CTC Laboratories, Inc.

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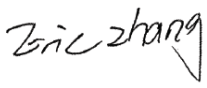
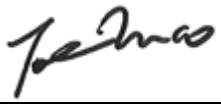
TEST REPORT

Report No. ·····:	**CTC2024145202**
FCC ID·····:	**2BA5U-RRU32121M**
Applicant·····:	**Shenzhen RoyalRay Science and Technology Co., Ltd**
Address·····:	West Wing, 4F, A1 Building, Xiufeng Industrial Park, No.2 Xiufeng Road, Longgang District, Shenzhen, China
Manufacturer·····:	Shenzhen RoyalRay Science and Technology Co., Ltd
Address·····:	West Wing, 4F, A1 Building, Xiufeng Industrial Park, No.2 Xiufeng Road, Longgang District, Shenzhen, China
Product Name·····:	**Ex10 UHF RFID Module(1-Port)**
Trade Mark·····:	/
Model/Type reference·····:	RRU32121M
Listed Model(s) ·····:	RRU72121M, RRU52121M
Standard·····:	**FCC CFR Title 47 Part 15 Subpart C Section 15.247**
Date of receipt of test sample…:	Jun. 18, 2024
Date of testing……...:	Jun. 19, 2024~ Jun. 27, 2024
Date of issue……....:	Jun. 28, 2024
Result……:	**PASS**

Compiled by: (Printed name+signature)	Terry Su	
Supervised by: (Printed name+signature)	Eric Zhang	
Approved by: (Printed name+signature)	Totti Zhao	

Testing Laboratory Name…...:	**CTC Laboratories, Inc.**
Address……:	Room 101 Building B, No. 7, Lanqing 1st Road, Luhu Community, Guanhu Subdistrict, Longhua District, Shenzhen, Guangdong, China

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1. TEST SUMMARY

1.1. Test Standards

The tests were performed according to following standards:

FCC Rules Part 15.247: Operation within the bands of 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz.
RSS 247 Issue 3: Standard Specifications for Frequency Hopping Systems (FHSs) and Digital Transmission Systems (DTSs) Operating in the Bands 902-928MHz, 2400-2483.5MHz and 5725-5850MHz.
ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.

1.2. Report version

Revised No.	Report No.	Date of issue	Description
01	CTC2024105502	Jun. 28, 2024	Original

1.3. Test Description

FCC Part 15 Subpart C (15.247)/ RSS 247 Issue 3				
Test Item	Standard Section		Result	Test Engineer
	FCC	IC		
Antenna Requirement	15.203	/	Pass	Alicia Liu
Conducted Emission	15.207	RSS-Gen 8.8	Pass	Evan Hu
Restricted Bands	15.205	RSS-Gen 8.10	Pass	Alicia Liu
Hopping Channel Separation	15.247(a)(1)	RSS 247 5.1 (b)	Pass	Alicia Liu
Dwell Time	15.247(a)(1)(i)	RSS 247 5.1 (c)	Pass	Alicia Liu
Peak Output Power	15.247(b)(2)	RSS 247 5.4 (a)	Pass	Alicia Liu
Number of Hopping Frequency	15.247(a)(1)(i)	RSS 247 5.1 (c)	Pass	Alicia Liu
Conducted Band Edge and Spurious Emissions	15.247(d)	RSS 247 5.5	Pass	Alicia Liu
Radiated Band Edge and Spurious Emissions	15.205&15.209& 15.247(d)	RSS 247 5.5	Pass	Alicia Liu
Radiated Spurious Emission	15.247(d)&15.209	RSS 247 5.5& RSS-Gen 8.9	Pass	Alicia Liu
20dB Bandwidth	15.247(a)(1)(i)	RSS 247 5.1 (c)	Pass	Alicia Liu

Note: The measurement uncertainty is not included in the test result.

1.4. Test Facility

CTC Laboratories, Inc.
Add: Room 101 Building B, Room 107, 108, 207, 208, 303 Building A, No. 7, Lanqing 1st Road, Luhu Community, Guanhu Subdistrict, Longhua District, Shenzhen, Guangdong, China (Formerly 2/F., Building 1 and 1-2/F., Building 2, Jiaquan Building, High-Tech Park, Guanlan Sub-District, Longhua New District, Shenzhen, Guangdong, China)

Laboratory accreditation
The test facility is recognized, certified, or accredited by the following organizations:

A2LA-Lab Cert. No.: 4340.01
CTC Laboratories, Inc. EMC Laboratory has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025:2017 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

Industry Canada (Registration No.: 9783A, CAB Identifier: CN0029)
CTC Laboratories, Inc. EMC Laboratory has been registered by Certification and Engineer Bureau of Industry Canada for the performance of with Registration NO.: 9783A on Jan, 2016.

FCC (Registration No.: 951311, Designation Number CN1208)
CTC Laboratories, Inc. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained inour files. Registration 951311, Aug 26, 2017.

1.5. Measurement Uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01" Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2 " and is documented in the CTC Laboratories, Inc. quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Below is the best measurement capability for CTC Laboratories, Inc.

Test Items	Measurement Uncertainty	Notes
20dB Emission Bandwidth	±0.0196%	(1)
Carrier Frequency Separation	±1.9%	(1)
Number of Hopping Channel	±1.9%	(1)
Time of Occupancy	±0.028%	(1)
Max Peak Conducted Output Power	±0.743 dB	(1)
Band-edge Spurious Emission	±1.328 dB	(1)
Conducted RF Spurious Emission	9kHz-1GHz: ±0.746dB 1GHz-26GHz: ±1.328dB	(1)
Conducted Emissions 9kHz~30MHz	±3.08 dB	(1)
Radiated Emissions 30~1000MHz	±4.51 dB	(1)
Radiated Emissions 1~18GHz	±5.84 dB	(1)
Radiated Emissions 18~40GHz	±6.12 dB	(1)

Note (1): This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

1.6. Environmental conditions

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

Temperature:	21°C ~ 27°C
Relative Humidity:	40% ~ 60%
Air Pressure:	101kPa

2. GENERAL INFORMATION

2.1. Client Information

Applicant:	Shenzhen RoyalRay Science and Technology Co., Ltd
Address:	West Wing, 4F, A1 Building, Xiufeng Industrial Park, No.2 Xiufeng Road, Longgang District, Shenzhen, China
Manufacturer:	Shenzhen RoyalRay Science and Technology Co., Ltd
Address:	West Wing, 4F, A1 Building, Xiufeng Industrial Park, No.2 Xiufeng Road, Longgang District, Shenzhen, China

2.2. General Description of EUT

Product Name:	Ex10 UHF RFID Module(1-Port)
Trade Mark:	/
Model/Type reference:	RRU32121M
Listed Model(s):	RRU72121M, RRU52121M
Model Different:	All these models are identical in the same PCB, layout and electrical circuit, The only difference is the model name
Power supply:	3.6~5.5Vdc from PCB board
Hardware version:	/
Software version:	/
RF ID Specification	
Modulation:	ASK
Operation frequency:	902.75MHz ~ 927.25MHz
Channel number:	50
Channel separation:	0.5MHz
Antenna type:	Ceramic Antenna
Antenna gain:	3.81dBi

2.3. Accessory Equipment information

Equipment Information			
Name	Model	S/N	Manufacturer
Notebook	ThinkPad T430	MP246QDR	Lenovo
AC/DC Adapter	A1443	---	Apple
Cable Information			
Name	Shielded Type	Ferrite Core	Length
DC In Cable	Without	Without	0.5M
Test Software Information			
Name	Version	/	/
UHFReader288Demo	V6.1	/	/

2.4. Operation state

Operation Frequency List: The EUT has been tested under typical operating condition. The Applicant provides communication tools software to control the EUT for staying in continuous transmitting and receiving mode for testing. Channels 01/26/50 were selected for testing.

Operation Frequency List:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
01	**902.75**	14	909.25	27	915.75	40	922.25
02	903.25	15	909.75	28	916.25	41	922.75
03	903.75	16	910.25	29	916.75	42	923.25
04	904.25	17	910.75	30	917.25	43	923.75
05	904.75	18	911.25	31	917.75	44	924.25
06	905.25	19	911.75	32	918.25	45	924.75
07	905.75	20	912.25	33	918.75	46	925.25
08	906.25	21	912.75	34	919.25	47	925.75
09	906.75	22	913.25	35	919.75	48	926.25
10	907.25	23	913.75	36	920.25	49	926.75
11	907.75	24	914.25	37	920.75	**50**	**927.25**
12	908.25	25	914.75	38	921.25	/	/
13	908.75	**26**	**915.25**	39	921.75	/	/

Note: The display in grey were the channel selected for testing.

Test mode

For RF test items:
The engineering test program was provided and enabled to make EUT continuous transmit
For AC power line conducted emissions:
The EUT was set to connect with the instrument under large package sizes transmission.
For Radiated spurious emissions test item:
The engineering test program was provided and enabled to make EUT continuous transmit. The EUT in each of three orthogonal axis emissions had been tested, but only the worst case (X axis) data recorded in the report.

2.5. Measurement Instruments List

RF Test System					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated Until
1	Spectrum Analyzer	R&S	FSV40-N	101331	Mar. 21, 2025
2	Spectrum Analyzer	R&S	FSV40-N	101654	Aug. 07, 2024
3	Spectrum Analyzer	R&S	FSU26	100105	Dec. 12, 2024
4	MXA Signal Analyzer	Keysight	N9020A	MY46471737	Dec. 12, 2024
5	MXA Signal Analyzer	Keysight	N9020A	MY52091402	Aug. 22, 2024
6	MXG Vector Signal Generator	Agilent	N5182A	MY47420864	Dec. 12, 2024
7	PSG Analog Signal Generator	Agilent	E8257D	MY46521908	Dec. 12, 2024
8	EXG Analog Signal Generator	Keysight	N5173B	MY59100842	Dec. 12, 2024
9	MXG Vector Signal Generator	Keysight	N5182B	MY59100212	Dec. 12, 2024
10	USB Wideband Power Sensor	Keysight	U2021XA	MY55130004	Mar. 21, 2025
11	USB Wideband Power Sensor	Keysight	U2021XA	MY55130006	Mar. 21, 2025
12	Wideband Radio Communication Tester	R&S	CMW500	102414	Dec. 12, 2024
13	RF Control Unit	Tonscend	JS0806-2	/	Aug. 22, 2024
14	High and low temperature test chamber	ESPEC	MT3035	/	Mar. 21, 2025
15	Test Software	Tonscend	JS1120-3	V2.6.88.0346	/
16	Test Software	Tonscend	JS1120-3	V3.3.38	/
17	Test Software	WCS	WCS-WCN	2023.08.04	/

Radiated Emission (3m chamber 2)					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated Until
1	Trilog-Broadband Antenna	Schwarzbeck	VULB 9168	9168-1013	Dec. 07, 2024
2	Horn Antenna	Schwarzbeck	BBHA 9120D	9120D-648	Dec. 07, 2024
3	Spectrum Analyzer	R&S	FSU26	100105	Dec. 12, 2024
4	Spectrum Analyzer	R&S	FSV40-N	101331	Mar. 15, 2025
5	Pre-Amplifier	SONOMA	310	186194	Dec. 12, 2024
6	Low Noise Pre-Amplifier	EMCI	EMC051835	980075	Dec. 12, 2024
7	Test Receiver	R&S	ESCI7	100967	Dec. 12, 2024
8	3m chamber 2	Frankonia	EE025	/	Oct. 23, 2024
9	Test Software	FARA	EZ-EMC	FA-03A2	/

Radiated Emission (3m chamber 3)					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated Until
1	Trilog-Broadband Antenna	Schwarzbeck	VULB 9163	01026	Dec. 18, 2024
2	Horn Antenna	Schwarzbeck	BBHA 9120D	9120D-647	Dec. 01, 2024
3	Test Receiver	Keysight	N9038A	MY56400071	Dec. 12, 2024

4	Broadband Amplifier	SCHWARZBECK	BBV9743B	259	Dec. 12, 2024
5	Mirowave Broadband Amplifier	SCHWARZBECK	BBV9718C	111	Dec. 12, 2024
6	3m chamber 3	YIHENG	EE106	/	Aug. 28, 2026
7	Test Software	FARA	EZ-EMC	FA-03A2	/

Conducted Emission					
Item	Test Equipment	Manufacturer	Model No.	Serial No.	Calibrated Until
1	LISN	R&S	ENV216	101112	Dec. 12, 2024
2	LISN	R&S	ENV216	101113	Dec. 12, 2024
3	EMI Test Receiver	R&S	ESCS30	100353	Dec. 12, 2024
4	ISN CAT6	Schwarzbeck	NTFM 8158	CAT6-8158-0046	Dec. 12, 2024
5	ISN CAT5	Schwarzbeck	NTFM 8158	CAT5-8158-0046	Dec. 12, 2024
6	Test Software	R&S	EMC32	6.10.10	/

Note: 1. The Cal. Interval was one year.
2. The Cal. Interval was three year of the chamber
3. The cable loss has calculated in test result which connection between each test instruments.

