FCC Test Report

Report No.:	RF181101E11
FCC ID:	2AE2VRCZ2
Test Model:	Sigfox_RCZ2
Received Date:	Nov. 01, 2018
Test Date:	Nov. 22 to Dec. 05, 2018
Issued Date:	Jan. 03, 2019
Applicant:	SensingTek Co.,Ltd
Address:	4F-2, No. 8, Ziqiang S. Rd., Zhubei City, Hsinchu County 302, Taiwan (R.O.C.)
Issued By:	Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Hsin Chu Laboratory
Lab Address:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan R.O.C.
Test Location:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan R.O.C.
FCC Registration / Designation Number:	723255 / TW2022

Testing Laboratory
2022

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Release Control Record

Issue No.	Description	Date Issued
RF181101E11	Original release.	Jan. 03, 2019

1 Certificate of Conformity

Product:	Sigfox Module
Brand:	SensingTek
Test Model:	Sigfox_RCZ2
Sample Status:	ENGINEERING SAMPLE
Applicant:	SensingTek Co.,Ltd
Test Date:	Nov. 22 to Dec. 05, 2018
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 (H.K.) Ltd., Taoyuan 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 : Mary Ko , **Date:** Jan. 03, 2019

Mary Ko / Specialist

Approved by : , **Date:** Jan. 03, 2019

May Chen / Manager

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	Meet the requirement of limit. Minimum passing margin is -40.22dB at 20.91797MHz.
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 & 209 & 15.247(d)	Radiated Emissions & Band Edge Measurement	PASS	Meet the requirement of limit. Minimum passing margin is -3.1dB at 4510.69MHz, 4523.31MHz.
15.247(d)	Antenna Port Emission	PASS	Meet the requirement of limit.
15.203	Antenna Requirement	PASS	Antenna connector is IPEX -MHF4 not a standard connector.

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	1.84 dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	5.53 dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	5.08 dB
	6GHz ~ 18GHz	4.98 dB
	18GHz ~ 40GHz	5.19 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Sigfox Module
Brand	SensingTek
Test Model	Sigfox_RCZ2
Status of EUT	ENGINEERING SAMPLE
Power Supply Rating	3Vdc from host equipment
Modulation Type	D-BPSK
Modulation Technology	FHSS
Transfer Rate	600bps
Operating Frequency	902.137MHz ~ 904.662MHz
Number of Channel	Refer to 3.2
Output Power	185.78mW
Antenna Type	Refer to Note
Antenna Connector	Refer to Note
Accessory Device	NA
Data Cable Supplied	NA

Note:

1. The antenna provided to the EUT, please refer to the following table:

Antenna Net Gain(dBi)	Frequency range	Antenna Type	Connector Type
1.17	902.137~904.662 MHz	FPC	IPEX -MHF4

2. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

3.2 Description of Test Modes

Channel frequencies are distributed into 9 groups of 6 channels.

Groups	Micro Channel 1 (MHz)	Micro Channel 2 (MHz)	Micro Channel 3 (MHz)	Micro Channel 4 (MHz)	Micro Channel 5 (MHz)	Micro Channel 6 (MHz)
1	902.1375	902.1625	902.1875	902.2125	902.2375	902.2625
2	902.4375	902.4625	902.4875	902.5125	902.5375	902.5625
3	902.7375	902.7625	902.7875	902.8125	902.8375	902.8625
4	903.0375	903.0625	903.0875	903.1125	903.1375	903.1625
5	903.3375	903.3625	903.3875	903.4125	903.4375	903.4625
6	903.6375	903.6625	903.6875	903.7125	903.7375	903.7625
7	903.9375	903.9625	903.9875	904.0125	904.0375	904.0625
8	904.2375	904.2625	904.2875	904.3125	904.3375	904.3625
9	904.5375	904.5625	904.5875	904.6125	904.6375	904.6625

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 positioned of each 3 axis. The worst case was found when positioned on **X-plane**.

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.

Operating Frequency (MHz ~ MHz)	Tested Frequency	Modulation Technology	Modulation Type
902.1375 ~ 904.6625	902.1375, 904.6625	FHSS	DBPSK

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.

Operating Frequency (MHz ~ MHz)	Tested Frequency	Modulation Technology	Modulation Type
902.1375 ~ 904.6625	902.1375, 904.6625	FHSS	DBPSK

Power Line Conducted Emission Test:

☒ 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.

Operating Frequency (MHz ~ MHz)	Tested Frequency	Modulation Technology	Modulation Type
902.1375 ~ 904.6625	902.1375	FHSS	DBPSK

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.

Operating Frequency (MHz ~ MHz)	Tested Frequency	Modulation Technology	Modulation Type
902.1375 ~ 904.6625	902.1375, 904.6625	FHSS	DBPSK

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER (System)	TESTED BY
RE≥1G	23deg. C, 68%RH	120Vac, 60Hz	Frank Chuang
RE<1G	23deg. C, 68%RH	120Vac, 60 Hz	Frank Chuang
PLC	25deg. C, 75%RH	120Vac, 60 Hz	Frank Chuang
APCM	25deg. C, 60%RH	120Vac, 60 Hz	Anderson Chen

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.	DC Power Supply	GOOD WILL INSTRUMENT CO., LTD.	GPC-3030D	7700087	NA	Provided by Lab
B.	Test Tool	NA	NA	NA	NA	Supplied by client

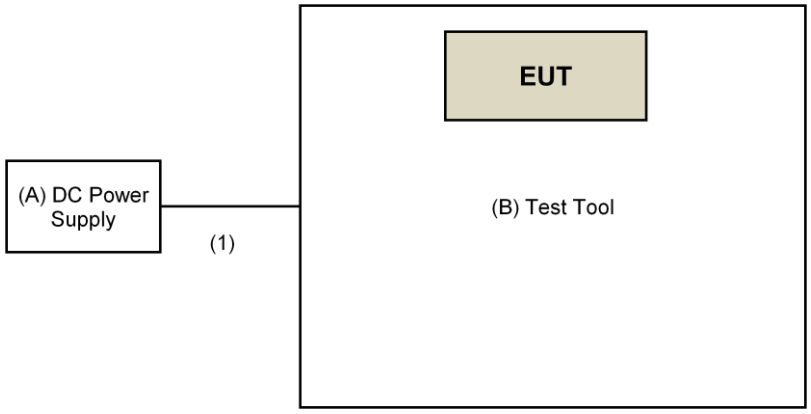
Note:

1. All power cords of the above support units are non-shielded (1.8m).

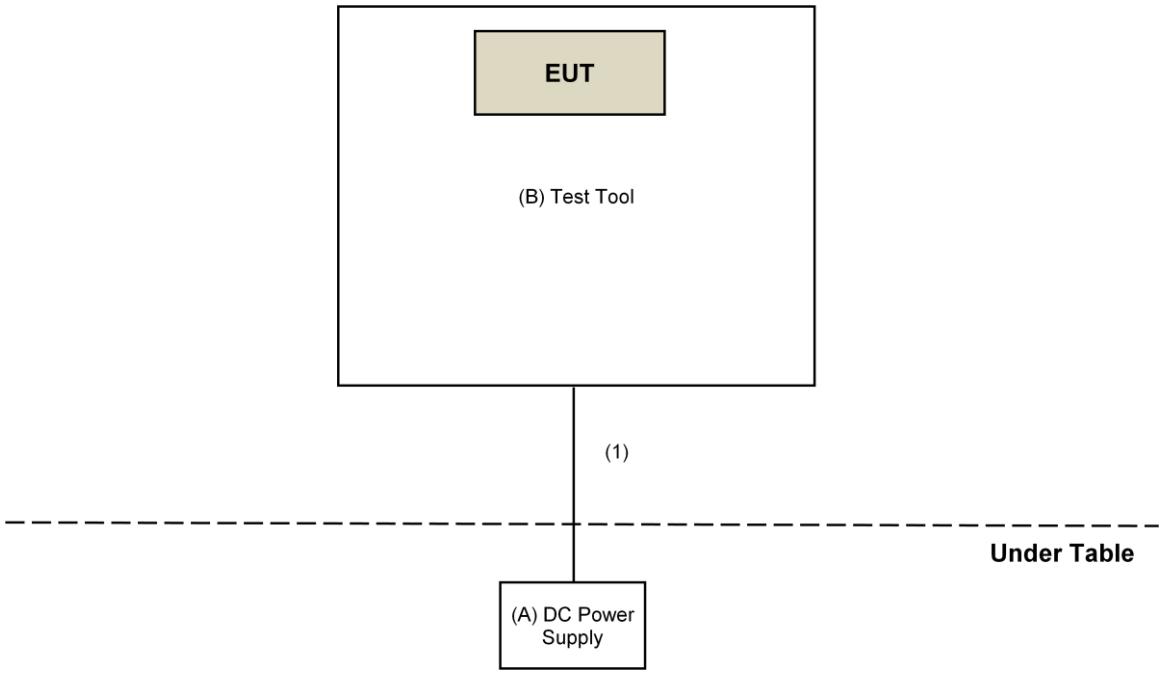
ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	DC Cable	1	1.8	No	0	Provided by Lab

3.3.1 Configuration of System under Test

For conducted emission test:



For radiated emission 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)
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.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver Agilent	N9038A	MY50010156	July 12, 2018	July 11, 2019
Pre-Amplifier EMCI	EMC001340	980142	Feb. 09, 2018	Feb. 08, 2019
Loop Antenna(*) Electro-Metrics	EM-6879	264	Dec. 16, 2016	Dec. 15, 2018
RF Cable	NA	LOOPCAB-001	Jan. 15, 2018	Jan. 14, 2019
RF Cable	NA	LOOPCAB-002	Jan. 15, 2018	Jan. 14, 2019
Pre-Amplifier Mini-Circuits	ZFL-1000VH2B	AMP-ZFL-05	May 05, 2018	May 04, 2019
Trilog Broadband Antenna SCHWARZBECK	VULB 9168	9168-361	Nov. 22, 2018	Nov. 21, 2019
RF Cable	8D	966-3-1	Mar. 20, 2018	Mar. 19, 2019
RF Cable	8D	966-3-2	Mar. 20, 2018	Mar. 19, 2019
RF Cable	8D	966-3-3	Mar. 20, 2018	Mar. 19, 2019
Fixed attenuator Mini-Circuits	UNAT-5+	PAD-3m-3-01	Sep. 27, 2018	Sep. 26, 2019
Horn_Antenna SCHWARZBECK	BBHA9120-D	9120D-406	Dec. 12, 2017	Dec. 11, 2018
Pre-Amplifier EMCI	EMC12630SE	980384	Jan. 29, 2018	Jan. 28, 2019
RF Cable	EMC104-SM-SM-1200	160922	Jan. 29, 2018	Jan. 28, 2019
RF Cable	EMC104-SM-SM-2000	150317	Jan. 29, 2018	Jan. 28, 2019
RF Cable	EMC104-SM-SM-5000	150322	Jan. 29, 2018	Jan. 28, 2019
Software	ADT_Radiated_V8.7.08	NA	NA	NA
Antenna Tower & Turn Table Max-Full	MF-7802	MF780208406	NA	NA
Boresight Antenna Fixture	FBA-01	FBA-SIP01	NA	NA
Spectrum Analyzer R&S	FSV40	100964	June 20, 2018	June 19, 2019
Power meter Anritsu	ML2495A	1014008	May 09, 2018	May 08, 2019
Power sensor Anritsu	MA2411B	0917122	May 09, 2018	May 08, 2019

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 calibration interval of the above test instruments is 24 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. The test was performed in 966 Chamber No. 3.
4. The CANADA Site Registration No. is 20331-1
5. Loop antenna was used for all emissions below 30 MHz.
6. Tested Date: Nov. 22 to Dec. 04, 2018

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. 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:

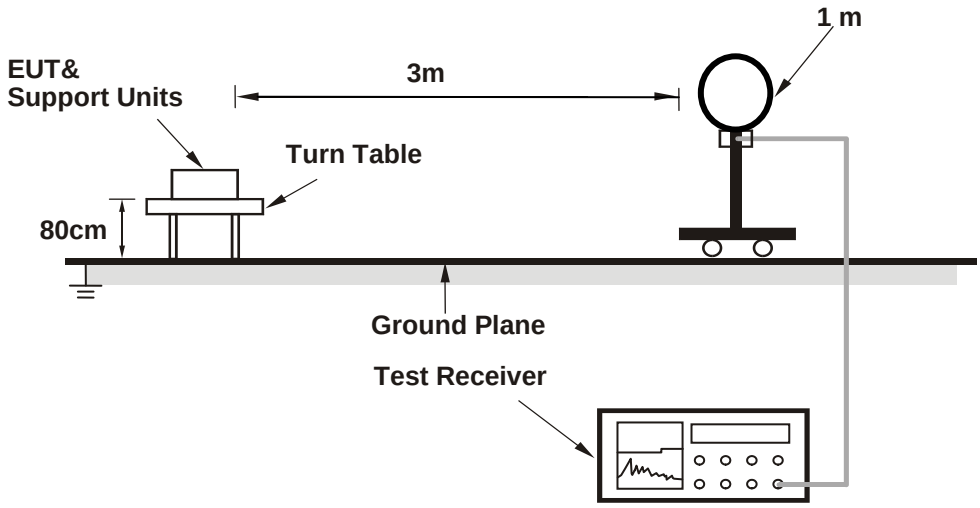
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.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

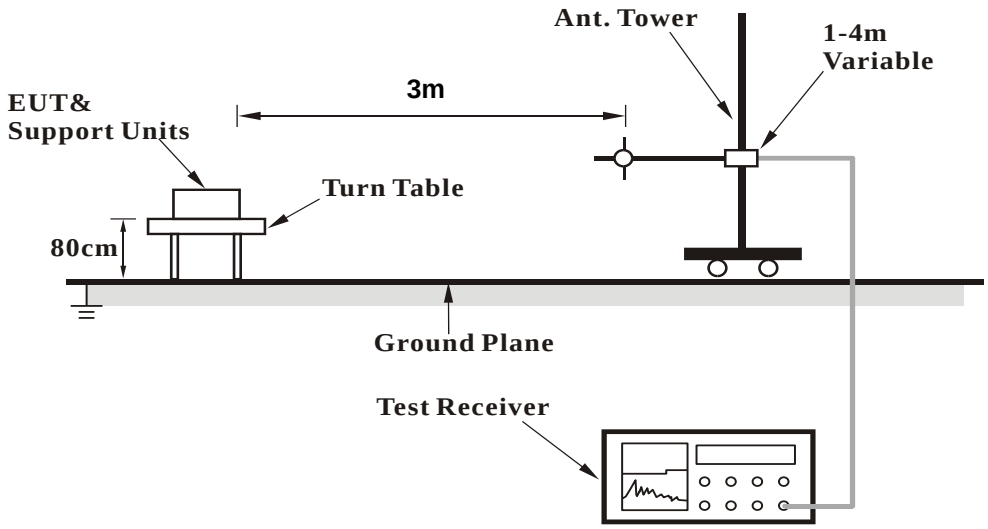
No deviation.

