

FCC RADIO TEST REPORT

FCC 47 CFR PART 15 SUBPART C

Test Standard	FCC Part 15.231
FCC ID	KR5TIS-09
Trade name	Continental
Product name	Wheel Unit
Model No.	TIS-09
Operation Freq.	TX: 433.92 MHz
Test Result	Pass

The test Result was tested by Compliance Certification Services Inc. The test data, data evaluation, test procedures, and equipment configurations shown in this report were given in ANSI C63.10: 2013 and compliance standards.

The test results of this report relate only to the tested sample (EUT) identified in this report.

The test Report of full or partial shall not copy. Without written approval of SGS Compliance Certification Services Inc. (Wugu Laboratory)



Approved by:



Sam Chuang
Manager

Reviewed by:



Jerry Chuang
Engineer

Revision History

Rev.	Issue Date	Revisions	Effect page	Revised By
00	April 10, 2018	Initial Issue	ALL	Allison Chen
01	May 7, 2018	1. Revised standard section in chapter 2. 2. Revised the standard section of the limit in section 4.5.	P.9, P.27	Allison Chen

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1. GENERAL INFORMATION

1.1 EUT INFORMATION

Applicant	Continental Automotive GmbH Siemensstrasse 12 SV C TS RBG EMC-Laboratory Regensburg, 93055 Germany
Manufacturer	Continental Automotive GmbH Siemensstrasse 12 SV C TS RBG EMC-Laboratory Regensburg, 93055 Germany
Factory	Continental Automotive Systems Corporation 45-29 Saeum-ro, Icheon-Si, Gyeonggi-Do 17308, Republic of Korea
Equipment	Wheel Unit
Model Name	TIS-09
Model Discrepancy	N/A
Received Date	March 30, 2018
Date of Test	April 3, 2018
Periodic operation	<input type="checkbox"/> (1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released. <input type="checkbox"/> (2) A transmitter activated automatically shall cease transmission within 5 seconds after activation <input type="checkbox"/> (3) Periodic transmissions at regular predetermined intervals are not permitted. <input checked="" type="checkbox"/> (4) Periodic transmissions (lower field strength): each transmission is not greater than 1 sec and the silent period between transmissions is at least 30 times the duration of the transmission but in no case less than 10 sec.
Power Operation	Lithium Standard-Battery: 3V
Operation Frequency	TX: 433.92 MHz

1.2 EUT CHANNEL INFORMATION

Frequency Range	433.92 MHz
Modulation Type	ASK / FSK
Bandwidth	ASK: 59.510 KHz
	FSK: 105.500KHz
Number of Channels	1 channel

Remark:

Refer as ANSI 63.10:2013 clause 5.6.1 Table 4 for test channels

Number of frequencies to be tested		
Frequency range in which device operates	Number of frequencies	Location in frequency range of operation
<input checked="" type="checkbox"/> 1 MHz or less	1	Middle
<input type="checkbox"/> 1 MHz to 10 MHz	2	1 near top and 1 near bottom
<input type="checkbox"/> More than 10 MHz	3	1 near top, 1 near middle, and 1 near bottom

1.3 ANTENNA INFORMATION

Antenna Type	Loop antenna
Antenna Gain	-22.4 dBi

1.4 MEASUREMENT UNCERTAINTY

PARAMETER	UNCERTAINTY
AC Powerline Conducted Emission	+/- 2.96
Emission bandwidth, 20dB bandwidth	+/- 1.4003
RF output power, conducted	+/- 1.1372
Power density, conducted	+/- 1.4003
3M Semi Anechoic Chamber / 30M~200M	+/- 4.0138
3M Semi Anechoic Chamber / 200M~1000M	+/- 3.9483
3M Semi Anechoic Chamber / 1GHz~8GHz	+/- 2.5975
3M Semi Anechoic Chamber / 8GHz~18GHz	+/- 2.6112
3M Semi Anechoic Chamber / 18GHz~26GHz	+/- 2.7389
3M Semi Anechoic Chamber / 26GHz~40GHz	+/- 2.9683
3M Semi Anechoic Chamber / 40GHz~60GHz	+/- 1.8509
3M Semi Anechoic Chamber / 60GHz~75GHz	+/- 1.9869
3M Semi Anechoic Chamber / 75GHz~110GHz	+/- 2.9651
3M Semi Anechoic Chamber / 110GHz~170GHz	+/- 2.7807
3M Semi Anechoic Chamber / 170GHz~220GHz	+/- 3.6437
3M Semi Anechoic Chamber / 220GHz~325GHz	+/- 4.2982

Remark:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$
2. ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report.

1.5 FACILITIES AND TEST LOCATION

All measurement facilities used to collect the measurement data are located at
No.11, Wugong 6th Rd., Wugu Dist., New Taipei City 24891, Taiwan. (R.O.C.)

Test site	Test Engineer	Remark
AC Conduction Room	N/A	Not applicable
Radiation	Jerry Chuang	-
RF Conducted	Jerry Chuang	-

Remark: The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.

1.6 INSTRUMENT CALIBRATION

RF Conducted Test Site					
Equipment	Manufacturer	Model	S/N	Cal Date	Cal Due
Spectrum Analyzer	R&S	FSV 40	101073	10/02/2017	10/01/2018
Directional Coupler	Agilent	87301D	MY44350252	07/25/2017	07/24/2018
SUCOFLEX Cable	HUBER SUHNER	SUCOFLEX 104PEA	25157	07/31/2017	07/30/2018
Divider	Solvang Technology	2-18GHz 4Way	STI08-0015	07/26/2017	07/25/2018
Signal Generator	Agilent	E8257C	US42340383	07/26/2017	07/25/2018

3M 966 Chamber Test Site					
Equipment	Manufacturer	Model	S/N	Cal Date	Cal Due
Bilog Antenna	Sunol Sciences	JB3	A030105	06/20/2017	06/19/2018
Horn Antenna	ETC	MCTD 1209	DRH13M02003	08/25/2017	08/24/2018
Pre-Amplifier	EMEC	EM330	60609	06/07/2017	06/06/2018
Spectrum Analyzer	Agilent	E4446A	US42510252	11/27/2017	11/26/2018
Loop Ant	COM-POWER	AL-130	121051	03/21/2018	03/20/2019
Antenna Tower	CCS	CC-A-1F	N/A	N.C.R	N.C.R
Controller	CCS	CC-C-1F	N/A	N.C.R	N.C.R
Turn Table	CCS	CC-T-1F	N/A	N.C.R	N.C.R
Pre-Amplifier	HP	8449B	3008A00965	06/27/2017	06/26/2018
Filter	N/A	580-6000	N/A	N/A	N/A
Cable	HUBER SUHNER	SUCOFLEX 104PEA	25157	07/31/2017	07/30/2018
Cable	HUBER SUHNER	SUCOFLEX 104PEA	20995	07/31/2017	07/30/2018

Remark: Each piece of equipment is scheduled for calibration once a year.

