



RF TEST REPORT

Applicant Amber-Link Network Technology Co., Ltd.
FCC ID 2A6UH-UGW800PUB
Product uGW800 Pro
Brand uG
Model uGW800PUB
Report No. R2203A0212-R1V4
Issue Date May 31, 2022

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **FCC CFR47 Part 15C**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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Version	Revision description	Issue Date
Rev.0	Initial issue of report.	May 18, 2022
Rev.1	Update description.	May 25, 2022
Rev.2	Update description.	May 27, 2022
Rev.3	Update data and description.	May 30, 2022
Rev.3	Update data.	May 31, 2022
Note: This revised report (Report No. R2203A0212-R1V4) supersedes and replaces the previously issued report (Report No. R2203A0212-R1V3). Please discard or destroy the previously issued report and dispose of it accordingly.		

Summary of Measurement Results

Number	Test Case	Clause in FCC rules	Verdict
1	Frequency Hopping System	15.247 (g), (h)	PASS
2	Output Power	15.247(b) (2)	PASS
3	Occupied Bandwidth (20dB)	15.247 (a) (1) (i)	PASS
4	Frequency Separation	15.247 (a) (1) (i)	PASS
5	Time of Occupancy (Dwell Time)	15.247 (a) (1) (i) 15.247(f)	PASS
6	Band Edge Compliance	15.247(d)	PASS
7	Power Spectral Density	15.247(f)	PASS
8	Number of Hopping Frequency	15.247 (a) (1) (i)	PASS
9	Spurious RF Conducted Emissions	15.247(d)	PASS
10	Unwanted Emissions	15.247(d)	PASS
11	Conducted Emissions	15.207	PASS

Date of Testing: April 18, 2022 ~ April 25, 2022 and May 16, 2022 ~ May 30, 2022

Date of Sample Received: March 8, 2022

Note: PASS: The EUT complies with the essential requirements in the standard.

FAIL: The EUT does not comply with the essential requirements in the standard.

All indications of Pass/Fail in this report are opinions expressed by TA Technology (Shanghai) Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.

1 Test Laboratory

1.1 Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **TA technology (shanghai) co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein .Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

1.2. Test facility

FCC (Designation number: CN1179, Test Firm Registration Number: 446626)

TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform measurements.

A2LA (Certificate Number: 3857.01)

TA Technology (Shanghai) Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform measurement.

1.3 Testing Location

Company: TA Technology (Shanghai) Co., Ltd.
Address: No.145, Jintang Rd, Tangzhen Industry Park, Pudong Shanghai, China
City: Shanghai
Post code: 201201
Country: P. R. China
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Website: <http://www.ta-shanghai.com>
E-mail: xukai@ta-shanghai.com

2 General Description of Equipment under Test

2.1 Applicant and Manufacturer Information

Applicant	Amber-Link Network Technology Co., Ltd.
Applicant address	Room 209, Building 1, Block 356, Guoshoujin Road, Pudong SH, China
Manufacturer	SHANGHAI FOJOAUTO COMPONENTS CO.,LTD
Manufacturer address	NO 767 XINGE ROAD SONGJIANG SHANGHAI CHINA

2.2 General information

EUT Description		
Model	uGW800PUB	
SN	2909469160010339	
Hardware Version	2022.7	
Software Version	2022.12.3	
Power Supply	AC adapter	
Antenna Type	Dipole Antenna	
Antenna Connector	A permanently attached antenna (meet with the standard FCC Part 15.203 requirement)	
Antenna Gain	3 dBi	
Operating Frequency Range(s)	Model 900MHz: 902.3 ~ 914.9MHz	
	Hybrid Mode: 902.3 ~ 914.9MHz	
Modulation Type	Chirp Spread Spectrum	
Max. Output Power	Model 900MHz	20.75 dBm
	Hybrid Mode	20.06 dBm
Note: 1. The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant.		

3 Applied Standards

According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

Test standards:

FCC CFR47 Part 15C Radio Frequency Devices

ANSI C63.10-2013

Reference standard:

KDB 558074 D01 15.247 Meas Guidance v05r02

3.1 Test Configuration

The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application.

The radiated emission was measured in the following position: EUT stand-up position (Z axis), lie-down position (X, Y axis). The worst emission was found in lie-down position (X axis) and the worst case was recorded.

Channel List

Band	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
Hybrid Mode	1	902.3	17	905.5	33	908.7	49	911.9
	2	902.5	18	905.7	34	908.9	50	912.1
	3	902.7	19	905.9	35	909.1	51	912.3
	4	902.9	20	906.1	36	909.3	52	912.5
	5	903.1	21	906.3	37	909.5	53	912.7
	6	903.3	22	906.5	38	909.7	54	912.9
	7	903.5	23	906.7	39	909.9	55	913.1
	8	903.7	24	906.9	40	910.1	56	913.3
	9	903.9	25	907.1	41	910.3	57	913.5
	10	904.1	26	907.3	42	910.5	58	913.7
	11	904.3	27	907.5	43	910.7	59	913.9
	12	904.5	28	907.7	44	910.9	60	914.1
	13	904.7	29	907.9	45	911.1	61	914.3
	14	904.9	30	908.1	46	911.3	62	914.5
	15	905.1	31	908.3	47	911.5	63	914.7
	16	905.3	32	908.5	48	911.7	64	914.9

Band	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
Model 900MHz	1	902.3	11	907.3	21	912.7
	2	902.8	12	907.8	22	913.2
	3	903.3	13	908.7	23	913.7
	4	903.8	14	909.2	24	914.2
	5	904.3	15	909.7	25	914.9
	6	904.8	16	910.2	--	--
	7	905.3	17	910.7	--	--
	8	905.8	18	911.2	--	--
	9	906.3	19	911.7	--	--
	10	906.8	20	912.2	--	--

4 Information about the FHSS characteristics

4.1 Frequency Hopping System Requirement

Standard requirement:

- (g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.
- (h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hop sets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

5 Test Case Results

5.1 Output Power

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Methods of Measurement

For Model 900MHz, during the process of the testing, The EUT was connected to the spectrum analyzer and Model 900MHz test set via a power splitter with a known loss. The EUT is controlled by the Model 900MHz test set to ensure max power transmission with proper modulation. The peak detector is used. RBW is set to 2 MHz; VBW is set to 6 MHz.

For Hybrid Mode, Method AVGSA-1 was used for this test.

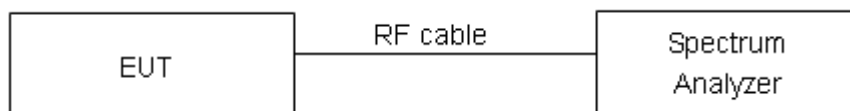
- Set span to at least 1.5 times the OBW.
- Set RBW= 1% to 5% of the OBW, not to exceed 1 MHz.
- Set VBW $\geq$ [3 $\times$ RBW].
- Sweep time = auto.
- Detector=RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.

Test Setup

For Model 900MHz



For Hybrid Mode



Limits

Rule Part 15.247 (b) (2) specifies that " 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."

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 2$, $U=0.44$ dB.

Test Results

Model 900MHz

Band	Frequency (MHz)	Peak Output Power (dBm)	Limit (dBm)	Conclusion
Model 900MHz	902.3	20.26	30	PASS
	908.7	20.75	30	PASS
	914.9	20.50	30	PASS

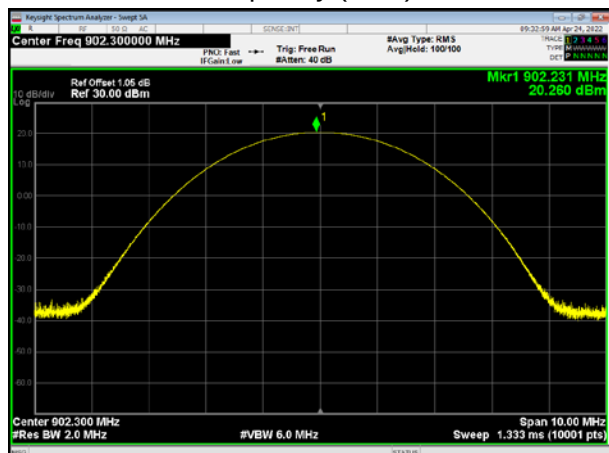
Hybrid Mode

Test Mode	T _{on} (ms)	T _(on+off) (ms)	Duty cycle	Duty cycle correction Factor(dB)
Hybrid Mode	0.44	0.46	0.957	0.193
Note: when Duty cycle ≥ 0.98 , Duty cycle correction Factor not required.				

Test Mode	Frequency (MHz)	Average Power Measured (dBm)	Average Power with duty factor (dBm)	Limit (dBm)	Conclusion
Hybrid Mode	902.3	19.42	19.61	21	PASS
	908.7	19.87	20.06	21	PASS
	914.9	19.66	19.85	21	PASS
Note: Average Power with duty factor = Average Power Measured +Duty cycle correction factor					

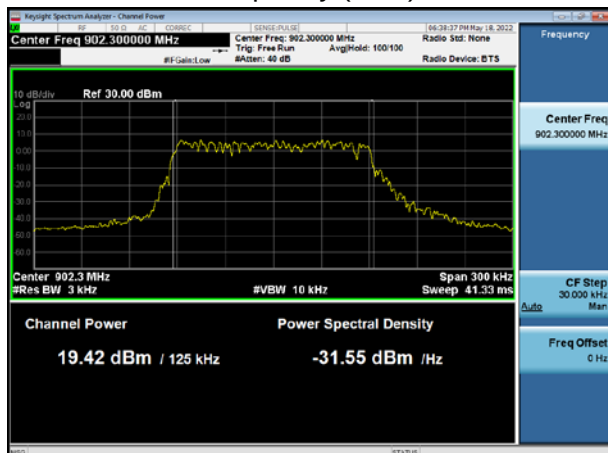
Model 900MHz

Carrier frequency (MHz): 902.3

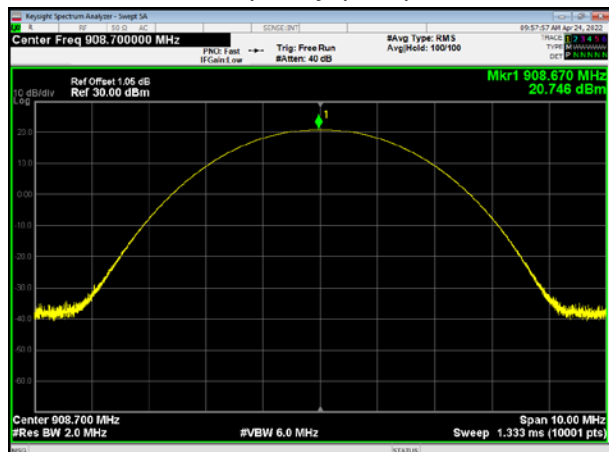


Hybrid Mode

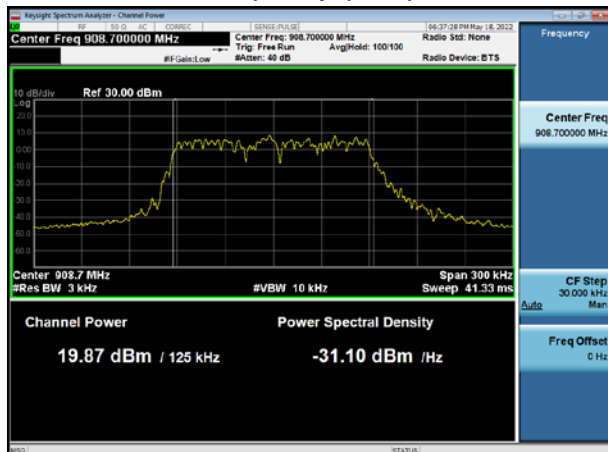
Carrier frequency (MHz): 902.3



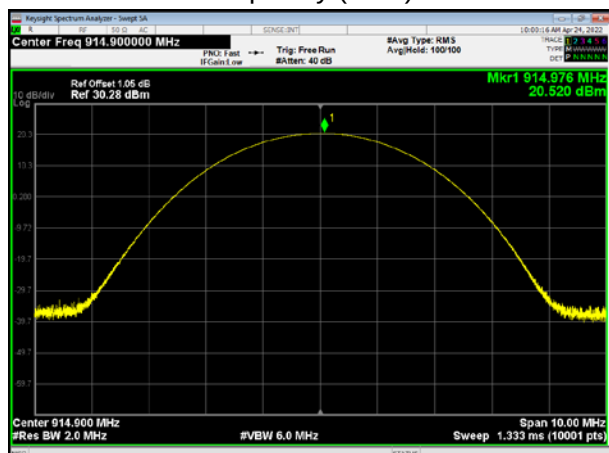
Carrier frequency (MHz): 908.7



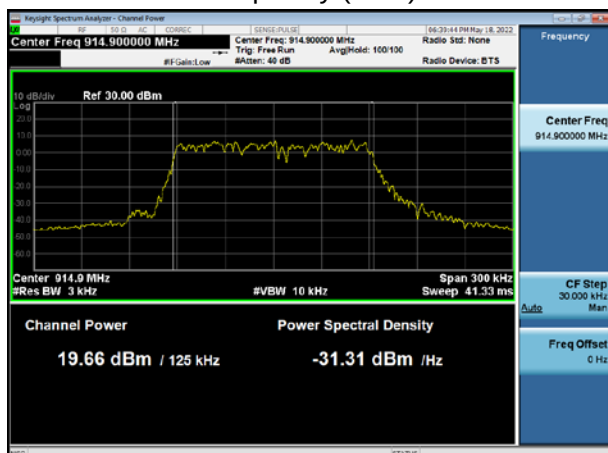
Carrier frequency (MHz): 908.7



Carrier frequency (MHz): 914.9



Carrier frequency (MHz): 914.9



5.2 Occupied Bandwidth (20dB)

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

For Model 900MHz

The EUT was connected to the spectrum analyzer and Model 900MHz test set via a power splitter with a known loss. The occupied bandwidth is measured using spectrum analyzer. RBW is set to 30kHz and VBW is set to 100kHz on spectrum analyzer. -20dB occupied bandwidths are recorded.

For Hybrid Mode

The EUT was connected to the spectrum analyzer through an external attenuator (20dB) and a known loss cable. RBW is set to 100 kHz; VBW is set to 300 kHz on spectrum analyzer.

Dector=Peak, Trace mode=max hold.

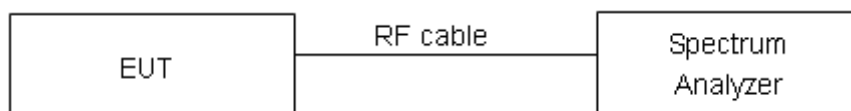
The EUT was connected to the spectrum analyzer through a known loss cable. The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value.

Test Setup

For Model 900MHz



For Hybrid Mode



Limits

No specific occupied bandwidth requirements in part 15.247(a) (1) (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.

