FCC Radio Test Report

FCC ID: 2ALN5-RLM

Report No.	:	TB-FCC156282
Applicant	:	Southern Imperial, Inc.
Equipment Under Test (EUT)		
EUT Name	:	Wireless LM Tag
Model No.	:	RLM-RF-S1-3K
Serial Model No.	:	RLM-xx-S1-3x (“x” represents mumber or letter)
Brand Name	:	N/A
Receipt Date	:	2017-06-19
Test Date	:	2017-06-20 to 2017-07-05
Issue Date	:	2017-07-06
Standards	:	FCC Part 15, Subpart C (15.231(a):2016)
Test Method	:	ANSI C63.10:2013
Conclusions	:	**PASS**
		In the configuration tested, the EUT complied with the standards specified above, The EUT technically complies with the FCC requirements
Test/Witness Engineer	:	IWAN SU
Approved& Authorized	:	

SHENZHEN TOBY TECHNOLOGY CO., LTD. TOBY

This report details the results of the testing carried out on one sample. The results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in the report.

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1. General Information about EUT

1.1 Client Information

Applicant	:	Southern Imperial, Inc.
Address	:	1400 Eddy Avenue Rockford, IL61103 USA
Manufacturer	:	Shenzhen Allcomm Electronic Company Limited
Address	:	Guangtian Road Left Side Tangxiayong community, Songgang Street, Shenzhen City, Guangdong Province, P.R. China

1.2 General Description of EUT (Equipment Under Test)

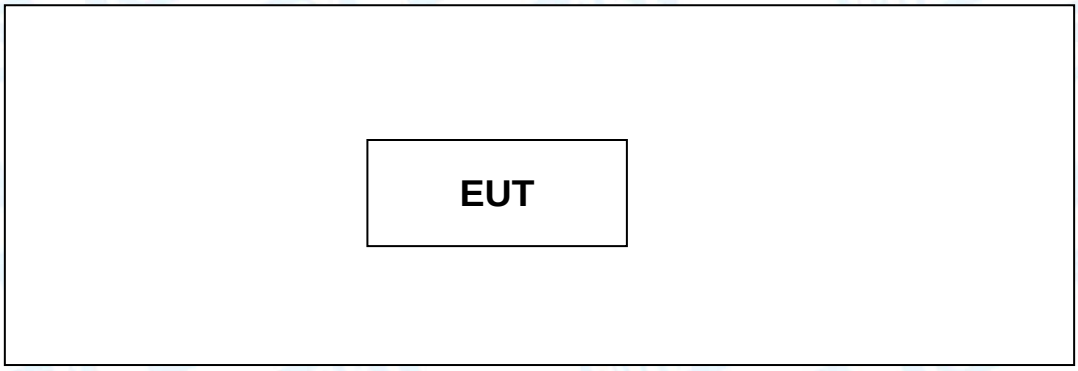
EUT Name	:	Wireless LM Tag	
Models No.	:	RLM-RF-S1-3K, RLM-xx-S1-3x (“x” represents mumber or letter)	
Model Difference	:	All these models are identical in the same PCB, layout and electrical circuit, the only difference is model name for commercial.	
Product Description	:	Operation Frequency:	433.92 MHz
		Out Power:	78.49 dBuV/m (PK Max.) 67.44 dBuV/m (AV Max.)
		Antenna Gain:	Integral Antenna(0 dBi)
		Modulation Type:	ASK
Power Supply	:	DC power from button Battery.	
Power Rating	:	DC 3.0V by button Battery(CR2430).	
Connecting I/O Port(S)	:	Please refer to the User's Manual	

Note:

(1) For a more detailed features description, please refer to the manufacturer’s specifications or the User’s Manual.

1.3 Block Diagram Showing the Configuration of System Tested

TX Mode



1.4 Description of Support Units

The EUT has been test as an independent unit.

1.5 Description of Test Mode

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned follow was evaluated respectively.

Test Items	Note
Conducted Emission	N/A
Radiated Emission	Continuously transmitting
Bandwidth	Continuously transmitting
Duty Cycle	Continuously transmitting
Release Time	Normal Mode

Note:

(1) During the testing procedure, the continuously transmitting mode was programmed by the customer.

(2) The EUT is considered a portable unit, and it was pre-tested on the positioned of each 3 axis: X axis, Y axis and Z axis. The worst case was found positioned on Z-plane. There for only the test data of this Z-plane were used for radiated emission measurement test.

1.6 Description of Test Software Setting

During testing channel& Power controlling software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product power parameters of transmitting mode.

RF Power Setting in Test SW:	DEF

1.7 Measurement Uncertainty

The reported uncertainty of measurement y ± U，where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2，providing a level of confidence of approximately 95 %.

Test Item	**Parameters**	**Expanded Uncertainty (U_{Lab})**
Conducted Emission	Level Accuracy: 9kHz~150kHz 150kHz to 30MHz	±3.42 dB ±3.42 dB
Radiated Emission	Level Accuracy: 9kHz to 30 MHz	±4.60 dB
Radiated Emission	Level Accuracy: 30MHz to 1000 MHz	±4.40 dB
Radiated Emission	Level Accuracy: Above 1000MHz	±4.20 dB

1.8 Test Facility

The testing report were performed by the Shenzhen Toby Technology Co., Ltd., in their facilities located at 1A/F., Bldg.6, Yusheng Industrial Zone, The National Road No.107 Xixiang Section 467, Xixiang, Bao'an, Shenzhen, Guangdong, China. At the time of testing, the following bodies accredited the Laboratory:

CNAS (L5813)

The Laboratory has been accredited by CNAS to ISO/IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories for the competence in the field of testing. And the Registration No.: CNAS L5813.

FCC List No.: (811562)

The Laboratory is listed in the United States of American Federal Communications Commission (FCC), and the registration number is 811562.

IC Registration No.: (11950A-1)

The Laboratory has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing. The site registration: Site# 11950A-1.

2. Test Summary

FCC Part 15 Subpart (15.231(a))			
Standard Section **FCC**	**Test Item**	**Judgment**	**Remark**
15.203	Antenna Requirement	PASS	**N/A**
15.207	Conducted Emission	N/A	**N/A**
15.231	Release Time	PASS	**N/A**
	Radiation Emission	PASS	**N/A**
	20 dB Bandwidth	PASS	**N/A**
	Duty Cycle	PASS	**N/A**
Note: N/A is an abbreviation for Not Applicable.			

