FCC PART 15.231
TEST REPORT

On Behalf of

Fujian Garmerain Fluid Technology Co., Ltd.

No.258, Xinju Village, Yangxia Street, Fuqing, Fuzhou, China

FCC ID: 2BK5X-GRG101R

Model: GRG101R, GRG101R-US, GRG101R-UK, GRG101R-AU

October 23, 2024

This Report Concerns:	**Equipment Type:**
☒ Original Report	Smart Gateway

Test Engineer:	LBi Li/ LBi Li
Report Number:	**QCT24IR-2050E-02**
Test Date:	September 4, 2024 ~ October 23, 2024
Reviewed By:	Vincent Yang / Vincent Yang
Approved By:	Kendy Wang / Kendy Wang
Prepared By:	**Shenzhen QC Testing Laboratory Co., Ltd.** East of 1/F., Building E, Xinghong Science Park, No.111, Shuiku Road, Fenghuanggang, Xixiang Street, Bao'an District, Shenzhen, Guangdong, China **Tel: 0755-23008269** **Fax: 0755-23726780**

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Revision History of This Test Report

Report Number	Description	Issued Date
QCT24IR-2050E-02	Initial Issue	2024-10-23

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1. GENERAL INFORMATION

1.1 Product Description for Equipment under Test (EUT)

EUT Description:	Smart Gateway
Model No.	GRG101R, GRG101R-US, GRG101R-UK, GRG101R-AU
Model Difference:	All models in each series have similar construction with the same diagram circuit and PCB layout, but different from model names. All tests were conducted on the models (GRG101R) and the test result was passed.
Tested Model:	GRG101R
Sample(s) Status:	Engineer sample
Operation Frequency:	433.92 MHz
Channel numbers:	1
Modulation type:	FSK
Antenna Type:	Spring Antenna
Antenna gain*1:	0dBi
Power supply:	AC 100-240V~, 50/60Hz, 0.5A
Trade Mark:	N/A
Applicant:	Fujian Garmerain Fluid Technology Co., Ltd.
Address:	No.258, Xinju Village, Yangxia Street, Fuqing, Fuzhou, China
Manufacturer:	Fujian Garmerain Fluid Technology Co., Ltd.
Address:	No.258, Xinju Village, Yangxia Street, Fuqing, Fuzhou, China
Sample No.:	Y24I2050E01YN

Note: *1This information provided by Manufacturer, SZ QC Lab is not responsible for the accuracy of this information.

1.2 System Test Configuration

1.2.1 Support Equipment

N/A

1.2.2 Test mode and voltage

Transmitting mode: Keep the EUT in continuously transmitting.
Test voltage: AC 120V/60Hz

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1.3 Test Facility

Test Firm: Shenzhen QC Testing Laboratory Co., Ltd.

The testing quality ability of our laboratory meet with "Quality Law of People's Republic of China" Clause 19. The testing quality system of our laboratory meets with ISO/IEC-17025 requirements. This approval result is accepted by MRA of APLAC.

Our test facility is recognized, certified, or accredited by the following organizations:

CNAS – Registration No.: L8464

The EMC Laboratory has been accredited by CNAS, and in compliance with ISO/IEC 17025:2017 General Requirements for testing Laboratories.

A2LA Certificate Number: 6759.01

The EMC Laboratory has been accredited by A2LA, and in compliance with ISO/IEC 17025:2017 General Requirements for testing Laboratories.

FCC Registration Number: 561109

The EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications commission.

IC Registration Number: 29628

CAB identifier: CN0141

The EMC Laboratory has been registered and fully described in a report filed with the (IC) Industry Canada.

1.4 Measurement Uncertainty

Parameter	Uncertainty
Occupied Channel Bandwidth	±1.42 x10^{-4}%
RF output power, conducted	±1.06dB
Power Spectral Density, conducted	±1.06dB
Unwanted Emissions, conducted	±2.51dB
AC Power Line Conducted Emission	±1.80dB
Radiated Spurious Emission test (9kHz-30MHz)	±2.66dB
Radiated Spurious Emission test (30MHz-1000MHz)	±4.04dB
Radiated Spurious Emission test (1000MHz-18000MHz)	±4.70 dB
Radiated Spurious Emission test (18GHz-40GHz)	±4.80dB
Temperature	±0.8℃
Humidity	±3.2%
DC and low frequency voltages	±0.1%
Time	±5%
Duty cycle	±5%

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

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2. Summary of Test Results

Test Item	Section	Result
Antenna Requirement	FCC Part 15.203	Pass
Conduction Emission	FCC Part 15.207	Pass
Radiated Emission	FCC Part 15.231(e)	Pass
20dB Bandwidth	FCC Part 15.231(c)	Pass
Release Time Measurement	FCC Part 15.231(e)	Pass
Duty Cycle	FCC Part 15.231	Pass
The product is a activated automatically transmitter.		

Note: 1. Pass: The EUT complies with the essential requirements in the standard.

2. Test according to ANSI C63.10:2013

3.. All indications of Pass/Fail in this report are opinions expressed by Shenzhen QC Testing Laboratory Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.

