

RF TEST REPORT

Test item : NFC Module
Model No. : WSNFM400A00
Order No. : DEMC1403-01167(FCC)
 DEMC1403-01168(IC)
Date of receipt : 2014-03-31
Test duration : 2014-04-07 ~ 2014-04-23
Date of issue : 2014-04-23
Use of report : FCC & IC Original Grant

Applicant : **Samsung Electronics Co., Ltd.**
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Test laboratory : **Digital EMC Co., Ltd.**
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Test specification : FCC Part 15.225
 RSS-210 A2.6
Test environment : See appended test report
Test result : ☒ Pass ☐ Fail

The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose. This test report shall not be reproduced except in full, without the written approval of DIGITAL EMC CO., LTD.

Tested by:



Engineer
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Reviewed by:



Deputy General Manager
WonJung Lee

Test Report Version

Test Report No.	Date	Description
DRTFCC1404-0534	Apr. 23. 2014	Initial issue

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1. Equipment information

1.1 Equipment description

FCC Equipment Class	Low Power Communications Device Transmitter(DXX)
Equipment type	NFC Module
Equipment model name	WSNFM400A00
Equipment add model name	N/A
Equipment serial no.	Identical prototype
Frequency band	13.56MHz
Modulation type	ASK
Channel	1
Power	DC 5.0V
Antenna type	Loop Antenna

1.2 Ancillary equipment

Equipment	Model No.	Serial No.	Manufacturer	Note
-	-	-	-	-
-	-	-	-	-

2. Information about test items

2.1 Test mode

Test mode1	Continuous transmitting mode with ASK 100%
Test mode2	Continuous transmitting mode with ASK 10%

Note: For this test mode, a test program was supported by manufacturer.

2.2 Auxiliary equipment

Equipment	Model No.	Serial No.	Manufacturer	Note
Laptop	P26F	HJXY0Z1	DELL	FCC DoC
-	-	-	-	-

2.3 Tested frequency

	TXFrequency(MHz)	RX Frequency(MHz)
Lowest Channel	13.56	13.56
Middle Channel	-	-
Highest Channel	-	-

2.4 Tested environment

Temperature	: 20 ~ 22°C
Relative humidity content	: 38 ~ 41 % R.H.
Details of power supply	: DC 5.0V(From USB of laptop)

2.5 EMI Suppression Device(s)/Modifications

EMI suppression device(s) added and/or modifications made during testing
→ None

3. Test report

3.1 Summary of tests

FCC part section(s)	IC section(s)	Parameter	Limit	Test condition	Status Note 1
2.1049	RSS-Gen [4.6.1]	Occupied bandwidth	N/A	Radiated	C
15.225 (a)	RSS-210 [A2.6 (a)]	In-band emissions	15,848 μ V/m @ 30m 15.553 – 13.567 MHz		C
15.225 (b)	RSS-210 [A2.6 (b)]	In-band emissions	334 μ V/m @ 30m 13.410 – 13.553 MHz 13.567 – 13.710 MHz		C
15.225 (c)	RSS-210 [A2.6 (c)]	In-band emissions	106 μ V/m @ 30m 13.110 – 13.410 MHz 13.710 – 14.010 MHz		C
15.225 (d) 15.205 15.209	RSS-210 [A2.6 (d)] RSS-Gen [7.2.2 & 5]	Out-of band emissions	Emissions outside of the specified band (13.110-14.010 MHz) must meet the radiated limits detailed in 15.209		C
15.225 (e)	RSS-210 [A2.6]	Frequency stability	$\pm$ 0.01% of operating frequency	Conducted	C
15.207	RSS-Gen [7.2.4]	AC conducted emissions	FCC Part 15.207	AC Line Conducted	C
15.203	-	Antenna requirements	FCC Part 15.203	-	C

Note 1: C=Comply NC=Not Comply NT=Not Tested NA=Not Applicable

Note 2: The worst case data is reported in the test modes.(Worst case mode: Test mode 1)

The sample was tested according to the following specification:
ANSI C-63.10-2009 & RSS-Gen Issue 3

