

TEST REPORT

 CTK Co., Ltd. The Prime Leader of Global Engineers 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-2023-00690 Page (1) / (21) Pages	
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1. Applicant

- Name : SOLUM CO., LTD
- Address : 4,5,6th F, 357, Guseong-ro, Giheung-gu, Yongin-si, Gyeonggi-do, Korea (Zip 16914)
- Date of Receipt : 2023-01-05

2. Manufacturer

- Name : SOLUM CO., LTD
- Address : 4,5,6th F, 357, Guseong-ro, Giheung-gu, Yongin-si, Gyeonggi-do, Korea (Zip 16914)

3. Factory

- Name : SOLUM VINA CO., LTD
- Address : Plot B3, Ba Thien 2 Industrial park, Thien Ke Ward, Binh Xuyen District, Vinh Phuc Province, 281200., People's Republic of Vietnam

4. Use of Report : For FCC Certification

5. Test Sample / Model : Hybrid Remocon Controller / EL090MBCX0

6. Date of Test : 2023-01-17 to 2023-03-31

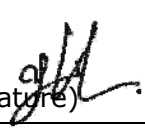
7. Test Standard(method) used : FCC 47 CFR part 15 subpart C 15.225

8. Testing Environment : Temp.: (23 ± 1) °C, Humidity: (48 ± 5) % R.H.

9. Test Results : Compliance

10. Location of Test : ☒ Permanent Testing Lab ☐ On Site Testing (Address : 5, Dongbu-ro 221beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, 17141 Korea)

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This report cannot be reproduced or copied without the written consent of CTK

Approval	Tested by  Seoung-uk Park: (Signature)	Technical Manager  Young-taek Lee: (Signature)
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Remark. This report is not related to KOLAS accreditation and relevant regulation

2023-04-03

CTK Co., Ltd.

	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-2023-00690 Page (2) / (21) Pages	
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REPORT REVISION HISTORY

Date	Revision	Page No
2023-04-03	Issued (CTK-2023-00690)	all

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1. General Product Description

1.1 Applicant Information

Company	SOLUM CO., LTD
Contact Point	4,5,6th F, 357, Guseong-ro, Giheung-gu, Yongin-si, Gyeonggi-do, Korea (Zip16914)
Contact Person	Name : Ki Dong Lee E-mail : kdlee@solu-m.com Tel : +82-31-8006-7677

1.2 Product Information

FCC ID	2AFWN-EL090MBCX0
Product Description	Hybrid Remocon Controller
Basic model (HVIN)	EL090MBWX0
Variant Model name	-
FVIN	V1.0
Operating Frequency Range	13.56 MHz
RF Output Power	66.6 dBuV/m @ 3 m
Antenna Type	PCB antenna(Loop antenna)
Power Source	DC 3 V(Battery)

1.3 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)

2. Accreditations

2.1 Laboratory Accreditations and Listings

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

2.2 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

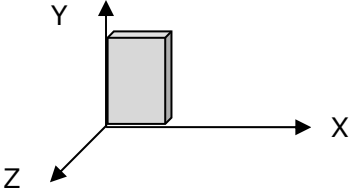
3.1 Standards

FCC Part Section(s)	Requirement(s)	Status (Note 1)	Report Clause
15.203	Antenna Requirement	C	1.3
15.215(c)	Emission Bandwidth	C	4.1
15.225 (a)(b)(c)(d)	Field strength emissions	C	4.2
15.225(e)	Frequency tolerance	C	4.3
15.207	AC Power line Conducted Emissions	NA(Note 4)	-
<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 sample was tested according to the following specification: ANSI C63.10-2013.			
<u>Note 4:</u> The equipment is operated on battery power only			

3.2 Mode of operation during the test

The EUT is operated in a manner representative of the typical of the equipments.
During at testing, system components were manipulated within the confines of typical usage to maximize each emission. All modulation modes were tests.

The Worst Case Measurement Configuration

Tests Item	Transmitter Radiated Emissions, Emission Bandwidth
Condition	Radiated measurement
User Position	☐ EUT will be placed in fixed position. ☐ EUT will be placed in mobile position and operating multiple positions. ☒ EUT will be a hand-held or body-worn battery-powered devices and operating multiple positions.
Operating Mode	DC Power supply mode
EUT faces identified relative to view from receiving antenna	

3.3 Peripheral Devices

No.	Device	Manufacturer	Model No.	Serial No.
1	DC Power Supply	Topward Electric Instruments	6303D	997931

3.4 Maximum Measurement Uncertainty

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

Test Item	Uncertainty
Radiated emissions	3.98 dB(C.L. : Approx. 95%, $k = 2$)
Frequency tolerance	10 Hz(C.L. : Approx. 95%, $k = 2$)

4. Technical Characteristic Test

4.1 Emission Bandwidth

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.

