FCC IC Test Report

Report No.:	FCC_IC_RF_SL20040701-FLU-002A1_Sensor
FCC ID:	2AOX8-F2100
IC:	26125-F2100
Test Model:	F2100
Received Date:	04/06/2020
Test Date:	04/08/2020-04/24/2020
Issued Date:	06/01/2020
Applicant:	Flume Inc
Address:	75 Higuera St Suite 120, San Luis Obispo,CA-93405
Manufacturer:	Flume Inc
Address:	75 Higuera St Suite 120, San Luis Obispo,CA-93405
Issued By:	Bureau Veritas Consumer Products Services, Inc.
Lab Address:	775 Montague Expressway, Milpitas, CA 95035
Test Location (1):	775 Montague Expressway, Milpitas, CA 95035
FCC Registration / Designation Number:	540430
ISED# / CAB identifier:	4842D

ACCREDITED
TESTING CERT # 2742-01

Table of Contents

Release Control Record

Issue No.	Description	Date Issued
FCC_IC_RF_SL20040701-FLU-002A1_Sensor	Initial Release	06/01/2020

1 Certificate of Conformity

Product:	Flume Sensor
Brand:	Flume
Test Model:	F2100
Sample Status:	Engineering sample
Applicant:	Flume Inc
Test Date:	04/08/2020-04/24/2020
Standards:	47 CFR FCC Part 15, Subpart C (Section 15.247) RSS-247 Issue 2, February 2017 ANSI C63.10: 2013 RSS-Gen Issue 5, March 2019 558074 D01 15.247 Meas Guidance v05r02

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:** 06/01/2020

Deon Dai / Test Engineer

Approved by : _____ , **Date:** 06/01/2020

Chen Ge / Engineer Reviewer

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (SECTION 15.247) RSS 247 Issue2, RSS Gen Issue5			
FCC Clause	Test Item	Result	Remarks
15.207 RSS Gen 8.8	AC Power Conducted Emission	N/A	Device work with battery.
15.247(a)(1) (iii) RSS 247 5.1.c	Number of Hopping Frequency Used	PASS	Meet the requirement of limit.
15.247(a)(1) (iii) RSS 247 5.1.c	Dwell Time on Each Channel	PASS	Meet the requirement of limit.
15.247(a)(1) RSS 247 5.1.c	1. Hopping Channel Separation 2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System	PASS	Meet the requirement of limit.
15.247(b) RSS 247 5.1.b	Maximum Peak Output Power	PASS	Meet the requirement of limit.
15.247(d) RSS 247 5.5	Band Edge Measurement	PASS	Meet the requirement of limit.
15.205 & 209 & 15.247(d) RSS Gen 8.9	Radiated Emissions	PASS	Meet the requirement of limit.
15.203	Antenna Requirement	PASS	Antenna type is Bowtie antenna. (The device is professionally installed)

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	3.51dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	3.73dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	4.64dB
	6GHz ~ 18GHz	4.82dB
	18GHz ~ 40GHz	4.91dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Flume Sensor
Brand	Flume
Test Model	F2100
Identification No. of EUT	N/A
Status of EUT	Engineering sample
Power Supply Rating	12Vdc (3A Battery *8)
Modulation Type	ASK
Modulation Technology	FHSS
Operating Frequency	902.5-927 MHz
Number of Channel	50
Output Power	15.431 dBm
Antenna Type	Bowtie PCB antenna
Antenna Gain	0.9 dBi
Antenna Connector	N/A

3.2 Description of Test Modes

50 channels are provided to this EUT:

Channel	Frequency (MHz)
Low	902.5
Mid	915
High	927

3.3 Description of Support Units

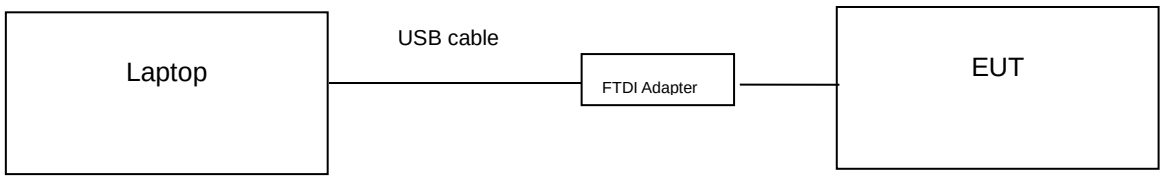
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	FTDI Adapter	LowPower LAB	R3	N/A	N/A	Provide by customer
B.	Laptop	Lenovo Thinkpad	T440	PC00U0PW	N/A	Provide by customer

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB cable	1	0.8	N	0	Provided by Customer

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

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:

47 CFR FCC Part 15, Subpart C (Section 15.247)
RSS 247 Issue2, February 2017
ANSI C63.10: 2013
RSS Gen Issue5, March 2019
558074 D01 15.247 Meas Guidance v05r02

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

4 Test Types and Results

4.1 Radiated Emission Measurement

4.1.1 Limits of Radiated Emission

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 Test Receiver ROHDE & SCHWARZ	ESIB 40	100179	08/28/2019	08/28/2020
Hybrid Antenna SUNAR	JB6	A111717	03/09/2020	03/09/2021
DRG Horn Antenna ETS LINDGREN	3117	214309	12/20/2019	12/20/2020
Preamplifier RF-LAMBDA	RAMP00M50GA	17032300047	10/19/2019	10/19/2020

4.1.3 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. 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 9 kHz 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 detects 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:

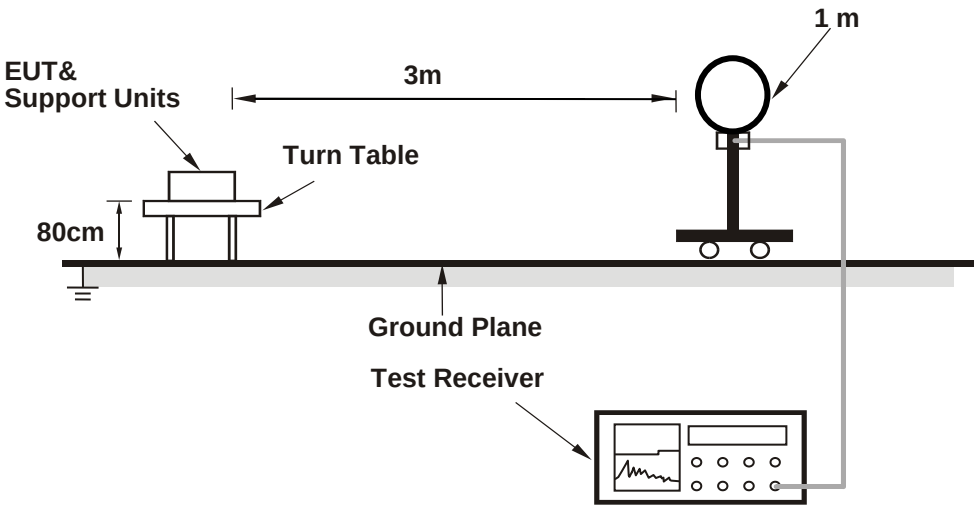
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
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.

