FCC PART 15.247
TEST REPORT

For

Astera LED-Technology GmbH

Stahlgruberring 36, 81829 Munich, Germany

FCC ID: X55FP3

Report Type:	Product Type:
Original Report	Hyperion tube

Report Number:	RSZ190815813-00A
Report Date:	2019-12-11
Reviewed By:	Jacob Kong RF Engineer
Prepared By:	Bay Area Compliance Laboratories Corp. (Shenzhen) 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China Tel: +86-755-33320018 Fax: +86-755-33320008 www.baclcorp.com.cn

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Hyperion tube
Model	FP3
Frequency Range	900MHz Band: 917-922.2MHz 2.4GHz Band: 2402-2480MHz
Transmit Power	900MHz Band: 8.40dBm 2.4GHz Band: 2.27dBm
Modulation Technique	900MHz Band: GFSK 2.4GHz Band: GFSK
Antenna Specification	2dBi
Voltage Range	DC 14.4 V from rechargeable Li-ion battery or DC 24V from adapter
Date of Test	2019/11/06~2019/12/06
Sample serial number	RSZ190815813-RF-S1(Assigned by BACL, Shenzhen)
Received date	2019/08/15
Sample/EUT Status	Good condition
Adapter information	Model: PA1090-240T1A400 Input: AC 100-240V, 50/60Hz, 2.0A Output: DC 24V, 4.0A 96W Max

Objective

This test report is prepared on behalf of *Astera LED-Technology GmbH* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commissions rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Related Submittal(s)/Grant(s)

Part of system with FCC ID: X55ART7-U.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

For Radiated Emissions testing, please refer to DA 00-705 Released March 30, 2000, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		±5%
RF Output Power with Power meter		±0.73dB
RF conducted test with spectrum		±1.6dB
AC Power Lines Conducted Emissions		±1.95dB
Emissions, Radiated	Below 1GHz	±4.75dB
	Above 1GHz	±4.88dB
Temperature		±1℃
Humidity		±6%
Supply voltages		±0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval.Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 6/F., West Wing, Third Phase of Wanli Industrial Building, Shihua Road, Futian Free Trade Zone, Shenzhen, Guangdong, China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 342867, the FCC Designation No.: CN1221.

The test site has been registered with ISED Canada under ISED Canada Registration Number 3062B.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

900MHz band:
Frequency range: 917-922.2MHz, channel spacing: 100kHz

2.4GHz band:
Frequency range: 2402-2480MHz, channel spacing: 1MHz

EUT Exercise Software

Software "AsteraApp_9.96" was used, the power level is default.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

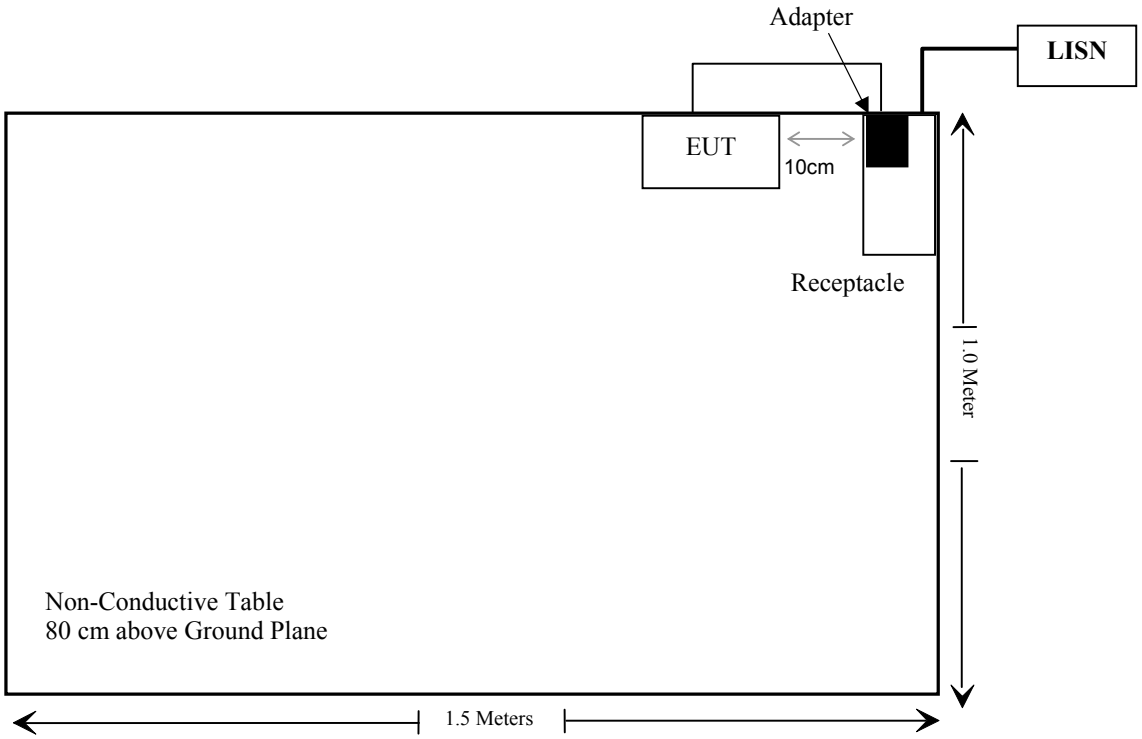
Manufacturer	Description	Model	Serial Number
N/A	N/A	N/A	N/A

External I/O Cable

Cable Description	Length (m)	From Port	To
Un-shielding Un-detachable DC Cable	0.8	EUT	Adapter

Block Diagram of Test Setup

For conducted emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§15.247 (i), §2.1091	Maximum Permissible Exposure(MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209 & §15.247(d)	Radiated Emissions	Compliance
§15.247(a)(1)	20 dB Emission Bandwidth	Compliance
§15.247(a)(1)	Channel Separation Test	Compliance
§15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliance
§15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliance
§15.247(b)(1)	Peak Output Power Measurement	Compliance
§15.247(d)	Band edges	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
R&S	EMI Test Receiver	ESCI	101120	2019-07-09	2020-07-08
Rohde & Schwarz	LISN	ENV216	3560.6650.12-101613-Yb	2019-01-25	2020-01-25
Rohde & Schwarz	Transient Limiter	ESH3Z2	DE25985	2019-03-02	2020-03-01
Rohde & Schwarz	CE Test software	EMC 32	V8.53.0	NCR	NCR
Un-known	Conducted Emission Cable	78652	UF A210B-1-0720-504504	2019-11-12	2020-11-12
Radiated Emission Test					
A.H. System	Horn Antenna	SAS-200/571	135	2018-09-01	2021-08-31
Rohde & Schwarz	Spectrum Analyzer	FSV40-N	102259	2019-07-22	2020-07-21
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2017-12-22	2020-12-21
COM-POWER	Pre-amplifier	PA-122	181919	2018-11-12	2019-11-12
Sonoma Instrument	Amplifier	310N	186238	2019-11-12	2020-11-12
Rohde & Schwarz	EMI Test Receiver	ESR3	102455	2019-07-09	2020-07-08
Ducommun technologies	RF Cable	UFA147A-2362-100100	MFR64639 231029-003	2018-11-12	2019-11-12
Ducommun technologies	RF Cable	104PEA	218124002	2018-11-12	2019-11-12
Ducommun technologies	RF Cable	RG-214	2	2018-11-12	2019-11-12
Unknown	Cable 2	RF Cable 2	/	2019/11/29	2020/11/28
Unknown	Cable	Chamber Cable 1	/	2019/11/29	2020/11/28
Unknown	Cable	Chamber Cable 4	EC-007	2019/11/29	2020/11/28
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-04	2017-12-29	2020-12-28
Heatsink Required	Amplifier	QLW-18405536-J0	15964001002	2018-11-12	2019-11-12
Sinoscite	Notch Filter	BSF2402-2480MN-0898-001	99632	2018-11-12	2019-11-12
Rohde & Schwarz	Auto test software	EMC 32	V9.10	NCR	NCR

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted Test					
Agilent	USB wideband power meter	U2021XA	MY54250003	2019-07-10	2020-07-09
WEINSCHEL	3dB Attenuator	6231	666	Each Time	
Rohde & Schwarz	Spectrum Analyzer	FSU26	200120	2019-03-02	2020-03-01
Ducommun technologies	RF Cable	RG-214	3	Each Time	

*** Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §15.247 (i) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for General Population/Uncontrolled Exposure

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (Minutes)**
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm2)
P = power input to the antenna (in appropriate units, e.g., mW).
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

Frequency (MHz)	Antenna Gain		Tune up conducted power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
	(dBi)	(numeric)	(dBm)	(mW)			
917-922.2	2	1.58	8.5	7.08	20	0.0022	0.61
2402-2480	2	1.58	2.4	1.74	20	0.0005	1

The 2.4GHz band and 900MHz band can not transmit simultaneously.

Note: To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliance

FCC §15.203 – ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 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 an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Antenna Connector Construction

The EUT has one integrated antenna arrangement, which was permanently attached and the antenna gain is 2 dBi for 900MHz band and 2dBi for 2.4GHz band, fulfill the requirement of this section. Please refer to the EUT photos.

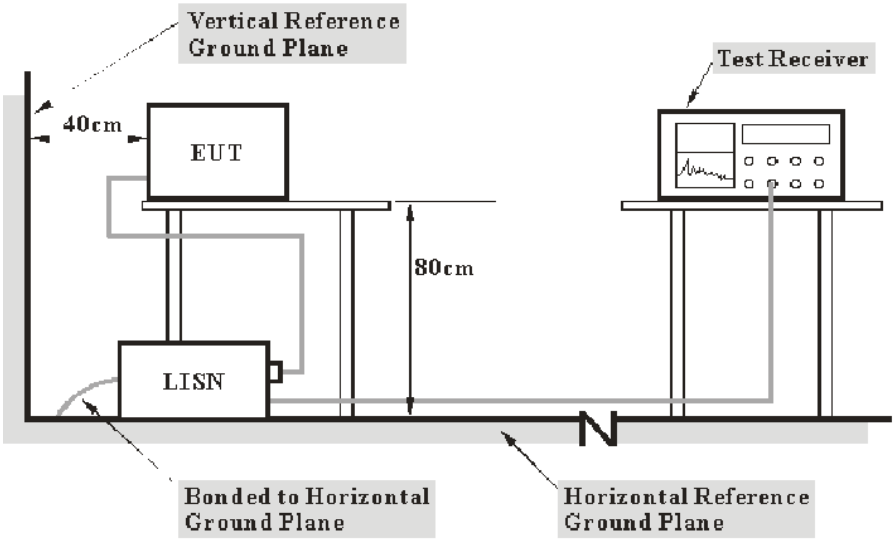
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Correction Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

Margin = Limit – Corrected Amplitude

Test Results Summary

According to the EUT complied with the FCC Part 15.207.

Test Data

Environmental Conditions

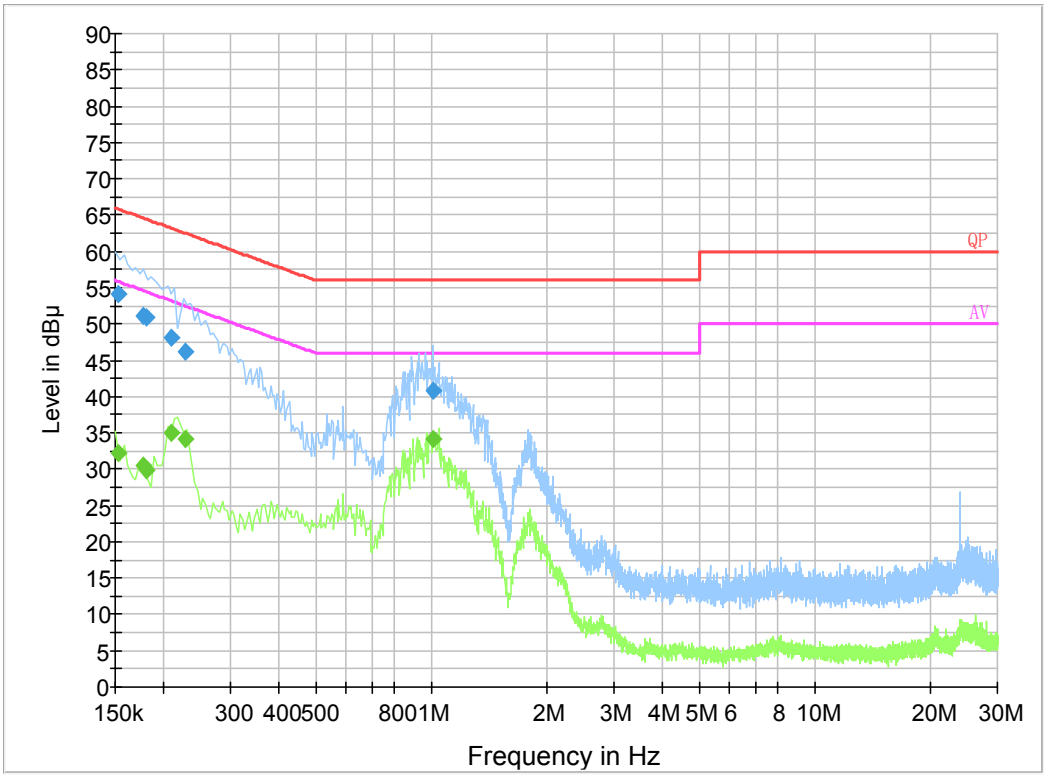
Temperature:	25 ℃
Relative Humidity:	50~52 %
ATM Pressure:	101.0 kPa

The testing was performed by Haiguo Li on 2019-11-18.

