

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT



Applicant: LEDGER SAS
106 Rue du Temple, 75003 Paris, France
Manufacturer: LEDGER SAS
106 Rue du Temple, 75003 Paris, France
Product Name: LEDGER STAX
Brand Name: [L] or [LEDGER]
Model No.: 2103
Model Difference: N/A
Report Number: TERF2407001902E2
FCC ID 2ASAL-2103
Date of EUT Received: N/A, the test results are fully leveraged, for more details please refer to section 3 in this report.
Date of Test: N/A, the test results are fully leveraged, for more details please refer to section 3 in this report.
Issue Date: July 30, 2024

Aken Huang

Approved By

Aken Huang

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT comply with FCC rule part §15.225.

The results of this report relate only to the sample identified in this report.

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Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TERF2407001902E2	00	CIIPC for update applicant address, Brand name, HW/SW version and change NFC antenna	July 30, 2024	Karen Huang	

Note:

- 1、The remark "***" indicates modification of the report upon requests from certification body.
- 2、Variant information of trademarks is provided by the applicant, test results of this report are applicable to the sample EUT(s) received.
And are assessed as electrically identical in RF characteristics, therefore, no further assessment required for the variant(s).
- 3、This is an addendum test report reference to the test report *TERF2212002635E2*.

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1 GENERAL INFORMATION

1.1 Product Description

Product Name:	LEDGER STAX
Brand Name:	[L] or [LEDGER]
Model No.:	2103
Model Difference:	N/A
Hardware Version:	PVT
Firmware Version:	MCU 5.27.0 + SE 1.5.0-rc1
EUT Series No.:	0UF444G00F
Power Supply:	3.8Vdc
Test Software (Name/Version)	termite / V3.4

1.2 RF specification

Radio Technology:	NFC
Operating Frequency	13.56MHz
Transmit Power	< 11.32dBuV/m at 30m.
Number of Channels	1
Modulation Type	ASK
Antenna Type	Coil antenna

Note: Antenna information is provided by the applicant.

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1.3 Test Methodology

FCC Part 15, Subpart C §15.225

ANSI C63.10:2013.

1.4 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan.	SAC 1	TW0027	TW3702
		SAC 2		
		SAC 3		
		Conduction 1		
		Conducted 1		
		Conducted 2		
		Conducted 3		
		Conducted 4		
		Conducted 5		
		Conducted 6		
	No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333	Conduction C	TW0028	
		SAC C		
		SAC D		
		SAC G		
		Conducted A		
		Conducted B		
		Conducted C		
		Conducted D		
		Conducted E		
		Conducted F		
Conducted G				

Note: Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.

1.5 Special Accessories

There is no other accessory attached. This is the worst case condition.

1.6 Equipment Modifications

There was no modification incorporated into the EUT.

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2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

The Transmitter was operated in the normal operating mode. The Tx frequency was fixed which was for the purpose of the measurements.

2.3 Test Procedure

2.3.1 Radiated Emissions

The EUT is placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.

2.3.2 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

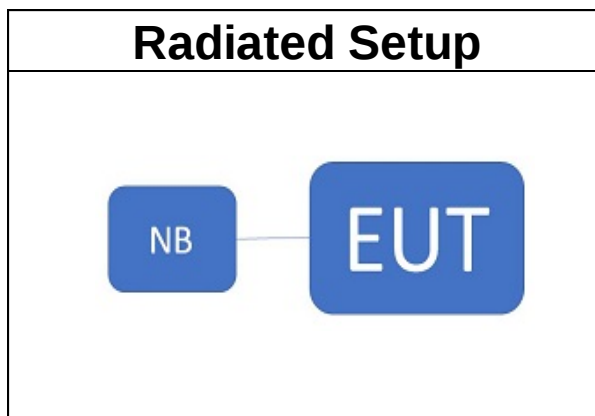
Radiated emission below 30MHz is measured in a 9m*6m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

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2.4 Test Configuration



2.5 Control Unit(s)

Radiated Emission Test Site: SAC C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Notebook	Lenovo	T14	P0003332	N/A	N/A
USB Cable	Interplus Industry	ADV-7570214	N/A	N/A	N/A

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3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result	Note
§15.225 (a)-(d)	Radiated Emission	Compliant	
§15.209	Radiated Emission Limits, general requirement	Compliant	

Note

1. N/S Indicates whether item(s) being newly tested [N] or spot checked [S].
2. Items other than newly tested [N] are leveraged from test report TERF2407001912E2.

