Test Report

Date : 2022-08-11
No. : HM22050022

Applicant:
AB CIRCLE LIMITED
Room 609, Cross Office Uchisaiwaicho,
1-18-6, Nishi-Shimbashi, Minatoku,
Tokyo, Japan 105-003

Manufacturer:
AB CIRCLE LIMITED
Room 609, Cross Office Uchisaiwaicho,
1-18-6, Nishi-Shimbashi, Minatoku,
Tokyo, Japan 105-003

Description of Sample(s):

Product:	Contactless Smart Card Reader with Keyboard Emulation
Brand Name:	AB Circle Limited
Model Number:	CIR615A
FCC ID:	2AUVM-CIR615A

Date Sample(s) Received: 2022-05-31

Date Tested: 2022-06-20 to 2022-07-07

Investigation Requested: Perform ElectroMagnetic Interference measurement in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15 and ANSI C63.10:2013 for FCC Certification.

Conclusion(s): The submitted product COMPLIED with the requirements of Federal Communications Commission [FCC] Rules and Regulations Part 15. The tests were performed in accordance with the standards described above and on Section 2.2 in this Test Report.

Remark(s): ---

Dr. CHAN Kwok Hung, Brian
Authorized Signatory

CONTENT:

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1.0 General Details

1.1 Equipment Under Test [EUT] Description of Sample(s)

Product:	Contactless Smart Card Reader with Keyboard Emulation
Manufacturer:	AB CIRCLE LIMITED Room 609, Cross Office Uchisaiwaicho, 1-18-6, Nishi-Shimbashi, Minatoku, Tokyo, Japan 105-003
Brand Name:	AB Circle Limited
Model Number:	CIR615A
Operating Frequency	13.56MHz +/- 7KHz
Modulation	ASK
Antenna / Gain	Integral (inductive type), Gain : -38.1dBi
Rating:	5Vd.c. of USB port of EUT

1.2 Description of EUT Operation

The Equipment Under Test (EUT) is 13.56MHz Contactless Smart Card Reader with Keyboard Emulation, which is 13.56MHz transceiver fixed transmit at 13.56MHz, the modulation is ASK type which is provided by IC. The module RF transmission configuration is controlled by software APDU.exe.

1.3 Date of Order

2022-05-31

1.4 Submitted Sample(s):

4 Samples

1.5 Test Duration

2022-06-20 to 2022-07-07

1.6 Country of Origin

Not Provided

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2.0 Technical Details

2.1 Investigations Requested

Perform Electromagnetic Interference measurements in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15 Regulations and ANSI C63.10:2013 for FCC Certification.

2.2 Test Standards and Results Summary Tables

Results Summary

Test Condition	Test Requirement	Test Method	Class / Severity	Test Result	
				Pass	Fail
Field Strength of Fundamental & Harmonics Emissions	FCC 47CFR 15.225(a-d)	ANSI C63.10:2013	N/A	☒	☐
The Frequency Tolerance of Carrier Signal	FCC 47CFR 15.225(e)	ANSI C63.10:2013	N/A	☒	☐
20 dB Bandwidth	FCC 47CFR 15.215	ANSI C63.10:2013	N/A	☒	☐
Radio Frequency powered Tags	FCC 47CFR 15.225(f)	ANSI C63.10:2013	N/A	N/A	
Radiated Emissions	FCC 47CFR 15.209	ANSI C63.10:2013	N/A	☒	☐
Antenna requirement	FCC 47CFR 15.203	N/A	N/A	☒	☐
AC power-line conducted emissions	FCC 47CFR 15.207	ANSI C63.10:2013	N/A	☒	☐

Note: N/A - Not Applicable

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3.0 Test Results

3.1 Emission

3.1.1 Field Strength of Fundamental & Harmonics Emissions

Test Requirement:	FCC 47CFR 15.225 a to d
Test Method:	ANSI C63.10:2013
Test Date:	2022-06-22
Mode of Operation:	On mode connected to PC

Test Method:

For emission measurements at or below 1 GHz, the sample was placed 0.8m above the ground plane of semi-anechoic Chamber*. For emission measurements above 1 GHz, the sample was placed 1.5m above the ground plane of semi-anechoic Chamber*. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. In the frequency range of 9kHz to 30MHz, The center of the loop antenna shall be 1 meter above the ground and rotated loop axis for maximum reading. The emissions worst-case are shown in Test Results of the following pages.

Remark: 3 orthogonal axis apply to hand-held device only.

*: Semi-anechoic chamber located on the G/F of The Hong Kong Standards and Testing Centre Ltd.
FCC Test Firm Registration Number 723883
Designation Number HK0001

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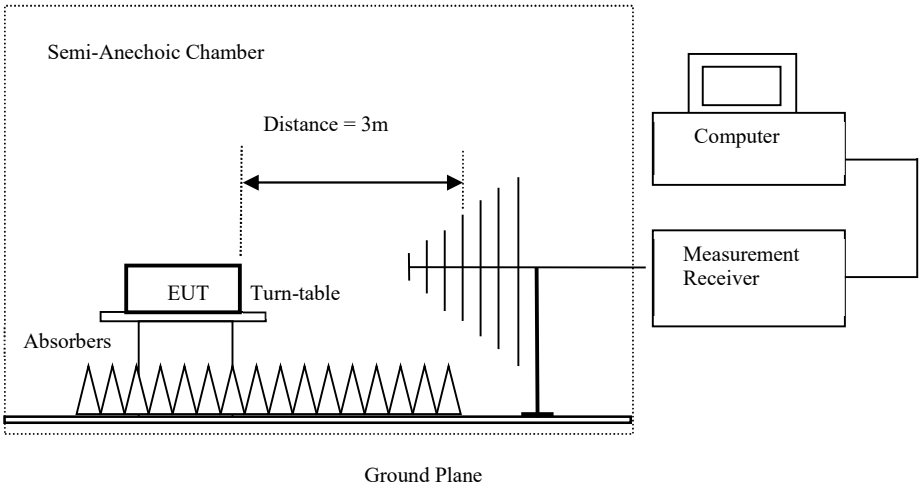
Spectrum Analyzer Setting:

9KHz – 30MHz (Pk & Av)	RBW:	10kHz
	VBW:	30kHz
	Sweep:	Auto
	Span:	Fully capture the emissions being measured
	Trace:	Max. hold
30MHz – 1GHz (QP)	RBW:	120kHz
	VBW:	120kHz
	Sweep:	Auto
	Span:	Fully capture the emissions being measured
	Trace:	Max. hold
Above 1GHz (Pk & Av)	RBW:	3MHz
	VBW:	3MHz
	Sweep:	Auto
	Span:	Fully capture the emissions being measured
	Trace:	Max. hold

Test Setup:



- Absorbers placed on top of the ground plane are for measurements above 1000MHz only.
- Measurements between 30MHz to 1000MHz made with Bi-log antennas, above 1000MHz horn antennas are used,
9kHz to 30MHz loop antennas are used.
-For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground

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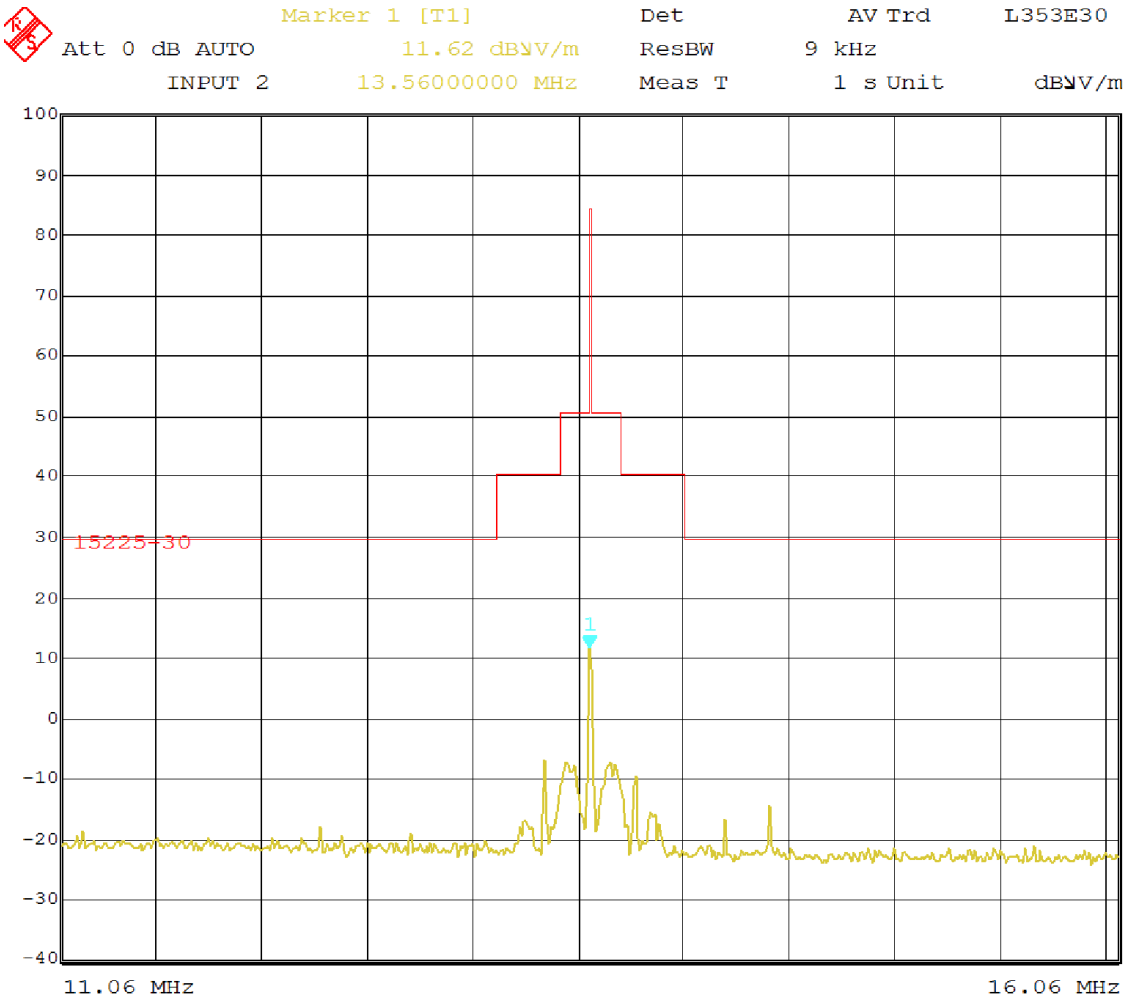
Limits for Field Strength of Fundamental & Harmonics Emissions [FCC 47CFR 15.225]:

Fundamental frequency [MHz]	Field strength of fundamental (microvolts /meter)
13.553–13.567 MHz	15848uV@30m (84dBuV/m)
13.410–13.553 MHz and 13.567–13.710 MHz	334uV@30m (50.4dBuV/m)
13.110–13.410 MHz and 13.710–14.010 MHz	106uV@30m (40.5dBuV/m)
outside of the 13.110–14.010 MHz	Refer to 15.209

Result of On mode connected to PC: Pass



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Result of On mode connected to PC: Pass [FCC 47CFR 15.225a]