4.1.4 Deviation from Test Standard

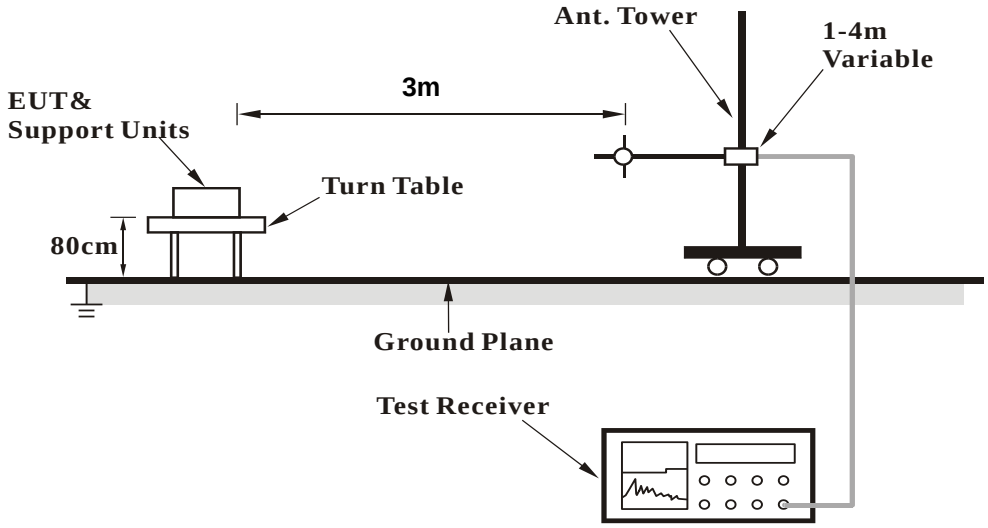
No deviation.

4.1.5 Test Setup

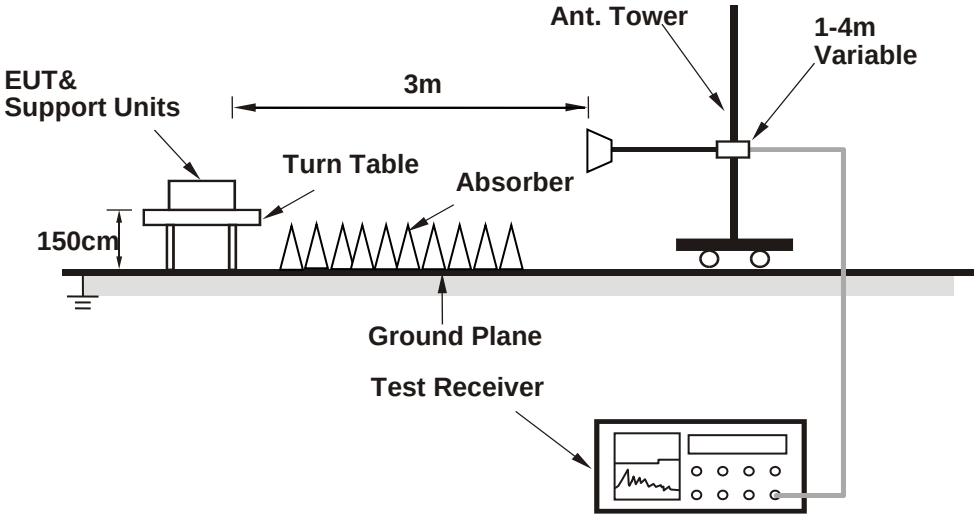
For Radiated emission below 30MHz



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).

4.1.6 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.

4.1.7 Test Results

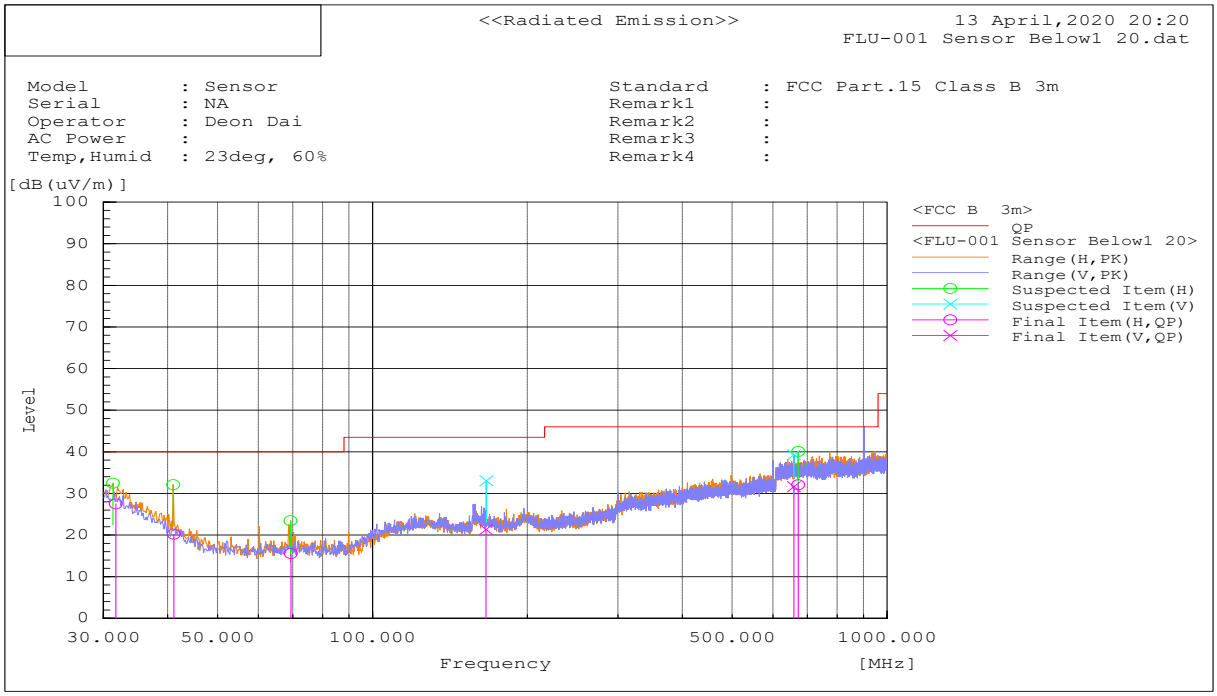
BELOW 1GHz WORST-CASE DATA:

CHANNEL	Middle Channel	**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	31.716	H	2.1	25.4	27.5	40	-12.5	222	103	Pass
2	41.132	H	1.9	18.3	20.2	40	-19.8	188	251	Pass
3	69.404	H	2	13.6	15.6	40	-24.4	197	0.1	Pass
4	166.081	V	3.2	18.2	21.4	43.5	-22.1	196	221	Pass
5	658.767	V	4.5	27.2	31.7	46	-14.3	214	141	Pass
6	671.915	H	4.4	27.7	32.1	46	-13.9	235	184	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)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)



ABOVE 1GHz TEST DATA:

CHANNEL	Low Channel	DETECTOR FUNCTION	Peak Average
FREQUENCY RANGE	1GHz ~ 10GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK [dB(uV/m)	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
1	2581.062	H	41.3	54.6	-9.1	32.2	45.5	54	74	-21.8	-28.5	Pass	208	Pass
2	4399.854	V	41.6	55.2	-7.1	34.5	48.1	54	74	-19.5	-25.9	Pass	315	Pass
3	5488.118	H	38.9	52	-4.7	34.2	47.3	54	74	-19.8	-26.7	Pass	201	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	Mid Channel	DETECTOR FUNCTION	Peak Average
FREQUENCY RANGE	1GHz ~ 10GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK [dB(uV/m)	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
1	2768.218	H	42.2	55.4	-9.1	33.1	46.3	54	74	-20.9	-27.7	Pass	258	Pass
2	3158.178	V	42.5	56.8	-8.5	34	48.3	54	74	-20	-25.7	Pass	373	Pass
3	4774.671	V	40.7	53.7	-6	34.7	47.7	54	74	-19.3	-26.3	Pass	265	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	High Channel	**DETECTOR FUNCTION**	Peak Average
FREQUENCY RANGE	1GHz ~ 10GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK dB(uV/m)	Limit\AV dB(uV/m)	Limit\PK [dB(uV/m)	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
1	3582.433	V	42	55.2	-7.9	34.1	47.3	54	74	-19.9	-26.7	Pass	251	Pass
2	3854.14	V	42.1	55.8	-7	35.1	48.8	54	74	-18.9	-25.2	Pass	165	Pass
3	6253.116	V	37.4	50.6	-2.8	34.6	47.8	54	74	-19.4	-26.2	Pass	194	Pass

REMARKS:

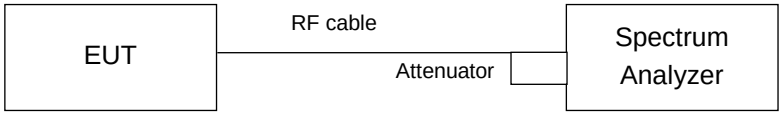
1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

4.2 Channel Bandwidth

4.2.1 Limits of Channel Bandwidth Measurement

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

4.2.2 Test Setup



4.2.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.2.4 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.

