



REPORT No.: SZ16080189W14A

FCC RF TEST REPORT

APPLICANT : Pycom Ltd
PRODUCT NAME : LoPy
MODEL NAME : LoPy1.0r
TRADE NAME : LoPy
BRAND NAME : Pycom
FCC ID : 2AJMTLOPY1R
STANDARD(S) : 47 CFR Part 15 Subpart C
ISSUE DATE : 2016-10-12



SHENZHEN MORLAB COMMUNICATIONS TECHNOLOGY Co., Ltd.

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Change History		
Issue	Date	Reason for change
1.0	2016-10-12	First edition



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TEST REPORT DECLARATION

Applicant	Pycom Ltd
Applicant Address	Registered Office 57 Avenue Road Cranleigh, Surrey GU6 7LJ UK
Manufacturer	In-Tech Electronics Ltd
Manufacturer Address	2/F Rhythm Home, 119 Shazui Road, Futian, Shenzhen, Guangdong, P.R.China
Product Name	LoPy
Model Name	LoPy1.0r
Brand Name	Pycom
HW Version	1.0r
SW Version	1.0
Test Standards	47 CFR Part 15 Subpart C
Test Date	2016-09-22 to 2016-10-09
Test Result	PASS

Tested by : Zou Jian
Zou Jian

Reviewed by : Qiu Xiaojun
Qiu Xiaojun

Approved by : Peng Huarui
Peng Huarui



1. TECHNICAL INFORMATION

Note: Provide by applicant.

1.1 EUT Description

EUT Type:	LoPy
Serial No.	(n.a, marked #1 by test site)
Hardware Version	1.0r
Software Version:	1.0
Applicant:	Pycom Ltd Registered Office 57 Avenue Road Cranleigh, Surrey GU6 7LJ UK
Manufacturer	In-Tech Electronics Ltd 2/F Rhythm Home, 119 Shazui Road, Futian, Shenzhen, Guangdong, P.R.China
Frequency Range:	The frequency range used is 902.3MHz-914.9MHz (64 channels, at intervals of 0.2MHz)
Channel Number	64(See Note)
Channel Spacing:	200KHz
Antenna Type	Dedicated Antenna
Antenna Gain	2.2dBi

NOTE: The EUT is a LoPy, it contains SX1272/73 Module operating at 902.3MHz-914.9MHz; the frequencies allocated for the EUT is $F(\text{MHz})=902.3+0.2*n$ ($0 \leq n \leq 63$). The lowest, middle, highest channel numbers of the EUT used and tested in this report are separately 0 (902.3MHz), 32 (908.7MHz) and 63 (914.9MHz).

For a more detailed description, please refer to Specification or User's Manual supplied by the applicant and/or manufacturer.

1.2 Test Standards and Results

The objective of the report is to perform testing according to 47 CFR Part 15 Subpart C for the EUT FCC ID Certification:

No.	Identity	Document Title
1	47 CFR Part 15 (10-1-13 Edition)	Radio Frequency Devices



Test detailed items/section required by FCC rules and results are as below:

No.	Section	Description	Test Date	Result
1	15.203	Antenna Requirement	N.A	<u>PASS</u>
2	15.215	Bandwidth	Sep 27, 2016	<u>PASS</u>
3	15.249(a)	Field strength	Oct 09, 2016	<u>PASS</u>
4	15.207	Conducted Emission	Sep 22, 2016	<u>PASS</u>
5	15.209 ,15.249(a)	Radiated Emission and field strength of harmonics	Oct 09, 2016	<u>PASS</u>

The tests of Conducted Emission and Radiated Emission were performed according to the method of measurements prescribed in ANSI C63.10:2013.

1.2.1 Test Environment Conditions

During the measurement, the environmental conditions were within the listed ranges:

Temperature (°C):	15 - 35
Relative Humidity (%):	30 -60
Atmospheric Pressure (kPa):	86-106

2. 47 CFR PART 15C REQUIREMENTS

2.1 Antenna requirement

2.1.1 Applicable Standard

According to FCC 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

2.1.2 Result: Compliant

The EUT has a permanently and irreplaceable attached antenna. Please refer to the EUT internal photos.

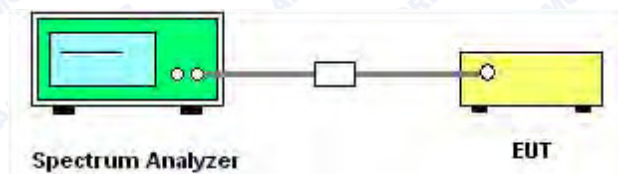
2.2 Bandwidth

2.2.1 Requirement

Note: for reporting purpose only.

2.2.2 Test Description

A. Test Set:



The EUT is coupled to the Spectrum Analyzer; the RF load attached to the EUT antenna terminal is 50Ohm; the path loss as the factor is calibrated to correct the reading.

Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. In order to make an accurate measurement, set the span greater than RBW.

B. Equipments List:

Please reference ANNEX A(1.5).



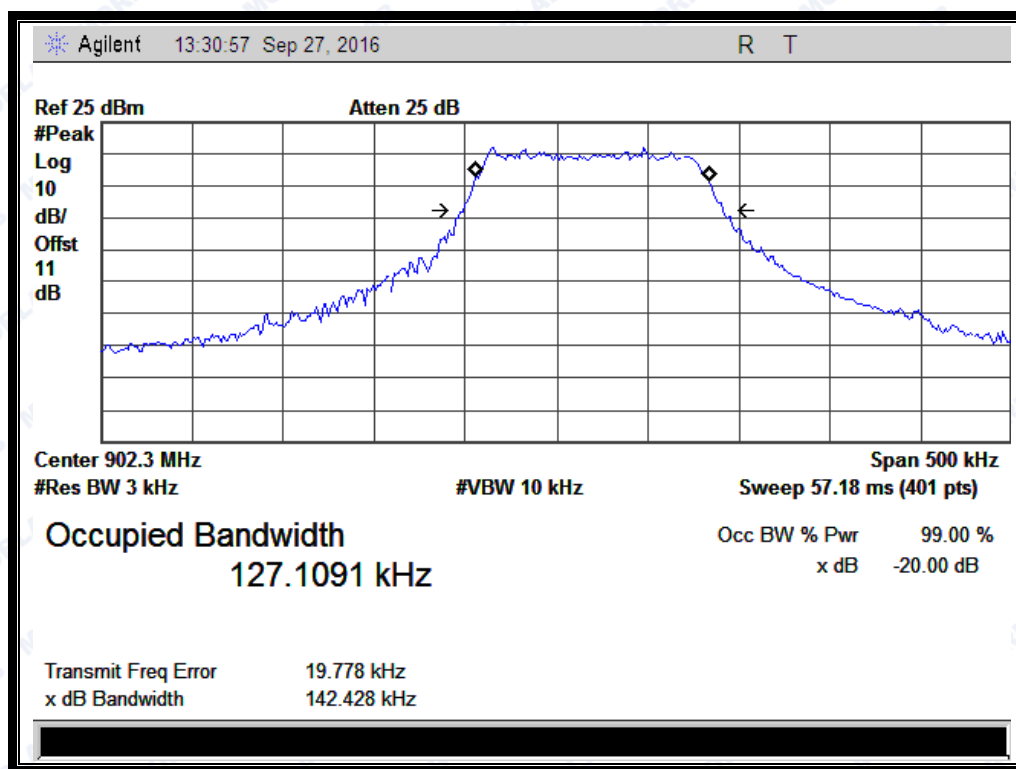
2.2.3 Test Result

The lowest, middle and highest channels are selected to perform testing to record the 20dB bandwidth of the Module.

