



Test Report

Date : 2020-10-16
No. : HM20090035

Page 1 of 20

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
Brand Name: AB Circle Limited
Model Number: CIR315C-02
FCC ID: 2AUVM-CIR315C-02

Date Sample(s) Received: 2020-09-24

Date Tested: 2020-10-06 to 2020-10-12

Investigation Requested: Perform ElectroMagnetic Interference measurement in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15: 2018 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. LEE Kam Chuen
Authorized Signatory



Test Report

Date : 2020-10-16
No. : HM20090035

Page 2 of 20

CONTENT:

Cover	Page 1 of 20
Content	Page 2 of 20
<u>1.0</u>	<u>General Details</u>
1.1	Equipment Under Test [EUT] Description of EUT operation
1.2	Description of EUT Operation
1.3	Date of Order
1.4	Submitted Sample
1.5	Test Duration
1.6	Country of Origin
<u>2.0</u>	<u>Technical Details</u>
2.1	Investigations Requested
2.2	Test Standards and Results Summary
<u>3.0</u>	<u>Test Results</u>
3.1	Emission
<u>Appendix A</u>	
	List of Measurement Equipment



Test Report

Date : 2020-10-16

No. : HM20090035

Page 3 of 20

1.0 General Details

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

Product:	Contactless Smart Card Reader
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:	CIR315C-02
Rating:	5Vd.c. of USB port of EUT

1.2 Description of EUT Operation

The Equipment Under Test (EUT) is 13.56MHz RFID Card reader, which is 13.56MHz transceiver fixed transmit at 13.56MHz, the modulation is ASK type which is provided by IC.

1.3 Date of Order

2020-09-24

1.4 Submitted Sample(s):

3 Samples

1.5 Test Duration

2020-10-06 to 2020-10-12

1.6 Country of Origin

China

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Test Report

Date : 2020-10-16

No. : HM20090035

Page 4 of 20

2.0 Technical Details

2.1 Investigations Requested

Perform Electromagnetic Interference measurements in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15: 2018 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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Test Report

Date : 2020-10-16
No. : HM20090035

Page 5 of 20

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:	2020-10-12
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.
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Designation Number HK0001

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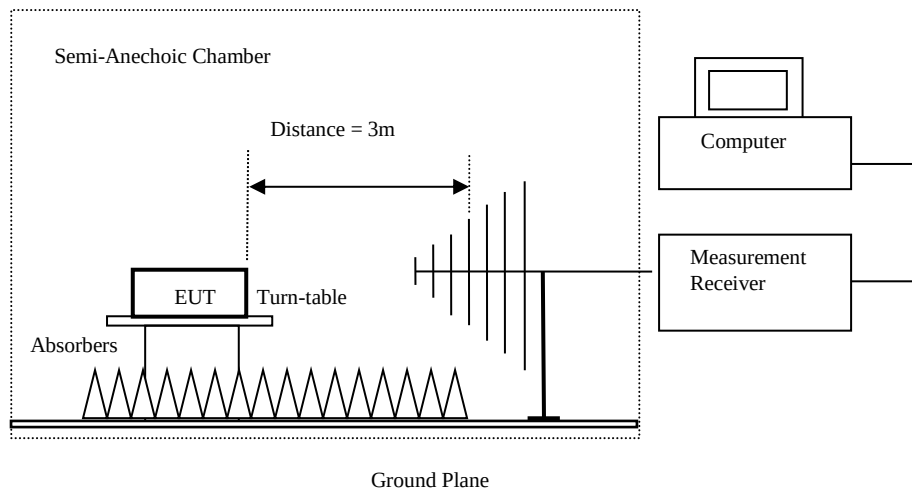
No. : HM20090035

