FCC RF Test Report

Report No.:	FCC_RF_SL21021001-EVER-001_Rev 1.2
FCC ID:	2AO7C-83000023
Test Model:	830-00023
Received Date:	02/23/2021
Test Date:	03/04/2021-08/14/2021
Issued Date:	10/08/2021
Applicant:	Everactive, Inc.
Address:	2986 Oakmead Village Ct. Santa Clara, CA 95051 U.S.A
Manufacturer:	Everactive, Inc.
Address:	2986 Oakmead Village Ct. Santa Clara, CA 95051 U.S.A
Issued By:	Bureau Veritas Consumer Products Services, Inc.
Lab Address:	775 Montague Expressway, Milpitas, CA 95035
FCC Registration / Designation Number:	540430

TESTING CERT # 2742-01

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Release Control Record

Issue No.	Description	Date Issued
FCC_IC_RF_SL21021001-EVER-001	Orignal Release	06/25/2021
FCC_RF_SL21021001-EVER-001_Rev 1.0	Update information	08/14/2021
FCC_RF_SL21021001-EVER-001_Rev 1.1	Update Section 4.7	09/01/2021
FCC_RF_SL21021001-EVER-001_Rev 1.2	Update The Device modification information/ Test equipment information	10/08/2021

1 Certificate of Conformity

Product:	Tranceiver Module
Brand:	Everactive
Test Model:	830-00023
Sample Status:	Final Product
Applicant:	Everactive, Inc.
Test Date:	03/04/2021-08/14/2021
Standards:	47 CFR FCC Part 15, Subpart C (Section 15.247) ANSI C63.10: 2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services, Inc., Milpitas Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : _____ **Date:** *8/14/2021*

Jude Semana / Test Engineer

Approved by : _____ **Date:** *10/08/2021*

Gary Chou / Engineer Reviewer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (SECTION 15.247)			
FCC Clause	Test Item	Result	Remarks
15.207	AC Power Conducted Emission	PASS	Powered by Support Laptop
15.247(a)(1) (iii)	Number of Hopping Frequency Used	PASS	Meet the requirement of limit.
15.247(a)(1) (iii)	Dwell Time on Each Channel	PASS	Meet the requirement of limit.
15.247(a)(1)	1. Hopping Channel Separation 2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System	PASS	Meet the requirement of limit.
15.247(b)	Maximum Peak Output Power	PASS	Meet the requirement of limit.
15.205 & 15.209 & 15.247(d)	Radiated Emissions & Band Edge Measurement	PASS	Meet the requirement of limit. Minimum passing QP margin
15.247(d)	Antenna Port Emission	PASS	Meet the requirement of limit.
15.203	Antenna Requirement	PASS	The EUT has an IPEX antenna connector

1. Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.
2. The module contains 2 antenna port. Only one operates and the other one is inactive.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.856 dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	4.638 dB
Radiated Emissions above 1 GHz	Above 1GHz	4.580dB

2.2 Modification Record

This is the part number of the tape used in the picture attached above:
3M™ EMI Absorber AB5100SHF-210X297 Series.
Manufacturer reworked the unit to pass unintentional radiation and this change will be carried forward to production units as well.

3 General Information

3.1 General Description of EUT

Product	Tranceiver Module
Brand	Everactive
Test Models	830-00023
Model Difference	All models have identical PCB
Status of EUT	Final Product
Power Input	Vdc supplied from Support Laptop (316mV/6.3mA)
Power Supply Rating	5V/720mA
Modulation Type	OOK and FSK
Transfer Rate	2.73Kbps in OOK Mode and 200Kbps in FSK Mode
Operating Frequency	902 ~ 928MHz
Number of Channel	OOK Mode=50 Hopping Channels, FSK Mode=64 Hopping Channels
Output Power	918.33 mW
Antenna Type	(Laird Antenna) Dipole, +2dBi Peak Gain
Antenna Connector	IPEX

3.2 Description of Test Modes

64 channels are provided for FSK mode:

Channel	Freq (MHz)	Channel	Freq (MHz)	Channel	Freq (MHz)	Channel	Freq (MHz)
0	902.4	16	908.8	32	915.2	48	921.6
1	902.8	17	909.2	33	915.6	49	922
2	903.2	18	909.6	34	916	50	922.4
3	903.6	19	910	35	916.4	51	922.8
4	904	20	910.4	36	916.8	52	923.2
5	904.4	21	910.8	37	917.2	53	923.6
6	904.8	22	911.2	38	917.6	54	924
7	905.2	23	911.6	39	918	55	924.4
8	905.6	24	912	40	918.4	56	924.8
9	906	25	912.4	41	918.8	57	925.2
10	906.4	26	912.8	42	919.2	58	925.6
11	906.8	27	913.2	43	919.6	59	926
12	907.2	28	913.6	44	920	60	926.4
13	907.6	29	914	45	920.4	61	926.8
14	908	30	914.4	46	920.8	62	927.2
15	908.4	31	914.8	47	921.2	63	927.6

Power Setting:

FSK	
Freq (MHz)	Power Setting
902.4	23
914.8	22
927.6	22

50 channels are provided for OOK mode:

Channel	Freq (MHz)	Channel	Freq (MHz)
0	902.75	25	915.25
1	903.25	26	915.75
2	903.75	27	916.25
3	904.25	28	916.75
4	904.75	29	917.25
5	905.25	30	917.75
6	905.75	31	918.25
7	906.25	32	918.75
8	906.75	33	919.25
9	907.25	34	919.75
10	907.75	35	920.25
11	908.25	36	920.75
12	908.75	37	921.25
13	909.25	38	921.75
14	909.75	39	922.25
15	910.25	40	922.75
16	910.75	41	923.25
17	911.25	42	923.75
18	911.75	43	924.25
19	912.25	44	924.75
20	912.75	45	925.25
21	913.25	46	925.75
22	913.75	47	926.25
23	914.25	48	926.75
24	914.75	49	927.25

Power Setting:

OOK	
Freq (MHz)	Power Setting
902.75	23
914.75	22
927.25	22

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE≥1G	RE<1G	PLC	APCM	
-	√	√	√	√	-

Where **RE≥1G:** Radiated Emission above 1GHz **RE<1G:** Radiated Emission below 1GHz
PLC: Power Line Conducted Emission **APCM:** Antenna Port Conducted Measurement

NOTE:
1. The EUT had been pre-tested on the positions of each 3 axis. The worst case was found when positioned on **X-plane**.
2. "-" means no effect.

Radiated Emission Test (Above 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
0 to 49	0,24, 49	OOK	2.73Kbps
0 to 63	0, 31, 63	FSK	200kbps

Radiated Emission Test (Below 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
0 to 49	0,24, 49	OOK	2.73Kbps
0 to 63	0, 31, 63	FSK	200kbps

Antenna Port Conducted Measurement:

☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
0 to 49	0,24, 49	OOK	2.73Kbps
0 to 63	0, 31, 63	FSK	200kbps

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE≥1G	25deg. C, 65%RH	5VDC	Jude Semana
RE<1G	25deg. C, 65%RH	5VDC	Jude Semana
APCM	21deg. C, 60%RH	5VDC	Jude Semana

3.3 Description of Support Units

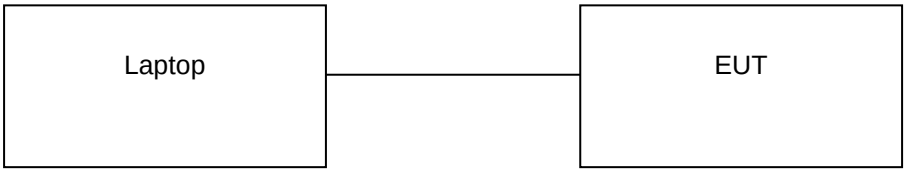
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Laptop	Lenovo	Thinkpad X1 Carbon	N/A	PD962205ANSU	Control the transmit channel/ power
B.	Test Fixture	everactive	SUNDANCE ADAPTER REV-1	N/A	N/A	RF Module install on the Fixture and then working on laptop

Note: The core(s) is (are) originally attached to the cable(s).

The EUT firmware installed during testing was fcc_v0.0.8. The test laptop is installed with wakeup-device-0.0.48 and device-0.1.9

3.3.1 Configuration of System under Test



3.4 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C (15.247)
KDB 558074 D01 15.247 Meas Guidance v05r02
ANSI C63.10-2013

All test items have been performed and recorded as per the above standards.

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

4.1.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
EMI Receiver (Rohde and Schwarz)	ESW44	1328.4100K-101662-MH	10/23/2020	10/23/2021
Biconilog Antenna (Sunol)	JB6	A111717	9/4/2020	9/4/2021
Horn Antenn (ETS-Lindgren)	3117	218554	4/21/2021	4/21/2022
Pre-Amplifier (RF-Lambda)	RAMP00M50GA	18040300055	10/1/2020	10/1/2021
FSB Antenna Cable, 0.5m (Microwave Town)	FSB360PK-KMKM-00.50M	201906110002	10/1/2020	10/1/2021
FSB Antenna Cable, 4m (Microwave Town)	FSB360PK-KMKM-400M	21030447-002	10/1/2020	10/1/2021
RODE & SCHWARZ EMI Receiver	ESIB 40	100179	01/29/2021	01/29/2022
9KHz-30MHz Antenna Loop (Keysight)	17025-Z540	10SL0058	11/25/2020	11/25/2021
10m Semi-Anechoic Chambe (ETS-Lindgren)	S2010BL8X8	1462	07/21/2020	07/21/2022
Loop Antenna	N/A	00049120	11/25/2020	11/25/2021

NOTE:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The horn antenna and HP preamplifier (model: 3117) are used only for the measurement of emission frequency above 1GHz if tested.

TEST PROCEDURES
For Radiated emission below 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. Both Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

For Radiated emission above 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

f. The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

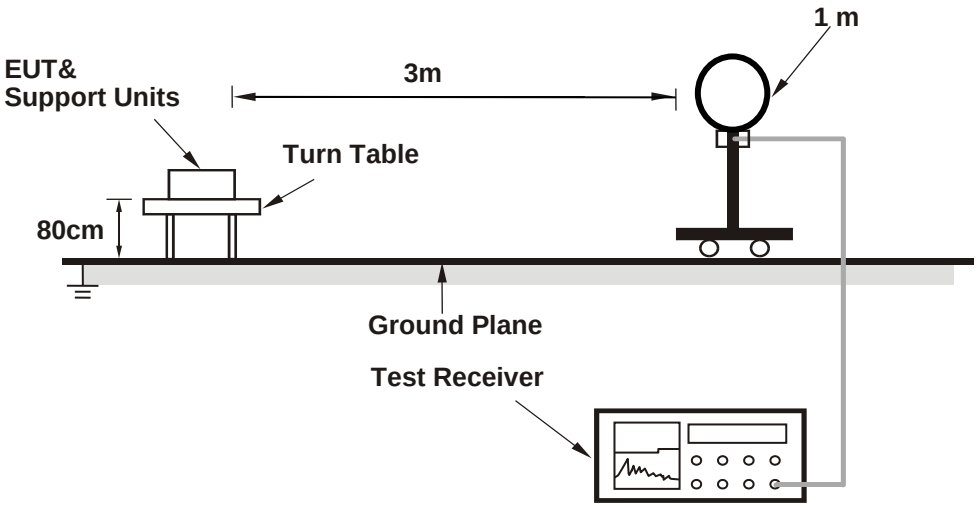
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.3 Deviation from Test Standard

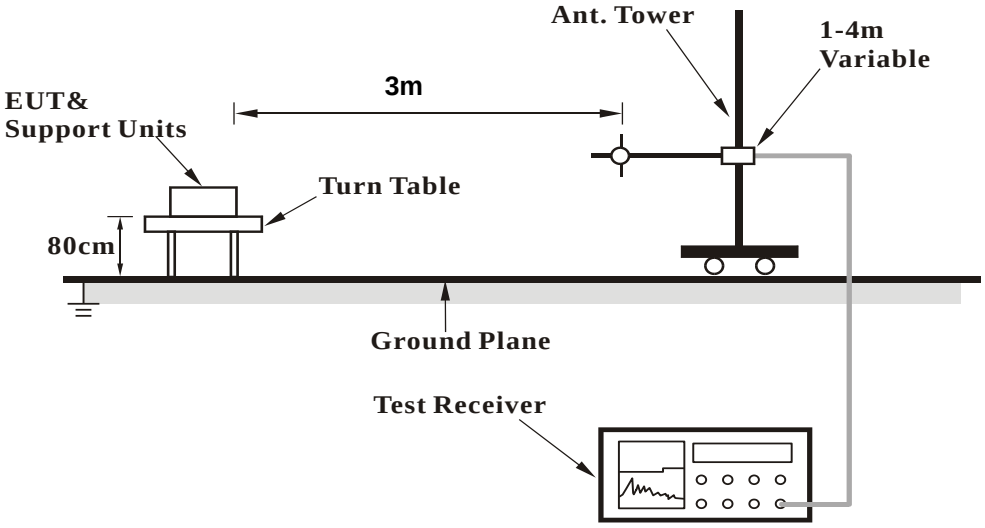
No deviation.

4.1.4 Test Setup

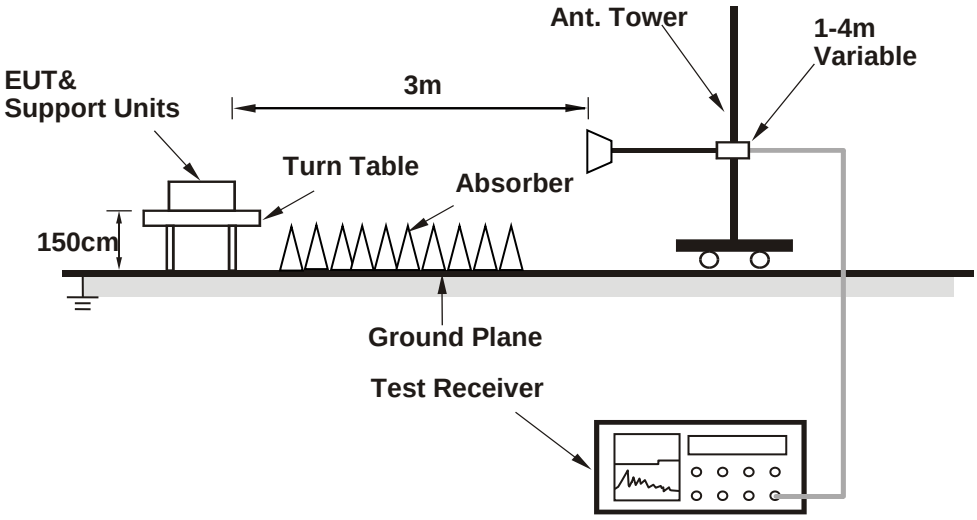
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.5 EUT Operating Conditions

a. Connected the EUT with the Notebook Computer which is placed on remote site.
b. Controlling software has been activated to set the EUT on specific status.