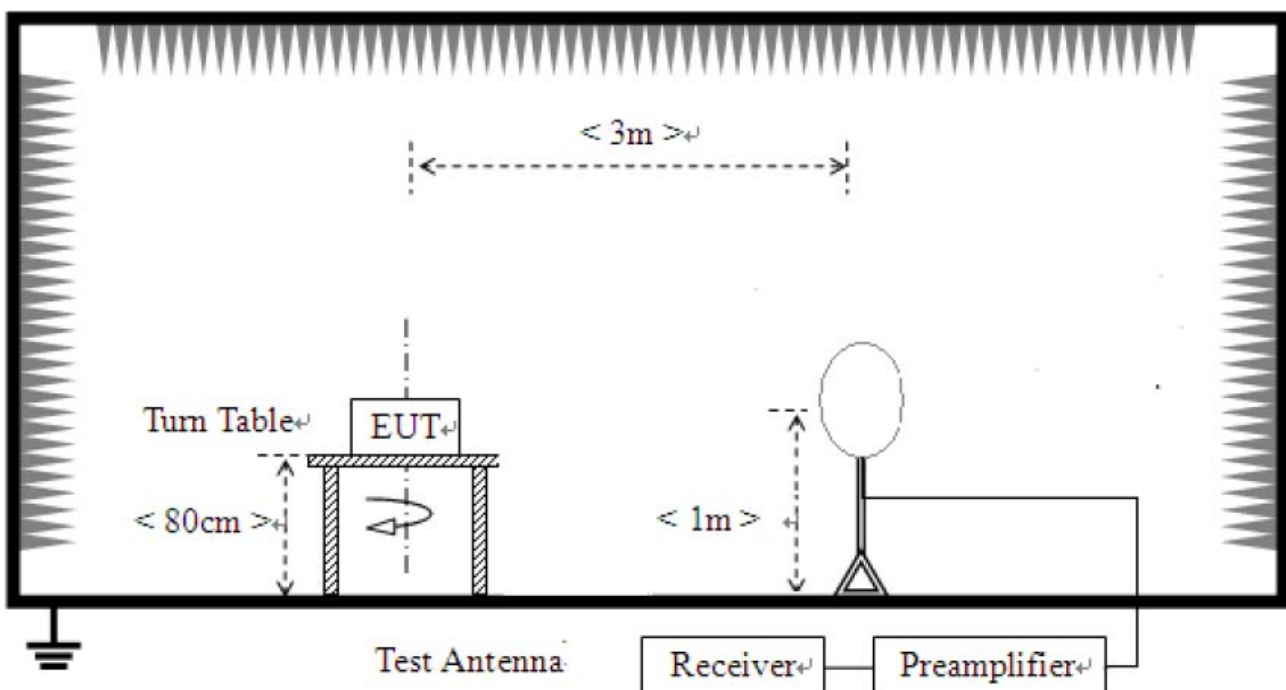
The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the "x dB bandwidth" is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