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4 DESCRIPTION OF TEST MODES

4.1 The Worst Test Modes and Channel Details

1. The EUT stay in continuous transmission mode.
2. The frequency 13.56 MHz is the default channel to test, where it is the only manipulative channel as this application supports.
3. Only one configuration is supported/applicable as follows.

RADIATED EMISSION TEST			
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION
NFC	1	1	ASK

The field strength of radiated emission was measured as the EUT positioned in different orthogonal planes (E1/E2/H) based on actual usage of the EUT to pre-scan the emissions for determining the worst case scenario.

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 1.54 dB
Frequency Stability	+/- 1.48 Hz
Emission Bandwidth	+/- 1.38 Hz
Temperature	+/- 0.6 °C
Humidity	+/- 3 %
DC / AC Power Source	+/- 1 %

Radiated Spurious Emission Measurement Uncertainty			
Polarization: Vertical	+/-	1.89 dB	9kHz~30MHz
	+/-	4.15 dB	30MHz - 1000MHz
	+/-	3.43 dB	1GHz - 18GHz
	+/-	3.86 dB	18GHz - 40GHz
Polarization: Horizontal	+/-	1.89 dB	9kHz~30MHz
	+/-	4.02 dB	30MHz - 1000MHz
	+/-	3.43 dB	1GHz - 18GHz
	+/-	3.86 dB	18GHz - 40GHz
Radiated Spurious Emission	+/-	2 dB	33GHz-50GHz
	+/-	1.59 dB	50GHz-60GHz
	+/-	1.7 dB	60GHz-90GHz
	+/-	1.64 dB	90GHz-140GHz
	+/-	3.83 dB	140GHz-220GHz

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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6 MEASUREMENT EQUIPMENT USED

6.1 Radiated Measurement

Radiated Emission Test Site: SAC C					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
3m Site NSA	SGS	966 chamber C	N/A	03/02/2024	03/01/2025
Active Loop Antenna	COM-POWER	AL-130R	10160105	12/04/2023	12/03/2024
Broadband Antenna	SCHWARZBECK	VULB 9168	9168-300	11/02/2023	11/01/2024
Coaxial Cable	Huber+Suhner	RG 214/U	W22.03	11/15/2023	11/14/2024
Pre-Amplifier	EMC Instruments	EMC330	980096	11/15/2023	11/14/2024
Spectrum Analyzer	KEYSIGHT	N9010A	MY57120290	04/10/2024	04/09/2025
EMI Test Receiver	R&S	ESCI	101342	04/29/2024	04/28/2025
Test Software	audix	e3	E3 20923 SGS Ver.9 (C)	N.C.R	N.C.R

NOTE: N.C.R refers to Not Calibrated Required.