1.7 SUPPORT AND EUT ACCESSORIES EQUIPMENT

There are no accessories and support equipment be used during the test.

EUT Accessories Equipment					
No.	Equipment	Brand	Model	Series No.	FCC ID
	N/A				

Support Equipment					
No.	Equipment	Brand	Model	Series No.	FCC ID
	N/A				

1.8 TEST METHODOLOGY AND APPLIED STANDARDS

The test methodology, setups and results comply with all requirements in accordance with ANSI C63.10:2013, FCC 15.231 Rules.

2. TEST SUMMARY

Standard Sec.	Chapter	Test Item	Result
15.203	1.3	Antenna Requirement	Pass
15.207	4.1	AC Power-line Conducted Emission	Not applicable
15.231(c)	4.2	Emission Bandwidth	Pass
15.231(e)	4.3	Fundamental Emission	Pass
15.209(b)	4.4	Transmitter Radiated Emission	Pass
15.231(e)	4.5	Operation Restriction	Pass

3. DESCRIPTION OF TEST MODES

3.1 THE WORST MODE OF OPERATING CONDITION

Operation mode	433.92 MHz
RF Filed strength	FSK <u>Peak: 78.71 dBuv/m</u> <u>Average : 62.80 dBuv/m</u>

Remark: Field strength performed Average level at 3m.

3.2 THE WORST MODE OF MEASUREMENT

Radiated Emission Measurement Above 1G	
Test Condition	Band edge, Emission for Unwanted and Fundamental
DC Voltage	DC 3V
Test Mode	Mode 1: EUT power by Battery.
Worst Mode	<input checked="" type="checkbox"/> Mode 1 <input type="checkbox"/> Mode 2 <input type="checkbox"/> Mode 3 <input type="checkbox"/> Mode 4
Worst Position	<input type="checkbox"/> Placed in fixed position. <input checked="" type="checkbox"/> Placed in fixed position at X-Plane (E2-Plane) <input type="checkbox"/> Placed in fixed position at Y-Plane (E1-Plane) <input type="checkbox"/> Placed in fixed position at Z-Plane (H-Plane)
Worst Polarity	<input type="checkbox"/> Horizontal <input checked="" type="checkbox"/> Vertical

Radiated Emission Measurement Below 1G	
Test Condition	Radiated Emission Below 1G
DC Voltage	DC 3V
Test Mode	Mode 1: EUT power by Battery.
Worst Mode	<input checked="" type="checkbox"/> Mode 1 <input type="checkbox"/> Mode 2 <input type="checkbox"/> Mode 3 <input type="checkbox"/> Mode 4

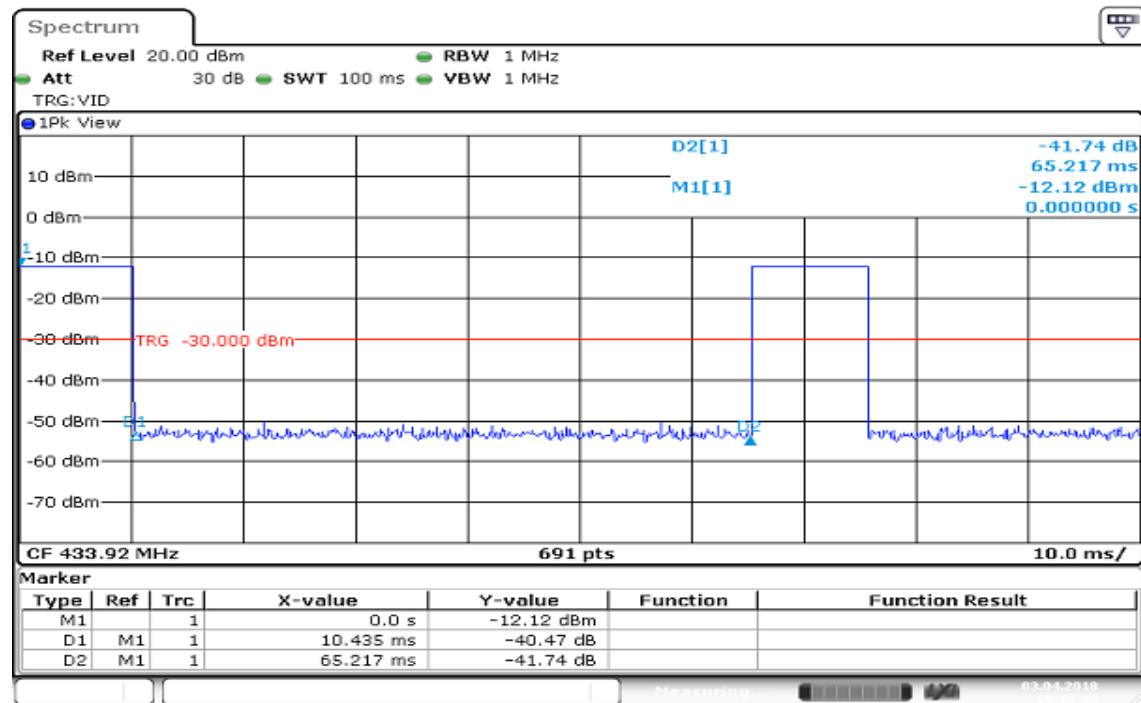
Remark:

1. The worst mode was record in this test report.
2. EUT pre-scanned in three axis, X, Y, Z and two polarity, Horizontal and Vertical for radiated measurement. The worst case (X-Plane and Vertical) were recorded in this report
3. For below 1G, radiation emission were performed the EUT transmit at the highest output power channel as worse case.

3.3 EUT DUTY CYCLE

ASK & FSK

Duty Cycle	
TX ON (ms)	Duty Factor(dB)
10.435	-15.91



Date: 3 APR 2018 10:25:03

Notes:

1. The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by $20 \log(\text{Time}_{(\text{on})} / [\text{Period or } 100 \text{ ms whichever is the lesser}])$
2. The EUT transmits for a $\text{Time}_{(\text{on})}$ of 10.435 milliseconds within the specified 100ms period.
 $20 \log(\text{Time}_{(\text{on})} / [\text{Period or } 100 \text{ ms whichever is the lesser}])$.
 $20 \log(10.435/65.217) = -15.91 \text{ dB}$

4. TEST RESULT

4.1 AC POWER LINE CONDUCTED EMISSION

4.1.1 Test Limit

According to §15.207(a) ,

Frequency Range (MHz)	Limits(dB μ V)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5	56	46
5 to 30	60	50

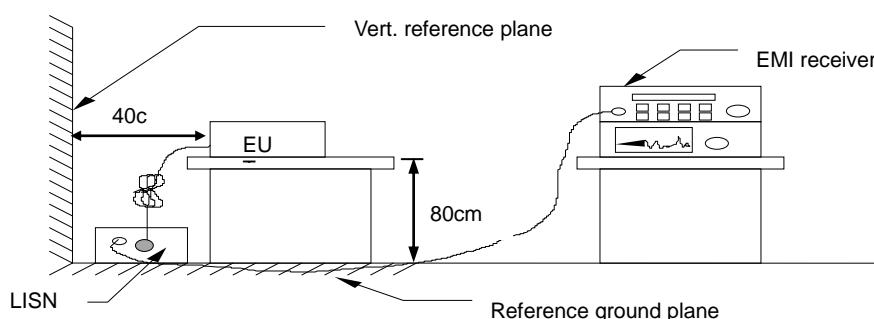
* Decreases with the logarithm of the frequency.

