TEST REPORT

Part 15 Subpart C 15.225

Equipment under test	NFC Reader
Model name	CSM-NFC reader
FCC ID	2AE6H-CSM-NFC
Applicant	Amotech Corp.
Manufacturer	Amotech Corp.
Date of test(s)	2015.06.04 ~2015.06.19
	2015.07.24 ~2015.07.25
Date of issue	2015.07.25

Issued to

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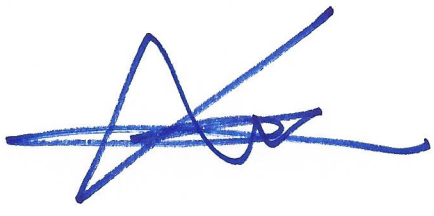
Test and report completed by :	**Report approval by :**
	
Kwon-se Kim Test engineer	Jeff Do Technical manager

Revision history

Revision	Date of issue	Test report No.	Description
-	2015.07.16	KES-RF-15T0052	Initial
R1	2015.07.25	KES-RF-15T0052-R1	Added emission mask

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1. General information

Applicant:	Amotech Corp.
Applicant address:	5BL-1LOT, 380, Namdongseo-ro, Namdong-gu, Incheon, Korea
Test site:	KES Co., Ltd.
Test site address:	C-3701, Simin-daero 365-40, Dongan-gu, Anyang-si, Gyeonggi-do,431-716, Korea 473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
FCC/IC rule part(s):	15.225
Model:	CSM-NFC reader
FCC ID:	2AE6H-CSM-NFC
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	NFC-Reader
Frequency range	13.563 ㎒
Modulation technique	ASK
Number of channels	1
Antenna specification	Antenna type: PCB

1.2. Test frequency/Channel operation

Ch.	Frequency (㎒)
01	13.563

1.3. Information about derivative model

N/A

1.4. Device modifications

N/A

2. Summary of tests

Reference	Parameter	Status
15.225(a)	The field strength of fundamental	Pass
15.225(b)(c)	The field strength of spurious emission(In-band)	Pass
15.225(d) 15.209	The field strength of spurious emission(Out-band)	Pass
15.225(e)	The frequency tolerance	Pass
15.215(c)	20 ㏈ bandwidth	Pass

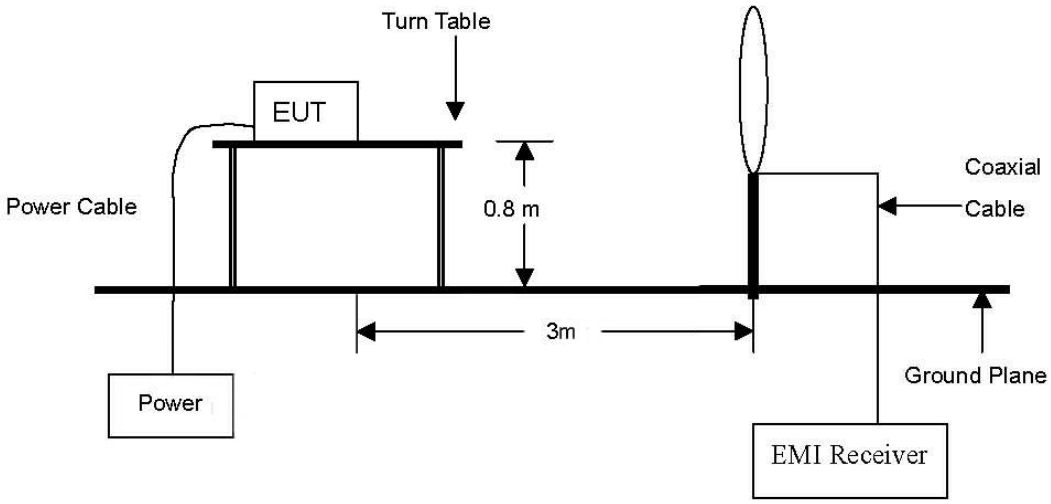
Test procedures;
The measurement procedures described in the American National Standard for Methods of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 ㎑ to 40 ㎓ (ANSI C63.10-2009)

