

TEST REPORT

Product : AMS lite
Trade mark : bambulab
Model/Type reference : SA005
Serial Number : N/A
Report Number : EED32P81159001
FCC ID : 2A6J8-SA005
Date of Issue : Aug. 29, 2023
Test Standards : 47 CFR Part 15 Subpart C
Test result : PASS

Prepared for:

Shenzhen Tuozhu Technology Co., Ltd.
Room 201, Building A, No. 1 First Qianwan Road, Qianhai Shengang
Cooperation Zone, Shenzhen

Prepared by:

Centre Testing International Group Co., Ltd.
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Date:

Tom Chen
Aug. 29, 2023



Aaron Ma

Check No.:1254270723

1 Version

Version No.	Date	Description
00	Aug. 29, 2023	Original

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3 Test Summary

Test Item	FCC Test Requirement	Test Method	Result
Antenna Requirement	47 CFR Part 15, Subpart C Section 15.203	ANSI C63.10 2013	Pass
Conducted Emission (150KHz to 30MHz)	47 CFR Part 15, Subpart C Section 15.207	ANSI C63.10 2013	N/A
Electric Field Strength of Fundamental and Outside the Allocated bands	47 CFR Part 15, Subpart C Section 15.225(a)/(b)/(c)	ANSI C63.10 2013	Pass
Radiated Emission	47 CFR Part 15, Subpart C Section 15.225(d)/15.209	ANSI C63.10 2013	Pass
Frequency Tolerance	47 CFR Part 15, Subpart C Section 15.225(e)	ANSI C63.10 2013	Pass
20dB Occupied Bandwidth	47 CFR Part 15, Subpart C Section 15.215	ANSI C63.10 2013	Pass

Remark:

N/A:The product is powered by DC.

The product has four antennas, and only one antenna is in operation at a time during normal operation.

Company Name and Address shown on Report, the sample(s) and sample Information was/ were provided by the applicant who should be responsible for the authenticity which CTI hasn't verified.

4 General Information

4.1 Client Information

Applicant:	Shenzhen Tuozhu Technology Co., Ltd.
Address of Applicant:	Room 201, Building A, No. 1 First Qianwan Road, Qianhai Shengang Cooperation Zone, Shenzhen
Manufacturer:	Shenzhen Tuozhu Technology Co., Ltd.
Address of Manufacturer:	Room 201, Building A, No. 1 First Qianwan Road, Qianhai Shengang Cooperation Zone, Shenzhen
Factory:	Shenzhen Tuozhu Technology Co., Ltd.
Address of Factory:	Room 201, Building A, No. 1 First Qianwan Road, Qianhai Shengang Cooperation Zone, Shenzhen

4.2 General Description of E.U.T.

Product Name:	AMS lite
Model No.(EUT):	SA005
Trade Mark:	bambulab
Product Type:	☐ Mobile ☐ Portable ☒ Fix Location
Operation Frequency:	13.56MHz
Modulation Type:	ASK
Antenna Type:	Coil antenna
Power Supply:	DC 24.0V
Test voltage:	DC 24.0V
Sample Received Date:	Aug. 10, 2023
Sample tested Date:	Aug. 10, 2023 to Aug. 15, 2023

4.3 Test Environment & Test Mode

Operating Environment:	
Radiated Emissions:	
Temperature:	24 °C
Humidity:	64 % RH
Atmospheric Pressure:	1010mbar
Test Mode:	
Test mode:	Keep EUT working in continuous transmitting mode with 100% duty cycle.

4.4 Description of Support Units

The EUT has been tested with associated equipment below.

1) support equipment

Description	Manufacturer	Model No.	Certification	Supplied by
Direct current source	KEYSIGHT	E3642A	FCC ID and DOC	CTI

4.5 Test Location

All tests were performed at:

Centre Testing International Group Co., Ltd

Building C, Hongwei Industrial Park Block 70, Bao'an District, Shenzhen, China

Telephone: +86 (0) 755 33683668 Fax: +86 (0) 755 33683385

No tests were sub-contracted.

FCC Designation No.: CN1164

4.6 Deviation from Standards

None.

4.7 Abnormalities from Standard Conditions

None.

4.8 Other Information Requested by the Customer

None.

4.9 Measurement Uncertainty (95% confidence levels, k=2)

No.	Item	Measurement Uncertainty
1	Radio Frequency	7.9×10^{-8}
2	RF power, conducted	0.46dB (30MHz-1GHz)
		0.55dB (1GHz-18GHz)
3	Radiated Spurious emission test	3.3dB (9kHz-30MHz)
		4.3dB (30MHz-1GHz)
		4.5dB (1GHz-12.75GHz)
4	Conduction emission	3.5dB (9kHz to 150kHz)
		3.1dB (150kHz to 30MHz)
5	Temperature test	0.64°C
6	Humidity test	3.8%
7	DC power voltages	0.026%

5 Equipment List

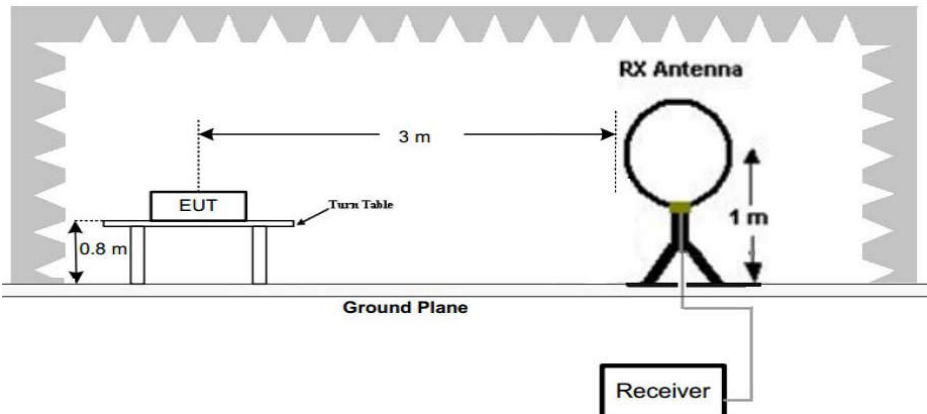
3M Semi-anechoic Chamber (2)- Radiated disturbance Test					
Equipment	Manufacturer	Model	Serial No.	Cal. Date	Due Date
3M Chamber & Accessory Equipment	TDK	SAC-3	---	05/22/2022	05/21/2025
Receiver	R&S	ESCI7	100938-003	09/28/2022	09/27/2023
Spectrum Analyzer	R&S	FSV40	101200	07/25/2023	07/24/2024
TRILOG Broadband Antenna	schwarzbeck	VULB 9163	9163-618	05/22/2022	05/21/2025
Loop Antenna	Schwarzbeck	FMZB 1519B	1519B-076	04/15/2021	04/14/2024
Microwave Preamplifier	Tonscend	EMC051845SE	980380	12/23/2022	12/23/2023
Horn Antenna	A.H.SYSTEMS	SAS-574	374	05/29/2021	05/28/2024
Horn Antenna	ETS-LINGREN	BBHA 9120D	9120D-1869	04/15/2021	04/14/2024
Preamplifier	Agilent	11909A	12-1	03/28/2023	03/27/2024
Preamplifier	CD	PAP-1840-60	6041.6042	07/03/2023	07/02/2024
Test software	Fara	EZ-EMC	EMEC-3A1-Pre	---	---
Cable line	Fulai(7M)	SF106	5219/6A	---	---
Cable line	Fulai(6M)	SF106	5220/6A	---	---
Cable line	Fulai(3M)	SF106	5216/6A	---	---
Cable line	Fulai(3M)	SF106	5217/6A	---	---

6 Test Result and Measurement Data

6.1 Antenna Requirement

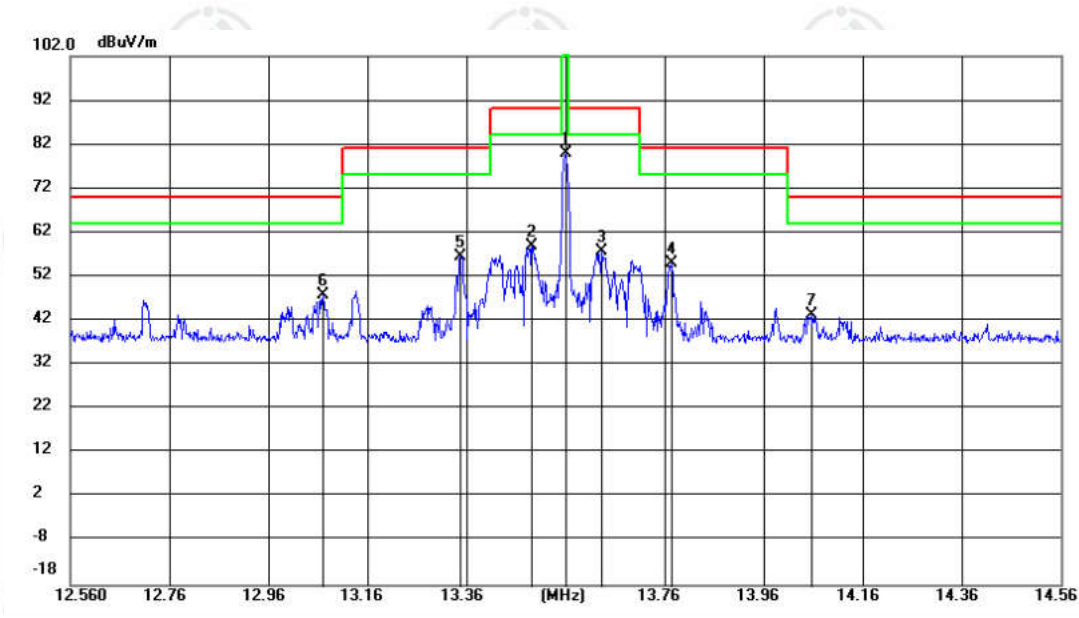
Standard requirement:	47 CFR Part15 C Section 15.203
15.203 requirement:	An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique 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 coil antenna and integrated on the main PCB and no consideration of replacement.	

6.2 Electric Field Strength of Fundamental and Outside the Allocated bands

Test Requirement:	47 CFR Part 15, Subpart C Section 15.225(a)/(b)/(c)																																							
Test Method:	ANSI C63.10: 2013																																							
Test Site:	3m (Semi-Anechoic Chamber)																																							
Receiver Setup:	<table><tr><td>Frequency</td><td>Detector</td><td>RBW</td><td>VBW</td><td>Remark</td></tr><tr><td>0.009MHz-0.090MHz</td><td>Peak</td><td>10kHz</td><td>30kHz</td><td>Peak</td></tr><tr><td>0.009MHz-0.090MHz</td><td>Average</td><td>10kHz</td><td>30kHz</td><td>Average</td></tr><tr><td>0.090MHz-0.110MHz</td><td>Quasi-peak</td><td>10kHz</td><td>30kHz</td><td>Quasi-peak</td></tr><tr><td>0.110MHz-0.490MHz</td><td>Peak</td><td>10kHz</td><td>30kHz</td><td>Peak</td></tr><tr><td>0.110MHz-0.490MHz</td><td>Average</td><td>10kHz</td><td>30kHz</td><td>Average</td></tr><tr><td>0.490MHz -30MHz</td><td>Quasi-peak</td><td>10kHz</td><td>30kHz</td><td>Quasi-peak</td></tr></table>					Frequency	Detector	RBW	VBW	Remark	0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak	0.009MHz-0.090MHz	Average	10kHz	30kHz	Average	0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak	0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak	0.110MHz-0.490MHz	Average	10kHz	30kHz	Average	0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
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Limit:	<table><tr><td>Frequency Range(MHz)</td><td>E-field Strength Limit @ 30 m (μV/m)</td><td>E-field Strength Limit @ 3 m (dBμV/m)</td></tr><tr><td>13.560 ± 0.007</td><td>15848</td><td>124</td></tr><tr><td>13.410 to 13.553 13.567 to 13.710</td><td>334</td><td>90</td></tr><tr><td>13.110 to 13.410 13.710 to 14.010</td><td>106</td><td>81</td></tr></table> Note: Where the limits have been defined at one distance, and a signal level measured at another, the limits have been extrapolated using the following formula: Extrapolation(dB)=40log₁₀(Measurement Distance/Specification Distance)				Frequency Range(MHz)	E-field Strength Limit @ 30 m (μV/m)	E-field Strength Limit @ 3 m (dBμV/m)	13.560 ± 0.007	15848	124	13.410 to 13.553 13.567 to 13.710	334	90	13.110 to 13.410 13.710 to 14.010	106	81																								
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Test Setup:	 Figure 1. Below 30MHz																																							
Test Procedure:	1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic 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. - 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 (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. - The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode. - 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. - The radiation measurements are performed in X, Y, Z axis positioning. And found the X axis positioning which it is worse case, only the test worst case mode is recorded in the report.
Test Mode:	Transmitting with ASK modulation.
Test Result:	Pass

Antenna 1 Measurement Data:



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	Level	Factor	ment			Height	Degree	
			dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		13.5600	59.50	20.35	79.85	124.00	-44.15	peak		
2		13.4920	38.68	20.35	59.03	90.00	-30.97	peak		
3		13.6329	37.44	20.35	57.79	90.00	-32.21	peak		
4		13.7739	34.77	20.35	55.12	81.00	-25.88	peak		
5		13.3480	36.31	20.35	56.66	81.00	-24.34	peak		
6	*	13.0700	27.55	20.35	47.90	70.00	-22.10	peak		
7		14.0570	22.91	20.34	43.25	70.00	-26.75	peak		

Remark:

Only the worst case data of X axis positioning was recorded in the report.