4.1.5 Test Setup

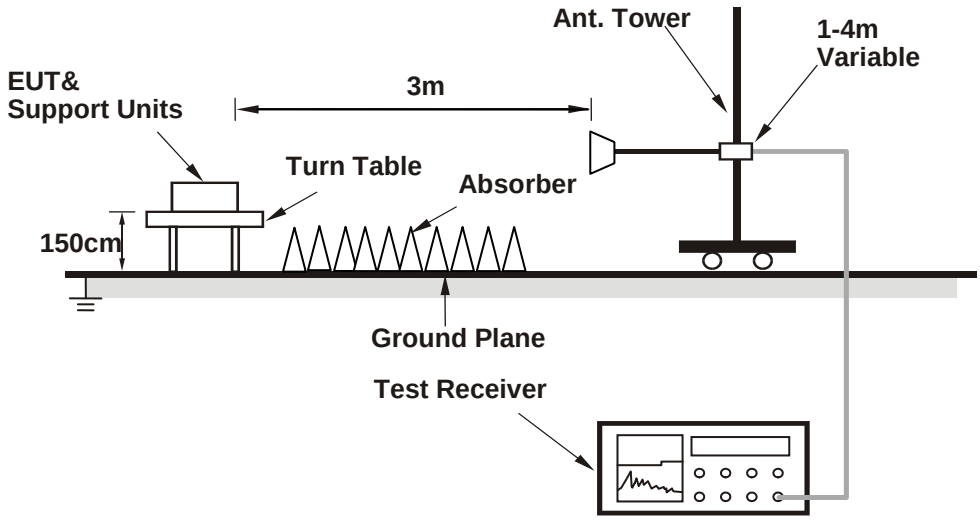
For Radiated emission below 30MHz



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. Placed the EUT on the testing table.
b. Controlling the test tool (Push button) to set the EUT on specific status.

4.1.7 Test Results

Above 1GHz Data:

TESTED FREQUENCY	902.1375 MHz	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 10GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2706.41	40.5 PK	74.0	-33.5	1.56 H	301	42.5	-2.0
2	2706.41	35.2 AV	54.0	-18.8	1.56 H	301	37.2	-2.0
3	3608.55	49.7 PK	74.0	-24.3	1.47 H	201	50.4	-0.7
4	3608.55	48.2 AV	54.0	-5.8	1.47 H	201	48.9	-0.7
5	4510.69	52.2 PK	74.0	-21.8	1.24 H	192	51.4	0.8
6	**4510.69**	**50.9 AV**	**54.0**	**-3.1**	**1.24 H**	**192**	**50.1**	**0.8**
7	5412.83	44.2 PK	74.0	-29.8	1.27 H	181	41.7	2.5
8	5412.83	42.4 AV	54.0	-11.6	1.27 H	181	39.9	2.5
9	8119.24	45.2 PK	74.0	-28.8	1.68 H	224	36.5	8.7
10	8119.24	34.3 AV	54.0	-19.7	1.68 H	224	25.6	8.7
11	9021.38	46.7 PK	74.0	-27.3	1.38 H	177	37.4	9.3
12	9021.38	36.8 AV	54.0	-17.2	1.38 H	177	27.5	9.3
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2706.41	37.8 PK	74.0	-36.2	1.52 V	19	39.8	-2.0
2	2706.41	30.2 AV	54.0	-23.8	1.52 V	19	32.2	-2.0
3	3608.55	46.9 PK	74.0	-27.1	3.71 V	267	47.6	-0.7
4	3608.55	44.9 AV	54.0	-9.1	3.71 V	267	45.6	-0.7
5	4510.69	48.5 PK	74.0	-25.5	2.53 V	38	47.7	0.8
6	4510.69	46.5 AV	54.0	-7.5	2.53 V	38	45.7	0.8
7	5412.83	45.4 PK	74.0	-28.6	1.21 V	5	42.9	2.5
8	5412.83	42.6 AV	54.0	-11.4	1.21 V	5	40.1	2.5
9	8119.24	47.8 PK	74.0	-26.2	2.05 V	258	39.1	8.7
10	8119.24	36.5 AV	54.0	-17.5	2.05 V	258	27.8	8.7
11	9021.38	45.7 PK	74.0	-28.3	1.35 V	172	36.4	9.3
12	9021.38	35.5 AV	54.0	-18.5	1.35 V	172	26.2	9.3

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

TESTED FREQUENCY	904.6625 MHz	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 10GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2713.99	40.4 PK	74.0	-33.6	1.52 H	313	42.4	-2.0
2	2713.99	34.9 AV	54.0	-19.1	1.52 H	313	36.9	-2.0
3	3618.65	49.4 PK	74.0	-24.6	1.48 H	190	50.1	-0.7
4	3618.65	47.8 AV	54.0	-6.2	1.48 H	190	48.5	-0.7
5	4523.31	52.1 PK	74.0	-21.9	1.25 H	195	51.3	0.8
6	**4523.31**	**50.9 AV**	**54.0**	**-3.1**	**1.25 H**	**195**	**50.1**	**0.8**
7	5427.98	44.4 PK	74.0	-29.6	1.28 H	179	41.9	2.5
8	5427.98	42.4 AV	54.0	-11.6	1.28 H	179	39.9	2.5
9	8141.96	45.0 PK	74.0	-29.0	1.63 H	210	36.3	8.7
10	8141.96	34.2 AV	54.0	-19.8	1.63 H	210	25.5	8.7
11	9046.63	46.7 PK	74.0	-27.3	1.43 H	189	37.4	9.3
12	9046.63	36.8 AV	54.0	-17.2	1.43 H	189	27.5	9.3
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	2713.99	38.0 PK	74.0	-36.0	1.57 V	26	40.0	-2.0
2	2713.99	30.6 AV	54.0	-23.4	1.57 V	26	32.6	-2.0
3	3618.65	46.6 PK	74.0	-27.4	3.69 V	272	47.3	-0.7
4	3618.65	44.4 AV	54.0	-9.6	3.69 V	272	45.1	-0.7
5	4523.31	48.1 PK	74.0	-25.9	2.56 V	50	47.3	0.8
6	4523.31	46.0 AV	54.0	-8.0	2.56 V	50	45.2	0.8
7	5427.98	45.6 PK	74.0	-28.4	1.25 V	18	43.1	2.5
8	5427.98	42.7 AV	54.0	-11.3	1.25 V	18	40.2	2.5
9	8141.96	47.1 PK	74.0	-26.9	2.05 V	266	38.4	8.7
10	8141.96	36.1 AV	54.0	-17.9	2.05 V	266	27.4	8.7
11	9046.63	45.6 PK	74.0	-28.4	1.38 V	173	36.3	9.3
12	9046.63	35.5 AV	54.0	-18.5	1.38 V	173	26.2	9.3

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value

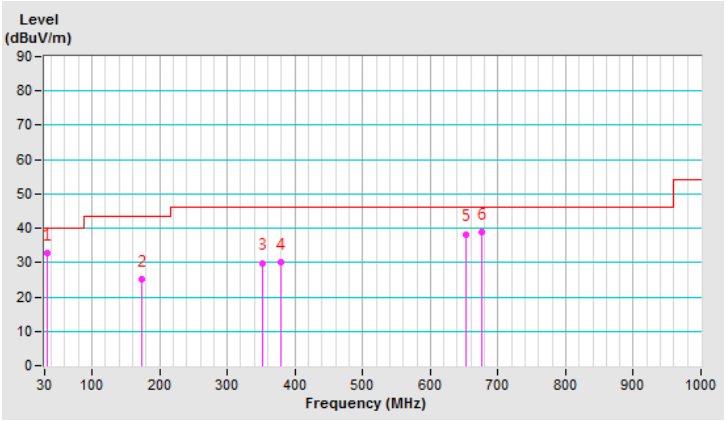
Below 1GHz Data:

TESTED FREQUENCY	902.1375 MHz	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	33.37	32.6 QP	40.0	-7.4	1.50 H	360	41.6	-9.0
2	172.66	25.1 QP	43.5	-18.4	1.00 H	267	33.7	-8.6
3	351.75	29.9 QP	46.0	-16.1	1.00 H	32	35.5	-5.6
4	379.59	30.2 QP	46.0	-15.8	1.00 H	61	35.1	-4.9
5	653.47	38.3 QP	46.0	-7.7	1.50 H	360	37.1	1.2
6	676.89	38.7 QP	46.0	-7.3	1.50 H	360	37.2	1.5

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

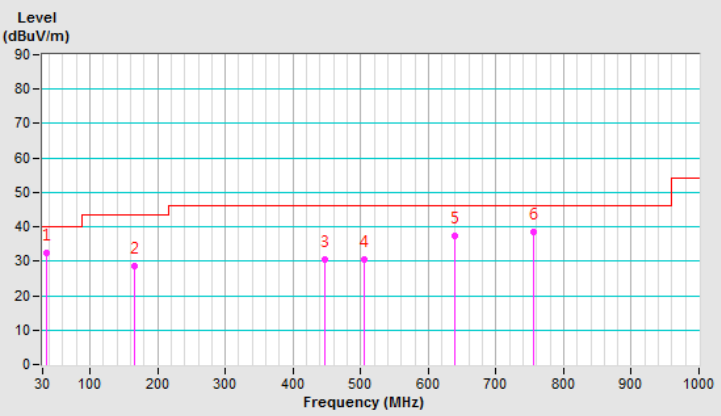


TESTED FREQUENCY	902.1375 MHz	**DETECTOR FUNCTION**	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	**FREQ. (MHz)**	**EMISSION LEVEL (dBuV/m)**	**LIMIT (dBuV/m)**	**MARGIN (dB)**	**ANTENNA HEIGHT (m)**	**TABLE ANGLE (Degree)**	**RAW VALUE (dBuV)**	**CORRECTION FACTOR (dB/m)**
1	35.43	32.4 QP	40.0	-7.6	2.00 V	243	41.2	-8.8
2	166.16	28.5 QP	43.5	-15.0	1.00 V	24	36.6	-8.1
3	447.75	30.5 QP	46.0	-15.5	1.00 V	360	33.5	-3.0
4	505.49	30.4 QP	46.0	-15.6	1.00 V	34	32.3	-1.9
5	640.08	37.5 QP	46.0	-8.5	1.50 V	330	36.3	1.2
6	755.90	38.6 QP	46.0	-7.4	1.50 V	0	35.3	3.3

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

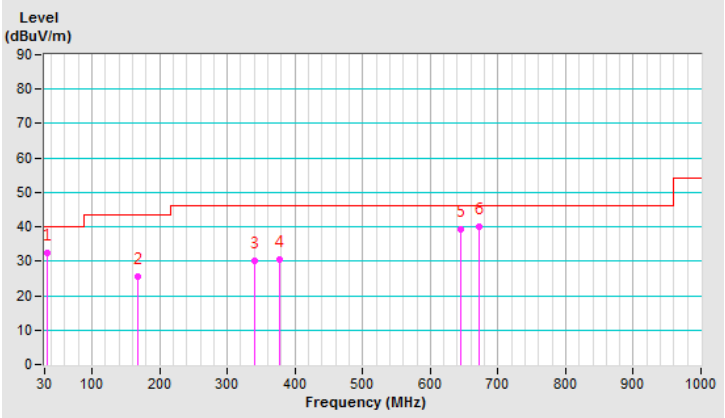


TESTED FREQUENCY	904.6625 MHz	**DETECTOR FUNCTION**	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	**FREQ. (MHz)**	**EMISSION LEVEL (dBuV/m)**	**LIMIT (dBuV/m)**	**MARGIN (dB)**	**ANTENNA HEIGHT (m)**	**TABLE ANGLE (Degree)**	**RAW VALUE (dBuV)**	**CORRECTION FACTOR (dB/m)**
1	33.61	32.5 QP	40.0	-7.5	1.00 H	46	41.4	-8.9
2	168.64	25.6 QP	43.5	-17.9	1.50 H	306	33.9	-8.3
3	340.93	30.1 QP	46.0	-15.9	1.00 H	50	35.9	-5.8
4	377.91	30.5 QP	46.0	-15.5	1.00 H	43	35.4	-4.9
5	645.66	39.3 QP	46.0	-6.7	1.50 H	28	38.1	1.2
6	672.33	40.0 QP	46.0	-6.0	1.50 H	360	38.6	1.4

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

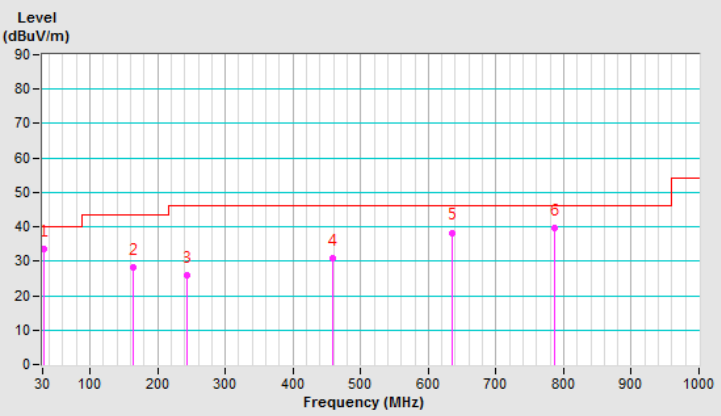


TESTED FREQUENCY	904.6625 MHz	**DETECTOR FUNCTION**	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	**FREQ. (MHz)**	**EMISSION LEVEL (dBuV/m)**	**LIMIT (dBuV/m)**	**MARGIN (dB)**	**ANTENNA HEIGHT (m)**	**TABLE ANGLE (Degree)**	**RAW VALUE (dBuV)**	**CORRECTION FACTOR (dB/m)**
1	32.59	33.5 QP	40.0	-6.5	2.00 V	203	42.5	-9.0
2	163.86	28.1 QP	43.5	-15.4	1.00 V	180	36.2	-8.1
3	243.47	25.8 QP	46.0	-20.2	1.00 V	360	35.0	-9.2
4	458.11	31.0 QP	46.0	-15.0	1.00 V	17	33.8	-2.8
5	635.11	38.3 QP	46.0	-7.7	1.50 V	0	37.1	1.2
6	786.55	39.7 QP	46.0	-6.3	1.50 V	0	36.2	3.5

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

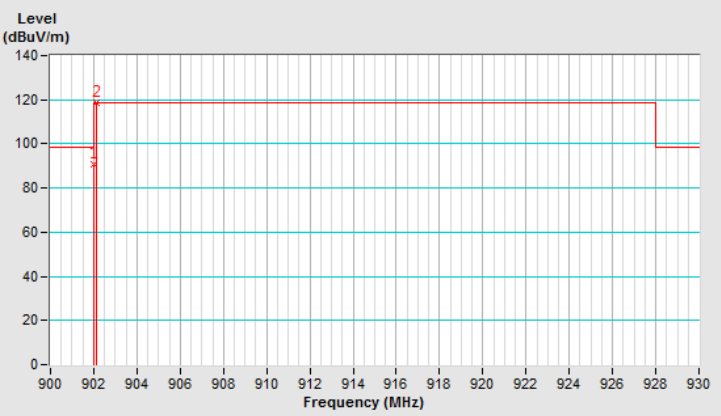


TESTED FREQUENCY	902.1375 MHz	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	900MHz ~ 930MHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	902.0000	90.5 QP	98.4	-7.9	1.00 H	322	59.6	30.9
2	***902.1375**	**118.4 QP**			**1.00 H**	**322**	**87.5**	**30.9**

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.

