

TEST REPORT



DT&C Co., Ltd.

42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17042
Tel : 031-321-2664, Fax : 031-321-1664

1. Report No : DRTFCC1807-0185
2. Customer
 - Name : Bluebird Inc.
 - Address : (Dogok-dong, SEI Tower 13,14) 39, Eonjuro30-gil, Gangnam-gu, Seoul, South Korea
3. Use of Report : FCC Original Grant
4. Product Name / Model Name : Enterprise Full Touch Handheld Computer / EF401
FCC ID : SS4EF401
5. Test Method Used : ANSI C63.10-2013
Test Specification : FCC Part 15.225
6. Date of Test : 2018.07.04 ~ 2018.07.17
7. Testing Environment : Refer to appended test report.
8. Test Result : Refer to the attached test result.

Affirmation	Tested by		Reviewed by	
	Name : Jaejin Lee	(Signature)	Name : GeunKi Son	(Signature)

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 DT&C Co., Ltd.

2018 . 07 . 24 .

DT&C Co., Ltd.

If this report is required to confirmation of authenticity, please contact to report@dtnc.net

Test Report Version

Test Report No.	Date	Description
DRTFCC1807-0185	Jul. 24, 2018	Initial issue

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1. General Information

1.1. Testing Laboratory

DT&C Co., Ltd.		
The 3 m test site and conducted measurement facility used to collect the radiated data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 17042. The test site comply with the requirements of § 2.948 according to ANSI C63.4-2014.		
- FCC MRA Accredited Test Firm No. : KR0034		
www.dtnet.net		
Telephone	:	+ 82-31-321-2664
FAX	:	+ 82-31-321-1664

1.2. Testing Environment

Ambient Condition	
▪ Temperature	+22 °C ~ +25 °C
▪ Relative Humidity	43 % ~ 55 %

1.3. Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C 63.4-2014. All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence.

Parameter	Measurement uncertainty
AC conducted emission	2.4 dB (The confidence level is about 95 %, $k = 2$)
Radiated Disturbance (Below 1 GHz)	5.1 dB (The confidence level is about 95 %, $k = 2$)

1.4. Details of Applicant

Applicant : Bluebird Inc.
 Address : (Dogok-dong, SEI Tower 13,14) 39, Eonjuro30-gil, Gangnam-gu, Seoul, South Korea
 Contact person : Yongsik Jang

1.5. Description of EUT

FCC Equipment Class	Low Power Communications Device Transmitter(DXX)
EUT	Enterprise Full Touch Handheld Computer
Model Name	EF401
Add Model Name	NA
Hardware Version	Rev0.2
Software Version	R1.12
Serial Number	Identical prototype
Power Supply	DC 3.8 V
Frequency Band	13.56 MHz
Modulation Type	ASK
Channel(s)	1
Antenna type	Loop Antenna

1.6. EUT Capabilities

This EUT contains the following capabilities:

802.11b/g/n WLAN(2.4GHz), 802.11a/n/ac WLAN(5GHz), Bluetooth(BDR, EDR, LE), NFC

2. Information about test items

2.1 Test mode

Test mode1	Continuous transmitting mode
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2.2 Tested frequency

Channel	TX Frequency(MHz)
Lowest	13.56
Middle	-
Highest	-

2.3 EMI Suppression Device(s)/Modifications

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

3. Antenna requirements

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.”

**The internal antenna is attached on the main PCB using the special spring tension. (Refer to Internal Photo file.)
 Therefore this E.U.T Complies with the requirement of §15.203**

4. Test report

4.1 Summary of tests

FCC part section(s)	RSS section(s)	Parameter	Limit	Test condition	Status Note 1
2.1049	-	20 dB Bandwidth	-	Radiated	C
-	RSS-Gen [6.7]	Occupied Bandwidth	-		NA
15.225 (a)	RSS-210 [B6(a)]	In-Band Emissions	15,848 $\mu\text{V}/\text{m}$ @ 30 m 13.553 – 13.567 MHz		C
15.225 (b)	RSS-210 [B6(b)]	In-Band Emissions	334 $\mu\text{V}/\text{m}$ @ 30 m 13.410 – 13.553 MHz 13.567 – 13.710 MHz		C
15.225 (c)	RSS-210 [B6(c)]	In-Band Emissions	106 $\mu\text{V}/\text{m}$ @ 30 m 13.110 – 13.410 MHz 13.710 – 14.010 MHz		C
15.225 (d) 15.209	RSS-210 [B6(d)] RSS-GEN [8.9]	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 [B6]	Frequency Stability	± 0.01 % of operating frequency	Temp & Humid Test Chamber	C
15.207	RSS-Gen [8.8]	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: For radiated emission tests below 30 MHz were performed on semi-anechoic chamber which is correlated with OATS.