3. Test Equipment

Conducted Emission Test					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Last Cal.**	**Cal. Due Date**
EMI Test Receiver	Rohde & Schwarz	ESCI	100321	Jul. 22, 2016	Jul. 21, 2017
RF Switching Unit	Compliance Direction Systems Inc	RSU-A4	34403	Jul. 22, 2016	Jul. 21, 2017
AMN	SCHWARZBECK	NNBL 8226-2	8226-2/164	Jul. 22, 2016	Jul. 21, 2017
LISN	Rohde & Schwarz	ENV216	101131	Jul. 22, 2016	Jul. 21, 2017
Radiation Emission Test					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Last Cal.**	**Cal. Due Date**
Spectrum Analyzer	Agilent	E4407B	MY45106456	Jul. 22, 2016	Jul. 21, 2017
EMI Test Receiver	Rohde & Schwarz	ESPI	100010/007	Jul. 22, 2016	Jul. 21, 2017
Bilog Antenna	ETS-LINDGREN	3142E	00117537	Mar. 25, 2017	Mar. 24, 2018
Bilog Antenna	ETS-LINDGREN	3142E	00117542	Mar. 25, 2017	Mar. 24, 2018
Horn Antenna	ETS-LINDGREN	3117	00143207	Mar. 24, 2017	Mar. 23, 2018
Horn Antenna	ETS-LINDGREN	3117	00143209	Mar. 24, 2017	Mar. 23, 2018
Loop Antenna	Laplace instrument	RF300	0701	Mar. 25, 2017	Mar. 24, 2018
Pre-amplifier	Sonoma	310N	185903	Mar. 24, 2017	Mar. 23, 2018
Pre-amplifier	HP	8449B	3008A00849	Mar. 29, 2017	Mar. 28, 2018
Cable	HUBER+SUHNER	100	SUCOFLEX	Mar. 29, 2017	Mar. 28, 2018
Positioning Controller	ETS-LINDGREN	2090	N/A	N/A	N/A
Antenna Conducted Emission					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Last Cal.**	**Cal. Due Date**
Spectrum Analyzer	Agilent	E4407B	MY45106456	Jul. 22, 2016	Jul. 21, 2017
Spectrum Analyzer	Rohde & Schwarz	ESCI	100010/007	Jul. 22, 2016	Jul. 21, 2017
Power Meter	Anritsu	ML2495A	25406005	Jul. 22, 2016	Jul. 21, 2017
Power Sensor	Anritsu	ML2411B	25406005	Jul. 22, 2016	Jul. 21, 2017

4. Conducted Emission Test

4.1 Test Standard and Limit

4.1.1Test Standard

FCC 15.207

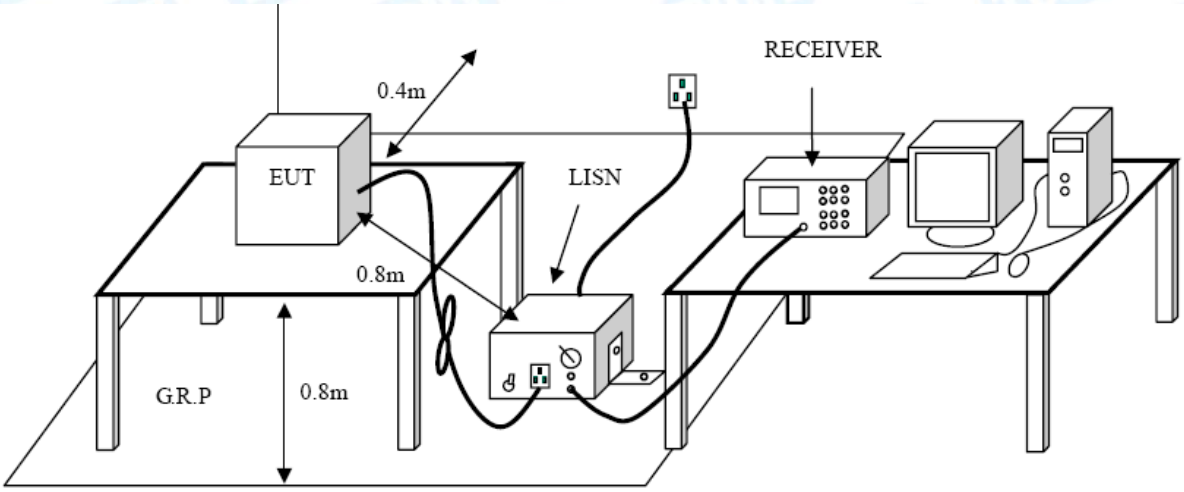
4.1.2 Test Limit

Conducted Emission Test Limit

Frequency	Maximum RF Line Voltage (dBμV)	
	Quasi-peak Level	Average Level
150kHz~500kHz	66 ~ 56 *	56 ~ 46 *
500kHz~5MHz	56	46
5MHz~30MHz	60	50

Notes:
(1) *Decreasing linearly with logarithm of the frequency.
(2) The lower limit shall apply at the transition frequencies.
(3) The limit decrease in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.2 Test Setup



4.3 Test Procedure

The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.

Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.

I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.

LISN at least 80 cm from nearest part of EUT chassis.

The bandwidth of EMI test receiver is set at 9kHz, and the test frequency band is from 0.15MHz to 30MHz.

4.4 Test Data

The EUT is powered by DC battery, no requirement for this test item.

5. Radiated Emission Test

5.1 Test Standard and Limit

5.1.1 Test Standard

FCC 15.231

5.1.2 Test Limit

According to FCC 15.231(a) requirement:

In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolt/meter) at 3m	Field Strength of Spurious Emissions (microvolt/meter) at 3m
40.66~40.70	2250	225
70~130	1250	125
130~174	1250 to 3750(**)	125 to 375(**)
174~260	3750	375
260~470	3750 to 12500(**)	375 to 1250(**)
Above 470	12500	1250

** Linear interpolations, the formulas for calculating the maximum permitted fundamental field strengths are as follows:

(1) for the band 130~174 MHz, uV/m at 3 meters= 56.81818(F)-6136.3636;

(2) for the band 260~470 MHz, uV/m at 3 meter= 41.6667(F)-7083.3333.

(3) The maximum permitted unwanted emissions level is 20 dB below the maximum permitted fundamental level. In addition field strength of any emissions which appear inside of the restriction band shall not exceed the general radiated emissions limits in RSS Gen 8.9.

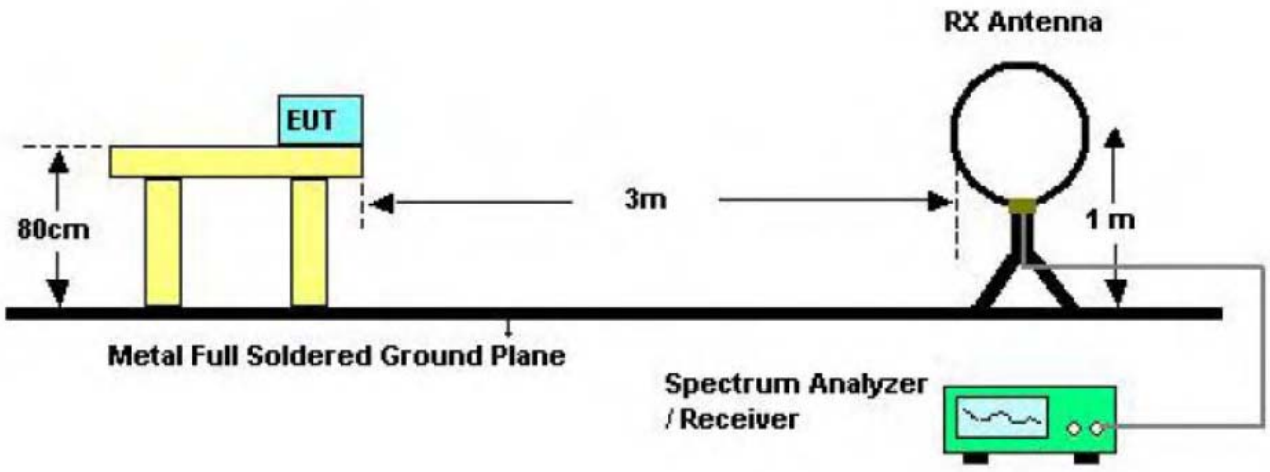
Frequency (MHz)	Field Strength (microvolt/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	2400/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

Note:
(1) The tighter limit applies at the band edges.
(2) Emission Level(dBuV/m)=20log Emission Level(uV/m)