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3. List of Test and Measurement Instruments

3.1 Radiated Emission Test

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1.	EMI Test Receiver	R&S	ESIB 7	2277573376	2024.03.14	2025.03.13
2.	EMI Test Receiver	ESPI3	ESPI3	101131	2024.03.14	2025.03.13
3.	Spectrum Analyzer	Rohde&Schwarz	FSV 40	101458	2024.03.14	2025.03.13
4.	TRILOG Broadband Test-Antenna	SCHWARZBECK	VULB9168	VULB9168-588	2023.04.01	2025.03.31
5.	Loop Antenna	EMCO	6502	2133	2023.03.18	2025.03.17
6.	horn antenna	SCHWARZBECK	BBHA9120D	2069	2023.04.01	2025.03.31
7.	Horn Antenna	COM-MW	ZLB7-18-40G -950	12221225	2023.01.12	2025.01.09
8.	Pre-amplifier	MITEQ	TTA0001-18	2063645	2024.03.27	2025.03.26
9.	Pre-amplifier	COM-MW	DLAN-18000 -40000-02	10229104	2024.03.14	2025.03.13
10.	966 Camber	ZhongYU	9*6*6	/	2023.05.08	2026.05.07
Radiated Emission Measurement Software: EZ_EMC Ver QCT03A2 RE+						

3.2 RF Conducted test

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal.Due
1.	Wideband Radio Communication Tester	Rohde & Schwarz	CW500	151583	2024.03.14	2025.03.13
2.	Spectrum Analyzer	ROHDE& SCHWARZ	FSV 40	101458	2024.03.14	2025.03.13
3.	Signal Generator	Agilent	N5182A	MY50141563	2024.03.14	2025.03.13
4.	RF Automatic Test System	MW	MW100-RFCB/ MW100-PSB	MW2007004	2024.03.14	2025.03.13
RF Conducted Measurement Software: MTS 8310 Ver 2.0.0.0						

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4. Antenna requirement

Standard requirement: FCC Part15 C Section 15.203

15.203 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, 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.

EUT Antenna: The antenna is Spring Antenna, reference to the Internal Photos for details.

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5. Radiated Emission Method

5.1 Applicable Standard

FCC Part15 C Section 15.231 (e) & Section 15.209

5.2 Limit

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	1000	100
70~130	500	50
130~174	500 to 1500(**)	50 to 150(**)
174~260	1500	150
260~470	1500 to 5000(**)	150 to 500(**)
Above 470	5000	500

** 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= 22.7273(F) – 2454.5455;

(2) for the band 260~470 MHz, uV/m at 3 meters= 16.6667(F)-2833.3333.

(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 FCC Part15.209.

Frequency (MHz)	Field Strength (microvolt/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 tighter limit applies at the band edges.

(2) For above 30MHz:

Emission Level(dBuV/m)=20log Emission Level(uV/m)

For 0.009~0.490MHz:

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Emission Level(dBuV/m)=20log Emission Level(uV/m) +40log(300/3)
For 0.049~30MHz:
Emission Level(dBuV/m)=20log Emission Level(uV/m) +40log(30/3)

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

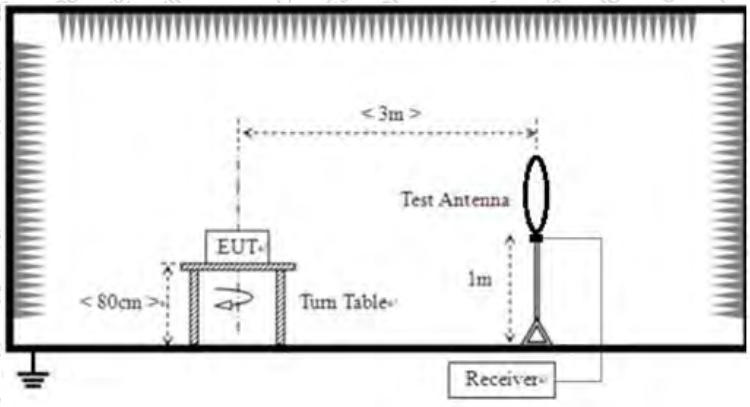
Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolt/meter) at 3m
433.92 MHz	72.87 (Average)
433.92 MHz	92.87 (Peak)

5.3 Receiver setup

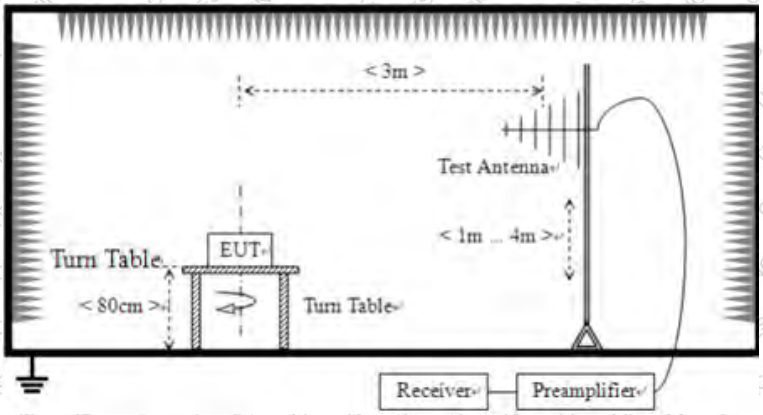
Frequency	Detector	RBW	VBW	Value
9KHz-150KHz	Quasi-peak	200Hz	600Hz	Quasi-peak
150KHz-30MHz	Quasi-peak	9KHz	30KHz	Quasi-peak
30MHz-1GHz	Quasi-peak	100KHz	300KHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

5.4 Test setup

For radiated emissions from 9kHz to 30MHz



For radiated emissions from 30MHz to1GHz



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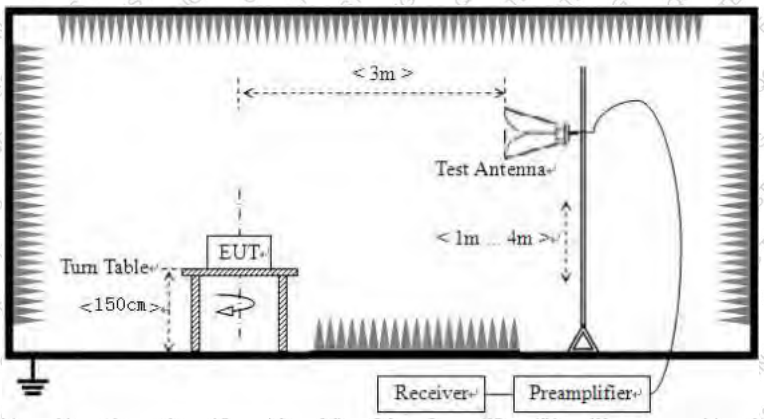
For radiated emissions above 1GHz