4.2 Transmitter requirements

4.2.1 20dB bandwidth

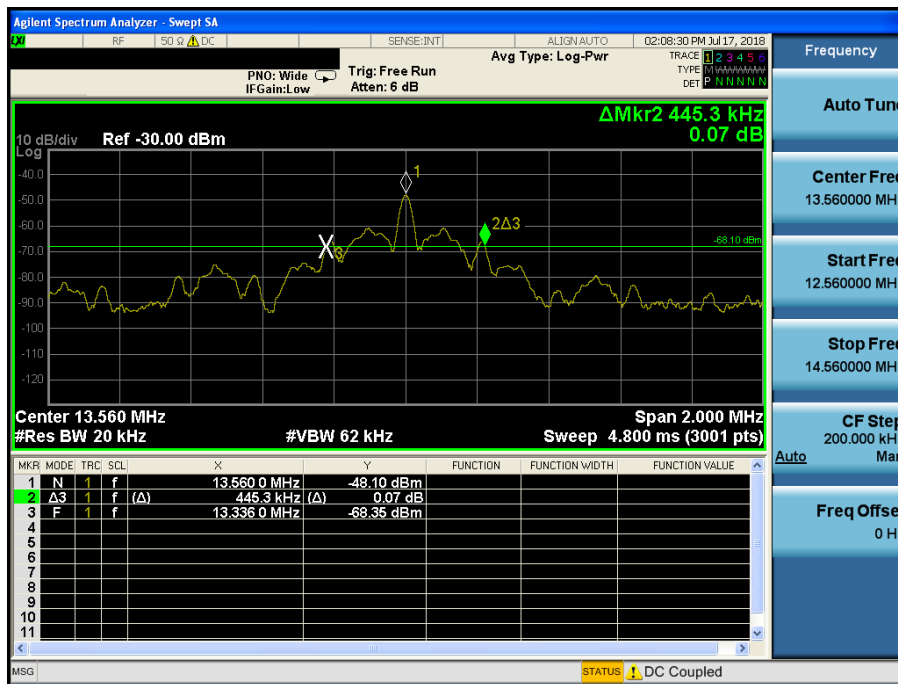
- Procedure:

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

And spectrum analyzer setting use following test procedure of **ANCSI C63.10-2013 – Section 6.9.2.**

1. Center frequency = EUT channel center frequency
2. Span = 2 ~ 5 times the OBW
3. RBW = 1 % ~ 5 % OBW
4. VBW ≥ 3 x RBW
5. Detector = Peak
6. Trace = Max hold
7. The trace was allowed to stabilize
8. Determine the reference value = Set the spectrum analyzer marker to the highest level of the displayed trace
9. Using the marker-delta function of the instrument, determine the “-xx dB down amplitude” using [(reference value) - xx].
10. Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

