FCC AND ISED CERTIFICATION TEST REPORT

Report No.: DDT-B24042312-2E01V1

Applicant	:	Rhino Sp. z o o
Address	:	Strzegomska 140A，54-429 Wrocław，Poland
Equipment under Test	:	Smart Metering Pulse Expansion Module
Model No.	:	Rhino ED DI
Trade Mark	:	N/A
FCC ID	:	2BE63EDDI915V14
IC	:	32201-EDDI915V14
Manufacturer	:	Rhino Sp. z o o
Address	:	Strzegomska 140A，54-429 Wrocław，Poland

Issued By: Tianjin Dongdian Testing Service Co., Ltd.
Address: Building D-1, No. 19, Weisi Road, Microelectronics Industrial Park Development Area, Tianjin, China.
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REPORT

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Test Report Declare

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Trade Mark	:	N/A
Manufacturer	:	Rhino Sp. z o o
Address	:	Strzegomska 140A，54-429 Wrocław，Poland

Test Standard Used:

FCC Rules and Regulations Part 15 Subpart C, RSS-247 Issue 3 August 2023.

Test Procedure Used:

ANSI C63.10:2020, RSS-Gen Issue 5, Apr. 2018.

We Declare:

The equipment described above is tested by Tianjin Dongdian Testing Service Co., Ltd and in the configuration tested the equipment complied with the standards specified above. The test results are contained in this test report and Tianjin Dongdian Testing Service Co., Ltd is assumed of full responsibility for the accuracy and completeness of these tests.

After test and evaluation, our opinion is that the equipment provided for test compliance with the requirement of the above FCC&ISED standards.

Report No.:	DDT-B24042312-2E01		
Date of Receipt:	Jul. 03, 2024	**Date of Test:**	Jul. 03, 2024~ Jul. 11, 2024

Prepared By: ***Approved By:***

Novak Wei Aaron Zhang

Novak Wei/Engineer ***Aaron Zhang/Manager***

Note: This report applies to above tested sample only. This report shall not be reproduced in parts without written approval of Tianjin Dongdian Testing Service Co., Ltd.
The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

Revision History

Rev.	Revisions	Issue Date	Revised By
---	Initial issue	Jul. 11, 2024	
V1	According request, add the PMN and HVIN in the report. This report (DDT-B24042312 2E01V1) replaces the original report (DDT B24042312-2E01), which is invalid.	Oct. 11, 2024	Novak Wei

1. Summary of Test Results

Description of Test Item	Standard	Results
6dB Bandwidth and 99% Bandwidth	FCC 15.247 (a) (2) RSS-247 Clause 5.2 (a)	Pass
Maximum Conducted Output Power	FCC 15.247 (b) (3) RSS-247 Clause 5.4 (e)	Pass
Power Spectral Density	FCC 15.247 (e) RSS-247 Clause 5.2 (b)	Pass
Band-edge and Spurious Emissions (Conducted)	FCC 15.247 (d) RSS-247 Clause 5.5	Pass
Radiated Spurious Emissions	FCC 15.247 (d) FCC 15.209 FCC 15.205 RSS-247 Clause 5.5 RSS-GEN Clause 8.9	Pass
Radiated Band Edge Compliance	FCC 15.247 (d) FCC 15.209 FCC 15.205 RSS-247 Clause 5.5 RSS-GEN Clause 8.9	Pass
Power Line Conducted Emission	FCC 15.207 RSS-GEN Clause 8.8	Pass
Antenna Requirement	FCC 15.203 RSS-GEN Clause 6.8	Pass

2. General Test Information

2.1. Description of EUT

EUT Name	:	Smart Metering Pulse Expansion Module
Model Number	:	Rhino ED DI
PMN	:	Rhino ED DI
HVIN	:	Rhino ED DI
EUT Function Description	:	Please reference user manual of this device
HW version	:	1.4
SW version	:	3.0
Power Supply	:	Built-in battery 3.6 v
Operation Band	:	902MHz-928MHz
Modulation	:	2GFSK
Data Rate	:	19.2 kbps
Antenna Gain	:	Peak Gain 3.0 dBi

Note: EUT is the abbreviation of equipment under test.

2.2. Accessories of EUT

Description of Accessories	Manufacturer	Model number	Serial No.	Other
N/A	N/A	N/A	N/A	N/A

2.3. Assistant equipment used for test

Assistant equipment	Manufacturer	Model number	EMC Compliance	SN
Notebook	Lenovo Beijing Co. Ltd.	ThinkPad E450c	CE/FCC	TP00067A

2.4. Block diagram of EUT configuration for test

Tx Mode:

EUT

Test software: putty

The test software was used to control EUT work in Continuous Tx mode, and select test channel, wireless mode as below table.

Tested mode, channel, information			
Mode	Setting Tx Power	Data rate (kbps)	Frequency (MHz)
TX Mode	14	19.2	915.369

2.5. Test environment conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature range:	+15 ℃ to +35 ℃
Humidity range:	20% to 75%
Pressure range:	86 kPa to 106 kPa

2.6. Deviations of test standard

No deviation.

2.7. Test laboratory

Tianjin Dongdian Testing Service Co., Ltd.
Address: Building D-1, No. 19, Weisi Road, Microelectronics Industrial Park Development Area, Tianjin, China.
Tel: +86-22-58038033, http://www.ddttest.com, Email: ddt@dgddt.com
NVLAP (National Voluntary Laboratory Accreditation Program) CODE: 500036-0
CNAS (China National Accreditation Service for Conformity Assessment) CODE: L13402
FCC Designation Number: CN5004; FCC Test Firm Registration Number: 368676
ISED (Innovation, Science and Economic Development Canada) Company Number: 27768
Conformity Assessment Body Identifier: CN0125
VCCI Facility Registration Number: C-20089, T-20093, R-20125, G-20122

2.8. Measurement uncertainty

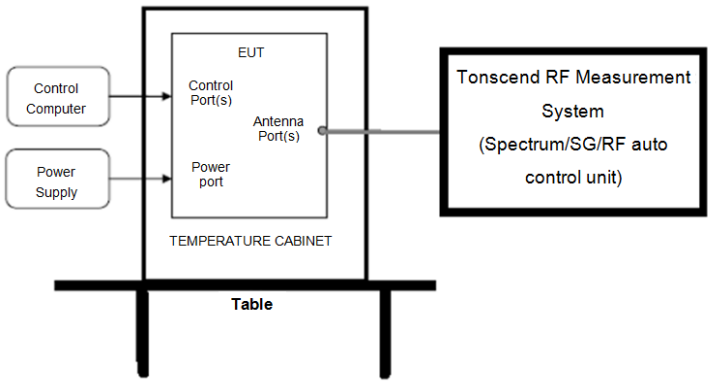
Test Item	Uncertainty
Bandwidth	0.14%
Peak Output Power (Conducted) (Spectrum Analyzer)	0.12 dB (10 MHz ≤ f < 3.6 GHz);
	0.32 dB (3.6 GHz ≤ f < 8 GHz)
Peak Output Power (Conducted) (Power Sensor)	0.51 dB
Power Spectral Density	0.12 dB (10 MHz ≤ f < 3.6 GHz);
	0.32 dB (3.6 GHz ≤ f < 8 GHz)
Frequencies Stability	6.7 x 10^{-8} (Antenna couple method)
	3.4 x 10^{-8} (Conducted method)
Conducted Spurious Emissions	0.12 dB (10 MHz ≤ f < 3.6 GHz);
	0.32 dB (3.6 GHz ≤ f < 8 GHz)
	0.52 dB (8 GHz ≤ f < 22 GHz)
Uncertainty for Radio Frequency (RBW < 20 kHz)	3×10^{-7}
Temperature	±2℃
Humidity	±1%
Uncertainty for Radiation Emission Test (30 MHz - 1 GHz)	2.72 dB (Antenna Polarize: V)
	2.72 dB (Antenna Polarize: H)
Uncertainty for Radiation Emission Test (1 GHz - 40 GHz)	2.74 dB (1 - 6 GHz)
	2.72 dB (6 GHz - 18 GHz)
	3.54 dB (18 GHz - 26 GHz)
	4.30 dB (26 GHz - 40 GHz)
Uncertainty for Power Line Conduction Emission Test	3.40 dB (150 kHz - 30 MHz)
Note: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.	

3. Equipment Used During Test

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
RF Connected Test (MWRFtest system)					
Microwave Signal Generator	R&S	SMF100A	101396	2024/02/21	1 Year
MXG Vector Signal Generator	Keysight	N5182A	MY50143288	2024/02/21	1 Year
EMI Test Receiver	R&S	ESU26	100243	2024/03/02	1 Year
Signal Analyzer	R&S	FSV	101730	2024/02/21	1 Year
Wideband Radio Communication Tester	R&S	CMW500	158800	2024/02/21	1 Year
Power Sensor	KEYSIGHT	U2021XA	MY59150007	2024/02/21	1 Year
Test Software	MWRFtest	MTS8310	V03	N/A	N/A
Radiated Emission -10m EMI Chamber					
Broadband Horn Antenna	TESEQ	BHA 9118	31754	2023/10/11	2 Year
Broad Band Horn Antenna	Schwarzbeck	BBHA 9170	790	2023/05/06	2 Year
Active Loop Antenna	R&S	HFH2-Z2	100269	2022/07/11	2 Year
EMI Test Receiver	R&S	ESCI	101027	2024/02/18	1 Year
EMI Test Receiver	R&S	ESCI	101030	2024/02/18	1 Year
Bilog Antenna	TESEQ	CBL6112D	29068	2022/10/10	2 Year
Bilog Antenna	TESEQ	CBL6112D	29069	2022/10/10	2 Year
Amplifier	Sonoma	310N	300913	2024/02/18	1 Year
Amplifier	Sonoma	310N	300911	2024/02/18	1 Year
Ant Mast	Innco	MA4000	N/A	N/A	N/A
Ant Mast	Innco	MA4000	N/A	N/A	N/A
Mast Controller	Innco	CO2000	N/A	N/A	N/A
Mast Controller	Innco	CO2000	N/A	N/A	N/A
RF Selector 4CH	TOYO	NS4904N	Selector1	N/A	N/A
RF Selector 4CH	TOYO	NS4904N	Selector2	N/A	N/A
Test software	TOYO	EP5/RSE	Ver 1.9.1	N/A	N/A
Test software	TOYO	EP5/RE	Ver 5.7.10	N/A	N/A
Test software	Audix	E3	V 6.11111b	N/A	N/A
Power Line Conducted Emissions Test					
Test Receiver	R&S	ESCI	101397	2024/02/18	1 Year
LISN	R&S	ENV216	101122	2024/02/18	1 Year
Test software	TOYO	EP5/CE	V 5.4.40	N/A	N/A

4. 6 dB Bandwidth and 99% Bandwidth

4.1. Block diagram of test setup



4.2. Limits

For direct sequence systems, the minimum 6 dB bandwidth shall be at least 500 kHz

4.3. Test procedure

(1) Connect EUT's antenna output to spectrum analyzer by RF cable.

(2) 99% Bandwidth set the spectrum analyzer as follows:

RBW:	30 kHz
VBW:	100 kHz
Detector Mode:	Peak
Sweep time:	auto
Trace mode	Max hold

(3) 6 dB Bandwidth set the spectrum analyzer as follows:

RBW:	100 kHz
VBW:	300 kHz
Detector Mode:	Peak
Sweep time:	auto
Trace mode	Max hold

(4) Allow the trace to stabilize, measure the 6 dB and 99% bandwidth of signal.

