

RF TEST REPORT

Report number		RAPA21-O-027
Applicant	Name	IOT WARE Co., Ltd
	Logo	N/A
	Address	#1303-1, Gasan Hansin IT Tower 2cha, 47, Digital-ro 9-gil, Geumcheno-gu, Seoul, Korea
Manufacturer	Name	IOT WARE Co., Ltd
	Address	#1303-1, Gasan Hansin IT Tower 2cha, 47, Digital-ro 9-gil, Geumcheno-gu, Seoul, Korea
Type of equipment		RFID reader
Basic model name		RFID reader
Multi model name		I1-5000N
Serial number		U1-5000N
FCC ID		2A2RE-I1-5000N
Test duration		September 1, 2021 to September 3, 2021
Date of issue		September 17, 2021
Total page		19 Pages (including this page)

SUMMARY

The equipment complies with the regulation; FCC CFR 47 PART 15 SUBPART C, SECTION 15.225

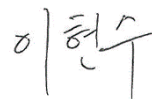
This test report only contains the result of a single test of the sample supplied for the examination.
It is not a general valid assessment of the features of the respective products of the mass-production.

September 17, 2021

September 17, 2021



Tested by MinGu Ji
Tester



Reviewed by Hyun Soo Lee
Executive Managing Director

Test Report Version History

Version	Date	Reason for revision
1.0	September 17, 2021	Original Document

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1. Description of EUT

1.1 Applicant

- Company name : IOT WARE Co., Ltd
- Address : #1303-1, Gasan Hansin IT Tower 2cha, 47, Digital-ro 9-gil, Geumcheno-gu, Seoul, Korea
- Contact person : Rack Eon Koo / Header of research center / rekoo@iotware.net
- Phone/Fax : +82-2-866-1150 / +82-2-866-0512

1.2 Manufacturer

- Company name : IOT WARE Co., Ltd
- Address : 76, Hanam-daero, Hanam-si, Gyeonggi-do, Republic of Korea
- Phone/Fax : +82-2-866-1150 / +82-2-866-0512

1.3 Basic description

- Product name : RFID reader
- Basic model name : I1-5000N
- Alternative model name : U1-5000N

1.4 General description

- EQUIPMENT CLASS : DXX – Low Power Communication Device Transmitter
- Frequency Range : 13.560 2 MHz
- Modulation Type : ASK
- Antenna Type : Patch Antenna
- Power Supply : DC 12.0 V

1.5 Alternative type(s)/model(s)

The Following Lists Consist to of the added model and their differences.

Model name	Differences	Tested
I1-5000N	Basic Model	☒
U1-5000N	It is the same as the I1-5000N model, only the model name is added.	☐

2. General information of test

2.1 Test standards and results

Applied Standards : FCC Part 15 Subpart C		
Section	Description of Test	Result
15.225	Operation within the band 13.110-14.010 MHz.	Pass
15.215(c)	Additional provisions to the general radiated emission limitations.	Pass
15.207	Conducted Limits	N/A
15.209	Radiated Emission Limits, General Requirement	Pass
15.203	Antenna Requirement	Pass

2.2 Description of EUT during the test

During the test, keep the EUT in continuously transmitting mode.

There was no mechanical or circuitry modification to improve RF and spurious characteristic, and any RF and spurious suppression device(s) was not added against the device tested.

The EUT was moved throughout the X, Y, and Z axis and worst case data was recorded in this report.

2.3 Test configuration

• Type of peripheral equipment used

Model	Manufacturer	Description	Connected to
I1-5000N	IOT WARE Co., Ltd	USB	EUT
6560b	HP	Notebook	EUT
PPP12D-S	Delta Electronics Ltd.	Power Adapter	Notebook
B05-24-12	Daygreen	DC IN	EUT

2.4 Test Facility

- FCC Registration No: 931589
- IC Company address code: 9355B
- RRA Designation Number: KR0027

• Place of Test

Anyang Test Site(RF Test Room)

#101 & B104 Anyang Megavalley, 268, Hagui-ro, Dongan-gu, Anyang-si, Gyeonggi-do, 14056, Korea

2.5 PRELIMINARY TEST

2.5.1 AC Power line Conducted Emissions Tests

Not tested as it is a DC power supply and is not intended for use in vehicles.