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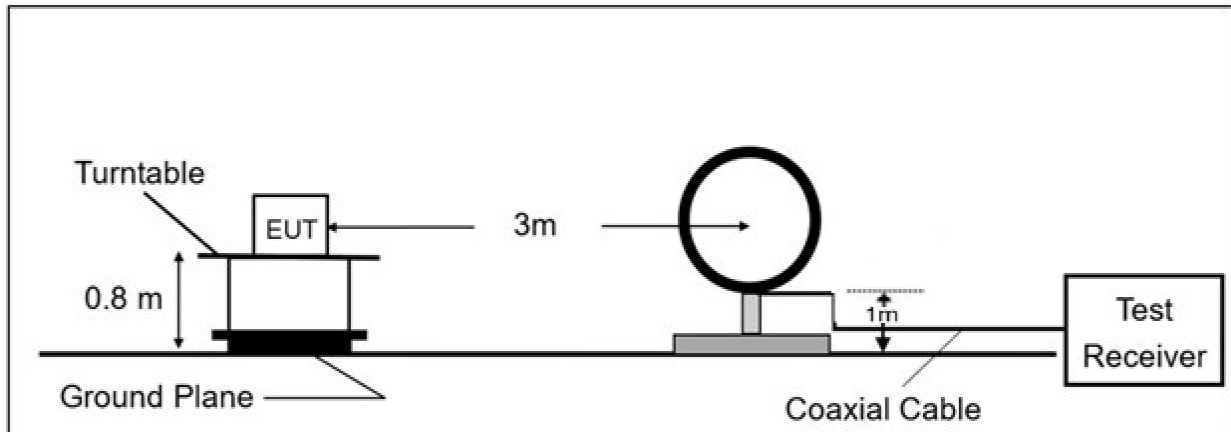
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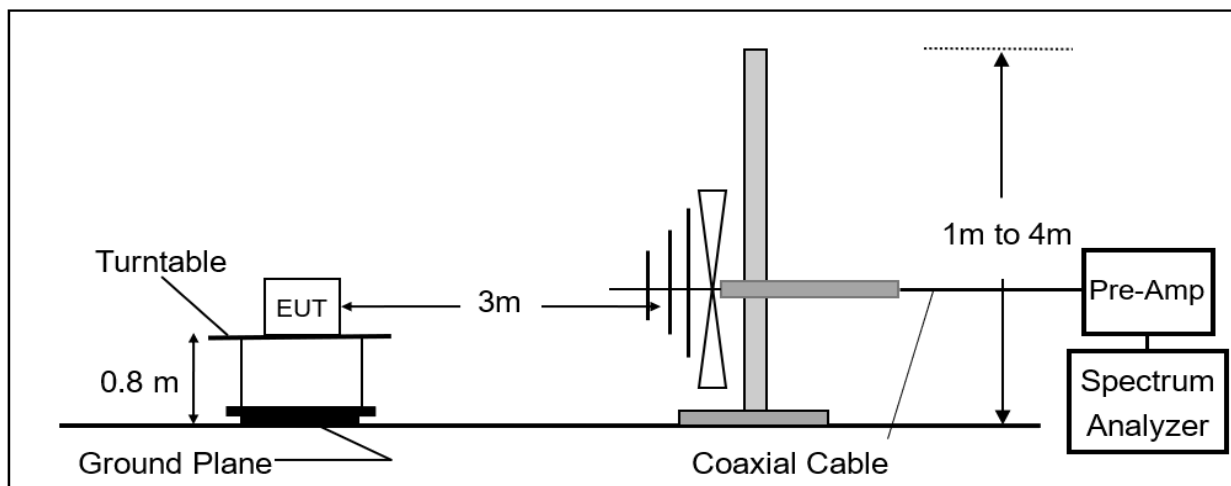
7 RADIATED EMISSION TEST

7.1 Test SET-UP (Block Diagram of Configuration)

(A) Radiated Emission Test Set-Up, Frequency Below 30MHz.



(B) Radiated Emission Test Set-Up, Frequency From 30MHz to 1000MHz.



7.2 Measurement Procedure

1. Configure the EUT according to ANSI C63.10.
2. The EUT was placed on a turn table which is 0.8m above ground plane and been measured in the frequency range between 0.009MHz to 30MHz and 30MHz to 1GHz.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission.
5. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
6. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
7. Repeat above procedures until all default test channel measured were complete.

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7.3 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

7.4 Field Strength of Fundamental Emission

7.4.1 Applicable standard

Rules and specifications	CFR 47 Part 15 section 15.225(a)-(d)	
Frequency of Emission (MHz)	Field Strength (μV/m)at 30m	Field Strength (dBμV/m)at 30m
1.705~13.110	30	29.5
13.110~13.410	106	40.5
13.410~13.553	334	50.5
13.553~13.567	15848	84
13.567~13.710	334	50.5
13.710~14.010	106	40.5
14.010~30.00	30	29.5

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7.4.2 Distance Extrapolation Factor

30m to 3m

Distance extrapolation = $40 \cdot \log(30/3) = 40 \text{ dB}$

30m to 10m

Distance extrapolation = $40 \cdot \log(30/10) = 19.08 \text{ dB}$

10m to 3m

Distance extrapolation = $40 \cdot \log(10/3) = 20.92 \text{ dB}$

Note:

1. Distance extrapolation factor = $40 \log(\text{required distance} / \text{test distance}) \text{ (dB)}$
2. The lower limit shall apply at the transition frequencies.
3. KDB 414788 D01 OATS and 3m semi-anechoic chamber Justification:
Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field. OATS and 3m SAC chamber testing had been performed and 3m SAC measured test result is the worst case test result.

Actual FS(dBμV/m) = Spectrum. Reading level(dBμV) + Factor(dB)

Below 30 MHz of Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Distance Factor (dB)

Above 30 MHz of Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre_Amp Gain (dB)

The trace on RE(radiation emission) plot is as colored blue, and the detection manner we've employed is peak detector.