5.5 Test Procedure

1. The EUT was placed on the top of a rotating table (0.8 meters for below 1GHz and 1.5 meters for above 1GHz) above the ground at a 3 meter camber. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
3. The antenna height 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.
4. 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 rota table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

5.6 Test Data

Temperature	26℃	Humidity	54%
ATM Pressure	101kPa	Antenna Gain	0dBi
Test by	LBi Li	Test result	PASS

Measurement data:

9 kHz ~ 30 MHz

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

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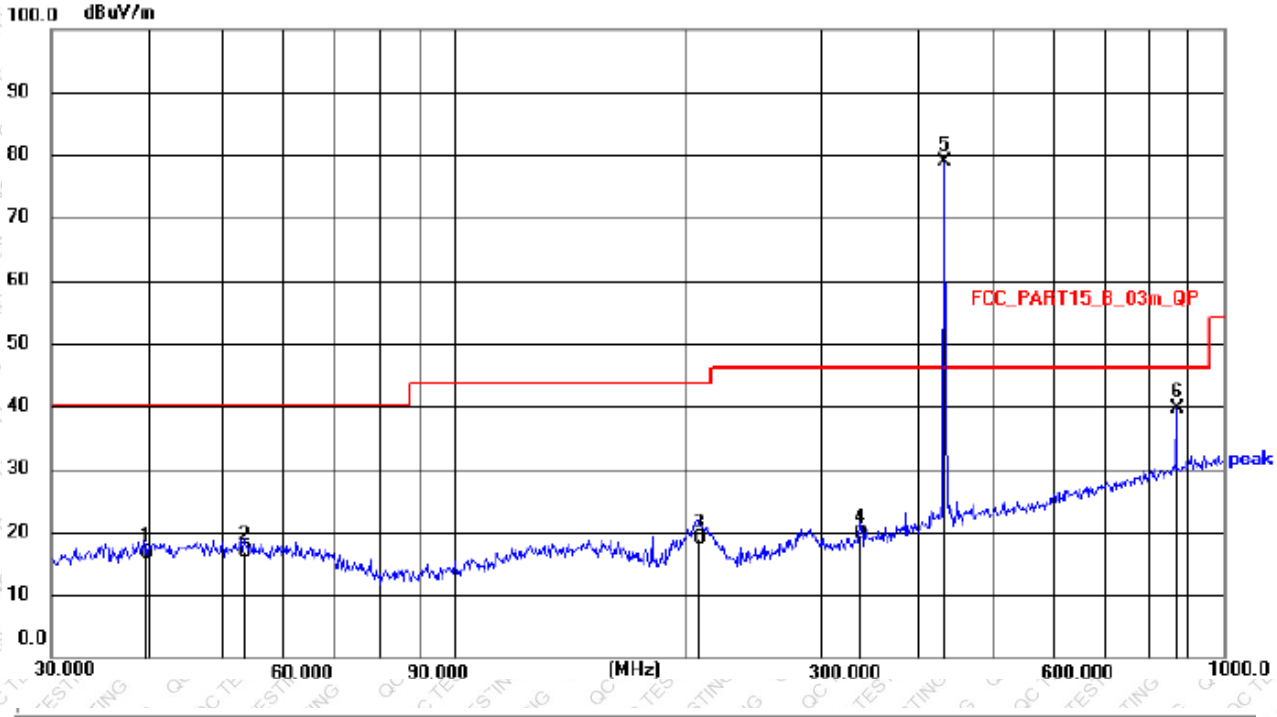
Below 1GHz:
Horizontal



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	39.5757	2.03	14.69	16.72	40.00	23.28	QP
2	53.3179	2.38	14.39	16.77	40.00	23.23	QP
3	207.8501	7.21	11.72	18.93	43.50	24.57	QP
4	337.2155	3.83	15.77	19.60	46.00	26.40	QP
5 *	433.9200	60.35	18.57	78.92	92.87	14.05	peak
6	867.8400	13.78	25.87	39.65	72.87	33.22	peak

