



Industrial Internet Innovation Center (Shanghai) Co.,Ltd.

NFC TEST REPORT

PRODUCT	Tedee Keypad PRO
BRAND	Tedee
MODEL	TKV2.0
APPLICANT	Tedee Sp. z o.o.
FCC ID	2BCK5TKV20
IC	31583-TKV20
ISSUE DATE	November 19, 2024
STANDARD(S)	FCC CFR47 Part 2, FCC CFR47 Part 15C, ANSI C63.10-2013, RSS-210 Issue 11, RSS-Gen Issue 5

Prepared by: Li Liukai

李柳凱

Reviewed by: Qin Yabin

秦彦斌

Approved by: Zhang Min

張旻

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1 Summary of Test Report

1.1 Test Standard (s)

No.	Test Standard(s)	Title
1	FCC CFR47 Part 2	Frequency allocations and radio treaty matters; general rules and regulations
2	FCC CFR47 Part 15C	Radio Frequency Devices-Intentional Radiators
3	ANSI C63.10	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
4	RSS-210	License-Exempt Radio Apparatus: Category I Equipment
5	RSS-Gen	General Requirements for Compliance of Radio Apparatus

NOTE: According to customer requirements, test and report using the latest version of the standard.

1.2 Summary of Test Results

No.	Item(s)	Sub-clause of FCC Standard	Sub-clause of IC Standard	Verdicts for Single Item	Detailed Results
1	20 dB bandwidth	2.1049	RSS Gen 6.7	Pass	See section 6.1
2	Frequency Stability	15.225(e)	RSS 210 B.6.b	Pass	See section 6.2
3	Radiated Emission	15.225 (a) (b) (c) (d) and 15.209	RSS 210 B.6.a (i , ii , iii , iv)	Pass	See section 6.3
4	Conducted Emissions	15.207	RSS Gen 8.8	N/A	See section 6.4
5	Occupied bandwidth	N/A	RSS Gen 6.7	Pass	See section 6.5
6	Antenna Requirement	15.203	RSS GEN 6.8	Pass	See Note 2

NOTE:

The TKV2.0, manufactured by Tedee Sp. z o.o. is a new product for testing.

Industrial Internet Innovation Center (Shanghai) Co., Ltd. only performed test cases which identified with Pass/Fail/Inc result in section 1.3.

Industrial Internet Innovation Center (Shanghai) Co., Ltd. has verified that the compliance of the tested device specified in section 4 of this test report is successfully evaluated according to the procedure and test methods as defined in type certification requirement listed in section 1 of this test report.

Note 2:

The EUT has an internal loop antenna for NFC (13.56MHz) function, so this EUT complies with the 15.203/ RSS Gen 6.8 antenna requirements, please refer to the internal photos.

2 General Information of The Laboratory

2.1 Testing Laboratory

Lab Name	Industrial Internet Innovation Center (Shanghai) Co.,Ltd.
Address	Building 4, No. 766, Jingang Road, Pudong, Shanghai, China
Telephone	021-68866880
FCC Registration No.	708870
FCC Designation No.	CN1364
IC designation No.	10766A
CAB identifier	CN0067

2.2 Laboratory Environmental Requirements

Temperature	15℃~35℃
Relative Humidity	25%RH~75%RH
Atmospheric Pressure	86kPa~106kPa
Supply Voltage	Battery powered or DC 12V powered

2.3 Project Information

Project Manager	Zhang Heng
Test Date	September 30, 2024 to October 29, 2024

3 General Information of The Customer

3.1 Applicant

Company	Tedee Sp. z o.o.
Address	Karola Bohdanowicza 21/57 Street
Telephone	+48 519 176 611

3.2 Manufacturer

Company	Tedee Sp. z o.o.
Address	Karola Bohdanowicza 21/57 Street
Telephone	+48 519 176 611

3.3 Factory

Company	N/A
Address	N/A

4 General Information of The Product

4.1 Product Description for Equipment under Test (EUT)

Product	Tedee Keypad PRO
Model	TKV2.0
Date of Receipt	October 28, 2024
EUT ID*	S13aa
SN/IMEI	N/A
Supported Radio Technology and Bands	BT 5.0 LE NFC
Hardware Version	P3
Software Version	V2.0
Operating Frequency	13.56MHz
Antenna Information	Loop Antenna
Modulation information	ASK
Product Class	1
NOTE1: EUT ID is the internal identification code of the laboratory. NOTE2: Photographs of EUT are shown in ANNEX A of this test report. NOTE3: Samples in the test report are provided by the customer. The test results are only applicable to the samples received by the laboratory.	

4.2 Description for Auxiliary Equipment (AE)

AE ID*	Description	Model	SN/Remark
AE1	DC Cable	N/A	N/A
AE2	Battery	LR03	1.5V
AE3	DC Source	N/A	N/A
NOTE: *AE ID is the internal identification code of the laboratory.			

5 Test Configuration Information

5.1 Laboratory Environmental Conditions

5.1.1 Permanent Facilities

Semi-anechoic chamber SAC3-1 (9 m*8m*6.2m) & SAC3-2 (9.8m*6.7m*6.7m)	
Shielding effectiveness	0.014MHz ~1MHz, >60dB; 1MHz~1000MHz, >90dB.
Electrical insulation	> 2MΩ
Ground system resistance	< 4Ω
Normalised site attenuation (NSA)	< ± 4 dB, 3m distance, from 30 to 1000 MHz
Site voltage standing-wave ratio (SVSWR)	Between 0 and 6 dB, from 1GHz to 18GHz
Uniformity of field strength	Between 0 and 6 dB, from 80 to 6000 MHz

Shielded room	
Shielding effectiveness	0.014MHz~1MHz, >60dB; 1MHz~1000MHz, >90dB.
Electrical insulation	> 2 MΩ
Ground system resistance	< 4Ω

5.2 Decision of final test mode

The EUT was tested in conjunction with the accessories in Section 4.2. We tested all of the following test modes and selected the worst mode from the test results and recorded them in the report.

