FCC IC Test Report

Report No.:	FCC_IC_RF_SL19082201-JAD-011 Rev 2.0
FCC ID:	QV5MERCURY6E-MH
IC:	5407A-MERCURY6EMH
Test Model:	M6e-Micro-A
Variant Model:	M6e-M-A
Received Date:	09/01/2019
Test Date:	09/05/2019/-09/24/2019
Issued Date:	01/14/2020
Applicant:	JADAK, a business unit of Novanta Corporation
Address:	125 Middlesex Turnpike, Bedford, MA 01730
Manufacturer:	JADAK, a business unit of Novanta Corporation
Address:	125 Middlesex Turnpike, Bedford, MA 01730
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

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Release Control Record

Issue No.	Description	Date Issued
FCC_IC_RF_SL19082201-JAD-011	Orignal Release	09/25/2019
FCC_IC_RF_SL19082201-JAD-011 Rev 1.0	Updated per client	09/30/2019
FCC_IC_RF_SL19082201-JAD-011 Rev 2.0	Updated IDs and model	01/14/2020

1 Certificate of Conformity

Product:	RFID module
Brand:	JADAK, a business unit of Novanta Corporation
Test Model:	M6e-Micro-A, M6e-M-A
Sample Status:	Engineering sample
Applicant:	JADAK, a business unit of Novanta Corporation
Test Date:	09/05/2019/-09/24/2019
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 DA 00-705, 2000

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:** 09/25/2019

Deon Dai / Test Engineer

Approved by : _____ , **Date:** 01/14/2020

Chen Ge / 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	N/A	Device is DC powered.
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.
15.247(d)	Band Edge Measurement	PASS	Meet the requirement of limit.
15.205 & 209 & 15.247(d)	Radiated Emissions	PASS	Meet the requirement of limit.
15.203	Antenna Requirement	PASS	Antenna connector is RP-TNC not a standard connector. Professional installation is required.

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	RFID module
Brand	JADAK, a business unit of Novanta Corporation
Test Model	M6e-Micro-A
Variant Model	M6e-M-A
Identification No. of EUT	N/A
Status of EUT	Engineering sample
Power Supply Rating	5Vdc
Modulation Type	AM
Modulation Technology	FHSS
Transfer Rate	160kHz
Operating Frequency	902.75-927.25MHz
Number of Channel	50
Output Power	Power at the output of module: 31.5 dBm Output Power at the end of the cable: 29.45 dBm.
Antenna Info	ANT 1: Antenna Type: RHCP Patch Antenna Gain: 9 dBiC Typical Brand: MTI Wireless Edge Ltd. Model No: MT-242043/TRH/A/K ANT2: Antenna Type: Dipole Gain: 6 dBi Brand: Laird Technologies Model No: S8964B
Antenna Connector	RP-TNC

There is no hardware difference between the 2 model numbers. The only difference is in the number of UHF RFID tags that the device reads. The M6e-Micro-A is limited to 50 tags per second, once this limit is reached no new tags are stored in the tag buffer. The M6e-M-A has no limitation on the number of tags that enters its tag buffer. This limitation is implemented in software. There is no change in the configuration of the RF transmitter or receiver between the 2 models.

3.2 Description of Test Modes

50 channels are provided to this EUT:

Channel	Frequency (MHz)
Low	902.75
Mid	915.25
High	927.25

3.3 Description of Support Units

The RFID module (which is the EUT) is soldered to the CARRIER BOARD.

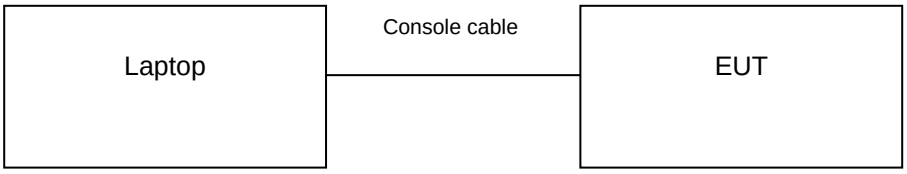
The M6E-DEVKIT provides power to the module and has Serial and USB interfaces to support both board-to-board and board-to-host connectivity.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	DC power supply	RIGOL	DP712	SED234155	N/A	N/A
B.	Laptop	Dell	XPS	C1MR31G5G944	N/A	N/A
C.	M6E-DEVKIT	JADAK, a business unit of Novanta Corporation	540-0061-01	N/A	N/A	N/A
D.	M6e-Micro-A Carrier board	JADAK, a business unit of Novanta Corporation	450-0056-01	N/A	N/A	N/A
E.	12 ft. cable	ThingMagic	CBL-P12	N/A	N/A	N/A

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB console 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
DA 00-705, 2000

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
Spectrum Analyzer KEYSIGHT	N9030B	MY57140374	07/22/2019	07/22/2020
Hybrid Antenna SUNAR	JB6	A111717	03/09/2019	03/09/2020
DRG Horn Antenna ETS LINDGREN	3117	214309	11/22/2018	11/22/2019
Preamplifier RF-LAMBDA	RAMP00M50GA	17032300047	10/19/2018	10/19/2019
Preamplifier RF-BAY	LPA-6-30	11170602	05/06/2019	05/06/2020

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:

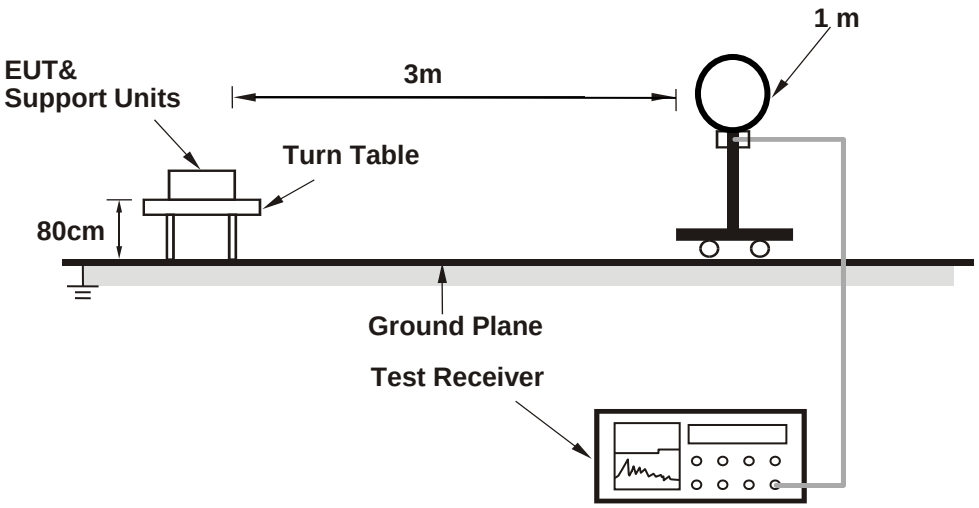
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.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

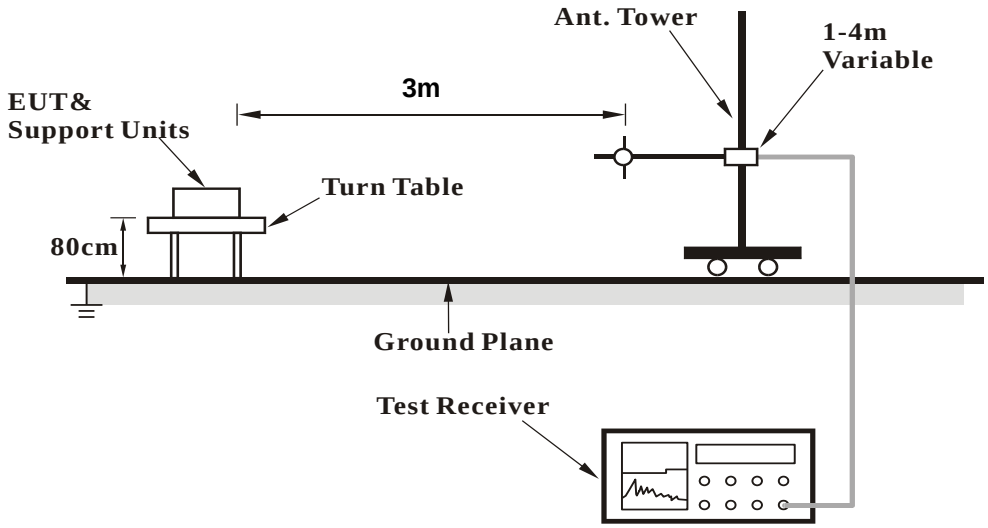
No deviation.