A. Test Verdict:

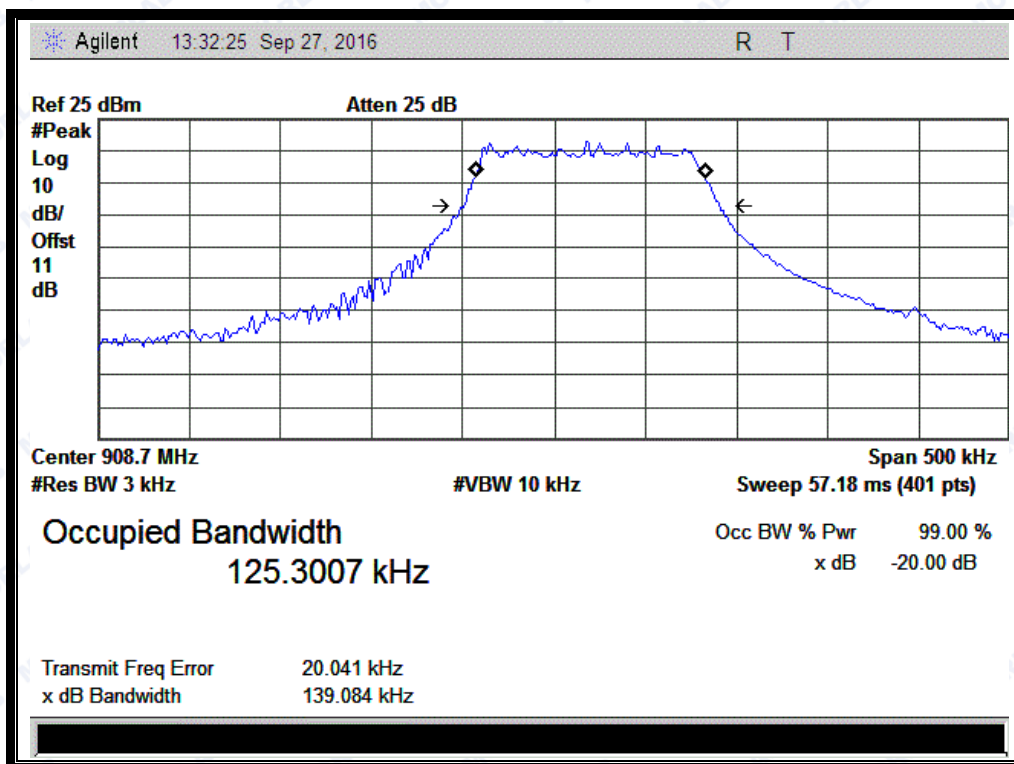
Channel	Frequency (MHz)	20 dB Bandwidth (KHz)	Refer Plot
Lowest	902.3	142.428	Plot A
Middle	908.7	139.084	Plot B
Highest	914.9	139.227	Plot C

B. Test Plots

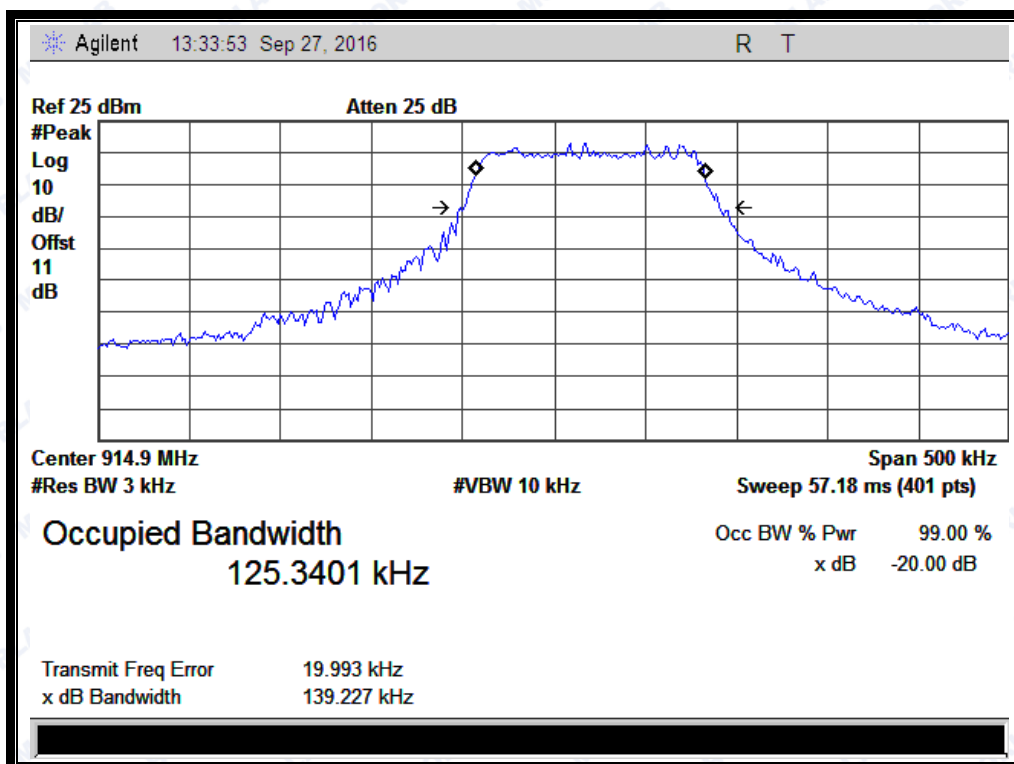




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(Plot B@ Middle Channel: 908.7MHz)



(Plot C@ Highest Channel: 914.9MHz)

2.3 Conducted Emission

2.3.1 Requirement

According to FCC section 15.207, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150kHz to 30MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN).

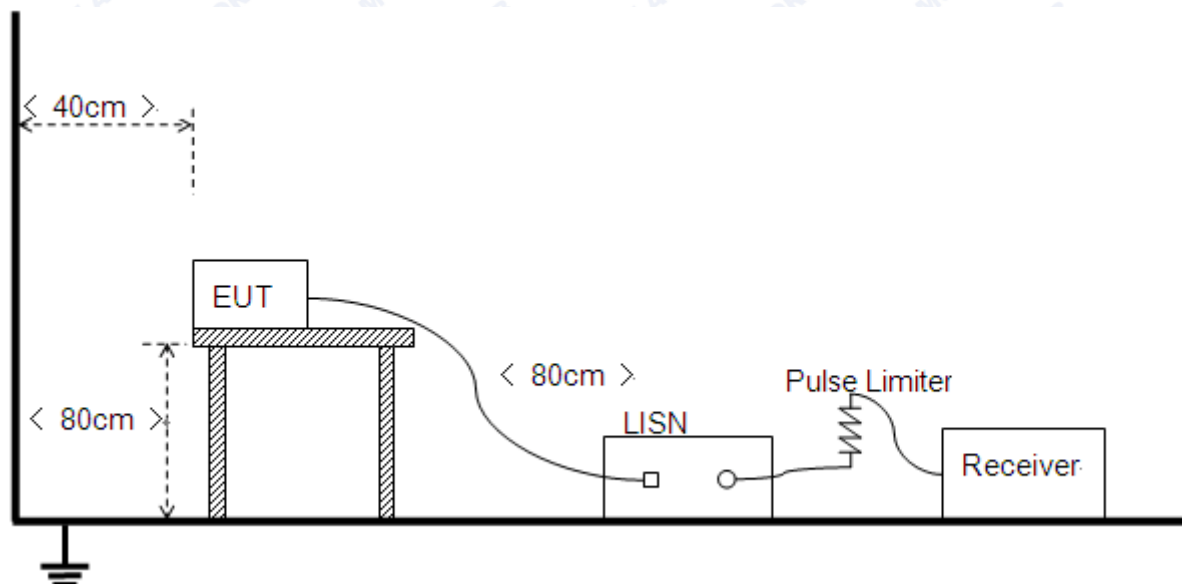
Frequency range (MHz)	Conducted Limit (dB μ V)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
5 - 30	60	50

NOTE:

- The lower limit shall apply at the band edges.
- The limit decreases linearly with the logarithm of the frequency in the range 0.15 - 0.50MHz.

2.3.2 Test Description

A. Test Setup:



The Table-top EUT was placed upon a non-metallic table 0.8m above the horizontal metal reference ground plane. EUT was connected to LISN and LISN was connected to reference Ground Plane. EUT was 80cm from LISN. The set-up and test methods were according to ANSI C63.10 2013.

B. Equipments List:

Please reference ANNEX A(1.5).