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 2$, $U=936$ Hz.

Test Results

Model 900MHz

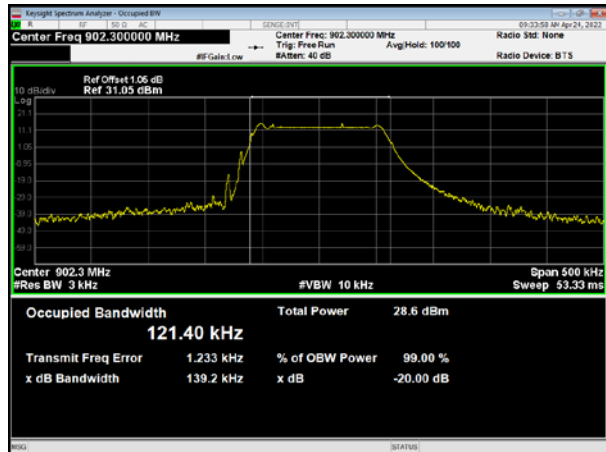
Test Mode	Frequency (MHz)	99% bandwidth(kHz)	20dB Bandwidth(kHz)
Model 900MHz	902.3	121.40	139.2
	908.7	120.45	134.7
	914.9	120.20	134.4

Hybrid Mode

Test Mode	Frequency (MHz)	99% bandwidth(kHz)	20dB Bandwidth(kHz)
Hybrid Mode	902.3	120.58	131.4
	908.7	122.71	135.2
	914.9	122.99	135.1

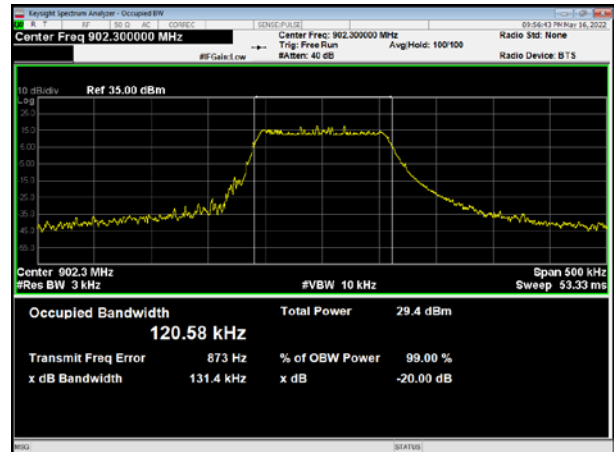
Model 900MHz

Carrier frequency (MHz): 902.3

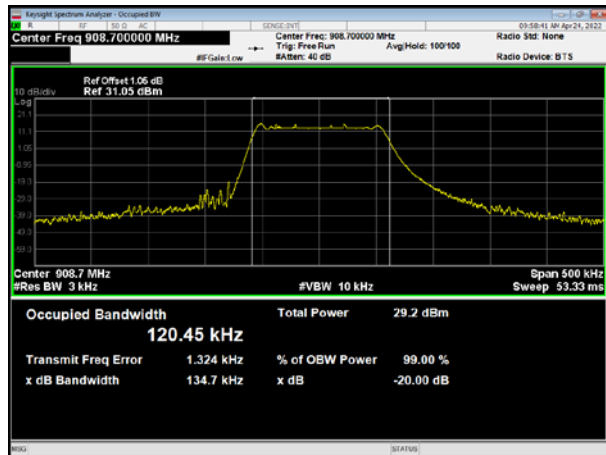


Hybrid Mode

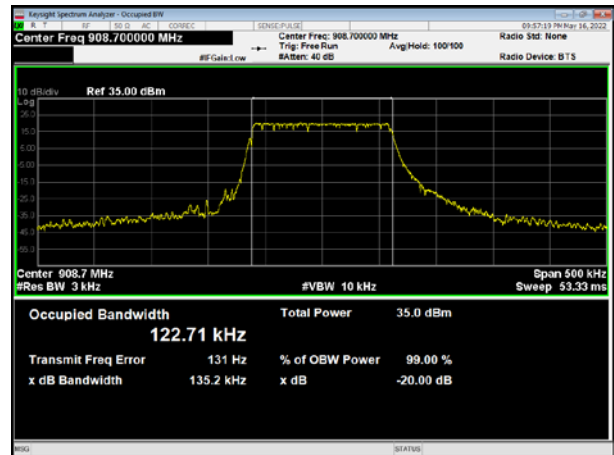
Carrier frequency (MHz): 902.3



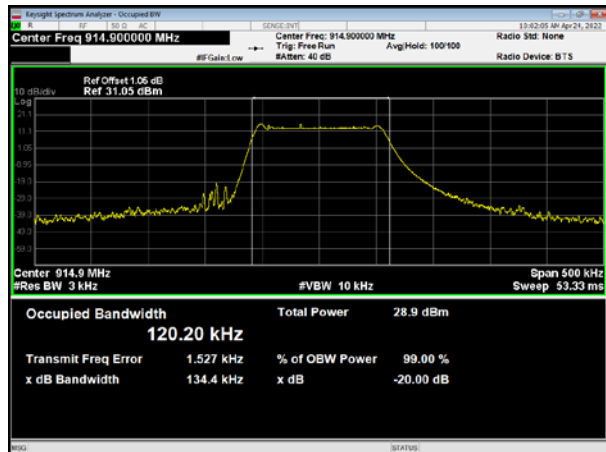
Carrier frequency (MHz): 908.7



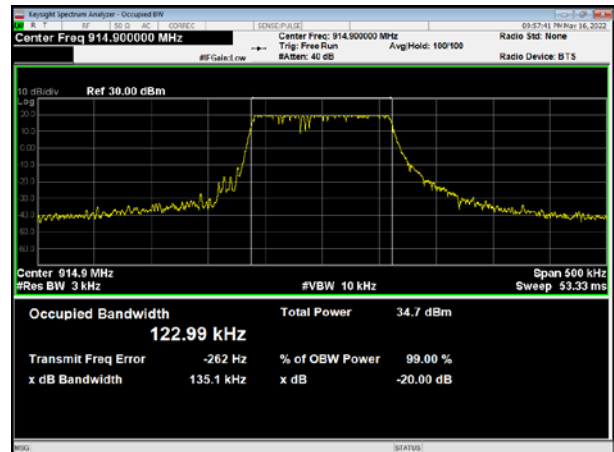
Carrier frequency (MHz): 908.7



Carrier frequency (MHz): 914.9



Carrier frequency (MHz): 914.9



5.3 Frequency Separation

Ambient condition

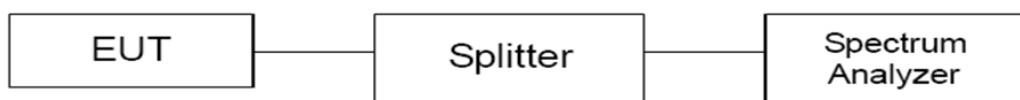
Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

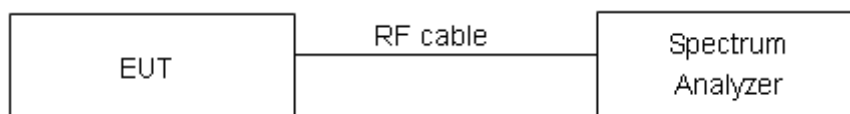
The EUT was connected to the spectrum analyzer and Model 900MHz test set via a power splitter with a known loss. RBW is set to 30 kHz and VBW is set to 100 kHz on spectrum analyzer. Set EUT on Hopping on mode.

Test setup

For Model 900MHz



For Hybrid Mode



Limits

Rule Part 15.247(a)(1) (i) specifies that “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. ”

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 2$, $U=936$ Hz.

Test Results:
Model 900MHz

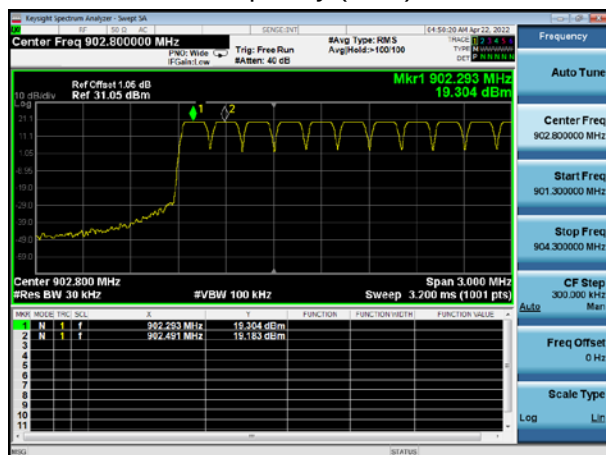
Test Mode	Carrier frequency (MHz)	Carrier frequency separation(kHz)	Limit (kHz)	Conclusion
Model 900MHz	902.3	198	139.2	PASS
	908.7	197	134.7	PASS
	914.9	204	134.4	PASS
Note: The limit is 20 dB bandwidth.				

Hybrid Mode

Test Mode	Carrier frequency (MHz)	Carrier frequency separation(kHz)	Limit (kHz)	Conclusion
Hybrid Mode	902.3	210	131.4	PASS
	908.7	207	135.2	PASS
	914.9	214	135.1	PASS
Note: The limit is 20 dB bandwidth.				

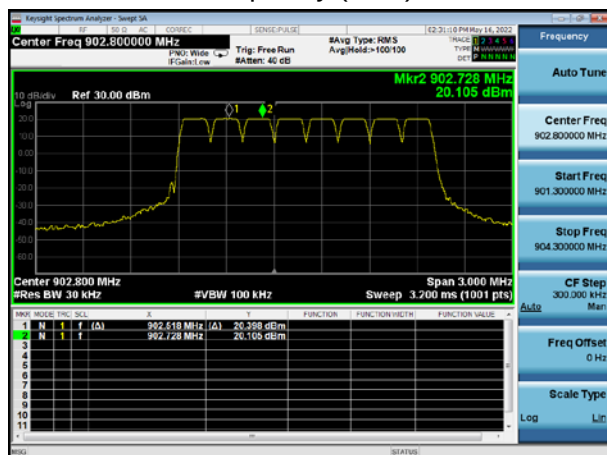
Model 900MHz

Carrier frequency (MHz): 902.3

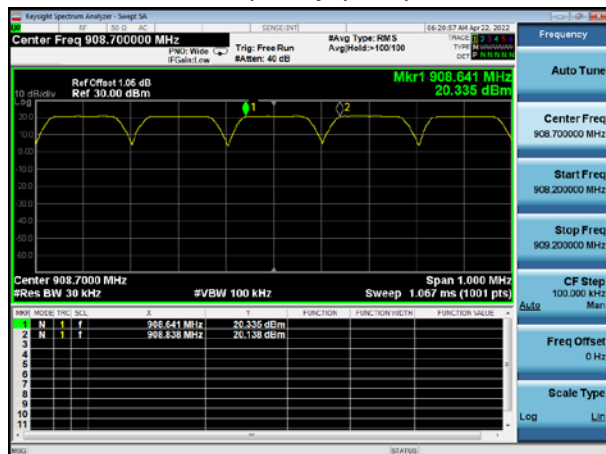


Hybrid Mode

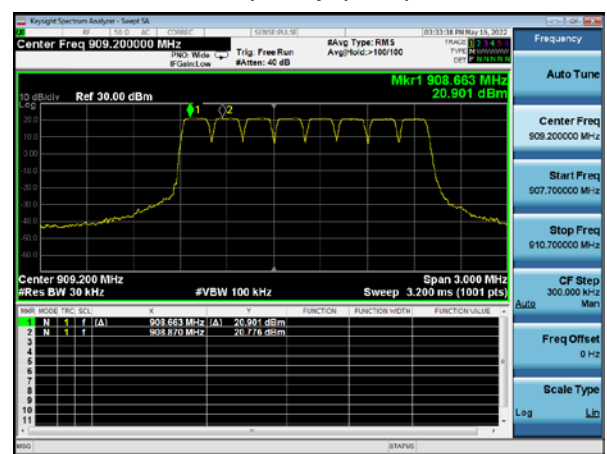
Carrier frequency (MHz): 902.3



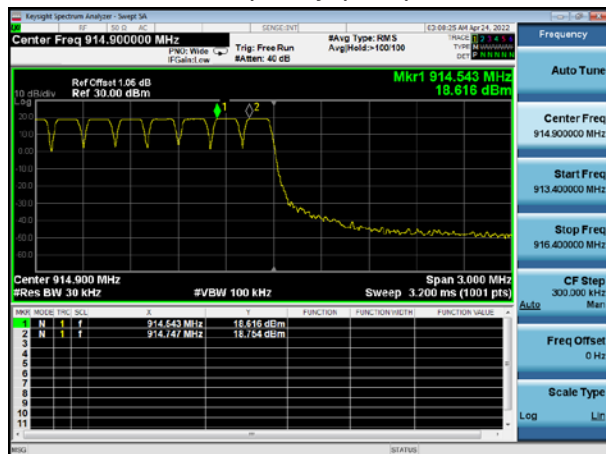
Carrier frequency (MHz): 908.7



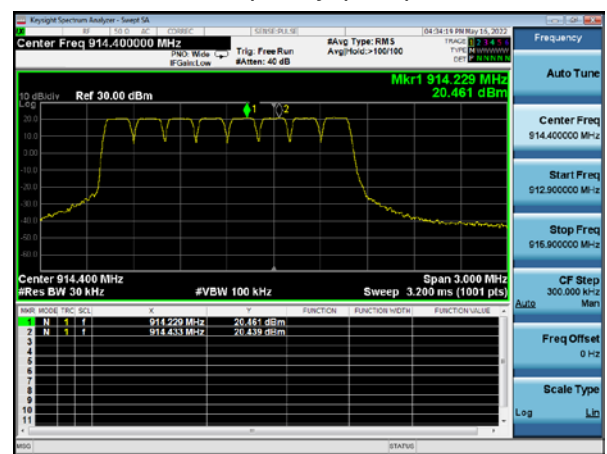
Carrier frequency (MHz): 908.7



Carrier frequency (MHz): 914.9



Carrier frequency (MHz): 914.9



5.4 Time of Occupancy (Dwell Time)

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Methods of Measurement

The EUT was connected to the spectrum analyzer and Model 900MHz test set via a power splitter with a known loss. RBW 100 KHz, VBW 300 KHz. The dwell time is calculated by:

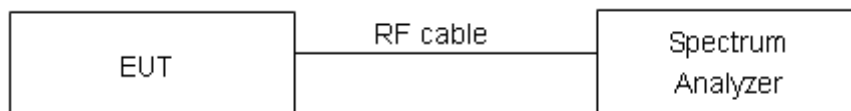
Dwell time = Average Transmit Time/ Channel (ms)*Number of Hops in 20s

Test Setup

For Model 900MHz



For Hybrid Mode



Limits

Rule Part15.247(a) (1) (i) specifies that " 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."