Test Procedures

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

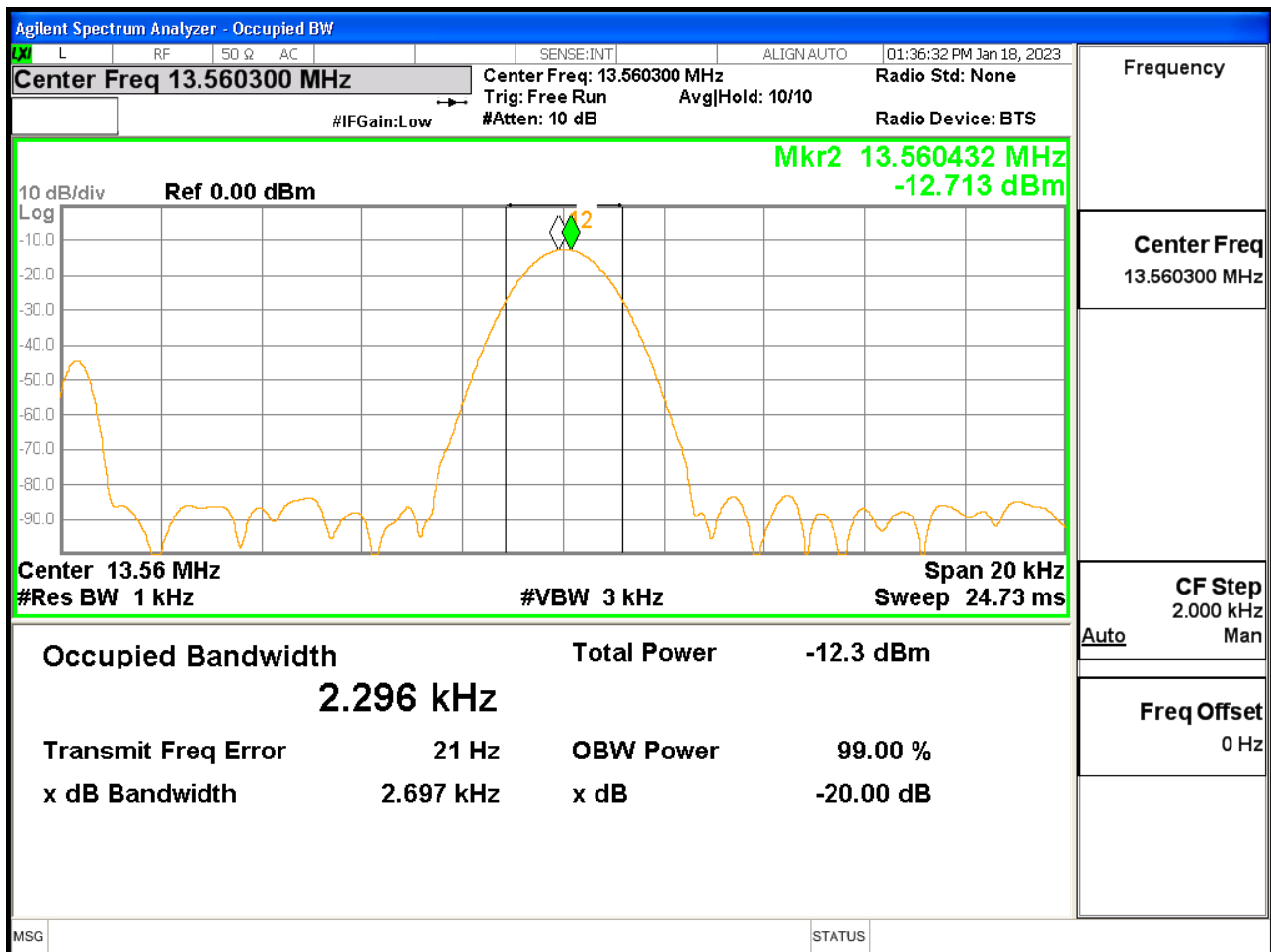
Test Setup



Test results

Emission Bandwidth	Result	Limit
20dB Bandwidth	2.697 kHz	N/A
99 % Bandwidth	2.296 kHz	N/A

Emission Bandwidth Plot 20dB & 99 % Bandwidth



4.2 Field strength emissions

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.

Frequency(MHz)	Field Strength uV / m@30m	Field Strength dBuV / m@30m	Field Strength dBuV / m@3m
13.553-13.567	15,848	84.0	124.0

- (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.

Frequency(MHz)	Field Strength uV / m@30m	Field Strength dBuV / m@30m	Field Strength dBuV / m@3m
13.410-13.553	334	50.5	90.5
13.567-13.710	334	50.5	90.5

- © 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.

Frequency(MHz)	Field Strength uV / m@30m	Field Strength dBuV / m@30m	Field Strength dBuV / m@3m
13.110-13.410	106	40.5	80.5
13.710-14.010	106	40.5	80.5

- (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(RSS-GEN).

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

Frequency(MHz)	Field Strength uV / m	Field Strength dBuV / m	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)

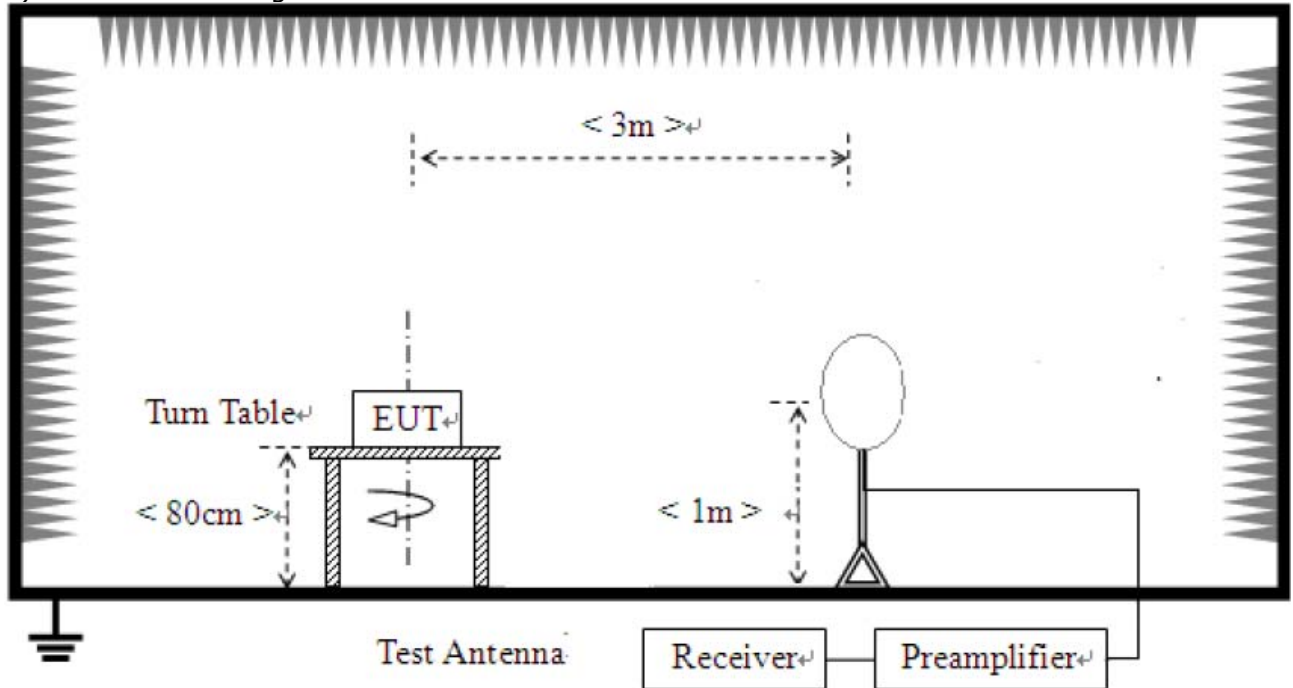
Test Procedures

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.

