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TEST REPORT

Part 15 Subpart C 15.225

Equipment under test	Computed Radiography Scanner
Model name	FireCR Spark
FCC ID	X68CRSCANNER3
Applicant	3D Imaging & Simulations Corp.
Manufacturer	3D Imaging & Simulations Corp.
Date of test(s)	2013.08.12 ~ 2013.08.19
Date of issue	2013.08.21

Issued to

3D Imaging & Simulations Corp.
#201~202, 815, Tamnip-dong, Yuseong-Gu, Daejeon, KOREA

Issued by

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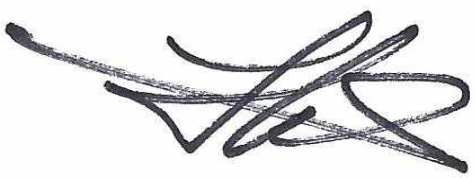
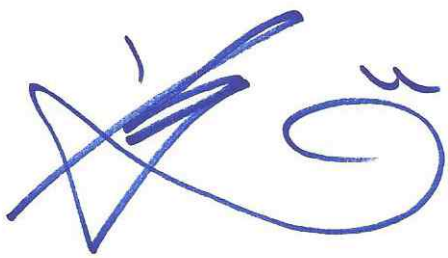
Test and report completed by :	**Report approval by :**
	
Hyeon-Su, Jang Test engineer	Jeff Do Technical manager

Revision history

Revision	Date of issue	Test report No.	Description
-	2013.08.21	KES-RF-13T0017	Initial

TABLE OF CONTENTS

1. General information

1.1. EUT description

Equipment under test	Computed Radiography Scanner
Model name	FireCR Spark
Serial number	N/A
Frequency range	13.562 ㎒
Modulation technique	ASK
Channel separation	1
Antenna type	Fixed type(PCB antenna)
Power source	AC 110 V

1.2. Test frequency

	Low channel	**Middle channel**	**High channel**
Frequency (㎒)	13.562	N/A	N/A

1.3. Information about variant model

N/A

1.4. Device modifications

N/A

1.5. Test facility

C3701 Dongil Techno Town, 889-1, Gwanyang 2-dong, Dongan-gu, Anyang-si, Gyeonggi-do, 431-716, Korea
477-6, Hageo-ri, Yeoju-eup, Yeoju-gun, Gyeonggi-do, 469-803, Korea

The open area test site is constructed in conformance with the requirements ANSI C63.4-2003.

1.6. Laboratory accreditations and listings

Country	Agency	Scope of accreditation	Certificate No.
USA	FCC	3 & 10 meter Open Area Test Sites and one conducted site to perform FCC Part 15/18 measurements.	343818
KOREA	KC	EMI (10 meter Open Area Test Site and two conducted sites) Radio (3 & 10 meter Open Area Test Sites and one conducted site)	KR0100
CANADA	IC	3 & 10 meter Open Area Test Sites and one conducted site	4769B-1

2. Summary of tests

Reference	Parameter	Status
15.225(a)	The field strength of fundamental	C
15.225(b)(c)	The field strength of spurious emission(In-band)	C
15.225(d) 15.209	The field strength of spurious emission(Out-band)	C
15.225(e)	The frequency tolerance	C
15.215(c)	20 dB bandwidth	C
15.207	AC conducted emission	C
Note 1: C=Complies NC=Not complies NT=Not tested NA=Not applicable		

3. Test results

3.1. Fundamental and spurious emission

Test procedures

[9 ㎑ to 30 ㎒]

The EUT was placed on the top of a rotating table 0.8 meter above the ground at a 3 meter Open Area Test Site. The table was rotated 360 degrees to determine the position of the highest radiation. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading. The test-receiver system was set to Quasi-peak function and specified bandwidth with maximum hold mode.

The spectrum analyzer is set to:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 200 ㎐ for Quasi-peak detection (QP) at frequency below 9 ㎑~ 150 ㎑.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 9 ㎑ for Quasi-peak detection (QP) at frequency below 150 ㎑~ 30 ㎒.