2.5.2 General Radiated Emissions Tests

During Preliminary Tests, the following operating modes were investigated

Operation Mode	The Worse operating condition (Please check one only)
Transmitting mode.	X

2.5.3 Special conditions for testing

This product uses 4 antenna ports, but does not support MIMO mode operation and operates in sequential SISO mode.

Antenna Port	Radiated Power (dBuV/m)
1	44.13
2	44.26
3	44.16
4	44.43

As a result of the test for each port, port 4 was the worst, so the wired test was conducted with port 4.

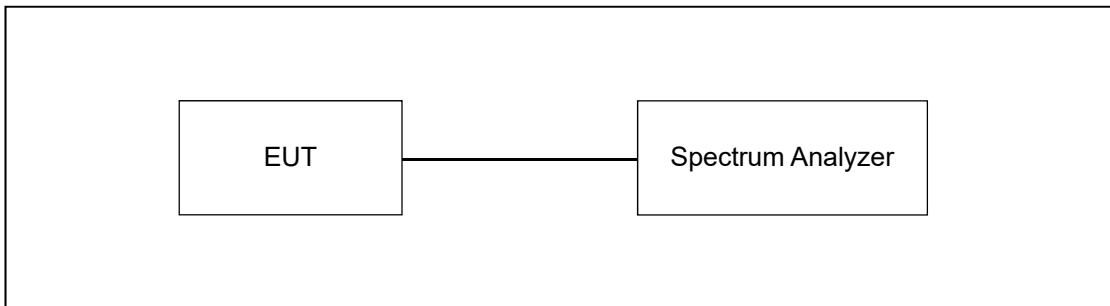
3. Measurement data

3.1 Minimum 20 dB Bandwidth

3.1.1 Requirement

- FCC Part15 subpart C Section 15.215(c)

3.1.2 Test Procedure



The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, and peak detection was used. The 20 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 20 dB.