Frequency Range(MHz)	Highest Field strength measured @3m (dBuV/m)	Highest Field strength calculated @30m (dBuV/m)	Limit@30m (dBuV/m)
13.553 - 13.567	51.62@13.56MHz	11.62@13.56MHz	84.0

Result of On mode connected to PC: Pass [FCC 47CFR 15.225b]

Frequency Range(MHz)	Highest Field strength measured @3m (dBuV/m)	Highest Field strength calculated @30m (dBuV/m)	Limit@30m (dBuV/m)
13.410-13.553 and 13.567-13.710	32.72@13.464MHz	-7.28@13.464MHz	50.4
	33.35@13.66MHz	-6.65@13.66MHz	

Result of On mode connected to PC: Pass [FCC 47CFR 15.225c]

Frequency Range(MHz)	Highest Field strength measured @3m (dBuV/m)	Highest Field strength calculated @30m (dBuV/m)	Limit@30m (dBuV/m)
13.110-13.410 and 13.710-14.010	33.47 @13.348MHz	-6.53 @13.348MHz	40.5
	33.6@13.773MHz	-6.4@13.772MHz	

Result of On mode connected to PC: Pass [FCC 47CFR 15.225d]

Frequency Range(MHz)	Highest Field strength measured @3m (dBuV/m)	Highest Field strength calculated @30m (dBuV/m)	Limit@30m (dBuV/m)
Others frequencies < 30MHz	24.95 @14.408MHz	-15.05@14.408MHz	29.5

Remark:
The Measurement was performed at 3m distance between the EUT and the receiving antenna, the distance factor was applied to at the spectrum analyzer, the correction factor is equal to 40dB. The distance factor from 3m to 30m was refer to C63.10:2013.

Formula:
Highest Field strength calculated @30m = Highest Field strength measured @3m – Correction Factor

Calculated measurement uncertainty : **9kHz to 30MHz: 2.4dB**
30MHz to 18GHz: 5.0dB
18GHz – 26.5Hz: 5.24dB

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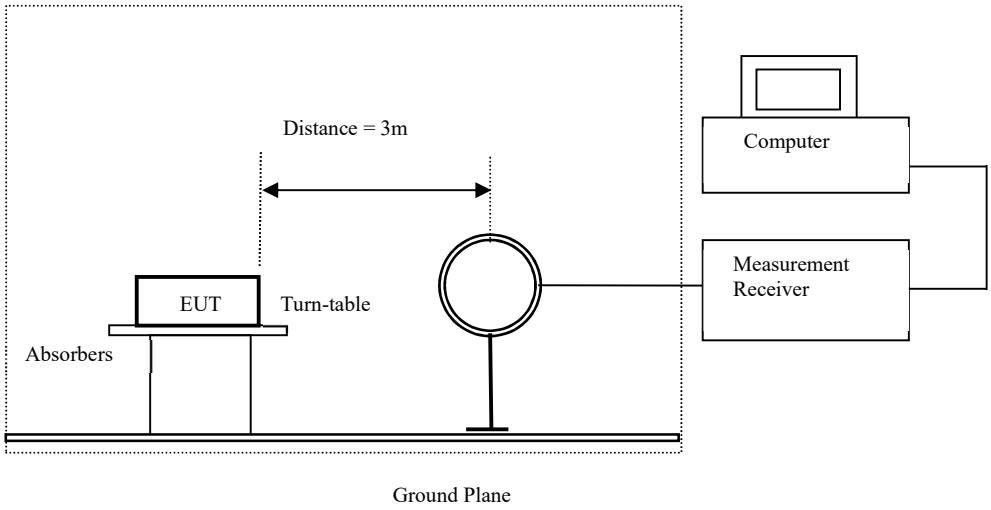
3.1.2 20DB BANDWIDTH

Ambient Temperature: 25°C Relative Humidity: 45%

Test Requirement:	FCC 47CFR 15.215
Test Method:	ANSI C63.10:2013
Test Date:	2022-06-24
Mode of Operation:	On mode connected to PC