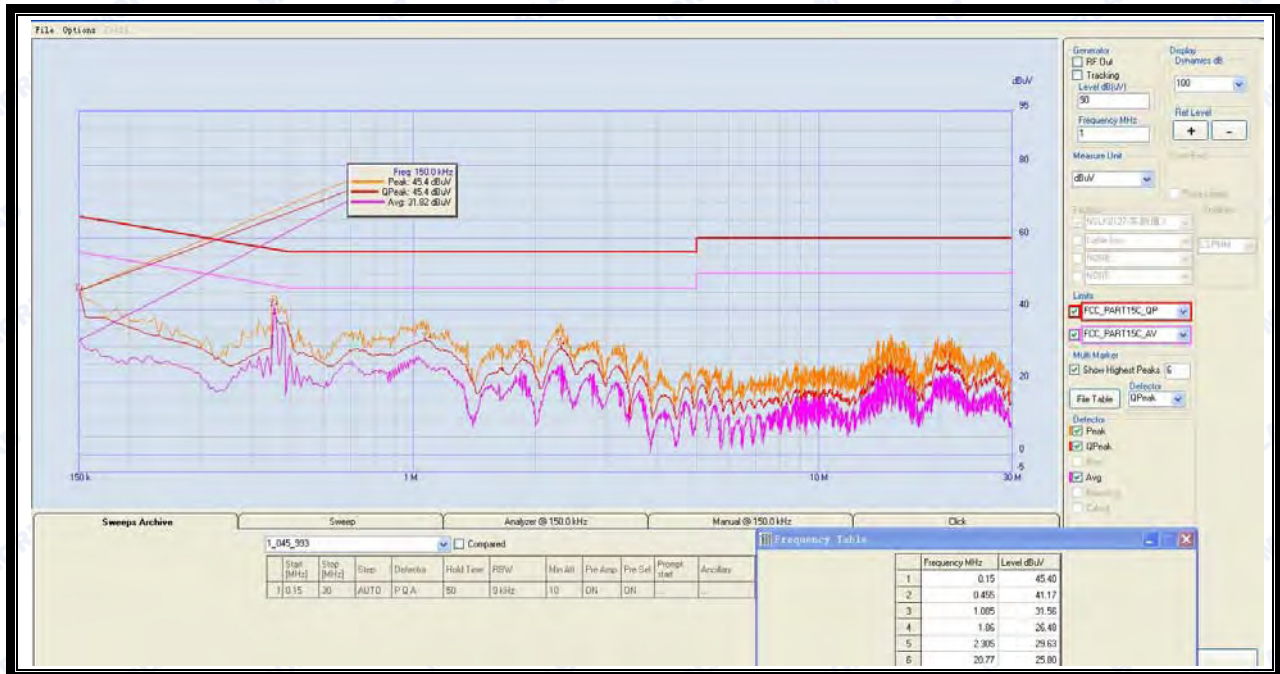
2.3.3 Test Result

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

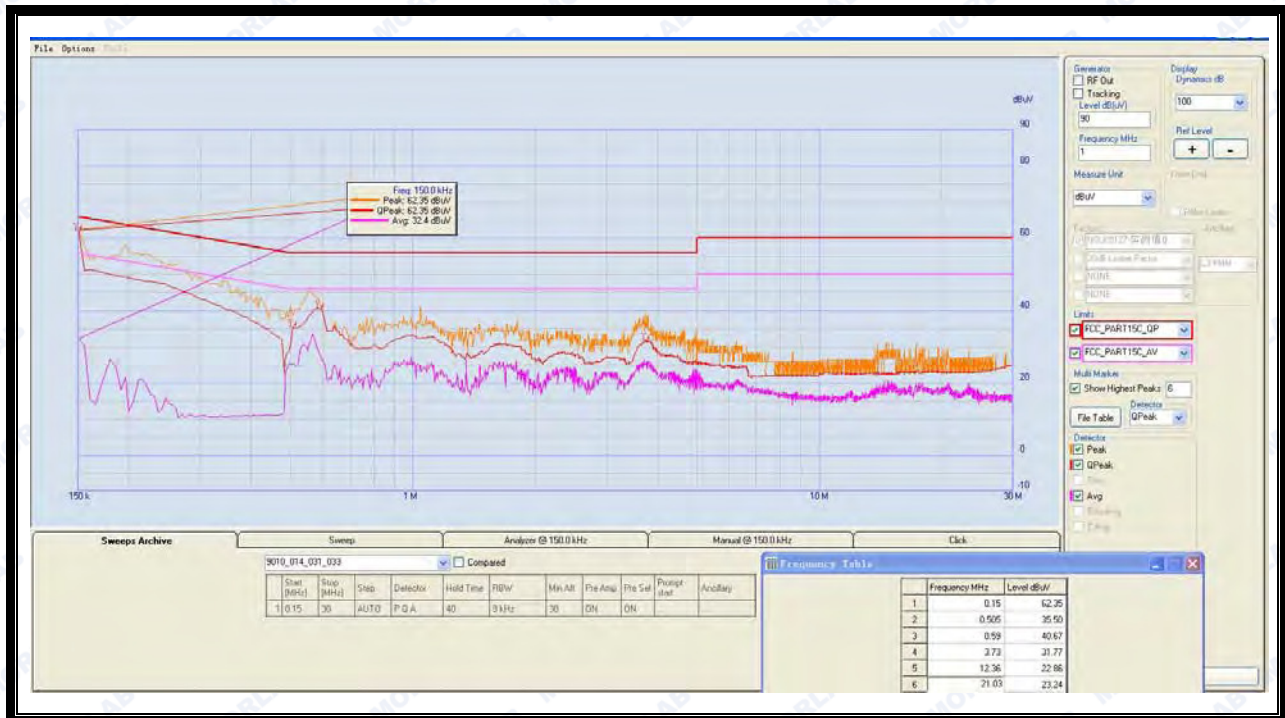
A. Test setup:

The EUT configuration of the emission tests is EUT + Link.

B. Test Plots:



(Plot A: L Phase)



(Plot B: N Phase)

2.4 Field strength of fundamental

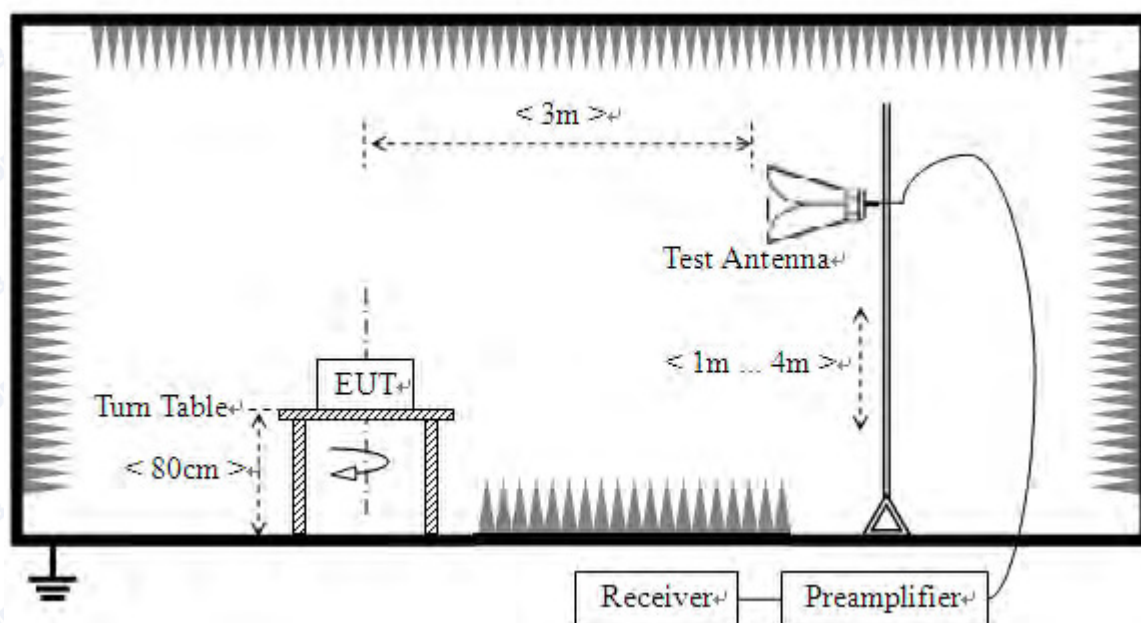
2.4.1 Requirement

According to FCC section 15.249(a), except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

2.4.2 Test Description

A. Test Setup



The EUT is located in a 3m Semi-Anechoic Chamber; the antenna factors, cable loss and so on of the site as factors are calculated to correct the reading.

For the Test Antenna:

Test Antenna is 3m away from the EUT. Test Antenna height is varied from 1m to 4m above the



ground to determine the maximum value of the field strength.

B. Equipments List:

Please reference ANNEX A(1.5).

2.1.1 Test Procedure

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

2.1.2 Test Result

The lowest and highest channels are tested to verify Restricted Frequency Bands.

The measurement results are obtained as below:

$$E \text{ [dB}\mu\text{V/m]} = U_R + A_T + A_{\text{Factor}} \text{ [dB]}; A_T = L_{\text{Cable loss}} \text{ [dB]} - G_{\text{preamp}} \text{ [dB]}$$

A_T : Total correction Factor except Antenna

U_R : Receiver Reading

G_{preamp} : Preamplifier Gain

A_{Factor} : Antenna Factor at 3m

During the test, the total correction Factor A_T and A_{Factor} were built in test software.