Page 6 of 20

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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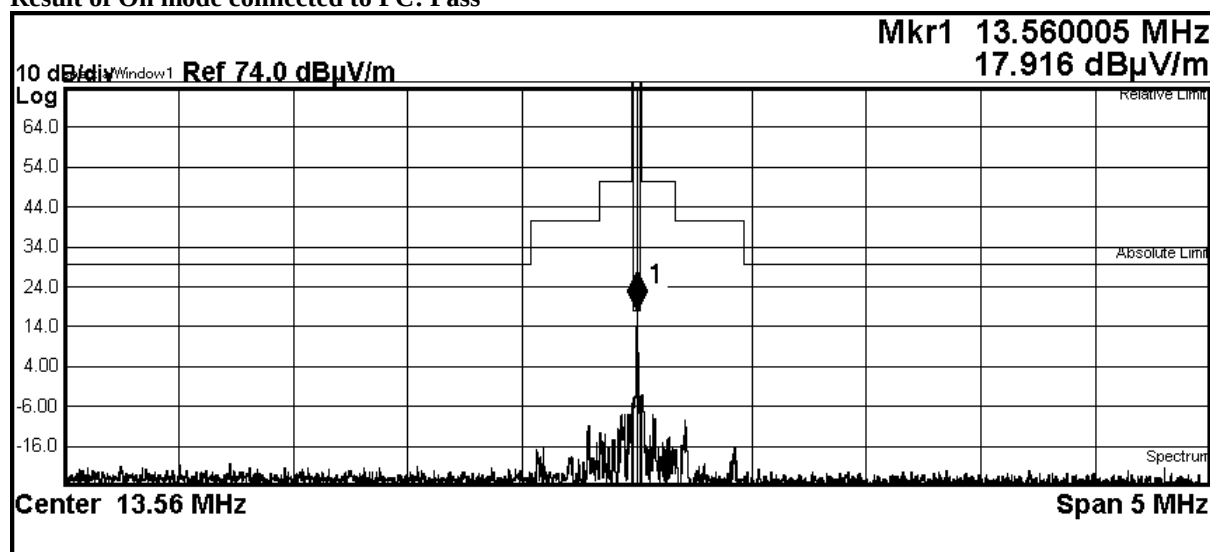
Date : 2020-10-16
No. : HM20090035

Page 7 of 20

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



Total Power -27.85 dBμV/m / 0.01 MHz Spectrum Peak Ref 84.00 dBμV/m

Start Freq	Stop Freq	Integ BW	dBμV/	Lower ΔLim(dB)	<- Peak -> Freq (Hz)	dBμV/	Upper ΔLim(dB)	Freq (Hz)
7.000 kHz	150.0 kHz	3.000 kHz	-112.16	(-55.67)	-7.496 k	-110.00	(-53.51)	11.99 k
150.0 kHz	450.0 kHz	3.000 kHz	-117.97	(-51.48)	-193.5 k	-116.52	(-50.03)	198.0 k
450.0 kHz	900.0 kHz	3.000 kHz	-128.47	(-50.98)	-619.4 k	-128.85	(-51.36)	517.4 k
900.0 kHz	2.500 MHz	3.000 kHz	-127.49	(-50.00)	-1.758 M	-128.50	(-51.01)	2.287 M

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Test Report

Date : 2020-10-16
No. : HM20090035

Page 8 of 20

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	57.9@13.56MHz	17.9@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	31.4@13.59MHz	-8.6@13.59MHz	50.4

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	30.9 @13.37MHz	-9.1 @13.37MHz	40.5

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	19.7 @12.33MHz	-20.3 @12.33MHz	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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No. : HM20090035