Rule Part 15.247(f)

Hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4.

Dwell time	≤ 400ms
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Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 2$.

Requirements	Uncertainty
Dwell Time	$U=0.70\text{ms}$

Test Results:
Model 900MHz

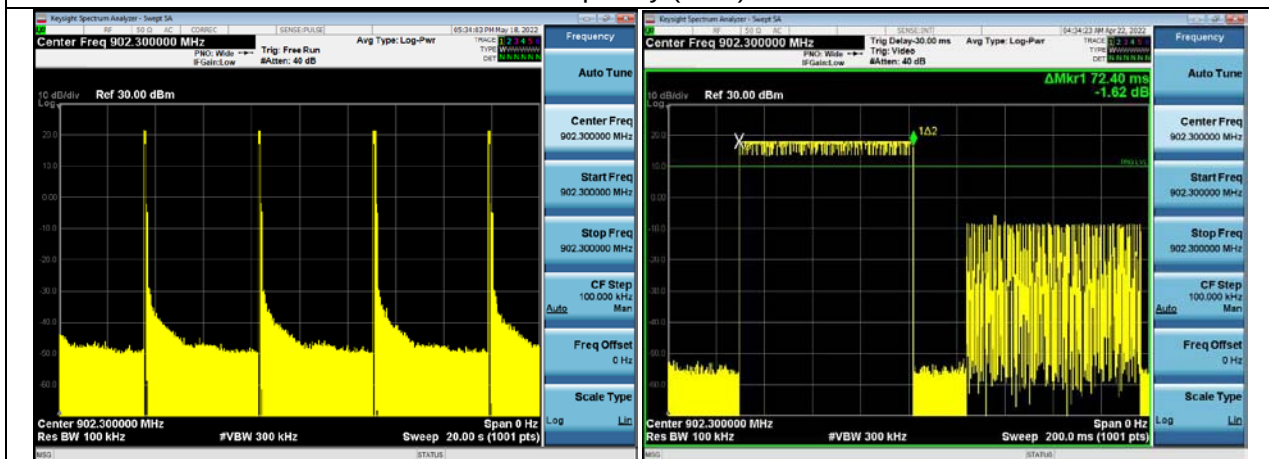
Test Mode	Carrier frequency (MHz)	Average Transmit Time/ Channel (ms)	Number of Hops in 20s	Dwell time (ms)	Limit (ms)	Conclusion
Model 900MHz	902.3	72.40	4.00	289.60	400	PASS
	908.7	72.00	4.00	288.00	400	PASS
	914.9	70.80	4.00	283.20	400	PASS
Note: Dwell time = Average Transmit Time/ Channel (ms)*Number of Hops in 20s						

Hybrid Mode

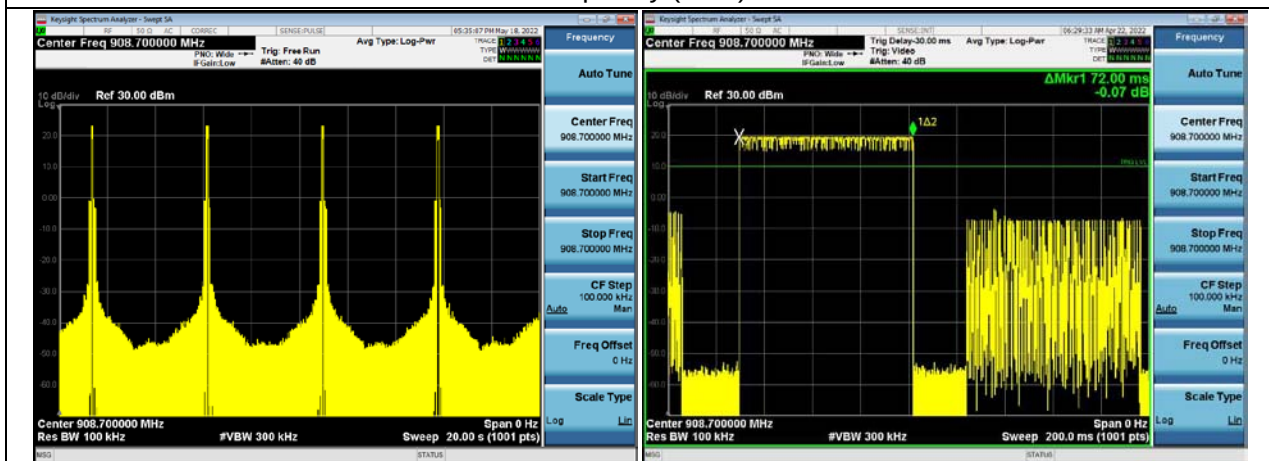
Test Mode	Carrier frequency (MHz)	Average Transmit Time/ Channel (ms)	Number of Hops in 3.2s	Dwell time (ms)	Limit (ms)	Conclusion
Hybrid Mode	902.3	72.40	4.00	289.60	400	PASS
	908.7	72.00	4.00	288.00	400	PASS
	914.9	72.00	4.00	288.00	400	PASS
Note: Dwell time = Average Transmit Time/ Channel (ms)*Number of Hops in 3.2s						

Model 900MHz

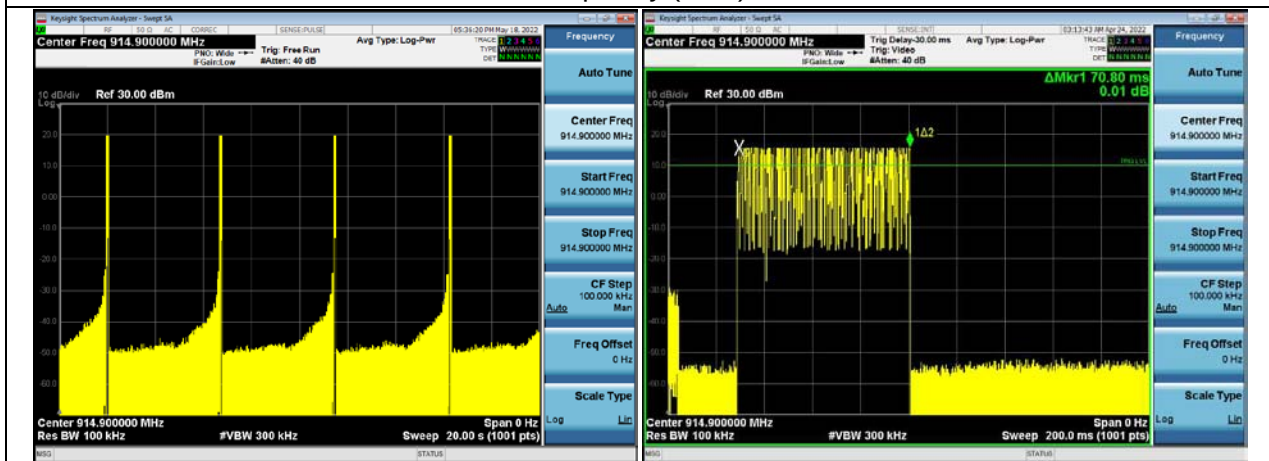
Carrier frequency (MHz): 902.3



Carrier frequency (MHz): 908.7

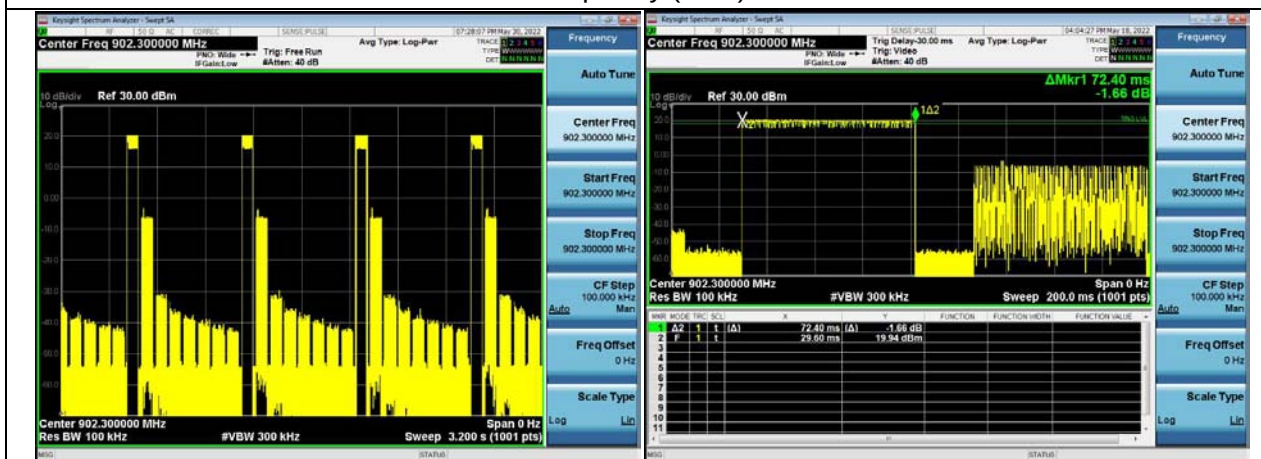


Carrier frequency (MHz): 914.9

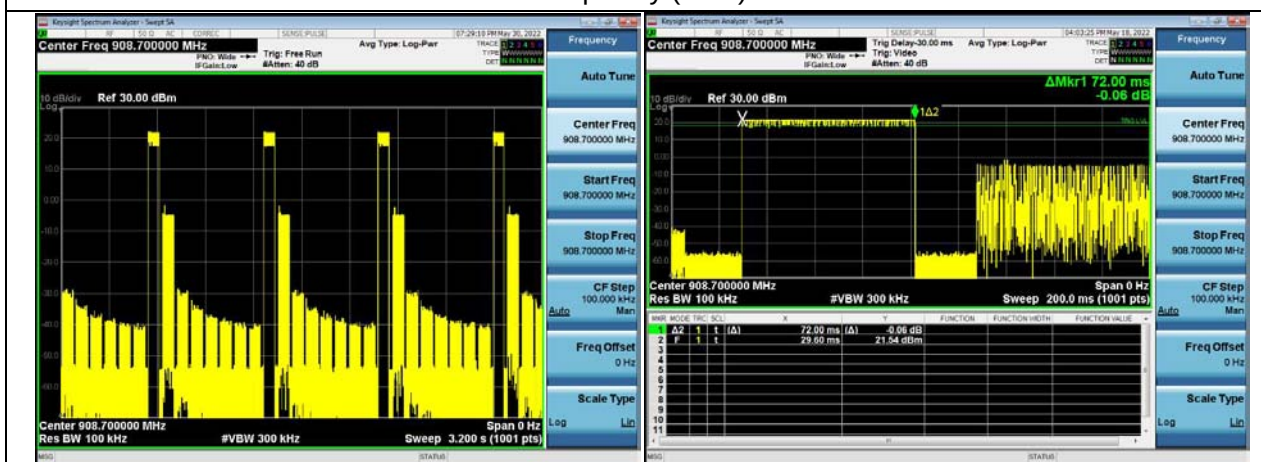


Hybrid Mode

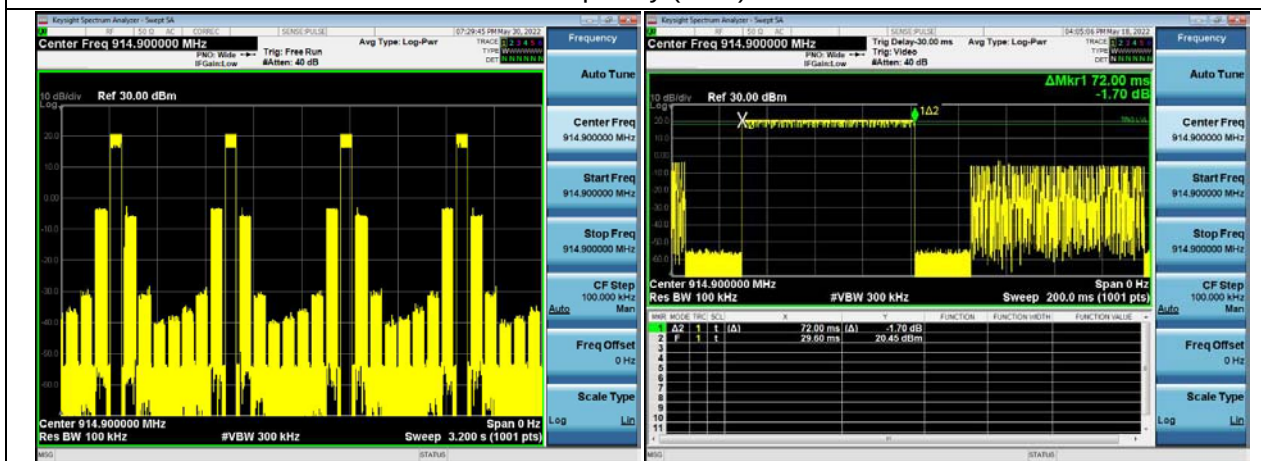
Carrier frequency (MHz): 902.3



Carrier frequency (MHz): 908.7



Carrier frequency (MHz): 914.9



5.5 Band Edge Compliance

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

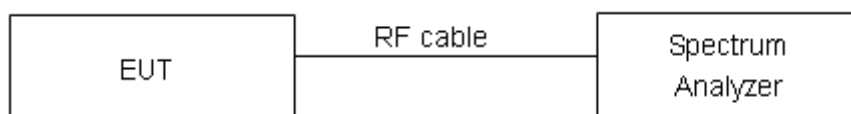
The EUT was connected to the spectrum analyzer and Model 900MHz test set via a power splitter with a known loss. The lowest and highest channels were measured. The peak detector is used. RBW is set to 100 kHz and VBW is set to 300 kHz on spectrum analyzer. EUT test for Hopping On mode and Hopping Off mode.

Test Setup

For Model 900MHz



For Hybrid Mode



Limits

Rule Part 15.247(d) specifies that “In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated 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, provided the transmitter demonstrates compliance with the peak conducted power limits.”

