

TEST REPORT

Applicant Name & Address : Gree Electric Appliances, Inc. of Zhuhai
Jinji West Road, Qianshan, Zhuhai, Guangdong 519070, P. R. China

Sample Description

Product : Module transmitter
IC : 12478A-CS532U
ID : 2ADAP-CS532U
Model No. : CS532U
Electrical Rating : DC 3.3V
Frequency : 2.425GHz, 2.450GHz and 2.475GHz Transceiver

Date Received : 15 Aug., 2014

Date Test Conducted : 15 Aug., 2014 – 21 Sept., 2014

Test standards : RSS-210 Issue 8
RSS-Gen Issue 4: December 2010
FCC Part 15: 2013

Test Result : Pass

Conclusion : The submitted samples complied with the above rules/standards.

Remark : None.

*****End of Page*****

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08 Jan., 2015 *Date*

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1. General Description

1.1 Product Description

The equipment under test (EUT) is a transceiver in Module transmitter, which it contains WIFI module and 2.4GHz Connection. This test report is for 2.4GHz Connection. The EUT is powered by DC 3.3V from host (Air conditioner for indoor) input AC 208/230V/60Hz. It sends the status of module transmitter function to remote controller, when the remote controller is pressed the module transmitter will receive control command.

Antenna Type: PCB antenna.

We tested the module transmitter, model: CS532U, to determine if it was in compliance with the relevant RSS standards. We found that the unit met the requirements of ANSI C63.4-2013. The worst case's test data was presented in this test report.

1.2 Related Submittal (s) / Grants

The IC of corresponding transceiver for this transceiver is 12478A - SAA1FB1F.
The FCC ID of corresponding transceiver for this transceiver is 2ADAP-SAA1FB1F.

1.3 Test Methodology

Radiated emission measurements were performed according to the procedures in RSS-Gen Issue 4. Radiated emission measurement was performed in semi-anechoic chamber room. For radiated emission measurement, preliminary scans were performed in the semi-anechoic chamber only to determine the worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "Justification Section" of this Application.

Conducted emission test was performed according to RSS-Gen Issue 4. The EUT was set to achieve the maximum emission level. The mains terminal disturbance voltage was measured with the EUT in a shielded room. The EUT was connected to AC power source through an Artificial Mains Network which provides a 50Ω linear impedance. Artificial hand is used if appropriate (for handheld apparatus). The load/control terminal disturbance voltage was measured with passive voltage probe if appropriate.

The vertical conducting plane or wall of a screened room shall be located 40 cm to the rear of the EUT. All other surfaces of tabletop EUTs shall be at least 80 cm from any other grounded conducting surface, including the case or cases of one or more LISNs. The table-top EUT was placed on a 0.8m high non-metallic table above earthed ground plane (Ground Reference Plane). And for floor standing EUT, was placed on a 0.1m high non-metallic supported on GRP. The Artificial Mains Network is situated at a distance of 0.8m from the EUT.

During the test, mains lead of EUT excess 0.8m was folded back and forth parallel to the lead so as to form a horizontal bundle with a length between 0.3m and 0.4m.

The bandwidth of test receiver was set at 9 kHz. The frequency range from 150 kHz to 30MHz was checked.

1.4 Test Facility

All of the tests are performed at:
Intertek Testing Services Shenzhen Ltd. Guangzhou Branch.
Block E, No.7-2 Guang Dong Software Science Park, Caipin Road, Guangzhou Science City, GETDD Guangzhou, China 510663.

This test facility and site measurement data have been fully placed on file with the IC and FCC, test firm registration number is 2042U-1 for IC and 549654 for FCC.

Test Equipment List

Equipment No.	Equipment	Model	Manufacturer	Cal. Due date (YYYY-MM-DD)	Calibration Interval
EM030-01	3m Semi-Anechoic Chamber	9×6×6 m ³	ETS•LINDGR EN	2015-04-02	1Y
EM030-02	Control room for 3m Semi-Anechoic Chamber	4×4×3 m ³	ETS•LINDGR EN		
EM031-02	EMI Test Receiver (9 kHz~7 GHz)	R&S ESR7	R&S	2015-06-03	1Y
EM031-03	Signal and Spectrum Analyzer (10 Hz~40 GHz)	R&S FSV40	R&S	2015-06-03	1Y
EM011-04	Loop antenna (9 kHz-30 MHz)	HFH2-Z2	R&S	2015-05-25	1Y
EM061-03	TRILOG Super Broadband test Antenna (30 MHz-1.5 GHz)	VULB 9161	SCHWARZBECK	2015-05-25	1Y
EM033-02	Bouble-Ridged Waveguide Horn Antenna (800 MHz-18 GHz)	R&S HF907	R&S	2015-05-25	1Y
EM031-02-01	Coaxial cable	/	R&S	2015-06-03	1Y
EM080-05	EMI Test Receiver	ESCI	R&S	2015-08-04	1Y
EM006-05	LISN	ENV216	R&S	2015-07-02	1Y

1.5 Measurement Uncertainty

Conducted Emission: 2.58 dB in the frequency range of 150kHz-30MHz at a level of confidence of 95%.

Radiated Emission: 4.87dB in the frequency range of 30MHz-1000MHz; 4.79dB in the frequency range of 1GHz-6GHz and 5.17dB in the frequency range of 6GHz-26.5GHz at a level of confidence of 95%.

When determining the test conclusion, the Measurement Uncertainty of test has been considered.

2. System Test Configuration

2.1 Justification

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in ANSI C63.4 (2013).

The EUT was powered by DC 3.3V from host (Air conditioner for indoor) input AC 230V/60Hz in the testing.

Type of modulation: 2-FSK modulation, and only the worst data was reported in this report.

For maximizing emissions, the unit was placed in the center of the turntable, and the turntable was rotated through 360°, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the data reported in Chapter 3.

Switch is installed for changing the frequency for measurement.

2.2 EUT Exercising Software

There was no special software to exercise the device.

2.3 Special Accessories

The module will be installed in indoor unit of air conditioner. The below model is a typical one:

Model No:	GWH09UC-D3DNA4A
EUT Power Supply:	AC 208/230V/ 60 Hz
Power cord:	1.8 m x 3 wires unscreened AC supply cable

2.4 Equipment Modification

Any modifications installed previous to testing by Gree Electric Appliances, Inc. of Zhuhai will be incorporated in each production model sold/leased in the United States. No modifications were installed by Intertek Testing Services Shenzhen Ltd. Guangzhou Branch.

2.5 Support Equipment List and Description

N/A

3. Summary of Test Results

RSS-Gen Issue 4	Description of Test	Result
7.1.2	Antenna Requirement	Pass
4.6.1	Occupied Bandwidth	Pass
7.2.4	AC Power Line Conducted Emission	Pass

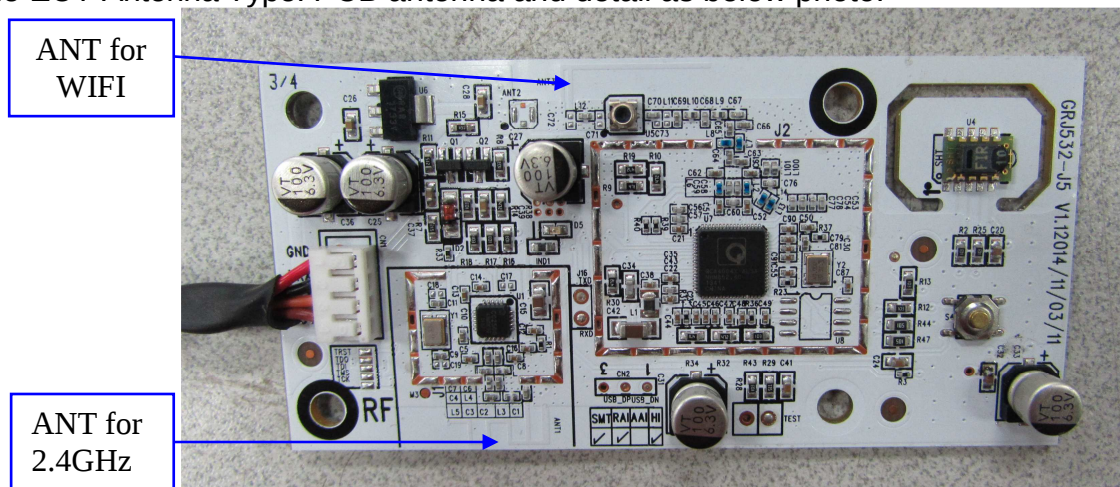
RSS-210 Issue 8	Description of Test	Result
2.2 & A2.9	Radiated Emission	Pass
A2.9	Band Edges Measurement	Pass

FCC Rules	Description of Test	Result
15.203	Antenna Requirement	Pass
15.207	Disturbance Voltage at the Mains Terminals	Pass
15.215	20dB Bandwidth	Pass
15.249	Radiated Emission	Pass
15.249	Band Edges Measurement	Pass

Remark: When determining the test results, measurement uncertainty of tests has been considered.