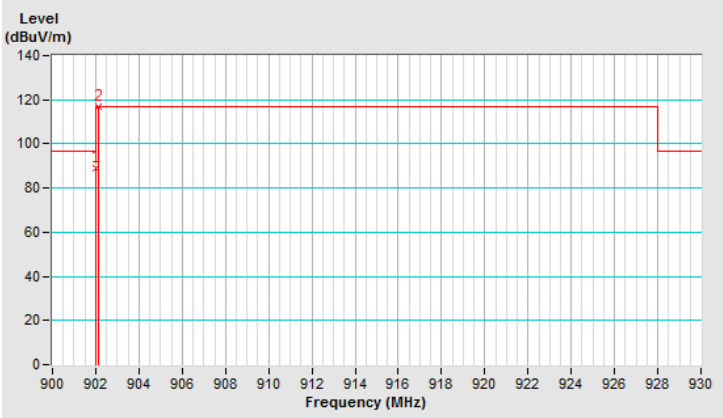


TESTED FREQUENCY	902.1375 MHz	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	900MHz ~ 930MHz		

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	902.0000	88.7 QP	96.6	-7.9	1.63 V	355	57.8	30.9
2	***902.1375**	**116.6 QP**			**1.63 V**	**355**	**85.7**	**30.9**

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.

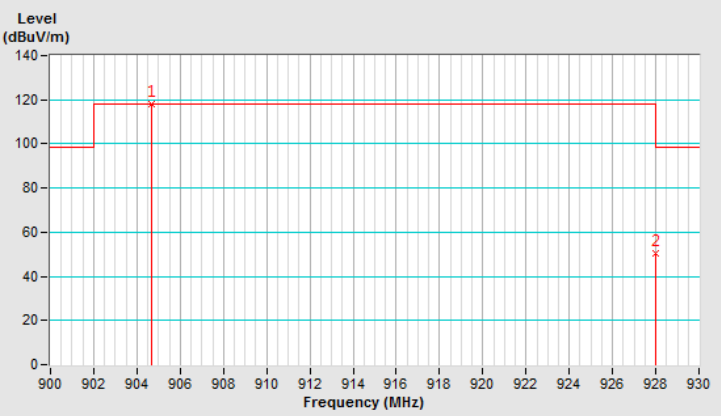


TESTED FREQUENCY	904.6625 MHz	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	900MHz ~ 930MHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	***904.6625**	**118.3 QP**			**1.01 H**	**321**	**87.3**	**31.0**
2	928.0000	50.7 QP	98.3	-47.6	1.01 H	321	19.4	31.3

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.

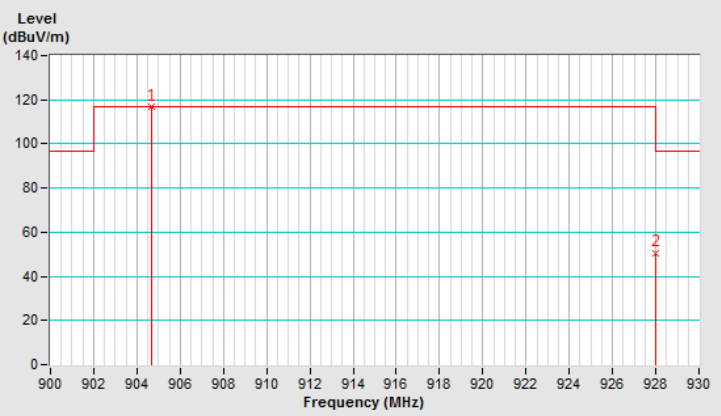


TESTED FREQUENCY	904.6625 MHz	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	900MHz ~ 930MHz		

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	***904.6625**	**116.7 QP**			**1.61 V**	**352**	**85.7**	**31.0**
2	928.0000	50.5 QP	96.7	-46.2	1.61 V	352	19.2	31.3

REMARKS:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency.



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 Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver R&S	ESCS 30	847124/029	Oct. 24, 2018	Oct. 23, 2019
Line-Impedance Stabilization Network (for EUT) R&S	ESH3-Z5	848773/004	Oct. 22, 2018	Oct. 21, 2019
Line-Impedance Stabilization Network (for Peripheral) R&S	ENV216	100072	June 04, 2018	June 03, 2019
50 ohms Terminator	N/A	3	Oct. 22, 2018	Oct. 21, 2019
RF Cable	5D-FB	COCCAB-001	Sep. 28, 2018	Sep. 27, 2019
Fixed attenuator EMCI	STI02-2200-10	003	Mar. 16, 2018	Mar. 15, 2019
Software BVADT	BVADT_Cond_ V7.3.7.4	NA	NA	NA

Note:
1. The calibration interval of the above test instruments are 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in Conduction 1.
3. Tested Date: Dec. 05, 2018

4.2.3 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.

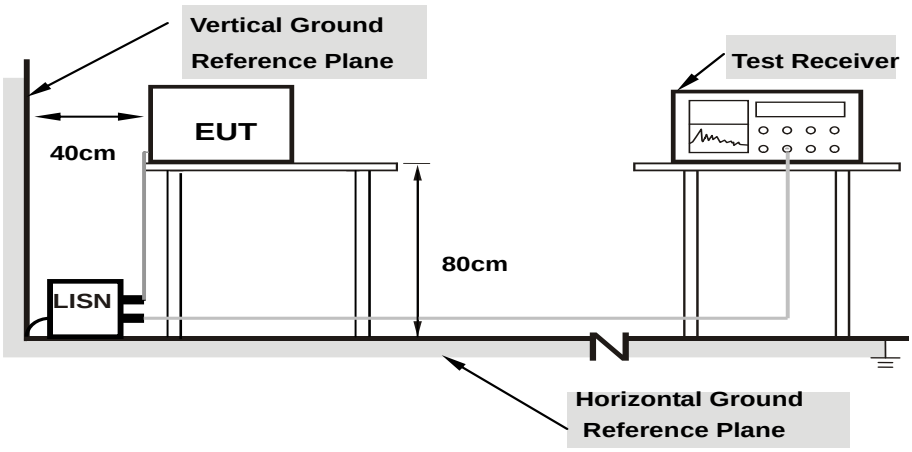
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

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.

4.2.4 Deviation From Test Standard

No deviation.

4.2.5 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).

4.2.6 EUT Operating Condition

Same as 4.1.6.