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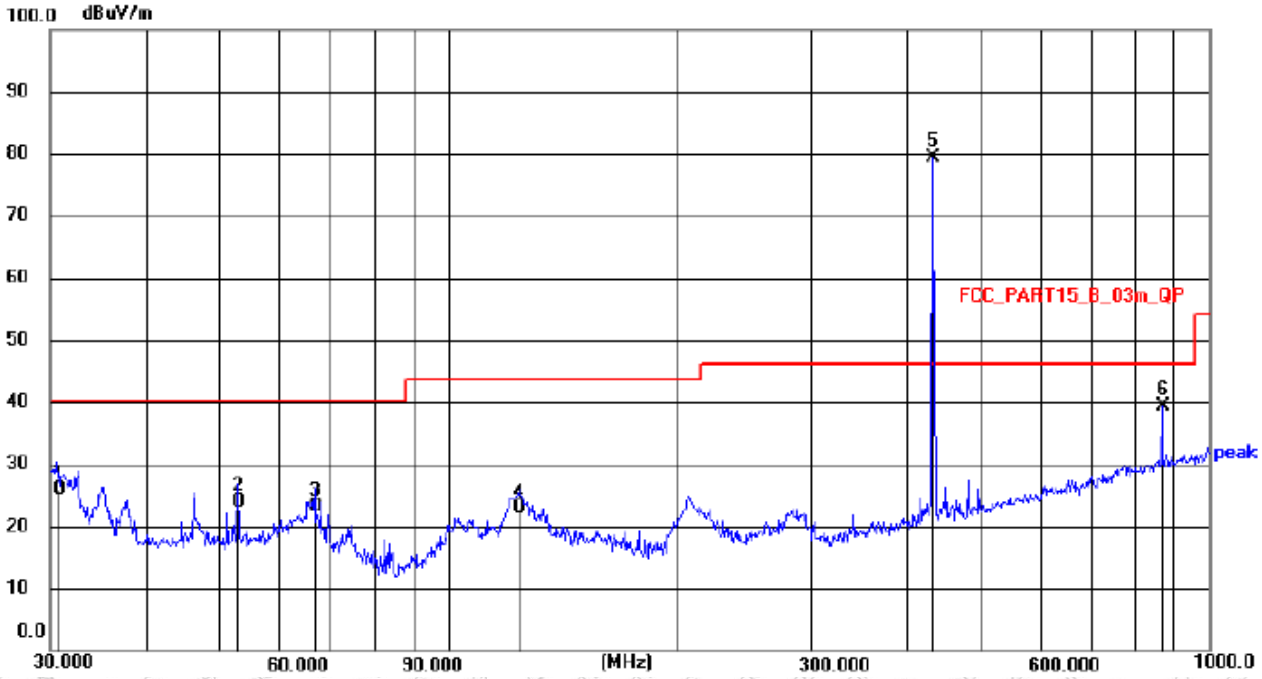
Vertical



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	30.7454	13.25	12.58	25.83	40.00	14.17	QP
2	52.9453	9.77	14.19	23.96	40.00	16.04	QP
3	66.7325	10.71	12.41	23.12	40.00	16.88	QP
4	123.6984	9.51	13.33	22.84	43.50	20.66	QP
5 *	433.9200	61.20	18.26	79.46	92.87	13.41	peak
6	867.8400	13.80	25.69	39.49	72.87	33.38	peak

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Frequency (MHz)	Reading (dBμV/m)	Factor Corr.	Average Factor	Result (dBμV/m)		Limit (dBμV/m)		Margin (dB)		Polarization
	PEAK	(dB)	(dB)	AV	PEAK	AV	PEAK	AV	PEAK	
867.8400	13.78	25.87	-11.32	28.33	39.65	52.87	72.87	24.54	33.22	Horizontal
867.8400	13.80	25.69	-11.32	28.17	39.49	52.87	72.87	24.70	33.38	Vertical

Above 1G:

Frequency (MHz)	Reading (dBμV/m)	Factor Corr.	Average Factor	Result (dBμV/m)		Limit (dBμV/m)		Margin (dB)		Polarization
	PEAK	(dB)	(dB)	AV	PEAK	AV	PEAK	AV	PEAK	
1301.760	57.29	-14.81	-11.32	31.16	42.48	54	74	22.84	31.52	Horizontal
1735.680	57.20	-14.20	-11.32	31.68	43.00	52.87	72.87	21.19	29.87	
2169.600	55.11	-11.98	-11.32	31.81	43.13	52.87	72.87	21.06	29.74	
2603.520	54.11	-10.25	-11.32	32.54	43.86	52.87	72.87	20.33	29.01	
5935.842	49.02	-3.72	-11.32	33.98	45.30	52.87	72.87	18.89	27.57	
1301.768	57.20	-14.81	-11.32	31.07	42.39	54	74	22.93	31.61	Vertical
1735.680	57.22	-14.20	-11.32	31.70	43.02	52.87	72.87	21.17	29.85	
2169.653	55.80	-11.98	-11.32	32.50	43.82	52.87	72.87	20.37	29.05	
2603.520	54.91	-10.25	-11.32	33.34	44.66	52.87	72.87	19.53	28.21	
5935.842	49.05	-3.72	-11.32	34.01	45.33	52.87	72.87	18.86	27.54	

Field Strength of The Fundamental Signal

Frequency (MHz)	Reading (dBμV/m)	Factor Corr.	Average Factor	Result (dBμV/m)		Limit (dBμV/m)		Margin (dB)		Polarization
	PEAK	(dB)	(dB)	AV	PEAK	AV	PEAK	AV	PEAK	
433.92	60.35	18.57	-11.32	67.60	78.92	72.87	92.87	5.27	14.05	Horizontal
433.92	61.20	18.26	-11.32	68.14	79.46	72.87	92.87	4.73	13.41	Vertical

Remarks:

1. *Level = Reading + Factor*
2. *Average value=Peak value + Duty cycle factor*
3. *If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to performa separate average measurement.*

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6. 20dB Occupy Bandwidth

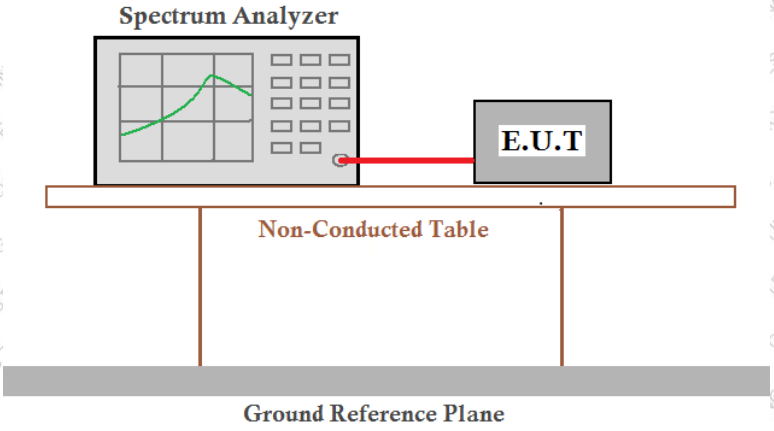
6.1 Applicable Standard

FCC Part15 C Section 15.231 (c)

6.2 Limit

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

6.3 Test setup



6.4 Test Data

Temperature	22 ℃	Humidity	52%
ATM Pressure	101kPa	Antenna Gain	0dBi
Test by	LBi Li	Test result	PASS

Please refer to following table and plots.