3.1 Antenna Requirement

The EUT Antenna Type: PCB antenna and detail as below photo.



3.2 Conducted Emission

3.2.1 Conducted Emission Limits

According to RSS-Gen Issue 4, Clause 7.2.4 and FCC 15.207, for any radio apparatus equipped to operate from the public utility AC power supply, either directly or indirectly (such as with a battery charger), the radio frequency voltage of emission conducted back onto the AC power lines in the frequency range of 0.15MHz to 30MHz shall not exceed the limits shown in the table below.

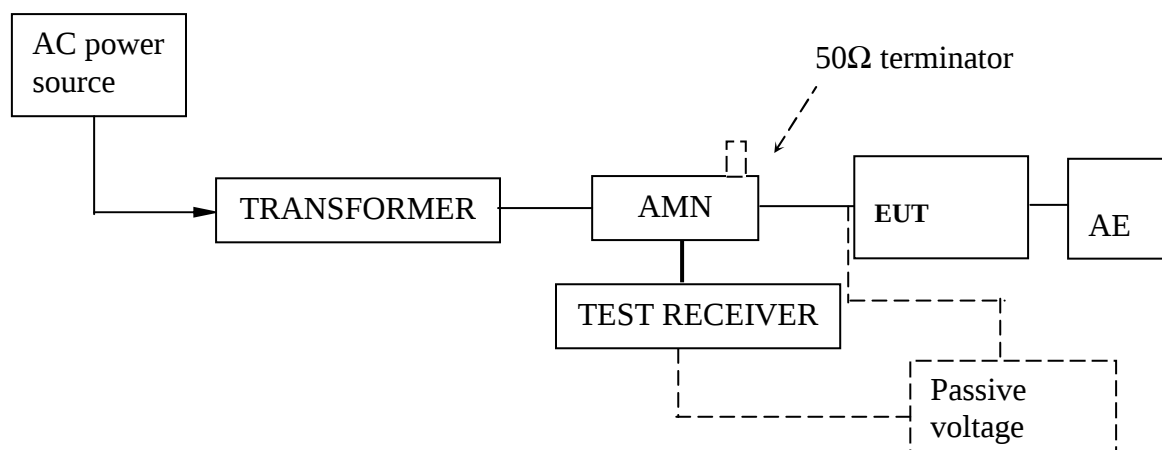
Frequency of emission(MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

Note:

Pre-test in the three channels: 2425MHz, 2450MHz and 2475MHz and found the conducted emission on 2425MHz is the worst case, so below test data is for 2425MHz.

3.2.2 Block Diagram of Test Setup



3.2.3 Conducted Emission Test Data

Conducted Emissions Requirement

Tested Wire: Live

Operation Mode: EUT transmitting on 2425MHz

EDIT PEAK LIST (Final Measurement Results)				
Trace1:	CE22QP			
Trace2:	CE22AV			
Trace3:	---			
TRACE	FREQUENCY	LEVEL	dB μ V	DELTA LIMIT dB
1 Quasi Peak	546 kHz	28.90	L1	-27.09
2 Average	546 kHz	24.12	L1	-21.88
1 Quasi Peak	742 kHz	32.00	L1	-23.99
2 Average	742 kHz	26.28	L1	-19.71
1 Quasi Peak	1.45 MHz	28.88	L1	-27.12
2 Average	1.914 MHz	27.84	L1	-18.15
2 Average	3.606 MHz	29.75	L1	-16.24
1 Quasi Peak	3.618 MHz	34.43	L1	-21.56
2 Average	4.386 MHz	30.98	L1	-15.01
1 Quasi Peak	4.43 MHz	35.85	L1	-20.14
2 Average	10.514 MHz	35.49	L1	-14.50
1 Quasi Peak	10.63 MHz	42.31	L1	-17.68
2 Average	23.674 MHz	29.71	L1	-20.28
1 Quasi Peak	23.87 MHz	43.00	L1	-16.99



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Issued: 2015-01-08

Tested Wire: Neutral

Operation Mode: EUT transmitting on 2425MHz

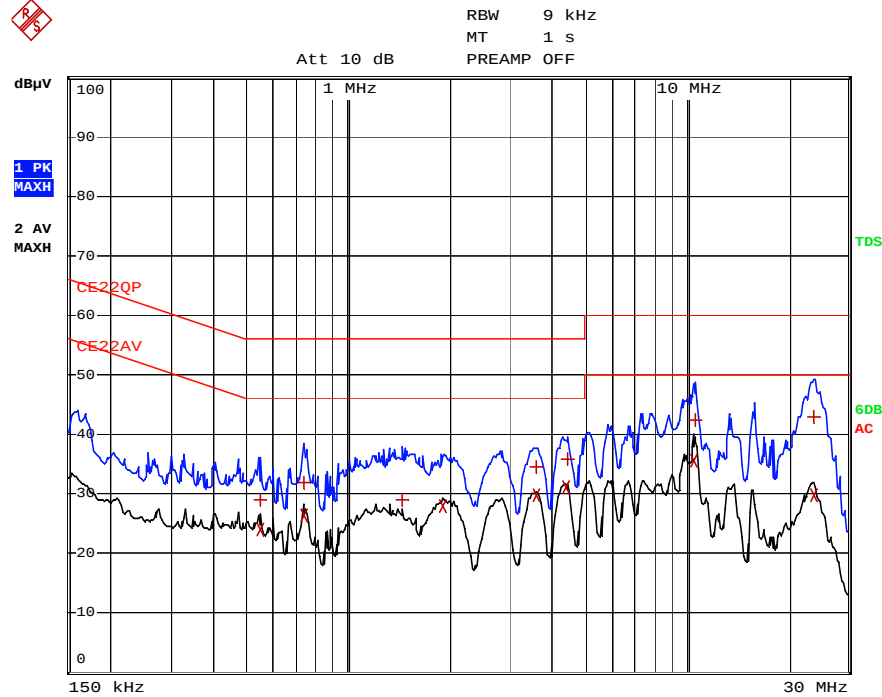
EDIT PEAK LIST (Final Measurement Results)						
Trace1:		CE22QP				
Trace2:		CE22AV				
Trace3:		---				
TRACE		FREQUENCY		LEVEL dBµV		DELTA LIMIT dB
1	Quasi Peak	494 kHz		34.65	L1	-21.44
2	Average	494 kHz		28.82	L1	-17.27
1	Quasi Peak	738 kHz		35.88	L1	-20.12
2	Average	746 kHz		29.28	L1	-16.71
1	Quasi Peak	2.05 MHz		35.42	L1	-20.57
2	Average	2.078 MHz		29.13	L1	-16.86
2	Average	3.582 MHz		33.58	L1	-12.41
1	Quasi Peak	3.586 MHz		39.00	L1	-17.00
1	Quasi Peak	4.946 MHz		41.27	L1	-14.72
2	Average	4.962 MHz		35.73	L1	-10.26
2	Average	9.918 MHz		41.64	L1	-8.35
1	Quasi Peak	10.018 MHz		47.33	L1	-12.67
2	Average	15.822 MHz		33.35	L1	-16.64
1	Quasi Peak	23.878 MHz		43.16	L1	-16.83

3.2.4 Emission Curve

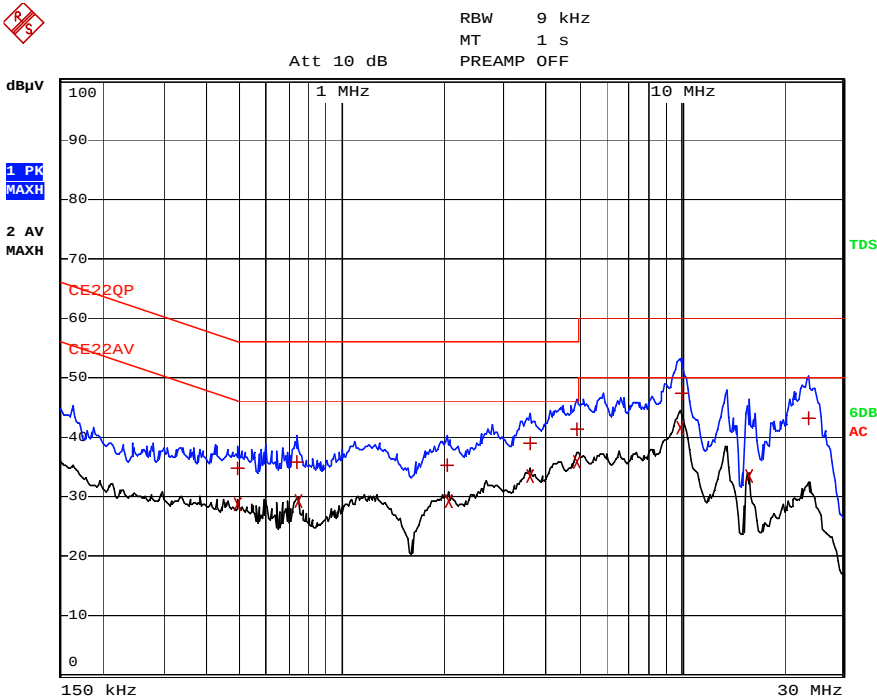
At mains terminal:

Operation Mode: EUT transmitting on 2425MHz

Tested Wire: Live



Tested Wire: Neutral



3.3 Radiated Emission

Data is included worst-case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included.

