Bundesnetzagentur
BNetzA-CAB-14/21-09

DAkkS Deutsche Akkreditierungsstelle D-PL-11020-03-01

SGS Germany GmbH

Test Report No.: L29Z0001

Order No.: L29Z **Pages:** 74

Client:	BOWA-electronic GmbH & Co. KG
Equipment Under Test:	RFID Reader Monopolar TAG-PCB Type BOWA E225_RFID_Mono_V02
Manufacturer / Importer:	BOWA-electronic GmbH & Co. KG
Task:	Compliance with the requirements mentioned below:
Test Specification(s): [covered by accreditation]	• FCC 47 CFR Part 15 • RSS Gen Issue 4 • RSS-210 Issue 9
Result:	The EUT complies with the requirements of the test specifications.

The results relate only to the items tested as described in this test report.

approved by:	**Date**	**Signature**
Bauer Lab Manager EMC	Jun 20, 2018	Josef Bauer

This document was signed electronically.

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1 Result Summary

The measurements described in this report were conducted pursuant to 47 CFR § 2.947 and § 2.1041 for the US. All applicable paragraphs of the 47 CFR Part 15 of the most current version of the rules were considered.

The measurements described in this report were also conducted pursuant to RSS Gen and RSS-210 for Canada. All applicable paragraphs of the RSS Gen and RSS-210 of the most current version of the rules were considered.

The following test program was performed according to the FCC/IC rules to assess the ability of the tested sample(s) to successfully satisfy the FCC/IC requirements listed in section 2.1 Specification(s) of this test report:

Tables of Results:

Test No.	Measurement	FCC/IC Rules	Page Number of this Report	Result
1	AC Power Line Conducted Emissions [1]	§ 15.207 RSS Gen, 8.8	17	compliant
2	Occupied Bandwidth	§ 15.215(c) RSS Gen, 6.6	24	compliant
3	Radiated Emission [2]	§ 15.205, § 15.209, § 15.225(a-d) RSS Gen, 8.9, 8.10 RSS-210, B.6 (a-d)	26	compliant
4	Frequency Stability	§ 15.225(e) RSS Gen, 8.11 RSS-210, B.6	42	compliant

Table 1-1: Results – Summary

In accordance with the FCC Rule §15.3 (o) the equipment was tested with the limits that are valid for an *intentional radiator*.

[1] According ANSI C.63.10 chapter 6.2.1: If the EUT normally receives power from another device that in turn connects to the public-utility ac power lines, measurements shall be made on that device with the EUT in operation to demonstrate that the device continues to comply with the appropriate limits while providing the EUT with power. If the EUT is operated only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines (600 VAC or less) to operate the EUT (such as an adapter), then ac power-line conducted measurements are not required.

[2] See chapt. 4.2.4; Clock frequencies of the EUT resulting in determination of frequency range

2 References

2.1 Specification(s)

[1] FCC 47 CFR Part 15:
Code of Federal Regulations
Title 47: Telecommunication Part 15: Radio Frequency Devices

[2] ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

[3] FCC Public Notice DA 09-2478; Nov 25, 2009; Office of Engineering and Technology Clarifies Use of Recently Published ASC C63®
Measurement Standards for Compliance Testing of Intentional and Unintentional Radiators under Part 15

[4] KDB174176 D01 Line Conducted

[5] RSS-Gen Issue 4, November 2014; General Requirements for Compliance of Radio Apparatus

[6] RSS-210 Issue 9, August 2016; License-exempt Radio Apparatus): Category I Equipment.

2.2 Glossary

AC	Alternating Current
AMN	Artificial Mains Network
AV	Average Detector
DC	Direct Current
EMC	Electromagnetic Compatibility
EUT	Equipment Under Test
HW	Hardware
LISN	Line Impedance Stabilization Network
QP	Quasi Peak Detector

3 General Information

3.1 Identification of Client

BOWA-electronic GmbH & Co. KG
Heinrich-Herz-Straße 4-10
72810 Gomaringen
Reinhard Flad

3.2 Test Laboratory

SGS Germany GmbH
Hofmannstraße 50
81379 München

3.3 Time Schedule

Delivery of EUT: Oct 10, 2016
Start of test: Oct 14, 2016
End of test: Mar 07, 2017

Test No.:	1	2	3	4
Start of Test:	Jan 27, 2017	Jan 18, 2017	Oct 31, 2016	Jan 17, 2017
End of Test:	Mar 07, 2017	Jan 18, 2017	Dec 19, 2016	Jan 18, 2017

3.4 Participants

Name	Function
André Stéphane Nakpane	Accredited testing, Editor

3.5 Environmental conditions

During the measurement, if not otherwise specified, the environmental conditions were within the listed ranges:
Temperature: 20 - 26 °C
Humidity: 30 - 60 %

4 Equipment Under Test

Test item description ..:	RFID Reader Monopolar
Trade Mark .....:	
Manufacturer / Importer .:	BOWA-electronic GmbH & Co. KG
Model/Type .....:	TAG-PCB Type BOWA E225_RFID_Mono_V02
Number of tested samples .....:	2
Serial Number(s) .....:	
Ratings .....:	+5 V ± 15% DC
Primary functions of EUT:	RFID
Type of modulation .....:	ASK 100% according to ISO 15693
Operating frequency bands.....:	13.110 – 14.010 MHz
Environment in which EUT is intended to be used.....:	Indoor 0°C to +35°C

The RFID reader is conceived for integration in the BOWA ARC-Series and Karl Storz Autocon III Series HF Generator with coding system. Communication via a DCU-Unit is made over serial protocol UART TTL.
The RFID reader is provided with 2 integrated antennas, which are controlled independently from each other. The antenna cannot be activated simultaneously but sequentially

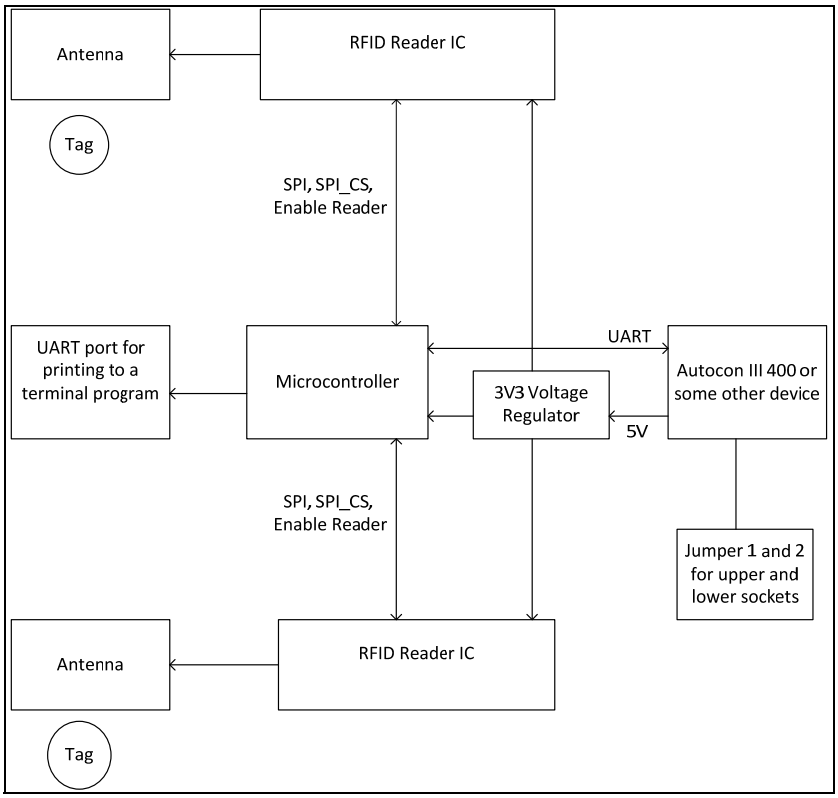


Figure 4-1: Block diagram of RFID device

4.1 Operational conditions

4.1.1 Software

Software necessary for operating, controlling and monitoring the EUT:

Name	Identification Code/Issue	Task

4.1.2 Radio parameters

The tested radio equipment was qualified acc. the following conditions:

Permitted Frequency Range			13.553 … 13.567 MHz
Frequency Separation			n/a
Number of Channels			1
Test Frequencies:			
	Transmitter		13.56 MHz
	Receiver		13.56 MHz
Transmitter:	**Rated Output Power (Prat)**		23 dBm
Modulation:	**Type**		ASK, 100%, ISO 15693
	Operation w/o modulation		Yes
Antenna:	**Type**		Integral
	Number of Antenna Ports		2
Power Src.:	**Type**		DC Supply
	Battery type (if applicable)		N/A
	Voltage	**nominal**	+5 V DC
		minimal	+4.25 V DC
		maximum:	+5.75 V DC

Table 4-1: Overview of EUT radio parameters

4.1.3 Operation modes

Operation mode	Active	State	Comment
1	☒	Continuous operation without transponder:	Continuous unmodulated carrier signal with maximum output power
2	☒	Continuous operation with a RFID transponder:	Reading of the RFID transponder
3	☒	Standby mode:	Device connected to active host, but TX/RX mode disabled.

4.1.4 Test configurations

Config.	EUT orientation		Active Antenna		Tag		Comment
	Vertical	Horizontal	Bottom	Top	Yes	No	
1	☒	☐	☒	☐	☐	☒	None
2	☒	☐	☐	☒	☐	☒	None
3	☐	☒	☒	☐	☐	☒	None
4	☐	☒	☐	☒	☐	☒	None
5	☒	☐	☒	☐	☒	☐	None
6	☒	☐	☐	☒	☒	☐	None
7	☐	☒	☒	☐	☒	☐	None
8	☐	☒	☐	☒	☒	☐	None
9	☒	☐	☐	☐	☒	☐	None
10	☐	☒	☐	☐	☐	☐	None
11	☒	☐	☒	☒	☐	☒	RFID Bipolar also connected and activated. All antennas sequentially polled
12	☒	☐	☒	☒	☒	☐	RFID Bipolar also connected and activated. All antennas sequentially polled. Tag @ one antenna of the RFID monopolar only
13	☒	☐	☒	☒	☐	☒	Test with Dummy Loads. RFID Bipolar also connected and activated. All antennas sequentially polled

4.2 Hardware Configuration

4.2.1 Components of the EUT

Name	Identification Code/Issue/Serial Number	Interface type	Quantity
RFID reader Monopolar	E225_RFID_Monopolar_V02		1
RFID reader Monopolar	E225_RFID_Monopolar_V02		1
HF Tag	--	Induction loop	1

4.2.2 Interface description

All interfaces are identified independent whether they are tested or not.

4.2.2.1 Power supply port

Type (AC/DC)	Voltage	Frequency	Current	Power
AC	100 V – 127 V 220 V – 240 V	60 Hz 50 Hz		
DC	5V	--	< 1A	

4.2.2.2 Earthing and Grounding connections [3]

Type	Task	Connected to	Test E/I/NA
None			

4.2.2.3 Communication [4] and signal [5] ports

Type	Bit rate/frequency/ Signal	Task	Connected to
UART	115200 BAUD	Control of Reader and monitoring of the Communication.	Control unit

3 Safety ground, functional earth, specific ground connections

4 Connections to communication networks, analog, Ethernet, antenna, wireless, GPS,

5 Signaling, monitoring and control ports

4.2.3 Cabling

Name	Identification Code/Issue/ Serial Number	shield	Description of Connection / plug type	length	Quantity
--					

4.2.4 Clock frequencies of the EUT resulting in determination of frequency range

System / Sub-system	Highest clock frequency
RFID	13.56 MHz

The result of the table above with the highest frequency of internal source is basis of the determination of the necessity of measurement above 1 GHz. The highest internal source of an EUT is defined as the highest frequency generated or used within the EUT or on which the EUT operates or tunes.

See **FCC §15.33 a)** for relevant frequency range of **intentional radiators**.
See **FCC §15.33 b)** for relevant frequency range of **unintentional radiators**.

See e.g. the following table taken from FCC §15.33 b) 1)

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	**Upper frequency of measurement range (MHz)**
Below 1.705	30
1.705-108	1000
108-500	2000
500-1000	5000
Above 1000	5th harmonic of the highest frequency or 40 GHz, whichever is lower

4.2.5 External protection devices or measures

EMC relevant external protection devices or measures specified in the user's manual (e.g. over-voltage, shielding, bonding and grounding).

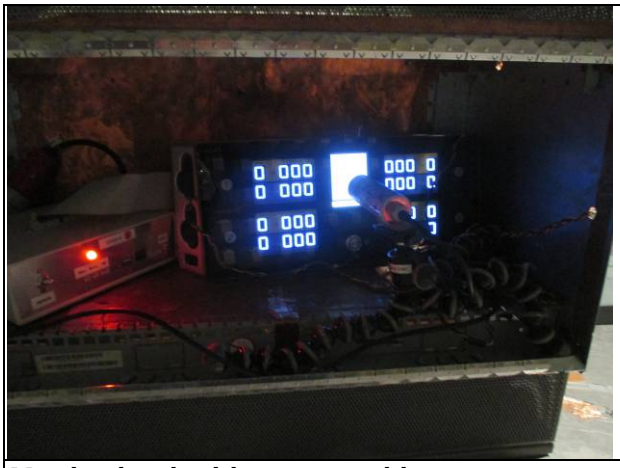
None

4.2.6 Modifications during the test

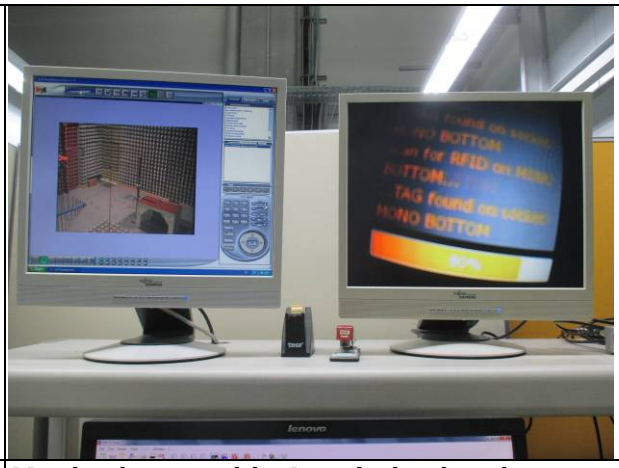
None

4.2.7 Operation and monitoring equipment

Name / Identification	Task	Availability [6] C/L
Host controller	Provide power supply and control signal to DUT	C
Power supply	Supplies host controller	C



Monitoring inside screened box



Monitoring outside Anechoic chamber

4.3 Deviations from Standard

None

[6] C: Provided by the customer, L: Available at laboratory

5 Test Equipment

5.1 Test Facility

The EMC-tests are carried out in the EMC-laboratory of SGS Germany, Consumer and Retail, Hofmannstraße 50, 81379 München, Germany.

Chamber	**1**	**2**	**3**	**4 / 5**	**6**
Dimensions (net)	17.7 * 10.8 * 6.8 m	9.6 * 8.5 * 5.3 m	7.4 * 6.6 * 5.2 m	4.1 * 3.5 * 3.5m	6.4 * 4.3 * 4.3m
Max. Door Exit (w x h)	2.9 * 3.86 m	3.9 * 4.0 m	2.0 * 2.7 m	0.9 * 2.25 m	1.8 * 3.0 m
Shielding material	Sheet steel (Thickness:1.5mm on floor, 1.0 mm on walls and ceiling)	Sheet steel	Sheet steel	Sheet steel	Sheet steel
Absorbers	Hybrid absorbers on walls and ceiling (TDK), length 1 m	Hybrid absorbers on walls and ceiling (E+C), length 0.5 m	Hybrid absorbers on walls and ceiling (E+C), length 0.3 m	Without absorbers	Without absorbers
Floor	Metallic ground plane floor load: 12 t/m²	Metallic ground plane floor load: 1.5 t/m²	Metallic ground plane floor load: 1 t/m²	Metallic ground plane	Metallic ground plane
Turntable	∅ 4 m / 7 t	∅ 3.2 m / 1.5 t	∅ 2.0 m / 1 t		
Listings	FCC-listed until Nov. 2017, Reg. No.: 90932 Industry Canada listed until June 2018 Reg. No. 9058A-1	FCC-listed until Nov. 2017, Reg. No.: 97242 Industry Canada listed until June 2018 Reg. No. 9058A-2 VCCI-listed until Oct. 2016, Reg. No. R-2623, G-266	FCC-listed until Nov. 2017, Reg. No.: 299569 Industry Canada listed until June 2018 Reg. No. 9058A-3		VCCI-listed until Oct. 2016, Reg. No. C-2866 & No. T-1942
Specials	***Emission*:** ***30 – 1000 MHz (d = 10 m)*** - NSA acc. to: ・ EN 55022 ・ CISPR 16-1-4 ・ ANSI C63.4 ***1 – 18 GHz (d = 3 m)*** Site VSWR 1 – 18 GHz acc. to CISPR 16-1-4	***Emission*:** ***30 – 1000 MHz (d = 3 m)*** - NSA acc. to: ・ EN 55022 ・ CISPR 16-1-4 ・ ANSI C63.4 ***1 – 18 GHz (d = 3 m)*** Site VSWR 1 – 18 GHz acc. to CISPR 16-1-4	***Emission*:** ***30 – 1000 MHz (d = 3 m)*** - NSA acc. to: ・ EN 55022 ・ CISPR 16-1-4 ・ ANSI C63.4 ***1 – 18 GHz (d = 3 m)*** Site VSWR 1 – 18 GHz acc. to CISPR 16-1-4		
	Immunity: Field uniformity 27 – 6000 MHz acc. EN 61000-4-3	***Immunity:*** Field uniformity 80 – 6000 MHz acc. EN 61000-4-3	***Immunity:*** Field uniformity 80 – 6000 MHz acc. EN 61000-4-3		
FCC (Federal Communication Commission): Accreditation by Bundesministerium für Wirtschaft und Arbeit (BMWA; BNetzA-CAB-14/21-09) and Designation as **CAB (Conformity Assessment Body):** Designation Number DE0013; Test firm Registration #: 366296					
Designation **KBA** (**Kraftfahrt-Bundesamt**) as Technical Service category A and D. Registration Number: KBA-P 00083-97					
CB Testing Laboratory under the responsibility of SGS CEBEC as National Certification Body and to carry out testing within the **IECEE CB Scheme.**					

5.2 Calibration of the Test Equipment

All relevant test equipment has a valid calibration. Additionally the used signal analyzers have a built-in self-calibration procedure. This calibration procedure was activated prior to the measurements so that the analyzer is deemed to be accurate. High quality cables were used to connect the measurement equipment. The actual loss of the attenuators and the cables was measured with a high precision network analyzer and taken into account for all measurements.

5.3 Measurement Uncertainty

As far as the underlying standards include requirements concerning the uncertainty of measuring instruments or measuring methods, they are met.
The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities.

The expanded measurement uncertainty of the measuring chain was calculated for all tests according to the “ISO Guide to the expression of uncertainty in measurement (GUM)”. The results are documented in an “internal controlled document”.

The measuring accuracy for all measuring devices is given in their technical description. The measuring instruments, including any accessories, are calibrated respectively verified to ensure the necessary accuracy. Depending on the kind of measuring equipment it is checked within regular intervals or directly before the measurement is performed. Adjustments are made and correction factors applied to measured data in accordance with the specifications of the specific instrument.

The expanded measurement instrumentation uncertainty of our Test Laboratory meets the requirements of IEC CISPR 16-4-2 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics and limit modeling – Measurement instrumentation uncertainty” and the relevant basic standards for all listed Tests.

6 Test Conditions and Results

6.1 Test No. 1: Conducted Emissions (§ 15.207)

6.1.1 Purpose

The AC power-line conducted emissions caused by the EUT via the power lines were measured pursuant to [4] KDB174176 in the frequency range from 150 kHz to 30 MHz.

6.1.2 Limits

Following conducted emission limits are specified by [1] § 15.207:

Frequency of Emission [MHz]	Conducted Limit [dBµV]	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5.0	56	46
5.0-30.0	60	50

Table 6-1: Limits – Conducted Emissions

6.1.3 EUT Operating Condition

The standard setup procedure as described in section 4.1.3 of this report was used.

Climatic condition during test:	Test Chamber 6	Test Chamber 4
Temperature (°C):	23.2	23.5
Rel. Humidity (%):	37.3	27.1

Operation mode (see 4.1.3)		
☒ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)												
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☒ 11	☒ 12	☒ 13

6.1.4 Test Configuration

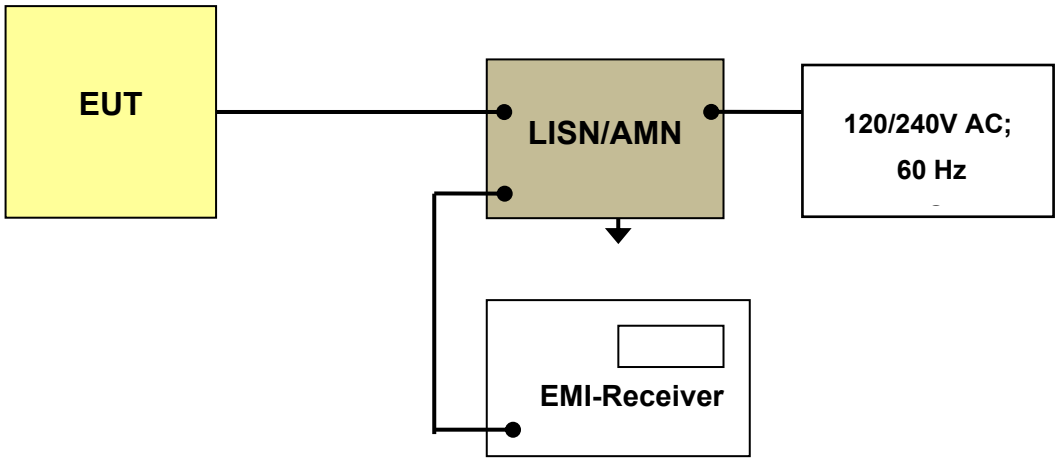


Figure 6-1: Test Configuration – Conducted Emissions (150 kHz – 30 MHz)

Photographs of the EUT setup for conducted emission measurement are shown on page 65 of this report.

6.1.5 Test instruments and accessories

ID. No.	Equipment	Specification	Status	Next Cal.
P1100	EMI receiver	9 kHz - 3 GHz	cal	Mar 2018
P0323	EMI receiver	5 Hz - 1 GHz	cal	Mar 2018
P0441	LISN (integrated pulse limiter P0488)	2 x 10 A; 50 Ohm	cal	Mar 2017
P2076	Power Supply	max Power: 4000 VA; Accuracy: 0.2% +0.2% F.S.; Frequency: DC, 15-1 kHz; Accuracy: 0.15%;	ind	
P1813	multimeter, digital (MZ06)	60 mV...600V, 60mA....10A, 600Ohm...40MOhm, 0.1Hz...1kHz, -50,0 °C ...+400,0°C	cal	Jun 2017
P1917	Data logger for humidity and temperature (MZ6)	Sensortyp NTC: -20....+ 70°C, Auflösung: 0.1 °C; Genauigkeit: +/- 0.4 °C; Feuchtesensor kapazitiv: 0 ... 100 %rF; Genauigkeit: +/- 2 %rF bei 25 °C; Au	chk	Dec 2017
P0977	test chamber 6	6.4 • 4.3 • 4.35 m; without absorbers	chk	Jan 2017

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, calchk = Calibration and check, ind = for indication only, cnn = Calibration not necessary

Test instruments and accessories for DUT with Dummy Load

ID. No.	Equipment	Specification	Status	Next Cal.
P0320	EMI receiver, MZ4	9 kHz - 2.75 GHz	cal	Mar 2018
P1325	EMI receiver	9 kHz - 3 GHz, with preselector	cal	Mar 2017
P1891	RF-Relais-Matrix	0 - 6 GHz (1-3); 0 - 0.5 GHz (4-6)	cnn	
P2076	Power Supply	max Power: 4000 VA; Accuracy: 0.2% +0.2% F.S.; Frequency: DC, 15-1 kHz; Accuracy: 0.15%;	ind	
P0438	LISN (integrated pulse limiter P0993)	2 x 10 A; 50 Ohm	cal	Mar 2017
P1915	Data logger for humidity and temperature (MZ4)	Sensortyp NTC: -20....+ 70°C, Auflösung: 0.1 °C; Genauigkeit: +/- 0.4 °C; Feuchtesensor kapazitiv: 0 ... 100 %rF; Genauigkeit: +/- 2 %rF bei 25 °C; Au	chk	Dec 2017
P1560	multimeter, digital	60 mV...600V, 60mA....10A, 600Ohm...40MOhm, 0.1Hz...1kHz, -50,0 °C ...+400,0°C	cal	Apr 2017
P0339	test chamber 4	4.1 • 3.5 • 3.0 m; without absorbers	chk	Feb 2018

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, calchk = Calibration and check, ind = for indication only, cnn = Calibration not necessary

6.1.6 Test Procedure and Results

Measured levels of power-line conducted emission are the radio-noise voltage levels across the 50 Ω LISN port (to which the EUT is connected) terminated into a 50 Ω EMI receiver. All radio-noise voltage measurements are made on each current carrying conductor at the plug end of the EUT power cord. The measurement is performed using a receiver with peak and average detector.
Only if the measured peak value is near or above the quasi-peak limit the detector function is changed to quasi-peak for final measurement of the highest voltage levels.