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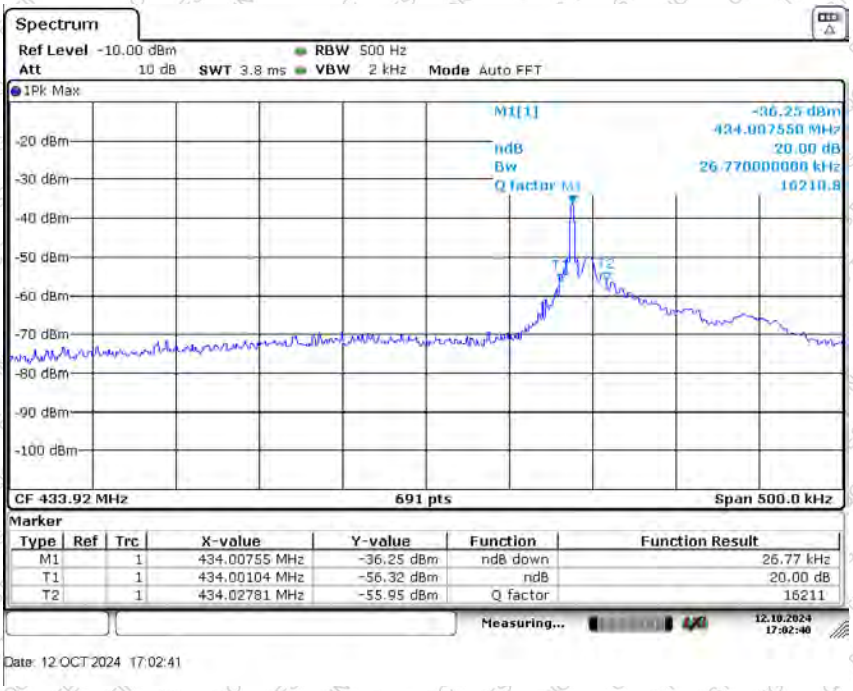
Test Frequency (MHz)	20dB bandwidth (MHz)	Limit (MHz)	Result
433.92	0.02677	1.085	Pass

Note: Limit= Fundamental frequency×0.25%

433.92×0.25%=1.085MHz

Test plot as follows:



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7. Release Time Measurement

7.1 Applicable Standard

FCC Part15 C Section 15.231 (e)

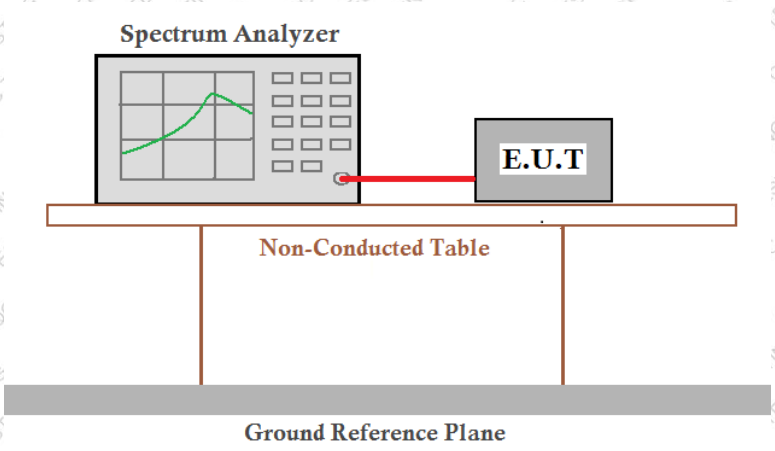
7.2 Limit

According to FCC §15.231(e), Section 15.231(e) devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10seconds.

7.3 Test Procedure

1. Set SPA Center Frequency = Fundamental frequency,
   RBW = 100 kHz, VBW = 300 kHz, Span = 0 Hz.
2. Set EUT as normal operation and press Transmitter button.
3. Set SPA View. Delta Mark time.

7.4 Test setup



7.5 Test Data

Temperature	22 ℃	Humidity	52%
ATM Pressure	101kPa	Antenna Gain	0dBi
Test by	LBi Li	Test result	PASS

Please refer to following table and plots.