Note: All radiated emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report

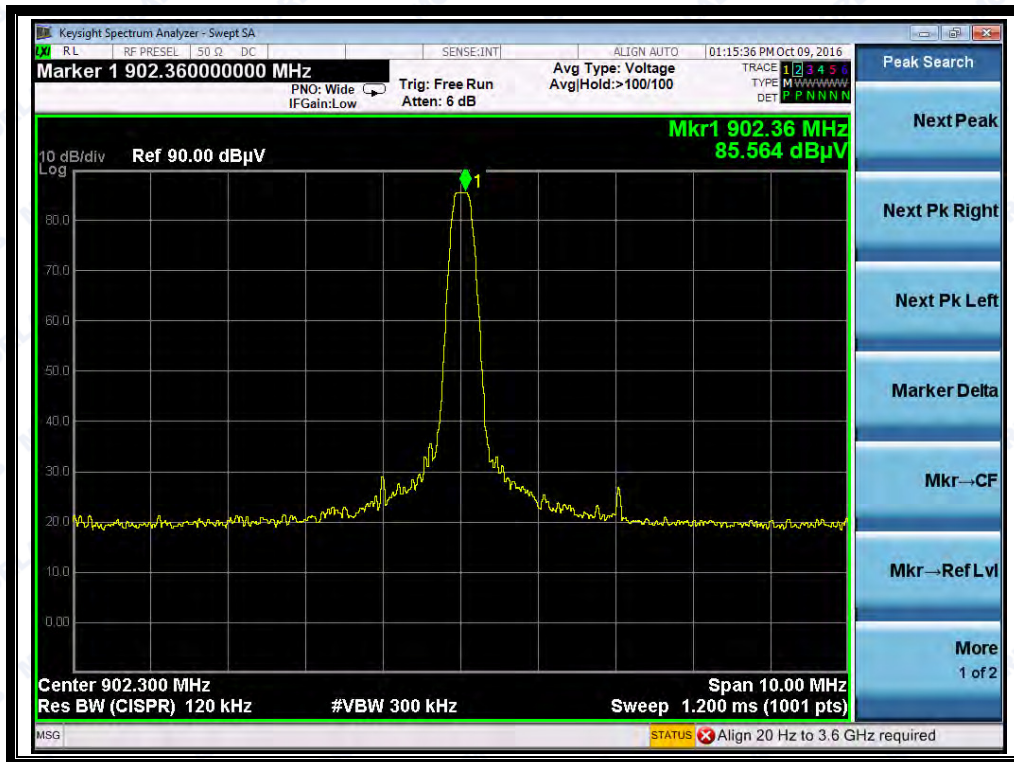
Test Verdict:

Channel	Frequency (MHz)	Detector	Max. Emission E (dB μ V/m)	Refer Plot	Limit (dB μ V/m)	Verdict
		PK/ AV				
Lowest	902.3	PK	85.564	Plot1	113.98	Pass
		AV	72.963	Plot2	93.98	Pass
Middle	908.7	PK	84.392	Plot3	113.98	Pass
		AV	72.617	Plot4	93.98	Pass
Highest	914.9	PK	84.427	Plot5	113.98	Pass
		AV	72.381	Plot6	93.98	Pass

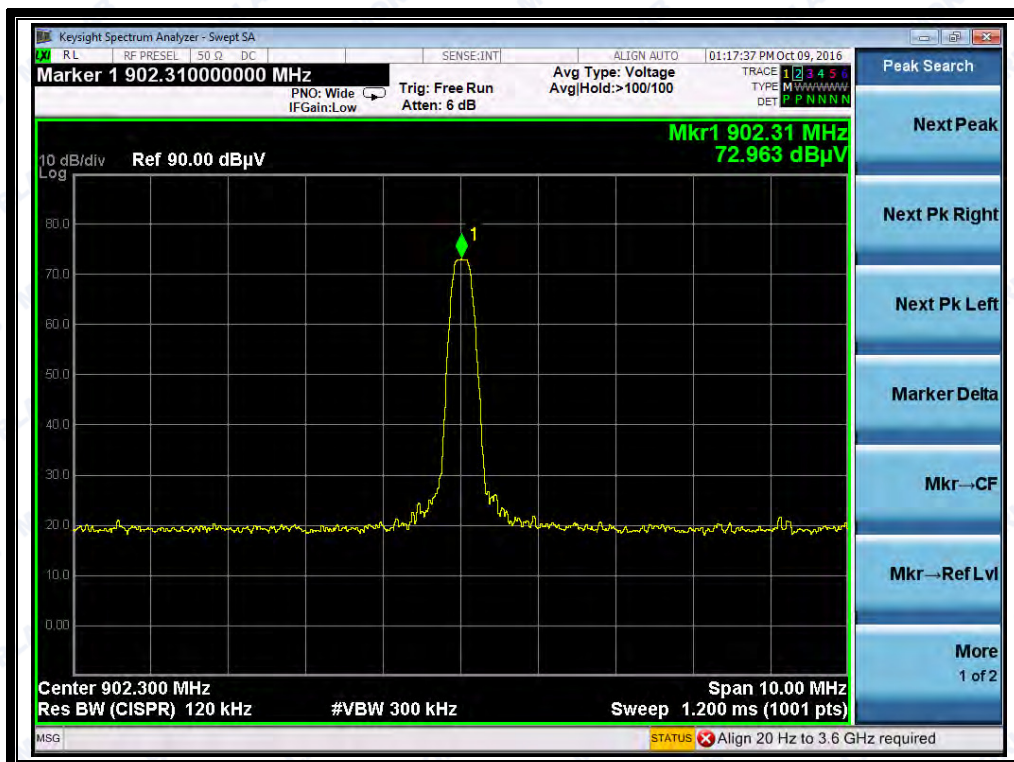
Test Plots:



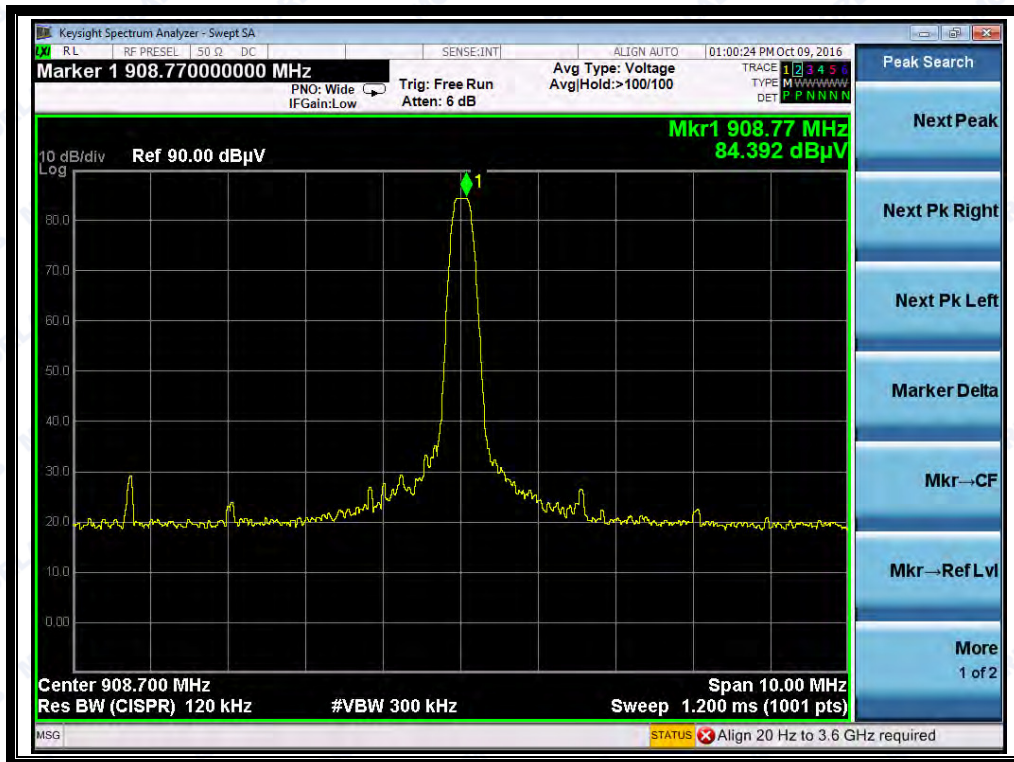
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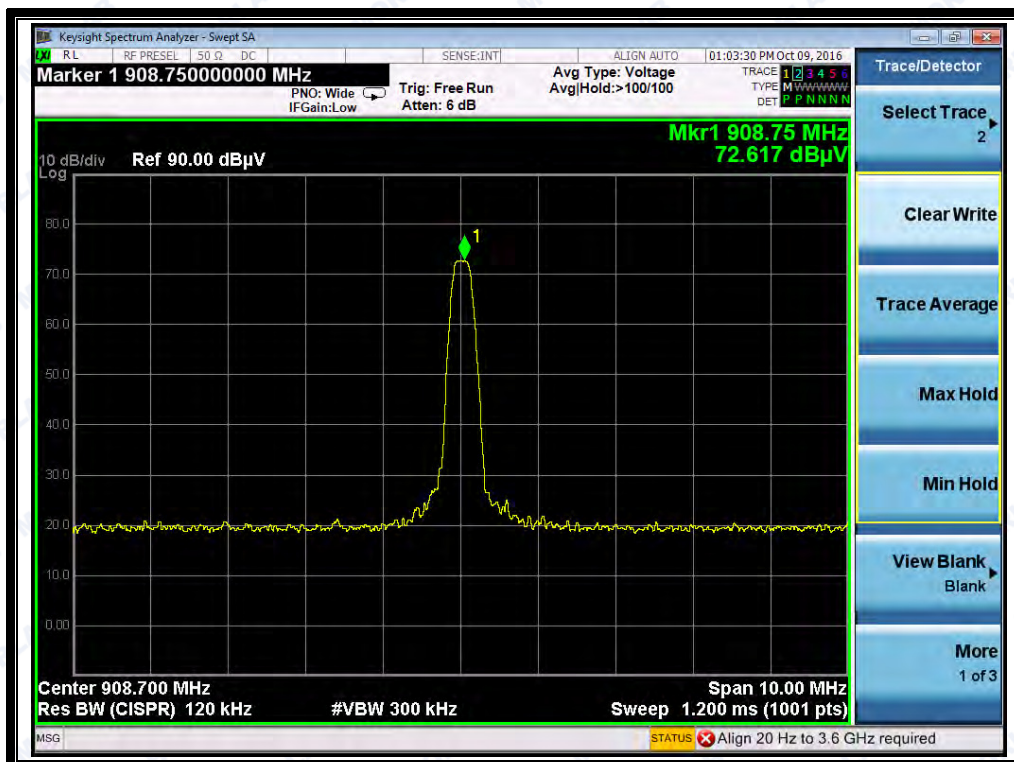
(Plot 1 PK @ Lowest Channel: 902.3MHz)



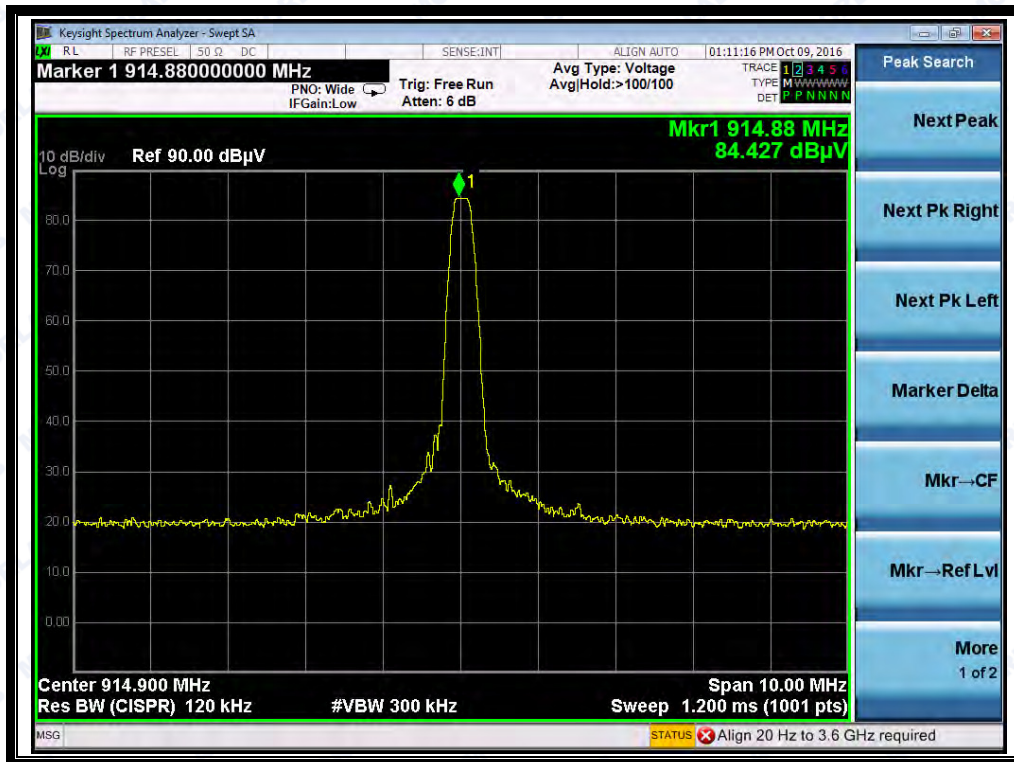
(Plot 2 AV @ Lowest Channel: 902.3MHz)



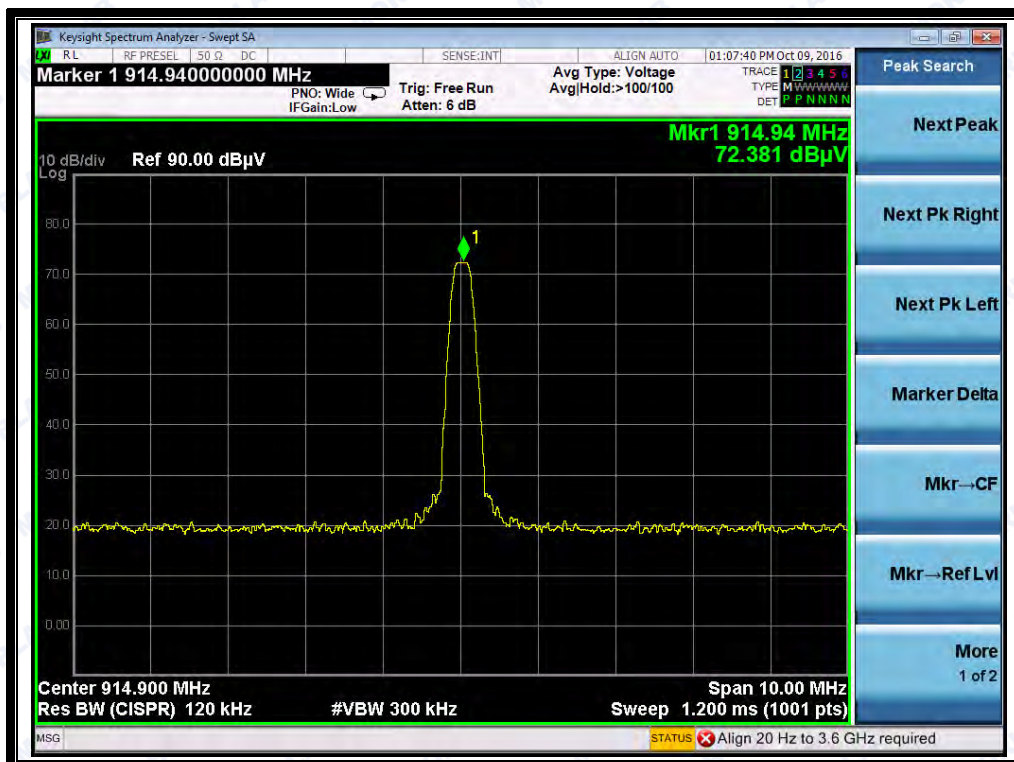
(Plot 3 PK@ Middle Channel: 908.7MHz)



(Plot 4 AV@ Middle Channel: 908.7MHz)



(Plot 5PK@ Highest Channel: 914.9MHz)



(Plot 6 AV @ Highest Channel: 914.9MHz)



2.2 Radiated Emission and field strength of harmonics

2.4.1 Requirement

According to section 15.249(a), the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

According to section 15.249(d), Emission Radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50dB below the level of the fundamental or to the general radiated emission limits in Section 15.209:

Frequency (MHz)	Field Strength (μV/m)	Measurement Distance (m)	Field Strength Limitation at 3m Measurement Dist	
			(uV/m)	(dBuV/m)
0.009 - 0.490	2400/F(kHz)	300	10000* 2400/F(KHz)	20log 2400/F(KHz) + 80
0.490 - 1.705	24000/F(kHz)	30	100* 2400/F(KHz)	20log 2400/F(KHz) + 40
1.705 - 30.0	30	30	100*30	20log 30 + 40
30 - 88	100	3	100	20log 100
88 - 216	150	3	150	20log 150
216 - 960	200	3	200	20log 200
Above 960	500	3	500	20log 500

According to section 15.249(e), for frequencies above 1000MHz, the above field strength limits are based on average limits. 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.