4.1.5 Test Setup

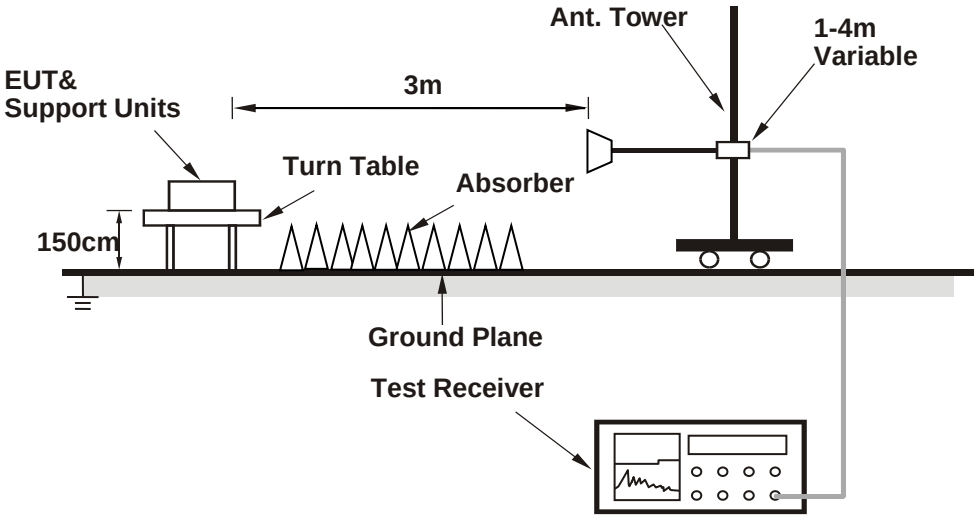
For Radiated emission below 30MHz



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:

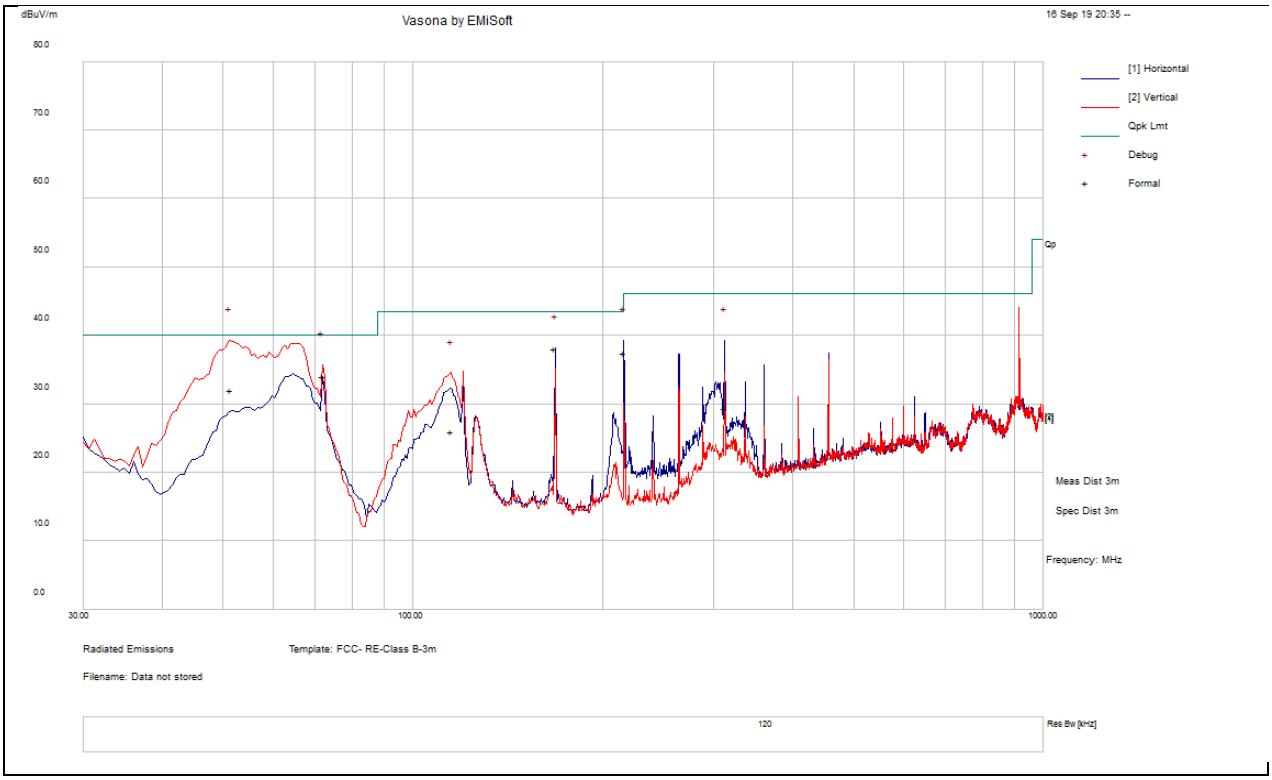
Antenna 1 RHCP Patch Antenna

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

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB)	(dB/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	51.44	47.09	11.45	-26.43	32.11	Quasi Max	V	213	105	40	-7.89	Pass
2	72.08	50.18	11.6	-27.64	34.14	Quasi Max	V	101	155	40	-5.86	Pass
3	168.15	49.97	12.34	-24.16	38.15	Quasi Max	H	204	18	43.5	-5.35	Pass
4	216.17	50.2	12.77	-25.39	37.59	Quasi Max	H	136	14	46	-8.41	Pass
5	312.54	37.88	13.29	-21.79	29.38	Quasi Max	H	114	356	46	-16.62	Pass
6	114.95	37.08	12.01	-23.05	26.04	Quasi Max	V	157	191	43.5	-17.46	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss (dB) + AF (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.



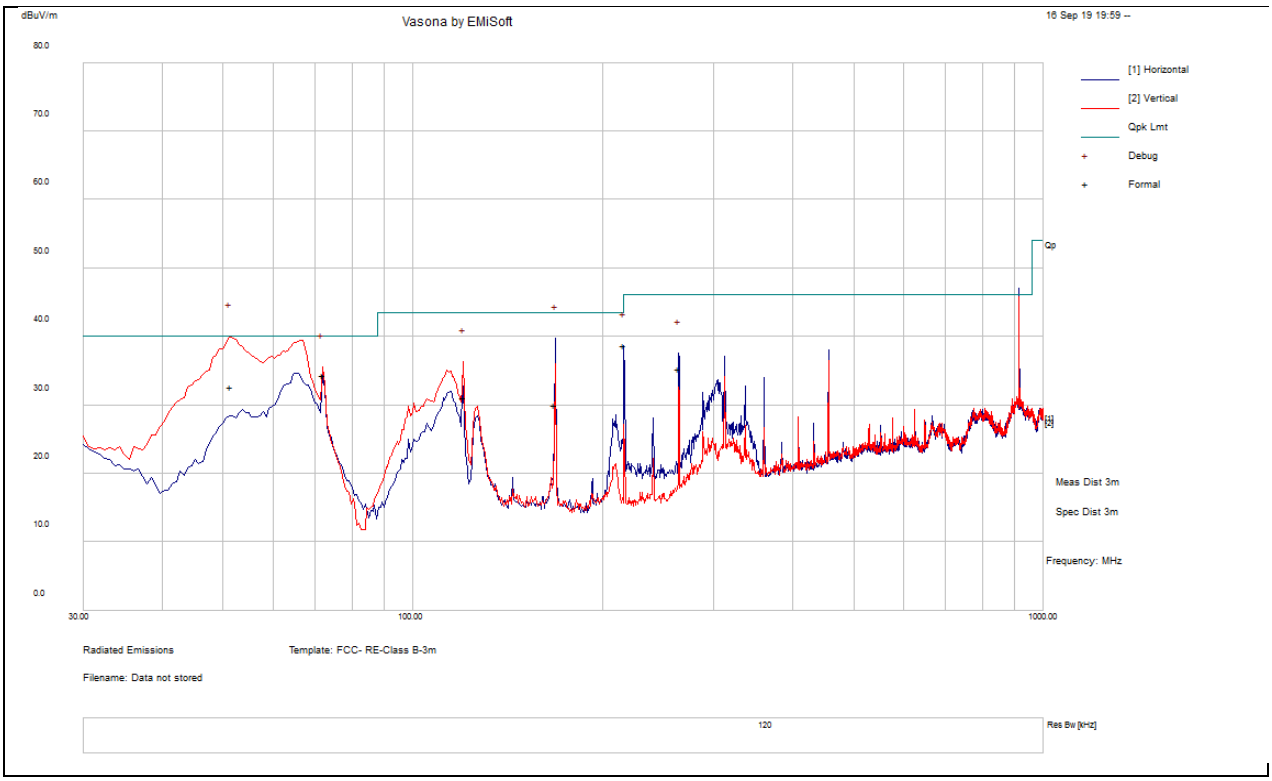
Antenna 2 (Dipole antenna)

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

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB)	(dB/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	51.42	47.66	11.45	-26.43	32.68	Quasi Max	V	100	259	40	-7.32	Pass
2	168.16	41.9	12.34	-24.16	30.08	Quasi Max	H	147	106	43.5	-13.42	Pass
3	72.06	50.51	11.6	-27.64	34.47	Quasi Max	V	111	89	40	-5.53	Pass
4	120.13	41.86	12.07	-22.73	31.2	Quasi Max	V	146	116	43.5	-12.3	Pass
5	216.25	51.37	12.77	-25.38	38.76	Quasi Max	H	146	8	46	-7.25	Pass
6	264.24	46.15	13.04	-23.79	35.4	Quasi Max	H	110	110	46	-10.61	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss (dB) + AF (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.



