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

SGS Germany GmbH

Test Report No.: N4420010

FCC ID: 2AVPQGC269016

Order No.: N442 **Pages:** 57

Client:	PULSION Medical Systems SE
Equipment Under Test:	NICCI NFC Unit
Manufacturer / Importer:	PULSION Medical Systems SE
Task:	Compliance with the requirements mentioned below:
Test Specification(s): [covered by accreditation]	• FCC 47 CFR Part 15
Test Specification(s): [not covered by accreditation]	• RSS Gen Issue 5 • RSS-210 Issue 10
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	Sep 08, 2020	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]
2	Occupied Bandwidth	§ 15.215(c) RSS Gen, 6.6	21	compliant
3	Radiated Emission [3]	§ 15.205, § 15.209, § 15.225(a-d) RSS Gen, 8.9, 8.10 RSS-210, B.6 (a-d)	23	compliant
4	Frequency Stability	§ 15.225(e) RSS Gen, 8.11 RSS-210, B.6	34	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] Measurement was done on the DC port as supplied by host. Measurement on AC line with EUT in place shall be additionally made at the specific host device.

[3] 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

PULSION Medical Systems SE
Hans-Riedl-Str. 17
85622 Feldkirchen
Claudia Rischer

3.2 Test Laboratory

SGS Germany GmbH
Hofmannstraße 50
81379 München

3.3 Time Schedule

Delivery of EUT: Apr 11, 2019
Start of test: Apr 11, 2019
End of test: Apr 24, 2019

Test No.:	1	2	3	4
Start of Test:	Apr 16, 2019	Apr 24, 2019	Apr. 11, 2019	Apr 23, 2019
End of Test:	Apr 16, 2019	Apr 24, 2019	Apr. 12, 2019	Apr 24, 2019

3.4 Participants

Name	Function
André Stéphane Nakpane	Accredited testing, Editor
Claudia Rischer	Operating of EUT, Setup of EUT

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 ..:	NICCI NFC Unit
Trade Mark .....:	none
Manufacturer / Importer .:	PULSION Medical Systems SE
Model/Type .....:	
Number of tested samples .....:	2
Serial Number(s) .....:	NFC Module on Sensor Frontend PCBA (part number F000044)
Ratings .....:	+5 V ± 15% DC
Primary functions of EUT:	NFC
Type of modulation .....:	ASK 100%; load modulation, Manchester coding according to ISO/IEC 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 NFC RF Module is integrated on Sensor Frontend PCBA (F000044). F000044 is part of the NICCI NFC Unit, operating according to ISO 15693. The antenna is a magnetic loop antenna with a rectangular shape. The EUTs uses amplitude shift keying (ASK). The antenna is matched to 50 ohms at 13.56 MHz. The EUT is controlled and powered via Controller PCBA (F000043).