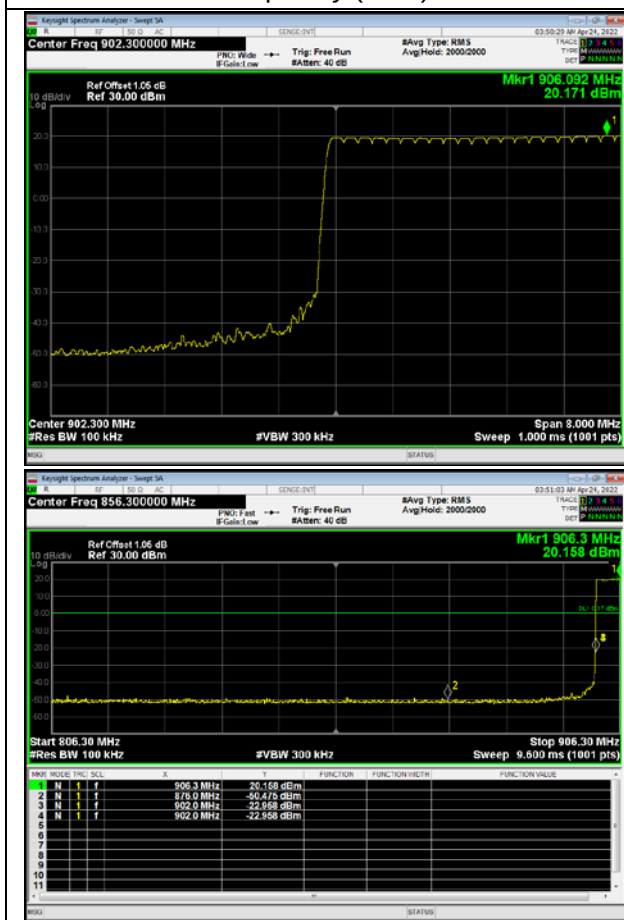
Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 1.96$.

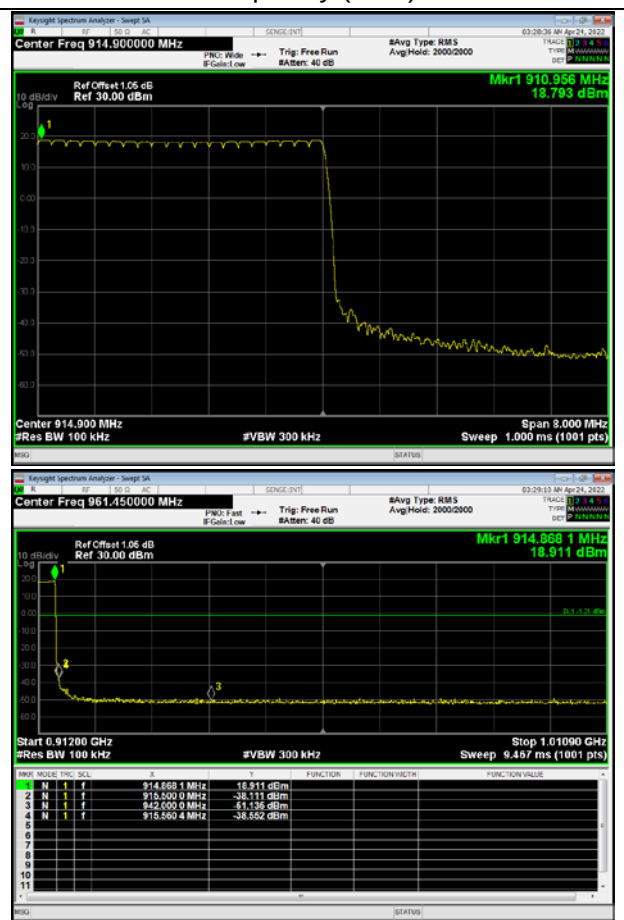
Frequency	Uncertainty
2GHz-3GHz	1.407 dB

Test Results
Model 900MHz
Hopping On

Carrier frequency (MHz): 902.3

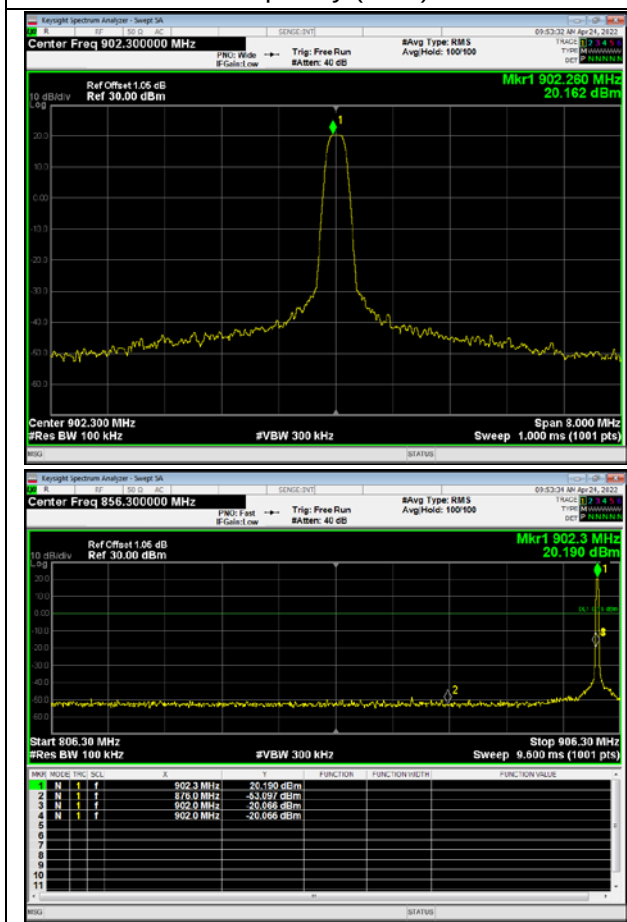


Carrier frequency (MHz): 914.9

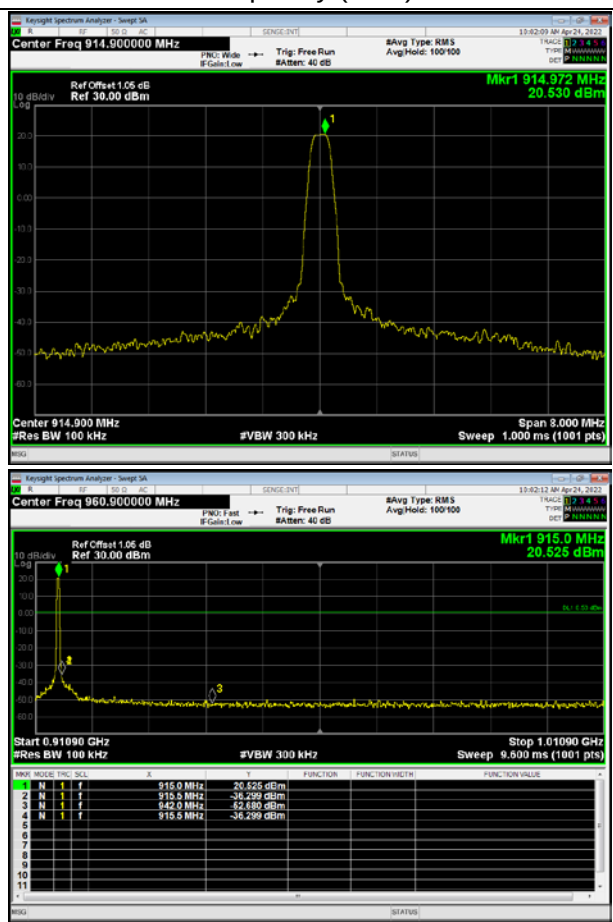


Hopping Off

Carrier frequency (MHz): 902.3

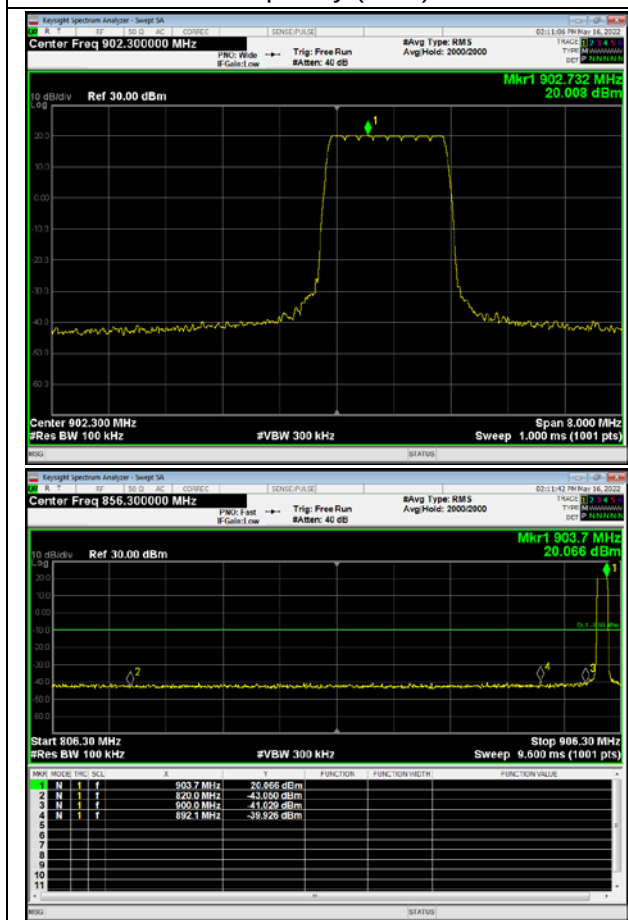


Carrier frequency (MHz): 914.9

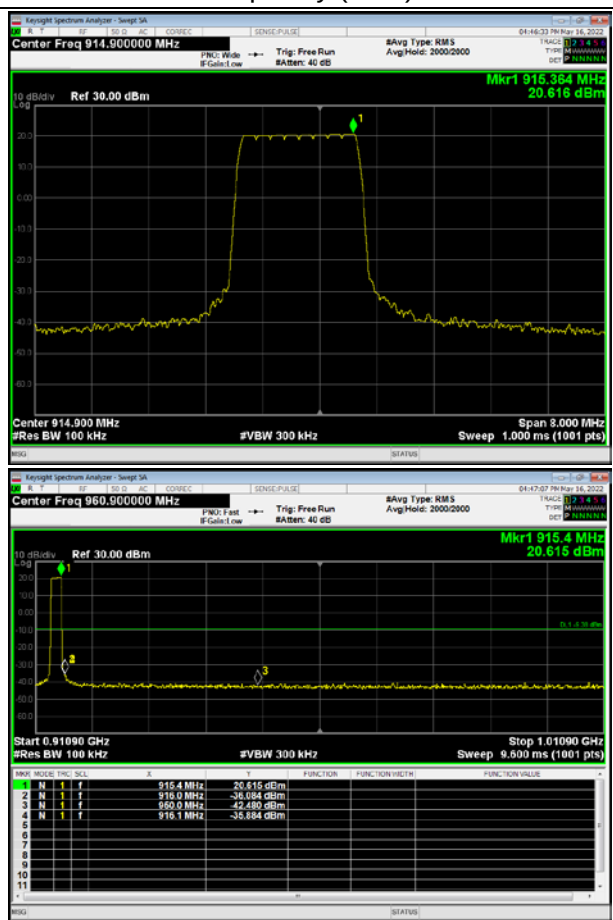


Hybrid Mode Hopping On

Carrier frequency (MHz): 902.3

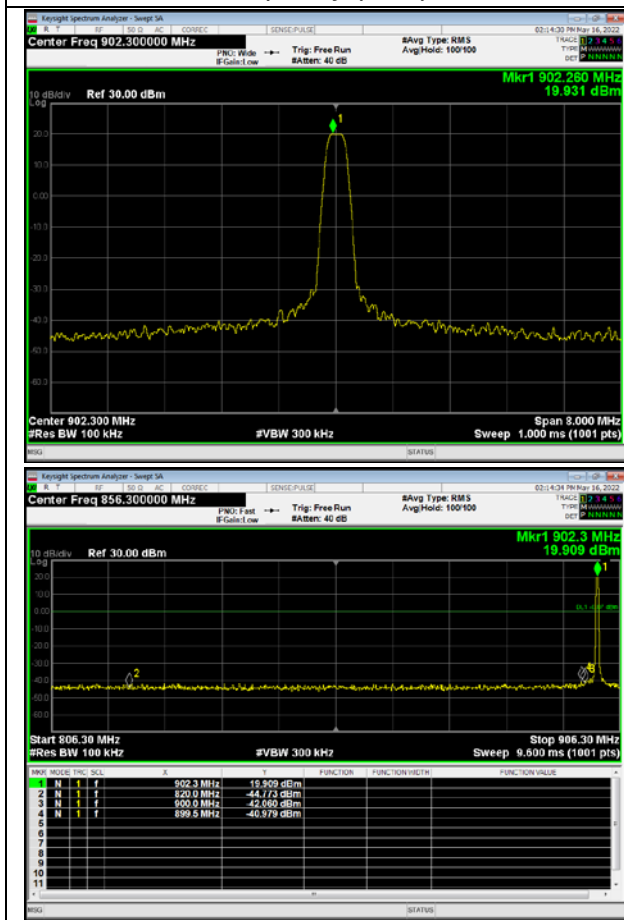


Carrier frequency (MHz): 914.9

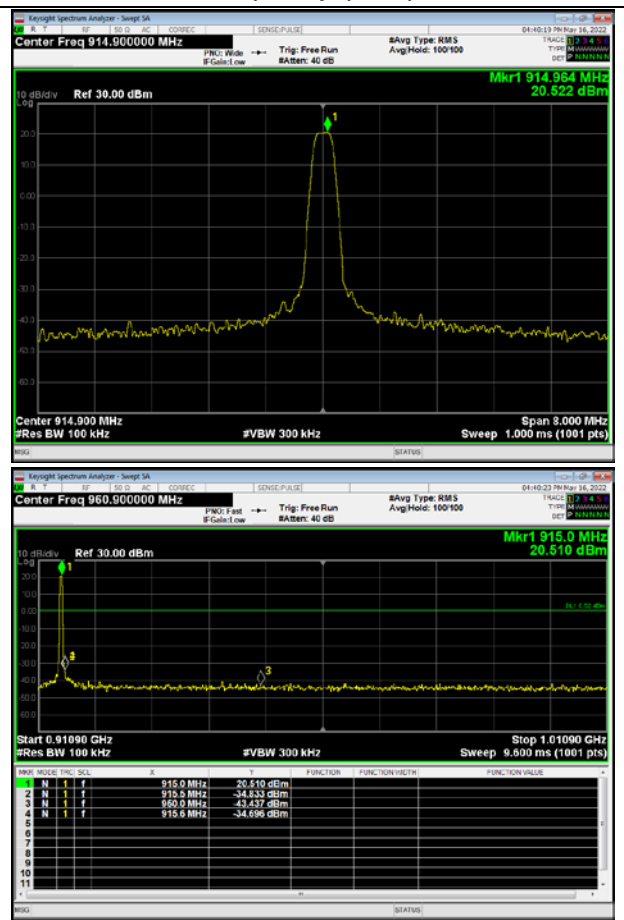


Hopping Off

Carrier frequency (MHz): 902.3



Carrier frequency (MHz): 914.9



5.6 Power Spectral Density

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

During the process of the testing, The EUT was connected to Spectrum Analyzer with a known loss. The EUT is max power transmission with proper modulation.

Method AVGPS-1 was used for this test.