3.3.1 Radiated Emission Limits

According to RSS-Gen Issue 4 clause 6.1 and FCC 15.209, the field strength of radiated emission outside of the specified frequency bands, except for harmonics at a distance of 3 meters shall not exceed the following values:

Radiated Emission Limits:

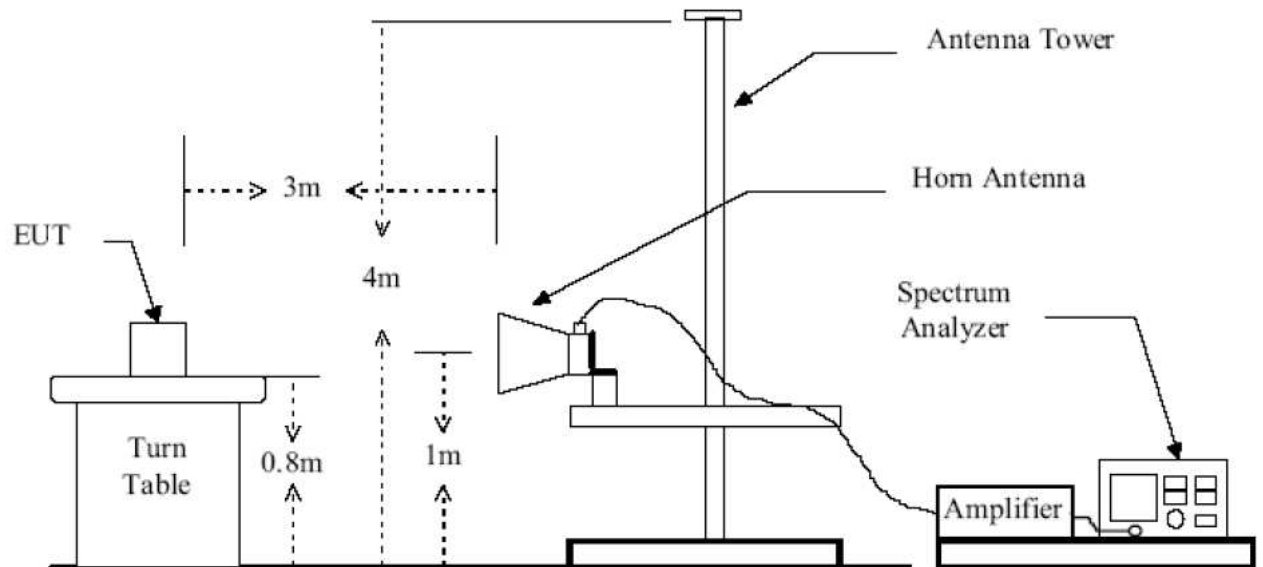
Frequency (MHz)	Field Strength (microvolts/m at 3 metres)
30-88	100
88-216	150
216-960	200
Above 960	500

According to RSS-210 Issue 8 clause A2.9 and FCC 15.249, operating within the bands 2400-2483.5 MHz, the field strength of emissions from intentional radiators operated within this frequency bands shall comply with the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (millivolts/meter)	Field Strength of Harmonics (millivolts /meter)
2400 - 2483.5	50 ^(Note 1)	0.5

Note 1: Equivalent to 0.75 mW e.i.r.p

3.3.2 Test Setup



3.3.3 Field Strength Calculation

The field strength is calculated by adding the reading on the Spectrum Analyzer to the factors associated with preamplifiers (if any), antennas, cables, pulse desensitization and average factors (when specified limit is in average and measurements are made with peak detectors). A sample calculation is included below.

$$\begin{aligned} & \text{FS} = \text{RA} + \text{AF} + \text{CF} - \text{AG} + \text{PD} + \text{AV} \\ \rightarrow & \text{FS} = \text{RA} + \text{Correct Factor} + \text{AV} \end{aligned}$$

Where

- FS = Field Strength in dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB
- PD = Pulse Desensitization in dB
- AV = Average Factor in –dB
- Correct Factor = AF + CF – AG + PD

In the radiated emission table which follows, the reading shown on the data table may reflect the preamplifier gain. An example of the calculations, where the reading does not reflect the preamplifier gain, follows:

$$\text{FS} = \text{RA} + \text{AF} + \text{CF} - \text{AG} + \text{PD} + \text{AV}$$

3.3.4 Radiated Emission Test Data

Radiated Emissions (Below 1GHz)

Operation mode: Transmitting

Operation Frequency: 2425MHz

Emissions Requirement (30MHz-1GHz)

Antenna Polarization	Frequency [MHz]	Measured Net at 3m [dB(μV/m)]	Limit at 3m [dB(μV/m)]
Horizontal	234.000	39.60	46.0
Horizontal	264.400	37.80	46.0
Horizontal	264.800	37.60	46.0
Vertical	32.480	32.90	40.0
Vertical	35.880	32.70	40.0
Vertical	234.440	35.30	46.0

Operation mode: Transmitting

Operation Frequency: 2450MHz

Emissions Requirement (30MHz-1GHz)

Antenna Polarization	Frequency [MHz]	Measured Net at 3m [dB(μV/m)]	Limit at 3m [dB(μV/m)]
Horizontal	40.000	<30	40.0
Horizontal	180.000	<33.5	43.5
Horizontal	400.000	<36	46.0
Vertical	40.000	<30	40.0
Vertical	180.000	<33.5	43.5
Vertical	400.000	<36	46.0

Operation mode: Transmitting

Operation Frequency: 2475MHz

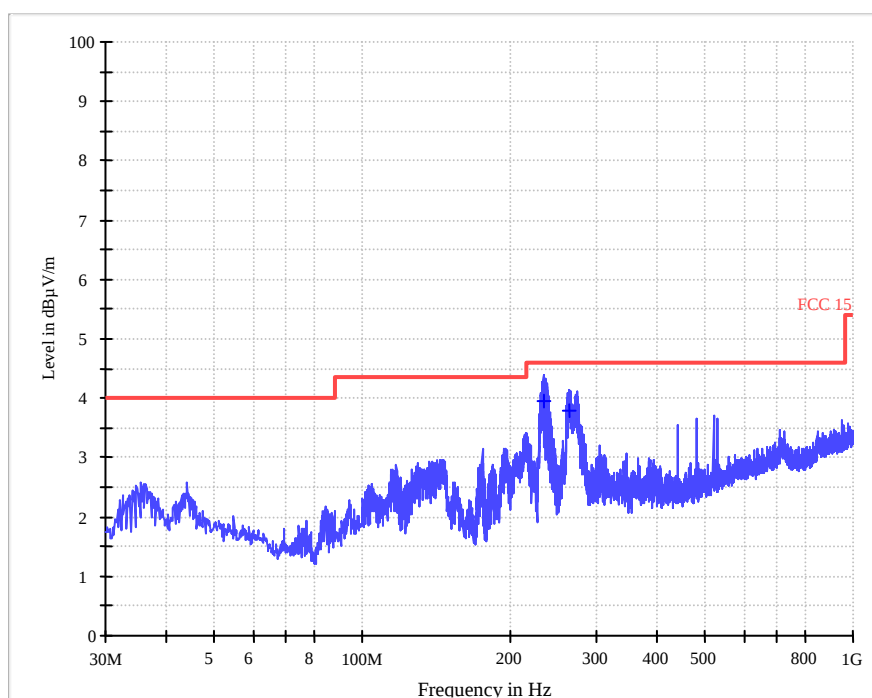
Emissions Requirement (30MHz-1GHz)

Antenna Polarization	Frequency [MHz]	Measured Net at 3m [dB(μ V/m)]	Limit at 3m [dB(μ V/m)]
Horizontal	234.440	39.30	46.0
Horizontal	263.680	38.80	46.0
Horizontal	483.250	35.20	46.0
Vertical	32.200	32.70	40.0
Vertical	35.440	32.00	40.0
Vertical	234.440	35.30	46.0

