

Test report

Number T251-0659/22

Project file: C20221443

Date: 2022-12-22

Pages: 36

Product: Wireless charger – Primary Box and Primary Pad

Type reference: EOE18010815, EOE18010851

Ratings: Input: 400 - 480 Vac; 50/60 Hz; 48A
Output: Pairing with WPP
Protection class: I

Trademark:



Applicant: Delta Energy Systems (Germany) GmbH
Tscheulinstrasse 21, DE-79331 Teningen, Germany

Manufacturer: Delta Energy Systems (Germany) GmbH
Tscheulinstrasse 21, DE-79331 Teningen, Germany

Place of manufacture: Delta Energy Systems (Germany) GmbH
Tscheulinstrasse 21, DE-79331 Teningen, Germany

Summary of testing

Testing method: 47 CFR Part 15.225 in conjunction with ANSI C63.10:2013

Testing location: SIQ Ljubljana
Mašera-Spasičeva ulica 10, SI-1000 Ljubljana, Slovenia

Remarks: Date of receipt of test items: 2022-07-15
Number of items tested: 1
Date of performance of tests: 2022-07-20 - 2022-08-03
The test results presented in this report relate only to the items tested.
The product complies with the requirements of the testing methods.

Tested by: Luka Cvajnar

Approved by: Marjan Mak

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1 GENERAL

History sheet			
Date	Report No.	Change	Revision
2022-12-22	T251-0659/22	Initial Test Report issued.	--

Environmental conditions:

Ambient temperature: 15°C to 35°C

Relative humidity: 30% to 60%

Atmospheric pressure: 860 mbar to 1060 mbar

1.1 Equipment under test

Wireless charger – Primary Box and Primary Pad

Type: EOE18010815, EOE18010851

FCC ID: 2AVWKPU30KW

Equipment marking plates

(The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.)


DELTA
 EOE18010815
 CS WPB STD 30KW 3AC
 [WPB 30KW]
 Input: 400V~/50Hz
 480V~/60Hz
 48A 3Ph + PE
 Output: Pairing with WPP
 Protection Class: IP21


 FCC ID :
 2AVWKWPU30KW




 UL 62368-1; UL1564
 CSA C22.2 No 62368-1
 CSA C22.2 No. 107.2
 Made in: CC (Country)
 Rev:XX Date:YYWW S/N:ZZZZZZ
 Delta Energy Systems (Germany) GmbH
 Tscheulinstr. 21 79331 Teningen (Germany)


DELTA
 EOE18010851
 CS WPP STD 30KW
 [WPP 30KW]
 Input: Supplied by WPB
 Output: Pairing with WSU
 Protection Class: IP69


 FCC ID :
 2AVWKWPU30KW




 UL 62368-1; UL1564
 CSA C22.2 No 62368-1
 CSA C22.2 No. 107.2
 Made in: CC (Country)
 Rev:XX Date:YYWW S/N:ZZZZZZ
 Delta Energy Systems (Germany) GmbH
 Tscheulinstr. 21 79331 Teningen (Germany)



1.1.1 General product information

Product	Wireless charger
Type / Model	Primary pad
Supply voltage of transmitter	24 Vdc
Operating frequency	13.56 MHz
Number of channels	1
Antenna type	Rectangular planar antenna
Modulation type	ASK Modulation (100%)
Hardware version	Primary box: 01; Primary pad: 00
Software version	Primary box: V12.99; Primary pad: V7.99

Device is a wireless charger for charging of electrical forklifts. Device consist of Primary Box (EOE18010815) that gets power from the grid and of Primary Pad (EOE18010851) that transfers the energy to secondary pad (EOE18010850).

Energy is transferred in the frequency range 55 – 65 kHz. Communication between primary and secondary pad is at 13.56 MHz.

Test mode	Description
1	Primary pad was activated and waiting for communication with secondary pad
2	Communication between primary pad and secondary pad was established. The secondary pad was set to declared distance to the primary pad.

1.2 Antenna requirements (§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 shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

Conclusion:

PASS; EUT has internal PCB antenna.



1.3 ANSI C63.4 Subpart selection

Subpart C: Intentional Radiators

1.4 Class statement requirements

- The Class B statement offers several suggestions for minimizing interference to radio or TV receivers, including reorienting the receiving antenna and moving the Class B device farther away from the receiver.

1.5 Occupied bandwidth measurement

Fundamental frequency	Minimum resolution bandwidth
9 kHz to 30 MHz	1 kHz
30 to 1000 MHz	10 kHz
1000 MHz to 40 GHz	100 kHz

1.6 Quasi-peak detector

Frequency range	Bandwidth (-6dB)
10 Hz to 20 kHz	Full range (wideband)
10 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz
30 MHz to 1 GHz	120 kHz

1.7 Peak, rms, and average detectors

Frequency range	Bandwidth (-6dB)
10 Hz to 20 kHz	10, 100, 1000 Hz
10 kHz to 150 kHz	1 and 10 kHz
150 kHz to 30 MHz	1 and 10 kHz
30 MHz to 1 GHz	10 and 100 kHz
1 GHz to 40 GHz	0.1, 1.0 and 10 MHz

2 LIMITS

2.1 Subpart C: Intentional Radiators

2.1.1 Section 15.207, Conducted emission limits:

Frequency Range (MHz)	Limits (dBµV)	
	Quasi-peak	Average
0.15 to 0.5	66 – 56*	56 – 46*
0.5 to 5.0	56	46
5.0 to 30.0	60	50

* Decreases with the logarithm of the frequency.

The shown limits in table shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

- For carrier current systems containing their fundamental emission within the frequency band 535-1705 kHz and intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.
- For all other carrier current systems: 1000 µV within the frequency band 535-1705 kHz, as measured using a 50 µH/50 ohms LISN.
- Carrier current systems operating below 30 MHz are also subject to the radiated emission limits as appropriate.

2.1.2 Section 15.209, Radiated emission limits:

Limits:

Frequency Range (MHz)	Limits (dBµV/m)		Test distance (m)
	VERTICAL	HORIZONTAL	
0.009 to 0.490	$20 \cdot \log(2400/F(\text{kHz}))$	$20 \cdot \log(2400/F(\text{kHz}))$	300
0.490 to 1.705	$20 \cdot \log(24000/F(\text{kHz}))$	$20 \cdot \log(24000/F(\text{kHz}))$	30
1.705 to 30.0	30	30	30
30 to 88	40**	40**	3
88 to 216	43.5**	43.5**	3
216 to 960	46**	46**	3
Above 960	54	54	3

** Except as provided in paragraph below, fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz.

Perimeter protection systems may operate in the 54-72 MHz and 76-88 MHz bands under the provisions of this section. The use of such perimeter protection systems is limited to industrial, business and commercial applications.

Additional provisions to the general radiated emission limitations – Section 15.215: In no case shall the level of the unwanted emissions from an intentional radiator operating under these additional provisions exceed the field strength of the fundamental emission as per clause 15.209.