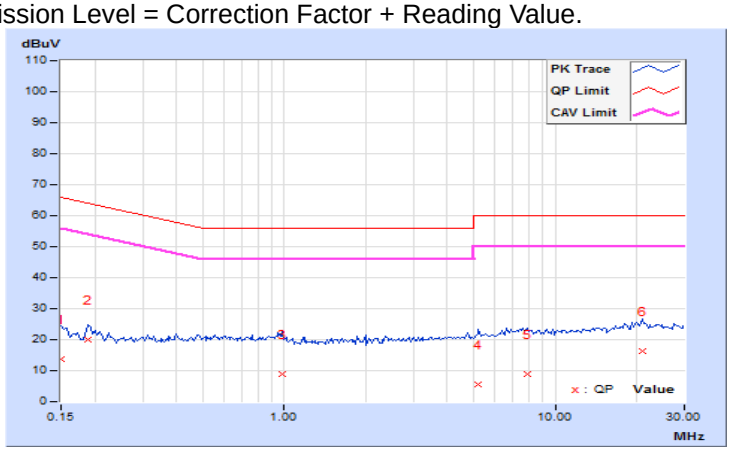
4.2.7 Test Results

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

No	Freq.	Corr. Factor	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
	[MHz]	(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	10.02	3.64	-2.84	13.66	7.18	66.00	56.00	-52.34	-48.82
2	0.18906	10.04	9.99	0.48	20.03	10.52	64.08	54.08	-44.05	-43.56
3	0.98203	10.11	-1.33	-10.04	8.78	0.07	56.00	46.00	-47.22	-45.93
4	5.22656	10.31	-4.81	-13.47	5.50	-3.16	60.00	50.00	-54.50	-53.16
5	7.93750	10.43	-1.55	-11.79	8.88	-1.36	60.00	50.00	-51.12	-51.36
6	**20.91797**	**11.08**	**5.38**	**-1.30**	**16.46**	**9.78**	**60.00**	**50.00**	**-43.54**	**-40.22**

REMARKS:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value.

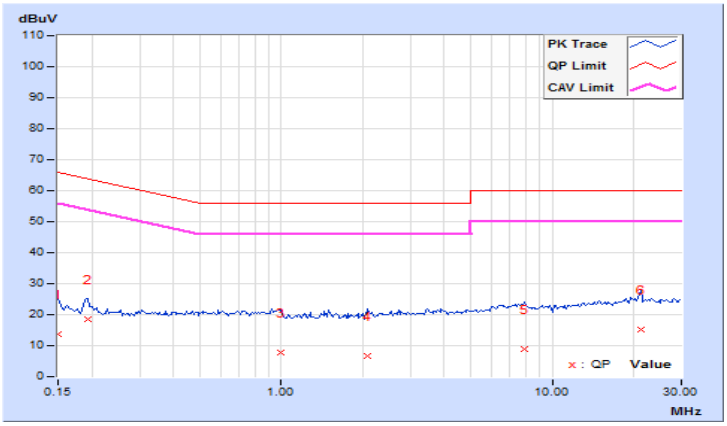


Phase	Neutral (N)	Detector Function	Quasi-Peak (QP) / Average (AV)

No	Freq.	Corr. Factor	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
	[MHz]	(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	9.93	3.78	-2.62	13.71	7.31	66.00	56.00	-52.29	-48.69
2	0.19297	9.94	8.63	-0.80	18.57	9.14	63.91	53.91	-45.34	-44.77
3	0.99766	9.99	-2.04	-10.14	7.95	-0.15	56.00	46.00	-48.05	-46.15
4	2.09375	10.04	-3.40	-14.00	6.64	-3.96	56.00	46.00	-49.36	-49.96
5	7.92969	10.29	-1.55	-11.79	8.74	-1.50	60.00	50.00	-51.26	-51.50
6	21.25781	10.88	4.20	-1.47	15.08	9.41	60.00	50.00	-44.92	-40.59

REMARKS:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value.



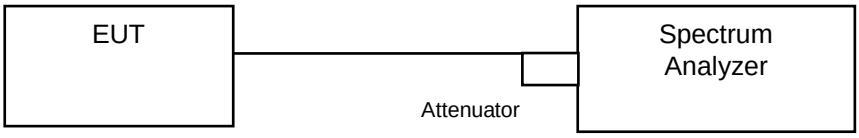
4.3 Number of Hopping Frequency Used

4.3.1 Limits of Hopping Frequency Used Measurement

At least 15 channels frequencies, and should be equally spaced.

Condition	Hopping Frequency Used	Application
20dB Bandwidth <250kHz	hopping channels ≧50	v
20dB Bandwidth >250kHz	hopping channels ≧25	x

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

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.

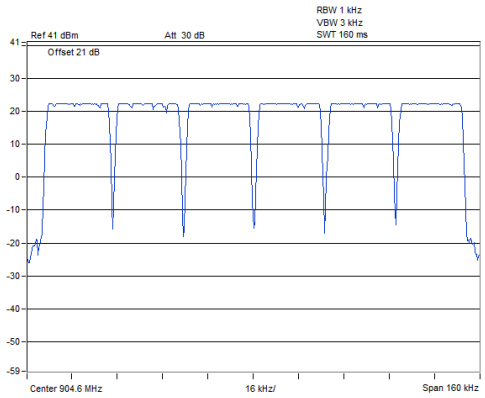
4.3.5 Deviation from Test Standard

No deviation.

4.3.6 Test Results

There are 54 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.

Frequency: 902.1375~904.6625MHz

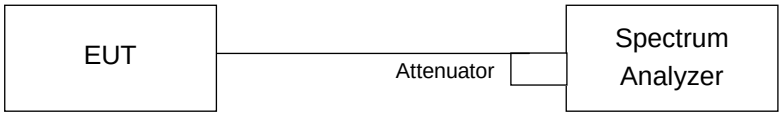

RBW 1 kHz
VBW 3 kHz
SWT 160 ms
Ref 41 dBm
Att 30 dB
Offset 21 dB
41
30
20
10
0
-10
-20
-30
-40
-50
-59
Center 904.6 MHz
16 kHz/
Span 160 kHz

4.4 Dwell Time on Each Channel

4.4.1 Limits of Dwell Time on Each Channel Measurement

Condition	Dwell Time	Application
20dB Bandwidth <250kHz (hopping channels ≧50)	0.4 seconds within a 20 second period	v
20dB Bandwidth >250kHz (hopping channels ≧25)	0.4 seconds within a 10 second period	x

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 (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.

.

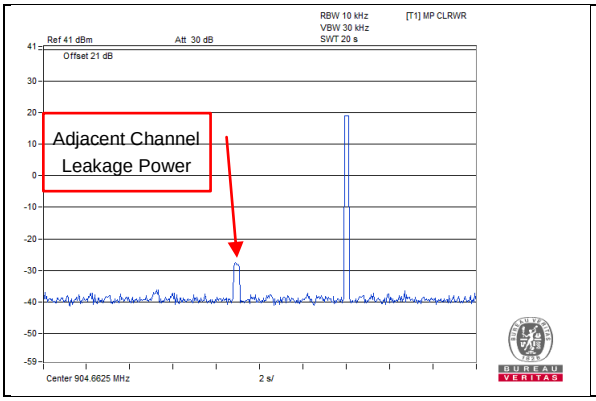
4.4.5 Deviation from Test Standard

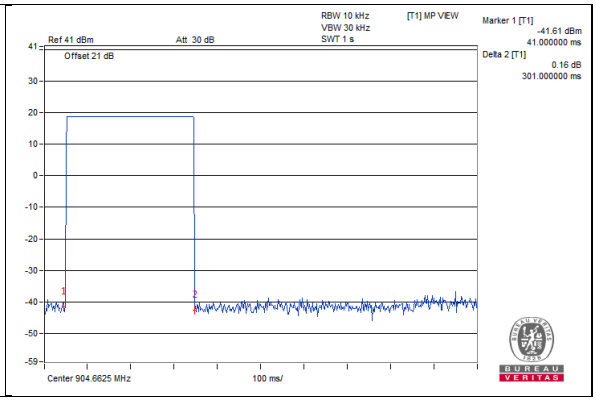
No deviation.