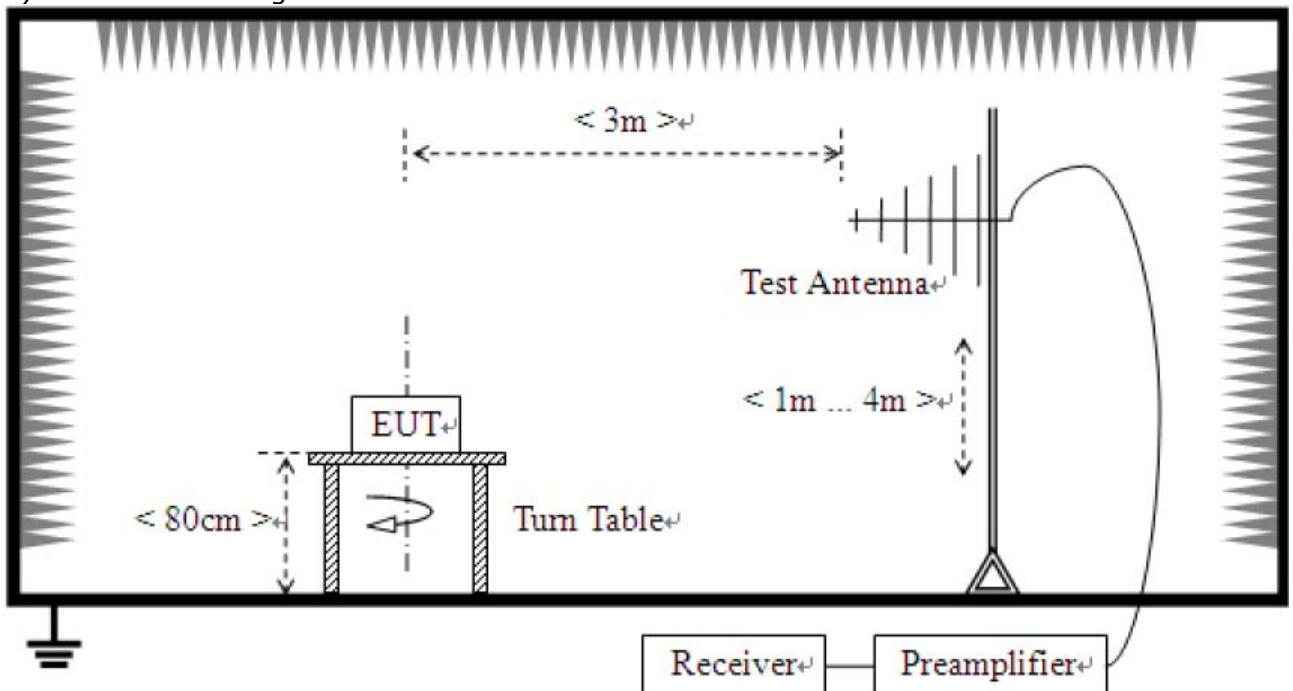
Measuring instrument Settings	
Frequency Range	9 kHz – 1 000 MHz
RBW	200 Hz (9 kHz – 150 kHz) 9 kHz (150 kHz – 30 MHz) 120 kHz (30 MHz – 1 000 MHz)
VBW	≥ RBW
Sweep time	auto couple
Detector function	CISPR quasi-peak(below 1 000 MHz)