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier.

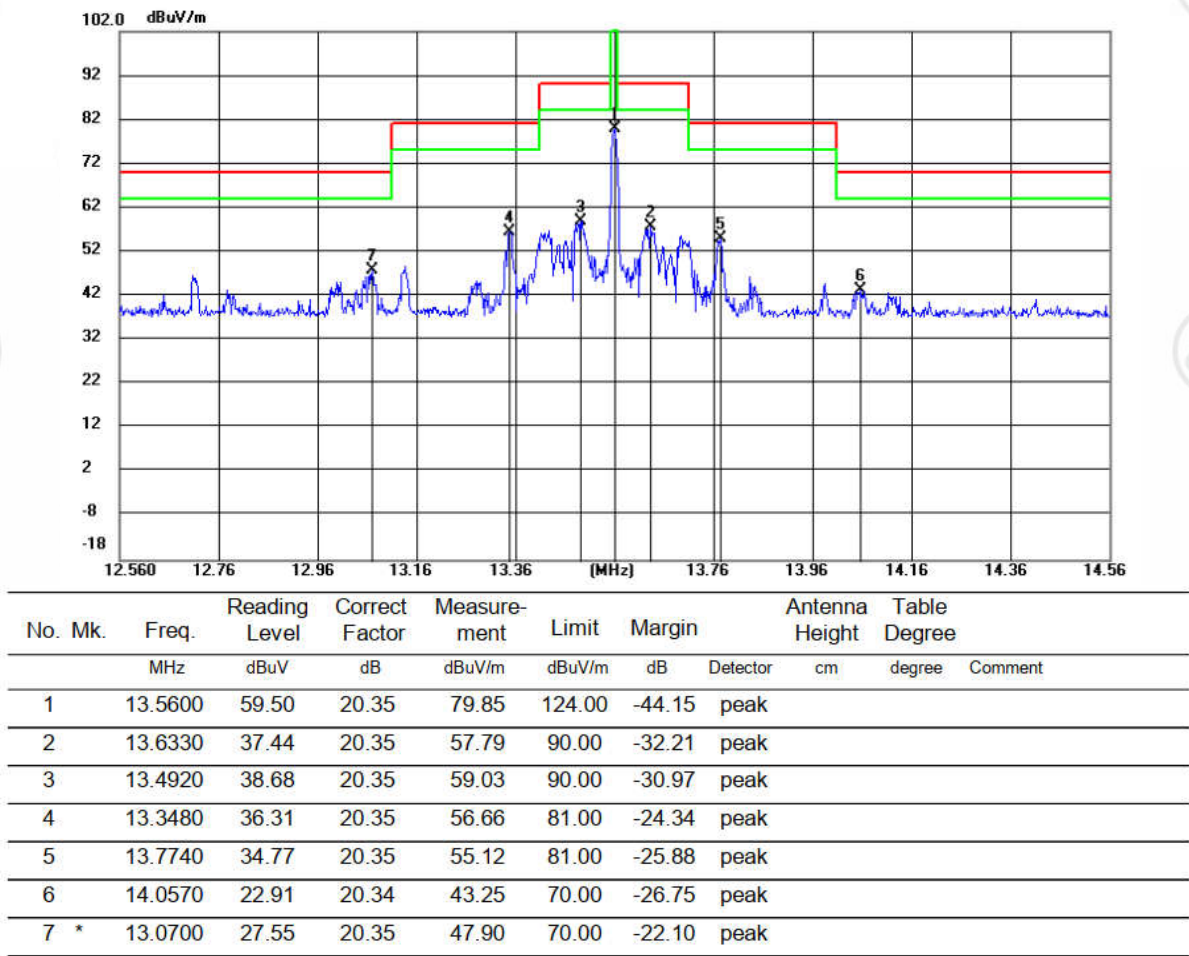
The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

Antenna 2 Measurement Data:



Remark:

Only the worst case data of X axis positioning was recorded in the report.

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier.

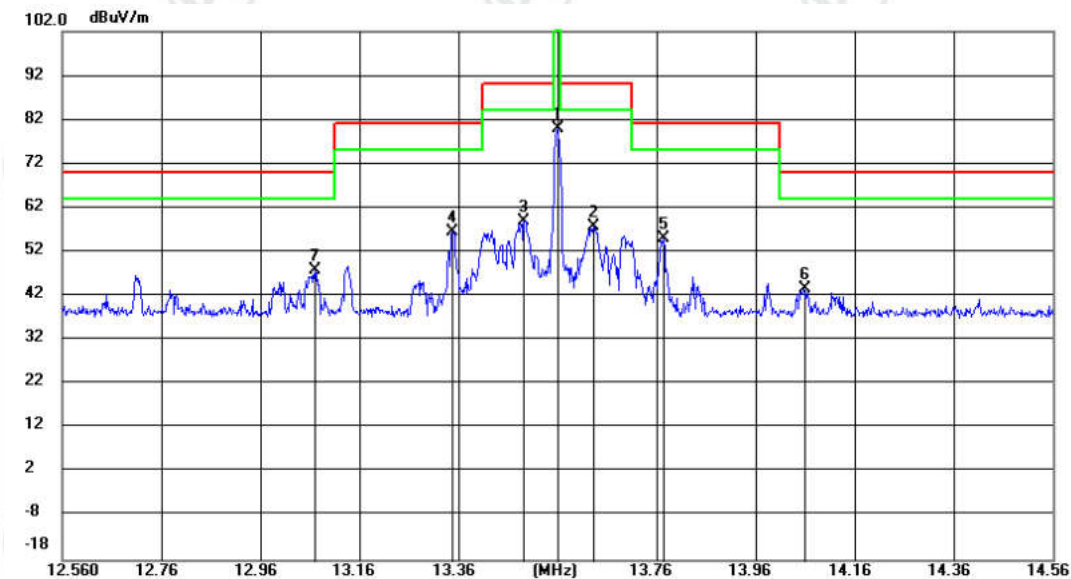
The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

Antenna 3 Measurement Data:



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	Level	Factor	ment			Height	Degree	
			dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		13.5600	59.50	20.35	79.85	124.00	-44.15	peak		
2		13.6330	37.44	20.35	57.79	90.00	-32.21	peak		
3		13.4920	38.68	20.35	59.03	90.00	-30.97	peak		
4		13.3480	36.31	20.35	56.66	81.00	-24.34	peak		
5		13.7740	34.77	20.35	55.12	81.00	-25.88	peak		
6		14.0590	23.26	20.34	43.60	70.00	-26.40	peak		
7	*	13.0700	27.55	20.35	47.90	70.00	-22.10	peak		

Remark:

Only the worst case data of X axis positioning was recorded in the report.

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier.

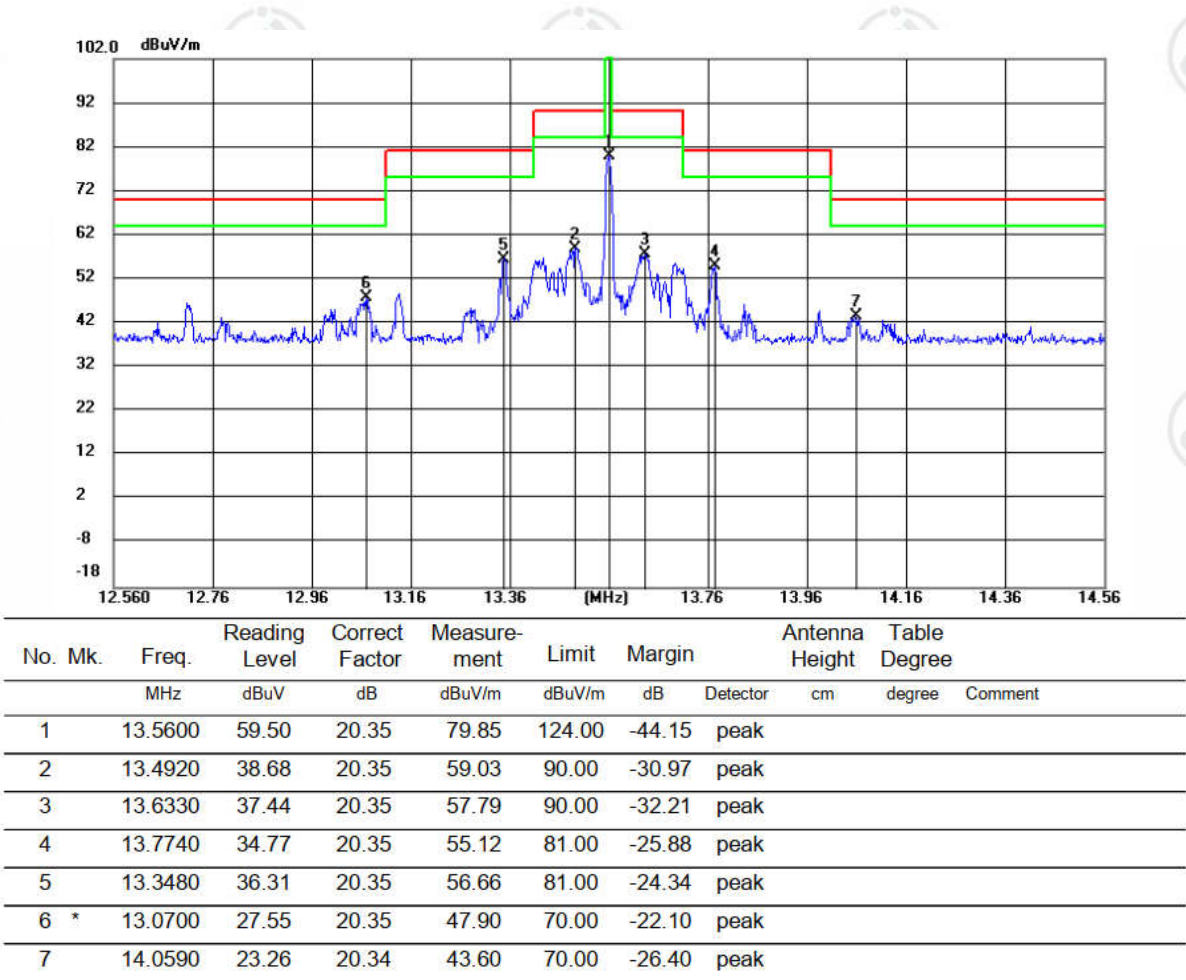
The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

Antenna 4 Measurement Data:



Remark:

Only the worst case data of X axis positioning was recorded in the report.

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier.