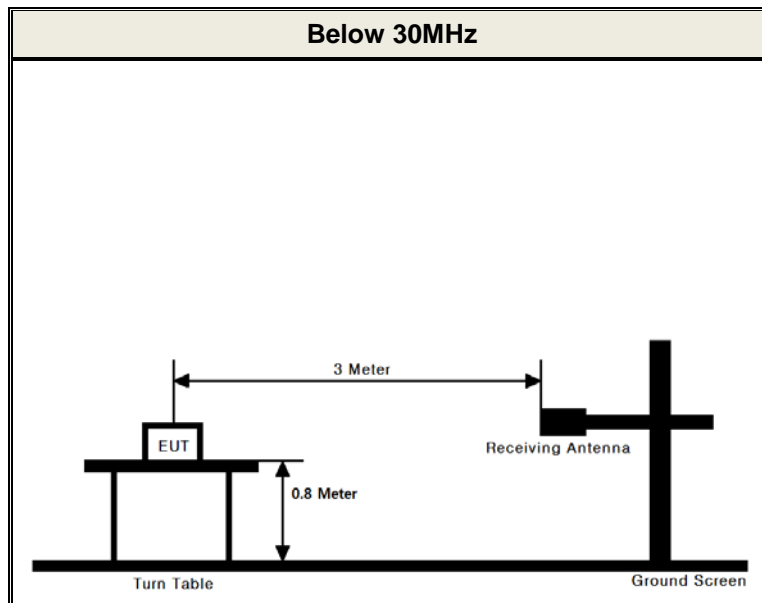
- Measurement Data: Comply



- Minimum Standard: NA

4.2.2 In-band emissions

- Test Configuration



- **Procedure:** The radiated emission was tested according to the **section 6.4 of the ANSI C63.10-2013.**

The EUT was placed on a 0.8 m high non-conductive table and it was placed at 3m distance from the antenna. Measurements were performed for each of the three antenna orientations. (ie. parallel, perpendicular, and ground-parallel)

Also, measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine worst-case orientation for maximum emissions.

RBW = As specified in below table, VBW ≥ 3 x RBW, Sweep = Auto, Detector = Peak
Trace mode = Max Hold until the trace stabilizes.

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

- **Minimum Standard: Part 15.225(a), (b), (c) & RSS-210 [B6(a), (b), (c)]**

Frequency Band [MHz]	Limit at 30 m measurement distance	
	[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

- Measurement Data:

Tested Frequency : 13.56 MHz
 Measurement Distance : 3 Meters

Test Frequency Band [MHz]	Freq. [MHz]	EUT Axis.	ANT (Note 1)	Reading Level [dBuV]	T.F [dB/m]	Field Strength @3 m [dBuV/m]	Field Strength @30 m [dBuV/m]	Limit [dBuV/m]	Margin [dB]
13.110 ~ 13.410	13.346	Z	P	16.90	19.22	36.12	-3.88	40.50	44.38
13.410 ~ 13.553	13.553	Z	P	25.40	19.22	44.62	4.62	50.50	45.88
13.553 ~ 13.567	13.559	Z	P	31.60	19.22	50.82	10.82	84.00	73.18
13.567 ~ 13.710	13.671	Z	P	15.10	19.22	34.32	-5.68	50.50	56.18
13.710 ~ 14.010	13.771	Z	P	14.90	19.22	34.12	-5.88	40.50	46.38

Note 1. Loop antenna orientation

“P”: Parallel, “V”: perpendicular, “G”: ground-parallel

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

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

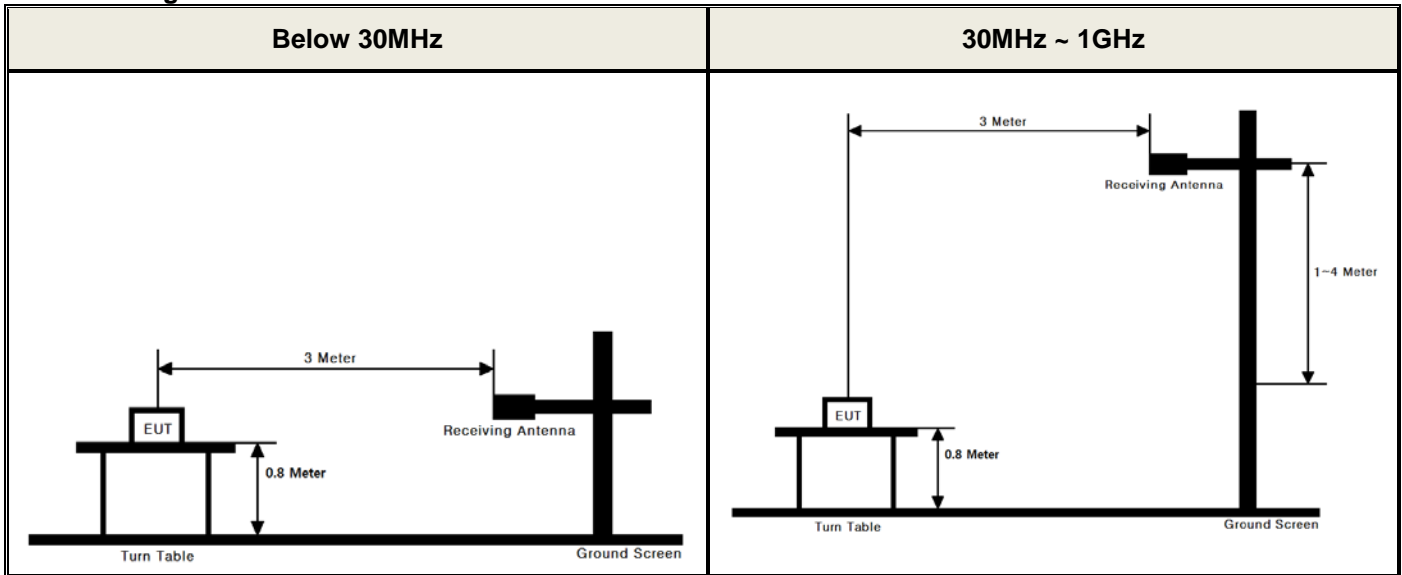
Margin = Limit – Field Strength @ 30 m / Field Strength @ 30 m = Field Strength @ 3 m – 40 dB