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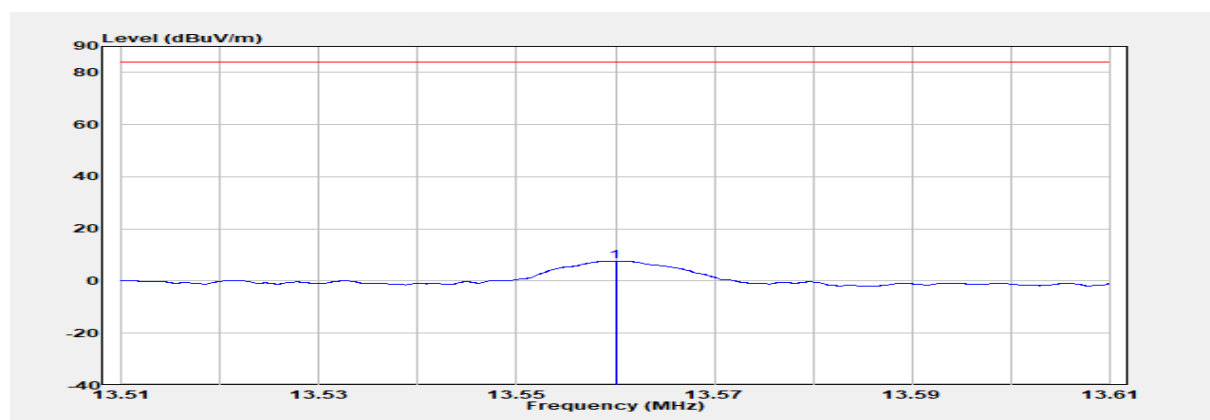
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7.4.3 Field Strength of Fundamental Emission Measurement Result

Report Number	:TERF2407001912E2	Test Site	:SAC C
Operation Mode	:NFC	Test Date	:2024-07-11
Test Frequency	:13.56 MHz	Temp./Humi.	:24.2°C/55%
Test Mode	:Main	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Pony Chen



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual dB μ V/m	Limit dB μ V/m	Margin dB
13.560	Peak	32.34	-24.60	7.74	84.00	-76.26

Actual level = Reading level + Factor

Factor = Antenna factor + cable loss – Pre_Amplifier Gain – distance factor

Test distance= 3m

For Actual level and limit:

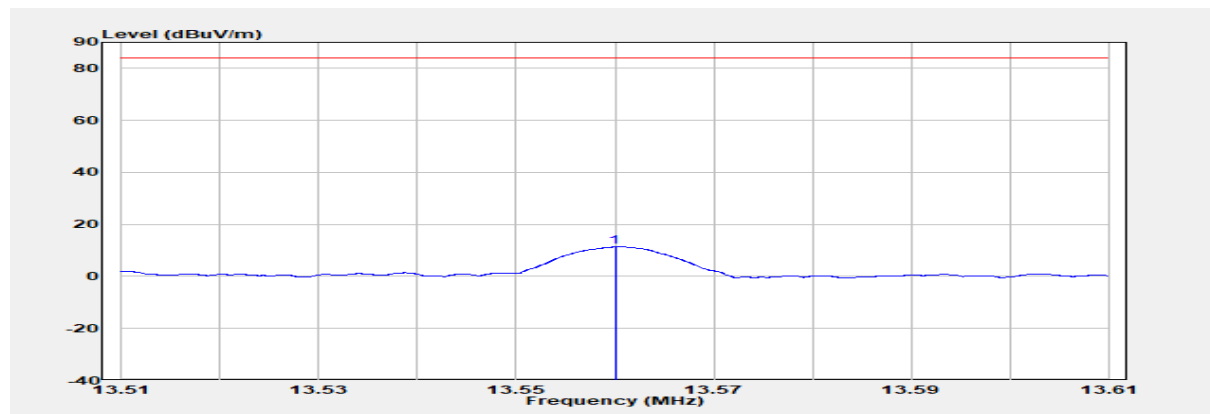
Field strength (dBuV/m) at 300m, within the band 9 kHz - 490 kHz.

Field strength (dBuV/m) at 30m, within the band 490 kHz - 30 MHz.