Intentional radiators operating under the alternative provisions to the general emission limits must be designed to ensure that the 20 dB bandwidth of the emission, or whatever 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 ALL TEST EQUIPMENT AND THEIR DESCRIPTION

3.1 General information

Description	Model No.	SIQ No.	Last calibration	Calibrated until	Calibration period	Used
Rohde-Schwarz, RFI receiver	ESR 7	111549	2022-01	2023-07	18 months	X
Rohde-Schwarz, RFI receiver	ESW 8	100958	2022-05	2023-11	18 months	X
Rohde-Schwarz, RFI receiver	ESU26	100428	2022-01	2023-07	18 months	X
Rohde & Schwarz, Artificial main network	ESH2-Z5	106899	2021-08	2024-08	36 months	
Rohde & Schwarz, Artificial main network	ENV216	109818	2021-08	2024-08	36 months	
Comtest Engineering, Semi Anechoic Chamber SAC 1	SAC 3m	NPS001	2022-04	2025-04	36 months	
Comtest Engineering, Semi Anechoic Chamber SAC 2	SAC 3m	NPS002	2022-04	2025-04	36 months	X
Rohde & Schwarz, Horn Antenna	HF907 (SN 102508)	102508	2020-08	2023-08	36 months	X
Rohde & Schwarz, Ultra Broadband Antenna	HL562E (SN 100842)	100842	2020-09	2023-09	36 months	X
Rohde & Schwarz, Horn Antenna	HF907 (SN 102494)	102494	2020-07	2023-07	36 months	
Rohde & Schwarz, Ultra Broadband Antenna	HL562E (SN 100843)	100843	2020-07	2023-07	36 months	
Maturo, Turn table (2 m diameter)	TT 2.0 SI	/	N/A	N/A	N/A	X
Maturo, Bore-sight antenna mast	BAM-4.0-P	/	N/A	N/A	N/A	X
Maturo, Multi-channel positioning equipment	Maturo NCD	/	N/A	N/A	N/A	X
Schwarzbeck, Biconical antenna	VHBB9124 (SN 9124-317)	105112	2021-04	2024-04	36 months	/
Schwarzbeck Active loop antenna	FMZB 1519B	/	2021-04	2022-10	18 months	X
Kambič, Temperature chamber	I-190 CK	107298	N/A	N/A	/	X

3.2 Other instrument information and auxiliary equipment

Description	Model No.	Bandwidth	Detector functions	Antenna factors	Cable loss	Range
Rohde-Schwarz, AMN	ENV216	/	/	/	/	9 kHz – 30 MHz
Rohde & Schwarz, Artificial main network	ESH 2-Z5	/	/	/	/	9 kHz – 30 MHz
Rohde-Schwarz, RFI receiver	ESU8	200Hz, 9kHz, 120kHz, 1MHz	Peak, Q-peak, Average	/	/	20 Hz – 8 GHz
Rohde-Schwarz, RFI receiver	ESU26	200Hz, 9kHz, 120kHz, 1MHz	Peak, Q-peak, Average	/	/	20 Hz – 26.5 GHz
Hewlett Packard, RF Spectrum Analyzer	8593E	200Hz, 9kHz, 120kHz, 1MHz	Peak, Q-peak, Average	/	/	9 kHz – 26.5 GHz
Comtest Engineering, Semi Anechoic Chamber SAC 1	SAC 3m	/	/	/	/	30 MHz – 18 GHz
Comtest Engineering, Semi Anechoic Chamber SAC 2	SAC 3m	/	/	/	/	30 MHz – 18 GHz
Rohde & Schwarz, Horn Antenna	HF907 (SN 102508)	/	/	See section 3.2.2	/	0.8 GHz – 18 GHz
Rohde & Schwarz, Ultra Broadband Antenna	HL562E (SN 100842)	/	/	See section 3.2.2	/	30 MHz – 6 GHz
Rohde & Schwarz, Horn Antenna	HF907 (SN 102494)	/	/	See section 3.2.2	/	0.8 GHz – 18 GHz
Rohde & Schwarz, Ultra Broadband Antenna	HL562E (SN 100843)	/	/	See section 3.2.2	/	30 MHz – 6 GHz
Schwarzbeck, Biconical antenna	VHBB9124 (SN 9124-317)	/	/	See section 3.2.2	/	30 MHz – 300 MHz
Schwarzbeck, Loop Antenna	FMZB 1519 B	/	/	See section 3.2.2	/	9 kHz – 30 MHz



3.2.1 Cable loss and attenuation of radiated emission

3.2.1.1 Conducted emission cable (SIQ-K024)

Point	Frequency (9kHz-30MHz)	Cable length (meters)	Loss (dB)
1	190 kHz	1	0.4
2	530 kHz	1	0.26
3	2.53 MHz	1	0.16
4	5.19 MHz	1	0.07
5	11.05 MHz	1	0.03
6	22.01 MHz	1	0.06
7	24.03 MHz	1	0.04

3.2.1.2 Radiated emission attenuation

Point	Frequency (30 MHz – 26.5 GHz)	Attenuation (dB)
1	30 MHz	0.501
2	150 MHz	1.174
3	400 MHz	2.034
4	800 MHz	2.995
5	1 GHz	3.416
6	1.363	1.666667
7	2.686	3.58333
8	5.332	5.25
9	7.978	6.25
10	10.624	7.5
11	13.27	8.333333
12	15.916	9.166666
13	18.562	9.833333
14	21.208	10.66667
15	23.854	11.5
16	26.5	12.16667

3.2.2 Antenna factors

3.2.2.2 Antenna FMZB 1519 B

Frequency (MHz)	Antenna factor (dB)
0.009	-30.60
0.010	-30.80
0.020	-31.80
0.030	-32.00
0.040	-32.10
0.050	-32.20
0.060	-32.20
0.070	-32.20
0.080	-32.20
0.090	-32.30
0.100	-32.30
0.150	-32.30
0.200	-32.40
0.300	-32.40
0.400	-32.40
0.500	-32.40
0.600	-32.40
0.700	-32.50
0.800	-32.50
0.900	-32.50
1.000	-32.50
2.000	-32.50
3.000	-32.50
4.000	-32.50
5.000	-32.50
6.000	-32.50
7.000	-32.50
8.000	-32.50
9.000	-32.50
10.000	-32.50
11.000	-32.50
12.000	-32.50
13.000	-32.50
14.000	-32.40
15.000	-32.40
16.000	-32.40
17.000	-32.40
18.000	-32.30
19.000	-32.30
20.000	-32.20
21.000	-32.10
22.000	-32.10
23.000	-32.00
24.000	-31.90
25.000	-31.80
26.000	-31.70
27.000	-31.60
28.000	-31.50
29.000	-31.40
30.000	-31.30



3.2.2.3 Antenna HL562E

Frequency (MHz)	Antenna factor HL562E (SN 100842)	Antenna factor HL562E (SN 100843)
30	18.12	18.17
32	17.08	17.07
34	16.01	16
36	14.91	14.94
38	13.76	13.75
40	12.64	12.61
42	11.43	11.4
44	10.17	10.15
46	8.86	8.81
48	7.42	7.44
50	6.01	5.96
52	4.59	4.56
54	3.38	3.37
56	2.84	2.85
58	3.06	3.14
60	3.78	3.76
62	4.44	4.4
64	5.36	5.32
66	6.19	6.18
68	6.96	6.92
70	7.56	7.52
72	8.04	8.01
74	8.38	8.35
76	8.67	8.64
78	8.88	8.85
80	9.04	9.03
82	9.14	9.09
84	9.2	9.14
86	9.22	9.16
88	9.22	9.17
90	9.21	9.17
92	9.22	9.15
94	9.22	9.16
96	9.21	9.16
98	9.22	9.17
100	9.33	9.05
105	9.38	9.39
110	9.67	9.74
115	9.55	10.33
120	10.51	9.88
125	10.15	9.87
130	9.23	9.13
135	8.79	8.71
140	8.4	8.4
145	7.93	7.82
150	7.74	7.75
155	7.68	7.76
160	7.86	7.78
165	8.47	8.33
170	9.83	9.66
175	10.29	10.3
180	7.86	7.93