The test configuration modes are as the following:

Test Item	Test setup and operating modes
20 dB bandwidth	Mode 1: TX Mode+ AE2
Frequency Stability	Mode 2: TX Mode+ AE1+ AE3
Radiated emission	Mode 1: TX Mode+ AE2
Occupied bandwidth	Mode 1: TX Mode+ AE2
Note: After the verification of Part 15B, CA01 is the worst adapter for testing Conducted Emissions.	

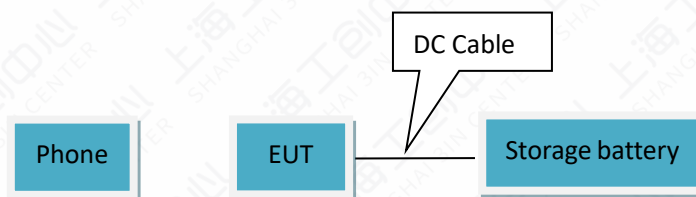
5.3 EUT System Operation

1. Connect the EUT with AE.
2. Setup the EUT according to the standard.
3. Start testing and monitoring the function.
4. TX mode: The EUT will transmit the NFC signal continuously during the test.

5.4 EUT Connection Diagram of Test System



<Figure 5.5-1> Mode 1



<Figure 5.5-2> Mode 2

5.5 Test Equipment Utilized

No.	Name	Model	S/N	SW Version	HW Version	Manufacturer	Cal. Date	Cal. Interval
1	Test Receiver	ESU40	100307	00	01	R&S	2023-12-19	1 year
2	Trilog Antenna	VULB9163	01345	N/A	N/A	Schwarzbeck	2024-03-29	1 year
3	EMI Test Software	EMC32 V10.35.02	N/A	N/A	N/A	R&S	N/A	N/A
4	Loop Antenna	AL-130R	121083	N/A	N/A	COM-POWER	2024-08-31	1 year
5	Temperature Box	B-TF-107C	201804107	N/A	N/A	Boyi	2024-06-07	1 year

5.6 Measurement Uncertainty

Item (s)	Uncertainty
20 dB bandwidth	$\pm 1.9\%$
Frequency Stability	$\pm 1.9\%$
Electric Field Strength of Fundamental Emissions	4.38 dB
Electric Field Radiated Emissions (Below 30MHz)	4.38 dB
Electric Field Radiated Emissions (Above 30MHz)	5.10 dB
Occupied bandwidth	$\pm 1.9\%$
Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.	

6 Test Results

6.1 20dB Bandwidth

6.1.1 Measurement Methods

- The transmitter output signal was picked up by coil antenna to the spectrum analyzer.
- The transmitter output signal was picked up by coil antenna connected to the spectrum analyzer.
- The bandwidth of the center frequency was measured with 200Hz RBW, 500Hz VBW and 14kHz span.

6.1.2 EUT Connection Diagram of Test System

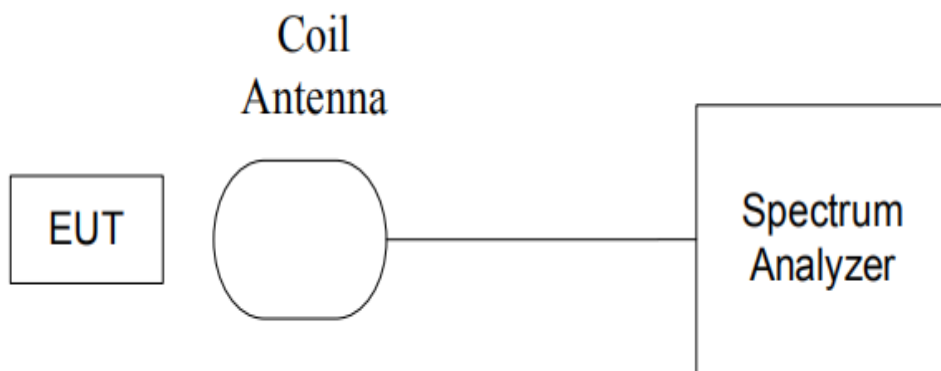


Figure 6.1.2-1 20dB Bandwidth Connection Diagram

6.1.3 Test Condition

The measurement of EUT is carried out under the transmit state of NFC and without modulation.

EUT had been not connected to a travel adapter.

During the measurements, the ambient temperature is in the range of 15~25℃.

6.1.4 Test environmental conditions

Temperature	24.7℃
Relative Humidity	58.1%RH
Atmospheric Pressure	101.3kPa

6.1.5 Test Results

Carrier frequency (MHz)	20dB Bandwidth (kHz)	Test Results	Conclusion
13.56	0.830	See Annex A.1-1	Pass

6.2 Frequency Stability

6.2.1 Measurement Methods

The transmitter output signal was picked up by coil antenna connected to the frequency counter. The center frequency was measured with 30Hz RBW and 1kHz span.

During the test, the EUT was placed in a thermal chamber until thermal balance and lasting appropriate time.

