95 %	0.5	B	A (See note 1)
	30 %	25	C	
Voltage interruptions	> 95 %	250	C	C (See note 2)

* Note 1: There was no deviation from normal operation condition.

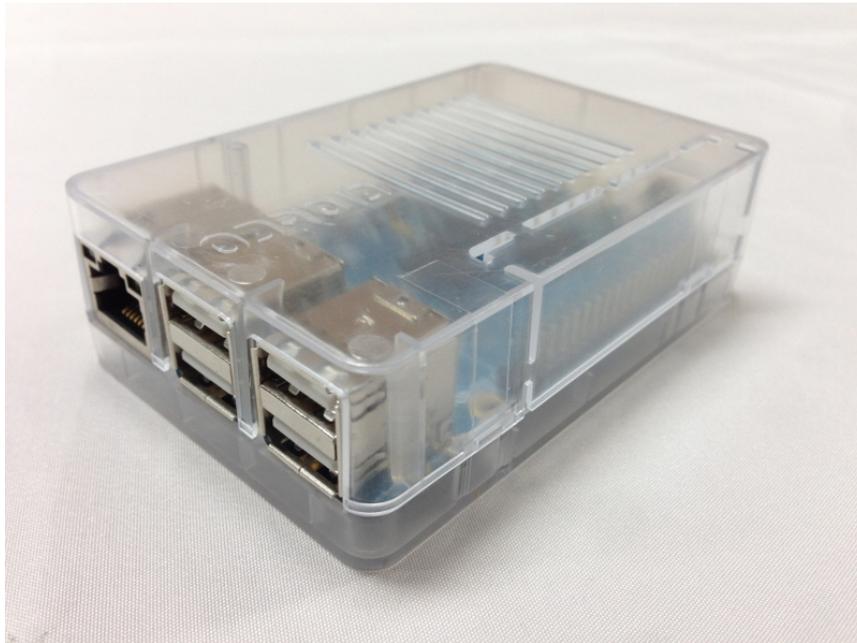
* Note 2: The power of EUT was turned off during the test, but returned to normal operating condition after the test.

* Test result of both 100 V~ and 240 V~ are same.

7. EUT Photos

7.1 External view

[Front view]



[Rear view]



7.2 Internal view



7.3 Internal Board