The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

6.3 Radiated Emissions

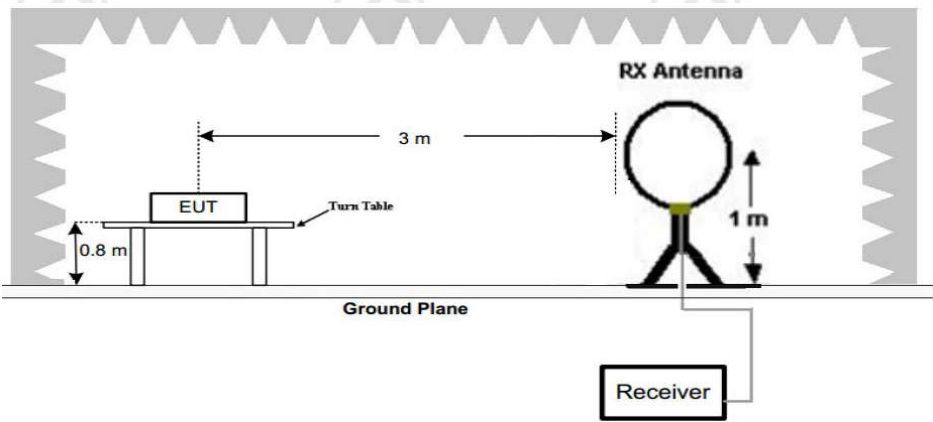
Test Requirement:	47 CFR Part 15C Section 15.209 and 15.225(d),				
Test Method:	ANSI C63.10: 2013				
Test Site:	3m (Semi-Anechoic Chamber)				
Receiver Setup:	Frequency	Detector	RBW	VBW	Remark
	0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
	0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
	0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
	0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
	0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	30MHz-1GHz	Peak	100 kHz	300kHz	Peak
Limit:	Frequency	Field strength (microvolt/meter)	Limit (dBuV/m) @ 3 m	Remark	
	0.009MHz-0.490MHz	2400/F(kHz) @300m	128.5-93.8	Quasi-peak	
	0.490MHz-1.705MHz	24000/F(kHz) @30m	73.8-63	Quasi-peak	
	1.705MHz-30MHz	30 @30m	70	Quasi-peak	
	30MHz-88MHz	100 @3m	40.0	Quasi-peak	
	88MHz-216MHz	150 @3m	43.5	Quasi-peak	
	216MHz-960MHz	200 @3m	46.0	Quasi-peak	
	960MHz-1GHz	500 @3m	54.0	Quasi-peak	
Note: Where the limits have been defined at one distance, and a signal level measured at another, the limits have been extrapolated using the following formula: Extrapolation(dB)=40log ₁₀ (Measurement Distance/Specification Distance)					
Test Setup:					

Figure 1. Below 30MHz

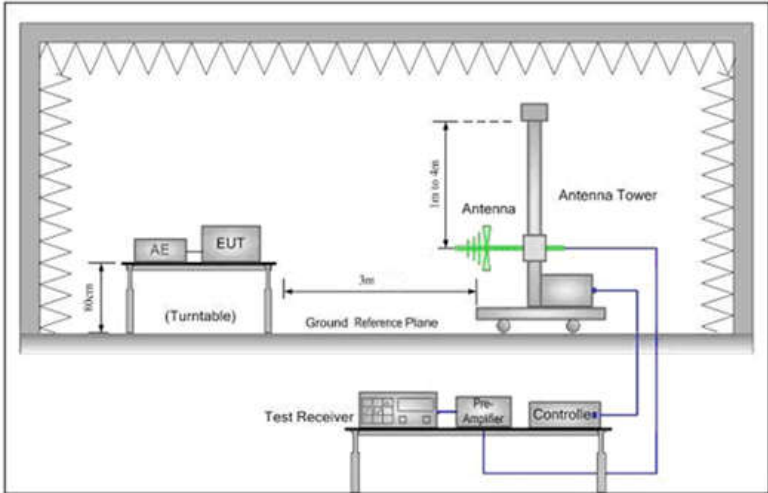


Figure 2. 30MHz to 1GHz

Test Procedure:

- 5. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- 6. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- 7. 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.
- 8. 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 (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable 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.
- 7. The radiation measurements are performed in X, Y, Z axis positioning. And found the X axis positioning which it is worse case, only the test worst case mode is recorded in the report.

Test Mode:

Transmitting with ASK modulation.

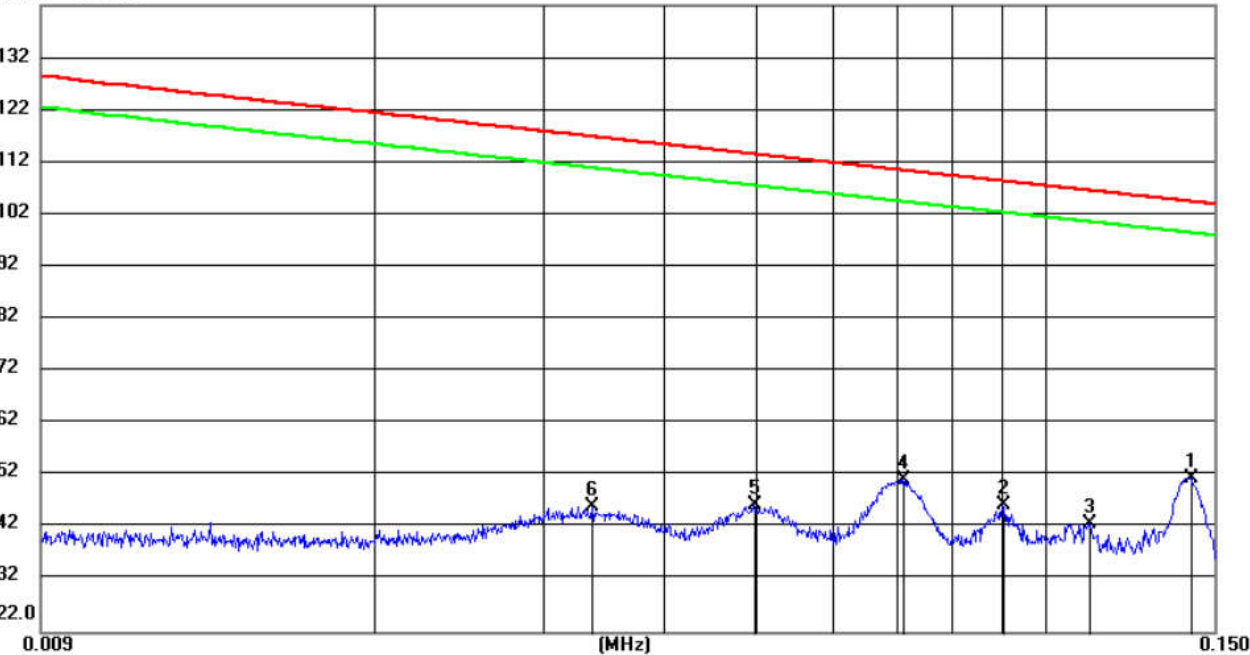
Test Result:

Pass

Antenna 1 Measurement Data

9kHz – 150kHz:

142.0 dBuV/m



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	dBuV	Factor	ment			Height	Degree	Comment
1	*	0.1416	31.05	20.56	51.61	104.52	-52.91	peak	100	317
2		0.0902	25.82	20.61	46.43	108.41	-61.98	peak	100	7
3		0.1113	22.44	20.55	42.99	106.59	-63.60	peak	100	7
4		0.0710	30.71	20.64	51.35	110.48	-59.13	peak	100	317
5		0.0497	25.77	20.72	46.49	113.55	-67.06	peak	100	7
6		0.0337	25.38	20.76	46.14	116.91	-70.77	peak	100	327

Remark:

Only the worst case data of X axis positioning was recorded in the report.

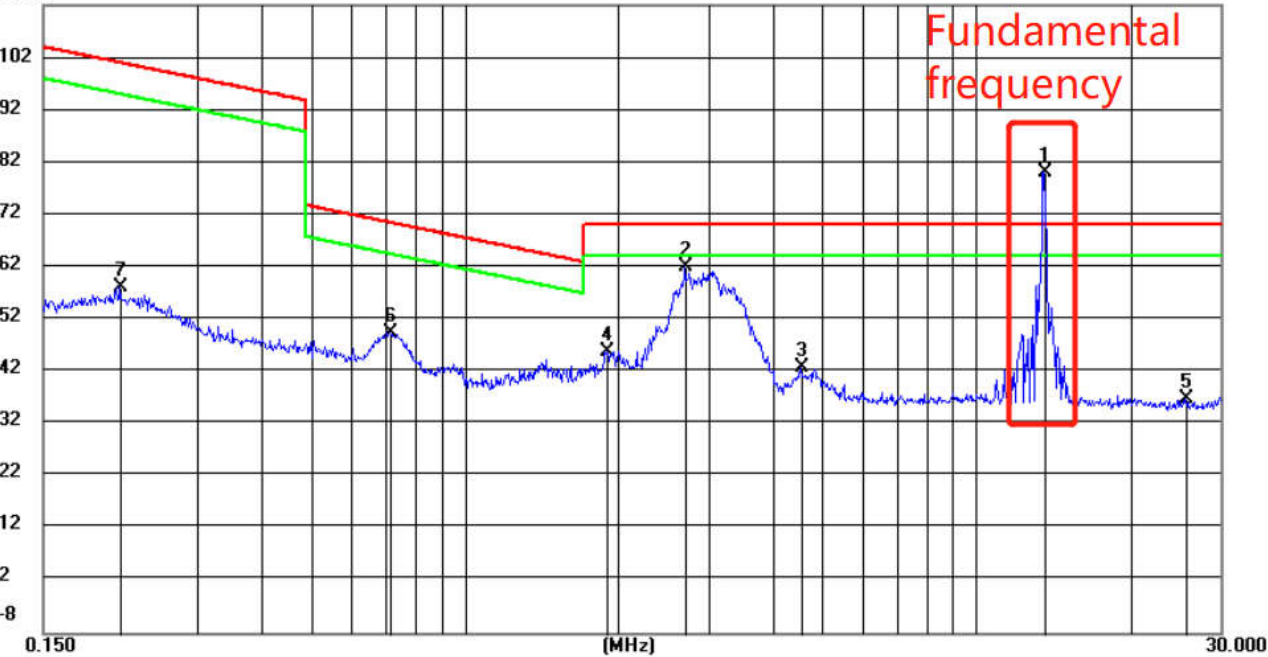
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

150kHz-30MHz:
112.0 dBuV/m



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	dBuV	Factor	ment			Height	Degree	
				dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1	*	13.5580	59.79	20.35	80.14	70.00	10.14	peak		
2		2.6996	41.77	20.37	62.14	70.00	-7.86	peak		
3		4.5265	22.33	20.38	42.71	70.00	-27.29	peak		
4		1.8979	25.55	20.39	45.94	70.00	-24.06	peak		
5		25.6251	16.37	20.42	36.79	70.00	-33.21	peak		
6		0.7157	28.93	20.43	49.36	70.52	-21.16	peak		
7		0.2121	37.74	20.54	58.28	101.03	-42.75	peak		

Remark:

Only the worst case data of X axis positioning was recorded in the report.