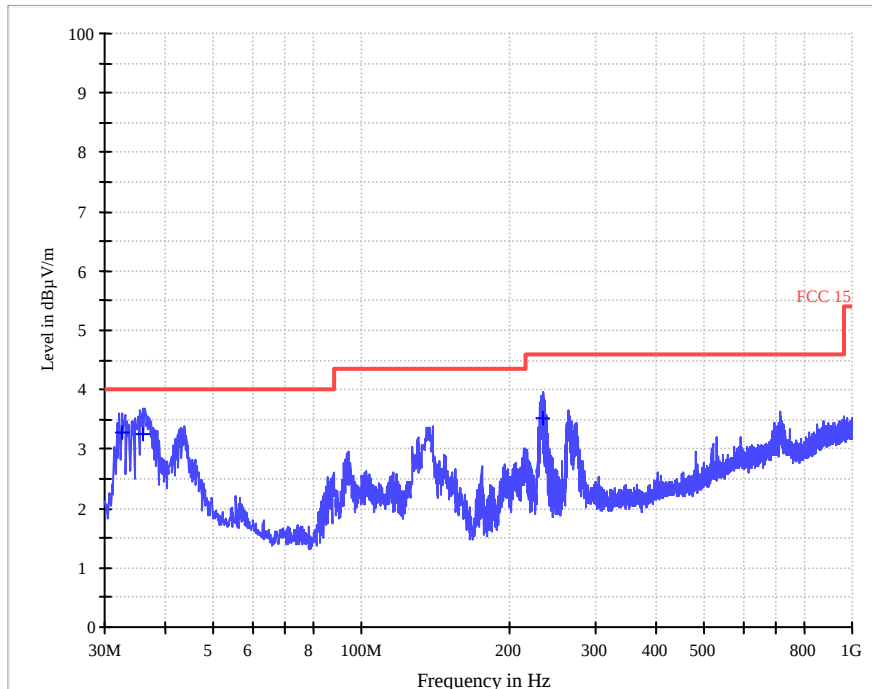
3.3.5 Test Curve

Operation mode: Transmitting
Horizontal:

Operation Frequency: 2425MHz

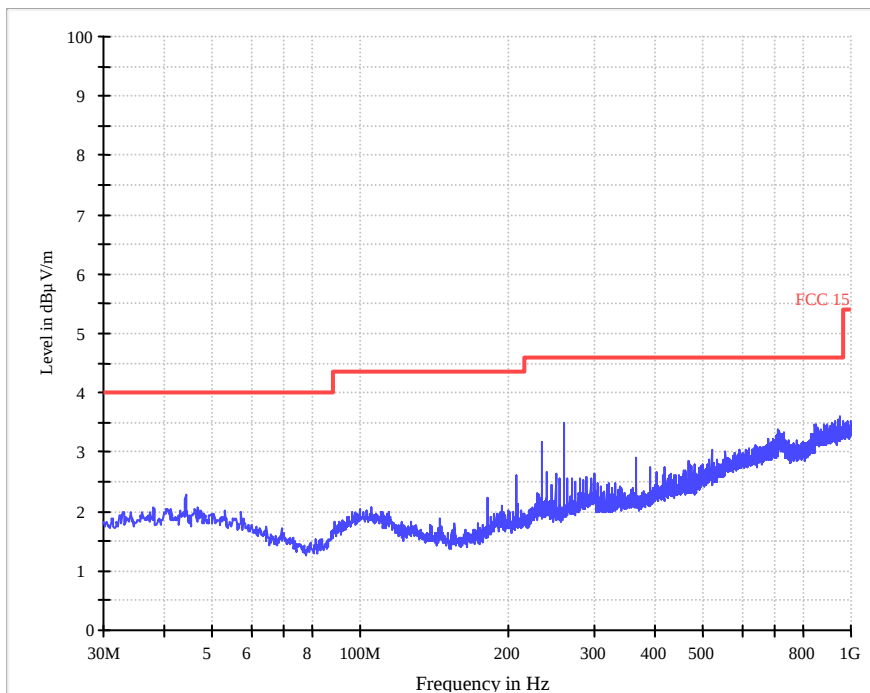


Vertical:

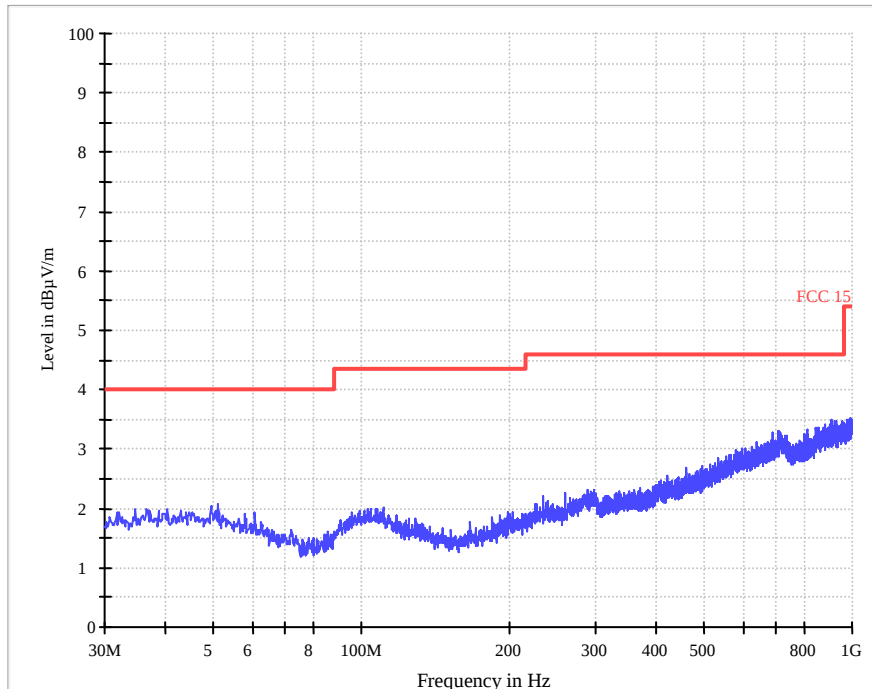


Operation mode: Transmitting
 Horizontal:

Operation Frequency: 2450MHz

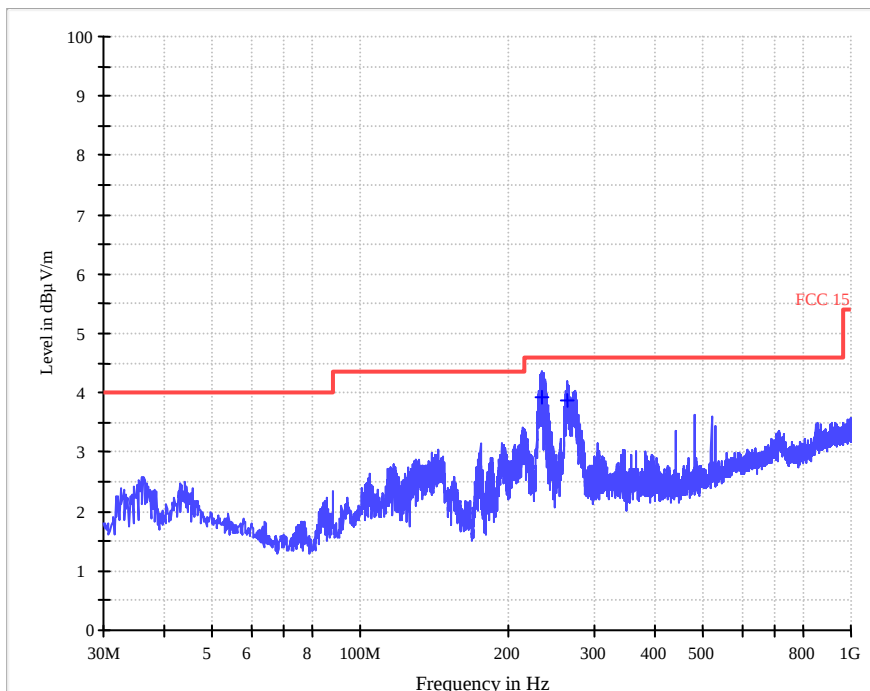


Vertical:

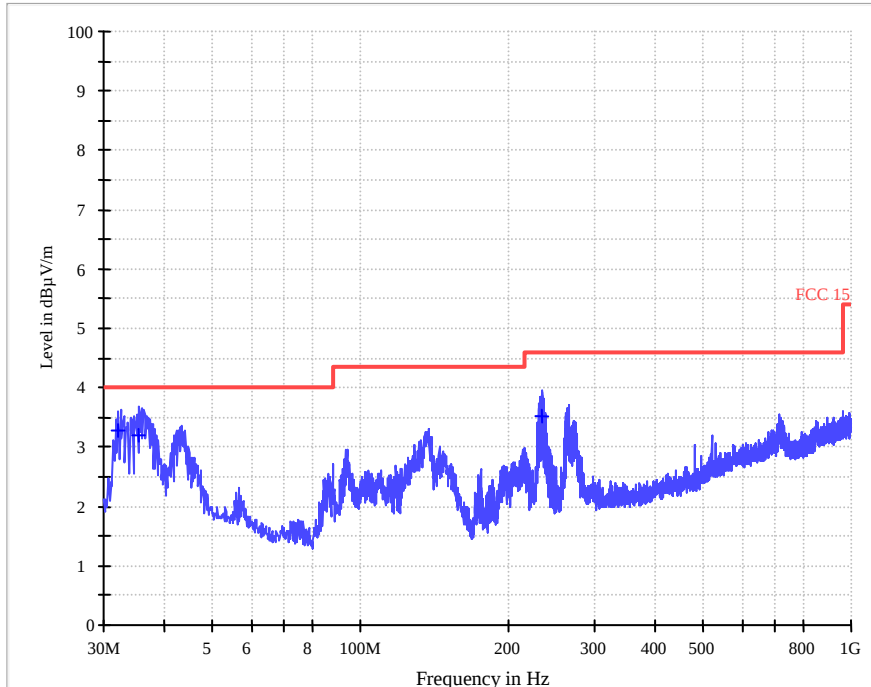


Operation mode: Transmitting
 Horizontal:

Operation Frequency: 2475MHz



Vertical:



Radiated Emissions (Above 1GHz)

Operation Frequency: 2425MHz

Emissions Requirement(above 1GHz)

Polarization	Frequency (MHz)	PK Reading (dBµV)	Correction Factor (dB)	PK Net at 3m (dBµV/m)	Average Limit at 3m (dBµV/m)	Margin (dB)
Horizontal	2423.600	83.2	-7.2	76.0	94.0	-18.0
Horizontal	6977.600	45.5	3.7	49.2	54.0	-4.8
Vertical	2423.600	92.0	-7.2	84.8	94.0	-9.2
Vertical	4848.400	50.6	-0.4	50.2	54.0	-3.8
Vertical	6992.400	45.6	3.7	49.3	54.0	-4.7

Operation Frequency: 2450MHz

Emissions Requirement(above 1GHz)

Polarization	Frequency (MHz)	PK Reading (dBμV)	Correction Factor (dB)	PK Net at 3m (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2449.200	83.7	-7.1	76.6	94.0	-17.4
Horizontal	4899.200	44.9	-0.4	44.5	54.0	-9.5
Horizontal	6998.800	44.9	3.7	48.6	54.0	-5.4
Vertical	2449.200	90.9	-7.1	83.8	94.0	-10.2
Vertical	4901.600	48.0	-0.4	47.6	54.0	-6.4
Vertical	7018.000	44.6	3.7	48.3	54.0	-5.7

Operation Frequency: 2475MHz

Emissions Requirement(above 1GHz)

Polarization	Frequency (MHz)	PK Reading (dBμV)	Correction Factor (dB)	PK Net at 3m (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2474.800	81.5	-7.0	74.5	94.0	-19.5
Horizontal	4848.400	44.1	-0.4	43.7	54.0	-10.4
Horizontal	9625.200	43.9	8.3	52.2	54.0	-1.8
Vertical	2474.800	89.3	-7.0	82.3	94.0	-11.8
Vertical	4950.400	43.8	-0.4	43.4	54.0	-10.6
Vertical	9682.800	43.7	8.0	51.7	54.0	-2.3

- Notes: 1. AT frequencies equal to or less than 1000MHz, quasi-peak detector was used, above 1000MHz, Peak detector was used.
2. All measurements were made at 3 meter.
3. Negative value in the margin column shows emission below limit.
4. Horn antenna is used for the emission over 1000MHz.

3.4 Band Edges Measurement

3.4.1 Limited of the band edges measurement

RSS-210 Issue 8 clause A2.9 (b):

(b) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general field strength limits listed in RSS-Gen, whichever is less stringent.

RSS-Gen Issue 4, clause 4.6.1:

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

FCC Sec15.249:

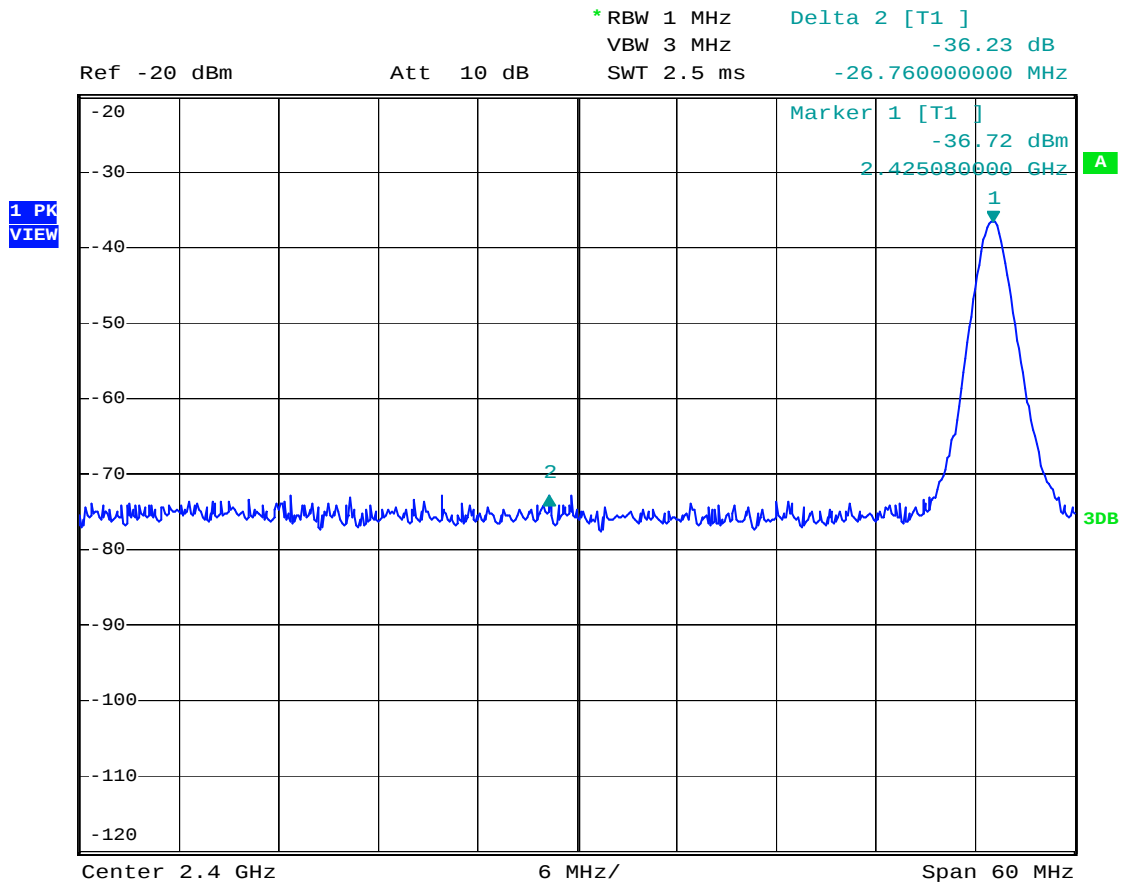
(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Section 15.209, whichever is the lesser attenuation.

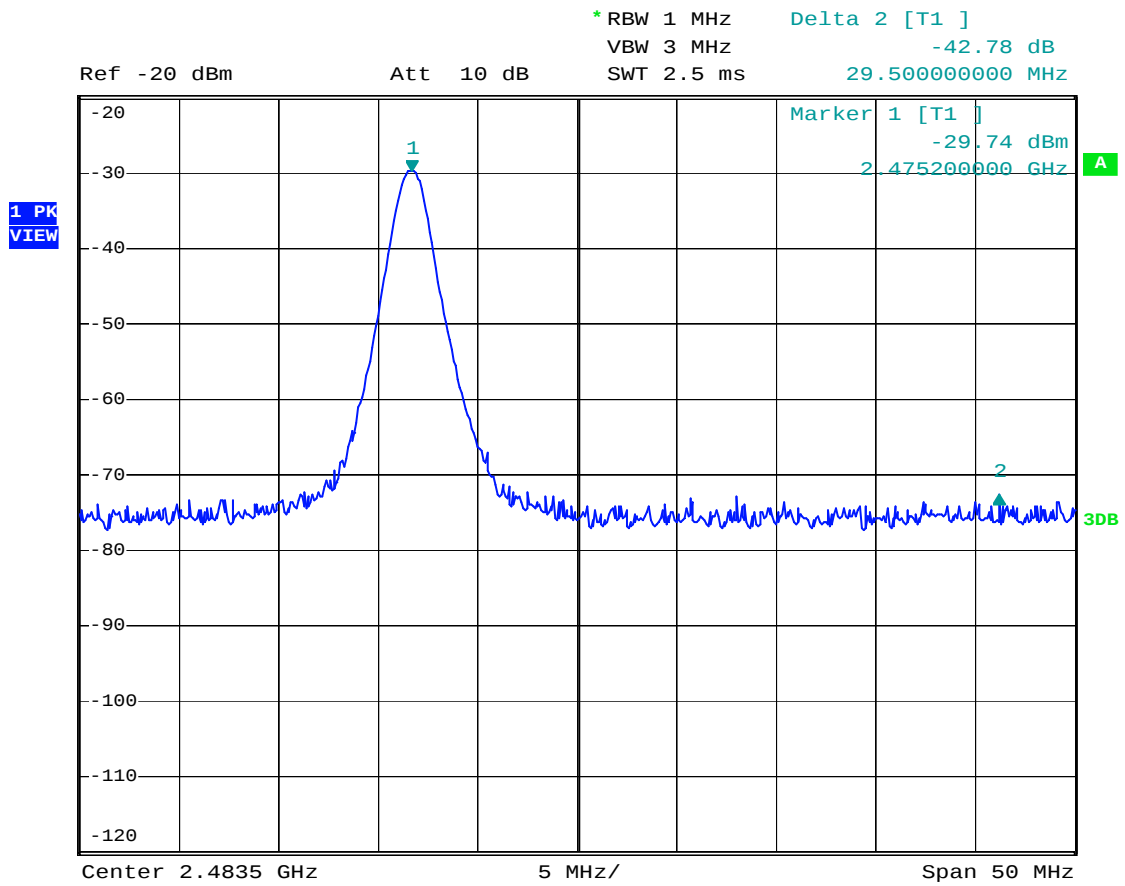
Sec15.215:

(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in § 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20dB bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

3.4.2 Test Plot

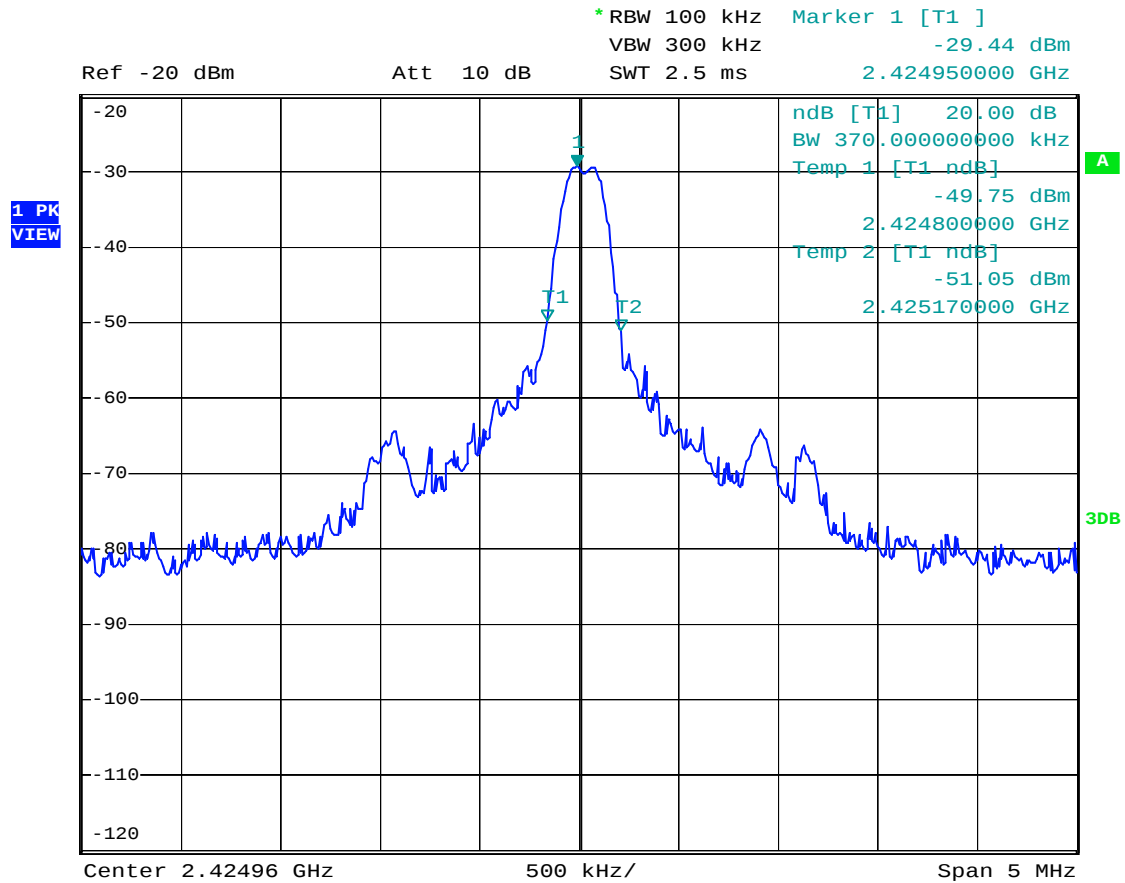
Band Edges
Operating mode: Transmitting





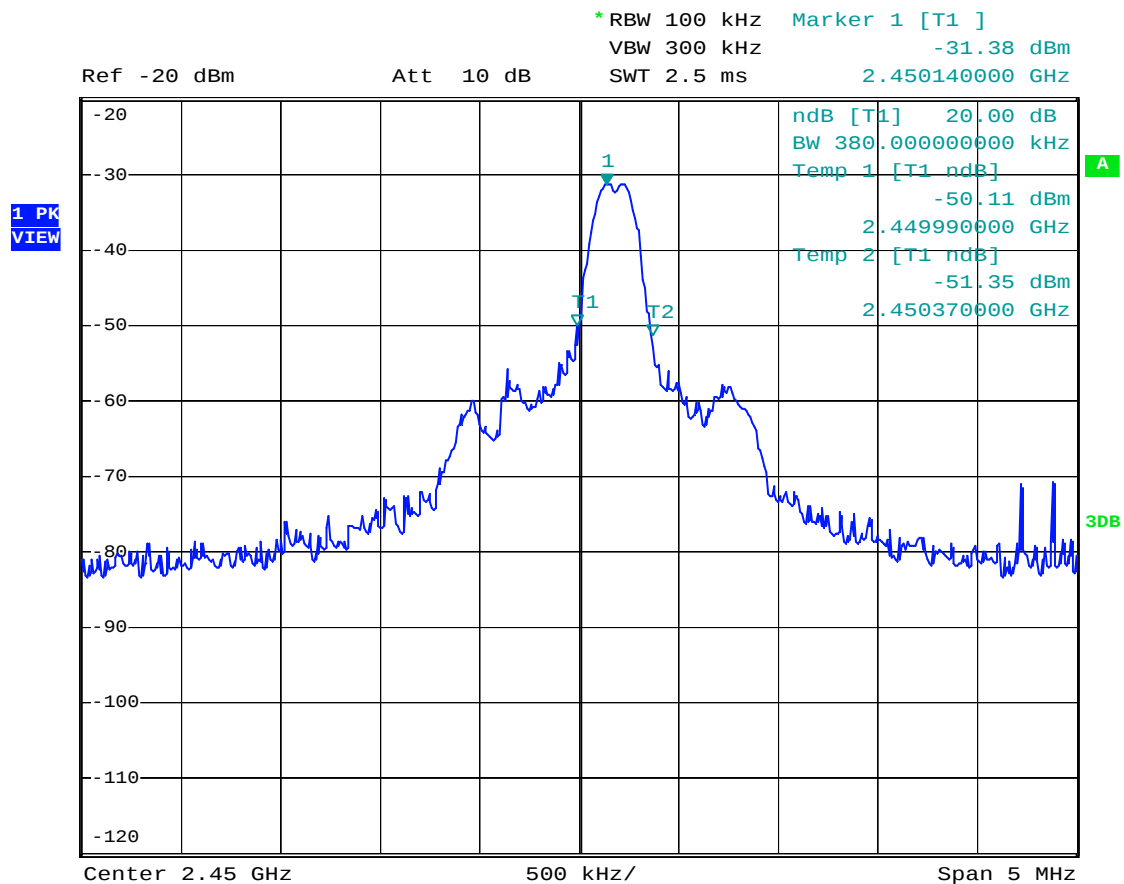
20dB Modulation Bandwidth
 Operating mode: Transmitting