ABOVE 1GHz TEST DATA:

Antenna 1 RHCP Patch Antenna

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

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB)	(dB/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	4515.78	50.74	5.21	-11.59	44.36	Peak Max	V	139	360	74	-29.64	Pass
2	16851.59	45.78	9.59	1.85	57.21	Peak Max	V	120	134	74	-16.79	Pass
3	6322.94	49.78	6.04	-8.32	47.51	Peak Max	V	142	60	74	-26.49	Pass
4	5420.92	50.42	5.55	-10.33	45.64	Peak Max	V	125	179	74	-28.36	Pass
5	4515.78	38.8	5.21	-11.59	32.42	Average Max	V	139	360	54	-21.58	Pass
6	16851.59	33.61	9.59	1.85	45.05	Average Max	V	120	134	54	-8.95	Pass
7	6322.94	36.88	6.04	-8.32	34.61	Average Max	V	142	60	54	-19.4	Pass
8	5420.92	38.17	5.55	-10.33	33.39	Average Max	V	125	179	54	-20.61	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss (dB) + AF (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.

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

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB)	(dB/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	6406.56	64.85	6.12	-8.18	62.78	Peak Max	V	130	257	74	-11.22	Pass
2	4580.41	51.67	5.2	-11.35	45.52	Peak Max	V	140	186	74	-28.48	Pass
3	16641.86	45.42	9.57	1.7	56.69	Peak Max	H	140	305	74	-17.31	Pass
4	5493.58	49.74	5.7	-10.31	45.14	Peak Max	V	157	4	74	-28.86	Pass
5	6406.56	47.36	6.12	-8.18	45.3	Average Max	V	130	257	54	-8.7	Pass
6	4580.41	38.42	5.2	-11.35	32.28	Average Max	V	140	186	54	-21.73	Pass
7	16641.86	33.08	9.57	1.7	44.35	Average Max	H	140	305	54	-9.65	Pass
8	5493.58	37.81	5.7	-10.31	33.21	Average Max	V	157	4	54	-20.79	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss (dB) + AF (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.

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

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB)	(dB/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	6491.14	60.67	6.2	-8.03	58.84	Peak Max	V	122	257	74	-15.16	Pass
2	16266.87	46.32	9.4	0.74	56.46	Peak Max	H	193	340	74	-17.54	Pass
3	4635.71	61.12	5.19	-11.2	55.12	Peak Max	V	183	245	74	-18.89	Pass
4	5556.91	50.53	5.63	-10.22	45.95	Peak Max	V	159	139	74	-28.05	Pass
5	1850.63	53.18	3.13	-14.03	42.28	Peak Max	V	116	111	74	-31.72	Pass
6	6491.14	44.47	6.2	-8.03	42.64	Average Max	V	122	257	54	-11.36	Pass
7	16266.87	34.28	9.4	0.74	44.42	Average Max	H	193	340	54	-9.58	Pass
8	4635.71	49.28	5.19	-11.2	43.27	Average Max	V	183	245	54	-10.73	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss (dB) + AF (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.

ABOVE 1GHz TEST DATA:

Antenna 2 (Dipole antenna)

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

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB)	(dB/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	4518.67	51.14	5.21	-11.58	44.77	Peak Max	V	191	66	74	-29.23	Pass
2	16627.38	45.53	9.57	1.68	56.77	Peak Max	V	107	360	74	-17.23	Pass
3	6324.90	49.31	6.04	-8.31	47.04	Peak Max	V	100	240	74	-26.96	Pass
4	5418.99	50.65	5.55	-10.33	45.87	Peak Max	V	145	171	74	-28.13	Pass
5	4518.67	38.38	5.21	-11.58	32.02	Average Max	V	191	66	54	-21.99	Pass
6	16627.38	33.09	9.57	1.68	44.34	Average Max	V	107	360	54	-9.67	Pass
7	6324.90	36.77	6.04	-8.31	34.5	Average Max	V	100	240	54	-19.5	Pass
8	5418.99	38.23	5.55	-10.33	33.44	Average Max	V	145	171	54	-20.56	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss (dB) + AF (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.

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

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB)	(dB/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	6406.48	64.67	6.12	-8.18	62.61	Peak Max	V	141	258	74	-11.4	Pass
2	4579.53	50.55	5.2	-11.35	44.41	Peak Max	V	125	255	74	-29.59	Pass
3	16787.42	46.01	9.56	1.9	57.47	Peak Max	H	125	240	74	-16.53	Pass
4	5496.13	49.43	5.71	-10.3	44.83	Peak Max	V	158	51	74	-29.17	Pass
5	6406.48	46.73	6.12	-8.18	44.67	Average Max	V	141	258	54	-9.34	Pass
6	4579.53	38.46	5.2	-11.35	32.31	Average Max	V	125	255	54	-21.69	Pass
7	16787.42	33.61	9.56	1.9	45.07	Average Max	H	125	240	54	-8.94	Pass
8	5496.13	37.9	5.71	-10.3	33.3	Average Max	V	158	51	54	-20.7	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss (dB) + AF (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.

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

ANTENNA POLARITY & test distance: HORIZONTAL& VERTICAL at 3 m												
No	Freq.	Raw	Cale Loss	AF	Level	Measurement Type	Pol	Hgt	Azt	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB)	(dB/m)	(dBuV/m)			(cm)	Deg	(dBuV/m)	(dB)	
1	6491.16	60.26	6.2	-8.03	58.42	Peak Max	V	134	284	74	-15.58	Pass
2	17639.82	45.4	9.55	1.73	56.68	Peak Max	H	189	279	74	-17.32	Pass
3	4634.53	51.03	5.19	-11.2	45.02	Peak Max	V	148	351	74	-28.98	Pass
4	5558.40	50.2	5.63	-10.22	45.61	Peak Max	V	151	347	74	-28.39	Pass
5	1850.49	54.38	3.13	-14.03	43.47	Peak Max	V	182	326	74	-30.53	Pass
6	6491.16	45.24	6.2	-8.03	43.41	Average Max	V	134	284	54	-10.59	Pass
7	17639.82	33.21	9.55	1.73	44.48	Average Max	H	189	279	54	-9.52	Pass
8	4634.53	38.74	5.19	-11.2	32.74	Average Max	V	148	351	54	-21.26	Pass

REMARKS:

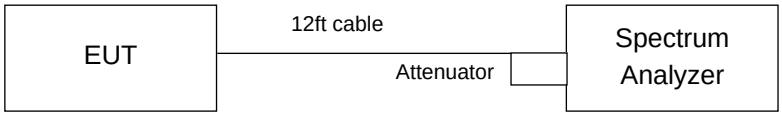
1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss (dB) + AF (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.

4.2 Channel Bandwidth

4.2.1 Limits of Channel Bandwidth Measurement

For frequency hopping system operating in the 2400-2483.5MHz, If the 20dB bandwidth of hopping channel is greater than 25kHz, two-thirds 20dBbandwidth of hopping channel shell be a minimum limit for the hopping channel separation.

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.