4.4.6 Test Results

Frequency: 904.6625MHz

Number of transmission in a 20 s	Length of transmission time (msec)	Result (msec)	Limit (msec)
1 time	301	301	400



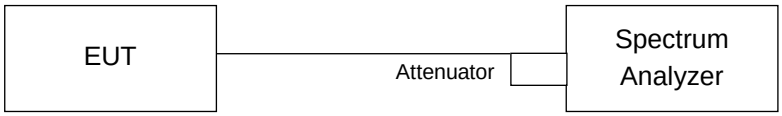


4.5 Channel Bandwidth

4.5.1 Limits of Channel Bandwidth Measurement

Condition	Application
20dB Bandwidth <250kHz (hopping channels ≧50)	v
20dB Bandwidth >250kHz (hopping channels ≧25)	x

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 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.

4.5.5 Deviation from Test Standard

No deviation.

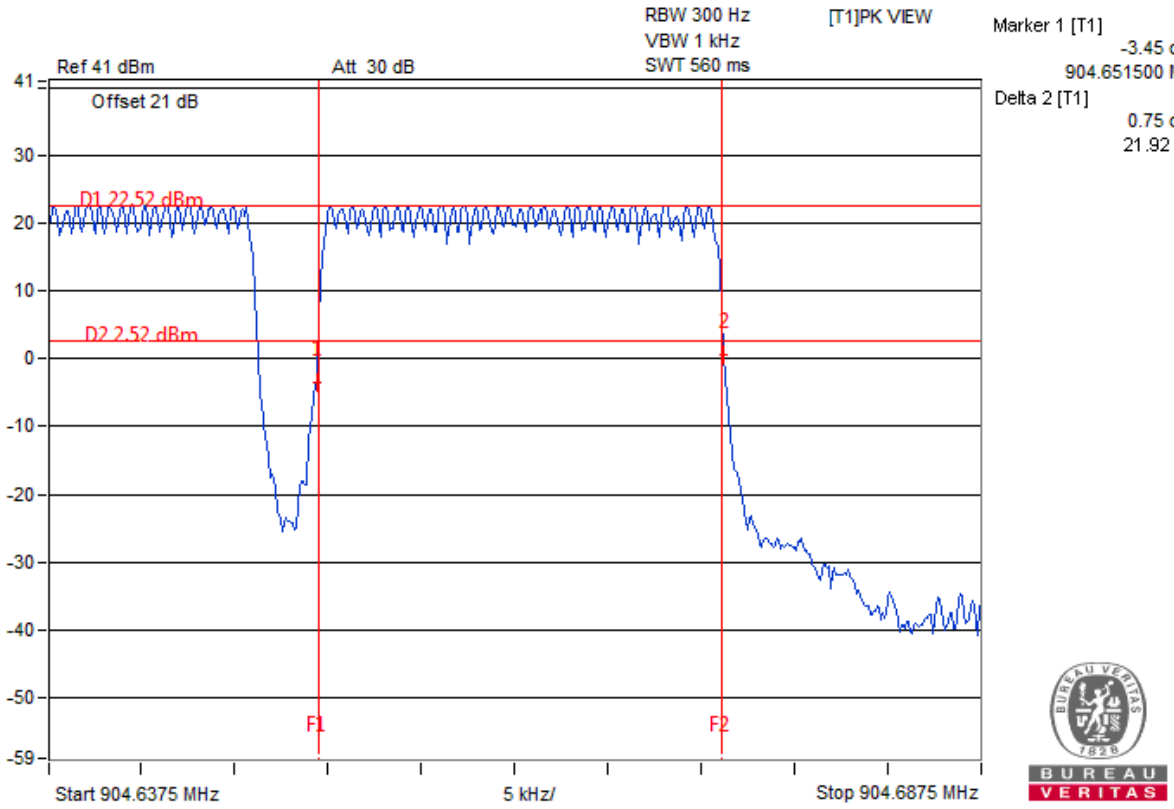
4.5.6 EUT Operating Condition

Controlling the test tool (Push button) provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

4.5.7 Test Results

Frequency (MHz)	20dB Bandwidth (kHz)	Maximum Limit (kHz)	Pass / Fail
902.1375	21.82	<250	Pass
904.6625	21.92	<250	Pass

Spectrum Plot of Worst Value

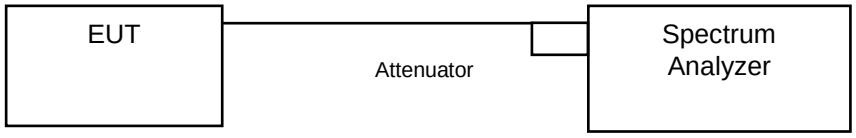


4.6 Hopping Channel Separation

4.6.1 Limits of Hopping Channel Separation Measurement

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

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 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.

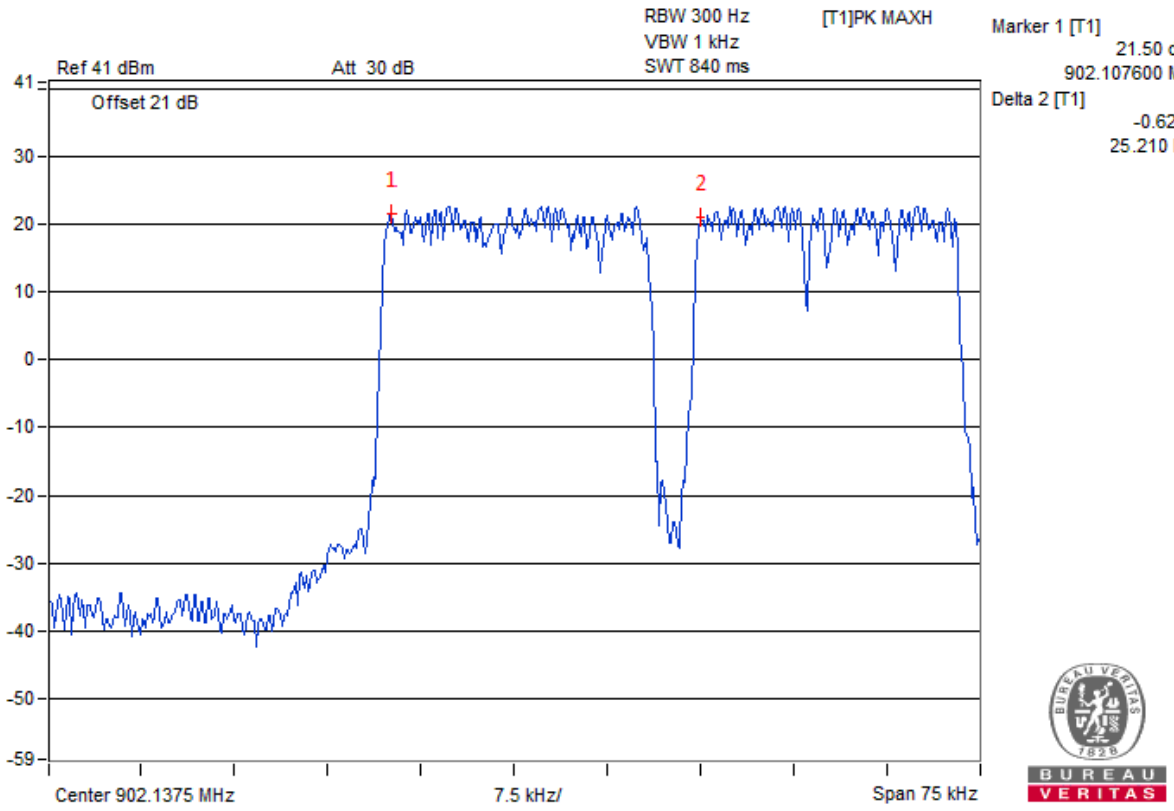
4.6.5 Deviation from Test Standard

No deviation.