4.1.2 Test Procedure

Test method Refer as ANSI 63.10:2013 clause 6.2,

1. The EUT was placed on a table, which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete

4.1.3 Test Setup



4.1.4 Test Result

Not applicable

4.2 EMISSION BANDWIDTH

4.2.1 Test Limit

According to §15.231© ,

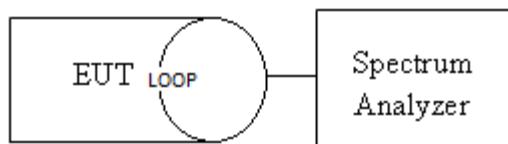
Limit	<input checked="" type="checkbox"/> 70 MHz – 900 MHz : $F_c * 0.25 \%$ <input type="checkbox"/> Above 900 MHz : $F_c * 0.5 \%$
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4.2.2 Test Procedure

Test method Refer as ANSI 63.10:2013 clause 6.9.2,

The Loop antenna connected to the spectrum analyzer, was touching to the transmitter antenna. Set the RBW=10KHz, VBW $\geq 3 \times$ RBW, Detector = Peak, Trace mode = Max hold, Sweep = Auto. Measure the maximum width of the emission that is constrained by the frequencies associated with the 20dB Bandwidth.

4.2.3 Test Setup



4.2.4 Test Result

ASK

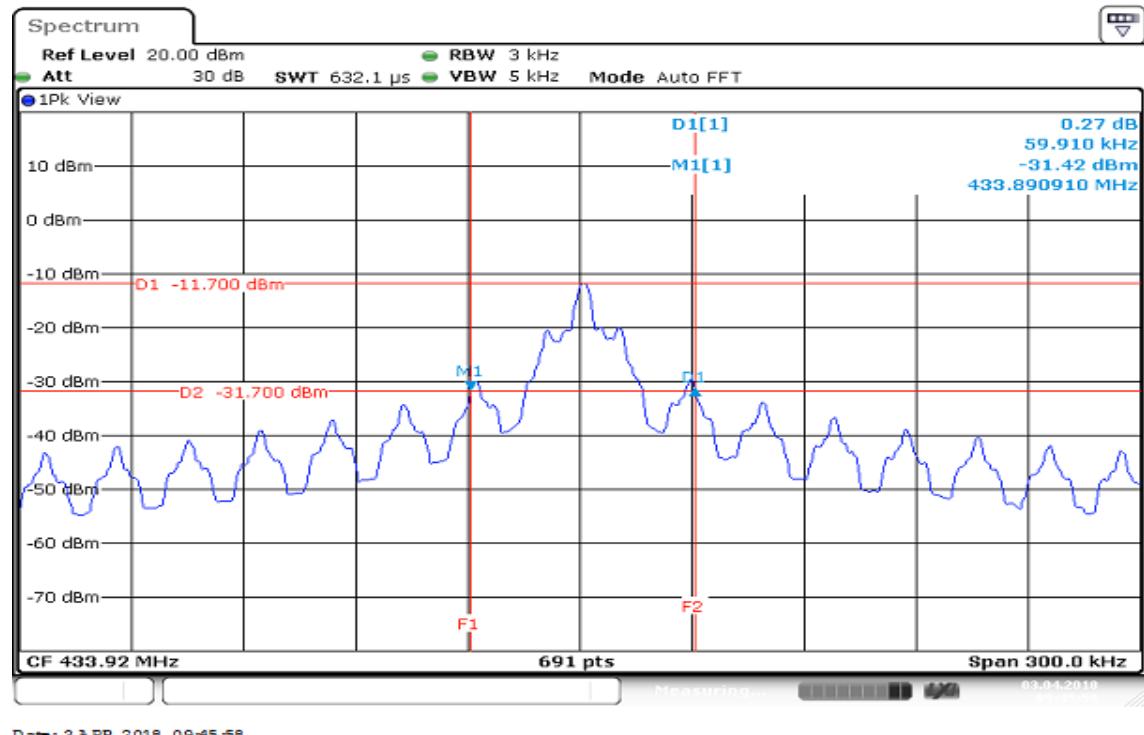
Spectrum Bandwidth		
Frequency (MHz)	20dB Bandwidth (KHz)	20dB Bandwidth Limits (MHz)
433.92	59.910	1.0848

FSK

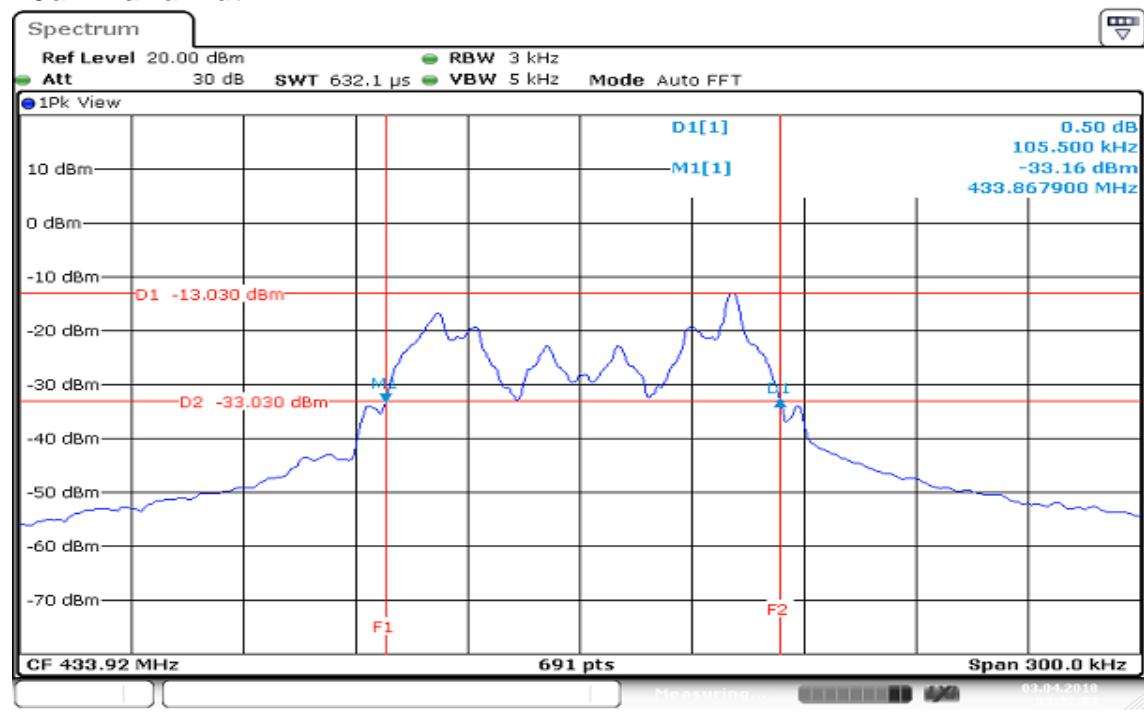
Spectrum Bandwidth		
Frequency (MHz)	20dB Bandwidth (KHz)	20dB Bandwidth Limits (MHz)
433.92	105.500	1.0848