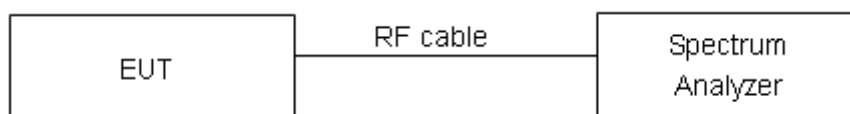
- Set instrument center frequency to DTS channel center frequency
- Set RBW to 3kHz
- Set VBW $\geq$ [3x RBW]
- Detector=power averaging (rms) or sample detector (when rms not available)
- Ensure that the number of measurement points in the sweep $2[2 \times \text{span}/\text{RBW}]$
- Sweep time auto couple
- Employ trace averaging (rms) mode over a minimum of 100 traces
- Use the peak marker function to determine the maximum amplitude level.

Test setup

For Model 900MHz



For Hybrid Mode



Limits

Rule Part 15.247(f) specifies that "The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. "

Limits	$\leq 8 \text{ dBm} / 3\text{kHz}$
--------	------------------------------------

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 2$, $U = 0.75\text{dB}$.

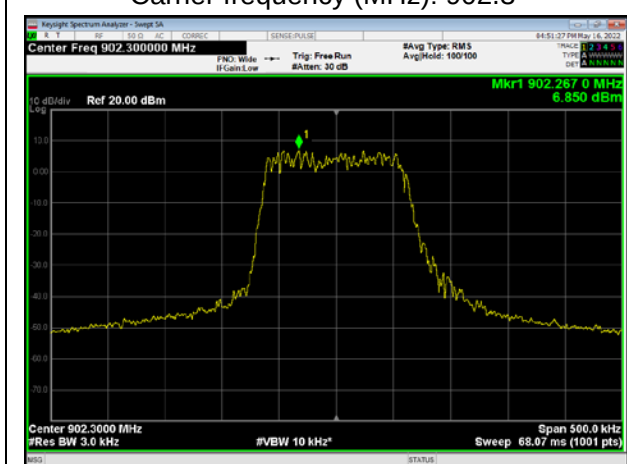
Test Results:

Hybrid Mode

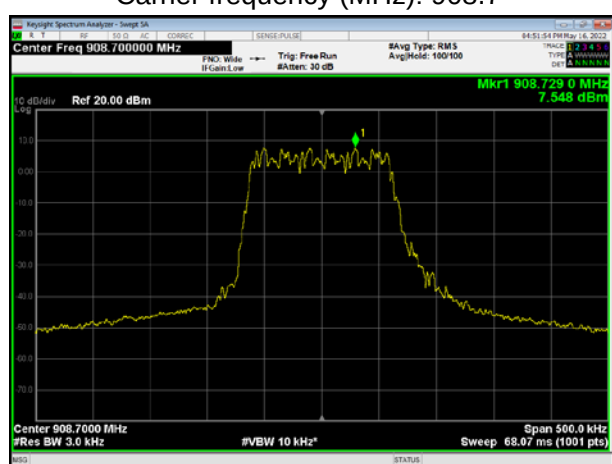
Test Mode	Carrier frequency (MHz)	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Hybrid Mode	902.3	6.85	7.04	8	PASS
	908.7	7.55	7.74	8	PASS
	914.9	7.38	7.57	8	PASS

Note: Power Spectral Density =Read Value+Duty cycle correction factor

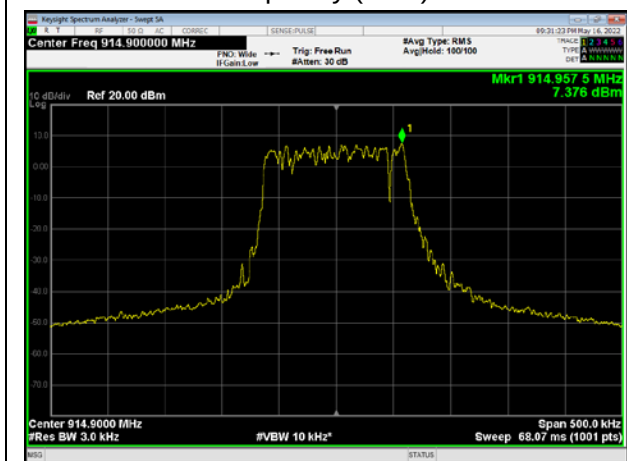
Carrier frequency (MHz): 902.3



Carrier frequency (MHz): 908.7



Carrier frequency (MHz): 914.9



5.7 Number of hopping Frequency

Ambient condition

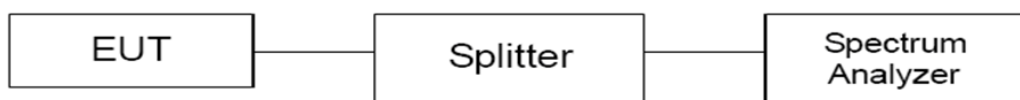
Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

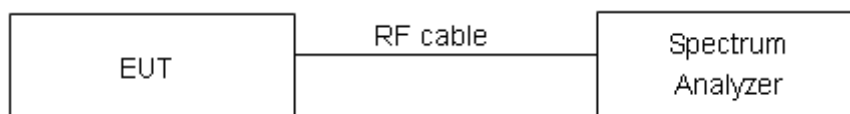
The EUT was connected to the spectrum analyzer and Model 900MHz test set via a power splitter with a known loss. RBW is set to 100kHz and VBW is set to 300kHz on spectrum analyzer. Set EUT on Hopping on mode.

Test setup

For Model 900MHz



For Hybrid Mode



Limits

Rule Part 15.247(a) (1) (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.

Frequency Band	20 dB Bandwidth of the hopping channel	Hopping Number
902.3~914.9	≤250 kHz	≥50 channels
	≥250 kHz	≥25 channels

Rule Part 15.247(f)

Hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4.

Test Results:

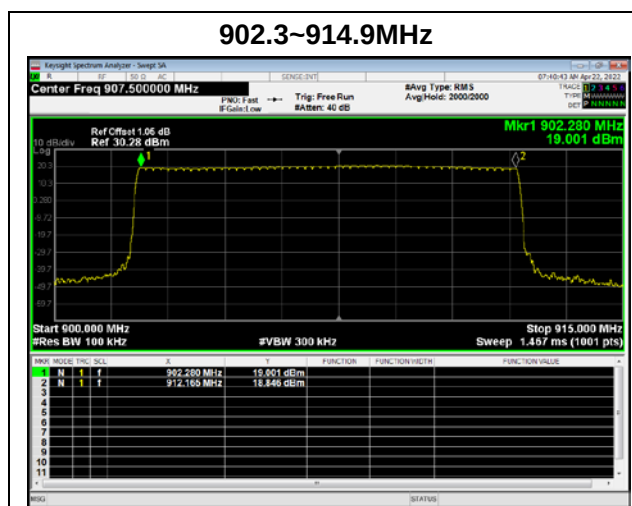
Model 900MHz

Channel	Range (MHz)	Number of Hopping Measured	Limits	Results
Middle Channel	902.3~914.9	50	≥50 channels	Pass

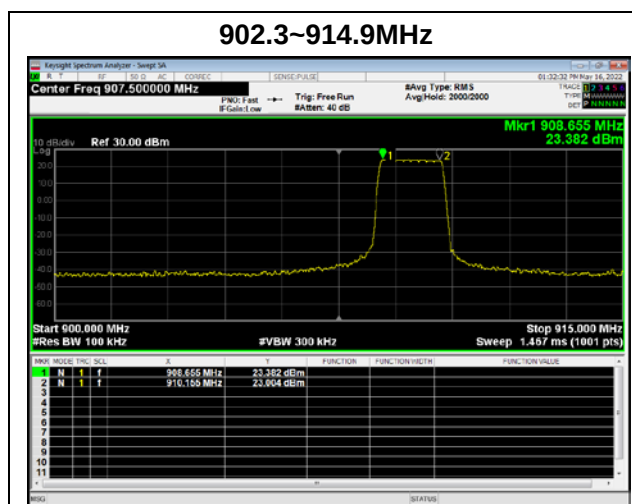
Hybrid Mode

Channel	Range (MHz)	Number of Hopping Measured
Middle Channel	902.3~914.9	8

Model 900MHz



Hybrid Mode



5.8 Spurious RF Conducted Emissions

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

The EUT was connected to the spectrum analyzer with a known loss. The spectrum analyzer scans from 30MHz to the 10th harmonic of the carrier. The peak detector is used. Set RBW 100kHz and VBW 300 kHz, Sweep is set to ATUO.

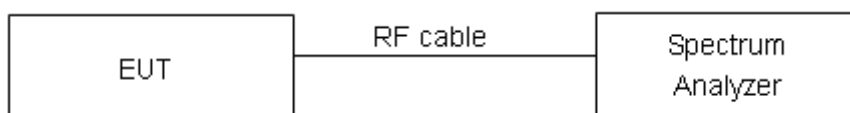
The test is in transmitting mode.

Test setup

For Model 900MHz



For Hybrid Mode



Limits

Rule Part 15.247(d) pacifies that “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.”

Test Mode	Carrier frequency (MHz)	Reference value (dBm)	Limit
Model 900MHz	902.3	20.17	0.17
	908.7	20.71	0.71
	914.9	20.53	0.53
Hybrid Mode	902.3	19.99	-0.01
	908.7	20.68	0.68
	914.9	20.54	0.54

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 1.96$.

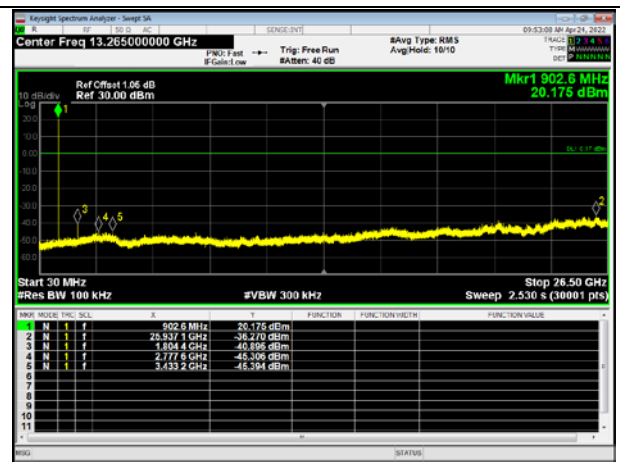
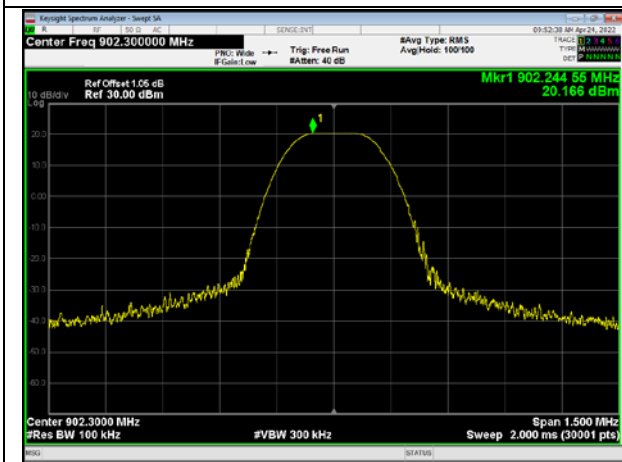
Frequency	Uncertainty
100kHz-2GHz	0.684 dB
2GHz-26GHz	1.407 dB

Test Results:

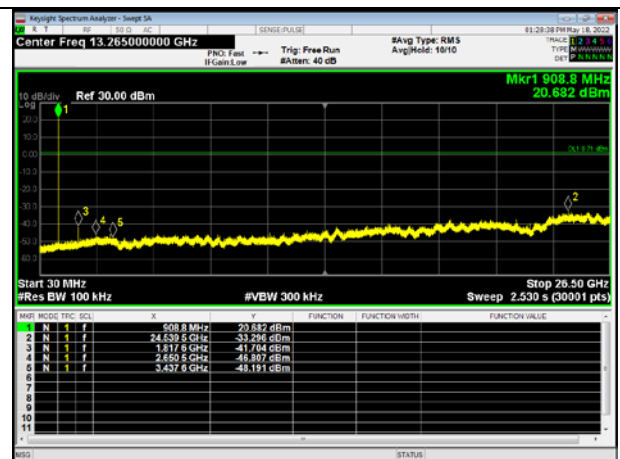
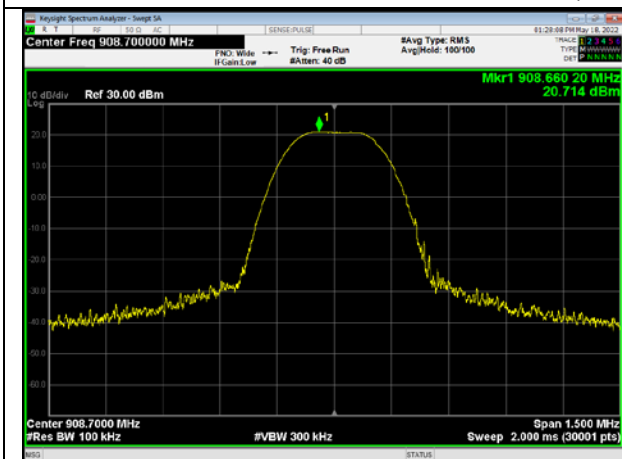
The signal beyond the limit is carrier.