Exploratory emission measurements are to be performed considering operation states and cable arrangement to evaluate configuration with highest emission levels (C63.10-2013, Clause 6.2.4).

Acc. ANSI C63.10-2013 Annex B.2.8.3 AC power-line conducted emissions measurements are to be separately carried out only on each of the phase ("hot") line(s) and (if used) on the neutral line(s), but not on the ground [protective earth) line(s).

EMC-Test-SW: EMC32 version 10.10.02 (R&S)

Test location: EMC-chamber No. 6

Sample Calculation with all conversion and correction factors used:
$\sum CF = CF_{Cables} + CF_{LISN}$

Result:

verdict:	**compliant**

The following table shows the measured conducted emissions. Plots of the measurements are included on pages 46 to 53 of this report.

Result table Neutral line (120 V AC / 60 Hz) – no Tag:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.150000	---	37.97	56.00	18.03	1000.0	9.000	N	GND	10.1
0.578000	---	21.95	46.00	24.05	1000.0	9.000	N	GND	10.1
0.594000	---	23.25	46.00	22.75	1000.0	9.000	N	GND	10.1
0.606000	---	24.55	46.00	21.45	1000.0	9.000	N	GND	10.1
0.626000	---	26.91	46.00	19.09	1000.0	9.000	N	GND	10.1
0.638000	---	26.53	46.00	19.47	1000.0	9.000	N	GND	10.1
13.614000	45.03	---	60.00	14.97	1000.0	9.000	N	GND	10.6
27.122000	---	32.89	50.00	17.11	1000.0	9.000	N	GND	11.2
29.010000	---	32.27	50.00	17.73	1000.0	9.000	N	GND	11.2

Result table Phase line (120 V AC / 60 Hz) – no Tag:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.162000	---	32.11	55.36	23.25	1000.0	9.000	L1	GND	10.1
0.606000	---	23.73	46.00	22.27	1000.0	9.000	L1	GND	10.1
0.614000	---	25.88	46.00	20.12	1000.0	9.000	L1	GND	10.1
0.638000	---	25.16	46.00	20.84	1000.0	9.000	L1	GND	10.1
13.414000	---	8.53	50.00	41.47	1000.0	9.000	L1	GND	10.6
13.414000	32.47	---	60.00	27.53	1000.0	9.000	L1	GND	10.6
27.122000	---	31.56	50.00	18.44	1000.0	9.000	L1	GND	11.2
29.006000	---	30.92	50.00	19.08	1000.0	9.000	L1	GND	11.2

Result table Neutral line (120 V AC / 60 Hz) – Dummy Load without Tag:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.150000	---	36.37	56.00	19.63	1000.0	9.000	N	GND	10.1
0.634000	---	24.76	46.00	21.24	1000.0	9.000	N	GND	10.1
0.638000	31.04	---	56.00	24.96	1000.0	9.000	N	GND	10.1
13.558000	30.20	---	60.00	29.80	1000.0	9.000	N	GND	10.7
13.558000	---	25.50	50.00	24.50	1000.0	9.000	N	GND	10.7
13.562000	28.40	---	60.00	31.60	1000.0	9.000	N	GND	10.7
13.562000	---	25.31	50.00	24.69	1000.0	9.000	N	GND	10.7
22.014000	29.83	---	60.00	30.17	1000.0	9.000	N	GND	11.1

Result table Phase line (120 V AC / 60 Hz) – Dummy Load without Tag:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.154000	---	32.28	55.78	23.50	1000.0	9.000	L1	GND	10.1
0.622000	33.66	---	56.00	22.34	1000.0	9.000	L1	GND	10.1
0.634000	---	26.94	46.00	19.06	1000.0	9.000	L1	GND	10.1
13.562000	29.43	---	60.00	30.57	1000.0	9.000	L1	GND	10.7
13.562000	---	26.02	50.00	23.98	1000.0	9.000	L1	GND	10.7
21.726000	30.86	---	60.00	29.14	1000.0	9.000	L1	GND	11.0

Result table Neutral line (240 V AC / 60 Hz) – no Tag:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.150000	---	38.13	56.00	17.87	1000.0	9.000	N	GND	10.1
0.634000	---	23.05	46.00	22.95	1000.0	9.000	N	GND	10.1
0.654000	---	24.78	46.00	21.22	1000.0	9.000	N	GND	10.1
27.122000	---	32.87	50.00	17.14	1000.0	9.000	N	GND	11.2
29.010000	---	32.22	50.00	17.78	1000.0	9.000	N	GND	11.2

Result table Phase line (240 V AC / 60 Hz) – no Tag:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.158000	---	34.59	55.57	20.97	1000.0	9.000	L1	GND	10.1
0.190000	---	30.77	54.04	23.26	1000.0	9.000	L1	GND	10.1
0.198000	---	29.98	53.69	23.72	1000.0	9.000	L1	GND	10.1
13.594000	42.66	---	60.00	17.34	1000.0	9.000	L1	GND	10.6
13.642000	---	8.84	50.00	41.16	1000.0	9.000	L1	GND	10.6
13.642000	32.91	---	60.00	27.09	1000.0	9.000	L1	GND	10.6
27.118000	---	31.35	50.00	18.65	1000.0	9.000	L1	GND	11.2
29.010000	---	30.60	50.00	19.40	1000.0	9.000	L1	GND	11.2

Result table Neutral line (240 V AC / 60 Hz) – Dummy Load without Tag:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.150000	---	36.97	56.00	19.03	1000.0	9.000	N	GND	10.1
0.150000	43.14	---	66.00	22.86	1000.0	9.000	N	GND	10.1
0.662000	29.89	---	56.00	26.11	1000.0	9.000	N	GND	10.1
13.562000	---	25.68	50.00	24.32	1000.0	9.000	N	GND	10.7
13.562000	27.51	---	60.00	32.49	1000.0	9.000	N	GND	10.7
21.322000	27.00	---	60.00	33.00	1000.0	9.000	N	GND	11.0

Result table Phase line (240 V AC / 60 Hz) – Dummy Load without Tag:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.150000	---	35.99	56.00	20.01	1000.0	9.000	L1	GND	10.1
0.658000	31.38	---	56.00	24.62	1000.0	9.000	L1	GND	10.1
13.562000	---	25.18	50.00	24.82	1000.0	9.000	L1	GND	10.7
13.562000	29.32	---	60.00	30.68	1000.0	9.000	L1	GND	10.7
21.630000	28.79	---	60.00	31.21	1000.0	9.000	L1	GND	11.0

Result table Neutral line (120 V AC / 60 Hz) – Tag @ antenna bottom:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.614000	---	27.03	46.00	18.97	1000.0	9.000	N	GND	10.1
0.630000	---	26.54	46.00	19.46	1000.0	9.000	N	GND	10.1
13.574000	55.88	---	60.00	4.12	1000.0	9.000	N	GND	10.6
13.622000	---	22.73	50.00	27.27	1000.0	9.000	N	GND	10.6
13.622000	48.72	---	60.00	11.28	1000.0	9.000	N	GND	10.6
14.034000	---	10.89	50.00	39.11	1000.0	9.000	N	GND	10.7
27.122000	---	34.16	50.00	15.84	1000.0	9.000	N	GND	11.2
29.006000	---	32.50	50.00	17.50	1000.0	9.000	N	GND	11.2

Result table Phase line (120 V AC / 60 Hz) – Tag @ antenna bottom:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.162000	---	32.00	55.36	23.36	1000.0	9.000	L1	GND	10.1
0.610000	---	25.45	46.00	20.55	1000.0	9.000	L1	GND	10.1
0.626000	---	25.38	46.00	20.62	1000.0	9.000	L1	GND	10.1
0.642000	---	24.29	46.00	21.71	1000.0	9.000	L1	GND	10.1
13.642000	42.04	---	60.00	17.96	1000.0	9.000	L1	GND	10.6
13.646000	---	13.51	50.00	36.49	1000.0	9.000	L1	GND	10.6
13.782000	---	10.19	50.00	39.81	1000.0	9.000	L1	GND	10.6
13.918000	---	8.56	50.00	41.44	1000.0	9.000	L1	GND	10.6
27.122000	---	32.71	50.00	17.29	1000.0	9.000	L1	GND	11.2
29.010000	---	30.74	50.00	19.26	1000.0	9.000	L1	GND	11.2

Result table Neutral line (240 V AC / 60 Hz) – Tag @ antenna bottom:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.150000	---	38.13	56.00	17.87	1000.0	9.000	N	GND	10.1
0.662000	---	25.06	46.00	20.94	1000.0	9.000	N	GND	10.1
13.410000	---	16.10	50.00	33.90	1000.0	9.000	N	GND	10.6
13.410000	41.27	---	60.00	18.73	1000.0	9.000	N	GND	10.6
13.830000	---	11.71	50.00	38.29	1000.0	9.000	N	GND	10.6
13.830000	35.86	---	60.00	24.14	1000.0	9.000	N	GND	10.6
14.250000	---	6.80	50.00	43.20	1000.0	9.000	N	GND	10.7
29.010000	---	32.27	50.00	17.73	1000.0	9.000	N	GND	11.2

Result table Phase line (240 V AC / 60 Hz) – Tag @ antenna bottom:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.150000	---	38.35	56.00	17.65	1000.0	9.000	L1	GND	10.1
0.170000	---	32.41	54.96	22.55	1000.0	9.000	L1	GND	10.1
13.094000	---	8.46	50.00	41.54	1000.0	9.000	L1	GND	10.6
13.370000	---	7.50	50.00	42.50	1000.0	9.000	L1	GND	10.6
13.506000	38.75	---	60.00	21.25	1000.0	9.000	L1	GND	10.6
13.722000	---	15.57	50.00	34.43	1000.0	9.000	L1	GND	10.6
13.722000	28.97	---	60.00	31.03	1000.0	9.000	L1	GND	10.6
27.118000	---	32.77	50.00	17.23	1000.0	9.000	L1	GND	11.2
29.006000	---	30.80	50.00	19.20	1000.0	9.000	L1	GND	11.2

Result table Neutral line (120 V AC / 60 Hz) – Tag @ antenna Top:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.598000	---	23.78	46.00	22.22	1000.0	9.000	N	GND	10.1
0.618000	---	26.86	46.00	19.14	1000.0	9.000	N	GND	10.1
0.630000	---	26.81	46.00	19.19	1000.0	9.000	N	GND	10.1
13.210000	31.36	---	60.00	28.64	1000.0	9.000	N	GND	10.6
13.482000	46.21	---	60.00	13.79	1000.0	9.000	N	GND	10.6
13.482000	---	20.60	50.00	29.40	1000.0	9.000	N	GND	10.6
13.618000	49.55	---	60.00	10.45	1000.0	9.000	N	GND	10.6
13.750000	34.81	---	60.00	25.19	1000.0	9.000	N	GND	10.6
13.754000	---	11.16	50.00	38.84	1000.0	9.000	N	GND	10.6
13.890000	---	8.70	50.00	41.30	1000.0	9.000	N	GND	10.6
14.026000	---	10.94	50.00	39.06	1000.0	9.000	N	GND	10.7
14.026000	32.22	---	60.00	27.78	1000.0	9.000	N	GND	10.7
27.122000	---	34.45	50.00	15.55	1000.0	9.000	N	GND	11.2

Result table Phase line (120 V AC / 60 Hz) – Tag @ antenna Top:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.150000	---	38.23	56.00	17.77	1000.0	9.000	L1	GND	10.1
0.150000	43.11	---	66.00	22.89	1000.0	9.000	L1	GND	10.1
0.178000	---	29.24	54.58	25.33	1000.0	9.000	L1	GND	10.1
0.610000	---	25.52	46.00	20.48	1000.0	9.000	L1	GND	10.1
0.618000	---	26.13	46.00	19.87	1000.0	9.000	L1	GND	10.1
0.626000	---	25.23	46.00	20.77	1000.0	9.000	L1	GND	10.1
27.122000	---	32.52	50.00	17.48	1000.0	9.000	L1	GND	11.2
29.010000	---	30.75	50.00	19.25	1000.0	9.000	L1	GND	11.2

Result table Neutral line (240 V AC / 60 Hz) – Tag @ antenna Top:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.154000	---	35.08	55.78	20.70	1000.0	9.000	N	GND	10.1
0.650000	---	24.94	46.00	21.06	1000.0	9.000	N	GND	10.1
13.486000	45.41	---	60.00	14.59	1000.0	9.000	N	GND	10.6
13.486000	---	15.72	50.00	34.28	1000.0	9.000	N	GND	10.6
13.710000	---	16.73	50.00	33.27	1000.0	9.000	N	GND	10.6
13.710000	41.86	---	60.00	18.14	1000.0	9.000	N	GND	10.6
13.846000	33.89	---	60.00	26.11	1000.0	9.000	N	GND	10.6
14.122000	---	8.59	50.00	41.41	1000.0	9.000	N	GND	10.7
29.010000	---	32.25	50.00	17.75	1000.0	9.000	N	GND	11.2

Result table Phase line (240 V AC / 60 Hz) – Tag @ antenna Top:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.150000	---	38.28	56.00	17.72	1000.0	9.000	L1	GND	10.1
0.202000	---	29.39	53.53	24.14	1000.0	9.000	L1	GND	10.1
27.118000	---	32.24	50.00	17.76	1000.0	9.000	L1	GND	11.2
29.010000	---	30.68	50.00	19.32	1000.0	9.000	L1	GND	11.2

6.2 Test No. 2: Occupied Bandwidth (§ 15.215c)

6.2.1 Purpose

The occupied bandwidth of the EUT was measured pursuant to [2] ANSI 63.10 Clause 6.9.2. The measurement was performed to verify the 20 dB and 99% bandwidth of the emission.

6.2.2 Limits

According to § 15.215 intentional radiators operating under the alternative provisions to the general emission limits, as contained in [1] § 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, 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.

6.2.3 EUT Operating Condition

The standard setup procedure as described in section 4.1 of this report was used.

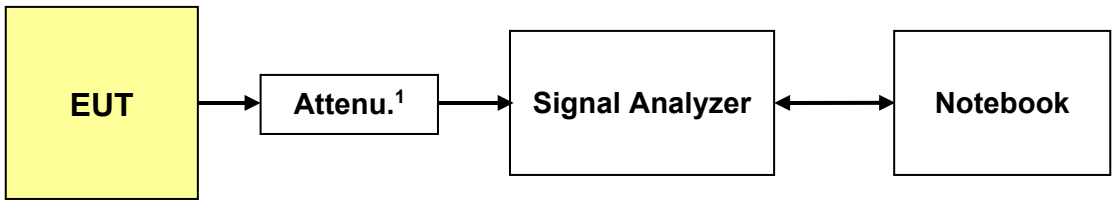
Climatic condition during test

Temperature (°C): 21.6
Rel. Humidity (%): 22.0

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☐ 1	☐ 2	☐ 3	☐ 4	☒ 5	☒ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12

6.2.4 Test Configuration



1) Attenuator (if applicable)

Figure 6-2: Test Configuration – Occupied Bandwidth

Photographs of the EUT setup for occupied bandwidth measurement are shown on page 66 of this report.

6.2.5 Test instruments and accessories

ID. No.	Equipment	Specification	Status	Next Cal.
P1845	Spectrum Analyzer	20 Hz bis 26,5 GHz; Linearität: 0,1 dB (0 dB bis –70 dB)	cal	Mar 2018
P1740	Frequency Standard		cal	Mar 2018
P1689	Power Supply (DC Switch Mode)	Output (DC): 3 - 15V / 25A	ind	
P1814	multimeter, digital (MZ-Spibe)	60 mV...600V, 60mA....10A, 600Ohm...40MOhm, 0.1Hz...1kHz, -50,0 °C ...+400,0°C	cal	Jun 2017
P1353	multimeter, digital	10µV...1000V, 10nA....10A, 10mOhm...40MOhm, 10pF...1mF, 0.1Hz...30kHz	cal	Apr 2017
P1576	Heating Cabinet	Temperaturbereich: ca. -70 °C bis + 180° C; Nutzraum-volumen: 115 Liter	ind	

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, calchk = Calibration and check, ind = for indication only, cnn = Calibration not necessary

6.2.6 Test Procedure and Results

The 20 dB bandwidth of the carrier emission is measured using a spectrum analyzer.
In order to measure the modulated signal properly, a resolution bandwidth that is small compared with the bandwidth required by the procuring or regulatory agency shall be used on the measuring instrument. However, the resolution bandwidth of the measuring instrument shall be set to a value within 1 % to 5% of the signal bandwidth requirements.

Screenshots of the measurements are included on pages 54 and 55 of this report.
The following table summarizes the results:

The occupied bandwidth was found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

6.2.6.1 Results for Test configuration 5

Carrier Frequency	Occupied Bandwidth		Result
[MHz]	[Hz]		
	-20 dB	99%	
13.56	26.042	22.292	compliant
Measurement Uncertainty:			±48kHz

Table 6-2: Results – Occupied Bandwidth – Configuration 5

6.2.6.2 Results for Test configuration 6

Carrier Frequency	Occupied Bandwidth		Result
[MHz]	[kHz]		
	-20 dB	99%	
13.56	26.250	22.500	compliant
Measurement Uncertainty:			±48kHz

Table 6-3: Results – Occupied Bandwidth – Configuration 6

6.3 Test No. 3: Radiated Emissions (§ 15.205, § 15.209, § 15.225a-d)

6.3.1 Purpose

The radiated emissions of the EUT were measured pursuant to [2] ANSI 63.10 Clauses 6.4, and 6.5. The measurement was performed to verify that emissions radiated directly from the cabinet, control circuits, power leads or intermediate circuit elements are attenuated below the specified limits.

6.3.2 Limits

According to § 15.205, only spurious emissions are permitted in restricted band of operation.

According to § 15.209 and 15.225(a-d), the radiated emissions of an intentional radiator must not exceed following field strength levels:

Frequency of Emission [MHz]	Field strength [µV/m]	Meas. Distance [m]
0.009-0.490	2400/F [kHz]	300
0.490-1.705	24000/F [kHz]	30
1.705-13.110	30	30
13.110-13.410	106	30
13.410-13.553	334	30
13.553-13.567	15848	30
13.567-13.710	334	30
13.710-14.010	106	30
14.010-30.00	30	30
30–88	100	3
88–216	150	3
216–960	200	3
Above 960	500	3

1) According to § 15.205 (d7) devices operating in the frequency band 13.11 to 14.01 MHz are exempt from complying with this requirements for the 13.36 to 13.41 MHz band only.

Table 6-4: Limits – Radiated Emissions

6.3.3 EUT Operating Condition

The standard setup procedure as described in section 4.1 of this report was used.

6.3.4 Test Configuration

The measurements were performed in an anechoic chamber. The radiated test site complies with the site attenuation requirements listed in ANSI C63.4 and is listed with the FCC.

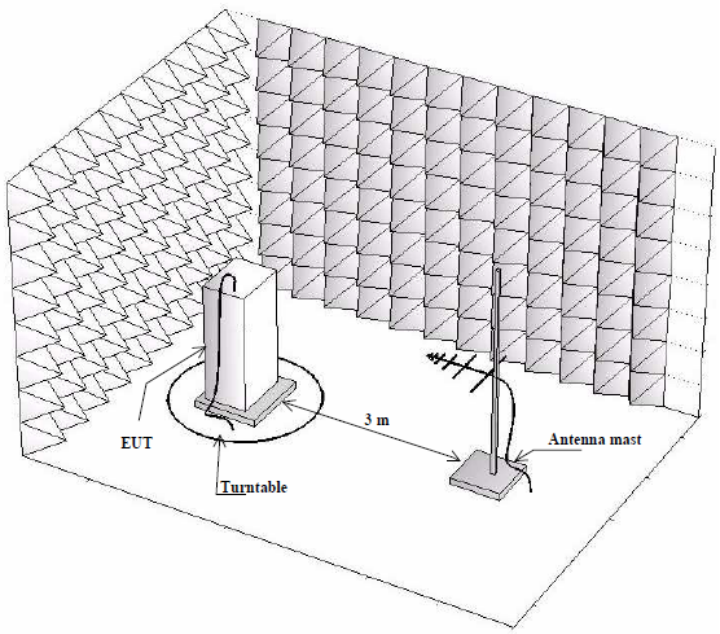


Figure 6-3: Test Configuration – Radiated Emissions

Photographs of the EUT in the anechoic chamber are shown on page 67 of this report.

6.3.5 Test Procedure and Results

6.3.5.1 Radiated emissions - 30 MHz to 1000 MHz (§ 15.205, § 15.209)

Phenomena	Reference	Frequency Range	Criteria	Verdict
Radio Disturbance Electric Field	FCC 47 CFR Part 15 §15.209	30 MHz - 1 GHz distance 3 m	Class B	P
Radio Disturbance Electric Field	ICES-003	30 MHz - 1 GHz distance 3 m	Class B	P

(The radiated emission limits < 1 GHz of FCC 47 CFR Part 15 §15.209 Class A/B are identical with ICES-003 class A/B.)

Test procedure:

Radiated measurements are performed in a semi-anechoic chamber meeting the normalized site attenuation of ANSI C63.4 and listed with the FCC. The applicable frequency spectrum is scanned with a calibrated RF measuring system using an appropriate broadband antenna and an EMI-receiver/spectrum analyzer and compared to the required limits. The measuring instrument performs the field strength calculations automatically. The measuring software provides resident AF and CF figures for individual antennas and cables. The receiver/analyzer is set to

"peak" mode from 30 MHz to 1 GHz. On any emission of concern, the receiver is set to quasi-peak mode.

“Maximization” of each suspect frequency is accomplished by a combination of a 360° azimuth search using a turntable and varying the antenna to ground plane height from 1 m to 4 m. Also, both the vertical and horizontal polarization is scanned in the required frequency range per ANSI C63.10.
Maximization of emission results starts at 0° of the turn table with antenna in horizontal polarization is set to 1 m. While the turntable slowly moves to 360°, the spectrum analyzer is sweeping from 30 to 1000 MHz and maximum data is recorded. Antenna is set to 2 m and turntable slowly moves back to 0° while the spectrum analyzer is sweeping again. This is repeated until the antenna height of 4 m is reached.
The antenna polarization is set to vertical and the procedure described above is repeated.
For each frequency the measuring software stores the maximum level as well as the corresponding settings of turntable and antenna. An azimuth resolution of about 3° is realized using this method.
At least the six highest frequencies are selected automatically by the software for performing the final measurements.
At each of these frequencies the turntable as well as the antenna is set to the corresponding settings. Then the antenna is slowly moved 50 cm down/up related to initial position while the receiver is measuring at this frequency. The highest emission level and the corresponding height are recorded. At this final position, the measurement is performed with quasi-peak detector.
Exploratory emission measurements are to be performed considering operation states and cable arrangement to evaluate configuration with highest emission levels (C63.10, Clause 6.6.4.2).