Test Data

ASK 20dB Bandwidth



FSK 20dB Bandwidth



4.3 FIELD STRENGTH OF FUNDAMENTAL

4.3.1 Test Limit

According to §15.231(e)

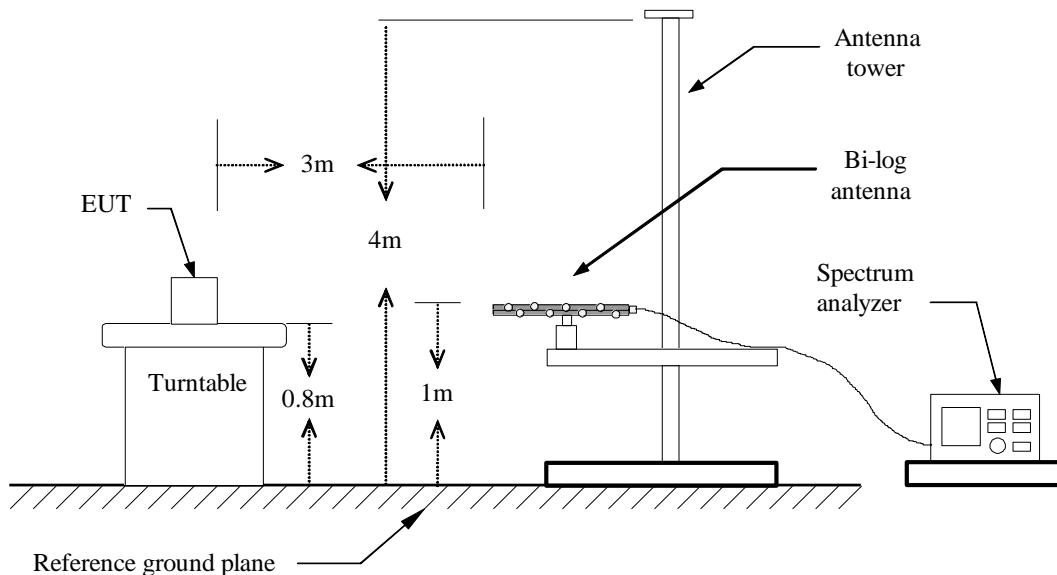
Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of fundamental (microvolts/meter)
40.66-40.70	1,000	100
70-130	500	50
130-174	500 to 1,500 ¹	50 to 150 ¹
174-260	1,500	150
260-470	1,500 to 5,000 ¹	150 to 500 ¹
Above 470	5,000	500

4.3.2 Test Procedure

Test method Refer as ANSI 63.10:2013 clause 4.1.4 and clause 6.5

clause 4.1.4	<input checked="" type="checkbox"/> 4.1.4.2.2: Measurement Peak value. <input type="checkbox"/> 4.1.4.2.3: Duty cycle $\geq 100\%$. <input checked="" type="checkbox"/> 4.1.4.2.4: Measurement Average value.
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4.3.3 Test Setup



4.3.4 Test Result

ASK

Field Strength					
Frequency (MHz)	Fundamental (dBuV/m) at 3m	Limit (dBuV/m) at 3m	Margin (dB)	Axis/Pol.	Remark
433.9180	62.66	72.87	-10.21	X/V	AVG

Remark:

1. Fundamental measured method setting on spectrum, $RBW=100\text{ kHz}$, $VBW=100\text{kHz}$ and $Detector=Peak$.
2. Average result = Peak result + Duty factor = $78.57\text{ dBuV/m} - 15.91 = 62.66\text{dBuV/m}$
3. $260\text{MHz} \sim 470\text{MHz}$ limit is $16.6667 * (Frequency, \text{MHz}) - 2833.3333$
 $Limit = 16.6667 * (433.9180\text{ MHz}) - 2833.3333$
 $=4398.647831\text{ (uV/m)}$
 $dBuV/m = 20 \text{ Log}(\text{uV/m}) = 20 \text{ Log}(4398.647831\text{ uV/m}) = 72.87\text{dBuV/m}$

FSK

Field Strength					
Frequency (MHz)	Fundamental (dBuV/m) at 3m	Limit (dBuV/m) at 3m	Margin (dB)	Axis/Pol.	Remark
433.9120	62.80	72.87	-10.07	X/V	AVG

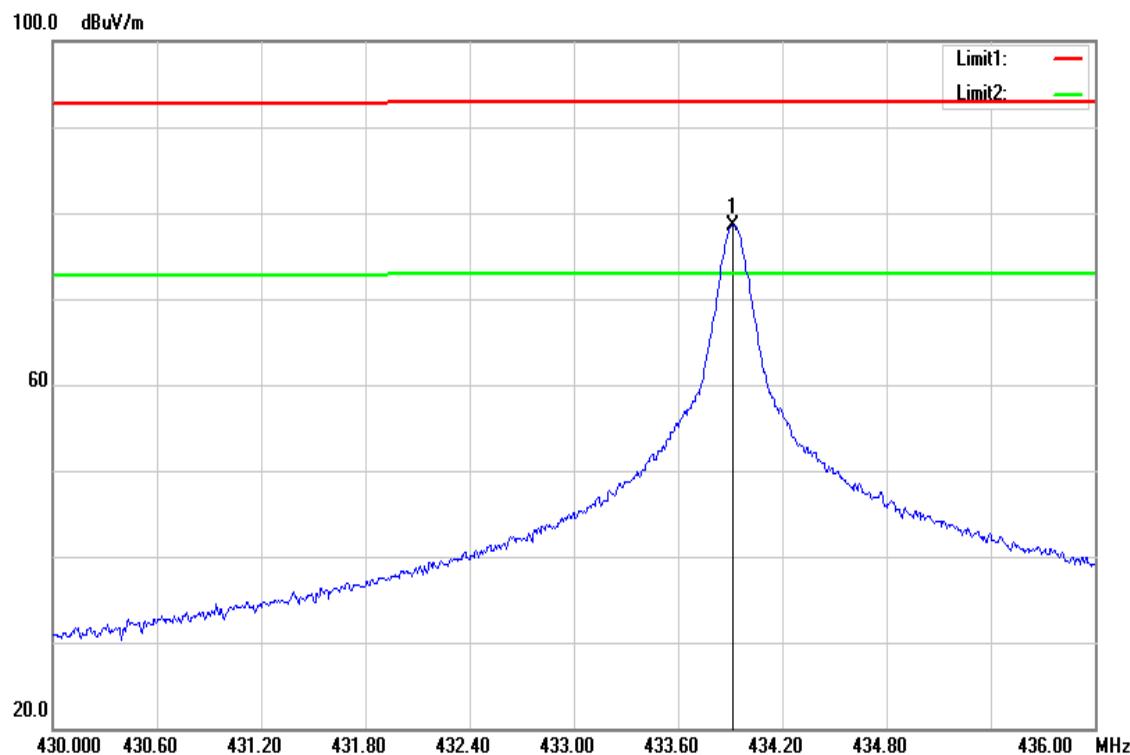
Remark:

1. Fundamental measured method setting on spectrum, $RBW=100\text{ kHz}$, $VBW=100\text{kHz}$ and $Detector=Peak$.
2. Average result = Peak result + Duty factor = $78.71\text{ dBuV/m} - 15.91 = 62.80\text{dBuV/m}$
3. $260\text{MHz} \sim 470\text{MHz}$ limit is $16.6667 * (Frequency, \text{MHz}) - 2833.3333$
 $Limit = 16.6667 * (433.9120\text{ MHz}) - 2833.3333$
 $=4398.54783040\text{ (uV/m)}$
 $dBuV/m = 20 \text{ Log}(\text{uV/m}) = 20 \text{ Log}(4398.54783040\text{ uV/m}) = 72.87\text{dBuV/m}$
4. The worst modulation was the FSK of field strength of fundamental, we selected worst modulation to performed the radiation unwanted emission test.

Test Data

ASK

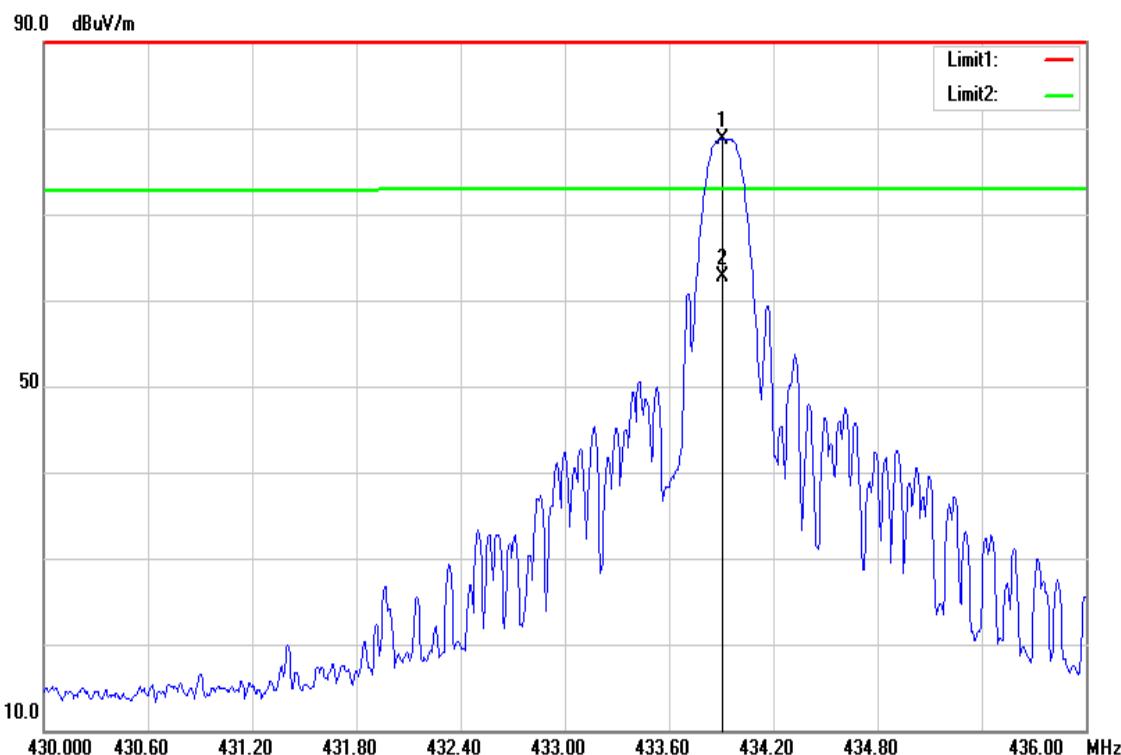
Test Mode:	TX-433.92MHz	Temp/Hum	22(°C)/ 34%RH
Test Item	Fundamental	Test Date	2018/04/03
Axis/Polarize	X-Plane/Vertical	Test Engineer	Jerry Chuang
Detector	Peak & AVG	Test Voltage:	3Vdc



No	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	433.9180	88.74	-10.17	78.57	92.87	-14.30	peak

FSK

Test Mode:	TX-433.92MHz	Temp/Hum	22(°C)/ 34%RH
Test Item	Fundamental	Test Date	2018/04/03
Axis/Polarize	X-Plane/Vertical	Test Engineer	Jerry Chuang
Detector	Peak & AVG	Test Voltage:	3Vdc



No	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	433.9120	88.88	-10.17	78.71	92.87	-14.16	peak
2	433.9120	78.71	-15.91	62.80	72.87	-10.07	AVG

4.4 RADIATION UNWANTED EMISSION

4.4.1 Test Limit

According to §15.231(e) and §15.209

Unwanted emissions limit follow the table or the FCC Part 15.209, whichever limit permits higher field strength.

According to §15.231(e)

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of fundamental (microvolts/meter)
40.66-40.70	1,000	100
70-130	500	50
130-174	500 to 1,500 ¹	50 to 150 ¹
174-260	1,500	150
260-470	1,500 to 5,000 ¹	150 to 500 ¹
Above 470	5,000	500

Below 30MHz

Frequency (MHz)	Field Strength				
	(μ V/m)	(dB μ V/m)	Measurement Distance (meter)	(dB μ V/m)	Measurement Distance (meter)
0.009 - 0.490	2400/F(kHz)	48.52 – 13.80	300	128.52–104.84	3
0.490 - 1.705	24000/F(kHz)	33.80 – 22.97	30	73.80– 62.97	3
1.705 – 30.0	30	29.54	30	69.54	3

Above 30MHz

Frequency (MHz)	Field Strength		Measurement Distance (meter)
	(μ V/m)	(dB μ V/m)	
30-88	100	40.0	3
88-216	150	43.5	3
216-960	200	46.0	3
Above 960	500	54.0	3

4.4.2 Test Procedure

Test method Refer as ANSI 63.10:2013

<input checked="" type="checkbox"/> Unwanted Emission	<input checked="" type="checkbox"/> clause 4.1.4.2.2: Measurement Peak value. <input type="checkbox"/> clause 4.1.4.2.3: Duty cycle $\geq 100\%$. <input checked="" type="checkbox"/> clause 4.1.4.2.4: Measurement Average value.
<input checked="" type="checkbox"/> Radiated Emission	<input checked="" type="checkbox"/> clause 6.4: below 30 MHz and test distance is 3m. <input checked="" type="checkbox"/> clause 6.5: below 30 MHz -1 GHz and test distance is 3m. <input checked="" type="checkbox"/> clause 6.6: Above 30 MHz and test distance is 3m.