Model 900MHz

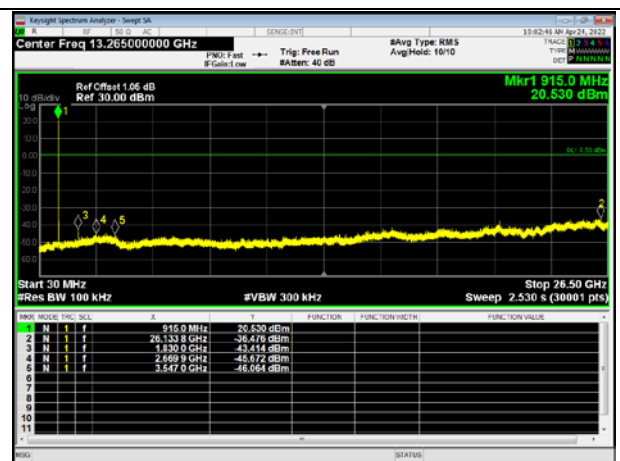
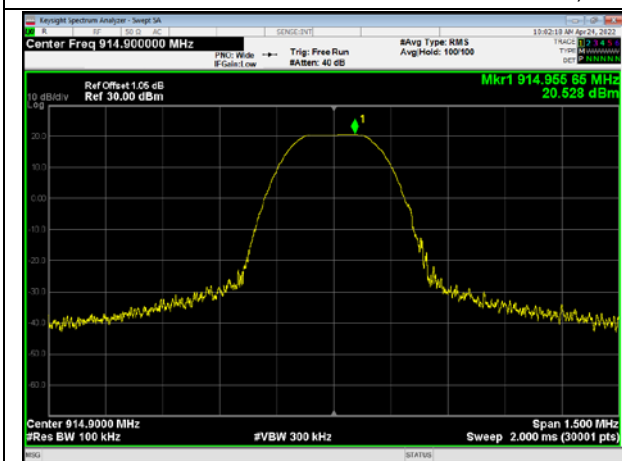
902.3MHz, 30MHz to 26.5GHz



908.7MHz, 30MHz to 26.5GHz

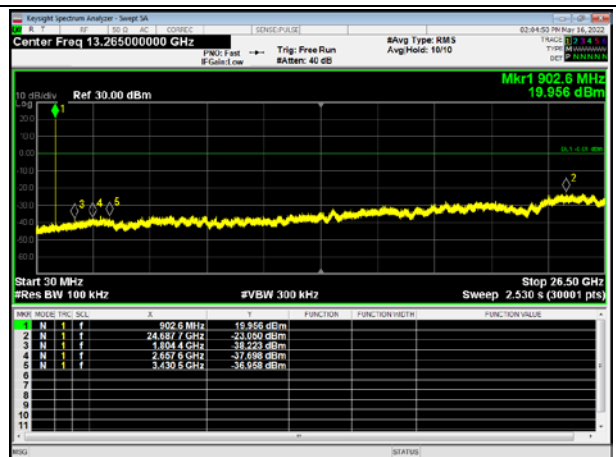
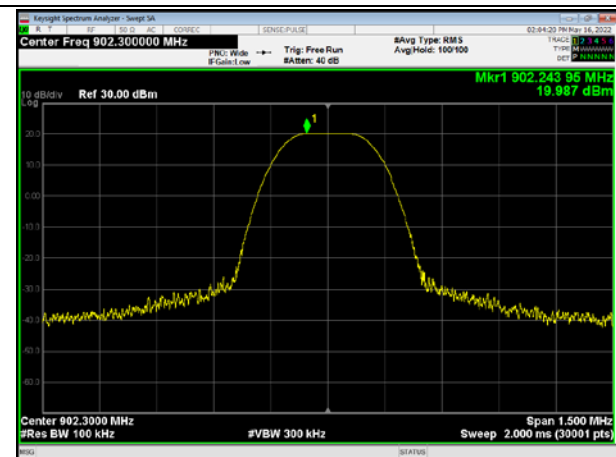


914.9MHz, 30MHz to 26.5GHz

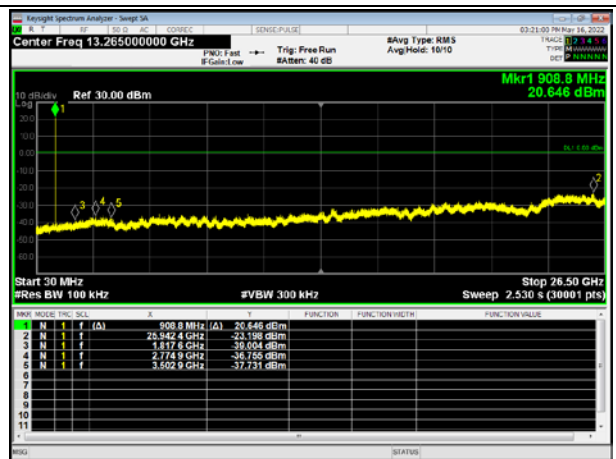
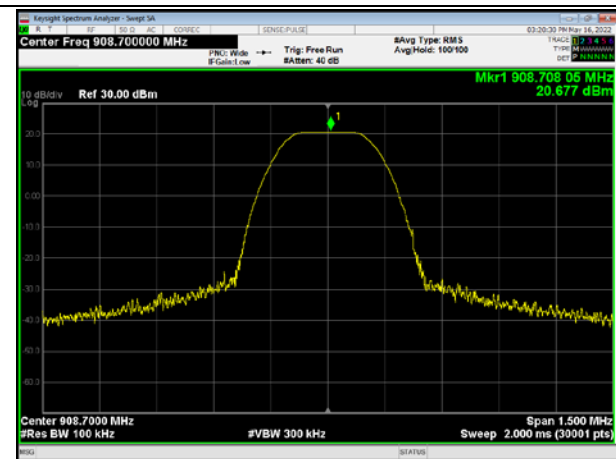


Hybrid Mode

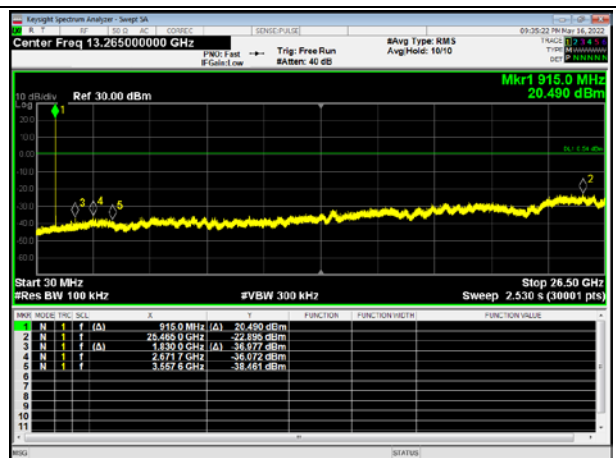
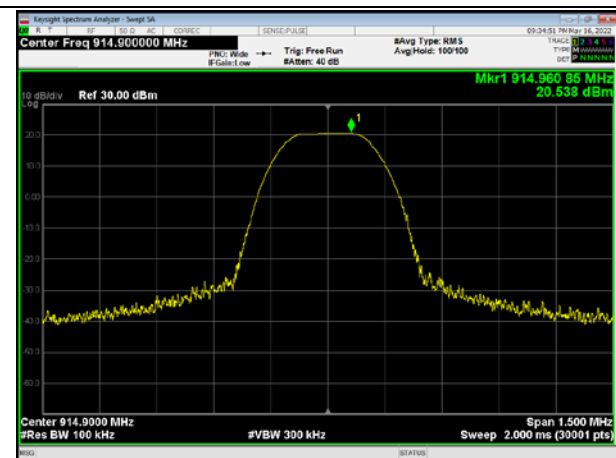
902.3MHz, 30MHz to 26.5GHz



908.7MHz, 30MHz to 26.5GHz



914.9MHz, 30MHz to 26.5GHz



5.9 Unwanted Emission

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

The test set-up was made in accordance to the general provisions of ANSI C63.10. The Equipment Under Test (EUT) was set up on a non-conductive table in the semi-anechoic chamber. The test was performed at the distance of 3 m between the EUT and the receiving antenna. The radiated emissions measurements were made in a typical installation configuration.

Sweep the whole frequency band through the range from 9 kHz to the 10th harmonic of the carrier, and the emissions less than 20 dB below the permissible value are reported.

During the test, below 30MHz, the center of the loop shall be 1 meters; above 30MHz, the height of receive antenna shall be moved from 1 to 4 meters, and the antenna shall be performed under horizontal and vertical polarization. The turntable shall be rotated from 0 to 360 degrees for detecting the maximum of radiated spurious signal level. The measurements shall be repeated with orthogonal polarization of the test antenna. The data of cable loss and antenna factor has been calibrated in full testing frequency range before the testing.

Set the spectrum analyzer in the following:

9kHz~150 kHz

RBW=200Hz, VBW=1kHz/ Sweep=AUTO

150 kHz~30MHz

RBW=9KHz, VBW=30KHz,/ Sweep=AUTO

Below 1GHz

RBW=100kHz / VBW=300kHz / Sweep=AUTO

Above 1GHz

(a) PEAK: RBW=1MHz VBW=3MHz/ Sweep=AUTO

(b) AVERAGE: RBW=1MHz / VBW=3MHz / Sweep=AUTO

detector; The measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

The dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a "duty cycle correction factor", derived from $20\log(\text{dwell time}/100 \text{ ms})$, in an effort to demonstrate compliance with the 15.209 limit.

If the emission is pulsed, modify the unit for continuous operation; use the settings shown above, then correct the reading by subtracting the peak- average correction factor, derived from the appropriate duty cycle calculation.

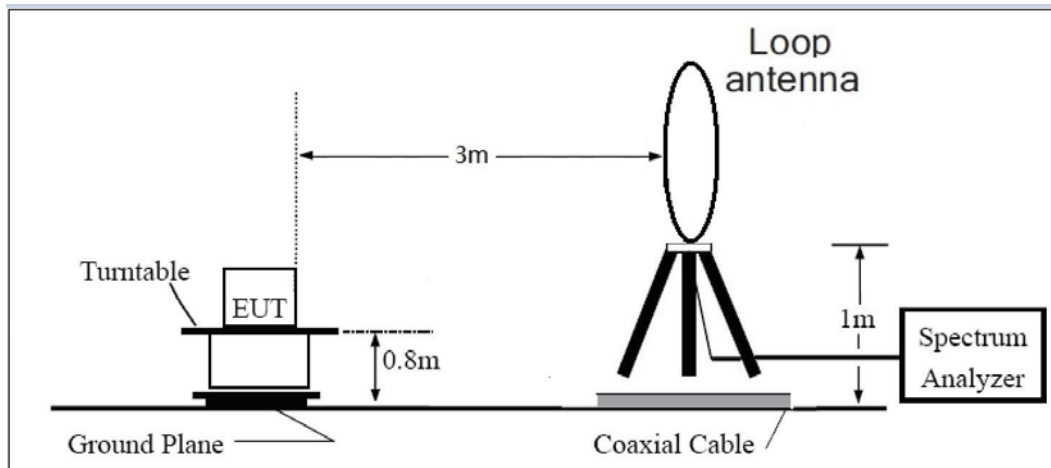
This setting method can refer to **KDB 558074 D01**.

This mode was measured in the following mode: EUT with cradle and EUT without cradle. The worst emission was found in EUT with cradle mode and the worst case was recorded.

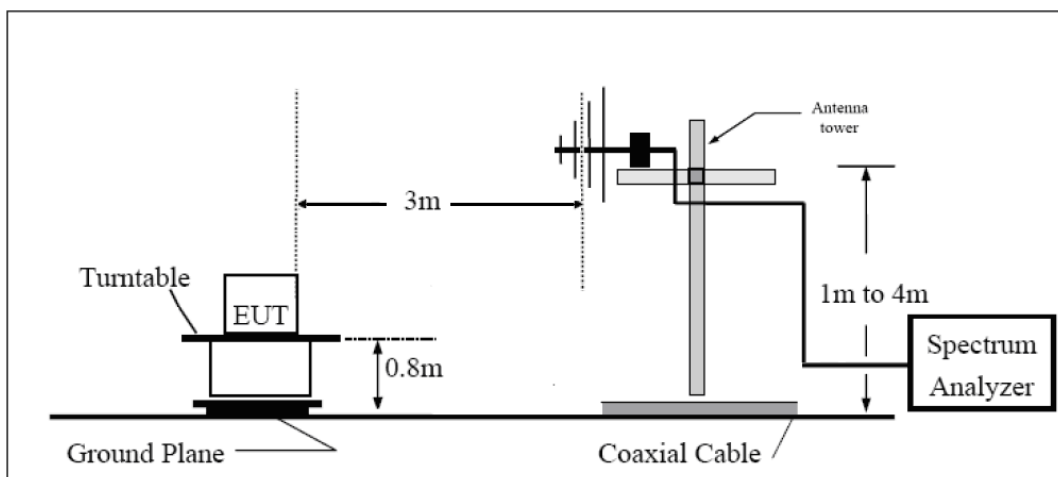
The test is in transmitting mode.

Test setup

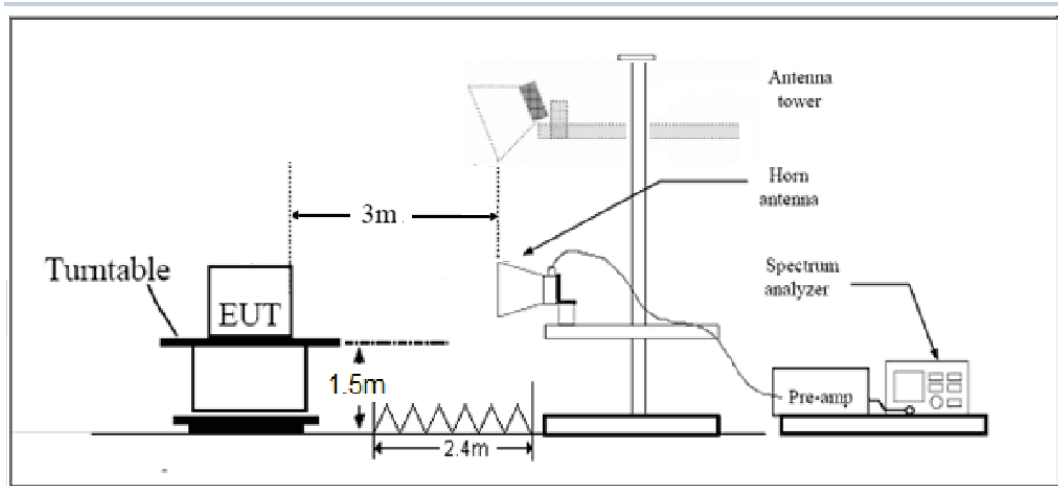
9KHz ~ 30MHz



30MHz ~ 1GHz



Above 1GHz



Limits

Rule Part 15.247(d) specifies that “In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).”

Limit in restricted band

Frequency of emission (MHz)	Field strength(uV/m)	Field strength(dBuV/m)
0.009–0.490	2400/F(kHz)	/
0.490–1.705	24000/F(kHz)	/
1.705–30.0	30	/
30-88	100	40
88-216	150	43.5
216-960	200	46
Above960	500	54

§15.35(b)

There is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.

Peak Limit=74dBuV/m

Average Limit=54dBuV/m



Spurious Radiated Emissions are permitted in any of the frequency bands listed below:

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
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	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			

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 1.96$.