Test location: semi anechoic chamber No. 3

EMC-Test-SW: EMC32 version 10.01.00 (R&S)

Instruments and accessories

ID	Measuring Instrument	Specification	Status	Calibration due
P1326	EMI receiver	20Hz - 26.5GHz, FFT-Scan, Preamplifier 100kHz - 26.5GHz, 30dB	cal	Mar 2018
P1299	video camera MZ3		ind	
P1303	Mast (MZ3)	1 - 4m, hor./vert., Tilt	cnn	
P1304	Controller	4 ports, fiber optic, GPIB & LAN	cnn	
P0311	antenna	30 - 1000 MHz E	cal	Apr 2018
P1811	multimeter, digital (MZ03)	60 mV...600V, 60mA....10A, 600Ohm...40MOhm, 0.1Hz...1kHz, -50,0 °C ...+400,0°C	cal	Jun 2017
P1546	Frequency Converter	2,0 kVA 1-phase; AC-input-input: 230V 50/60Hz +/- 10% 1-phase; idle approx. 0,3 A;	cnn	
P1269	absorbing clamp	1 - 1000 MHz	cnn	
P1914	Data logger for humidity and temperature (MZ3)	Sensortyp NTC: -20....+ 70°C, Auflösung: 0.1 °C; Genauigkeit: +/- 0.4 °C; Feuchtesensor kapazitiv: 0 ... 100 %rF; Genauigkeit: +/- 2 %rF bei 25 °C; Au	chk	Dec 2016
P0338	test chamber 3	7.4 x 6.6 x 5.2 m (net), 0.4 m hybrid absorbers	chk	Jan 2017

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, calchk = Calibration and check, ind = for indication only, cnn = Calibration not necessary, man = Maintenance

Climatic condition during test

Temperature (°C): 22.1 – 22.6
Rel. Humidity (%): 27.2 – 26.7

6.3.5.1.1 Results for configuration 5

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☐ 1	☐ 2	☐ 3	☐ 4	☒ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 61 of this report.

Result table:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.670000	21.76	40.00	18.24	1000.0	120.000	100.0	V	55.0	-19.7
46.926500	21.29	40.00	18.71	1000.0	120.000	136.0	V	325.0	-22.9
76.317500	14.90	40.00	25.10	1000.0	120.000	99.0	V	170.0	-25.8
144.023500	22.11	43.50	21.39	1000.0	120.000	99.0	V	120.0	-20.9
288.068500	25.21	46.00	20.79	1000.0	120.000	99.0	H	171.0	-18.6

6.3.5.1.2 Results for configuration 6

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☒ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 61 of this report.

Result table:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.718500	17.49	40.00	22.51	1000.0	120.000	100.0	V	293.0	-19.7
41.155000	20.26	40.00	19.74	1000.0	120.000	150.0	V	12.0	-19.9
75.444500	15.02	40.00	24.98	1000.0	120.000	109.0	V	97.0	-25.9
144.023500	18.84	43.50	24.66	1000.0	120.000	108.0	V	84.0	-20.9
288.068500	27.44	46.00	18.56	1000.0	120.000	160.0	H	54.0	-18.6
833.451000	18.22	46.00	27.78	1000.0	120.000	219.0	H	185.0	-6.9
841.502000	28.22	46.00	17.78	1000.0	120.000	125.0	H	9.0	-6.4

6.3.5.1.3 Results for configuration 9

Operation mode (see 4.1.3)		
☐ 1	☐ 2	☒ 3

Test configuration (see 4.1.4)											
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☒ 9	☐ 10	☐ 11	☐ 12

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 62 of this report.

Result table:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
35.965500	9.89	40.00	30.11	1000.0	120.000	144.0	V	173.0	-17.3
95.863000	12.98	43.50	30.52	1000.0	120.000	109.0	V	211.0	-22.6
240.102000	15.47	46.00	30.53	1000.0	120.000	260.0	H	57.0	-21.1
288.068500	16.68	46.00	29.32	1000.0	120.000	99.0	H	313.0	-18.6
551.132500	18.90	46.00	27.10	1000.0	120.000	99.0	H	275.0	-10.4

6.3.5.1.4 Results for configuration 7

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☒ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 62 of this report.

Result table:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.670000	19.13	40.00	20.87	1000.0	120.000	150.0	V	253.0	-19.7
42.949500	14.22	40.00	25.78	1000.0	120.000	137.0	V	282.0	-20.9
47.945000	17.40	40.00	22.60	1000.0	120.000	99.0	V	294.0	-23.5
144.023500	20.92	43.50	22.58	1000.0	120.000	111.0	V	122.0	-20.9
288.068500	27.54	46.00	18.46	1000.0	120.000	169.0	H	68.0	-18.6
841.502000	16.79	46.00	29.21	1000.0	120.000	150.0	V	96.0	-6.4

6.3.5.1.5 Results for configuration 8

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☒ 8	☐ 9	☐ 10	☐ 11	☐ 12

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 63 of this report.

Result table:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
42.416000	20.96	40.00	19.04	1000.0	120.000	146.0	V	303.0	-20.6
144.072000	21.56	43.50	21.94	1000.0	120.000	99.0	V	97.0	-20.9
192.038500	20.30	43.50	23.20	1000.0	120.000	110.0	H	74.0	-23.9
240.053500	20.85	46.00	25.15	1000.0	120.000	249.0	H	49.0	-21.1
288.068500	27.62	46.00	18.38	1000.0	120.000	170.0	H	68.0	-18.6
832.626500	23.49	46.00	22.51	1000.0	120.000	100.0	V	327.0	-7.0
841.114000	16.74	46.00	29.26	1000.0	120.000	128.0	H	74.0	-6.4

6.3.5.1.6 Results for configuration 10

Operation mode (see 4.1.3)		
☐ 1	☐ 2	☒ 3

Test configuration (see 4.1.4)											
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☒ 10	☐ 11	☐ 12

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 63 of this report.

Result table:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
319.108500	22.25	46.00	23.75	1000.0	120.000	99.0	V	175.0	-17.6
377.114500	22.43	46.00	23.57	1000.0	120.000	100.0	H	250.0	-16.2
832.675000	21.65	46.00	24.35	1000.0	120.000	150.0	V	112.0	-7.0

6.3.5.2 Radiated Emissions – 9 kHz to 30 MHz (§ 15.225a-d, §15.209)

Phenomena	Reference	Test Specification	Criteria	Verdict [7]
Radio Disturbance Magnetic Field	FCC 47 CFR Part 15 §15.225a-d	9 kHz -30 MHz Distance 10 m	Class B	P

Climatic condition during test

Temperature (°C): 20.0 – 20.0
Rel. Humidity (%): 45.1 – 44.1

Test procedure:

Radiated measurements are performed in a semi-anechoic chamber listed with the FCC. The applicable frequency spectrum is scanned with a calibrated RF measuring system using an appropriate loop antenna and an EMI-receiver/spectrum analyzer and compared to the required limits. The measuring instrument performs the field strength calculations automatically. The measuring software provides resident AF and CF figures for individual antennas and cables. The receiver/analyzer is set to "peak" mode from 9 kHz to 30 MHz. For the RFID Mask frequency range is limited from 12.66 MHz to 14.46 MHz.

“Maximization” is accomplished by a combination of a 360° azimuth search using a turntable. Also, both the vertical and horizontal polarization is scanned in the required frequency range per ANSI C63.4.

Limits:

Compliance with § 15.225a-d requires that the field strength of any emissions shall not exceed limits given in µV/m at 30 meters.

The magnetic field measurements have been performed using a loop antenna at a measuring distance of 3 meters, yielding results in dBµA/m unit. Thus FCC compliance limits need to be converted from µV/m at different measuring distance (300m, 30 m) to dBµA/m at the used measuring distance of 3 meters by calculation as given in Annex A.

Test location: semi anechoic chamber No. 2

EMC-Test-SW: EMC32 version 9.21 (R&S)

Sample Calculation with all conversion and correction factors used:
$\sum CF = CF_{Cables} + CF_{Antenna}$

[7] P (Pass): test object meets the requirement; F (Fail): test object does not meet the requirement; N/A: test case does not apply to the test object; NR: test case is not requested by the client. FCC requires radiated emission testing up to the 5th harmonic of the highest clock rate of the tested system.

Instruments and accessories

ID. No.	Equipment	Specification	Status	Next Cal.
P2062	EMI receiver	9 kHz - 26,5 GHz	cal	Aug 2018
P1544	DC-Block (9kHz - 18 GHz)	9 kHz - 18 GHz; 0.9 dB max; +50 VDC / 20W max.	chk	May 2017
P1140	Controller	4 ports, fiber optic, GPIB & LAN	cnn	
P0073	antenna	0.01 - 30 MHz	chk	Jun 2017
P1366	video camera MZ1		ind	
P1546	Frequency Converter	2,0 kVA 1-phase; AC-input-input: 230V 50/60Hz +/- 10% 1-phase; idle approx. 0,3 A;	cnn	
P1912	Data logger for humidity and temperature (MZ1)	Sensortyp NTC: -20....+ 70°C, Auflösung: 0.1 °C; Genauigkeit: +/- 0.4 °C; Feuchtesensor kapazitiv: 0 ... 100 %rF; Genauigkeit: +/- 2 %rF bei 25 °C; Au	chk	Dec 2016
P0336	test chamber 1	17.7 x 10.8 x 6.8 m (net), 1 m hybrid absorbers	chk	Jan 2017

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, calchk = Calibration and check, ind = for indication only, cnn = Calibration not necessary

Photo documentation of the test set-up:

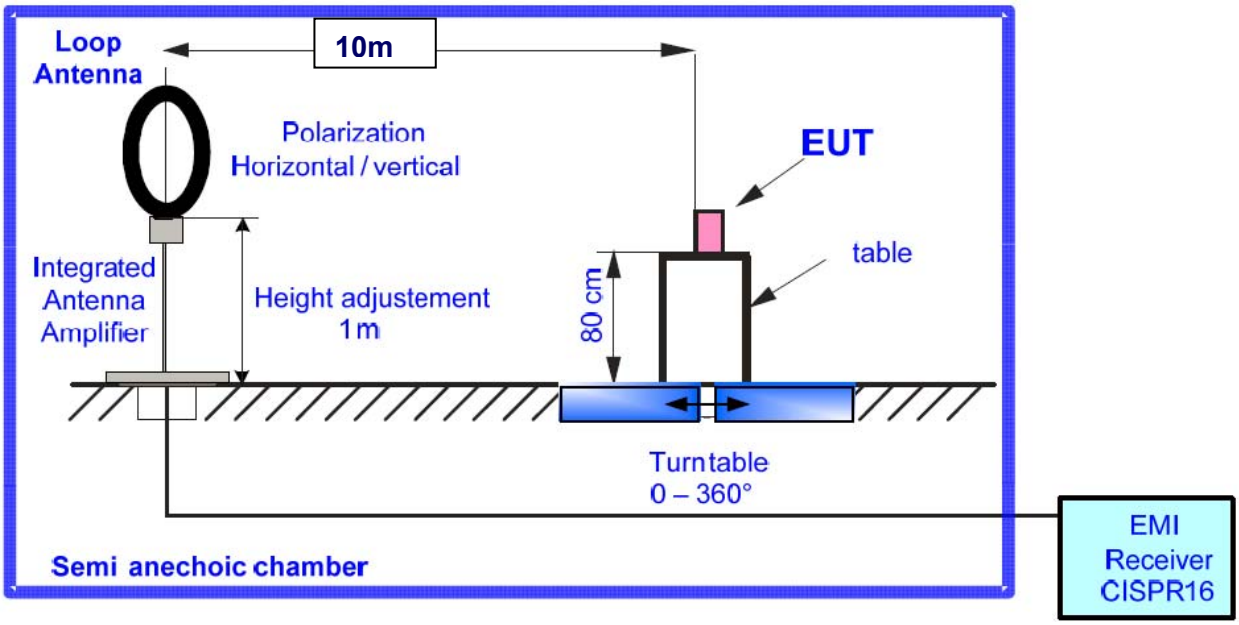


Figure 6-4: test setup for Radiated disturbances 30 MHz to 1000 MHz

6.3.5.2.1 Results for configuration 1

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☒ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 56 of this report.

Final result (Quasipeak) according to §15.225a-c; Vertical Polarisation

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)	Comment
13.560000	-0.25	32.98	32.23	1000.0	0.200	V	149.0	-30.9	12:38:09 - 31.10.2016

Final result (Quasipeak) according to §15.225a-c; Horizontal Polarisation

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)	Comment
13.560000	-9.64	32.98	42.62	1000.0	0.200	H	232.0	-30.9	12:23:02 - 31.10.2016

The measured emission levels were found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

6.3.5.2.2 Results for configuration 2

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☐ 1	☒ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 57 of this report.

Final result (Quasipeak) according to §15.225a-c; Vertical Polarisation

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)	Comment
13.560000	-1.83	32.98	34.81	1000.0	0.200	V	89.0	-30.9	11:56:56 - 31.10.2016

Final result (Quasipeak) according to §15.225a-c; Horizontal Polarisation

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)	Comment
13.560000	-11.58	32.98	44.56	1000.0	0.200	H	231.0	-30.9	12:12:02 - 31.10.2016

The measured emission levels were found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

6.3.5.2.3 Results for configuration 3

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☐ 1	☐ 2	☒ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 58 of this report.

Final result (Quasipeak) according to §15.225a-c; Vertical Polarisation

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)	Comment
13.560000	-0.49	32.98	33.47	1000.0	0.200	V	200.0	-30.9	14:18:11 - 31.10.2016

Final result (Quasipeak) according to §15.225a-c; Horizontal Polarisation

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)	Comment
13.560000	-9.48	32.98	42.46	1000.0	0.200	H	276.0	-30.9	14:29:21 - 31.10.2016

The measured emission levels were found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

6.3.5.2.4 Results for configuration 4

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☐ 1	☐ 2	☐ 3	☒ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 59 of this report.

Final result (Quasipeak) according to §15.225a-c; Vertical Polarisation

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)	Comment
13.560000	-1.87	32.98	34.85	1000.0	0.200	V	202.0	-30.9	22:53:36 - 26.10.2016

Final result (Quasipeak) according to §15.225a-c; Horizontal Polarisation

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)	Comment
13.560000	-21.15	32.98	54.13	1000.0	0.200	H	90.0	-30.9	23:11:06 - 26.10.2016

The measured emission levels were found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

6.3.5.2.5 Results for configuration 5

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☐ 1	☐ 2	☐ 3	☐ 4	☒ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on pages 60 of this report.

Final result (Quasipeak) according to §15.225a-c; Vertical Polarisation

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)	Comment
13.560000	5.04	32.98	27.94	1000.0	0.200	V	181.0	-30.9	12:51:39 - 31.10.2016

Final result (Quasipeak) according to §15.225d and §15.209;

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)	Comment
0.017742	56.55	101.71	45.16	1000.0	0.200	V	43.0	20.1	13:54:47 - 31.10.2016
0.048663	45.18	92.95	47.77	1000.0	0.200	V	150.0	20.2	13:58:29 - 31.10.2016
0.066429	43.25	90.24	46.99	1000.0	0.200	V	107.0	20.2	13:56:38 - 31.10.2016
0.448496	28.99	73.65	44.66	1000.0	9.000	H	2.0	20.2	13:48:24 - 31.10.2016
1.432600	25.14	43.57	18.43	1000.0	9.000	V	323.0	20.3	14:02:25 - 31.10.2016
1.636650	24.92	42.41	17.49	1000.0	9.000	V	245.0	20.2	14:00:26 - 31.10.2016
1.697282	24.93	42.09	17.16	1000.0	9.000	H	168.0	20.2	13:51:03 - 31.10.2016

The measured emission levels were found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

6.4 Test No. 4: Frequency Stability (§ 15.225e)

6.4.1 Purpose

The frequency stability of the EUT was measured pursuant to [2] ANSI 63.10 Clause 6.8. The measurement was performed to verify that the frequency deviation of the emission stays within the assigned frequency block under extreme temperature conditions (-20°C to +50°C) and supply voltage conditions according to § 15.225(e).

6.4.2 Limits

According to § 15.225(e), the carrier frequency of the EUT shall be maintained within 0.01 percent (100 ppm) of the operating frequency, independent of the ambient temperature (-20°C to 50°C) and the primary supply voltage (85% to 115% of the rated voltage).

6.4.3 EUT Operating Condition

The standard setup procedure as described in section 4.1 of this report was used.

6.4.4 Test Configuration

Frequency Stability with Temperature Variation:

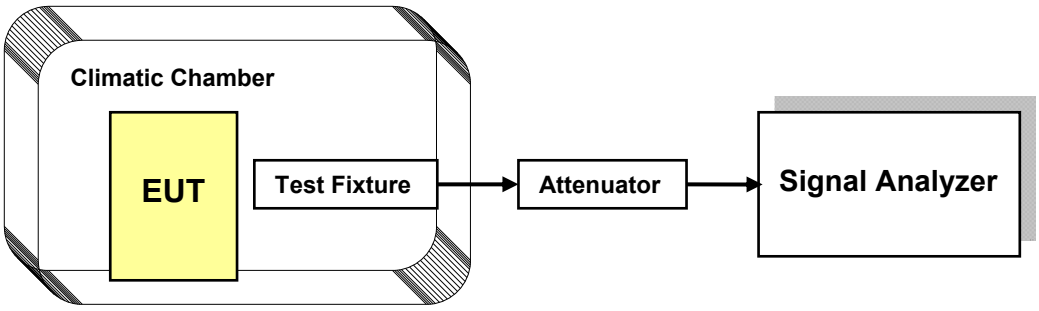


Figure 6-5: Test Configuration – Frequency Stability with temperature variation

Frequency Stability with Voltage Variation:

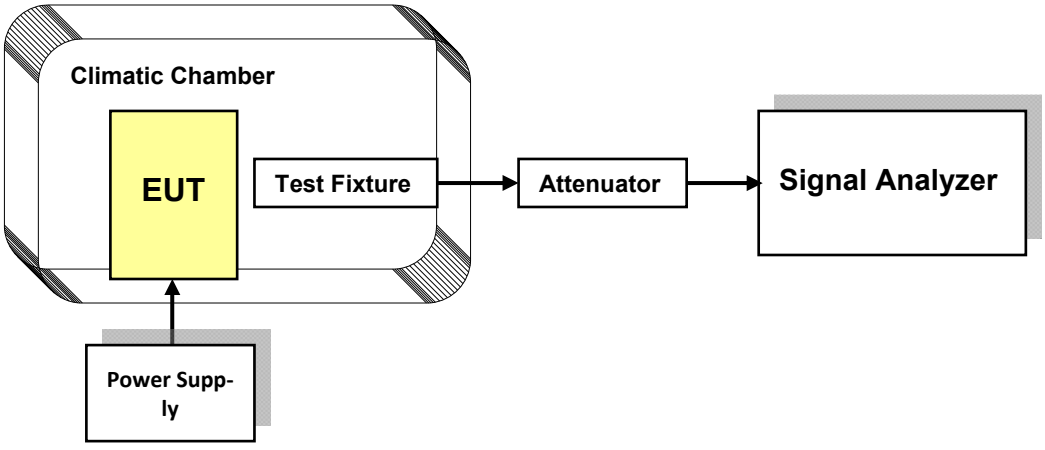


Figure 6-6: Test Configuration – Frequency Stability with voltage variation

6.4.5 Test instruments and accessories

ID. No.	Equipment	Specification	Status	Next Cal.
P1845	Spectrum Analyzer	20 Hz bis 26,5 GHz; Linearität: 0,1 dB (0 dB bis –70 dB)	cal	Mar 2018
P1740	Frequency Standard		cal	Mar 2018
P1689	Power Supply (DC Switch Mode)	Output (DC): 3 - 15V / 25A	ind	
P1814	multimeter, digital (MZ-Spibe)	60 mV...600V, 60mA....10A, 600Ohm...40MOhm, 0.1Hz...1kHz, -50,0 °C ...+400,0°C	cal	Jun 2017
P1353	multimeter, digital	10µV...1000V, 10nA....10A, 10mOhm...40MOhm, 10pF...1mF, 0.1Hz...30kHz	cal	Apr 2017
P1576	Heating Cabinet	Temperaturbereich: ca. -70 °C bis + 180° C; Nutzraum-volumen: 115 Liter	ind	

cal = Calibration, car = Calibration restricted use, chk = Check, chr = Check restricted use, cpu = Check prior to use, calchk = Calibration and check, ind = for indication only, cnn = Calibration not necessary

6.4.6 Test Procedure and Results

Frequency Stability with Temperature Variation:

The primary supply voltage to the EUT was set to the rated voltage and the temperature of the environmental chamber is varied in 10 degree steps from -20 degrees celsius to +50 degrees celsius. The EUT is allowed to stabilize at each temperature and the frequency error is measured.

Frequency Stability with Voltage Variation:

The EUT is placed in an environmental chamber and allowed to stabilize at +20 degrees celsius for at least 15 minutes. With the voltage input to the EUT set to 85% of the rated supply voltage, the frequency error is measure. This procedure is repeated at 100% and 115% of the rated supply voltage.