6.2.2 EUT Connection Diagram of Test System

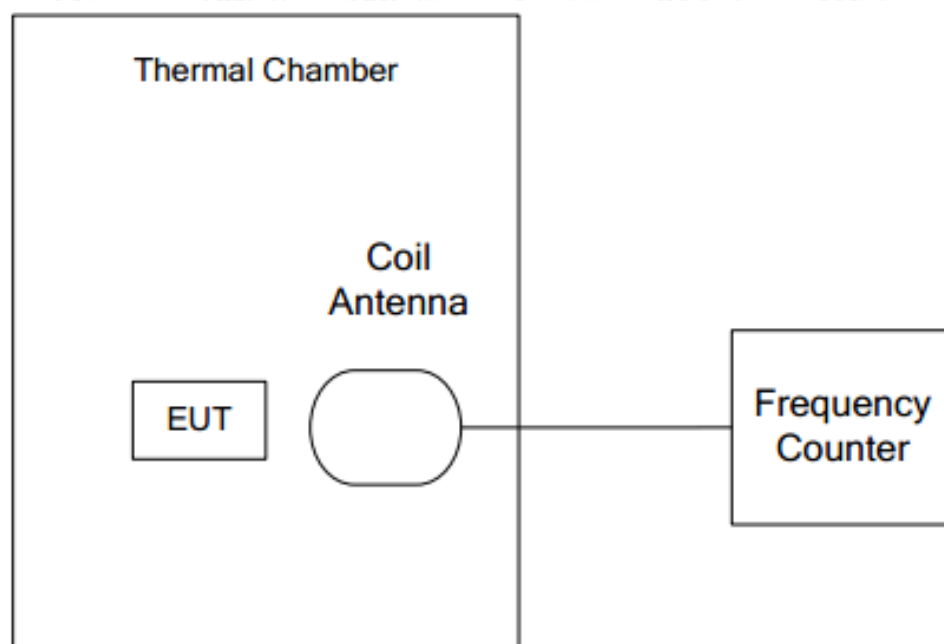


Figure 6.2.2-1 Frequency Stability Connection Diagram

6.2.3 Test Condition

The measurement of EUT is carried out under the transmit state of without modulation, EUT had been not connected to a travel adapter.

Operation Temperature: -20°C、-10°C、0°C、10°C、20°C、25°C、30°C、40°C、50°C

Operation Voltage: Vmin=DC 5V, Vmax=DC 25V, and Tnom=DC 12V.

6.2.4 Limit/Criterion

15.225(e): The frequency tolerance of the carrier signal shall be maintained within +/- 0.01% of the operating frequency.

RSS-210 B.6.b: The frequency tolerance of the carrier signal shall be maintained within ± 100 ppm of the operating frequency.

6.2.5 Test environmental conditions

Temperature	24.7℃
Relative Humidity	58.1%RH
Atmospheric Pressure	101.3kPa

6.2.6 Test Results

See Annex A.2-1

6.3 Radiated Emission

6.3.1 Electric Field Strength of Fundamental Emissions

6.3.1.1 Method of Measurement

a. The test set-up was made in accordance to the general provisions of ANSI C63.10-2013. The transmitter carrier output levels (E-Field) from the EUT are measured in a semi-anechoic chamber. The EUT is placed on a non-conductive stand of 80cm high, and at a measurement distance of 3m from the receiving antenna. The center of the receiving antenna is 1 meter above the ground. The E-field is measured with a shielded loop antenna connected to a measurement receiver. Detected E-field was maximized by rotating the EUT through 360° and adjusting the receiving antenna polarizations. Both horizontal and vertical polarizations of the antenna were set during the measurement. The maximization processes were repeated with the EUT positioned respectively in its three orthogonal axes. The measurements were performed with the peak detector and if required, the quasi-peak detector.

b. The EUT was placed on the axis of X, Y and Z respectively for testing. Only the worst direction data is represented in the report.

c. The measurement bandwidth:

Frequency (MHz)	RBW / VBW
12.56-14.56	10 / 30kHz

6.3.1.2 EUT Connection Diagram of Test System

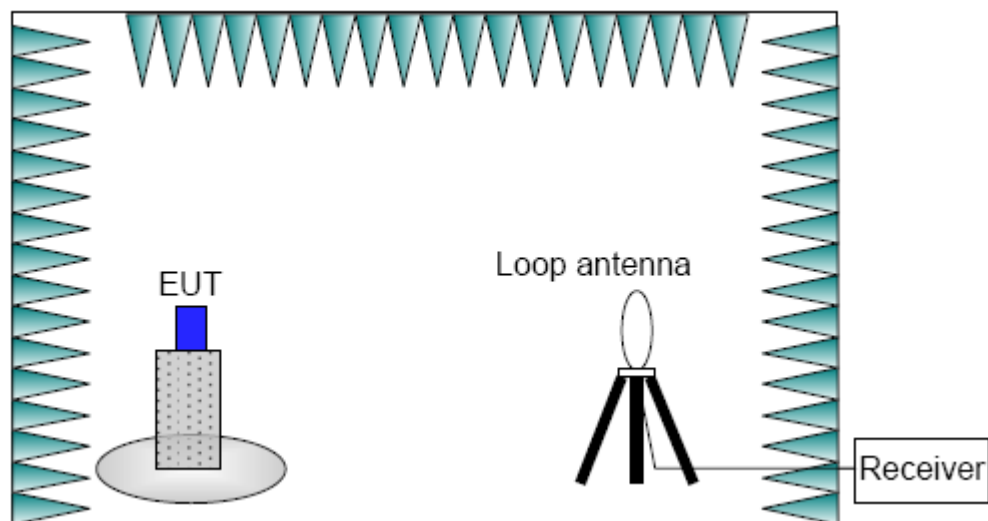


Figure 6.3.1.2-1 Electric Field Strength of Fundamental Emissions Connection Diagram

6.3.1.3 Test Condition

Frequency Range (MHz)	RBW/VBW	Sweep Time (s)
12.56-14.56	10kHz/30kHz	AUTO

6.3.1.4 Limit/Criterion

Clause 15.225(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.