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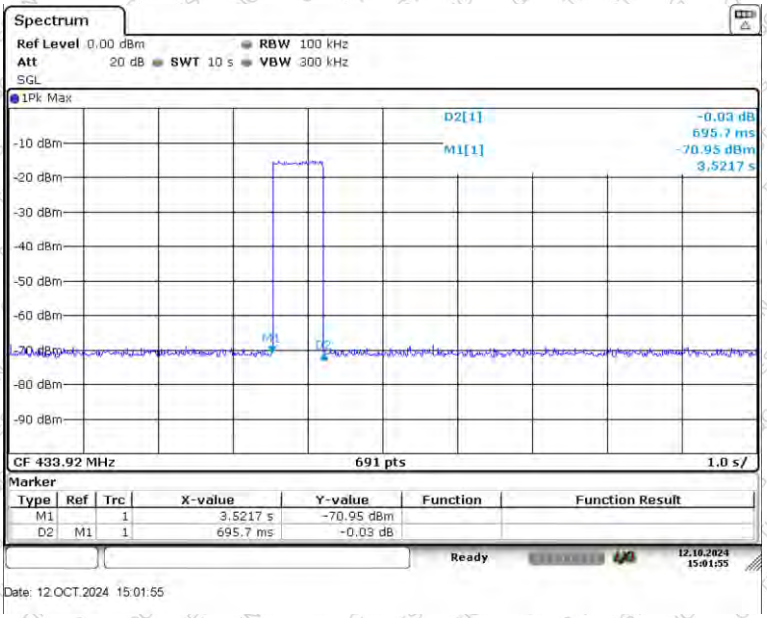
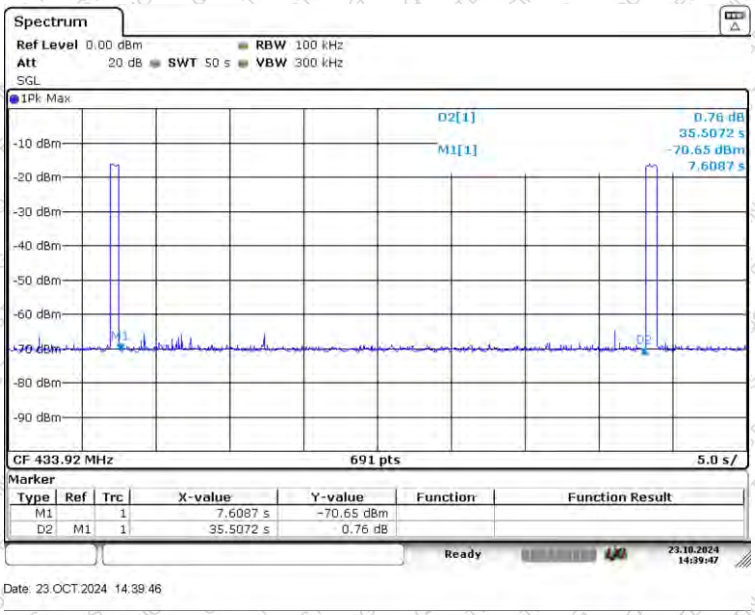
Frequency (MHz)	Duration of each TX (second)	Limit (second)	Result
433.92	0.6957	<1	Pass



Frequency (MHz)	Silent time (second)	Limit (second)	Result
433.92	35.5072	>10s	Pass
		>30* Duration time	



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8. Duty Cycle

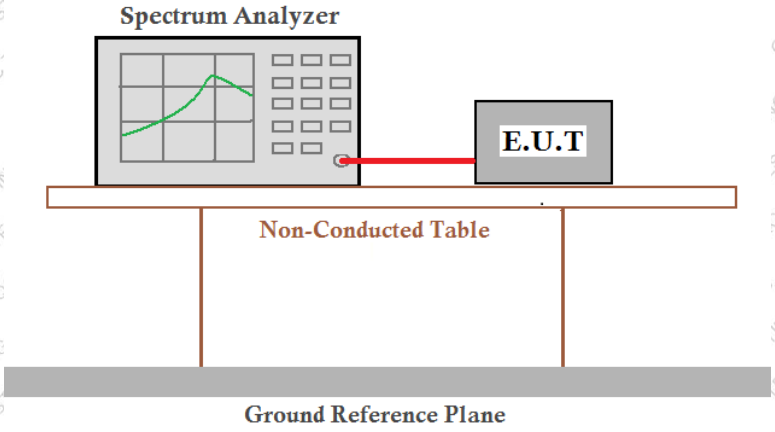
8.1 Applicable Standard

FCC Part15 C Section 15.231

8.2 Limit

No dedicated limit specified in the Rules.

8.3 Test setup



8.4 Test Procedure

1.Place the EUT on the table and set it in transmitting mode.

2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

3. Set centre frequency of spectrum analyzer=operating frequency.

4. Set the spectrum analyzer as RBW=100kHz, VBW=100KHz, Span=0Hz, Adjust Sweep=100ms to obtain the “worst-case” pulse on time

5. Repeat above procedures until all frequency measured was complete.

8.5 Test Data

2 Temperature	22 ℃	Humidity	52%
ATM Pressure	101kPa	Antenna Gain	0dBi
Test by	LBi Li	Test result	PASS

Please refer to following table and plots.

Calculate Formula: Duty cycle factor =20 log(Duty cycle)
Duty cycle=on time/0.1 seconds or period, whichever is less

Test data:

T on time =37*0.5652ms =20.9124(ms)
T period =76.957(ms)
Duty cycle=20.9124/76.957=0.27174=27.174%
Duty cycle factor =20 log(0.27174)=-11.32

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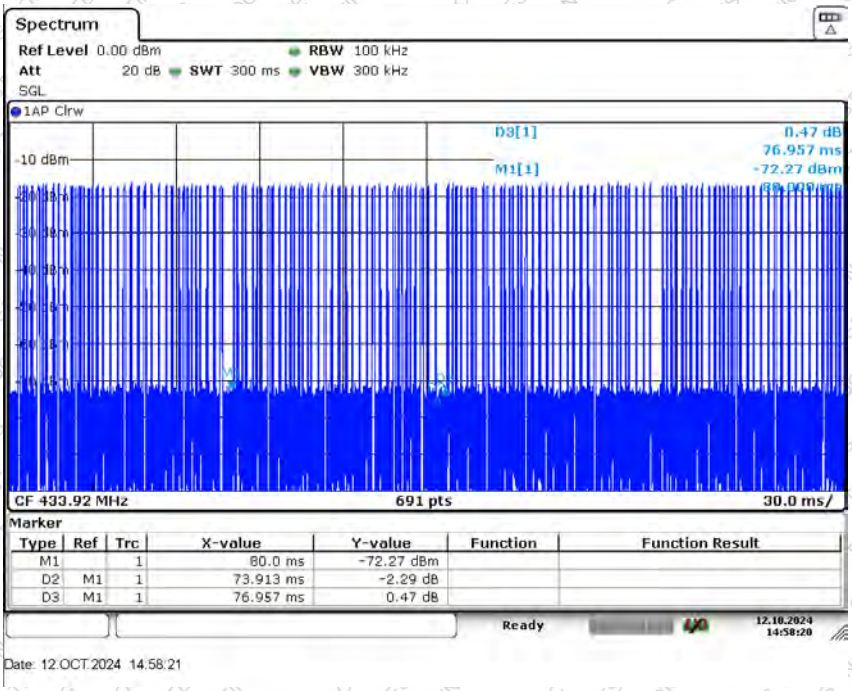