3. TEST ITEM AND RESULTS

3.1. Conducted Emission

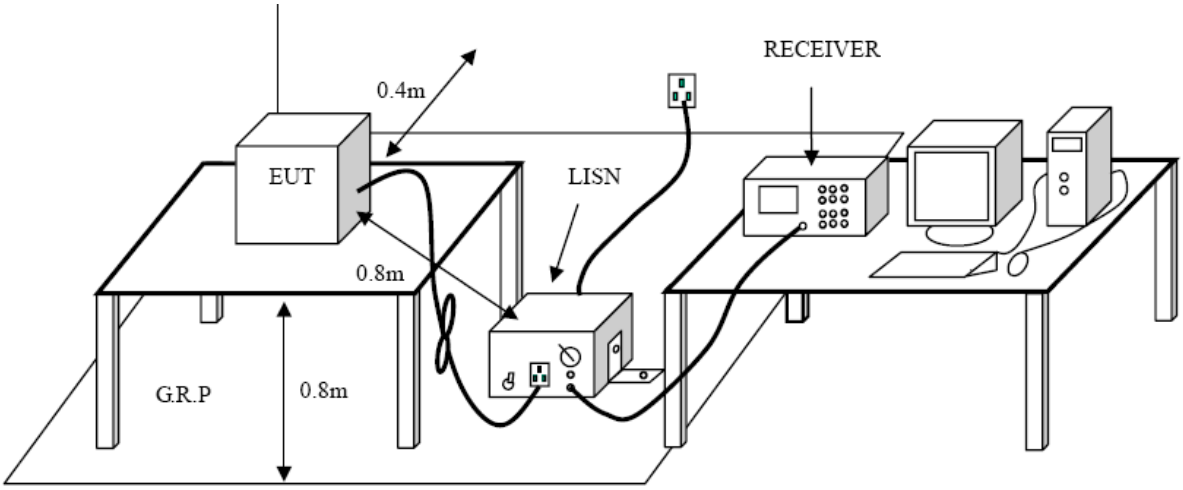
Limit

FCC CFR Title 47 Part 15 Subpart C Section 15.207/ RSS – Gen 8.8

Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

Test Configuration



Test Procedure

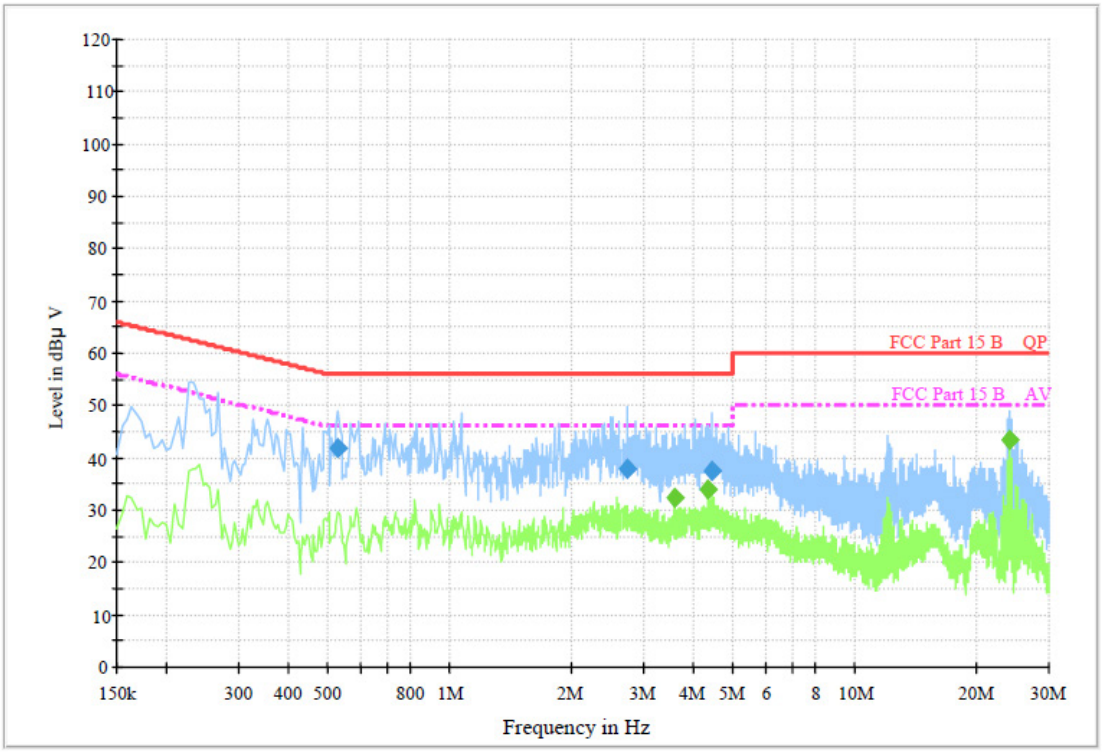
1. The EUT was setup according to ANSI C63.10:2013 requirements.
2. The EUT was placed on a platform of nominal size, 1 m by 1.5 m, raised 80 cm above the conducting ground plane. The vertical conducting plane was located 40 cm to the rear of the EUT. All other surfaces of EUT were at least 80 cm from any other grounded conducting surface.
3. The EUT and simulators are connected to the main power through a line impedances stabilization network (LISN). The LISN provides a 50ohm /50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN. (Please refer to the block diagram of the test setup and photographs)
4. Each current-carrying conductor of the EUT power cord, except the ground (safety) conductor, was individually connected through a LISN to the input power source.
5. The excess length of the power cord between the EUT and the LISN receptacle were folded back and forth at the center of the lead to form a bundle not exceeding 40 cm in length.
6. Conducted Emissions were investigated over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9 kHz.
7. During the above scans, the emissions were maximized by cable manipulation.

Test Mode

Please refer to the clause 2.4.

Test Results

Test Voltage:	AC 120V/60 Hz
Terminal:	Line



Final Measurement Detector 1

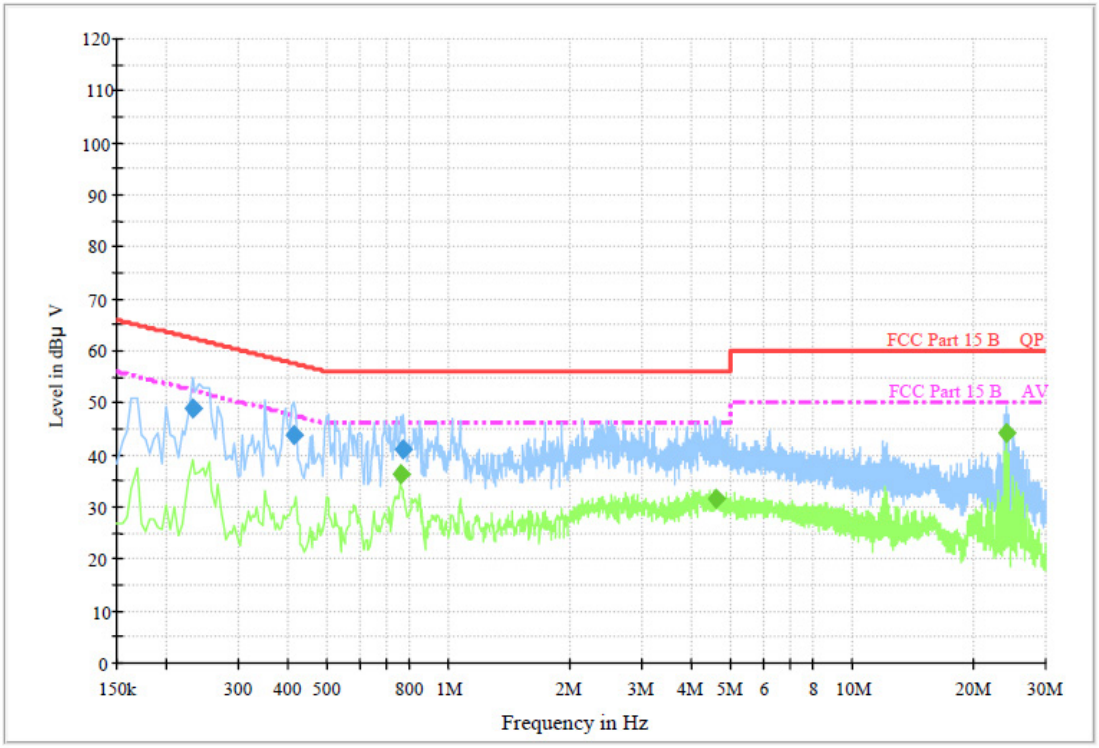
Frequency (MHz)	QuasiPeak (dBµ V)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµ V)	Comment
0.528000	42.0	1000.00	9.000	On	L1	9.5	14.0	56.0	
2.728500	37.9	1000.00	9.000	On	L1	9.5	18.1	56.0	
4.420500	37.4	1000.00	9.000	On	L1	9.5	18.6	56.0	

Final Measurement Detector 2

Frequency (MHz)	Average (dBµ V)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµ V)	Comment
3.574500	32.5	1000.00	9.000	On	L1	9.5	13.5	46.0	
4.339500	34.0	1000.00	9.000	On	L1	9.5	12.0	46.0	
23.982000	43.6	1000.00	9.000	On	L1	9.7	6.4	50.0	

Emission Level= Read Level+ Correct Factor

Test Voltage:	AC 120V/60 Hz
Terminal:	Neutral



Final Measurement Detector 1

Frequency (MHz)	QuasiPeak (dBµ V)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµ V)	Comment
0.231000	49.1	1000.00	9.000	On	N	9.4	13.3	62.4	
0.411000	43.8	1000.00	9.000	On	N	9.4	13.8	57.6	
0.771000	41.0	1000.00	9.000	On	N	9.4	15.0	56.0	

Final Measurement Detector 2

Frequency (MHz)	Average (dBµ V)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµ V)	Comment
0.757500	36.2	1000.00	9.000	On	N	9.4	9.8	46.0	
4.555500	31.4	1000.00	9.000	On	N	9.4	14.6	46.0	
23.941500	44.2	1000.00	9.000	On	N	9.5	5.8	50.0	

Emission Level= Read Level+ Correct Factor

3.2. Radiated Emission

Limit

FCC CFR Title 47 Part 15 Subpart C Section 15.209/ RSS – Gen 8.9

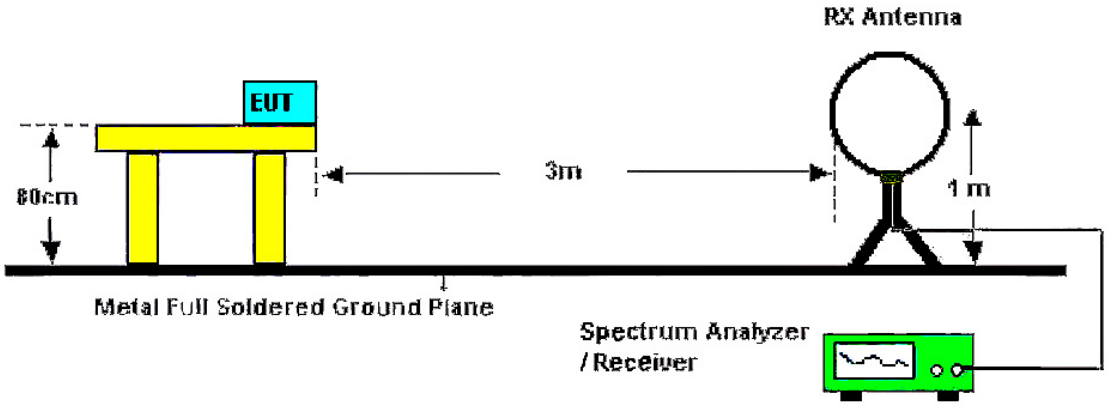
Frequency	Limit (dBuV/m @3m)	Value
30 MHz ~ 88 MHz	40.00	Quasi-peak
88 MHz ~ 216 MHz	43.50	Quasi-peak
216 MHz ~ 960 MHz	46.00	Quasi-peak
960 MHz ~ 1 GHz	54.00	Quasi-peak
Above 1 GHz	54.00	Average
	74.00	Peak

Note:

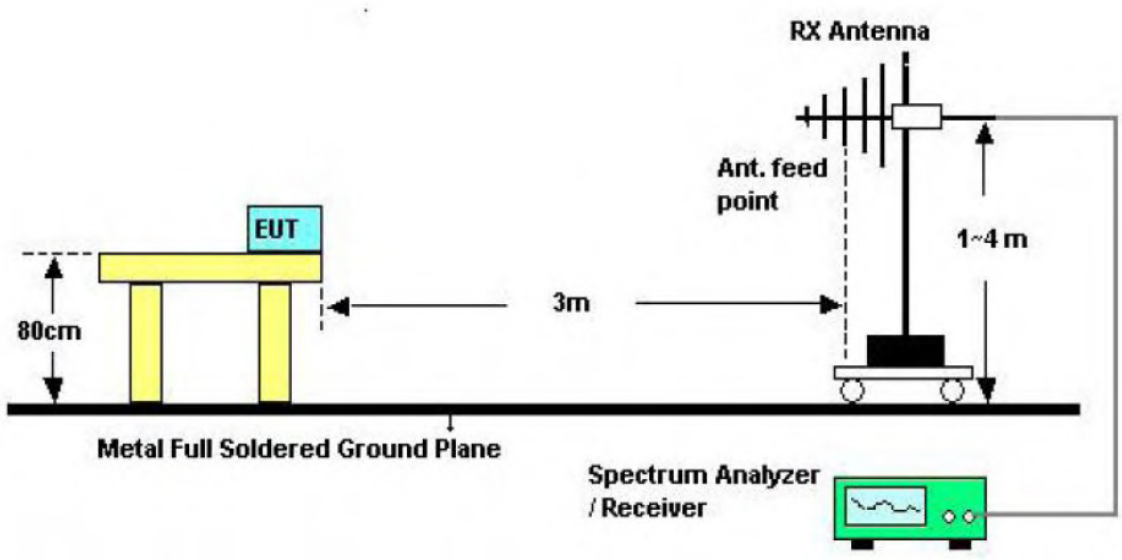
(1) The tighter limit applies at the band edges.

(2) Emission Level (dBuV/m)=20log Emission Level (uV/m).