Clause 15.225(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.

Clause 15.225(c) 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 Range (MHz)	E-field Strength Limit @30m (uV/m)	E-field Strength Limit @3m (dBuV/m)
13.560 ± 0.007	+15,848	124
13.410 to 13.553 13.567 to 13.710	+334	90
13.110 to 13.410 13.710 to 14.010	+106	81
Note: Where the limits have been defined at one distance, and a signal level measured at another, the limits have been extrapolated using the following formula: Extrapolation (dB) = 40log10(Measurement Distance / Specification Distance)		

6.3.1.5 Test environmental conditions

Temperature	24.7°C
Relative Humidity	58.1%RH
Atmospheric Pressure	101.3kPa

6.3.1.6 Test Results

Mode	Frequency (MHz)	Test Results	Verdicts
Mode 1: TX Mode+ AE2	13.2-14	See Annex A.3.1-1	Pass
NOTE: a. Abbreviations used in this clause: Pass—P; Fail—F; Not applicable—N/A b. The result displayed take into account applicable antenna factors and cable losses.			

6.3.2 Electric Field Radiated Emissions (Below 30MHz)

6.3.2.1 Method of Measurement

a. The electric field radiated emissions from the EUT are measured in a semi-anechoic chamber. The EUT is placed on a non-conductive stand of 80cm high, and at a measurement distance of 3m from the receiving antenna. The center of the receiving antenna is 1 meter above the ground. The E-field is measured with a shielded loop antenna connected to a measurement receiver. Detected E-field was maximized by rotating the EUT through 360° and adjusting the receiving antenna polarizations. Both horizontal and vertical polarizations of the antenna were set during the measurement. The maximization processes were repeated with the EUT positioned respectively in its three orthogonal axes. The measurements were performed with the peak detector and if required, the quasi-peak detector.

b. The EUT was placed on the axis of X, Y and Z respectively for testing. Only the worst direction data is represented in the report.

c. The measurement bandwidth:

Frequency (MHz)	RBW / VBW
0.009-30	10 / 30kHz

6.3.2.2 EUT Connection Diagram of Test System

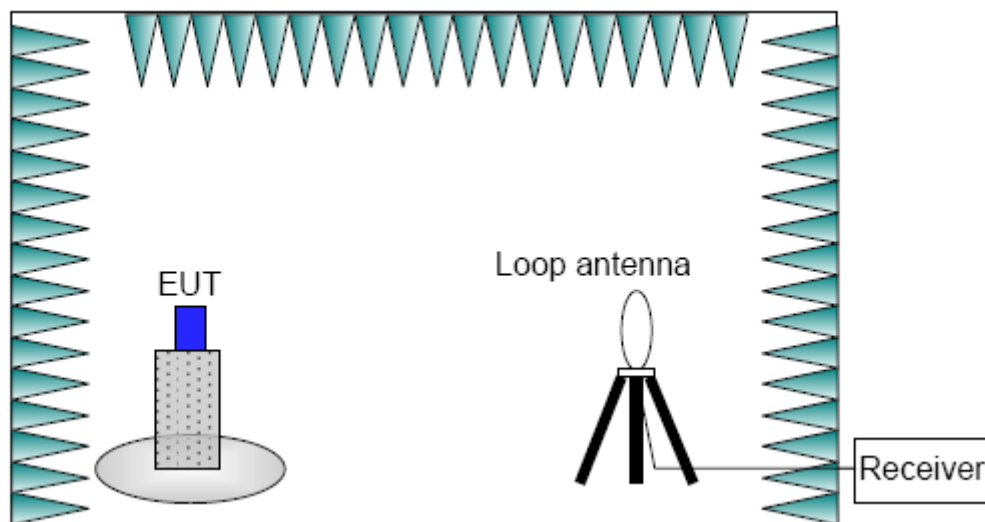


Figure 6.3.2.2-1 Electric Field Radiated Emissions (Below 30MHz) Connection Diagram

6.3.2.3 Test Condition

Frequency Range (MHz)	RBW/VBW	Sweep Time (s)
0.009-30	10kHz/30kHz	AUTO

6.3.2.4 Limit/Criterion

Frequency Range (MHz)	E-field Strength Limit @30m (mV/m)	E-field Strength Limit @3m (dBuV/m)
0.009-0490	2400/F (kHz)	129-94
0.490-1.705	24000/F (kHz)	74-63
1.705-30	30	70
Note: Where the limits have been defined at one distance, and a signal level measured at another, the limits have been extrapolated using the following formula: Extrapolation (dB) = 40log10(Measurement Distance / Specification Distance) $\text{dBuA/m} = \text{dBuV/m} / 120\pi$		