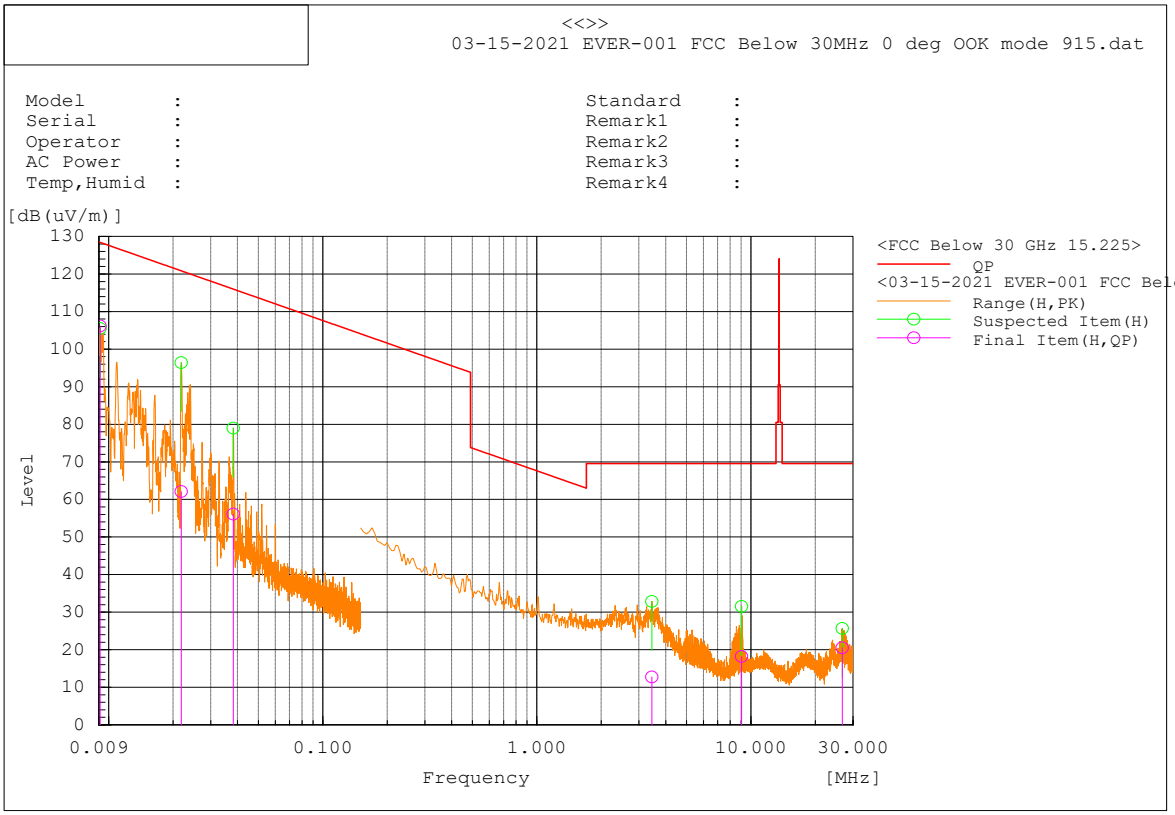
4.1.6 Test Results

BELOW 30GHz WORST-CASE DATA:
(OOK Mode)

CHANNEL	TX Channel 24	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	.009-30MHz		

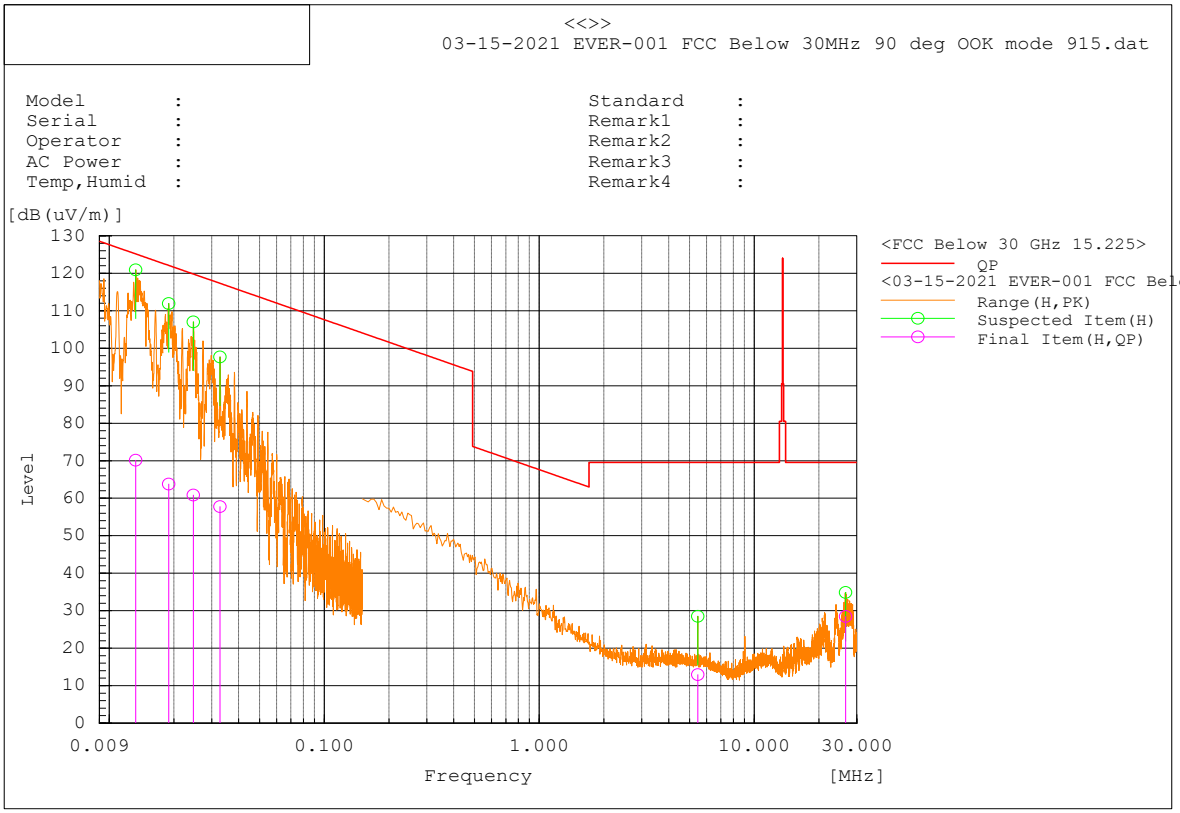
ANTENNA POLARITY & test distance: 0 Degree at 3 m

No	Freq.	Raw	Factor	Level	Measurement Type	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)		(cm)	Deg	(dBuV/m)	(dB)	
1	0.009	54.7	51.5	106.2	Quasi Max	100	0	128.4	-22.2	Pass
2	0.022	15.8	46.3	62.1	Quasi Max	100	1.8	120.8	-58.7	Pass
3	0.038	15.2	40.9	56.1	Quasi Max	100	5.4	116	-59.9	Pass
4	3.448	8.6	4.1	12.7	Quasi Max	100	261.7	69.5	-56.8	Pass
5	9.045	15.9	2.3	18.2	Quasi Max	100	123.5	69.5	-51.3	Pass
6	26.712	18.7	1.8	20.5	Quasi Max	100	271.6	69.5	-49	Pass



CHANNEL	TX Channel 24	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	.009-30MHz		

ANTENNA POLARITY & test distance: 90 Degree at 3 m										
No	Freq.	Raw	Factor	Level	Measurement Type	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)		(cm)	Deg	(dBuV/m)	(dB)	
1	0.013	19.5	50.7	70.2	Quasi Max	100	355.7	125.1	-54.9	Pass
2	5.458	10.9	2	12.9	Quasi Max	100	255.7	69.5	-56.6	Pass
3	26.592	26.6	1.9	28.5	Quasi Max	100	269.3	69.5	-41	Pass
4	0.019	16	47.8	63.8	Quasi Max	100	356.4	122.1	-58.3	Pass
5	0.025	15.6	45.2	60.8	Quasi Max	100	358.5	119.8	-59	Pass
6	0.033	15.3	42.5	57.8	Quasi Max	100	1.1	117.3	-59.5	Pass

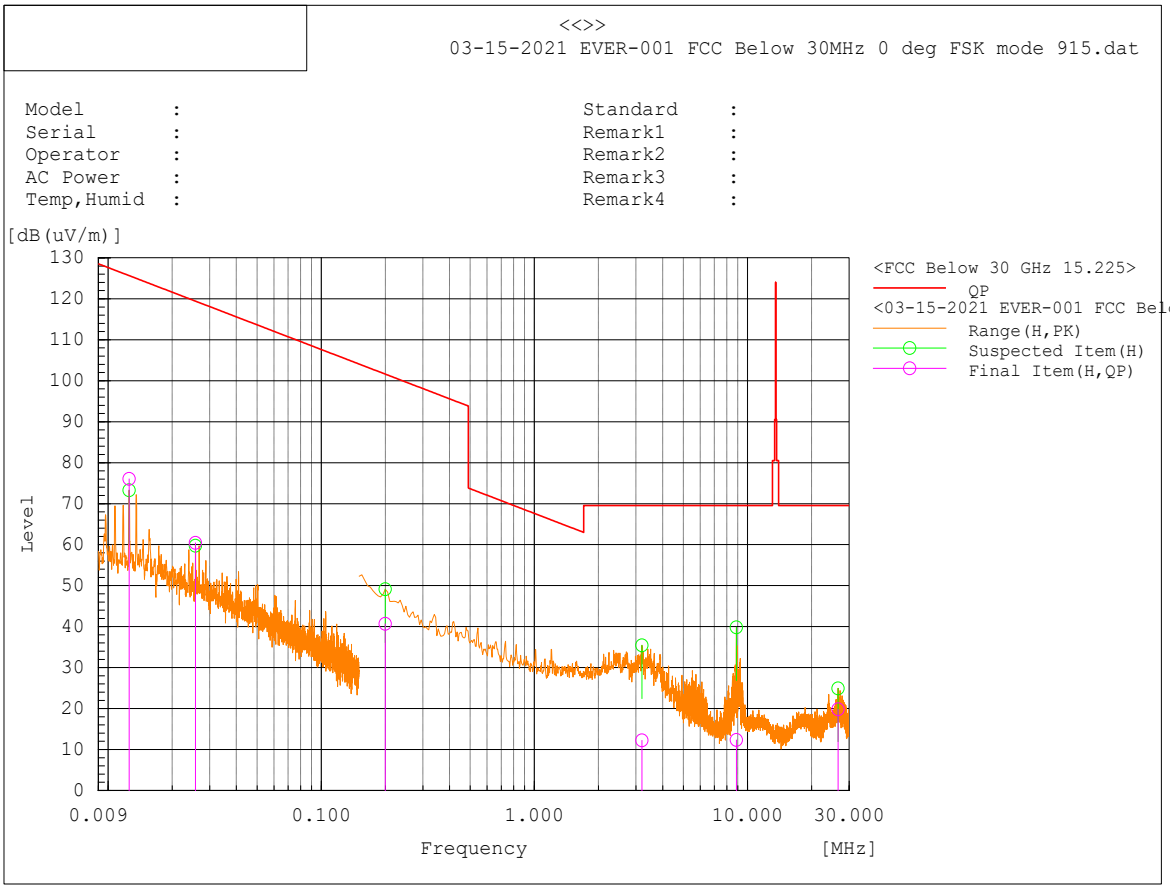


BELOW 30GHz WORST-CASE DATA:
(FSK Mode)

CHANNEL	TX Channel 31	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	.009-30MHz		

ANTENNA POLARITY & test distance: 0 Degree at 3 m

No	Freq.	Raw	Factor	Level	Measurement Type	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)		(cm)	Deg	(dBuV/m)	(dB)	
1	0.013	25	51	76	Quasi Max	100	317.2	125.6	-49.6	Pass
2	0.026	15.6	44.8	60.4	Quasi Max	100	154.4	119.4	-59	Pass
3	0.2	14.5	26.2	40.7	Quasi Max	100	0	101.6	-60.9	Pass
4	3.195	7.6	4.6	12.2	Quasi Max	100	261.2	69.5	-57.3	Pass
5	8.866	10	2.3	12.3	Quasi Max	100	127.8	69.5	-57.2	Pass
6	26.602	17.9	1.9	19.8	Quasi Max	100	269.1	69.5	-49.7	Pass



CHANNEL	TX Channel 31	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	.009-30MHz		

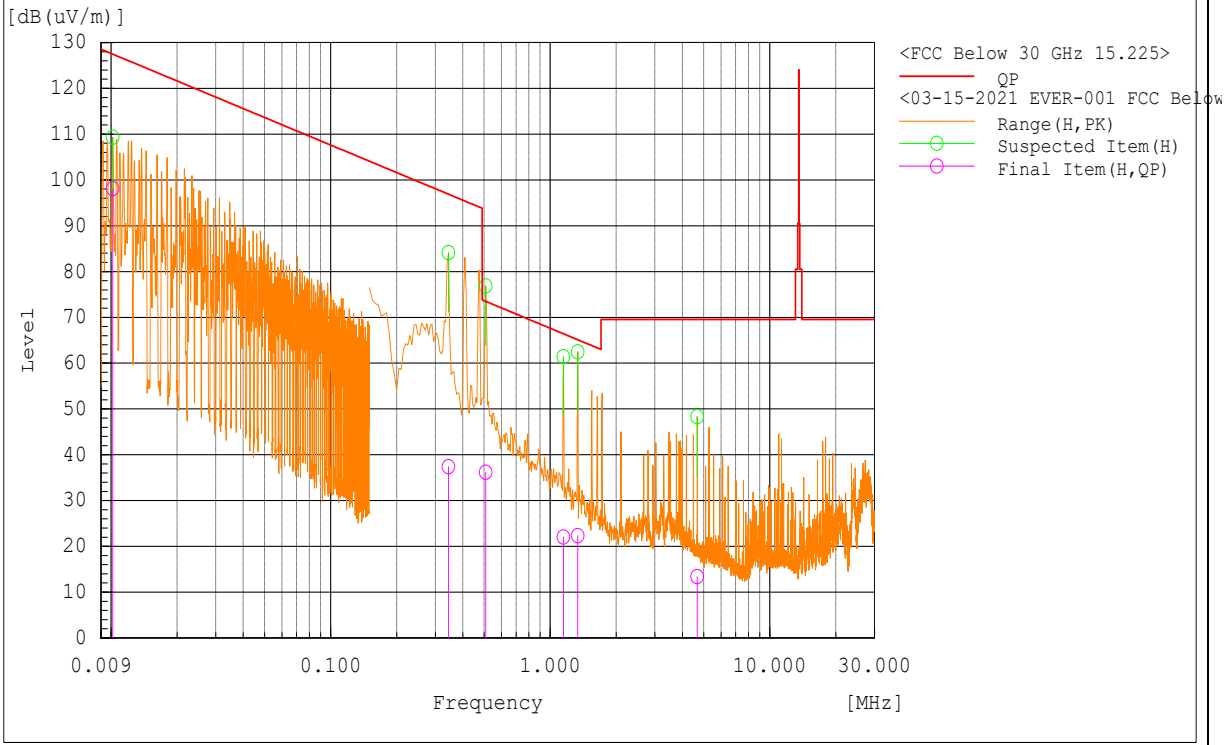
ANTENNA POLARITY & test distance: 90 Degree at 3 m

No	Freq.	Raw	Factor	Level	Measurement Type	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)		(cm)	Deg	(dBuV/m)	(dB)	
1	0.01	46.7	51.4	98.1	Quasi Max	100	326	127.5	-29.4	Pass
2	0.508	17.9	18.3	36.2	Quasi Max	100	197.7	73.5	-37.3	Pass
3	1.334	11.5	10.8	22.3	Quasi Max	100	197.2	65.1	-42.8	Pass
4	1.15	10.1	11.9	22	Quasi Max	100	197.1	66.4	-44.4	Pass
5	4.672	11.5	1.9	13.4	Quasi Max	100	256.1	69.5	-56.1	Pass
6	0.344	15.8	21.6	37.4	Quasi Max	100	214.6	96.9	-59.5	Pass

<<>>
03-15-2021 EVER-001 FCC Below 30MHz 90 deg FSK mode 915.dat

Model :
Serial :
Operator :
AC Power :
Temp,Humid :

Standard :
Remark1 :
Remark2 :
Remark3 :
Remark4 :