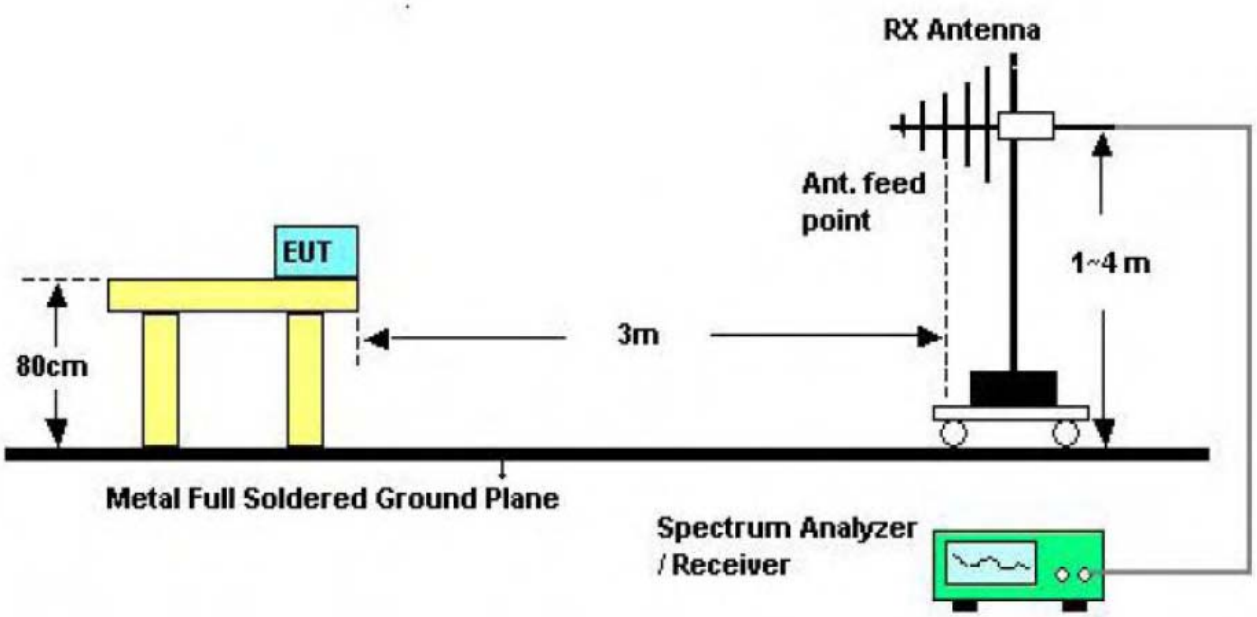
So the field strength of emission limits have been calculated in below table.

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolt/meter) at 3m
433.92 MHz	80.82 (Average)
433.92 MHz	100.82 (Peak)

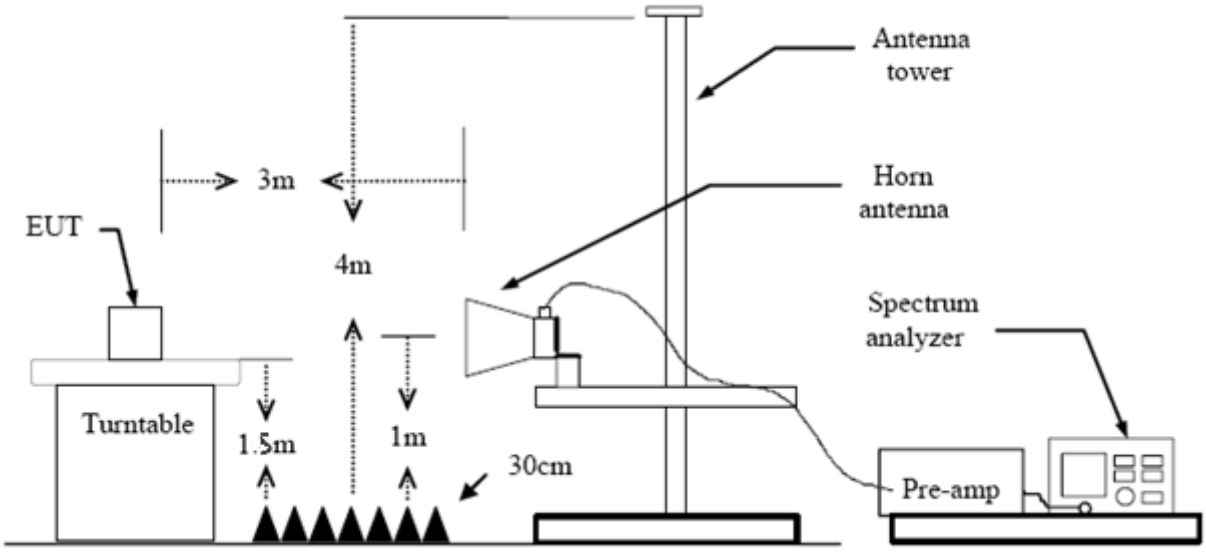
5.2 Test Setup



Bellow 30MHz Test Setup



Bellow 1000MHz Test Setup



Above 1GHz Test Setup

5.3 Test Procedure

(1) The measuring distance of 3m shall be used for measurements at frequency up to 1GHz. The EUT was placed on a rotating 0.8m high above the ground, the table was rotated 360 degrees to determine the position of the highest radiation.
(2) Measurements at frequency above 1GHz. The EUT was placed on a rotating 1.5m high above the ground. RF absorbers covered the ground plane with a minimum area of 3.0m by 3.0m between the EUT and measurement receiver antenna. The RF absorber shall not exceed 30cm in high above the conducting floor. The table was rotated 360 degrees to determine the position of the highest radiation.
(3) The Test antenna shall vary between 1m and 4m, Both Horizontal and Vertical antenna are set to make measurement.
(4) The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
(5) If the Peak Mode measured value compliance with and lower than Quasi Peak Mode Limit Bellow 1 GHz, the EUT shall be deemed to meet QP Limits and then no additional QP Mode measurement performed. But the Peak Value and average value both need to comply with applicable limit above 1 GHz.
(6) Testing frequency range below 1GHz the measuring instrument use VBW=120 kHz with Quasi-peak detection.
(7) Testing frequency range above 1GHz the measuring instrument use RBW=1 MHz and VBW=3 MHz with Peak Detector for Peak Values, and use RBW=1 MHz and VBW=10 Hz with Peak Detector for Average Values.
(8) For the actual test configuration, please see the test setup photo.

5.4 EUT Operating Condition

The Equipment Under Test was set to Continual Transmitting in maximum power.

5.5 Test Data

Test data please refer the following pages.

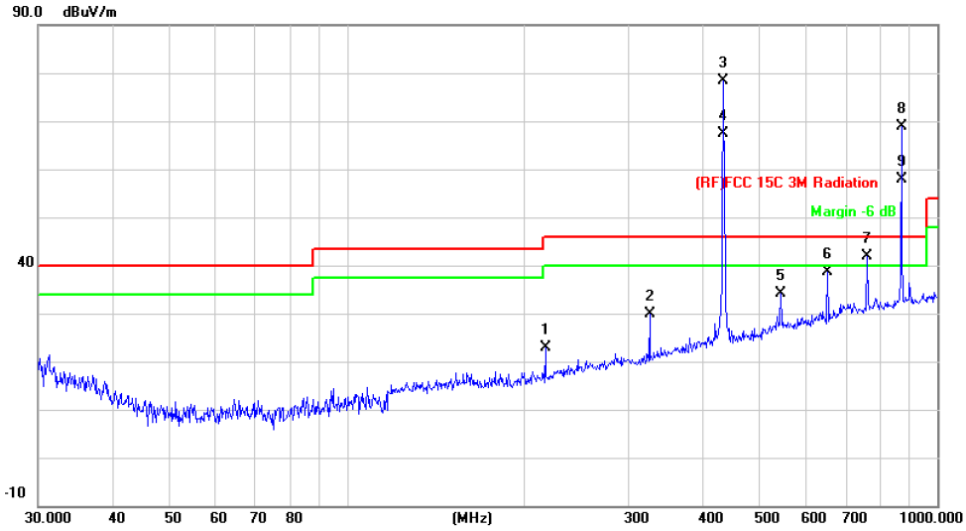
9 KHz~30 MHz

From 9 KHz to 30 MHz: Conclusion: PASS

Note: The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

Fundamental and Harmonics emissions(**30MHz-1GHz**)

EUT:	Wireless LM Tag	**Model Name :**	RLM-RF-S1-3K
Temperature:	25 ℃	**Relative Humidity:**	55%
Test Voltage:	DC 3.0V		
Ant. Pol.	Horizontal		
Test Mode:	TX Mode		
Remark:	No report for the emission which more than 10 dB below the prescribed limit.		