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

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

4.2.3 Out-of-band emissions

- Test configuration



- **Procedure:** The radiated emission was tested according to the **section 6.4, 6.5 of the ANSI C63.10-2013.**

The EUT was tested from 9 kHz up to the 1 GHz excluding the band 13.110-14.010 MHz.

A The EUT was placed on a 0.8 m high non-conductive table and it was placed at 3m distance from the antenna. For measurements below 30MHz were performed for each of the three antenna orientations. (ie. parallel, perpendicular, and ground-parallel) For measurements above 30MHz were performed for each of the both horizontal and vertical polarizations.

Also, measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine worst-case orientation for maximum emissions.

RBW = As specified in below table, VBW ≥ 3 x RBW, Sweep = Auto, Detector = Peak
Trace mode = Max Hold until the trace stabilizes.

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

- **Minimum Standard: Part 15.209, 225(d) & RSS-210[B6(d)], RSS-GEN[8.9]**

• **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, 76-88 MHz, 174-216 MHz or 470-806 MHz. 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 : 13.56 MHz
 Measurement Distance : 3 Meters

Frequency [MHz]	EUT Axis.	ANT (Note 1)	Reading [dBuV]	T.F [dB/m]	Distance factor [dB]	Field Strength [dBuV/m]	Limit [dBuV/m]	Margin [dB]
0.543	Z	P	20.7	18.65	40	-0.65	32.9	33.55
9.310	Z	P	13.1	19.33	40	-7.57	29.5	37.07
20.060	Z	P	12.3	19.66	40	-8.04	29.5	37.54
27.160	Z	P	11.4	20.39	40	-8.21	29.5	37.71
31.091	Z	V	35.8	-16.52	NA	19.28	40	20.72
148.459	Z	V	32.3	-13.73	NA	18.57	43.5	24.93
447.816	Z	V	25.8	-7.71	NA	18.09	46	27.91
937.516	Z	H	22.2	3.32	NA	25.52	46	20.48
-	-	-	-	-	-	-	-	-

Note 1. Loop antenna orientation (30 MHz Below)

“P”= Parallel, “V”= perpendicular, “G”= ground-parallel

Bilog antenna polarization (30 MHz above)

“H”= Horizontal, “V”= Vertical

Note 2. 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 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

4.2.4 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 : 13,560,000 Hz

VOLTAGE (%)	POWER (V _{DC})	TEMP (°C)	Frequency (Hz)	Freq. Dev. (Hz)	Deviation (%)
100%	3.80	+20(ref)	13,559,211	-789	0.005819
100%		-20	13,559,154	-846	0.006239
100%		-10	13,559,213	-787	0.005804
100%		0	13,559,234	-766	0.005649
100%		+10	13,559,351	-649	0.004786
100%		+20	13,559,211	-789	0.005819
100%		+30	13,559,284	-716	0.005281
100%		+40	13,559,443	-557	0.004108
100%		+50	13,559,343	-657	0.004845
85%		3.23	+20	13,559,235	-765
115%	4.37	+20	13,559,261	-739	0.005450

- Minimum Standard: Part 15. 225(e) & RSS-210 [B6]

The frequency tolerance of the carrier signal shall be maintained within ± 0.01 % of the operating frequency.