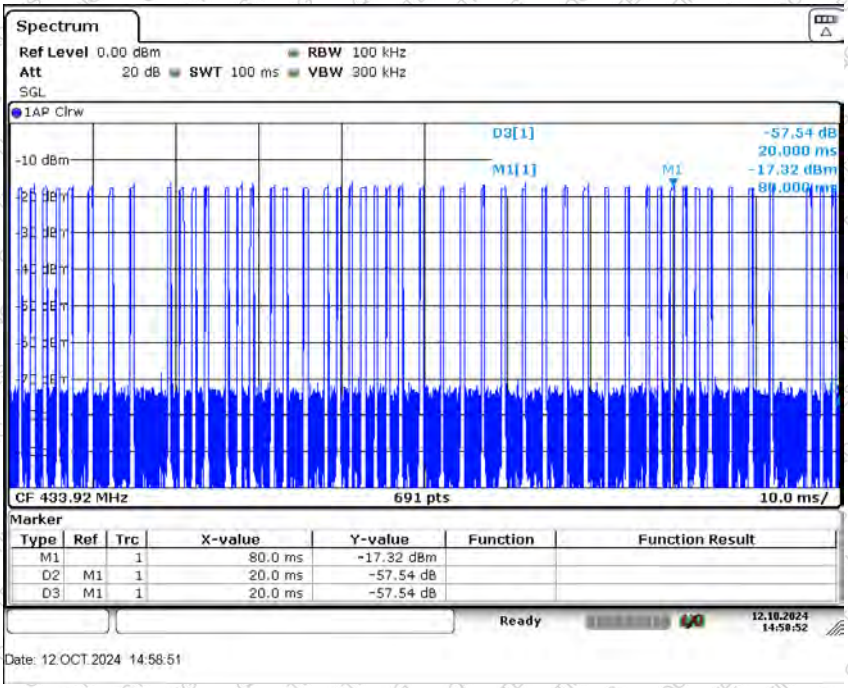

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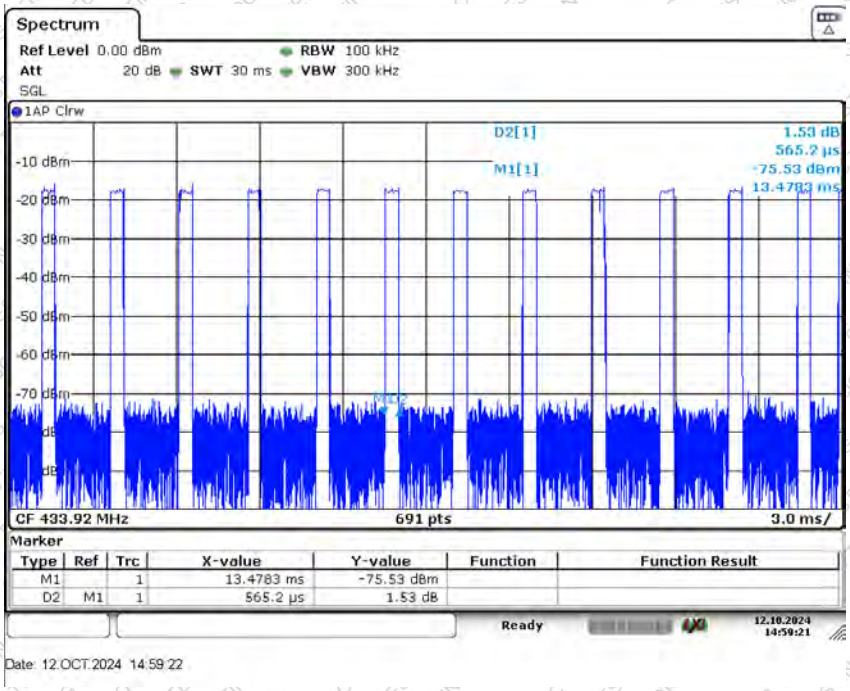

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9. Conducted Emissions

9.1 Applicable Standard

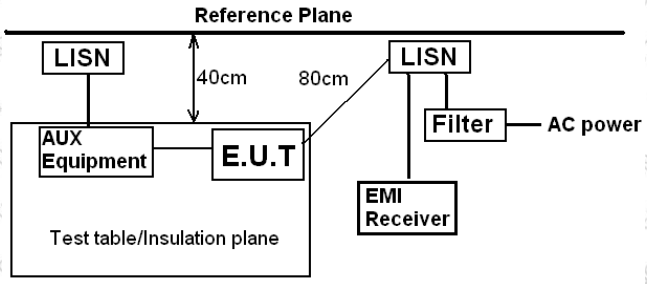
FCC Part15 C Section 15.207

9.2 Limit

Frequency range (MHz)	Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

Note *: The level decreases linearly with the logarithm of the frequency.