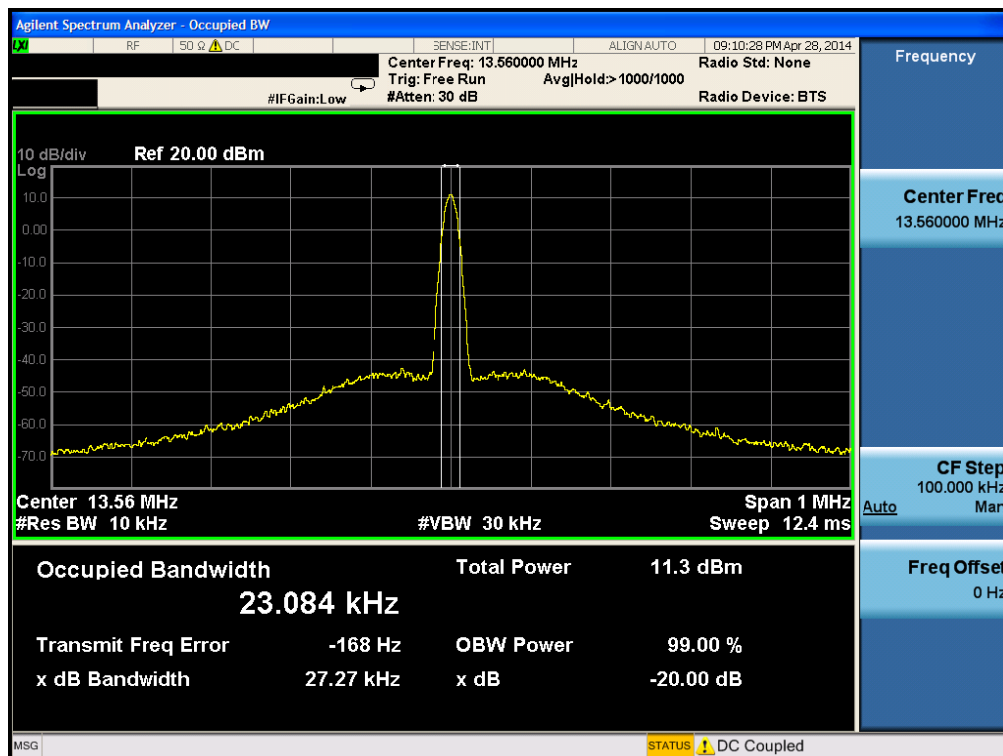
3.2 Transmitter requirements

3.2.1 Occupied bandwidth

- Procedure:

The 20dB Bandwidth is measured with a spectrum analyzer connected via a receive antenna placed near the EUT while the EUT is operating in transmission mode.

- Measurement Data: Comply



- Minimum Standard: N/A

3.2.2 In-band emissions

- Procedure:

The EUT was placed on a 0.8m high wooden table inside a 10m semi anechoic chamber. An antenna was placed at 3 m distance from the EUT. Measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine worst-case orientation for maximum emissions. A loop antenna was used for this test item. And this test item was performed for both vertical and horizontal polarization.

- Measurement Data: **Comply**

Test Frequency Band [MHz]	Freq. [MHz]	EUT Posi.	Reading Level [dBuV]	T.F	Field Strength @3m [dBuV/m]	Field Strength @30m [dBuV/m]	Limit [dBuV/m]	Margin [dB]
13.110 ~ 13.410	13.348	Z	28.80	10.10	38.90	-1.10	40.51	41.61
13.410 ~ 13.553	13.485	Z	31.10	10.10	41.20	1.20	50.47	49.27
13.553 ~ 13.567	13.560	Z	51.40	10.10	61.50	21.50	84.00	62.50
13.567 ~ 13.710	13.634	Z	32.10	10.10	42.20	2.20	50.47	48.27
13.710 ~ 14.010	13.770	Z	30.20	10.10	40.30	0.30	40.51	40.21

Note 1. This test item was performed using a loop antenna.

Note 2. This test item was performed at 3m and the data were extrapolated to the specified measurement distance of 30m using the square of an inverse linear distance extrapolation factor (40 dB/decade) as specified in §15.31(f)2.

▪ Extrapolation Factor = $20 \log_{10}(30/3)^2 = 40\text{dB}$

Note 3. All data were recorded using a spectrum analyzer employing a peak detector.

If PK results were meet Quasi-peak limit, Quasi-peak measurements were omitted.

Note 4. Sample Calculation.