4.4. Test result

Frequency	99% bandwidth Result (MHz)	6 dB bandwidth Result (MHz)	6 dB width Limit (MHz)	Verdict
915.369MHz	0.457	0.548	>0.5	Pass

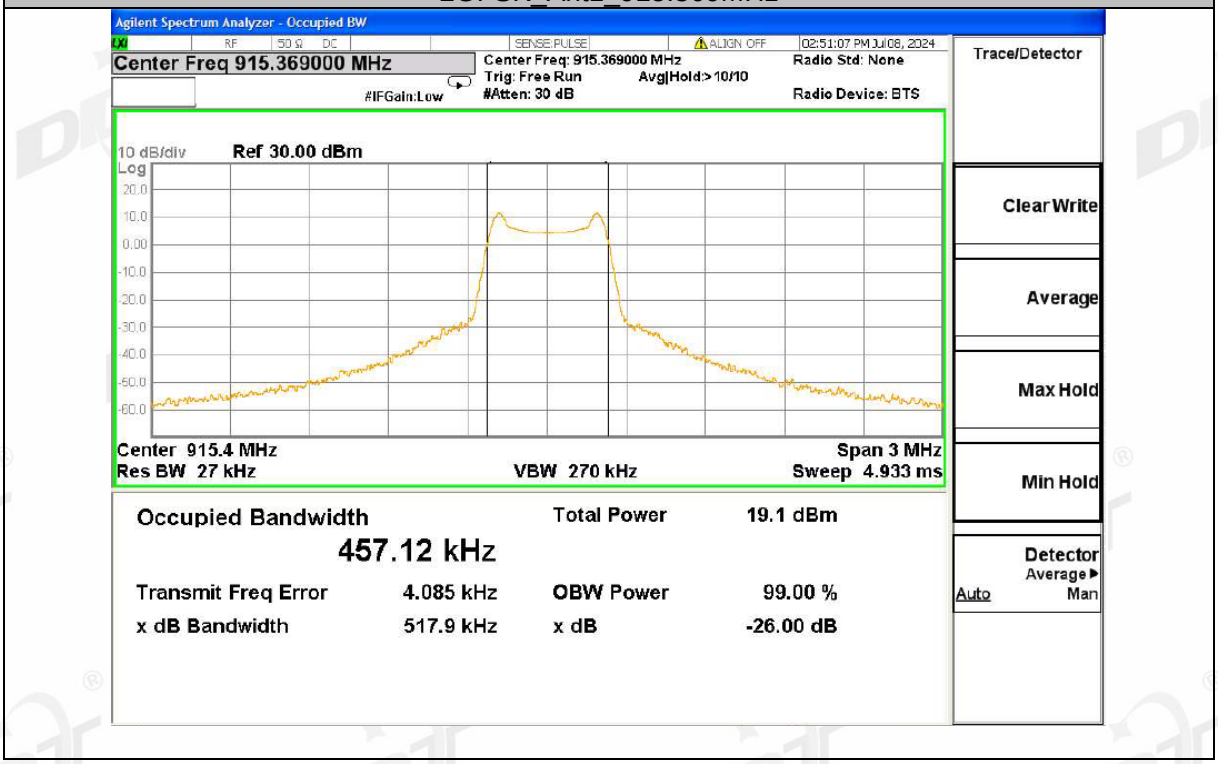
4.5. Original test data

6 dB Bandwidth:

2GFSK_Ant1_915.369MHz

99% Bandwidth

2GFSK_Ant1_915.369MHz



5. Maximum Peak Output Power

5.1. Block diagram of test setup

Same as 4.1.

5.2. Limits

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. If transmitting antennas of directional gain greater than 6dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi, the e.i.r.p shall not exceed 4W.

5.3. Test procedure

(1) Connect EUT's antenna output to spectrum analyzer by RF cable.

(2) Set the spectrum analyzer as follows:

RBW: ⩾DTS bandwidth

VBW: ⩾3 x RBW

Span⩾3 x RBW

Detector Mode: Peak

Sweep time: auto

Trace mode Max hold

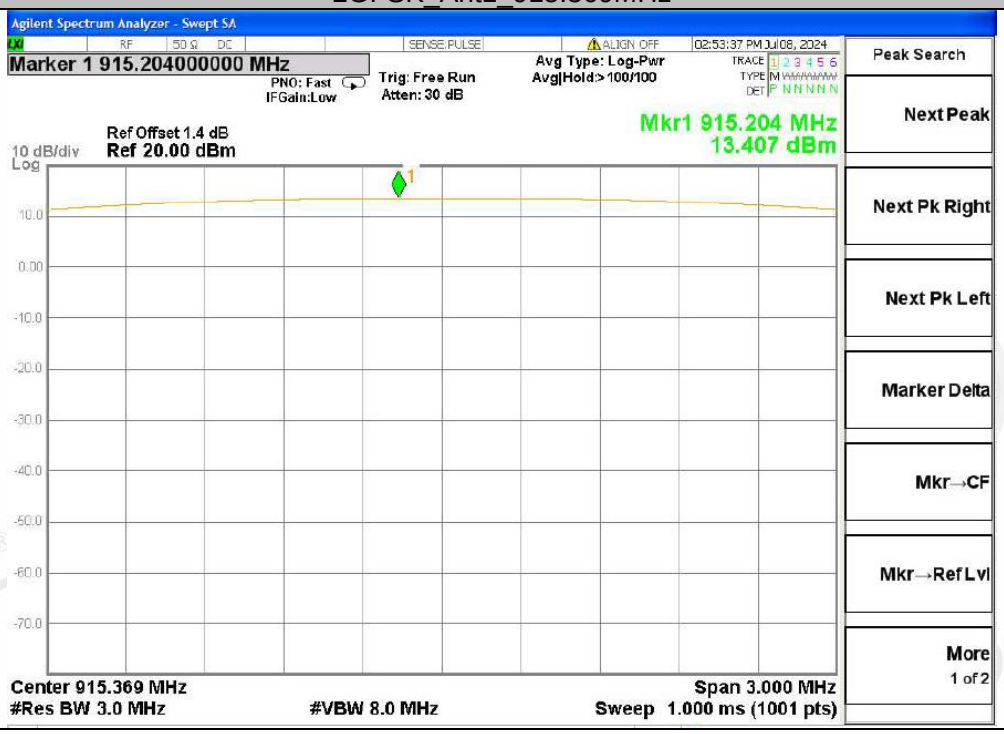
(3) Allow the trace to stabilize, Use the instrument's band/channel power measurement function with the band limits set equal to the DTS bandwidth edges measure out the PK output power.

5.4. Test result

Test Mode	Antenna	Frequency [MHz]	Conducted Peak Power [dBm]	Conducted Limit [dBm]	Antenna Gain [dBi]	EIRP [dBm]	EIRP Limit [dBm]	Verdict
2GFSK	Ant1	915.369	13.407	≤30	3	16.407	≤36	PASS

5.5. Original test data

2GFSK_Ant1_915.369MHz



6. Power Spectral Density

6.1. Block diagram of test setup

Same as 4.1.

6.2. Limits

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

6.3. Test procedure

(1) Connect EUT's antenna output to spectrum analyzer by RF cable.

(2) Set the spectrum analyzer as follows:

Center frequency	DTS Channel center frequency
RBW:	3 kHz ≤ RBW ≤ 100 kHz
VBW:	≥ 3RBW
Span	1.5 times the DTS bandwidth
Detector Mode:	Peak
Sweep time:	auto
Trace mode	Max hold

(3) Allow the trace to stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.

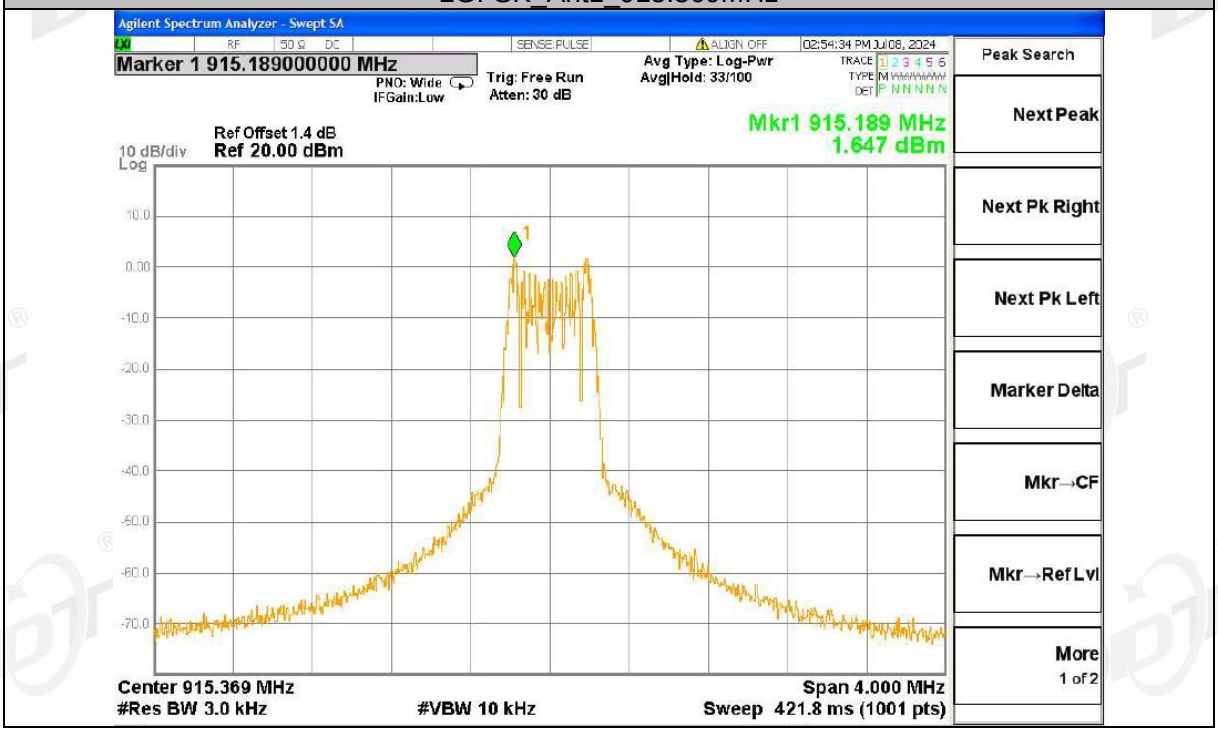
(4) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

6.4. Test result

Test Mode	Antenna	Frequency [MHz]	Result [dBm/3kHz]	Limit [dBm/3kHz]	Verdict
2GFSK	Ant1	915.987	1.647	≤8	PASS

6.5. Test graphs

2GFSK_Ant1_915.369MHz



7. Band Edge Compliance (Conducted Method)

7.1. Block diagram of test setup

Same as 4.1.

7.2. Limits

In any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

7.3. Test procedure

(1) Connect EUT's antenna output to spectrum analyzer by RF cable.

(2) Establish a reference level by using the following procedure:

Center frequency	DTS Channel center frequency
RBW:	100 kHz
VBW:	300 kHz
Span	1.5 times the DTS bandwidth
Detector Mode:	Peak
Sweep time:	Auto
Trace mode	Max hold

(3) Allow the trace to stabilize, use the peak marker function to determine the maximum peak power level to establish the reference level.