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

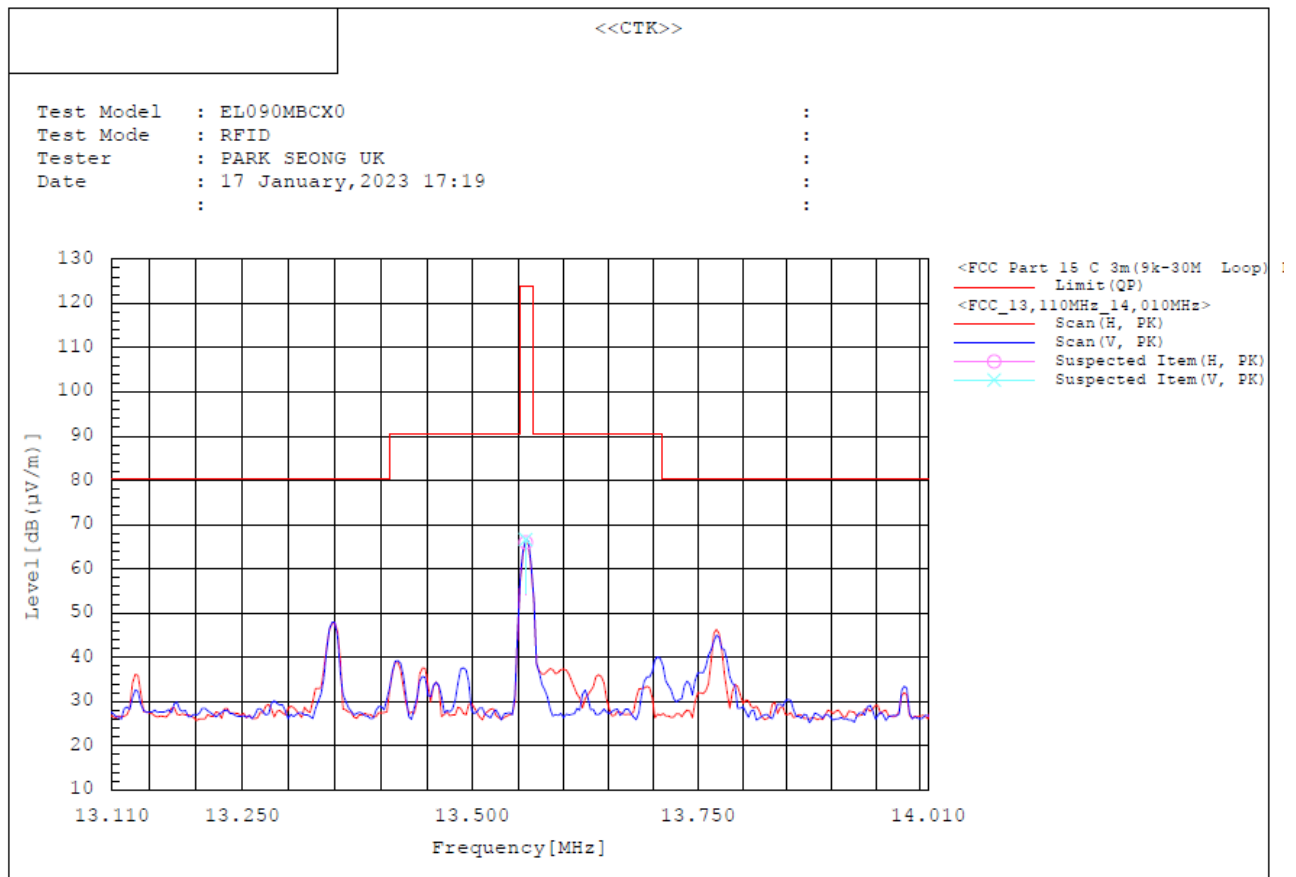


Test results

1) Radiated emissions within the band 13.110-14.010 MHz

The requirements are:

☒ Complies



Spectrum Selection

No.	Frequency [MHz]	Pol	Reading PK [dB(μV)]	c.f [dB(1/m)]	Result PK [dB(μV/m)]	Limit QP [dB(μV/m)]	Margin QP-PK [dB]	Height [cm]	Angle [deg]	Remark
1	13.559	H	39.8	26.2	66.0	124.0	58.0	100.0	20.8	
2	13.559	V	40.4	26.2	66.6	124.0	57.4	100.0	98.5	

Remark :