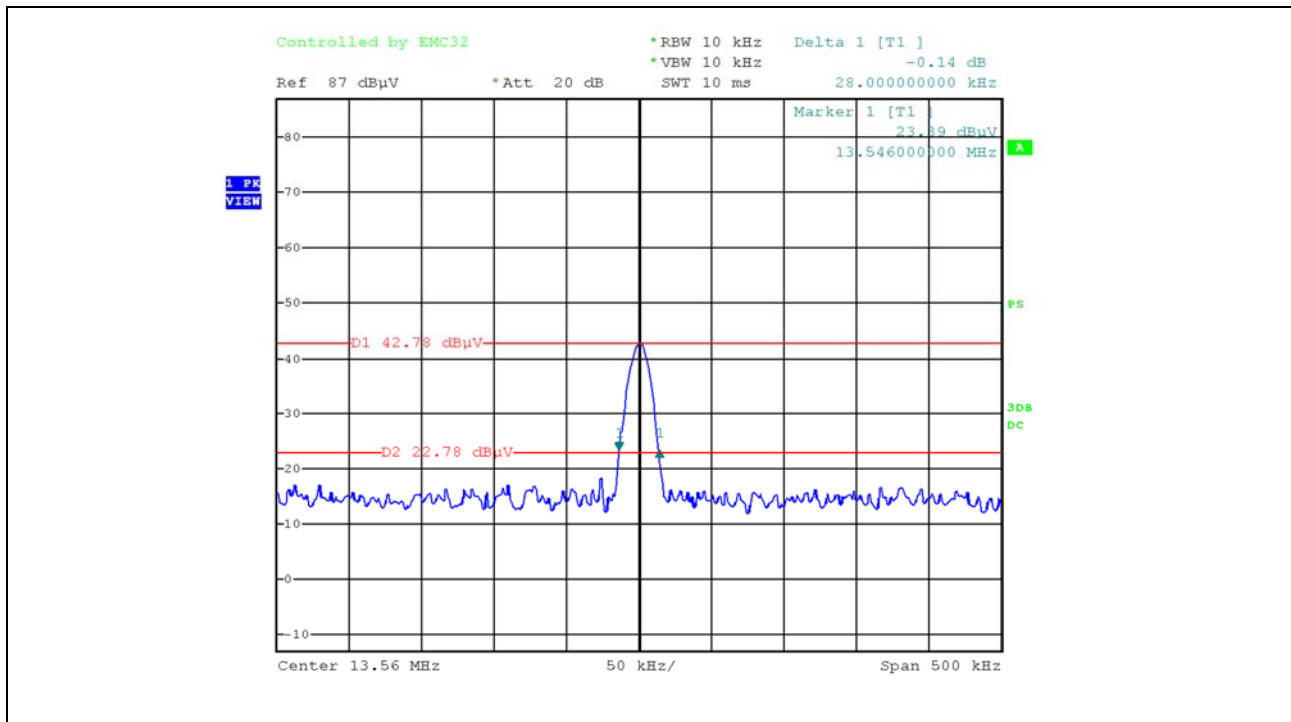
3.1.3 Test environment

- 24 °C, 46 % R.H.

3.1.4 Test results

Frequency [MHz]	Measured Value [kHz]	Assigned Operating Frequency Band (kHz)	Result
13.560 2	28.0	900	PASS

3.1.5 Test Plots



3.2 Frequency Stability With Temperature Variation

3.2.1 Requirement

- FCC Part15 subpart C Section 15.225(e)

3.2.2 Test set-up

Turn EUT off and set chamber temperature to -20 °C and then allow sufficient time (approximately 20 to 30 minutes after chamber reach the assigned temperature) for EUT to stabilize. Turn ON EUT and measure the EUT operating frequency and then turn off the EUT after the measurement. The temperature in the chamber was raised 10 °C step from -20 °C to +50°C. Repeat above method for frequency measurements every 10 °C step and then record all measured frequencies on each temperature step.

3.2.3 Test environment

- 24 °C, 46 % R.H.

3.2.4 Test data

Temperature (°C)	Carrier Freq. (Hz)	Measured Freq. (Hz)	Difference (Hz)
-20	13 560 200	13 560 247	47.0
-10		13 560 264	64.0
0		13 560 210	10.0
10		13 560 215	15.0
20		13 560 332	132.0
30		13 560 346	146.0
40		13 560 357	157.0
50		13 560 372	172.0

3.3 Frequency Stability With Voltage Variation

3.3.1 Requirement

- FCC Part15 subpart C Section 15.225(e)

3.3.2 Test set-up

An external DC power supply was connected to the input of the EUT. The voltage of EUT set to 115 % of the nominal value and then was reduced to 85 % of nominal voltage. The output frequency was recorded at each step.

3.3.3 Test environment

- 24 °C, 46 % R.H.

3.3.4 Test data

Voltage (Vdc)	Carrier Freq. (Hz)	Measured Freq. (Hz)	Difference (Hz)
13.8(115 %)	13 560 200	13 560 221	21.0
12.0(100 %)		13 560 247	47.0
10.2(85 %)		13 560 289	89.0

3.4 Radiated Emission

3.4.1 Requirement

- FCC Part15 subpart C Section 15.225(a),(b),(c), 15.209

3.4.2 Test Procedure

The radiated emissions measurements were performed on the 3 m anechoic chamber. The EUT was placed on a non-conductive turntable above the ground plane. The frequency spectrum from 30 kHz to 10.0 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

3.4.3 Test environment

- 24 °C, 46 % R.H.