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Report Number	:TERF2407001912E2	Test Site	:SAC C
Operation Mode	:NFC	Test Date	:2024-07-11
Test Frequency	:13.56 MHz	Temp./Humi.	:24.2°C/55%
Test Mode	:Main	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Pony Chen



Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode	Reading Level				
	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
13.560	Peak	35.92	-24.60	11.32	84.00	-72.68

Actual level = Reading level + Factor

Factor = Antenna factor + cable loss – Pre_Amplifier Gain – distance factor

Test distance= 3m

For Actual level and limit:

Field strength (dBuV/m) at 300m, within the band 9 kHz - 490 kHz.

Field strength (dBuV/m) at 30m, within the band 490 kHz - 30 MHz.

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7.5 Radiated Spurious Emission Measurement

7.5.1 Standard Applicable

The field strength of any emissions appearing outside of the 13.110-14.010 MHz shall not exceed the general radiated emission limits as below.

Frequency (MHz)	Field strength (μV/m)	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	500	3

Note:

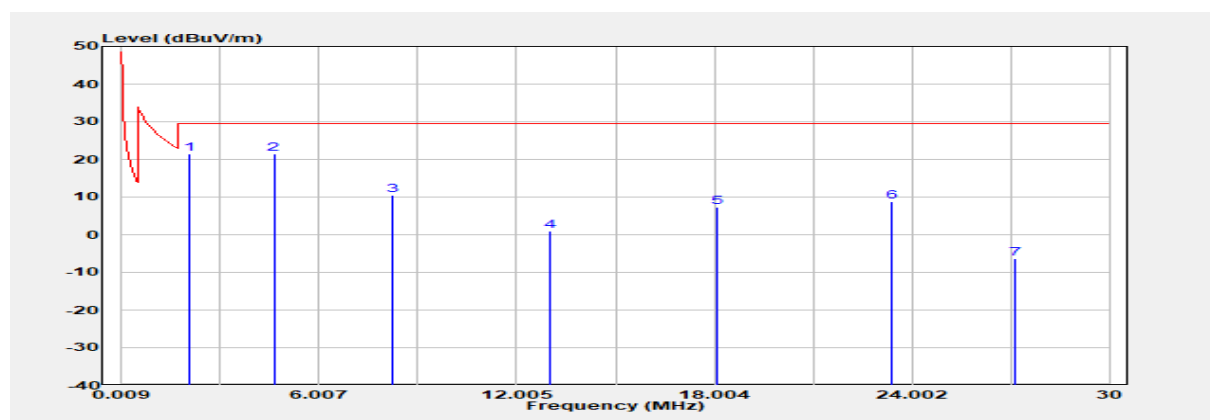
1. Emission level in dBμV/m = $20 \log (\mu\text{V/m})$
2. Distance extrapolation factor = $40 \log (\text{required distance} / \text{test distance})$ (dB)
3. $20 * \log(30 \mu\text{V/m}) = 29.54 \text{ dBuV/m}$
4. The lower limit shall apply at the transition frequencies.
5. The measurement was undertaken in closer distance at 3m, where extrapolation factor is offset to convert the limit of the measurement.
6. Only spurious frequency is permitted to locate within the Restricted Bands specified in provision of §15.205.
7. The general radiated emission limits in §15.209 apply for the spurious emission generate from UE, except for the fundamental emission where the respective section specifies otherwise.

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7.5.2 Radiated Spurious Emission Measurement Result

Report Number	:TERF2407001912E2	Test Site	:SAC C
Operation Mode	:NFC	Test Date	:2024-07-11
Test Frequency	:13.56 MHz	Temp./Humi.	:24.2°C/55%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Pony Chen



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual dBμV/m	Limit dBμV/m	Margin dB
2.048	Peak	47.49	-26.05	21.44	29.54	-8.10
4.628	Peak	46.78	-25.42	21.37	29.54	-8.17
8.257	Peak	35.24	-24.86	10.39	29.54	-19.15
13.025	Peak	25.58	-24.60	0.98	29.54	-28.56
18.064	Peak	31.99	-24.61	7.38	29.54	-22.16
23.402	Peak	34.12	-25.44	8.68	29.54	-20.86
27.120	Peak	20.07	-26.33	-6.26	29.54	-35.80

Actual level = Reading level + Factor

Factor = Antenna factor + cable loss – Pre_Amplifier Gain – distance factor

Test distance= 3m

For Actual level and limit:

Field strength (dBuV/m) at 300m, within the band 9 kHz - 490 kHz.

Field strength (dBuV/m) at 30m, within the band 490 kHz - 30 MHz.