3. Test results

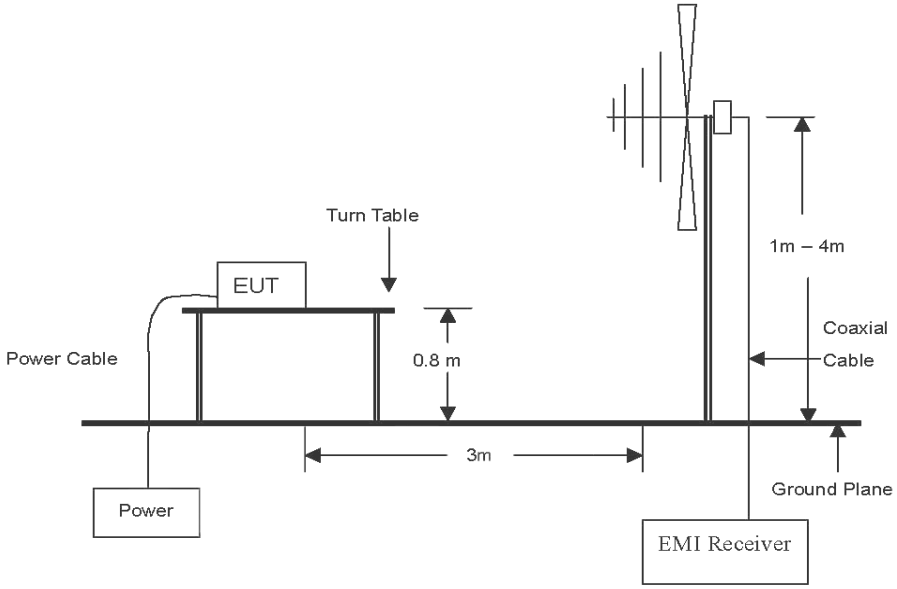
3.1. Radiated spurious emissions

Test setup

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.



Test procedure

[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 ㎓.

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 ㏈㎶/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 ㏈㎶/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 ㏈㎶/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

Operating frequency: 13.563 ㎒

Distance of measurement: 3 meter

Radiated emissions		Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Distance factor (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
13.563	44.73	H	20.81	0.38	40	25.92	84.00	58.08
13.563	45.60	V	20.81	0.38	40	26.79	84.00	57.21

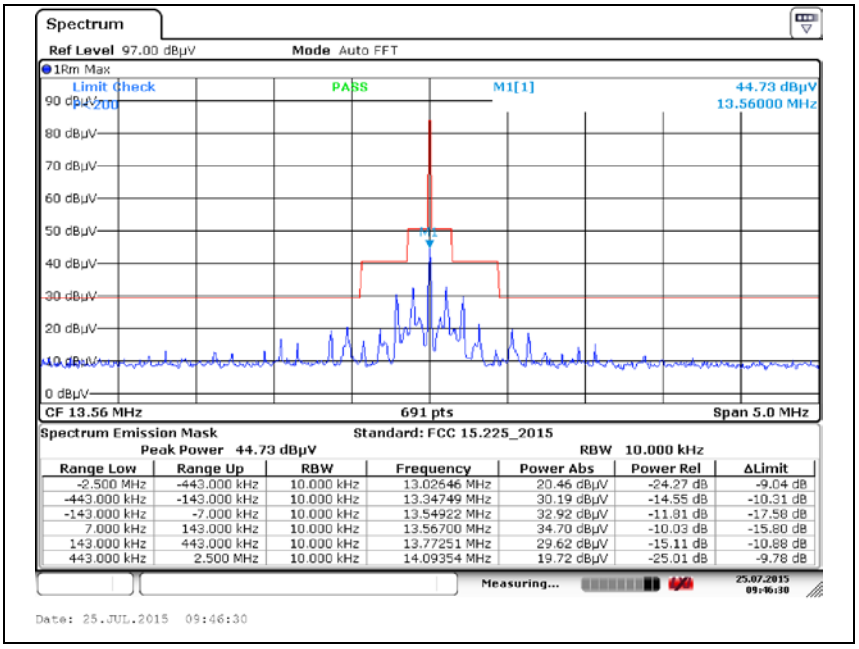
Test results for in-band & out-band(9 ㎑ to 30 ㎒)

Radiated emissions		Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Distance factor (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
13.026	20.46	H	20.80	0.38	40	1.64	29.54	27.90
13.033	22.08	V	20.80	0.38	40	3.26	29.54	26.28
13.347	30.94	V	20.81	0.38	40	12.13	40.50	28.37
13.549	34.12	V	20.81	0.38	40	15.31	50.50	35.19
13.567	36.23	V	20.82	0.38	40	17.43	50.50	33.07
13.772	30.85	V	20.82	0.38	40	12.05	40.50	28.45
14.094	21.15	V	20.83	0.39	40	2.37	29.54	27.17