185	7.19	7.27
190	7.54	7.21
195	7.32	7.2
200	7.56	7.49
205	7.56	7.68
210	7.71	7.95
215	8.68	8.29
220	8.43	8.49
225	8.51	8.62
230	8.85	8.82
235	9.1	9.05
240	9.31	9.29
245	9.33	9.33
250	9.5	9.45
255	9.71	9.64
260	9.86	9.81
265	9.95	9.9
270	10	10.02
275	10.15	10.15
280	10.37	10.36
285	10.58	10.61
290	10.76	10.8
295	10.84	10.9
300	10.83	11.12
305	11.38	11.37
310	11.36	11.32
315	11.53	11.48
320	11.7	11.67
325	11.84	11.81
330	11.98	11.94
335	12.32	12.13
340	12.19	12.22
345	12.29	12.35
350	12.43	12.47
355	12.59	12.61
360	12.72	12.73
365	12.83	12.81
370	12.99	12.99
375	13.08	13.1
380	13.12	13.11
385	13.21	13.2
390	13.38	13.33
395	13.54	13.5
400	13.65	13.63
405	13.74	13.73
410	13.84	13.83
415	14.14	13.96
420	14.1	14
425	14.13	14.08
430	14.24	14.2
435	14.4	14.4
440	14.55	14.49
445	14.7	14.65
450	14.82	14.79
455	14.89	14.91
460	14.9	15.09
465	15.16	15.19



470	15.24	15.22
475	15.31	15.25
480	15.38	15.32
485	15.48	15.43
490	15.58	15.52
495	15.66	15.6
500	15.72	15.7
505	15.74	15.75
510	15.83	15.82
515	16.05	15.92
520	15.95	15.93
525	15.97	15.97
530	16.05	16.01
535	16.09	16.07
540	16.16	16.15
545	16.21	16.21
550	16.29	16.3
555	16.38	16.41
560	16.51	16.53
565	16.67	16.68
570	16.78	16.85
575	16.87	17.02
580	17.03	17.11
585	17.06	17.08
590	17.1	17.09
595	17.15	17.13
600	17.22	17.18
605	17.28	17.25
610	17.35	17.33
615	17.42	17.37
620	17.41	17.42
625	17.48	17.48
630	17.56	17.55
635	17.67	17.65
640	17.8	17.79
645	17.94	17.95
650	18.08	18.13
655	18.16	18.12
660	18.18	18.03
665	18.12	17.99
670	18.13	18.01
675	18.19	18.09
680	18.26	18.24
685	18.42	18.41
690	18.56	18.56
695	18.62	18.61
700	18.67	18.67
705	18.7	18.74
710	18.74	18.79
715	18.81	18.86
720	18.89	18.95
725	19.09	19.09
730	19.22	19.26
735	19.17	19.23
740	19.19	19.14
745	19.14	19.1
750	19.13	19.09

755	19.17	19.1
760	19.19	19.15
765	19.24	19.21
770	19.34	19.29
775	19.37	19.36
780	19.36	19.36
785	19.43	19.41
790	19.51	19.48
795	19.59	19.56
800	19.7	19.66
805	19.83	19.79
810	19.98	19.95
815	20.07	20.04
820	20.1	19.96
825	20.11	19.92
830	20.09	19.94
835	20.09	19.96
840	20.14	20.05
845	20.19	20.11
850	20.27	20.2
855	20.36	20.29
860	20.42	20.37
865	20.46	20.44
870	20.5	20.51
875	20.52	20.55
880	20.59	20.61
885	20.7	20.69
890	20.82	20.77
895	20.89	20.83
900	20.88	20.92
905	20.83	21.08
910	20.93	21.21
915	21.19	21.17
920	21.22	21.1
925	21.09	21.03
930	20.98	21
935	20.95	21
940	20.96	21.01
945	21	21.04
950	21.05	21.06
955	21.09	21.07
960	21.15	21.13
965	21.23	21.2
970	21.27	21.26
975	21.31	21.3
980	21.36	21.37
985	21.43	21.44
990	21.52	21.53
995	21.63	21.64
1000	21.73	21.73



4 TEST SUMMARY

STANDARDS (details on first page)	Tested		Sample	
	yes	no	pass	not pass
ANSI C63.10-2013; 47 CFR Part 15, Subpart C	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Test	47 CFR Part 15 section	Section within the report	Conclusion
Restricted bands of operation	15.205	6.1	PASS
Conducted emission	15.207	6.2	PASS
Radiated emission	15.209	6.3	PASS
Bandwidth of the emission	15.215	6.4	PASS
Spectrum mask	15.225	6.5	PASS
Frequency tolerance of the carrier signal	15.225	6.6	PASS

4.1 Operating voltages/frequencies used for testing

Section	Test	Operating conditions
6.1	Restricted bands of operation	24 Vdc
6.2	Conducted emission	/
6.3	Radiated emission	24 Vdc
6.4	Bandwidth of the emission	24 Vdc
6.5	Spectrum mask	24 Vdc
6.6	Frequency tolerance of the carrier signal	24 Vdc

5 CONVERSION FACTORS AND ALL OTHER FORMULAS

Unit	Conversion unit	Formula of conversion
$\text{dB}\mu\text{V}$	$\text{dB}\mu\text{V/m}$	$\text{dB}\mu\text{V/m} = \text{dB}\mu\text{V} + \text{AF}$
$\mu\text{V/m}$	$\text{dB}\mu\text{V/m}$	$\text{dB}\mu\text{V/m} = 20\log(X(\mu\text{V/m})/1\mu\text{V})$

Test distance stated in standard	Test distance of measurement	Conversion factor
3 m	3 m	/
10 m	3 m	20dB/decade (over 30 MHz)
		40dB/decade (under 30 MHz)



6 EMISSION TESTS

6.1 Restricted bands of operation (§15.205 of FCC 47 CFR 15)

6.1.1 Requirement

Except as shown in paragraph (d) of §15.205 only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
¹ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(²)
13.36-13.41			

¹Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

²Above 38.6

6.1.2 Test results

See Radiated emission results under 6.3 Radiated emission and 6.5 Spectrum mask.

6.2 Conducted emission measurement (§15.207 of FCC 47 CFR 15)

6.2.1 Requirement

Frequency Range (MHz)	Limits (dBµV)	
	Quasi-peak	Average
0.15 to 0.5	66 – 56*	56 – 46*
0.5 to 5.0	56	46
5.0 to 30.0	60	50

* Decreases with the logarithm of the frequency.

The shown limits in table shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

- For carrier current systems containing their fundamental emission within the frequency band 535-1705 kHz and intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.
- For all other carrier current systems: 1000 µV within the frequency band 535-1705 kHz, as measured using a 50 µH/50 ohms LISN.
- Carrier current systems operating below 30 MHz are also subject to the radiated emission limits as appropriate.

6.2.2 Test procedure

- As per clause 6.2 from ANSI C63.10-2013.
- The EUT is placed on a non-conductive 0.8 meters high table, 0.4 meters from the vertical conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). LISN provide 50 Ohm / 50 µH + 5 Ohm of coupling impedance for the measuring instrument.
- Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition.
- AC power lines of EUT are checked for maximum conducted interference.
- The frequency range from 150 kHz to 30 MHz is searched using PEAK, QUASI-PEAK and AVERAGE function of the receiver to determine compliance with Section 15.207 limits outside the transmitter's fundamental emission band. Bandwidth is set to 9 kHz.
- Measurement repeated with a dummy load in lieu of the antenna to determine compliance with Section 15.207 limits within the transmitter's fundamental emission band.

