

TEST REPORT

**CTK Co., Ltd.**

(Ho-dong), 113, Yejik-ro, Cheoin-gu,
Yongin-si, Gyeonggi-do, Korea
Tel: +82-31-339-9970
Fax: +82-31-624-9501

Report No.:

CTK-2020-02666

Page (1) / (17) Pages

1. Client

- Name : SOLUM CO.,LTD.
- Address : 4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea
- Date of Receipt : 2020-06-12

2. Manufacturer

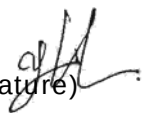
- Name #1 : SOLUM CO.,LTD.
- Address #1 : 4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea
- Name #2 : SOLUM VINA CO., LTD
- Address #2 : Plot B3, Ba Thien 2 Industrial park, Thien Ke Ward, Binh Xuyen District, Vinh Phuc Province, 281200., People's Republic of Vietnam

3. Use of Report : For FCC Certification & Canadian Certification**4. Test Sample / Model** : NFC Remote Controller / EL090NBBX0**5. Date of Test** : 2020-06-30 to 2020-07-07

6. Test Standard(method) used : FCC 47 CFR part 15 subpart C 15.225,
RSS-Gen Issue 5, RSS-210 Issue 10
ANSI C63.10-2013

7. Testing Environment : Temp.: (23 ± 1) °C, Humidity: (51 ± 3) % R.H.**8. Test Results** : Compliance

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full.

Affirmation	Tested by	Technical Manager
	Bong-seok Kim: (Signature) 	Young-taek Lee: (Signature) 

2020-07-09

Republic of KOREA **CTK Co., Ltd.**

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REPORT REVISION HISTORY

Date	Revision	Page No
2020-07-09	Issued (CTK-2020-02666)	all

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 CTK Co., Ltd. The Prime Leader of Global Regulatory Certification	CTK Co., Ltd. (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea Tel: + 82-31-339-9970 Fax: + 82-31-624-9501	Report No.: CTK-2020-02666 Page (4) / (17) Pages	
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1. General Product Description

1.1 Client Information

Company	SOLUM CO.,LTD.
Contact Point	4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea
Contact Person	Name : KIM TAE HUN E-mail : th0428.kim@solu-m.com Tel : +82-31-8006-0968

1.2 Product Information

FCC ID	2AFWN-EL090NBBX0
IC	22800-EL090NBBX0
Product Description	NFC Remote Controller
Model name	EL090NBBX0
Variant Model name	-
Operating Frequency	13.560 3 MHz
RF Output Power	65.14 dBuV/m @ 3 m
Antenna Specification	Antenna type : PCB Antenna Peak Gain : -
Number of channels	1
Channel Spacing	-
Type of Modulation	ASK
Power Source	DC 3.0 V(Battery)
Firmware Version Id Number(FVIN)	6.0
RF Power setting in Test SW	Initial value

1.3 Peripheral Devices

- For Radiated Measurement

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

*Measured without Peripheral Devices in conduction measurement and radiation measurement.

1.4 Antenna Information

☒	Integral antenna (antenna permanently attached)
☐	Temporary RF connector provided
☒	No temporary RF connector provided Transmit chains bypass antenna and soldered temporary RF connector provided for connected measurement. In case of conducted measurements the transmitter shall be connected to the measuring equipment via a suitable attenuator and correct for all losses in the RF path.
☐	External antenna (dedicated antennas)

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2. Facility and Accreditations

2.1 Test Facility

The measurement facility is located at (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yong-in-si, Gyeonggi-do, Korea.

2.2 Laboratory Accreditations and Listings

Country	Agency	Registration Number
USA	FCC	805871
CANADA	ISED	8737A
KOREA	NRRA	KR0025

2.3 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.