4.2.5 Deviation from Test Standard

No deviation.

4.2.6 EUT Operating Condition

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

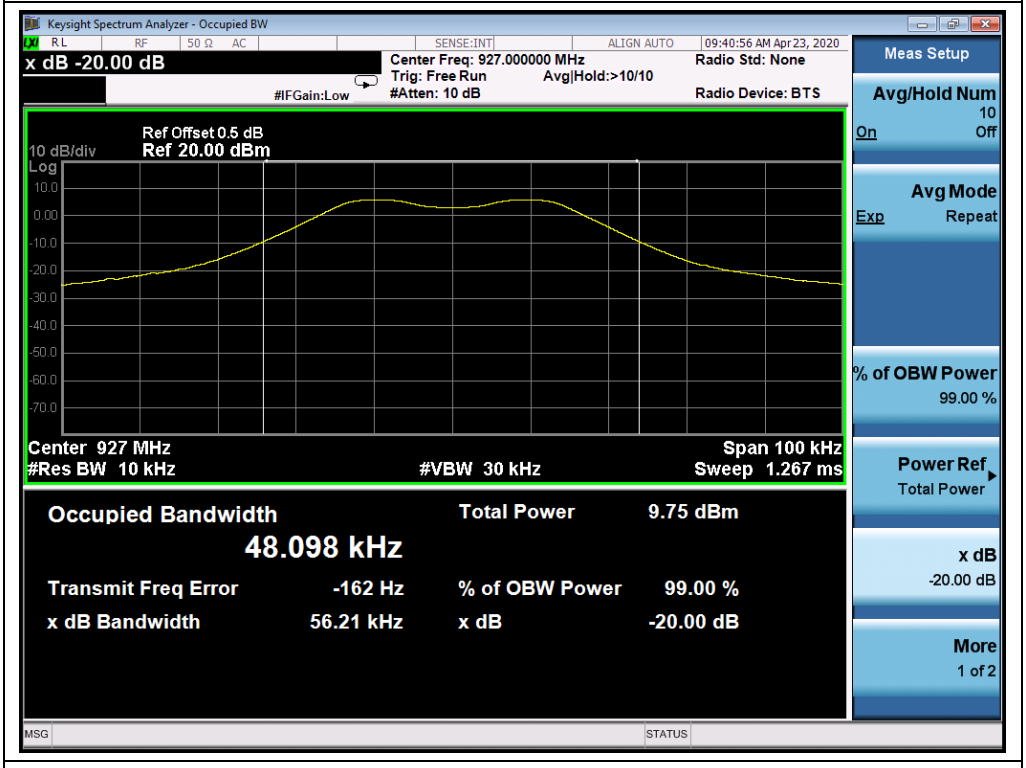
4.2.7 Test Results

Channel	Frequency (MHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)	20dB Bandwidth Limit (kHz)
Low	902.5	57.77	49.43	500
Mid	915	56.13	48.13	500
High	927	56.21	48.10	500

Test Plots:

Low Channel

Middle Channel



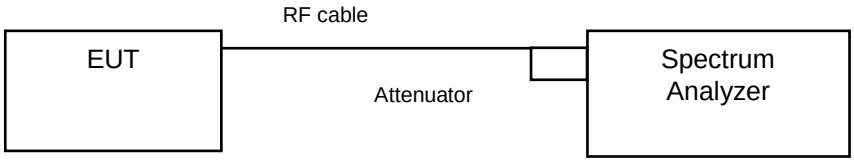
High Channel

4.3 Hopping Channel Separation

4.3.1 Limits of Hopping Channel Separation Measurement

At least 25kHz or 20dB hopping channel bandwidth (whichever is greater).

4.3.2 Test Setup



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 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.

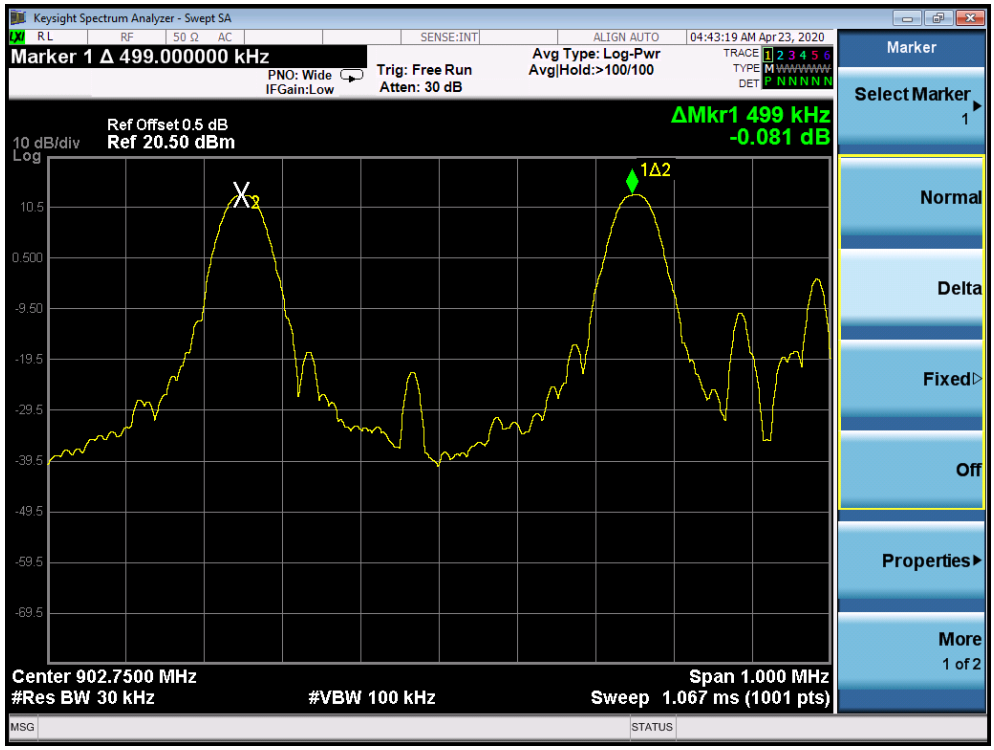
4.3.5 Deviation from Test Standard

No deviation.

4.3.6 Test Results

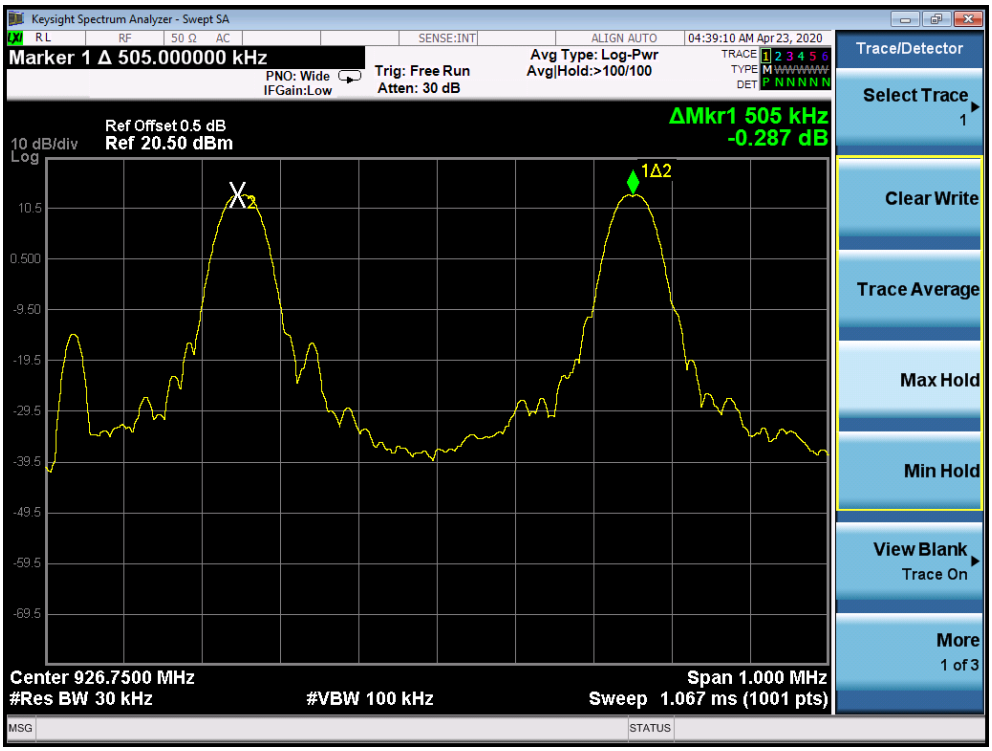
Channel	Frequency (MHz)	Adjacent Channel Separation (kHz)	Maximum Limit (kHz)	Pass / Fail
Low	902.5	499	57.77	Pass
Mid	915	502	56.13	Pass
High	927	505	56.21	Pass