[30 ㎒ to 1 ㎓]

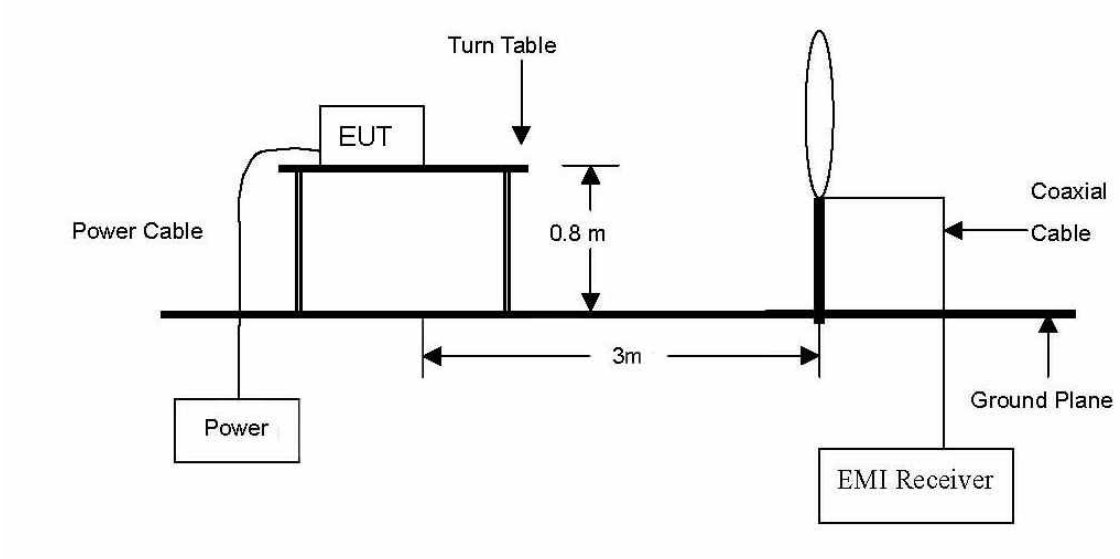
The height of the measuring antenna was varied between 1 to 4 m and the table was rotated a full revolution in order to obtain maximum values of the electric field intensity.

The measurement was made in both the vertical and horizontal polarization, and the maximum value is presented in the report.

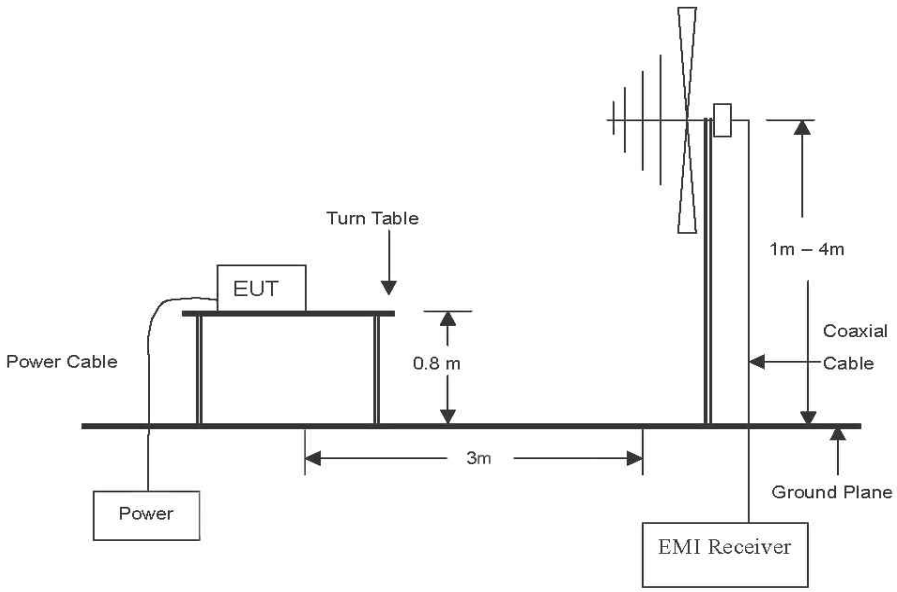
The spectrum analyzer is set to:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 ㎑ for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 ㎓.