Note:

- 1) The tighter limit shall apply at the boundary between two frequency range.
- 2) Limitation expressed in dBuV/m is calculated by 20log Emission Level(uV/m).
- 3) If measurement is made at 3m distance, then F.S Limitation at 3m distance is adjusted by using the formula of $L_{d1} = L_{d2} * (d_2/d_1)^2$.

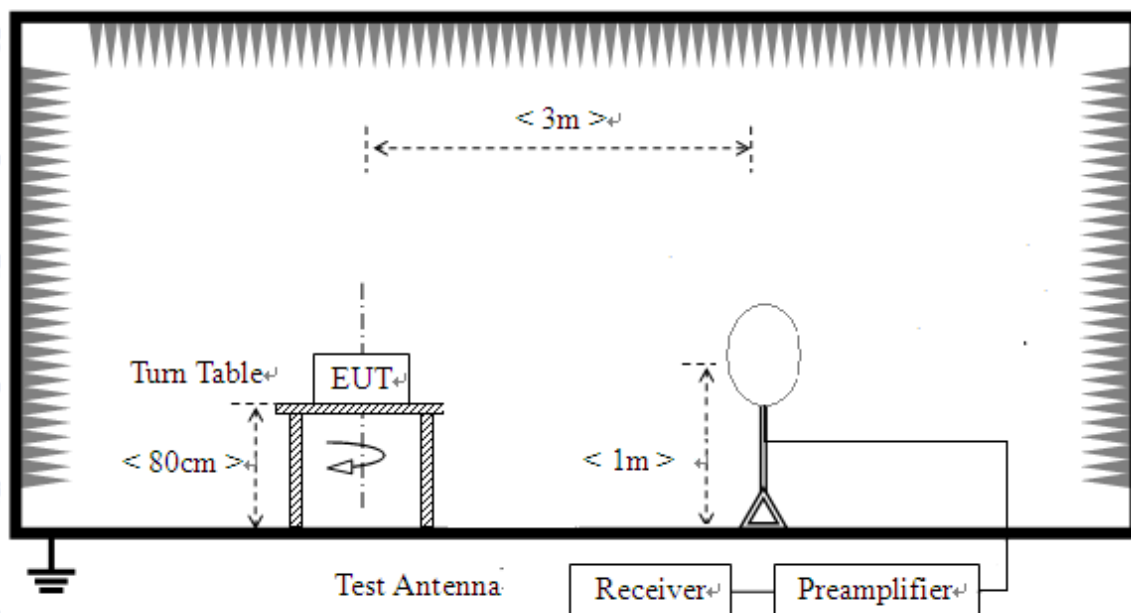
Example: F.S Limit at 30m distance is 30uV/m, then F.S Limitation at 3m distance is adjusted as

$$L_{d1} = L_1 = 30\text{uV/m} * (10)^2 = 100 * 30\text{uV/m}$$

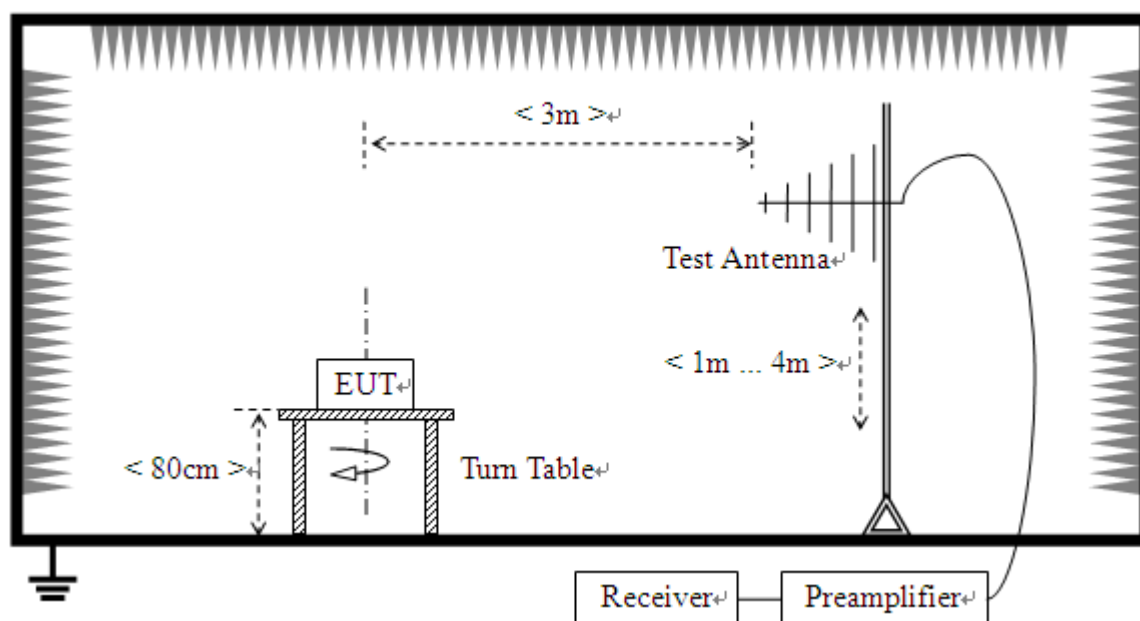
2.4.2 Test Description

A. Test Setup:

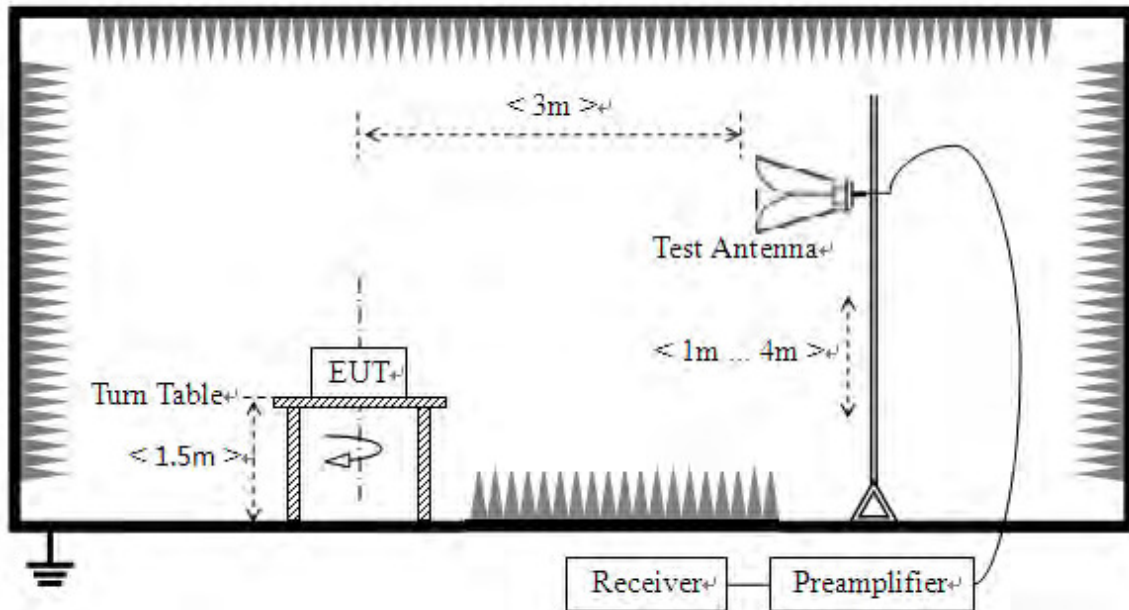
- 1) For radiated emissions from 9kHz to 30MHz



- 2) For radiated emissions from 30MHz to 1GHz



3) For radiated emissions above 1GHz



The test site semi-anechoic chamber has met the requirement of NSA tolerance 4dB according to the standards: ANSI C63.10 (2013). For radiated emissions below or equal to 1GHz, The EUT was set-up on insulator 80cm above the Ground Plane, For radiated emissions above 1GHz, The EUT was set-up on insulator 150cm above the Ground Plane. The set-up and test methods were according to ANSI C63.10.