Operation Frequency: 2425MHz



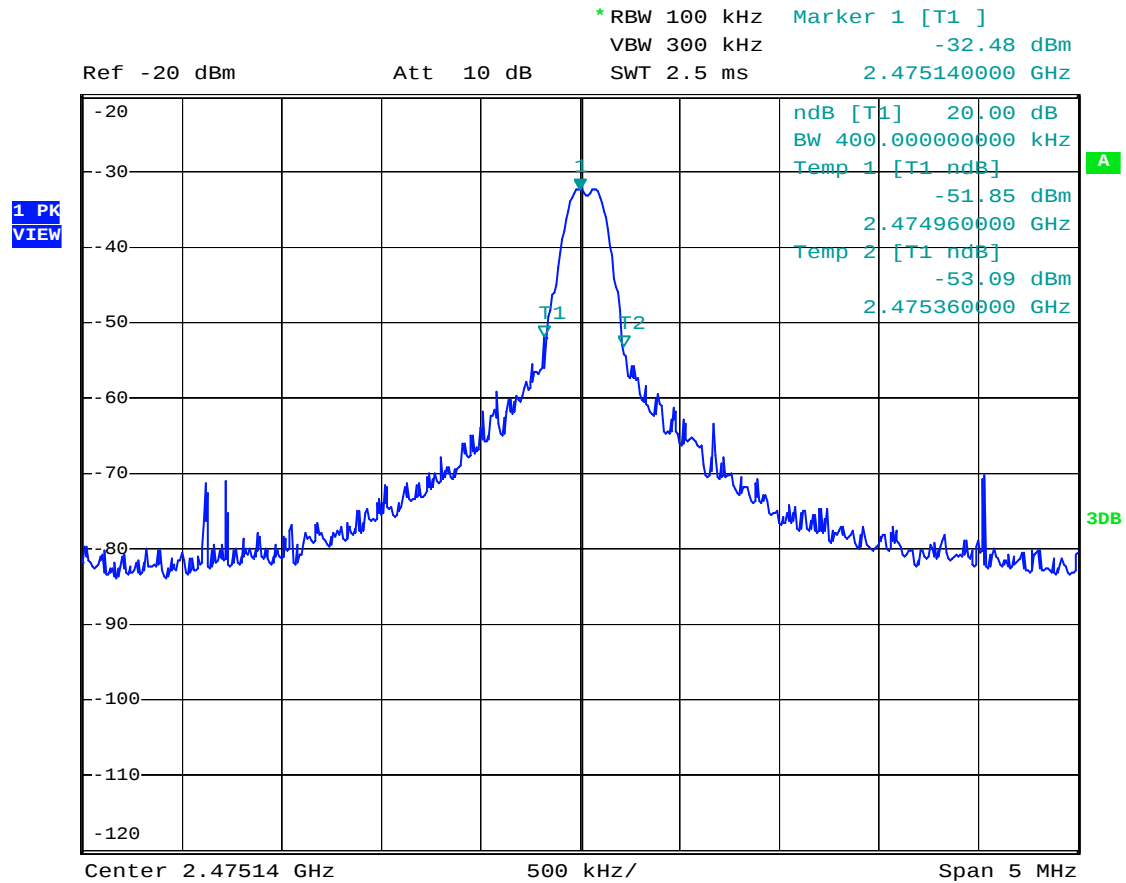
20dB Modulation Bandwidth
 Operating mode: Transmitting

Operation Frequency: 2450MHz



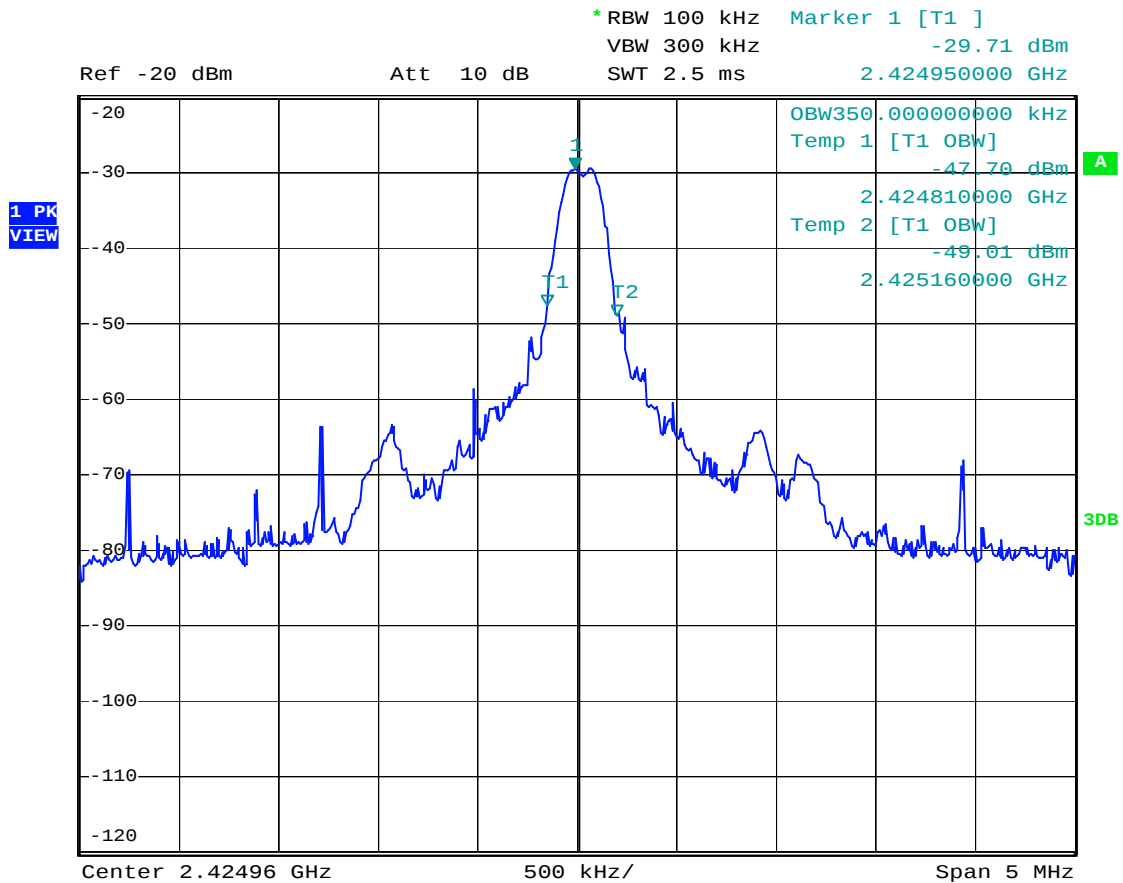
20dB Modulation Bandwidth
 Operating mode: Transmitting

Operation Frequency: 2475MHz



99% Modulation Bandwidth
 Operating mode: Transmitting

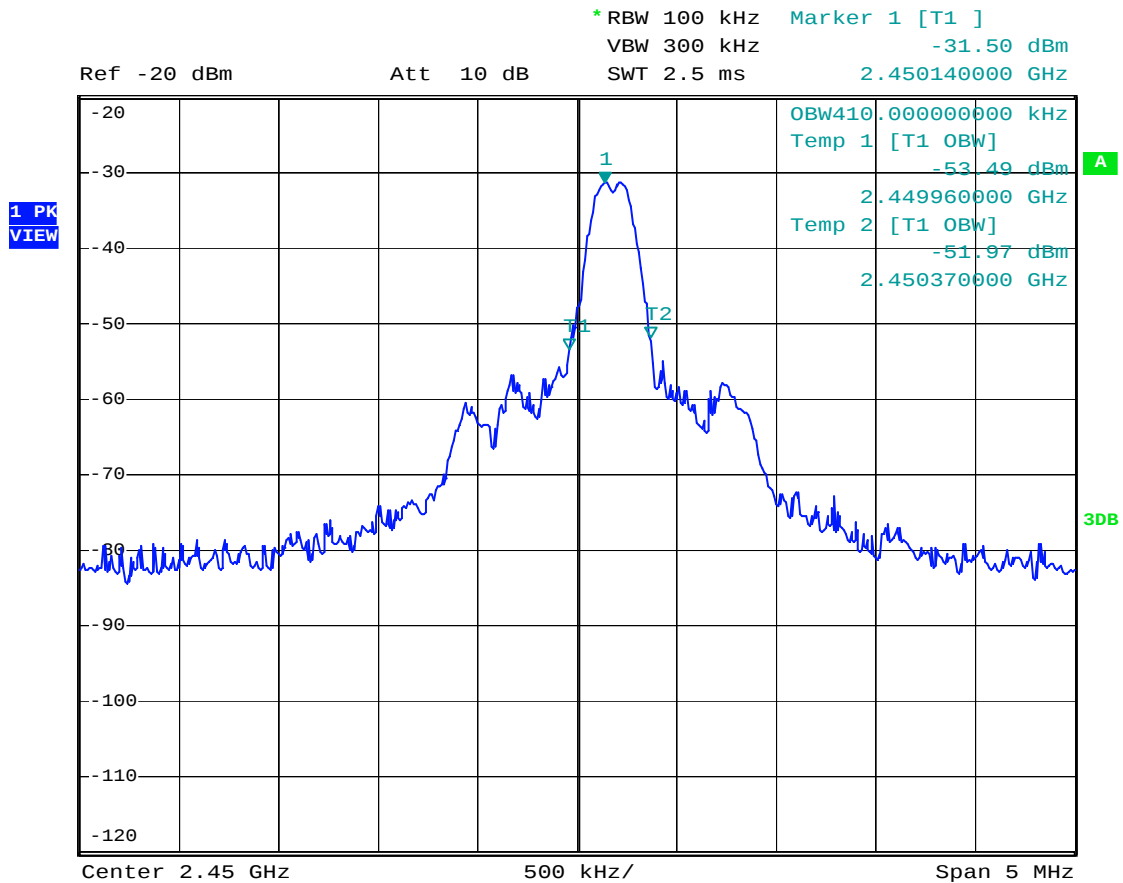
Operation Frequency: 2425MHz



The bandwidth is 0.350MHz from above plot.