4.2.5 AC Line Conducted Emissions

- Test Requirements and limit

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 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN).

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

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

- Test Configuration

See test photographs for the actual connections between EUT and support equipment.

- Test Procedure

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors – Quasi Peak and Average Detector.

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

Measurement Data

Results of Conducted Emission

DTNC

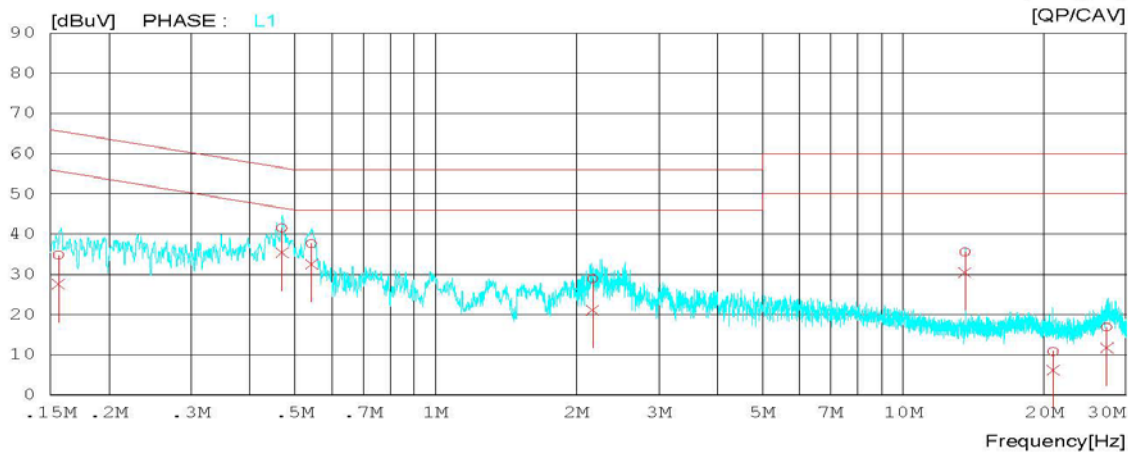
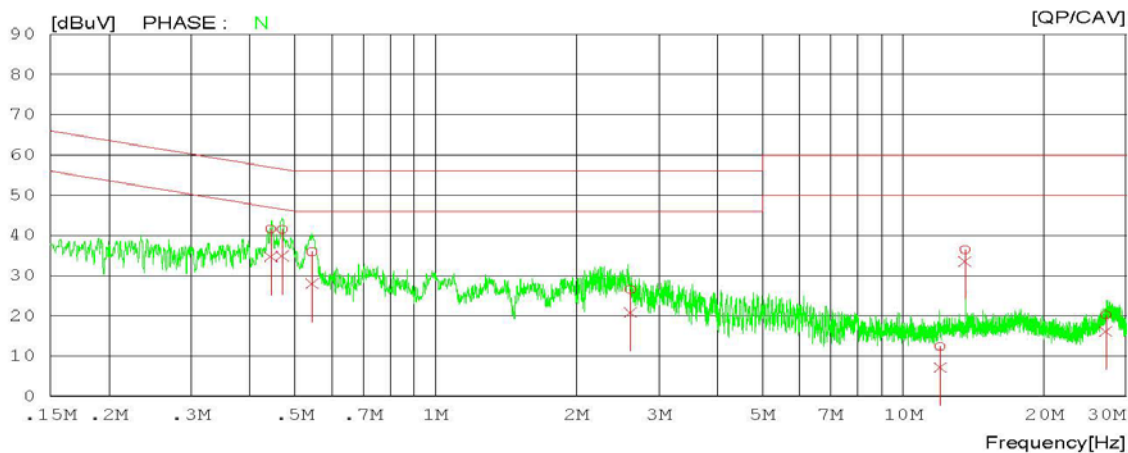
Date 2018-07-07