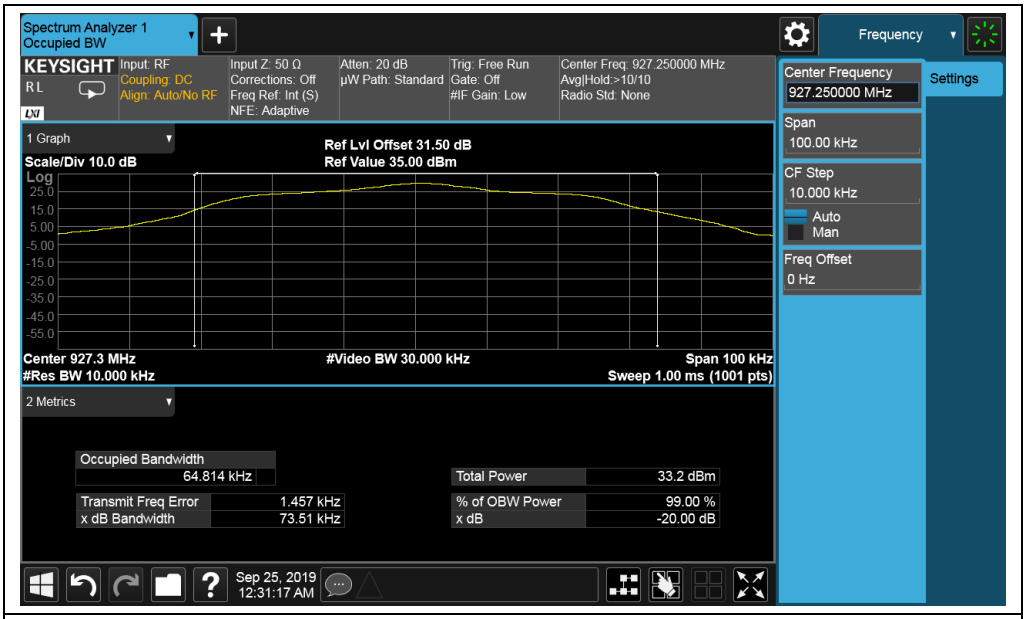
4.2.7 Test Results

Channel	Frequency (MHz)	20dB Bandwidth (kHz)
Low	902.25	73.94
Mid	915.25	72.94
High	927.25	73.51

Test Plots:

Low Channel

Middle Channel



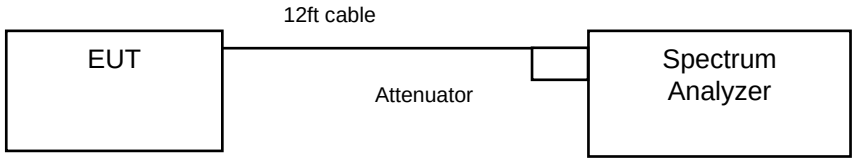
High Channel

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

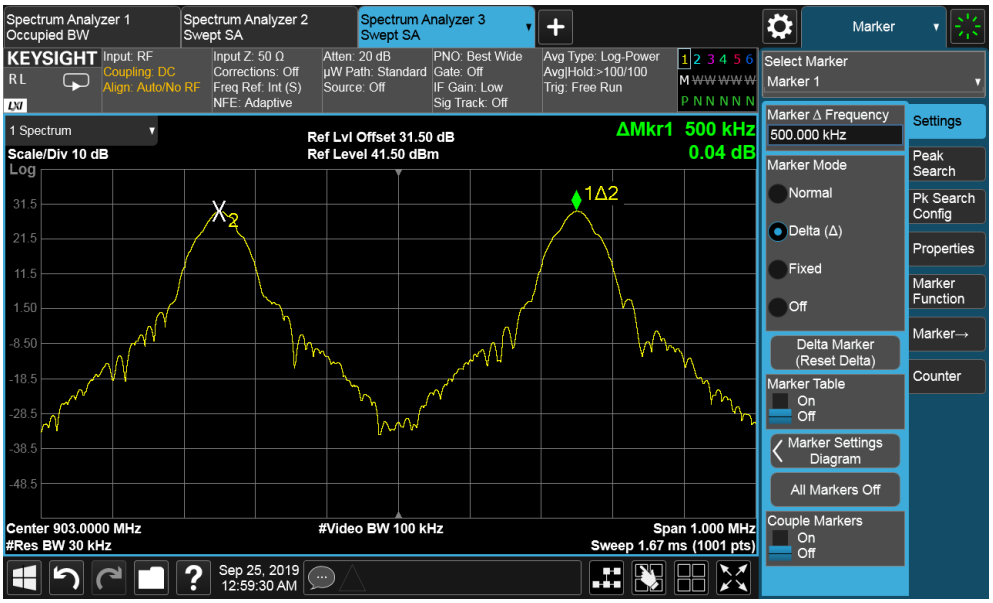
No deviation.

4.3.6 Test Results

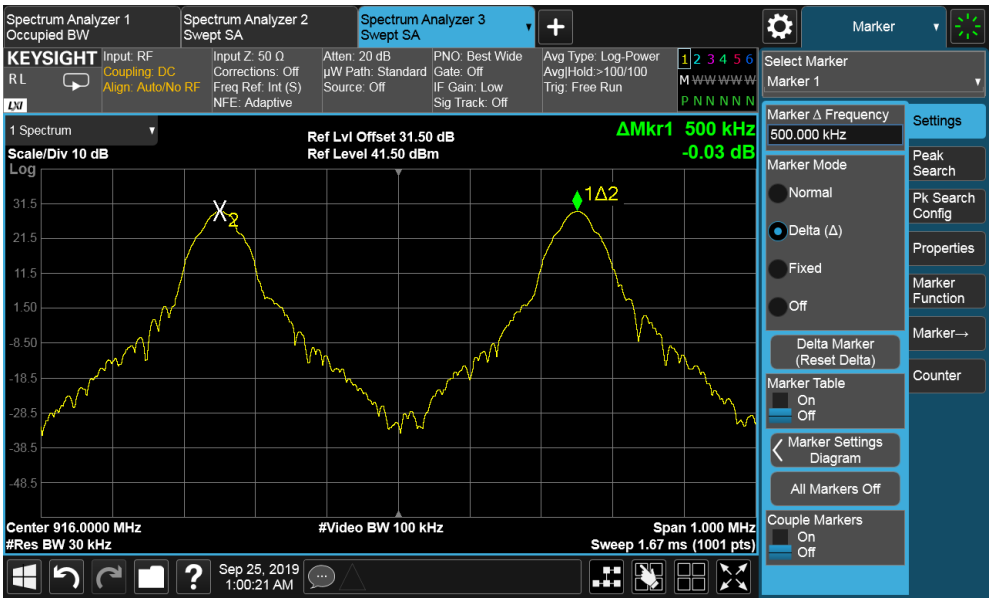
Channel	Frequency (MHz)	Adjacent Channel Separation (kHz)	20dB Bandwidth (kHz)	Minimum Limit (kHz)	Pass / Fail
Low	902.25	500	73.94	73.94	Pass
Mid	915.25	500	72.94	72.94	Pass
High	927.25	500	73.51	73.51	Pass

NOTE: The minimum limit is two-third 20dB bandwidth.

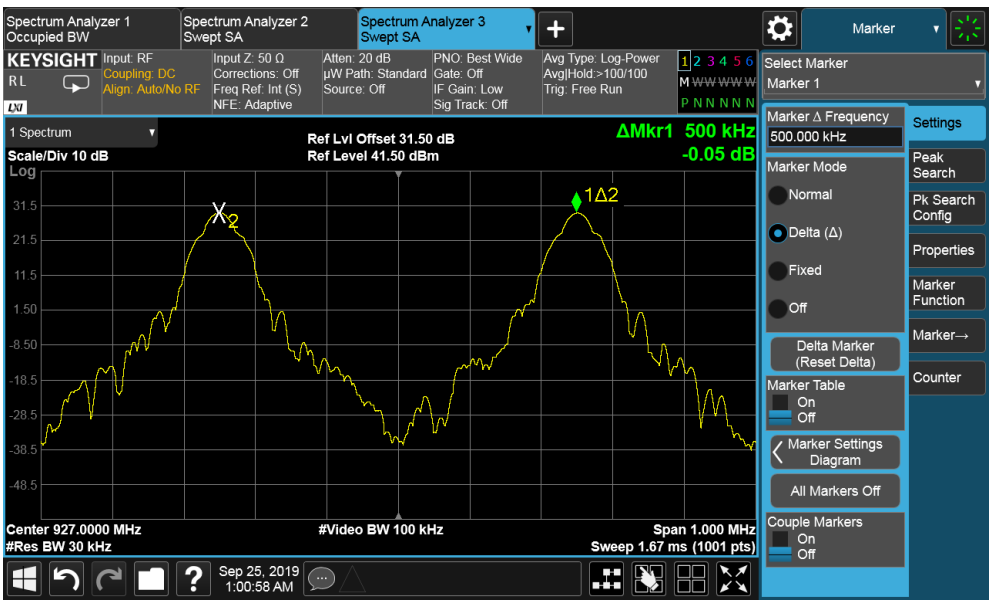
Test Plots:



Low Channel



Middle Channel



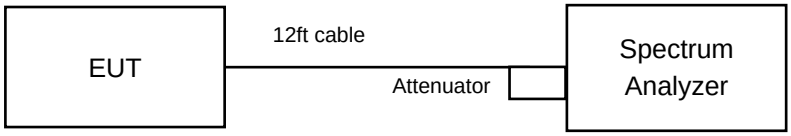
High Channel

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.