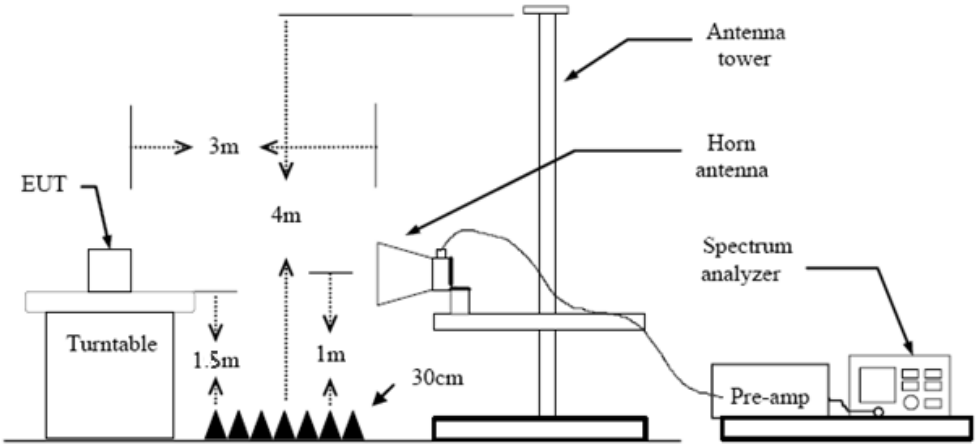
Test Configuration



Below 30MHz Test Setup



Below 1000MHz Test Setup



Above 1GHz Test Setup

Test Procedure

1. The EUT was setup and tested according to ANSI C63.10:2013
2. The EUT is placed on a turn table which is 0.8 meter above ground for below 1 GHz, and 1.5 m for above 1 GHz. The turn table is rotated 360 degrees to determine the position of the maximum emission level.
3. The EUT was set 3 meters from the receiving antenna, which was mounted on the top of a variable height antenna tower.
4. For each suspected emission, the EUT was arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
5. Set to the maximum power setting and enable the EUT transmit continuously.
6. Use the following spectrum analyzer settings

   (1) Span shall wide enough to fully capture the emission being measured;

   (2) Below 1 GHz:

   RBW=120 kHz, VBW=300 kHz, Sweep=auto, Detector function=peak, Trace=max hold;

   If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

   (3) From 1 GHz to 10th harmonic:

   RBW=1MHz, VBW=3MHz Peak detector for Peak value.

   RBW=1MHz, VBW$\geqslant$1/T Peak detector for Average value.

   Note 1: For the 1/T& Duty Cycle please refer to clause 3.10 Duty Cycle.

Test Mode

Please refer to the clause 2.4.

Test Result

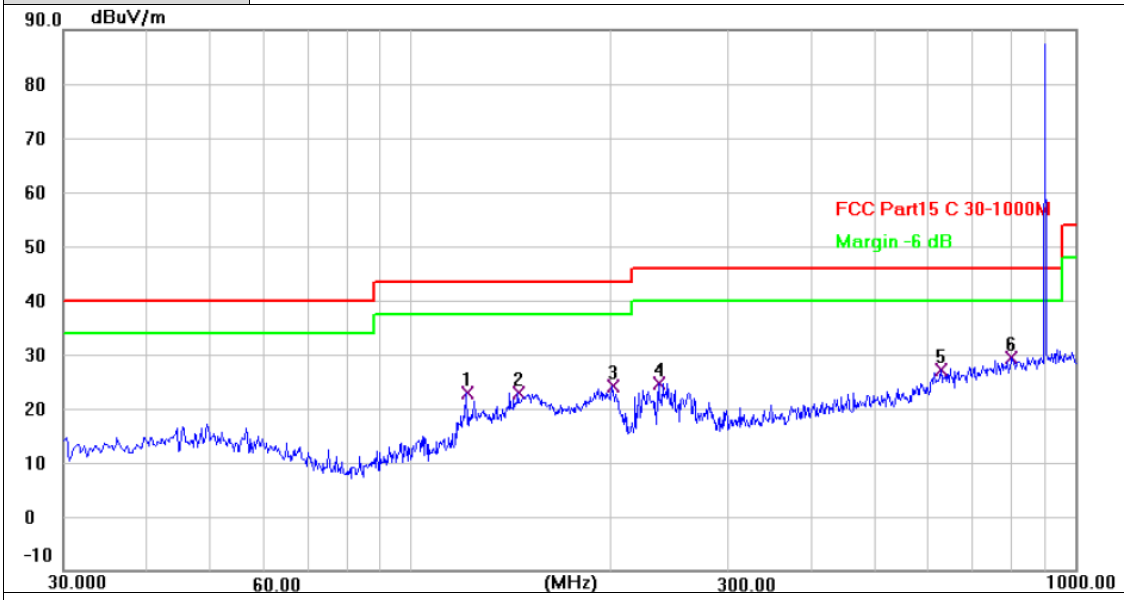
9 KHz~30 MHz

From 9 KHz to 30 MHz: Conclusion: PASS

Note: The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

0MHz-1GHz

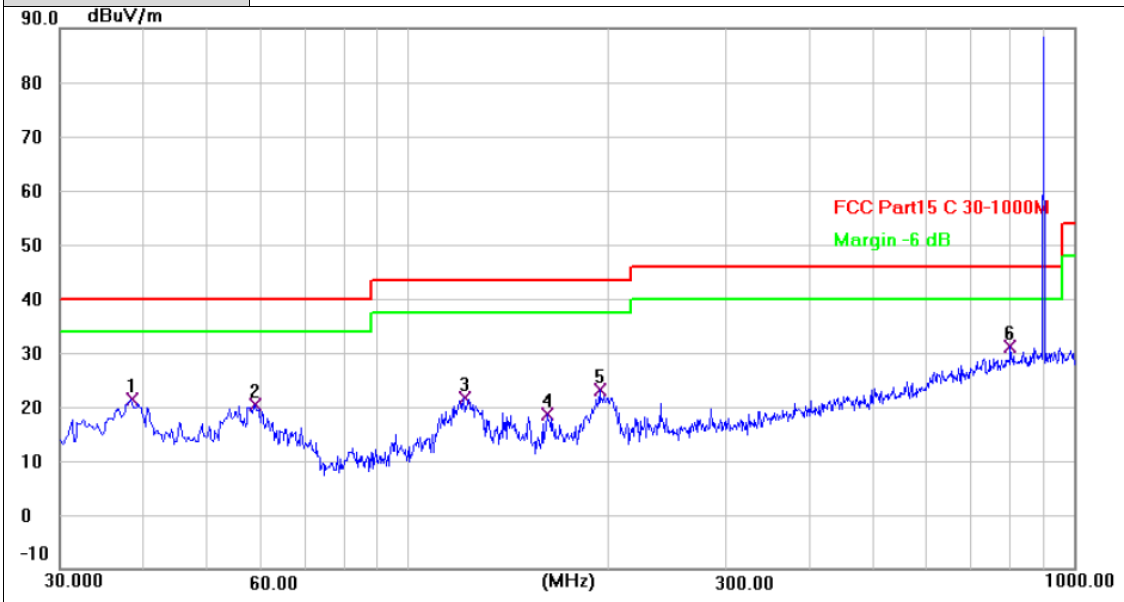
Ant. Pol.	Horizontal
Test Mode:	TX Mode 902.75MHz
Remark:	Only worse case is reported



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	121.5033	42.47	-19.66	22.81	43.50	-20.69	QP
2	145.1067	44.12	-21.32	22.80	43.50	-20.70	QP
3	201.3667	41.81	-17.73	24.08	43.50	-19.42	QP
4	236.6100	41.24	-16.63	24.61	46.00	-21.39	QP
5	627.5200	35.07	-7.91	27.16	46.00	-18.84	QP
6 *	801.7965	34.76	-5.37	29.39	46.00	-16.61	QP

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

Ant. Pol.	Vertical
Test Mode:	TX Mode 902.75MHz
Remark:	Only worse case is reported

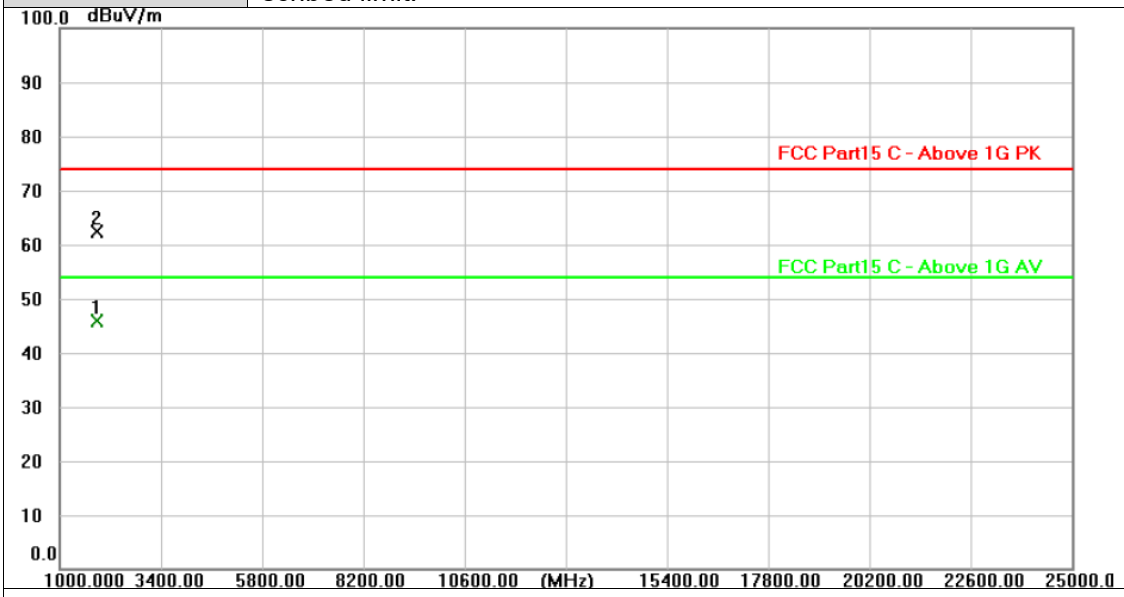


No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	38.4067	38.13	-16.86	21.27	40.00	-18.73	QP
2	59.1000	37.47	-17.07	20.40	40.00	-19.60	QP
3	121.5033	41.19	-19.66	21.53	43.50	-21.97	QP
4	161.5966	39.37	-20.69	18.68	43.50	-24.82	QP
5	193.9299	41.40	-18.23	23.17	43.50	-20.33	QP
6 *	804.3832	36.43	-5.33	31.10	46.00	-14.90	QP

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

Above 1GHz

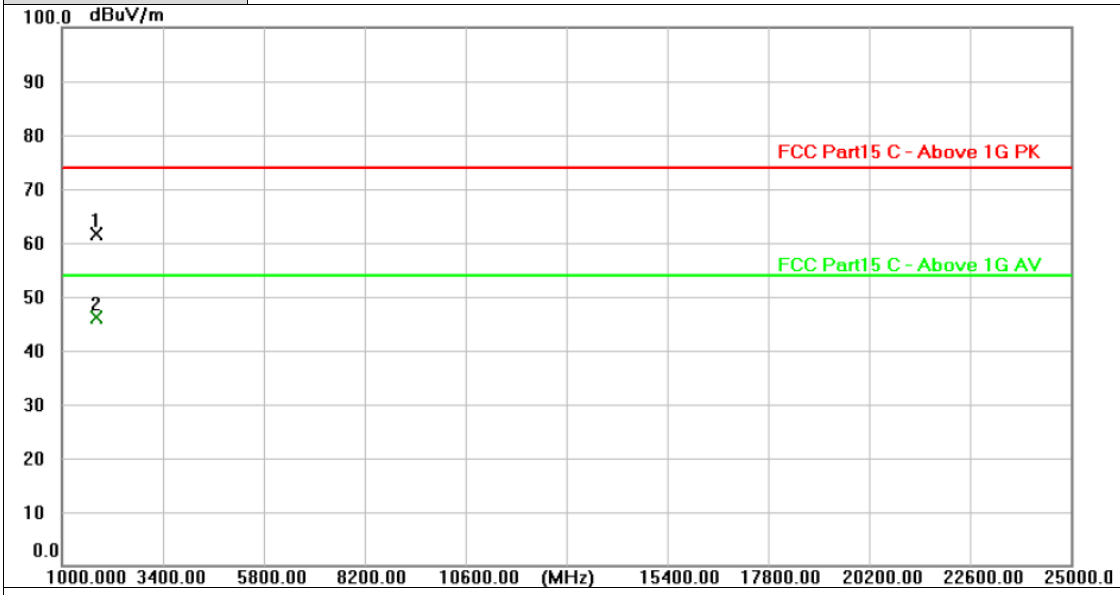
Ant. Pol.	Horizontal
Test Mode:	TX Mode 902.75MHz
Remark:	No report for the emission which more than 10 dB below the prescribed limit.



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	1854.575	17.39	28.45	45.84	54.00	-8.16	AVG
2	1855.150	34.04	28.45	62.49	74.00	-11.51	peak

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

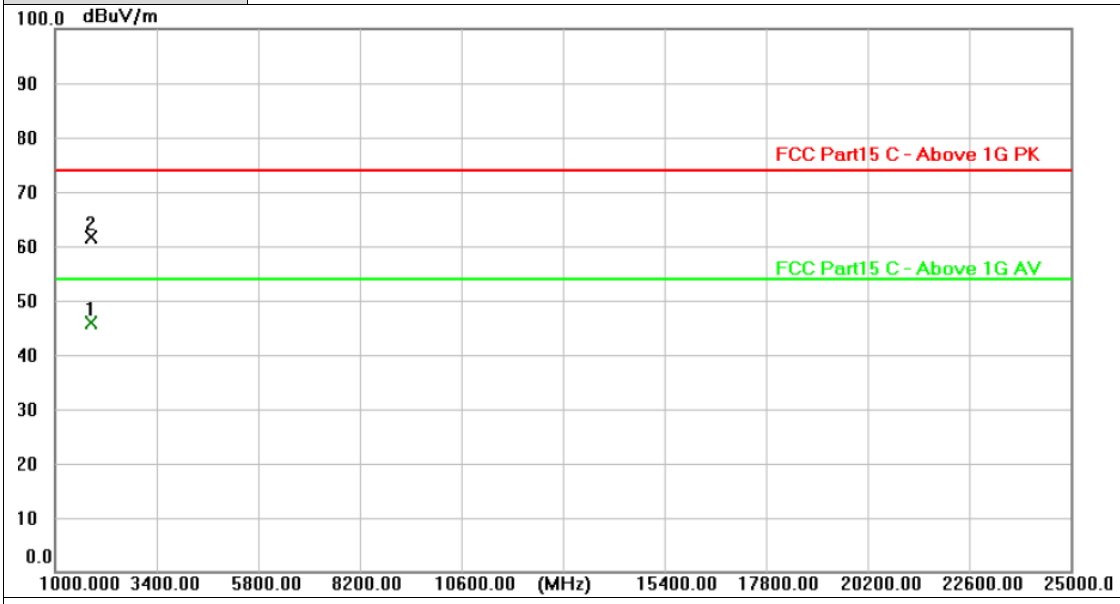
Ant. Pol.	Vertical
Test Mode:	TX Mode 902.75MHz
Remark:	No report for the emission which more than 10 dB below the pre-scribed limit.