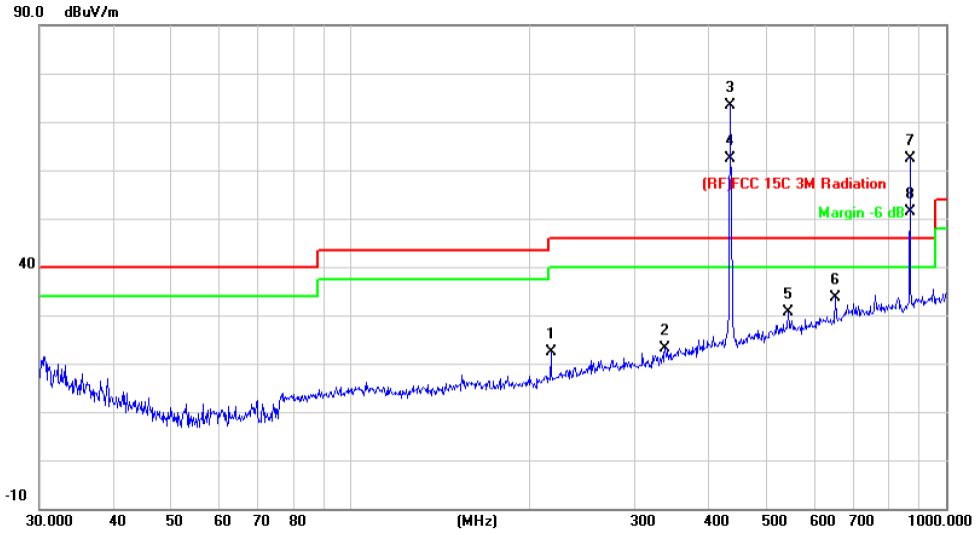


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		216.7828	41.78	-19.01	22.77	46.00	-23.23	peak
2		325.5958	45.30	-15.31	29.99	46.00	-16.01	peak
3	*	434.0651	90.44	-11.95	78.49	**100.82**	-22.33	peak
4	X	434.0651	79.39	-11.95	67.44	**80.82**	-13.38	AVG
5		543.2742	43.41	-9.27	34.14	46.00	-11.86	peak
6		651.9417	46.38	-7.66	38.72	46.00	-7.28	peak
7	!	760.7036	47.78	-5.83	41.95	46.00	-4.05	peak
8	X	869.1300	73.76	-4.93	68.83	**80.82**	-11.99	peak
9	X	869.1300	62.71	-4.93	57.78	**60.82**	-3.04	AVG

Average Value=Peak Value-11.05

Emission Level= Read Level+ Correct Factor

EUT:	Wireless LM Tag	Model Name :	RLM-RF-S1-3K
Temperature:	25 ℃	Relative Humidity:	55%
Test Voltage:	DC 3.7V		
Ant. Pol.	Vertical		
Test Mode:	TX Mode		
Remark:	No report for the emission which more than 10 dB below the prescribed limit.		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		216.7828	41.43	-19.01	22.42	46.00	-23.58	peak
2		337.2155	37.64	-14.59	23.05	46.00	-22.95	peak
3	*	434.0651	85.43	-11.95	73.48	**100.82**	-27.34	peak
4	X	434.0651	74.38	-11.95	62.43	**80.82**	-18.39	AVG
5		543.2742	39.85	-9.27	30.58	46.00	-15.42	peak
6		651.9417	41.19	-7.66	33.53	46.00	-12.47	peak
7	X	869.1302	67.30	-4.93	62.37	**80.82**	-18.45	peak
8	X	869.1302	56.25	-4.93	51.32	**60.82**	-9.5	AVG

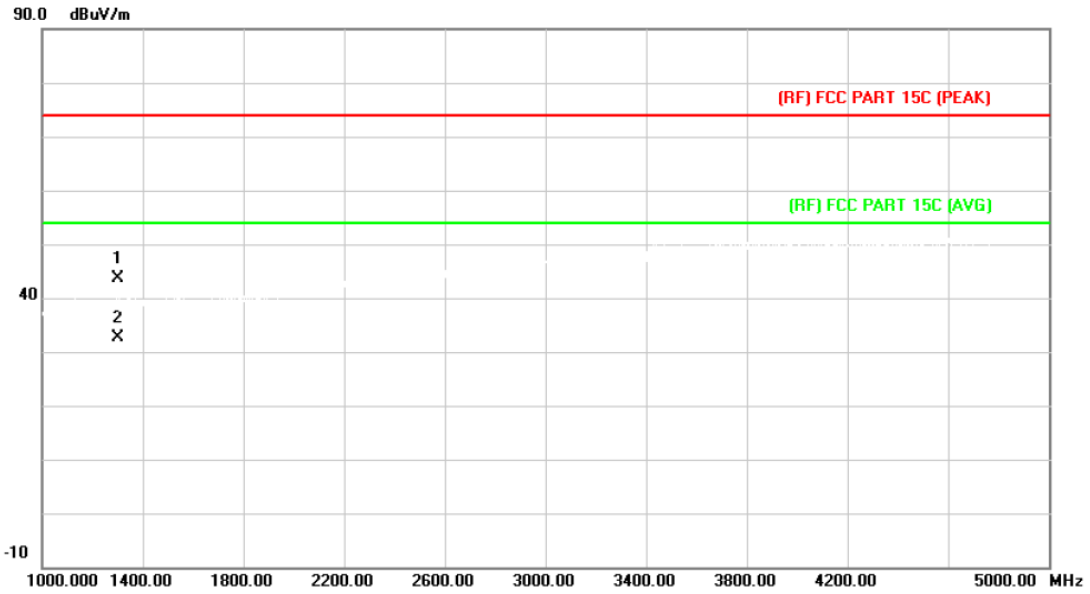
Average Value=Peak Value-11.05

Emission Level= Read Level+ Correct Factor

Note: (1) All Readings are Peak Value.
(2) Emission Level= Reading Level+ Probe Factor +Cable Loss
(3) The QP measurement was not performed when the peak measured data under the limit of QP detection.

Above 1G

EUT:	Wireless LM Tag	**Model Name :**	RLM-RF-S1-3K
Temperature:	25 ℃	**Relative Humidity:**	55%
Test Voltage:	DC 3.0V		
Ant. Pol.	Horizontal		
Test Mode:	TX Mode		
Remark:	No report for the emission which more than 10 dB below the prescribed limit.		