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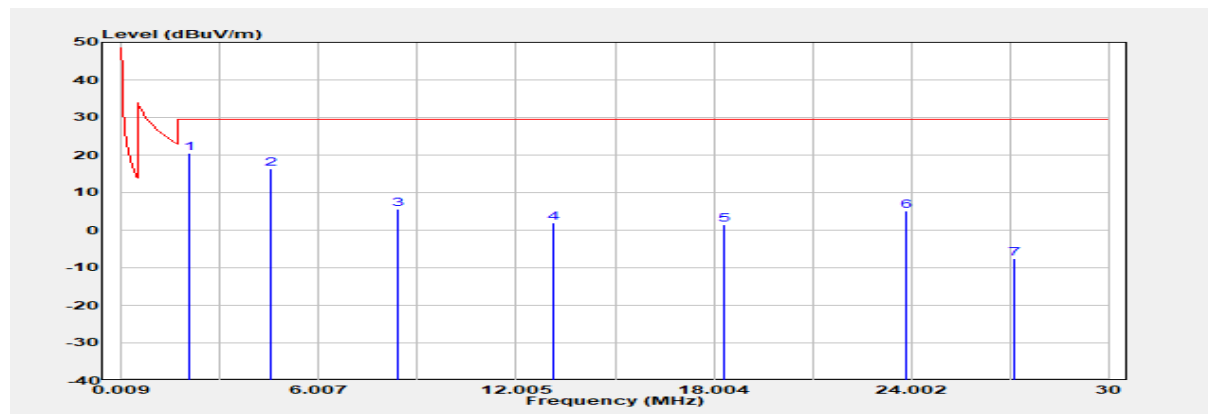
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Report Number	:TERF2407001912E2	Test Site	:SAC C
Operation Mode	:NFC	Test Date	:2024-07-11
Test Frequency	:13.56 MHz	Temp./Humi.	:24.2°C/55%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Pony Chen



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual dBμV/m	Limit dBμV/m	Margin dB
2.078	Peak	46.55	-26.04	20.51	29.54	-9.03
4.568	Peak	41.86	-25.43	16.43	29.54	-13.11
8.406	Peak	30.35	-24.83	5.52	29.54	-24.02
13.145	Peak	26.62	-24.60	2.02	29.54	-27.52
18.334	Peak	26.10	-24.61	1.49	29.54	-28.05
23.852	Peak	30.75	-25.54	5.21	29.54	-24.33
27.120	Peak	18.80	-26.33	-7.53	29.54	-37.07

Actual level = Reading level + Factor

Factor = Antenna factor + cable loss – Pre_Amplifier Gain — distance factor

Test distance= 3m

For Actual level and limit:

Field strength (dBuV/m) at 300m, within the band 9 kHz - 490 kHz.

Field strength (dBuV/m) at 30m, within the band 490 kHz - 30 MHz.

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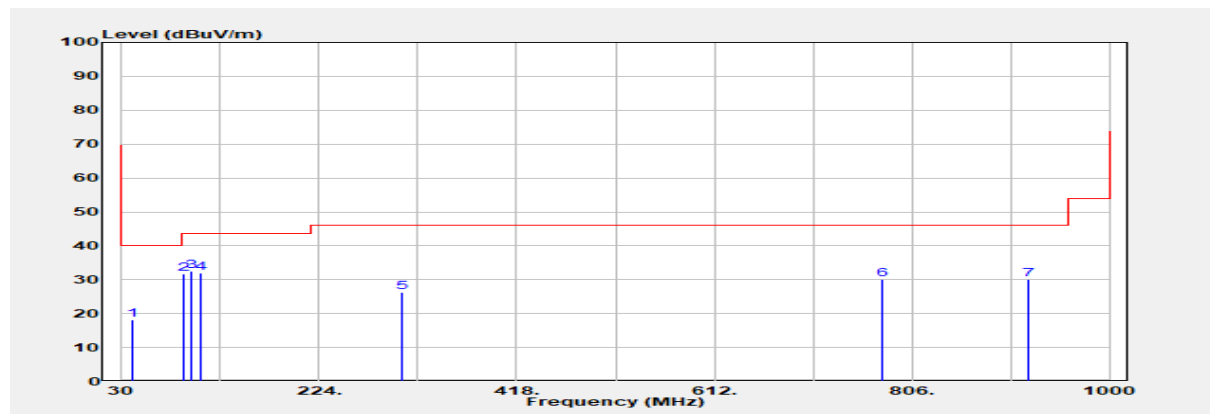
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Report Number	:TERF2407001912E2	Test Site	:SAC C
Operation Mode	:NFC	Test Date	:2024-07-11
Test Frequency	:13.56 MHz	Temp./Humi.	:24.2°C/55%
Test Mode	:Tx	Antenna Pol.	:Vertical
EUT Pol	:E2 Plane	Engineer	:Pony Chen