1. The EUT is placed on a turntable, which is 0.8m for test below 1GHz and 1.5m for test above 1GHz, above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Set the spectrum analyzer in the following setting as:

Below 1GHz:

RBW=100kHz / VBW=300kHz / Sweep=AUTO

Above 1GHz:

(a)PEAK: RBW=1MHz / VBW=3MHz / Sweep=AUTO

(b)AVERAGE: RBW=1MHz,

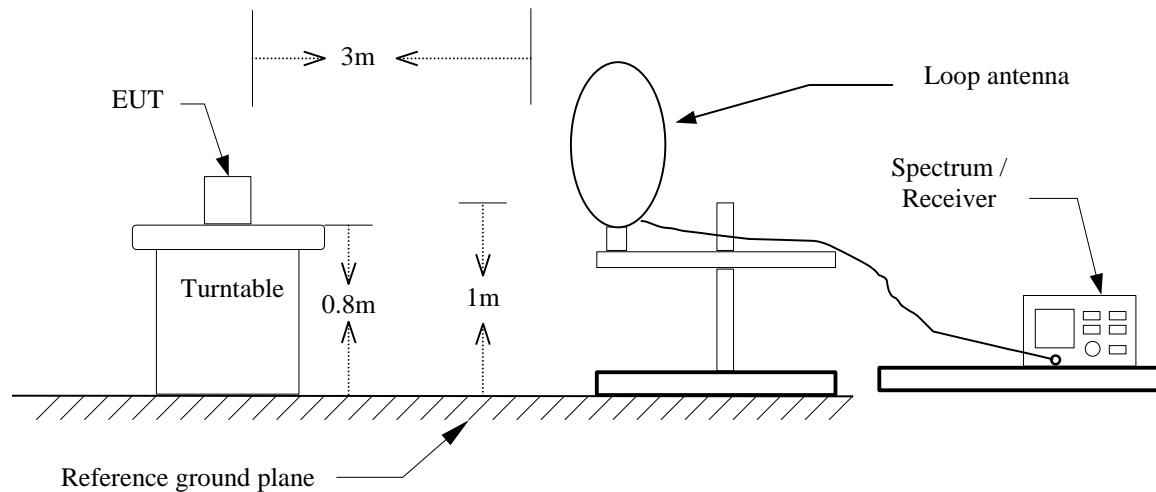
7. Repeat above procedures until the measurements for all frequencies are complete.

Remark.

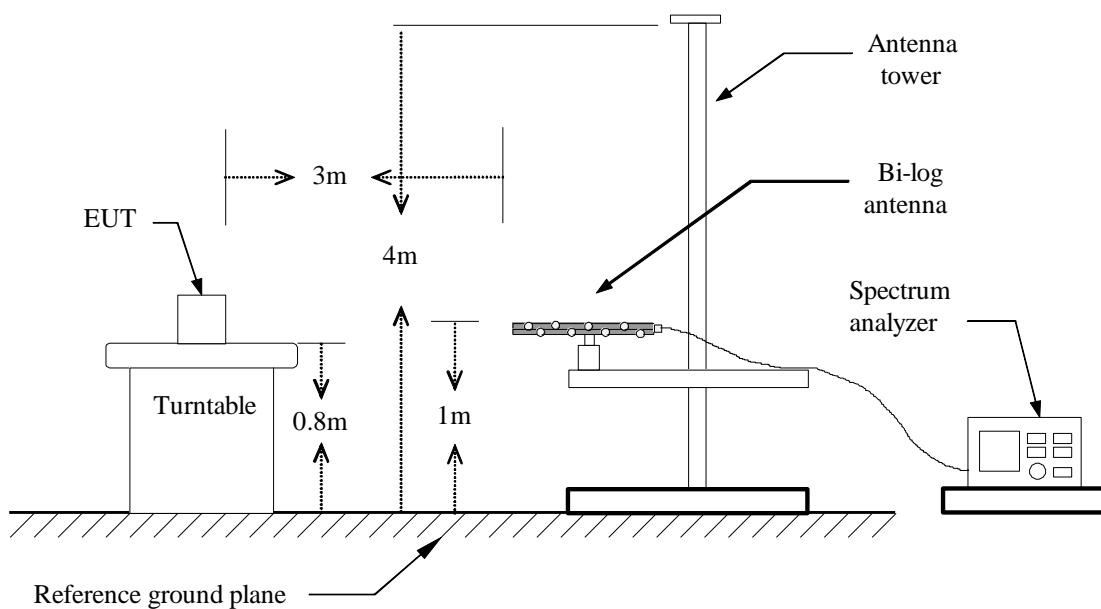
1. The EUT has a oscillator operating at 26MHz, harmonic/spurious was verified. And didn't catch any emission at 26MHz.
2. Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30 m open are test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 937606.
3. No emission found between lowest internal used/generated frequency to 30MHz (9kHz~30MHz).

4.4.3 Test Setup

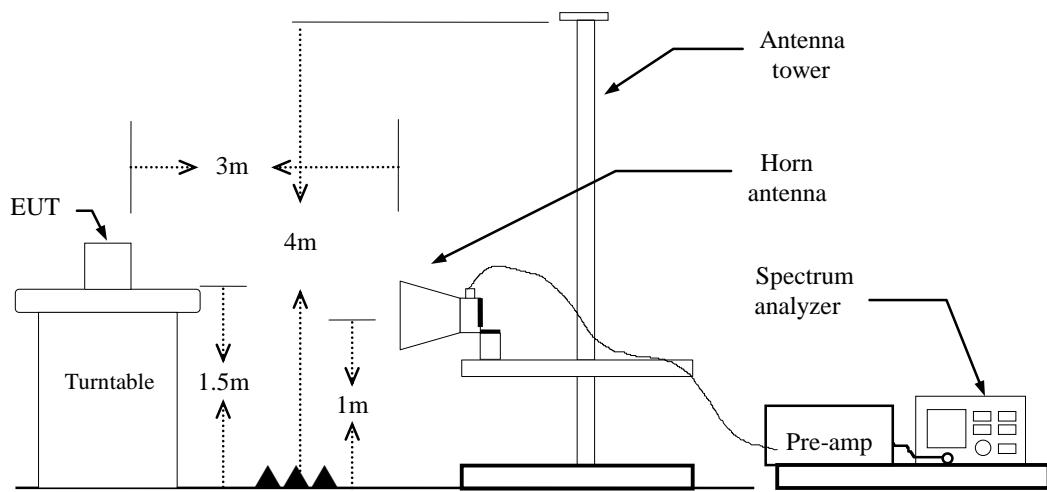
9kHz ~ 30MHz



30MHz ~ 1 GHz



Above 1 GHz



4.4.4 Test Result

The worst modulation was the FSK of field strength of fundamental, we selected worst modulation to performed the radiation unwanted emission test.