Test Plots:



Low Channel

Middle Channel



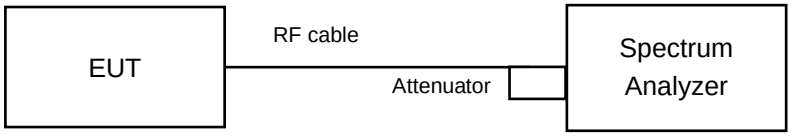
High Channel

4.4 Conducted Output Power Measurement

4.4.1 Limits of Conducted Output Power Measurement

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels.

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedures

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.

4.4.5 Deviation from Test Standard

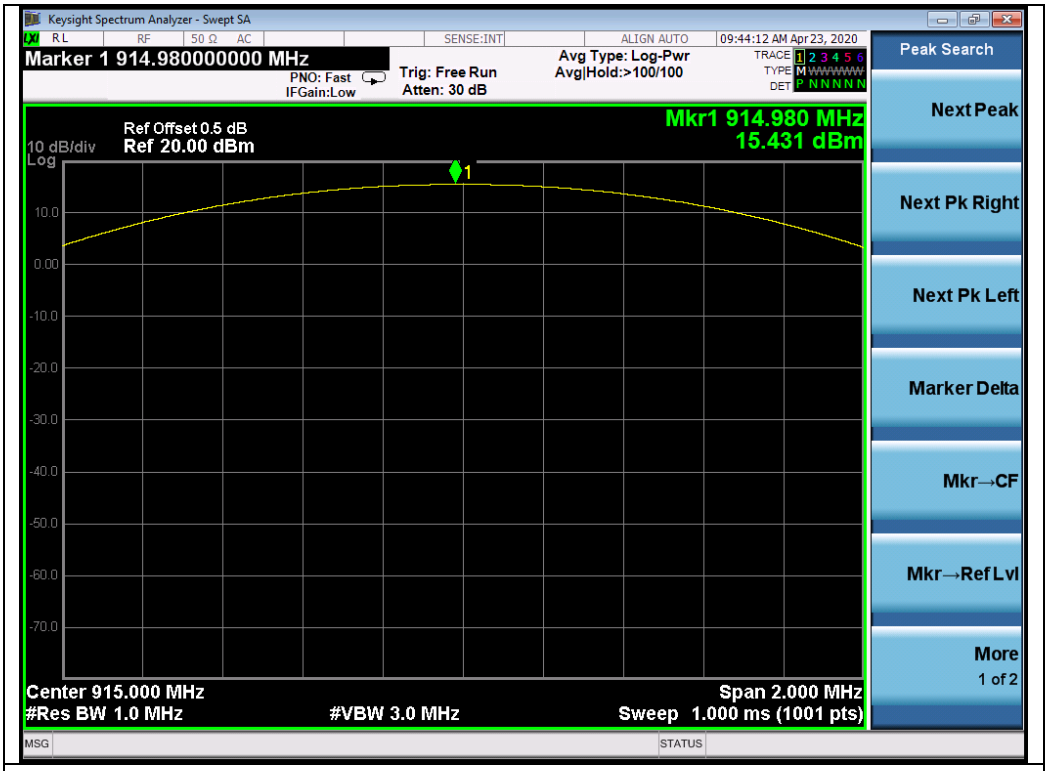
No deviation.

4.4.6 Test Results

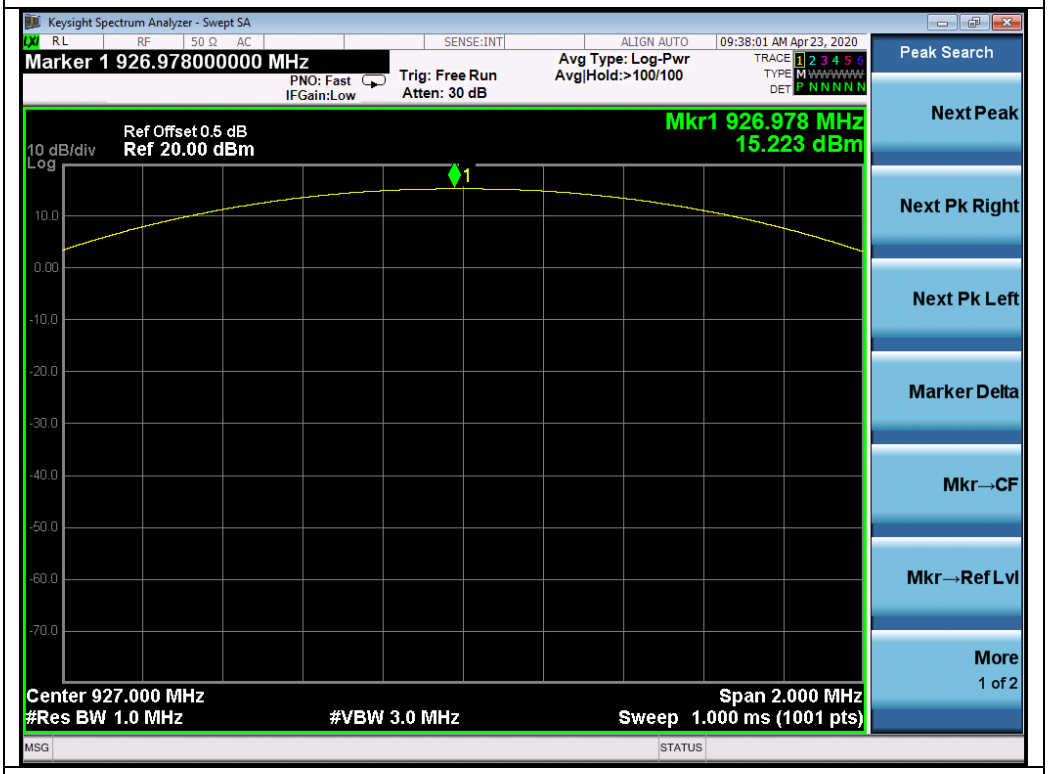
Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
Low	902.5	15.272	30	Pass
Mid	915	15.431	30	Pass
High	927	15.223	30	Pass

Test Plots:

Low Channel



Middle Channel



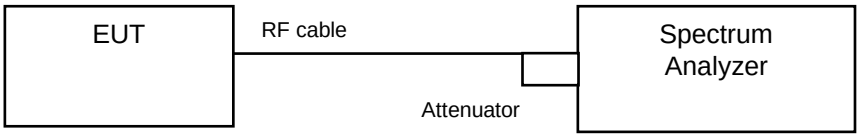
High Channel

4.5 Number of Hopping Frequency Used

4.5.1 Limits of Hopping Frequency Used 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

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 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.