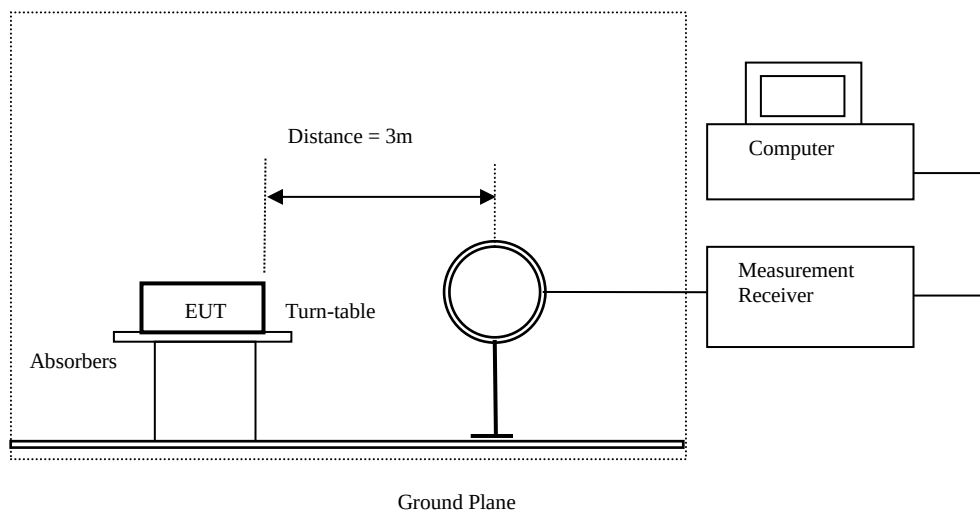
Page 9 of 20

3.1.2 20DB BANDWIDTH

Ambient Temperature: 21°C

Relative Humidity: 45%

Test Requirement: FCC 47CFR 15.215
Test Method: ANSI C63.10:2013
Test Date: 2020-10-12
Mode of Operation: On mode connected to PC



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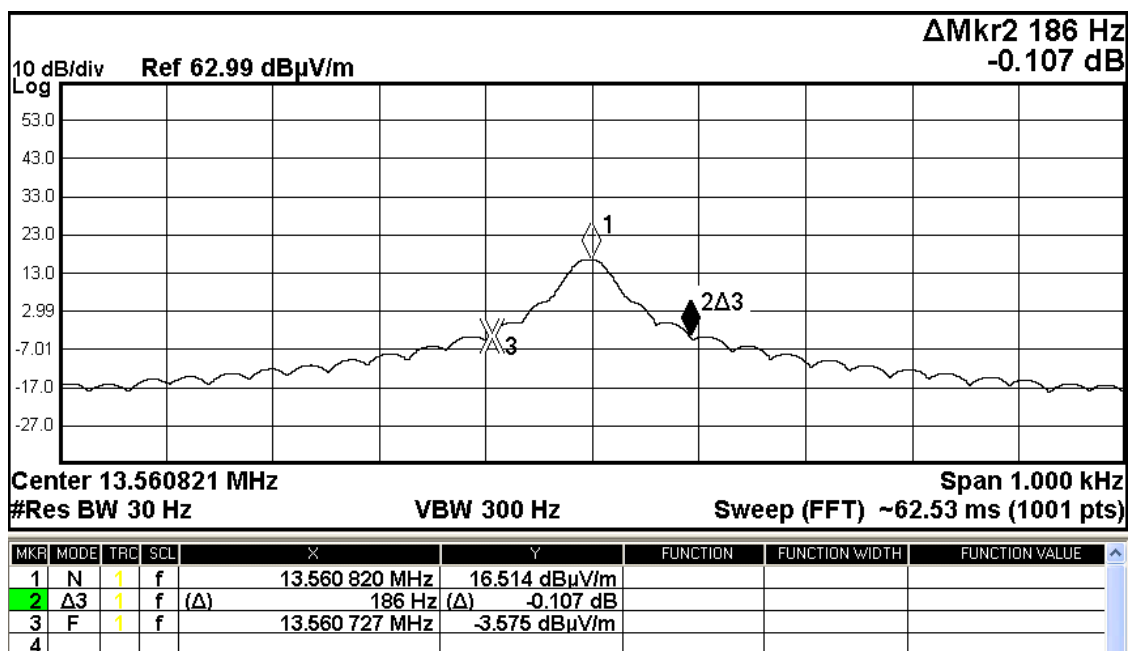


Test Report

Date : 2020-10-16
No. : HM20090035

Page 10 of 20

Center Frequency [MHz] 13.56	20dB Bandwidth [kHz] 0.19
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Date : 2020-10-16
No. : HM20090035