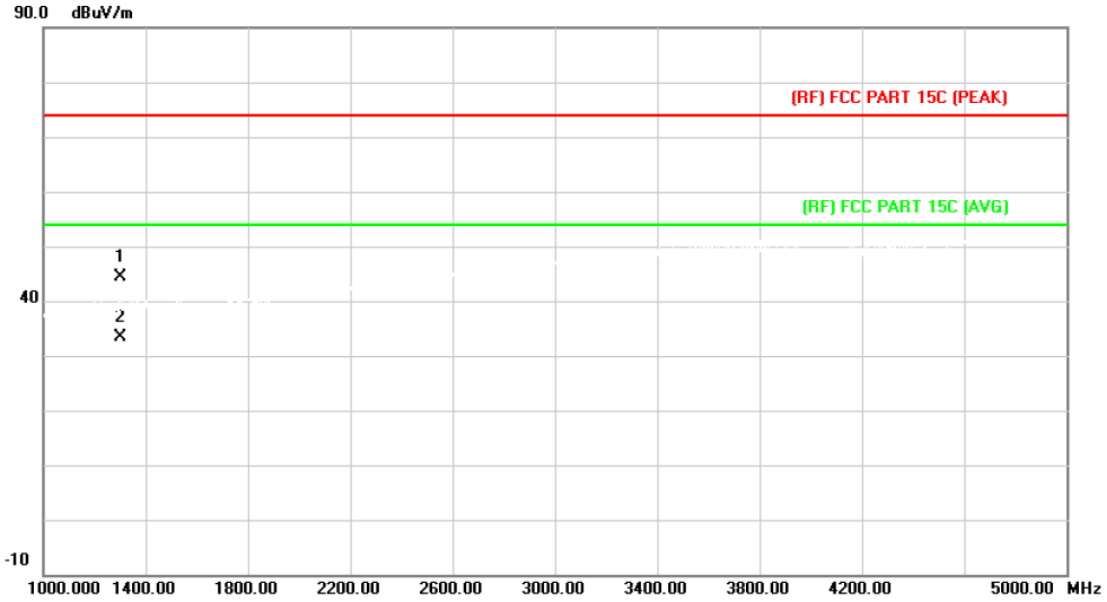


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		1300.000	49.10	-5.39	43.71	74.00	-30.29	peak
2	*	1300.000	38.05	-5.39	32.66	54.00	-21.34	AVG

Emission Level= Read Level+ Correct Factor

Average Value=Peak Value-11.05

EUT:	Wireless LM Tag	**Model Name :**	RLM-RF-S1-3K
Temperature:	25 ℃	**Relative Humidity:**	55%
Test Voltage:	DC 3.0V		
Ant. Pol.	Vertical		
Test Mode:	TX Mode		
Remark:	No report for the emission which more than 10 dB below the prescribed limit.		



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector
1		1300.000	49.86	-5.39	44.47	74.00	-29.53	peak
2	*	1300.000	38.81	-5.39	33.42	54.00	-20.58	AVG

Emission Level= Read Level+ Correct Factor

Average Value=Peak Value-11.05

Other harmonics emissions are lower than 20dB below the allowable limit.

Note: (1) All Readings are Peak Value and AV. And AV is calculated by the following:
Testing frequency range below 1GHz the measuring instrument use VBW=120 kHz with Quasi-peak detection.
Testing frequency range above 1GHz the measuring instrument use RBW=1 MHz and VBW=3 MHz with Peak Detector for Peak Values.
Average Values=Peak Values+20log (Duty Cycle)
(2) Emission Level= Reading Level + Probe Factor +Cable Loss
(3) Data of measurement within this frequency range shown " -- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

Pulse Desensitization Correction Factor

Note:
(1)The Smallest Pulse Width (PW)= 0.400ms

(2) 2/PW=2/0.400 (ms)= 5 kHz<100 kHz

Because 2/PW<RBW, so the PDCF is not needed.

6. Bandwidth

6.1 Test Standard and Limit

6.1.1 Test Standard

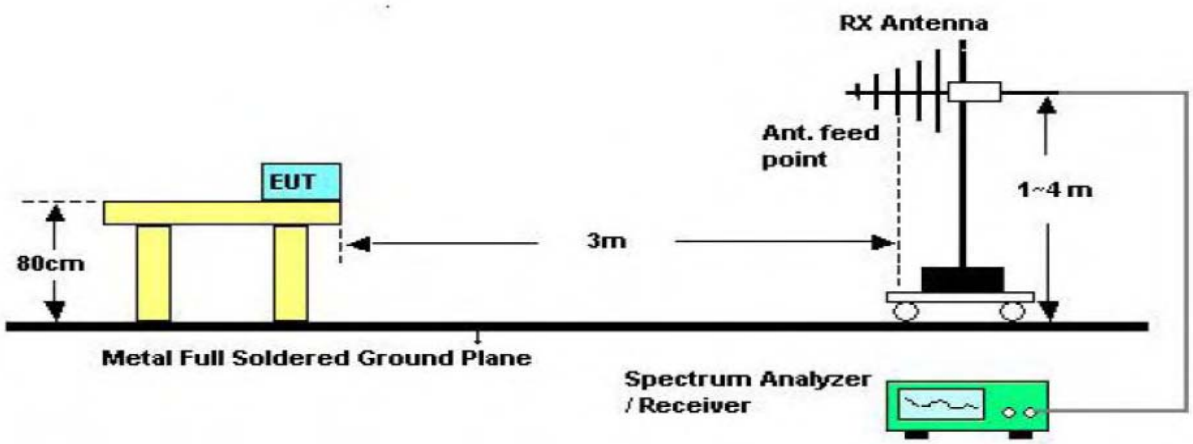
FCC 15.231

6.1.2 Test Limit

The 99%bandwidth of the emissions shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. So the emission bandwidth limits have been calculated in below table.

Fundamental Frequency	20 dB Bandwidth Limits (MHz)
433.92 MHz	1.0847

6.2 Test Setup



6.3 Test Procedure

(1) Set Spectrum Analyzer Center Frequency= Fundamental Frequency, RBW=10 kHz, VBW= 30 kHz, Span= 1 MHz.

(2) Measured the spectrum width with power higher than 20 dB below carrier.

6.4 EUT Operating Condition

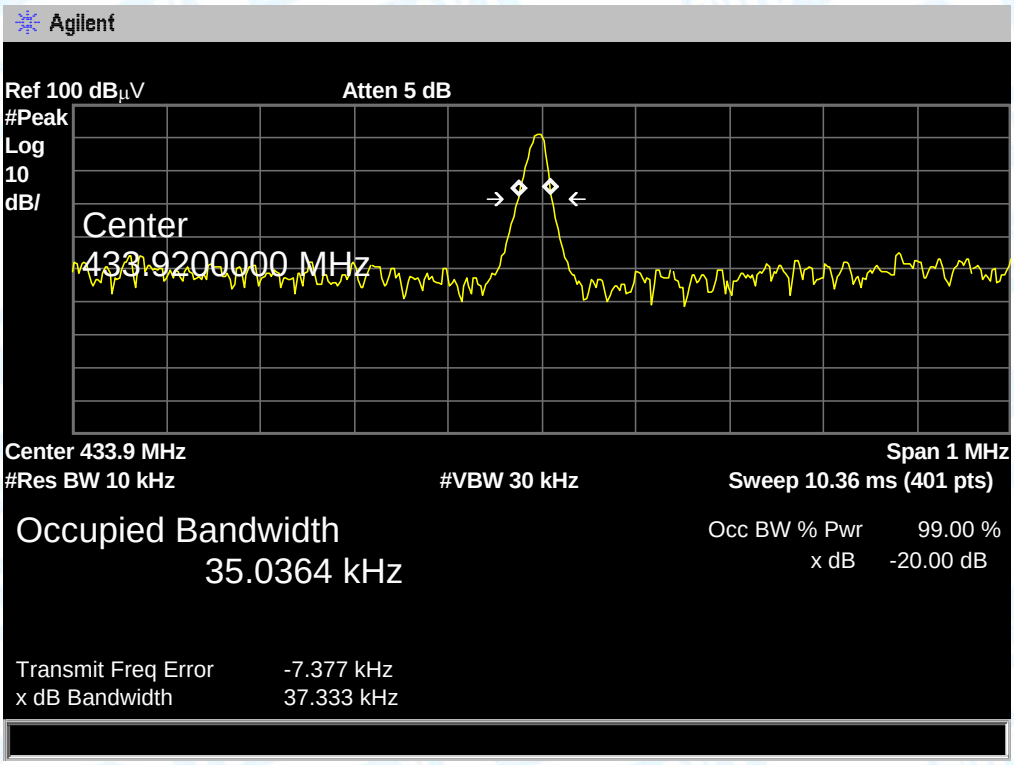
The Equipment Under Test was Programmed to be in continuously transmitting mode.