3. Test Specifications

3.1 Standards

Section in FCC(s)	Section in RSS(s)	Requirement(s)	Status (Note 1)	Test Condition
15.203	RSS-Gen 6.8	Antenna Requirement	C	-
15.215(c)	RSS-Gen 6.7	Emission Bandwidth	C	Radiated
15.225 (a),(b),(c),(d)	RSS-210 Annex B.6 (a),(b),(c),(d)	Radiated Electric Field Emissions	C	
15.225(e)	RSS-210 Annex B.6	Frequency tolerance	C	
15.207(a)	RSS-Gen 8.8	AC Conducted Emission	NA(Note 3)	Line Conducted
<u>Note 1:</u> C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable				
<u>Note 2:</u> The data in this test report are traceable to the national or international standards.				
<u>Note 3:</u> The equipment is operated on battery power only.				
<u>Note 4:</u> The sample was tested according to the following specification: FCC Part 15.225, ANSI C63.10-2013				
<u>Note 5:</u> The tests were performed according to the method of measurements prescribed in KDB No.558074.				

3.2 Mode of operation during the test

The EUT is operated in a manner representative of the typical of the equipments.
 During the test, the EUT transmitted a modulation signal continuously.
 The results are only attached worst cases.

Test Frequency

F1
13 560 300 Hz

3.3 Maximum Measurement Uncertainty

The value of the measurement uncertainty for the measurement of each parameter.
 Coverage factor $k = 2$, Confidence levels of 95 %

Description	Uncertainty
Occupied Bandwidth	0.1 MHz
Radiated Emissions ($f \leq 1$ GHz)	5.0 dB
Radiated Emissions ($f > 1$ GHz)	5.0 dB

4. Technical Characteristic Test

4.1 20 dB Bandwidth & 99 % Bandwidth – 15.215 (c)

Requirement

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

Test Procedures

For the emission bandwidth refer ANSI C63.10-2013, clause 6.9(Occupied bandwidth).

Limit :

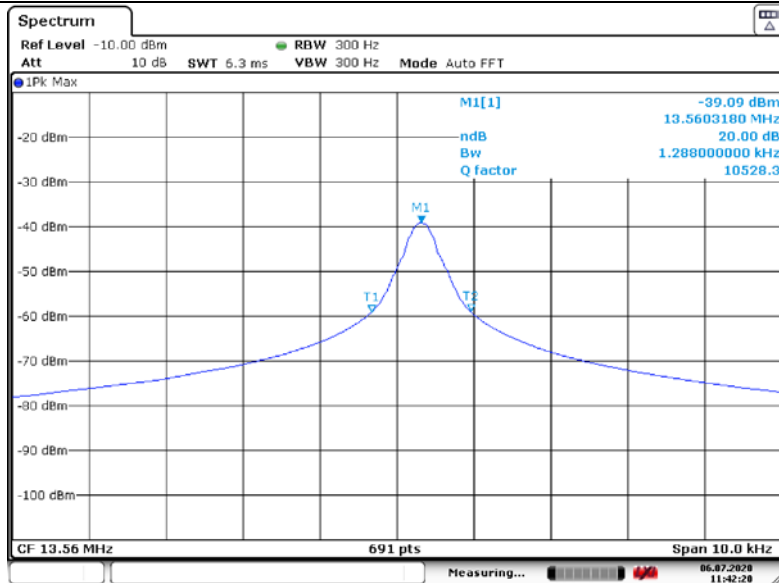
20 dB Bandwidth (N/A)

Test Data :

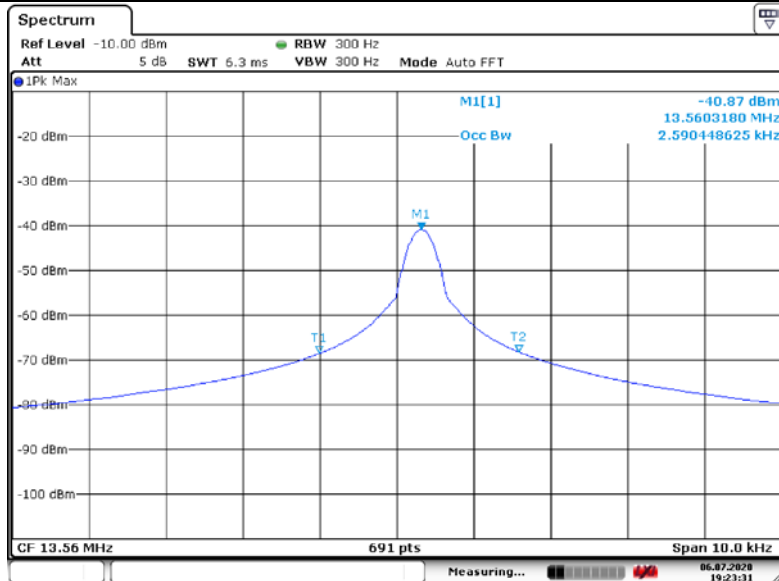
Frequency [MHz]	20 dB Bandwidth [kHz]	99 % Bandwidth [kHz]	Limit	Result
13.560 3	1.288 (F _L : 13 559.674 F _H : 13 560.962)	2.590	N/A	Complies

See next pages for actual measured spectrum plots.