4.6.6 Test Results

Frequency (MHz)	Adjacent Channel Separation (kHz)	Minimum Limit (kHz)	Pass / Fail
902.1375	25.21	25	Pass
904.6625	25.22	25	Pass

Spectrum Plot of Worst Value



4.7 Maximum Output Power

4.7.1 Limits of Maximum Output Power Measurement

Condition	Output Power	Application
hopping channels ≧50	1 W	v
hopping channels ≧25 & ≦50	0.25W	x

4.7.2 Test Setup

4.7.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.7.4 Test Procedure

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

Average power sensor was used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

4.7.5 Deviation from Test Standard

No deviation.

4.7.6 EUT Operating Condition

Controlling the test tool (Push button) provided by client enabled the EUT to transmit and receive data at lowest and highest channel frequencies individually.

4.7.7 Test Results

FOR PEAK POWER

Frequency (MHz)	Output Power (mW)	Output Power (dBm)	Power Limit (mW)	Pass / Fail
902.1375	185.78	22.69	30.00	Pass
904.6625	181.97	22.60	30.00	Pass

FOR AVERAGE POWER

Frequency (MHz)	Average Power (mW)	Average Power (dBm)
902.1375	184.502	22.66
904.6625	180.302	22.56

4.8 Conducted Out of Band Emission Measurement

4.8.1 Limits of Conducted Out of Band Emission Measurement

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

4.8.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.8.3 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.

4.8.4 Deviation from Test Standard

No deviation.

4.8.5 EUT Operating Condition

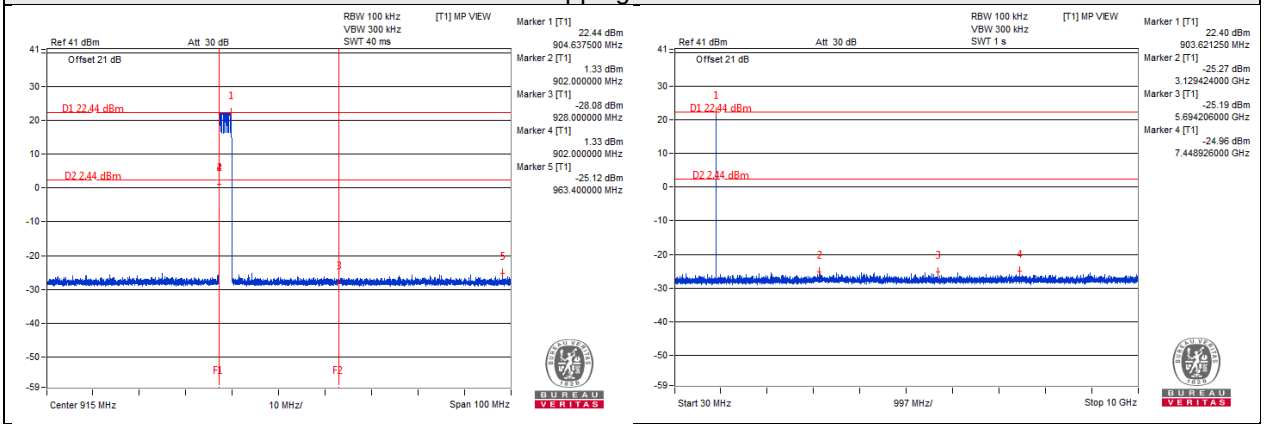
Controlling the test tool (Push button) provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

4.8.6 Test Results

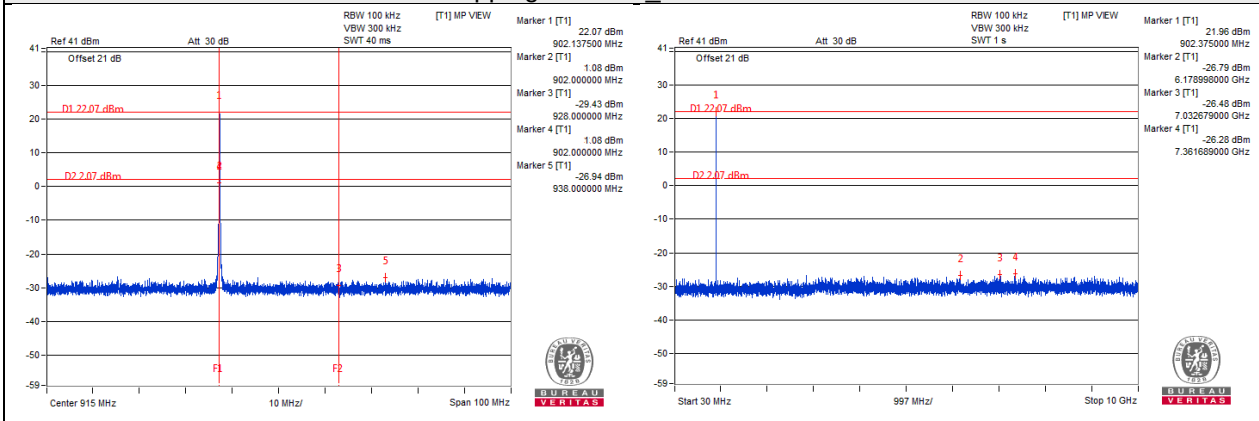
The spectrum plots are attached on the following images. D1 line indicates the highest level, D2 line indicates the 20dB offset below D1. It shows compliance with the requirement.

902.1375~904.6625MHz

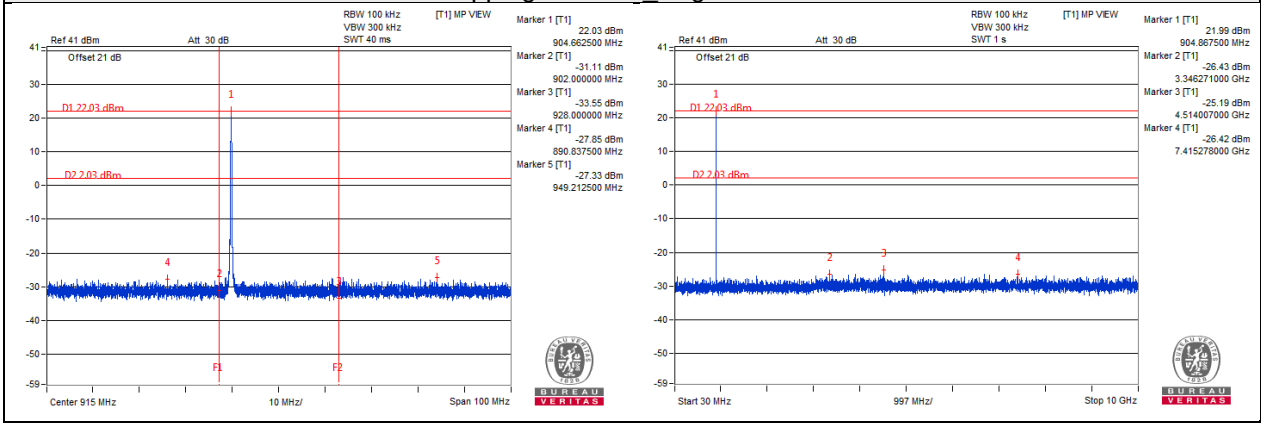
Hopping enabled



Hopping disabled_ Low Channel



Hopping disabled_ High Channel



5 Pictures of Test Arrangements

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

Appendix – Information on the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited according to ISO/IEC 17025.

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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