6.3.2.5 Test environmental conditions

Temperature	24.7°C
Relative Humidity	58.1%RH
Atmospheric Pressure	101.3kPa

6.3.2.6 Test Results

Mode	Frequency (MHz)	Test Results	Verdicts
Mode 1: TX Mode+ AE2	0.009-30	See Annex A.3.2-1	Pass
NOTE: a. Abbreviations used in this clause: Pass—P; Fail—F; Not applicable—N/A b. The result displayed take into account applicable antenna factors and cable losses c. dBuV/m and dBuA/m can be converted to each other, so the test data of dBuV/m are reflected in the report			

6.3.3 Electric Field Radiated Emissions (Above 30MHz)

6.3.3.1 Method of Measurement

a. The electric field radiated emissions from the EUT are measured in a semi-anechoic chamber. The EUT is placed on a non-conductive stand of 80cm high, and at a measurement distance of 3m from the receiving antenna. The center of the receiving antenna is 1 meter above the ground. The E-field is measured with a shielded loop antenna connected to a measurement receiver. Detected E-field was maximized by rotating the EUT through 360° and adjusting the receiving antenna polarizations. Both horizontal and vertical polarizations of the antenna were set during the measurement. The maximization processes were repeated with the EUT positioned respectively in its three orthogonal axes. The measurements were performed with the peak detector and if required, the quasi-peak detector.

b. The EUT was placed on the axis of X, Y and Z respectively for testing. Only the worst direction data is represented in the report.

c. The measurement bandwidth:

Frequency (MHz)	RBW / VBW
30-1000	120 kHz / 300kHz

6.3.3.2 EUT Connection Diagram of Test System

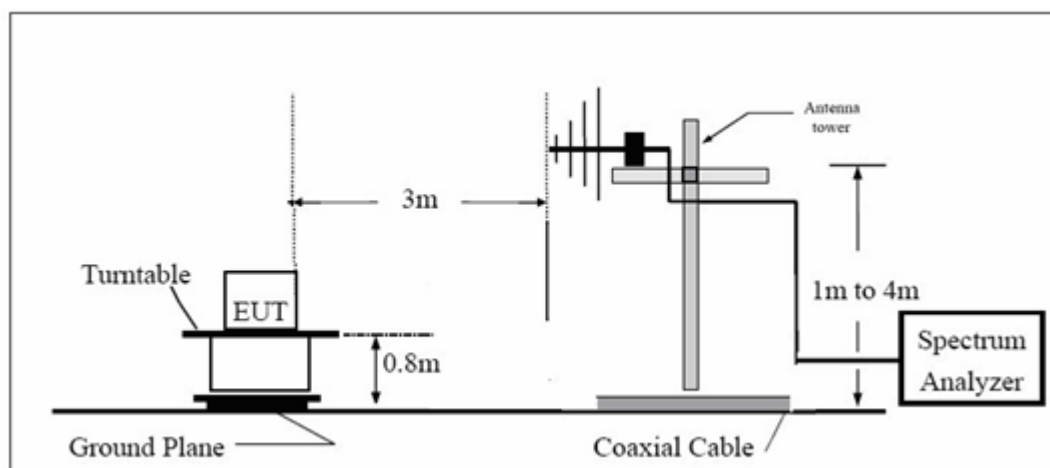


Figure 6.3.3.2-1 Electric Field Radiated Emissions (Above 30MHz) Connection Diagram

6.3.3.3 Test Condition

Frequency Range (MHz)	RBW/VBW	Sweep Time (s)
30-1000	120kHz/300kHz	AUTO

6.3.3.4 Limit/Criterion

Frequency Range (MHz)	Quasi-Peak (dBμV/m)	Peak (dBμV/m)	Average (dBμV/m)
30-88	40	N/A	N/A
88-216	43.5	N/A	N/A
216-960	46	N/A	N/A
Above 960	54	N/A	N/A
Above 1000	N/A	74	54

6.3.3.5 Test environmental conditions

Temperature	24.7℃
Relative Humidity	58.1%RH
Atmospheric Pressure	101.3kPa

6.3.3.6 Test Results

Mode	Frequency (MHz)	Test Results	Verdicts
Mode 1: TX Mode+ AE2	30-1000	See Annex A.3.3-1	Pass
NOTE: a. Abbreviations used in this clause: Pass—P; Fail—F; Not applicable—N/A b. The result displayed take into account applicable antenna factors and cable losses c. QP detection is used in radiated emissions test, and the Duty Cycle of NFC main frequency signal is 100%.			

6.4 Conducted Emissions

Since the EUT not support AC power supply, the test item is not applicable.

6.5 Occupied bandwidth

6.5.1 Reference

See Clause 6.7 of RSS-Gen.

6.5.2 Measurement Methods

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.

The following conditions shall be observed for measuring the occupied bandwidth:

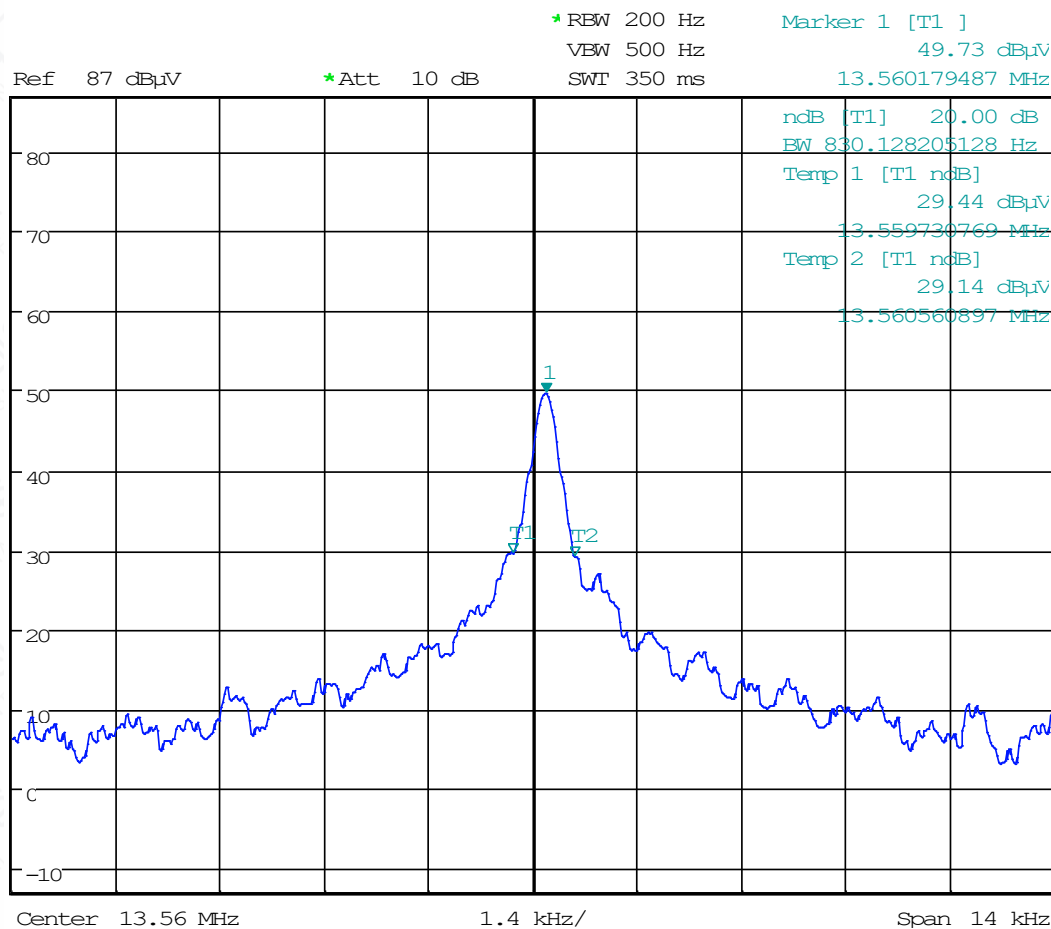
- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

6.5.3 Measurement Results

See Annex A.4-1

Annex A: Measurement Data



A.1-1 Mode 1 20dB Bandwidth

Temperature	Voltage	Frequency Error (MHz)			
		Startup	2Min Later	5Min Later	10Min Later
-20℃	DC 12V	13.561070	13.560354	13.561136	13.560827
-10℃		13.561134	13.560968	13.561042	13.561112
0℃		13.561230	13.561282	13.560791	13.560933
10℃		13.561211	13.561156	13.560686	13.560342
20℃		13.560892	13.560729	13.560837	13.560522
30℃		13.560944	13.560941	13.560212	13.560821
40℃		13.560829	13.560832	13.561239	13.560755
50℃		13.560769	13.560420	13.560219	13.561262
25℃	DC 5V	13.560957	13.560766	13.561048	13.560861
25℃	DC 25V	13.560558	13.560692	13.560977	13.560670
Temperature	Voltage	Frequency Error (%)			
-20℃	DC 12V	0.006571	0.001291	0.007057	0.004779
-10℃		0.007043	0.005819	0.006364	0.006880
0℃		0.007751	0.008134	0.004513	0.005560
10℃		0.007611	0.007205	0.003739	0.001202
20℃		0.005258	0.004056	0.004852	0.002529
30℃		0.005642	0.005619	0.000243	0.004734
40℃		0.004793	0.004816	0.007817	0.004248
50℃		0.004351	0.001777	0.000295	0.007987
25℃	DC 5V	0.005737	0.004329	0.006408	0.005029
25℃	DC 25V	0.002795	0.003783	0.005885	0.003621
Temperature	Voltage	Frequency Error (ppm)			
-20℃	DC 12V	65.707097	12.905434	70.574290	47.786980
-10℃		70.426799	58.185073	63.642228	68.804401

0℃		77.506352	81.341109	45.132148	55.603986
10℃		76.105190	72.049196	37.388887	12.020490
20℃		52.580427	40.559937	48.524433	25.294651
30℃		56.415184	56.193948	2.433596	47.344508
40℃		47.934470	48.155706	78.170060	42.477315
50℃		43.509750	17.772627	2.949814	79.866202
25℃	DC 5V	57.373874	43.288514	64.084700	50.294321
25℃	DC 25V	27.949484	37.831359	58.848781	36.208962