EUT operation mode: Transmitting & lighting

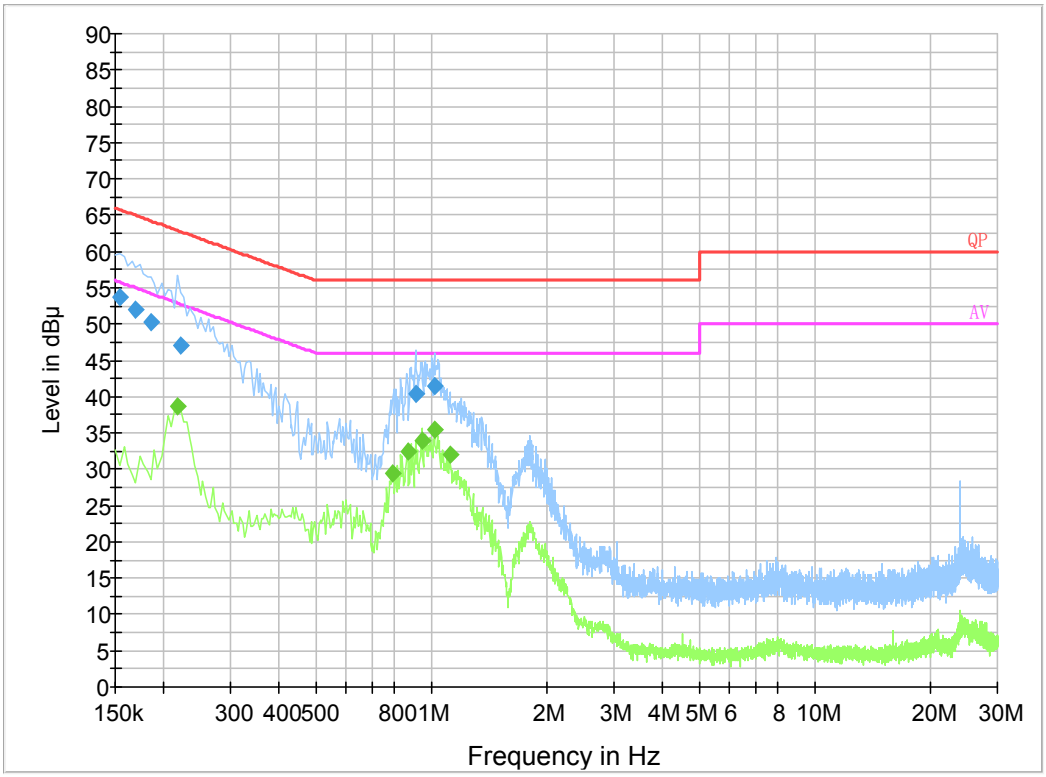
2.4GHz Band:

AC 120V/60 Hz, Line



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.153500	54.1	19.8	65.8	11.7	QP
0.177500	51.1	19.9	64.6	13.5	QP
0.181500	50.9	19.9	64.4	13.5	QP
0.209500	48.1	19.8	63.2	15.1	QP
0.229500	46.2	19.8	62.5	16.3	QP
1.010850	40.8	19.9	56.0	15.2	QP
0.153500	32.3	19.8	55.8	23.5	Ave.
0.177500	30.4	19.9	54.6	24.2	Ave.
0.181500	29.9	19.9	54.4	24.5	Ave.
0.209500	34.9	19.8	53.2	18.3	Ave.
0.229500	34.2	19.8	52.5	18.3	Ave.
1.010850	34.2	19.9	46.0	11.8	Ave.

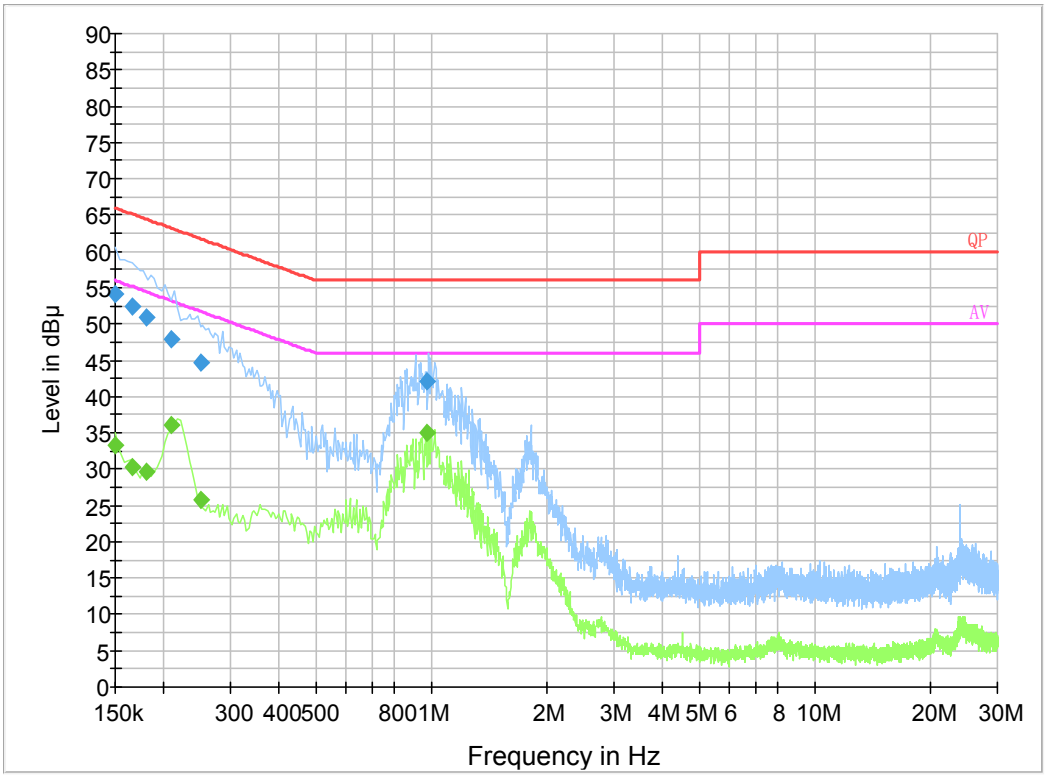
AC 120V/60 Hz, Neutral



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.154000	53.7	19.8	65.8	12.1	QP
0.169500	52.0	19.8	65.0	13.0	QP
0.185500	50.3	19.8	64.2	13.9	QP
0.222500	47.1	19.8	62.7	15.6	QP
0.912350	40.3	19.7	56.0	15.7	QP
1.022670	41.5	19.8	56.0	14.5	QP
0.218000	38.7	19.8	52.9	14.2	Ave.
0.794000	29.4	19.8	46.0	16.6	Ave.
0.870000	32.5	19.7	46.0	13.5	Ave.
0.946000	33.9	19.8	46.0	12.1	Ave.
1.022000	35.4	19.8	46.0	10.6	Ave.
1.126000	32.0	19.8	46.0	14.0	Ave.

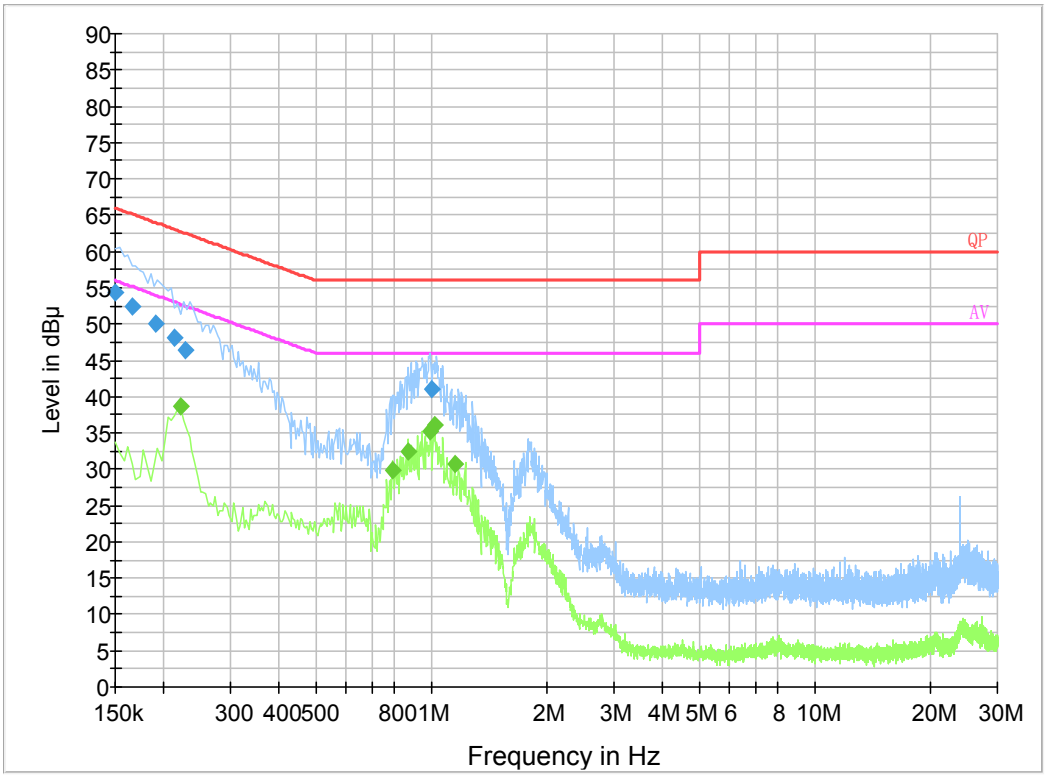
900MHz Band:

AC 120V/60 Hz, Line



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.150000	54.2	19.8	66.0	11.8	QP
0.165500	52.4	19.9	65.2	12.8	QP
0.181500	50.9	19.9	64.4	13.5	QP
0.209500	47.9	19.8	63.2	15.3	QP
0.250501	44.6	19.8	61.7	17.1	QP
0.971210	42.1	19.9	56.0	13.9	QP
0.150000	33.3	19.8	56.0	22.7	Ave.
0.165500	30.3	19.9	55.2	24.9	Ave.
0.181500	29.6	19.9	54.4	24.8	Ave.
0.209500	36.1	19.8	53.2	17.1	Ave.
0.250501	25.8	19.8	51.7	25.9	Ave.
0.971210	35.0	19.9	46.0	11.0	Ave.

AC 120V/60 Hz, Neutral



Frequency (MHz)	Corrected Amplitude (dBµV)	Correction Factor (dB)	Limit (dBµV)	Margin (dB)	Detector (PK/Ave./QP)
0.150000	54.3	19.8	66.0	11.7	QP
0.165500	52.5	19.8	65.2	12.7	QP
0.190501	50.1	19.8	64.0	13.9	QP
0.214501	48.1	19.8	63.0	14.9	QP
0.229500	46.3	19.8	62.5	16.2	QP
1.007030	41.1	19.8	56.0	14.9	QP
0.222000	38.6	19.8	52.7	14.2	Ave.
0.794000	29.9	19.8	46.0	16.1	Ave.
0.870000	32.5	19.7	46.0	13.5	Ave.
0.998000	35.3	19.8	46.0	10.7	Ave.
1.022000	36.0	19.8	46.0	10.0	Ave.
1.150000	30.8	19.8	46.0	15.2	Ave.

Note:

1) Correction Factor =LISN VDF (Voltage Division Factor) + Cable Loss + Transient Limiter Attenuation
2) Corrected Amplitude = Reading + Correction Factor
3) Margin = Limit – Corrected Amplitude

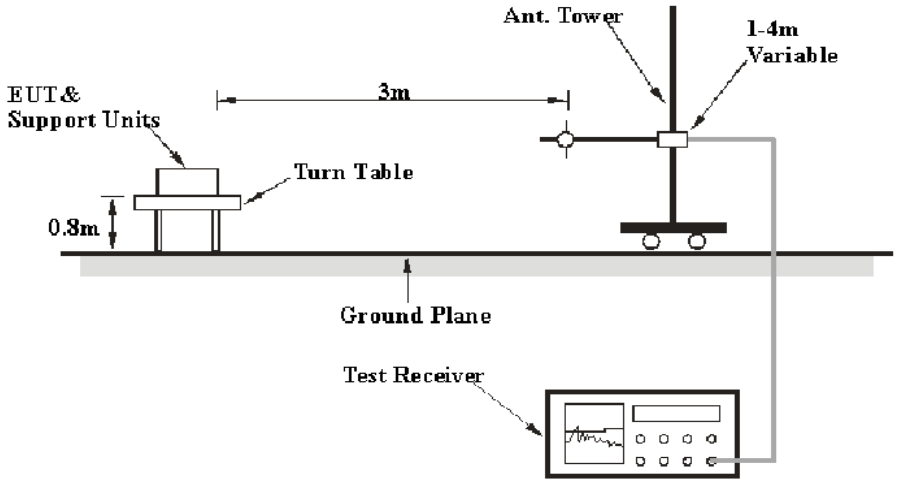
FCC §15.205, §15.209 & §15.247(d) – RADIATED EMISSIONS

Applicable Standard

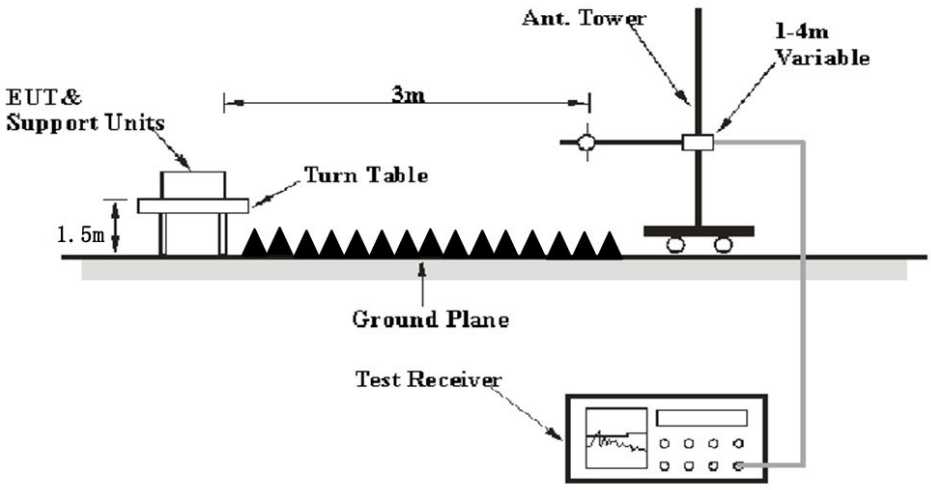
FCC §15.205; §15.209; §15.247(d)

EUT Setup

Below 1 GHz:



Above 1GHz:



The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, according to the DA 00-705 Released March 30, 2000, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1 MHz	3 MHz	/	PK
	1 MHz	10 Hz	/	Average

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All final data was recorded in Quasi-peak detection mode for frequency range of 30 MHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Corrected Amplitude = Meter Reading + Antenna Factor + Cable Loss - Amplifier Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin = Limit – Corrected Amplitude

Test Results Summary

According to the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

Test Data

Environmental Conditions

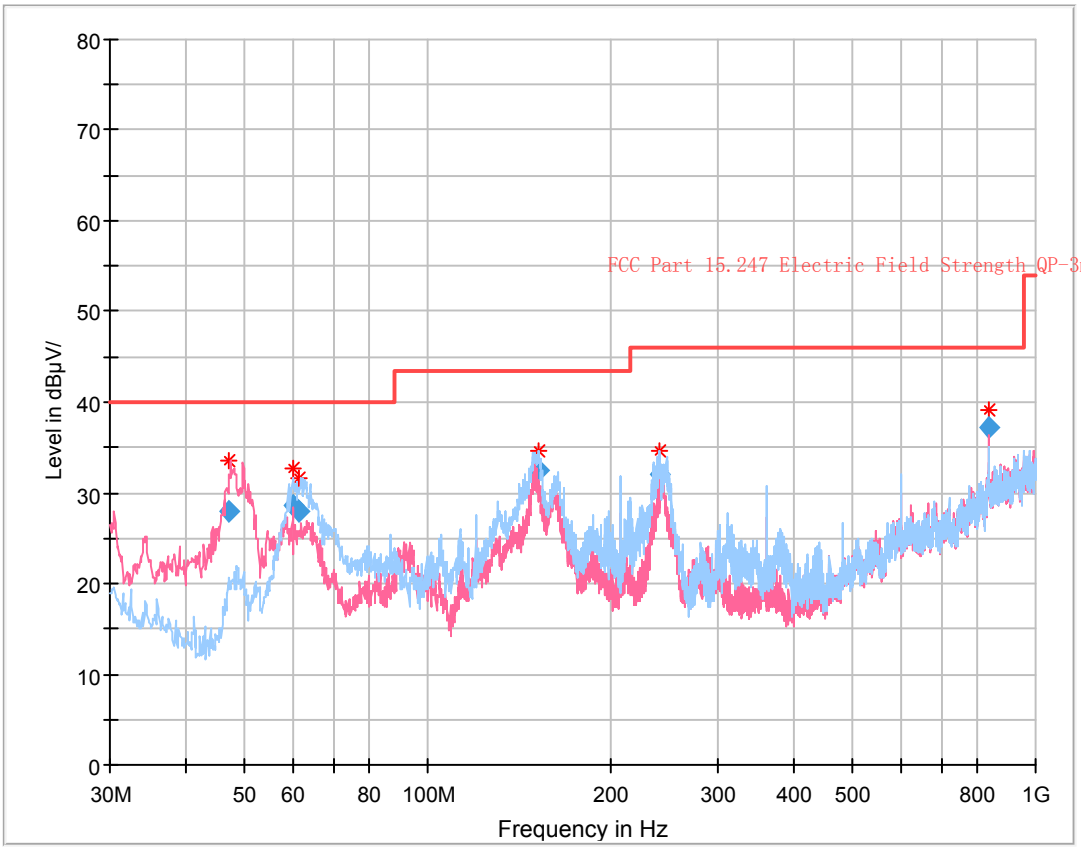
Temperature:	24~25 ℃
Relative Humidity:	52~56 %
ATM Pressure:	100.9~101.0 kPa

The testing was performed by Zero Yan on 2019-12-06 for Below 1GHz and Alan He on 2019-11-09 and 2019-11-11 for Above 1GHz.