The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



Limit

In the section 15.209:

Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2400 / F(㎑)
0.490 ~ 1.705	30	24000 / F(㎑)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 ㎒, 76 ~ 88 ㎒, 174 ~ 216 ㎒ or 470 ~ 806 ㎒. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

In the section 15.225:

(a) The field strength of any emissions within the band 13.553 ~ 13.567 ㎒ shall not exceed 15,848 microvolts/meter (= 84 dB㎶/m) at 30 meters.

(b) Within the bands 13.410 ~ 13.553 ㎒ and 13.567 ~ 13.710 ㎒, the field strength of any emissions shall not exceed 334 microvolts/meter (=50.5 dB㎶/m) at 30 meters.

(c) Within the bands 13.110 ~ 13.410 ㎒ and 13.710 ~ 14.010 ㎒ the field strength of any emissions shall not exceed 106 microvolts/meter (=40.5 dB㎶/m) at 30 meters.

(d) The field strength of any emissions appearing outside of the 13.110 ~ 14.010 ㎒ band shall not exceed the general radiated emission limits in § 15.209.

Test results for fundamental

Radiated emissions		Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dB㎶/m)	Limit (dB㎶/3m)	Margin (dB)
13.561	23.98	H	18.30	0.75	43.03	124.00	80.97
13.561	25.21	V	18.30	0.75	44.26	124.00	79.74

Test results for in-band & out-band(9 ㎑ to 14.010 ㎒)

Radiated emissions		Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dB㎶/m)	Limit (dB㎶/3m)	Margin (dB)
12.079	19.06	H	18.70	0.69	38.45	69.54	31.09
12.047	24.27	V	18.24	0.69	43.20	69.54	26.34

Test results for in-band & out-band(14.010 ㎒ to 30 ㎒)

Radiated emissions		Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dB㎶/m)	Limit (dB㎶/3m)	Margin (dB)
19.014	18.97	H	18.70	0.90	38.57	69.54	30.97
18.352	18.65	V	18.64	0.88	38.17	69.54	31.37

※ Remark

1. Actual = Reading + Ant. factor + Cable loss
2. Measurement distance: 3 m
3. Detector mode: Quasi peak
4. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

Test results (Below 1 000 ㎒)

Radiated emissions		Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Actual (dB㎶/m)	Limit (dB㎶/3m)	Margin (dB)
67.891	20.80	H	10.48	1.53	32.81	40.00	7.19
94.991	28.50	H	9.04	1.86	39.40	43.50	4.10
122.105	25.00	V	11.62	2.14	38.86	43.50	4.64
203.486	24.20	H	9.43	2.87	36.50	43.50	7.00
380.211	19.50	V	14.46	4.09	38.05	46.00	7.95
407.045	20.30	V	15.05	4.27	39.62	46.00	6.38
420.493	19.70	H	15.40	4.35	39.45	46.00	6.55
433.892	19.50	H	15.75	4.43	39.68	46.00	6.32
526.213	17.50	H	17.28	4.98	39.76	46.00	6.24
787.204	12.30	V	21.11	6.37	39.78	46.00	6.22
868.405	11.50	V	21.83	6.77	40.10	46.00	5.90
923.006	11.20	V	22.45	7.04	40.69	46.00	5.31