6.5 Test Condition

Temperature	:	25 ℃
Relative Humidity	:	65 %
Pressure	:	1010 hPa
Test Power	:	DC 3.0V

6.6 Test Data

Frequency (MHz)	20 dBc Bandwidth (kHz)	99% OBW (kHz)	Result
433.92	37.330	35.0364	PASS



7. Release Time Measurement

7.1 Test Standard and Limit

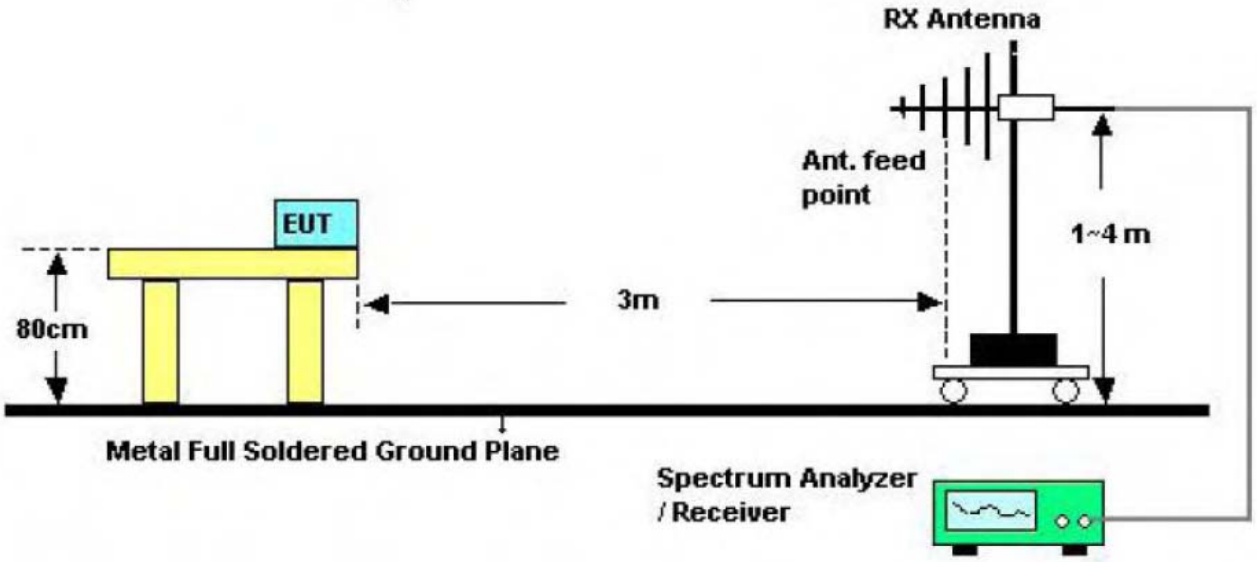
7.1.1 Test Standard

FCC 15.231

7.1.2 Test Limit

According to FCC 15.231a, A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

7.2 Test Setup



7.3 Test Procedure

(1) Setup the EUT as show in the block diagram above.
(2) Set Spectrum Analyzer Centre Frequency= Fundamental Frequency, RBW=100 kHz, VBW= 300 kHz, Span= 0 Hz. Sweep Time= 5 Seconds.
(3) Setup the EUT as normal operation and press Transmitter button.
(4) Set Spectrum Analyzer View, Delta Mark time.

7.4 EUT Operating Condition

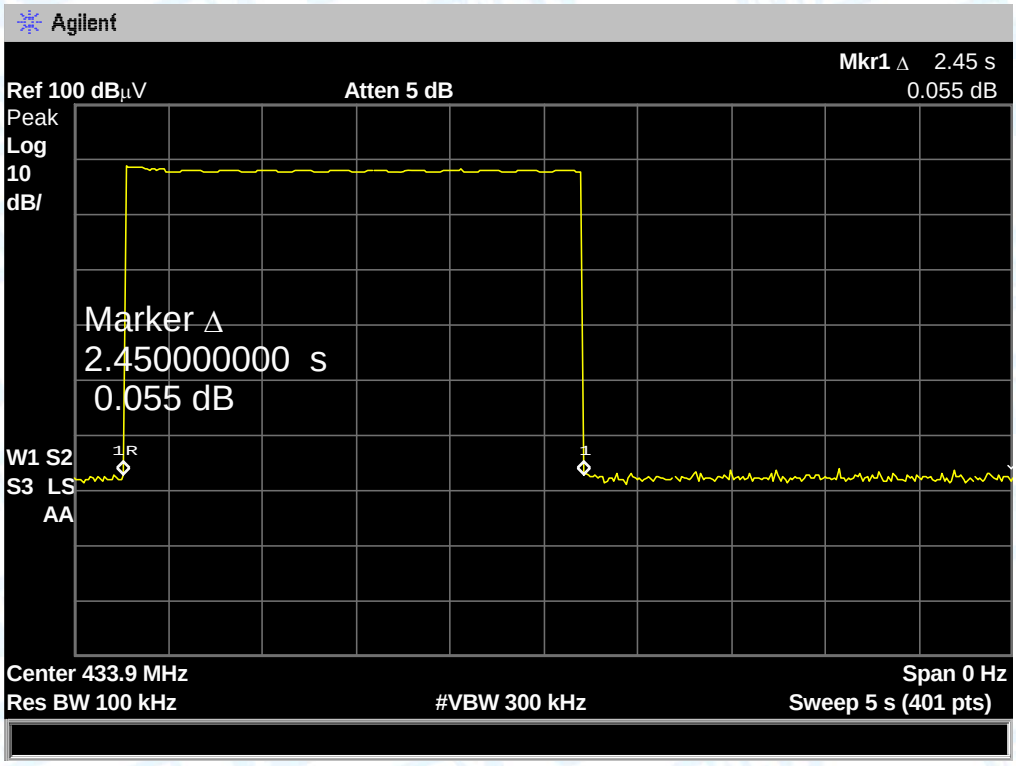
The EUT was set to work in transmitting mode.