The EUT is located in a 3m Semi-Anechoic Chamber; the antenna factors, cable loss and so on of the site as factors are calculated to correct the reading

For the Test Antenna:

- In the frequency range of 9kHz to 30MHz, magnetic field is measured with Loop Test Antenna. The Test Antenna is positioned with its plane vertical at 1m distance from the EUT. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.
- In the frequency range above 30MHz, Bi-Log Test Antenna (30MHz to 1GHz) and Horn Test Antenna (above 1GHz) are used. Test Antenna is 3m away from the EUT. Test Antenna height is varied from 1m to 4m above the ground to determine the maximum value of the field strength. The emission levels at both horizontal and vertical polarizations should be tested.

B. Equipments List:

Please reference ANNEX A(1.5).



2.4.3 Test Result

According to ANSI C63.10, because of peak detection will yield amplitudes equal to or greater than amplitudes measured with the quasi-peak (or average) detector, the measurement data from a spectrum analyzer peak detector will represent the worst-case results, if the peak measured value complies with the quasi-peak limit, it is unnecessary to perform an quasi-peak measurement.

The measurement results are obtained as below:

$$E [\text{dB}\mu\text{V/m}] = U_R + A_T + A_{\text{Factor}} [\text{dB}]; A_T = L_{\text{Cable loss}} [\text{dB}] - G_{\text{preamp}} [\text{dB}]$$

A_T : Total correction Factor except Antenna

U_R : Receiver Reading

G_{preamp} : Preamplifier Gain

A_{Factor} : Antenna Factor at 3m

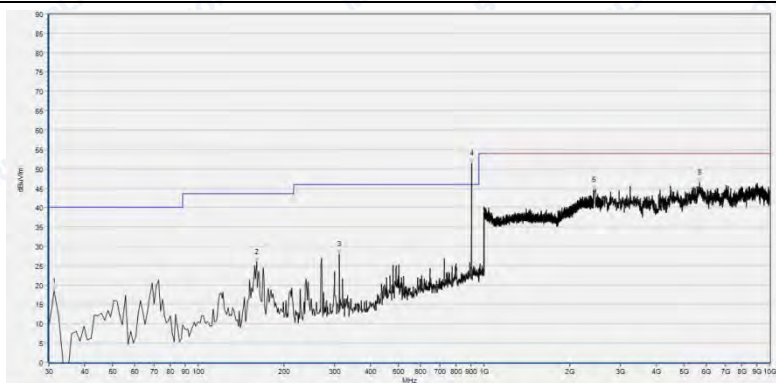
During the test, the total correction Factor A_T and A_{Factor} were built in test software.

Note: All radiated emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

The low frequency, which started from 9KHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

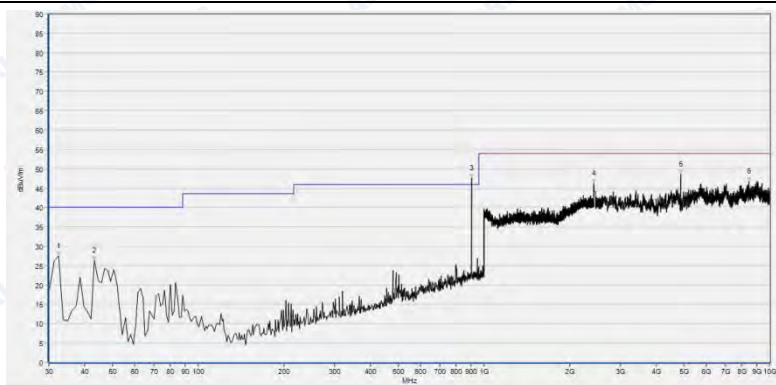


Plot for lowest Channel = 902.3



Fre. (MHz)	Pk	QP	AV	Limit-PK	Limit-QP	Limit-AV	Antenna	Verdict
31.214	18.44	N.A	N.A	N.A	40.00	N.A	Horizontal	PASS
159.900	25.91	N.A	N.A	N.A	43.50	N.A	Horizontal	PASS
311.652	28.02	N.A	N.A	N.A	46.00	N.A	Horizontal	PASS
902.879	21.53	N.A	N.A	N.A	46.00	N.A	Horizontal	N.A
2418.808	44.57	N.A	N.A	74.0	N.A	54.0	Horizontal	PASS
5691.762	46.43	N.A	N.A	74.0	N.A	54.0	Horizontal	PASS

(Antenna Horizontal, 30MHz to 10GHz)



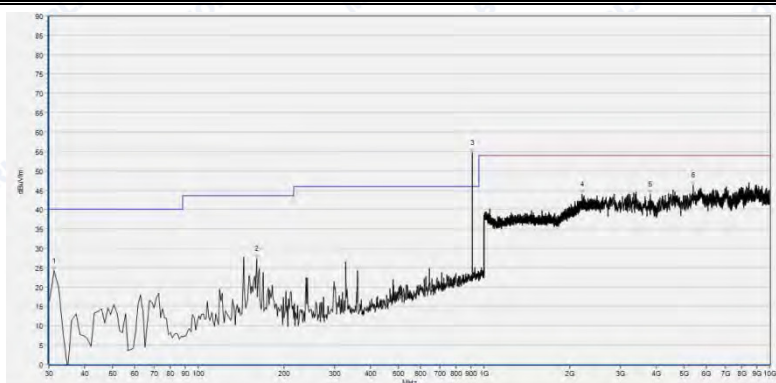
Fre.(MHz)	Pk	QP	AV	Limit-PK	Limit-QP	Limit-AV	Antenna	Verdict
32.428	27.43	N.A	N.A	N.A	40.00	N.A	Vertical	PASS
43.354	26.37	N.A	N.A	N.A	40.00	N.A	Vertical	PASS
902.879	21.66	N.A	N.A	N.A	46.00	N.A	Vertical	N.A
2420.728	46.30	N.A	N.A	74.0	N.A	54.0	Vertical	PASS
4872.995	51.59	N.A	N.A	74.0	N.A	54.0	Vertical	PASS
8437.280	46.84	N.A	N.A	74.0	N.A	54.0	Vertical	PASS

(Antenna Vertical, 30MHz to 10GHz)



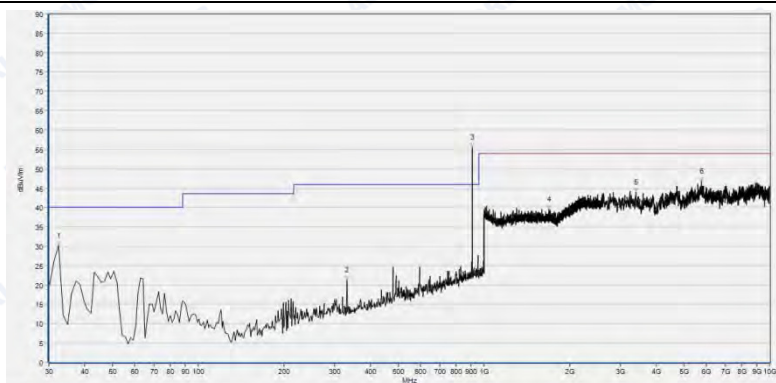
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Plot for middle Channel = 908.7



Fre. (MHz)	Pk	QP	AV	Limit-PK	Limit-QP	Limit-AV	Antenna	Verdict
31.214	24.12	N.A	N.A	N.A	40.00	N.A	Horizontal	PASS
159.900	27.28	N.A	N.A	N.A	43.50	N.A	Horizontal	PASS
908.949	24.59	N.A	N.A	N.A	46.00	N.A	Horizontal	N.A
2208.163	43.86	N.A	N.A	74.0	N.A	54.0	Horizontal	PASS
3822.040	43.90	N.A	N.A	74.0	N.A	54.0	Horizontal	PASS
5402.546	46.22	N.A	N.A	74.0	N.A	54.0	Horizontal	PASS

(Antenna Horizontal, 30MHz to 10GHz)