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

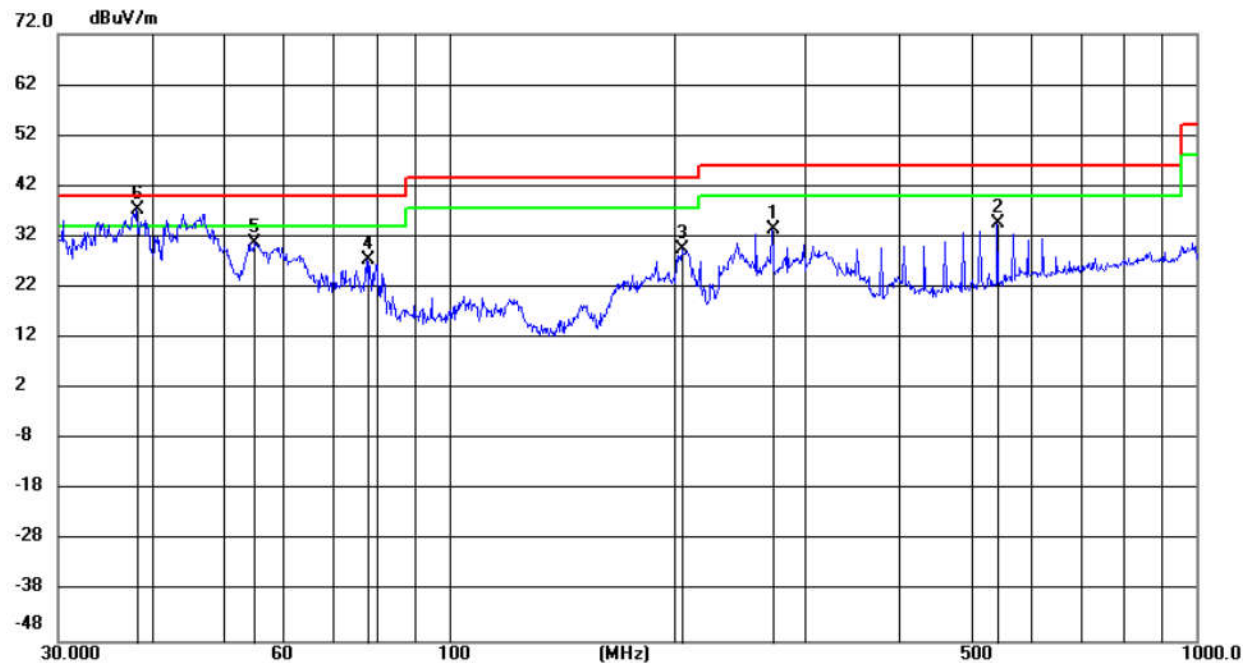
Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

30MHz-1GHz

Horizontal



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		271.2294	17.10	16.25	33.35	46.00	-12.65	peak	199	251
2		542.4176	12.10	22.60	34.70	46.00	-11.30	peak	100	54
3		205.1348	15.57	13.95	29.52	43.50	-13.98	peak	199	283
4		77.8380	17.66	9.85	27.51	40.00	-12.49	peak	199	219
5		54.9503	16.88	13.92	30.80	40.00	-9.20	peak	100	246
6	*	38.3126	23.17	14.23	37.40	40.00	-2.60	peak	199	283

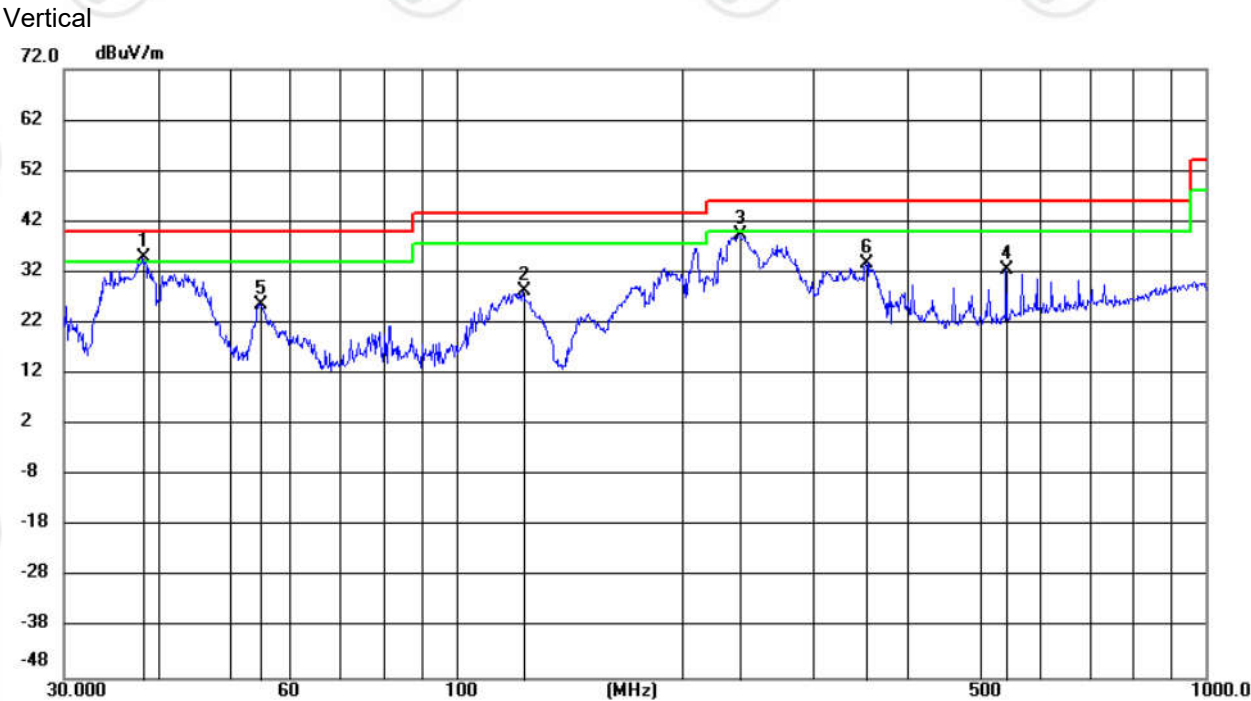
Remark:

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin	Antenna Height	Table Degree
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree
1	*	38.3194	20.77	14.23	35.00	40.00	-5.00	peak	262
2		123.2438	17.65	10.72	28.37	43.50	-15.13	peak	262
3		239.1473	24.18	15.14	39.32	46.00	-6.68	peak	262
4		542.4176	9.96	22.60	32.56	46.00	-13.44	peak	70
5		54.6812	11.70	13.95	25.65	40.00	-14.35	peak	240
6		352.5723	15.50	18.38	33.88	46.00	-12.12	peak	262

Remark:

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

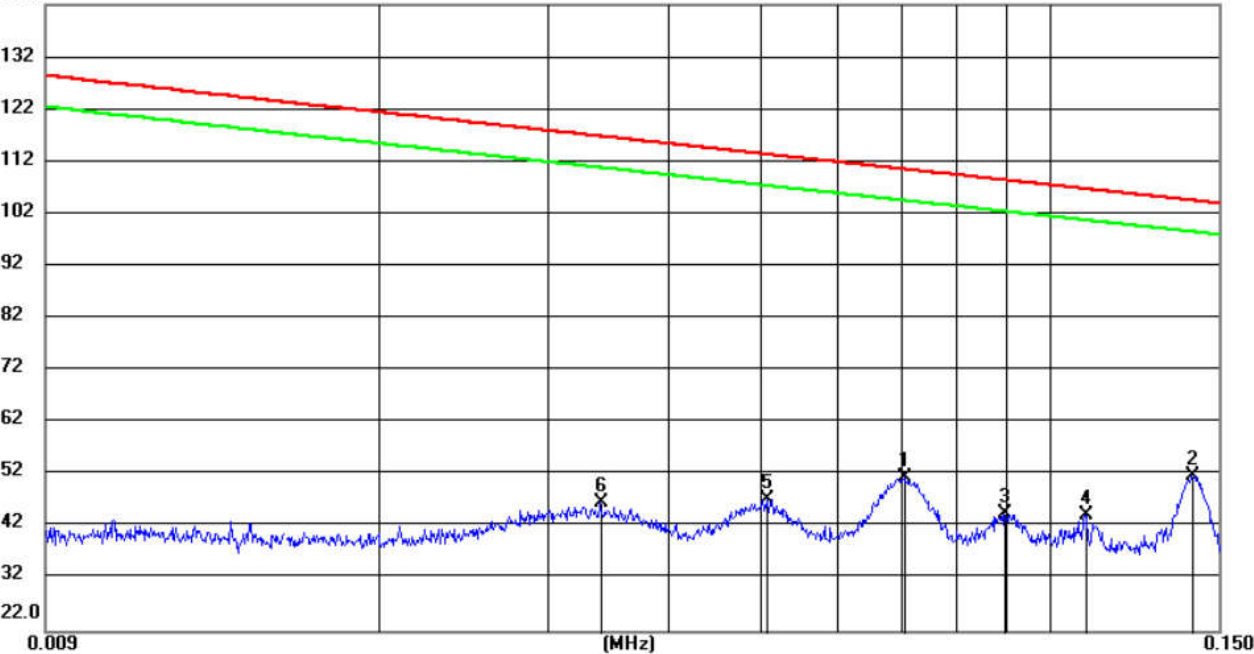
Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

Antenna 2 Measurement Data

9kHz – 150kHz:
142.0 dBuV/m



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		0.0707	30.80	20.64	51.44	110.51	-59.07	peak	100	299
2	*	0.1409	31.37	20.56	51.93	104.56	-52.63	peak	100	299
3		0.0897	24.01	20.61	44.62	108.46	-63.84	peak	100	352
4		0.1089	23.90	20.54	44.44	106.78	-62.34	peak	100	352
5		0.0507	26.59	20.72	47.31	113.38	-66.07	peak	100	352
6		0.0341	26.12	20.76	46.88	116.81	-69.93	peak	100	288

Remark:

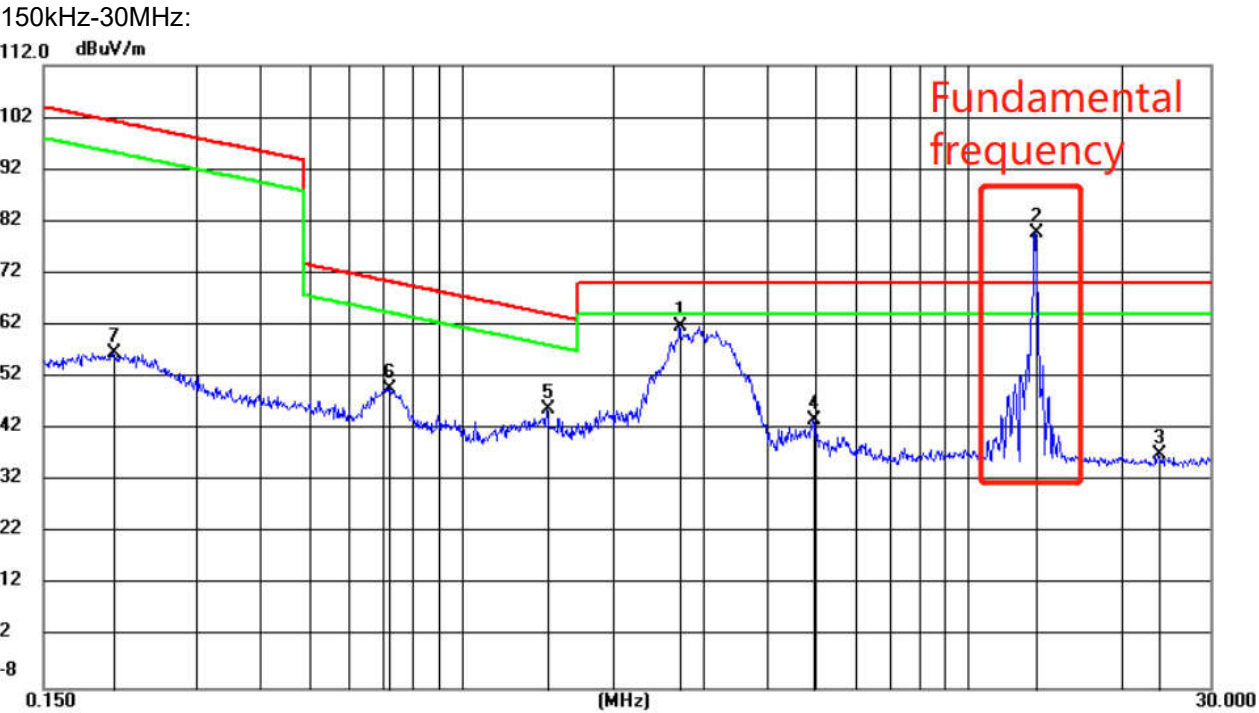
Only the worst case data of X axis positioning was recorded in the report.

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		2.6989	41.53	20.37	61.90	70.00	-8.10	peak		
2	*	13.5652	59.51	20.35	79.86	70.00	9.86	peak		
3		23.7238	16.76	20.40	37.16	70.00	-32.84	peak		
4		4.9413	23.43	20.39	43.82	70.00	-26.18	peak		
5		1.4756	25.32	20.40	45.72	64.25	-18.53	peak		
6		0.7165	29.33	20.43	49.76	70.51	-20.75	peak		
7		0.2058	36.18	20.54	56.72	101.29	-44.57	peak		

Remark:

Only the worst case data of X axis positioning was recorded in the report.