7.5 Test Condition

Temperature	:	25 ℃
Relative Humidity	:	65 %
Pressure	:	1010 hPa
Test Power	:	DC 3.0V

7.6 Test Data

Release Time (s)	Limit (s)	Result
2.45	5	PASS

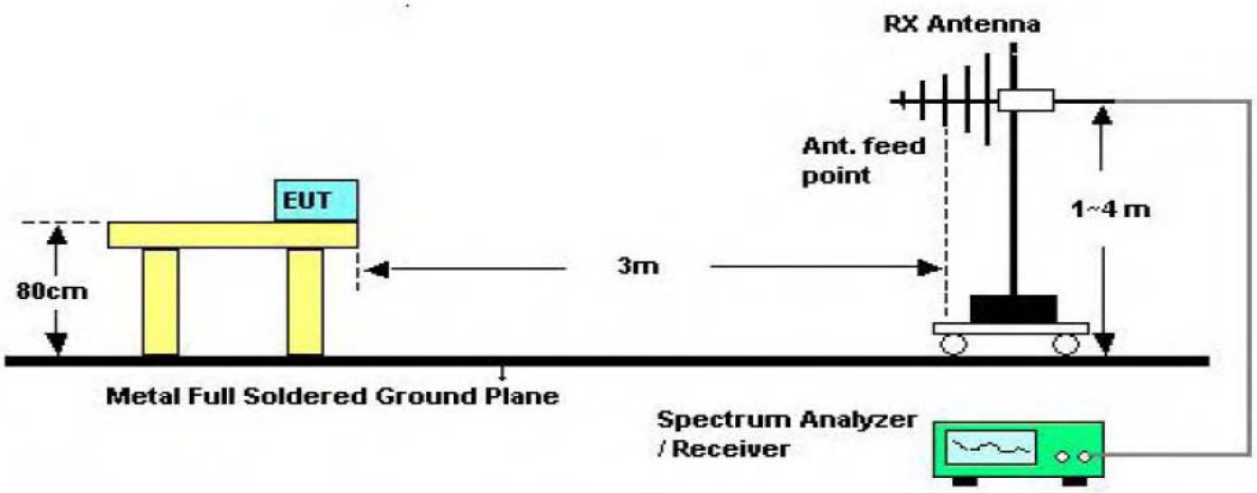


8. Duty Cycle

8.1 Test Standard and Limit

5.1.1 Test Standard
FCC 15.231

8.2 Test Setup



8.3 Test Procedure

(1) The EUT was placed on a turntable which is 0.8m above ground plane.
(2) Set EUT operating in continuous transmitting mode.
(3) Set the Spectrum Analyzer to the transmitter carrier frequency, and set the spectrum analyzer resolution bandwidth (RBW) to 100 kHz and video bandwidth (VBW) to 300 kHz, Span was set to 0 Hz.
(4) The Duty Cycle was measured and recorded.

8.4 EUT Operating Condition

The EUT was programmed to be in transmitting mode.

8.5 Test Condition

Temperature	:	25 ℃
Relative Humidity	:	65 %
Pressure	:	1010 hPa
Test Power	:	DC 3.0V

8.6 Test Data

Please refer the following pages:

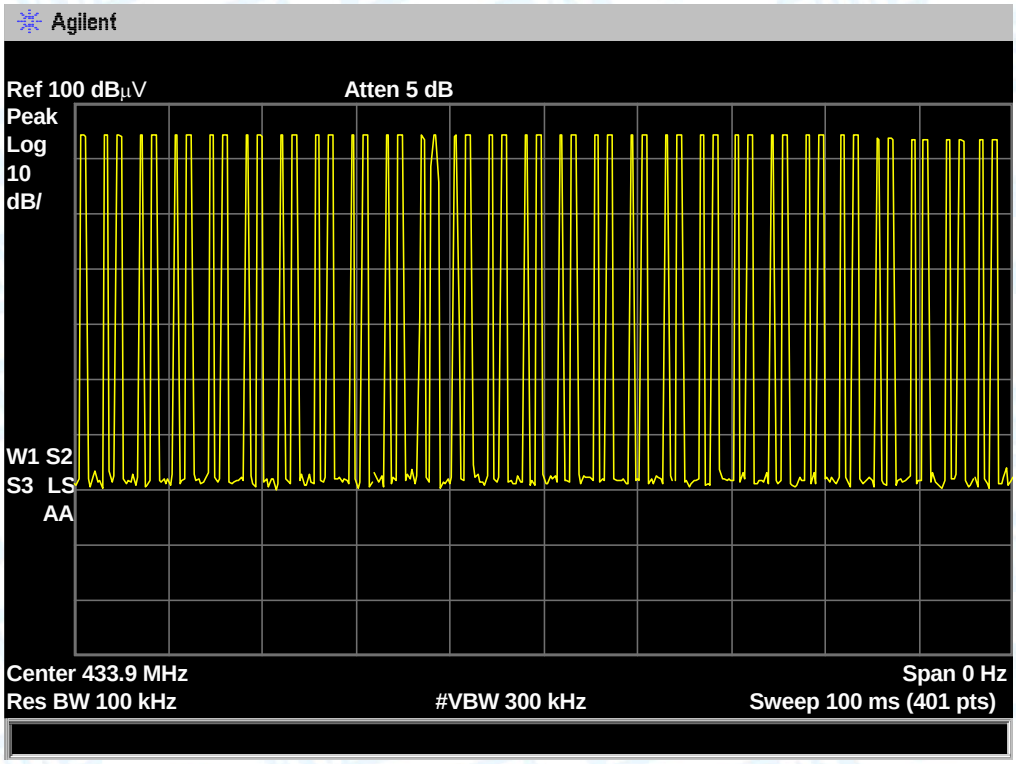
Plot 1/Plot 2: transmit once in 20ms, and each cycle is 3.75ms there are three kinds of pulse in each cycle, the large pulses total 1, the small pulses total 1.

Plot 3: one small pulse in a time period of 0.400ms

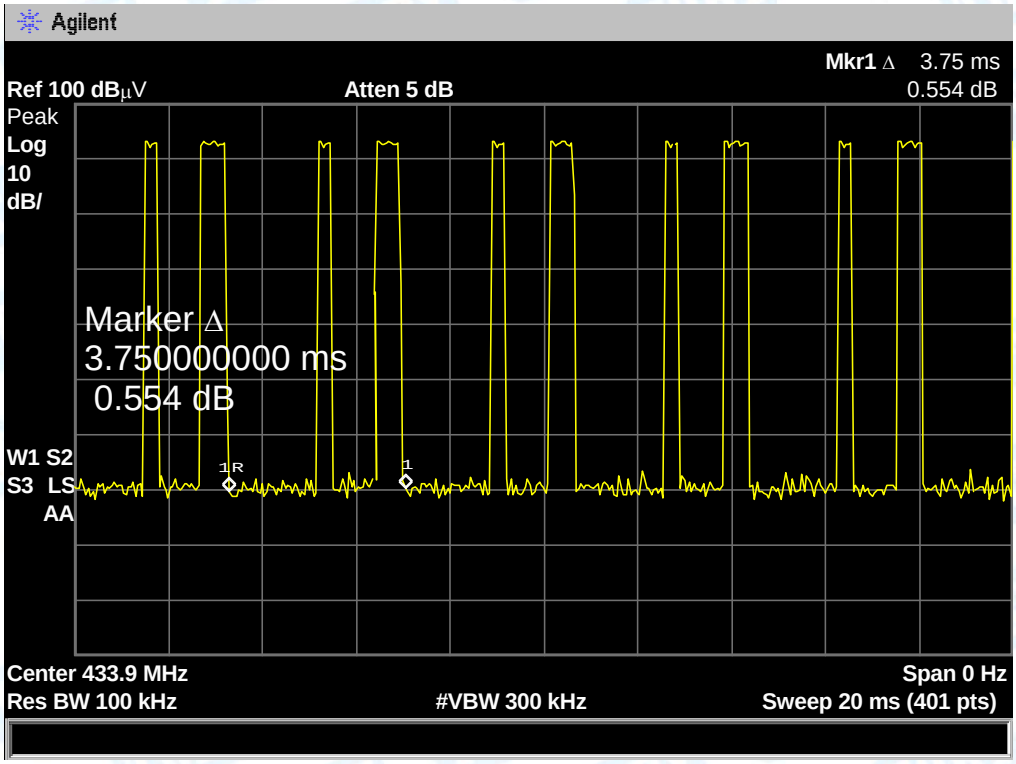
Plot 4: one large pulse in a time period of 0.650ms