(4) Set the spectrum analyzer as follows:

RBW:	100 kHz
VBW:	300 kHz
Span	Encompass frequency range to be measured
Number of measurement points	≥ span/RBW
Detector Mode:	Peak
Sweep time:	Auto
Trace mode	Max hold

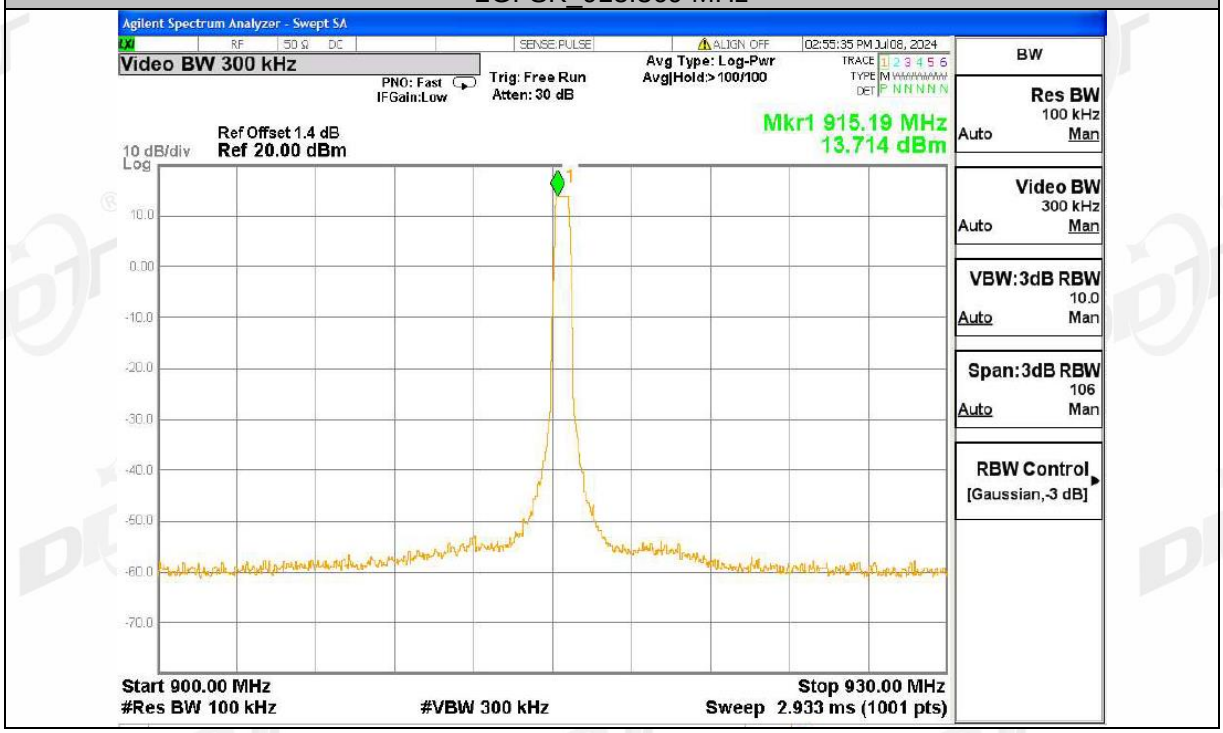
(5) Allow the trace to stabilize, use the peak marker function to determine the maximum amplitude of all unwanted emissions outside of the authorized frequency band.

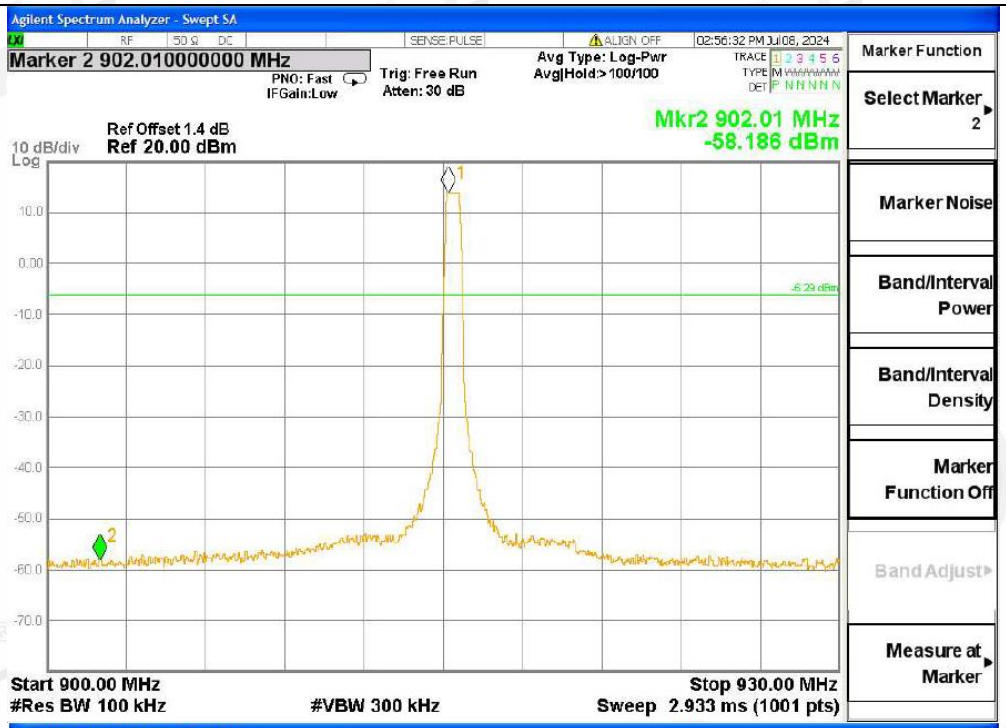
7.4. Test result

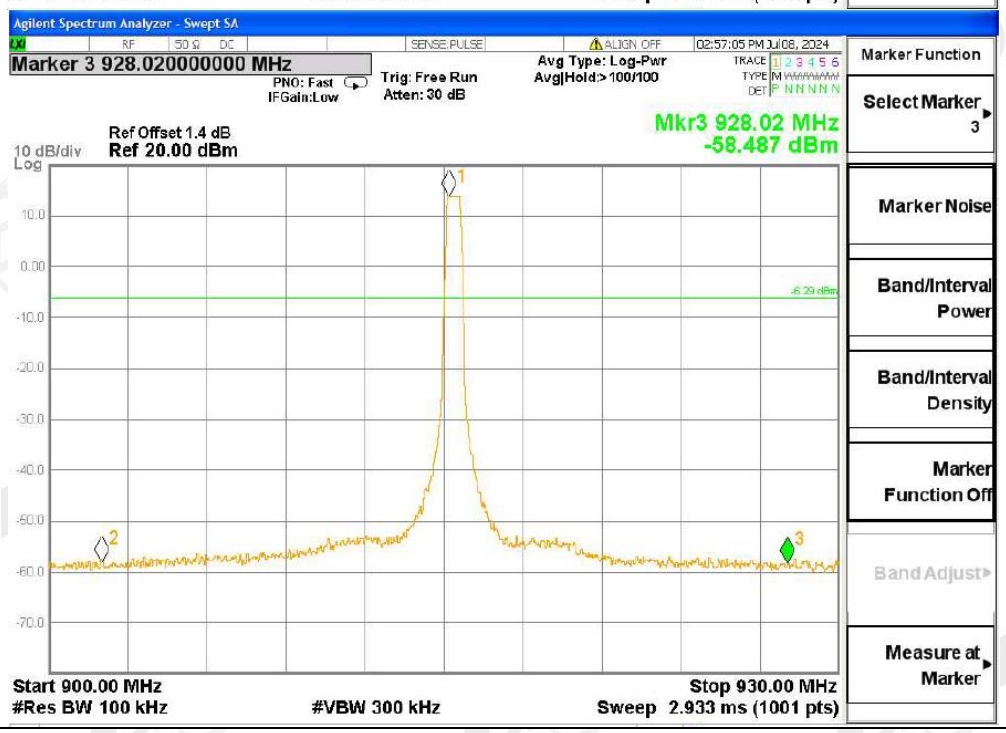
EUT Set Mode	Channel or Frequency	Measured Range	Frequency (MHz)	Result (dBm)	Limit (dBm)	Verdict
2GFSK	915.369 MHz	900 MHz - 930 MHz	902	-58.186	-6.29	Pass
			928	-58.487	-6.29	Pass

7.5. Test graphs

2GFSK_915.369 MHz

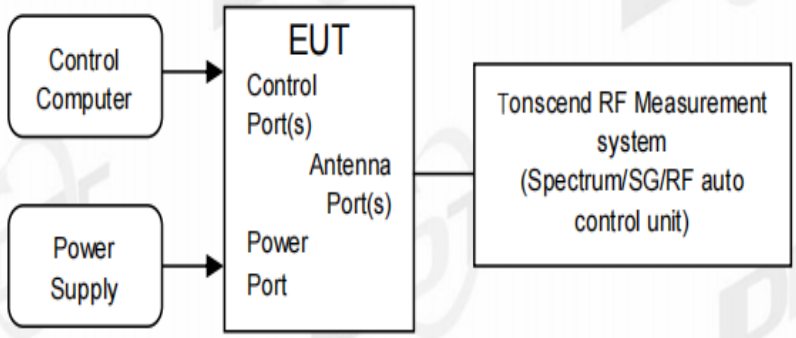



Agilent Spectrum Analyzer - Swept SA
Marker 2 902.010000000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
02:56:32 PM Jul 08, 2024
Ref Offset 1.4 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr2 902.01 MHz
-58.186 dBm
Start 900.00 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 930.00 MHz
Sweep 2.933 ms (1001 pts)
Marker Function
Select Marker 2
Marker Noise
Band/Interval Power
Band/Interval Density
Marker Function Off
Band Adjust
Measure at Marker


Agilent Spectrum Analyzer - Swept SA
Marker 3 928.020000000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
02:57:05 PM Jul 08, 2024
Ref Offset 1.4 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr3 928.02 MHz
-58.487 dBm
Start 900.00 MHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 930.00 MHz
Sweep 2.933 ms (1001 pts)
Marker Function
Select Marker 3
Marker Noise
Band/Interval Power
Band/Interval Density
Marker Function Off
Band Adjust
Measure at Marker

8. Duty cycle

8.1. Block diagram of test setup



8.2. Limit

Just for Report and determining the average value of pulsed emissions.

8.3. Test procedure

(1) Connected the EUT's antenna port to the Spectrum Analyzer by suitable attenuator, The cable loss and attenuator loss have been put into spectrum analyzer as amplitude offset.

set the Spectrum Analyzer as below:

Centre Frequency: The centre frequency of the middle hopping channel.

Resolution BW: 1 MHz.

Video BW: 1 MHz.

Span: Zero span.

Detector: Peak.

Trace Mode: Max Hold.

Sweep: Video Trigger

Sweep time: 100 ms

(2) When the trace is complete, measure the sending time of 1 burst and the duty cycle of 1 burst cycle.

(3) Calculate dwell time follow below formula:

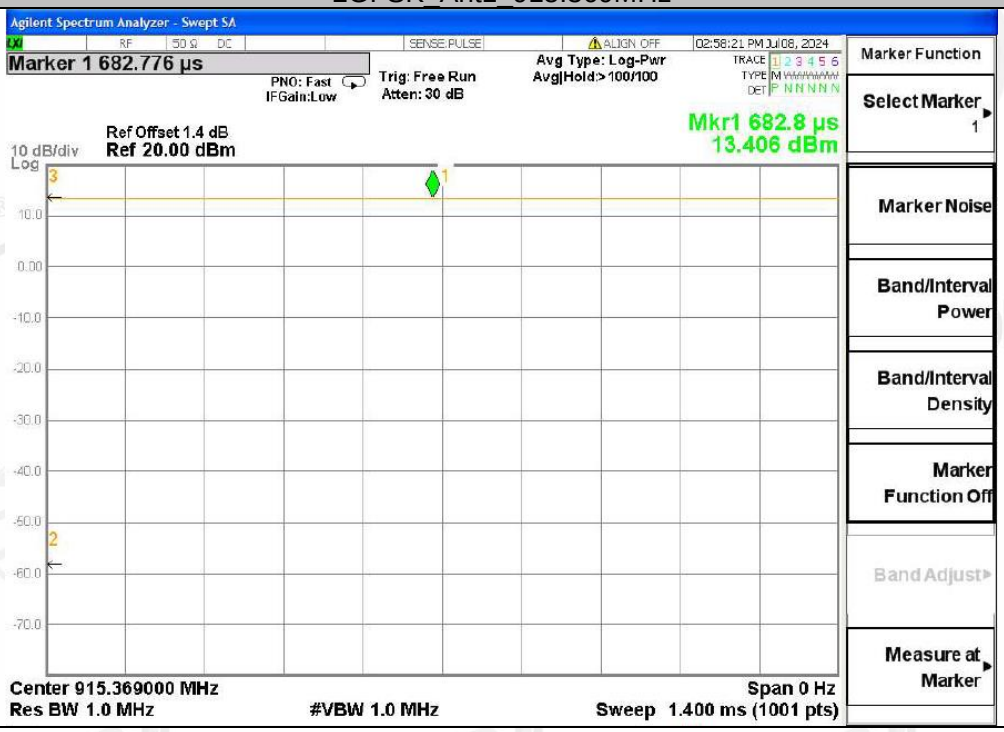
Duty cycle= Pulse's on time / Burst cycle

8.4. Test result

Test Mode	Antenna	Frequency [MHz]	ON Time [ms]	Period [ms]	Duty Cycle [%]	Duty Cycle Factor [dB]
2GFSK	Ant1	915.369	100	100	100	0

Note 1: Different frequencies have the same duty cycle.