6.4.6.1 Results for Configuration 1

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☒ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12

Carrier Frequency: 13.56 MHz						
Supply Voltage (DC)	**Ambient Temperature**	**Frequency Deviation**		**Maximum allowed Deviation**		**Result**
[V]	**[°C]**	**[Hz]**	**[ppm]**	**[Hz]**	**[ppm]**	
5V	-20	77.67	5.73	±1356	±100	compliant
	-10	13.87	1.02	±1356	±100	compliant
	0	-29.18	-2.15	±1356	±100	compliant
	+10	-43.07	-3.18	±1356	±100	compliant
	+20	-45.83	-3.38	±1356	±100	compliant
	+30	-45.09	-3.33	±1356	±100	compliant
	+40	-47.67	-3.52	±1356	±100	compliant
	+50	-60.64	-4.47	±1356	±100	compliant
Measurement Uncertainty:					±3.6 Hz	

Table 6-5: Results – Frequency Stability with temp. variation for DC Supply – Configuration 1

Carrier Frequency: 13.56 MHz						
Supply Voltage (DC)	**Ambient Temperature**	**Frequency Deviation [ppm]**		**Maximum allowed Deviation**		**Result**
[V]	**[°C]**	**[Hz]**	**[ppm]**	**[Hz]**	**[ppm]**	
4.25	+20	-44.85	-3.31	±1356	±100	compliant
5.00		-45.75	-3.37	±1356	±100	compliant
5.75		-45.83	-3.38	±1356	±100	compliant
Measurement Uncertainty:					±3.6 Hz	

Table 6-6: Results – Frequency Stability with voltage variation for DC Supply – Configuration 1

The measured frequency stability was found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

6.4.6.2 Results for Configuration 2

Operation mode (see 4.1.3)		
☐ 1	☒ 2	☐ 3

Test configuration (see 4.1.4)											
☐ 1	☒ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	☐ 10	☐ 11	☐ 12

Carrier Frequency: 13.56 MHz						
Supply Voltage (DC)	**Ambient Temperature**	**Frequency Deviation**		**Maximum allowed Deviation**		**Result**
[V]	**[°C]**	**[Hz]**	**[ppm]**	**[Hz]**	**[ppm]**	
5V	-20	48,80	3,60	±1356	±100	compliant
	-10	-21,55	-1,59	±1356	±100	compliant
	0	-54,17	-3,99	±1356	±100	compliant
	+10	-67,83	-5,00	±1356	±100	compliant
	+20	-69,29	-5,11	±1356	±100	compliant
	+30	-65,84	-4,86	±1356	±100	compliant
	+40	-64,16	-4,73	±1356	±100	compliant
	+50	-73,45	-5,42	±1356	±100	compliant
Measurement Uncertainty:					±3.6 Hz	

Table 6-7: Results – Frequency Stability with temp. variation for DC Supply – Configuration 2

Carrier Frequency: 13.56 MHz						
Supply Voltage (DC)	**Ambient Temperature**	**Frequency Deviation [ppm]**		**Maximum allowed Deviation**		**Result**
[V]	**[°C]**	**[Hz]**	**[ppm]**	**[Hz]**	**[ppm]**	
4.25	+20	-68,51	-5,05	±1356	±100	compliant
5.00		-69,28	-5,11	±1356	±100	compliant
5.75		-69,30	-5,11	±1356	±100	compliant
Measurement Uncertainty:					±3.6 Hz	

Table 6-8: Results – Frequency Stability with voltage variation for DC Supply – Configuration 2

The measured frequency stability was found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

7 Test Data and Screenshots

7.1 Spectral Plots

7.1.1 Test No. 1: Conducted Emissions (§ 15.207)

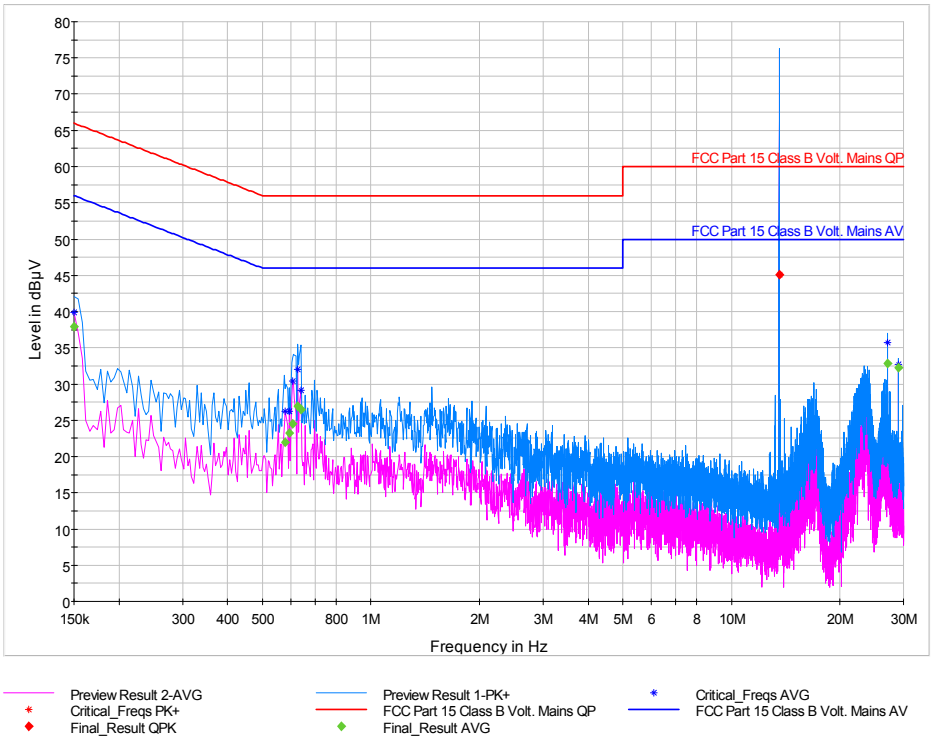


Figure 7-1: Conducted Emissions (150 kHz – 30 MHz), Neutral line – Configuration 11 (120 V / 60 Hz)

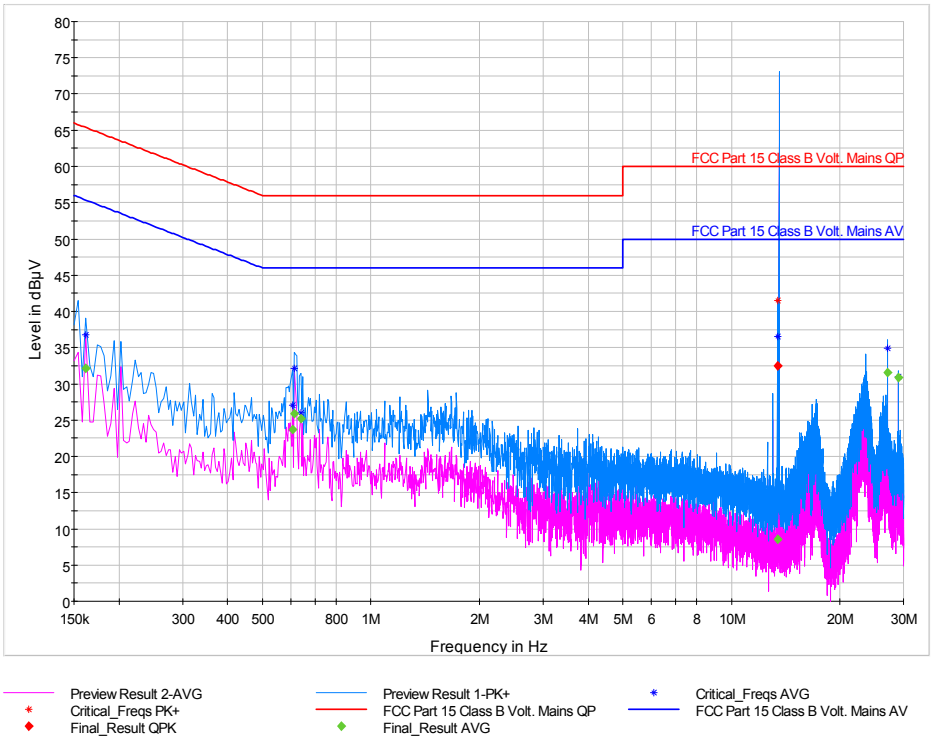


Figure 7-2: Conducted Emissions (150 kHz – 30 MHz), Phase Line – Configuration 11 (120 V / 60 Hz)

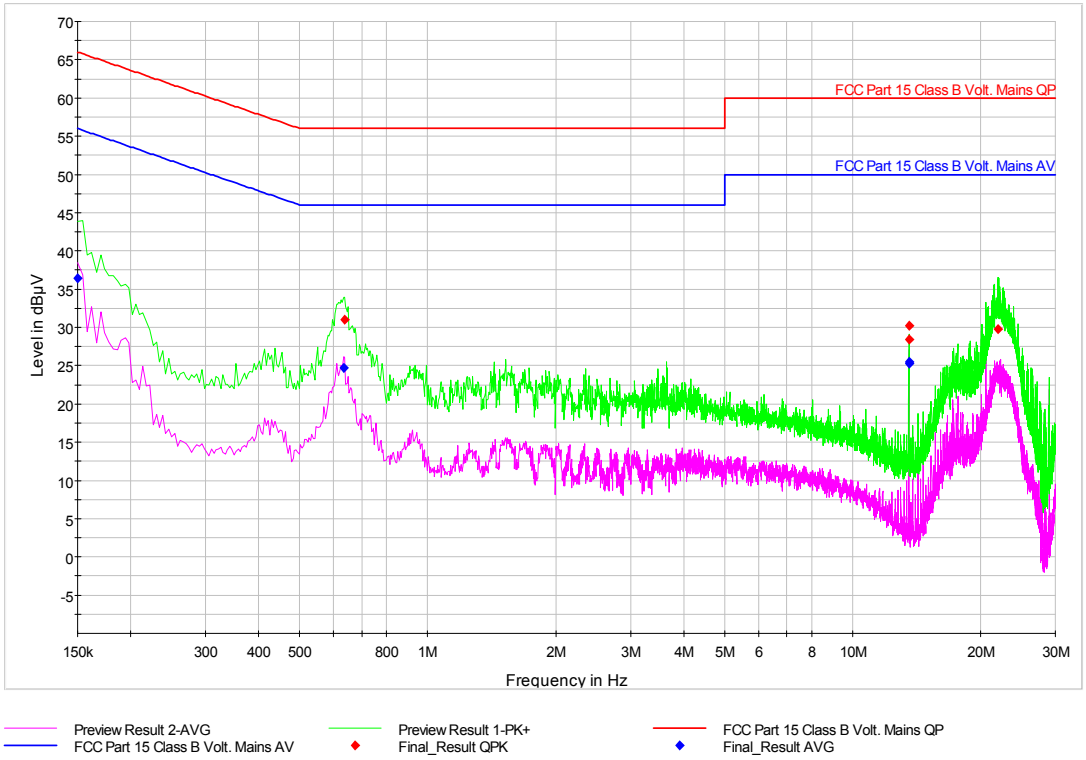


Figure 7-3: Conducted Emissions (150 kHz – 30 MHz), Neutral line – Configuration 13 (120 V / 60 Hz)

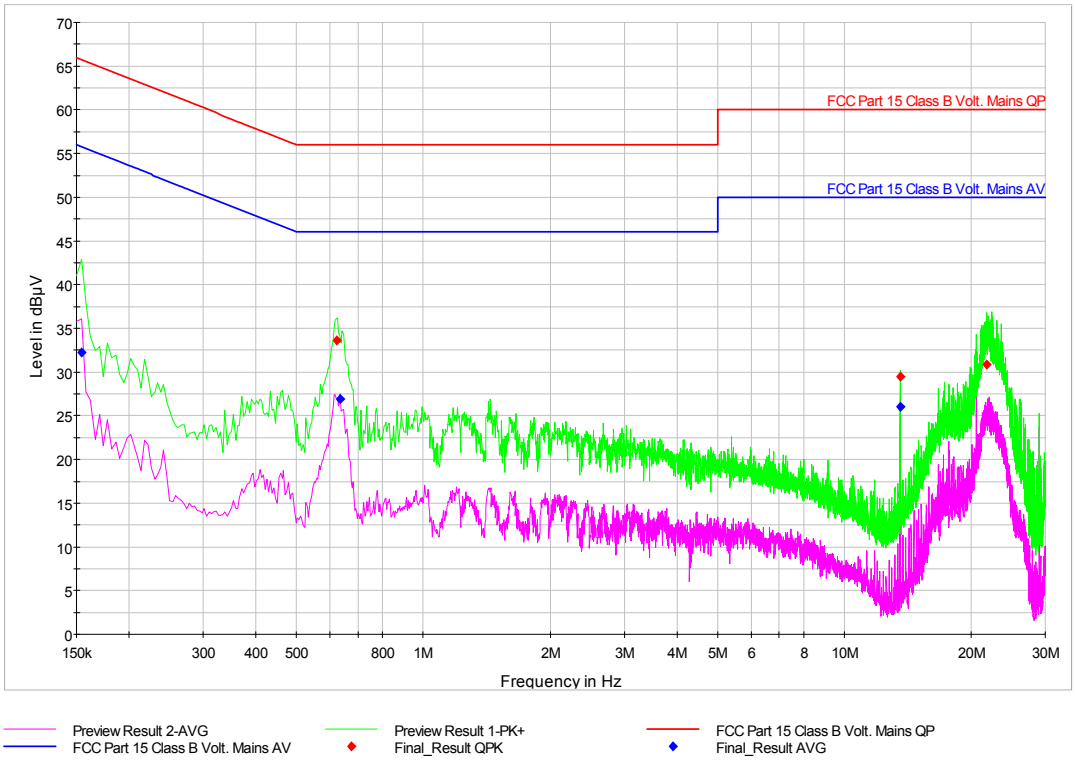


Figure 7-4: Conducted Emissions (150 kHz – 30 MHz), Phase Line – Configuration 13 (120 V / 60 Hz)

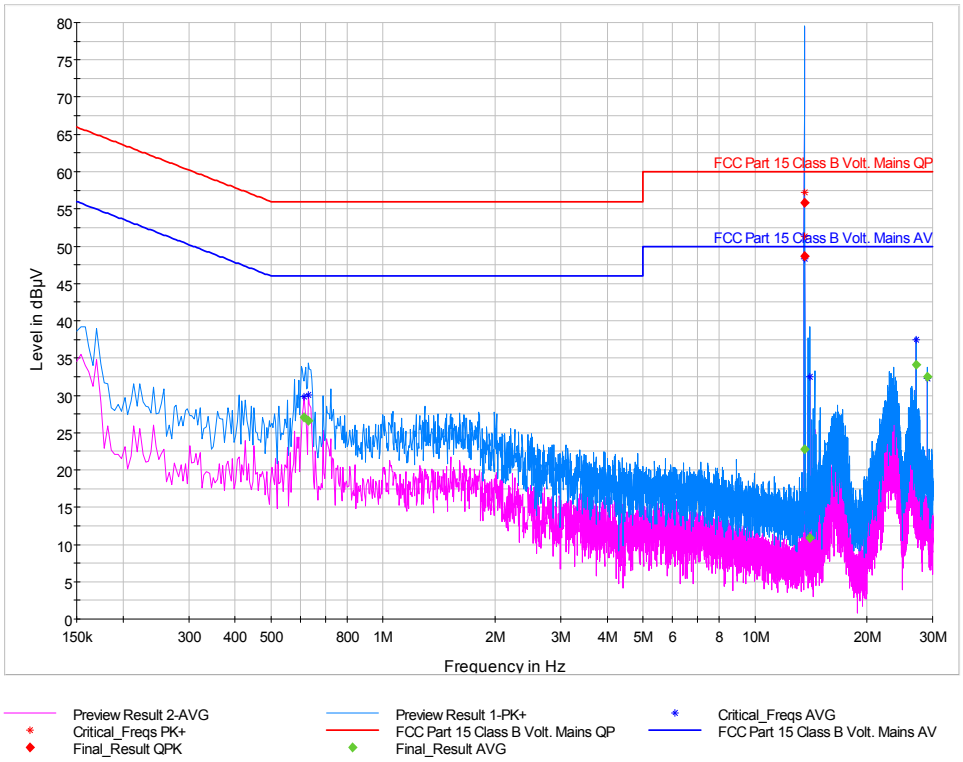


Figure 7-5: Conducted Emissions (150 kHz – 30 MHz), Neutral line – Configuration. 12, Bottom antenna (120 V / 60 Hz)

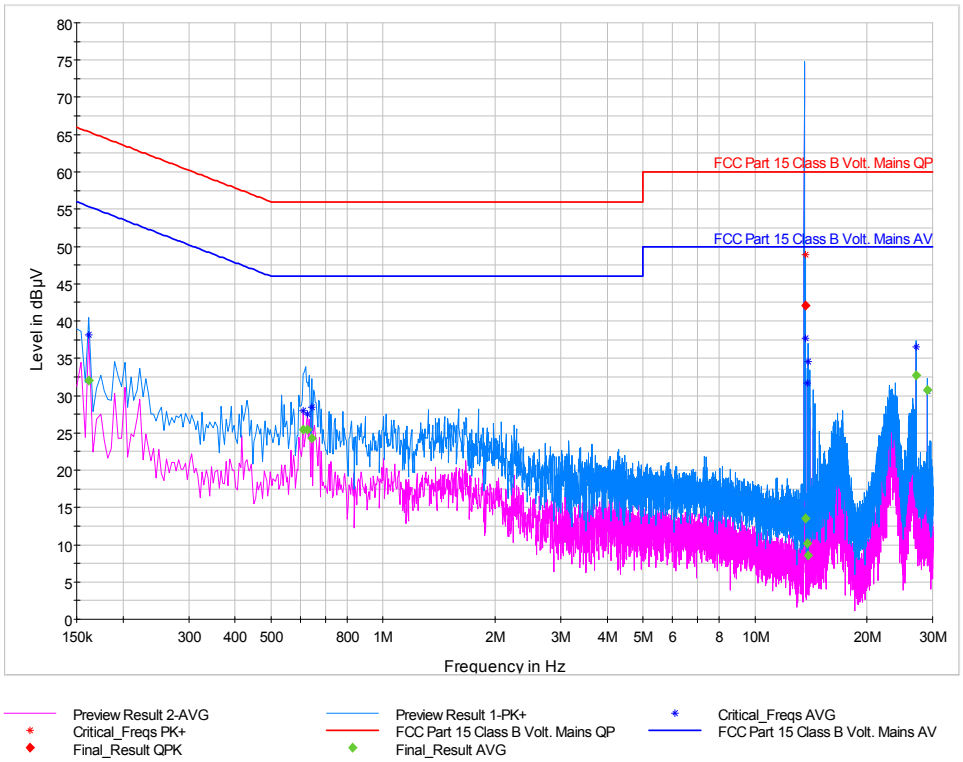


Figure 7-6: Conducted Emissions (150 kHz – 30 MHz),Phase Line – Configuration 12, Bottom antenna (120 V / 60 Hz)

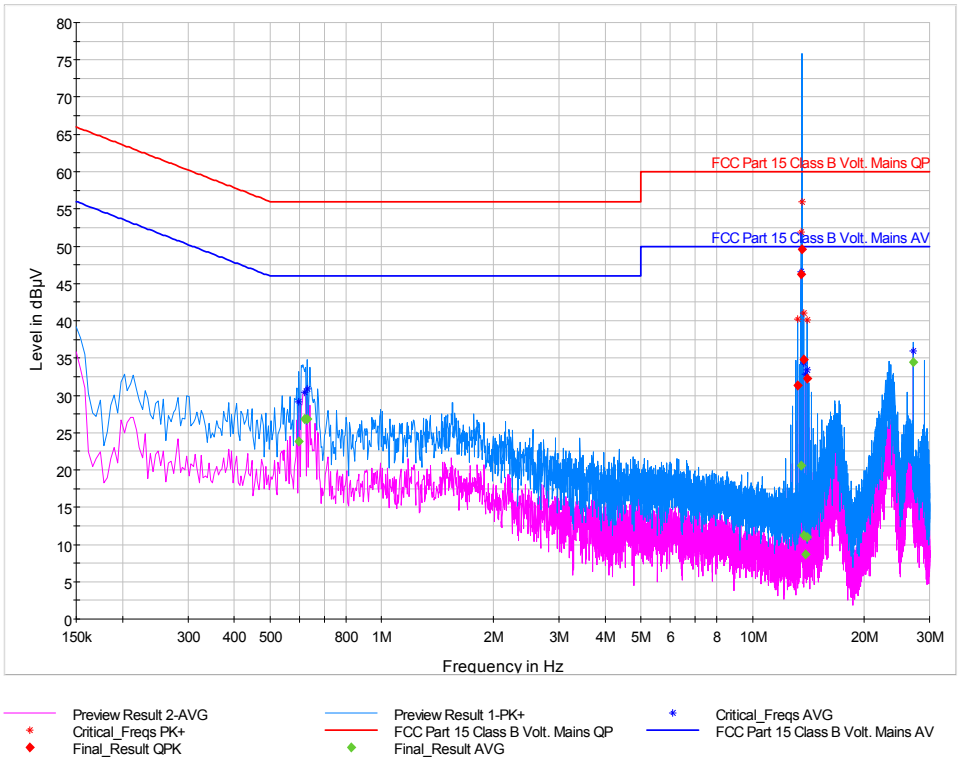


Figure 7-7: Conducted Emissions (150 kHz – 30 MHz), Neutral line – Configuration 12, Top antenna (120 V / 60 Hz))

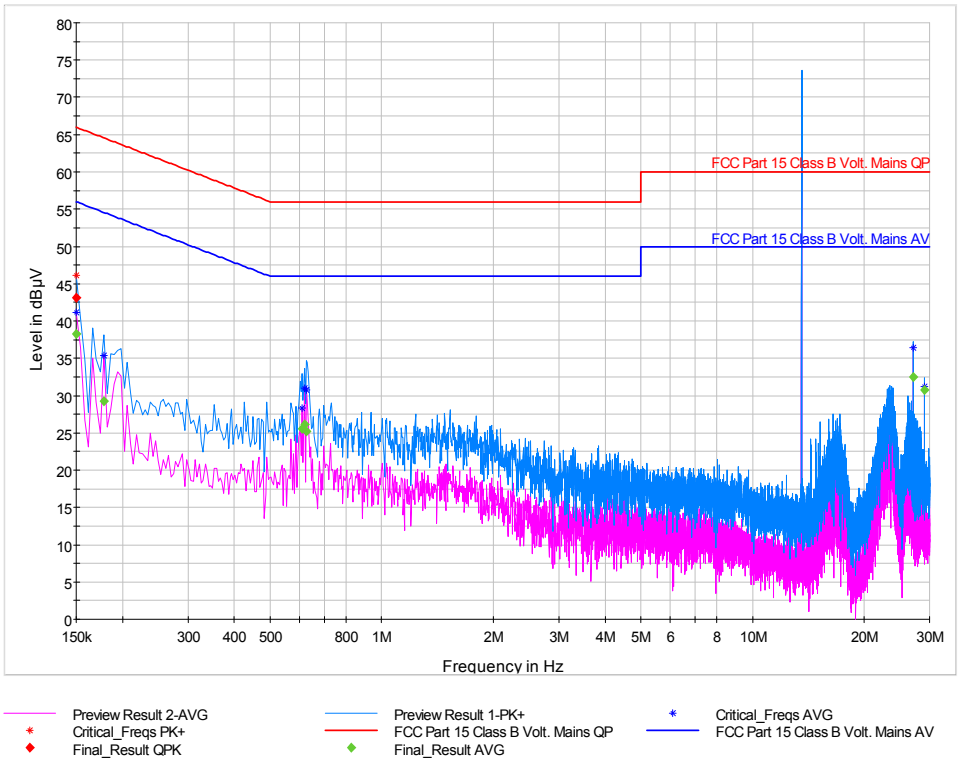


Figure 7-8: Conducted Emissions (150 kHz – 30 MHz), Phase Line – Configuration 12, Top antenna (120 V / 60 Hz)

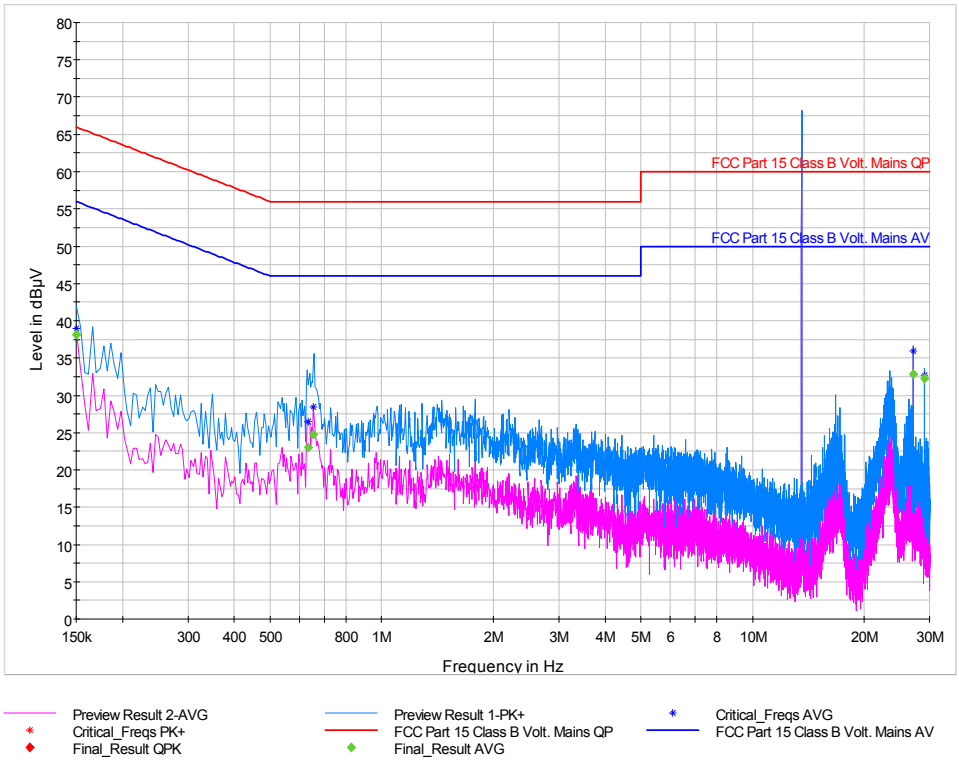


Figure 7-9: Conducted Emissions (150 kHz – 30 MHz), Neutral line – Configuration 11 (240 V / 60 Hz)