Margin = Limit – Field Strength @ 30m / Field Strength @ 30m = Field Strength @ 3m – 40

Field Strength @ 3m = Reading + T.F / T.F = AF + CL – AG

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain

- Minimum Standard: Part 15.225(a), (b), (c)& RSS-210 A2.6(a), (b), (c)

Frequency Band [MHz]	Limit	
	[uV/m]	[dBuV/m]
13.553-13.567	15,848	84.00
13.410-13.553 13.567-13.710	334	50.47
13.110-13.410 13.710-14.010	106	40.51

3.2.3 Out-of-band emissions

- Procedure:

The EUT was tested from 9kHz up to the 1GHz excluding the band 13.110-14.010MHz. All measurements were recorded with spectrum analyzer employing a peak detector for emissions below 30MHz. Above 30MHz a Quasi-peak detector was used. All out-of-band emissions must not exceed the limits §15.209. A loop antenna was used for searching for emissions below 30MHz.

- Measurement Data: **Comply**(refer to the next page)

- Minimum Standard: Part 15. 205, 209, 225(d)& RSS-210 A2.6(d), RSS-Gen 7.2.2, RSS-Gen 7.2.5

• FCC Part 15.205 (a): Only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	GHz	GHz
0.009 ~ 0.110	8.41425 ~ 8.41475	108 ~ 121.94	1300 ~ 1427	3.6 ~ 4.4	14.47 ~ 14.5
0.495 ~ 0.505	12.29 ~ 12.293	123 ~ 138	1435 ~ 1626.5	4.5 ~ 5.15	15.35 ~ 16.2
2.1735 ~ 2.1905	12.51975 ~ 12.52025	149.9 ~ 150.05	1645.5 ~ 1646.5	5.35 ~ 5.46	17.7 ~ 21.4
4.125 ~ 4.128	12.57675 ~ 12.57725	156.52475 ~ 156.52525	1660 ~ 1710	7.25 ~ 7.75	22.01 ~ 23.12
4.17725 ~ 4.17775	13.36 ~ 13.41	156.7 ~ 156.9	1718.8 ~ 1722.2	8.025 ~ 8.5	23.6 ~ 24.0
4.20725 ~ 4.20775	16.42 ~ 16.423	162.0125 ~ 167.17	2200 ~ 2300	9.0 ~ 9.2	31.2 ~ 31.8
6.215 ~ 6.218	16.69475 ~ 16.69525	167.72 ~ 173.2	2310 ~ 2390	9.3 ~ 9.5	36.43 ~ 36.5
6.26775 ~ 6.26825	16.80425 ~ 16.80475	240 ~ 285	2483.5 ~ 2500	10.6 ~ 12.7	Above 38.6
6.31175 ~ 6.31225	25.5 ~ 25.67	322 ~ 335.4	2655 ~ 2900	13.25 ~ 13.4	
8.291 ~ 8.294	37.5 ~ 38.25	399.90 ~ 410	3260 ~ 3267		
8.362 ~ 8.366	73 ~ 74.6	608 ~ 614	3332 ~ 3339		
8.37625 ~ 8.38675	74.8 ~ 75.2	960 ~ 1240	3345.8 ~ 3358		

• FCC Part 15.205(b):

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

• FCC Part 15.209(a):

Frequency [MHz]	Field Strength [uV/m]	Measurement Distance [Meters]
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30	30	30
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	200	3

** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88MHz, 174-216MHz or 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

• FCC Part 15.209(b):

In the emission table above, the tighter limit applies at the band edges.

- Measurement Data:

Tested Frequency : 13.56MHz
Measurement Distance : 3 Meters

Frequency [MHz]	EUT Posi.	ANT Pol	Reading [dBuV]	T.F [dB/m]	Distance factor	Field Strength [dBuV/m]	Limit [dBuV/m]	Margin [dB]
1.202	Y	H	30.3	10.8	40	1.1	26.0	24.9
107.996	X	H	38.6	-10.2	0	28.4	43.5	15.1
366.590	Y	H	35.5	-6.0	0	29.5	46.0	16.5
398.600	Y	H	37.3	-5.5	0	31.8	46.0	14.2
399.570	Z	H	34.3	-5.5	0	28.8	46.0	17.2
479.960	X	H	35.2	-4.3	0	30.9	46.0	15.1
-	-	-	-	-	-	-	-	-

Note 1.All measurements were recorded using a spectrum analyzer employing a peak detector for below 30MHz and a Quasi-peak detector for above 30MHz.

Note 2.Both Vertical and Horizontal polarities of the receiver antenna were evaluated with the worst case emissions being reported. The worst-case emissions are reported.