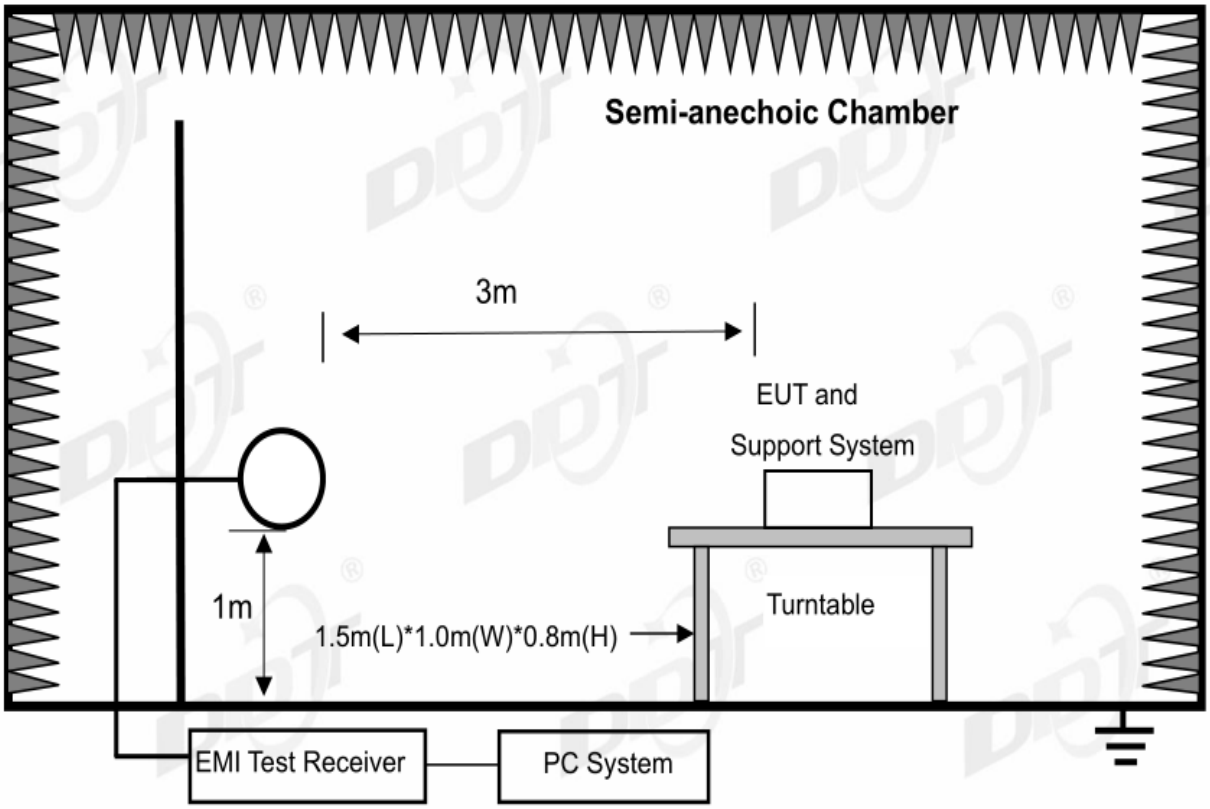
2GFSK_Ant1_915.369MHz



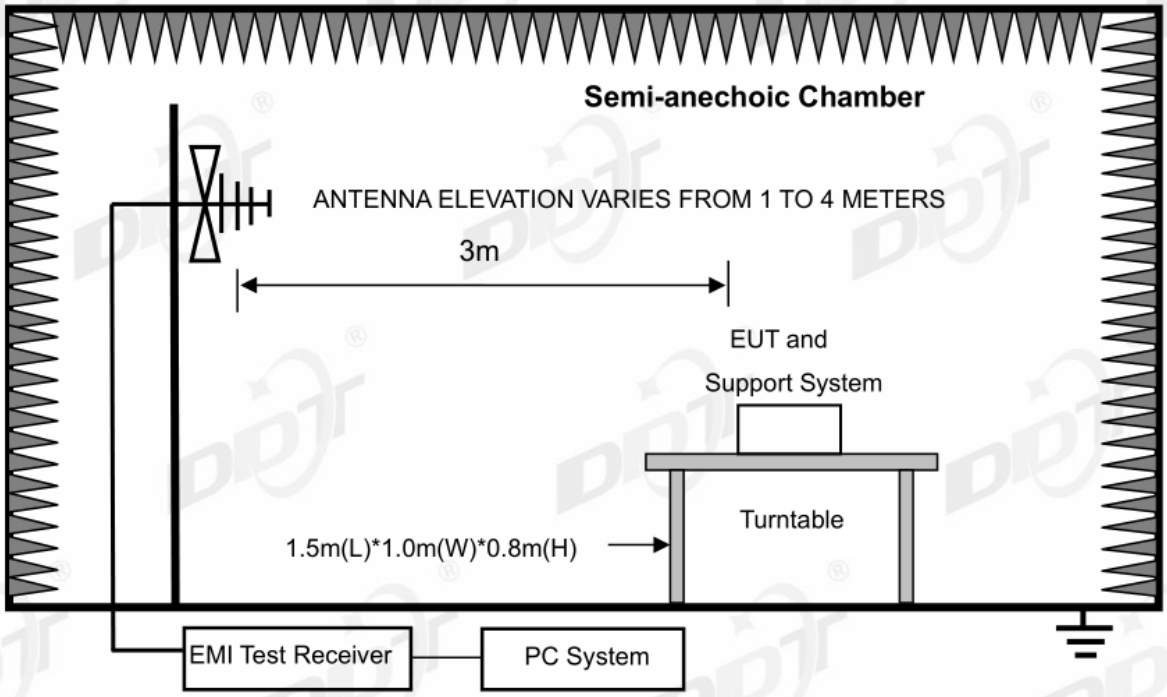
9. Radiated Emission

9.1. Block diagram of test setup

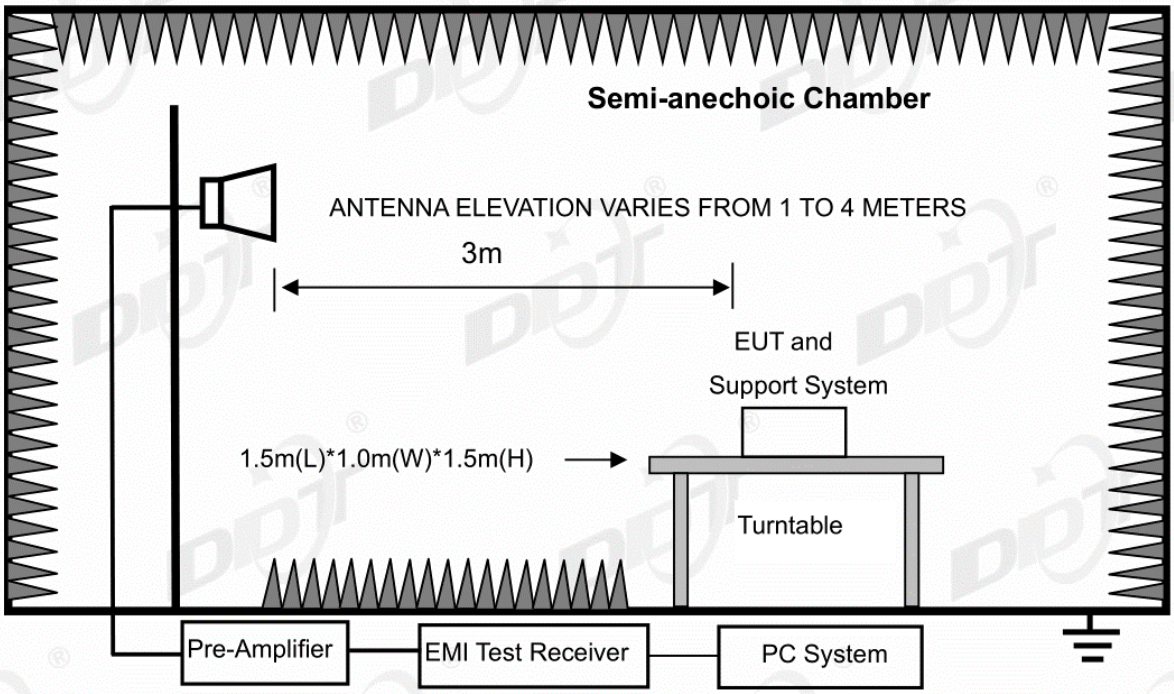
In 3 m Anechoic Chamber, test setup diagram for 9 kHz - 30 MHz:



In 3 m Anechoic Chamber, test setup diagram for 30 MHz - 1 GHz:



In 3 m Anechoic Chamber, test setup diagram for frequency above 1 GHz:



Note: For harmonic emissions test an appropriate high pass filter was inserted in the input port of AMP.

9.2. Limit

(1) FCC 15.205 Restricted frequency band

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.1772&4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.2072&4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	([2])
13.36-13.41			

[1]Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

[2]Above 38.6

RSS-Gen section 8.10 Restricted frequency bands*

MHz	MHz	MHz	GHz
0.090-0.110	12.51975-12.52025	240-285	3.5-4.4
0.495-0.505	12.57675-12.57725	322-335.4	4.5-5.15
2.1735-2.1905	13.36-13.41	399.9-410	5.35-5.46
3.020-3.026	16.42-16.423	608-614	7.25-7.75
4.125-4.128	16.69475-16.69525	960-1427	8.025-8.5
4.1772&4.17775	16.80425-16.80475	1435-1626.5	9.0-9.2
4.2072&4.20775	25.5-25.67	1645.5-1646.5	9.3-9.5
5.677-5.683	37.5-38.25	1660-1710	10.6-12.7
6.215-6.218	73-74.6	1718.8-1722.2	13.25-13.4
6.26775-6.26825	74.8-75.2	2200-2300	14.47-14.5
6.31175-6.31225	108-138	2310-2390	15.35-16.2
8.291-8.294	149.9-150.05	2483.5-2500	17.7-21.4
8.362-8.366	156.52475-156.52525	2655-2900	22.01-23.12
8.37625-8.38675	156.7-156.9	3260-3267	23.6-24.0
8.41425-8.41475	162.0125-167.17	3332-3339	31.2-31.8
12.29-12.293	167.72-173.2	3345.8-3358	36.43-36.5
			Above 38.6

* Certain frequency bands listed in table and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

(2) FCC 15.209 Limit & RSS-Gen section 8.9 Limit

FREQUENCY (MHz)	DISTANCE Meters	FIELD STRENGTHS LIMIT	
		μV/m	dB(μV)/m
0.009 ~ 0.490	300	2400/F(kHz)	67.6-20log(F)
0.490 ~ 1.705	30	24000/F(kHz)	87.6-20log(F)
1.705 ~ 30.0	30	30	29.54
30 ~ 88	3	100	40.0
88 ~ 216	3	150	43.5
216 ~ 960	3	200	46.0
960 ~ 1000	3	500	54.0
Above 1000	3	74.0 dB(μV)/m (Peak) 54.0 dB(μV)/m (Average)	

Note: (1) The emission limits shown in the above table are based on measurements employing a CISPR QP detector except for the frequency bands 9 - 90 kHz, 110 - 490 kHz and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector.