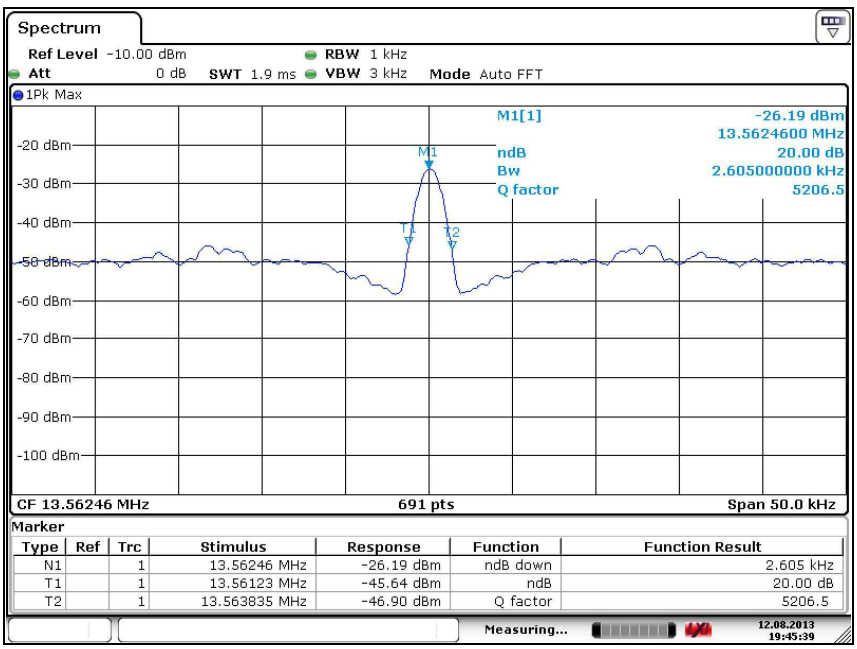
※ Remark

1. Actual = Reading + Ant. factor + Cable loss
2. Detector mode: Quasi peak
3. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes.

3.2 20 dB bandwidth

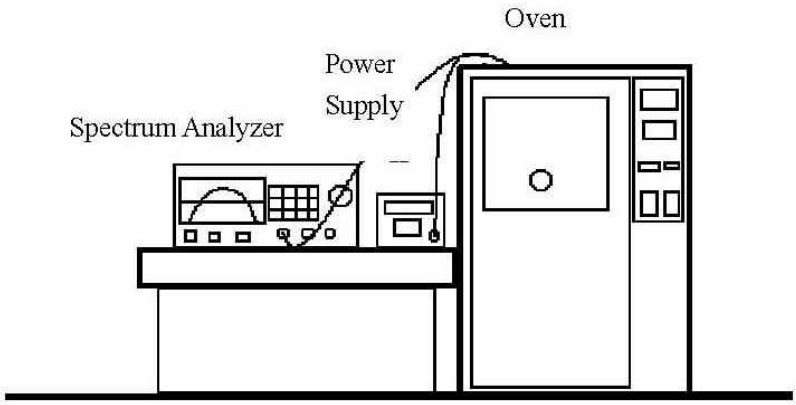
Test setup: The EUT was connected to a spectrum analyzer.

Test procedure: The 20 dB bandwidth was measured by using a spectrum analyzer.



3.3. Frequency tolerance

Test setup



Test procedure

1. The transmitter output was connected to the spectrum analyzer through an attenuator.
2. The transmission time was measured with the spectrum analyzer using RBW=1 ㎑, VBW=1 ㎑.
3. Set the temperature of chamber to -20℃. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize. While maintaining a constant temperature inside the chamber, turn the EUT on and measure the EUT operating frequency.
4. Repeat step 2 with a 10℃ decreased per stage until the highest temperature 50℃ is measured, record all measured frequencies on each temperature step.

Limit

According to FCC Part 15 Section 15.225 (e),
The frequency tolerance of the carrier signal shall be maintained within +/-0.01 % of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

Test results

Test voltage (%)	Test voltage (V)	Temperature (℃)	Measure frequency (㎒)	Frequency deviation (㎐)	Deviation (%)
100 %	AC 110	-20	13.561 814	-186	-0.001 371
100 %		-10	13.561 863	-137	-0.001 010
100 %		0	13.561 961	-39	-0.000 287
100 %		10	13.562 132	132	0.000 973
100 %		20	13.562 165	165	0.001 216
100 %		30	13.562 140	140	0.001 032
100 %		40	13.562 227	227	0.001 674
100 %		50	13.562 231	231	0.001 703
85 %	AC 93.5	20	13.562 160	160	0.001 180
115 %	AC 126.5	20	13.562 163	163	0.001 202

3.4. AC conducted emissions

Test procedures

The EUT was placed on a non-metallic table 0.8m above the metallic, grounded floor and 0.4m from the reference ground plane wall. The distance to other metallic surfaces was at least 0.8m. Amplitude measurements were performed with a quasi-peak detector and an average detector.