99% Modulation Bandwidth
 Operating mode: Transmitting

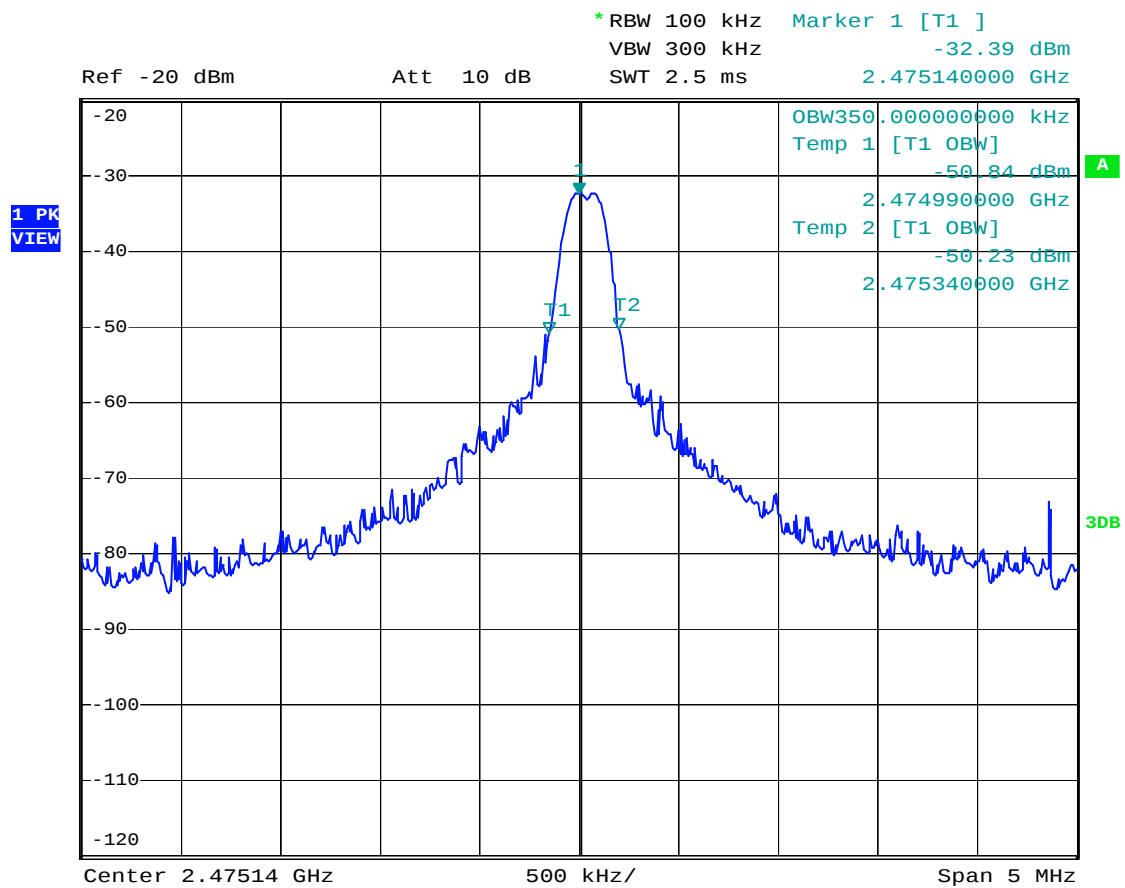
Operation Frequency: 2450MHz



The bandwidth is 0.410MHz from above plot.

99% Modulation Bandwidth
Operating mode: Transmitting

Operation Frequency: 2475MHz



The bandwidth is 0.350MHz from above plot.

3.4.3 Test Result

From the plot, the field strength of any emissions outside of the specified frequency band are attenuated to the general field strength limits listed in RSS-Gen. It fulfils the requirement of RSS-210 clause A2.9 (b).

Peak Measurement

Bandedge compliance is determined by applying marker-delta method, i.e (Bandedge Plot).

(i) Lower bandedge:

Peak Resultant field strength = Fundamental emissions (peak value) – delta from the bandedge plot

$$\begin{aligned} &= 84.8\text{dB}\mu\text{v/m} - 36.23\text{dB} \\ &= 48.57\text{dB}\mu\text{v/m} \end{aligned}$$

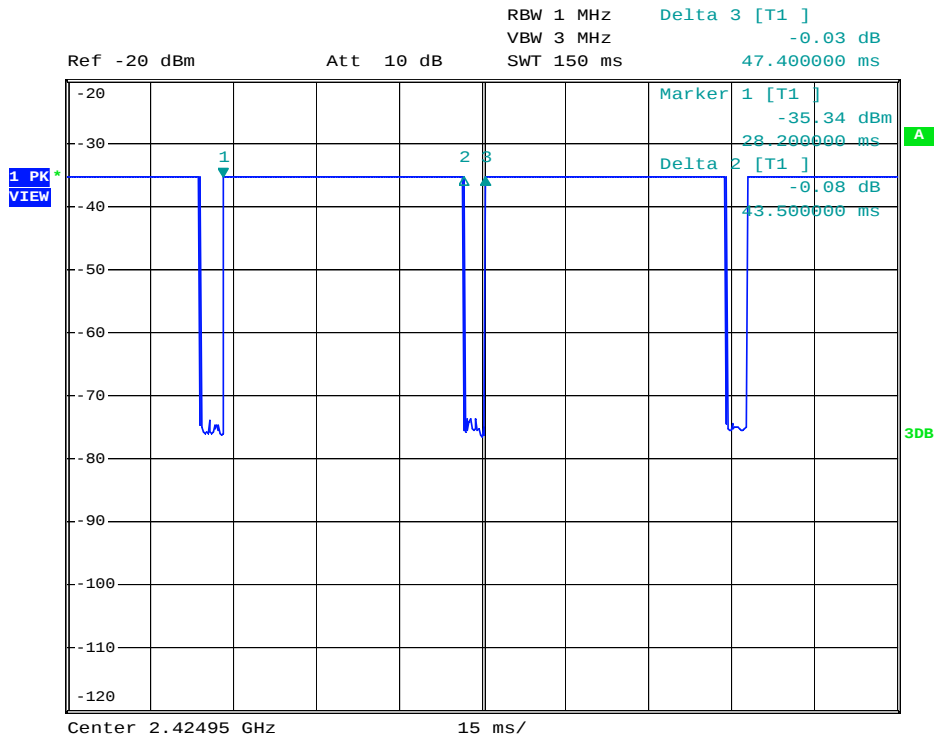
(ii) Upper bandedge:

Peak Resultant field strength = Fundamental emissions (peak value) – delta from the bandedge plot

$$\begin{aligned} &= 82.3\text{dB}\mu\text{v/m} - 42.78\text{dB} \\ &= 39.52\text{dB}\mu\text{v/m} \end{aligned}$$

The Peak resultant field strength meets the general radiated emission AV limit in RSS-Gen, so it complies with the requirement.

3.4.4 Transmitter Duty Cycle Calculation in RSS-Gen clause 4.5 and FCC Rule 15.35(b, c)



Averaging factor in dB = $20 \log (\text{duty cycle})$

The specification for output field strengths in accordance with the FCC rules specify measurements with an average detector. During testing, a spectrum analyzer incorporating a peak detector was used. Therefore, a reduction factor can be applied to the resultant peak signal level and compared to the limit for measurement instrumentation incorporating an average detector.

The time period over which the duty cycle is measured is 100 milliseconds, or the repetition cycle, whichever is a shorter time frame. The worst case (highest percentage on) duty cycle is used for the calculation. The duty cycle is measured by placing the spectrum analyzer in zero scan (receiver mode) and linear mode at maximum bandwidth (1 MHz at 3 dB down) and viewing the resulting time domain signal output from the analyzer on a Tektronix oscilloscope. The oscilloscope is used because of its superior time base and triggering facilities.

A plot of the worst-case duty cycle as detected in this manner is shown below.

The duty cycle is simply the on-time divided by the period:

The duration of one cycle = 47.400ms
Effective period of the cycle = 43.500ms

DC = $43.500/47.400 = 0.91772$ or 91.772%

Therefore, the averaging factor is found by $20 \lg 0.91772 = -0.75 \text{ dB}$