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

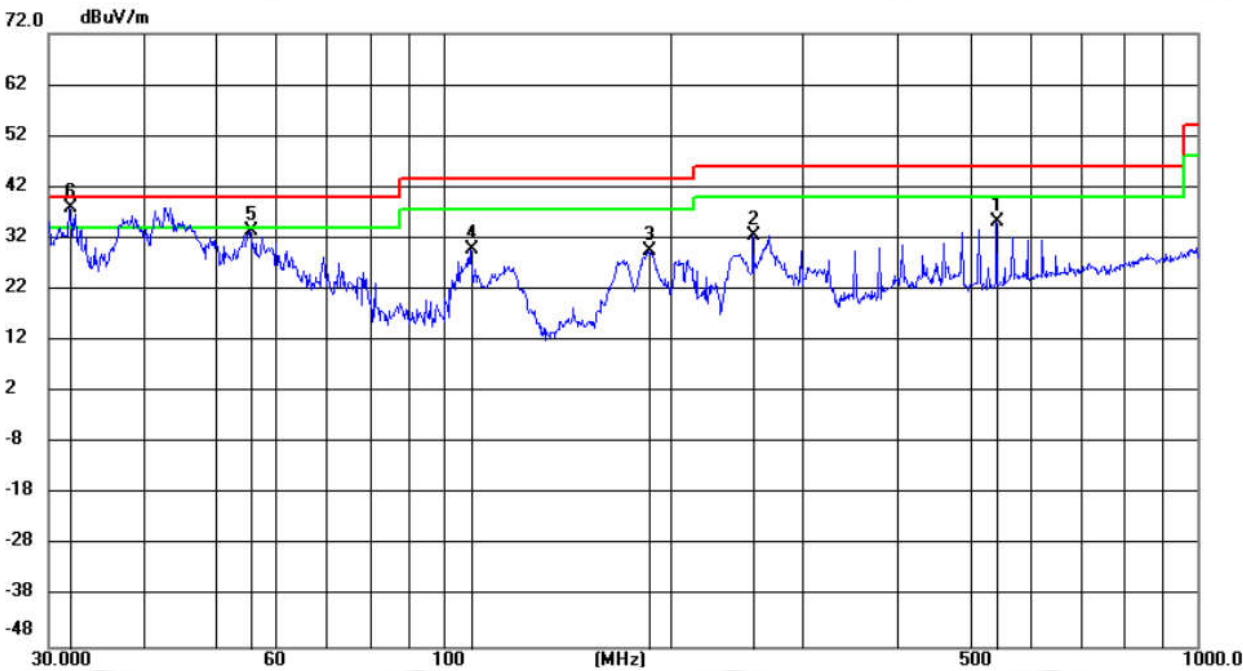
Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

30MHz-1GHz

Horizontal



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	Level	Factor	ment			Height	Degree	
			dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		542.4176	12.59	22.60	35.19	46.00	-10.81	peak	100	54
2		257.6479	16.81	15.78	32.59	46.00	-13.41	peak	199	81
3		187.7200	17.87	11.64	29.51	43.50	-13.99	peak	100	309
4		108.8949	17.15	12.78	29.93	43.50	-13.57	peak	100	288
5		55.5119	19.52	13.88	33.40	40.00	-6.60	peak	100	267
6	*	32.0500	24.90	13.12	38.02	40.00	-1.98	peak	100	320

Remark:

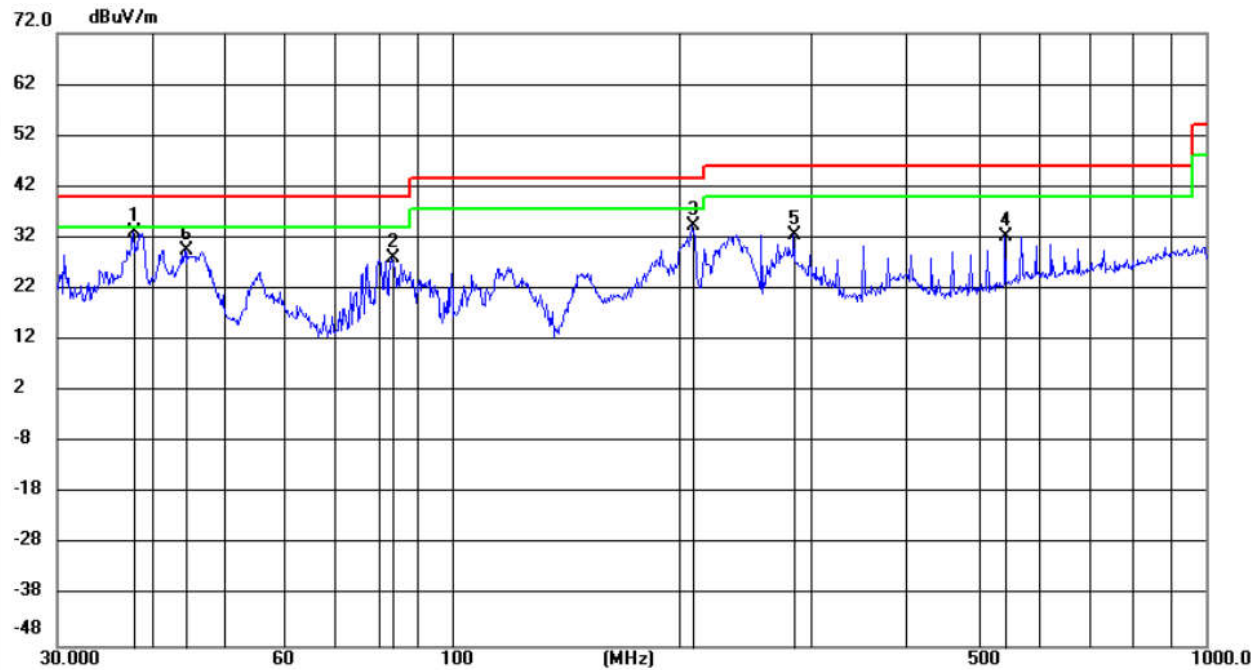
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

Vertical



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1	*	37.9383	18.86	14.16	33.02	40.00	-6.98	peak	200	331
2		83.4051	17.22	10.78	28.00	40.00	-12.00	peak	200	331
3		208.7998	20.20	14.09	34.29	43.50	-9.21	peak	200	342
4		542.4176	9.62	22.60	32.22	46.00	-13.78	peak	100	71
5		284.7769	15.97	16.72	32.69	46.00	-13.31	peak	100	71
6		44.3373	15.24	14.42	29.66	40.00	-10.34	peak	200	352

Remark:

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

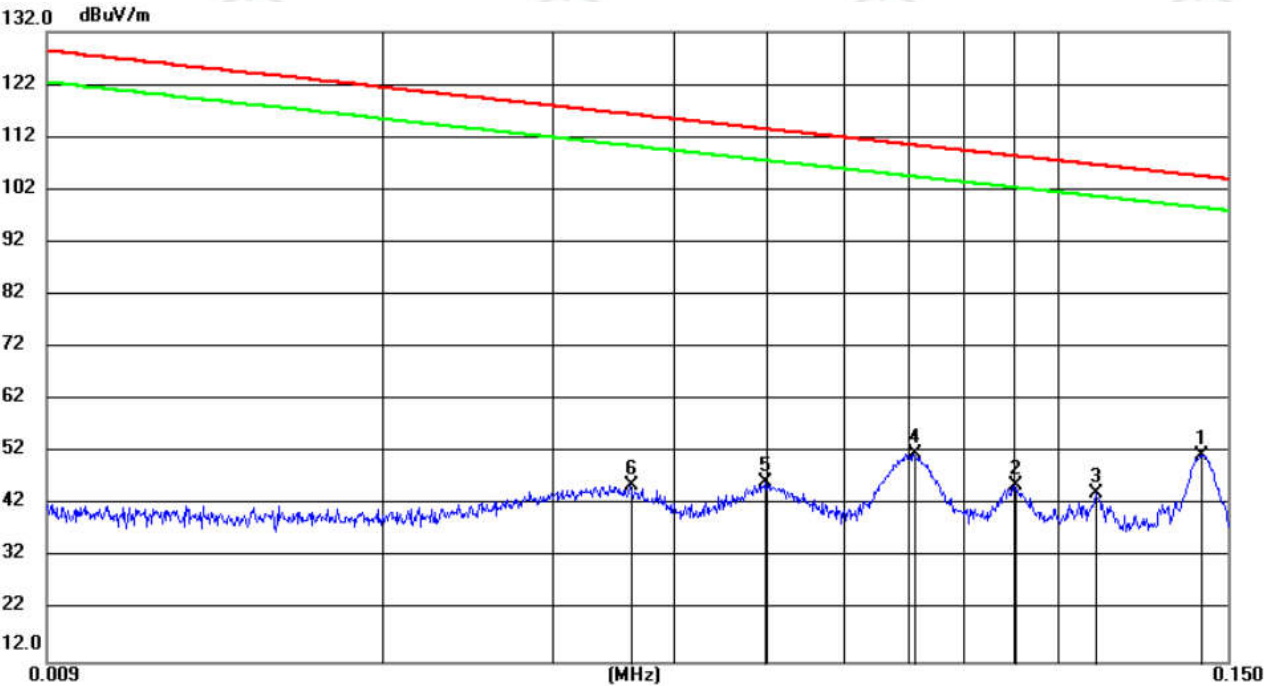
Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

Antenna 3 Measurement Data

9kHz – 150kHz:



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	Level	Factor	ment			Height	Degree	Comment
			dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	
1	*	0.1409	31.00	20.56	51.56	104.56	-53.00	peak	100	314
2		0.0902	25.11	20.61	45.72	108.41	-62.69	peak	100	7
3		0.1096	23.62	20.54	44.16	106.73	-62.57	peak	100	360
4		0.0711	31.11	20.64	51.75	110.46	-58.71	peak	100	314
5		0.0498	25.58	20.72	46.30	113.54	-67.24	peak	100	360
6		0.0362	24.90	20.76	45.66	116.29	-70.63	peak	100	336

Remark:

Only the worst case data of X axis positioning was recorded in the report.

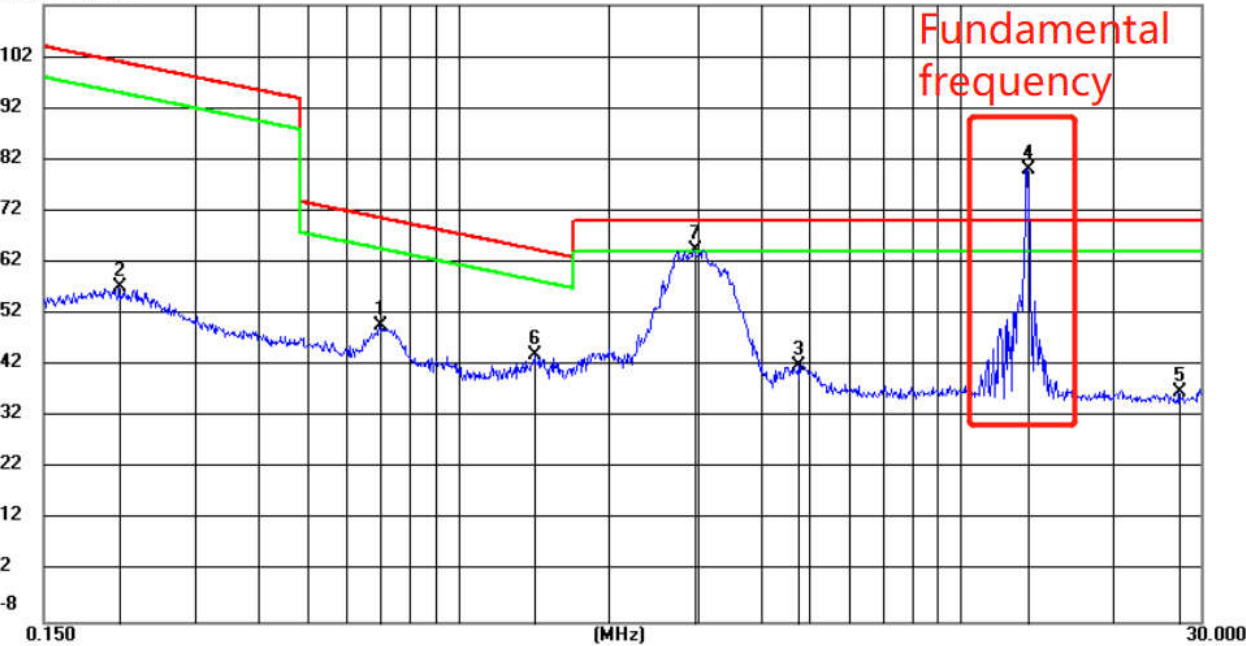
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

150kHz-30MHz:
112.0 dBuV/m



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		0.7007	29.20	20.43	49.63	70.70	-21.07	peak	100	50
2		0.2121	36.59	20.54	57.13	101.03	-43.90	peak	100	317
3		4.7665	21.63	20.39	42.02	70.00	-27.98	peak	100	264
4	*	13.5580	59.80	20.35	80.15	70.00	10.15	peak	100	82
5		27.1701	16.36	20.41	36.77	70.00	-33.23	peak	100	103
6		1.4211	23.68	20.40	44.08	64.58	-20.50	peak	100	82
7	!	2.9485	44.06	20.36	64.42	70.00	-5.58	peak	100	125

Remark:

Only the worst case data of X axis positioning was recorded in the report.