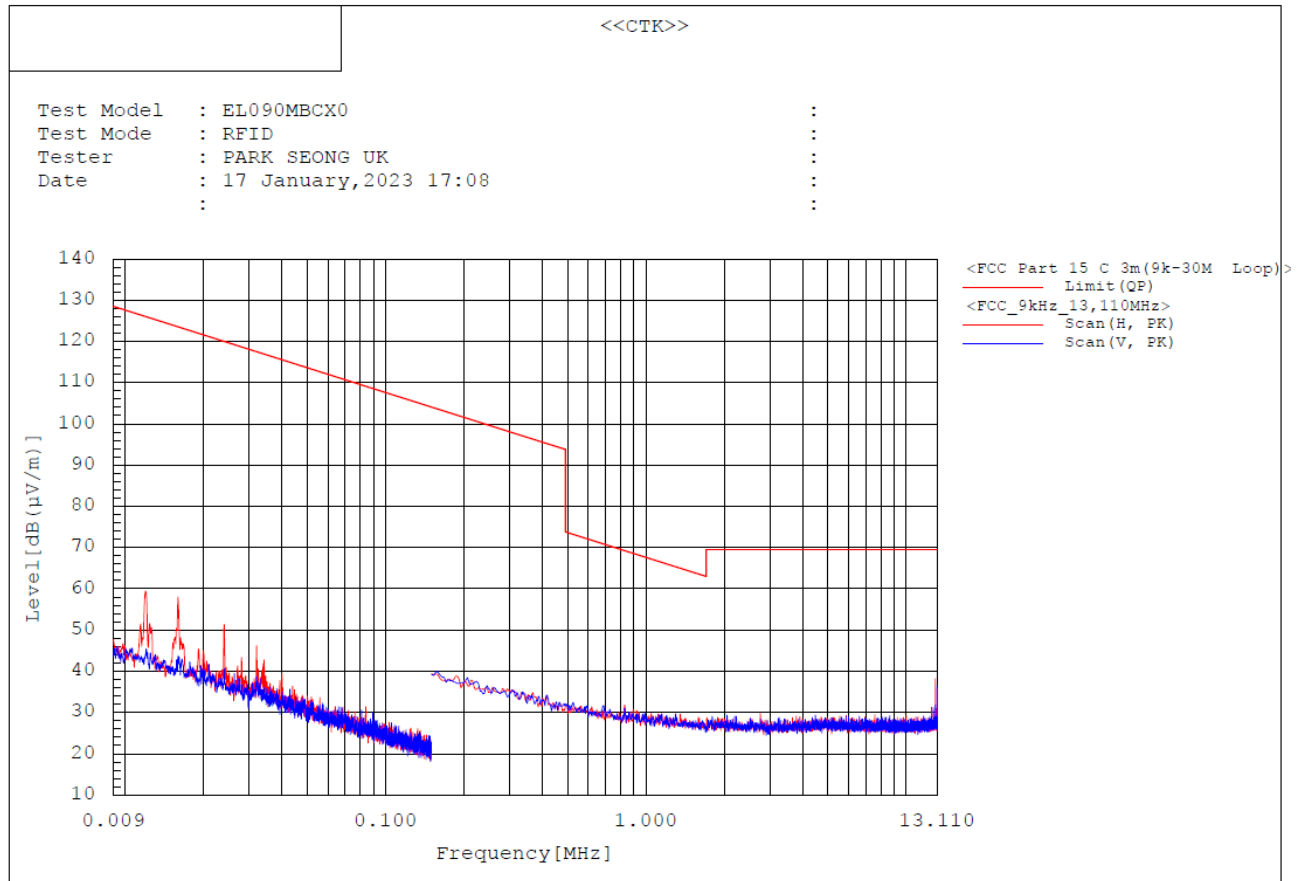
1. Result = Reading + c.f(correction factor)
2. Correction factor = Antenna factor + Cable loss + 6 dB attenuator
3. The test result in peak detector is less than quasi-peak limit.

2) Field strength of any emissions appearing outside of the 13.110-14.010 MHz

Frequency range : 9 kHz – 13.110 MHz

The requirements are:

☒ Complies



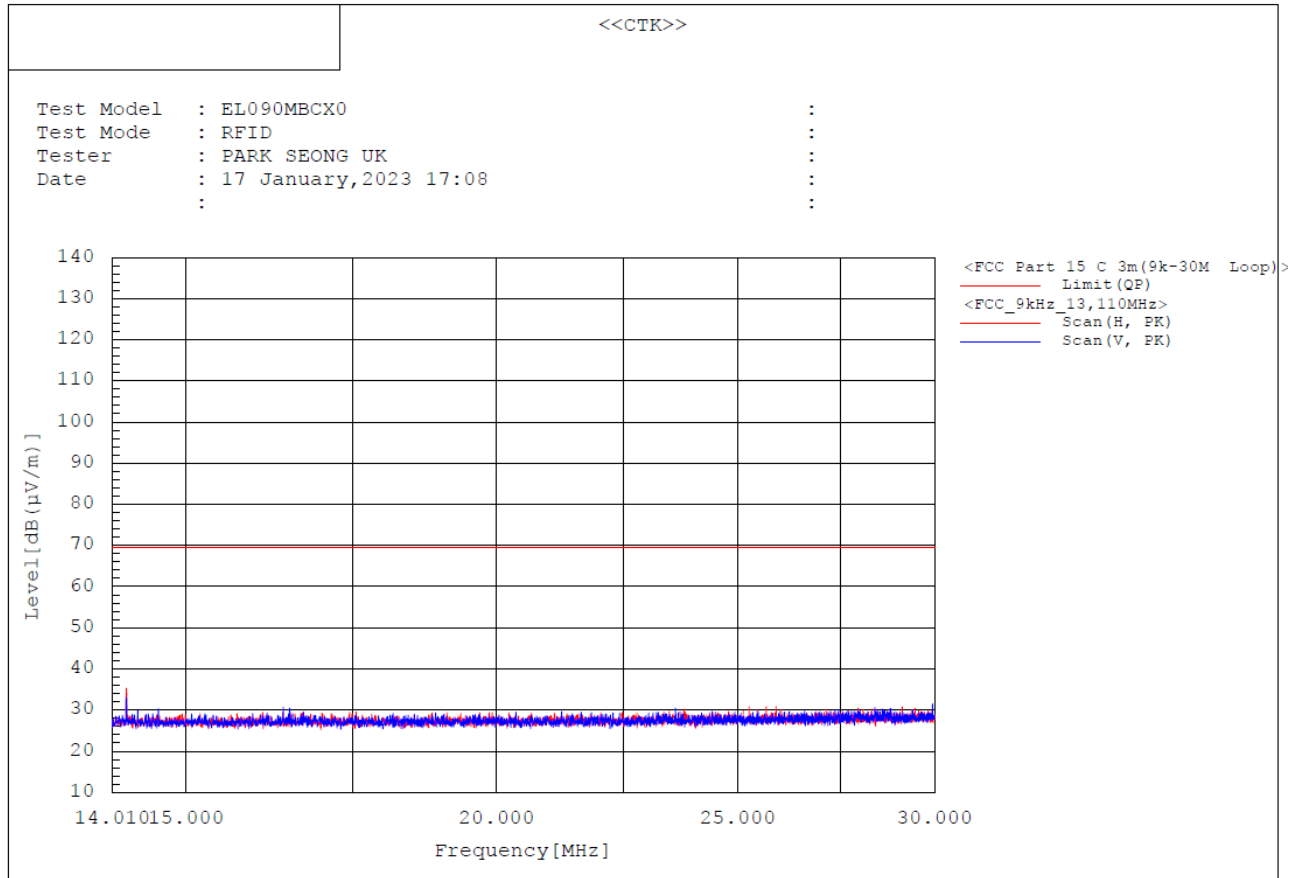
Remark :