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	1804.689	33.59	28.14	61.73	74.00	-12.27	peak
2 *	1806.487	17.86	28.15	46.01	54.00	-7.99	AVG

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

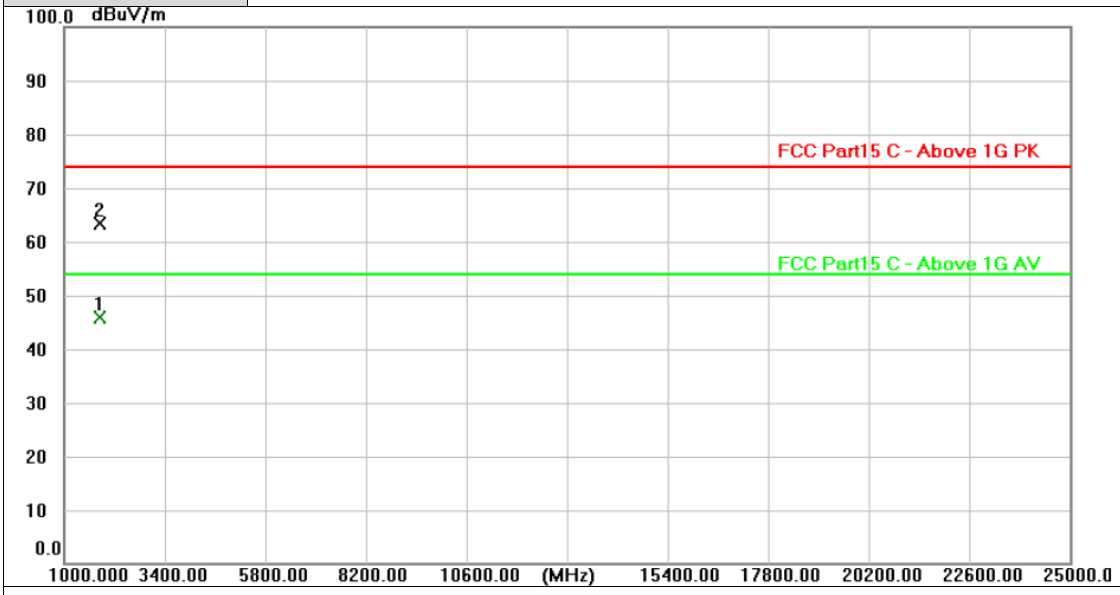
Ant. Pol.	Horizontal
Test Mode:	TX Mode 915.25MHz
Remark:	No report for the emission which more than 10 dB below the pre-scribed limit.



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	1830.348	17.63	28.30	45.93	54.00	-8.07	AVG
2	1831.009	33.30	28.30	61.60	74.00	-12.40	peak

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

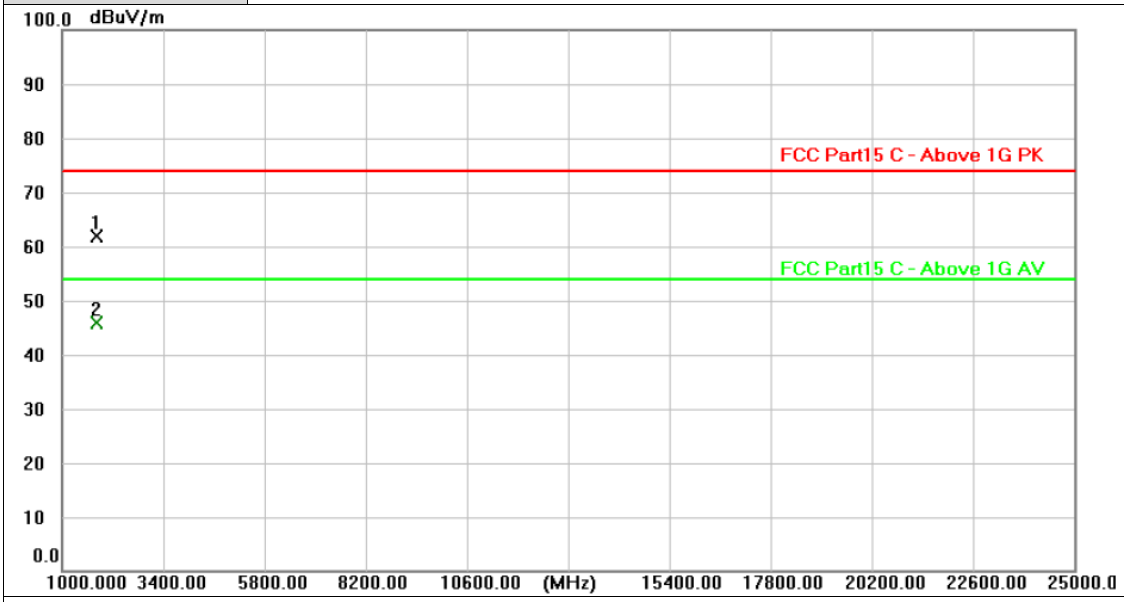
Ant. Pol.	Vertical
Test Mode:	TX Mode 915.25MHz
Remark:	No report for the emission which more than 10 dB below the pre-scribed limit.



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	1829.544	17.53	28.29	45.82	54.00	-8.18	AVG
2	1831.151	35.16	28.30	63.46	74.00	-10.54	peak

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

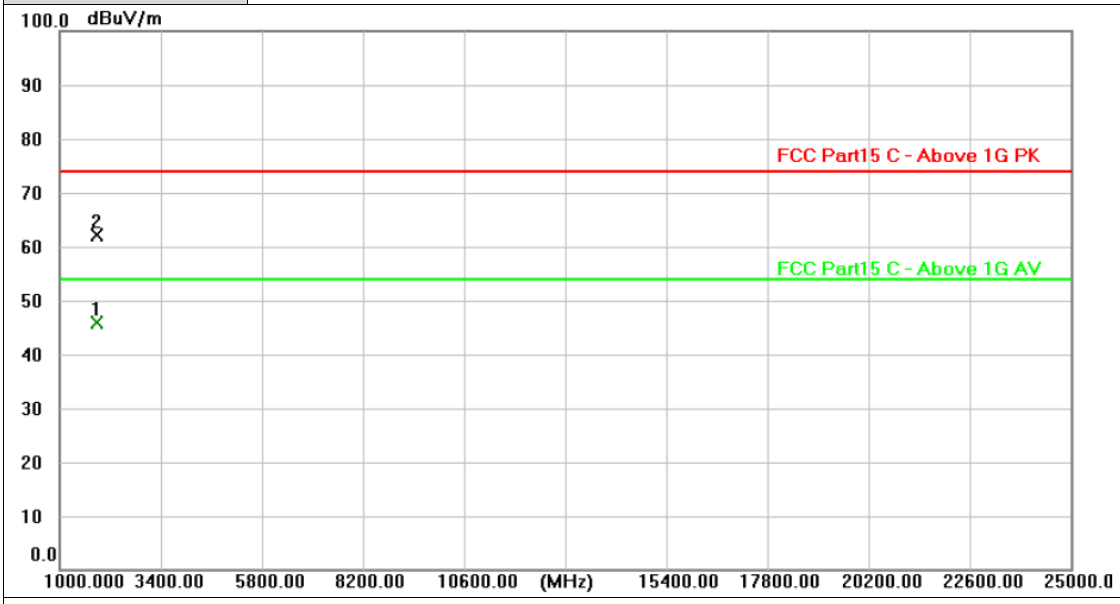
Ant. Pol.	Horizontal
Test Mode:	TX Mode 927.25MHz
Remark:	No report for the emission which more than 10 dB below the pre-scribed limit.



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	1805.549	33.65	28.14	61.79	74.00	-12.21	peak
2 *	1805.768	17.67	28.14	45.81	54.00	-8.19	AVG

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

Ant. Pol.	Vertical
Test Mode:	TX Mode 927.25MHz
Remark:	No report for the emission which more than 10 dB below the pre-scribed limit.



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	1855.061	17.40	28.45	45.85	54.00	-8.15	AVG
2	1855.314	33.64	28.45	62.09	74.00	-11.91	peak

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

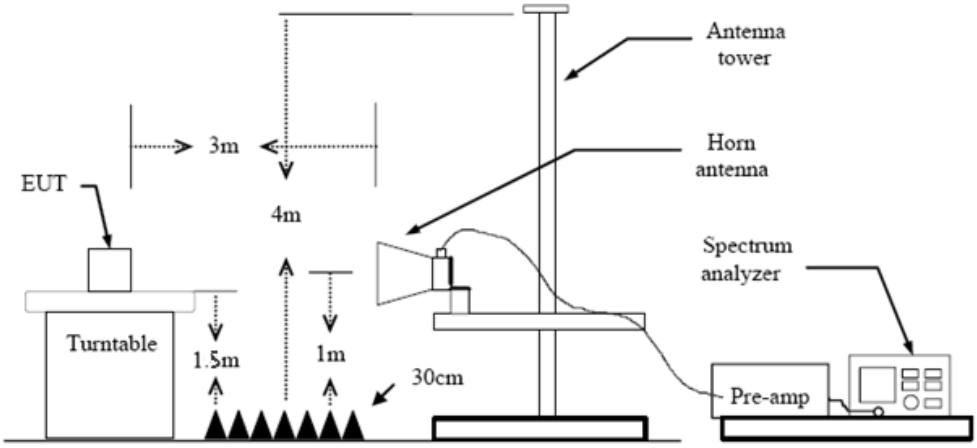
3.3. Band Edge Emissions (Radiated)

Limit

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (d)/ RSS – 247 5.5

Restricted Frequency Band (MHz)	(dBuV/m)(at 3m)	
	Peak	Average
2310 ~ 2390	74	54
2483.5 ~ 2500	74	54

Test Configuration



Test Procedure

1. The EUT was setup and tested according to ANSI C63.10:2013 requirements.
2. The EUT is placed on a turn table which is 1.5 meter above ground. The turn table is rotated 360 degrees to determine the position of the maximum emission level.
3. The EUT was positioned such that the distance from antenna to the EUT was 3 meters.
4. The antenna is scanned from 1 meter to 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10:2013 on radiated measurement.
5. The receiver set as follow:
   RBW=1MHz, VBW=3MHz Peak detector for Peak value.
   RBW=1MHz, VBW see note 1 with Peak Detector for Average Value.

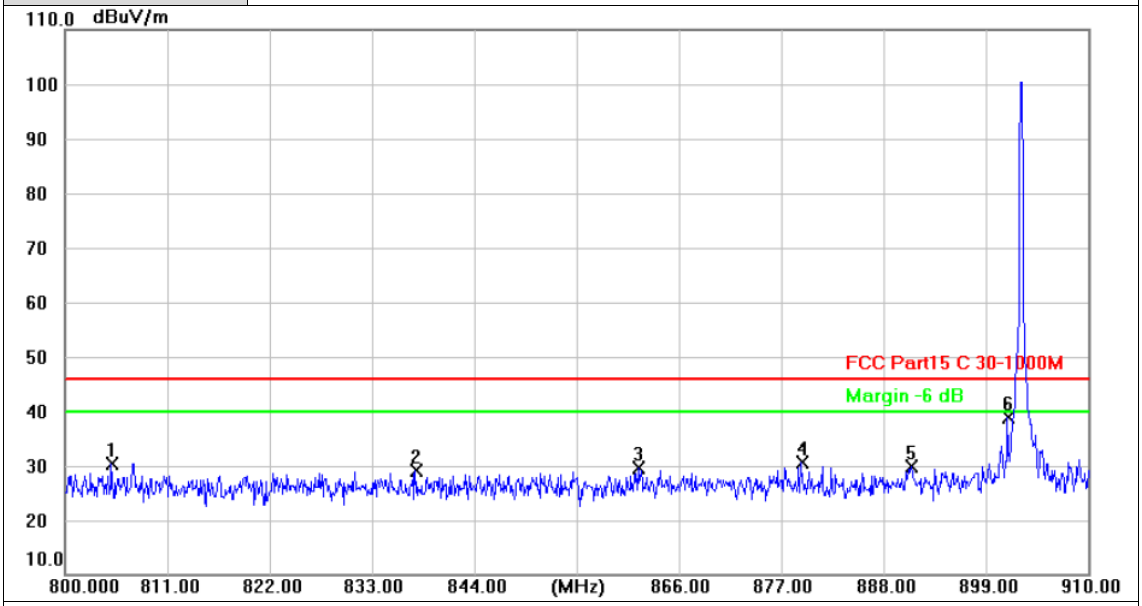
Test Mode

Please refer to the clause 2.4.

Test Results

Pre-scan all antenna, only show the test data for worse case antenna on the test report.