3.4.4 Test results

3.4.4.1 Operation frequency band: (13.553 ~ 13.567) MHz

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.225(a)

Type of Test : Low Power Transmitter below 1 705 kHz

Result : PASSED

EUT : RFID Reader Date: September 3, 2021

Operating Mode : Transmitting Mode

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 9 kHz)

Distance : 3 m

Radiated Emission		Ant	Correction Factors		Total	FCC	
Freq. (MHz)	Amplitud (dBμV)	Pol.	Antenna (dB/m)	Cable (dB)	Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
13.560 2	34.13	H	9.75	0.6	44.48	124	79.52
13.560 2	27.29	V	9.75	0.6	37.64	124	86.36

Remark. The EUT was tested at 3 m, so conversation factor was included at above limit.

3.4.4.2 Operation frequency band: Below 13.553 MHz and above 13.567 MHz

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.225(b) and (c)

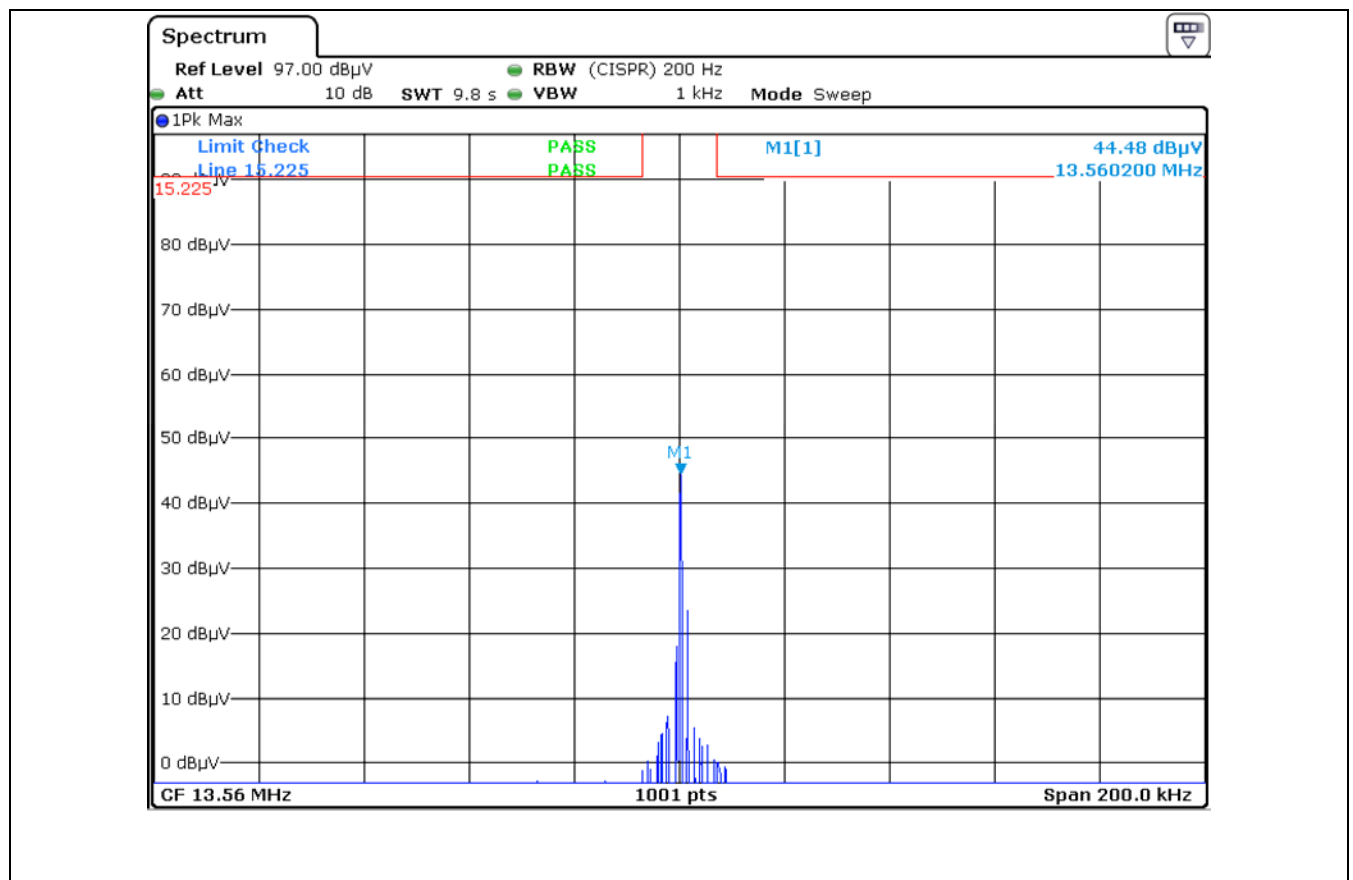
Type of Test : Low Power Transmitter below 1 705 kHz