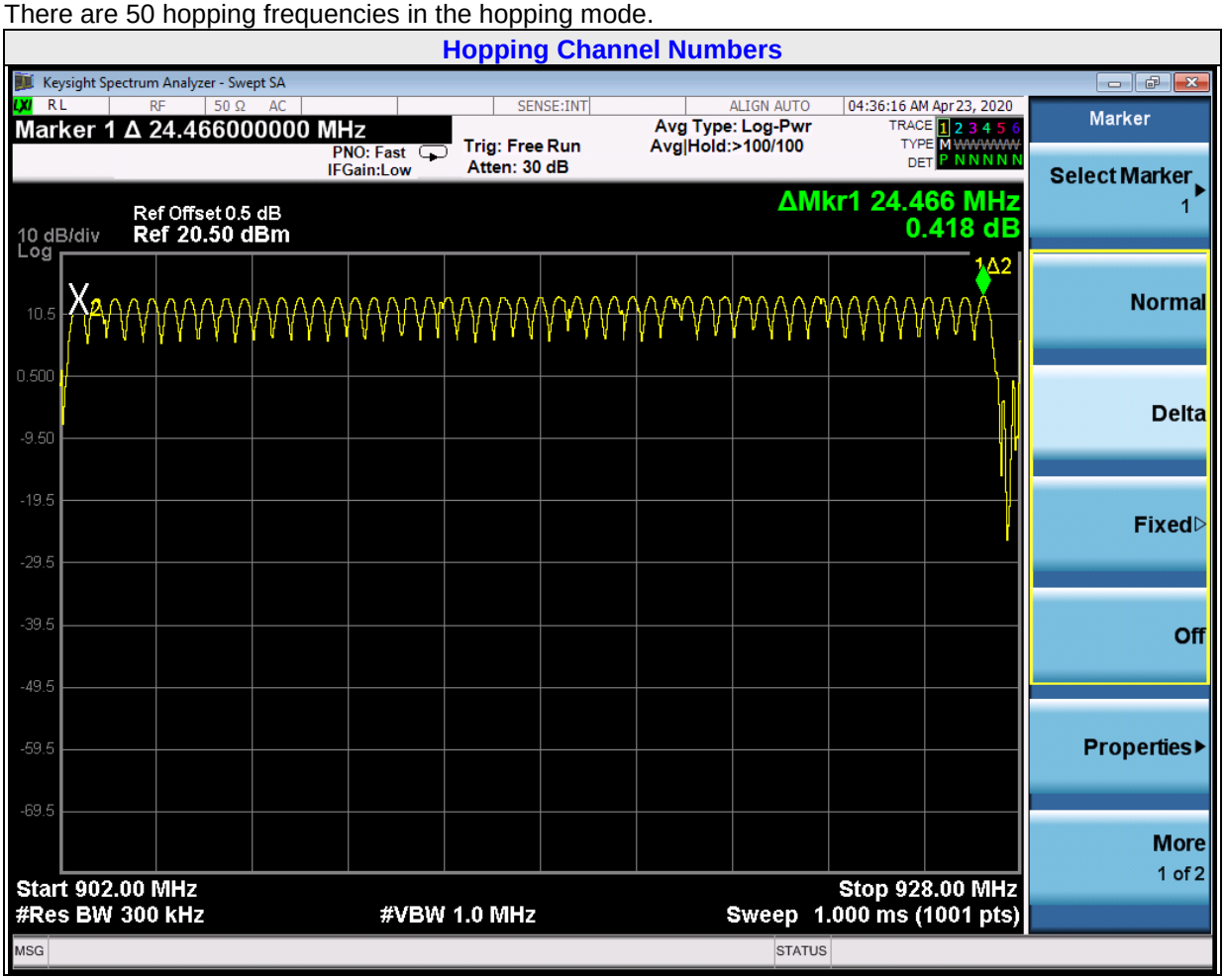
4.5.5 Deviation from Test Standard

No deviation.

4.5.6 Test Results

There are 50 hopping frequencies in the hopping mode.

Hopping Channel Numbers

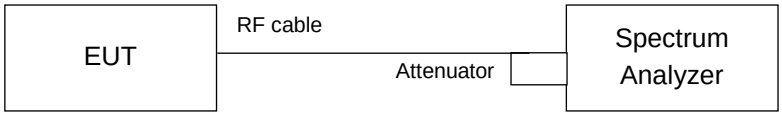


4.6 Dwell Time on Each Channel

4.6.1 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

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.6.4 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.

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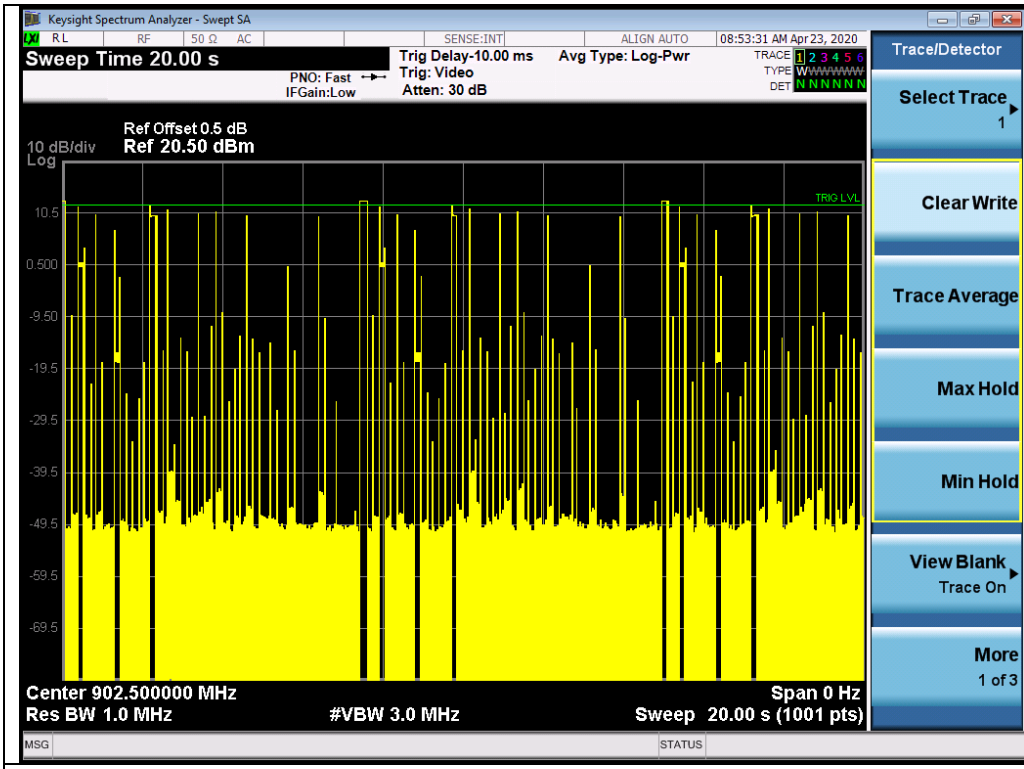
4.6.5 Deviation from Test Standard

No deviation.