(2) At frequencies below 30 MHz, measurement may be performed at a distance closer than that specified, and the limit at closer measurement distance can be extrapolated by below formula:

$$Limit_{3m}(dBuV/m) = Limit_{30m}(dBuV/m) + 40Log(30m/3m)$$

(3) Limit for this EUT

The emissions appearing within 15.205 restricted frequency bands shall not exceed the limits shown in 15.209, and the emissions appearing within RSS-Gen section 8.10 Restricted frequency bands shall not exceed the limits shown in RSS-Gen section 8.9, all the other emissions shall be at least 20 dB below the fundamental emissions or comply with 15.209 limits and RSS-Gen section 8.9 limits.

9.3. Test Procedure

(1) EUT was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber for below 1 G and 150 cm above the ground plane inside a semi-anechoic chamber for above 1 G.

(2) Test antenna was located 3 m from the EUT on an adjustable mast, and the antenna used as below table.

Test frequency range	Test antenna used	Test antenna distance
9 kHz - 30 MHz	Active Loop antenna	3 m
30 MHz - 1 GHz	Trilog Broadband Antenna	3 m
1 GHz - 18 GHz	Double Ridged Horn Antenna (1 GHz - 18 GHz)	3 m
18 GHz - 40 GHz	Horn Antenna (18 GHz - 40 GHz)	1 m

According ANSI C63.10:2013 clause 6.4.4.2 and 6,5.3, for measurements below 30 MHz, the loop antenna was positioned with its plane vertical from the EUT and rotated about its vertical axis for maximum response at each azimuth position around the EUT. And the loop antenna also is positioned with its plane horizontal at the specified distance from the EUT. The center of the loop is 1 m above the ground. For measurement above 30 MHz, the Trilog Broadband Antenna or Horn Antenna was located 3 m from EUT, Measurements were made with the antenna positioned in both the horizontal and vertical planes of Polarization, and the measurement antenna was varied from 1 m to 4 m. in height above the reference ground plane to obtain the maximum signal strength.

(3) Below pre-scan procedure was first performed in order to find prominent frequency spectrum radiated emissions from 9 kHz to 25 GHz:

(a) Scanning the peak frequency spectrum with the antenna specified in step (3), and the EUT was rotated 360 degree, the antenna height was varied from 1 m to 4 m (Except loop antenna, it's fixed 1 m above ground.)

(b) Change work frequency or channel of device if practicable.

(c) Change modulation type of device if practicable.

(d) Change power supply range from 85% to 115% of the rated supply voltage

(e) Rotated EUT though three orthogonal axes to determine the attitude of EUT arrangement produces highest emissions.

Spectrum frequency from 9 kHz to 25 GHz (tenth harmonic of fundamental frequency) was investigated, and no any obvious emission were detected from 9 kHz to 30 MHz and 18 GHz to 25 GHz, so below final test was performed with frequency range from 30 MHz to 18 GHz.

(4) For final emissions measurements at each frequency of interest, the EUT was rotated and the antenna height was varied between 1 m and 4 m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. In order to find the maximum emission, the relative positions of equipments and all of the interface cables were changed according to ANSI C63.10:2013 on Radiated Emission test.

(5) The emissions from 9 kHz to 1 GHz were measured based on CISPR QP detector except for the frequency bands 9 - 90 kHz, 110 - 490 kHz, for emissions from 9 kHz - 90 kHz, 110 kHz - 490 kHz and above 1 GHz were measured based on average detector, for emissions above 1 GHz, peak emissions also be measured and need comply with Peak limit.

(6) The emissions from 9 kHz to 1 GHz, QP or average values were measured with EMI receiver with below RBW

Frequency band	RBW
9 kHz - 150 kHz	200 Hz
150 kHz - 30 MHz	9 kHz
30 MHz - 1 GHz	120 kHz

(7) For emissions above 1 GHz, both Peak and Average level were measured with Spectrum Analyzer, and the RBW is set at 1 MHz, VBW is set at 3 MHz for Peak measure; According ANSI C63.10:2013 clause 4.1.4.2.2 procedure for average measure.

9.4. Test result

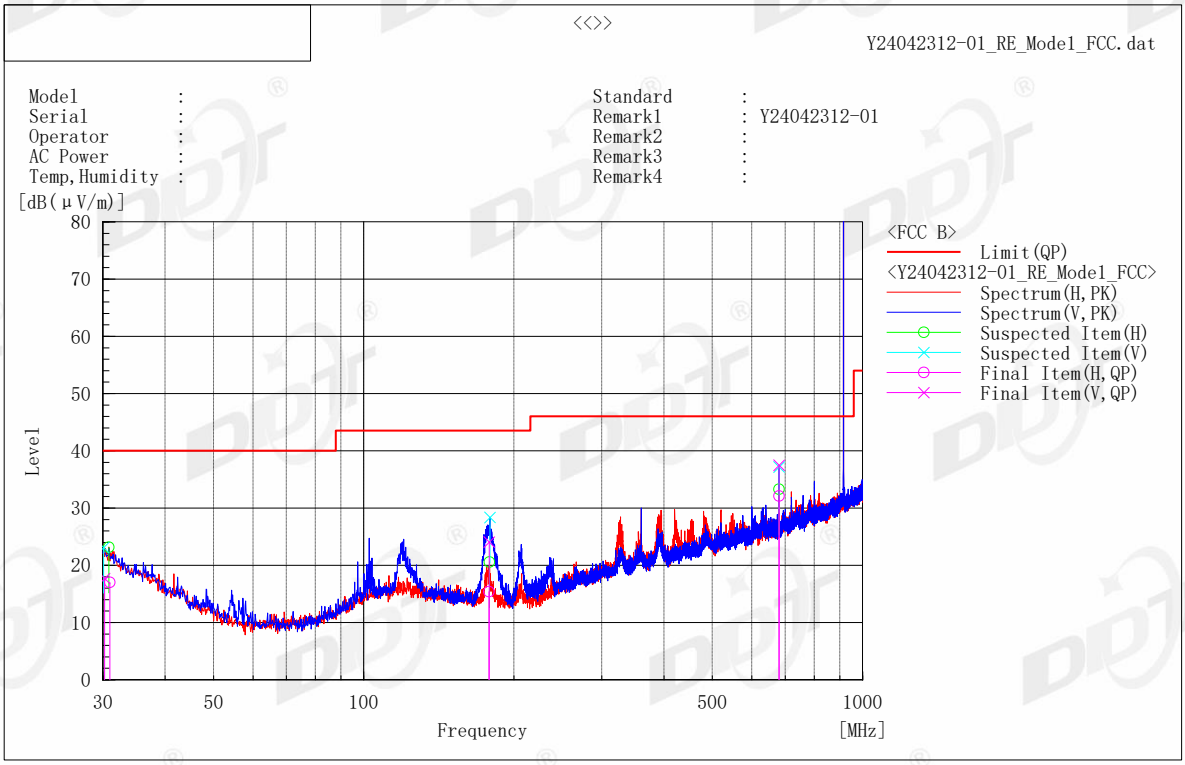
Pass. (See below detailed test result)

All the emissions except fundamental emission from 9 kHz to 25 GHz were comply with 15.209 limits and RSS-Gen section 8.9 limits.

Note1: According exploratory test, the emission levels are 20 dB below the limit detected from 9 kHz to 30 MHz and 18 GHz to 25 GHz, so the final test was performed with frequency range from 30 MHz to 18 GHz and recorded in below.

Note2: For emissions above 1 GHz. If peak results comply with AV limit, AV Result is deemed to comply with AV limit.

Radiated Emission test (below 1 GHz)



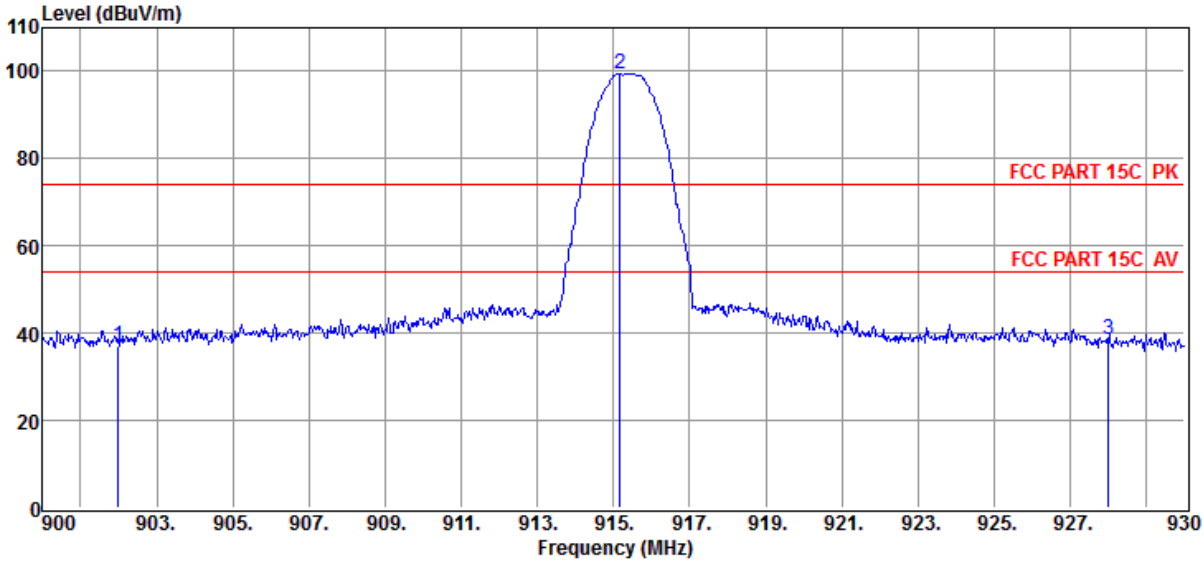
Final Result

No.	Frequency [MHz]	(P)	Reading QP [dB(μV)]	c.f [dB(1/m)]	Result QP [dB(μV/m)]	Limit QP [dB(μV/m)]	Margin QP [dB]	Height [cm]	Angle [°]
1	30.995	H	22.6	-5.6	17.0	40.0	23.0	215.0	128.5
2	178.306	H	27.9	-12.5	15.4	43.5	28.1	226.0	325.7
3	679.997	H	31.3	0.8	32.1	46.0	13.9	112.0	4.2
4	30.228	V	22.8	-5.1	17.7	40.0	22.3	213.0	231.1
5	178.444	V	36.6	-12.5	24.1	43.5	19.4	109.0	357.1
6	679.999	V	36.7	0.8	37.5	46.0	8.5	107.0	283.5

Radiated Emission Test Result

Test Site	: 3m Chamber		
Test Date	: 07-09-2024	**Tested By**	: Novak
EUT	: Smart Metering Pulse Expansion Module	**Model Number**	: Rhino ED DI
Power Supply	: Battery	**Test Mode**	: Tx mode
Memo	:		

Data: 18



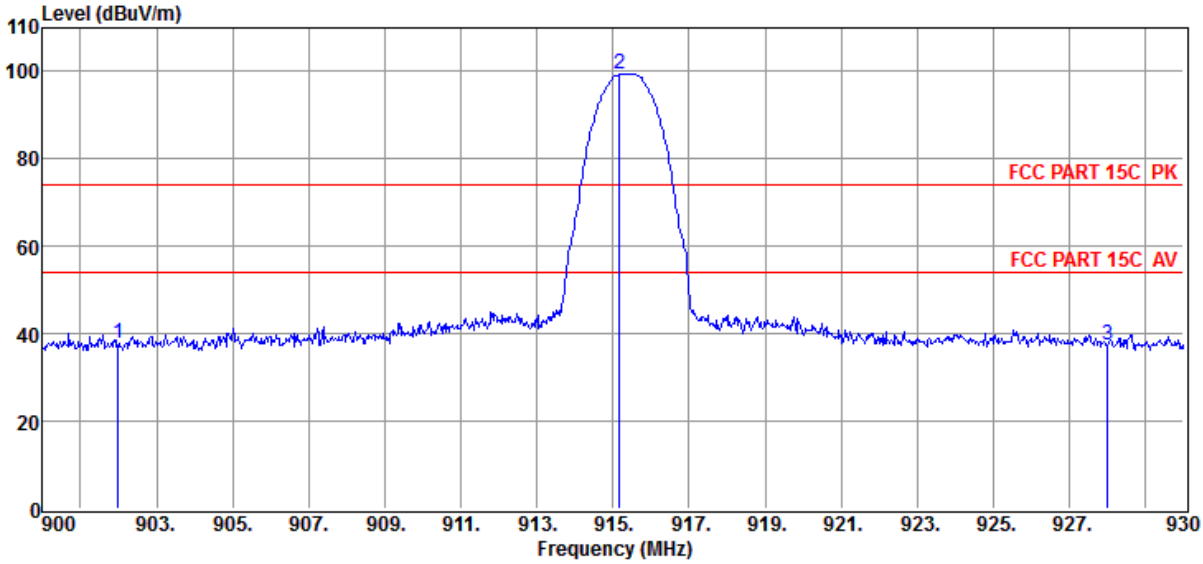
Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Polarization
1	902.00	45.65	26.06	-34.60	37.11	74.00	-36.89	Peak	HORIZONTAL
2	915.18	107.79	26.10	-34.56	99.33	74.00	25.33	Peak	HORIZONTAL
3	928.00	46.75	26.30	-34.47	38.58	74.00	-35.42	Peak	HORIZONTAL

Note: 1. Result Level = Read Level + Antenna Factor + Cable loss.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 1 MHz, VBW: 3 MHz, Sweep time: auto.
4. Margin = Result Level - Limit.