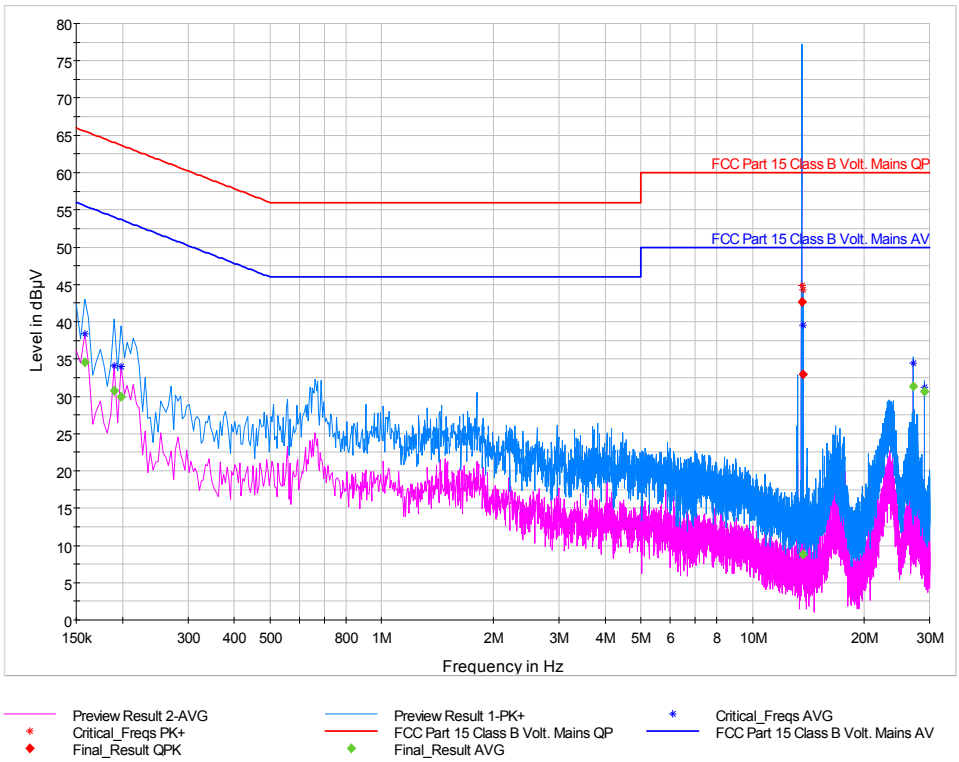


Figure 7-10: Conducted Emissions (150 kHz – 30 MHz), Phase Line – Configuration 11 (240 V / 60 Hz)

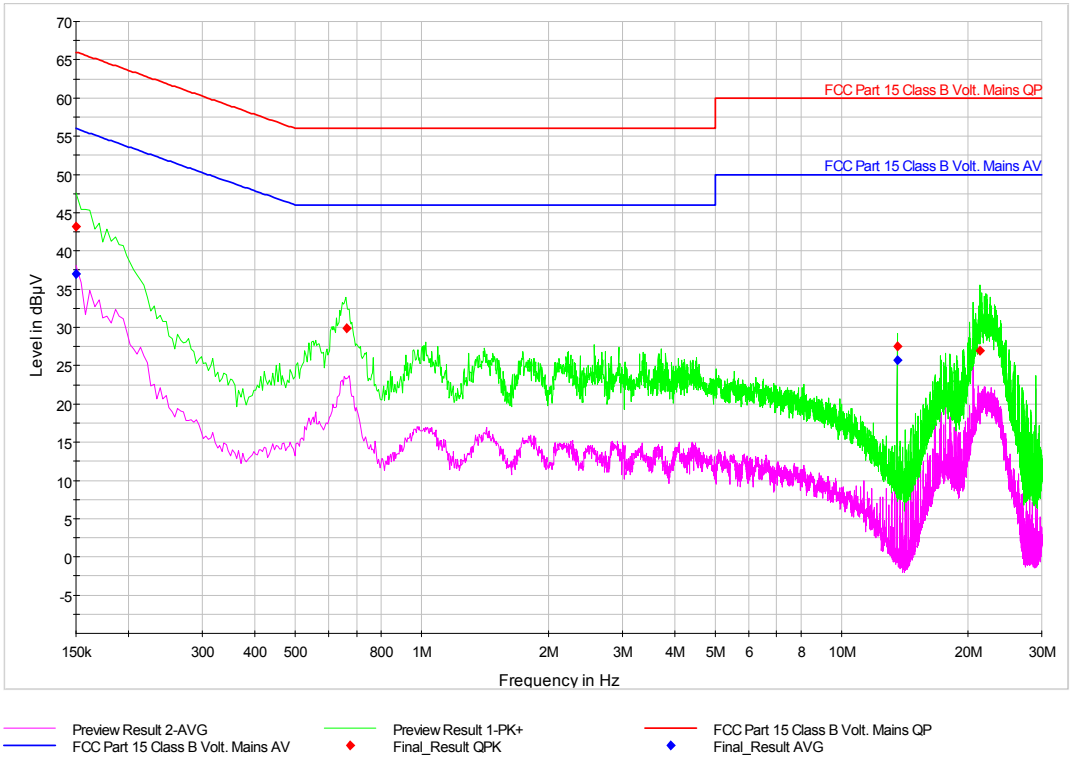


Figure 7-11: Conducted Emissions (150 kHz – 30 MHz), Neutral line – Configuration 13 (240 V / 60 Hz)

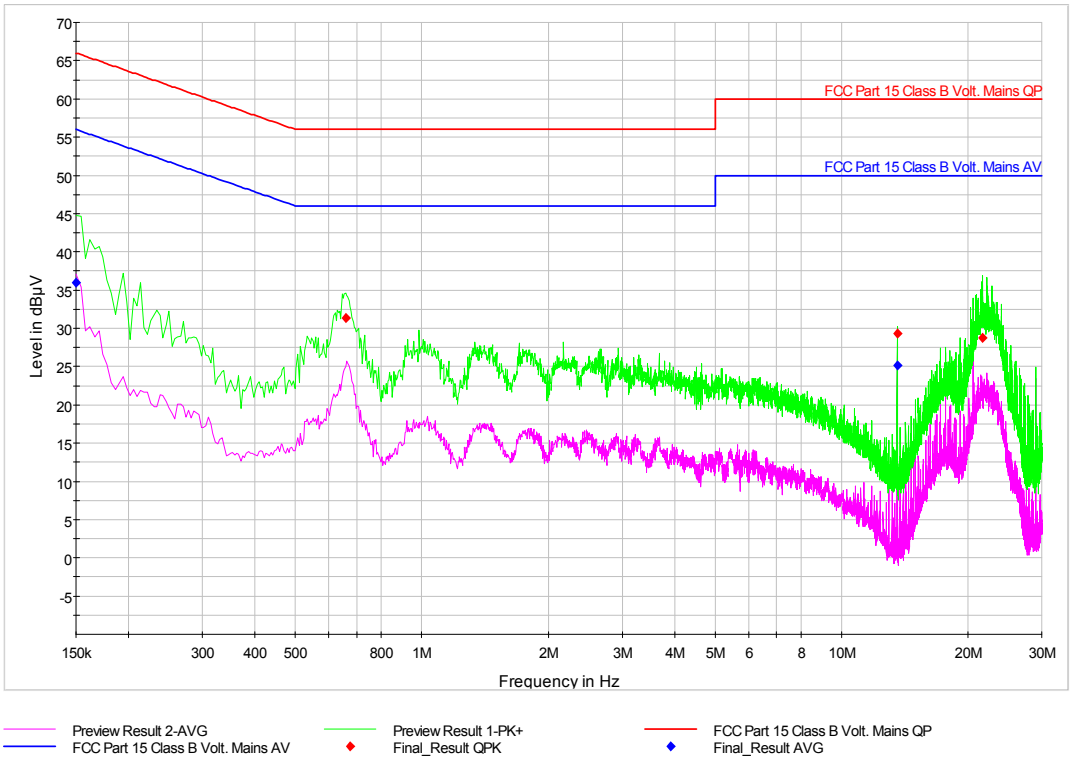


Figure 7-12: Conducted Emissions (150 kHz – 30 MHz), Phase Line – Configuration 13 (240 V / 60 Hz)

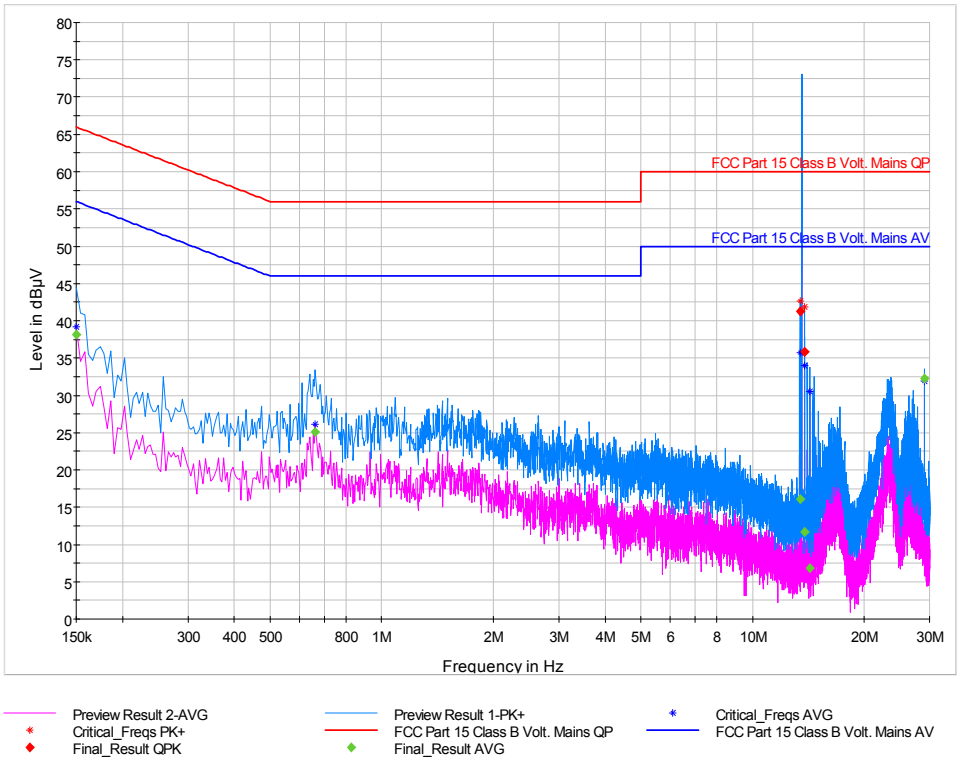


Figure 7-13: Conducted Emissions (150 kHz – 30 MHz), Neutral line – Configuration. 12, Bottom antenna (240 V / 60 Hz)

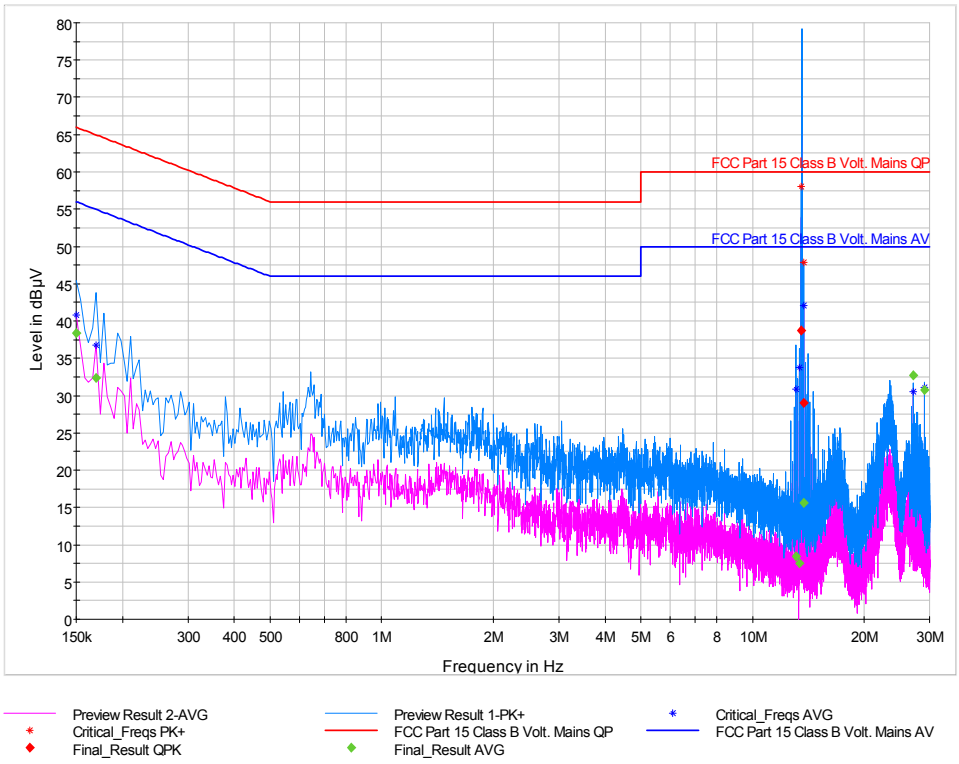


Figure 7-14: Conducted Emissions (150 kHz – 30 MHz),Phase Line – Configuration 12, Bottom antenna (240 V / 60 Hz)

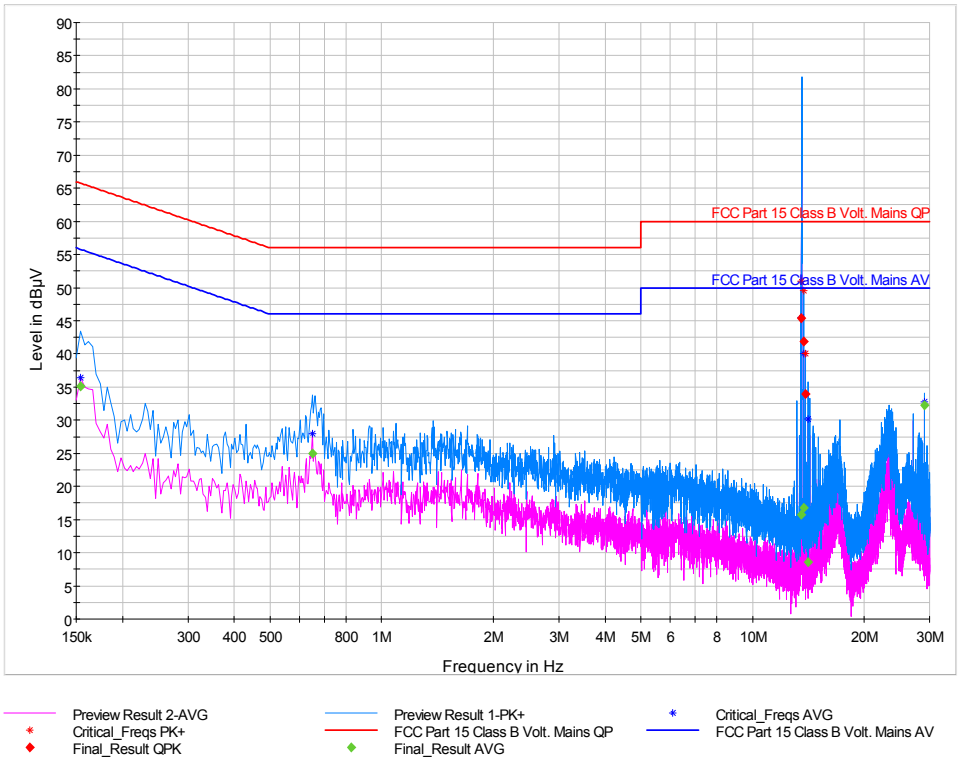


Figure 7-15: Conducted Emissions (150 kHz – 30 MHz), Neutral line – Configuration 12, Top antenna (240 V / 60 Hz))

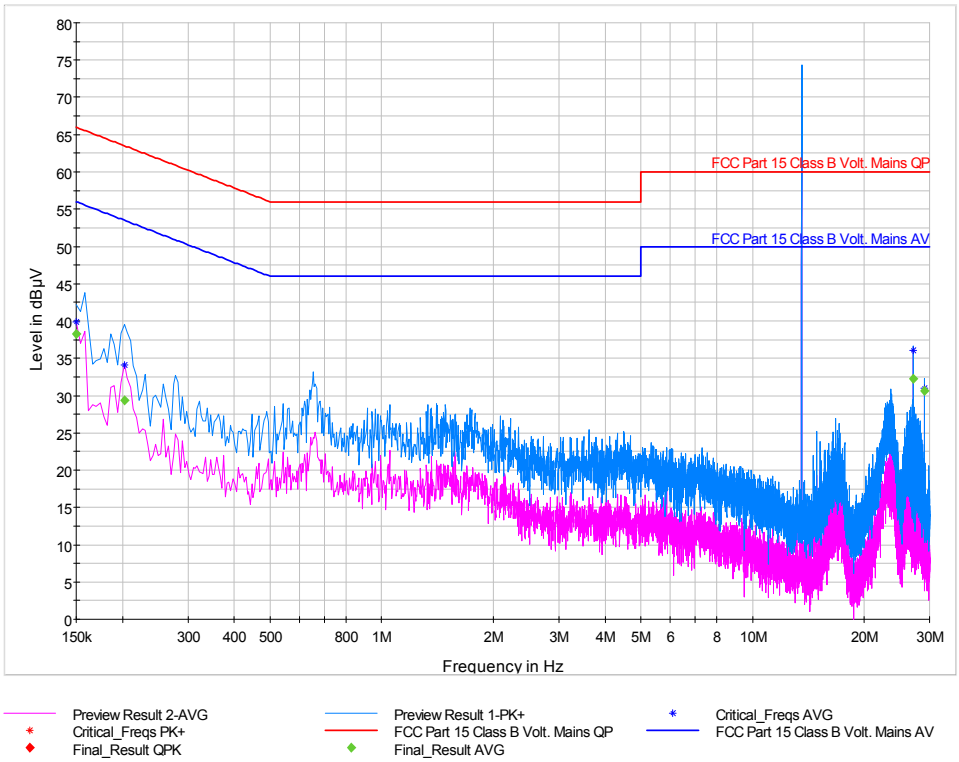


Figure 7-16: Conducted Emissions (150 kHz – 30 MHz), Phase Line – Configuration 12, Top antenna (240 V / 60 Hz)

7.1.2 Test No. 2: Occupied Bandwidth (§ 15.215c)

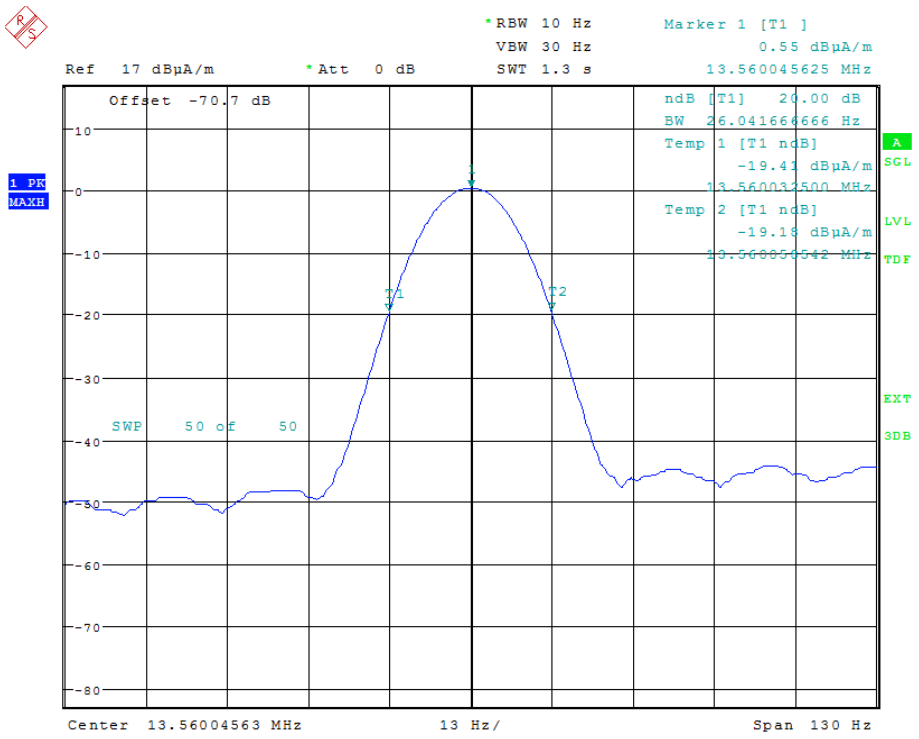


Figure 7-17: Occupied Bandwidth -20 dB (Carrier Frequency 13.56 MHz) – configuration 5

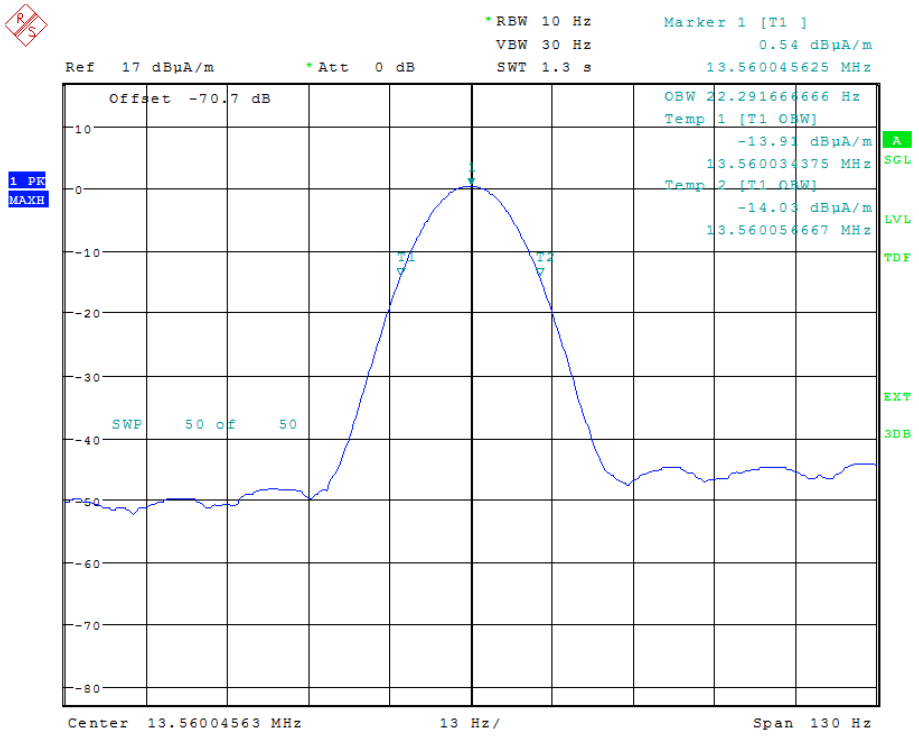


Figure 7-18: Occupied Bandwidth 99% (Carrier Frequency 13.56 MHz) – configuration 5

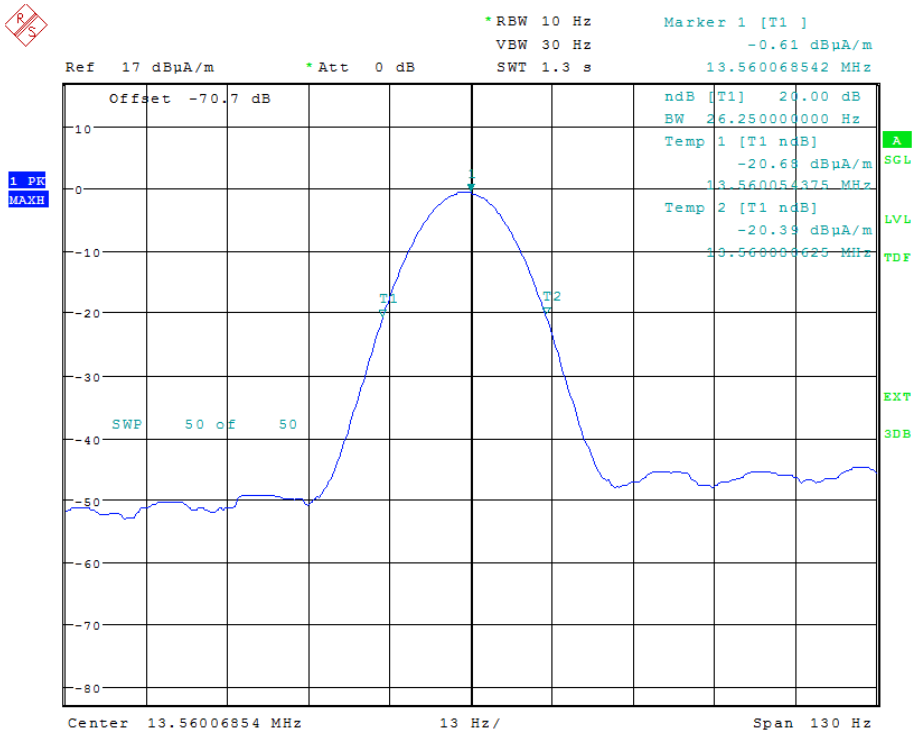


Figure 7-19: Occupied Bandwidth -20 dB (Carrier Frequency 13.56 MHz) – configuration 6