1. Result = Reading + c.f.(correction factor)
2. Correction factor = Antenna factor + Cable loss + 6 dB attenuator
3. Emissions more than 20 dB below the limit do not need to be reported.

Frequency range : 14.010 MHz – 30 MHz

The requirements are:

☒ Complies



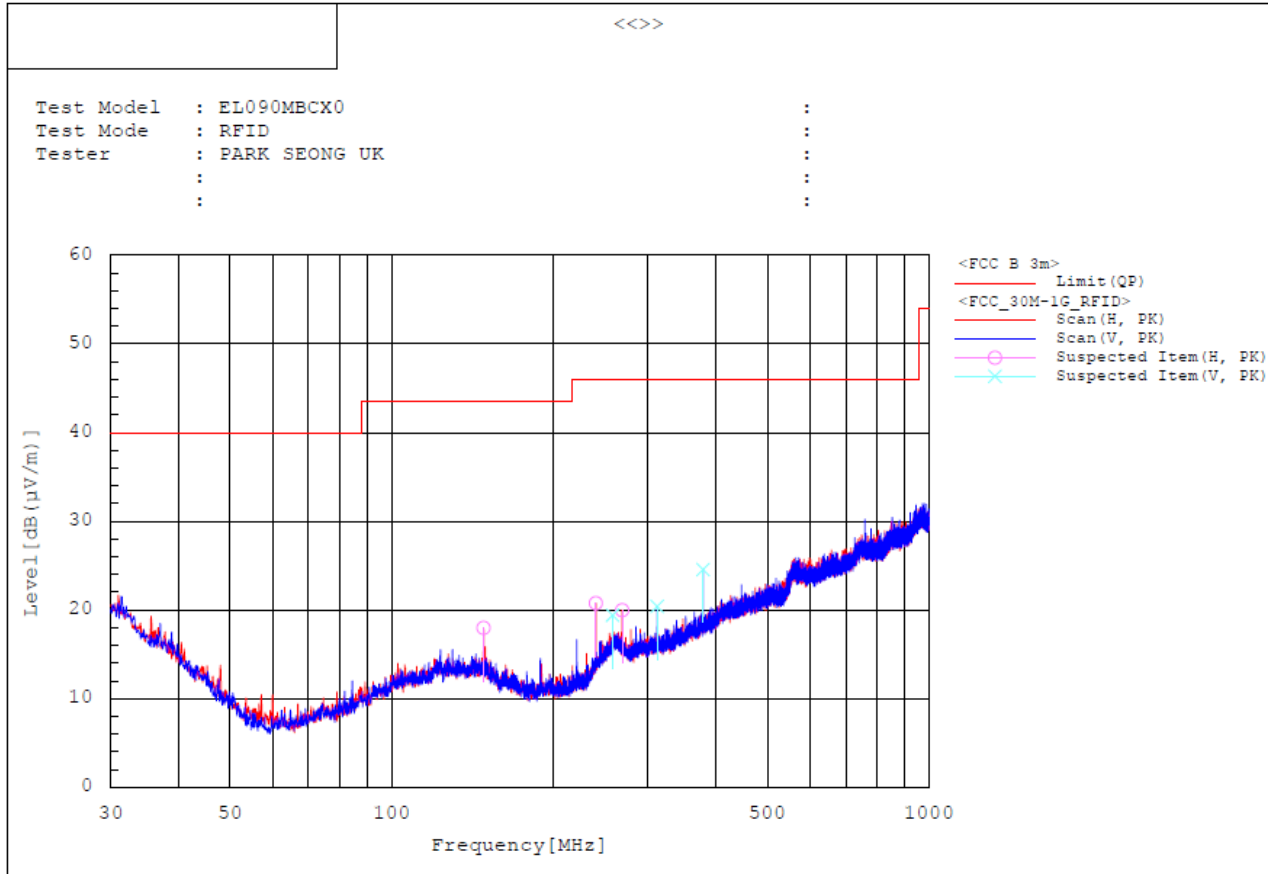
Remark :

1. Result = Reading + c.f(correction factor)
2. Correction factor = Antenna factor + Cable loss + 6 dB attenuator
3. Emissions more than 20 dB below the limit do not need to be reported.