Result : PASSED

EUT : RFID Reader

Date: September 3, 2021

Operating Mode : Transmitting Mode



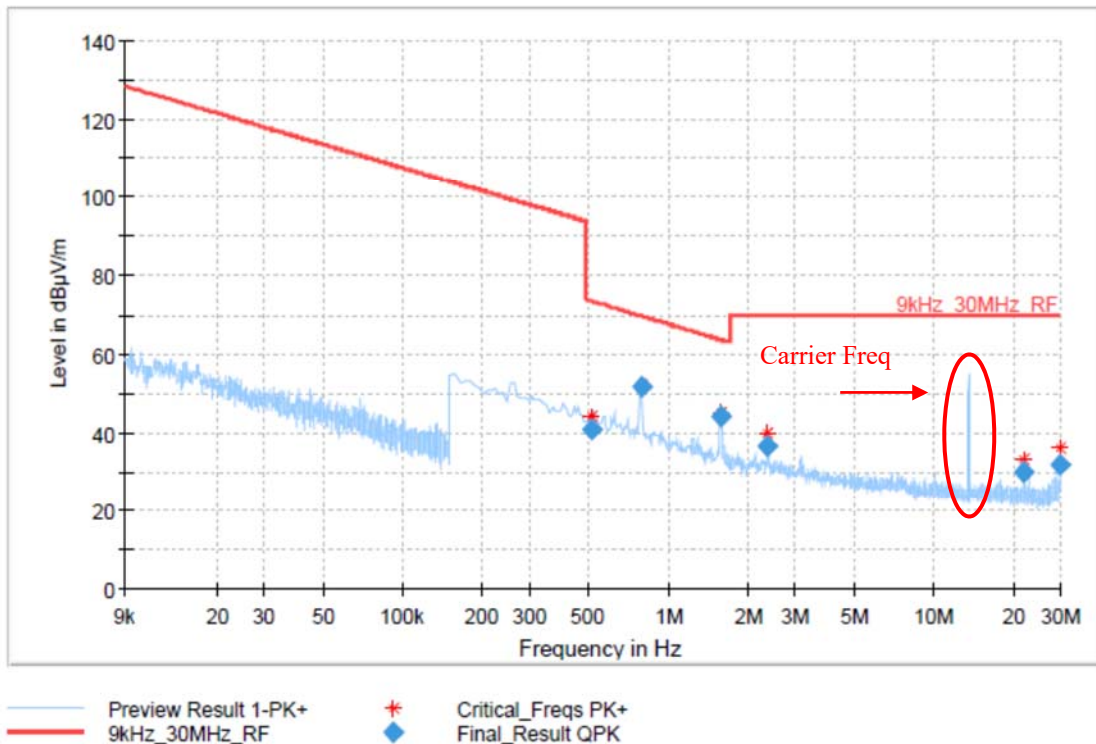
cc. to above test data, the field strength level of 13.560 2 MHz is 44.48 dBuV/m and the worst limit subject to 15.225 (b) and (c) is 80.5 dBuV/m, so the EUT meets the requirement.