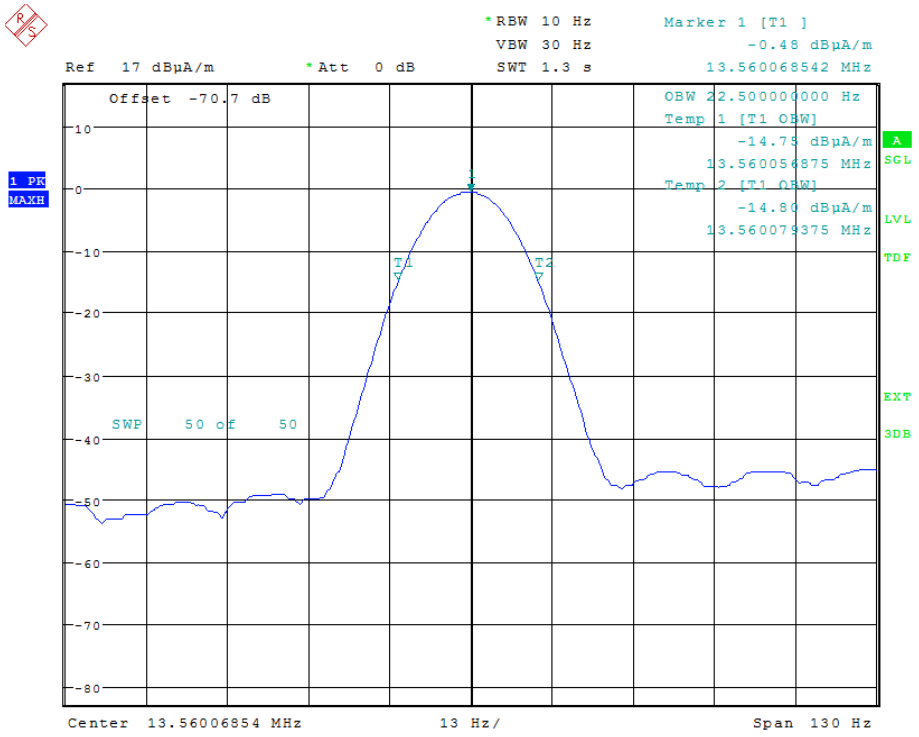


Figure 7-20: Occupied Bandwidth 99% (Carrier Frequency 13.56 MHz) – configuration 6

7.1.3 Test No. 3: Radiated Emissions (§ 15.205, § 15.209, § 15.225a-d)

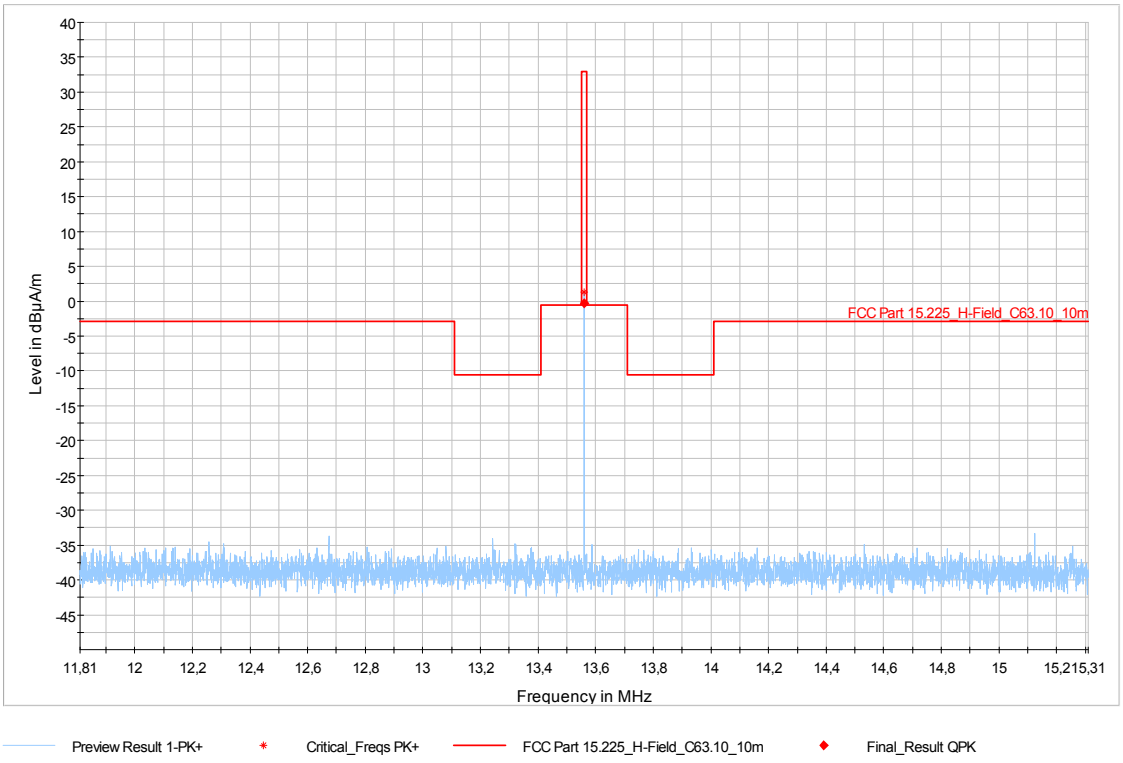


Figure 7-21: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 1; Vertical Polarization

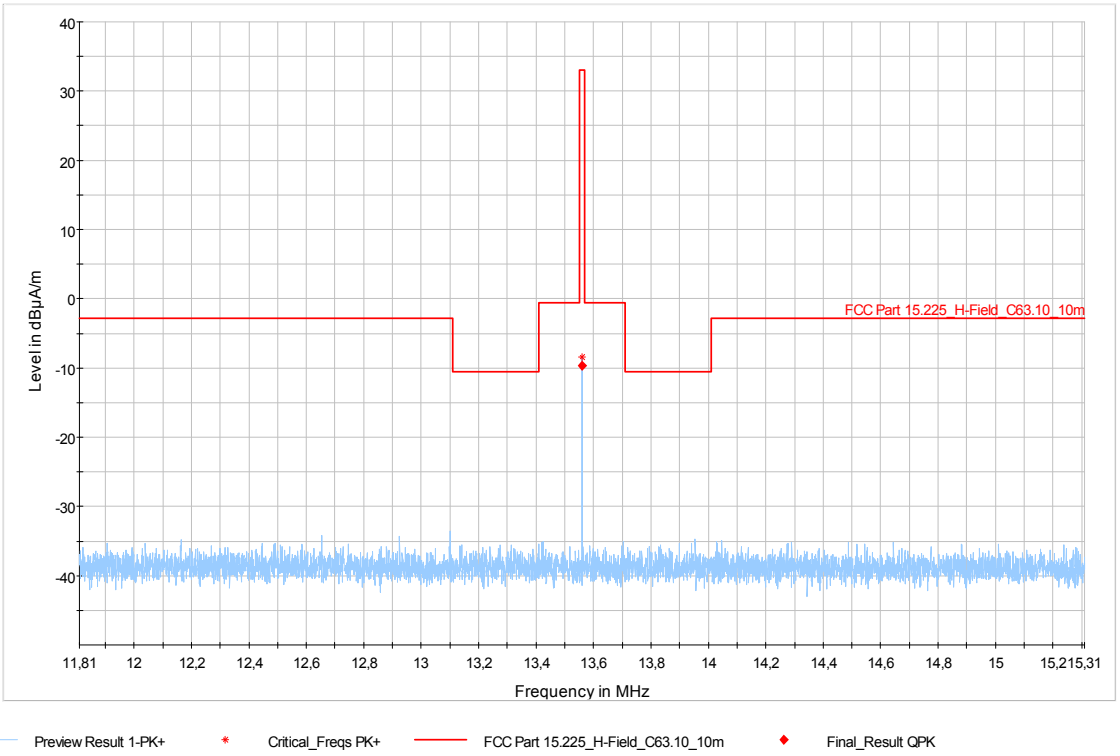


Figure 7-22: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 1; Horizontal Polarization

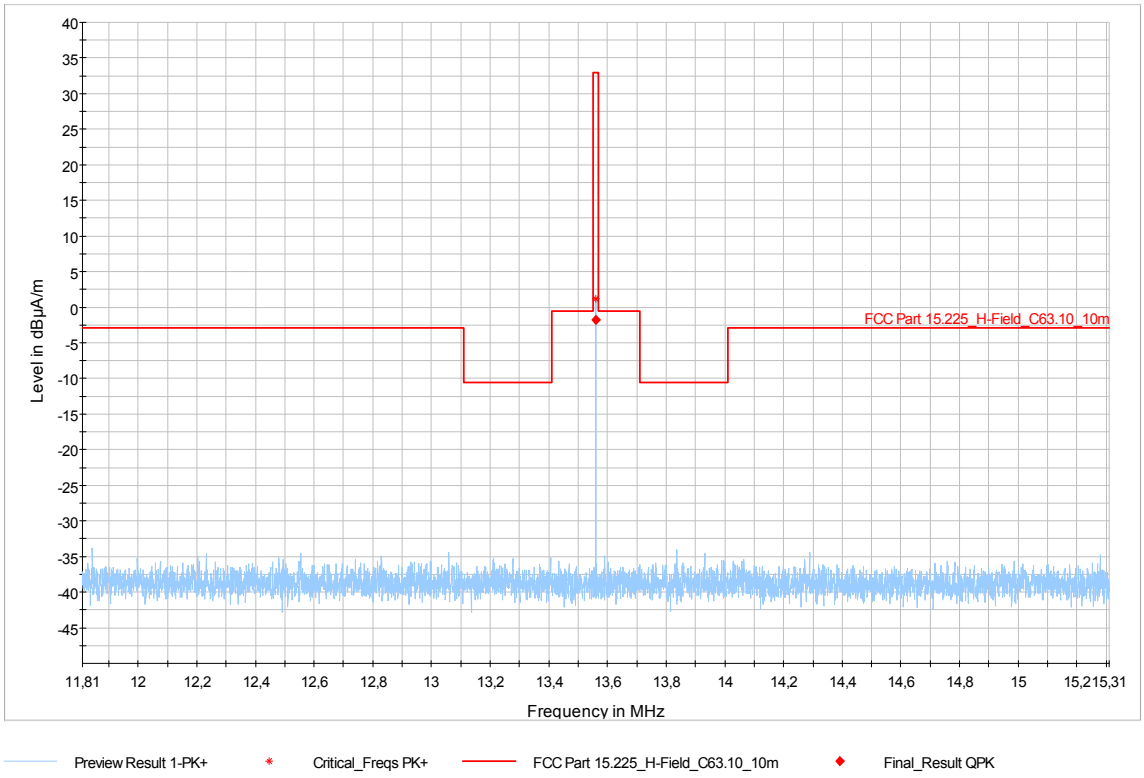


Figure 7-23: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 2; Vertical Polarization

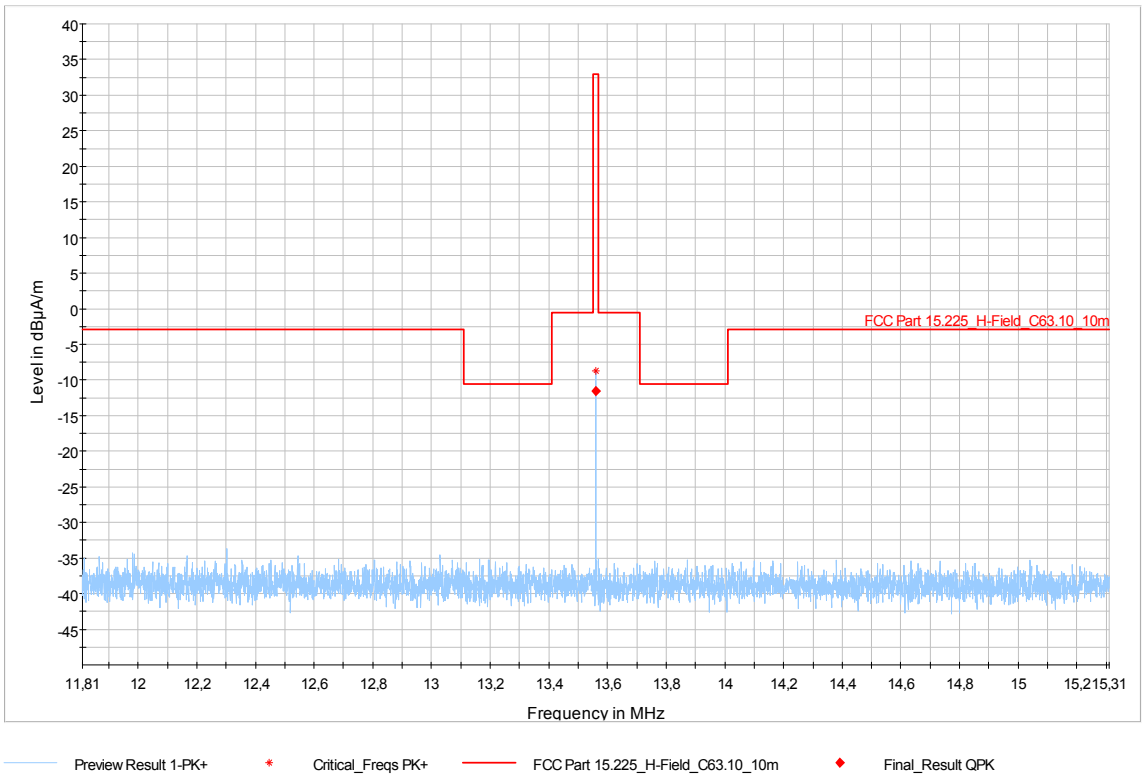


Figure 7-24: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 2; Horizontal Polarization

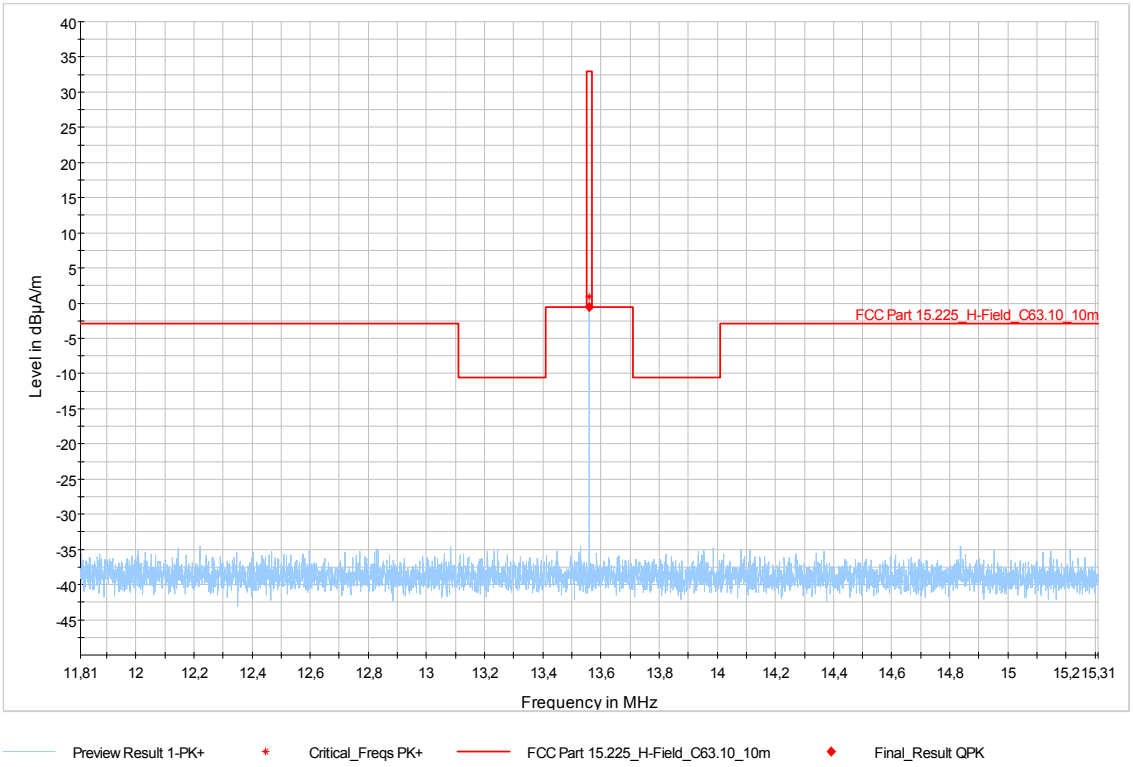


Figure 7-25: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 3; Vertical Polarization

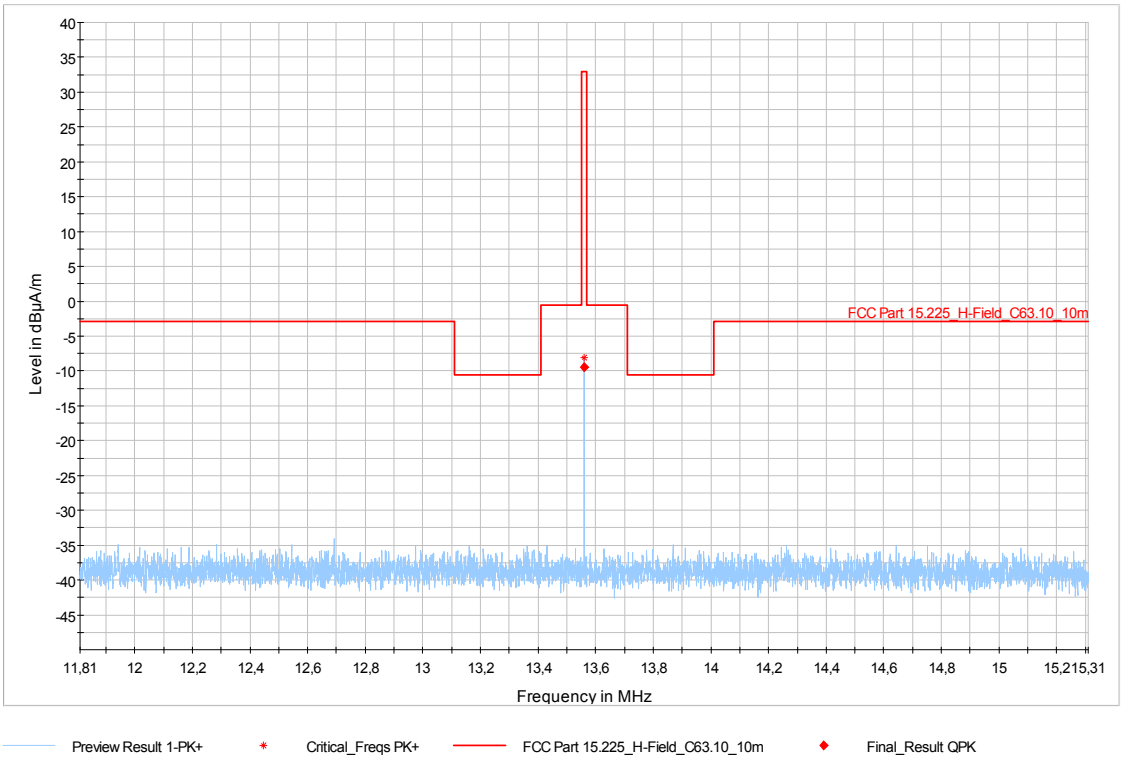


Figure 7-26: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 3; Horizontal Polarization

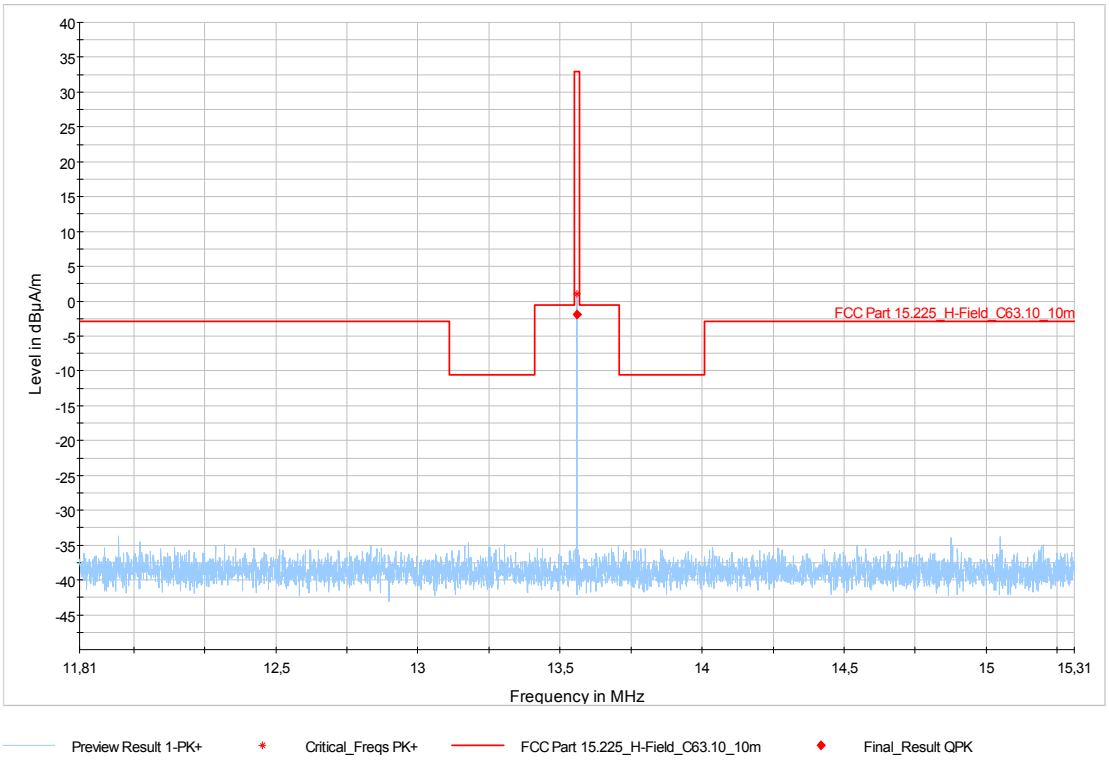


Figure 7-27: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 4; Vertical Polarization