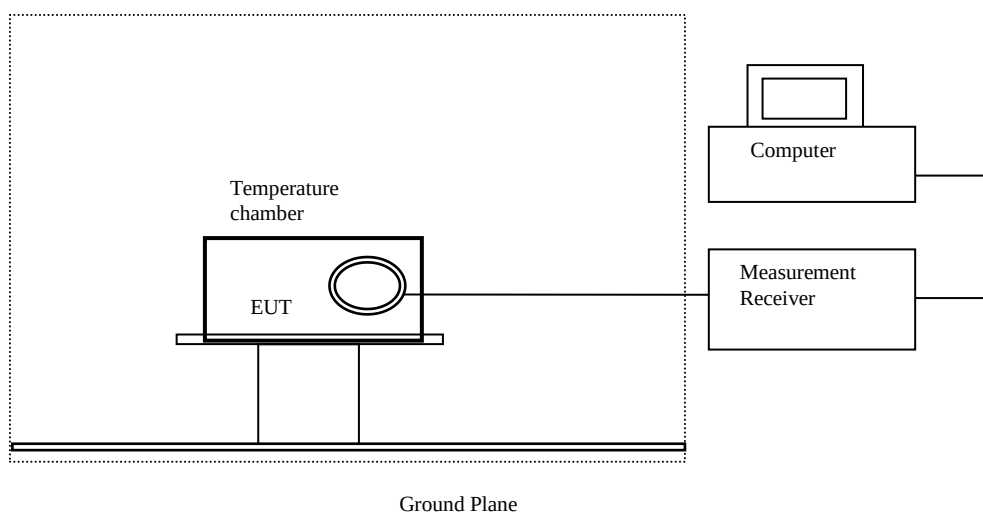
Page 11 of 20

3.1.3 THE FREQUENCY TOLERANCE OF CARRIER SIGNAL

Ambient Temperature: 21°C

Relative Humidity: 45%

Test Requirement: FCC 47CFR 15.225e
 Test Method: ANSI C63.10:2013
 Test Date: 2020-10-09
 Mode of Operation: On mode connected to PC



The frequency tolerance, results: PASS

TEST CONDITIONS		Measured Frequency (MHz)	Frequency Error (%)
		F_{carrier} (MHz)	
Tnom: 20 °C	Unom: 5.0Vd.c.	13.5608	N/A
Ulow: -20°C	Umax: 5.75Vd.c.	13.5609	0.0010
	Umin: 4.25Vd.c.	13.5609	0.0010
Tmax: 50°C	Umax: 5.75Vd.c.	13.5606	-0.0015
	Umin: 4.25Vd.c.	13.5606	-0.0015
Max. Freq. Error (%)			-0.0015
Limit		±0.01%	
Measurement uncertainty		<±1* 10 ⁻⁷	

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Test Report

Date : 2020-10-16
No. : HM20090035

Page 12 of 20

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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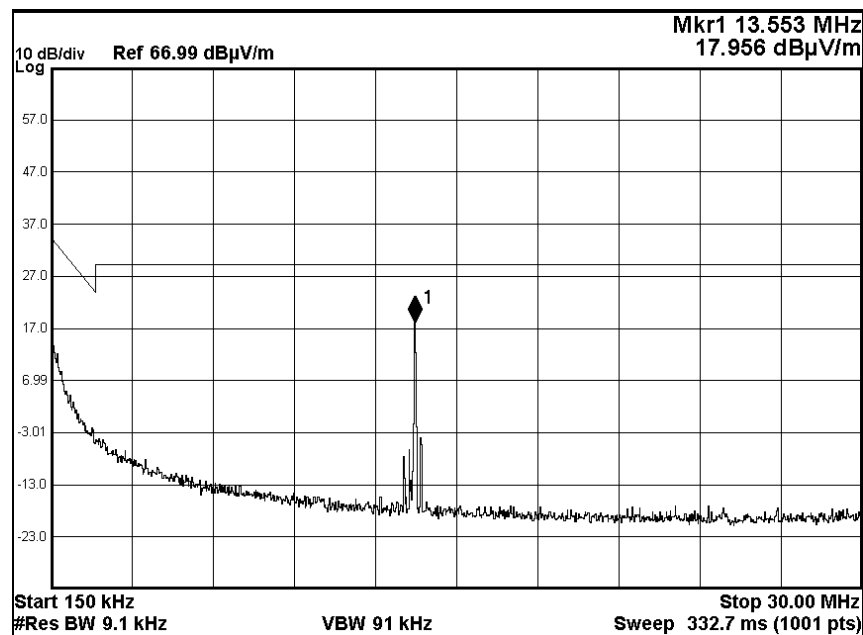
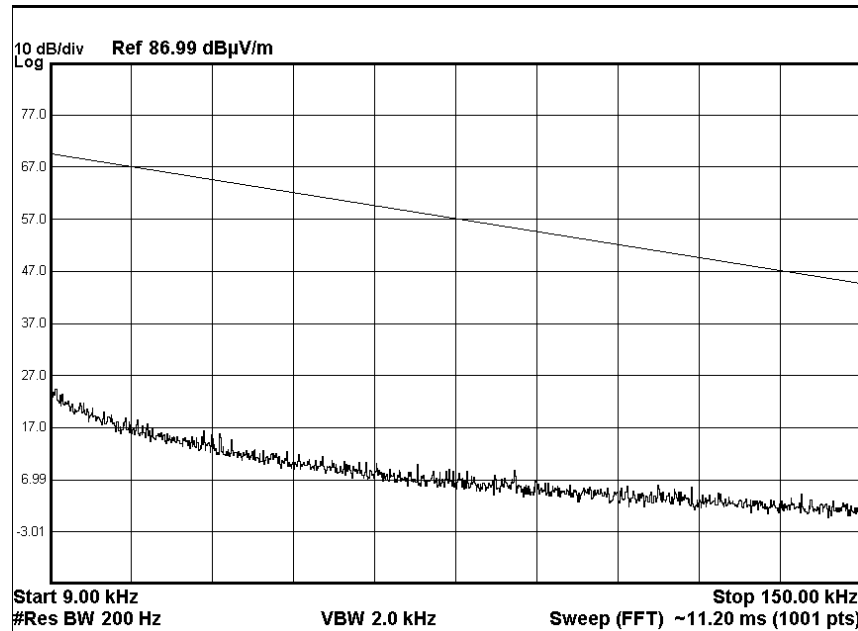