Duty Cycle=ON/Total=(0.65+0.4)/3.75=1.05/3.75=28%
20 log(Duty Cycle)=-11.05
Average=Peak Value+20log(Duty Cycle), AV=PK-11.05

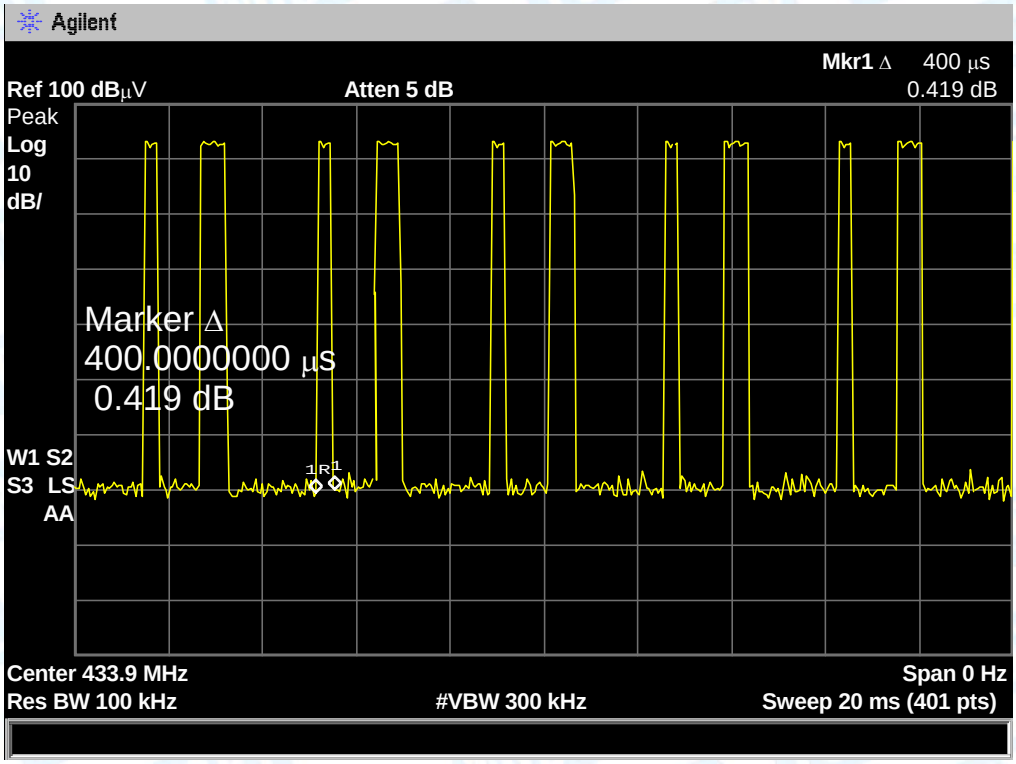
Plot 1



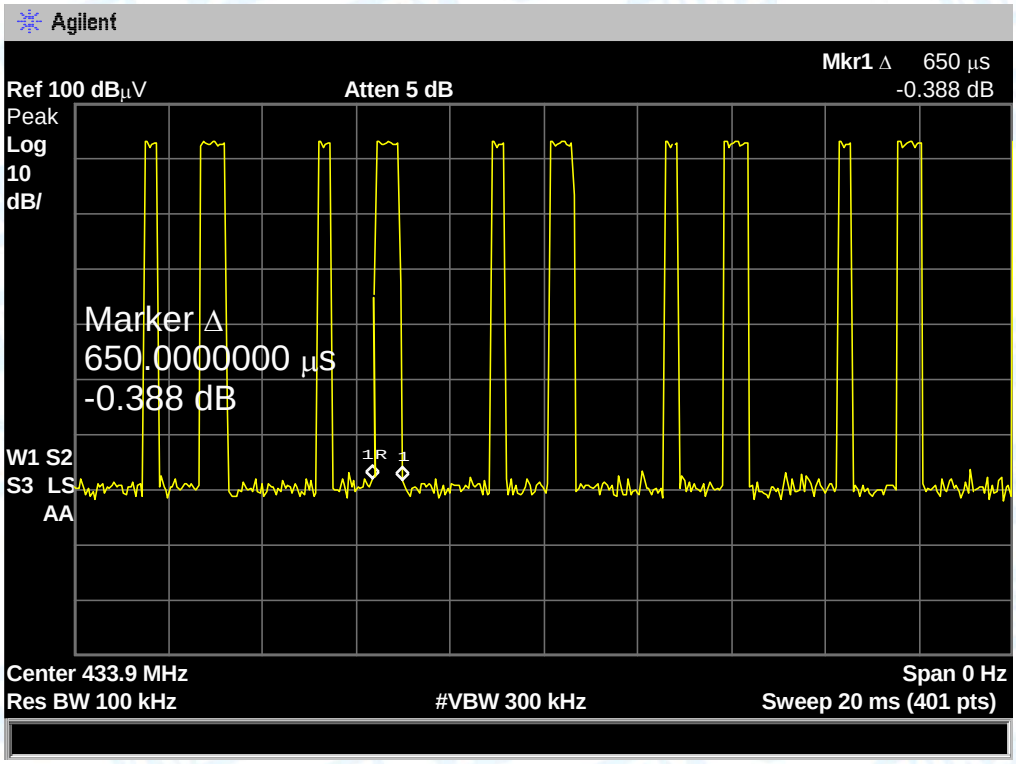
Plot 2


Agilent
Mkr1 Δ 3.75 ms
0.554 dB
Ref 100 dBµV
Atten 5 dB
Peak
Log
10
dB/
Marker Δ
3.750000000 ms
0.554 dB
W1 S2
S3 LS
AA
Center 433.9 MHz
Res BW 100 kHz
#VBW 300 kHz
Span 0 Hz
Sweep 20 ms (401 pts)

Plot 3


Agilent
Mkr1 Δ 400 µs
0.419 dB
Ref 100 dBµV
Atten 5 dB
Peak
Log
10
dB/
Marker Δ
400.0000000 µs
0.419 dB
W1 S2
S3 LS
AA
Center 433.9 MHz
Res BW 100 kHz
#VBW 300 kHz
Span 0 Hz
Sweep 20 ms (401 pts)

Plot 4


Agilent
Mkr1 Δ 650 µs
-0.388 dB
Ref 100 dBµV
Atten 5 dB
Peak
Log
10
dB/
Marker Δ
650.0000000 µs
-0.388 dB
1R 1
W1 S2
S3 LS
AA
Center 433.9 MHz
Res BW 100 kHz
#VBW 300 kHz
Span 0 Hz
Sweep 20 ms (401 pts)

9. Antenna Requirement

9.1 Standard Requirement

9.1.1 Standard

FCC Part 15.203

9.1.2 Requirement

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. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

9.2 Antenna Connected Construction

The directional gains of the antenna used for transmitting is 0 dBi, and the antenna connector is de-signed with permanent attachment and no consideration of replacement. Please see the EUT photo for details.

Result

The EUT antenna is an Printed Antenna. It complies with the standard requirement.

Antenna Type
☑ Permanent attached antenna
☐ Unique connector antenna
☐ Professional installation antenna