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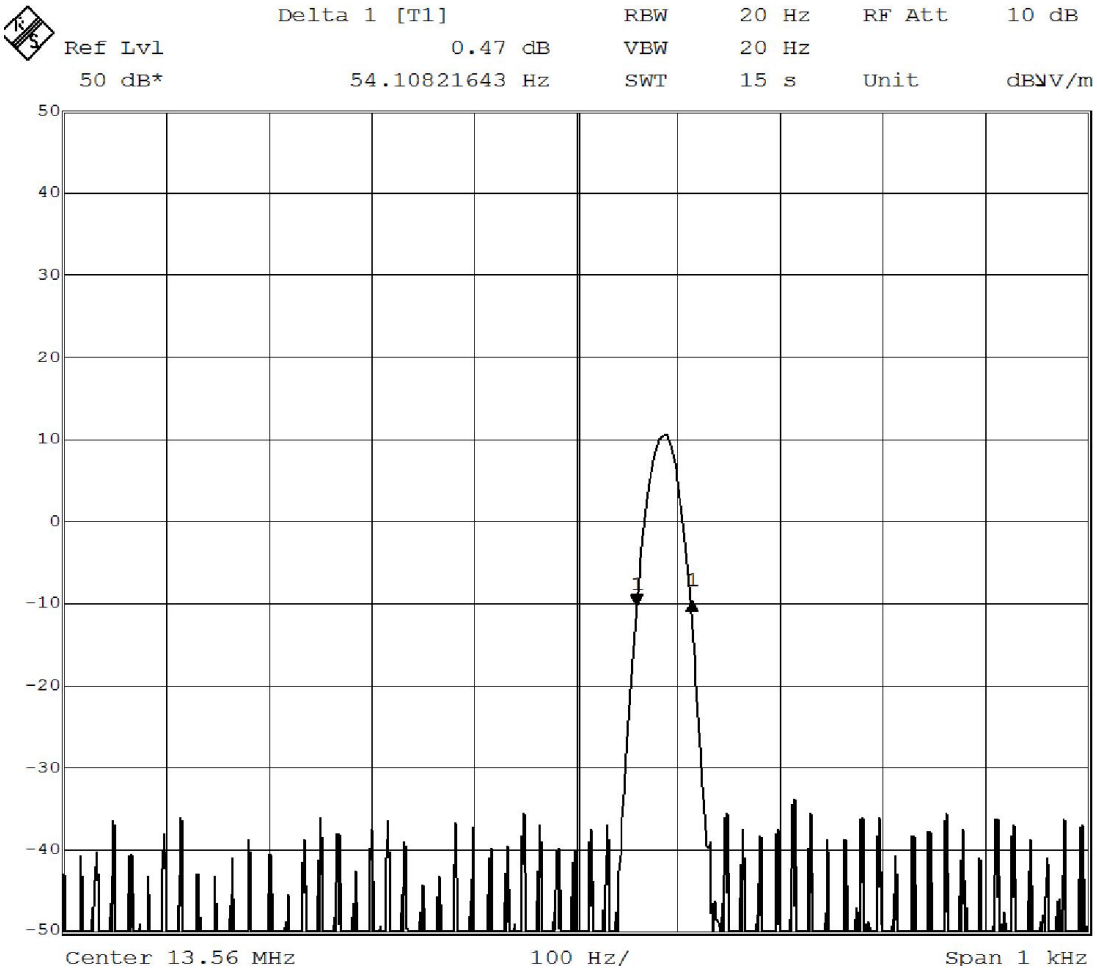
Center Frequency [MHz]	20dB Bandwidth [kHz]
13.56	0.054



Units in dBuV/m

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3.1.3 THE FREQUENCY TOLERANCE OF CARRIER SIGNAL

Ambient Temperature: 25°C Relative Humidity: 45%

Test Requirement: FCC 47CFR 15.225e
Test Method: ANSI C63.10:2013
Test Date: 2022-06-24
Mode of Operation: On mode connected to PC

The frequency tolerance, results: PASS

TEST CONDITIONS		Measured Frequency (MHz)	Frequency Error (%)
		$F_{carrier}$(MHz)	
Tnom: 25 °C	Unom: 5.0Vd.c.	13.5601	N/A
Ulow: -20°C	Umax: 5.75Vd.c.	13.5600	-0.0007
	Umin: 4.25Vd.c.	13.5602	0.0007
Tmax: 50°C	Umax: 5.75Vd.c.	13.56006	-0.0003
	Umin: 4.25Vd.c.	13.56006	-0.0003
Max. Freq. Error (%)			0.0015
Limit		±0.01%	
Measurement uncertainty		$<\pm 1 * 10^{-7}$	

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3.1.4 Radiated Emissions

Limits for Radiated Emissions [FCC 47 CFR 15.209]:

Frequency Range [MHz]	Quasi-Peak Limits [μV/m]
0.009-0.490	2400/F (kHz)@300m
0.490-1.705	24000/F (kHz)@30m
1.705-30	30@30m
30-88	100@3m
88-216	150@3m
216-960	200@3m
Above960	500@3m

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Remarks:

The Measurement was performed at 3m distance between the EUT and the receiving antenna. And the correction factor was included antenna factor and distance factor (3m to 30m) which shown on the pre-scan plot and the final value.

Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate in the table below is the worst case rate with respect to the specific test item.
Investigation has been done on all the possible configurations for searching the worst cases.

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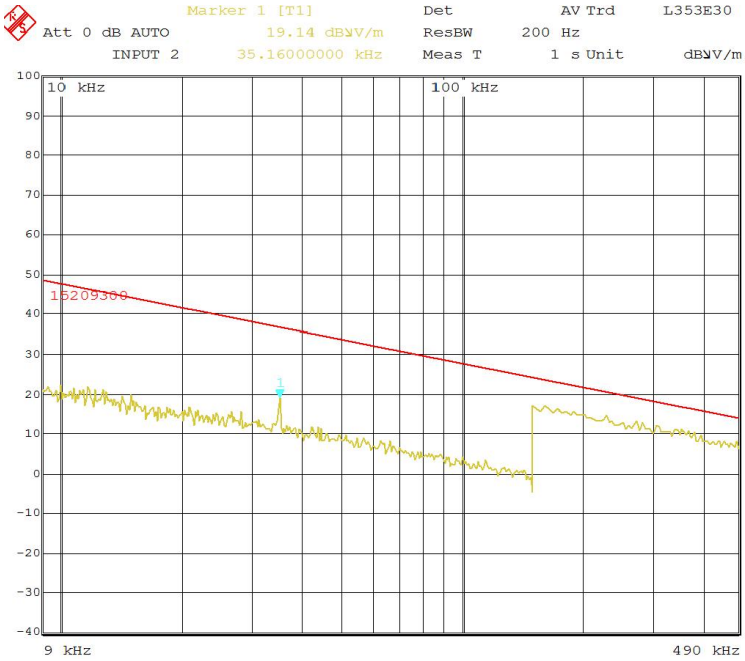
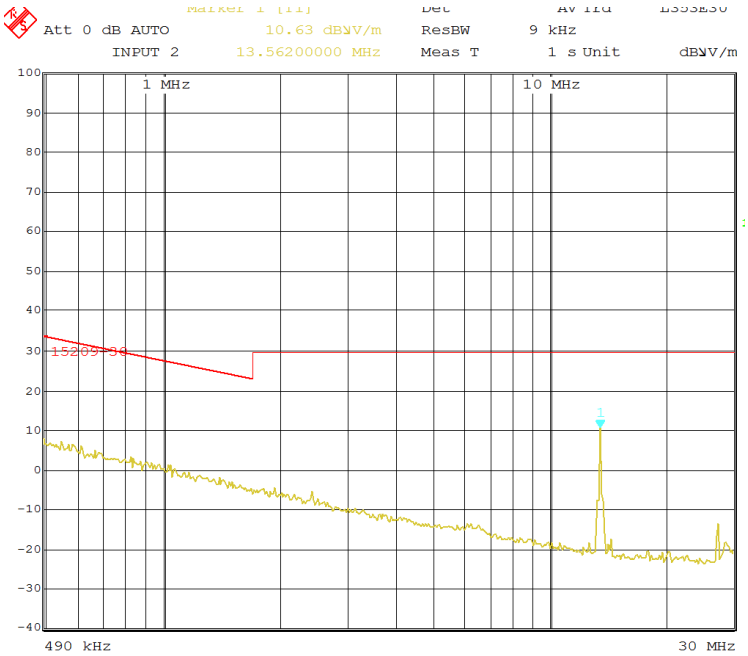
Result of On mode connected to PC, (9kHz – 30MHz): PASS