6.2.3 Test results



EUT Information

EUT:

Operating mode:

Supply voltage:

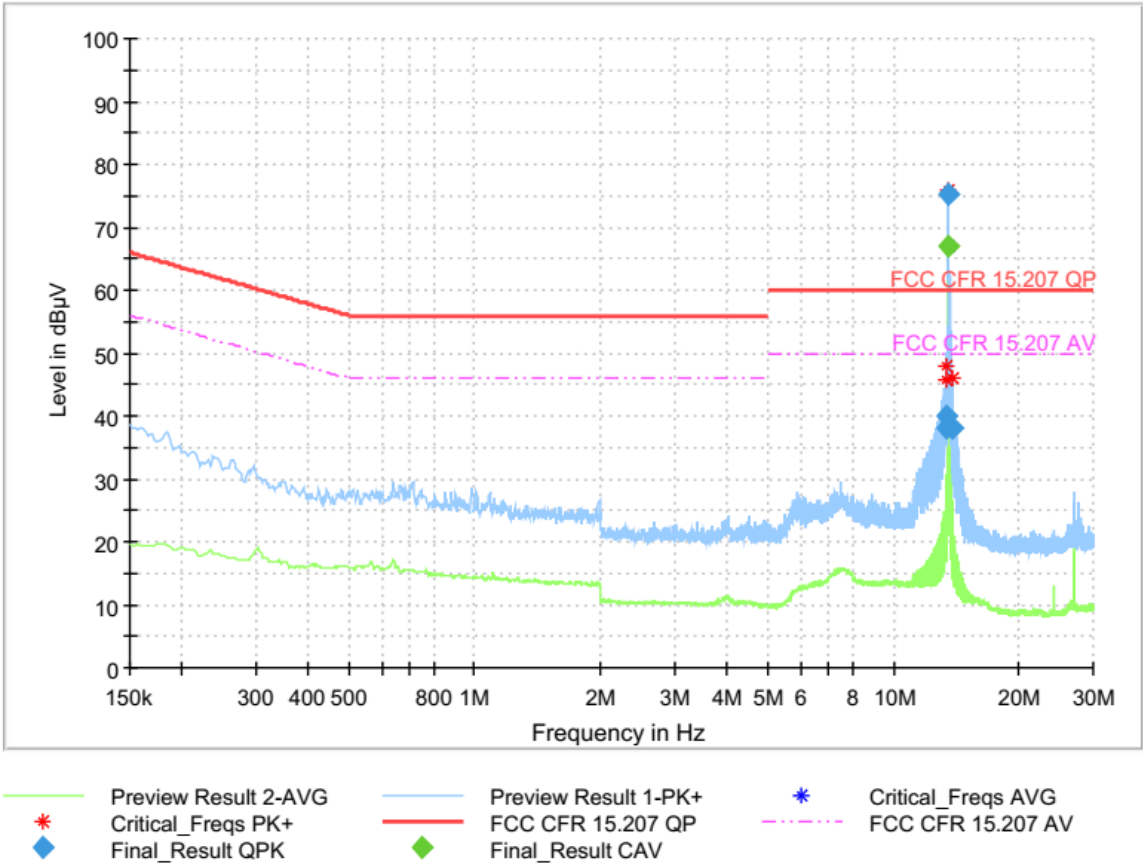
Line:

30kW Primary box

PPL Mode

3x275 Vac, 60 Hz

L1+L2+L3+N

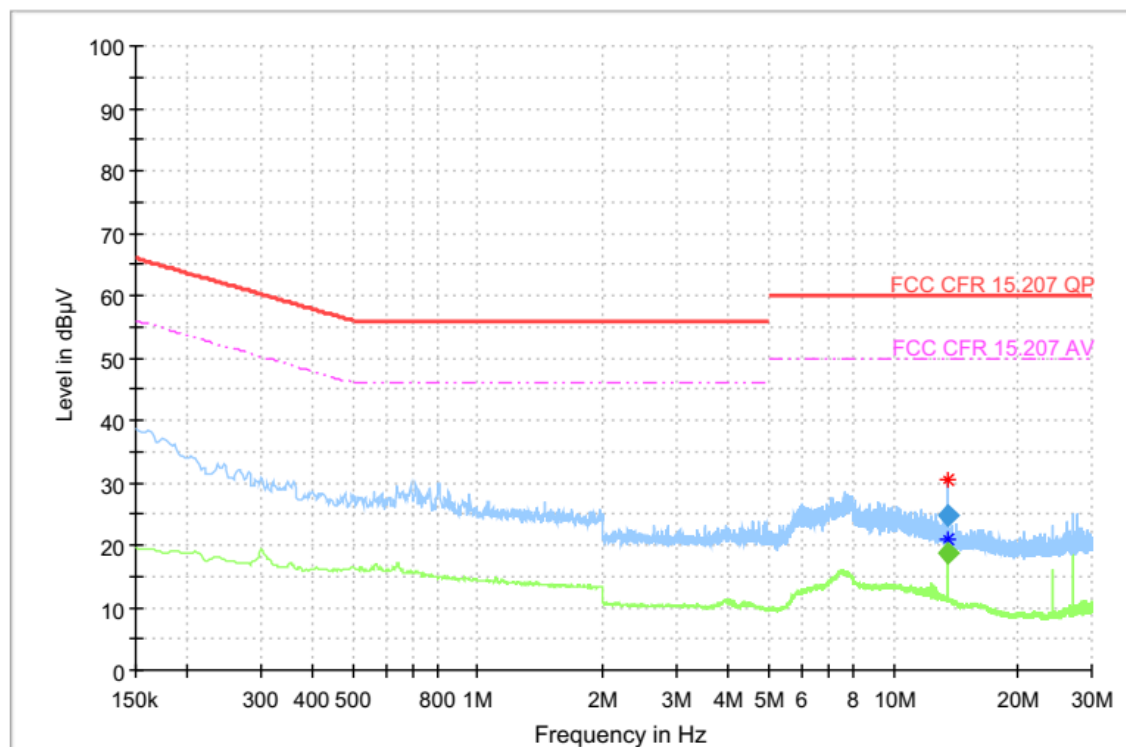


Final Result

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
13.299000	38.14	---	60.00	21.86	1000.0	9.000	L1	GND	10.4
13.357500	40.00	---	60.00	20.00	1000.0	9.000	L1	GND	10.4
13.560000	75.19	---	60.00	-15.19	1000.0	9.000	L2	GND	10.3
13.560000	---	67.04	50.00	-17.04	1000.0	9.000	L2	GND	10.3
13.762500	38.07	---	60.00	21.93	1000.0	9.000	L1	GND	10.5

EUT Information

EUT: 30kW Primary box
Operating mode: PPL Mode - Output of the radio module terminated with 50 Ohm
Supply voltage: 3x275 Vac, 60 Hz
Line: L1+L2+L3+N



— Preview Result 2-AVG
— Preview Result 1-PK+
— FCC CFR 15.207 QP
- - - FCC CFR 15.207 AV
* Critical_Freqs PK+
◆ Final_Result QPK
* Critical_Freqs AVG
◆ Final_Result CAV

Final Result

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
13.560000	---	18.62	50.00	31.38	1000.0	9.000	L2	GND	10.3
13.560000	24.86	---	60.00	35.14	1000.0	9.000	L2	GND	10.3



6.3 Radiated emission measurement (§15.209 of FCC 47 CFR 15)

6.3.1 Requirement

Frequency Range (MHz)	Limits (dBμV/m)	Test distance (m)
0.009 to 0.490	$20 \cdot \log(2400/F(\text{kHz}))$	300
0.490 to 1.705	$20 \cdot \log(24000/F(\text{kHz}))$	30
1.705 to 30.0	30	30
30 to 88	40**	3
88 to 216	43.5**	3
216 to 960	46**	3
Above 960	54	3

** Except as provided in paragraph below, fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz.

Perimeter protection systems may operate in the 54-72 MHz and 76-88 MHz bands under the provisions of this section. The use of such perimeter protection systems is limited to industrial, business and commercial applications

6.3.2 Test procedure

Measurements from 9 kHz to 30 MHz

1. As per clause 6.4 from ANSI C63.10-2013
2. Radiated emission in the frequency range 9 kHz to 30 MHz are measured Active loop Antenna.
3. First preliminary measurements were performed in Semi-anechoic chamber at a distance of 3 m using active loop antenna.
4. The EUT was placed on the top of a rotating table 0.8 meters above the ground in an Anechoic Chamber. The table and antenna was rotated 360 degrees to determine the position of the highest radiation.
5. Final measurements were done at a distance of 10 m at Open Area Test Site due to low emissions measured during preliminary measurements acc. to the clauses from Part 15, Sections 15.31(d) and 15.31(f)(2). Test results were extrapolated by using the square of an inverse linear distance extrapolation factor (40 dB/decade).