EUT operation mode: Transmitting

2.4GHz Band:

30 MHz~1 GHz:



Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
47.129250	27.96	109.0	V	322.0	-18.3	40.00	12.04
60.015625	28.62	400.0	H	337.0	-20.2	40.00	11.38
61.309250	28.05	355.0	H	182.0	-20.2	40.00	11.95
152.006750	32.50	219.0	H	218.0	-14.2	43.50	11.00
239.937625	32.02	105.0	H	237.0	-14.1	46.00	13.98
840.005625	37.19	116.0	V	110.0	2.8	46.00	8.81

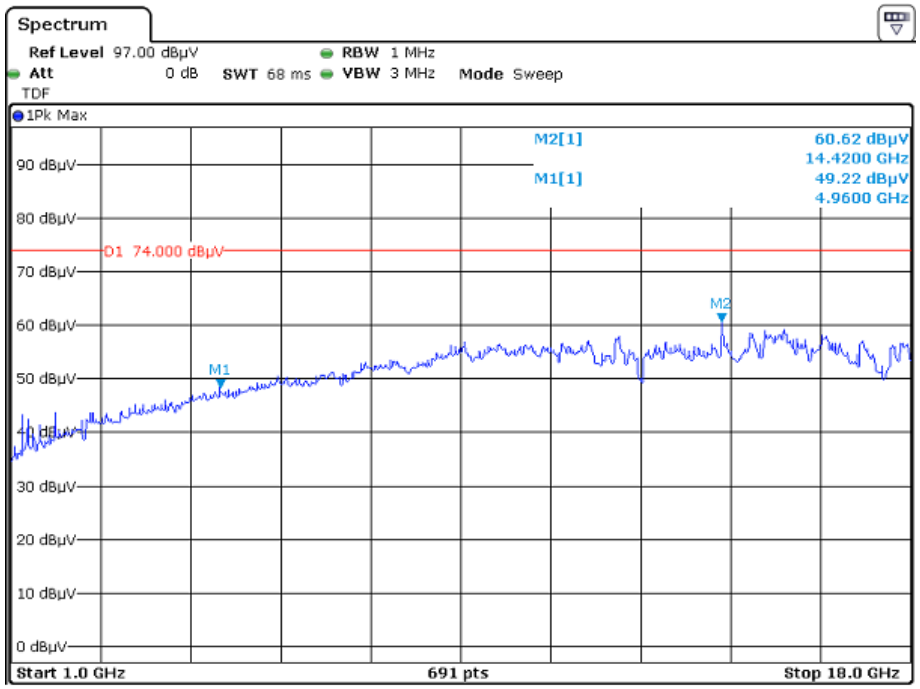
1 GHz - 25 GHz:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (2402 MHz)									
2402.00	68.13	PK	17	2.3	H	31.87	100.00	/	/
2402.00	46.66	Ave.	17	2.3	H	31.87	78.53	/	/
2402.00	61.25	PK	104	1.6	V	31.87	93.12	/	/
2402.00	42.32	Ave.	104	1.6	V	31.87	74.19	/	/
2352.08	30.86	PK	109	2.3	H	31.77	62.63	74	11.37
2352.08	13.65	Ave.	109	2.3	H	31.77	45.42	54	8.58
2488.72	28.35	PK	141	2.0	H	32.13	60.48	74	13.52
2488.72	13.71	Ave.	141	2.0	H	32.13	45.84	54	8.16
1225.43	51.58	PK	39	1.5	H	-4.68	46.90	74	27.10
1225.43	40.86	Ave.	39	1.5	H	-4.68	36.18	54	17.82
2533.38	63.51	PK	249	1.7	H	-0.05	63.46	80	16.54
2533.38	28.24	Ave.	249	1.7	H	-0.05	28.19	58.53	30.34
4804.00	44.08	PK	320	1.8	H	5.40	49.48	74	24.52
4804.00	30.02	Ave.	320	1.8	H	5.40	35.42	54	18.58
Middle Channel (2440 MHz)									
2440.00	70.37	PK	341	1.7	H	31.97	102.34	/	/
2440.00	47.89	Ave.	341	1.7	H	31.97	79.86	/	/
2440.00	62.15	PK	5	2.2	V	31.97	94.12	/	/
2440.00	42.7	Ave.	5	2.2	V	31.97	74.67	/	/
1220.10	52.19	PK	2	1.9	H	-4.78	47.41	74	26.59
1220.10	40.79	Ave.	2	1.9	H	-4.78	36.01	54	17.99
2533.38	64.57	PK	353	2.4	H	-0.05	64.52	82.34	17.82
2533.38	28.16	Ave.	353	2.4	H	-0.05	28.11	59.86	31.75
4880.00	43.69	PK	328	2.1	H	6.43	50.12	74	23.88
4880.00	28.4	Ave.	328	2.1	H	6.43	34.83	54	19.17

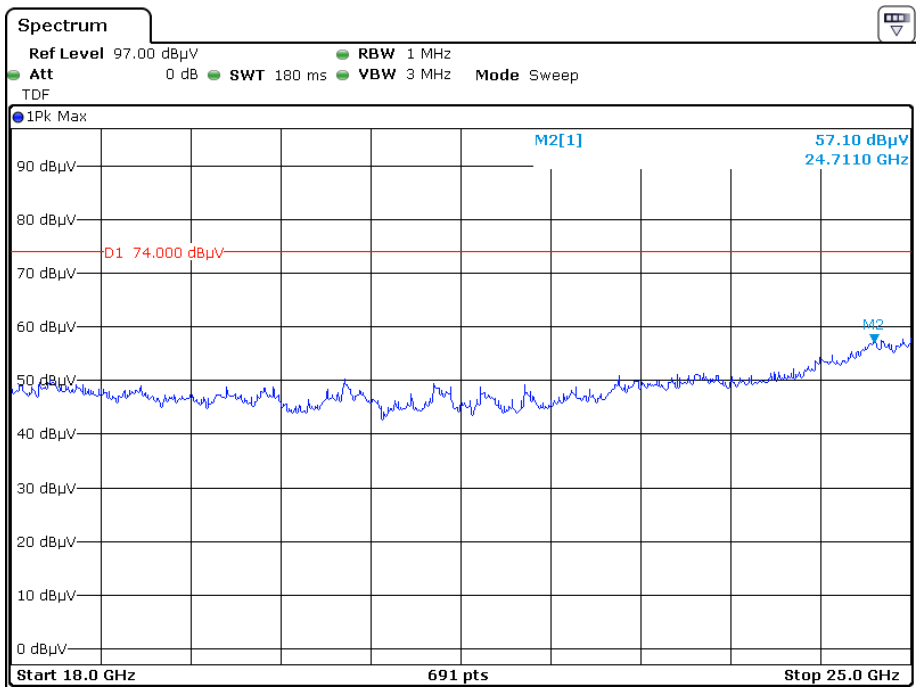
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
High Channel (2480 MHz)									
2480.00	71.65	PK	290	2.1	H	32.13	103.78	/	/
2480.00	48.31	Ave.	290	2.1	H	32.13	80.44	/	/
2480.00	65.95	PK	285	1.1	V	32.13	98.08	/	/
2480.00	45.04	Ave.	285	1.1	V	32.13	77.17	/	/
2340.39	28.42	PK	238	2.2	H	31.64	60.06	74	13.94
2340.39	13.65	Ave.	238	2.2	H	31.64	45.29	54	8.71
2483.56	35.82	PK	278	1.2	H	32.13	67.95	74	6.05
2483.56	14.14	Ave.	278	1.2	H	32.13	46.27	54	7.73
1239.99	51.79	PK	337	1.8	H	-4.68	47.11	74	26.89
1239.99	40.21	Ave.	337	1.8	H	-4.68	35.53	54	18.47
2533.38	63.67	PK	236	2.2	H	-0.05	63.62	83.78	20.16
2533.38	28.25	Ave.	236	2.2	H	-0.05	28.20	60.44	32.24
4960.00	44.35	PK	159	1.9	H	6.95	51.30	74	22.70
4960.00	31.52	Ave.	159	1.9	H	6.95	38.47	54	15.53

Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude
The other spurious emission which is 20dB to the limit was not recorded.
And for the pre-scan is performed with the 2400-2483.5MHz band filter.