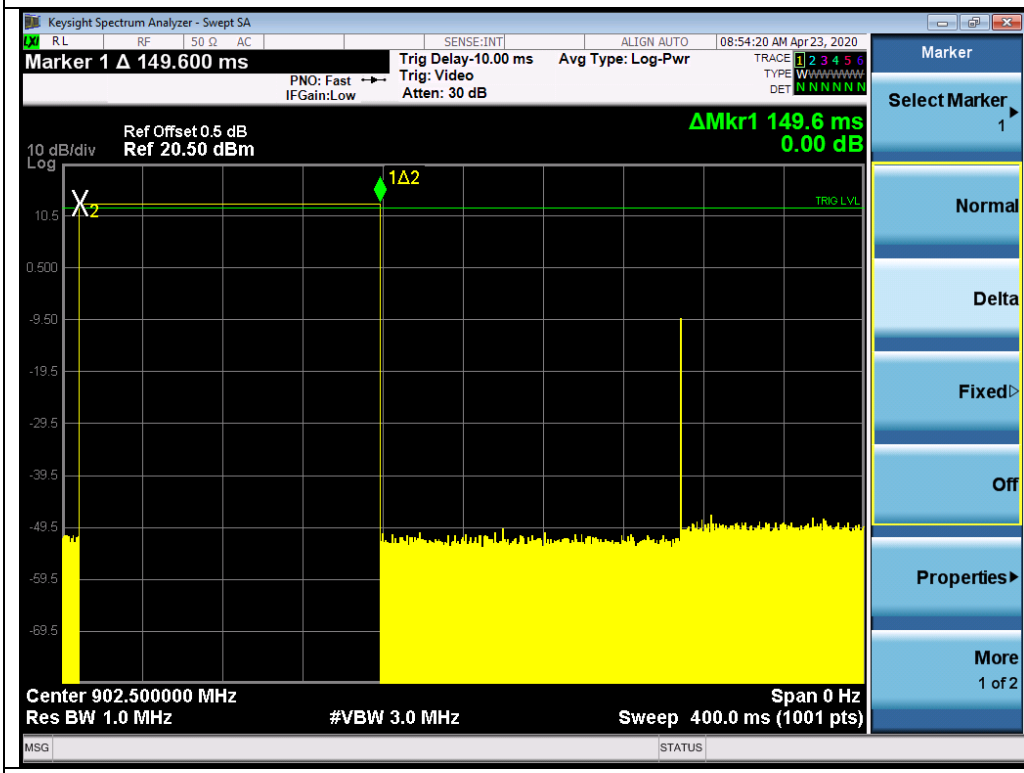
4.6.6 Test Results

Mode	Number of transmission in a 20 sec	Length of transmission time (msec)	Result (msec)	Limit (msec)
Low	2 times	149.6	299.2	400
Middle	2 times	149.6	299.2	400
High	2 times	149.6	299.2	400

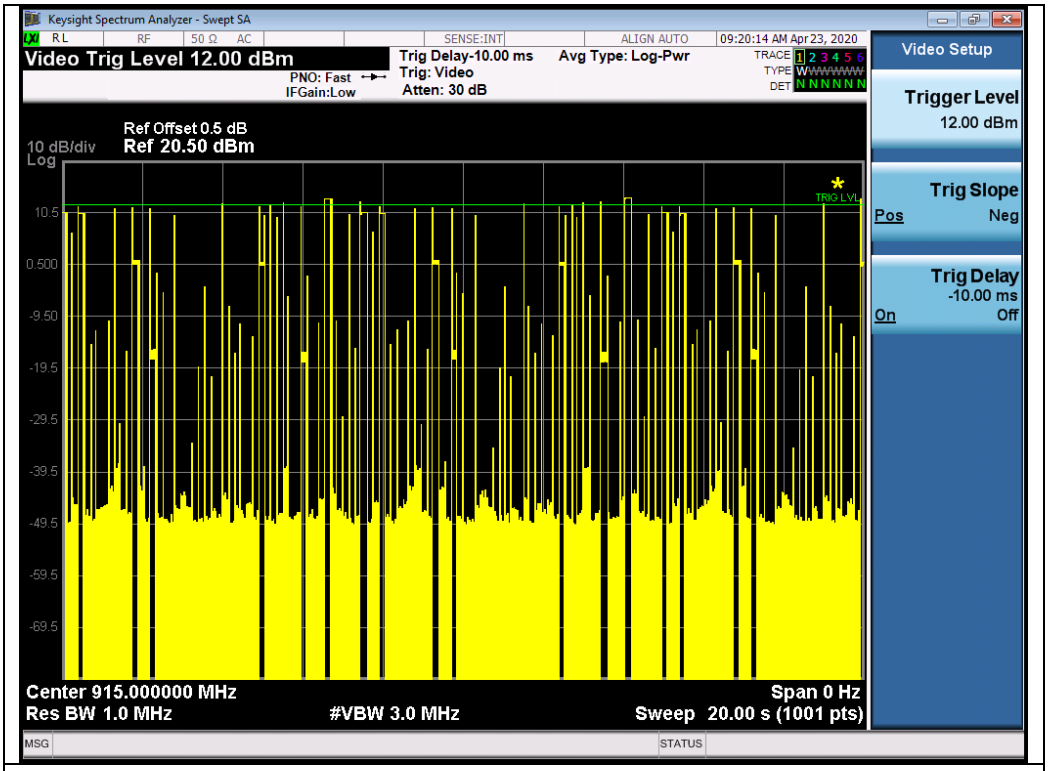
NOTE: Test plots of the transmitting time slot are shown on next page.