Emission Bandwidth Plot 20 dB Bandwidth



Emission Bandwidth Plot 99 % Bandwidth



4.2 Field strength emissions - 15.225 (a)(b)(C)(d)

Requirement

- (a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.
- (b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.
- (c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.
- (d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

Test Procedures

Test Method	
☒	Refer as ANSI C63.10-2013, clause 6.4(Radiated emissions from unlicensed wireless devices below 30 MHz).
☒	Radiated emission tests shall be performed in the frequency range of 9 kHz to 30 MHz, using a calibrated loop antenna. When perpendicular to the ground plane, the lowest height of the magnetic antenna shall be 1 m above the ground and shall be positioned at the specified distance from the EUT. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.
☒	The results shall be by using the square of an inverse linear distance extrapolation factor(40 dB/decade).
☒	Refer as ANSI C63.10-2013, clause 6.5(Radiated emissions from unlicensed wireless devices in the frequency range of 30 MHz to 1000 MHz).
☒	In the frequency rage above 30 MHz, Bi-Log Test Antenna(30 MHz to 1 GHz) is used. Test Antenna height is carried from 1m to 4m above the ground to determine the maximum value of the field strength. The emissions levels at both horizontal and vertical polarizations should be tested.
☒	Emissions more than 20 dB below the limit do not need to be reported.

Measuring instrument Settings	
Frequency Range	9 kHz – 1 000 MHz
RBW	200 Hz (9 kHz – 150 kHz) 9 kHz (150 kHz – 30 MHz) 120 kHz (30 MHz – 1 000 MHz)
VBW	≥ RBW
Sweep time	auto couple
Detector function	CISPR quasi-peak(below 1 000 MHz)

Limit :

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

Frequency(MHz)	Field Strength uV / m@3m	Field Strength dBuV / m@3m	Measurement Distance (meters)
0.009-0.490	2400/F(kHz)	48.5 – 13.8	300
0.490-1.705	24000/F(kHz)	33.8 – 23	30
1.705-30	30	29.5	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	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 54-72MHz, 76-88MHz, 174-216MHz, 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g.15.231 and 15.241.

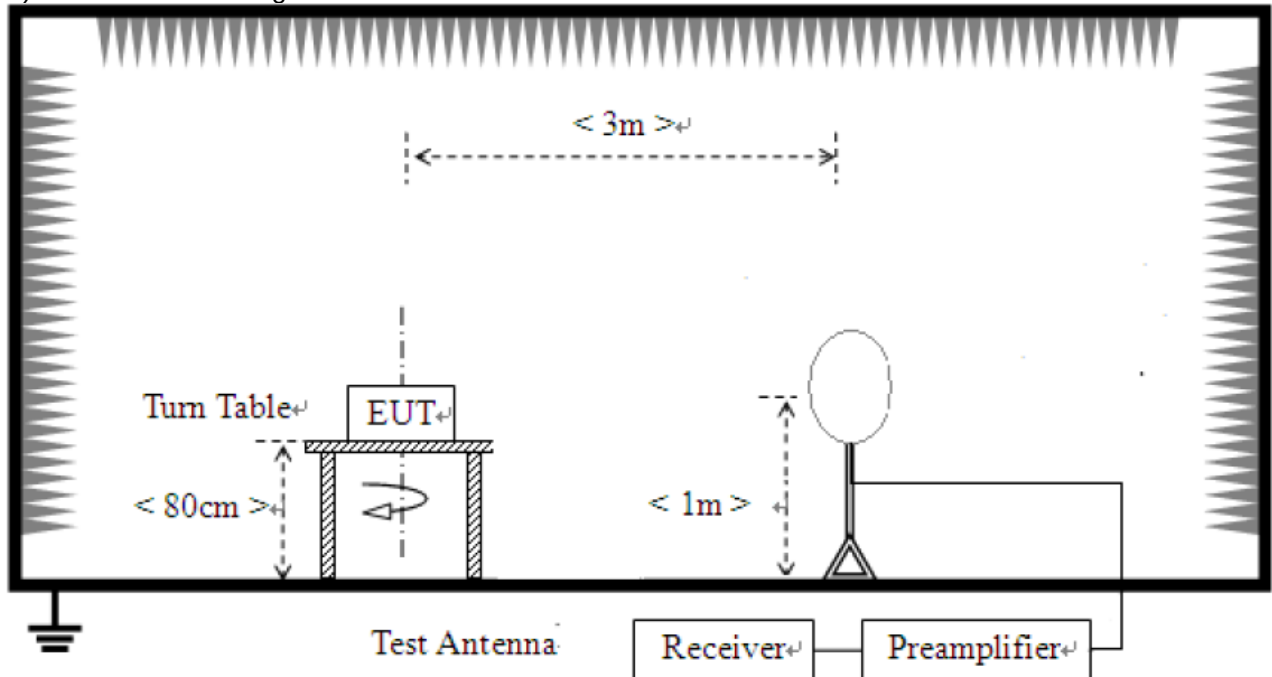
Note : The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