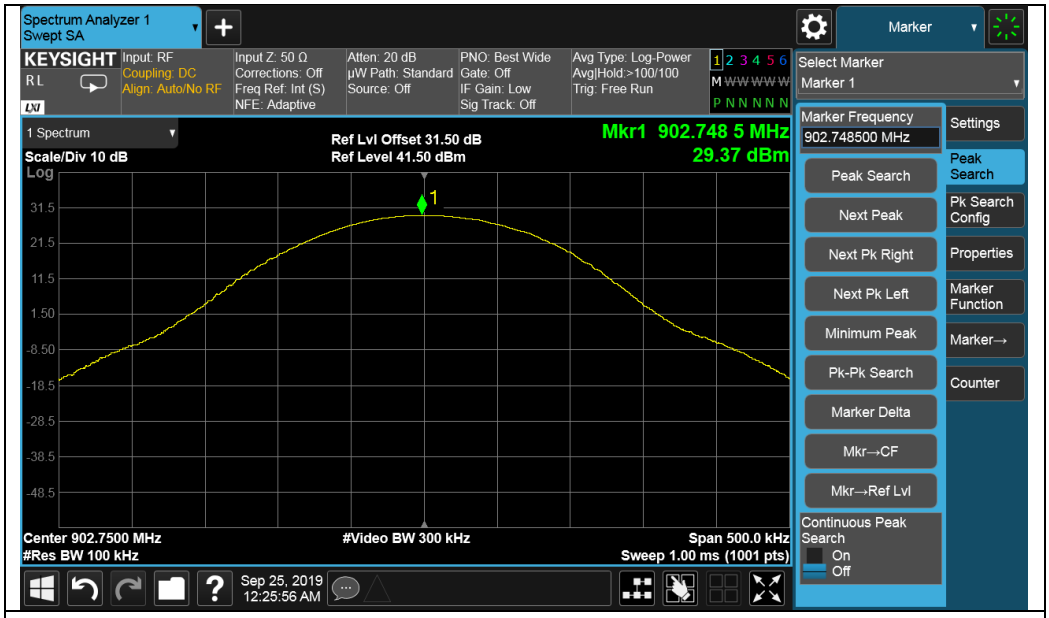
4.4.6 Test Results

The power transmitted at the output port of the module is 31.5 dBm.

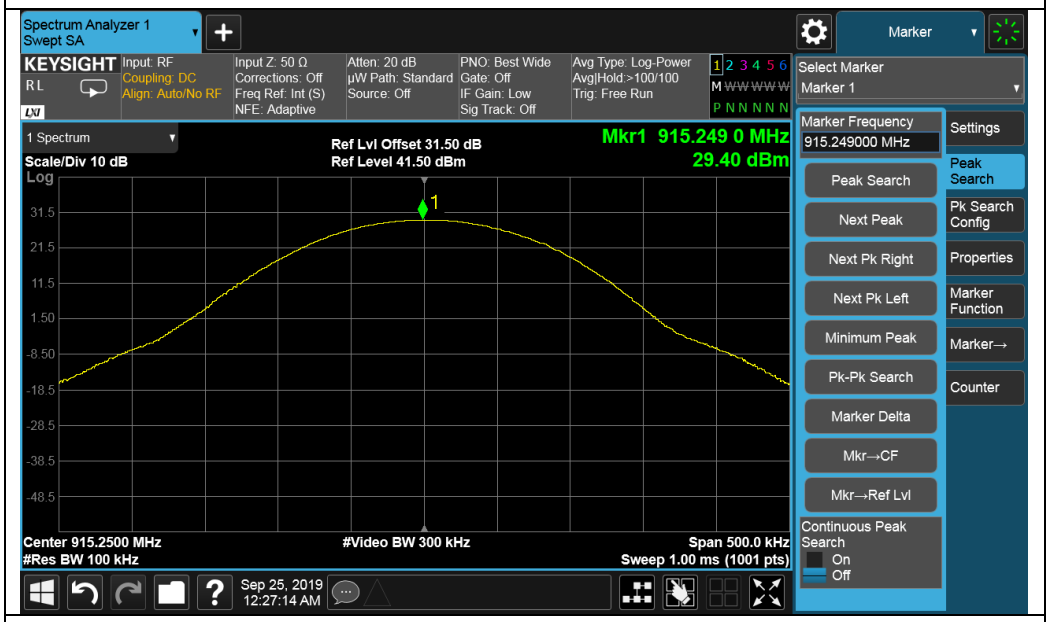
Channel	Frequency (MHz)	Conducted Power at the end of the cable (dBm)"	Limit (dBm)	Pass/Fail
Low	902.25	29.37	30	Pass
Mid	915.25	29.40	30	Pass
High	927.25	29.45	30	Pass

Note: The power result is measured at antenna port, the actual power from module is 1.5dB higher, a cable with 1.3dB loss is connected between the module and antenna.

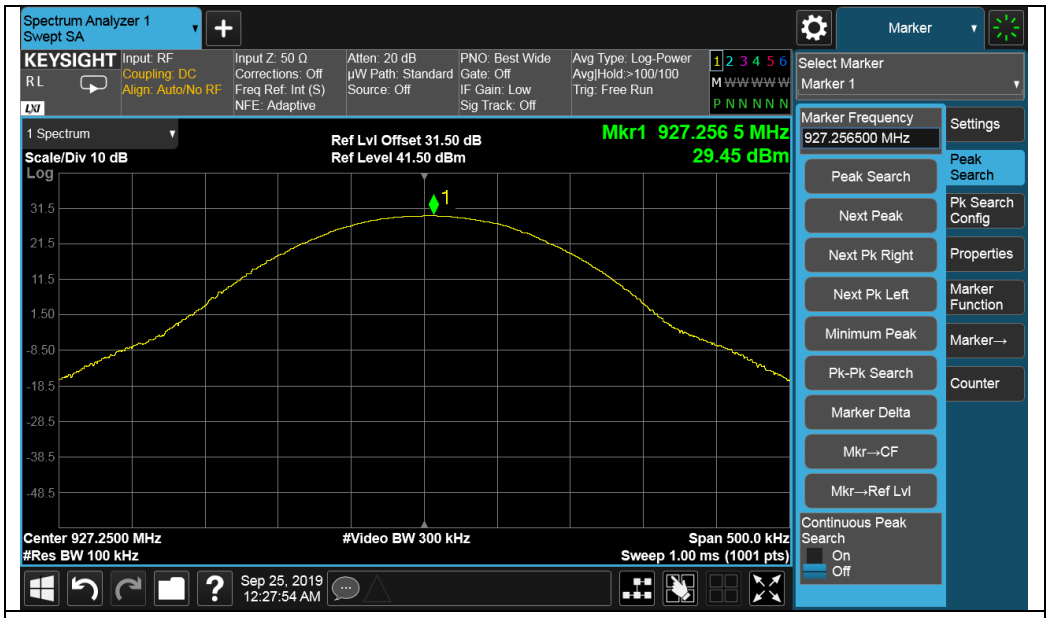
Test Plots:



Low Channel



Middle Channel



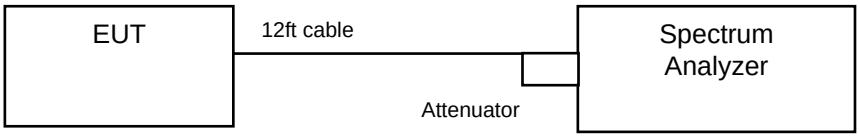
High Channel

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.