Measurements from 30 MHz to 1 GHz

6. As per clause 6.5 from ANSI C63.10-2013
7. The EUT was placed on the top of a rotating table 0.8 meters above the ground in an Anechoic Chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
8. The EUT was set 3 m away from the interference-receiving antenna, which was mounted on the top of variable-height antenna tower.
9. The antenna is a broadband antenna, and its 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.
10. 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 turn table was turned from 0 degrees to 360 degrees to find the maximum reading.
11. The test-receiver system was set to PEAK and QUAS-PEAK Detect Function and Specified Bandwidth with Maximum Hold Mode.
12. The highest points would be re-tested one by one using the quasi-peak method.

Measurements from 1 GHz to 18 GHz

13. As per clause 6.6 from ANSI C63.10-2013
14. The EUT was placed on the top of a rotating table 1.5 meters above the ground in an Anechoic Chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
15. The EUT was set 3 m away from the interference-receiving antenna, which was mounted on the top of variable-height antenna tower.
16. The antenna is a horn antenna, and its 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.
17. 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 turn table was turned from 0 degrees to 360 degrees to find the maximum reading.
18. The test-receiver system was set to AVERAGE Detect Function and Specified Bandwidth with Maximum Hold Mode.
19. The highest points would be re-tested one by one using the AVERAGE detector.



6.3.3 Test results

Device passed the requirements stated in 47 CFR Part 15, Subpart C, Section 15.209
Preliminary measurements at 3 m:

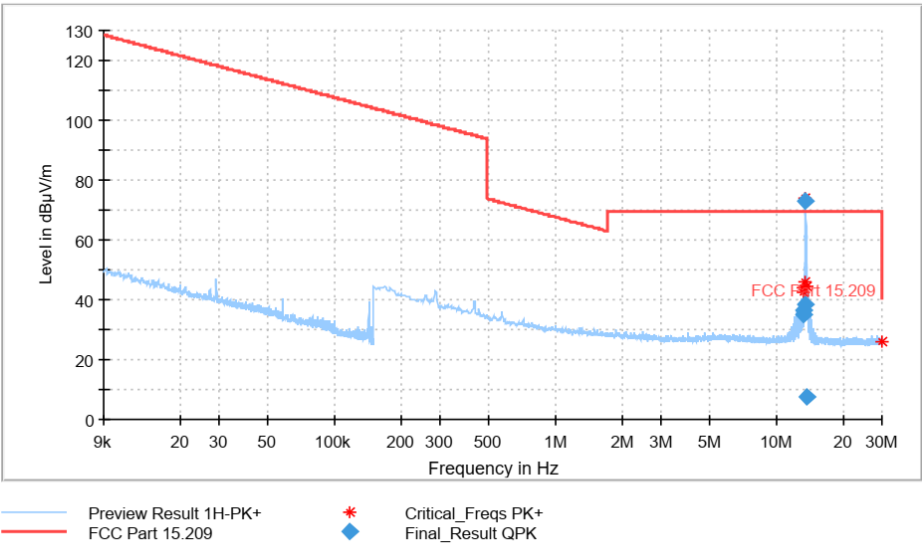
Only primary pad active:

EUT Information

EUT:
Operating mode:
Supply:

Primary pad
PPL Mode
480 Vac

Full Spectrum



Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)
13.242750	35.12	69.50	34.38	100.0	H	178.0
13.299000	36.50	69.50	33.00	100.0	H	176.0
13.357500	38.52	69.50	30.98	100.0	H	173.0
13.560000	73.25	69.50	-3.75	100.0	H	173.0
13.762500	7.47	69.50	62.03	100.0	H	180.0

Primary and secondary pad active:

EUT Information

EUT:

Operating mode:

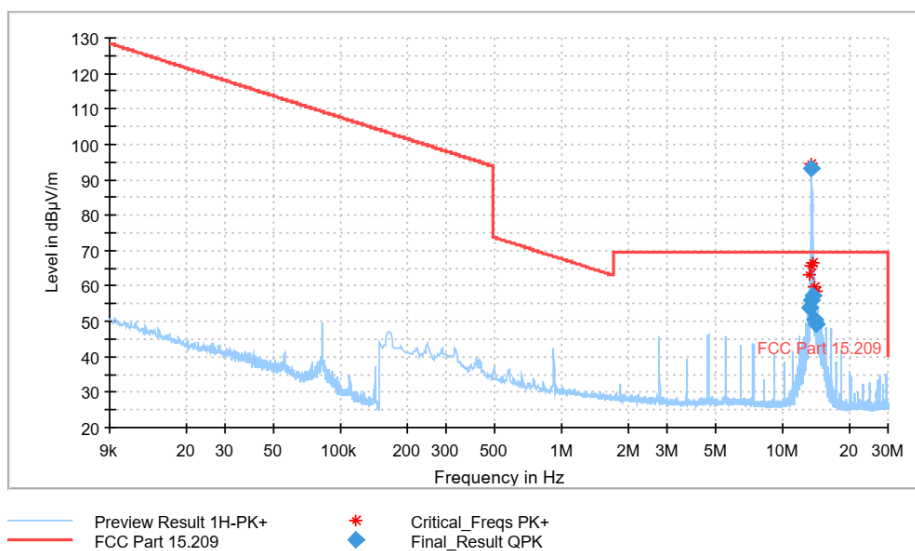
Supply:

Primary pad + Secondary pad

PPL Mode

480 Vac + 100 Vdc

Full Spectrum



Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)
13.299000	53.83	69.50	15.67	100.0	H	193.0
13.357500	56.09	69.50	13.41	100.0	H	193.0
13.560000	93.40	69.50	-23.90	100.0	H	193.0
13.762500	57.13	69.50	12.37	100.0	H	193.0
13.994250	50.62	69.50	18.88	100.0	H	191.0
14.052750	49.11	69.50	20.39	100.0	H	191.0



Final measurement at 10 m on OATS

Results with measuring distance of 10 m				
Mode	Frequency (MHz)	Measured value (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
Only primary pad	13.56	60.93	103	42.07
Primary and secondary pad	13.56	81.38	103	21.62

Calculated value from 10 m to 30 m						
Mode	Frequency (MHz)	Measured value at 10 m (dB μ V/m)	Correction factor from 10 m to 30 m (dB)	Calculated value at 30 m (dB μ V/m)	Limit at 30 m (dB μ V/m)	Margin (dB)
Only primary pad	13.56	60.93	19	41.93	84.00	42.07
Primary and secondary pad	13.56	81.38	19	62.38	84.00	21.62

NOTE: Antenna factor and cable loss are included in measurement correction.

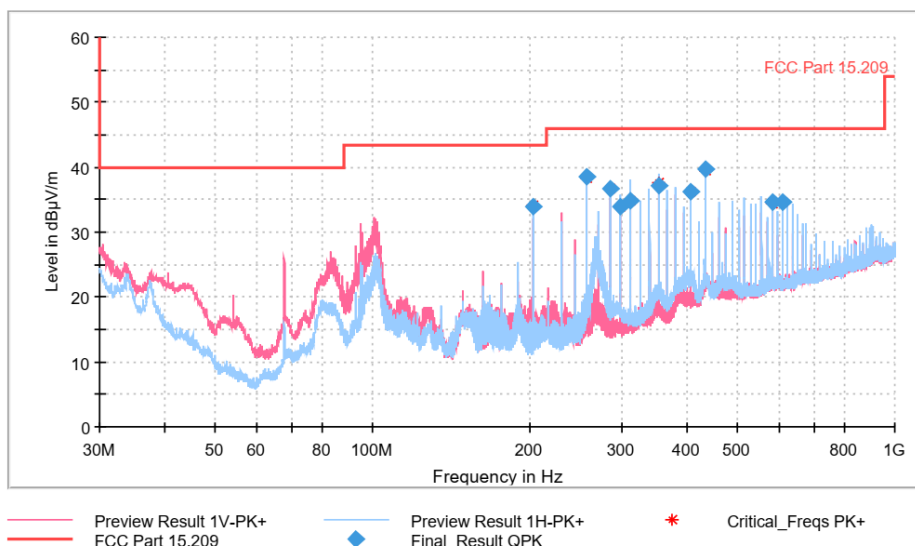
Final measurements from 30 MHz to 1 GHz

Only primary pad active:

EUT Information

EUT: Primary pad
Operating mode: PPL Mode
Supply: 480 Vac

Full Spectrum



Final Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)
203.400000	33.93	43.50	9.57	122.0	H	210.0
257.640000	38.53	46.00	7.47	100.0	H	222.0
284.760000	36.75	46.00	9.25	100.0	H	222.0
298.320000	33.95	46.00	12.05	100.0	H	222.0
311.850000	34.78	46.00	11.22	100.0	H	27.0
352.560000	37.08	46.00	8.92	100.0	H	231.0
406.800000	36.21	46.00	9.79	173.0	H	236.0
433.920000	39.59	46.00	6.41	154.0	H	236.0
583.080000	34.54	46.00	11.46	100.0	H	166.0
610.200000	34.52	46.00	11.48	100.0	H	169.0



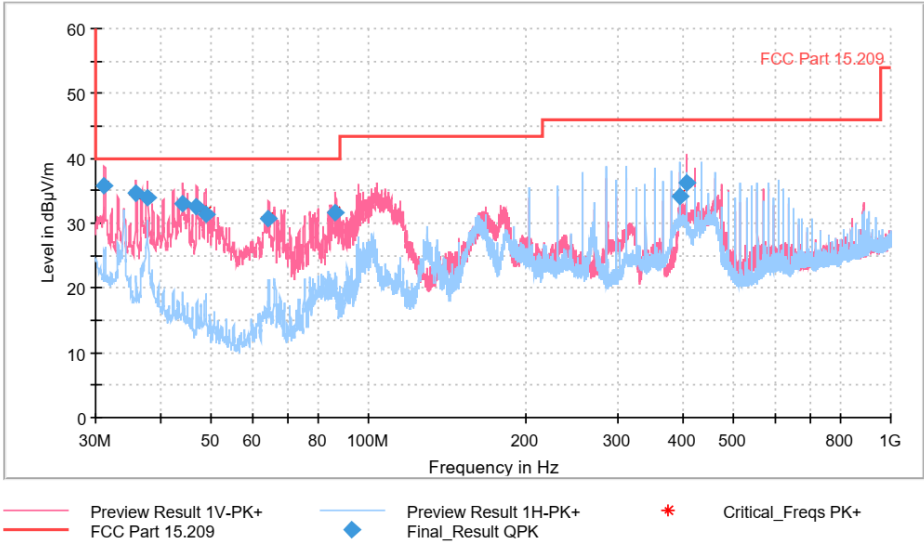
Primary and secondary pad active:

EUT Information

EUT:
Operating mode:
Supply:

Primary pad + Secondary pad
PPL Mode
480 Vac + 100 Vdc

Full Spectrum



Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)
31.230000	35.80	40.00	4.20	100.0	V	202.0
35.880000	34.56	40.00	5.44	100.0	V	343.0
37.710000	33.83	40.00	6.17	100.0	V	14.0
44.160000	32.90	40.00	7.10	100.0	V	10.0
46.890000	32.49	40.00	7.51	100.0	V	0.0
48.720000	31.44	40.00	8.56	100.0	V	14.0
64.380000	30.72	40.00	9.28	153.0	V	199.0
86.460000	31.62	40.00	8.38	123.0	V	152.0
393.240000	34.25	46.00	11.75	100.0	H	238.0
406.800000	36.20	46.00	9.80	100.0	V	248.0

6.4 Bandwidth of the emission (§15.215 of FCC 47 CFR 15)

6.4.1 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 FCC Part 15, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever 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.

6.4.2 Test procedure

1. As per Clause 6.9.2 from ANSI C63.10-2013
2. The EUT is placed on the top of a rotating table 0.8 meters above the ground in an Anechoic Chamber. The table is rotated 360 degrees to determine the position of the highest radiation.
3. The EUT is set 3 m away from the interference-receiving antenna.
4. Resolution bandwidth is set to a value greater than 5% of the allowed bandwidth.



6.4.3 Test results

Device passed the requirements stated in 47 CFR Part 15, Subpart C, Section 15.215

Only primary pad active:

1.1.1 Settings

Instrument: ESW-8

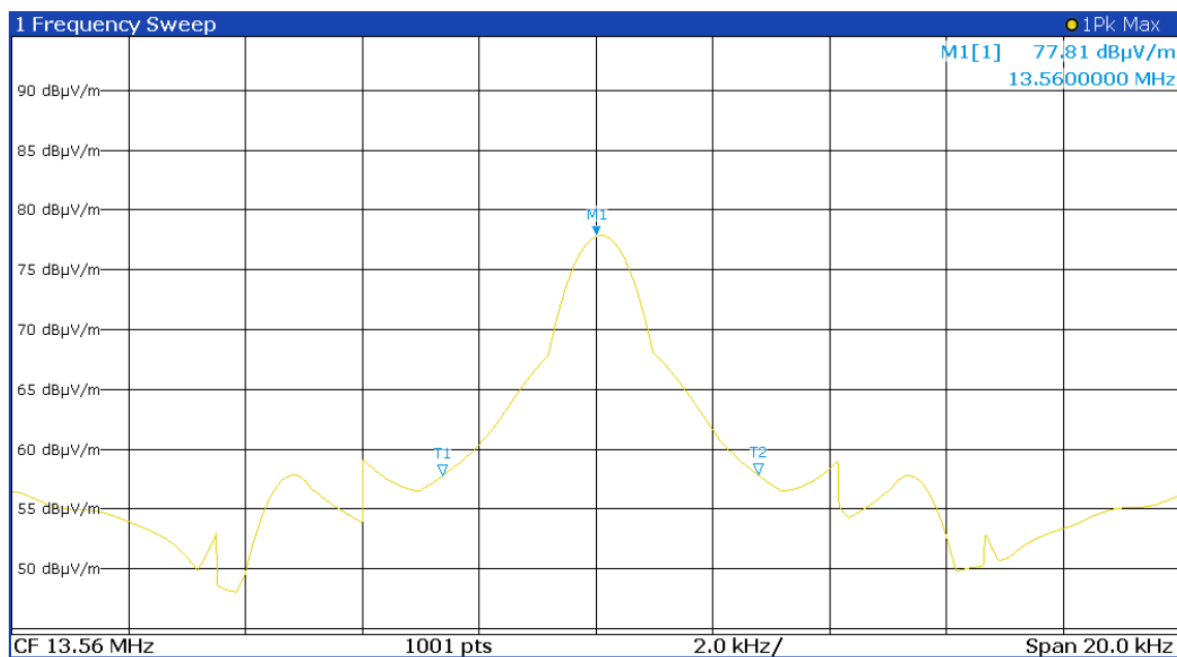
Version: 2.10SP2

Date: 20.Jul 2022

Mode: Spectrum

Center Freq: 13.56 MHz	Freq Offset: 0 Hz	Start: 13.55 MHz	Stop: 13.57 MHz
Span: 20 kHz	RBW: 1 kHz	Filter Type: Normal(3dB)	VBW: 3 kHz
SWT: 4.21 ms	Ref Level: 94.5 dBμV/m	Level Offset: 0 dB	Rf Att: 10 dB
Input: 2 DC	Preamplifier: OFF	Preselector: On	Filter Split: Off
Notch Filter 1: Off	Notch Filter 2: Off		