Test Location

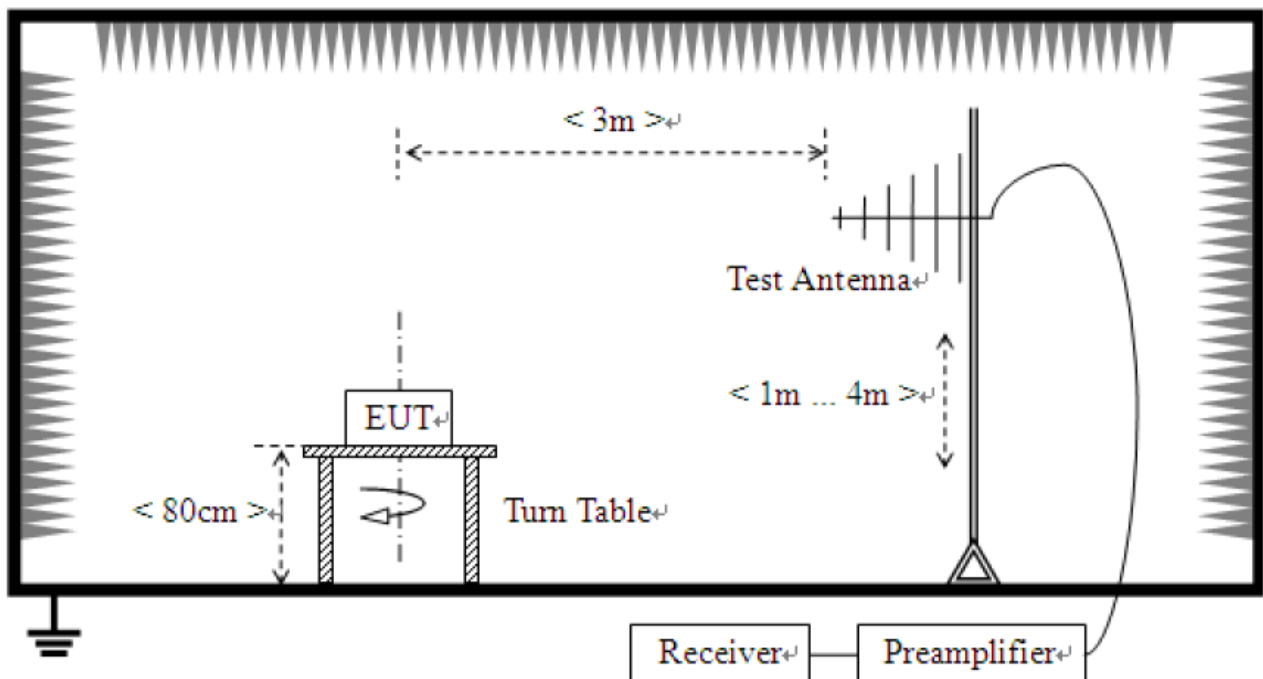
- ☒ 10 m SAC (test distance : ☐ 10 m, ☒ 3 m)
☐ 3 m SAC (test distance : 3 m)