Test Report

Date : 2020-10-16
No. : HM20090035

Page 13 of 20

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



The peak value shown on the graph was 13.56MHz which the result was measured and calculated at page 7-8, others missions detected outside the spectrum mask are more than 20 dB below the FCC Limits

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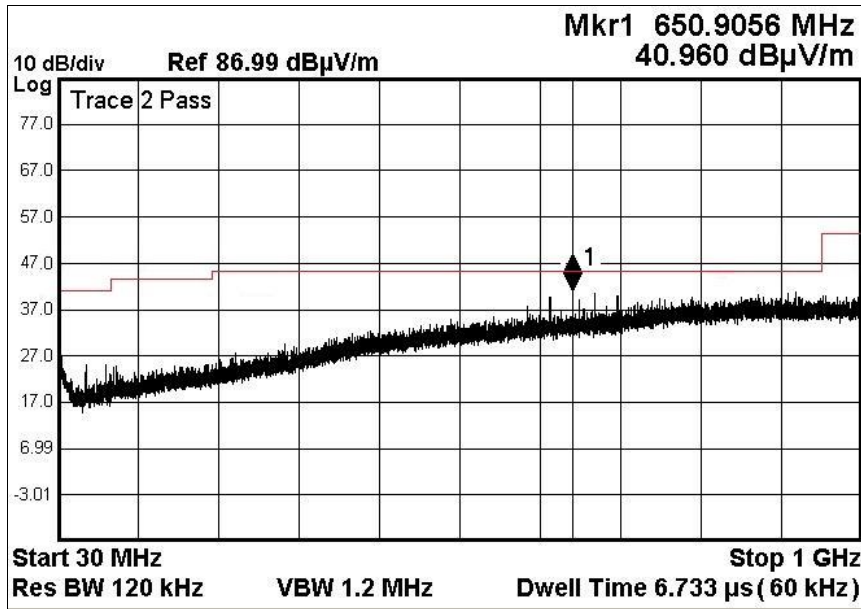


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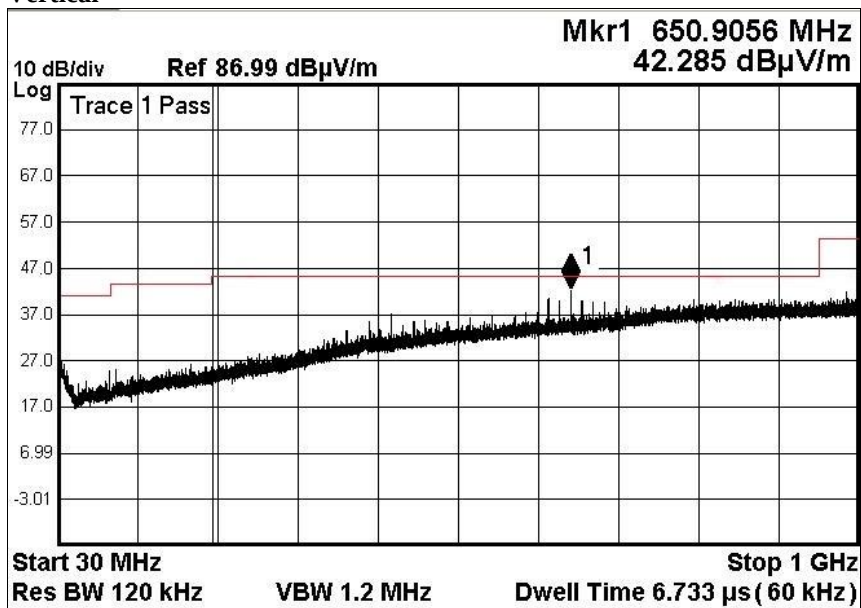
Date : 2020-10-16
No. : HM20090035