3.4.4.3 Spurious Radiated Emission

3.4.4.3.1 Test Data for Below 30 MHz

- Detector : Quasi-Peak (6 dB Bandwidth: 200 Hz, 9 kHz)
- Measurement distance : 3 m
- Frequency range : 9 kHz ~ 30 MHz
- Operating Condition : Highest Output Power Transmitting Mode
- Result : PASS

RE Test Report



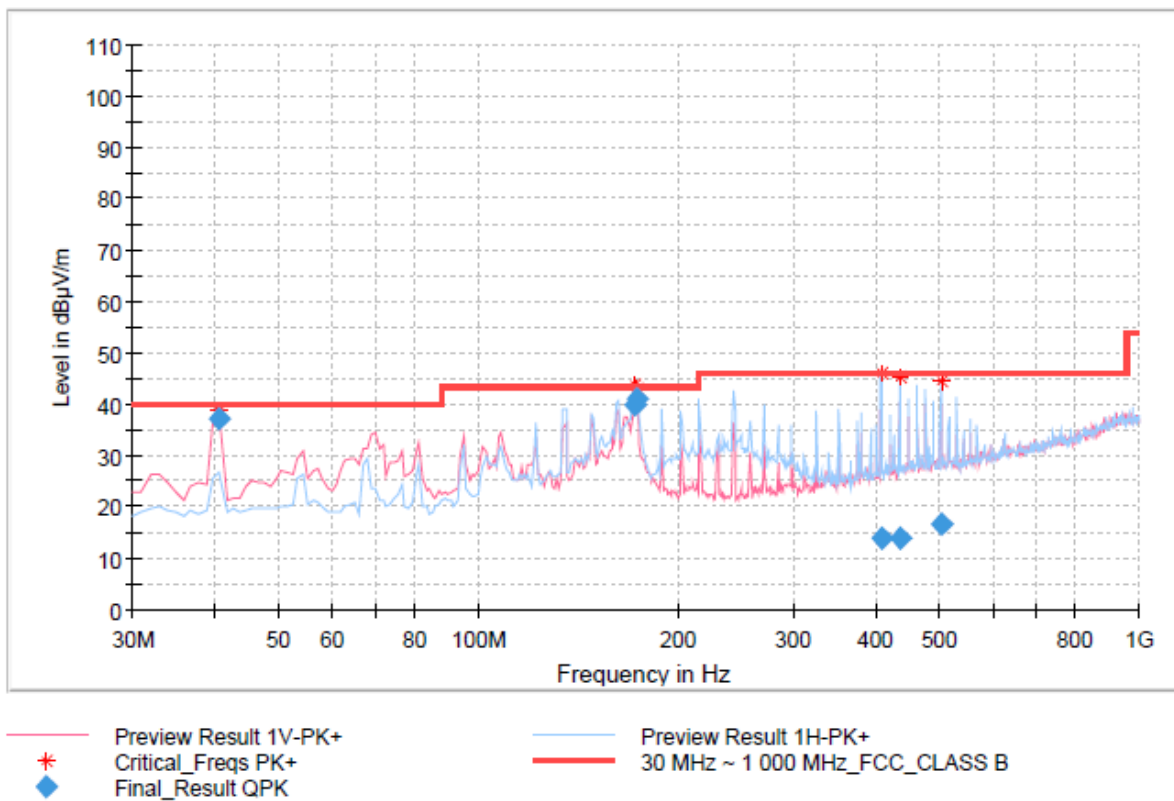
Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Pol	Azim uth (deg)	Corr. (dB)	Com ment
0.52	40.65	73.35	32.70	15000.0	H	0.0	11.0	
0.79	51.93	69.61	17.67	15000.0	H	94.0	11.0	
1.59	44.21	63.51	19.30	15000.0	H	94.0	11.1	
2.36	36.77	70.00	33.23	15000.0	H	117.0	11.0	
21.90	29.92	70.00	40.08	15000.0	H	151.0	9.5	
29.90	31.56	70.00	38.44	15000.0	H	140.0	8.6	