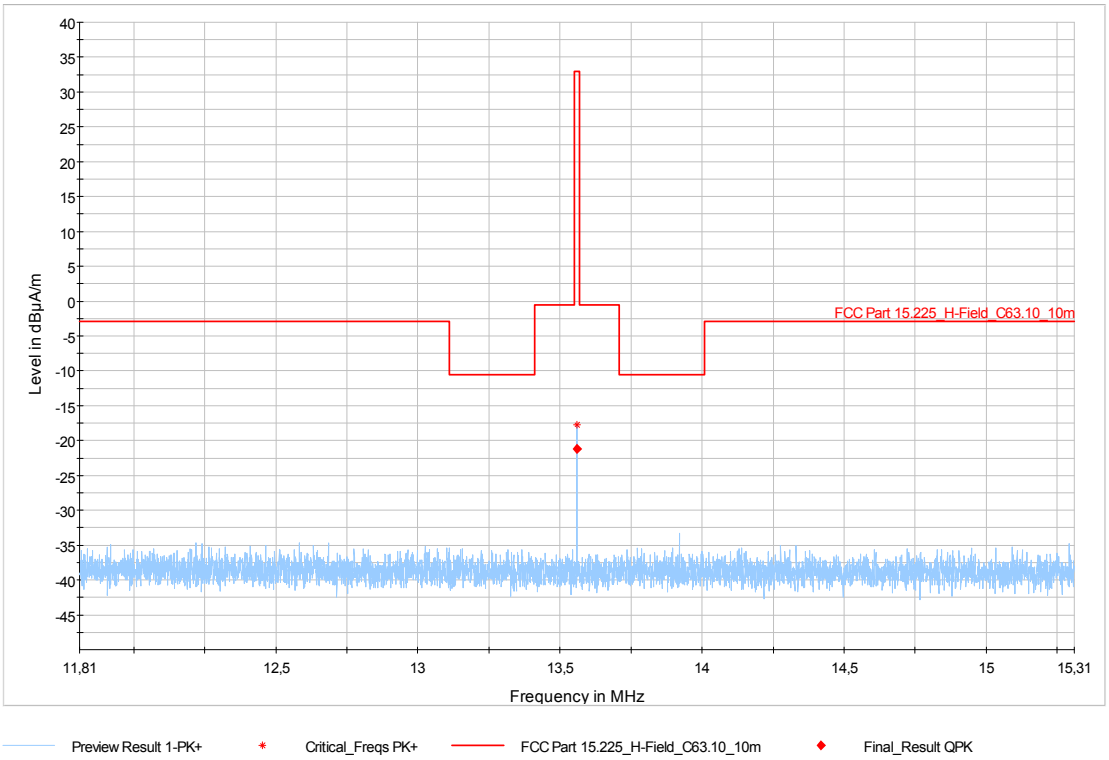


Figure 7-28: Radiated Emissions – 11.810 MHz to 15.010 MHz (§ 15.225a-c) – Configuration 4; Horizontal Polarization

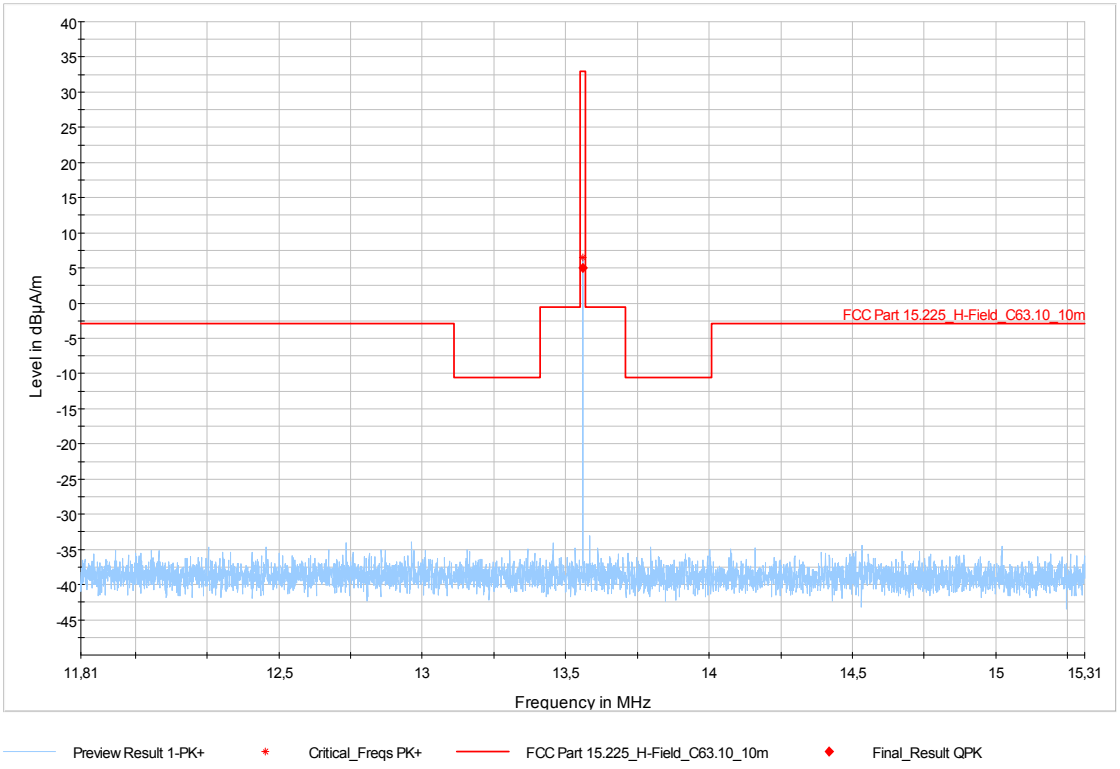


Figure 7-29: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 5; Vertical Polarization

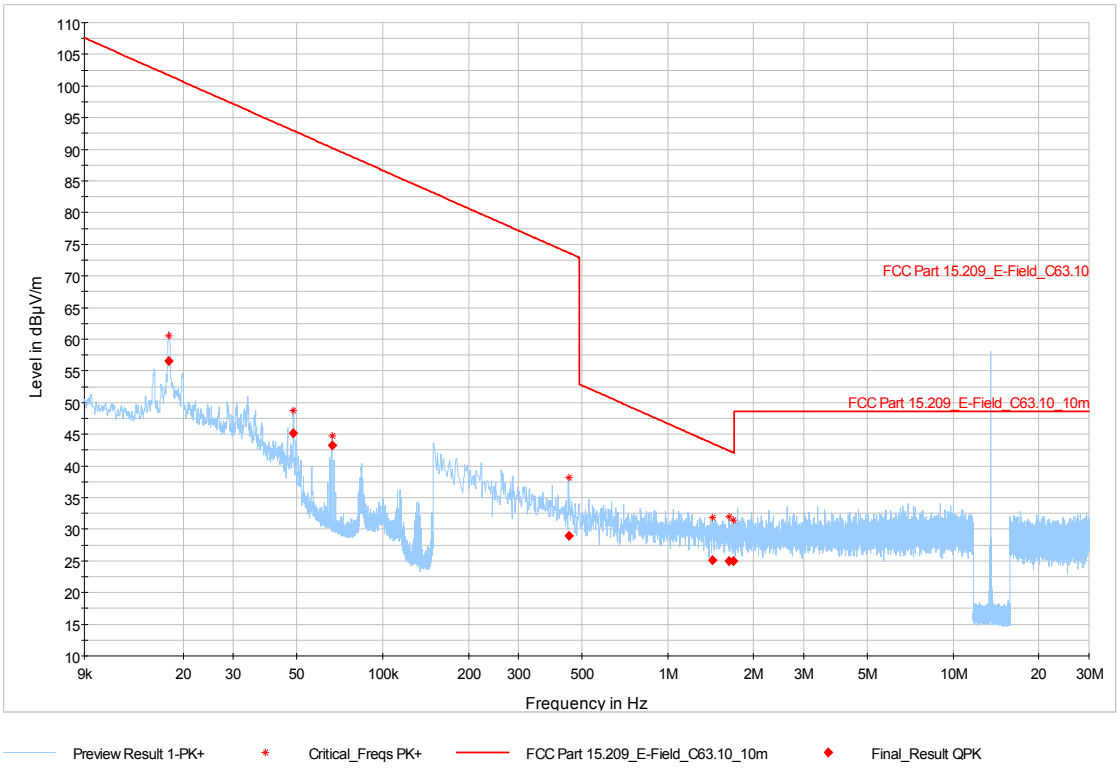


Figure 7-30: Radiated Emissions – 9 kHz to 30 MHz (§ 15.225d) – Configuration 5

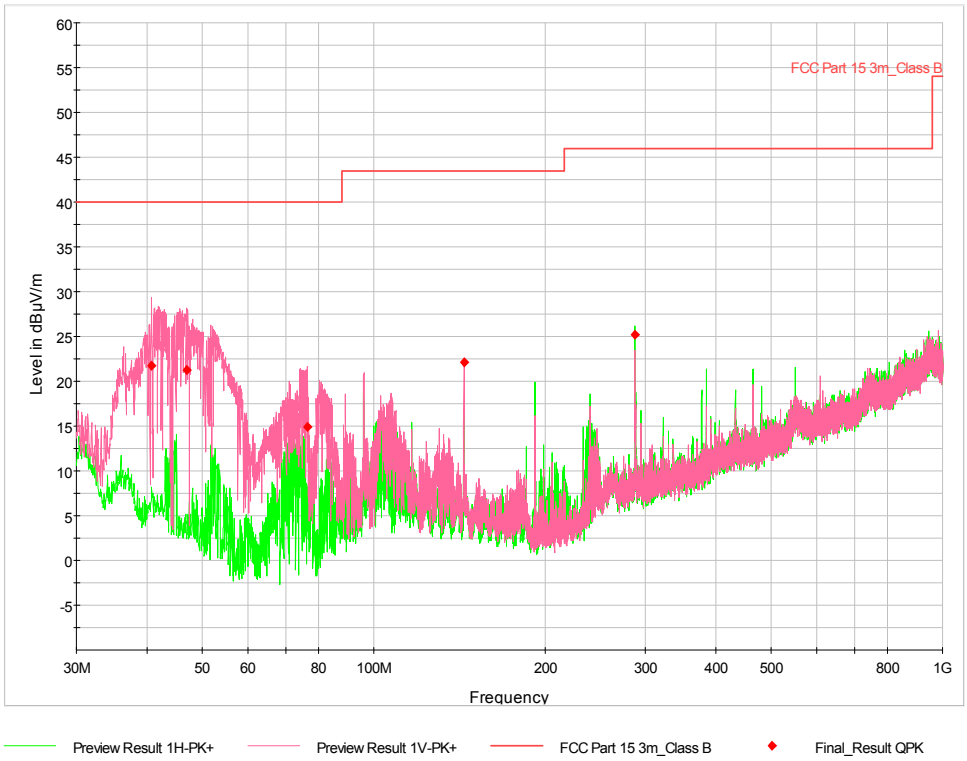


Figure 7-31: Radiated Emissions - 30 MHz to 1 GHz (§ 15.205, 15.209) – Configuration 5

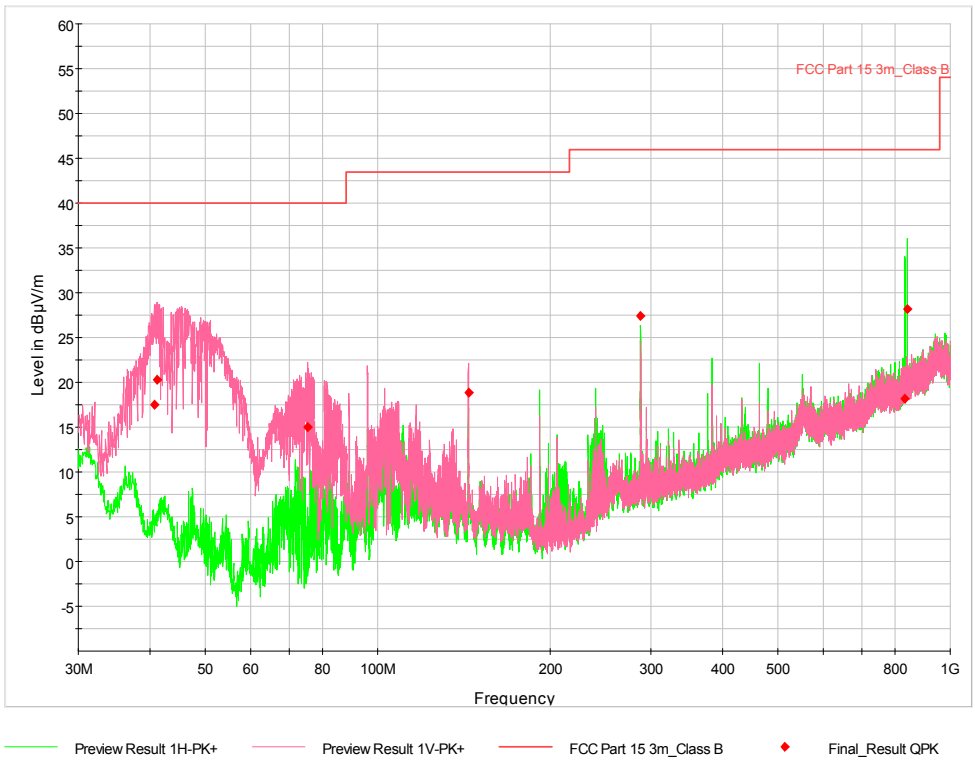


Figure 7-32: Radiated Emissions - 30 MHz to 1 GHz (§ 15.205, 15.209) – Configuration 6

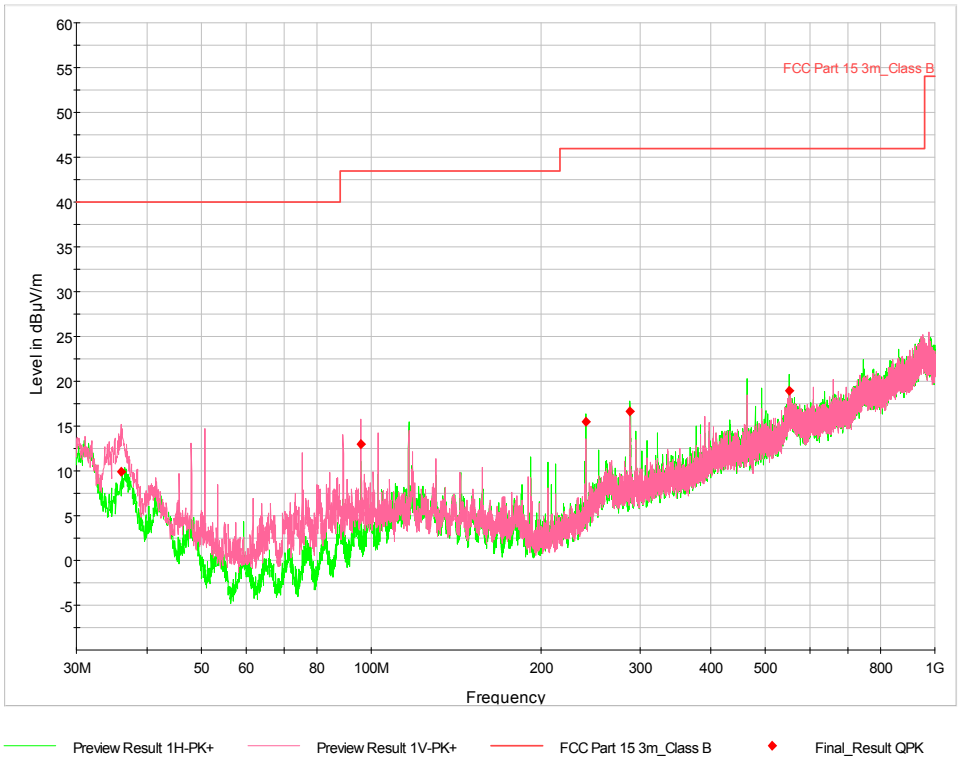


Figure 7-33: Radiated Emissions - 30 MHz to 1 GHz (§ 15.205, 15.209) – Configuration 9

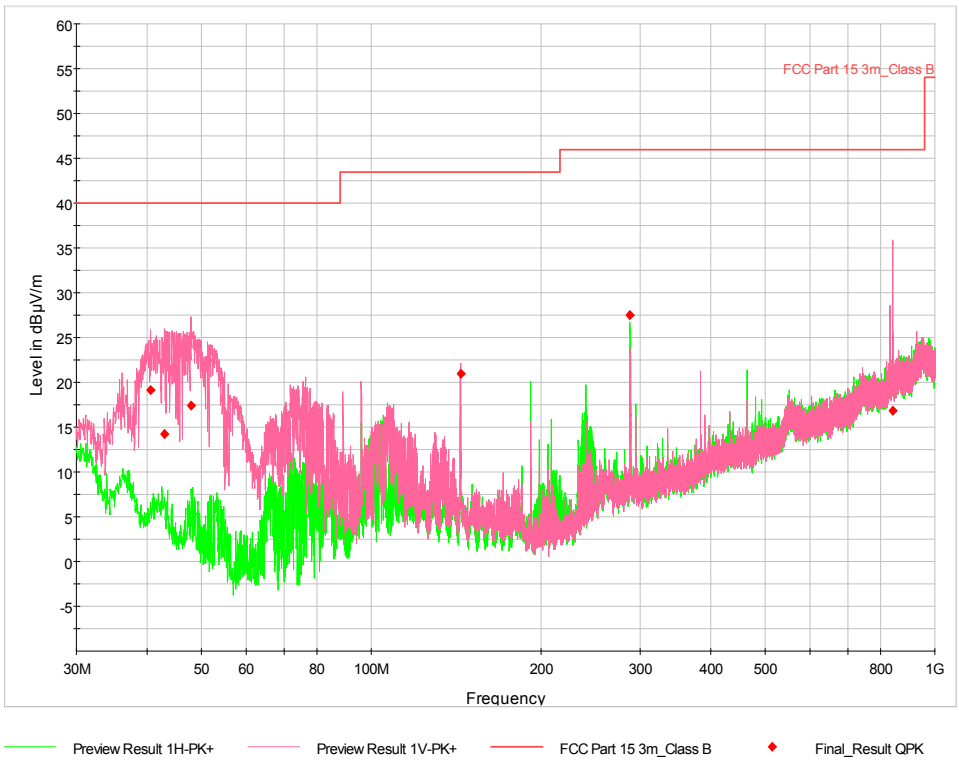


Figure 7-34: Radiated Emissions - 30 MHz to 1 GHz (§ 15.205, 15.209) – Configuration 7

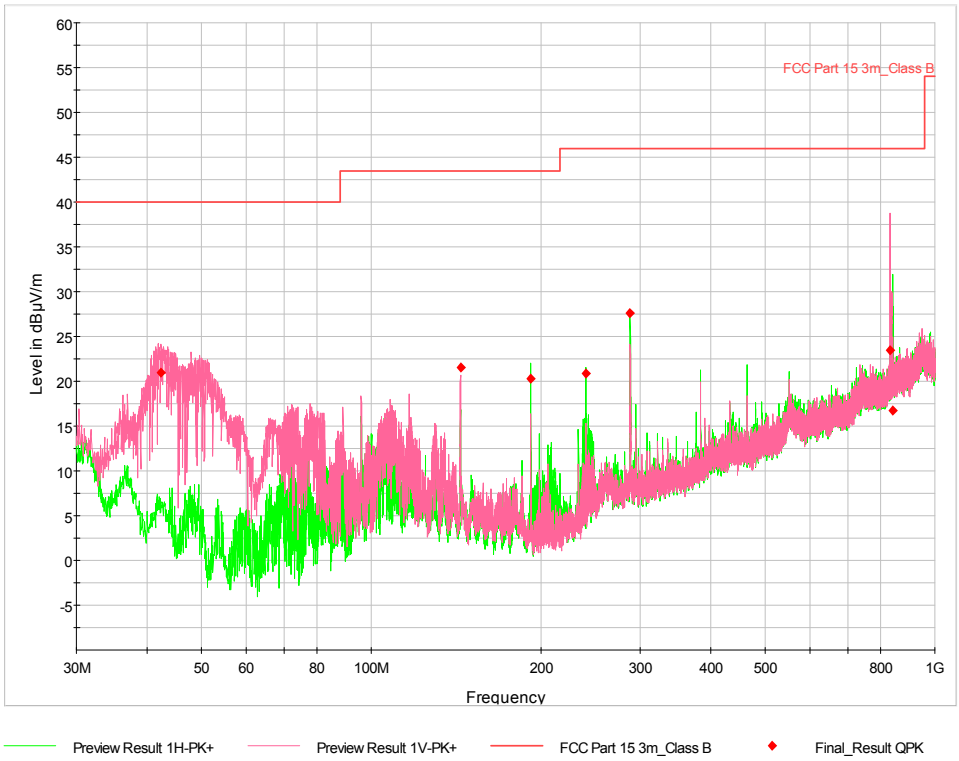


Figure 7-35: Radiated Emissions - 30 MHz to 1 GHz (§ 15.205, 15.209) – Configuration 8

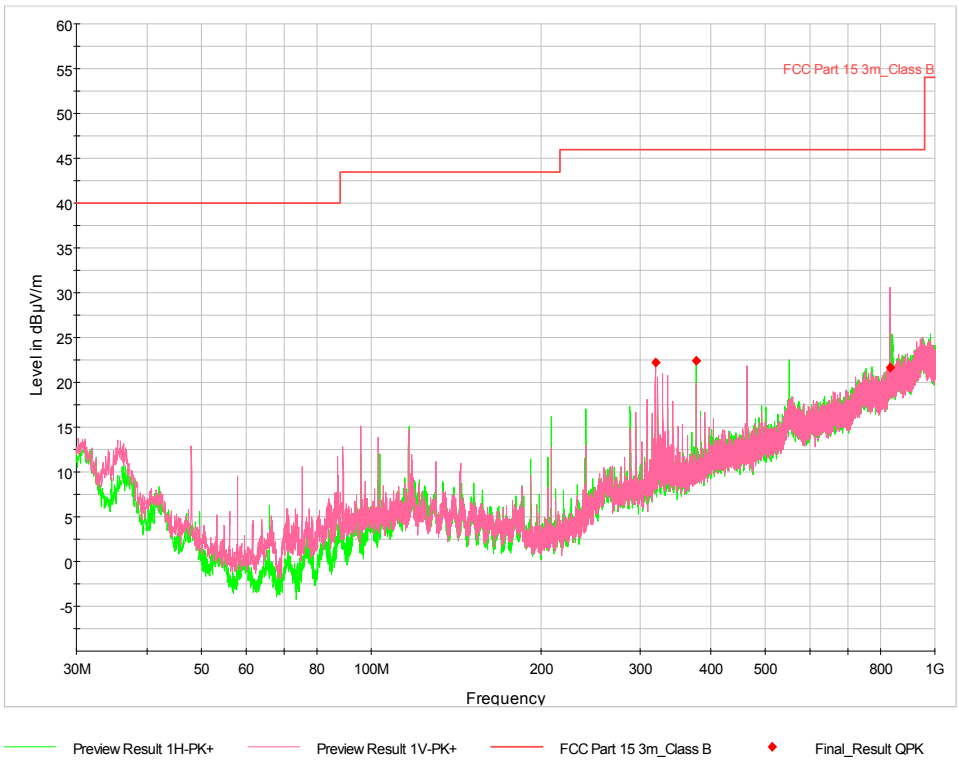


Figure 7-36: Radiated Emissions - 30 MHz to 1 GHz (§ 15.205, 15.209) – Configuration 10