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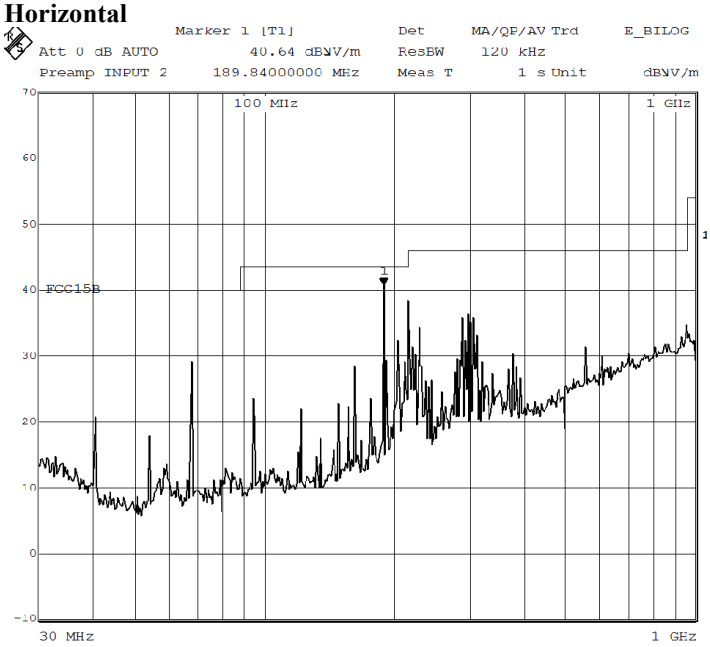
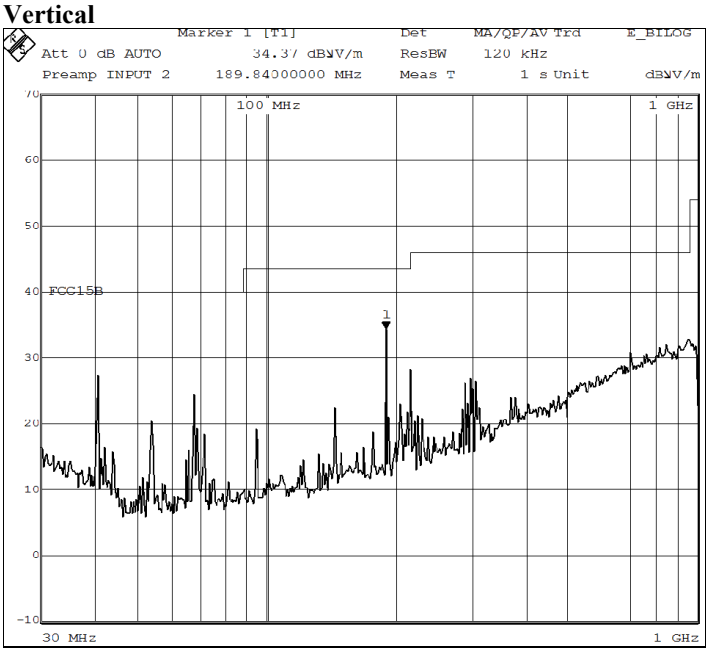
Pre-scan result of On mode connected to PC (30MHz – 1GHz):

Horizontal



Vertical



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Result of On mode connected to PC (30MHz – 1GHz): PASS

Field Strength of Fundamental and Harmonics Emissions Quasi-Peak Value						
Frequency MHz	Measured Level @3m dBμV/m		Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarization
67.8	29.1		29.1	28.5	150	Horizontal
189.8	40.6		40.6	107.6	150	Horizontal
217.0	38.4		38.4	83.1	200	Horizontal
297.2	36.3		36.3	65.2	200	Horizontal
40.7	26.4		26.4	20.9	200	Vertical
68.2	25.1		25.1	18.0	200	Vertical
189.8	34.4		34.4	52.3	200	Vertical
	20 dB below the FCC Limits					

Result of On mode connected to PC, (1GHz – 18GHz):
Not listed Emissions detected are more than 20 dB below the FCC Limits

Remarks:

The pre-scan results are for reference, the frequencies found will perform final measurement which shown on the table below the graphs, therefore, there may be some different in measured frequencies and field strength shown on the graph and the table.