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

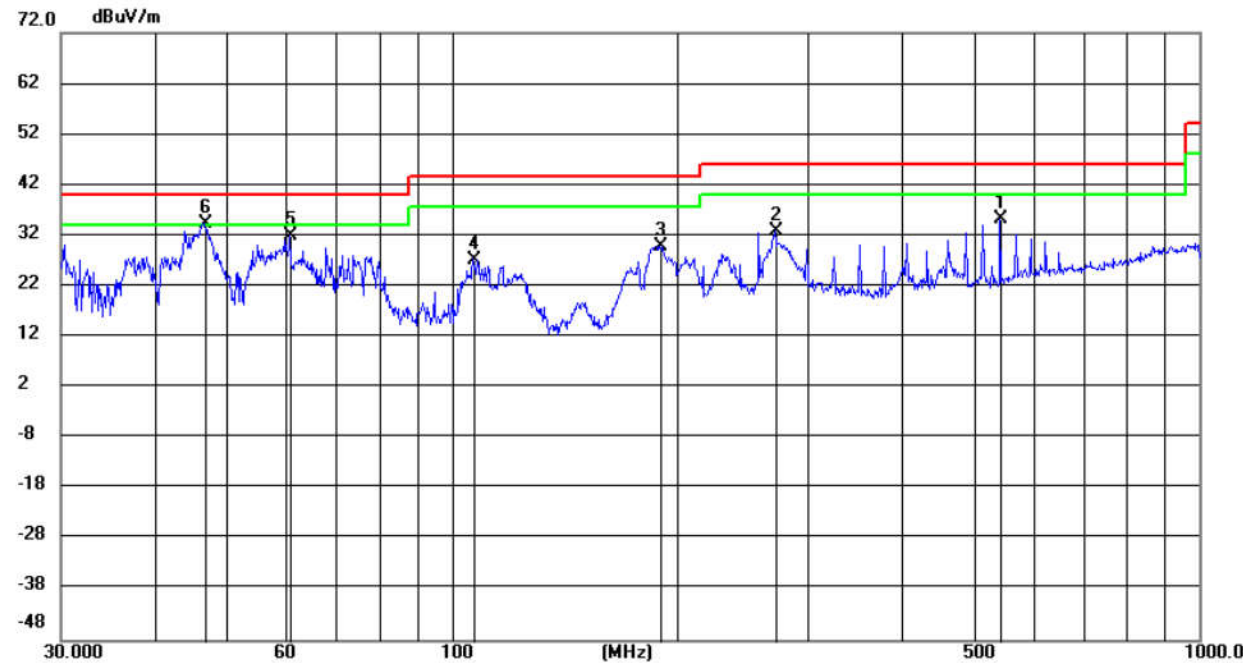
Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

30MHz-1GHz

Horizontal



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	Level	Factor	ment			Height	Degree	
			dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		542.4176	12.52	22.60	35.12	46.00	-10.88	peak	100	54
2		271.1818	16.69	16.25	32.94	46.00	-13.06	peak	100	0
3		190.0048	18.16	11.74	29.90	43.50	-13.60	peak	100	0
4		107.0961	14.27	13.03	27.30	43.50	-16.20	peak	100	12
5		60.7150	18.50	13.32	31.82	40.00	-8.18	peak	200	7
6	*	46.8220	20.09	14.36	34.45	40.00	-5.55	peak	100	0

Remark:

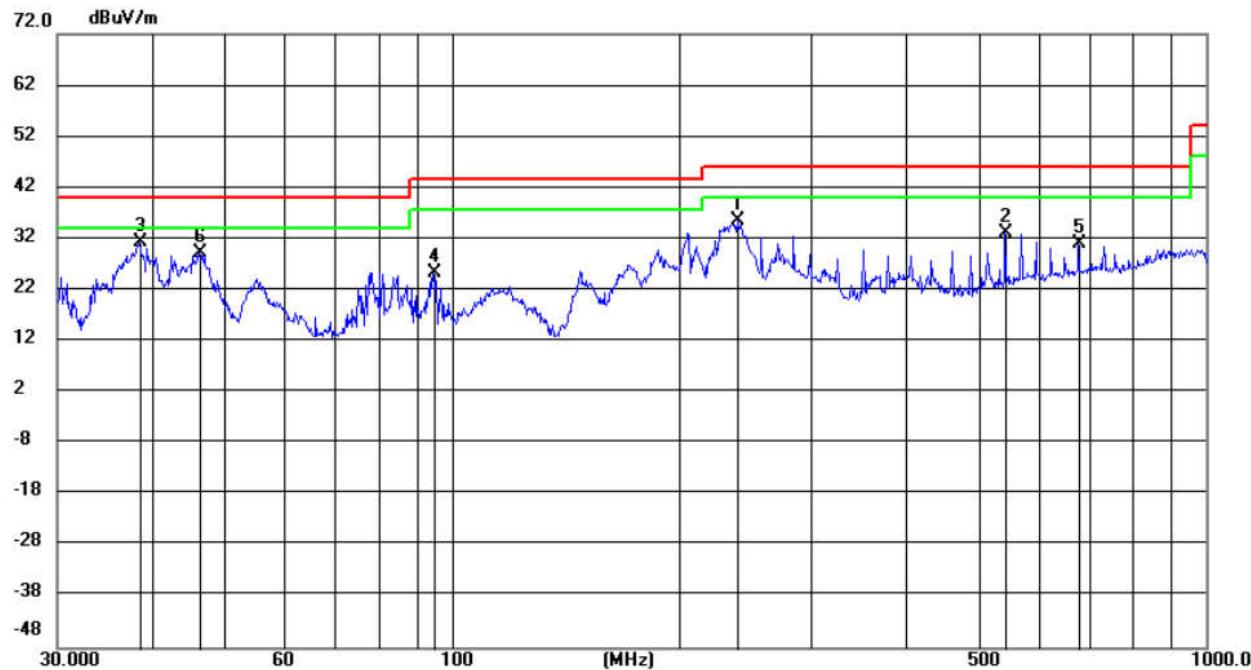
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

Vertical



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	Level	Factor	ment			Height	Degree	
			dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		239.5250	20.28	15.15	35.43	46.00	-10.57	peak	200	66
2		542.4176	10.45	22.60	33.05	46.00	-12.95	peak	100	60
3	*	38.5282	16.98	14.26	31.24	40.00	-8.76	peak	200	12
4		94.6439	12.16	13.31	25.47	43.50	-18.03	peak	200	0
5		678.0552	6.53	24.59	31.12	46.00	-14.88	peak	100	241
6		46.2834	14.85	14.37	29.22	40.00	-10.78	peak	200	2

Remark:

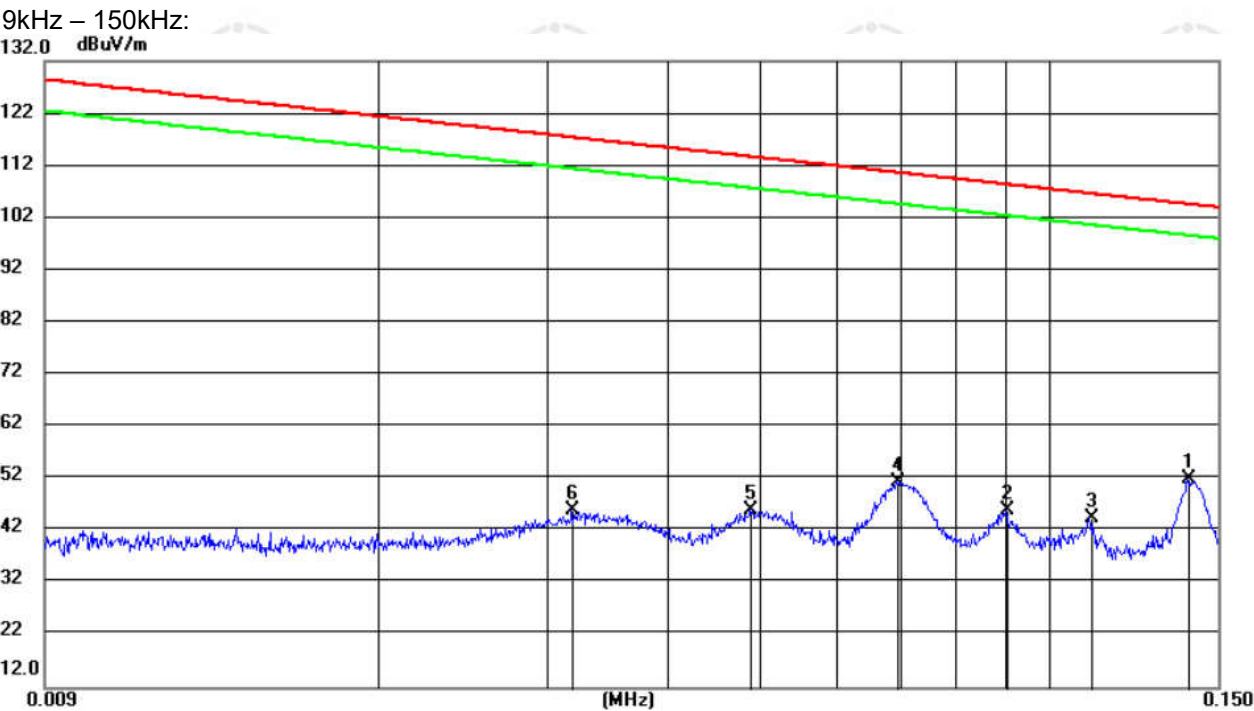
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

Antenna 4 Measurement Data



Remark:

Only the worst case data of X axis positioning was recorded in the report.