Limit

According to 15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

Frequency of Emission (㎒)	Conducted limit (dB㎶/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

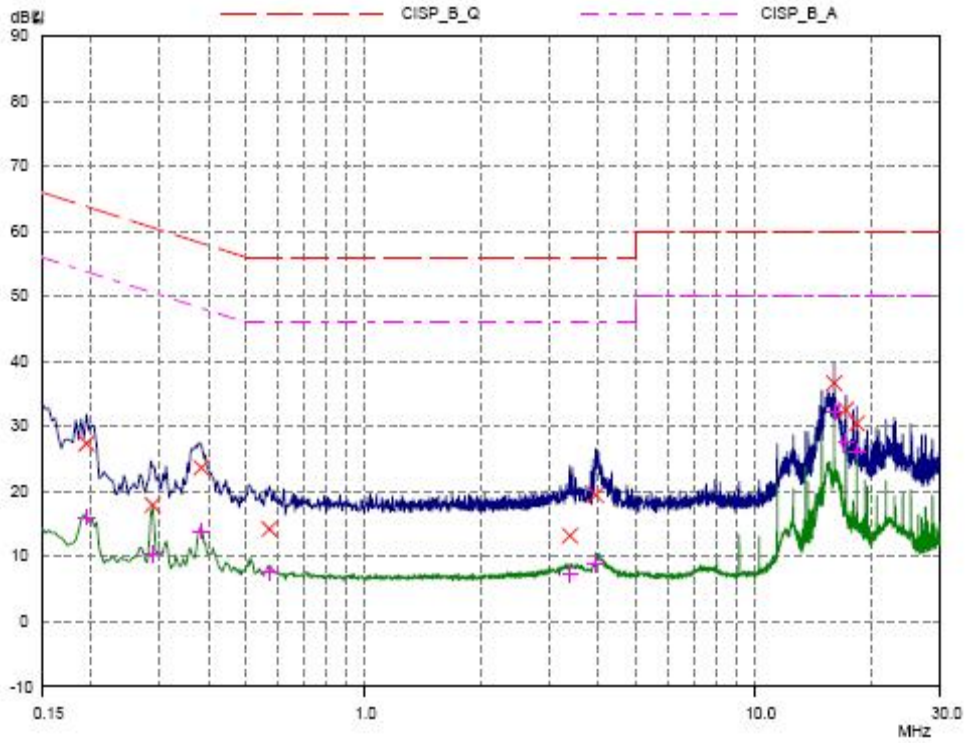
※ Remark

Decreases with the logarithm of the frequency.