7.1.4 Test No. 4: Frequency Stability (§ 15.225e)

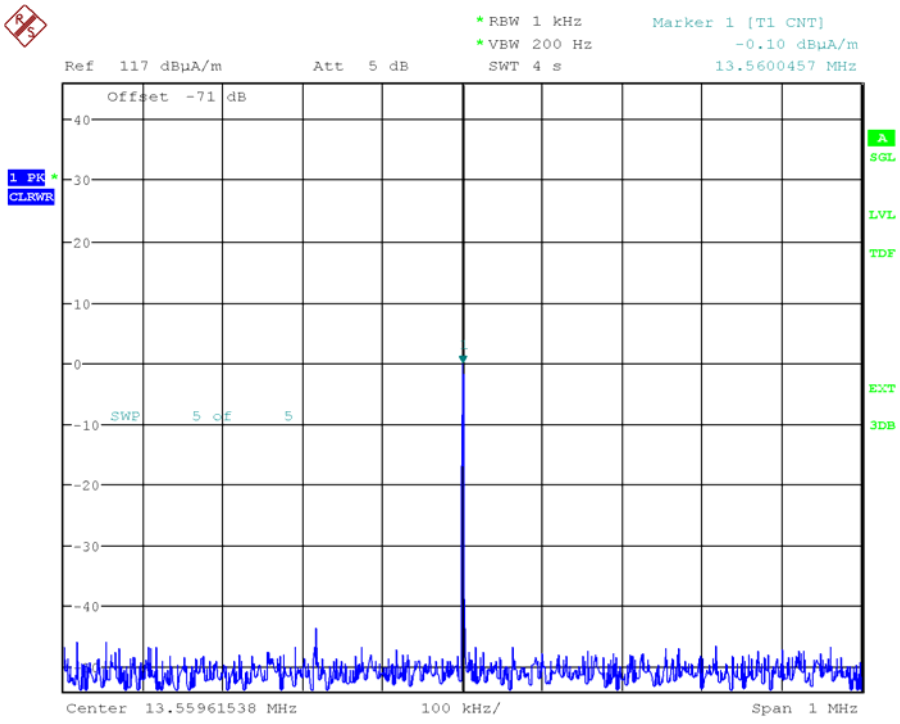


Figure 7-37: Frequency stability – 20 °C/ 5 V at startup – Configuration 1

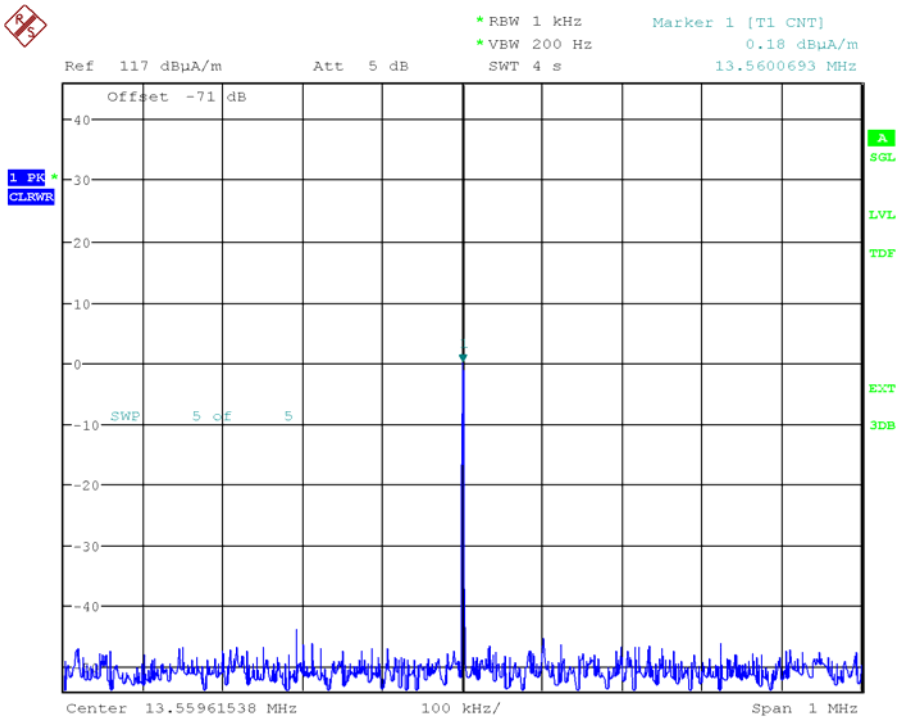


Figure 7-38: Frequency stability – 20°C / 5 V at startup – Configuration 2

7.2 Test Setups

7.2.1 Test No. 1: Conducted Emissions (§ 15.207)

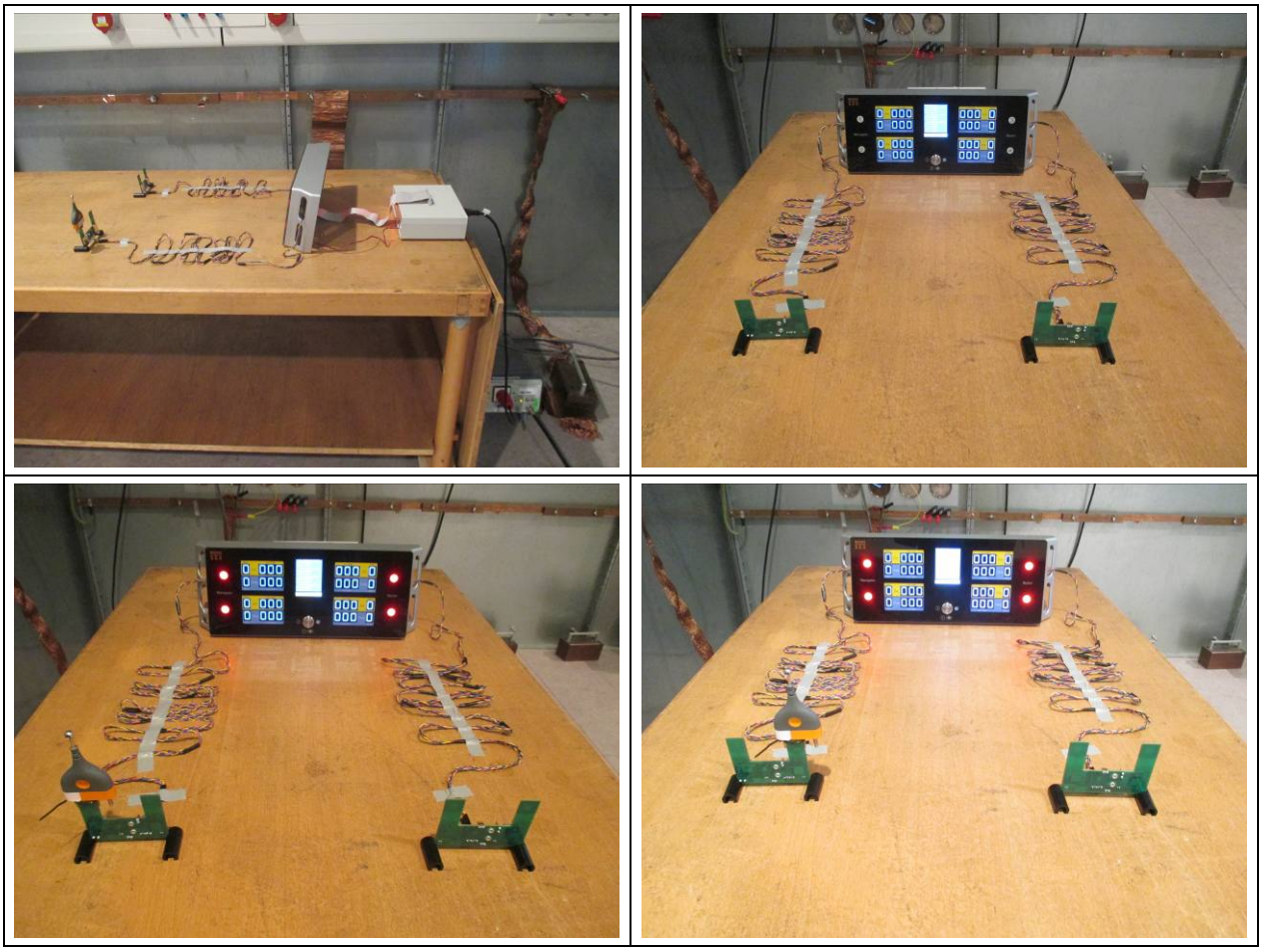


Figure 7-39: Test Setup Conducted Emissions (150 kHz – 30 MHz) – Configurations 11

7.2.2 Test No. 2: Occupied Bandwidth (§ 15.215c)

Figure 7-40: Test Setup Occupied Bandwidth – Configuration 5

Figure 7-41: Test Setup Occupied Bandwidth – Configuration 6

7.2.3 Test No. 3: Radiated Emissions (§ 15.205, § 15.209, § 15.225a-d)

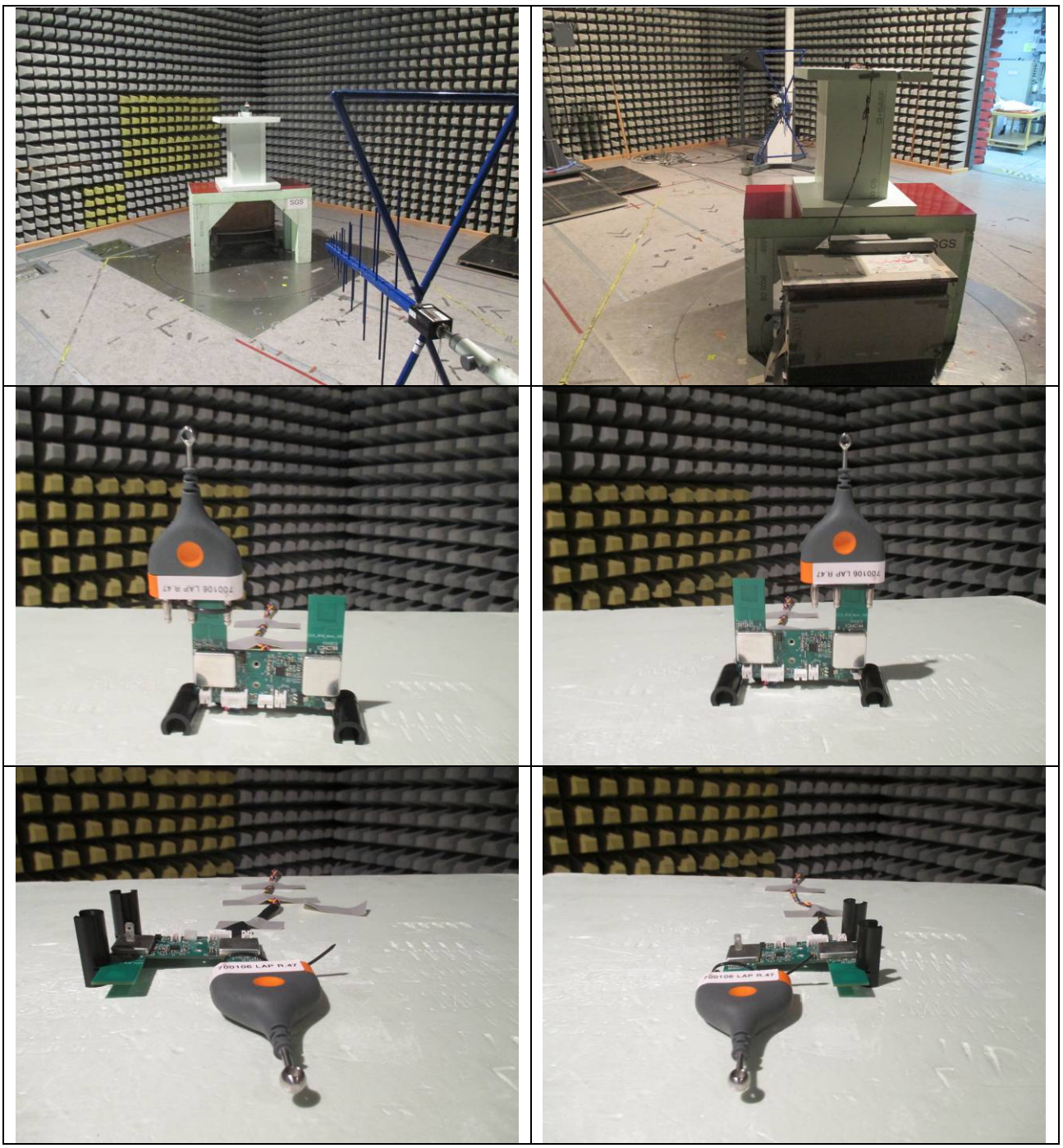


Figure 7-42: Test Setup Radiated Emission 30 MHz – 1 GHz – Configurations 5, 6, 7, 8

Figure 7-43: Test Setup Radiated Emission 9 kHz – 30 MHz – Configuration 1, 2, 3, 4, 5

7.2.4 Test No. 4: Frequency Stability (§ 15.225e)

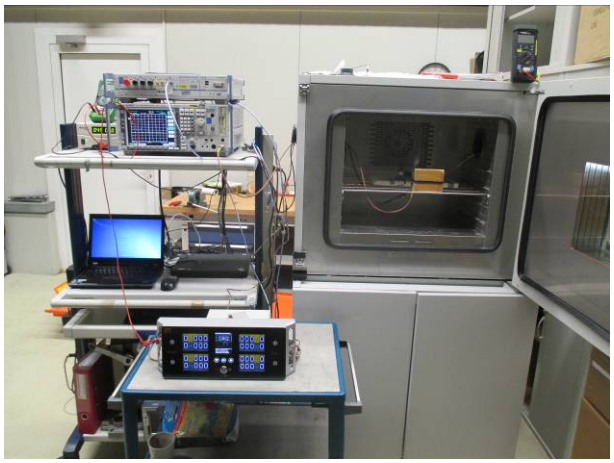


Figure 7-44: Test Setup – Frequency Stability with voltage or Temperature variation – Configurations 1 & 2

7.3 Photographs of EUT and accessories

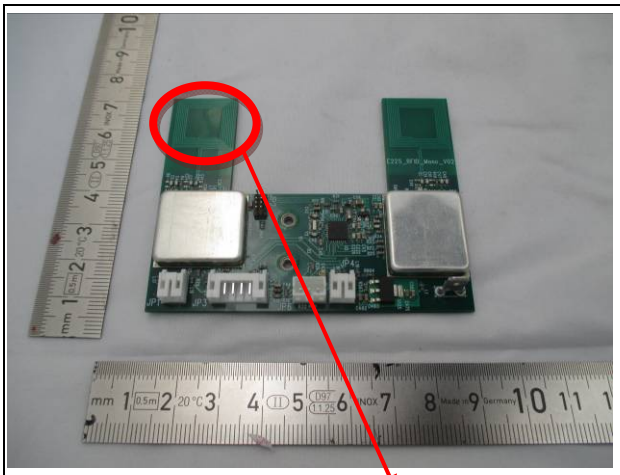
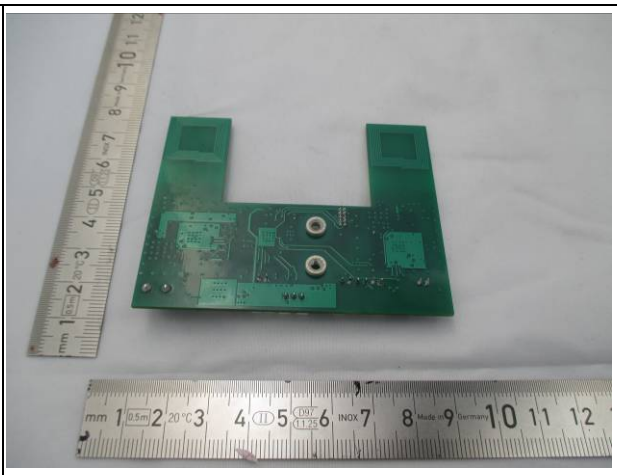
	
Front view of EUT (Left: Antenna Top; Right: Antenna Bottom)	*Rear view of EUT*

Figure 7-45: RFID Reader Monopolar

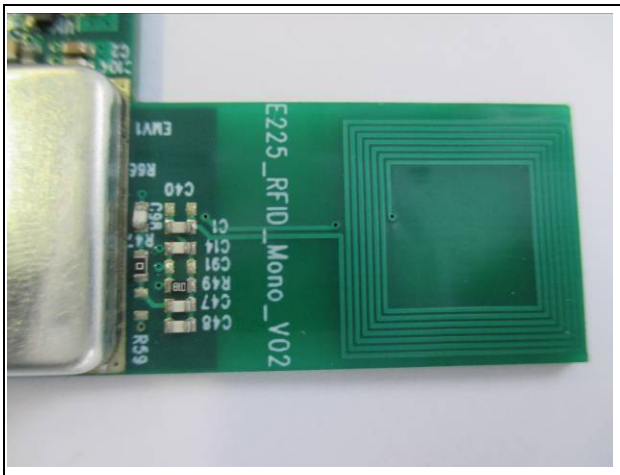
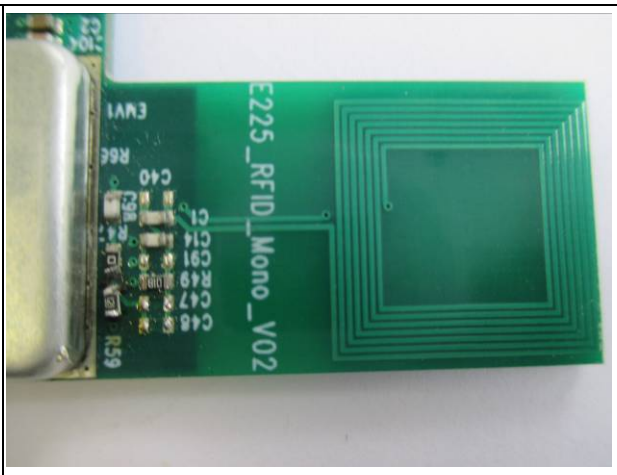
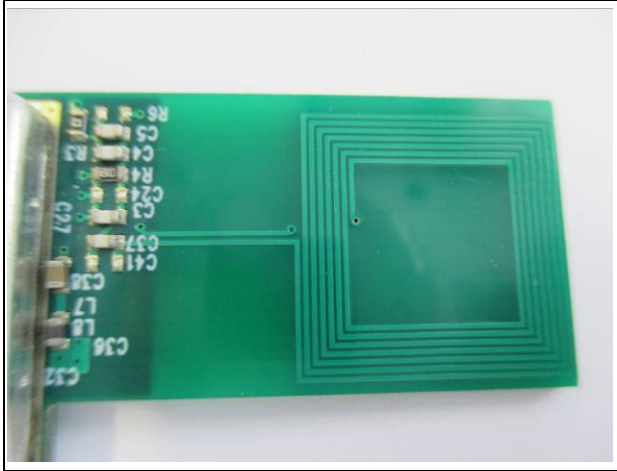
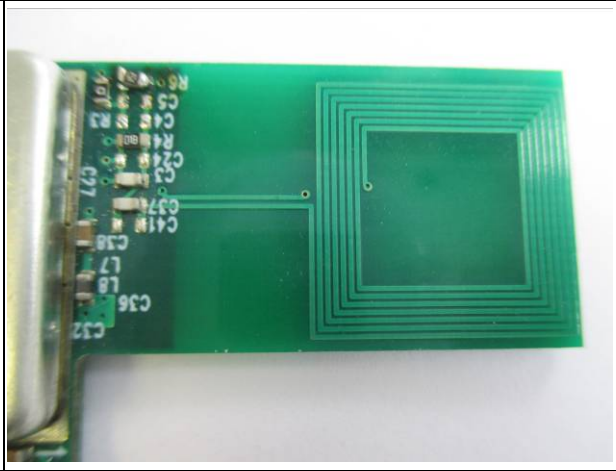
	
Real DUT (Antenna Bottom)	*DUT with Dummy Load (Antenna Bottom)*
	
Real DUT (Antenna Top)	*DUT with Dummy Load (Antenna Top)*

Figure 7-46: RFID Reader Monopolar - Differences between real Module and Dummy Load

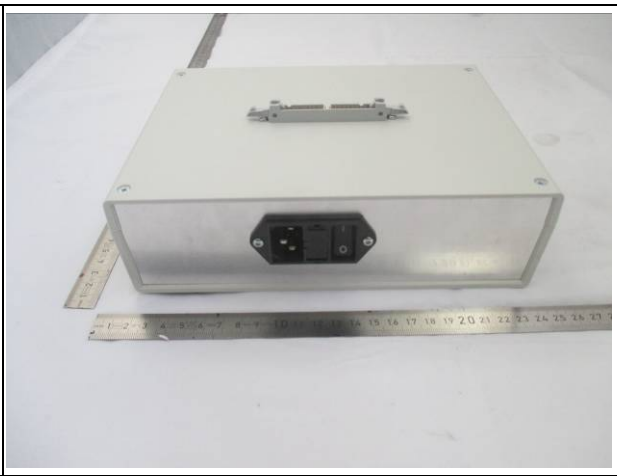
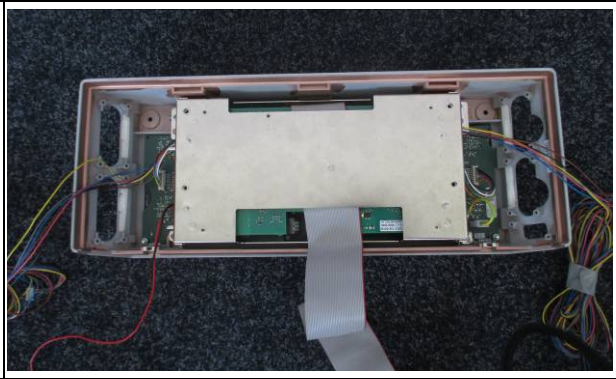
	
Front view of power supply	*Rear view of power supply*
	
Front view of host controller	*Rear view of host controller*
	
Front view of tag	*Rear view of tag*

Figure 7-47: Auxiliary Equipment

7.4 Annex A

Compliance with § 15.225a-d and § 15.225 requires that the field strength of any emissions shall not exceed limits given in µV/m at a specified limit distances.

Since measurement has been made with a loop antenna at a measurement distance of 3 meters the compliance limit was extrapolated from the respective limit distances to 3 meters by calculation according to C63.10-2013 chapter 6.6.4.2.

FCC Electric fields limit [µV/m]:	$L_{\mu V/m}$
Converted FCC Electric fields limit [dBµV/m]:	$FS_{limit} = 20 \log (L_{\mu V/m}) + 120$
Reference limit distance [m]:	d_{limit}
distance of the measurement point [m]:	$d_{measure}$
Nearfield distance [m] :	$d_{nearfield} = 47.77/f_{MHz}$

If the single point measured closer to the EUT than λ/2π and limit distance greater than λ/2π following equation has been used

$$\mathbf{FS_{max}}[dB\mu V/m] = FS_{limit} + 40\log(d_{nearfield/}\ d_{measure)} + 20\log(d_{limit/}\ d_{nearfied)}$$

If the single point measured greater than λ/2π following equation has been used

$$\mathbf{FS_{max}}[dB\mu V/m] = FS_{limit} + 20\log(d_{limit/}\ d_{measure}$$

If both the single point and the limit distance are equal or closer to the EUT than λ/2π following equation has been used

$$\mathbf{FS_{max}}[dB\mu V/m] = FS_{limit} + 40\log(d_{limit/}\ d_{measure)}$$

For measuring equipment calibrated in dBµV/m, the reading should be reduced by 51.5 dB to be converted to dBµA/m

Using the equations above appropriately yield following conversion table

Frequency Ranges [MHz]	L [µV/m]	d_{limit} [m]	FS_{limit} [dBµV/m]	FS_{max} [dBµV/m]	$d_{measure}$ [m]	FS_{max} [dBµA/m]
11.810	30	30	29.54	48.63	10	-2.87
13.110	30	30	29.54	48.63	10	-2.87
13.110	106	30	40.51	40.99	10	-10.51
13.410	106	30	40.51	40.99	10	-10.51
13.410	334	30	50.47	50.96	10	-0.54
13.553	334	30	50.47	50.96	10	-0.54
13.553	15848	30	84.00	84.48	10	32.98
13.567	15848	30	83.00	84.48	10	32.98
13.567	334	30	50.47	50.96	10	-0.54
13.710	334	30	50.47	50.96	10	-0.54
13.710	106	30	40.51	40.99	10	-10.51
14.010	106	30	40.51	40.99	10	-10.51
14.010	30	30	29.54	48.63	10	-2.87
15.310	30	30	29.54	48.63	10	-2.87

Table 7-1: Conversion table for radiated emissions limits § 15.225a-c

Frequency Ranges [MHz]	L [µV/m]	d_{limit} [m]	FS_{limit} [dBµV/m]	FS_{max}[m [dBµV/m]	$d_{measure}$ [m]	FS_{max} [dBµA/m]
0.009	266.67	300	48.52	107.60	10	56.10
0.490	4.90	300	13.80	72.89	10	21.39
0.490	48.98	30	33.80	52.89	10	1.39
1.705	14.08	30	22.97	42.05	10	-9.45
1.705	30.00	30	29.54	48.63	10	-2.87
30.0	30.00	30	29.54	48.63	10	-2.87

Table 7-2: Conversion table for radiated emissions limits § 15.225d

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