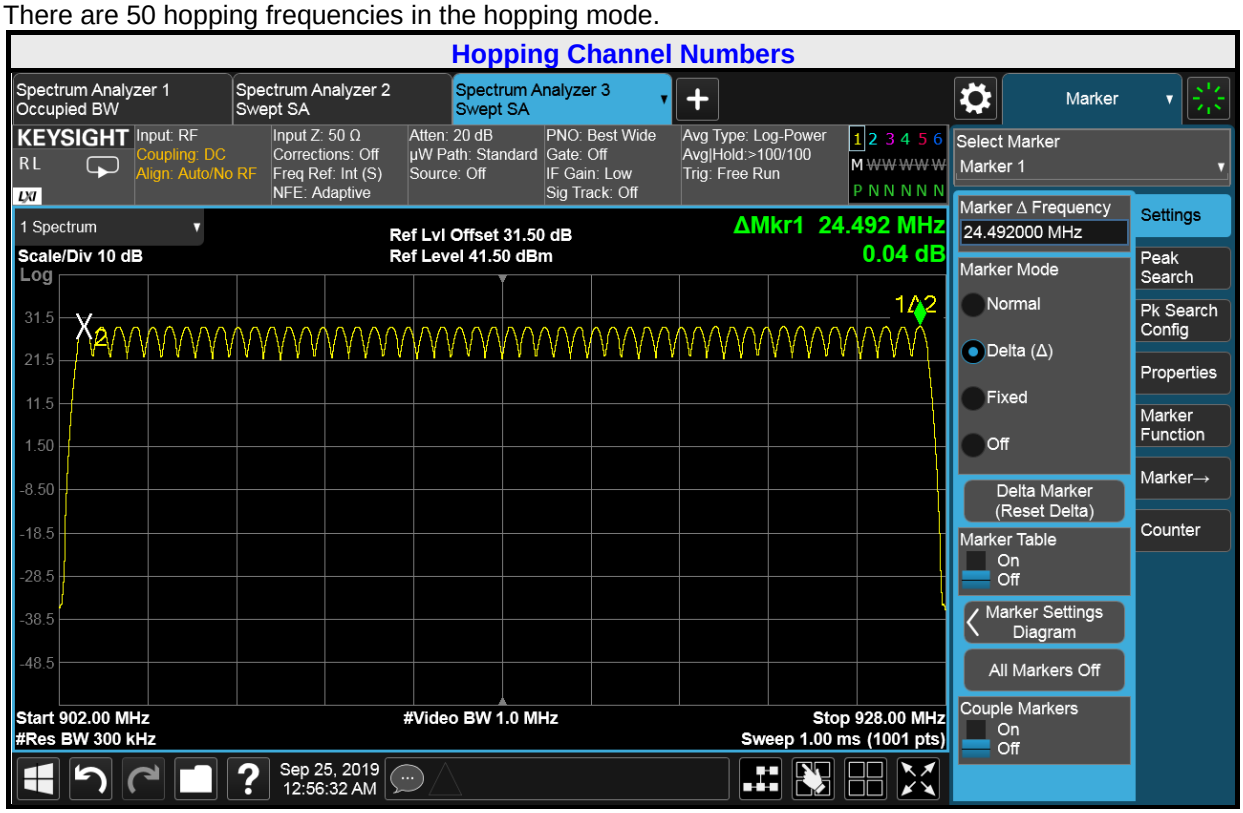
e. Repeat above procedures until all frequencies measured were complete.

4.5.5 Deviation from Test Standard

No deviation.

4.5.6 Test Results

There are 50 hopping frequencies in the hopping mode.

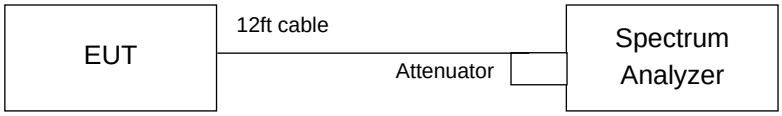


4.6 Dwell Time on Each Channel

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.

.

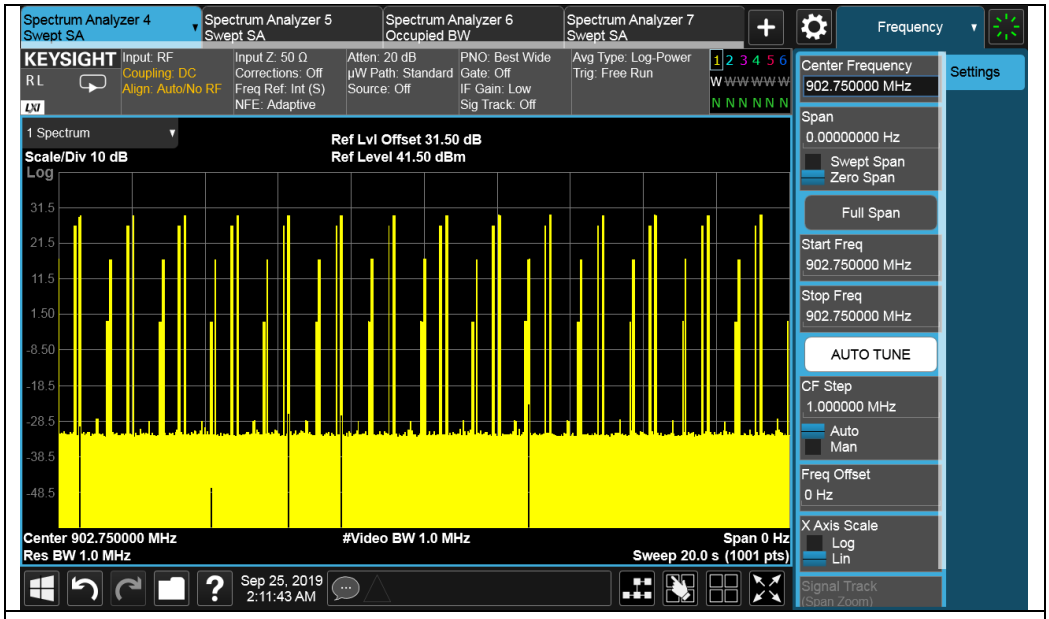
4.6.5 Deviation from Test Standard

No deviation.

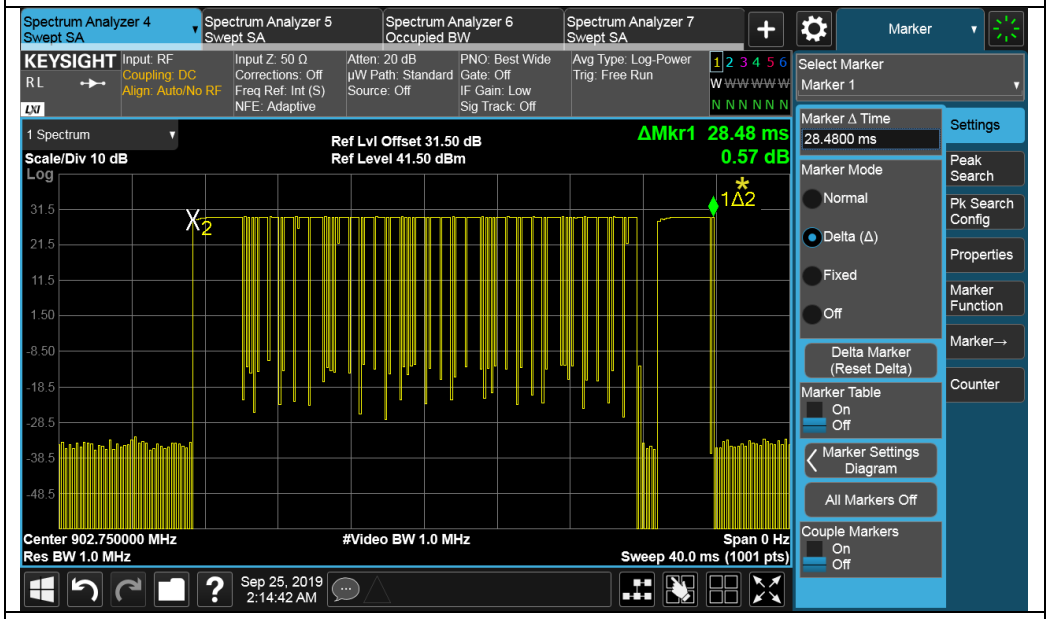
4.6.6 Test Results

Mode	Number of transmission in a 20 sec	Length of transmission time (msec)	Result (msec)	Limit (msec)
Low	14 times	28.48	398.72	400
Middle	14 times	27.28	381.92	400
High	14 times	28.28	395.92	400