Pass.

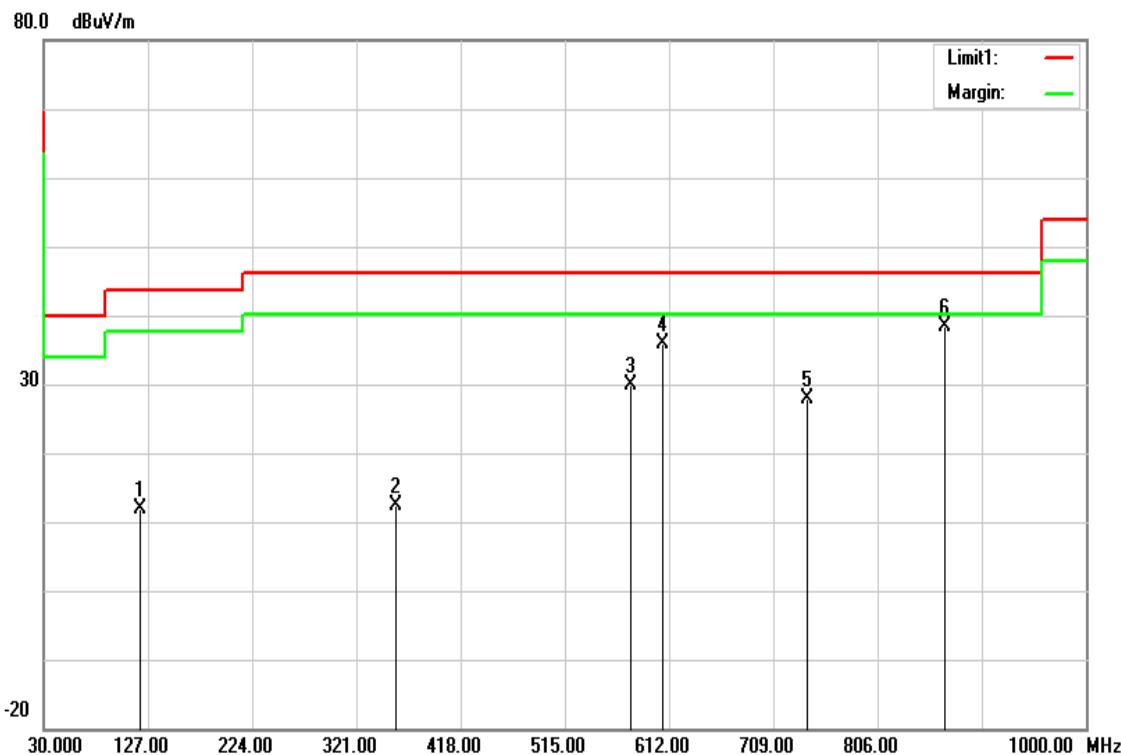
Test Data

Below 1GHz

Test Mode:	TX-433.92MHz	Temp/Hum	22(°C)/ 34%RH
Test Item	Below 1GHz	Test Date	2018/04/03
Polarize	Vertical	Test Engineer	Jerry Chuang
Detector	Peak	Test Voltage:	3Vdc

Frequency (MHz)	Reading (dBuV)	Correction Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
201.6900	25.40	-15.48	9.92	43.52	-33.60	peak
570.2900	27.55	-7.30	20.25	46.02	-25.77	peak
660.5000	29.86	-5.42	24.44	46.02	-21.58	peak
789.5100	26.93	-3.57	23.36	46.02	-22.66	peak
868.0800	36.94	-2.55	34.39	46.02	-11.63	peak
959.2600	25.73	-1.08	24.65	46.02	-21.37	peak

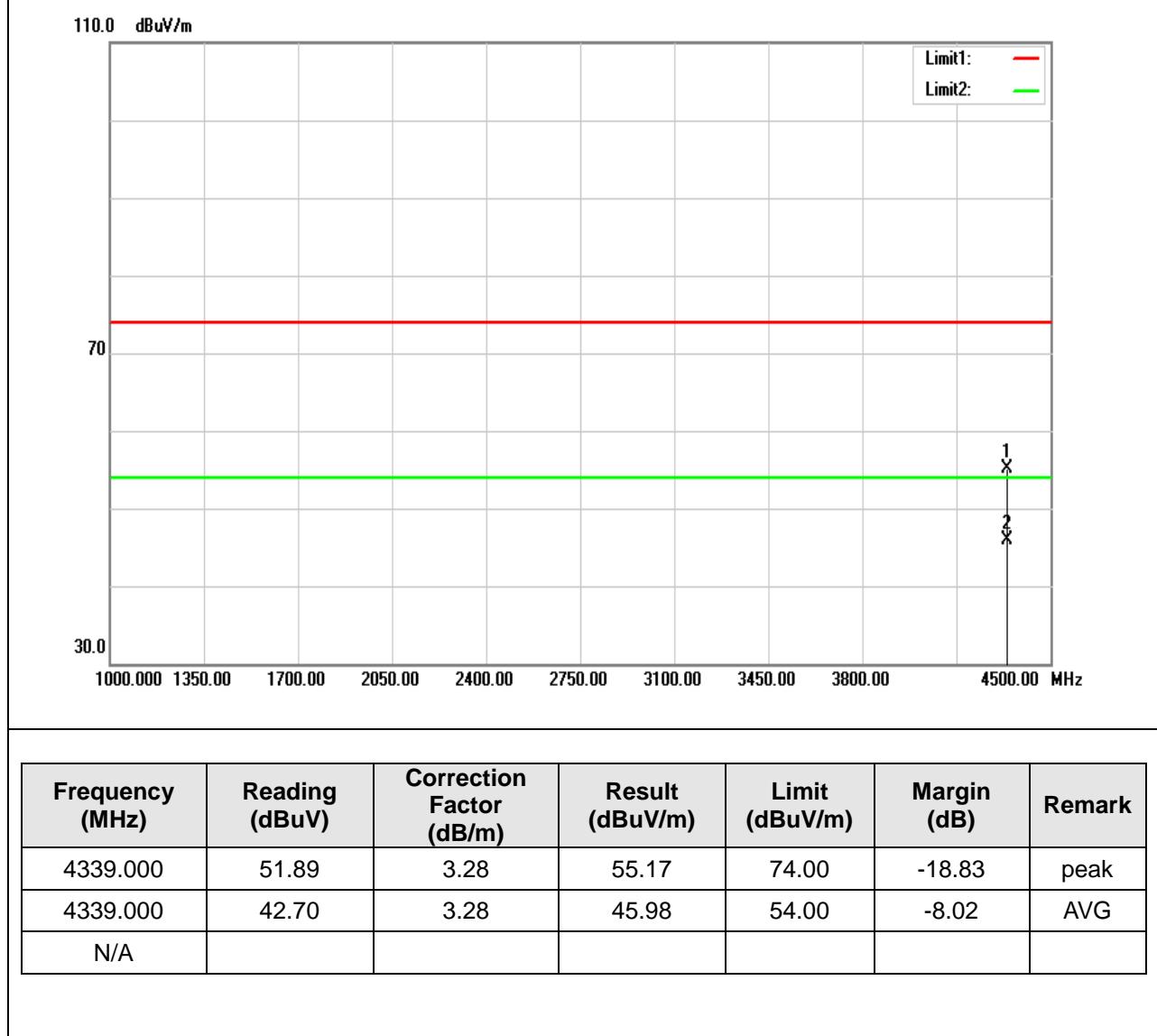
Test Mode:	TX-433.92MHz	Temp/Hum	22(°C)/ 34%RH
Test Item	Below 1GHz	Test Date	2018/04/03
Polarize	Horizontal	Test Engineer	Jerry Chuang
Detector	Peak	Test Voltage:	3Vdc