Page 14 of 20

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



Vertical



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Test Report

Date : 2020-10-16
No. : HM20090035

Page 15 of 20

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 dB μ V/m	Correction Factor dB μ V/m	Field Strength dB μ V/m	Field Strength μ V/m	Limit @3m μ V/m	E-Field Polarity
165.6	12.7	10.1	22.8	13.9	150	Horizontal
352.6	12.9	15.9	28.8	27.7	200	Horizontal
623.8	18.6	21.3	39.9	98.7	200	Horizontal
650.9	19.8	21.4	41.2	115.0	200	Vertical
718.7	12.4	22.4	34.8	54.7	200	Horizontal
745.8	12.9	22.5	35.4	58.9	200	Horizontal

Result of On mode connected to PC, (1GHz – 18GHz):

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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Test Report

Date : 2020-10-16
No. : HM20090035

Page 16 of 20

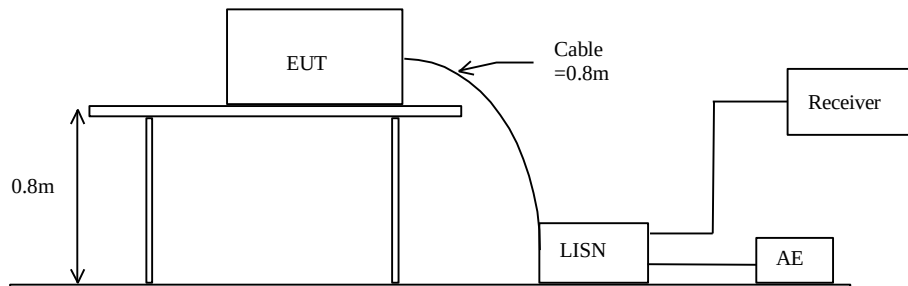
3.1.5 Conducted Emissions (0.15MHz to 30MHz)

Test Requirement:	FCC 47CFR 15.207 Class B
Test Method:	ANSI C63.10: 2013
Test Date:	2020-10-06
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: The antenna of the EUT was terminated with 50 ohm resistive load



Test Report

Date : 2020-10-16
No. : HM20090035

Page 17 of 20

Limits for Conducted Emissions (FCC 47 CFR 15.207):

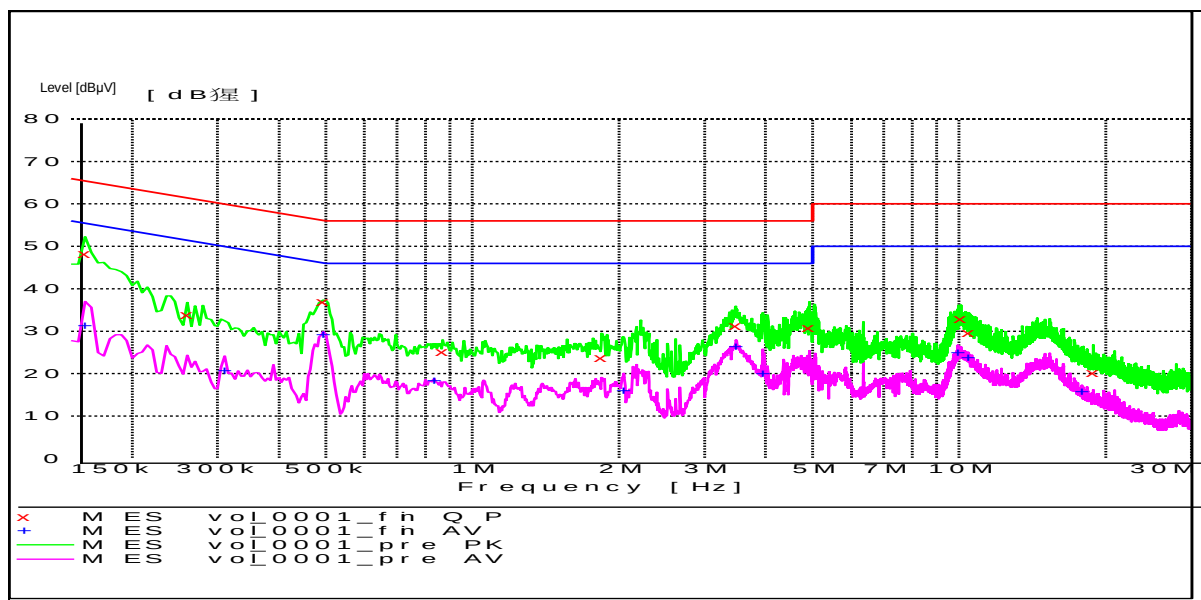
Frequency Range [MHz]	Quasi-Peak Limits [dB μ V]	Average [dB μ V]
0.15-0.5	66 to 56*	56 to 46*
0.5-5.0	56	46
5.0-30.0	60	50