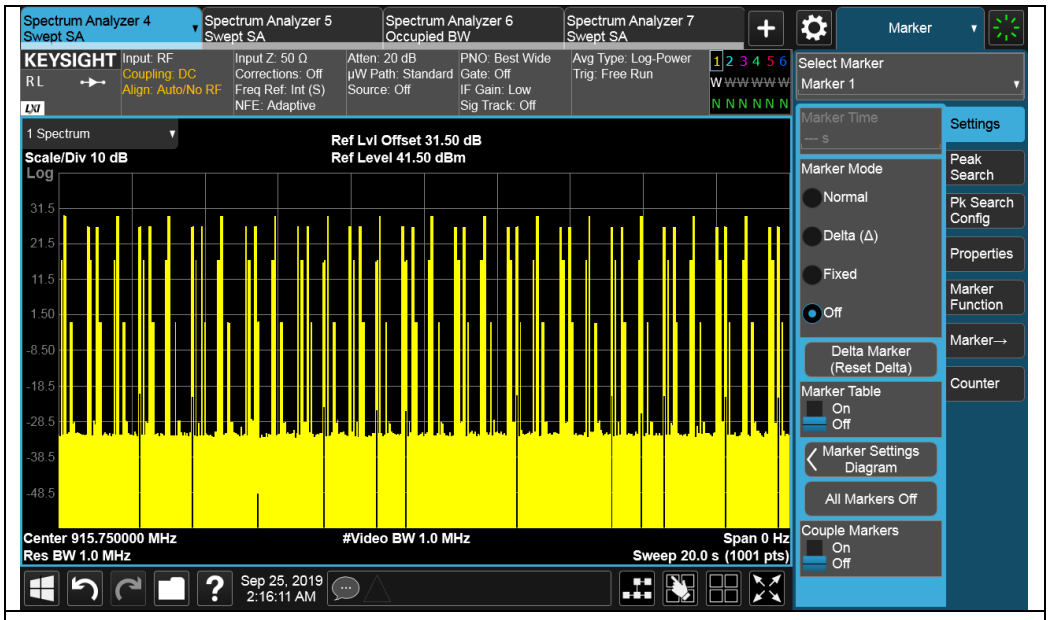
NOTE: Test plots of the transmitting time slot are shown on next page.



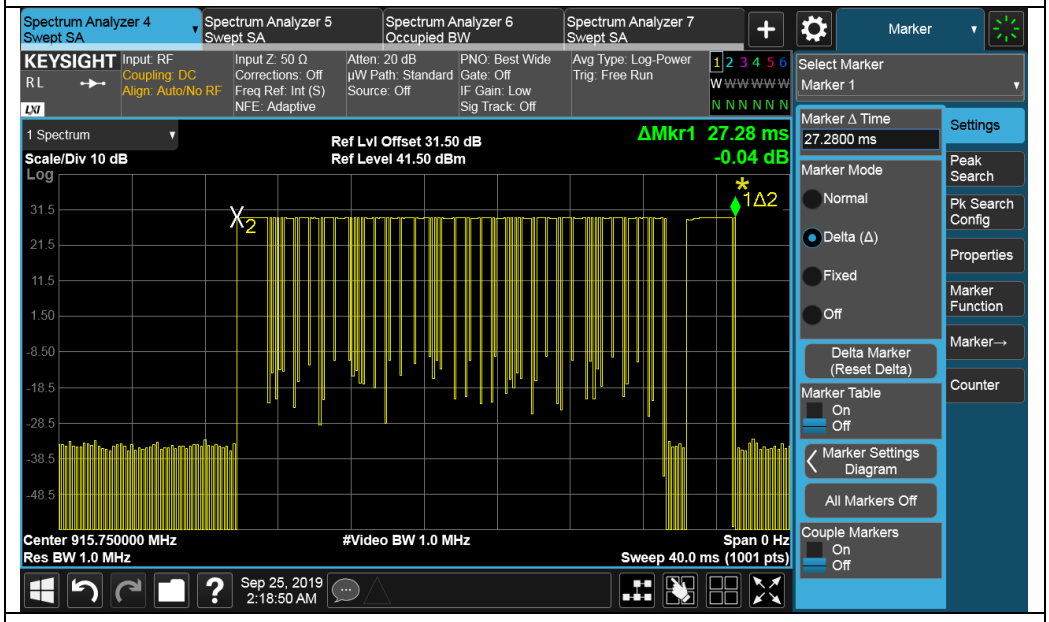
Low Channel – 20s



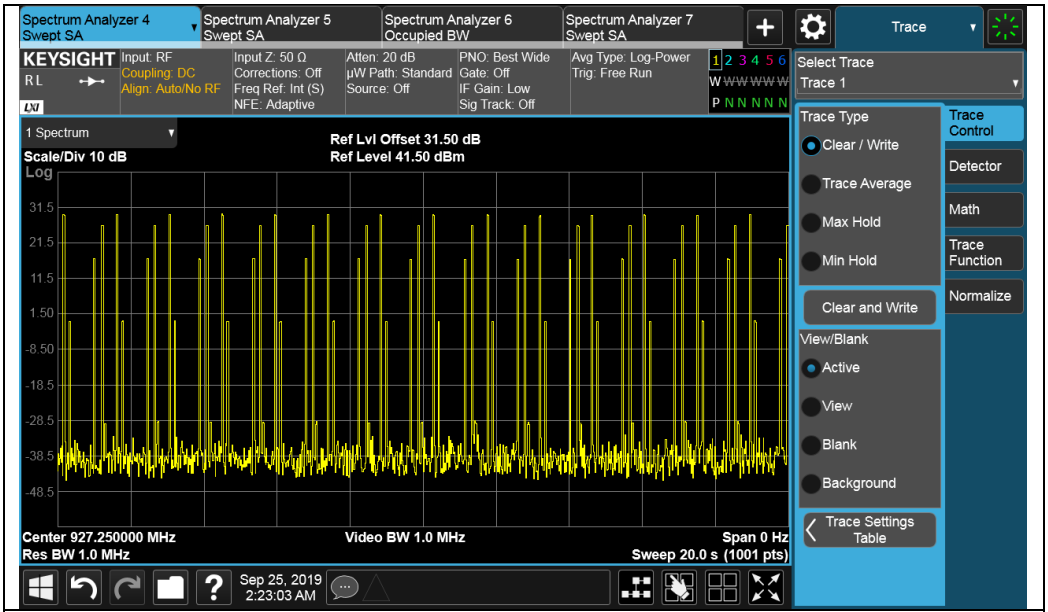
Low Channel – Pulse width



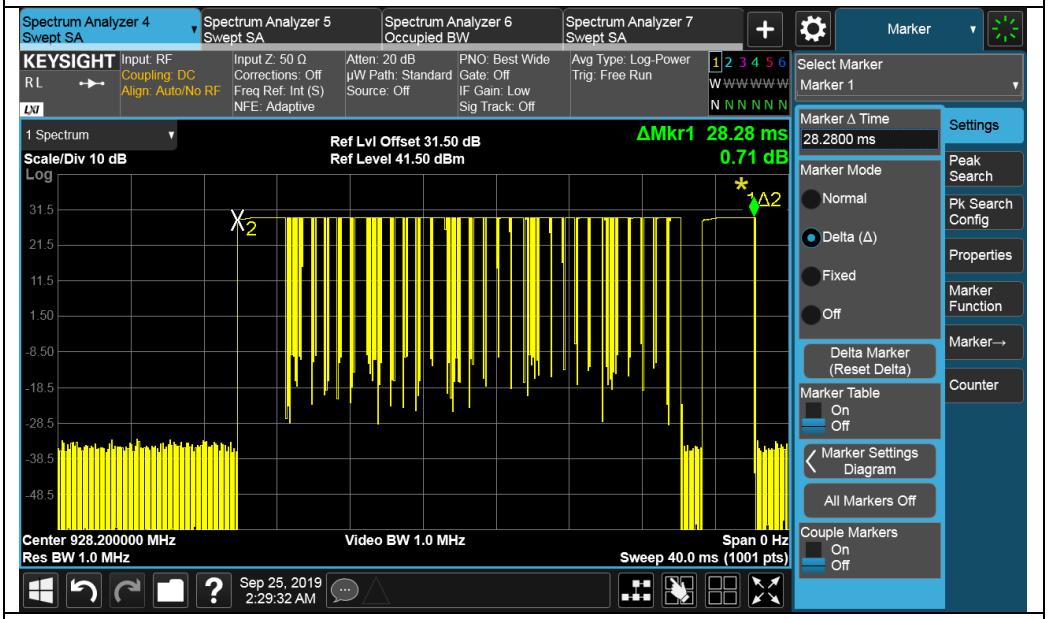
Middle Channel – 20s



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.