Order No.
Model No. EF401
Serial No.
Test Condition NFC

Reference No.
Power Supply
Temp/Humi. 23 °C / 46 %
Operator J.J.LEE

Memo

LIMIT : FCC P15.207 QP
FCC P15.207 AV



Measurement Data

Results of Conducted Emission

DTNC

Date 2018-07-07

Order No.		Reference No.	
Model No.	EF401	Power Supply	
Serial No.		Temp/Humi.	23 'C / 46 %
Test Condition	NFC	Operator	J.J.LEE

Memo

 LIMIT : FCC P15.207 QP
 FCC P15.207 AV

NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	CAV [dBuV]		QP [dBuV]	CAV [dBuV]	QP [dBuV]	CAV [dBuV]	QP [dBuV]	CAV [dBuV]	
1	0.44461	31.70	24.79	9.90	41.60	34.69	56.98	46.98	15.38	12.29	N
2	0.46953	31.62	24.92	9.90	41.52	34.82	56.52	46.52	15.00	11.70	N
3	0.54382	26.06	18.11	9.90	35.96	28.01	56.00	46.00	20.04	17.99	N
4	2.61080	16.69	10.87	9.96	26.65	20.83	56.00	46.00	29.35	25.17	N
5	11.98880	2.25	-2.97	10.12	12.37	7.15	60.00	50.00	47.63	42.85	N
6	13.55960	26.30	23.46	10.18	36.48	33.64	60.00	50.00	23.52	16.36	N
7	27.12100	9.90	5.76	10.37	20.27	16.13	60.00	50.00	39.73	33.87	N
8	0.15590	24.85	17.58	9.89	34.74	27.47	65.68	55.68	30.94	28.21	L1
9	0.46912	31.50	25.41	9.90	41.40	35.31	56.53	46.53	15.13	11.22	L1
10	0.54312	27.70	22.57	9.90	37.60	32.47	56.00	46.00	18.40	13.53	L1
11	2.16600	18.87	11.13	9.95	28.82	21.08	56.00	46.00	27.18	24.92	L1
12	13.55960	25.40	20.30	10.18	35.58	30.48	60.00	50.00	24.42	19.52	L1
13	20.95520	0.48	-4.12	10.29	10.77	6.17	60.00	50.00	49.23	43.83	L1
14	27.25460	6.37	1.31	10.37	16.74	11.68	60.00	50.00	43.26	38.32	L1

APPENDIX

TEST EQUIPMENT FOR TESTS

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent Technologies	N9020A	17/12/26	18/12/26	MY50200828
Multimeter	FLUKE	17B	17/12/26	18/12/26	26030065WS
Signal Generator	Rohde Schwarz	SMBV100A	17/12/27	18/12/27	255571
Thermohygrometer	BODYCOM	BJ5478	17/09/11	18/09/11	N/A
Temp & Humi Test Chamber	SJ Science	SJ-TH-S50	17/09/07	18/09/07	U5542113
			18/07/06	19/07/06	
Loop Antenna	Schwarzbeck	FMZB1513	18/01/30	20/01/30	1513-128
BILOG ANTENNA	Schwarzbeck	VULB 9168	18/03/26	20/03/26	9168-0819
PreAmplifier	tsj	MLA-10K01-B01-27	18/01/11	19/01/11	2005354
EMI Test Receiver	Rohde Schwarz	ESW44	17/08/21	18/08/21	101645
EMI Test Receiver	Rohde Schwarz	ESCI7	18/02/12	19/02/12	100910
PULSE LIMITER	Rohde Schwarz	ESH3-Z2	17/09/29	18/09/29	101333
LISN	SCHWARZBECK	NNLK 8121	18/03/20	19/03/20	06183
Cable	HUBER+SUHNER	SUCOFLEX	17/12/22	18/12/22	C-1
Cable	HUBER+SUHNER	SUCOFLEX	17/12/22	18/12/22	C-2
Cable	HUBER+SUHNER	SUCOFLEX	17/12/22	18/12/22	C-3
Cable	HUBER+SUHNER	SUCOFLEX	17/12/22	18/12/22	C-4

Note1: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017.

Note2: The cable is not a regular calibration item, so it has been calibrated by DT&C itself.