Test Setup:

- 1) For field strength of emissions from 9 kHz to 30 MHz



- 2) For field strength of emissions from 30 MHz to 1 GHz



Test Data :

1. Radiated emissions within the band 13.110-14.010 MHz

Frequency [MHz]	Frequency [kHz]	Reading* [dBuV/m]	c.f [dB/m]	Result [dBuV/m]	Limit [dBuV/m]
13.110-13.410	13.347	14.80	26.12	40.92	80.5
13.410-13.553	13.550	13.10	26.14	39.24	90.4
13.553-13.567	13.560	39.00	26.14	65.14	123.9
13.567-13.710	13.567	26.10	26.14	52.24	90.4
13.710-14.010	13.770	16.10	26.15	42.25	80.5

Note :

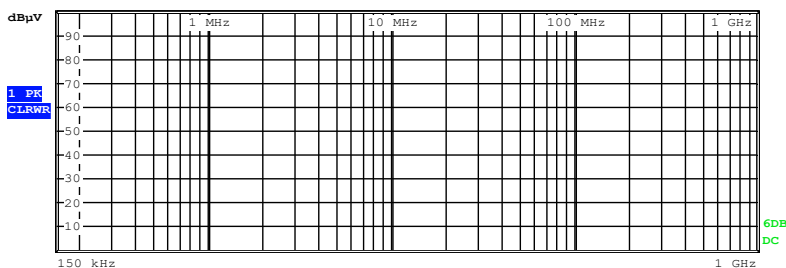
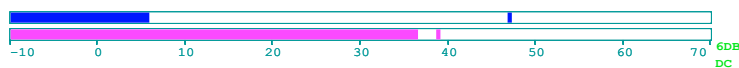
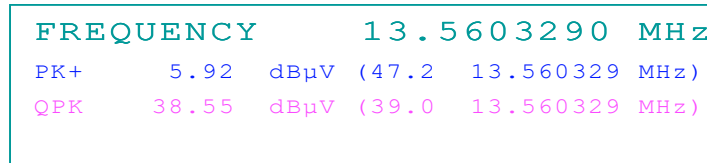
1. Measuring position : EUT stand-up position(Y)
2. Result = Reading + c.f(correction factor)
3. Correction factor = Antenna factor + Cable loss + 6 dB Attenuator

* Reading data is the QP value.