A.2-1 Mode 1 Frequency Stability

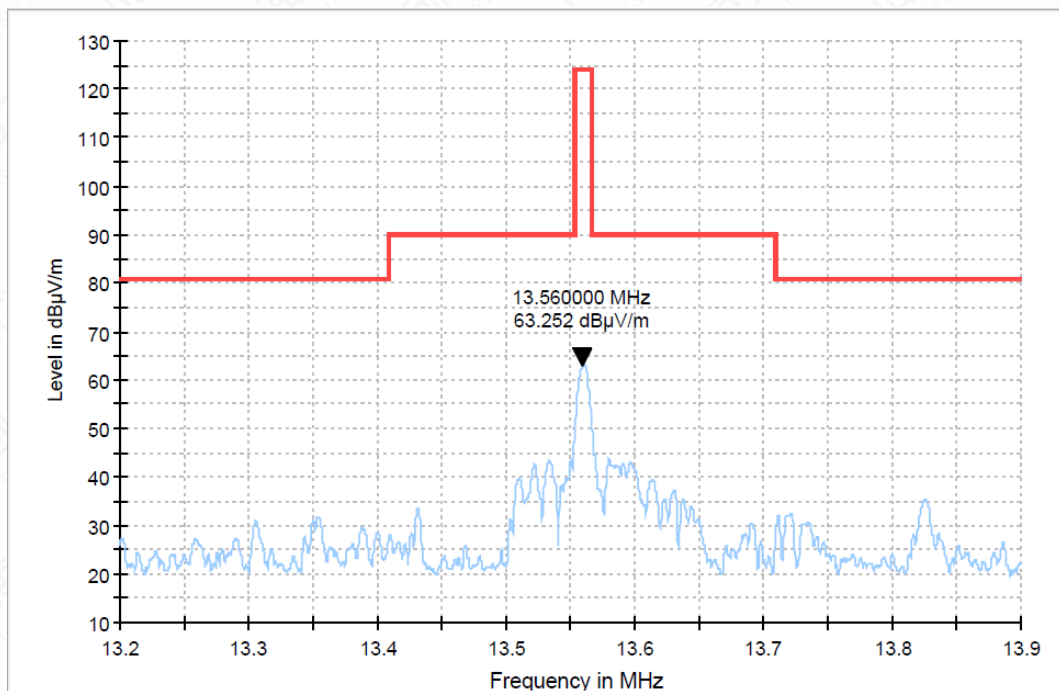


Figure A.3-1-1 Mode 1 Electric Field Strength of Fundamental Emissions

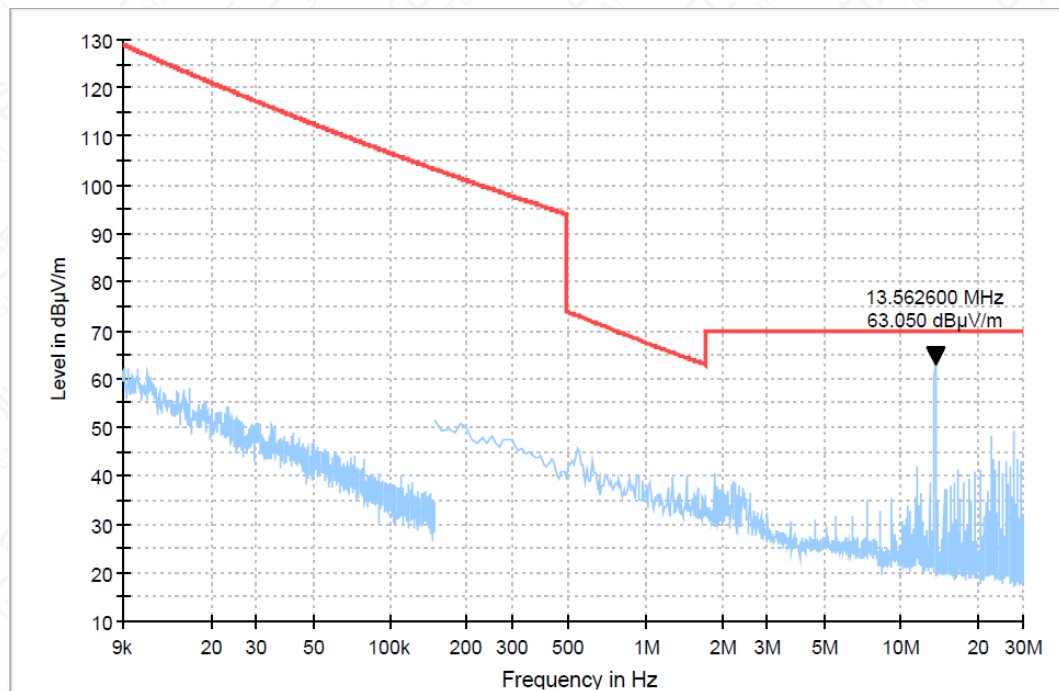


Figure A.3-2-1 Mode 1 Electric Field Radiated Emissions (Below 30MHz)