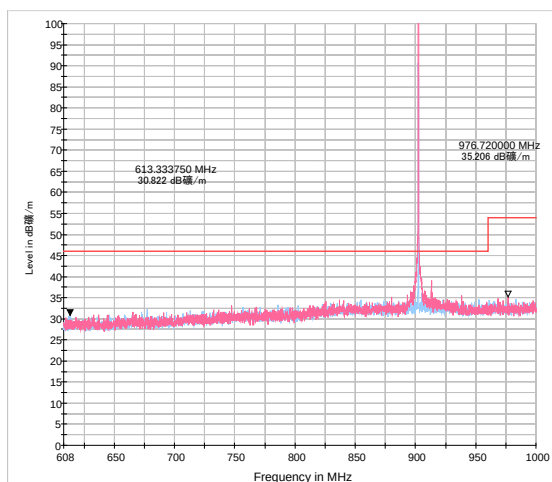
Frequency	Uncertainty
9KHz-30MHz	3.55 dB
30MHz-200MHz	4.17 dB
200MHz-1GHz	4.84 dB
1-18GHz	4.35 dB
18-26.5GHz	5.90 dB
26.5GHz~40GHz	5.92 dB

Test Results:

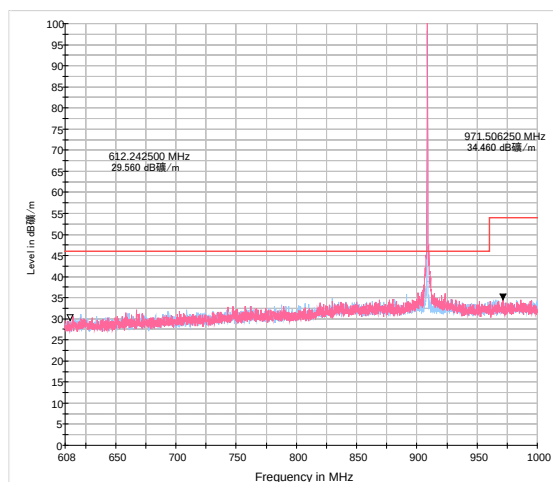
The signal beyond the limit is carrier.

A font (dB μ V/m) in the test plot =(dB μ V/m)

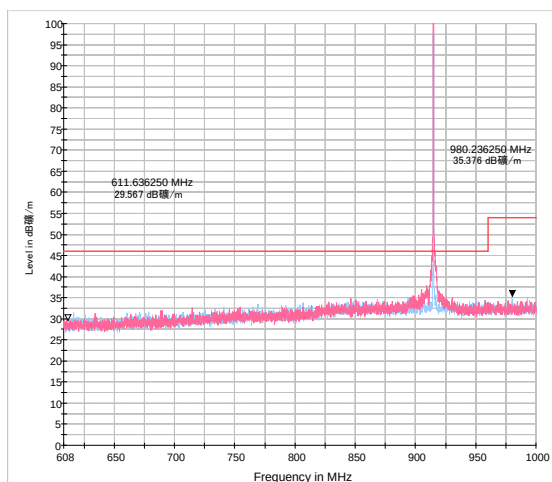
902.3MHz, 608 MHz to 1000MHz



908.7MHz, 608 MHz to 1000MHz



914.9MHz, 608 MHz to 1000MHz



Result of RE

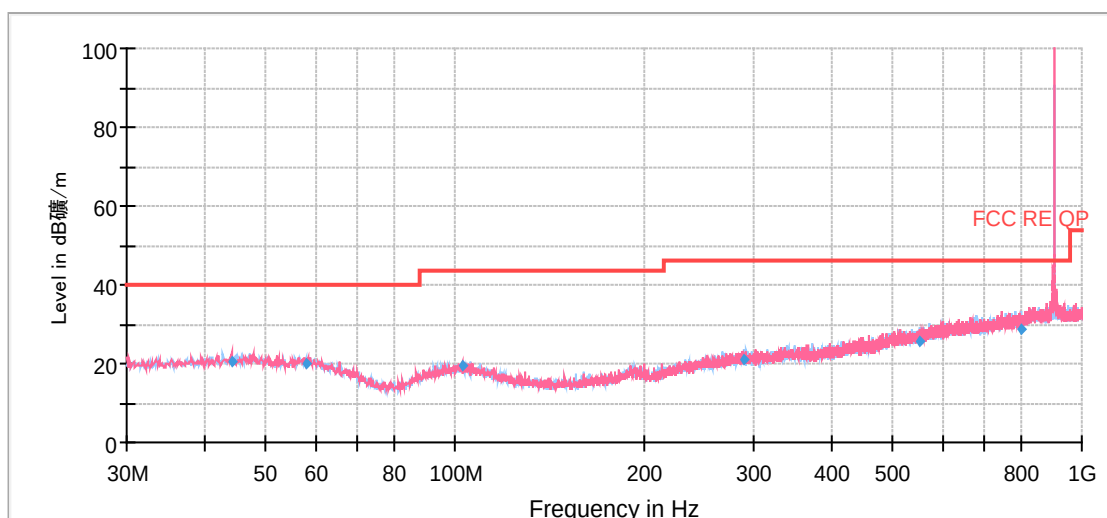
Test result

Sweep the whole frequency band through the range from 9kHz to the 10th harmonic of the carrier, the Emissions in the frequency band 9kHz-30MHz are more than 20dB below the limit are not reported.

The following graphs display the maximum values of horizontal and vertical by software.
For above 1GHz, Blue trace uses the peak detection, Green trace uses the average detection.

A font (Level in dB μ V/m) in the test plot =(level in dB μ V/m)

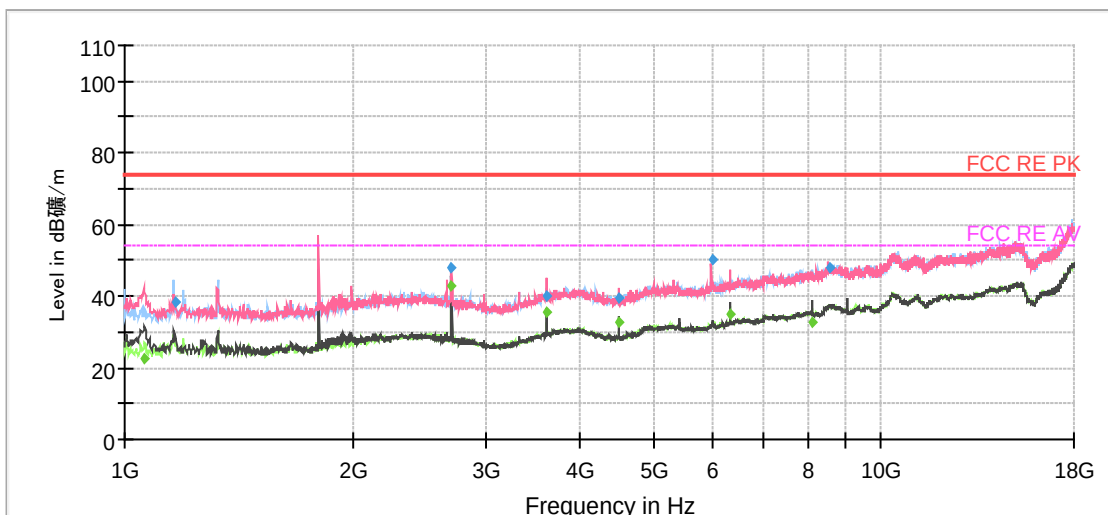
902.3MHz



Radiates Emission from 30MHz to 1GHz
Note: The signal beyond the limit is carrier.

Frequency (MHz)	Quasi-Peak (dBuV/m)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)	Margin (dB)	Limit (dBuV/m)
44.07	20.54	180.0	V	294.00	14	19.46	40.00
57.89	20.12	180.0	H	234.00	14	19.88	40.00
102.63	19.34	213.0	V	294.00	13	24.16	43.50
289.23	21.04	175.0	H	330.00	15	24.96	46.00
552.95	25.72	121.0	H	23.00	20	20.28	46.00
802.73	28.96	105.0	H	22.00	23	17.04	46.00

Remark: 1. Correction Factor = Antenna factor+ Insertion loss(cable loss+amplifier gain)
2. Margin = Limit – Quasi-Peak

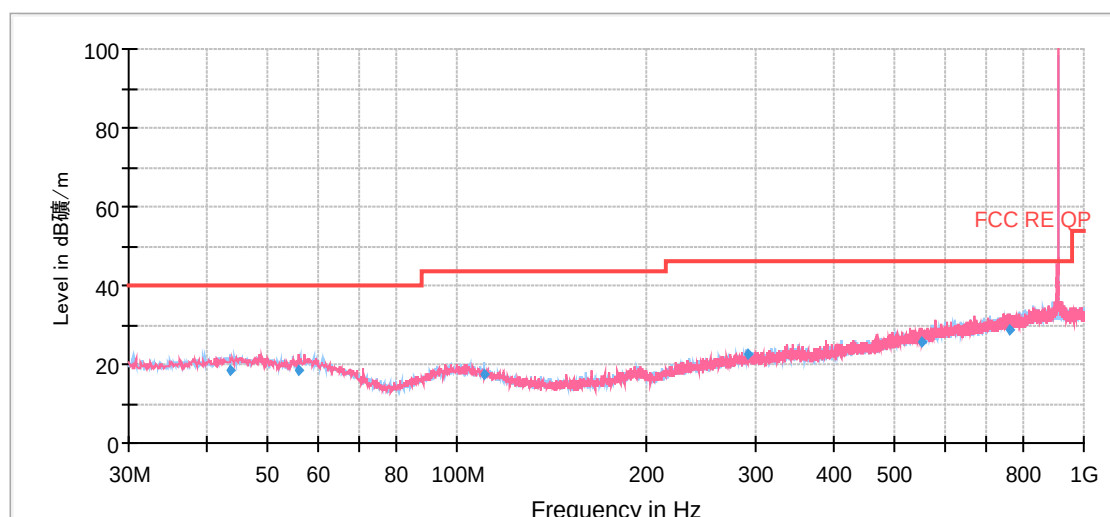


Radiates Emission from 1GHz to 18GHz

Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)
1063.77	---	22.63	54.00	31.37	196.0	V	1.00	-19
1166.37	38.43	---	74.00	35.57	225.0	H	220.00	-19
2706.87	---	43.04	54.00	10.96	119.0	V	120.00	-14
2706.59	48.22	---	74.00	25.78	125.0	V	160.00	-14
3604.28	39.77	---	74.00	34.23	108.0	V	227.00	-13
3611.77	---	35.73	54.00	18.27	119.0	V	218.00	-13
4512.72	---	32.61	54.00	21.39	175.0	V	186.00	-10
4513.67	39.51	---	74.00	34.49	108.0	V	201.00	-10
5975.35	50.13	---	74.00	23.87	175.0	V	212.00	-6
6317.70	---	35.23	54.00	17.77	225.0	V	204.00	-5
8116.76	---	32.89	54.00	21.11	125.0	V	122.00	-3
8536.73	47.94	---	74.00	26.06	196.0	V	64.00	-3

Remark: 1. Correction Factor = Antenna factor+ Insertion loss (cable loss + amplifier gain)

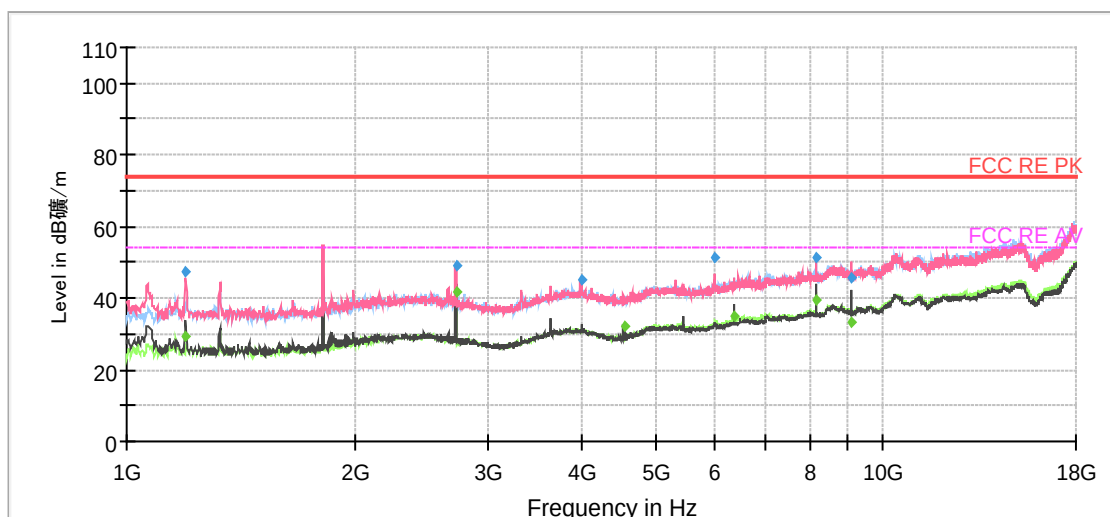
908.7MHz



Radiates Emission from 30MHz to 1GHz
Note: The signal beyond the limit is carrier.

Frequency (MHz)	Quasi-Peak (dBUV/m)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)	Margin (dB)	Limit (dBUV/m)
43.58	18.27	113.0	H	338.00	14	21.73	40.00
55.95	18.64	113.0	V	350.00	14	21.36	40.00
110.63	17.24	225.0	H	101.00	12	26.26	43.50
290.32	22.67	125.0	H	268.00	15	23.33	46.00
551.50	25.57	100.0	V	0.00	20	20.43	46.00
762.96	28.67	105.0	H	317.00	24	17.33	46.00

Remark: 1. Correction Factor = Antenna factor+ Insertion loss(cable loss+amplifier gain)
2. Margin = Limit – Quasi-Peak

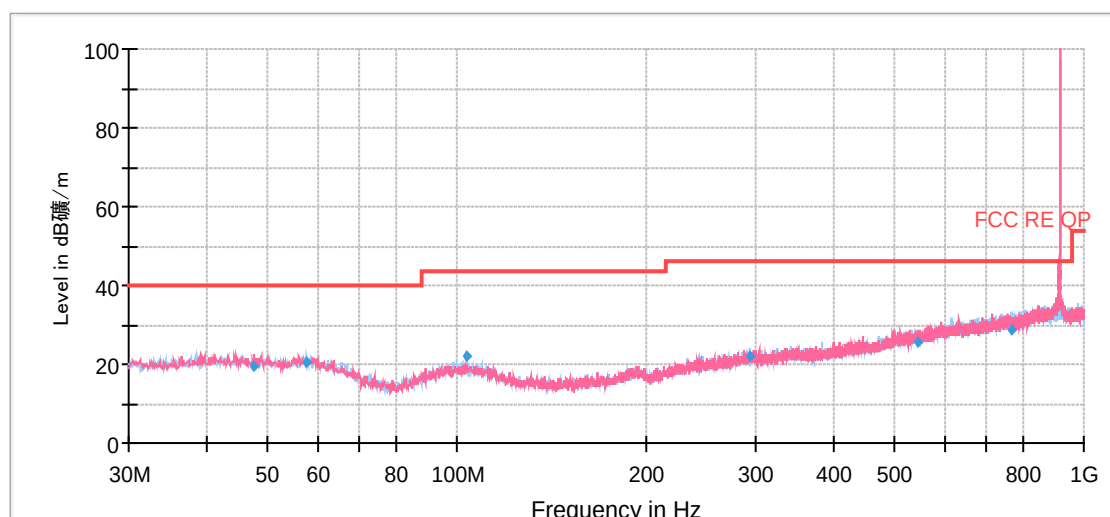


Radiates Emission from 1GHz to 18GHz

Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)
1196.08	47.14	---	74.00	26.86	119.0	V	6.00	-19
1198.21	---	29.35	54.00	24.65	125.0	V	0.00	-19
2725.50	49.21	---	74.00	24.79	108.0	V	126.00	-14
2725.66	---	41.70	54.00	12.30	108.0	V	126.00	-14
3986.64	45.30	---	74.00	28.70	108.0	V	269.00	-11
4544.14	---	31.88	54.00	22.12	108.0	V	193.00	-10
6000.09	51.10	---	74.00	22.90	175.0	V	120.00	-5
6360.00	---	35.23	54.00	18.77	125.0	V	22.00	-5
8176.59	---	39.51	54.00	14.49	100.0	V	98.00	-3
8177.12	51.22	---	74.00	22.78	100.0	V	96.00	-3
9083.87	45.94	---	74.00	28.06	118.0	V	270.00	-2
9087.82	---	33.16	54.00	20.84	100.0	V	270.00	-2