Frequency (MHz)	Reading (dBuV)	Correction Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
120.2100	26.84	-15.01	11.83	43.52	-31.69	peak
357.8600	25.24	-12.74	12.50	46.02	-33.52	peak
576.1100	37.07	-7.22	29.85	46.02	-16.17	peak
606.1800	42.60	-6.76	35.84	46.02	-10.18	peak
740.0400	32.28	-4.41	27.87	46.02	-18.15	peak
868.0800	40.90	-2.55	38.35	46.02	-7.67	peak

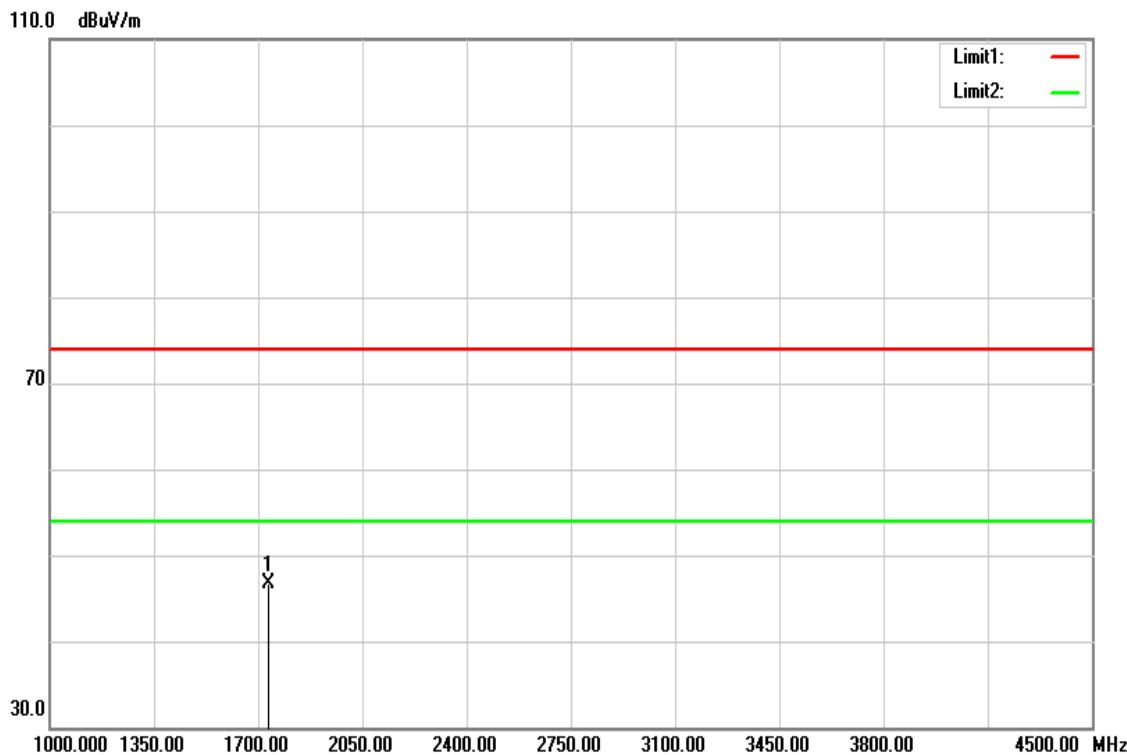
Above 1GHz

Test Mode:	TX-433.92MHz	Temp/Hum	22(°C)/ 34%RH
Test Item	Above 1GHz	Test Date	2018/04/03
Polarize	Vertical	Test Engineer	Jerry Chuang
Detector	Peak	Test Voltage:	3Vdc


Remark:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.

Test Mode:	TX-433.92MHz	Temp/Hum	22(°C)/ 34%RH
Test Item	Above 1GHz	Test Date	2018/04/03
Polarize	Horizontal	Test Engineer	Jerry Chuang
Detector	Peak	Test Voltage:	3Vdc



Frequency (MHz)	Reading (dBuV)	Correction Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1735.000	52.74	-6.05	46.69	74.00	-27.31	peak
N/A						

Remark:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.

4.5 OPERATION RESTRICTION

4.5.1 Test Limit

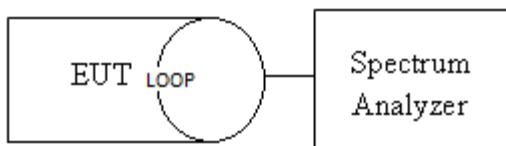
15.231(e), Periodic transmissions (lower field strength): each transmission is not greater than 1 sec and the silent period between transmissions is at least 30 times the duration of the transmission but in no case less than 10 sec.

4.5.2 Test Procedure

Test method Refer as ANSI 63.10:2013 clause 7.4

The Loop antenna connected to the spectrum analyzer, was touching to the transmitter antenna. Set the RBW=1MHz, VBW \geq 3 x RBW, Detector = Peak, Trace mode = Max hold, Sweep = 200s. Measure

4.5.3 Test Setup



4.5.4 Test Result

Dwell Time				
Operation condition	Burst Duration	Limits	Silent Period	Limits
Automatically Operated	53.625ms	1 sec	15.5942 s	>10 sec & >30* Burst Duration

Test Data