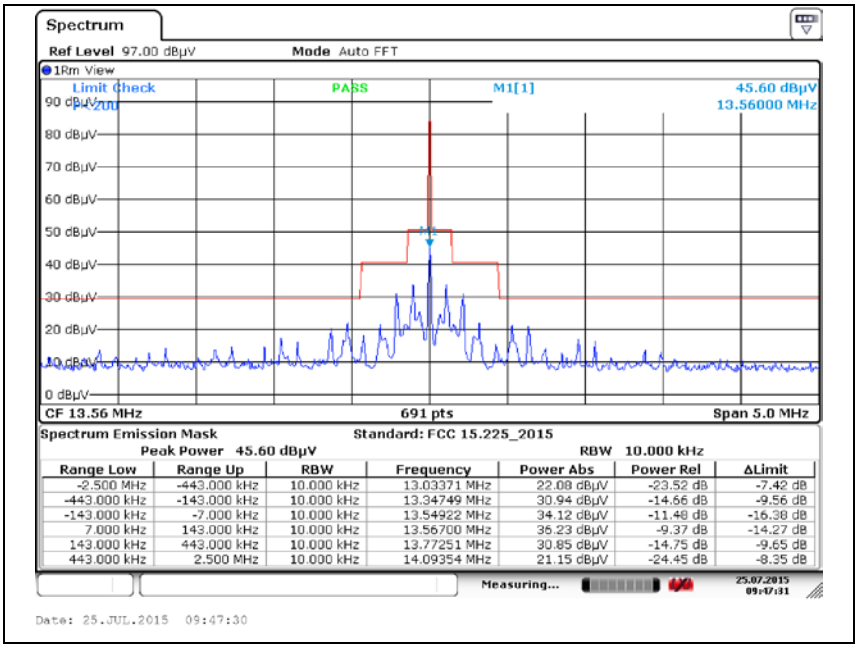
Note.

1. All measurements were performed using a loop antenna. The antenna was positioned in three orthogonal positions (X front, Y side, Z top) and the position with the highest emission level was recorded.
2. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
3. Measurements were performed at 3m and the data was extrapolated to the specified measurement distance of 30m using the square of an inverse linear distance extrapolation factor (40 ㏈/decade) as specified in §15.31(f)(2). Extrapolation Factor = 20 log10(30/3)^2 = 40 ㏈.
4. The spectrum was investigated from 9 ㎑ up to 30 ㎒ using the loop antenna. Only the emissions shown in the table above were found to be significant.
5. All measurements were recorded using a spectrum analyzer employing a quasi-peak detector.
6. Actual = Reading + Ant. factor + Cable loss - Distance factor
7. Margin [dB] = Limit [dB㎶//m] - Field Strength Level [dB㎶//m]

Horizontal



Vertical



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㎶/m)	Margin (dB)
56.031	21.76	V	13.33	1.73	36.82	40.00	3.18
84.000	22.53	H	8.52	2.13	33.18	40.00	6.82
102.30	22.42	V	9.08	2.36	33.86	43.52	9.66
134.60	23.08	H	12.36	2.77	38.21	43.52	5.31
143.00	22.69	V	12.82	2.85	38.36	43.52	5.16
228.60	22.87	V	10.95	3.69	37.51	46.02	8.51
258.10	23.41	H	12.02	3.95	39.38	46.02	6.64
317.10	22.43	V	13.77	4.51	40.71	46.02	5.31
355.00	23.30	V	14.60	4.80	42.70	46.02	3.32
429.40	22.97	V	16.22	5.37	44.56	46.02	1.46

Note.