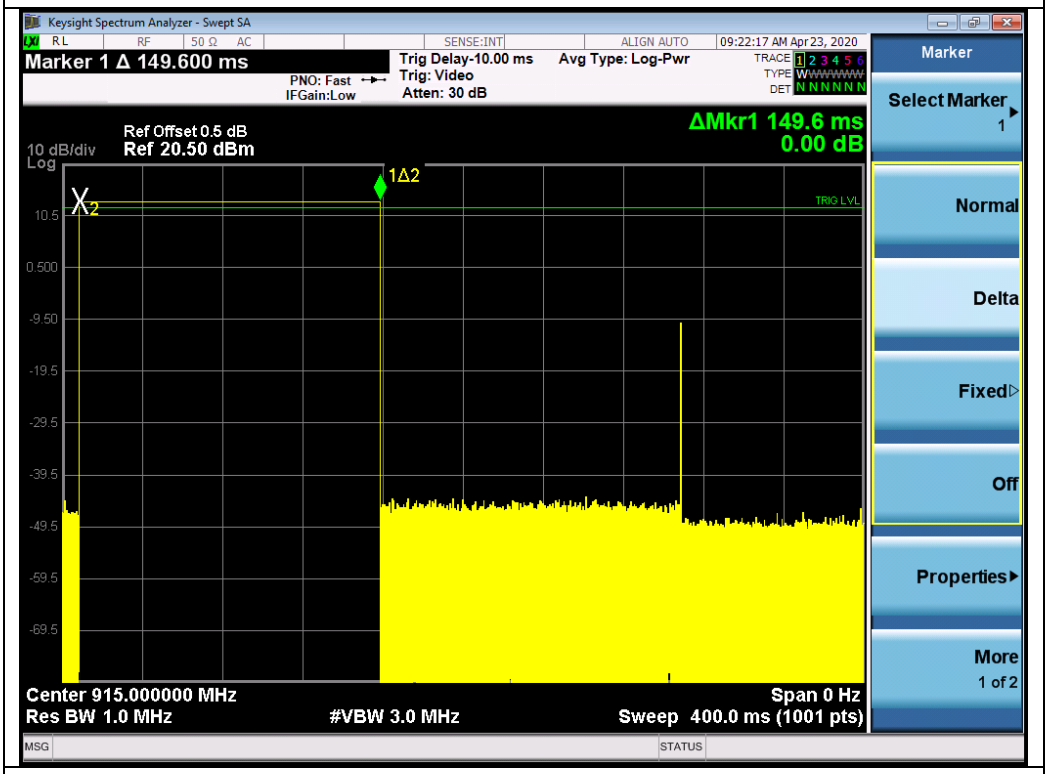
Low Channel – 20s



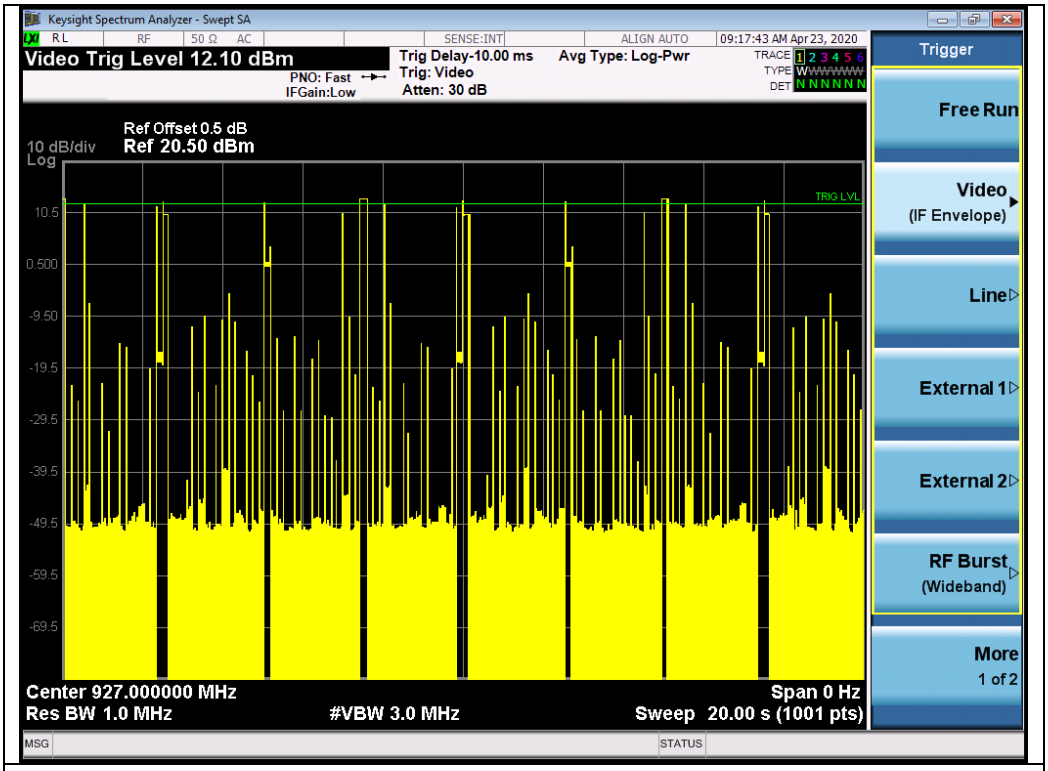
Low Channel – Pulse width



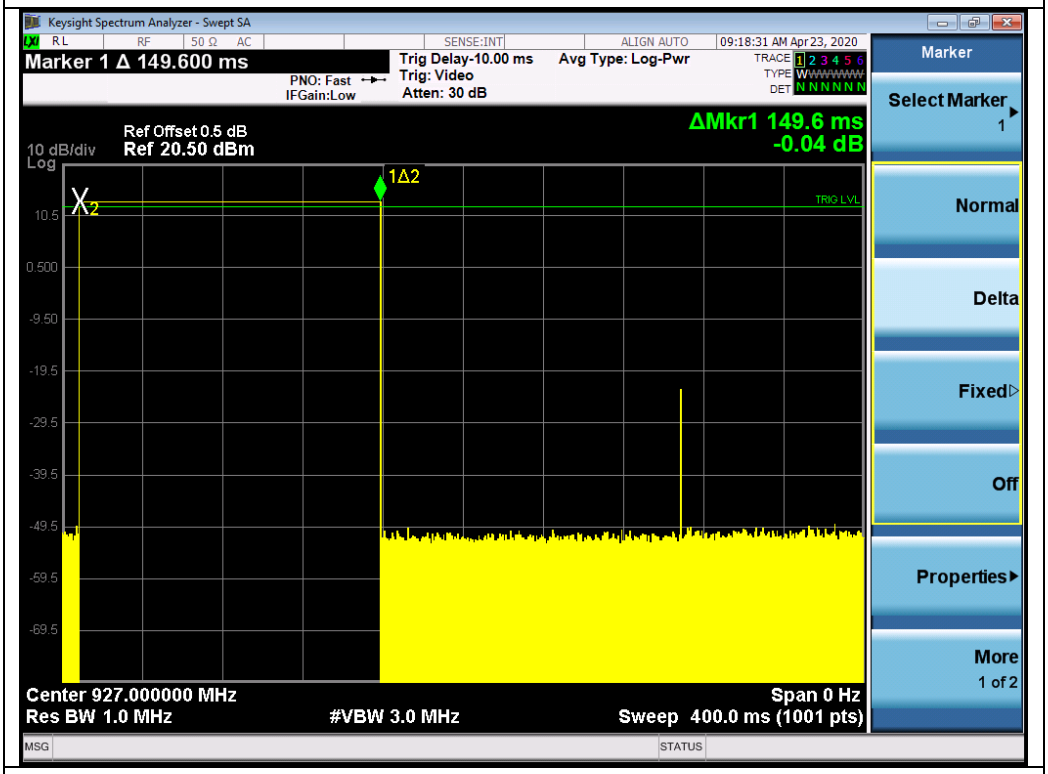
Middle Channel – 20s



Middle Channel – Pulse width



High Channel – 20s



High Channel – Pulse width

4.7 Conducted Out of Band Emission Measurement

4.7.1 Limits of Conducted Out of Band Emission Measurement

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

4.7.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.7.3 Test Procedure

The transmitter output was connected to the spectrum analyzer via a low lose 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.

4.7.4 Deviation from Test Standard

No deviation.