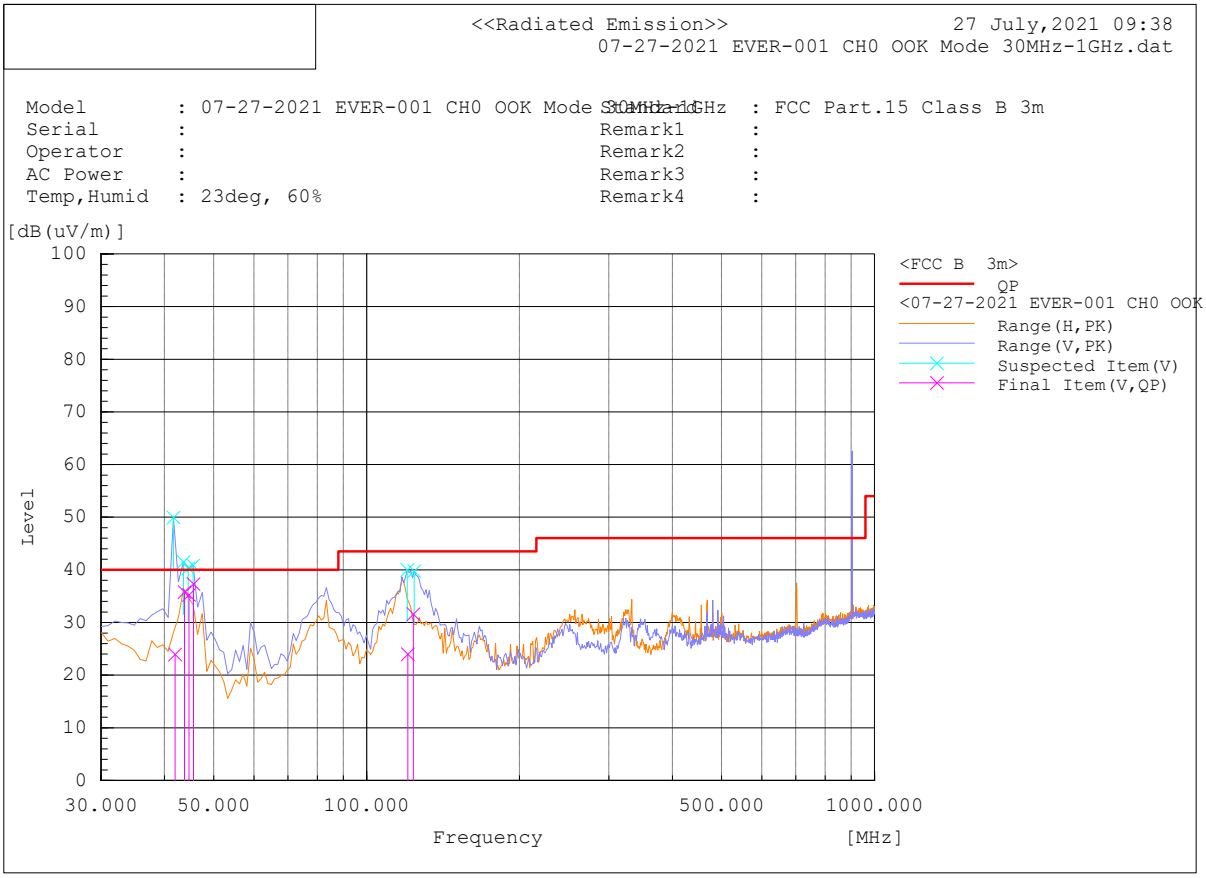
4.1.7 Test Results

BELOW 1GHz WORST-CASE DATA:

(OOK Mode)

CHANNEL	TX Channel 0	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m										
No.	**Frequency (MHz)**	**Polarization (H/V)**	**Reading QP [dB(uV)]**	**Factor [dB(1/m)]**	**Level QP [dB(uV/m)]**	**Limit\QP dB(uV/m)**	**Margin QP [dB]**	**Height (cm)**	**Angle (Deg)**	**Pass/ Fail**
1	41.968	V	6.7	17.2	23.9	40	-16.1	100	161.4	Pass
2	43.786	V	19.8	16	35.8	40	-4.2	115	126.6	Pass
3	45.606	V	22.3	15	37.3	40	-2.7	100	147.1	Pass
4	44.684	V	19.7	15.5	35.2	40	-4.8	134	174.4	Pass
5	120.537	V	4.7	19.3	24	43.5	-19.5	228	237.1	Pass
6	123.595	V	12.1	19.5	31.6	43.5	-11.9	100	204.7	Pass



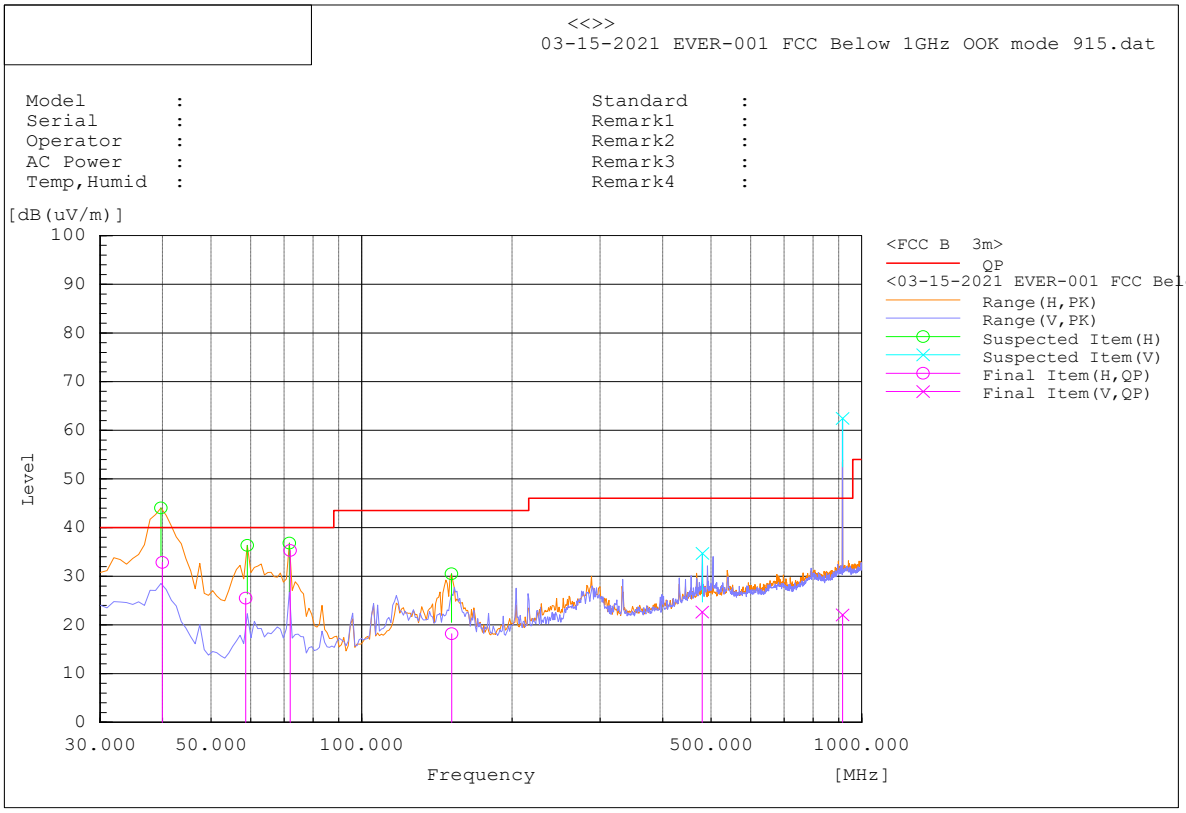
REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

CHANNEL	TX Channel 24	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

ANTENNA POLARITY & test distance: HORIZONTAL & VERTICAL at 3 m

No	Freq.	Raw	Factor	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	39.937	13.1	19.7	32.8	Quasi Max	H	102	216.6	40	-7.2	Pass
2	58.629	12.5	13	25.5	Quasi Max	H	103.5	199.4	40	-14.5	Pass
3	72.016	21.9	13.4	35.3	Quasi Max	H	101.9	212.9	40	-4.7	Pass
4	479.789	-1.7	24.4	22.7	Quasi Max	V	100.7	247.6	46	-23.3	Pass
5	151.458	-0.6	18.8	18.2	Quasi Max	H	100.7	164.1	43.5	-25.3	Pass
6	915.668	-8.2	30.3	22.1	Quasi Max	V	108.5	94.1	46	-23.9	Pass

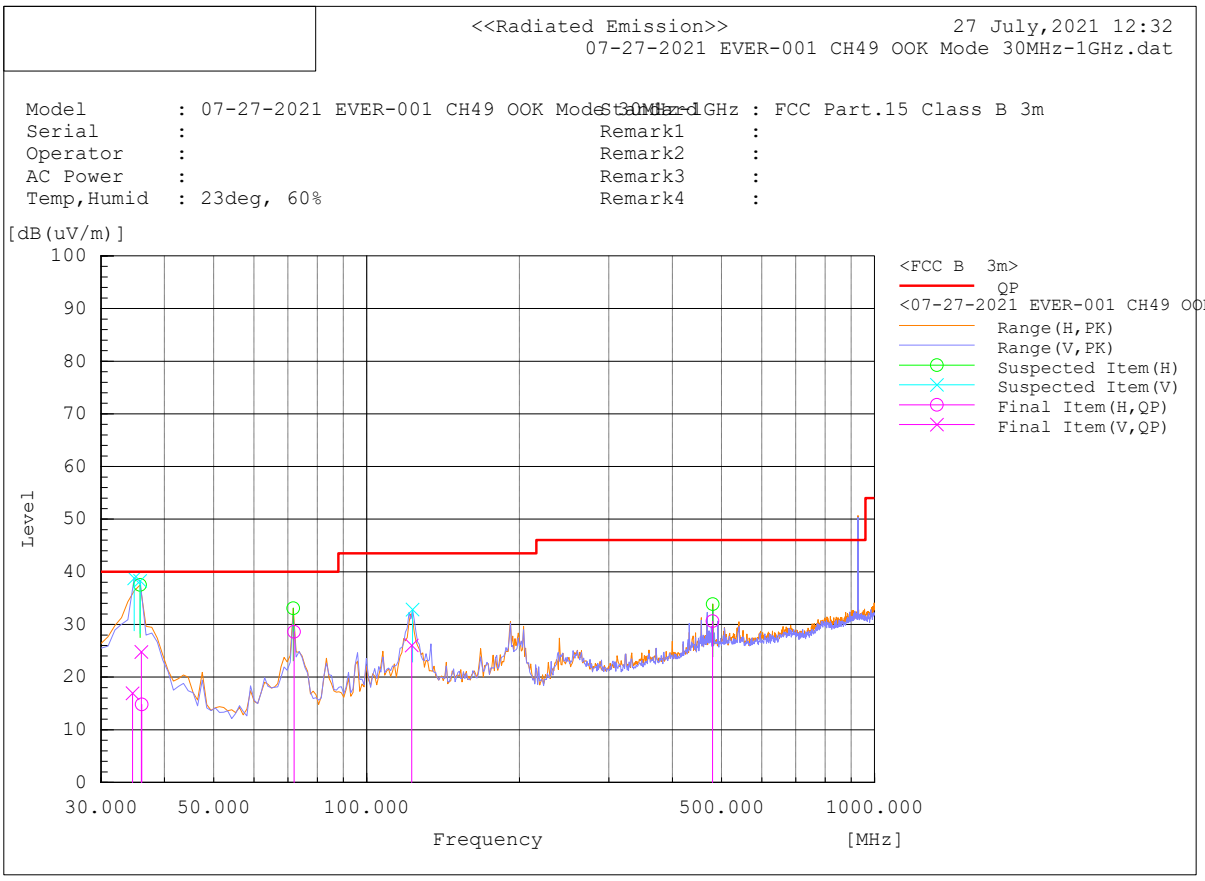


REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

CHANNEL	TX Channel 49	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m										
No.	**Frequency (MHz)**	**Polarization (H/V)**	**Reading QP [dB(uV)]**	**Factor [dB(1/m)]**	**Level QP [dB(uV/m)]**	**Limit\QP dB(uV/m)**	**Margin QP [dB]**	**Height (cm)**	**Angle (Deg)**	**Pass/ Fail**
1	71.988	H	15.2	13.4	28.6	40	-11.4	397	86.4	Pass
2	122.664	V	6.5	19.5	26	43.5	-17.5	100	204.7	Pass
3	480.005	H	5.9	24.7	30.6	46	-15.4	190	141.5	Pass
4	34.618	V	-5.4	22.3	16.9	40	-23.1	120	303.2	Pass
5	35.999	V	3.5	21.3	24.8	40	-15.2	100	19.8	Pass
6	36.083	H	-7.7	22.5	14.8	40	-25.2	196	238.2	Pass



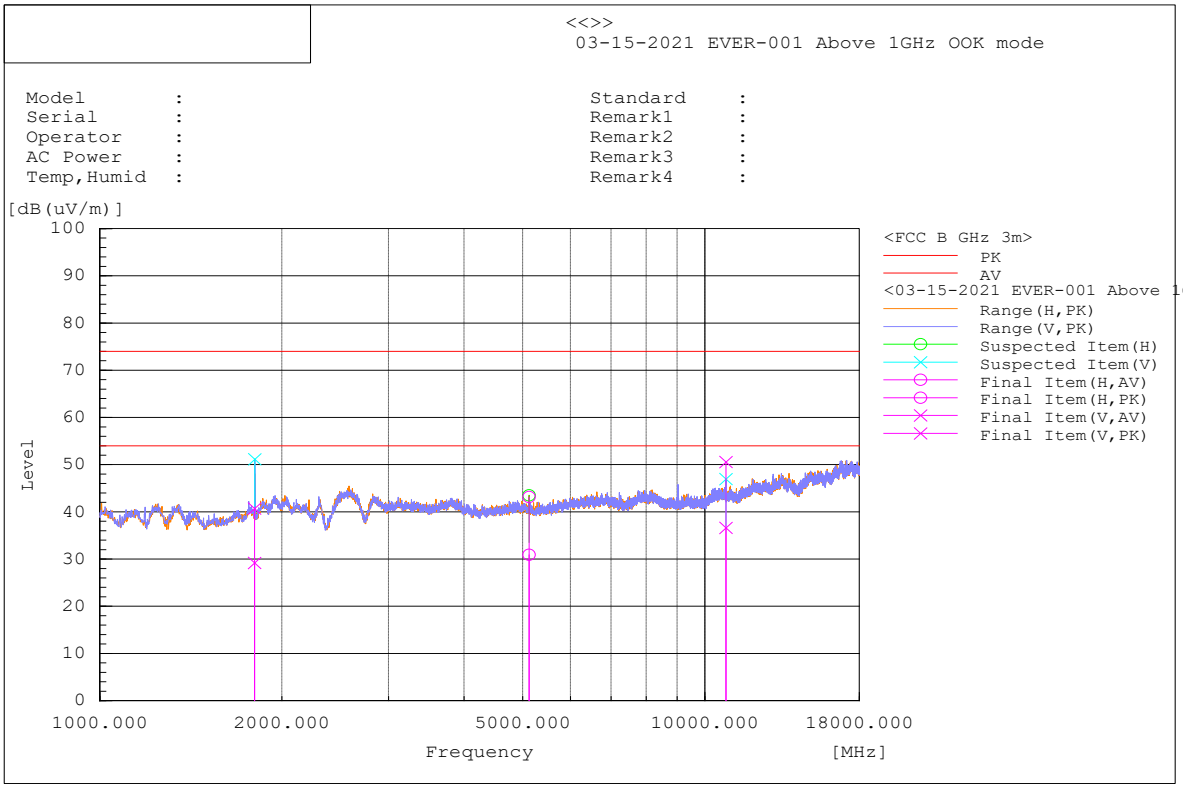
REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

ABOVE 1GHz TEST DATA (OOK Mode):