No additional spurious emissions found between lowest internal used/generated frequency and 30 MHz
Correction Factor included Antenna Factor and Cable Attenuation.

Calculated measurement uncertainty : (9kHz – 30MHz): 2.4dB
(30MHz – 18GHz): 5.0dB
(18GHz - 26GHz): 5.24dB

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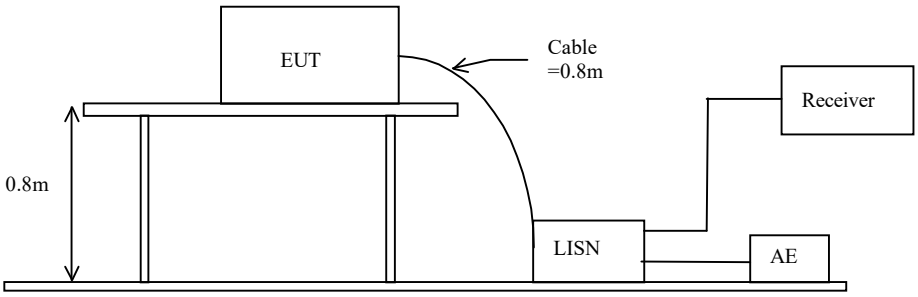
3.1.5 Conducted Emissions (0.15MHz to 30MHz)

Test Requirement:	FCC 47CFR 15.207 Class B
Test Method:	ANSI C63.10: 2013
Test Date:	2022-06-25
Mode of Operation:	*On mode connected to PC

Test Method:

The test was performed in accordance with ANSI C63.10: 2013, with the following: initial measurements were performed in peak and average detection modes on the live line, any emissions recorded within 30dB of the relevant limit lines were re-measured using quasi-peak and average detection on the live and neutral lines with the worst case recorded in the table of results.

Test Setup:



Remarks:

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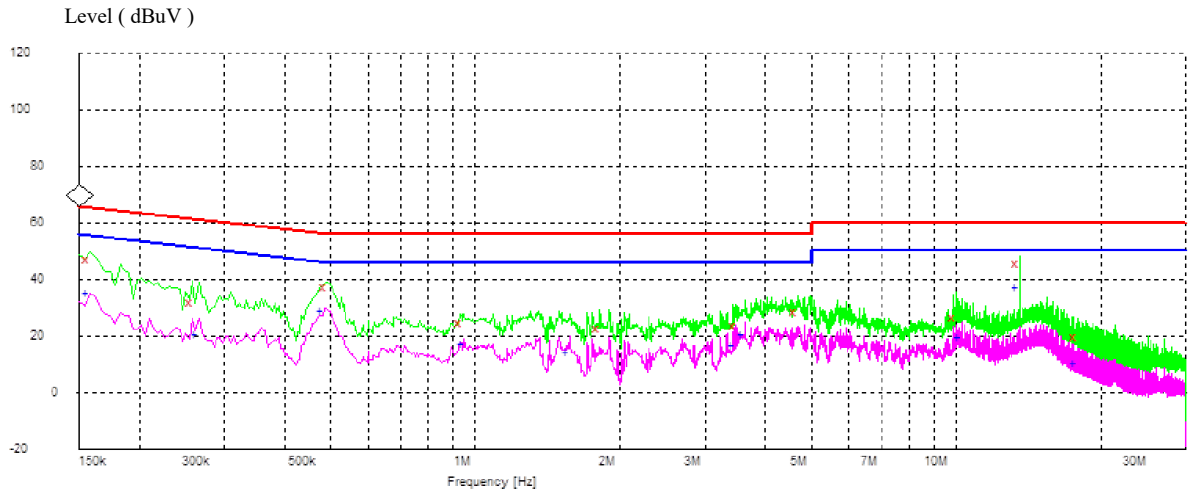
Limits for Conducted Emissions (FCC 47 CFR 15.207):

Frequency Range [MHz]	Quasi-Peak Limits [dBμV]	Average [dBμV]
0.15-0.5	66 to 56*	56 to 46*
0.5-5.0	56	46
5.0-30.0	60	50

* Decreases with the logarithm of the frequency.

Limits for Conducted Emissions Test, please refer to limit lines (Quasi-Peak and Average) in the following diagram.

Results of On mode connected to PC (Live and Neutral): PASS
Please refer to the following tables for individual results.



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MEASUREMENT RESULT: "vol_0001_fin QP"

Frequency (MHz)	Level (dBµV)	Transducer Factor(dB)	Limit (dBµV)	Margin (dB)	Line	Test
0.158000	46.90	19.9	66	18.7	L1	GND
0.258000	31.50	20.0	62	30.0	L1	GND
0.490000	36.90	20.0	56	19.3	L1	GND
0.938000	24.40	20.0	56	31.6	L1	GND
1.810000	22.20	20.0	56	33.8	L1	GND
3.486000	23.30	20.1	56	32.7	L1	GND
4.682000	28.00	20.1	56	28.0	N	GND
10.022000	26.40	20.2	60	33.6	N	GND
13.558000	45.40	20.2	60	14.6	L1	GND
17.854000	19.40	20.1	60	40.6	L1	GND

MEASUREMENT RESULT: "vol_0001_fin AV"

Frequency (MHz)	Level (dBµV)	Transducer Factor (dB)	Limit (dBµV)	Margin (dB)	Line	Test
0.158000	35.10	19.9	56	20.5	L1	GND
0.266000	20.30	20.0	51	30.9	L1	GND
0.486000	28.80	20.0	46	17.5	L1	GND
0.950000	17.20	20.0	46	28.8	L1	GND
1.574000	13.90	20.0	46	32.1	N	GND
3.466000	16.60	20.1	46	29.4	N	GND
3.634000	20.60	20.1	46	25.4	N	GND
10.286000	19.60	20.2	50	30.4	N	GND
13.558000	36.80	20.2	50	13.2	L1	GND
17.854000	9.90	20.1	50	40.1	L1	GND

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3.1.6 Antenna Requirement

Ambient temperature 25°C Relative humidity 50%

Test Requirements: § 15.203

Test Specification:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall 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 manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Test Results:

This is PCB antenna. There is no external antenna, the antenna gain is -38.1dBi. User is unable to remove or changed the Antenna.