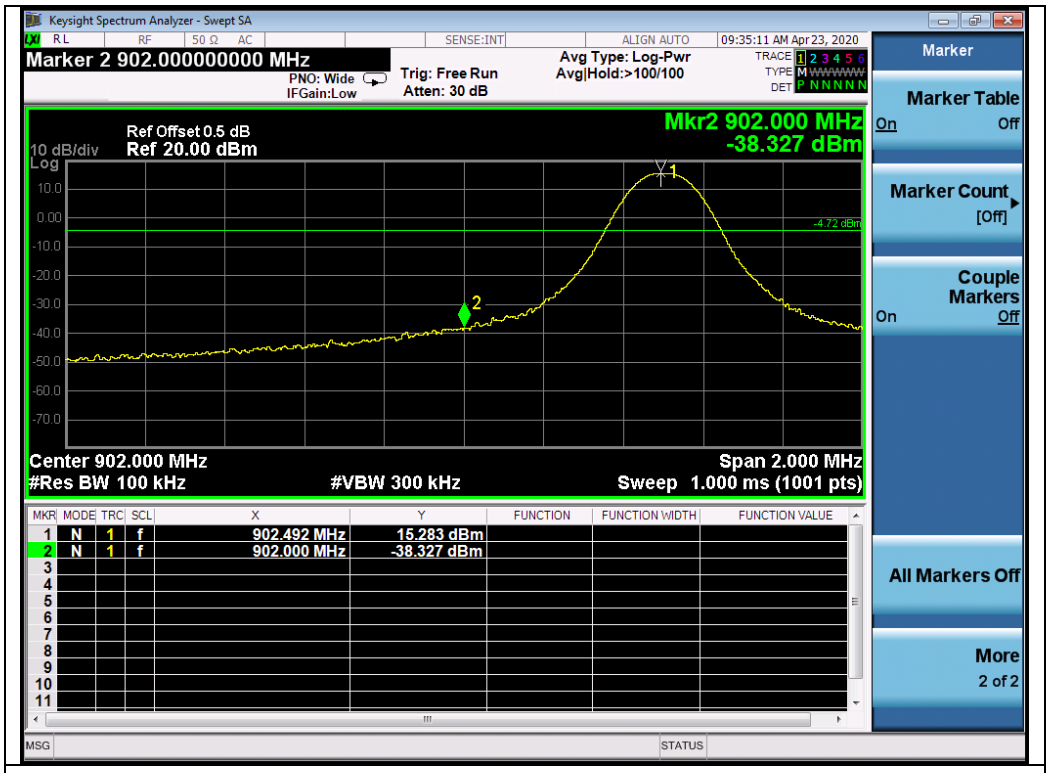
4.7.5 EUT Operating Condition

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

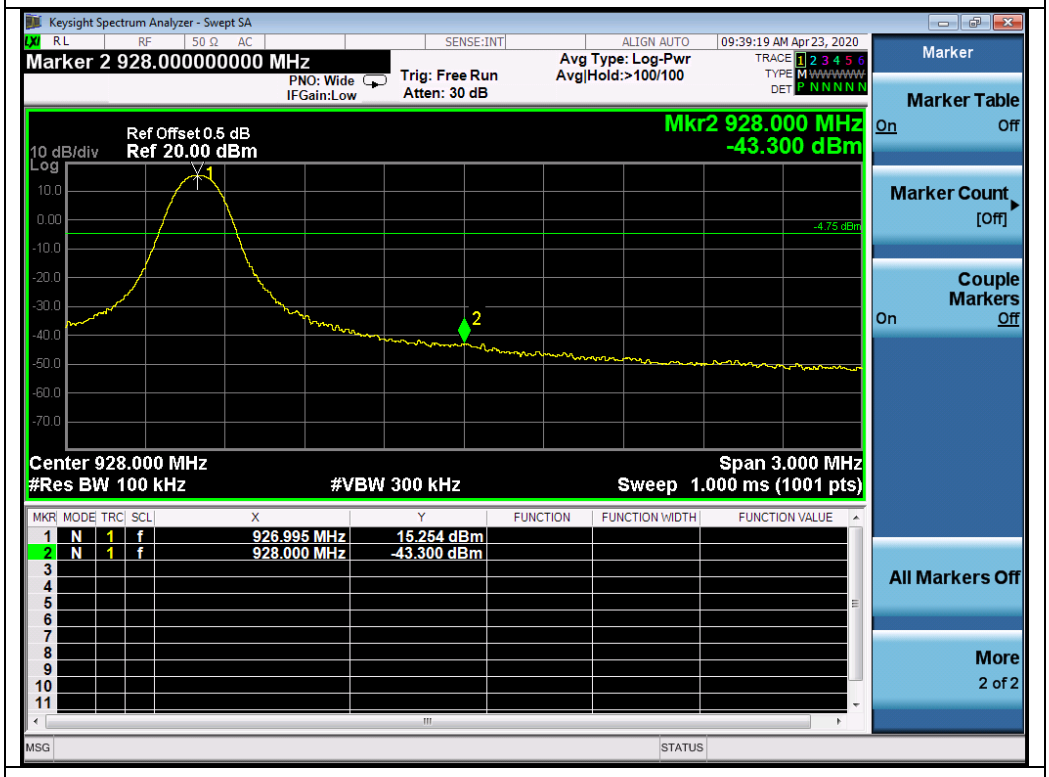
4.7.6 Test Results

The spectrum plots are attached on the following images. D1 line indicates the highest level, D2 line indicates the 20dB offset below D1. It shows compliance with the requirement.

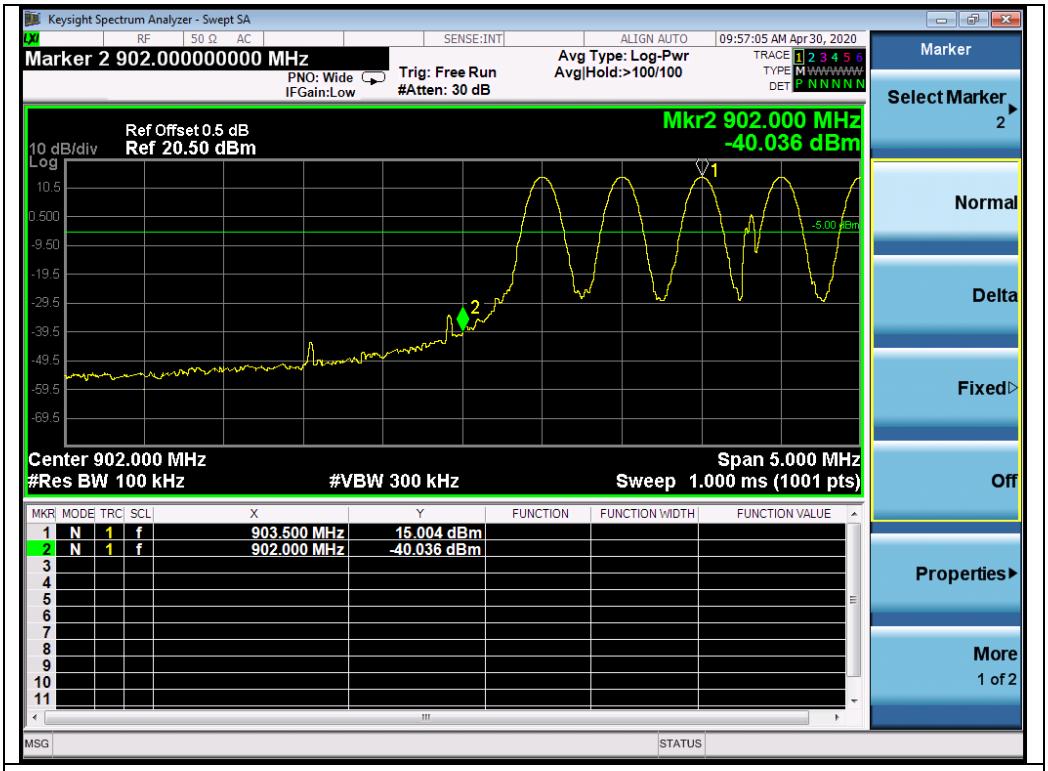
4.7.7 Test Results



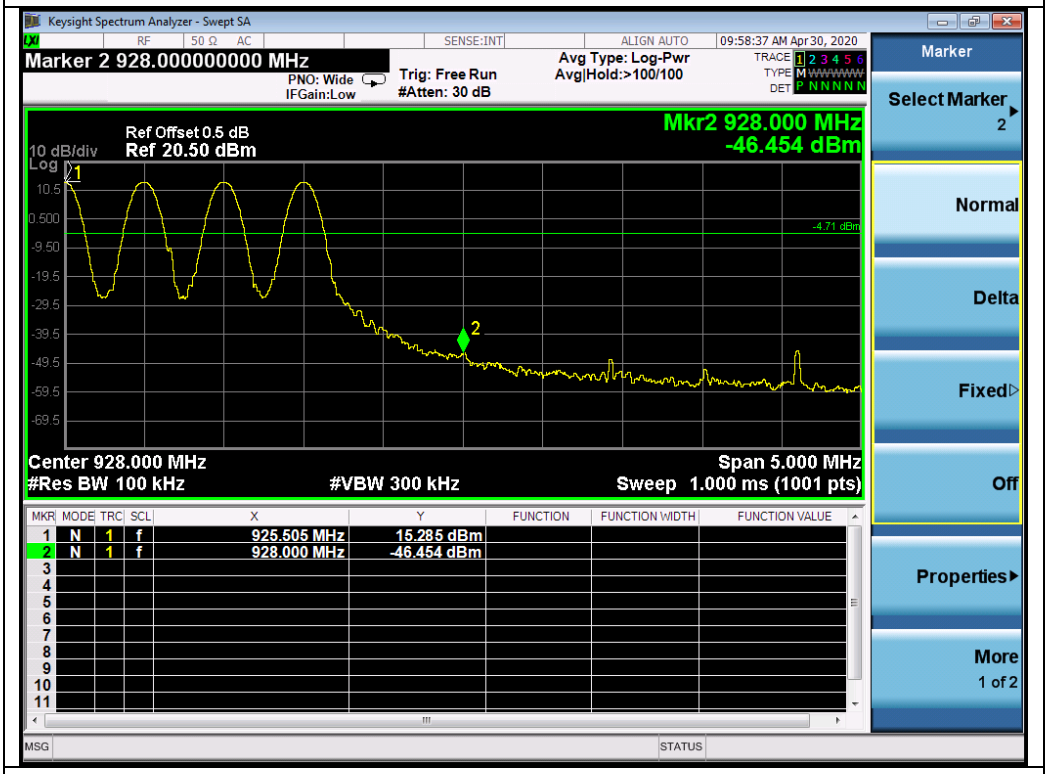
Low Channel



High Channel



Hopping mode left side



Hopping mode right side

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.

If you have any comments, please feel free to contact us at the following:

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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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