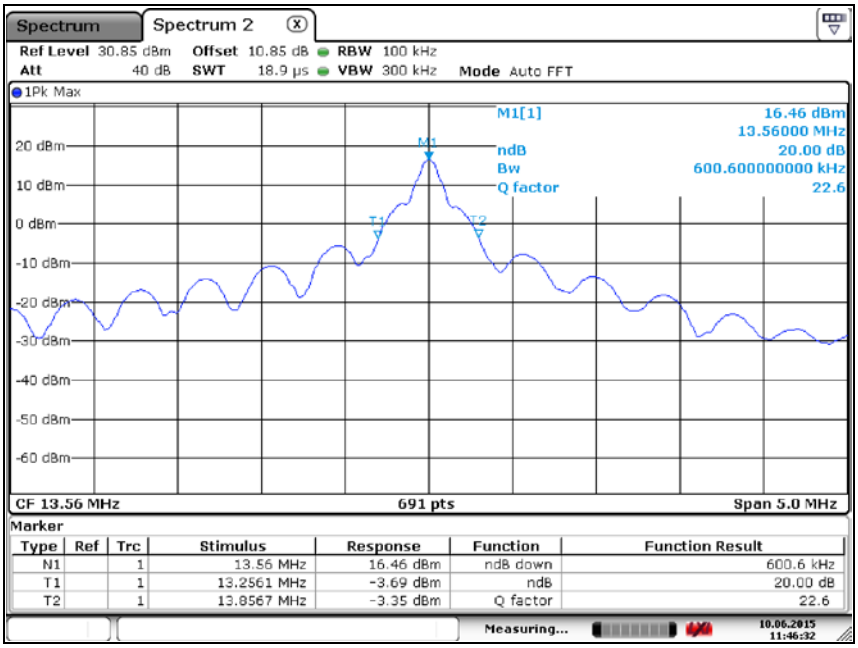
1. All measurements were recorded using a spectrum analyzer employing a quasi-peak detector for emissions below 960 ㎒.
2. Both Vertical and Horizontal polarities of the receive antenna were evaluated with the worst case emissions being reported. Below 30 ㎒ the loop antenna was positioned in 3 orthogonal planes (X front, Y side, Z top) to determine the orientation resulting in the worst case emissions.
3. The EUT was positioned in three orthogonal planes to determine the orientation resulting in the worst case emissions.
4. The spectrum is measured from 9 ㎑ to the 10th harmonic and the worst-case emissions are reported.
5. No spurious emissions levels were found to be greater than the level of the fundamental.

3.2 20 dB bandwidth

Test setup

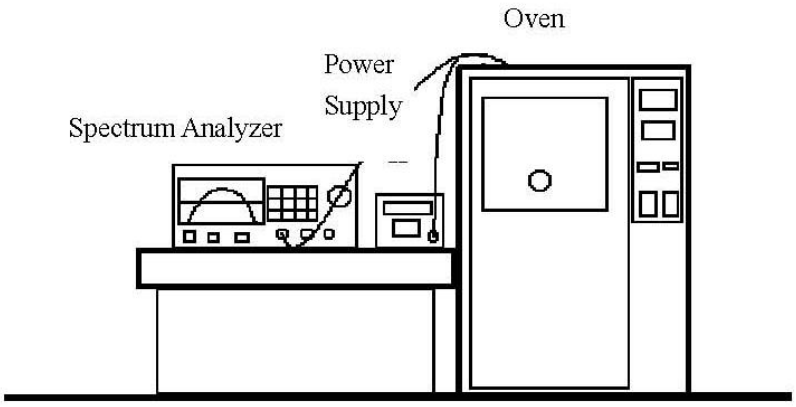
Test procedure

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 %	DC 12.0	-20	13.563 724	724	0.005 339
100 %		-10	13.563 738	738	0.005 442
100 %		0	13.563 724	724	0.005 339
100 %		10	13.563 724	724	0.005 339
100 %		20	13.563 695	695	0.005 125
100 %		30	13.563 681	681	0.005 022
100 %		40	13.563 666	666	0.004 911
100 %		50	13.563 652	652	0.004 808
85 %	DC 10.2	20	13.563 666	666	0.004 911
115 %	DC 13.8	20	13.563 652	652	0.004 808

Appendix A. Measurement equipment

Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due.
Spectrum analyzer	R&S	FSV30	100736	1 year	2016.07.24
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2016.01.23
Trilog-broadband antenna	Schwarzbeck	VULB 9168	9168-461	2 years	2017.04.03
Loop Antenna	R&S	HFH2-	HFH2-Z2.335.4711.52	2 years	2017.03.03
EMI Test Receiver	R&S	ESR3	101781	1 year	2016.05.06
DC power supply	Agilent	6632B	US36351824	1 year	2016.01.22
Temperature chamber	TABAI	MC711P	112000492	1 year	2016.01.23

Peripheral device

Device	Manufacturer	Model No.	Serial No.
-	-	-	-