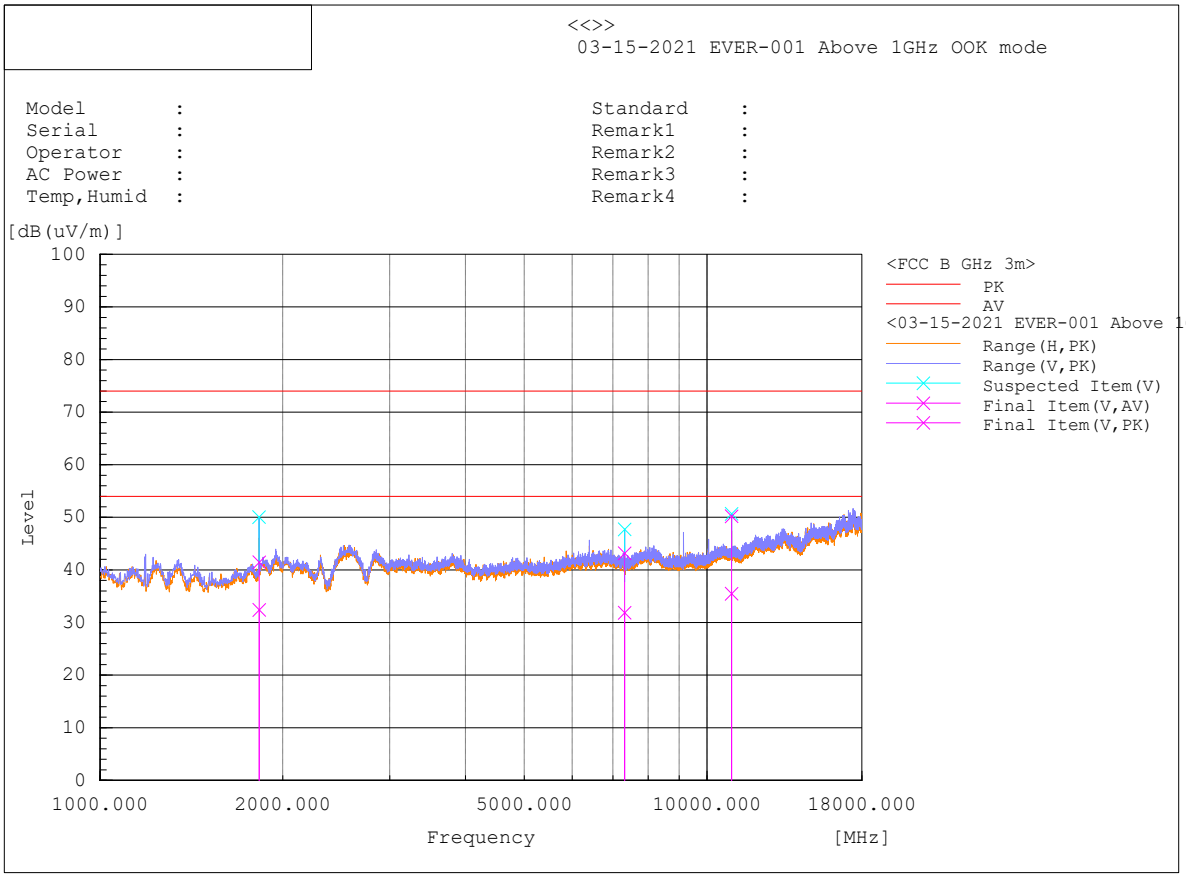
CHANNEL	TX Channel 0	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & test distance: HORIZONTAL & VERTICAL at 3 m											
No	Freq.	Raw	Factor	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	10833.05	34.1	2.5	36.6	Peak Max	V	136	281.9	74	-23.4	Pass
2	1803.265	41.5	-12.3	29.2	Peak Max	V	152.5	3.8	74	-33.3	Pass
3	5123.139	37.7	-6.8	30.9	Peak Max	H	400	354.1	74	-30.9	Pass
4	10833.05	48.1	2.5	50.6	Average Max	V	136	281.9	54	-17.4	Pass
5	1803.265	53	-12.3	40.7	Average Max	V	152.5	3.8	54	-24.8	Pass
6	5123.139	49.9	-6.8	43.1	Average Max	H	400	354.1	54	-23.1	Pass



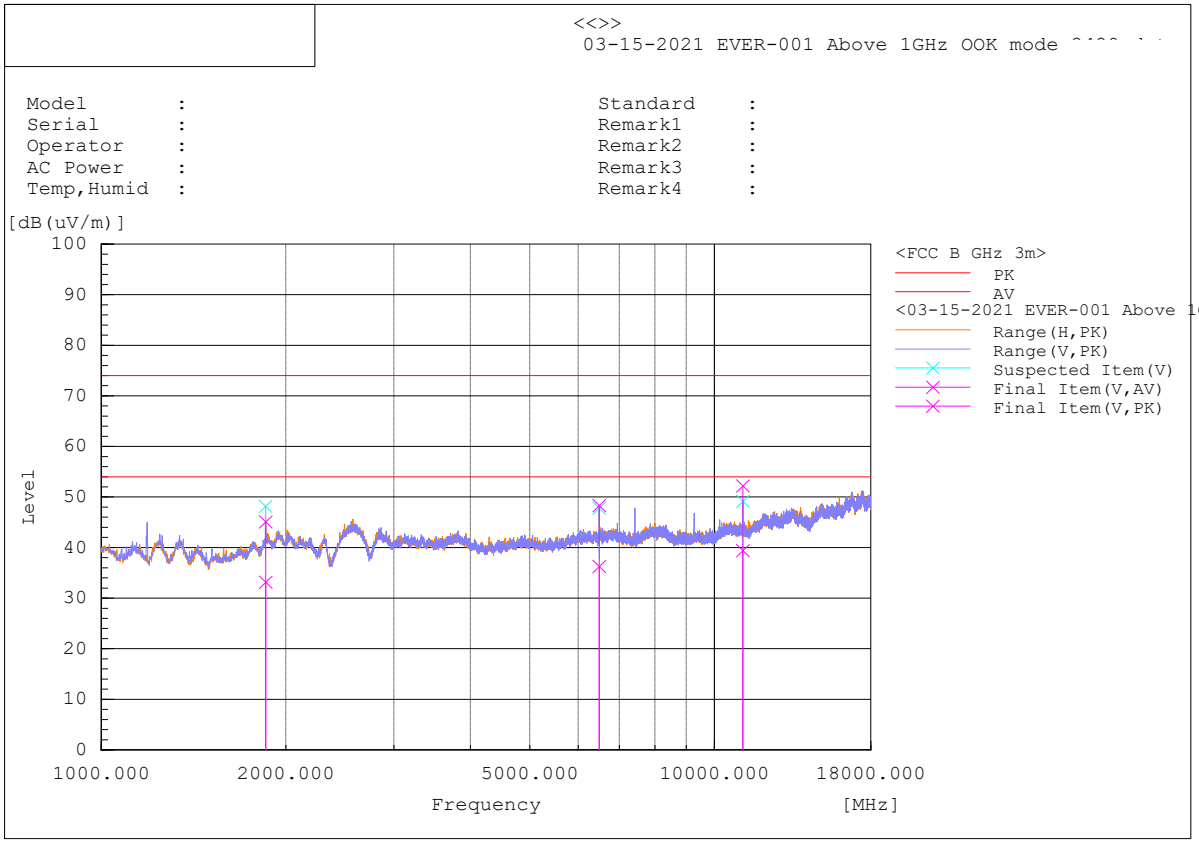
CHANNEL	TX Channel 24	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & test distance: HORIZONTAL & VERTICAL at 3 m											
No	Freq.	Raw	Factor	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	10977.04	47.7	2.5	50.2	Peak Max	V	206.3	100.6	74	-23.8	Pass
2	1828.91	53.5	-12	41.5	Peak Max	V	272.3	68.2	-	-	-
3	7317.253	45.4	-2.2	43.2	Peak Max	V	100.4	313.6	74	-30.8	Pass
4	10977.04	33	2.5	35.5	Average Max	V	206.3	100.6	54	-18.5	Pass
5	1828.91	44.4	-12	32.4	Average Max	V	272.3	68.2	-	-	-
6	7317.253	34.1	-2.2	31.9	Average Max	V	100.4	313.6	54	-22.1	Pass



CHANNEL	TX Channel 49	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & test distance: HORIZONTAL & VERTICAL at 3 m											
No	Freq.	Raw	Factor	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	1854.606	56.8	-11.7	45.1	Peak Max	V	116	277	-	-	-
2	6491.031	51.4	-3.1	48.3	Peak Max	V	128.6	207.9	-	-	-
3	11127.21	49.6	2.6	52.2	Peak Max	V	112.3	279.3	74	-21.8	Pass
4	1854.606	44.8	-11.7	33.1	Average Max	V	116	277	-	-	-
5	6491.031	39.3	-3.1	36.2	Average Max	V	128.6	207.9	-	-	-
6	11127.21	36.8	2.6	39.4	Average Max	V	112.3	279.3	54	-14.6	Pass



REMARKS:

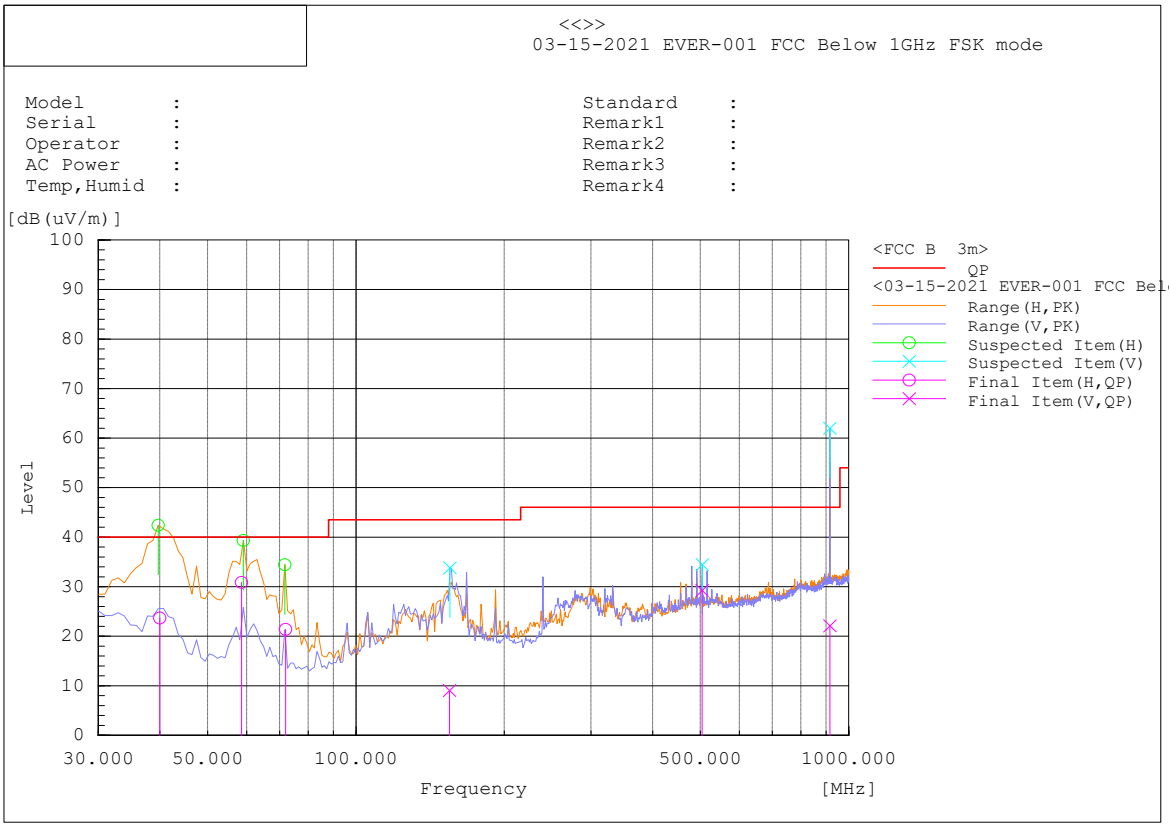
1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

BELOW 1GHz WORST-CASE DATA:

(FSK Mode)

CHANNEL	TX Channel 0	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

ANTENNA POLARITY & test distance: HORIZONTAL & VERTICAL at 3 m											
No	Freq.	Raw	Factor	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	39.995	4	19.7	23.7	Quasi Max	H	206.9	277.4	40	-16.3	Pass
2	58.605	17.8	13	30.8	Quasi Max	H	104.6	194.5	40	-9.2	Pass
3	72.003	8	13.4	21.4	Quasi Max	H	111.7	287.9	40	-18.6	Pass
4	915.707	-8.2	30.3	22.1	Quasi Max	V	122	154.8	46	-23.9	Pass
5	154.885	-9.8	18.9	9.1	Quasi Max	V	101.2	219.2	43.5	-34.4	Pass
6	504.009	4.4	24.9	29.3	Quasi Max	V	198.7	144.9	46	-16.7	Pass

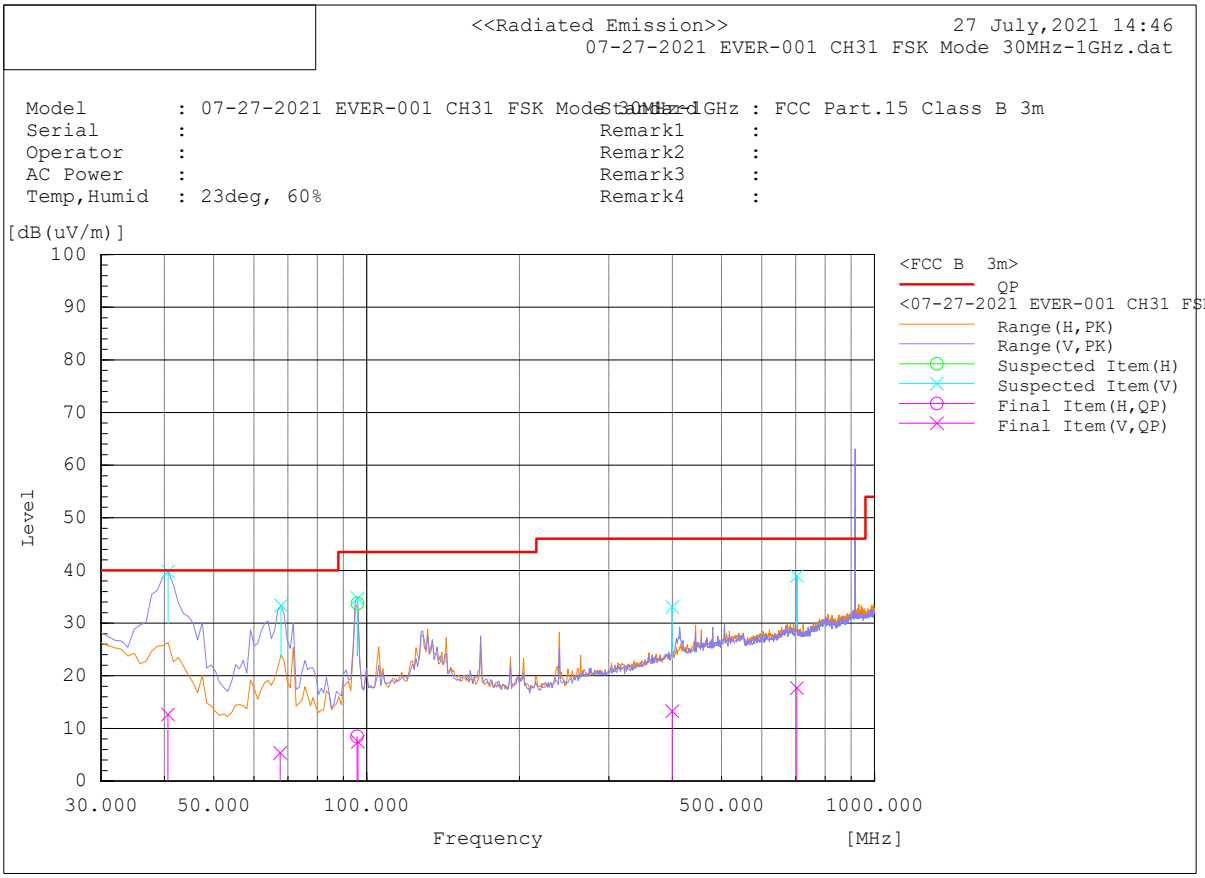


REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

CHANNEL	TX Channel 31	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m										
No.	**Frequency (MHz)**	**Polarization (H/V)**	**Reading QP [dB(uV)]**	**Factor [dB(1/m)]**	**Level QP [dB(uV/m)]**	**Limit\QP dB(uV/m)**	**Margin QP [dB]**	**Height (cm)**	**Angle (Deg)**	**Pass/ Fail**
1	40.636	V	-5.4	18.1	12.7	40	-27.3	100	332.2	Pass
2	67.589	V	-7.8	13.2	5.4	40	-34.6	153	295.1	Pass
3	96.091	V	-8.2	15.7	7.5	43.5	-36	397	0	Pass
4	95.759	H	-6.2	14.7	8.5	43.5	-35	303	99.4	Pass
5	399.561	V	-9.4	22.7	13.3	46	-32.7	124	350.6	Pass
6	702.904	V	-10.3	28	17.7	46	-28.3	121	294.9	Pass