Frequency range : 13.553-13.567 MHz



RBW 9 kHz
MT 100 ms
Att 10 dB AUTO
PREAMP OFF



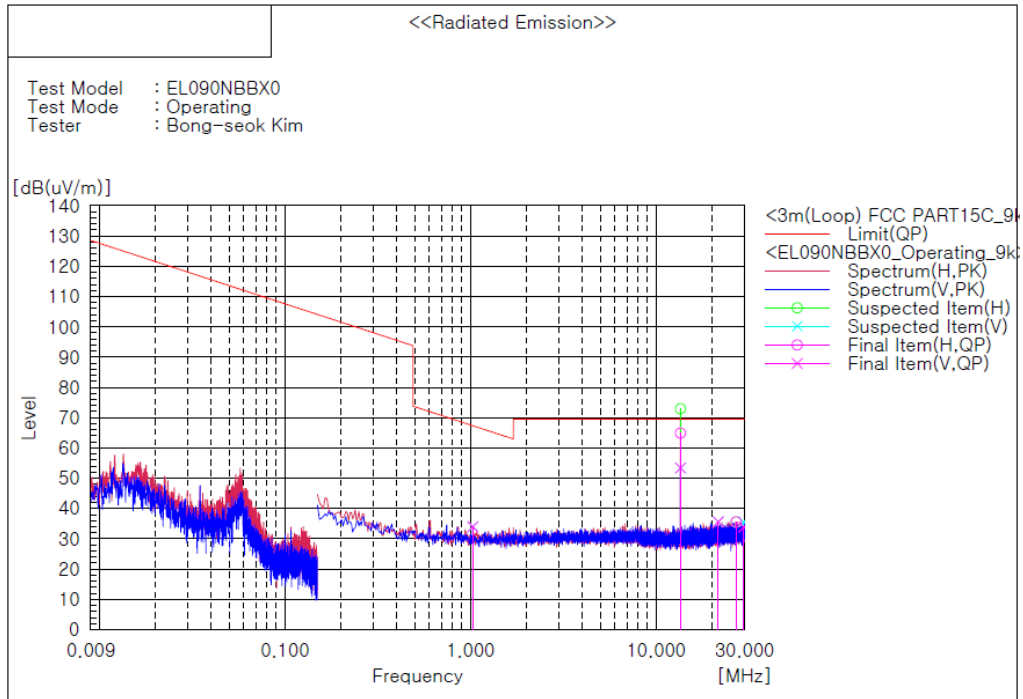
Date: 7.JUL.2020 02:30:58

2. 9 kHz to 30 MHz

Test mode : Transmit, Operating(Worst case)

The requirements are:

☒ Complies



Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(uV)]	c.f [dB(1/m)]	Result QP [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]
1	1.031	V	8.9	25.1	34.0	67.3	33.3	101.0	192.0
2	13.560	H	39.0	25.9	64.9	69.5	4.6	101.0	10.0
3	13.560	V	27.5	25.9	53.4	69.5	16.1	101.0	354.0
4	21.653	V	8.9	26.7	35.6	69.5	33.9	101.0	355.0
5	27.026	H	8.4	27.2	35.6	69.5	33.9	101.0	41.0
6	29.769	V	6.5	27.4	33.9	69.5	35.6	101.0	172.0

Note :

- The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.
- Result = Reading + c.f(correction factor)
- Correction factor = Antenna factor + Cable loss + 6 dB Attenuator

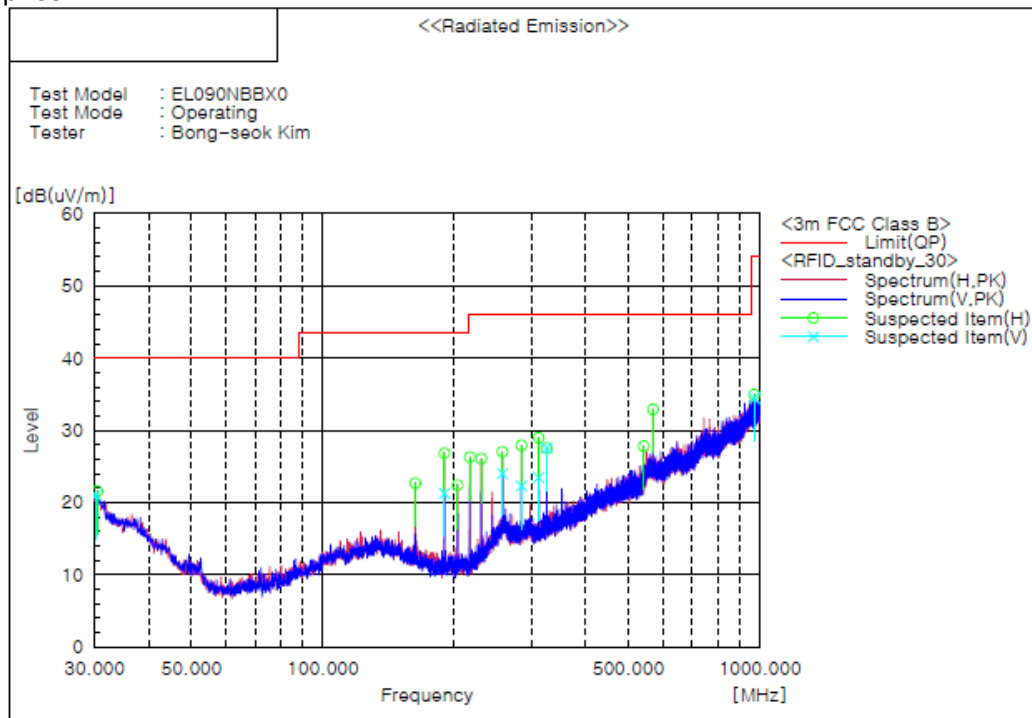
* Reading data is the peak value.