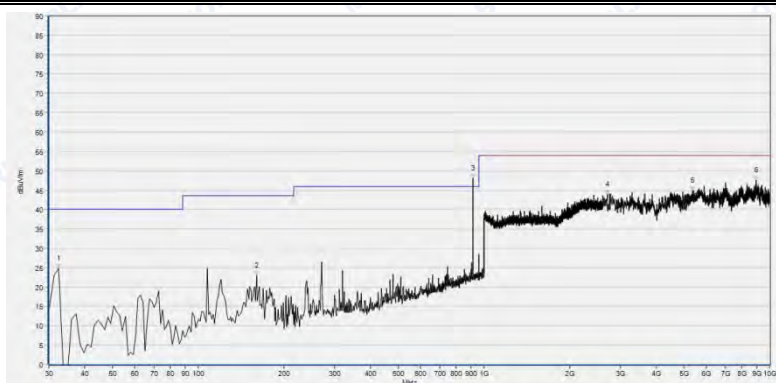
Fre.(MHz)	Pk	QP	AV	Limit-PK	Limit-QP	Limit-AV	Antenna	Verdict
32.428	30.17	N.A	N.A	N.A	40.00	N.A	Vertical	PASS
331.076	21.25	N.A	N.A	N.A	46.00	N.A	Vertical	PASS
908.949	22.51	N.A	N.A	N.A	46.00	N.A	Vertical	N.A
1685.074	39.49	N.A	N.A	74.0	N.A	54.0	Vertical	PASS
3402.473	43.84	N.A	N.A	74.0	N.A	54.0	Vertical	PASS
5761.011	46.70	N.A	N.A	74.0	N.A	54.0	Vertical	PASS

(Antenna Vertical, 30MHz to 10GHz)



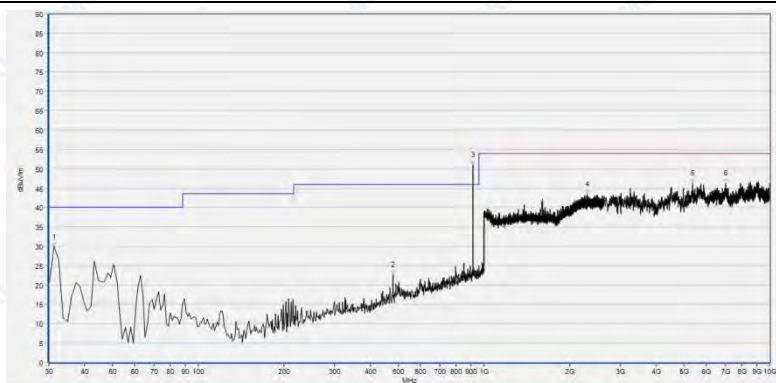
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Plot for highest Channel = 914.9



Fre. (MHz)	Pk	QP	AV	Limit-PK	Limit-QP	Limit-AV	Antenna	Verdict
32.428	24.73	N.A	N.A	N.A	40.00	N.A	Horizontal	PASS
159.900	22.89	N.A	N.A	N.A	43.50	N.A	Horizontal	PASS
915.019	22.16	N.A	N.A	N.A	46.00	N.A	Horizontal	N.A
2697.763	43.91	N.A	N.A	74.0	N.A	54.0	Horizontal	PASS
5374.032	44.98	N.A	N.A	74.0	N.A	54.0	Horizontal	PASS
8938.316	47.61	N.A	N.A	74.0	N.A	54.0	Horizontal	PASS

(Antenna Horizontal, 30MHz to 10GHz)



Fre.(MHz)	Pk	QP	AV	Limit-PK	Limit-QP	Limit-AV	Antenna	Verdict
31.214	29.91	N.A	N.A	N.A	40.00	N.A	Vertical	PASS
480.401	22.57	N.A	N.A	N.A	46.00	N.A	Vertical	PASS
915.019	22.10	N.A	N.A	N.A	46.00	N.A	Vertical	N.A
2299.720	43.49	N.A	N.A	74.0	N.A	54.0	Vertical	PASS
5378.105	46.28	N.A	N.A	74.0	N.A	54.0	Vertical	PASS
7015.639	46.25	N.A	N.A	74.0	N.A	54.0	Vertical	PASS

(Antenna Vertical, 30MHz to 10GHz)



ANNEX A GENERAL INFORMATION

1.1 Identification of the Responsible Testing Laboratory

Company Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Department:	Morlab Laboratory
Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China
Responsible Test Lab Manager:	Mr. Su Feng
Telephone:	+86 755 36698555
Facsimile:	+86 755 36698525

1.2 Identification of the Responsible Testing Location

Name:	Shenzhen Morlab Communications Technology Co., Ltd. Morlab Laboratory
Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China

1.3 Facilities and Accreditations

Shenzhen Morlab Communications Technology Co., Ltd. Morlab Laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L3572.

All measurement facilities used to collect the measurement data are located at FL.1, Building A, FeiYang Science Park, Block 67, BaoAn District, Shenzhen, 518101 P. R. China. The test site is constructed in conformance with the requirements of ANSI C63.10 2013 and CISPR Publication 22; the FCC registration number is 695796.

1.4 Maximum measurement uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for test performed on the EUT as specified in CISPR 16-1-2:

Measurements	Frequency	Uncertainty
Conducted emissions	9KHz~30MHz	2.44dB
Radiated emissions	9KHz~30MHz	2.44dB
	30MHz~200MHz	2.93dB
	200MHz~1000MHz	2.95dB
	1GHz~18GHz	2.26dB
	18GHz~40GHz	1.94dB



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This uncertainty represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$

1.5 Test Equipments Utilized

1.5.1 Conducted Test Equipments

Conducted Test Equipment						
No.	Equipment Name	Serial No.	Type	Manufacturer	Cal. Date	Cal. Due
1	Spectrum Analyzer	MY45101810	E4407B	Agilent	2016.03.02	2017.03.01
2	USB Wideband Power Sensor	MY54210011	U2021XA	Agilent	2016.03.02	2017.03.01
3	EXA Signal Analyzer	MY53470838	N9010A	Agilent	2016.03.02	2017.03.01
4	RF cable	CB01	RF01	Morlab	N/A	N/A
5	Attenuator	(n.a.)	10dB	Resnet	N/A	N/A
6	SMA connector Note	CN01	RF03	HUBER-SUHNER	N/A	N/A
Note: The SMA antenna connector is soldered on the PCB board in order to perform conducted tests and this SMA antenna connector is listed in the equipment list.						

1.5.2 Radiated Test Equipments

Radiated Test Equipments						
No.	Equipment Name	Serial No.	Type	Manufacturer	Cal. Date	Cal. Due Date
1	System Simulator	GB45360846	8960-E5515C	Agilent	2016.03.02	2017.03.01
2	Receiver	MY54130016	N9038A	Agilent	2016.03.02	2017.03.01
3	Test Antenna - Bi-Log	N/A	VULB9163	Schwarzbeck	2016.03.02	2017.03.01
4	Test Antenna - Horn	9170C-531	BBHA9170	Schwarzbeck	2016.03.02	2017.03.01
5	Test Antenna - Loop	1519-022	FMZB1519	Schwarzbeck	2016.03.02	2017.03.01
6	Test Antenna - Horn	71688	BBHA 9120D	Schwarzbeck	2016.03.02	2017.03.01
7	Coaxial cable(N male)	CB02	EMC02	Morlab	N/A	N/A
8	Coaxial cable(N male)	CB03	EMC03	Morlab	N/A	N/A
9	1-18GHz pre-Amplifier	MA02	TS-PR18	Rohde&Schwarz	2016.03.02	2017.03.01
10	18-26.5GHz pre-Amplifier	MA03	TS-PR18	Rohde&Schwarz	2016.03.02	2017.03.01



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1.5.3 Climate Chamber

Climate Chamber

No.	Equipment Name	Serial No.	Type	Manufacturer	Cal.Date	Cal.Due Date
1	Climate Chamber	2004012	HL4003T	Yinhe	2016.03.02	2017.03.01

1.5.4 Vibration Table

Vibration Table

No.	Equipment Name	Serial No.	Type	Manufacturer	Cal.Date	Cal.Due Date
1	Vibration Table	N/A	ACT2000-S015L	CMI-COM	2016.03.02	2017.03.01

1.5.5 Anechoic Chamber

Anechoic Chamber

No.	Equipment Name	Serial No.	Type	Manufacturer	Cal.Date	Cal.Due Date
1	Anechoic Chamber	N/A	9m*6m*6m	Changning	2016.03.02	2017.03.01

1.5.6 Auxiliary Test Equipment

Auxiliary Test Equipment

No.	Equipment Name	Serial No.	Type	Manufacturer	Cal.Date	Cal.Due Date
1	Computer	N.A	PU500C	Asus	N.A	N.A

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