9.3 Test setup



Remark:
E.U.T: Equipment Under Test
LISN: Line Impedence Stabilization Network
Test table height=0.8m

9.4 EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.
RBW=9 kHz, VBW=30 kHz, Sweep time=auto

9.5 Test procedure

1. The E.U.T and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm/50uH coupling impedance for the measuring equipment.
2. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs).
3. Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.

9.6 Test Data

Temperature	23 ℃	Humidity	52%
ATM Pressure	101kPa	Antenna Gain	0dBi
Test by	LBi Li	Test result	PASS

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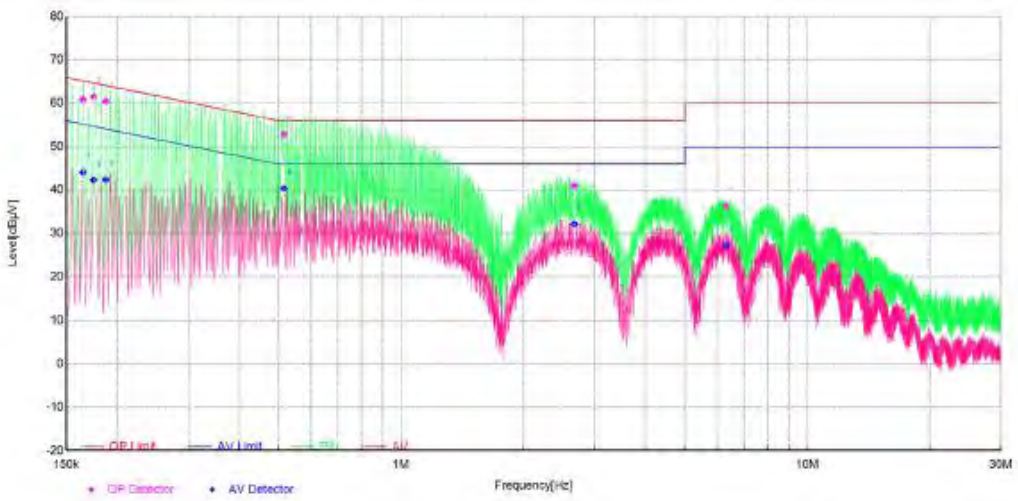
Measurement data:

Line:



Final Data List

NO.	Freq. [MHz]	Factor[dB]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Phase	Verdict
1	0.165	10.60	60.87	65.21	4.34	44.12	55.21	11.09	L	PASS
2	0.175	10.62	61.53	64.72	3.19	42.36	54.72	12.36	L	PASS
3	0.1875	10.65	60.40	64.15	3.75	42.45	54.15	11.70	L	PASS
4	0.515	10.73	52.88	56.00	3.12	40.41	46.00	5.59	L	PASS
5	2.6705	10.70	40.96	56.00	15.04	32.25	46.00	13.75	L	PASS
6	6.3065	10.75	36.26	60.00	23.74	27.20	50.00	22.80	L	PASS

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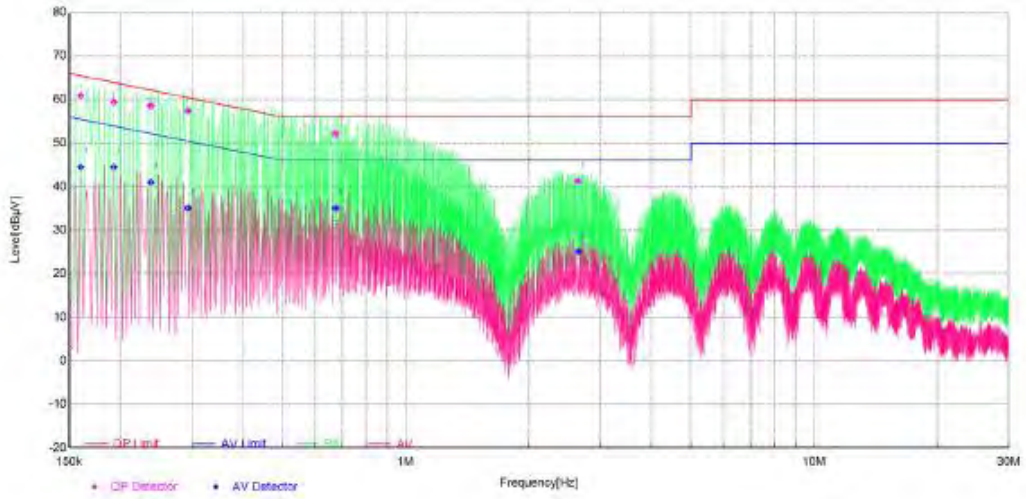
Neutral:



Final Data List

NO.	Freq. [MHz]	Factor[dB]	QP Value [dBµV]	QP Limit [dBµV]	QP Margin [dB]	AV Value [dBµV]	AV Limit [dBµV]	AV Margin [dB]	Phase	Verdict
1	0.16	10.48	60.91	65.46	4.55	44.46	55.46	11.00	N	PASS
2	0.1925	10.49	59.42	63.93	4.51	44.47	53.93	9.46	N	PASS
3	0.2375	10.63	58.59	62.18	3.59	40.98	52.18	11.20	N	PASS
4	0.2925	10.83	57.36	60.45	3.09	35.09	50.45	15.36	N	PASS
5	0.6725	10.75	52.09	56.00	3.91	35.06	46.00	10.94	N	PASS
6	2.639	10.66	41.25	56.00	14.75	25.04	46.00	20.96	N	PASS

Notes:

1. An initial pre-scan was performed on the line and neutral lines with peak detector.
2. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission.

---------- THE END OF TEST REPORT ----------

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