1.1.2 Frequency Sweep



Type	Ref	Trace	X-Value	Y-Value	Function	Func Result
M1		1	13.56 MHz	77.8 dBμV/m	ndB	20 dB
T1		1	13.56 MHz	57.8 dBμV/m	ndB down BW	5.395 kHz
T2		1	13.56 MHz	57.8 dBμV/m	Q Factor	2514

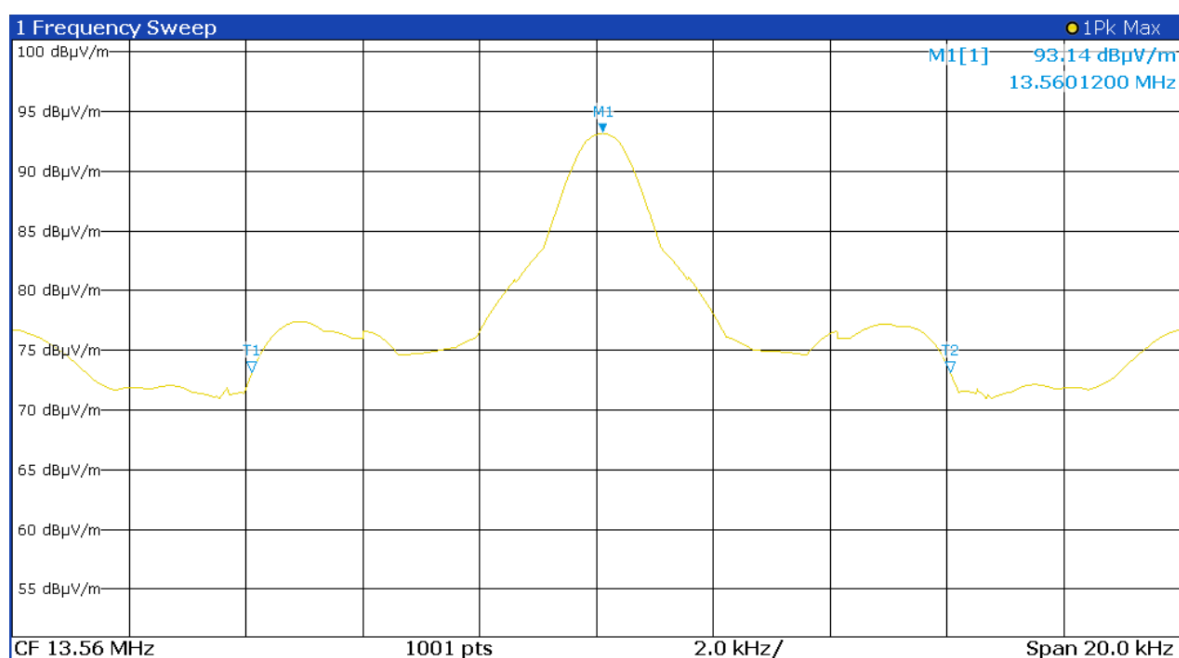
Primary and secondary pad active:

1.1.1 Settings

Instrument: ESW-8
Version: 2.10SP2
Date: 20.Jul 2022
Mode: Spectrum

Center Freq: 13.56 MHz	Freq Offset: 0 Hz	Start: 13.55 MHz	Stop: 13.57 MHz
Span: 20 kHz	RBW: 1 kHz	Filter Type: Normal(3dB)	VBW: 3 kHz
SWT: 4.21 ms	Ref Level: 101 dB μ V/m	Level Offset: 0 dB	Rf Att: 10 dB
Input: 2 DC	Preamplifier: OFF	Preselector: On	Filter Split: Off
Notch Filter 1: On	Notch Filter 2: On		

1.1.2 Frequency Sweep



Type	Ref	Trace	X-Value	Y-Value	Function	Func Result
M1		1	13.56 MHz	93.1 dB μ V/m	ndB	20 dB
T1		1	13.55 MHz	73.1 dB μ V/m	ndB down BW	11.95 kHz
T2		1	13.57 MHz	73.2 dB μ V/m	Q Factor	1135

Frequency (MHz)	Permitted frequency band (MHz)	20 dB bandwidth (kHz)	PASS/FAIL
13.56	13.110 – 14.010	11.95	PASS



6.5 Spectrum mask (§15.225 (a)-(d) of FCC 47 CFR 15)

6.5.1 Requirements

The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters. Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters. Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters. The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

6.5.2 Test procedure

1. As per clause 6.4 from ANSI C63.10-2013
2. The EUT was placed on the top of a rotating table 0.8 meters above the ground in an Anechoic Chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
3. The EUT was set 3 m away from the interference-receiving antenna.
4. Frequencies with maximum emission were retested on OATS.
5. 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 turn table was turned from 0 degrees to 360 degrees to find the maximum reading.

6.5.3 Test results

Device passed the requirements stated in 47 CFR Part 15, Subpart C, Section 15.225

Only primary pad active:

1.1.1 Settings

Instrument: ESW-8

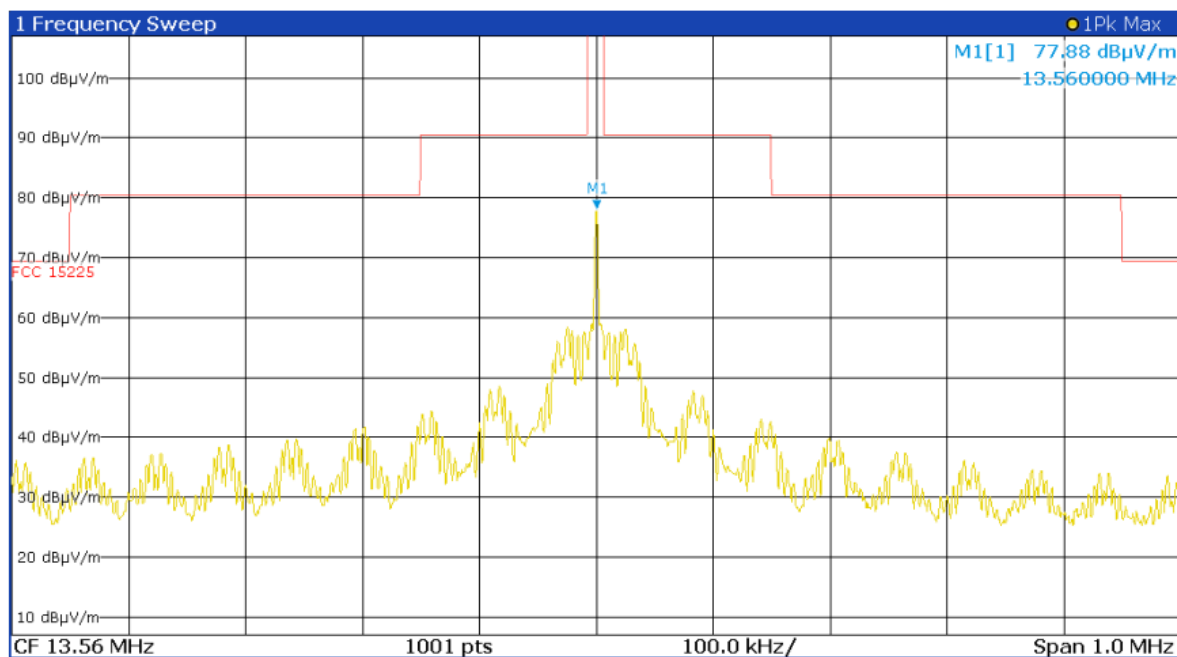
Version: 2.10SP2

Date: 20.Jul 2022

Mode: Spectrum

Center Freq: 13.56 MHz	Freq Offset: 0 Hz	Start: 13.06 MHz	Stop: 14.06 MHz
Span: 1 MHz	RBW: 1 kHz	Filter Type: Normal(3dB)	VBW: 3 kHz
SWT: 4.19 ms	Ref Level: 107 dB μ V/m	Level Offset: 0 dB	Rf Att: 10 dB
Input: 2 DC	Preamplifier: OFF	Preselector: On	Filter Split: Off
Notch Filter 1: Off	Notch Filter 2: Off		