Note 3.No other spurious and harmonic emissions were reported greater than listed emissions above table.

Note 4.Sample calculation

Margin = Limit – Field Strength

Field Strength = Reading + T.F – Distance factor

T.F = AF + CL – AG

Distance factor = $20\log(\text{Measurement distance} / \text{The measured distance})^2$

Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain

3.2.4 Frequency Stability

- Procedure:

Part 15.225 requires that devices operating in the 13.553 – 13.567 MHz shall maintain the carrier frequency within 0.01% of the operating frequency over the temperature variation of -20 degrees to + 50 degrees C at normal supply voltage.

- Measurement Data: Comply

Operating Frequency : 13,559,959Hz

VOLTAGE (%)	POWER (V _{DC})	TEMP (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
100%	5.00	+25(ref)	13,559,959	-41	-0.000302
100%		-20	13,559,975	-25	-0.000184
100%		-10	13,559,986	-14	-0.000103
100%		0	13,559,947	-53	-0.000391
100%		+10	13,559,961	-39	-0.000288
100%		+20	13,559,980	-20	-0.000147
100%		+30	13,559,963	-37	-0.000273
100%		+40	13,559,893	-107	-0.000789
100%		+50	13,559,901	-99	-0.000730
85%	4.25	+25	13,559,977	-23	-0.000170
115%	5.75	+25	13,559,944	-56	-0.000413
BATT.ENDPOINT	N/A	N/A	N/A	N/A	N/A

- Minimum Standard: Part 15. 225(e)& RSS-210 A2.6

The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency.

3.2.5 AC Line Conducted Emissions

- Procedure:

The conducted emissions are measured in the shielded room with a spectrum analyzer in peak hold. While the measurement, EUT had its hopping function disabled at the middle channels in line with Section 15.21(m). Emissions closest to the limit are measured in the quasi-peak and average detector mode with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation and Exerciser operation. The highest emissions relative to the limit are listed.

- Measurement Data: Comply

This test items was performed with 2 conditions.

-

- Minimum Standard: FCC Part 15.207(a)& RSS-Gen 7.2.4

Frequency Range (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 ~ 0.5	66 to 56 *	56 to 46 *
0.5 ~ 5	56	46
5 ~ 30	60	50

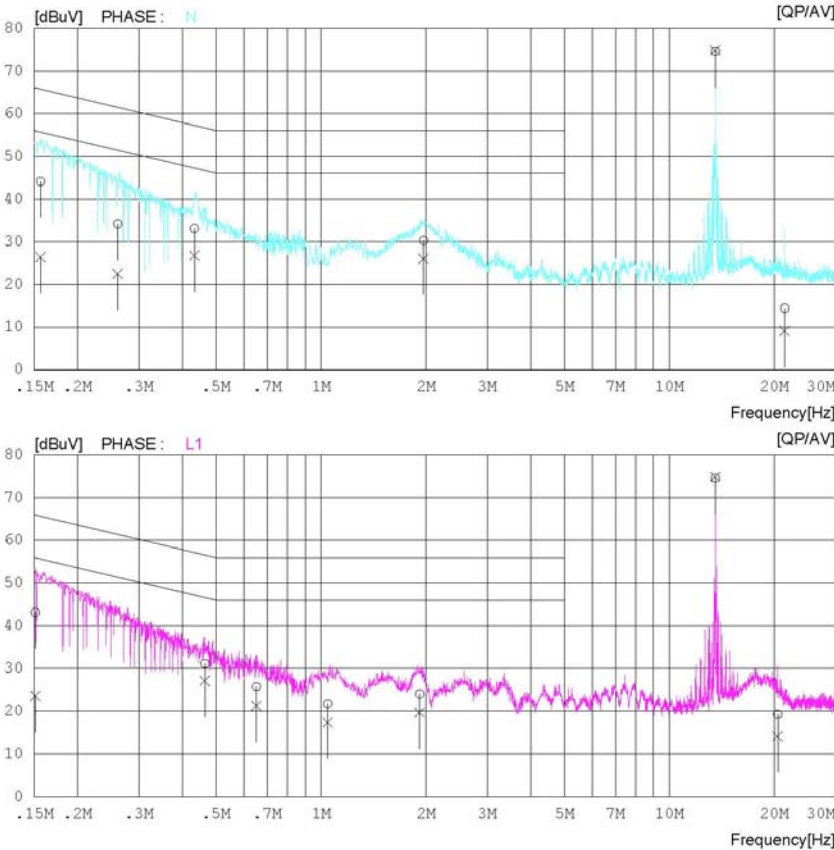
* Decreases with the logarithm of the frequency