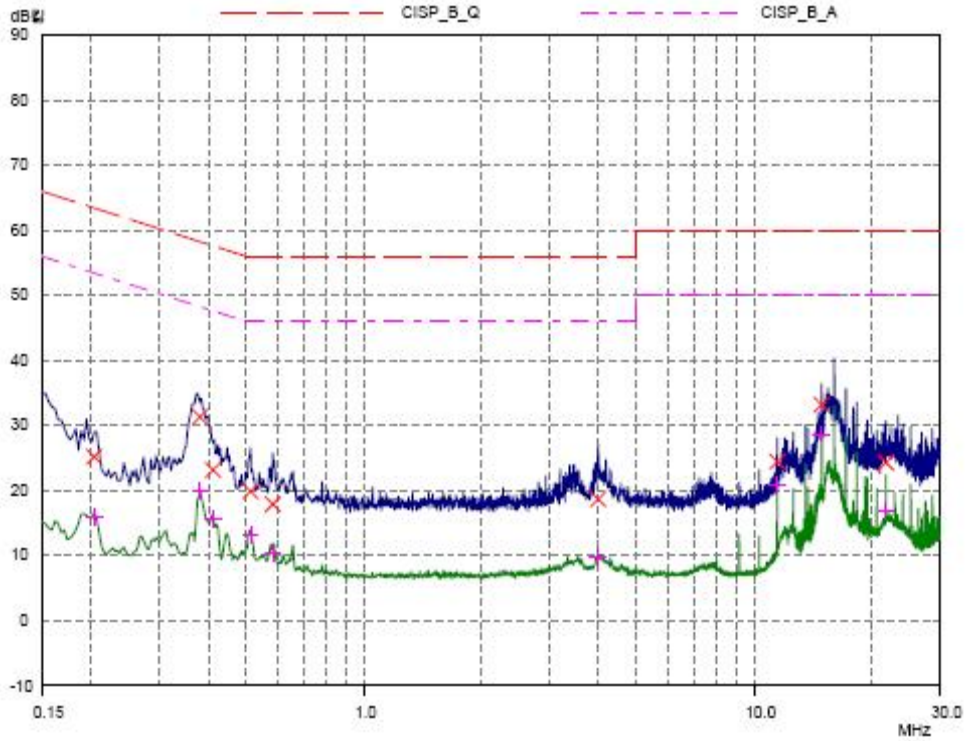
Test results

Frequency (㎒)	Correction		Phase Hot/ Neutral	Quasi peak			Average		
	LISN	Cable Loss		Reading	Result	Limit	Reading	Result	Limit
0.195	9.580	0.320	H	27.390	27.390	63.821	16.080	16.080	53.821
0.204	9.570	0.320	N	25.180	25.180	63.446	15.950	15.950	53.446
0.288	9.580	0.320	H	17.910	17.910	60.582	10.420	10.420	50.582
0.381	9.570	0.310	N	31.330	31.330	58.258	19.920	19.920	48.258
0.384	9.570	0.310	H	23.670	23.670	58.192	13.910	13.910	48.192
0.411	9.570	0.320	N	23.170	23.170	57.628	15.620	15.620	47.628
0.513	9.570	0.320	N	19.920	19.920	56.000	13.120	13.120	46.000
0.573	9.570	0.320	H	14.250	14.250	56.000	7.510	7.510	46.000
0.585	9.570	0.320	N	17.880	17.880	56.000	10.410	10.410	46.000
3.378	9.600	0.160	H	13.210	13.210	56.000	7.400	7.400	46.000
3.936	9.600	0.160	H	19.460	19.460	56.000	8.840	8.840	46.000
3.990	9.600	0.160	N	18.700	18.700	56.000	9.770	9.770	46.000
11.469	9.680	0.070	N	24.430	24.430	60.000	20.830	20.830	50.000
14.907	9.710	0.230	N	33.200	33.200	60.000	28.630	28.630	50.000
16.059	9.756	0.280	H	36.660	36.660	60.000	32.190	32.190	50.000
17.202	9.842	0.270	H	32.580	32.580	60.000	27.680	27.680	50.000
18.354	9.928	0.320	H	30.480	30.480	60.000	26.180	26.180	50.000
21.810	9.846	0.340	N	24.310	24.310	60.000	17.000	17.000	50.000

[Hot]



[Neutral]



Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Calibration due.
Spectrum Analyzer	R&S	FSV30	2014.01.09
Loop Antenna	R&S	HFH2-Z2.335.4711.52	2015.04.25
Trilog-Broadband Antenna	SCHWARZBECK	VULB 9168	2013.10.25
Temp. & Humid. Chamber	ALL THREE Eng	ATH-50M	2013.09.13
EMI Test Receiver	Agilent	E7410A	2014.04.09
EMI Test Receiver	R&S	ESHS10	2014.05.10
LISN	R&S	ENV216	2014.02.27
AC Power Source/Analyzer	HP	6813A	2014.05.06

Peripheral device

Device	Manufacturer	Model No.	Serial No.
Notebook	Samsung	NT-R519	ZLT393BSBOOZO4H

Appendix B. Test setup photo