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APPENDIX A

List of Measurement Equipment

Radiated Emission

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM215	MULTIDEVICE CONTROLLER	EMCO	2090	00024676	N/A	N/A
EM216	MINI MAST SYSTEM	EMCO	2075	00026842	N/A	N/A
EM217	ELECTRIC POWERED TURNTABLE	EMCO	2088	00029144	N/A	N/A
EM353	Active Loop Antenna	ETS-Lindgren	6502	206533	2020-06-10	2023-06-10
EM356	ANTENNA POSITIONING TOWER	ETS-LINDGREN	2171B	00150346	N/A	N/A
EM218	ANECHOIC CHAMBER	ETS-Lindgren	FACT-3	--	2019-04-16	2024-04-16
EM355	BICONILOG ANTENNA	ETS-Lindgren	3143B	00201783	2022-06-17	2023-06-17
EM229	EMI TEST RECEIVER	R&S	ESIB40	100248	2022-05-30	2023-05-30
EM363	SIGNAL ANALYZER (10Hz - 40GHz)	ROHDE & SCHWARZ	FSV40	101231	2022-01-24	2024-01-24
EM364	OPEN SWITCH PERFORM	ROHDE & SCHWARZ	OSP-B157W8	101002	2019-05-03	2023-07-29
EM365	SIGNAL GENERATOR	ROHDE & SCHWARZ	SMB100A	179970	2022-01-20	2024-01-20
EM367	WIRELESS COMMUNICATION TESTER	ROHDE & SCHWARZ	CMW270	101998	N/A	N/A
EM368	VECTOR SIGNAL GENERATOR	ROHDE & SCHWARZ	SMBV100A	261243	2022-01-20	2024-01-20

Electro-Static Discharge

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM102	VERTICAL COUPLING PLANE	HKSTC	N/A	N/A	CM	N/A
EM103	HORIZONTAL COUPLING PLANE	HKSTC	N/A	N/A	CM	N/A
EM220	ESD SIMULATOR	SCHAFFNER	NSG438	296	2021-03-19	2023-03-19

Radiated Immunity

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM082	ANECHOIC CHAMBER	FELJAS & MASSON	N/A	N/A	2019-04-16	2024-04-16
EM045	POWER METER	ROHDE & SCHWARZ	NRVD	843246/028	2020-12-28	2022-12-28
EM042	10V INSERTION UNIT	R & S	URV5-Z2	842558/023	2020-12-28	2022-12-28
EM203	POWER AMPLIFIER	BONN	BLMA0820-50	025257	N/A	N/A
EM256	SIGNAL GENERATOR	R&S	SMB100A	100844	2020-12-24	2022-12-24
EM257	POWER AMPLIFIER	MILMEGA	AS0204-60	1029240	N/A	N/A
EM316	POWER AMPLIFIER	EMPOWER RF SYSTEM	BBS2E4AUT	1004	N/A	N/A

Remark:
N/A Not Applicable

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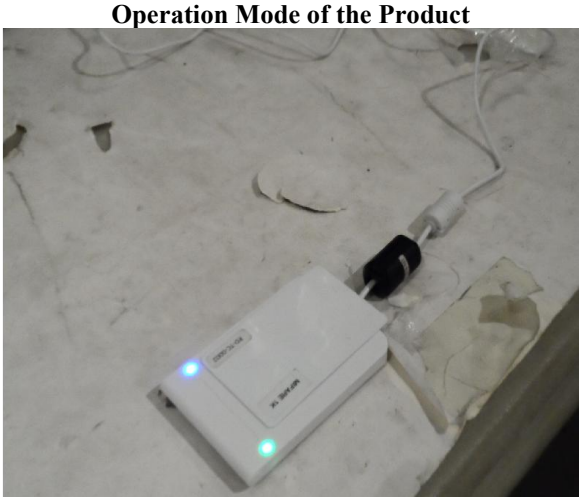
Appendix B