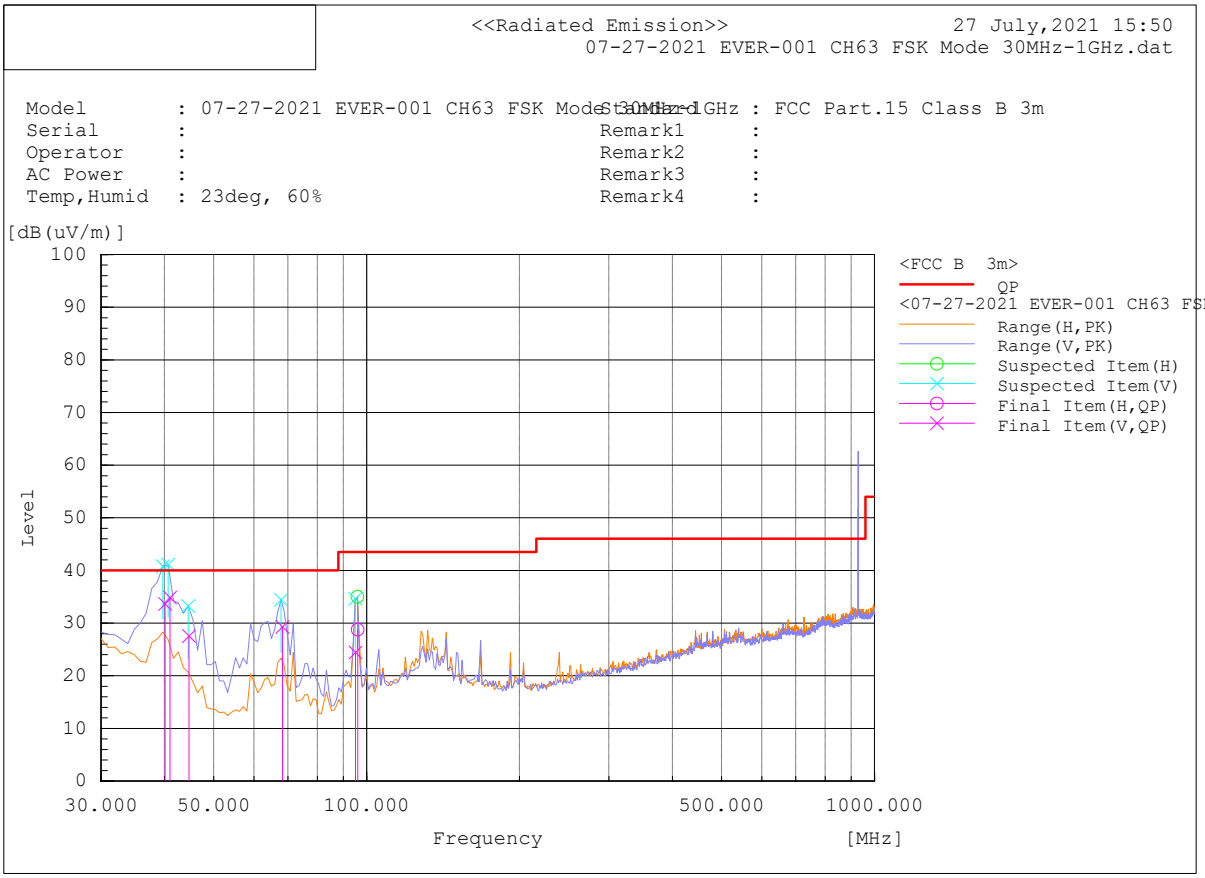


REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

CHANNEL	TX Channel 63	**DETECTOR FUNCTION**	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m										
No.	**Frequency (MHz)**	**Polarization (H/V)**	**Reading QP [dB(uV)]**	**Factor [dB(1/m)]**	**Level QP [dB(uV/m)]**	**Limit\QP dB(uV/m)**	**Margin QP [dB]**	**Height (cm)**	**Angle (Deg)**	**Pass/ Fail**
1	40.096	V	15.2	18.4	33.6	40	-6.4	100	0	Pass
2	40.993	V	17.1	17.8	34.9	40	-5.1	100	32.1	Pass
3	44.714	V	12.1	15.5	27.6	40	-12.4	106	115.4	Pass
4	68.278	V	16.2	13.1	29.3	40	-10.7	100	34.6	Pass
5	95.034	V	9.1	15.4	24.5	43.5	-19	134	158.8	Pass
6	96.025	H	14	14.8	28.8	43.5	-14.7	181	67.6	Pass



REMARKS:

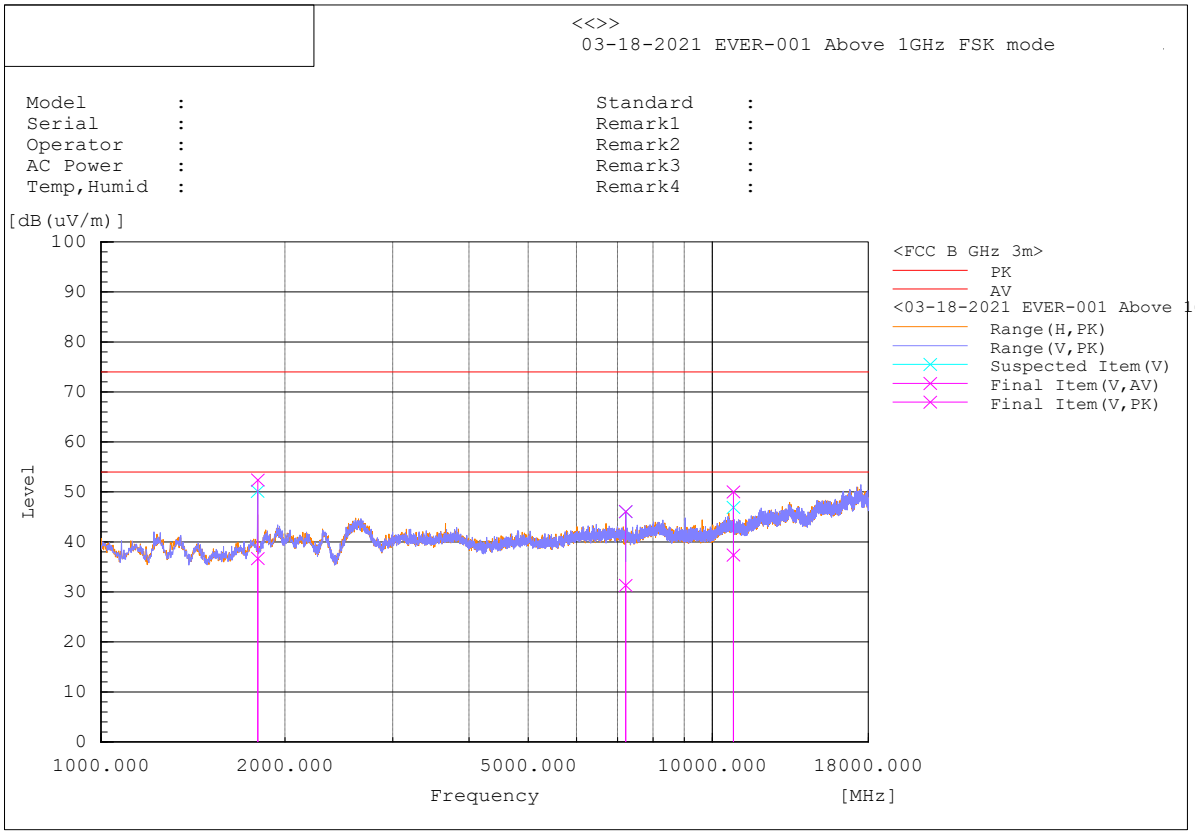
1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

ABOVE 1GHz TEST DATA:

(FSK Mode)

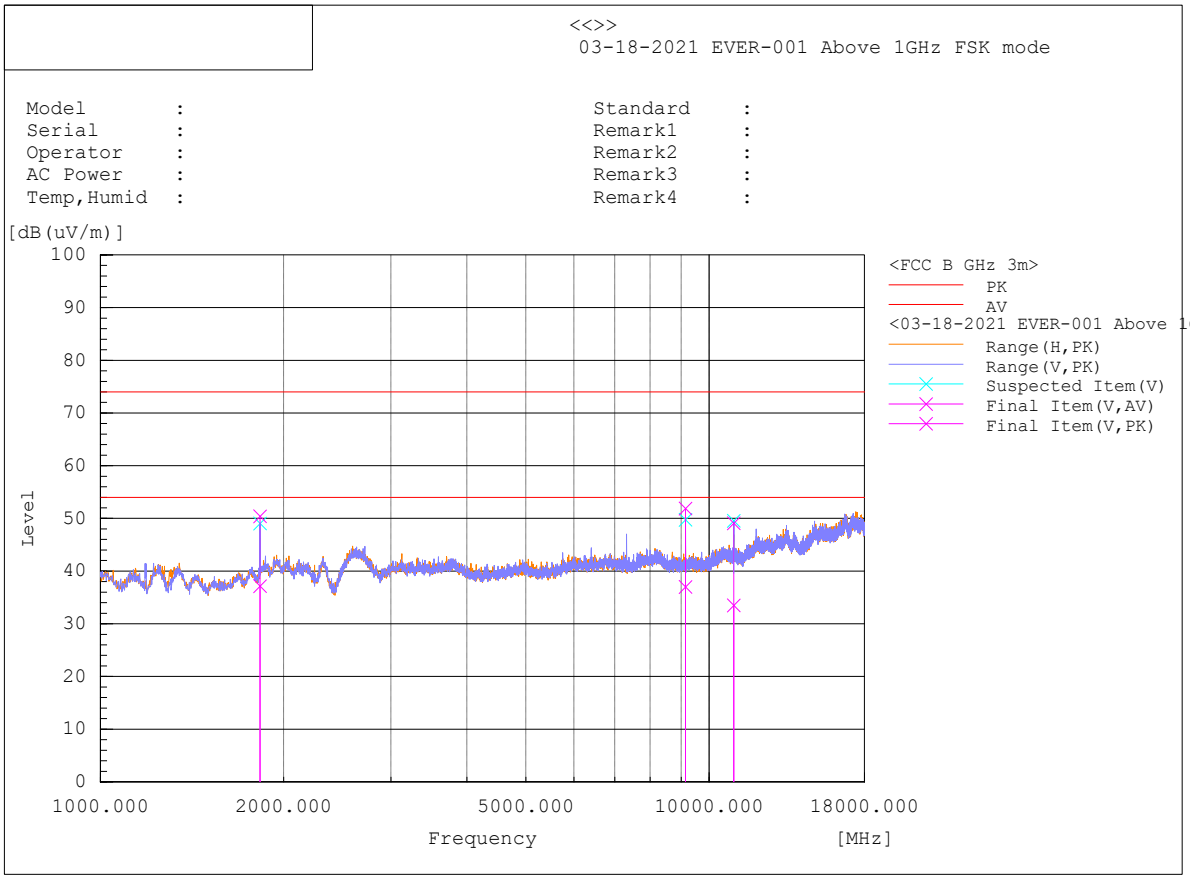
CHANNEL	TX Channel 0	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & test distance: HORIZONTAL & VERTICAL at 3 m											
No	Freq.	Raw	Factor	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	7218.326	48.5	-2.4	46.1	Peak Max	V	192	69.8	-	-	-
2	1805.184	64.7	-12.3	52.4	Peak Max	V	177	359.9	-	-	-
3	10828.45	47.5	2.5	50	Peak Max	V	100	282	74	-24	Pass
4	7218.326	33.7	-2.4	31.3	Average Max	V	192	69.8	-	-	-
5	1805.184	49	-12.3	36.7	Average Max	V	177	359.9	-	-	-
6	10828.45	34.9	2.5	37.4	Average Max	V	100	282	54	-16.6	Pass



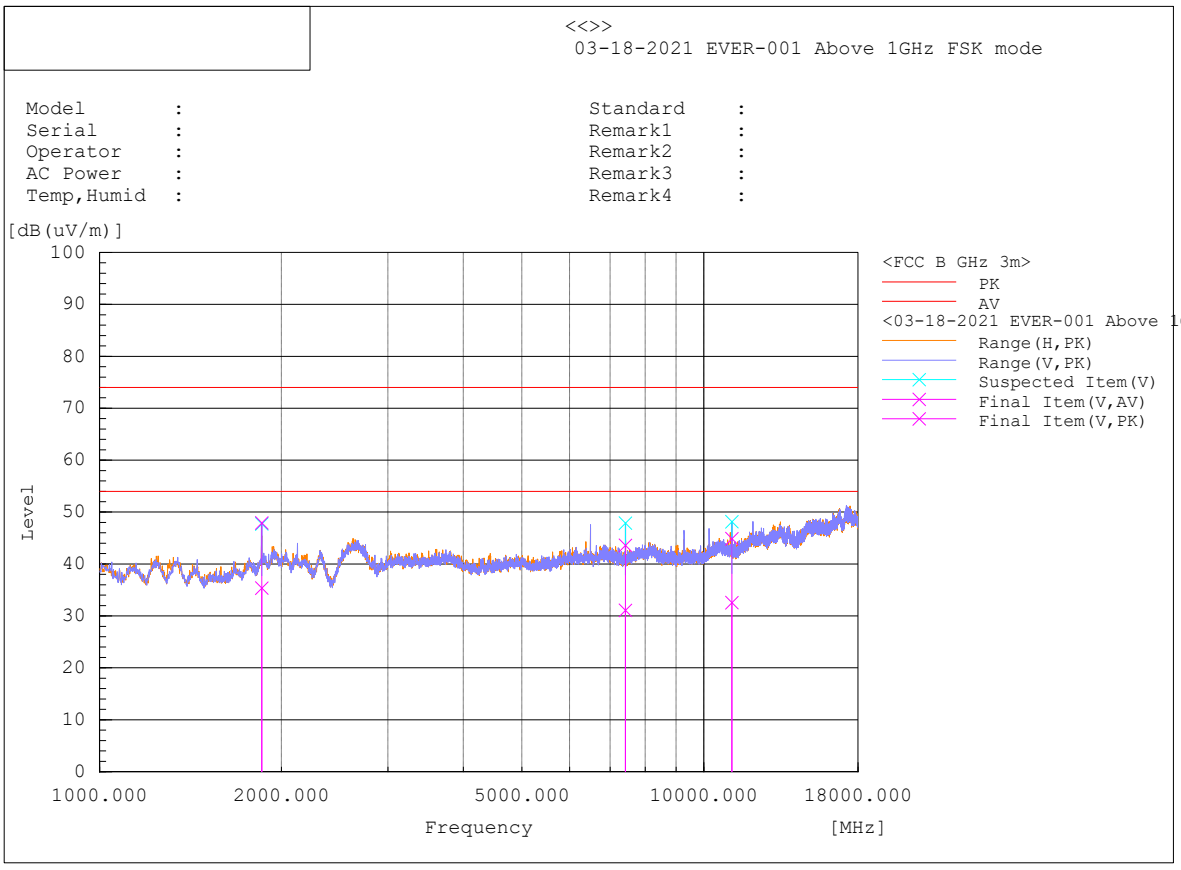
CHANNEL	TX Channel 31	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & test distance: HORIZONTAL & VERTICAL at 3 m											
No	Freq.	Raw	Factor	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	1829.383	62.4	-12	50.4	Peak Max	V	182	10.8	-	-	-
2	9148.689	51.6	0.3	51.9	Peak Max	V	100	258	74	-22.1	Pass
3	10977.82	46.6	2.5	49.1	Peak Max	V	192	108	74	-24.9	Pass
4	1829.383	49.2	-12	37.2	Average Max	V	182	10.8	-	-	-
5	9148.689	36.7	0.3	37	Average Max	V	100	258	54	-17	Pass
6	10977.82	31	2.5	33.5	Average Max	V	192	108	54	-20.5	Pass



CHANNEL	TX Channel 63	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & test distance: HORIZONTAL & VERTICAL at 3 m											
No	Freq.	Raw	Factor	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB1/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	1855.495	59.6	-11.7	47.9	Peak Max	V	100	211.8	-	-	-
2	11131.46	42.3	2.6	44.9	Peak Max	V	103	220.2	74	-29.1	Pass
3	7418.153	45.6	-2	43.6	Peak Max	V	100	339.2	74	-30.4	Pass
4	1855.495	47.1	-11.7	35.4	Average Max	V	100	211.8	-	-	-
5	11131.46	30	2.6	32.6	Average Max	V	103	220.2	54	-21.4	Pass
6	7418.153	33.1	-2	31.1	Average Max	V	100	339.2	54	-22.9	Pass



REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

4.2 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.2.2 Test Procedures

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.

b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

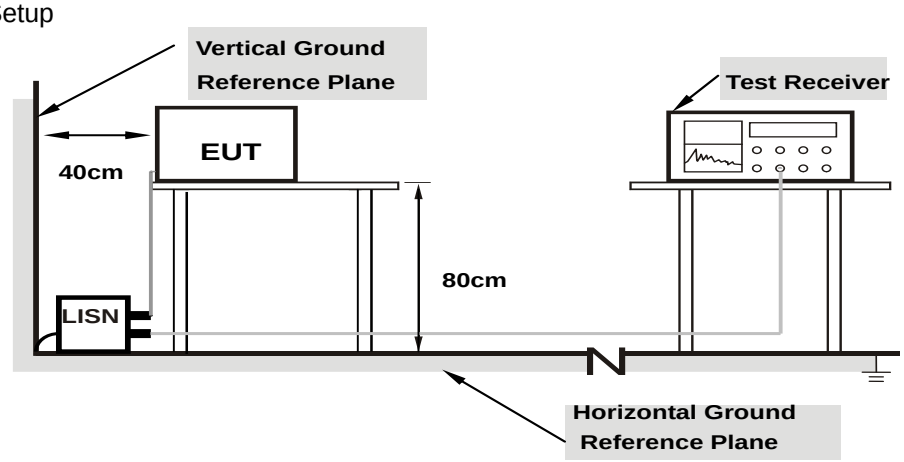
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

4.2.3 Deviation from Test Standard

No deviation.