Measurement Data

Results of Conducted Emission

Digital EMC
Date : 2014-04-23

Model No.	: WSNFM400A00	Reference No.	:
Type	: NFC Module	Power Supply	: 120 V 60 Hz
Serial No.	: Identical prototype	Temp/Humi.	: 21 °C 40 % R.H.
Test Condition	: AC Line Conducted	Operator	: OhHyun Kwon
Memo	: NFC (With Loop Antenna)		
LIMIT : CISPR22_B QP			
CISPR22_B AV			



Measurement Data

Results of Conducted Emission

Digital EMC
Date : 2014-04-23

Model No. : WSNFM400A00
Type : NFC Module
Serial No. : Identical prototype
Test Condition : AC Line Conducted
Reference No. :
Power Supply : 120 V 60 Hz
Temp/Humi. : 21 °C 40 % R.H.
Operator : OhHyun Kwon

Memo : NFC (With Loop Antenna)

LIMIT : CISPR22_B QP
CISPR22_B AV

NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.15631	33.8	16.1	10.3	44.1	26.4	65.7	55.7	21.6	29.3	N
2	0.26063	23.8	12.2	10.3	34.1	22.5	61.4	51.4	27.3	28.9	N
3	0.43260	22.8	16.6	10.2	33.0	26.8	57.2	47.2	24.2	20.4	N
4	1.96900	19.9	15.7	10.3	30.2	26.0	56.0	46.0	25.8	20.0	N
5	13.56000	63.8	64.1	10.7	74.5	74.8	60.0	50.0	-14.5	-24.8	N
6	21.46050	3.6	-1.7	10.8	14.4	9.1	60.0	50.0	45.6	40.9	N
7	0.15096	32.9	13.3	10.3	43.2	23.6	65.9	55.9	22.7	32.3	L1
8	0.46350	20.9	16.9	10.2	31.1	27.1	56.6	46.6	25.5	19.5	L1
9	0.65204	15.6	11.1	10.2	25.8	21.3	56.0	46.0	30.2	24.7	L1
10	1.04500	11.5	7.1	10.2	21.7	17.3	56.0	46.0	34.3	28.7	L1
11	1.92000	13.8	9.4	10.3	24.1	19.7	56.0	46.0	31.9	26.3	L1
12	13.55950	63.9	64.1	10.7	74.6	74.8	60.0	50.0	-14.6	-24.8	L1
13	20.50400	8.6	3.5	10.7	19.3	14.2	60.0	50.0	40.7	35.8	L1

Measurement Data(with a dummy load)