2. 30 MHz to 1 GHz

Test mode : Transmit, Operating(Worst case)

The requirements are:

☒ Complies



Spectrum Selection

No.	Frequency [MHz]	(P)	Reading [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Limit OP [dB(uV/m)]	Margin OP [dB]	Height [cm]	Angle [deg]
1	30.243	V	26.9	-5.9	21.0	40.0	19.0	191.0	37.0
2	30.485	H	27.7	-6.1	21.6	40.0	18.4	399.0	169.0
3	162.648	H	35.8	-13.1	22.7	43.5	20.8	209.0	8.0
4	189.808	H	40.9	-14.1	26.8	43.5	16.7	209.0	8.0
5	189.808	V	35.4	-14.1	21.3	43.5	22.2	191.0	318.0
6	203.388	H	36.1	-13.7	22.4	43.5	21.1	209.0	8.0
7	216.968	H	40.0	-13.7	26.3	46.0	19.7	209.0	8.0
8	230.548	H	38.4	-12.3	26.1	46.0	19.9	101.0	350.0
9	257.586	H	35.4	-8.4	27.0	46.0	19.0	101.0	350.0
10	257.708	V	32.4	-8.4	24.0	46.0	22.0	191.0	328.0
11	284.746	H	36.9	-9.0	27.9	46.0	18.1	101.0	353.0
12	284.746	V	31.3	-9.0	22.3	46.0	23.7	101.0	267.0
13	311.906	H	37.4	-8.4	29.0	46.0	17.0	101.0	353.0
14	311.906	V	31.9	-8.4	23.5	46.0	22.5	191.0	328.0
15	325.365	H	35.4	-7.9	27.5	46.0	18.5	101.0	353.0
16	325.486	V	35.4	-7.9	27.5	46.0	18.5	191.0	245.0
17	542.524	H	29.2	-1.4	27.8	46.0	18.2	309.0	37.0
18	569.563	H	32.9	0.0	32.9	46.0	13.1	399.0	166.0

Note :

1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.
2. Result = Reading + c.f(Correction factor)
3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain

* Reading data is the peak value.

4.3 Frequency tolerance - 15.225 (e)

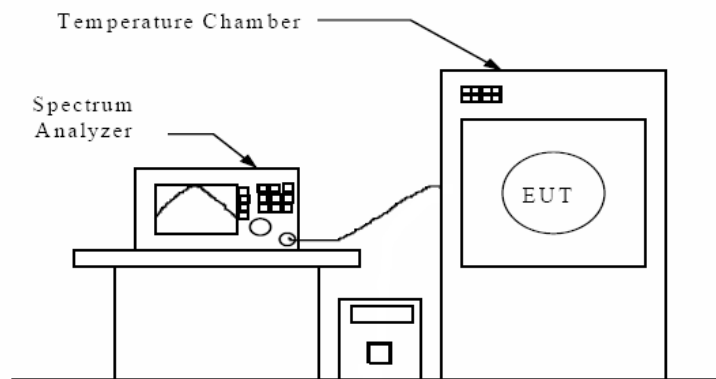
Requirement

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

For the emission bandwidth refer ANSI C63.10-2013, clause 6.8(Frequency stability tests).

Test Setup



Limit :

Frequency Error = $\pm 0.01\%$ ($\pm 1\ 356.030\ \text{Hz}$)

Test Data :