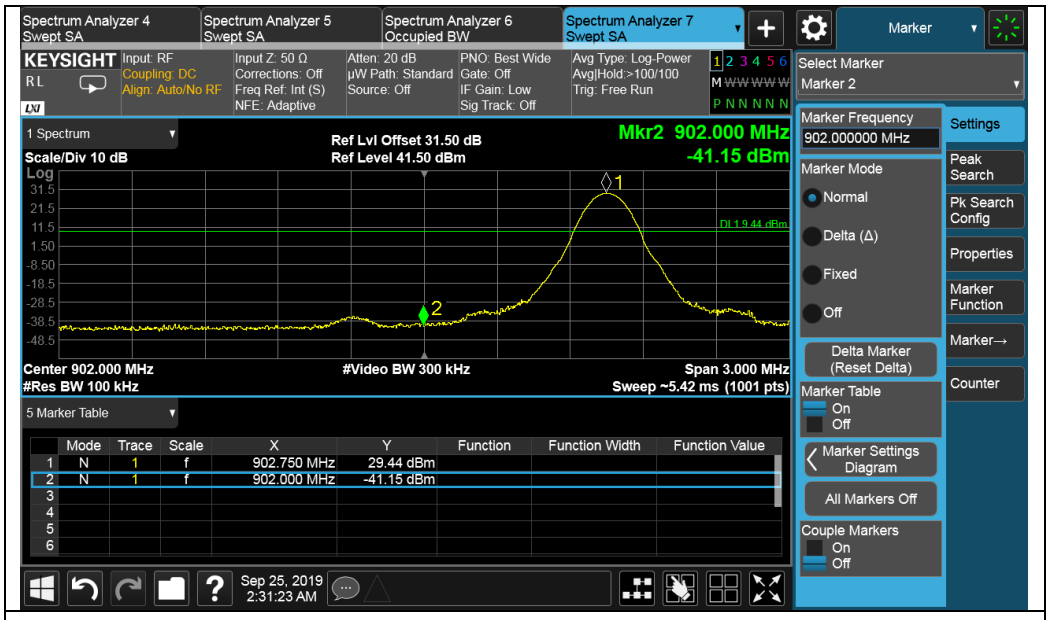
4.7.5 EUT Operating Condition

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

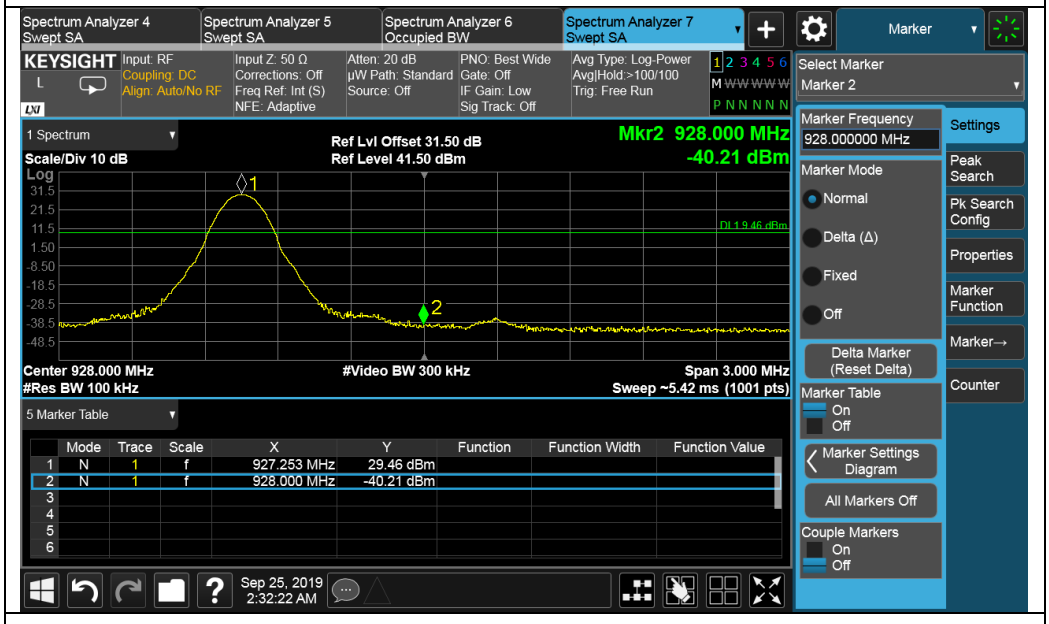
4.7.6 Test Results

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.

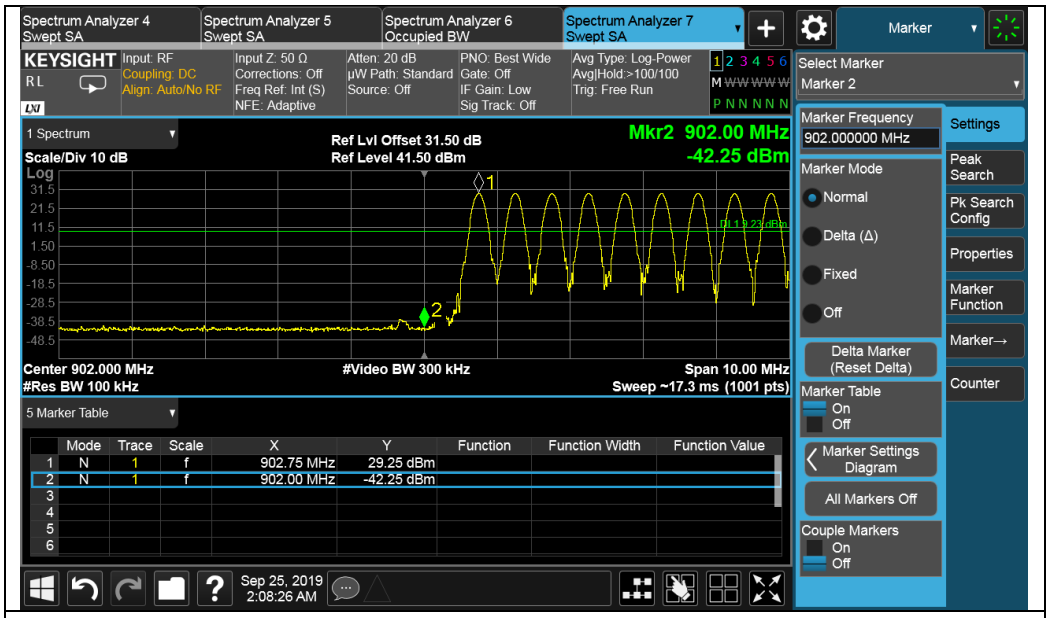
4.7.7 Test Results



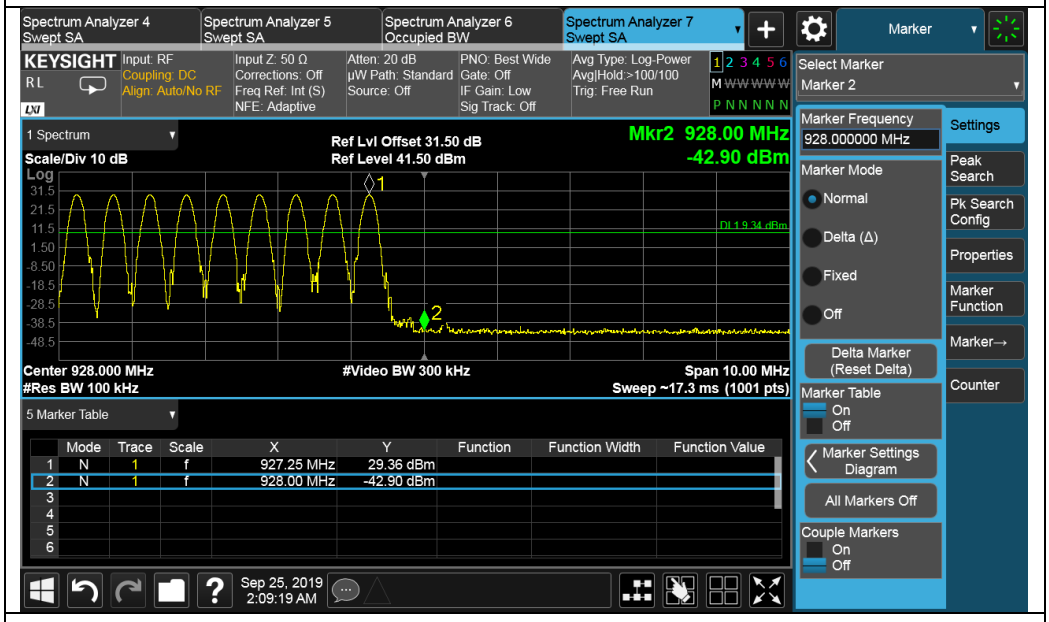
Low Channel



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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Web Site: www.cpsusa-bureauveritas.com

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

--- END ---