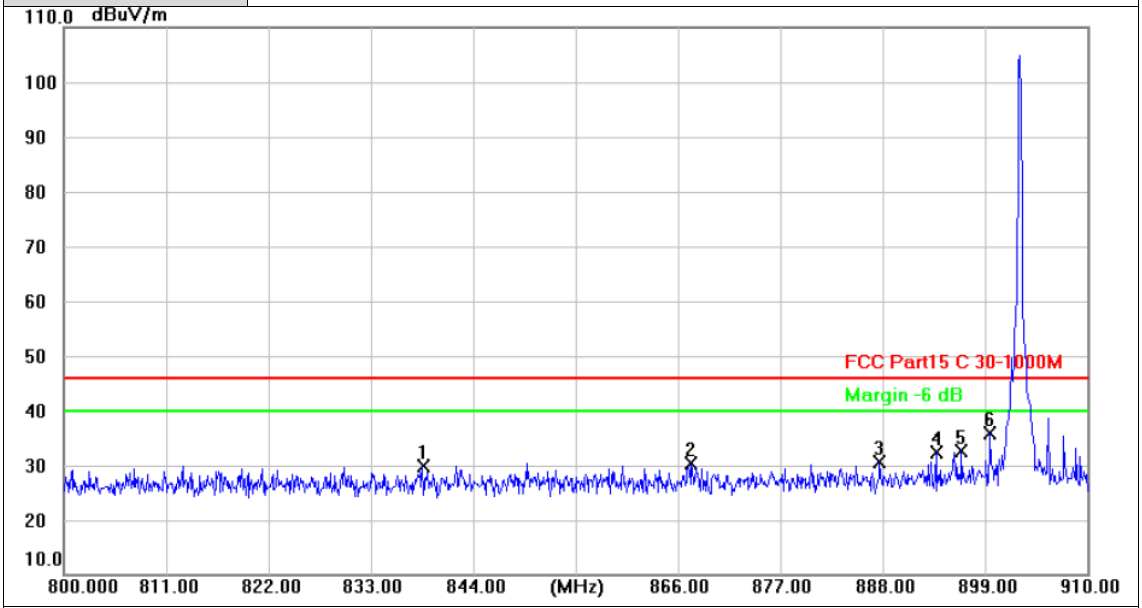
Ant. Pol.	Horizontal
Test Mode:	902.75MHz



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	804.8767	35.69	-5.32	30.37	46.00	-15.63	peak
2	837.5467	34.11	-4.91	29.20	46.00	-16.80	peak
3	861.5633	34.30	-4.59	29.71	46.00	-16.29	peak
4	879.0167	34.92	-4.33	30.59	46.00	-15.41	peak
5	890.9700	34.03	-4.15	29.88	46.00	-16.12	peak
6 *	901.2367	42.91	-4.01	38.90	46.00	-7.10	peak

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

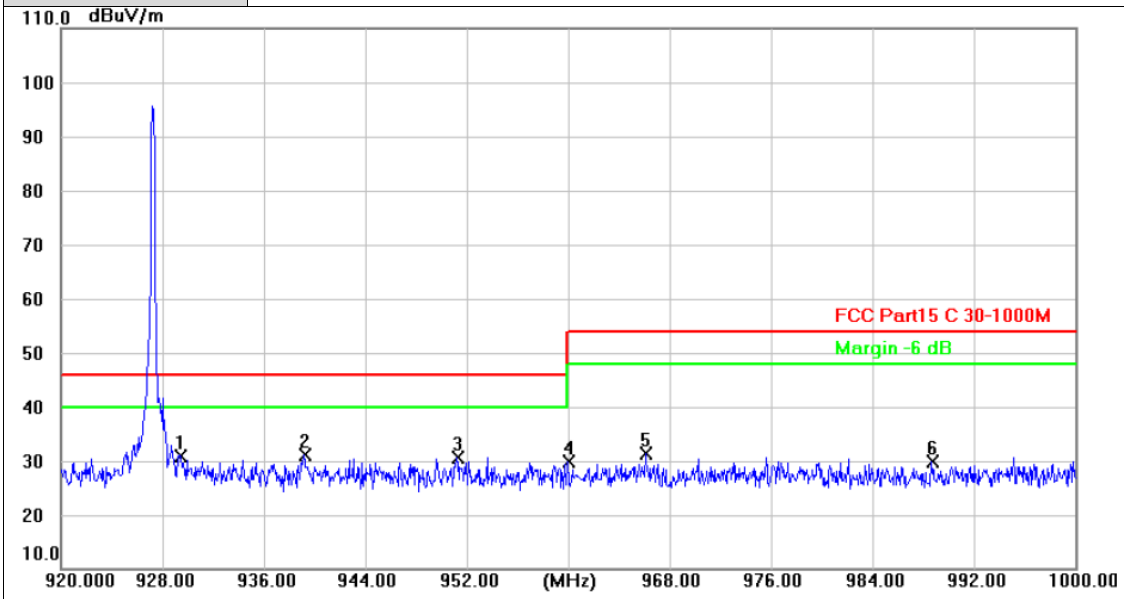
Ant. Pol.	Vertical
Test Mode:	902.75MHz



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	838.5367	34.73	-4.90	29.83	46.00	-16.17	peak
2	867.5033	34.77	-4.50	30.27	46.00	-15.73	peak
3	887.7433	34.91	-4.19	30.72	46.00	-15.28	peak
4	893.7933	36.50	-4.10	32.40	46.00	-13.60	peak
5	896.4700	36.78	-4.06	32.72	46.00	-13.28	peak
6 *	899.5500	39.95	-4.02	35.93	46.00	-10.07	peak

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

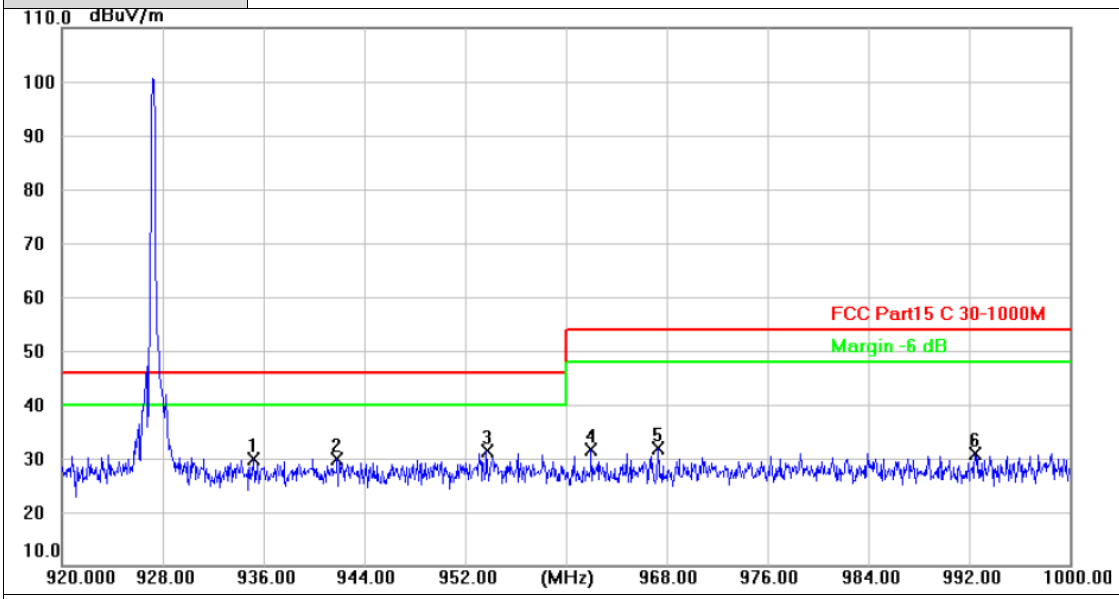
Ant. Pol.	Horizontal
Test Mode:	927.25MHz



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	929.4933	34.64	-3.76	30.88	46.00	-15.12	peak
2 *	939.1467	34.71	-3.68	31.03	46.00	-14.97	peak
3	951.2267	34.18	-3.58	30.60	46.00	-15.40	peak
4	959.9467	33.45	-3.46	29.99	46.00	-16.01	peak
5	966.1067	34.84	-3.39	31.45	54.00	-22.55	peak
6	988.6667	33.06	-3.11	29.95	54.00	-24.05	peak

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

Ant. Pol.	Vertical
Test Mode:	927.25MHz



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	935.2000	33.60	-3.72	29.88	46.00	-16.12	peak
2	941.8400	33.59	-3.65	29.94	46.00	-16.06	peak
3 *	953.7066	34.84	-3.54	31.30	46.00	-14.70	peak
4	962.0000	35.19	-3.44	31.75	54.00	-22.25	peak
5	967.2800	35.30	-3.38	31.92	54.00	-22.08	peak
6	992.5333	33.98	-3.06	30.92	54.00	-23.08	peak

Remarks:
1.Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
2.Margin value = Level -Limit value

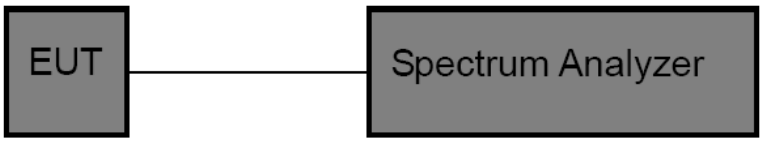
3.4. Band edge and Spurious Emissions (Conducted)

Limit

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (d):In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is 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, based on either an RF conducted or a radiated measurement.

RSS-247 (5.5):In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Test Configuration



Test Procedure

1. The transmitter output was connected to the spectrum analyzer through an attenuator, the path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously
3. Use the following spectrum analyzer settings:
   RBW = 100 kHz, VBW ≥ RBW, scan up through 10th harmonic.
   Sweep = auto, Detector function = peak, Trace = max hold
4. Measure and record the results in the test report.

Test Mode

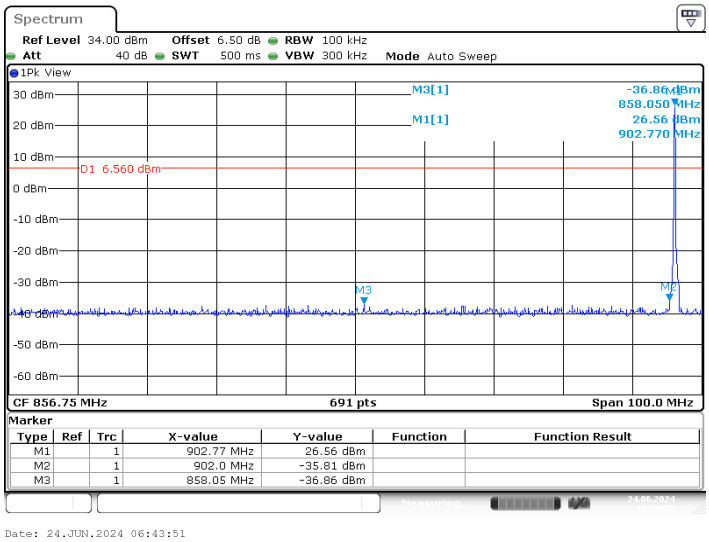
Please refer to the clause 2.4.

Test Results

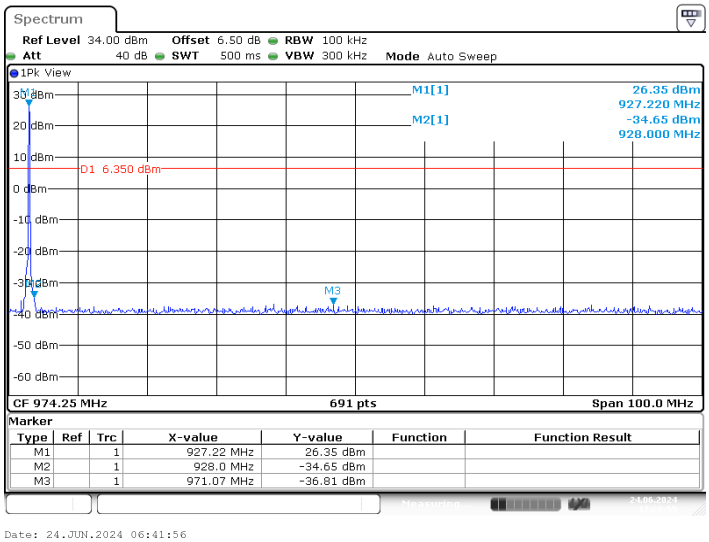
(1) Band edge Conducted Test

Test Mode	Frequency [MHz]	Ref Level[dBm]	Result[dBm]	Limit[dBm]	Verdict
RF ID	902.75	26.56	-35.81	≤6.56	PASS
	927.25	26.35	-34.65	≤6.35	PASS
	Hop_902.75	26.96	-35.38	≤6.96	PASS
	Hop_927.25	26.62	-36.23	≤6.62	PASS

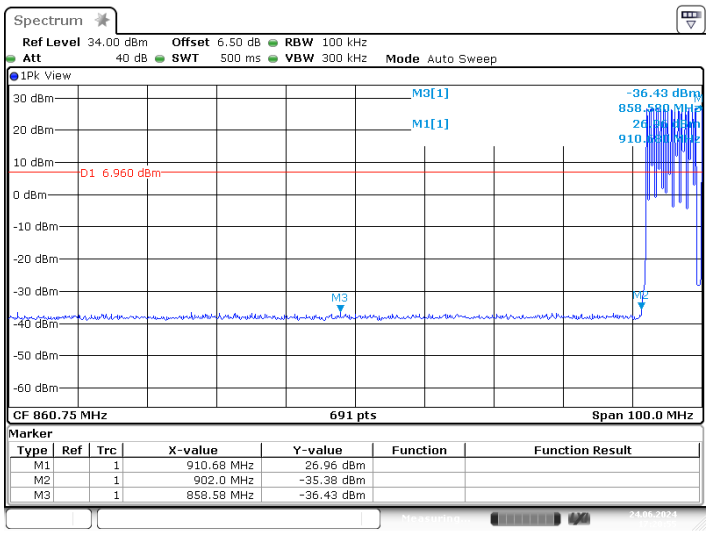
RF ID_Low_902.75



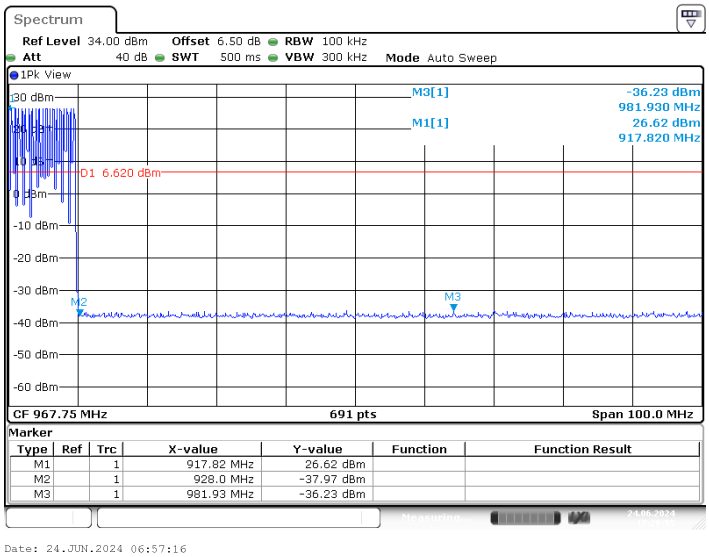
RF ID_High_927.25



RF ID_Low_Hop_902.75



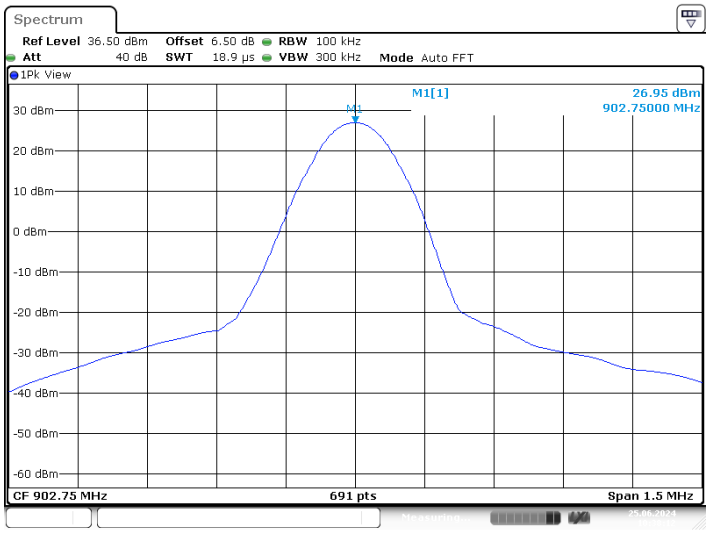
RF ID_High_Hop_927.25


Spectrum
Ref Level 34.00 dBm Offset 6.50 dB RBW 100 kHz
Att 40 dB SWT 500 ms VBW 300 kHz Mode Auto Sweep
1Pk View
M3[1] -36.23 dBm
981.930 MHz
M1[1] 26.62 dBm
917.820 MHz
D1 6.620 dBm
30 dBm
20 dBm
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
M2
M3
CF 967.75 MHz
691 pts
Span 100.0 MHz
Marker
Type Ref Trc X-value Y-value Function Function Result
M1 1 917.82 MHz 26.62 dBm
M2 1 928.0 MHz -37.97 dBm
M3 1 981.93 MHz -36.23 dBm
Date: 24.JUN.2024 06:57:16