Radiated Emission Test Result

Test Site	: 3m Chamber		
Test Date	: 07-09-2024	**Tested By**	: Novak
EUT	: Smart Metering Pulse Expansion Module	**Model Number**	: Rhino ED DI
Power Supply	: Battery	**Test Mode**	: Tx mode
Memo	:		

Data: 17



Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Polarization
1	902.00	46.44	26.06	-34.60	37.90	74.00	-36.10	Peak	VERTICAL
2	915.18	107.81	26.10	-34.56	99.35	74.00	25.35	Peak	VERTICAL
3	928.00	45.73	26.30	-34.47	37.56	74.00	-36.44	Peak	VERTICAL

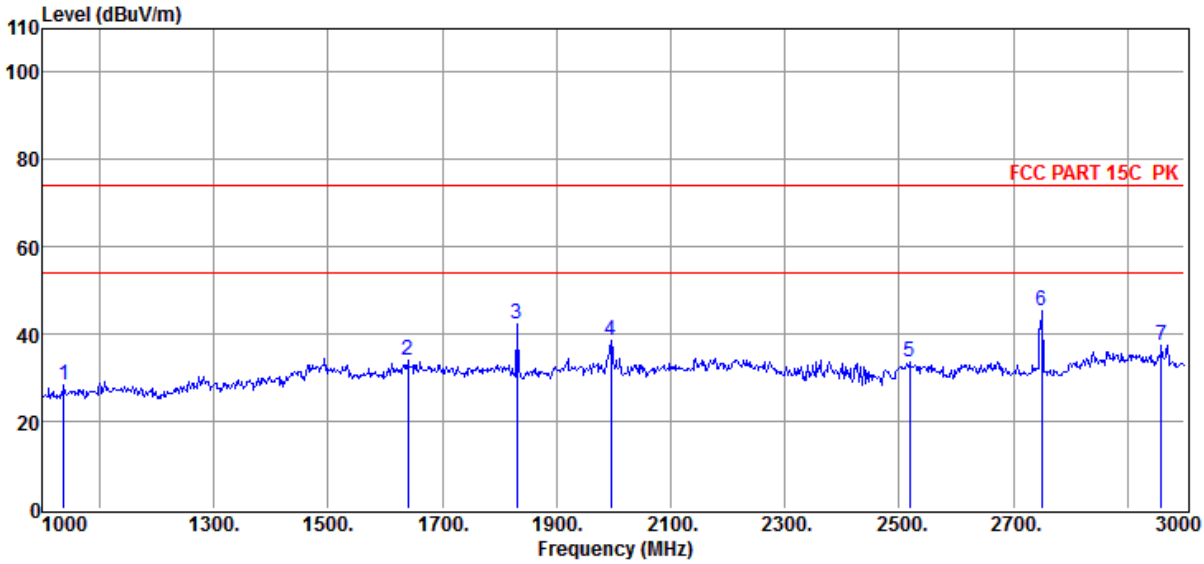
Note: 1. Result Level = Read Level + Antenna Factor + Cable loss.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 1 MHz, VBW: 3 MHz, Sweep time: auto.
4. Margin = Result Level - Limit.

Radiated Emission test (above 1 GHz)

Radiated Emission Test Result

Test Site	: 3m Chamber		
Test Date	: 07-09-2024	**Tested By**	: Novak
EUT	: Smart Metering Pulse Expansion Module	**Model Number**	: Rhino ED DI
Power Supply	: DC 3.6V	**Test Mode**	: Tx mode
Memo	:		

Data: 19



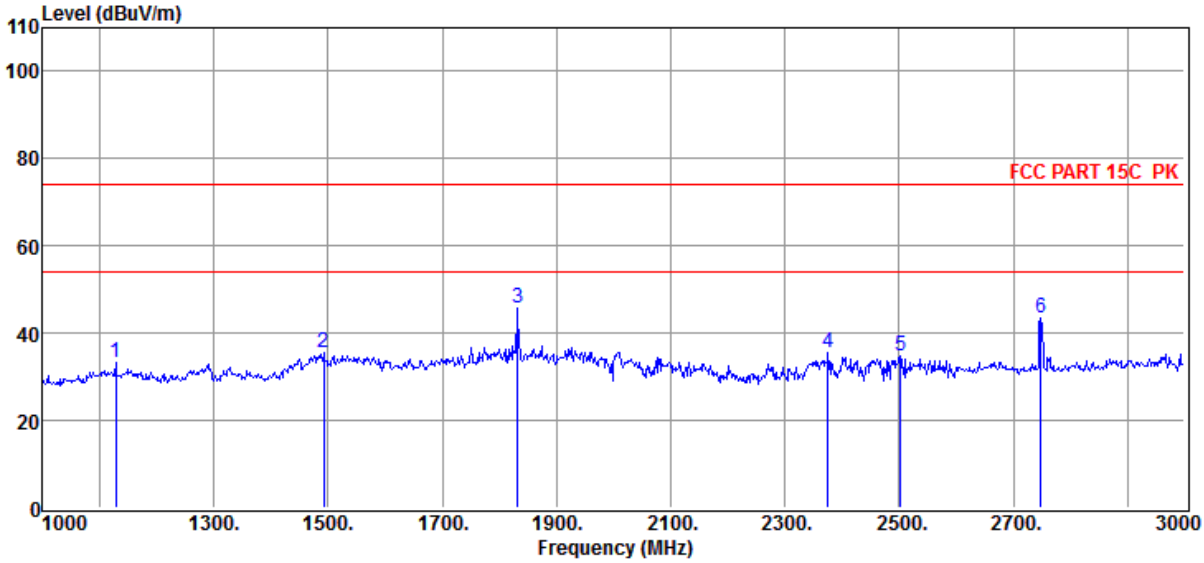
Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Polarization
1	1038.00	41.01	22.30	-35.13	28.18	74.00	-45.82	Peak	HORIZONTAL
2	1640.00	43.14	25.29	-34.55	33.88	74.00	-40.12	Peak	HORIZONTAL
3	1830.00	50.45	26.09	-34.39	42.15	74.00	-31.85	Peak	HORIZONTAL
4	1996.00	46.32	26.78	-34.39	38.71	74.00	-35.29	Peak	HORIZONTAL
5	2518.00	41.98	25.07	-33.53	33.52	74.00	-40.48	Peak	HORIZONTAL
6	2750.00	52.69	26.00	-33.46	45.23	74.00	-28.77	Peak	HORIZONTAL
7	2960.00	44.19	26.84	-33.56	37.47	74.00	-36.53	Peak	HORIZONTAL

Note: 1. Result Level = Read Level + Antenna Factor + Cable loss.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 1 MHz, VBW: 3 MHz, Sweep time: auto.
4. Margin = Result Level - Limit.

Radiated Emission Test Result

Test Site	: 3m Chamber		
Test Date	: 07-09-2024	**Tested By**	: Novak
EUT	: Smart Metering Pulse Expansion Module	**Model Number**	: Rhino ED DI
Power Supply	: DC 3.6V	**Test Mode**	: Tx mode
Memo	:		

Data: 20



Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Polarization
1	1128.00	45.50	22.77	-35.17	33.10	74.00	-40.90	Peak	VERTICAL
2	1492.00	45.43	24.66	-34.71	35.38	74.00	-38.62	Peak	VERTICAL
3	1832.00	53.88	26.09	-34.41	45.56	74.00	-28.44	Peak	VERTICAL
4	2376.00	43.93	25.45	-33.99	35.39	74.00	-38.61	Peak	VERTICAL
5	2502.00	43.17	25.01	-33.53	34.65	74.00	-39.35	Peak	VERTICAL
6	2748.00	50.84	25.99	-33.46	43.37	74.00	-30.63	Peak	VERTICAL

Note: 1. Result Level = Read Level + Antenna Factor + Cable loss.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 1 MHz, VBW: 3 MHz, Sweep time: auto.
4. Margin = Result Level - Limit.

Radiated Emission Test Result

Test Site : 3m Chamber

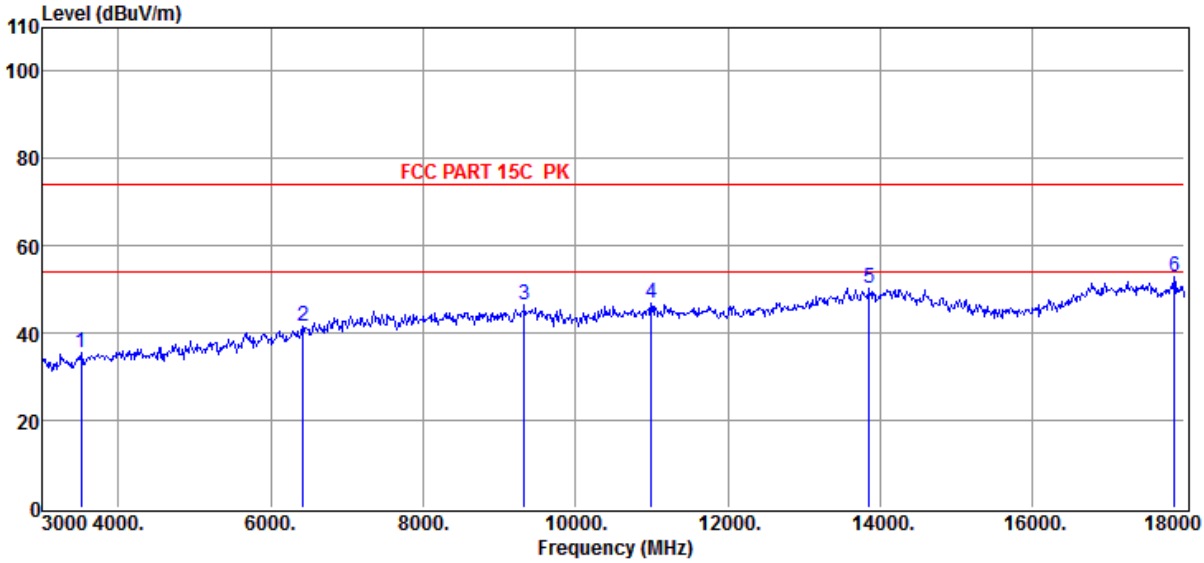
Test Date : 07-09-2024 **Tested By** : Novak

EUT : Smart Metering Pulse Expansion Module **Model Number** : Rhino ED DI

Power Supply : DC 3.6V **Test Mode** : Tx mode

Memo :

Data: 22



Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Polarization
1	3510.00	37.46	30.42	-32.52	35.36	74.00	-38.64	Peak	HORIZONTAL
2	6420.00	37.47	35.72	-31.75	41.44	74.00	-32.56	Peak	HORIZONTAL
3	9330.00	38.84	37.90	-30.07	46.67	74.00	-27.33	Peak	HORIZONTAL
4	10995.00	37.10	38.70	-28.86	46.94	74.00	-27.06	Peak	HORIZONTAL
5	13860.00	37.94	41.12	-28.77	50.29	74.00	-23.71	Peak	HORIZONTAL
6	17865.00	37.54	42.39	-27.11	52.82	74.00	-21.18	Peak	HORIZONTAL

Note: 1. Result Level = Read Level + Antenna Factor + Cable loss.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 1 MHz, VBW: 3 MHz, Sweep time: auto.
4. Margin = Result Level - Limit.