Pre-scan with high channel Peak
Horizontal

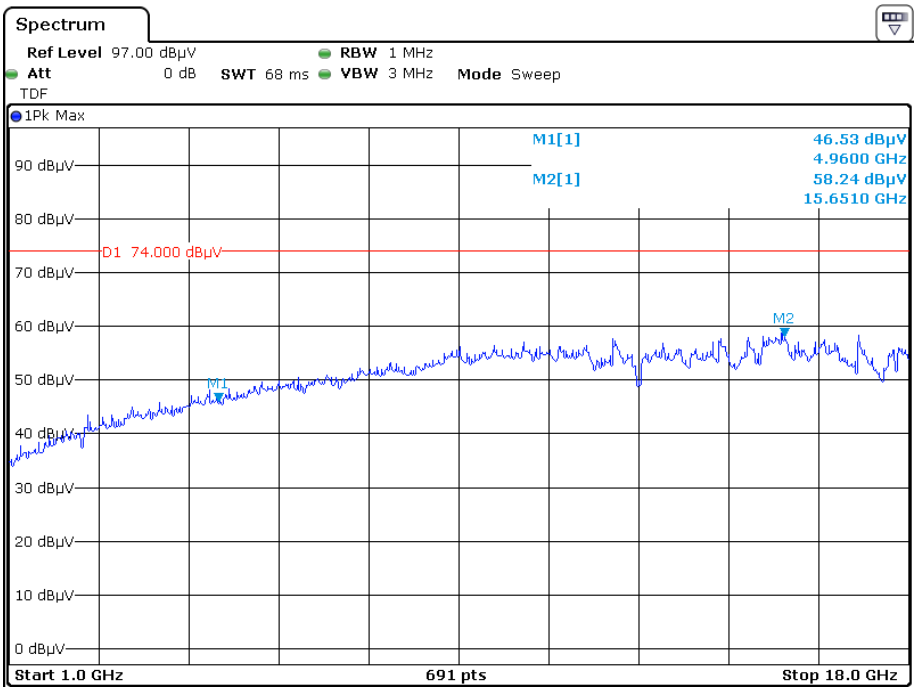


Date: 9.NOV.2019 15:22:50

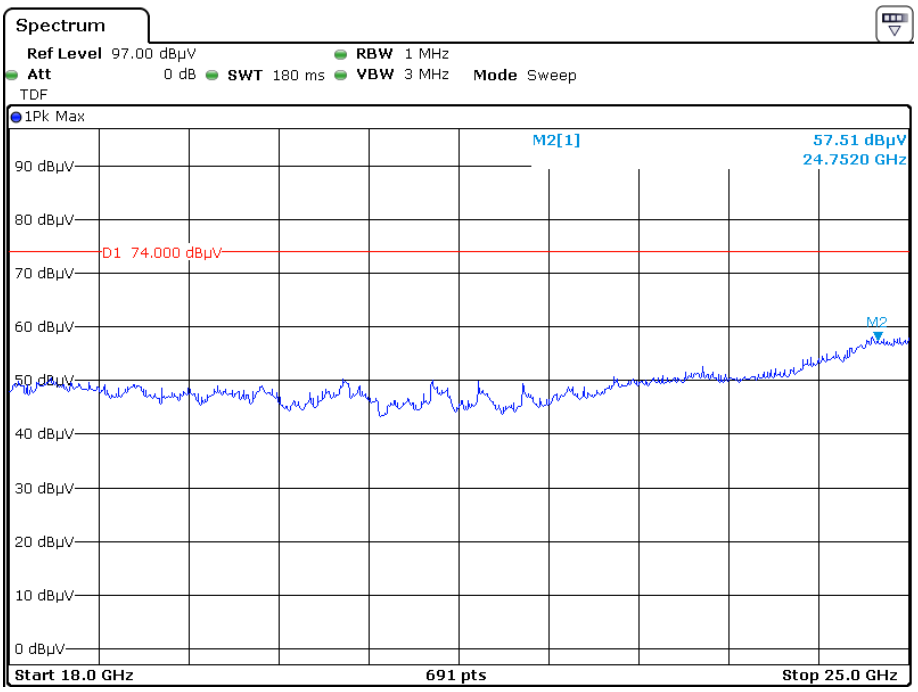


Date: 9.NOV.2019 16:04:52

Vertical

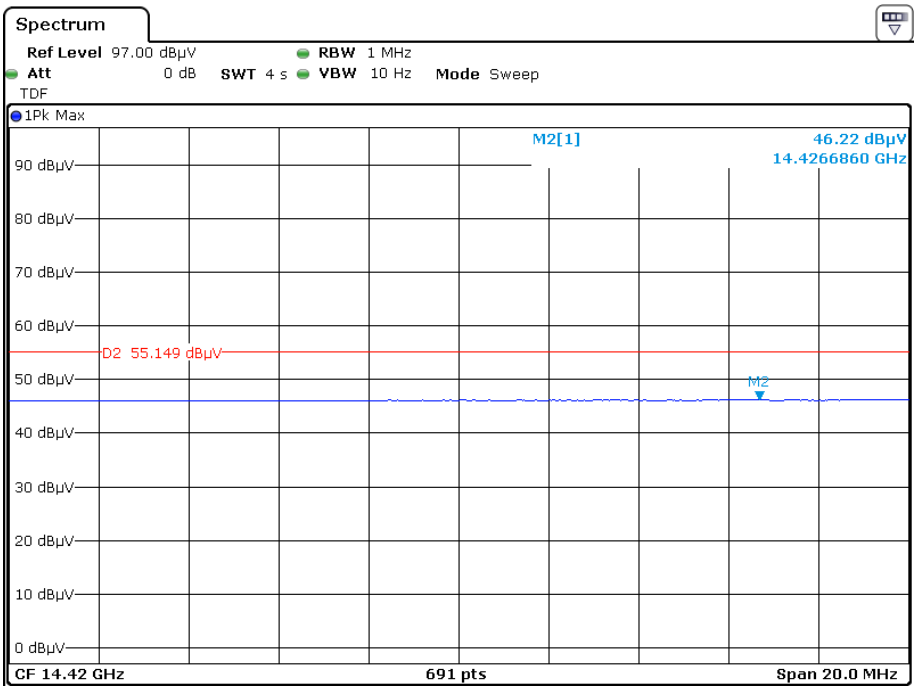


Date: 9.NOV.2019 15:27:46

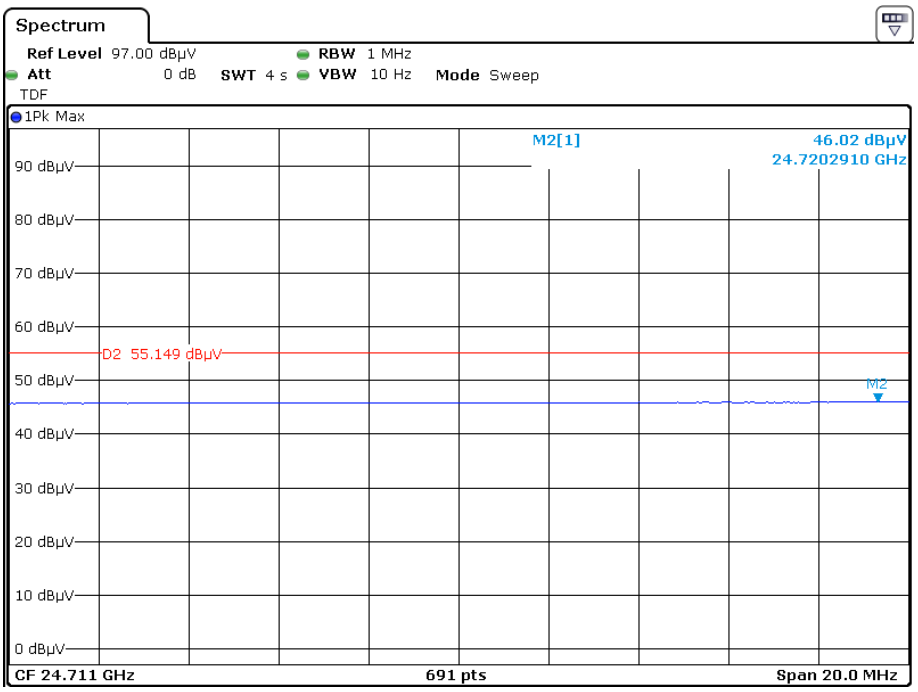


Date: 9.NOV.2019 16:17:10

Pre-scan for Average
Horizontal

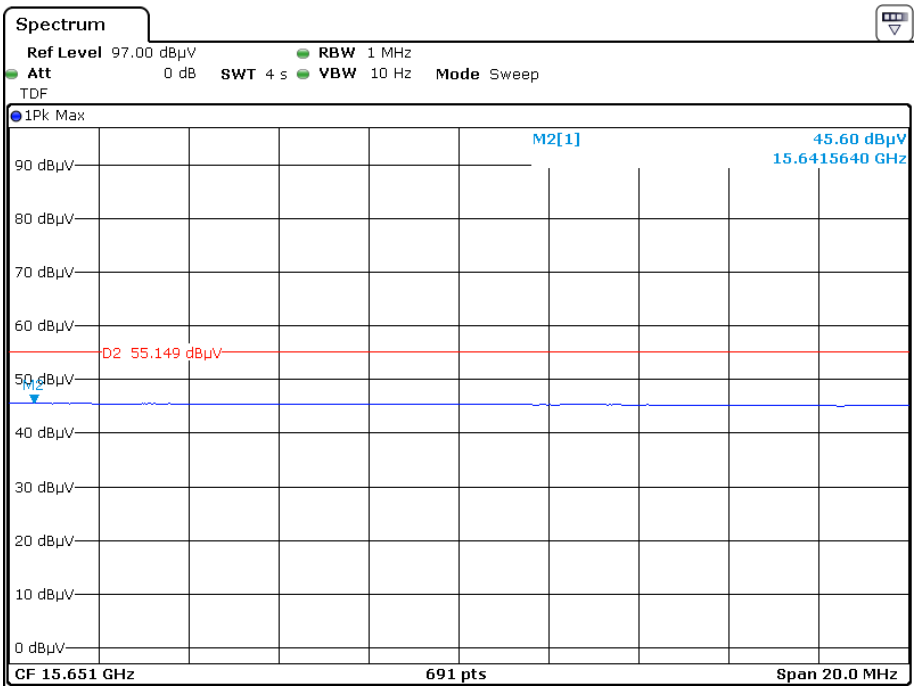


Date: 9.NOV.2019 15:27:16

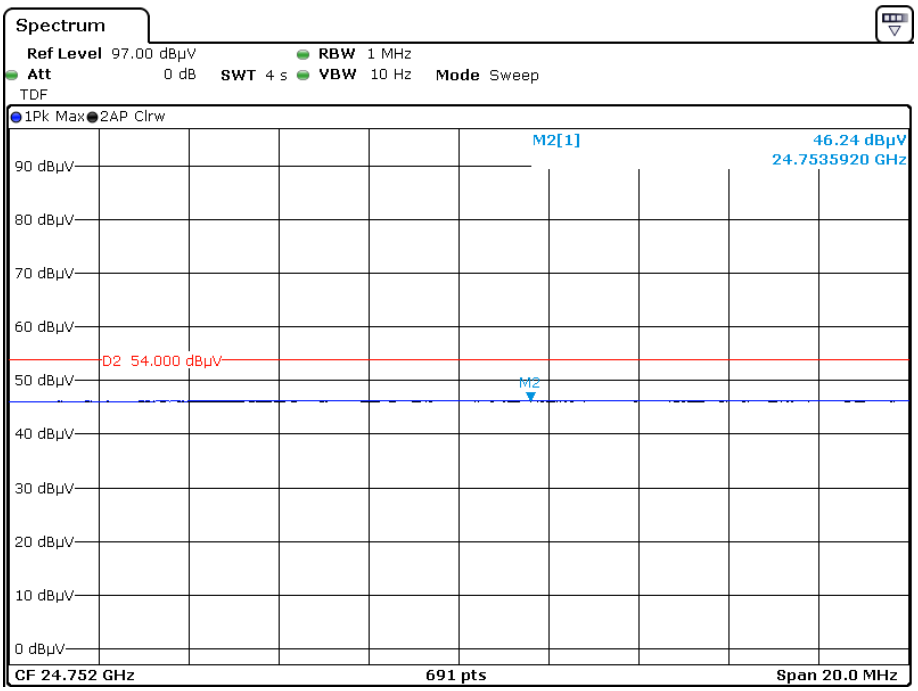


Date: 9.NOV.2019 16:10:20

Vertical



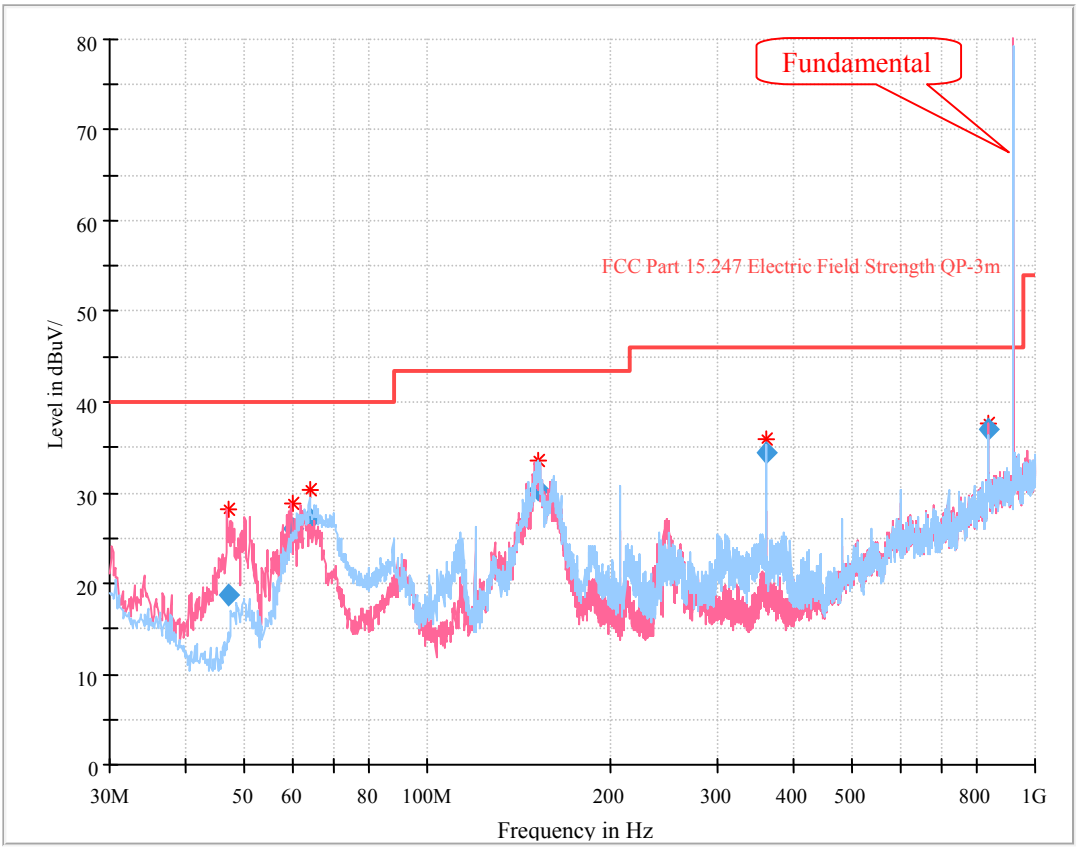
Date: 9.NOV.2019 15:34:12



Date: 9.NOV.2019 16:21:11

900MHz Band:

30 MHz~1 GHz:



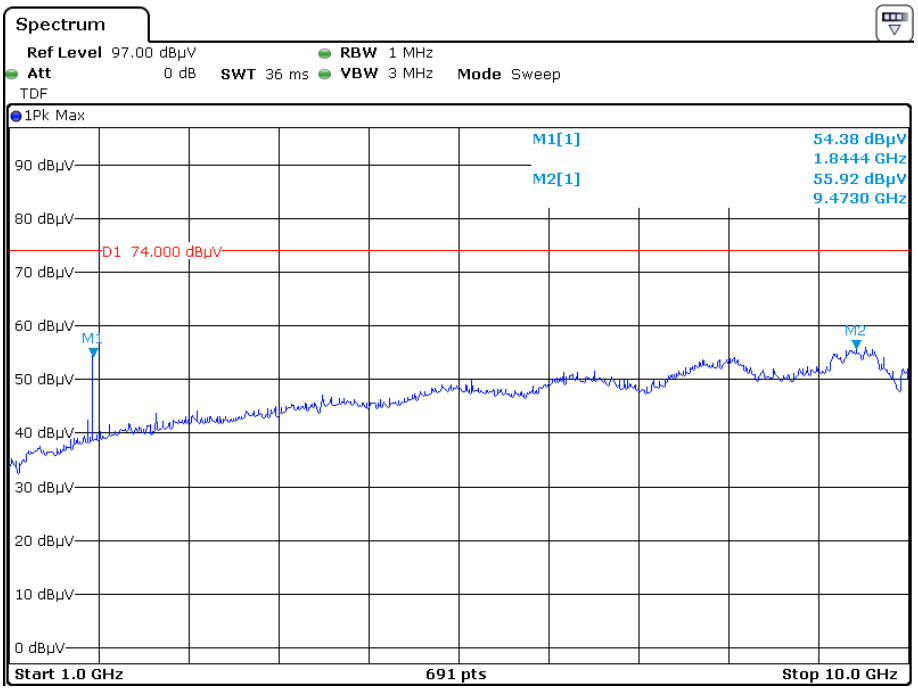
Frequency (MHz)	Corrected Amplitude (dBµV/m)	Antenna height (cm)	Antenna Polarity	Turntable position (degree)	Correction Factor (dB/m)	Limit (dBµV/m)	Margin (dB)
47.231625	18.72	108.0	V	46.0	-18.3	40.00	21.28
60.008875	25.97	102.0	V	65.0	-20.2	40.00	14.03
64.002000	27.19	315.0	H	352.0	-20.3	40.00	12.81
152.043125	30.38	210.0	H	217.0	-14.2	43.50	13.12
359.981750	34.37	102.0	H	291.0	-10.7	46.00	11.63
839.987875	36.90	134.0	V	110.0	2.8	46.00	9.10

1 GHz - 10 GHz:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
Low Channel (917 MHz)									
1834	56.28	PK	24	2.1	H	-1.55	54.73	74	19.27
1834	54.47	Ave.	24	2.1	H	-1.55	52.92	54	1.08
2751	45.93	PK	66	2.3	H	1.42	47.35	74	26.65
2751	37.66	Ave.	66	2.3	H	1.42	39.08	54	14.92
Middle Channel (919.6 MHz)									
1839.2	56.42	PK	147	1.9	H	-1.55	54.87	74	19.13
1839.2	54.75	Ave.	147	1.9	H	-1.55	53.20	54	0.80
2758.8	47.53	PK	216	2.4	H	1.42	48.95	74	25.05
2758.8	39.66	Ave.	216	2.4	H	1.42	41.08	54	12.92
High Channel (922.2 MHz)									
1844.40	56.62	PK	191	1.7	H	-1.55	55.07	74	18.93
1844.40	54.92	Ave.	310	2.2	H	-1.55	53.37	54	0.63
2766.60	47.51	PK	240	1.1	H	1.42	48.93	74	25.07
2766.60	40.03	Ave.	240	1.1	H	1.42	41.45	54	12.55