4.2.4 Test Setup



Note: 1.Support units were connected to second LISN.

For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.2.5 EUT Operating Conditions

Same as 4.1.6.

4.2.6 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
EMI Test Receiver (Rohde & Schwarz)	ESIB 40	100179	1/29/2021	1/29/2022
Transient Limiter (Electro-Metrics)	EM-7600-5	106	12/31/2020	12/31/2021
LISN (ETS-Lindgren)	3816/2NM	214372	1/29/2021	1/29/2022

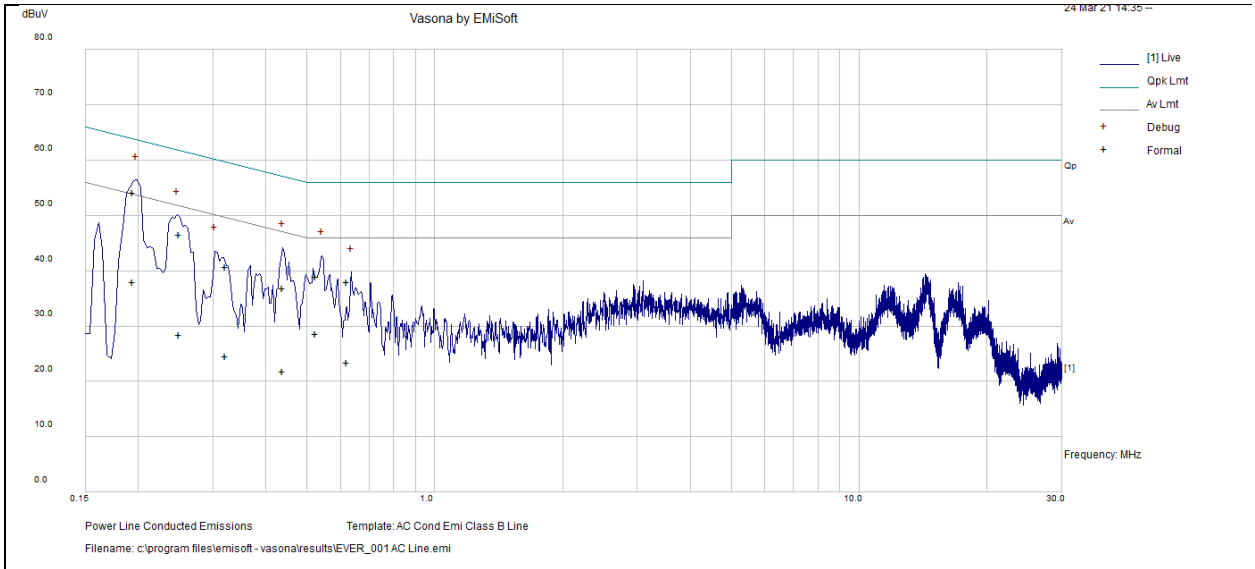
4.2.7 Test Results

Phase	Line (L)	Detector Function	Quasi-Peak / Average

No	Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line/Neutral	Limit dBuV	Margin dB	Pass /Fail
1	0.249643	37.13	9.43	0.04	46.6	Quasi Peak	Live	61.77	-15.17	Pass
2	0.19432	44.85	9.36	0.04	54.25	Quasi Peak	Live	63.85	-9.6	Pass
3	0.438481	27.41	9.45	0.04	36.9	Quasi Peak	Live	57.09	-20.19	Pass
4	0.525222	29.47	9.45	0.04	38.96	Quasi Peak	Live	56	-17.04	Pass
5	0.620873	28.48	9.46	0.04	37.98	Quasi Peak	Live	56	-18.02	Pass
6	0.321319	31.3	9.44	0.04	40.77	Quasi Peak	Live	59.67	-18.9	Pass
7	0.249643	18.92	9.43	0.04	28.39	Average	Live	51.77	-23.38	Pass
8	0.19432	28.58	9.36	0.04	37.98	Average	Live	53.85	-15.87	Pass
9	0.438481	12.4	9.45	0.04	21.89	Average	Live	47.09	-25.2	Pass
10	0.525222	19.2	9.45	0.04	28.7	Average	Live	46	-17.3	Pass
11	0.620873	13.9	9.46	0.04	23.4	Average	Live	46	-22.6	Pass
12	0.321319	15.12	9.44	0.04	24.6	Average	Live	49.67	-25.07	Pass

REMARKS:

1. The emission levels of other frequencies were very low against the limit.
2. Margin value = Emission level - Limit value
3. Emission Level = Correction Factor + Raw Value + Factors Value.



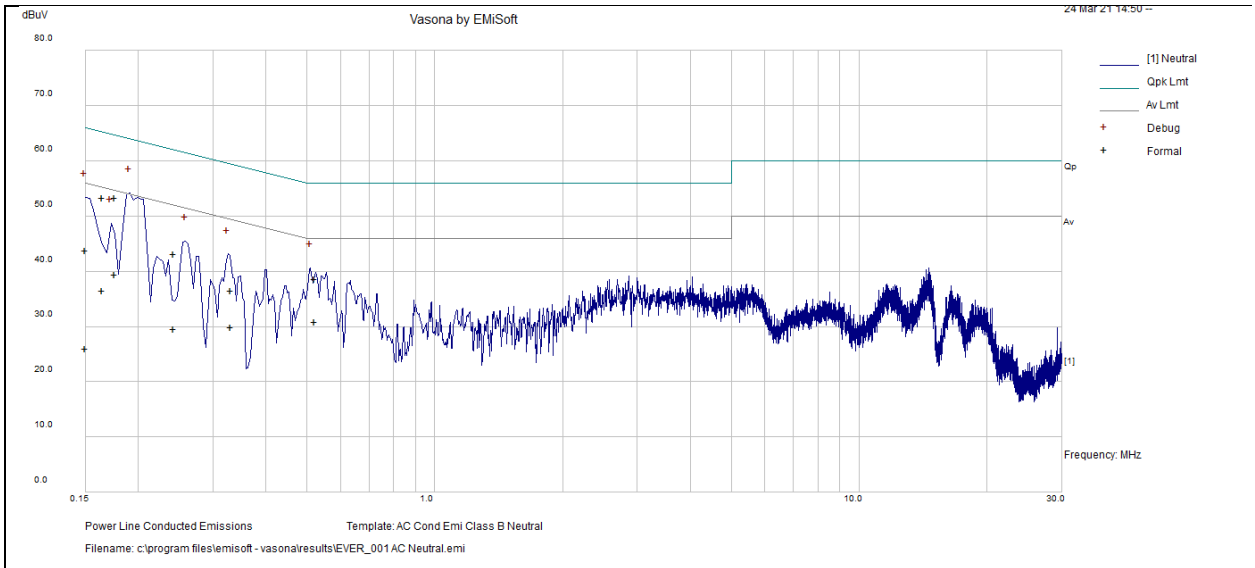
AC Line (FSK Mode-Mid Channel)

Phase	Neutral(N)	Detector Function	Quasi-Peak / Average

No	Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line/Neutral	Limit dBuV	Margin dB	Pass /Fail
1	0.150113	34.47	9.29	0.03	43.8	Quasi Peak	Neutral	65.99	-22.2	Pass
2	0.176236	44.08	9.34	0.03	53.45	Quasi Peak	Neutral	64.66	-11.22	Pass
3	0.522228	29.21	9.45	0.03	38.69	Quasi Peak	Neutral	56	-17.31	Pass
4	0.242898	33.67	9.43	0.03	43.13	Quasi Peak	Neutral	62	-18.87	Pass
5	0.165259	43.98	9.32	0.03	53.33	Quasi Peak	Neutral	65.2	-11.87	Pass
6	0.331924	27.12	9.44	0.03	36.58	Quasi Peak	Neutral	59.4	-22.82	Pass
7	0.150113	16.69	9.29	0.03	26.01	Average	Neutral	55.99	-29.98	Pass
8	0.176236	30.02	9.34	0.03	39.39	Average	Neutral	54.66	-15.27	Pass
9	0.522228	21.38	9.45	0.03	30.86	Average	Neutral	46	-15.14	Pass
10	0.242898	20.18	9.43	0.03	29.64	Average	Neutral	52	-22.36	Pass
11	0.165259	27.12	9.32	0.03	36.46	Average	Neutral	55.2	-18.73	Pass
12	0.331924	20.49	9.44	0.03	29.96	Average	Neutral	49.4	-19.45	Pass

REMARKS:

1. The emission levels of other frequencies were very low against the limit.
2. Margin value = Emission level - Limit value
3. Emission Level = Correction Factor + Raw Value + Factors Value.



AC Netural (FSK Mode-Mid Channel)

4.3 Conducted Measurement

4.3.1 Test Instruments

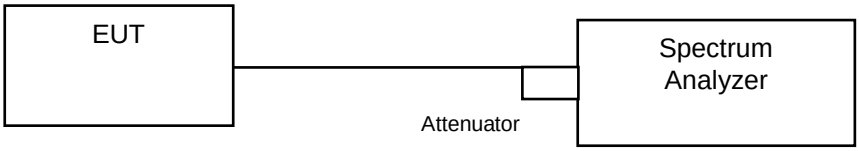
DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
PXA Signal Analyzer (Keysight)	N9030B	10SL0923	06/15/2021	06/15/2022
Attenuator/ MCL	BW-N30W5	1725	07/21/2020	07/21/2022
Attenuator/ Fairview Microwave	SA6021-30	N/A	07/21/2020	07/21/2022

4.4 Number of Hopping Frequency Used

4.4.1 Limits of Hopping Frequency Used Measurement

Limits of Hopping Frequency 4.3.1, Per 15.247- if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.3.1 to get information of above instrument.

4.4.4 Test Procedure

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

b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.

c. Set the SA on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.

d. Set the SA on View mode and then plot the result on SA screen.

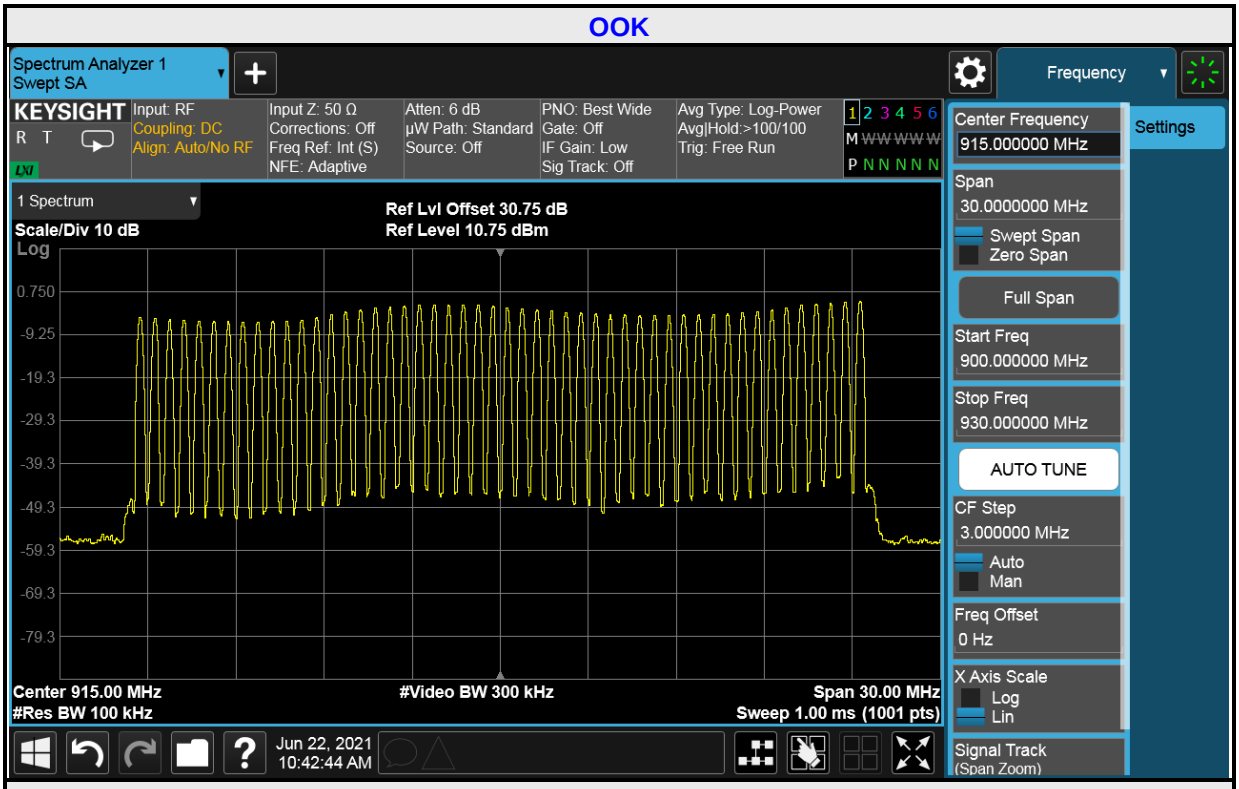
e. Repeat above procedures until all frequencies measured were complete.

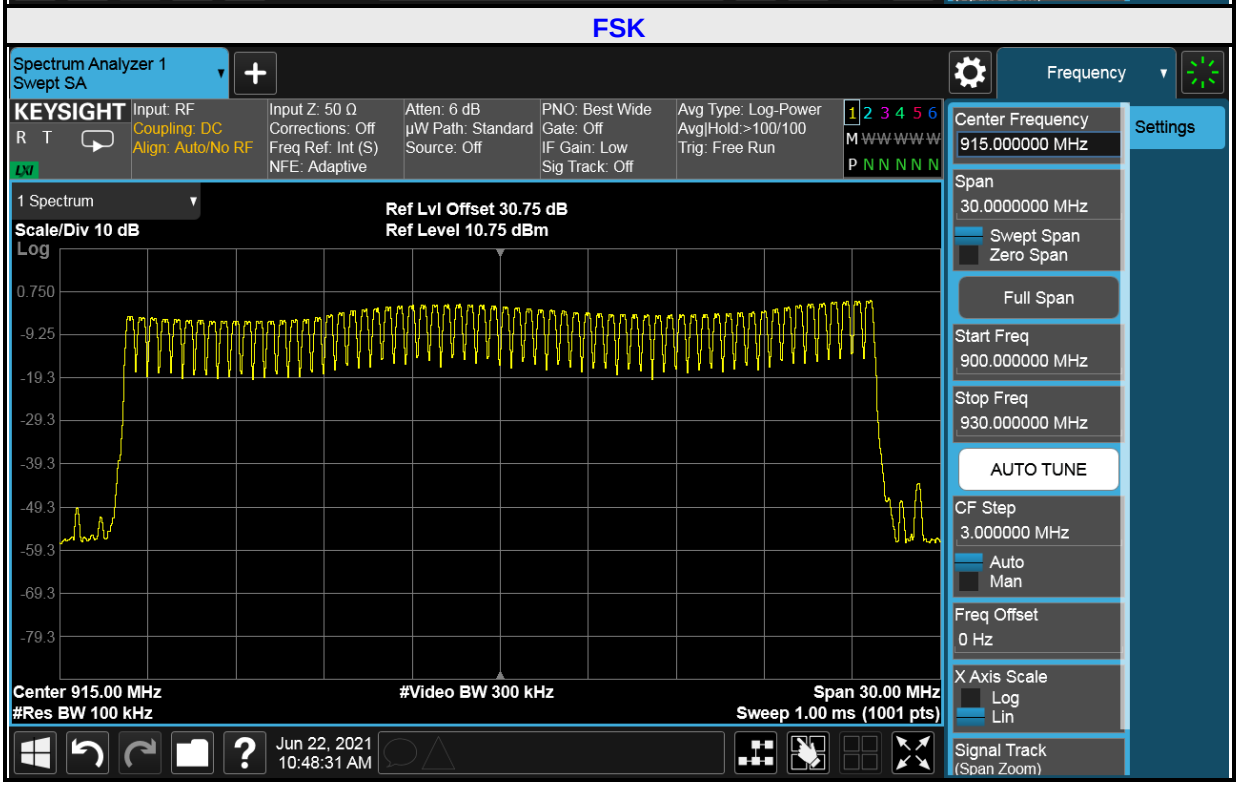
4.4.5 Deviation from Test Standard

No deviation.