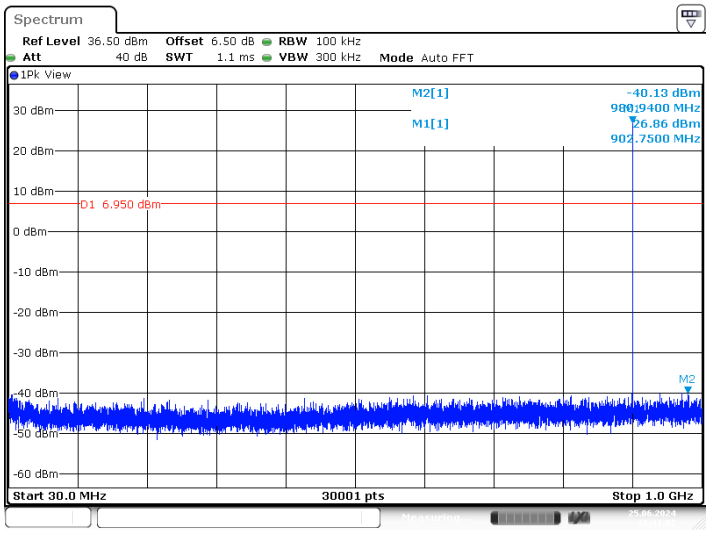
(2) Conducted Spurious Emissions Test

Test Mode	Frequency [MHz]	Freq Range [Mhz]	Ref Level [dBm]	Result [dBm]	Limit [dBm]	Verdict
RF ID	902.75	Reference	26.95	26.95	---	PASS
		30~1000	26.95	-40.13	≤6.95	PASS
		1000~26500	26.95	-25.42	≤6.95	PASS
	915.25	Reference	26.87	26.87	---	PASS
		30~1000	26.87	-39.77	≤6.87	PASS
		1000~26500	26.87	-19.86	≤6.87	PASS
	927.25	Reference	26.82	26.82	---	PASS
		30~1000	26.82	-39.66	≤6.82	PASS
		1000~26500	26.82	-24.87	≤6.82	PASS

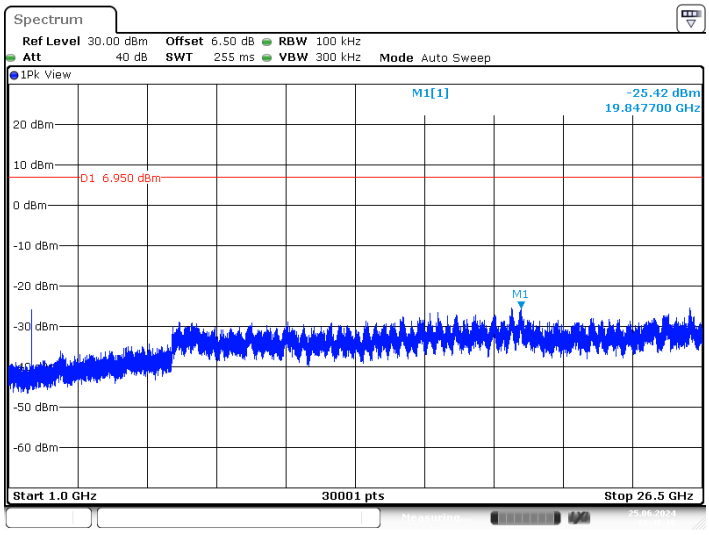
RF ID_902.75_0~Reference



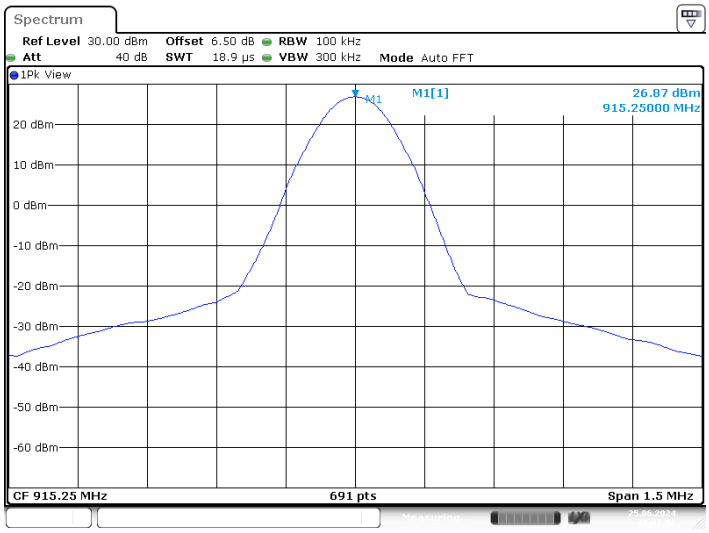
RF ID_902.75_30~1000



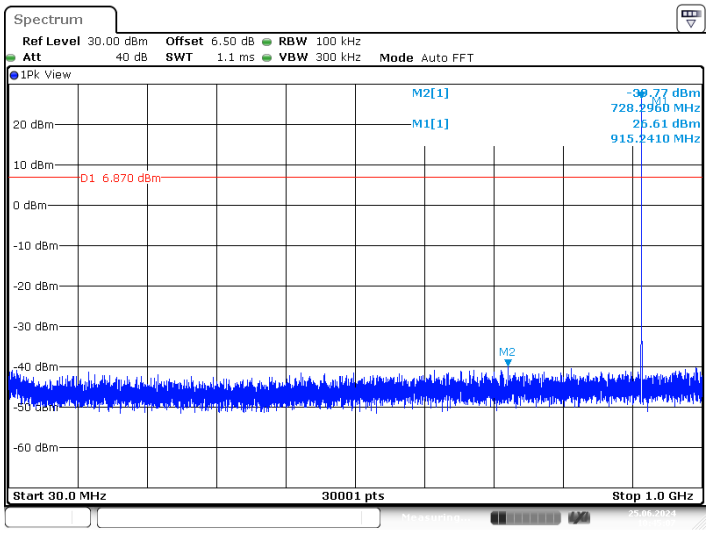
RF ID_902.75_1000~26500



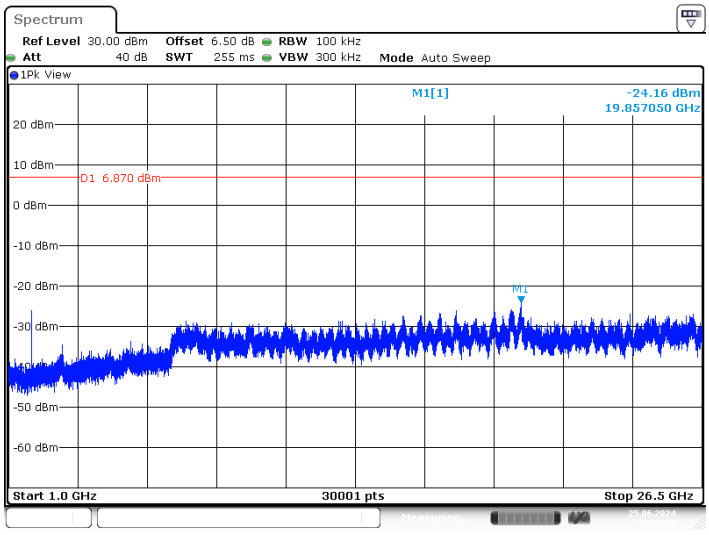
RF ID_915.25_0~Reference



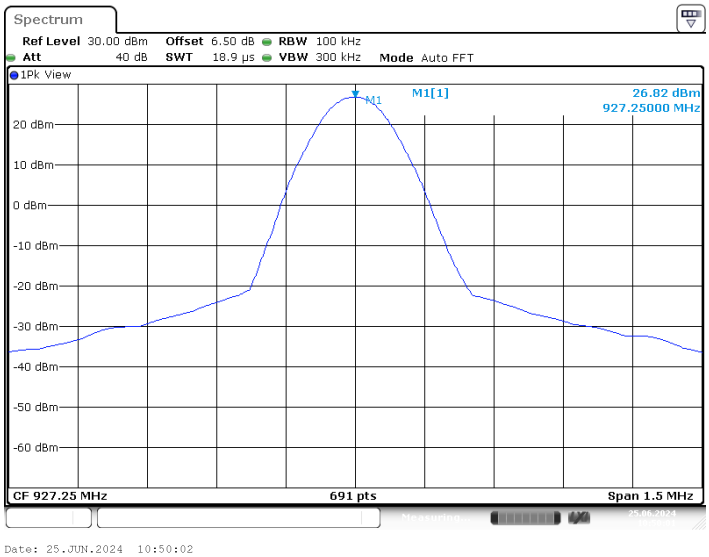
RF ID_915.25_30~1000



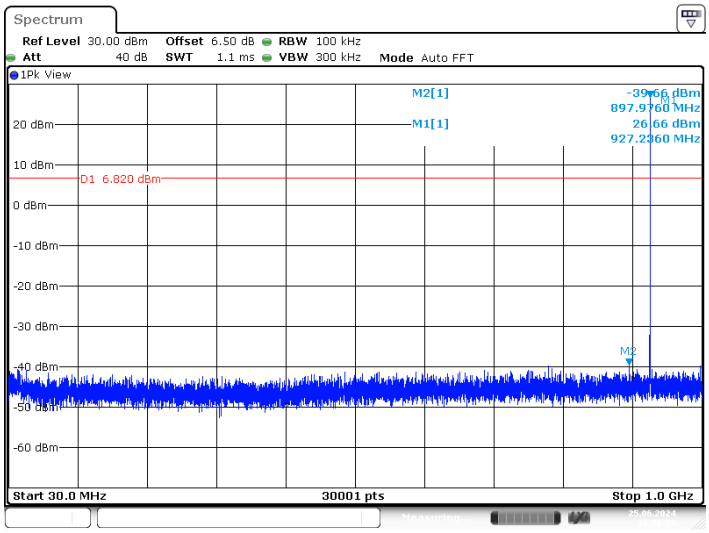
RF ID_915.25_1000~26500



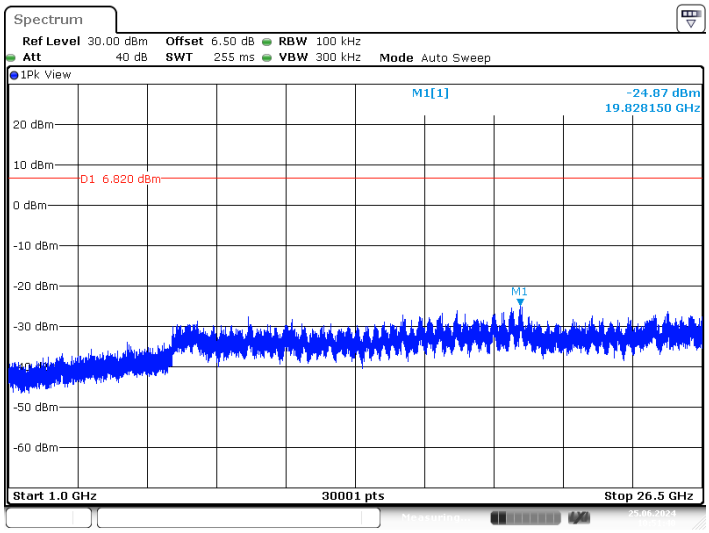
RF ID_927.25_0~Reference



RF ID_927.25_30~1000



RF ID_927.25_1000~26500

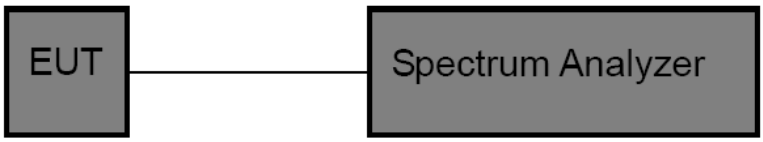


3.5. 20DB Bandwidth

Limit

The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

Test Configuration



Test Procedure

1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.
2. OCB and 20dB Spectrum Setting:
   (1) Set RBW = 1% ~ 5% occupied bandwidth.
   (2) Set the video bandwidth (VBW) ≥ 3 RBW.
   (3) Detector = Peak.
   (4) Trace mode = Max hold.
   (5) Sweep = Auto couple.