Photographs of EUT

Operation Mode of the Product



Being Test of the Product

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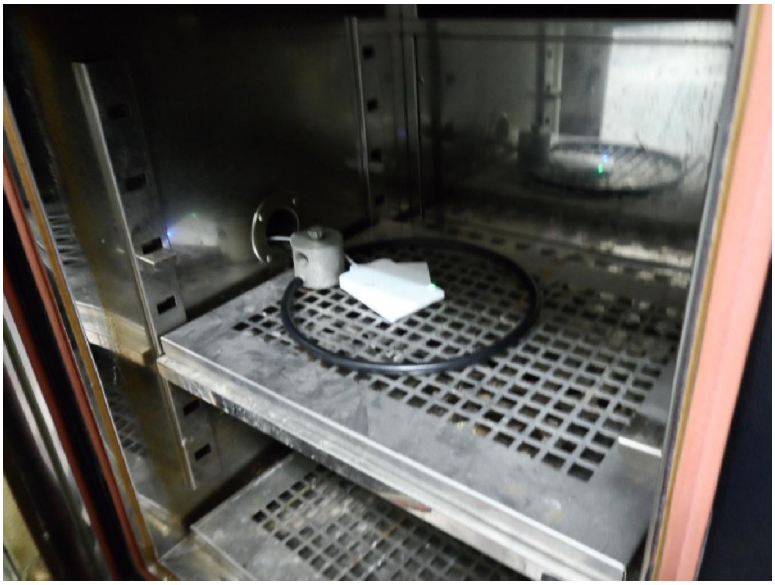
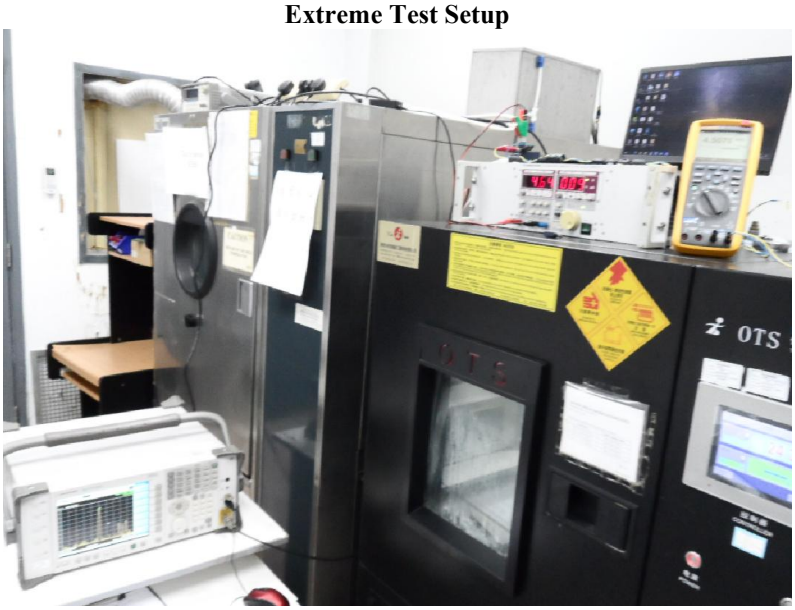
Photographs of EUT

Under Extreme Test



Extreme Test Setup



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Photographs of EUT

Front View

Rear View

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Appendix C

RF Exposure Evaluation

***SAR Test Exclusion Thresholds* for < 100 MHz and < 200 mm**

MHz	<50	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	mm
100	237	474	481	487	494	501	507	514	521	527	534	541	547	554	561	567	
50	308	617	625	634	643	651	660	669	677	686	695	703	712	721	729	738	
10	474	948	961	975	988	1001	1015	1028	1041	1055	1068	1081	1095	1108	1121	1135	
1	711	1422	1442	1462	1482	1502	1522	1542	1562	1582	1602	1622	1642	1662	1682	1702	mW
0.1	948	1896	1923	1949	1976	2003	2029	2056	2083	2109	2136	2163	2189	2216	2243	2269	
0.05	1019	2039	2067	2096	2125	2153	2182	2211	2239	2268	2297	2325	2354	2383	2411	2440	
0.01	1185	2370	2403	2437	2470	2503	2537	2570	2603	2637	2670	2703	2737	2770	2803	2837	

Result of On mode connected to PC: Pass [FCC 47CFR 15.225a]

Frequency Range(MHz)	Highest Field strength measured @3m (dBuV/m)	Highest Field strength calculated @30m (dBuV/m)	Limit@30m (dBuV/m)
13.553 - 13.567	51.62@13.56MHz	11.62@13.56MHz	84.0

51.62dBuV/m @3m to be -43.61EIRP (dBm) or 0.00004356EIRP (mW)

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According to FCC KDB 447498 D01 General RF Exposure Guidance V06 Chapter 4.31

a. For 100MHz to 6GHz and test separation distances less or equal to 50mm, the 1g and 10g SAR test exclusion thresholds are determined by :
[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] x [$\sqrt{f}$ (GHz)],
Results : ≤ 3.0 for 1g SAR and ≤for 10g extremity SAR.

b. For 100MHz to 6GHz and test separation distances more than 50mm, the 1g and 10g SAR test exclusion thresholds are determined by:
{[Power allowed at numeric threshold for 50mm in step a.] + [test separation distance-50mm] x (f (MHz) / 150)]} mW, for 100MHz to 1.5GHz.

c. For frequencies below 100MHz, the following may be considered for SAR test exclusion:
1. For test separation distances more than 50mm and less than 200mm, the power threshold at the corresponding test separation distance at 100MHz in step b. is multiplied by [1 + log (100 / f (MHz)]
2. For test separation distances less than or equal to 50mm, the power threshold determined by the equation in c.1. for 50mm and 100MHz is multiplied by 1/2.

Calculation:

a. [Pmax / dmin_1] x [$\sqrt{f}$] =3 Remark : dmin_1 =50mm, f = 0.1GHz

Pmax = [dmin_1 x 3] / $\sqrt{f}$

=[50 x 3] / $\sqrt{0.1}$

= 474.3mW

b. Pmax + [dmin_2 -50mm] x [f /150] Remark : dim_2 = 5mm f = 100MHz

474.3+ [(5-50)] x [100 / 150] =444.3 mW

c. 1. [the power threshold at the corresponding test separation distance at 100MHz in step b.] x [1 + log (100/ f2)]
=444.3 x [1 + log (100 / 13.56)] Remark : 13.56MHz
= 829.9mW
2. [the power threshold determined by equation in c. 1.] x 1/2
= 829.9 x 1/2
=414.9mW

SAR test exclusion threshold is 414.9mW

The power of EUT is -43.61 dBm = 0.00004356 mW

The SAR Exclusion Threshold conditions are satisfied and the SAR evaluation for general population exposure conditions are not require.

******* End of Test Report *******

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