4.4.6 Test Results

There are 50 (OOK Mode) and 64 (FSK Mode) hopping frequencies in the hopping mode. Please refer to next page for the test result. On the plots, it shows that the hopping frequencies are equally spaced.


OOK
Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto/No RF
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
1 Spectrum
Scale/Div 10 dB
Ref Lvl Offset 30.75 dB
Ref Level 10.75 dBm
Log
0.750
-9.25
-19.3
-29.3
-39.3
-49.3
-59.3
-69.3
-79.3
Center 915.00 MHz
#Res BW 100 kHz
#Video BW 300 kHz
Span 30.00 MHz
Sweep 1.00 ms (1001 pts)
Jun 22, 2021
10:42:44 AM
Frequency
Settings
Center Frequency
915.000000 MHz
Span
30.0000000 MHz
Swept Span
Zero Span
Full Span
Start Freq
900.000000 MHz
Stop Freq
930.000000 MHz
AUTO TUNE
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Signal Track
(Span Zoom)

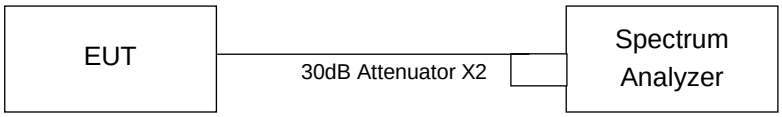

FSK
Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto/No RF
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
1 Spectrum
Scale/Div 10 dB
Ref Lvl Offset 30.75 dB
Ref Level 10.75 dBm
Log
0.750
-9.25
-19.3
-29.3
-39.3
-49.3
-59.3
-69.3
-79.3
Center 915.00 MHz
#Res BW 100 kHz
#Video BW 300 kHz
Span 30.00 MHz
Sweep 1.00 ms (1001 pts)
Jun 22, 2021
10:48:31 AM
Frequency
Settings
Center Frequency
915.000000 MHz
Span
30.0000000 MHz
Swept Span
Zero Span
Full Span
Start Freq
900.000000 MHz
Stop Freq
930.000000 MHz
AUTO TUNE
CF Step
3.000000 MHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Signal Track
(Span Zoom)

4.5 Dwell Time on Each Channel

4.5.1 Limits of Dwell Time on Each Channel Measurement

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.

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.3.1 to get information of above instrument.

4.5.4 Test Procedures

a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
c. Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
d. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
e. Repeat above procedures until all different time-slot modes have been completed.

.

4.5.5 Deviation from Test Standard

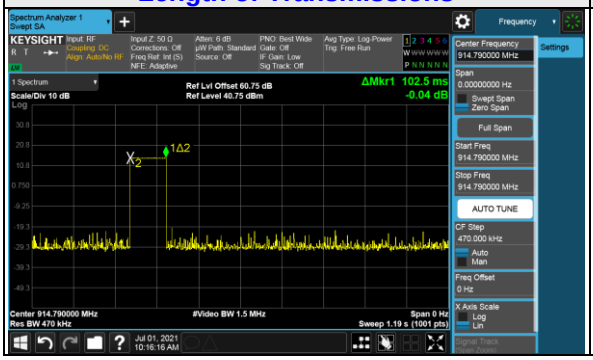
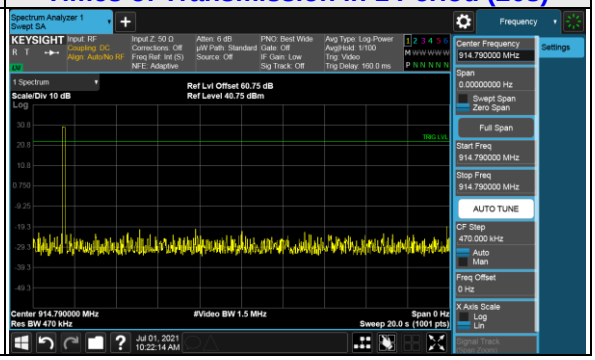
No deviation.

4.5.6 Test Results

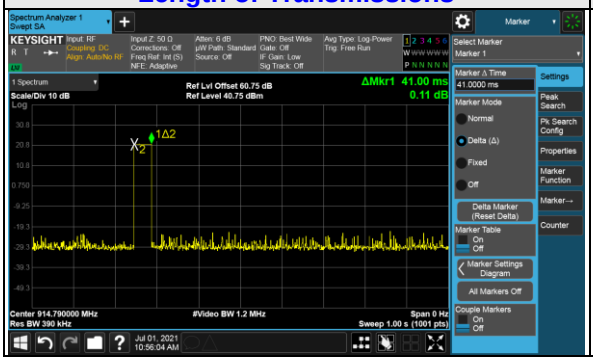
Mode	Number of Hopping Channel	Number of transmission in a period(channel number * 0.4 sec)		Length of transmission time (msec)	Result (msec)	Limit (msec)	PASS /FAIL
		Period (sec)	Times in a period				
OOK	50	20	1	102.5	102.5	400	Pass
FSK	64	10	2	41	82	400	Pass

NOTE: Test plots of the transmitting time slot are shown on next page

OOKs

Length of Transmissions	Times of Transmission in 1 Period (20s)
	

FSK

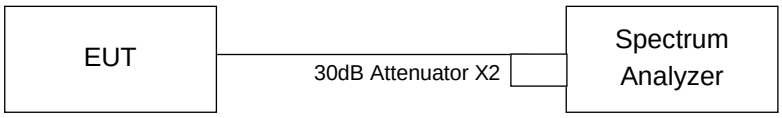
Length of Transmissions	Times of Transmission in 1 Period (10s)
	

4.6 Channel Bandwidth

4.6.1 Limits of Channel Bandwidth Measurement

The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.3.1 to get information of above instrument.

4.6.4 Test Procedure

a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
b. 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.
c. Measure the frequency difference of two frequencies that were attenuated 20dB from the reference level. Record the frequency difference as the emission bandwidth.
d. Repeat above procedures until all frequencies measured were complete.

4.6.5 Deviation from Test Standard

No deviation.

4.6.6 EUT Operating Condition

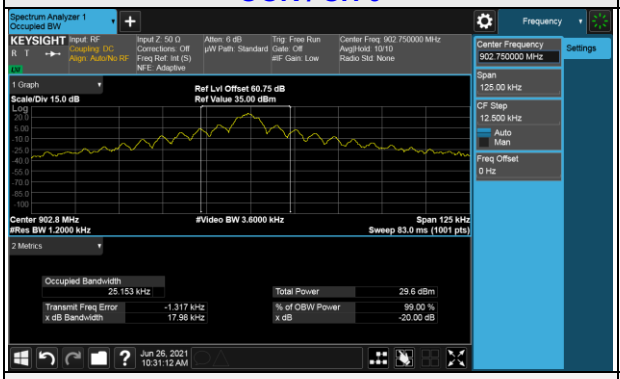
The software provided by client enabled the EUT to Test mode and transmit and receive data at lowest, middle and highest channel frequencies individually.

4.6.7 Test Results

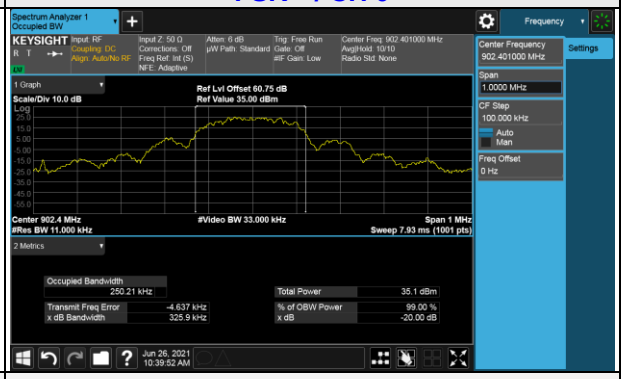
Channel (OOK)	Frequency (MHz)	Channel (FSK)	Frequency (MHz)	20dB Bandwidth (MHz)	
				OOK	FSK
0	902.7	0	902.4	0.0179	0.3259
24	914.7	31	914.8	0.0179	0.3338
49	927.2	63	927.6	0.0179	0.2604

Spectrum Plots

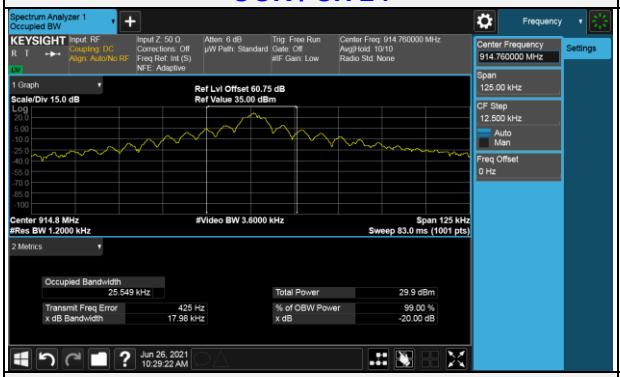
OOK / CH 0



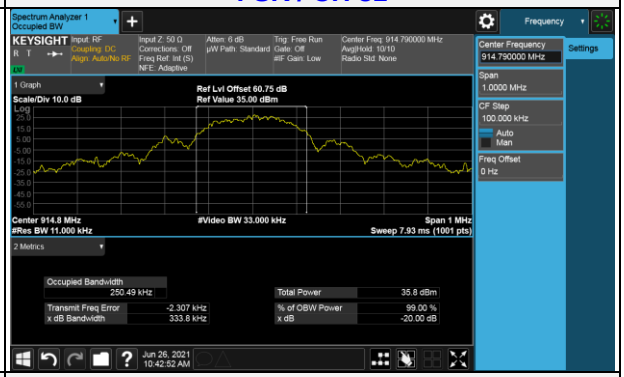
FSK / CH 0



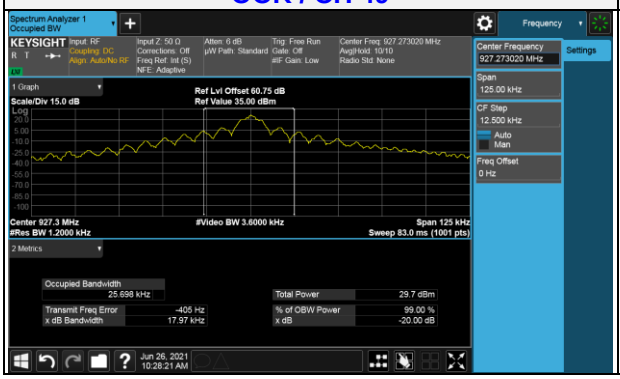
OOK / CH 24



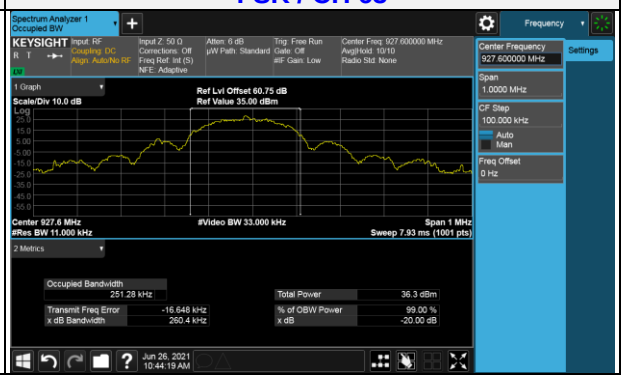
FSK / CH 31



OOK / CH 49



FSK / CH 63

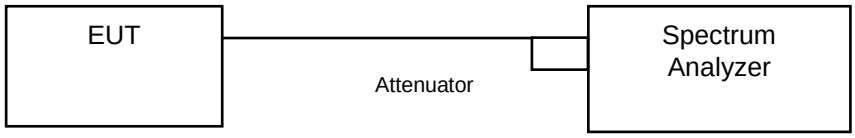


4.7 Hopping Channel Separation

4.7.1 Limits of Hopping Channel Separation Measurement

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

4.7.2 Test Setup



4.7.3 Test Instruments

Refer to section 4.3.1 to get information of above instrument.

4.7.4 Test Procedure

Measurement Procedure REF

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

b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.

c. By using the MaxHold function record the separation of two adjacent channels.

d. Measure the frequency difference of these two adjacent channels by SA MARK function. And then plot the result on SA screen.

e. Repeat above procedures until all frequencies measured were complete.

4.7.5 Deviation from Test Standard

No deviation.

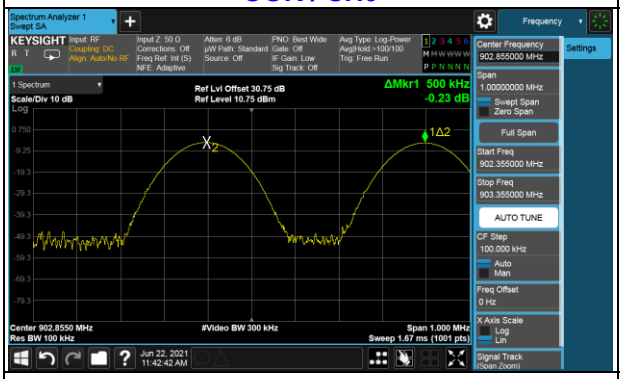
4.7.6 Test Results

OOK	Frequency (MHz)	FSK	Frequency (MHz)	Adjacent Channel Separation (MHz)		Limit(MHz)	Pass / Fail
				OOK	FSK		
0	902.7	0	902.4	0.500	0.400	0.025	Pass
24	914.7	31	914.8	0.500	0.400	0.025	Pass
49	927.2	63	927.6	0.500	0.400	0.025	Pass

NOTE:

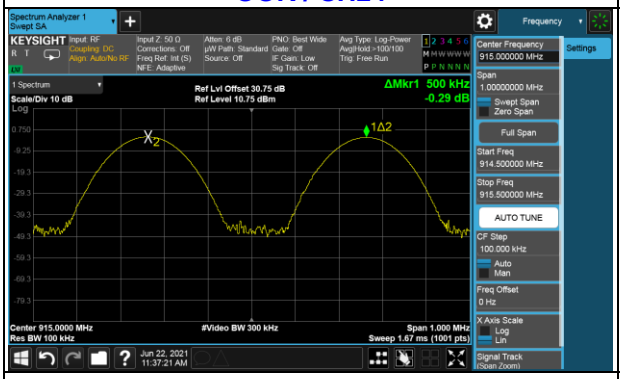
Spectrum Plots

OOK / CH0

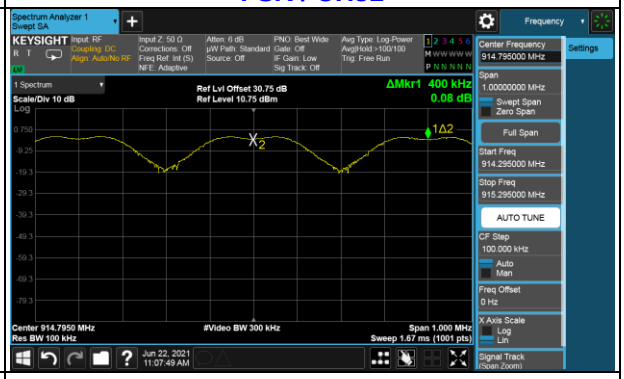


FSK / CH0

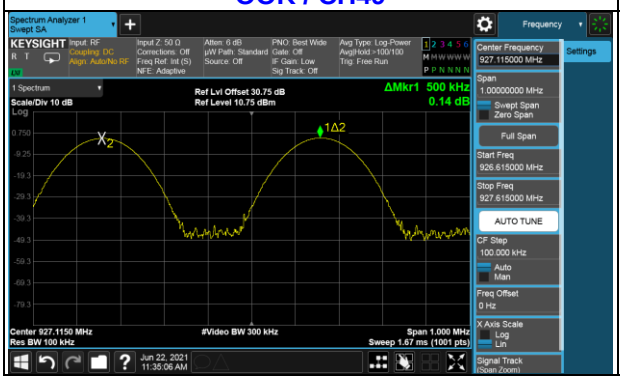
OOK / CH24



FSK / CH31



OOK / CH49



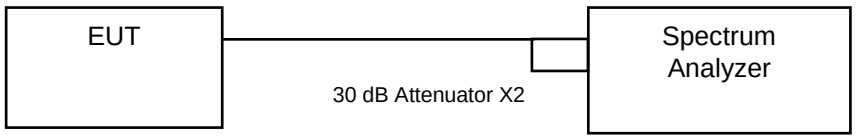
FSK / CH63

4.8 Maximum Output Power

4.8.1 Limits of Maximum Output Power Measurement

The Maximum Output Power Measurement is 1W.