3) Radiated emissions in the range of 30 MHz to 1 000 MHz band

The requirements are:

☒ Complies



Spectrum Selection

No.	Frequency [MHz]	Pol	Reading [dB (μV/m)]	c.f [dB (1/m)]	Result [dB (μV/m)]	Limit [dB (μV/m)]	Margin [dB]	Height [cm]	Angle [deg]	Remark
1	148.146	H	30.6	-12.6	18.0	43.5	25.5	100.9	320.6	
2	239.714	H	32.9	-12.1	20.8	46.0	25.2	100.9	1.0	
3	257.659	V	29.3	-9.9	19.4	46.0	26.6	400.0	0.7	
4	268.426	H	30.0	-10.0	20.0	46.0	26.0	200.0	209.8	
5	311.882	V	30.1	-9.7	20.4	46.0	25.6	100.0	213.1	
6	379.685	V	32.1	-7.5	24.6	46.0	21.4	100.0	359.3	

Remark :

1. Result = Reading + c.f(Correction factor)
2. Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain

4.3 Frequency Stability

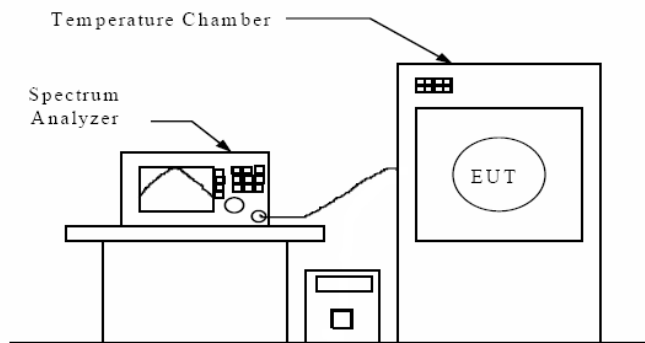
Requirement

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.

Test Procedures

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

Test Setup





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CTK-2023-00690
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Test Results

The requirements are:

☒ Complies

Condition	Measurement Frequency (MHz)				Frequency Stability (ppm)			
	Startup	2 min	5 min	10 min	Start-up	2 min	5 min	10 min
Temp. 50℃	13.560242	13.560236	13.560230	13.560228	-6.49	-6.93	-7.37	-7.52
Temp. 40℃	13.560270	13.560265	13.560260	13.560260	-4.42	-4.79	-5.16	-5.16
Temp. 30℃	13.560305	13.560300	13.560295	13.560295	-1.84	-2.21	-2.58	-2.58
Temp. 20℃	13.560330	13.560330	13.560330	13.560330	0.00	0.00	0.00	0.00
Temp. 10℃	13.560350	13.560350	13.560350	13.560350	1.47	1.47	1.47	1.47
Temp. 0℃	13.560354	13.560356	13.560356	13.560356	1.77	1.92	1.92	1.92
Temp. -10℃	13.560316	13.560334	13.560338	13.560338	-1.03	0.29	0.59	0.59
Temp. -20℃	13.560300	13.560298	13.560296	13.560292	-2.21	-2.36	-2.51	-2.80
Voltage 85%	13.560320	13.560325	13.560325	13.560325	-0.74	-0.37	-0.37	-0.37
Voltage 115%	13.560330	13.560310	13.560315	13.560320	0.00	-1.47	-1.11	-0.74
Limit(ppm)	-				100			

APPENDIX A – Test Equipment Used For Tests

No.	Name of Equipment	Manufacturer	Model No.	Serial No.	Date of Calibration	Due Date
1	EMI TEST RECEIVER	Rohde & Schwarz	ESW44	102039	2022-05-04	2023-05-04
2	Bilog Antenna	TESEQ	CBL6111D	60654	2021-09-03	2023-09-03
3	AMPLIFIER	SONOMA INSTRUMENT	310N	411011	2022-08-10	2023-08-10
4	ATTENUATOR	PASTERNAK	PE7AP006-06	L20210504000023	2022-08-10	2023-08-10
5	Dual-Tracking DC Power Supply	Topward Electric Instruments Co.,Ltd.	6303D	711196	2023-03-22	2024-03-22
6	Signal Analyzer	Agilent	N9020A	MY48011598	2022-10-07	2023-10-07
7	DC Power Supply	Agilent	E3632A	MY40009327	2023-03-27	2024-03-27
8	Temp&Humi Chamber	ESPEC CORP.	SH-642	93016524	2022-11-07	2023-11-07
9	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-125	2022-04-15	2024-04-15

	Cable	Manufacturer	Model No.	Serial No.	Check Date
1	RF Cable (Conducted)	Junkosha Inc.	MWX221	2008S240	2023-01-17
2	RF Cable (9kHz-1GHz Radiated)	Canare Corporation	L-5D2W	N/A	2022-11-10
3	RF Cable (9kHz-1GHz Radiated)	HUBER+SUHNER	SUCOFLEX 104	MY27558/4	2022-11-10

-END-