3.4.4.3.2 Test Data for 30 MHz ~ 1000 MHz

- . Detector : Quasi-Peak (6 dB Bandwidth: 120 kHz)
- .Measurement distance : 3 m
- .Frequency range : 30 MHz ~ 1000 MHz
- .Operating Condition : Highest Output Power Transmitting Mode
- .Result : PASS

RE Test Report



Final Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.67	37.23	40.00	2.77	15000.0	99.8	V	222.0	-23.9
172.59	39.94	43.50	3.56	15000.0	300.2	H	284.0	-17.9
173.56	40.95	43.50	2.55	15000.0	200.2	H	284.0	-18.0
407.33	13.94	46.00	32.06	15000.0	99.8	H	329.0	-15.8
434.49	13.86	46.00	32.14	15000.0	99.8	H	86.0	-15.1
501.42	16.82	46.00	29.18	15000.0	99.8	H	334.0	-14.2

3.5 Conducted Emission Test

3.5.1 Requirement

- FCC Part15 subpart C Section 15.207

3.5.2 Test Procedure

The EUT was placed on a wooden table, 0.8 m height above the floor. Power was fed to the EUT through a $50\ \Omega$ / $50\ \mu\text{H}$ + $5\ \Omega$ Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

3.5.3 Test data

- Not tested as it is a DC power supply and is not intended for use in vehicles.

3.6 Antenna Requirement

3.6.1 Requirement

- FCC Part15 subpart C Section 15.203
- An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with 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.

3.6.2 Result

- The antenna of the EUT is a Patch Antenna on the board in the EUT.

4. FIELD STRENGTH CALCULATION

Meter readings are compared to the specification limit correcting for antenna and cable losses.

+	Meter reading	(dBμV)
-	Amplifier Gain	(dB)
+	Cable Loss	(dB)
-	Antenna Factor	(dB/m)
=	Corrected Result	(dBμV/m)

Margin (dB)

	Specification Limit	(dBuV/m)
-	Corrected Result	(dBuV/m)
=	dB Relative to Spec	(± dB)

5. Test equipment list

Use	Model Number	Manufacturer	Description	Serial Number	Cal. Date.(Interval)
☒	AMP 20-1000	INFINITECH	BROADBAND PRE-AMP	2013 05 00003	Jan 14, 2021(1Y)
☒	GP-4303DU	EZ Digital Co.,Ltd.	DC Power Supply	2100196	Jan 14, 2021(1Y)
☒	DS 2000S	Innco GmbH	Turn Table	N/A	N/A
☒	MA4000-EP-HS	Innco GmbH	Antenna Mast	N/A	N/A
☒	MA4640-XP-ET	Innco GmbH	Tilt Antenna Mast	N/A	N/A
☒	CO3000	Innco GmbH	Controller	N/A	N/A
☒	CO3000	Innco GmbH	Controller	N/A	N/A
☒	N9020A	Agilent	Spectrum Analyzer	MY50200260	Jan 14, 2021(1Y)
☒	6502	EMCO	Loop Antenna	9609-3087	Nov 12, 2019(2Y)
☒	VULB 9168	SCHWARZBECK	Trilog-Broadband Antenna	9168-735	Nov 19, 2019(2Y)
☒	8449B	Agilent	Preamplifier	3008A02013	Jan 14, 2021(1Y)
☒	3115	ETS	Horn Antenna	9402-4229	July 28, 2020(2Y)
☒	ESCI7	Rohde & Schwarz	EMI Test Receiver	100938	Jan 14, 2021(1Y)
☐	ESH-Z2	Rohde & Schwarz	Pulse Limter	101631	Jan 14, 2021(1Y)
☐	ENV216	Rohde & Schwarz	LISN	101264	July 14, 2021(1Y)
☐	ES-SCAN	Rohde & Schwarz	EMI Software	N/A	N/A
☒	EMC32	Rohde & Schwarz	EMI Software	N/A	N/A
☒	FSV	Rohde & Schwarz	Spectrum Analyzer	101673	Jan 14, 2021(1Y)