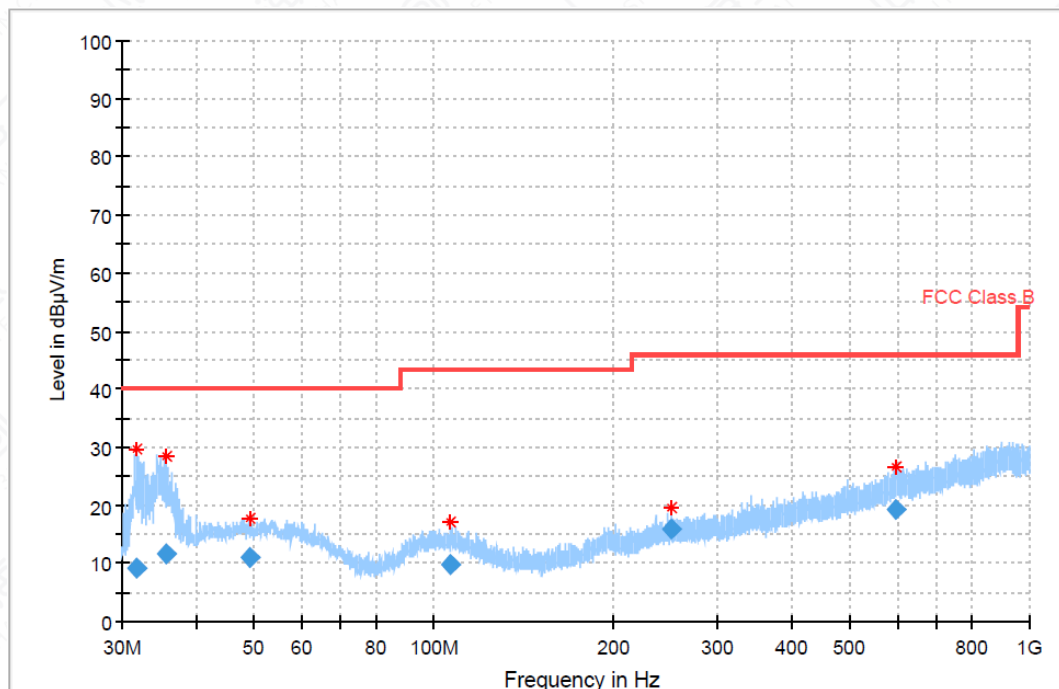


Figure A.3-3-1 Mode 1 Electric Field Radiated Emissions (Above 30MHz)

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.827248	9.25	40.00	30.75	1000.0	120.000	105.0	V
35.556008	11.62	40.00	28.38	1000.0	120.000	100.0	V
49.251829	11.07	40.00	28.93	1000.0	120.000	105.0	H
106.527928	9.73	43.50	33.77	1000.0	120.000	175.0	V
250.023080	16.01	46.00	29.99	1000.0	120.000	179.0	V
595.355509	19.41	46.00	26.59	1000.0	120.000	225.0	V

Note: Horizontal and vertical polarity is all have been tested, the result of them is synthesized in the above data diagram.

Center Freq. (MHz)	f_L (MHz)	f_H (MHz)	OBW
13.56	13.5590	13.5613	2.266 kHz

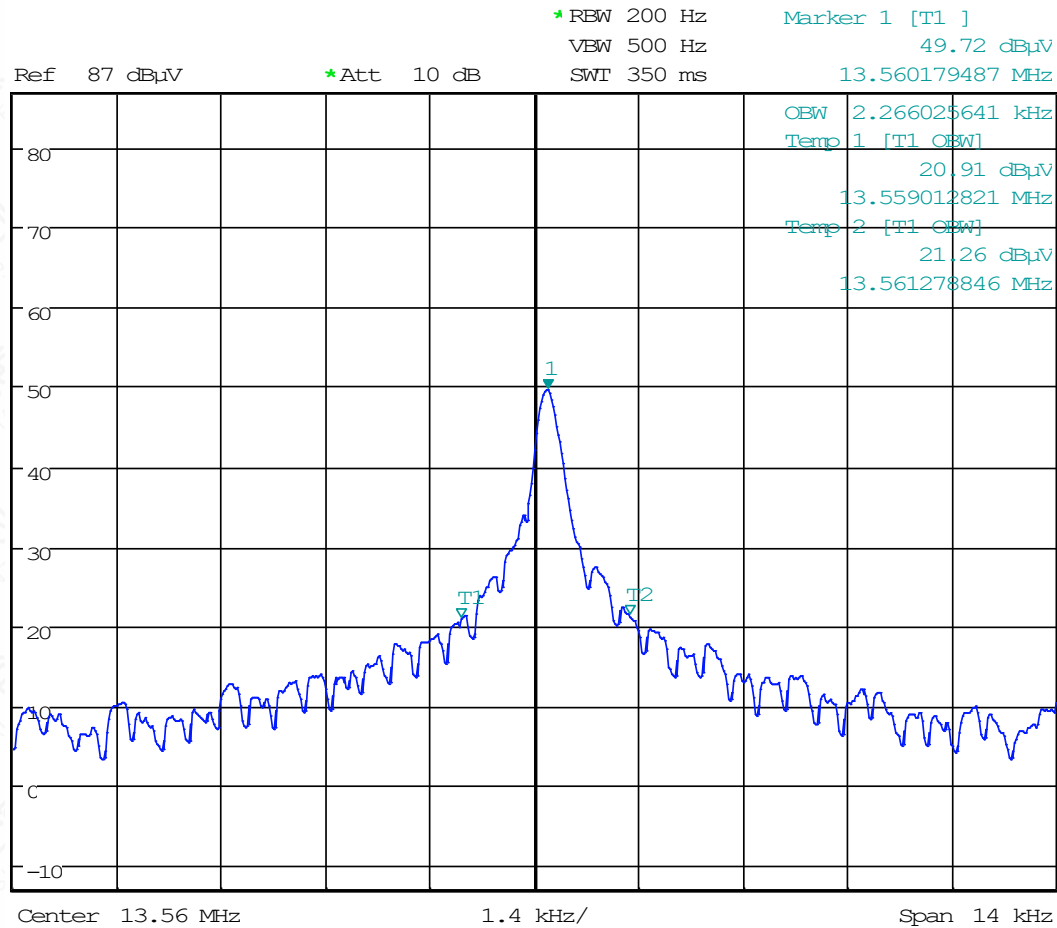


Figure A.4-1 Mode 1 Occupied bandwidth

Annex B: Revised History

Version	Revised Content
V0	Initial

Annex C: Accreditation Certificate





Accredited Laboratory

A2LA has accredited

**INDUSTRIAL INTERNET INNOVATION CENTER
(SHANGHAI) CO., LTD.**

Shanghai, People's Republic of China

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).



Presented this 20th day of September 2023.



Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3682.01
Valid to February 28, 2025

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.