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual dBμV/m	Limit dBμV/m	Margin dB
40.680	Peak	35.10	-16.83	18.27	40.00	-21.73
91.110	Peak	53.25	-21.56	31.69	43.50	-11.81
97.900	Peak	53.49	-20.93	32.56	43.50	-10.94
107.600	Peak	51.69	-19.60	32.08	43.50	-11.42
304.510	Peak	40.97	-14.79	26.18	46.00	-19.82
776.900	Peak	33.85	-3.73	30.12	46.00	-15.88
920.460	Peak	31.30	-1.18	30.13	46.00	-15.87

Actual level = Reading level + Factor

Factor = Antenna factor + cable loss – Pre_Amplifier Gain — distance factor

Test distance= 3m

For Actual level and limit:

Field strength (dBuV/m) at 300m, within the band 9 kHz - 490 kHz.

Field strength (dBuV/m) at 30m, within the band 490 kHz - 30 MHz.

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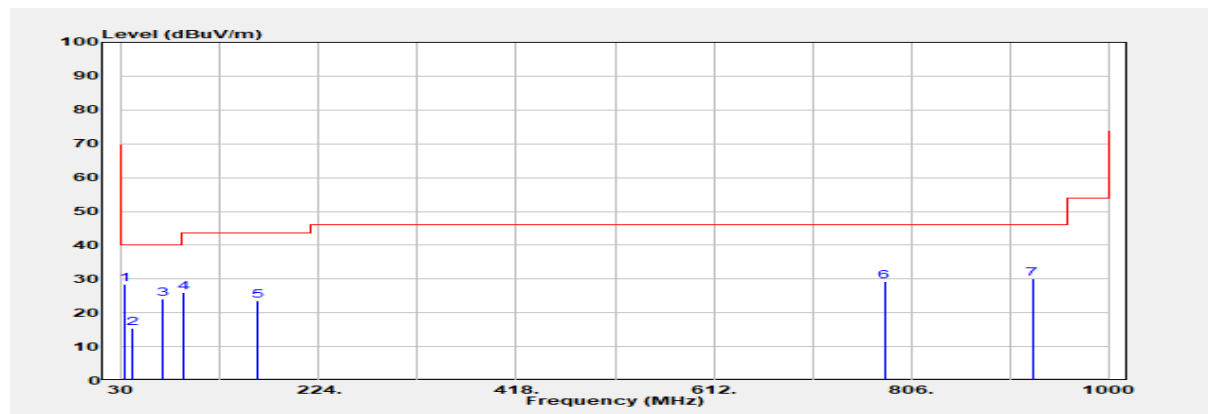
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Report Number	:TERF2407001912E2	Test Site	:SAC C
Operation Mode	:NFC	Test Date	:2024-07-11
Test Frequency	:13.56 MHz	Temp./Humi.	:24.2°C/55%
Test Mode	:Tx	Antenna Pol.	:Horizontal
EUT Pol	:E2 Plane	Engineer	:Pony Chen



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual dBμV/m	Limit dBμV/m	Margin dB
32.910	Peak	46.04	-17.56	28.48	40.00	-11.52
40.680	Peak	32.33	-16.83	15.50	40.00	-24.50
69.770	Peak	42.55	-18.47	24.08	40.00	-15.92
91.110	Peak	47.54	-21.56	25.98	43.50	-17.52
162.890	Peak	39.35	-15.86	23.49	43.50	-20.01
779.810	Peak	33.06	-3.76	29.30	46.00	-16.70
925.310	Peak	31.18	-1.05	30.13	46.00	-15.87

Actual level = Reading level + Factor

Factor = Antenna factor + cable loss – Pre_Amplifier Gain — distance factor

Test distance= 3m

For Actual level and limit:

Field strength (dBuV/m) at 300m, within the band 9 kHz - 490 kHz.

Field strength (dBuV/m) at 30m, within the band 490 kHz - 30 MHz.

~ End of Report ~

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