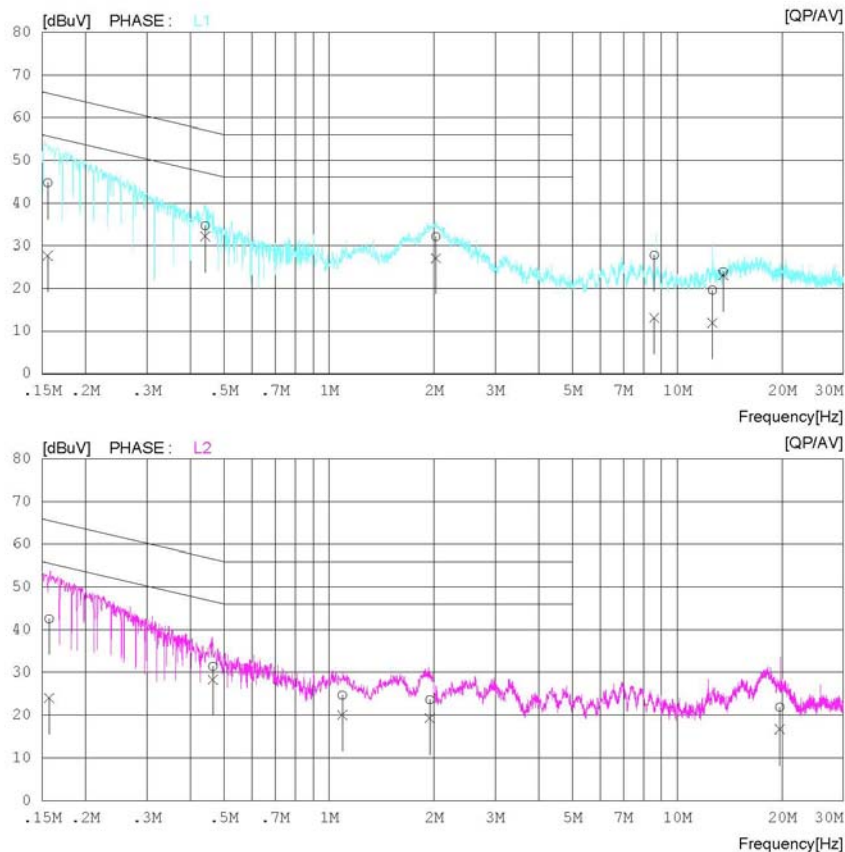
Results of Conducted Emission

Digital EMC
Date : 2014-04-23

Model No.	: WSNFM400A00	Reference No.	:
Type	: NFC Module	Power Supply	: 120 V 60 Hz
Serial No.	: Identical prototype	Temp/Humi.	: 21 °C 40 % R.H.
Test Condition	: AC Line Conducted	Operator	: OhHyun Kwon

Memo : NFC (Without Loop Antenna / Combind with Termination)

LIMIT : CISPR22_B QP
CISPR22_B AV



Measurement Data(with a dummy load)

Results of Conducted Emission

Digital EMC
Date : 2014-04-23

Model No. : WSNFM400A00
Type : NFC Module
Serial No. : Identical prototype
Test Condition : AC Line Conducted
Reference No. :
Power Supply : 120 V 60 Hz
Temp/Humi. : 21 °C 40 % R.H.
Operator : OhHyun Kwon

Memo : NFC (Without Loop Antenna / Combind with Termination)

LIMIT : CISPR22_B QP
CISPR22_B AV

NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.15550	34.3	17.3	10.3	44.6	27.6	65.7	55.7	21.1	28.1	L1
2	0.44074	24.4	21.9	10.2	34.6	32.1	57.0	47.0	22.4	14.9	L1
3	2.02650	21.7	16.8	10.3	32.0	27.1	56.0	46.0	24.0	18.9	L1
4	8.59250	17.3	2.6	10.5	27.8	13.1	60.0	50.0	32.2	36.9	L1
5	12.62700	8.9	1.2	10.7	19.6	11.9	60.0	50.0	40.4	38.1	L1
6	13.56200	13.2	12.4	10.7	23.9	23.1	60.0	50.0	36.1	26.9	L1
7	0.15695	32.3	13.7	10.3	42.6	24.0	65.6	55.6	23.0	31.6	L2
8	0.46350	21.2	18.2	10.2	31.4	28.4	56.6	46.6	25.2	18.2	L2
9	1.09150	14.5	9.9	10.2	24.7	20.1	56.0	46.0	31.3	25.9	L2
10	1.94700	13.3	9.0	10.3	23.6	19.3	56.0	46.0	32.4	26.7	L2
11	19.70900	11.2	6.0	10.7	21.9	16.7	60.0	50.0	38.1	33.3	L2

APPENDIX

TEST EQUIPMENT FOR TESTS

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent	N9020A	14/01/07	15/01/07	MY49100833
Multimeter	HP	34401A	14/02/27	15/02/27	3146A13475
Dynamic Measurement DC Source	Agilent	66332A	13/10/21	14/10/21	US37474353
Vector Signal Generator	Rohde Schwarz	SMJ100A	14/01/07	15/01/07	100148
Thermohygrometer	BODYCOM	BJ5478	13/06/01	14/06/01	120612-1
Constant Temp & Humidity Chamber	JISICO	KR-100/J-RHC2	13/09/13	14/09/13	30604493/021031
Loop Antenna	ETS	6502	12/12/11	14/12/11	3471
BILOG ANTENNA(30MHz~2GHz)	SCHAFFNER	CBL6112B	12/11/06	14/11/06	2737
Amplifier (22dB)	HP	8447E	14/01/08	15/01/08	2945A02865
EMI TEST RECEIVER	R&S	ESU	14/01/08	15/01/08	100014
EMI TEST RECEIVER	R&S	ESCI	14/02/27	15/02/27	100364
LISN	SCHWARZBECK	NNLK8121	13/08/12	14/08/12	NNLK8121-580