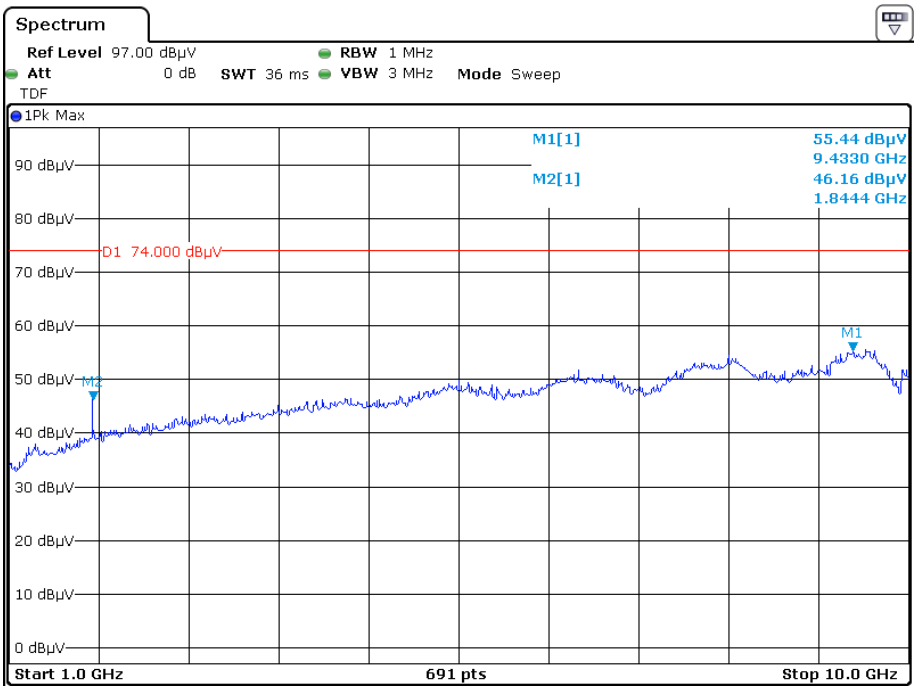
Note:
Corrected Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor
Corrected Amplitude = Corrected Factor + Reading
Margin = Limit - Corrected. Amplitude
The other spurious emission which is 20dB to the limit was not recorded.
And for the pre-scan is performed with the 2400-2483.5MHz band filter.

Pre-scan with high channel Peak
Horizontal



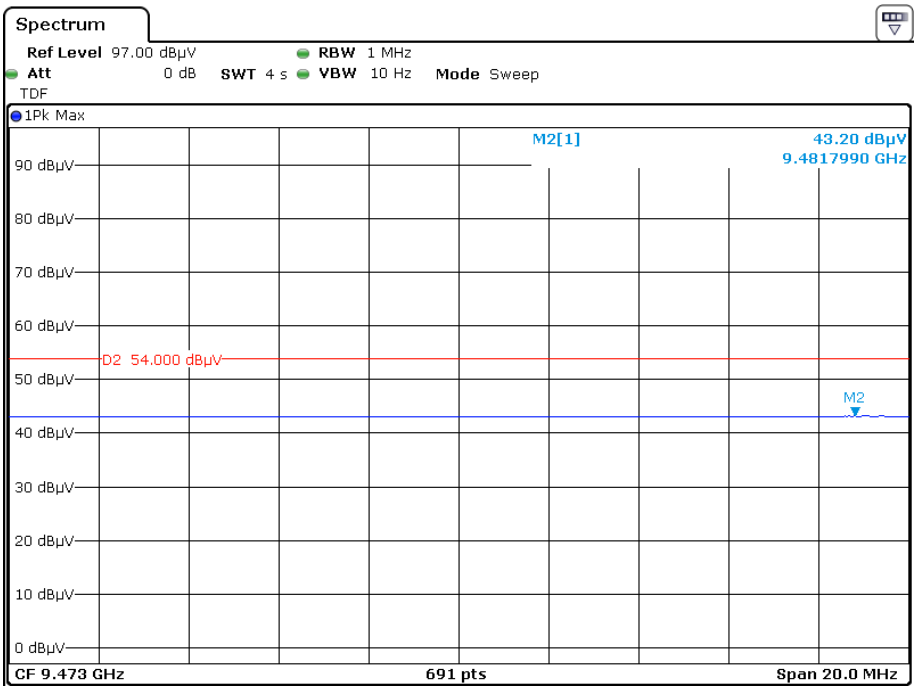
Date: 11.NOV.2019 08:41:20

Vertical

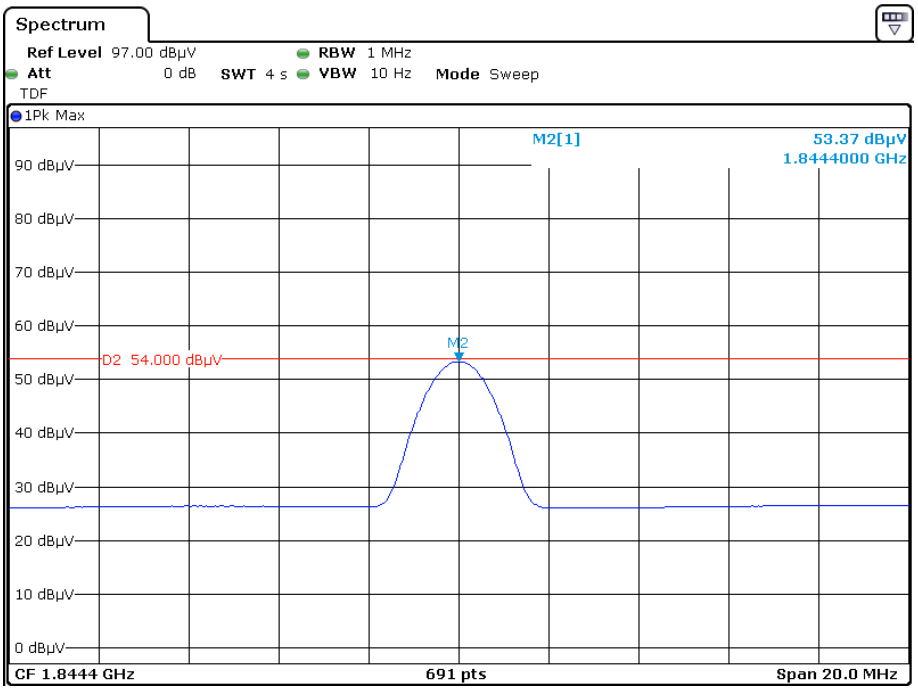


Date: 11.NOV.2019 08:58:30

Pre-scan for Average
Horizontal

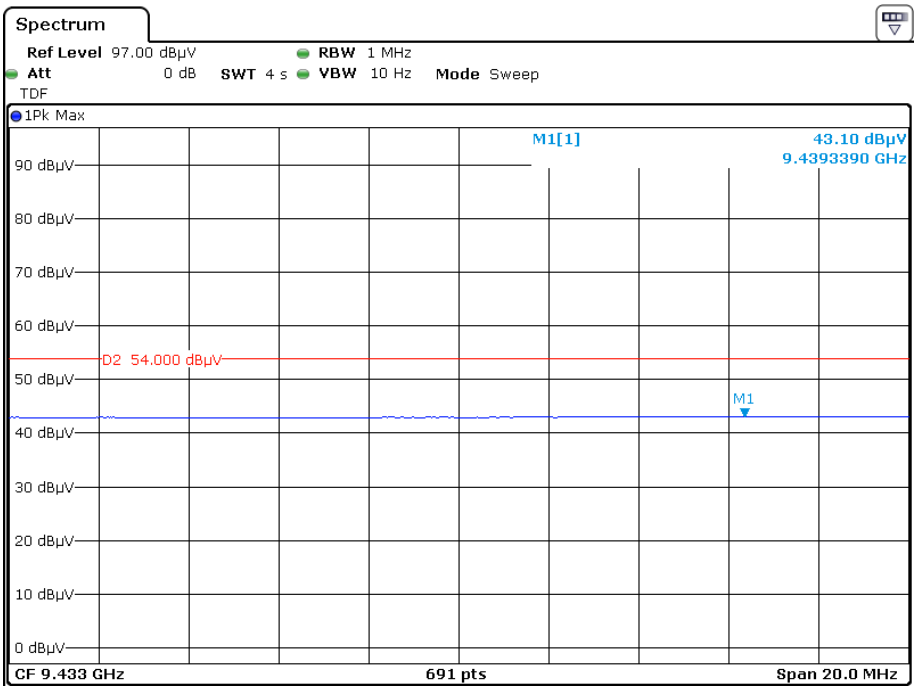


Date: 11.NOV.2019 08:47:02

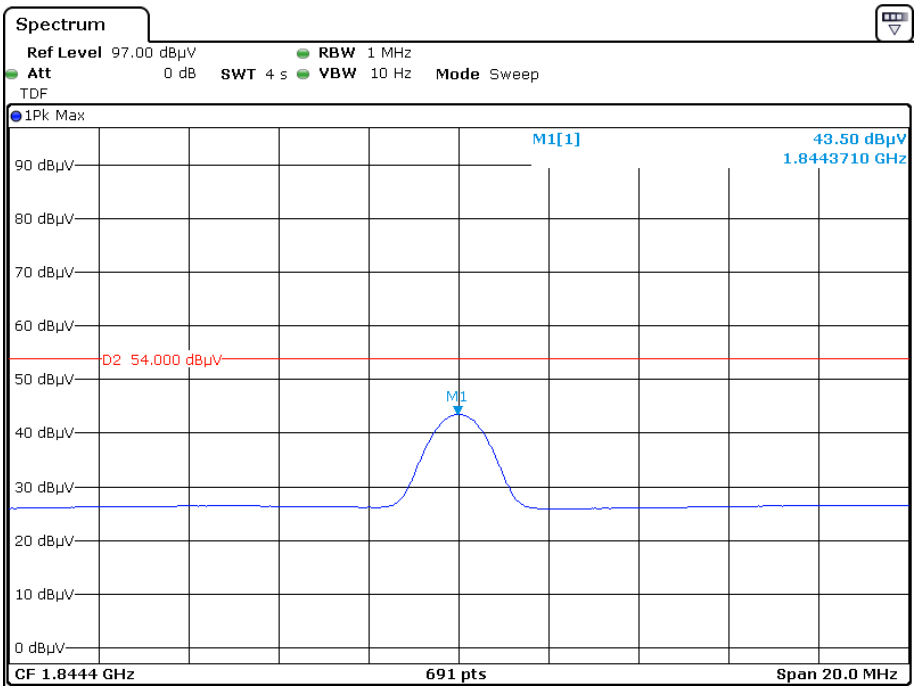


Date: 11.NOV.2019 08:52:43

Vertical



Date: 11.NOV.2019 09:04:08



Date: 11.NOV.2019 09:10:25

FCC §15.247(a) (1)-CHANNEL SEPARATION TEST

Applicable Standard

Frequency hopping systems shall have hoping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Test Procedure

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.

Test Data

Environmental Conditions

Temperature:	23~24 ℃
Relative Humidity:	53~55 %
ATM Pressure:	101.0 kPa

The testing was performed by Gavin Guo on 2019-11-06 amd 2019-11-15.

EUT operation mode: Transmitting

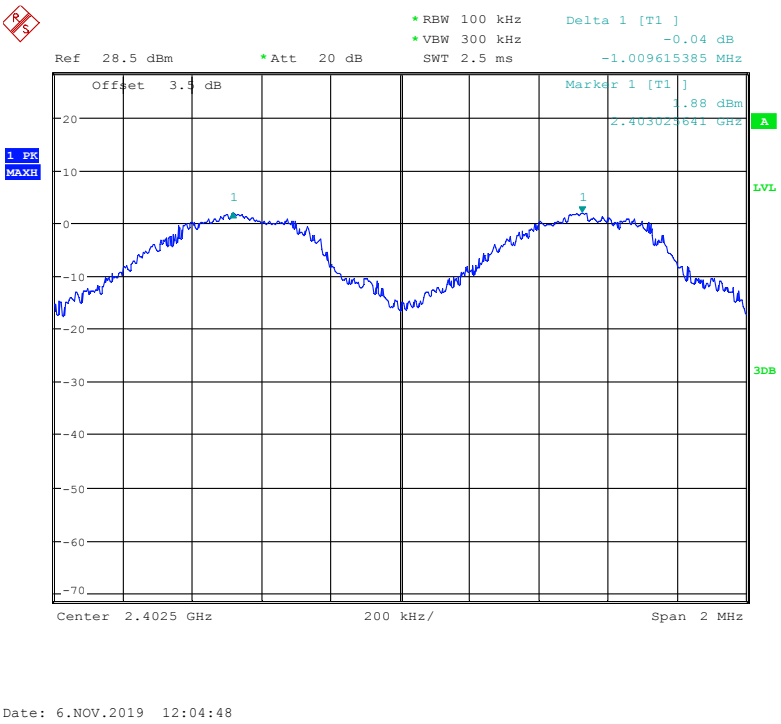
Test Result: Compliance. Please refer to following table and plots.

2.4GHz Band:

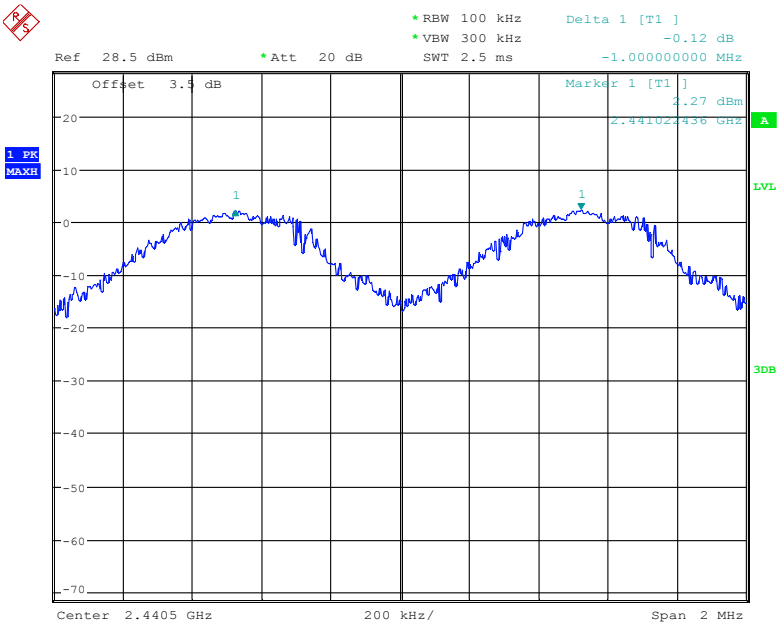
Channel	Channel Separation (MHz)	20 dBc BW (MHz)	Two-thirds of the 20 dB bandwidth (MHz)	Channel Separation Limit	Result
Low	1.010	0.889	0.593	> two-thirds of the 20 dB bandwidth	Compliance
Middle	1.000	0.903	0.602	> two-thirds of the 20 dB bandwidth	Compliance
High	0.990	0.913	0.609	> two-thirds of the 20 dB bandwidth	Compliance

Please refer to the following plots.