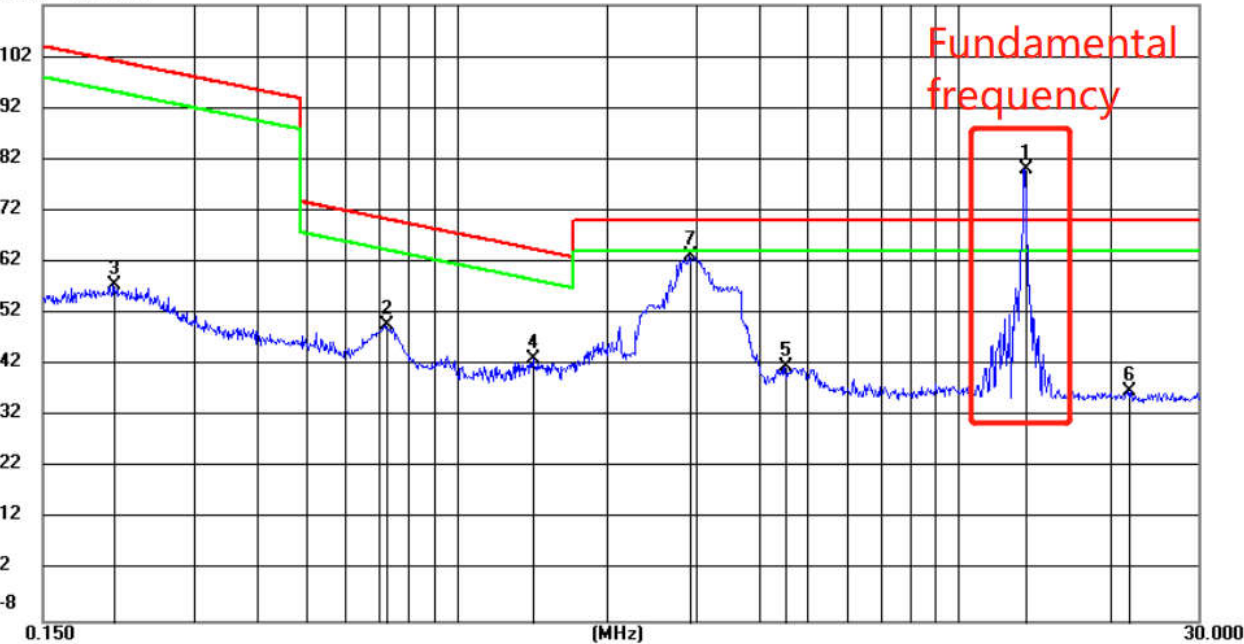
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

150kHz-30MHz:
112.0 dBuV/m



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna Height cm	Table Degree	Comment
1	*	13.5616	59.76	20.35	80.11	70.00	10.11	peak	100	84	
2		0.7263	29.28	20.43	49.71	70.39	-20.68	peak	100	245	
3		0.2080	37.15	20.54	57.69	101.20	-43.51	peak	100	320	
4		1.4185	22.70	20.40	43.10	64.59	-21.49	peak	100	234	
5		4.5050	21.33	20.38	41.71	70.00	-28.29	peak	100	320	
6		21.7380	16.52	20.36	36.88	70.00	-33.12	peak	100	95	
7		2.9036	42.80	20.36	63.16	70.00	-6.84	peak	100	245	

Remark:

Only the worst case data of X axis positioning was recorded in the report.

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

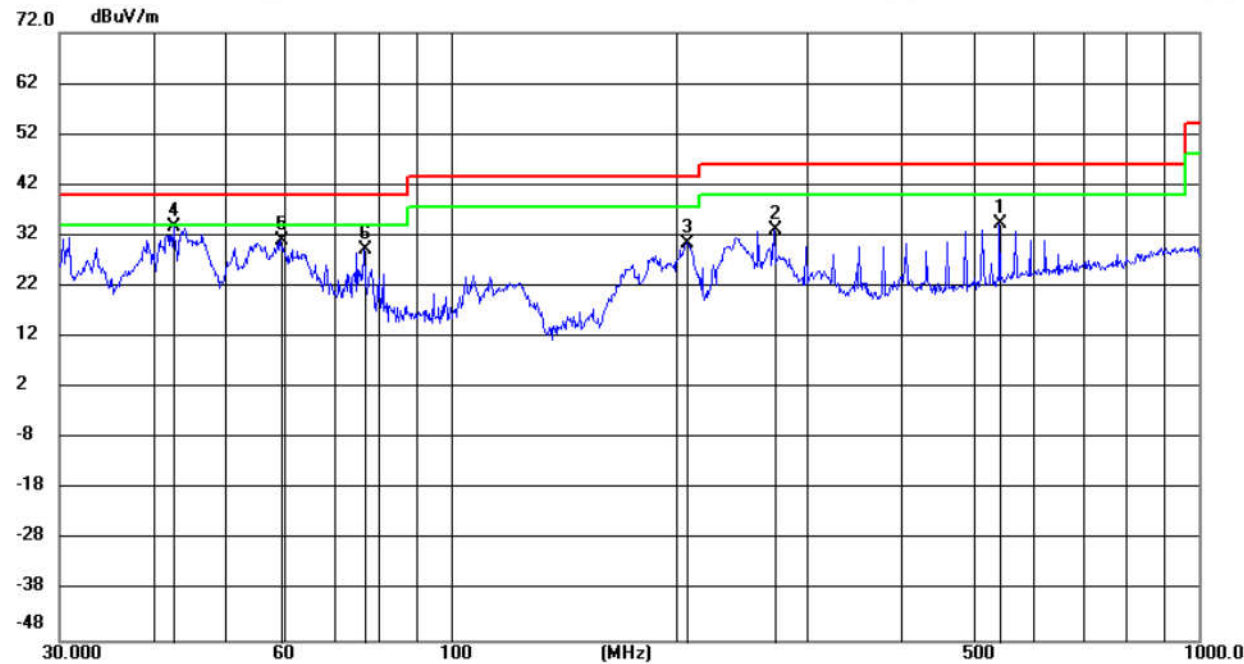
Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

30MHz-1GHz

Horizontal



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	Level	Factor	ment			Height	Degree	
			dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		542.4176	11.77	22.60	34.37	46.00	-11.63	peak	100	44
2		271.1818	16.83	16.25	33.08	46.00	-12.92	peak	200	71
3		207.0862	16.52	14.03	30.55	43.50	-12.95	peak	200	348
4	*	42.6971	19.40	14.46	33.86	40.00	-6.14	peak	200	348
5		59.4196	17.42	13.61	31.03	40.00	-8.97	peak	200	348
6		76.6194	19.47	9.89	29.36	40.00	-10.64	peak	200	348

Remark:

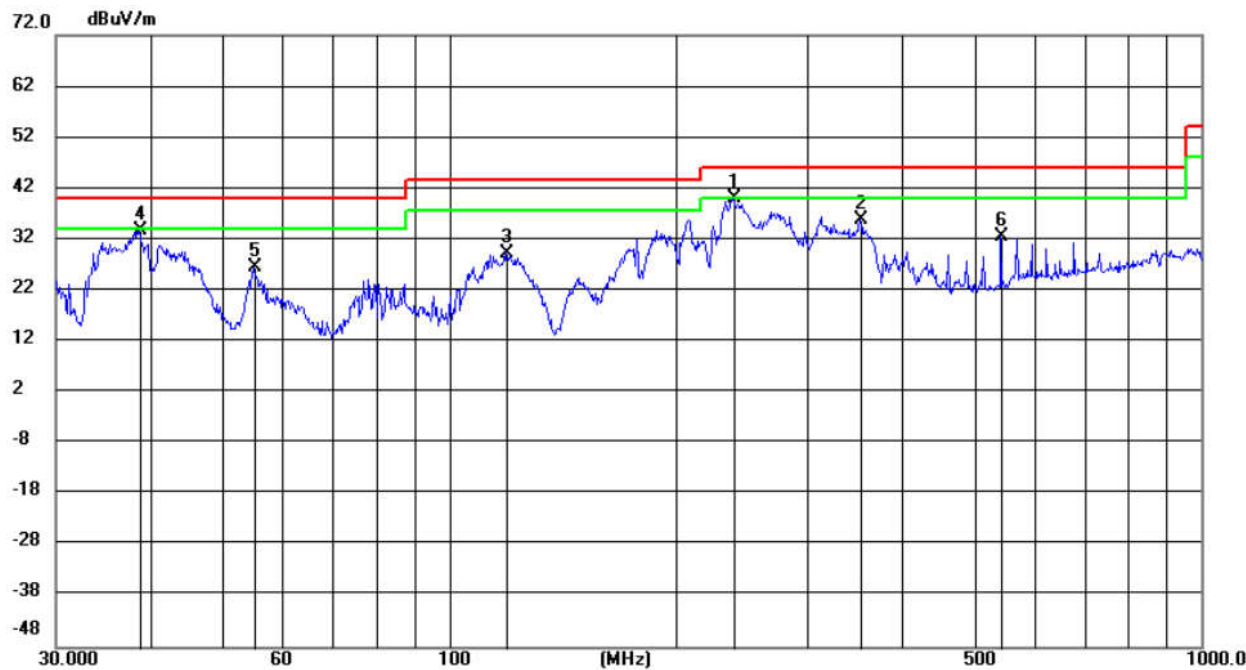
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

Vertical



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table
		MHz	Level	Factor	ment			Height	Degree
			dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree
1	*	238.6447	24.82	15.12	39.94	46.00	-6.06	peak	264
2		352.5723	17.54	18.38	35.92	46.00	-10.08	peak	296
3		119.0180	18.00	11.40	29.40	43.50	-14.10	peak	274
4		38.7518	19.47	14.31	33.78	40.00	-6.22	peak	274
5		55.0757	12.54	13.91	26.45	40.00	-13.55	peak	264
6		542.4176	9.91	22.60	32.51	46.00	-13.49	peak	71

Remark:

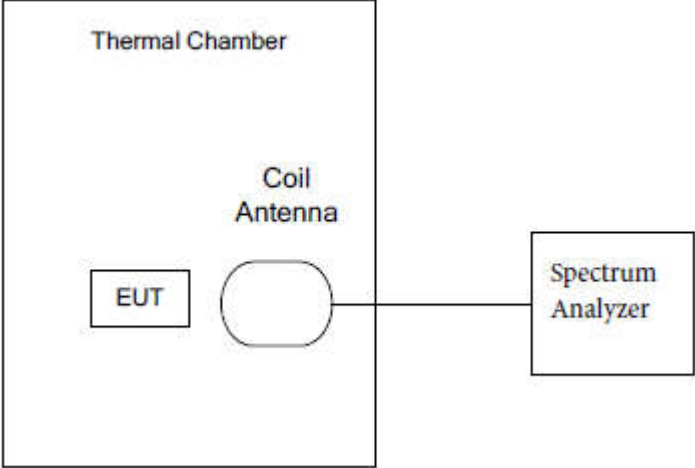
The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Factor= Antenna Factor + Cable Factor – Preamplifier Factor,

Level = Read Level + Factor,

Over Limit=Level-Limit Line.

6.4 Frequency Stability

Test Requirement:	47 CFR Part 15 C Section 15.225(e)
Test Method:	ANSI C63.10: 2013
Test Setup:	 The diagram illustrates the test setup. A large rectangular box labeled 'Thermal Chamber' contains two components: a smaller box labeled 'EUT' (Equipment Under Test) and a circle labeled 'Coil Antenna'. A line connects the 'Coil Antenna' to a box labeled 'Spectrum Analyzer' located outside the thermal chamber.
Frequency Range:	Operation within the band 13.110-14.010 MHz
Requirements:	The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20 degrees to $+50$ degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.
Method of Measurement:	The EUT was placed in an environmental test chamber and powered such that control element received normal voltage and the transmitter provided maximum RF output.
Test Result:	The unit does meet the FCC Part 15 C Section 15.225(e) requirements.

Antenna 1 Measurement Data:

Test Frequency: 13.56MHz			Temperature:20°C	
Supply Voltage (V) DC	Test Result (MHz)	Deviation (kHz)	Limit ±0.01% (kHz)	Result
24.0	13.55955	-0.45	1.3560	Pass
20.4	13.55959	-0.41	1.3560	Pass
27.6	13.55951	-0.49	1.3560	Pass

Test Frequency: 13.56MHz			Normal Voltage:24.0Vdc	
Temperature (°C)	Test Result (MHz)	Deviation (kHz)	Limit ±0.01% (kHz)	Result
-20	13.55953	-0.47	1.3560	Pass
-10	13.55954	-0.46	1.3560	
0	13.55952	-0.48	1.3560	
10	13.55959	-0.41	1.3560	
20	13.55957	-0.43	1.3560	
30	13.55959	-0.41	1.3560	
40	13.55952	-0.48	1.3560	
50	13.55958	-0.42	1.3560	

Note: Deviation (kHz) = (Test Result-13.56MHz)*1000

Antenna 2 Measurement Data:

Test Frequency: 13.56MHz			Temperature:20°C	
Supply Voltage (V) DC	Test Result (MHz)	Deviation (kHz)	Limit ±0.01% (kHz)	Result
24.0	13.55958	-0.42	13.55958	Pass
20.4	13.55953	-0.47	13.55953	Pass
27.6	13.55952	-0.48	13.55952	Pass

Test Frequency: 13.56MHz			Normal Voltage:24.0Vdc	
Temperature (°C)	Test Result (MHz)	Deviation (kHz)	Limit ±0.01% (kHz)	Result
-20	13.55956	-0.44	1.3560	Pass
-10	13.55958	-0.42	1.3560	
0	13.55952	-0.48	1.3560	
10	13.55958	-0.42	1.3560	
20	13.55958	-0.42	1.3560	
30	13.55958	-0.42	1.3560	
40	13.55960	-0.40	1.3560	
50	13.55950	-0.50	1.3560	