Radiated Emission Test Result

Test Site : 3m Chamber

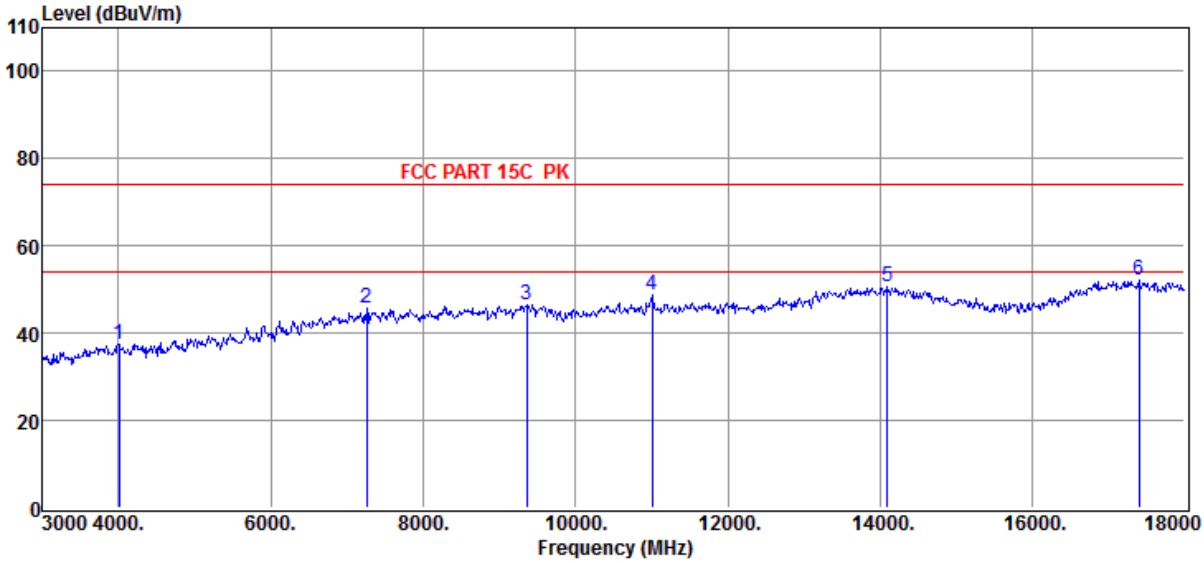
Test Date : 07-09-2024 **Tested By** : Novak

EUT : Smart Metering Pulse Expansion Module **Model Number** : Rhino ED DI

Power Supply : DC 3.6V **Test Mode** : Tx mode

Memo :

Data: 21

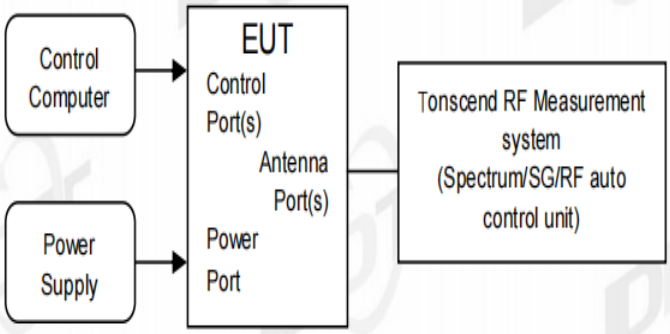


Item (Mark)	Freq. (MHz)	Read Level (dBµV)	Antenna Factor (dB/m)	Cable Loss dB	Result Level (dBµV/m)	Limit Line (dBµV/m)	Over Limit (dB)	Detector	Polarization
1	4005.00	37.81	31.60	-32.03	37.38	74.00	-36.62	Peak	VERTICAL
2	7260.00	39.20	37.02	-30.63	45.59	74.00	-28.41	Peak	VERTICAL
3	9360.00	38.34	37.92	-29.93	46.33	74.00	-27.67	Peak	VERTICAL
4	11010.00	38.84	38.70	-28.83	48.71	74.00	-25.29	Peak	VERTICAL
5	14100.00	37.46	41.26	-28.19	50.53	74.00	-23.47	Peak	VERTICAL
6	17400.00	36.52	42.76	-27.17	52.11	74.00	-21.89	Peak	VERTICAL

Note: 1. Result Level = Read Level + Antenna Factor + Cable loss.
2. If Peak Result complies with AV limit, AV Result is deemed to comply with AV limit.
3. Test setup: RBW: 1 MHz, VBW: 3 MHz, Sweep time: auto.
4. Margin = Result Level - Limit.

10. RF Conducted Spurious Emissions

10.1. Block diagram of test setup



10.2. Limits

In any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

10.3. Test procedure

(1) Connect EUT's antenna output to spectrum analyzer by RF cable.

(2) Establish a reference level by using the following procedure:

RBW:	100 kHz
VBW:	300 kHz
Span	Encompass frequency range to be measured
Detector Mode:	Peak
Sweep time:	Auto
Trace mode	Max hold

(3) Allow the trace to stabilize, use the peak marker function to determine the maximum peak power level to establish the reference level.

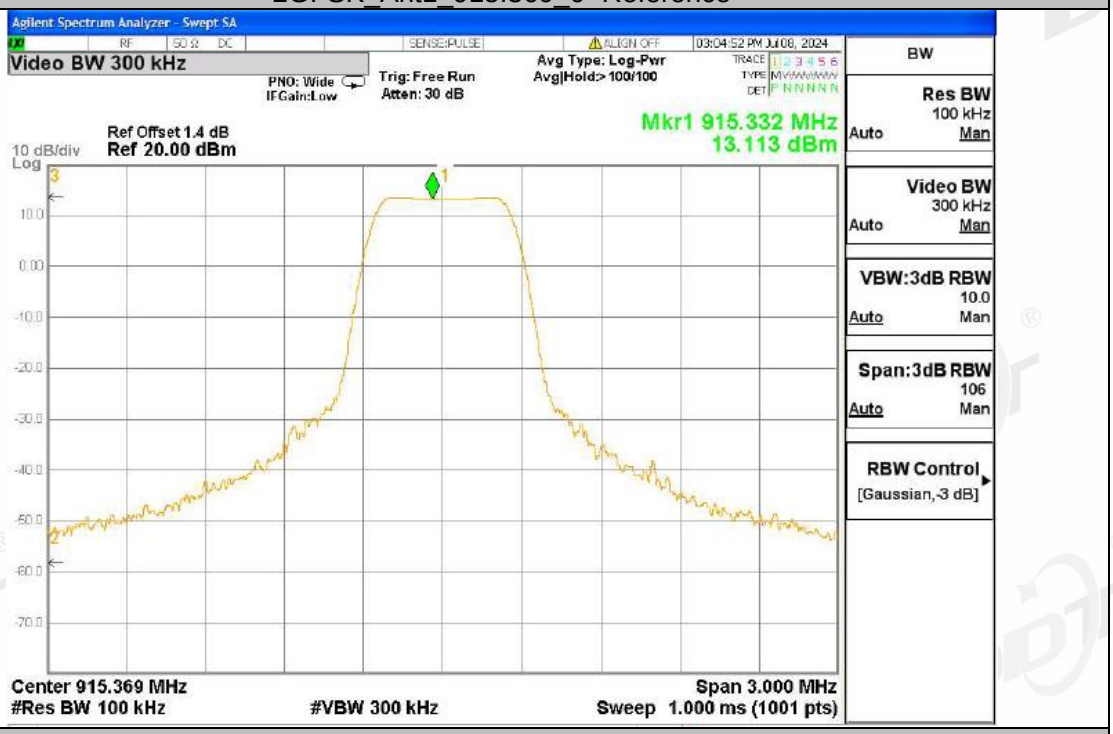
(4) Then mark the maximum amplitude of all unwanted emissions outside of the authorized frequency band.

10.4. Test result

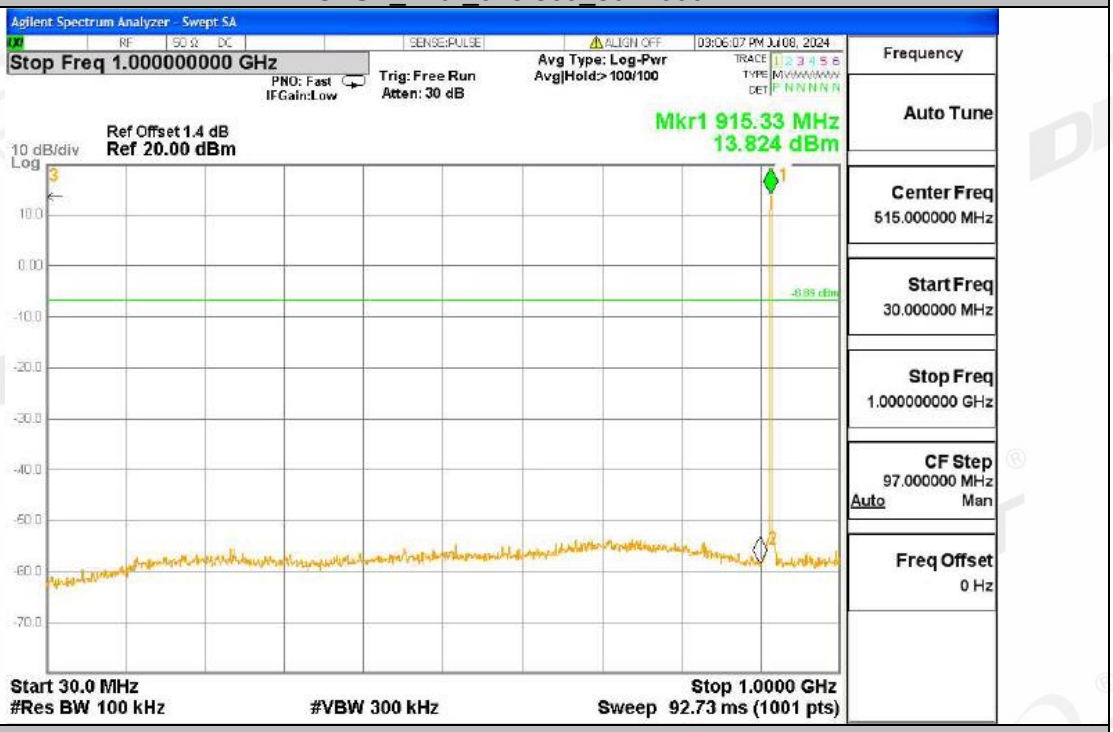
Mode	Frequency (MHz)	Verdict
2GFSK	915.369	Pass