Low Channel

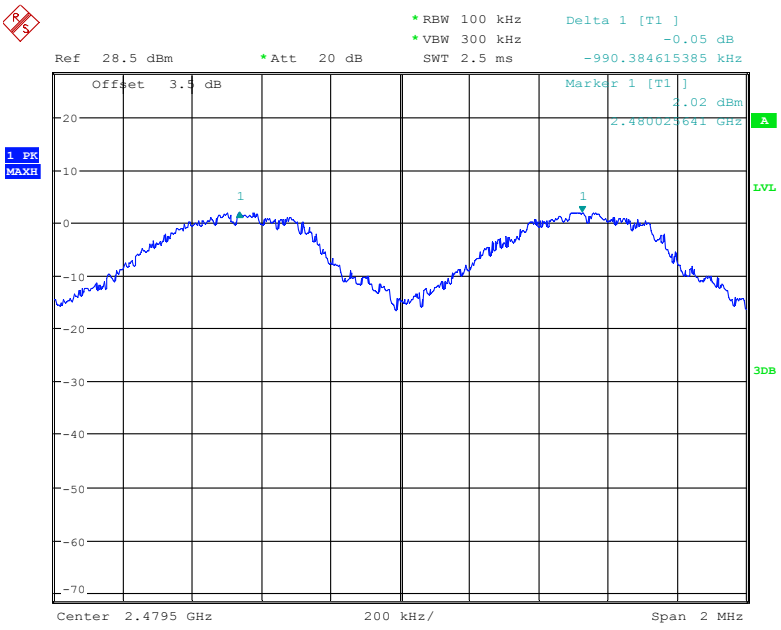


Middle Channel



Date: 6.NOV.2019 12:06:19

High Channel



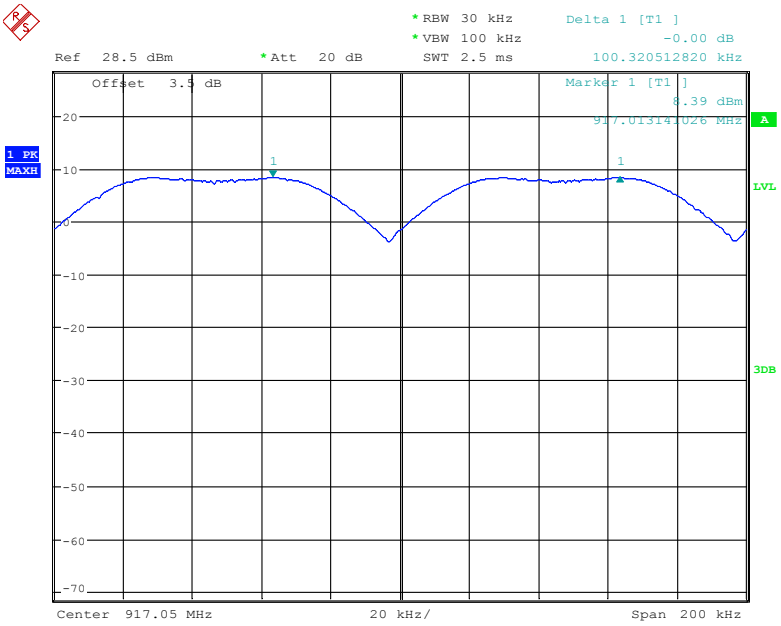
Date: 6.NOV.2019 12:08:26

900M Band:

Channel	Channel Separation (kHz)	20 dBc BW (kHz)	Channel Separation Limit	Result
Low	100.321	68.910	> 20 dB bandwidth	Compliance
Middle	100.321	69.551	> 20 dB bandwidth	Compliance
High	100.000	69.167	> 20 dB bandwidth	Compliance

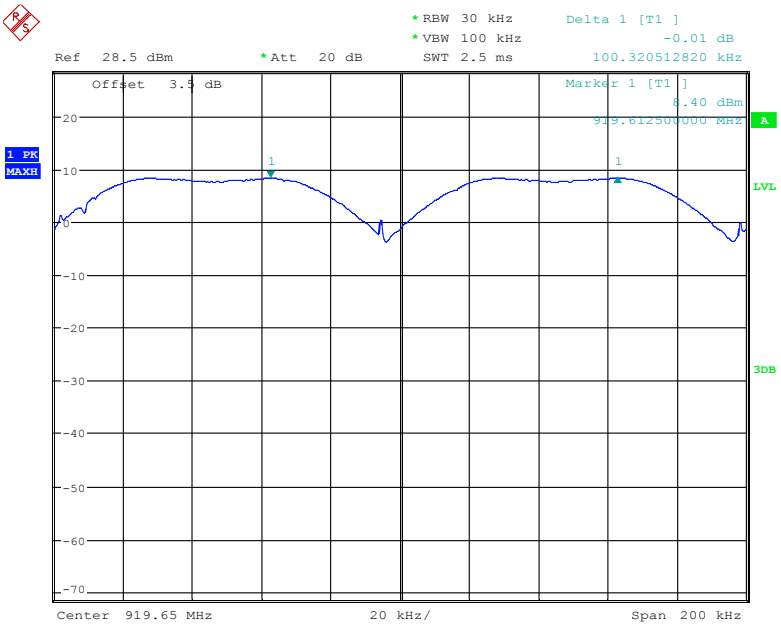
Please refer to the following plots.

Low Channel



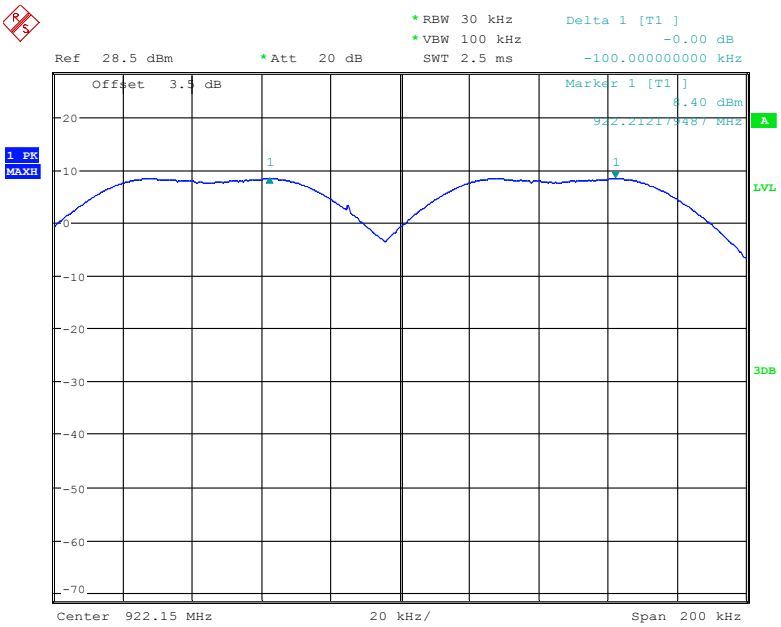
Date: 15.NOV.2019 13:12:47

Middle Channel



Date: 15.NOV.2019 13:10:41

High Channel



Date: 15.NOV.2019 13:14:53

FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH

Applicable Standard

Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

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.

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

Test Data

Environmental Conditions

Temperature:	23~25 ℃
Relative Humidity:	54~55 %
ATM Pressure:	101.0 kPa

The testing was performed by Gavin Guo on 2019-11-06 and 2019-11-15.

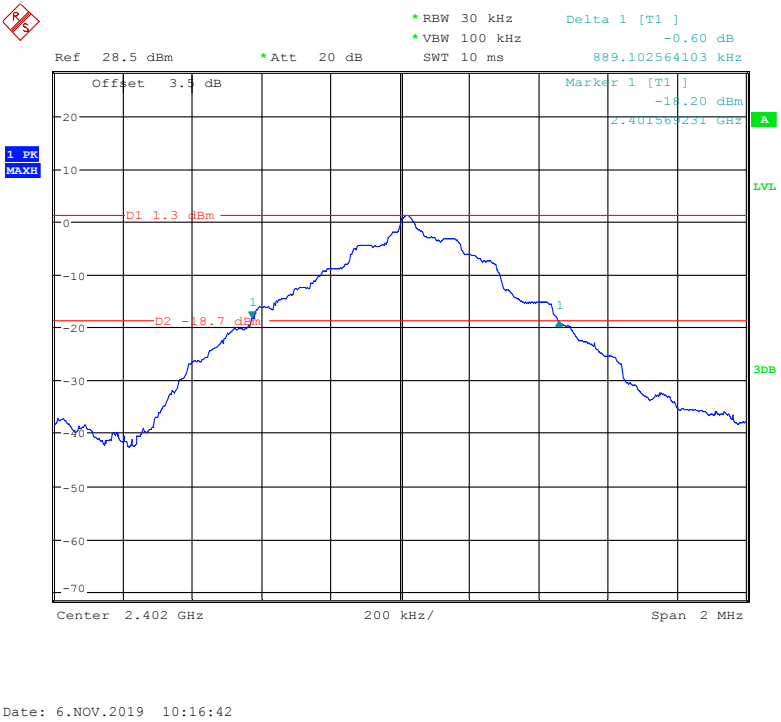
EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table and plots.

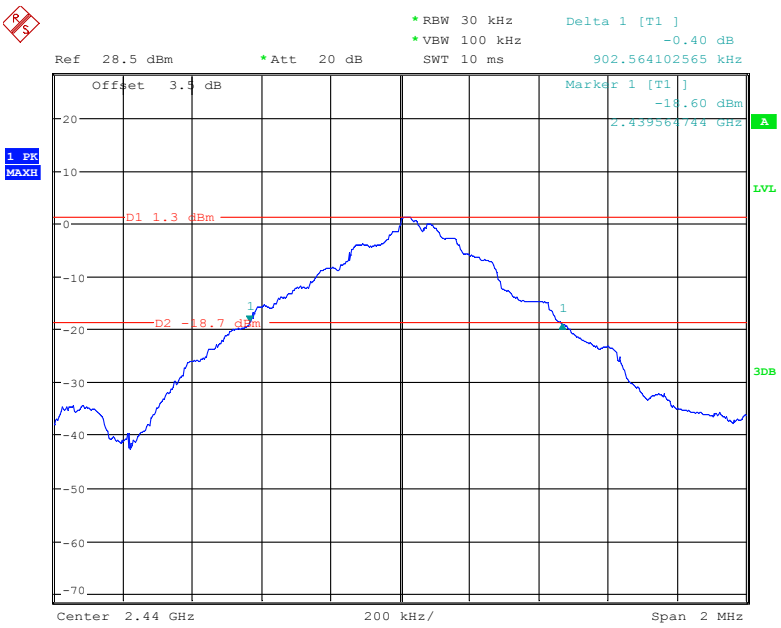
2.4GHz Band:

Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (MHz)
GFSK	Low	2402	0.889
	Middle	2440	0.903
	High	2480	0.913

Low Channel

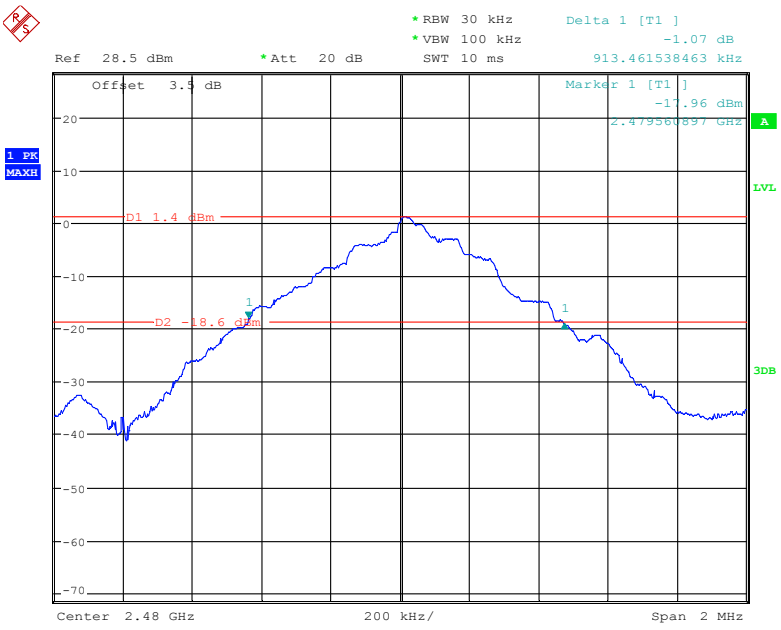


Middle Channel



Date: 6.NOV.2019 10:18:41

High Channel

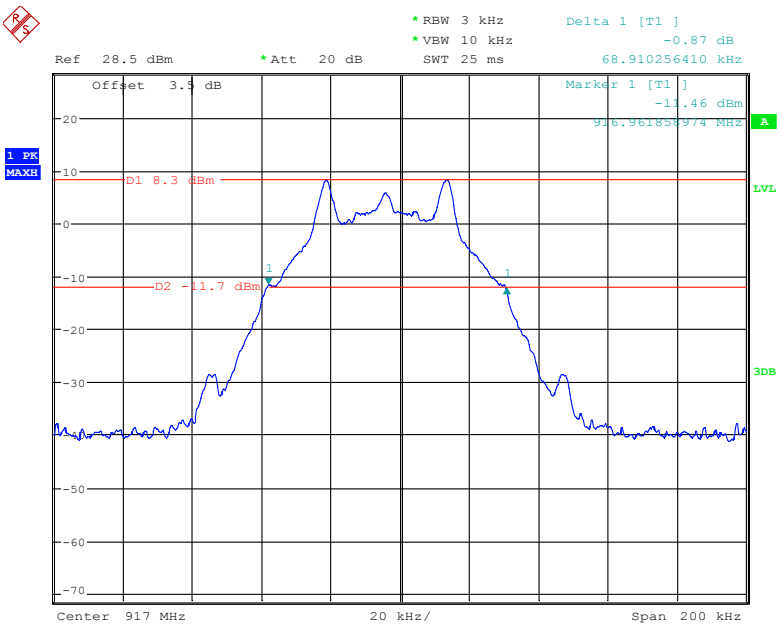


Date: 6.NOV.2019 10:14:15

900MHz Band:

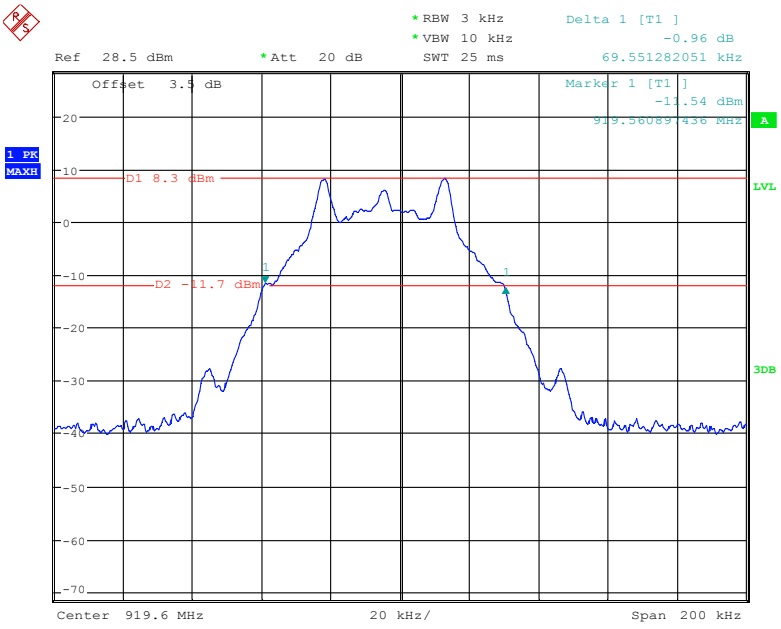
Mode	Channel	Frequency (MHz)	20 dB Emission Bandwidth (kHz)
GFSK	Low	917	68.910
	Middle	919.6	69.551
	High	922.2	69.167

Low Channel



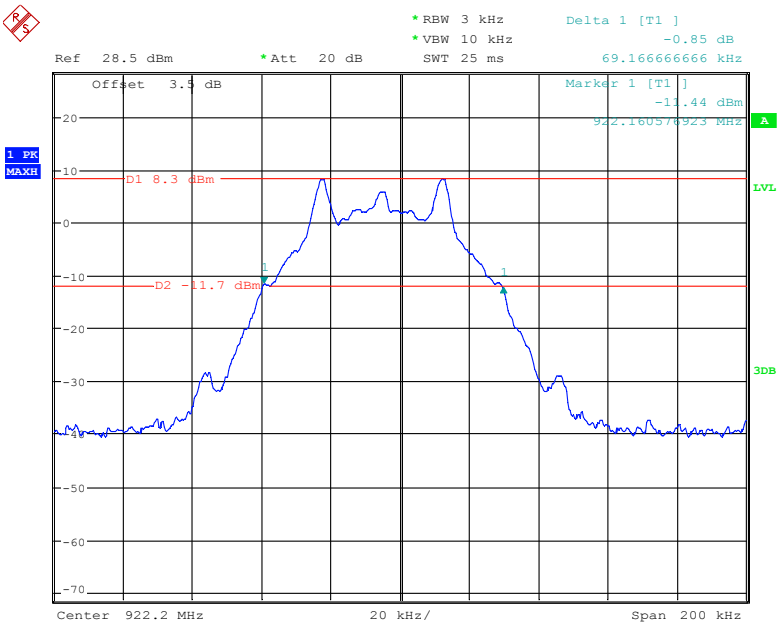
Date: 15.NOV.2019 15:08:30

Middle Channel



Date: 15.NOV.2019 15:20:51

High Channel



Date: 15.NOV.2019 15:26:20

FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST

Applicable Standard

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

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.

Test Procedure

1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.

2. Set the EUT in hopping mode from first channel to last.

3. By using the max-hold function record the quantity of the channel.

Test Data

Environmental Conditions

Temperature:	22~23 ℃
Relative Humidity:	54 %
ATM Pressure:	101.0 kPa

The testing was performed by Gavin Guo on 2019-11-15 and 2019-11-22.

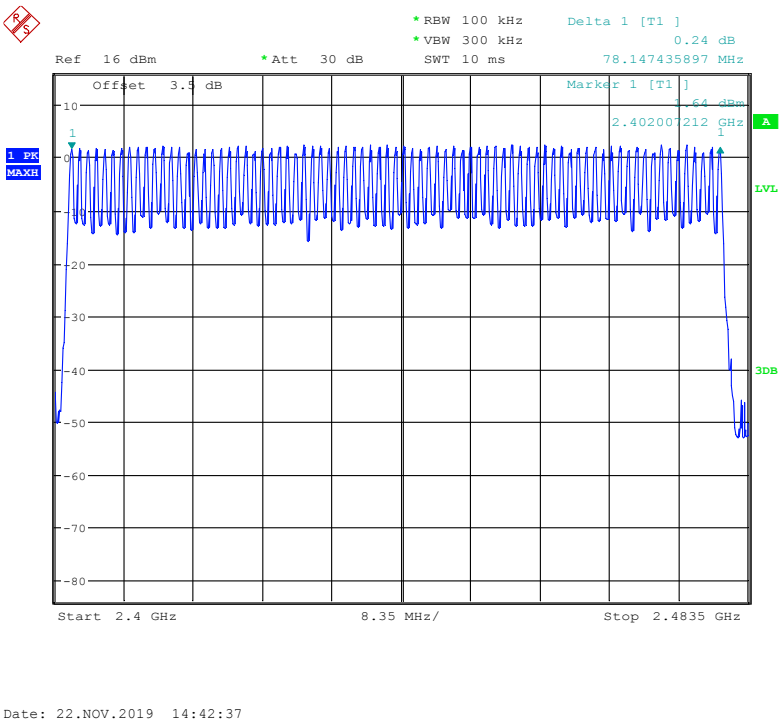
EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table and plots.

2.4GHz Band:

Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
GFSK	2400-2483.5	79	≥15

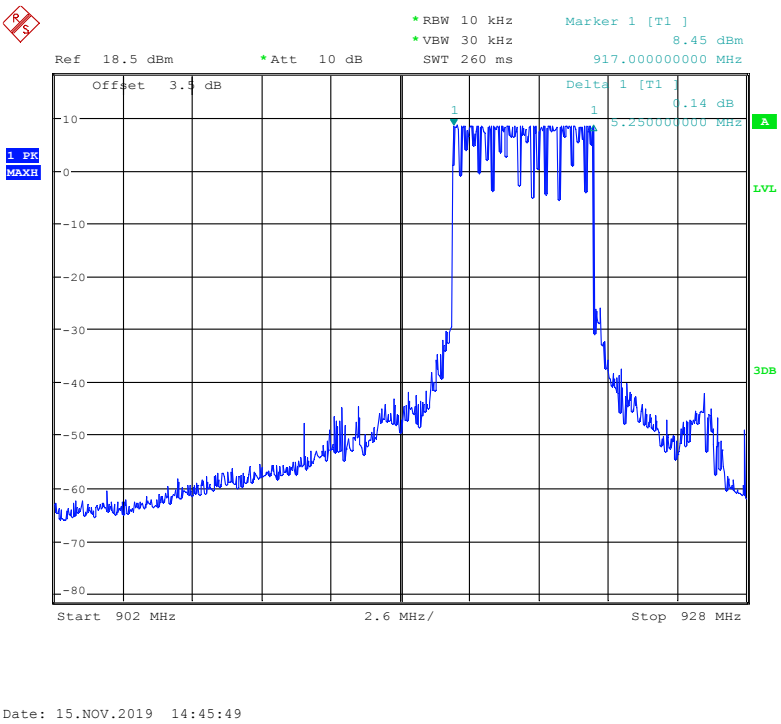
Number of Hopping Channels



900MHz Band:

Mode	Frequency Range (MHz)	Number of Hopping Channel (CH)	Limit (CH)
GFSK	902-928	53	≥50

Number of Hopping Channels



FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME)

Applicable Standard

Frequency hopping systems in the 2400-2483.5 MHz shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

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.

Test Procedure

1. The EUT was worked in channel hopping.
2. Set the RBW≤ channel spacing
3. Set the VBW ≥ 3×RBW.
4. Set the span to 0Hz.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Recorded the time of single pulses

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	53 %
ATM Pressure:	101.0 kPa

The testing was performed by Gavin Guo from 2019-11-06 to 2019-11-15.

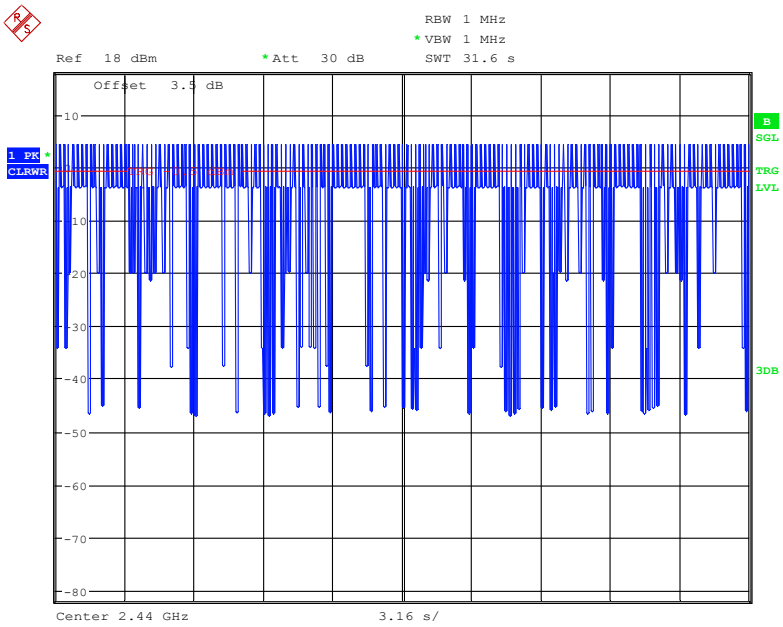
EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table and plots

2.4GHz Band:

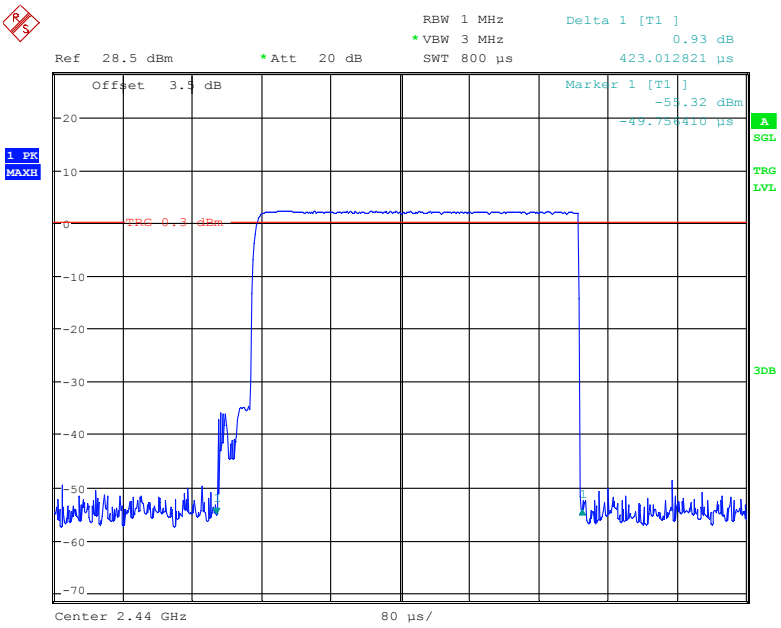
Mode	Pulse Time(ms)	Hopping Number	Period Time(s)	Total of Dwell(ms)	Limit(ms)	Result
GFSK	0.423	308	31.6	130.28	<400	PASS

Hops in 31.6s



Date: 7.NOV.2019 07:20:15

Pulse time

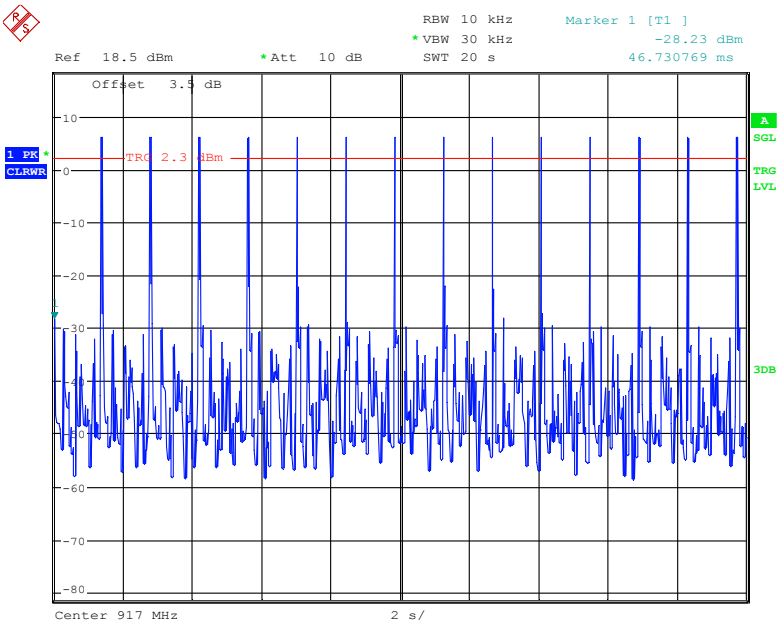


Date: 6.NOV.2019 12:22:12

900MHz Band:

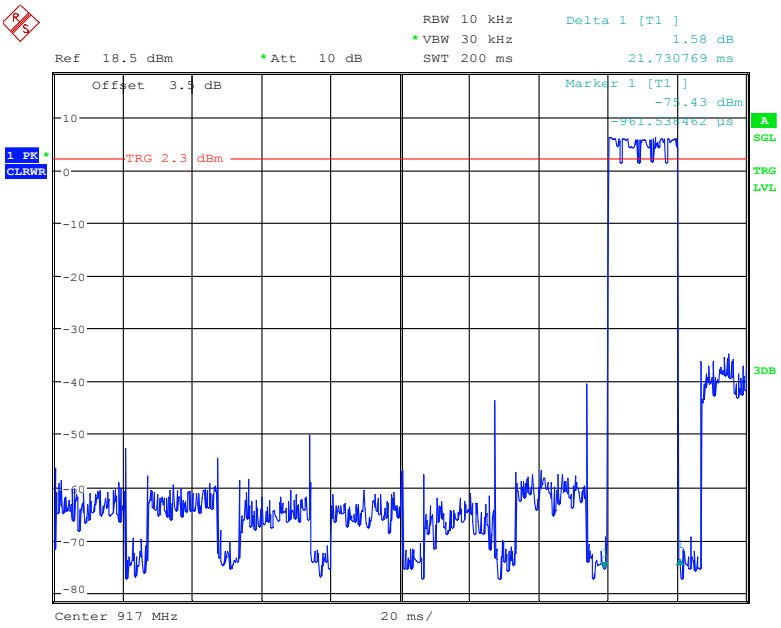
Mode	Pulse Time(ms)	Hopping Number	Period Time(s)	Total of Dwell(ms)	Limit(ms)	Result
GFSK	21.731	14	20	304.234	<400	PASS

Hops in 20s



Date: 15.NOV.2019 14:24:08

Pulse time



Date: 15.NOV.2019 14:32:09

FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

Applicable Standard

According to §15.247(b) (1), for frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

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.