Note: The EUT was set to continuously transmitting in each mode and low, middle and high channel for the test.

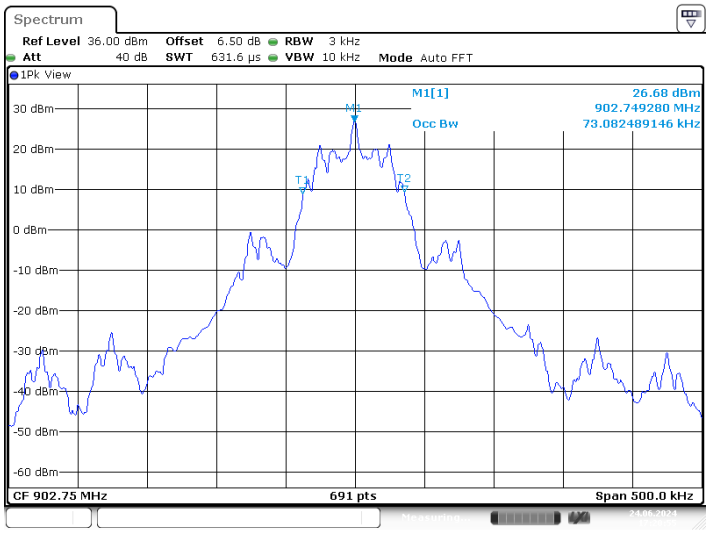
Test Mode

Please refer to the clause 2.4.

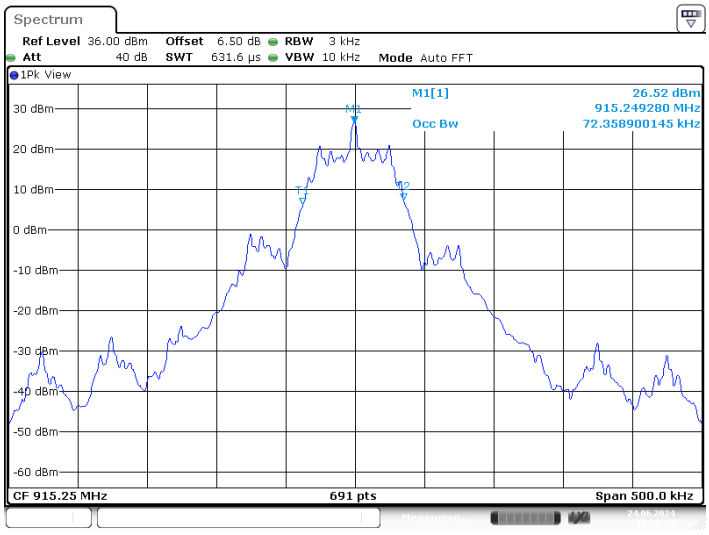
Test Results

Test Mode	Frequency [MHz]	99% Bandwidth[kHz]	20db EBW[kHz]	Limit[kHz]	Verdict
RF ID	902.75	73.08	75.98	500	PASS
	915.25	72.36	72.36	500	PASS
	927.25	73.08	75.25	500	PASS

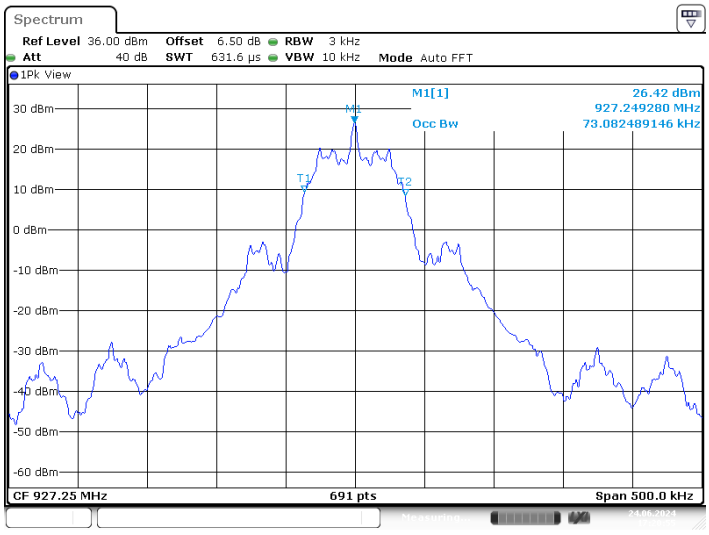
RF ID_OBW_902.75



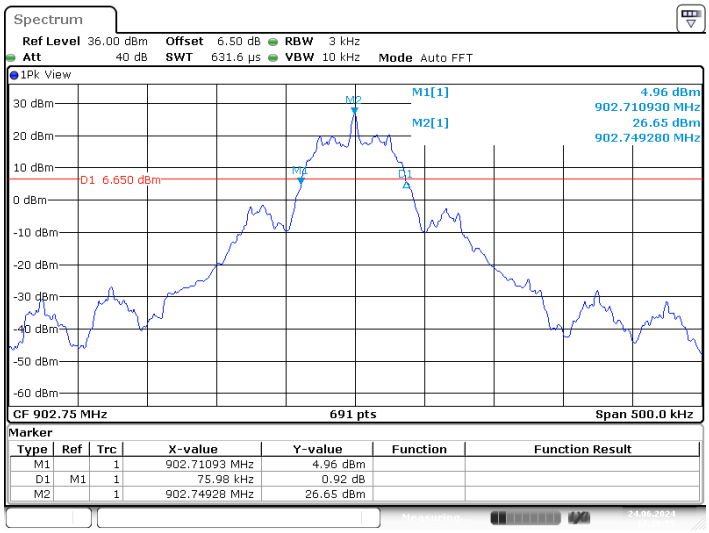
RF ID_OBW_915.25



RF ID_OBW_927.25

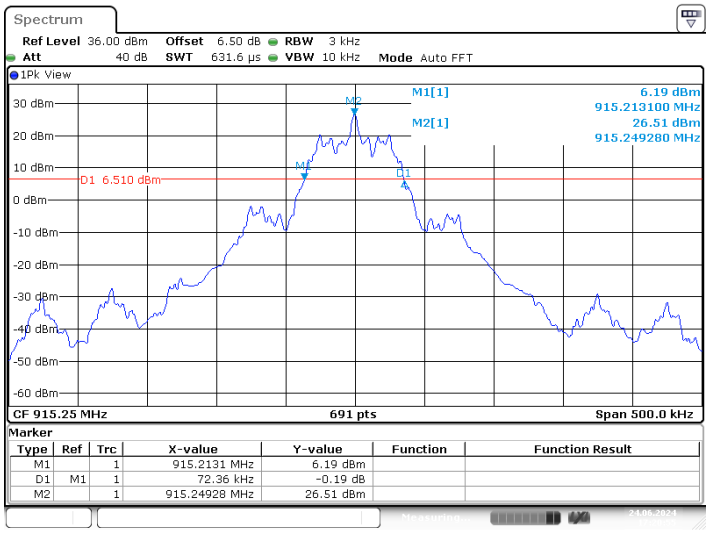


RF ID_EBW_902.75



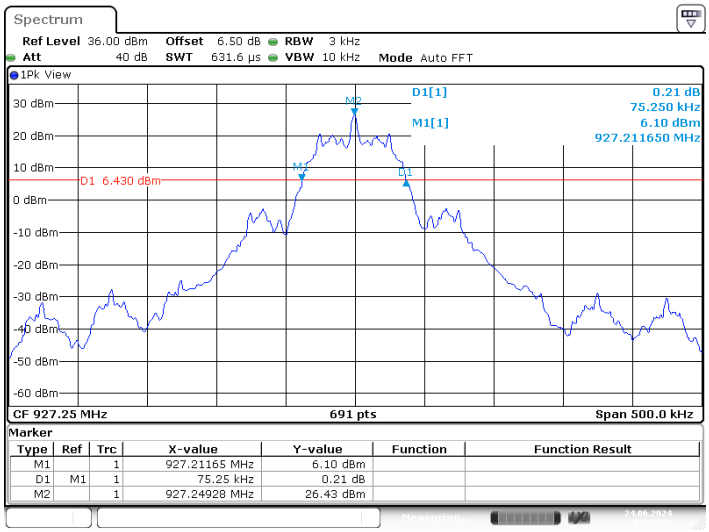
Date: 24.JUN.2024 05:51:22

RF ID_EBW_915.25



Date: 24.JUN.2024 05:50:04

RF ID_EBW_927.25



Date: 24.JUN.2024 05:48:32

3.6. Channel Separation

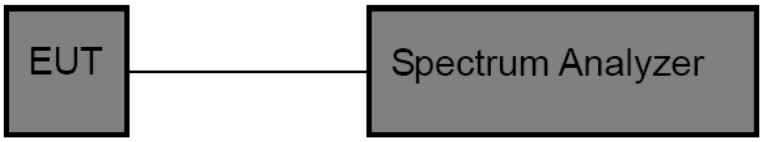
Limit

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1)/ RSS-247 5.1 b :

FCC 15.247: Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively

RSS-247: FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Test Configuration



Test Procedure

1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.
2. Spectrum Setting:
   (1) Set RBW = 100 kHz.
   (2) Set the video bandwidth (VBW) ≥ 3 RBW.
   (3) Detector = Peak.
   (4) Trace mode = Max hold.
   (5) Sweep = Auto couple.

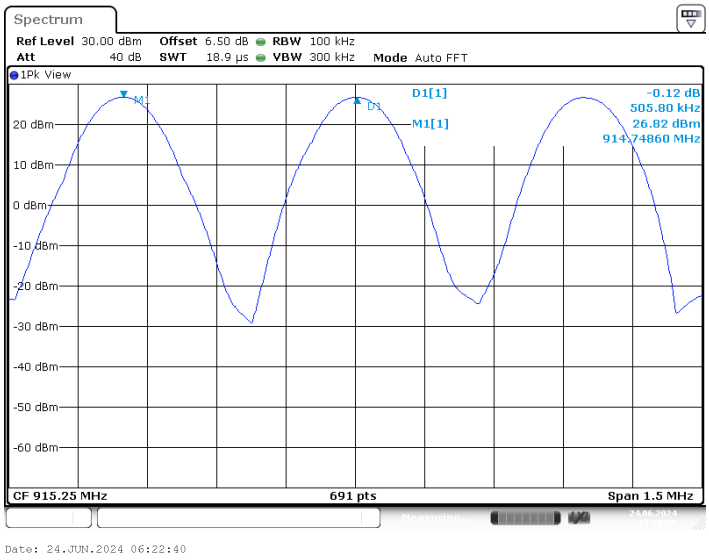
Test Mode

Please refer to the clause 2.4.

Test Results

Test Mode	Frequency [MHz]	Result[kHz]	Limit[kHz]	Verdict
RF ID	Hop_915.25	505.80	>173.7	PASS

RF ID_Hop_915.25



3.7. Number of Hopping Channel

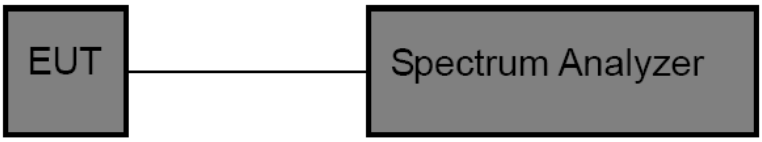
Limit

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1)(i)/ RSS-247 5.1 c :

FCC 15.247: (i)For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

RSS-247: For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10‑second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.

Test Configuration



Test Procedure

1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.
2. Spectrum Setting:
   (1) Peak Detector: RBW=100 kHz, VBW≥RBW, Sweep time= Auto.

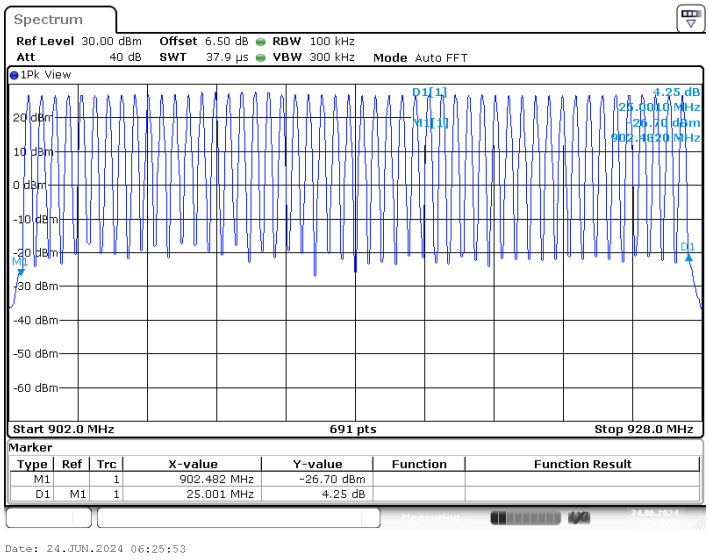
Test Mode

Please refer to the clause 2.4.

Test Result

Test Mode	Channel number	Limit	Result
RF ID	50	≥25.00	Pass

RF ID



3.8. Dwell Time

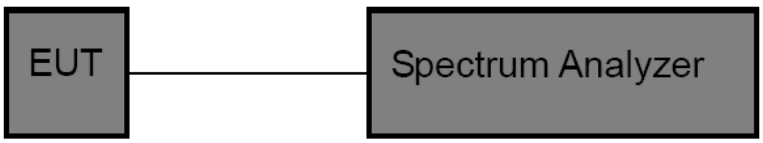
Limit

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (a)(1)(i)/ RSS-247 5.1 c :

FCC 15.247: For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

RSS-247: For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10‑second period.

Test Configuration



Test Procedure

1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.
2. Spectrum Setting:
   (1) Spectrum Setting: RBW=1MHz, VBW≥RBW.
   (2) Use video trigger with the trigger level set to enable triggering only on full pulses.
   (3) Sweep Time is more than once pulse time.
   (4) Set the center frequency on any frequency would be measure and set the frequency span to zero.
   (5) Measure the maximum time duration of one single pulse.
   (6) Set the EUT for packet transmitting.

Test Mode

Please refer to the clause 2.4.