Note: Deviation (kHz) = (Test Result-13.56MHz)*1000

Antenna 3 Measurement Data:

Test Frequency: 13.56MHz			Temperature:20°C	
Supply Voltage (V) DC	Test Result (MHz)	Deviation (kHz)	Limit ±0.01% (kHz)	Result
24.0	13.55953	-0.47	1.3560	Pass
20.4	13.55951	-0.49	1.3560	Pass
27.6	13.55952	-0.48	1.3560	Pass

Test Frequency: 13.56MHz			Normal Voltage:24.0Vdc	
Temperature (°C)	Test Result (MHz)	Deviation (kHz)	Limit ±0.01% (kHz)	Result
-20	13.55954	-0.46	1.3560	Pass
-10	13.55954	-0.46	1.3560	
0	13.55953	-0.47	1.3560	
10	13.55954	-0.46	1.3560	
20	13.55955	-0.45	1.3560	
30	13.55952	-0.48	1.3560	
40	13.55960	-0.40	1.3560	
50	13.55959	-0.41	1.3560	

Note: Deviation (kHz) = (Test Result-13.56MHz)*1000

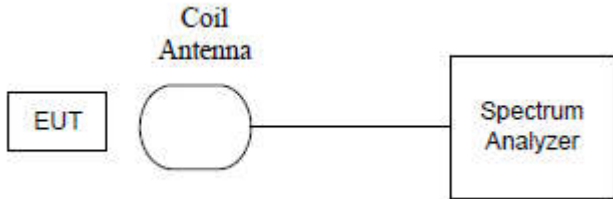
Antenna 4 Measurement Data:

Test Frequency: 13.56MHz			Temperature:20°C	
Supply Voltage (V) DC	Test Result (MHz)	Deviation (kHz)	Limit ±0.01% (kHz)	Result
24.0	13.55956	-0.44	1.3560	Pass
20.4	13.55957	-0.43	1.3560	Pass
27.6	13.55953	-0.47	1.3560	Pass

Test Frequency: 13.56MHz			Normal Voltage:24.0Vdc	
Temperature (°C)	Test Result (MHz)	Deviation (kHz)	Limit ±0.01% (kHz)	Result
-20	13.55953	-0.47	1.3560	Pass
-10	13.55955	-0.45	1.3560	
0	13.55957	-0.43	1.3560	
10	13.55951	-0.49	1.3560	
20	13.55951	-0.49	1.3560	
30	13.55952	-0.48	1.3560	
40	13.55956	-0.44	1.3560	
50	13.55956	-0.44	1.3560	

Note: Deviation (kHz) = (Test Result-13.56MHz)*1000

6.5 20dB Occupied Bandwidth

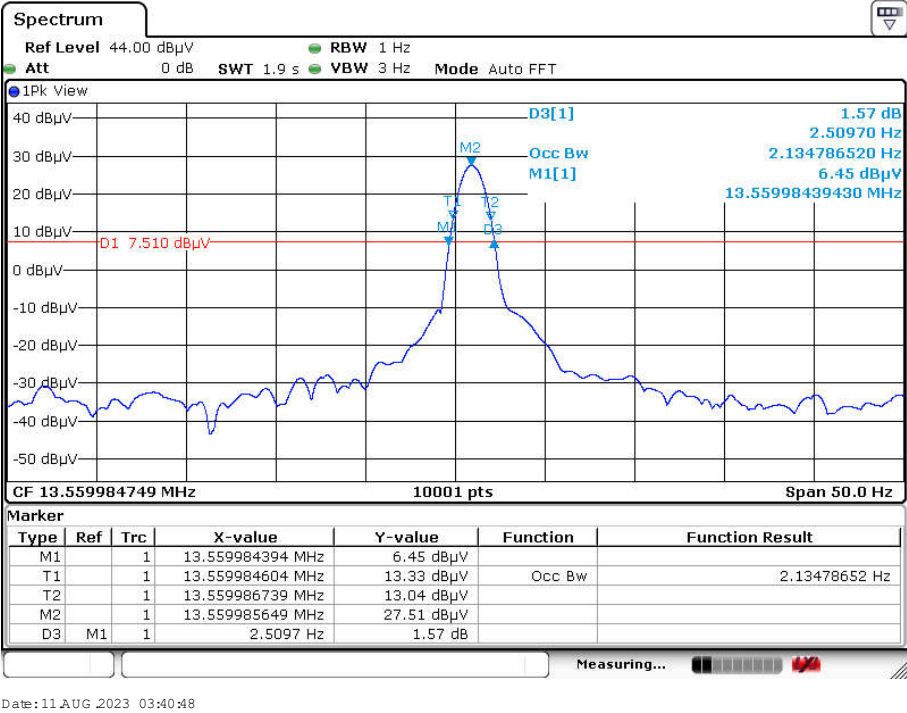
Test Requirement:	47 CFR Part 15 C Section 15.215 (C)
Test Method:	ANSI C63.10: 2013
Test Setup:	 <pre> graph LR EUT[EUT] --- Antenna[Coil Antenna] Antenna --- SA[Spectrum Analyzer] </pre>
Frequency Range:	Operation within the band 13.110 – 14.010 MHz
Requirements:	Intentional radiators operating under 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 20 dB bandwidth of the emission is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the 20 dB bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.
Limit:	For 13.56 MHz the permitted frequency band is 14kHz, so the limit is 11.2 kHz.

Test Data:

Antenna	20dB bandwidth (Hz)	Frequency Left (MHz)	Frequency Right (MHz)	Limit (MHz)	Result
1	2.5097	13.559984394	13.559986904	13.110 – 14.010	Pass
2	2.4848	13.559984464	13.559986949	13.110 – 14.010	Pass
3	2.4998	13.559984464	13.559986964	13.110 – 14.010	Pass
4	2.4998	13.559984509	13.559987009	13.110 – 14.010	Pass

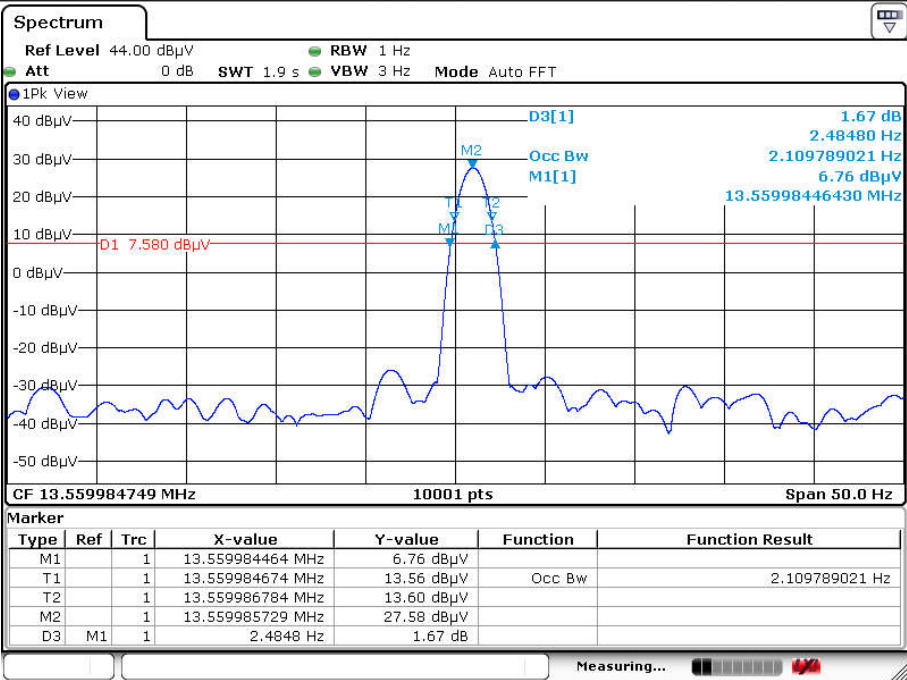
Test plot as follows:

Antenna 1 Measurement Data:



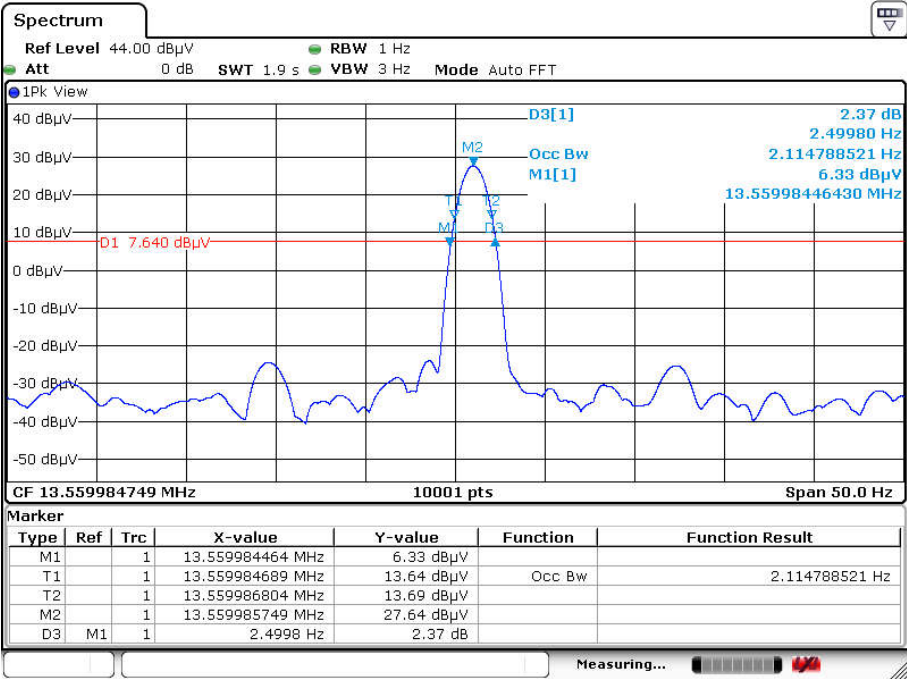
Date:11 AUG 2023 03:40:48

Antenna 2 Measurement Data:



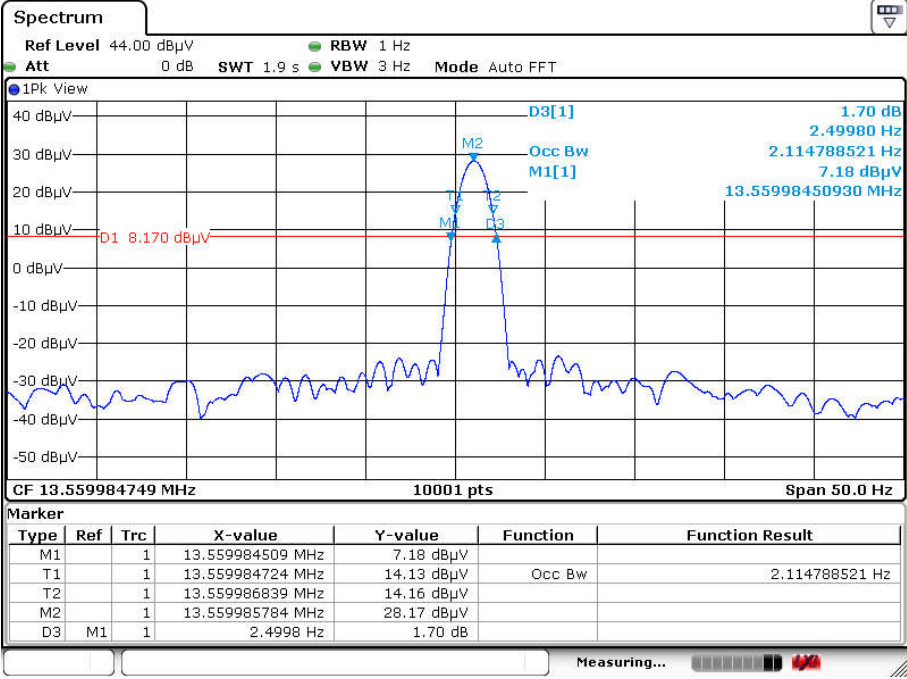
Date:11 AUG 2023 03:42:39

Antenna 3 Measurement Data:



Date:11 AUG 2023 03:43:23

Antenna 4 Measurement Data:



Date:11 AUG 2023 03:44:23