* 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 diagram for individual results.



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Test Report

Date : 2020-10-16
No. : HM20090035

Page 18 of 20

MEASUREMENT RESULT: "vol_0001_fin QP"

Frequency MHz	Level dB μ V	Transd dB	Limit dB μ V	Margin dB	Line	PE
0.160000	48.30	9.9	66	17.2	L1	GND
0.260000	33.80	9.9	61	27.6	N	GND
0.495000	37.00	10.0	56	19.1	L1	GND
0.870000	25.10	10.0	56	30.9	L1	GND
1.845000	23.80	10.0	56	32.2	N	GND
3.475000	31.40	10.1	56	24.6	L1	GND
4.915000	30.90	10.3	56	25.1	N	GND
10.090000	33.00	10.4	60	27.0	L1	GND
10.460000	29.50	10.5	60	30.5	L1	GND
18.840000	20.20	10.4	60	39.8	N	GND

MEASUREMENT RESULT: "vol_0001_fin AV"

Frequency MHz	Level dB μ V	Transd dB	Limit dB μ V	Margin dB	Line	PE
0.160000	31.30	9.9	56	24.1	L1	GND
0.310000	20.80	10.0	50	29.1	N	GND
0.495000	29.10	10.0	46	17.0	N	GND
0.835000	18.30	10.0	46	27.7	L1	GND
2.050000	16.00	10.1	46	30.0	N	GND
3.480000	26.40	10.1	46	19.6	N	GND
3.950000	19.90	10.2	46	26.1	N	GND
9.945000	24.80	10.4	50	25.2	N	GND
10.430000	23.80	10.5	50	26.2	N	GND
17.850000	15.70	10.3	50	34.3	N	GND

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Test Report

Date : 2020-10-16
No. : HM20090035

Page 19 of 20

3.1.6 Antenna Requirement

Ambient temperature 21°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 =0dBi. User is unable to remove or changed the Antenna.

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Test Report

Date : 2020-10-16
No. : HM20090035

Page 20 of 20

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
EM217	ELECTRIC POWERED TURNABLE	EMCO	2088	00029144	N/A	N/A
EM218	ANECHOIC CHAMBER	ETS-Lindgren	FACT-3	--	2020/04/13	2021/04/13
EM356	ANTENNA POSITIONING TOWER	ETS-LINDGREN	2171B	00150346	N/A	N/A
EM219	BICONILOG ANTENNA	EMCO	3142C	00029071	2019/11/07	2021/11/07
EM229	EMI TEST RECEIVER	R&S	ESIB40	100248	2020/05/13	2021/05/13
EM022	LOOP ANTENNA	ETS_LINDGREN	6502	00206533	2019/11/30	2021/11/30

Line Conducted

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM119	LISN	R & S	ESH3-Z5	0831.5518.52	2020/06/30	2021/06/30
EM181	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB7	100072	2020/05/13	2021/05/13
EM179	IMPULSE LIMITER	ROHDE & SCHWARZ	ESH3-Z2	357-8810.52/54	2020/01/13	2021/01/11

Remarks:

CM Corrective Maintenance
N/A Not Applicable or Not Available
TBD To Be Determined

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

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