Test Result

Test Mode	Frequency [MHz]	Pulse Time (ms)	Total of Dwell (ms)	Limit (Second)	Verdict
RF ID	915.25	27.83	278.30	≤ 0.4	PASS

Note:

Ant 1

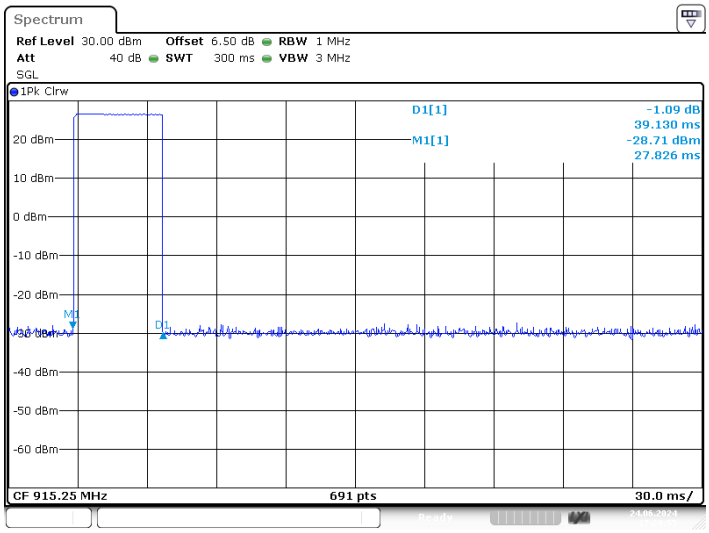
1. Occupied time for each channel = 27.83 ms

2. The number of occupied channels per 20 seconds = 10

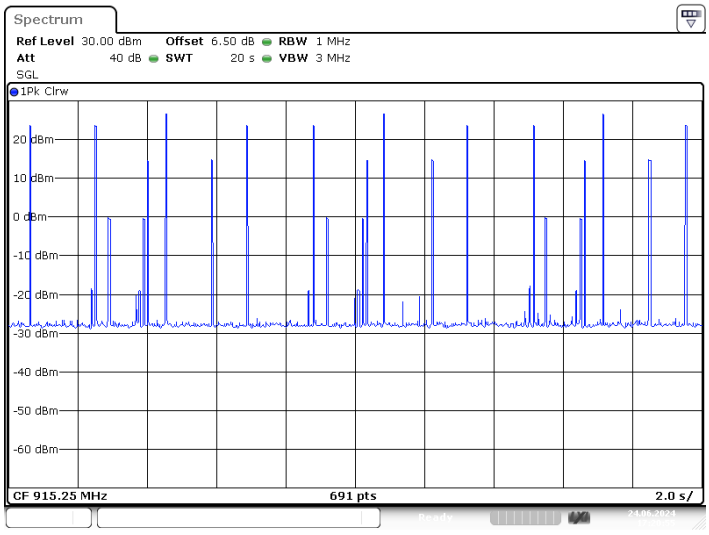
3. (Total dwell time) = (Occupied time) x (Channel number)

27.83 x 10 = 278.30 (ms)

RF ID_915.25 - 1



RF ID_915.25 - 2



3.9. Peak Output Power

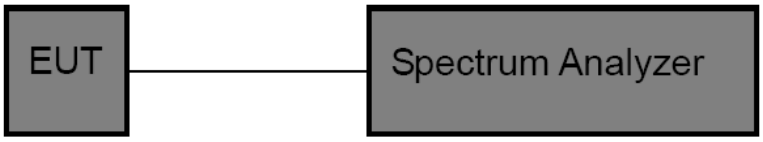
Limit

FCC CFR Title 47 Part 15 Subpart C Section 15.247 (b)(2) / RSS-247 5.4 a:

FCC 15.247: For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

RSS-247: For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

Test Configuration



Test Procedure

1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.
2. Spectrum Setting:
   (1) Set RBW> 20DB Bandwidth.
   (2) Set the video bandwidth (VBW) ≥ RBW.
   (3) Detector = Peak.
   (4) Trace mode = Max hold.
   (5) Sweep = Auto couple.

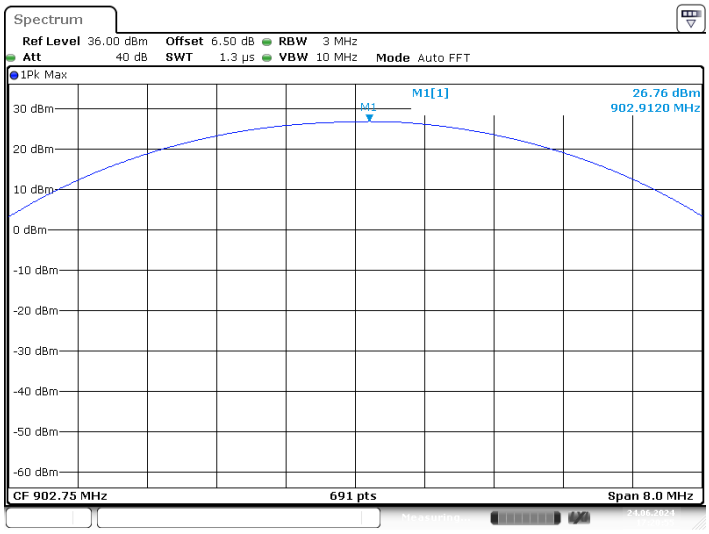
Test Mode

Please refer to the clause 2.4.

Test Result

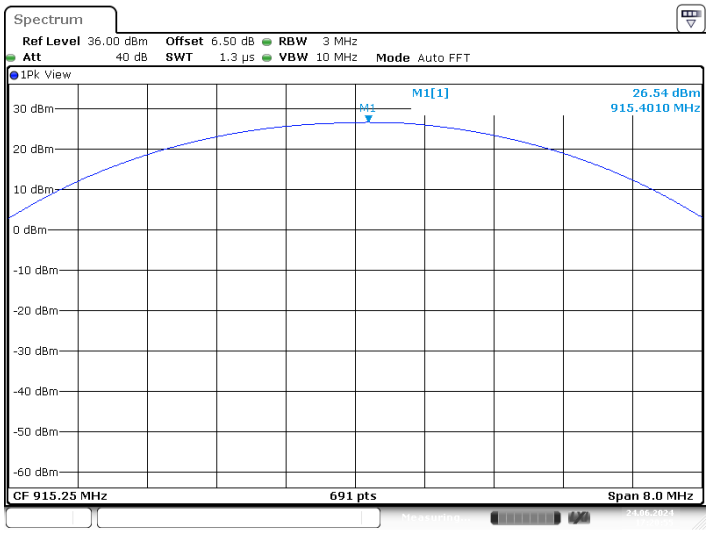
Test Mode	Frequency [MHz]	Result[dBm]	Limit[dBm]	Verdict
RF ID	902.75	26.76	<=30	PASS
	915.25	26.54	<=30	PASS
	927.25	26.44	<=30	PASS

RF ID_902.75



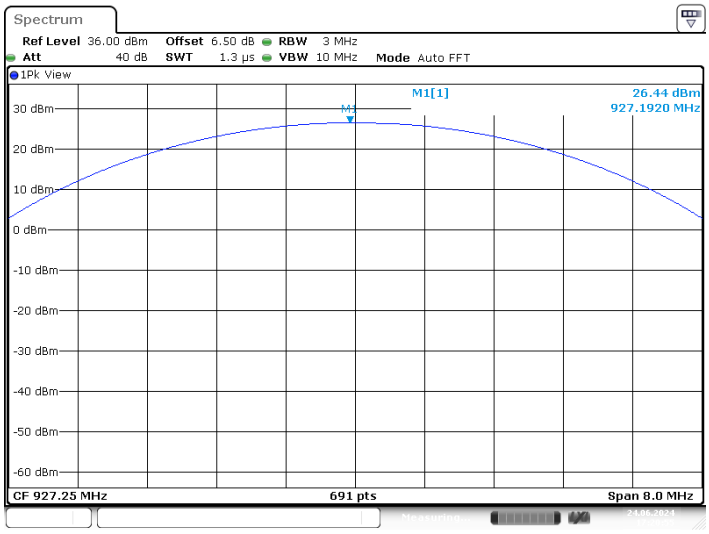
Date: 24.JUN.2024 05:54:18

RF ID_915.25



Date: 24.JUN.2024 05:56:10

RF ID_927.25



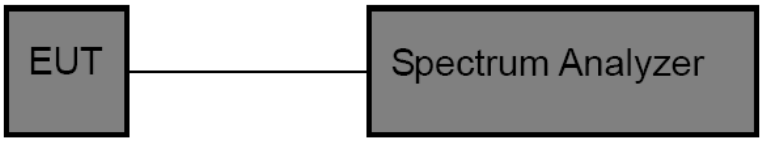
Date: 24.JUN.2024 06:19:13

3.10. Duty Cycle

Limit

None, for report purposes only.

Test Configuration



Test Procedure

1. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram above.
2. The EUT was directly connected to the Spectrum Analyzer and antenna output port as show in the block diagram above. The measurement according to section 10.2 of KDB 558074 D01 DTS Meas Guidance v05r02.
3. Spectrum Setting:

Set analyzer center frequency to test channel center frequency.
Set the span to 0Hz
Set the RBW to 10MHz
Set the VBW to 10MHz
Detector: Peak
Sweep time: Auto
Allow trace to fully stabilize. Then use the peak marker function to determine the maximum amplitude level.

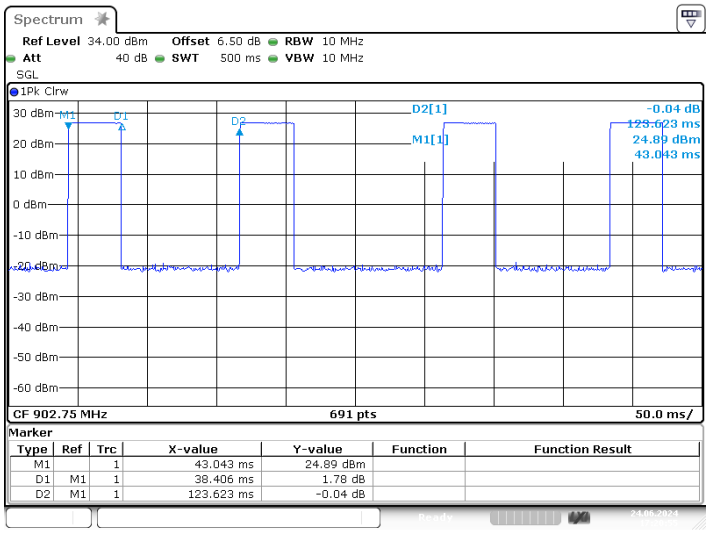
Test Mode

Please refer to the clause 2.4.

Test Result

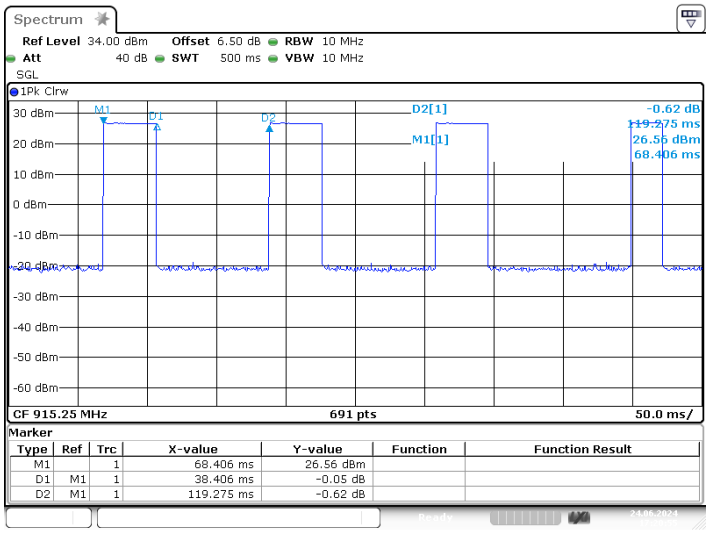
Test Mode	Frequency [MHz]	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]	1/T Minimum VBW (kHz)	Final setting For VBW (kHz)
RF ID	902.75	38.41	123.62	31.07	0.026	1
	915.25	38.40	119.28	32.19	0.026	1
	927.25	38.41	109.86	34.96	0.026	1

RF ID_902.75



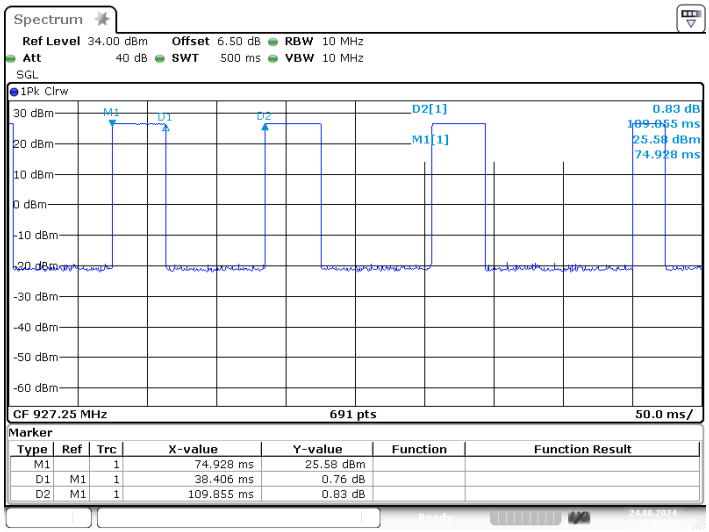
Date: 24.JUN.2024 06:35:11

RF ID_915.25



Date: 24.JUN.2024 06:36:52

RF ID_927.25



Date: 24.JUN.2024 06:37:54

3.11. Antenna requirement

Requirement

FCC CFR Title 47 Part 15 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 the device. The use of a permanently attached antenna or of antenna that uses a unique coupling to the intentional radiator, 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.

FCC CFR Title 47 Part 15 Subpart C Section 15.247(c) (1)(i):

(i) Systems operating in the 2400~2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

Test Result

The directional gain of the antenna less than 6dBi, please refer to the EUT internal photographs antenna photo.

**********THE END**********