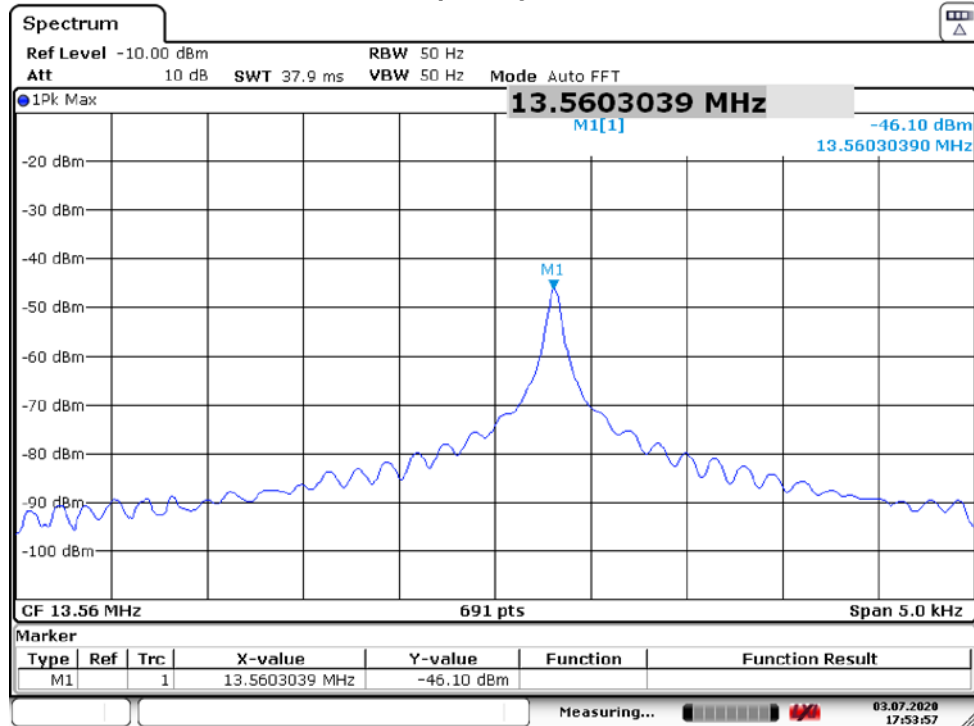
Tem* [°C]	Carrier Frequency Measured with Time Elapsed								Result
	Start up		2 minutes		5 minutes		10 minutes		
+50	13.560232	-68	13.560232	-68	13.560232	-68	13.560232	-68	Pass
+40	13.560282	-18	13.560275	-25	13.560268	-32	13.560261	-39	Pass
+30	13.560311	11	13.560304	4	13.560297	-3	13.560297	-3	Pass
+20	13.560333	33	13.560333	33	13.560333	33	13.560333	33	Pass
+10	13.560369	69	13.560362	62	13.560362	62	13.560362	62	Pass
0	13.560369	69	13.560369	69	13.560369	69	13.560369	69	Pass
-10	13.560355	55	13.560355	55	13.560355	55	13.560355	55	Pass
-20	13.560326	26	13.560311	11	13.560311	11	13.560311	11	Pass

Vol* [%]	Carrier Frequency Measured with Time Elapsed								Result
	Start up		2 minutes		5 minutes		10 minutes		
115	13.560304	4	13.560304	4	13.560311	11	13.560311	11	Pass
100	13.560304	4	13.560369	69	13.560355	55	13.560362	62	Pass
85	13.560304	4	13.560304	4	13.560304	4	13.560304	4	Pass

Note :

1. Tem : Temperature, Vol : Voltage

Reference Frequency: 13 560 300 Hz



APPENDIX A – Test Equipment Used For Tests

No.	Name of Equipment	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
1	SPECTRUM ANALYZER	R&S	FSV40	101574	2020-01-17	2021-01-17
2	EMI Test Receiver	Rohde & Schwarz	ESCI7	100814	2019-10-22	2020-10-22
3	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-125	2020-04-16	2022-04-16
4	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-126	2020-05-20	2022-05-20
5	Bilog Antenna	Schaffner	CBL6111C	2551	2019-04-17	2021-04-17
6	AMPLIFIER	SONOMA	310	291721	2020-01-22	2021-01-22
7	6dB Attenuator	BIRD	5W 6dB	1744	2020-01-03	2021-01-03
8	6dB Attenuator	R&S	DNF	272.4110.50-2	2019-10-25	2020-10-25
9	DC Power Supply	HP	E3642A	KR93300203	2020-01-07	2021-01-07
10	Temp&Humi Chamber	ESPEC CORP.	SH-242	93012243	2020-01-22	2021-01-22

No.	Name of Equipment	Manufacturer	Model No.	Serial No.	Check Date
1	RF Cable (conducted)	Junkosha Inc.	MWX221	1510S087	2020-02-02
2	3m Loop Cable (Radiated)	HUBER+SUHNER	N/A	N/A	2019-10-25
3	3 m 1GHz Above RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 104	MY27558/4	2020-01-28
4	3 m 1GHz Below RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 104	N/A (below 1GHz)	2020-01-28
4	3 m 1GHz Above RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 104	MY27573/4	2019-12-12
5	3 m 1GHz Above RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 104	801924/4	2019-12-12
6	3 m 1GHz Above RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 102	MY4728/2	2020-02-02
7	3 m 1GHz Above RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 102	MY2374/2	2020-02-02