1.1.2 Frequency Sweep





Primary and secondary pad active:

1.1.1 Settings

Instrument: ESW-8

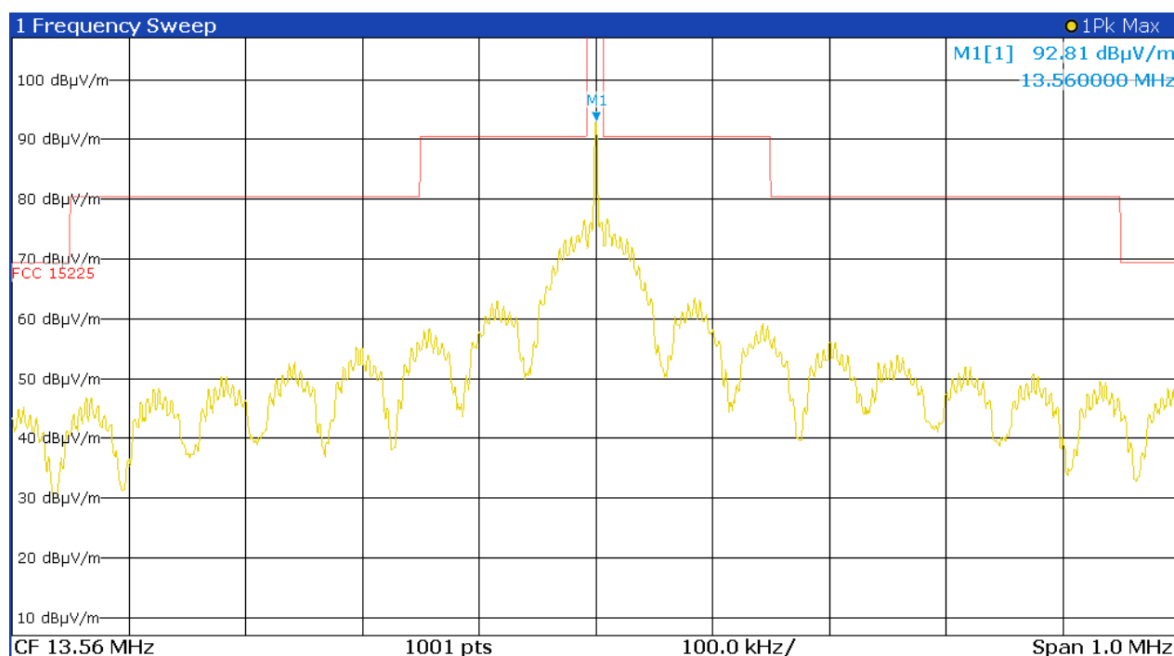
Version: 2.10SP2

Date: 20.Jul 2022

Mode: Spectrum

Center Freq: 13.56 MHz	Freq Offset: 0 Hz	Start: 13.06 MHz	Stop: 14.06 MHz
Span: 1 MHz	RBW: 1 kHz	Filter Type: Normal(3dB)	VBW: 3 kHz
SWT: 4.19 ms	Ref Level: 107 dB μ V/m	Level Offset: 0 dB	Rf Att: 10 dB
Input: 2 DC	Preamplifier: OFF	Preselector: On	Filter Split: Off
Notch Filter 1: On	Notch Filter 2: On		

1.1.2 Frequency Sweep



6.6 Frequency tolerance of the carrier signal (§15.225 (e)) of FCC 47 CFR 15)

6.6.1 Requirement

The frequency tolerance of the carrier signal shall be maintained within +/- 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.

6.6.2 Test procedure

1. As per clause 6.8 from ANSI C63.10-2013.
2. The frequency tolerance of the carrier signal is measured over a temperature variation of -20 °C to +50 °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 °C.
3. If the EUT provides an antenna connector the spectrum analyzer is connected to this port. In cases where the EUT does not provide an antenna connector a test fixture is used.
4. The peak detector of the spectrum analyzer is selected and the resolution bandwidth as well as the video bandwidth is set to values appropriate to the shape of the spectrum of the EUT.
5. While maintaining a constant temperature inside the environmental chamber, turn the EUT ON and record the operating frequency at startup, and at 2 minutes, 5 minutes, and 10 minutes after the EUT is energized.



6.6.3 Test results

Device passed the requirements stated in of FCC 47 CFR 15, Subpart C, Section 15.225

FREQUENCY STABILITY						
Temperature	Supply voltage (V)	Minutes after switch on	Measured Frequency (MHz)	Allowed tolerance (kHz)	Measured tolerance	RESULT
50	24.00	0	13.560034700	Fref±1.356 kHz	-0.138	PASS
	24.00	2	13.560030400	Fref±1.356 kHz	-0.143	PASS
	24.00	5	13.560034700	Fref±1.356 kHz	-0.138	PASS
	24.00	10	13.560030400	Fref±1.356 kHz	-0.143	PASS
40	24.00	0	13.560086800	Fref±1.356 kHz	-0.086	PASS
	24.00	2	13.560073800	Fref±1.356 kHz	-0.099	PASS
	24.00	5	13.560073800	Fref±1.356 kHz	-0.099	PASS
	24.00	10	13.560073800	Fref±1.356 kHz	-0.099	PASS
30	24.00	0	13.560138000	Fref±1.356 kHz	-0.035	PASS
	24.00	2	13.560120000	Fref±1.356 kHz	-0.053	PASS
	24.00	5	13.560120000	Fref±1.356 kHz	-0.053	PASS
	24.00	10	13.560120000	Fref±1.356 kHz	-0.053	PASS
20	27.60	0	13.560186000	Fref±1.356 kHz	0.013	PASS
	27.60	2	13.560173000	Fref±1.356 kHz	0.000	PASS
	27.60	5	13.560173000	Fref±1.356 kHz	0.000	PASS
	27.60	10	13.560173000	Fref±1.356 kHz	0.000	PASS
20	24.00	0	13.560186000	Fref±1.356 kHz	0.013	PASS
	24.00	2	13.560173000	Fref±1.356 kHz	0.000	PASS
	24.00	5	13.560173000	Fref±1.356 kHz	0.000	PASS
	24.00	10	13.560173000	Fref	0.000	PASS
20	20.40	0	13.560182000	Fref±1.356 kHz	0.009	PASS
	20.40	2	13.560178000	Fref±1.356 kHz	0.005	PASS
	20.40	5	13.560173000	Fref±1.356 kHz	0.000	PASS
	20.40	10	13.560173000	Fref±1.356 kHz	0.000	PASS
10	24.00	0	13.560225800	Fref±1.356 kHz	0.053	PASS
	24.00	2	13.560217100	Fref±1.356 kHz	0.044	PASS
	24.00	5	13.560217100	Fref±1.356 kHz	0.044	PASS
	24.00	10	13.560217100	Fref±1.356 kHz	0.044	PASS
0	24.00	0	13.560243100	Fref±1.356 kHz	0.070	PASS
	24.00	2	13.560243100	Fref±1.356 kHz	0.070	PASS
	24.00	5	13.560243100	Fref±1.356 kHz	0.070	PASS
	24.00	10	13.560243100	Fref±1.356 kHz	0.070	PASS
-10	24.00	0	13.560238800	Fref±1.356 kHz	0.066	PASS
	24.00	2	13.560243100	Fref±1.356 kHz	0.070	PASS
	24.00	5	13.560243100	Fref±1.356 kHz	0.070	PASS
	24.00	10	13.560243100	Fref±1.356 kHz	0.070	PASS
-20	24.00	0	13.560199700	Fref±1.356 kHz	0.027	PASS
	24.00	2	13.560208400	Fref±1.356 kHz	0.035	PASS
	24.00	5	13.560212700	Fref±1.356 kHz	0.040	PASS
	24.00	10	13.560212700	Fref±1.356 kHz	0.040	PASS