Test Procedure

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.

Test Data

Environmental Conditions

Temperature:	23 ℃
Relative Humidity:	54~55 %
ATM Pressure:	101.0 kPa

The testing was performed by Gavin Guo on 2019-11-06 and 2019-11-15.

EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following table.

2.4GHz Band:

Mode	Channel	Frequency (MHz)	Peak Output Power		Limit (mW)
			(dBm)	(mW)	
GFSK	Low	2402	1.84	1.53	125
	Middle	2440	2.27	1.69	125
	High	2480	2.15	1.64	125

900M Band:

Mode	Channel	Frequency (MHz)	Peak Output Power		Limit (mW)
			(dBm)	(mW)	
GFSK	Low	917	8.37	6.87	1000
	Middle	919.6	8.40	6.92	1000
	High	922.2	8.36	6.85	1000

FCC §15.247(d) - BAND EDGES TESTING

Applicable Standard

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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. 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)).

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

Test Data

Environmental Conditions

Temperature:	23~24 ℃
Relative Humidity:	55 %
ATM Pressure:	101.0 kPa

The testing was performed by Gavin Guo on 2019-11-06 and 2019-11-15.

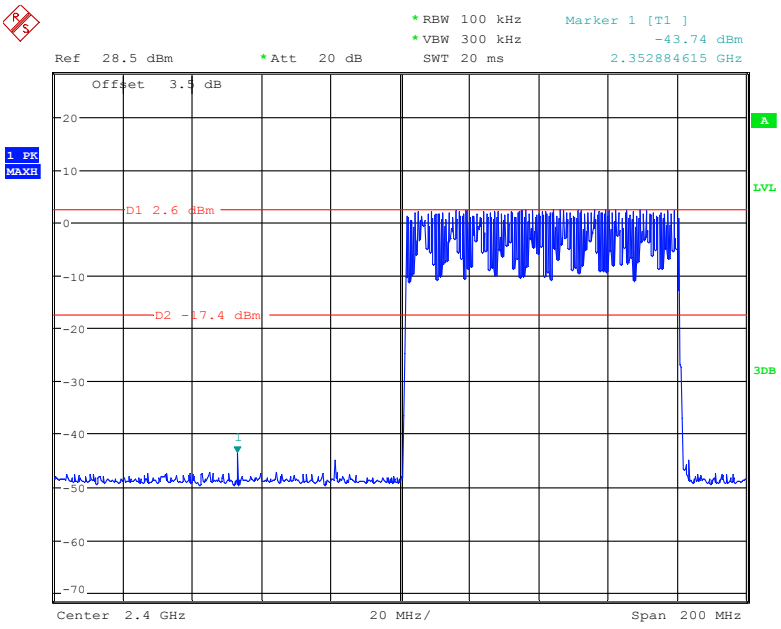
EUT operation mode: Transmitting

Test Result: Compliance. Please refer to following plots.

2.4G Band:

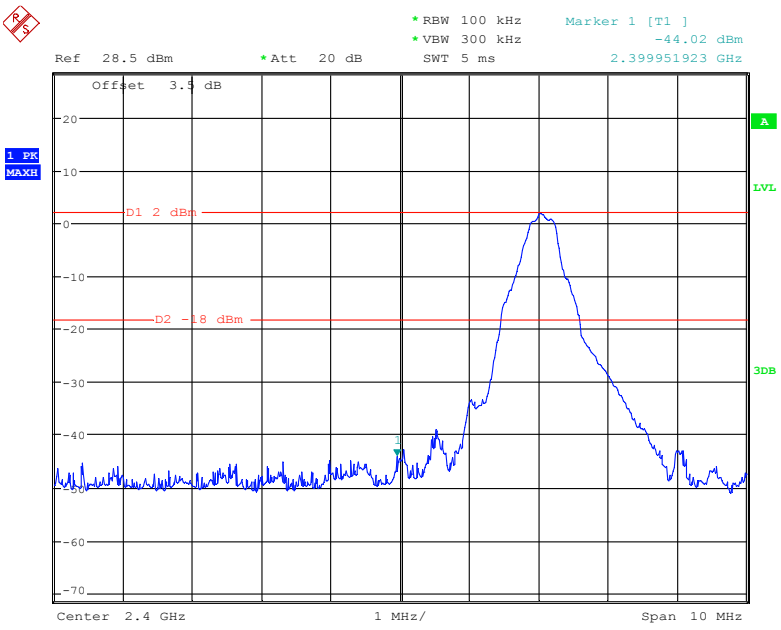
Band Edge-Left Side

Hopping



Date: 6.NOV.2019 10:25:50

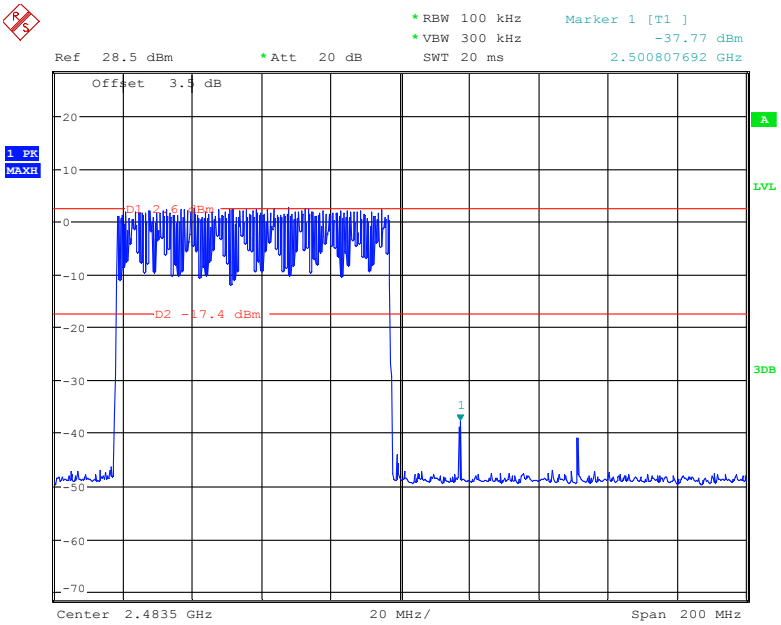
Single



Date: 6.NOV.2019 10:23:25

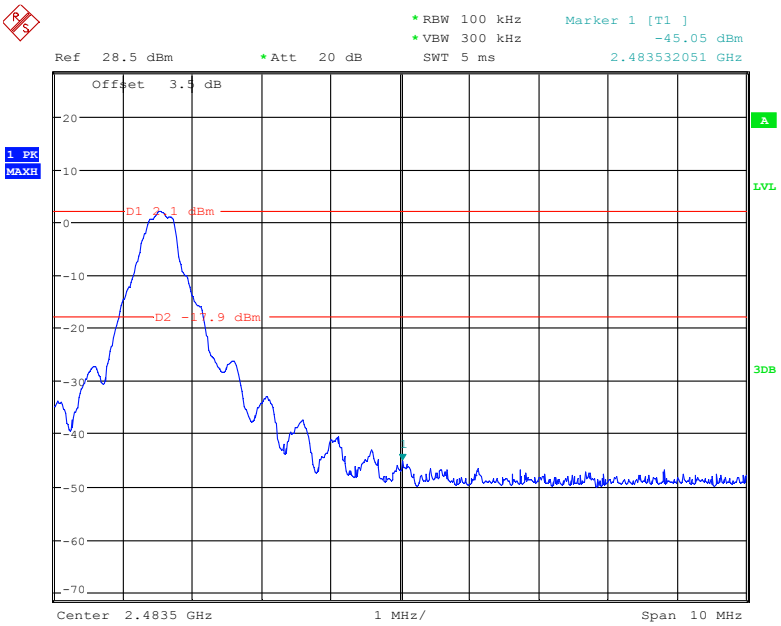
Band Edge-Right Side

Hopping



Date: 6.NOV.2019 10:27:05

Single

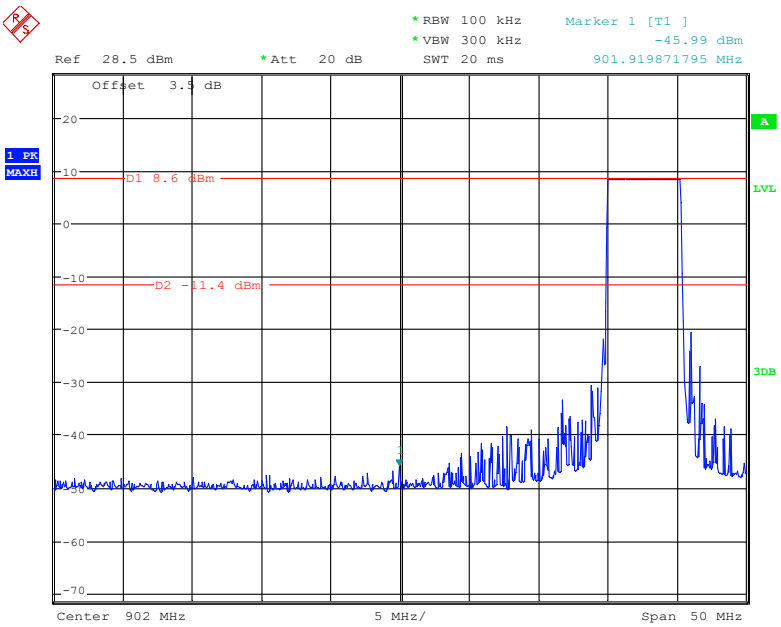


Date: 6.NOV.2019 10:22:19

900M Band:

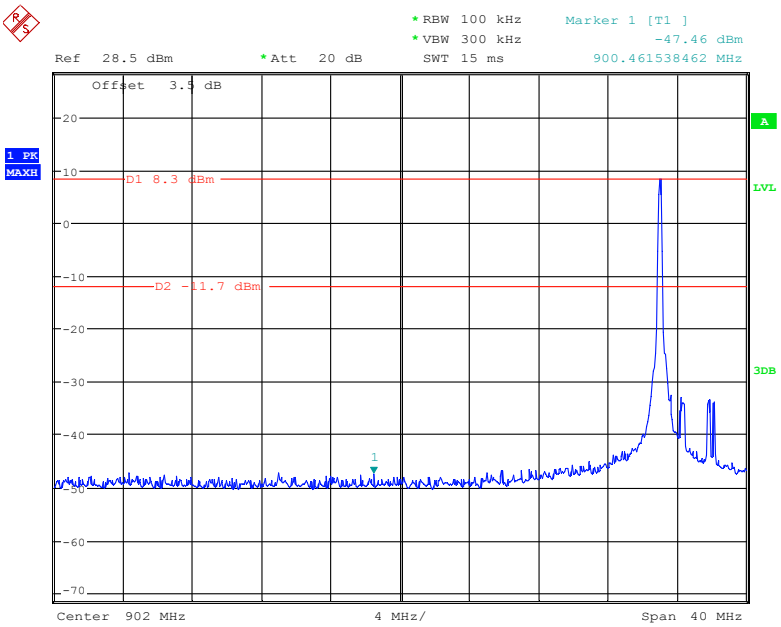
Band Edge-Left Side

Hopping



Date: 15.NOV.2019 12:59:51

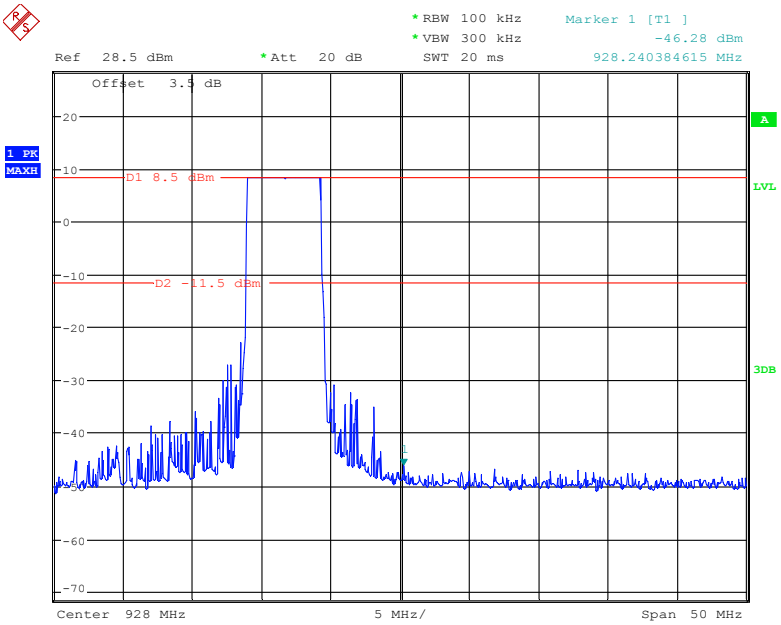
Single



Date: 15.NOV.2019 15:34:34

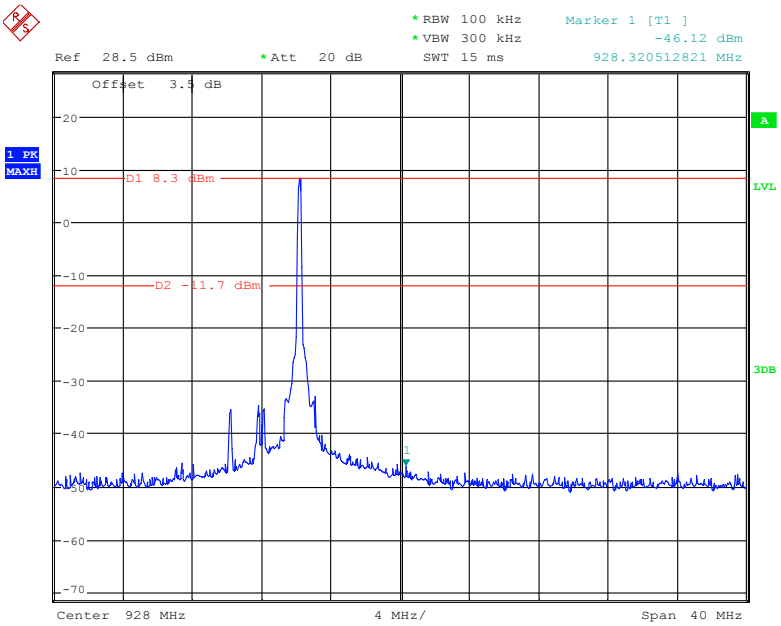
Band Edge-Right Side

Hopping



Date: 15.NOV.2019 15:37:52

Single



Date: 15.NOV.2019 15:28:41

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