4.8.2 Test Setup



4.8.3 Test Instruments

Refer to section 4.3.1 to get information of above instrument.

4.8.4 Test Procedure

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

b. 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.

c. The center frequency of the spectrum analyzer is set to the fundamental frequency and using 3MHz RBW and 10 MHz VBW.

d. Measure the captured power within the band and recording the plot.

e. Repeat above procedures until all frequencies required were complete.

4.8.5 Deviation from Test Standard

No deviation.

4.8.6 EUT Operating Condition

The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

4.8.7 Test Results

Channel		Frequency		Output Power (mW)		Output Power (dBm)		Power Limit (W)	Pass / Fail
OOK	FSK	OOK	FSK	OOK	FSK	OOK	FSK		
1	1	902.75	902.32	857.03	907.82	29.33	29.58	1	Pass
24	31	914.77	914.72	891.25	905.73	29.50	29.57	1	Pass
49	63	927.25	927.65	893.30	918.33	29.51	29.63	1	Pass

Spectrum Plot of Worst Value

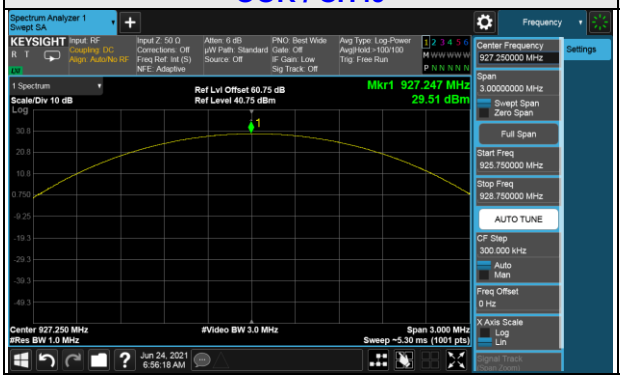
OOK / CH0

FSK / CH0

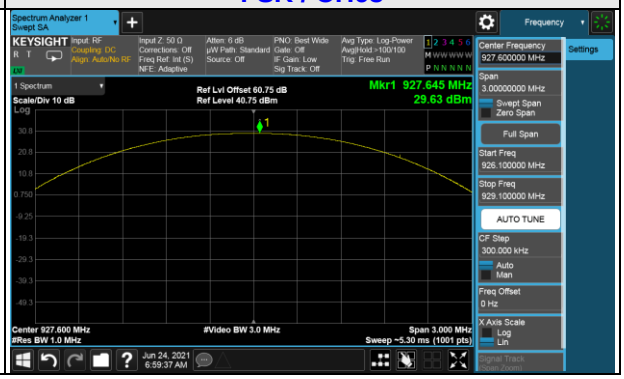
OOK / CH24

FSK / CH31

OOK / CH49



FSK / CH63



4.9 Conducted Out of Band Emission Measurement

4.9.1 Limits of Conducted Out of Band Emission Measurement

Below –20dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

4.9.2 Test Instruments

Refer to section 4.3.1 to get information of above instrument.

4.9.3 Test Procedure

The transmitter output was connected to the spectrum analyzer via a low loss cable. Set both RBW and VBW of spectrum analyzer to 100 kHz and 300 kHz with suitable frequency span including 100 MHz bandwidth from band edge. The band edges was measured and recorded.

4.9.4 Deviation from Test Standard

No deviation.

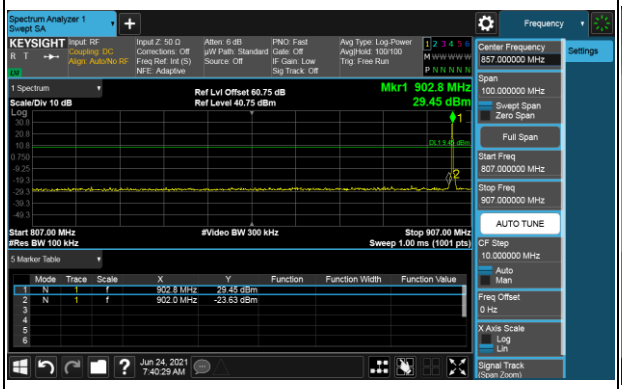
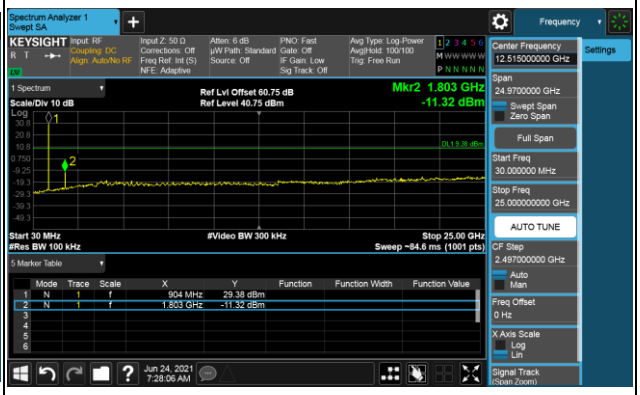
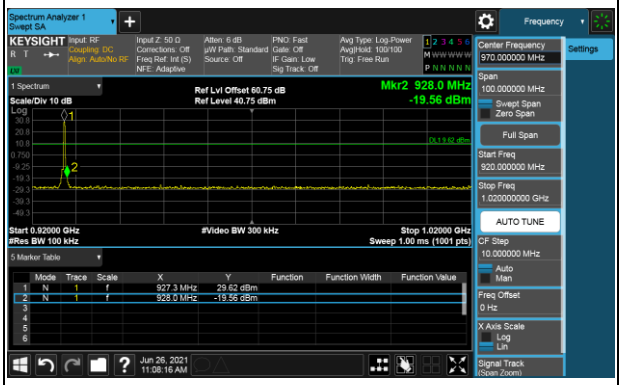
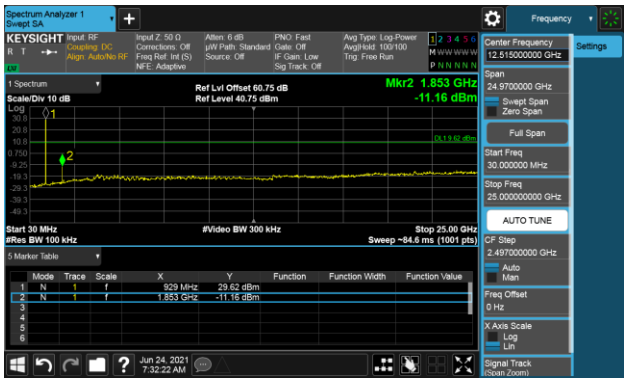
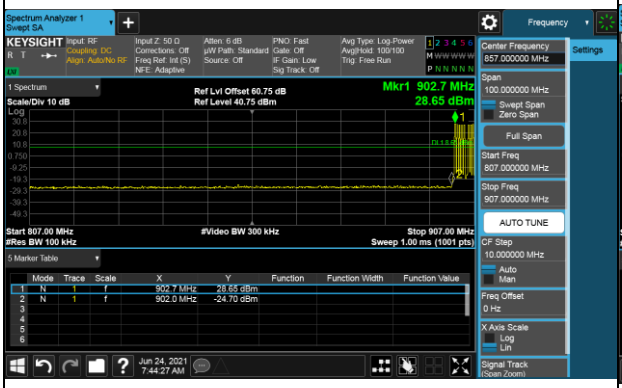
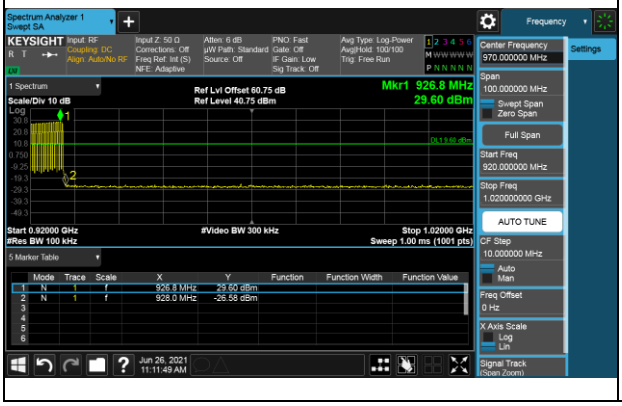
4.9.5 EUT Operating Condition

The software provided by client enabled the EUT to test mode and transmit and receive data at lowest, middle and highest channel frequencies individually.

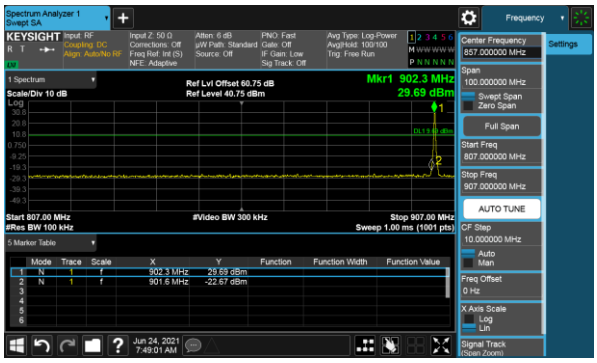
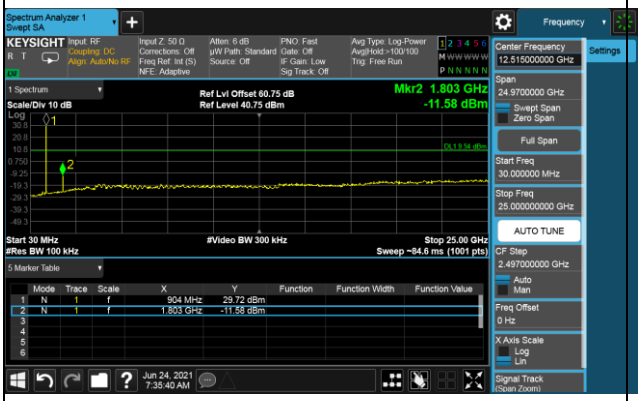
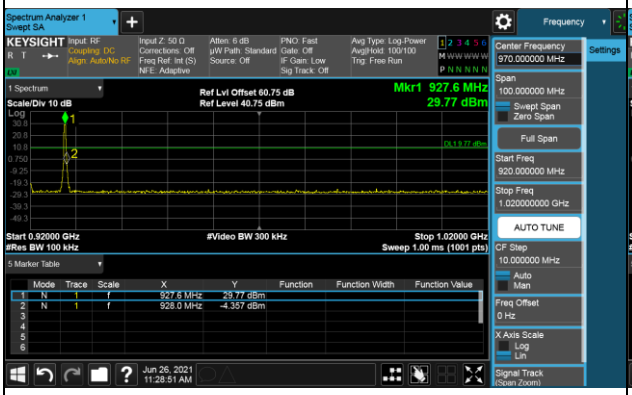
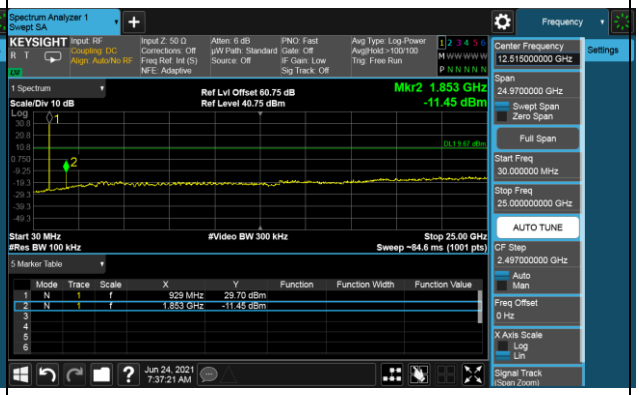
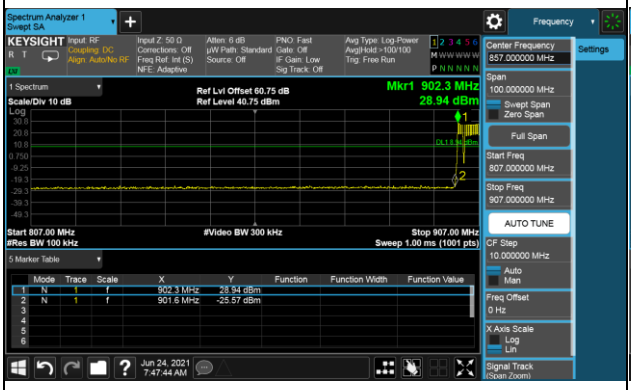
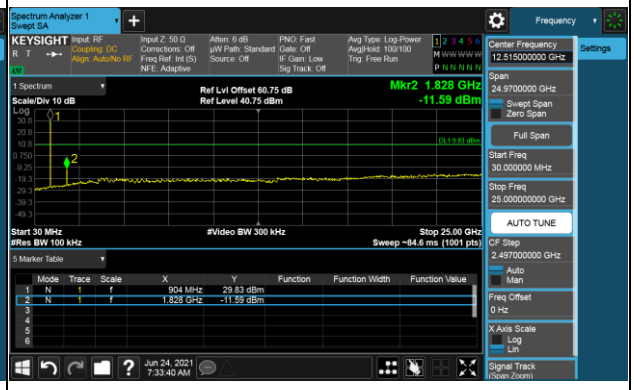
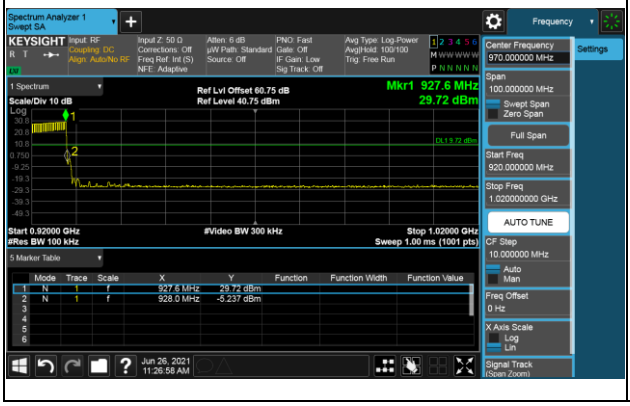
4.9.6 Test Results

The spectrum plots are attached on the following images. D1 line indicates the highest level, Mark 2 indicates the 20dB offset below D1. It shows compliance with the requirement.

OOK

Hopping disabled_ Low Channel 807MHz-907MHz	Hopping disabled_ Low Channel 30 MHz-25 GHz
	
Hopping disabled_ High Channel 920MHz-1020MHz	**Hopping disabled_ High Channel 30 MHz-25 GHz**
	
Hopping enabled_ Low Channel 807MHz-907MHz	**Hopping enabled 30 MHz-25 GHz**
	
Hopping enabled_ High Channel 920MHz-1020MHz	
	

FSK

Hopping disabled_ Low Channel 920MHz-1020MHz	Hopping disabled_ Low Channel 30 MHz-25 GHz
	
Hopping disabled_ High Channel 920MHz-1020MHz	**Hopping disabled_ High Channel 30 MHz-25 GHz**
	
Hopping enabled_ Low Channel 920MHz-1020MHz	**Hopping enabled 30 MHz-25 GHz**
	
Hopping enabled_ High Channel 920MHz-1020MHz	
	

5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

Appendix – Information on the Testing Laboratories

Bureau Veritas is a global leader in testing, inspection and certification (TIC) services. We help businesses improve safety, sustainability and productivity; and our clients include the majority of leading brands in retail, manufacturing and other industries. With a presence in every major country around the world, our quality assurance and compliance solutions are vital in helping our customers enhance product quality and concept-to-consumer journeys. We also assist with increasing speed to market, profitability and brand equity throughout the supply chain. Bureau Veritas is a leading wireless/IoT testing, inspection, audit and certification provider, with a global network of test laboratories to support the IoT industry in areas of connectivity, security, interoperability as well as quality, health & safety, and environmental/chemical requirements.

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The address and road map of all our labs can be found in our web site also.

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