Remark: 1. Correction Factor = Antenna factor+ Insertion loss (cable loss + amplifier gain)

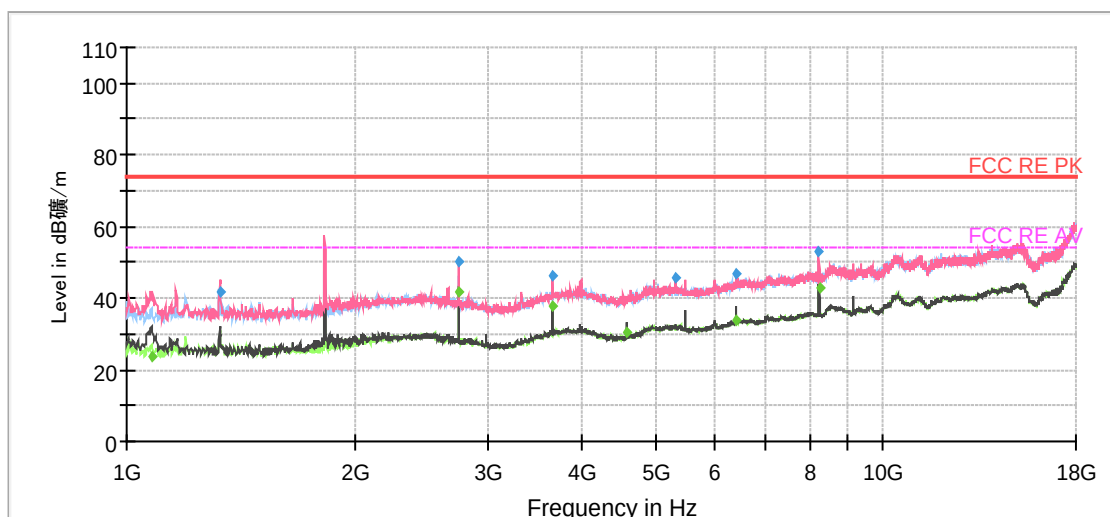
914.9MHz



Radiates Emission from 30MHz to 1GHz
Note: The signal beyond the limit is carrier.

Frequency (MHz)	Quasi-Peak (dBUV/m)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)	Margin (dB)	Limit (dBUV/m)
47.58	19.30	180.0	V	334.00	14	20.70	40.00
57.77	20.49	225.0	H	202.00	14	19.51	40.00
103.96	22.20	125.0	H	66.00	13	21.30	43.50
292.99	22.04	125.0	H	328.00	15	23.96	46.00
544.22	25.54	175.0	V	170.00	20	20.46	46.00
769.02	28.65	105.0	H	26.00	24	17.35	46.00

Remark: 1. Correction Factor = Antenna factor+ Insertion loss(cable loss+amplifier gain)
2. Margin = Limit – Quasi-Peak



Radiates Emission from 1GHz to 18GHz

Frequency (MHz)	Peak (dBuV/m)	Average (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Polarization	Azimuth (deg)	Correct Factor (dB)
1078.81	---	23.95	54.00	30.05	210.0	V	337.00	-19
1327.66	41.94	---	74.00	32.06	100.0	V	22.00	-18
2744.12	---	41.93	54.00	12.07	183.0	V	256.00	-14
2744.17	50.18	---	74.00	23.82	107.0	V	129.00	-14
3660.64	46.44	---	74.00	27.56	118.0	V	174.00	-12
3662.60	---	37.64	54.00	16.36	100.0	V	186.00	-12
4575.43	---	30.56	54.00	23.44	182.0	V	202.00	-9
5322.46	45.73	---	74.00	28.27	125.0	V	157.00	-7
6405.69	---	34.00	54.00	20.00	119.0	V	16.00	-5
6405.84	47.02	---	74.00	26.98	108.0	V	16.00	-5
8232.91	52.88	---	74.00	21.12	100.0	V	100.00	-3
8234.51	---	42.94	54.00	11.06	125.0	V	128.00	-3

Remark: 1. Correction Factor = Antenna factor+ Insertion loss (cable loss + amplifier gain)

5.10 Conducted Emission

Ambient condition

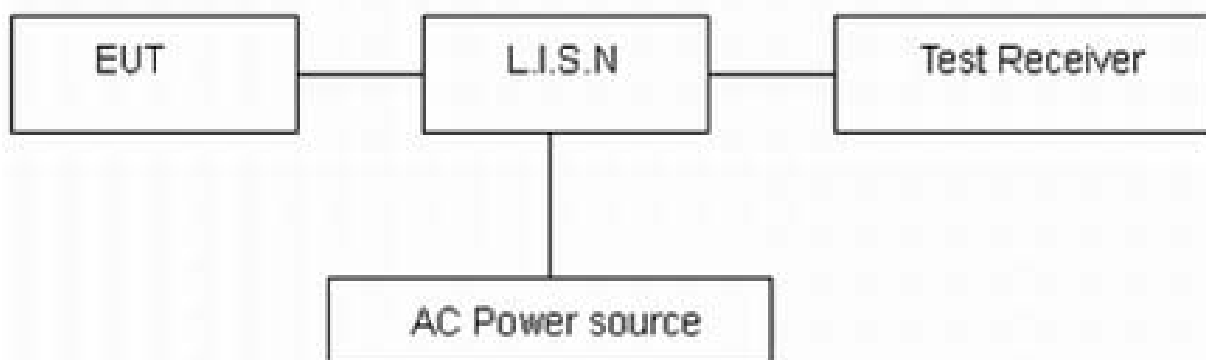
Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Methods of Measurement

The EUT is placed on a non-metallic table of 80cm height above the horizontal metal reference ground plane. During the test, the EUT was operating in its typical mode. The test method is according to ANSI C63.10. Connect the AC power line of the EUT to the L.I.S.N. Use EMI receiver to detect the average and Quasi-peak value. RBW is set to 9 kHz, VBW is set to 30kHz. The measurement result should include both L line and N line.

The test is in transmitting mode.

Test Setup



Note: AC Power source is used to 120V/60Hz.

Limits

Frequency (MHz)	Conducted Limits(dBμV)	
	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.		

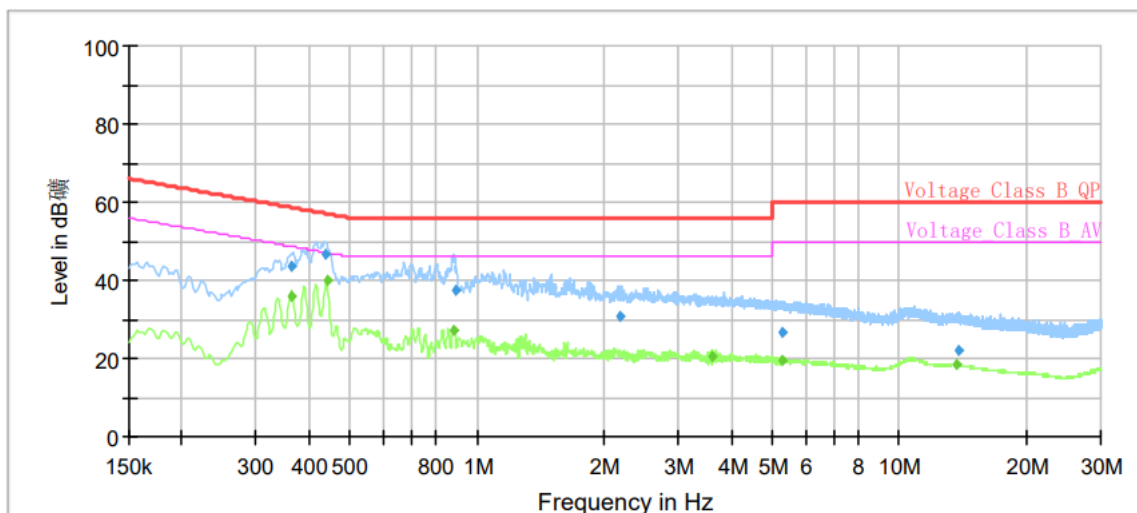
Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor $k = 1.96$, $U=2.69$ dB.

Test Results:

Following plots, Blue trace uses the peak detection, Green trace uses the average detection. During the test, the Conducted Emission was performed in all modes with all Frequency, 902.3MHz, are selected as the worst condition. The test data of the worst-case condition was recorded in this report.

A font (Level in dB μ V) in the test plot =(level in dB μ V)

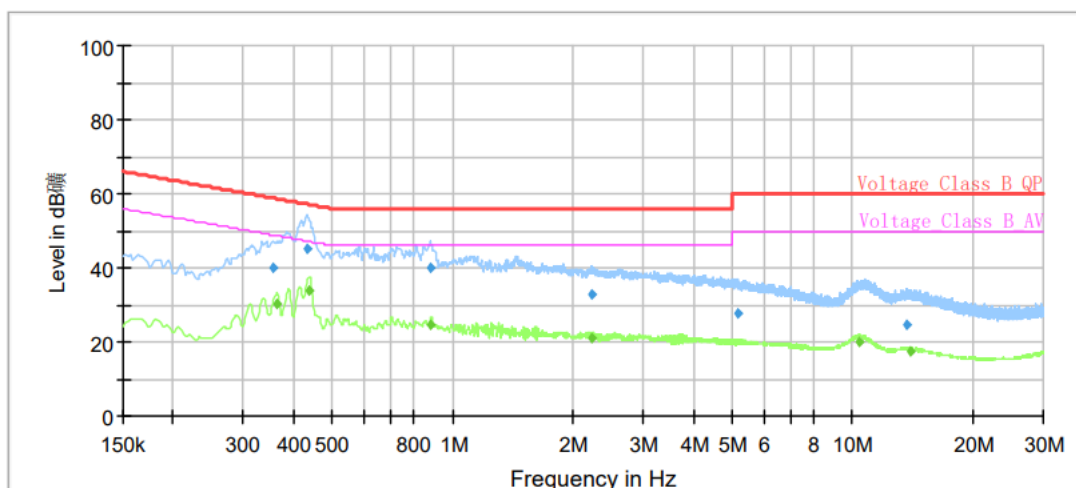


Frequency (MHz)	QuasiPeak (dB μ V)	Average (dB μ V)	Limit (dB μ V)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.36	---	36.01	48.69	12.68	1000.00	9.000	L1	ON	21
0.36	43.81	---	58.69	14.88	1000.00	9.000	L1	ON	21
0.44	46.67	---	57.10	10.43	1000.00	9.000	L1	ON	20
0.44	---	39.86	47.06	7.20	1000.00	9.000	L1	ON	20
0.88	---	27.02	46.00	18.98	1000.00	9.000	L1	ON	20
0.89	37.23	---	56.00	18.77	1000.00	9.000	L1	ON	20
2.19	30.64	---	56.00	25.36	1000.00	9.000	L1	ON	20
3.61	---	20.40	46.00	25.60	1000.00	9.000	L1	ON	19
5.28	26.74	---	60.00	33.26	1000.00	9.000	L1	ON	19
5.30	---	19.39	50.00	30.61	1000.00	9.000	L1	ON	19
13.61	---	18.36	50.00	31.64	1000.00	9.000	L1	ON	20
13.88	22.13	---	60.00	37.87	1000.00	9.000	L1	ON	20

Remark: Correct factor=cable loss + LISN factor

L line

Conducted Emission from 150 KHz to 30 MHz



Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.35	40.20	---	58.85	18.65	1000.00	9.000	N	ON	21
0.36	---	30.18	48.69	18.51	1000.00	9.000	N	ON	21
0.43	45.16	---	57.23	12.07	1000.00	9.000	N	ON	20
0.44	---	33.92	47.10	13.18	1000.00	9.000	N	ON	20
0.88	39.96	---	56.00	16.04	1000.00	9.000	N	ON	20
0.88	---	24.45	46.00	21.55	1000.00	9.000	N	ON	20
2.22	---	20.80	46.00	25.20	1000.00	9.000	N	ON	20
2.23	32.96	---	56.00	23.04	1000.00	9.000	N	ON	20
5.18	27.67	---	60.00	32.33	1000.00	9.000	N	ON	19
10.45	---	20.15	50.00	29.85	1000.00	9.000	N	ON	20
13.71	24.43	---	60.00	35.57	1000.00	9.000	N	ON	20
13.99	---	17.20	50.00	32.80	1000.00	9.000	N	ON	20

Remark: Correct factor=cable loss + LISN factor

N line

Conducted Emission from 150 KHz to 30 MHz

6 Main Test Instruments

Date of Testing: April 18, 2022 ~ April 25, 2022

Name	Manufacturer	Type	Serial Number	Calibration Date	Expiration Date
Power Splitter	R&S	NRP18S	101954	2021-05-15	2022-05-14
Spectrum Analyzer	KEYSIGHT	N9020A	MY54420163	2021-12-12	2022-12-11
LISN	R&S	ENV216	102191	2020-12-13	2022-12-12
EMI Test Receiver	R&S	ESR	101667	2021-05-15	2022-05-14
Software	R&S	EMC32	10.35.10	/	/
EMI Test Receiver	R&S	ESCI7	100936	2021-12-12	2022-12-11
Signal Analyzer	R&S	FSV30	103591	2021-05-15	2022-05-14
TRILOG Broadband Antenna	SCHWARZBECK	VULB 9163	391	2019-12-16	2022-12-15
Horn Antenna	Schwarzbeck	BBHA 9120D	430	2021-07-26	2024-07-25
Horn Antenna	ETS-Lindgren	3160-09	00102643	2018-06-20	2023-06-19
Software	R&S	EMC32	9.26.01	/	/

Date of Testing: May 16, 2022 ~ May 30, 2022

Name	Manufacturer	Type	Serial Number	Calibration Date	Expiration Date
Spectrum Analyzer	KEYSIGHT	N9020A	MY54420163	2021-12-12	2022-12-11

*******END OF REPORT *******



ANNEX A: The EUT Appearance

The EUT Appearance are submitted separately.

ANNEX B: Test Setup Photos

The Test Setup Photos are submitted separately.