10.5. Test graphs

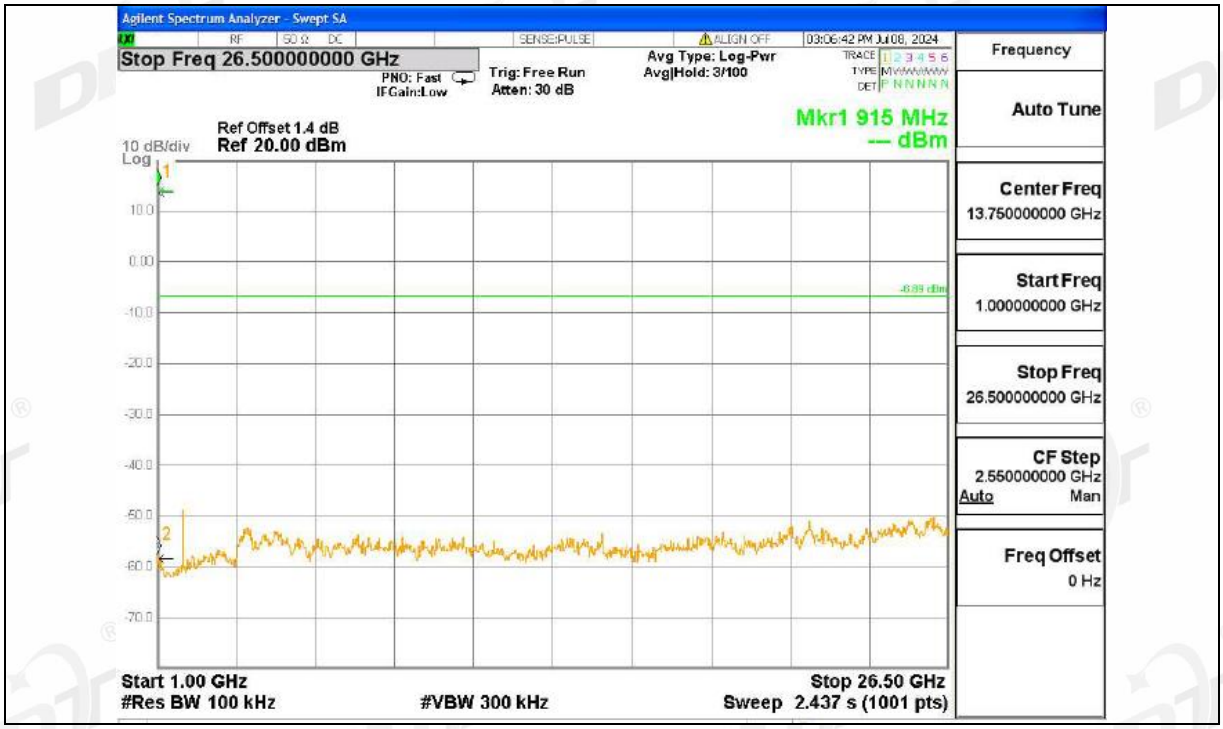
2GFSK_Ant1_915.369_0~Reference



2GFSK_Ant1_915.369_30~1000

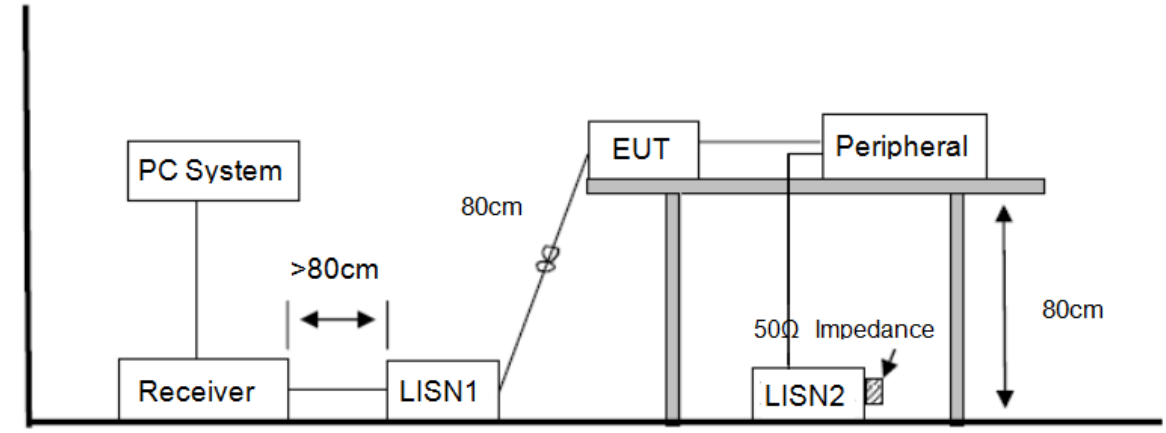


2GFSK_Ant1_915.369_1000~26500


Agilent Spectrum Analyzer - Swept SA
Stop Freq 26.500000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold: 3/100
Ref Offset 1.4 dB
10 dB/div
Ref 20.00 dBm
Log
Mkr1 915 MHz
--- dBm
Start 1.00 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 26.50 GHz
Sweep 2.437 s (1001 pts)
Frequency
Auto Tune
Center Freq
13.750000000 GHz
Start Freq
1.000000000 GHz
Stop Freq
26.500000000 GHz
CF Step
2.550000000 GHz
Auto
Man
Freq Offset
0 Hz

11. Power Line Conducted Emission

11.1. Block diagram of test setup



11.2. Power line conducted emission limits

Frequency	Quasi-Peak Level dB(μV)	Average Level dB(μV)
150 kHz ~ 500 kHz	66 ~ 56*	56 ~ 46*
500 kHz ~ 5 MHz	56	46
5 MHz ~ 30 MHz	60	50

Note 1: * Decreasing linearly with logarithm of frequency.

Note 2: The lower limit shall apply at the transition frequencies.

11.3. Test procedure

The EUT and Support equipment, if needed, were put placed on a non-metallic table, 80 cm above the ground plane.

Configuration EUT to simulate typical usage as described in clause 2.4 and test equipment setup as described in clause 13.1 of this report.

All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10.

All support equipment power received from a second LISN.

Emissions were measured on each current carrying line of the EUT using an EMI Test Receiver connected to the LISN powering the EUT.

The Receiver scanned from 150 kHz to 30 MHz for emissions in each of the test modes.

During the above scans, the emissions were maximized by cable manipulation.

The test mode(s) described in clause 2.4 were scanned during the preliminary test.

After the preliminary scan, we found the test mode producing the highest emission level.

The EUT configuration and worse cable configuration of the above highest emission levels were

recorded for reference of the final test.

EUT and support equipment were set up on the test bench as per the configuration with highest emission level in the preliminary test.

A scan was taken on both power lines, Neutral and Line, recording at least the six highest emissions.

Emission frequency and amplitude were recorded into a computer in which correction factors were used to calculate the emission level and compare reading to the applicable limit.

The test data of the worst-case condition(s) was recorded.

The bandwidth of test receiver is set at 9 kHz.

11.4. Test result

N/A

Note:
The EUT is powered by an internal battery and no testing is required

12. Antenna Requirements

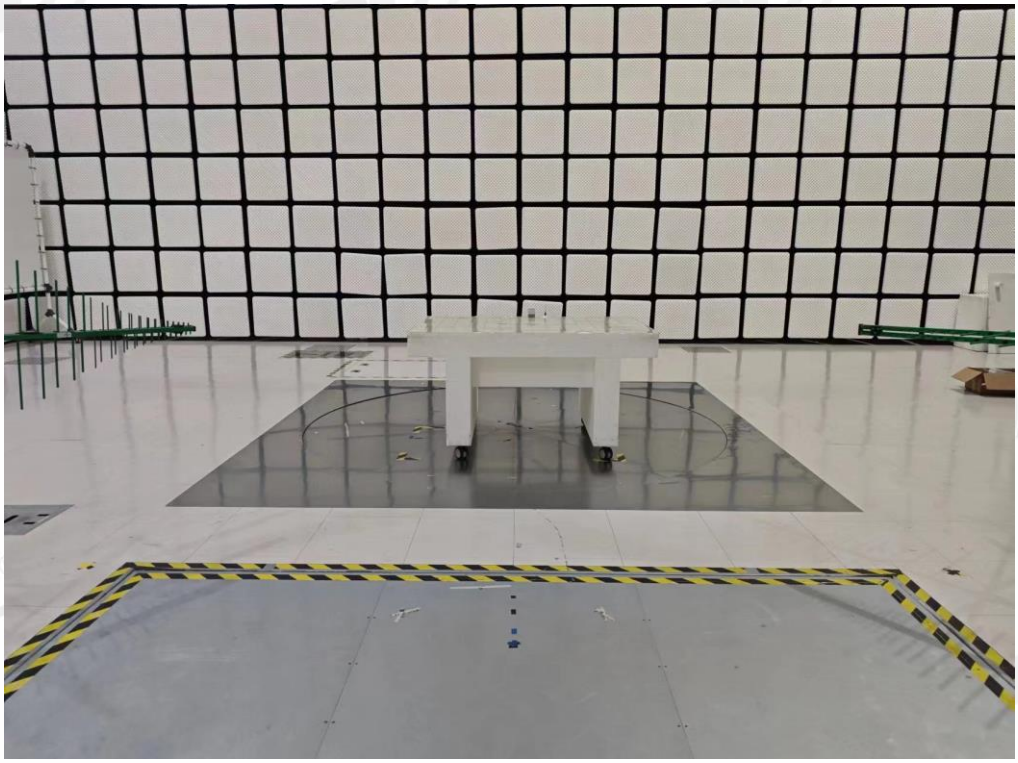
12.1. Limit

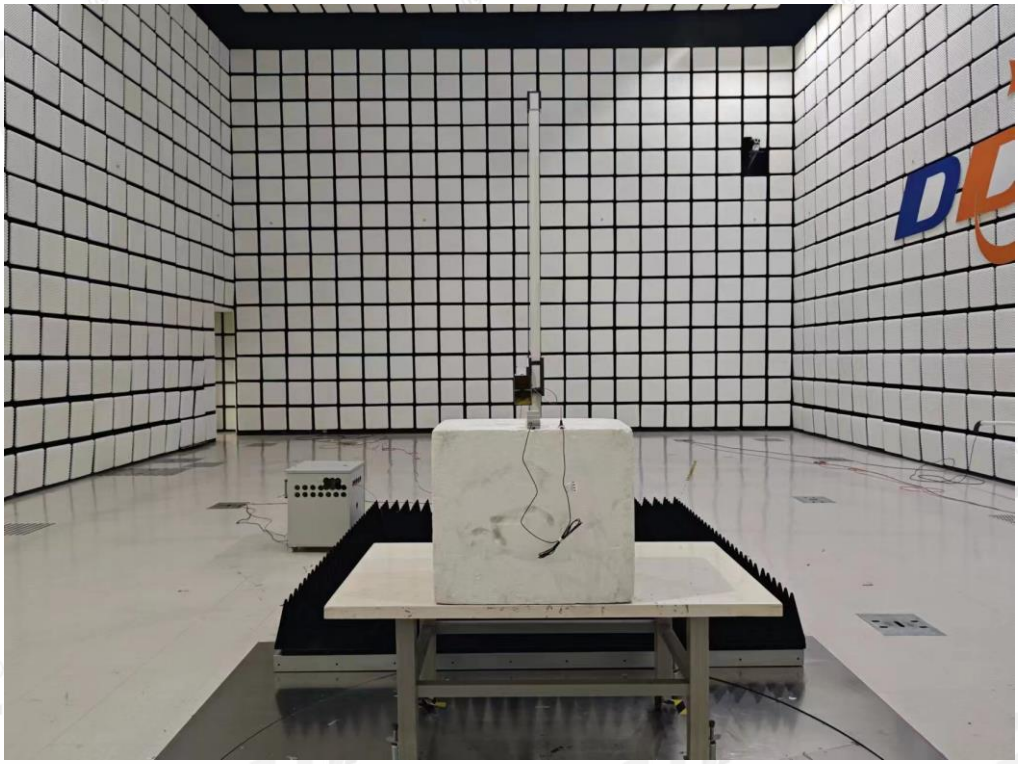
For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

12.2. Result

The antenna used for this product and that no antenna other than that furnished by the responsible party shall be used with the device, the maximum peak gain is 3.0 dBi.

13. Test Setup Photograph





14. Photos of the EUT

Please refer to Appendix I: Photos of the EUT.

END OF REPORT