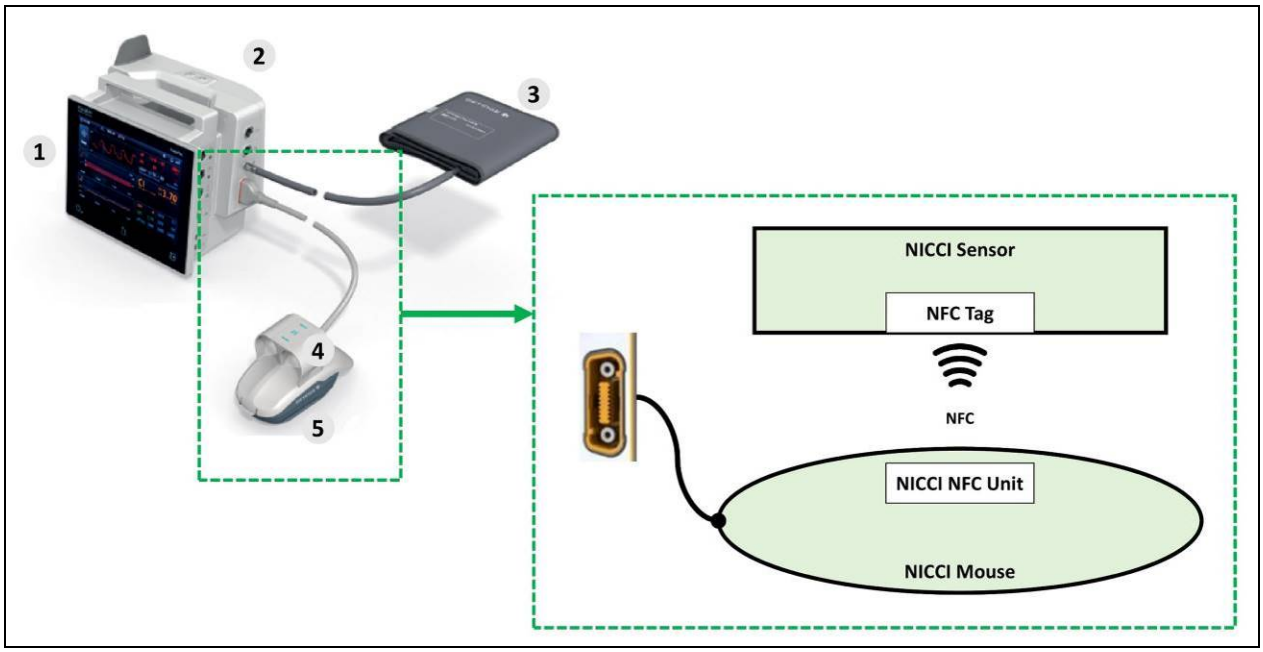


Figure 4-1: Block diagram of NICCI NFC Unit integrated in NICCI Mouse PC6510 with Host additional accessories.

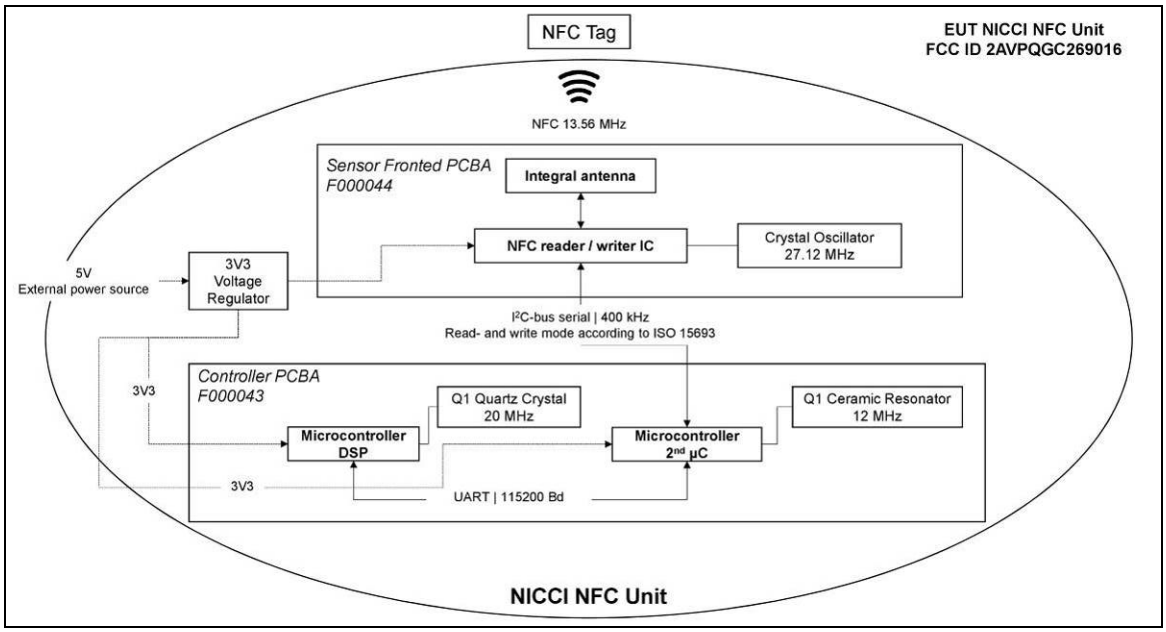


Figure 4-2: Block diagram of NICCI NFC Unit with Clock frequencies.

4.1 Operational conditions

4.1.1 Software

Software necessary for operating, controlling and monitoring the EUT:

Name	Identification Code/Issue	Task
None	--	--

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)**		1.5 Watt (
Modulation:	**Type**		ASK, 100%, ISO 15693
	Operation w/o modulation		Yes
Antenna:	**Type**		Integral
	Number of Antenna Ports		1
Power Src.:	**Type**		DC Supply
	Battery type (if applicable)		N/A
	Voltage	**nominal**	+5 V DC (EUT Sensor Frontend PCBA)
		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 the NFC transponder:	Reading of the NFC transponder

4.1.4 Test configurations

Test Configuration	EUT orientation		Tag		Comment
	Vertical	Horizontal	Yes	No	
1	☒	☐	☐	☒	None
2	☒	☐	☒	☐	None
3	☐	☒	☐	☒	None
4	☐	☒	☒	☐	None
5	☐	☒	☐	☒	Dummy load

4.2 Hardware Configuration

4.2.1 Components of the EUT

Name	Identification Code/Issue/Serial Number	Interface type	Quantity
NICCI NFC Sensor Frontend PCBA	F000044	Integral Antenna loop	1
NICCI NFC Sensor Frontend PCBA	F000044	Dummy load (modified for test purpose)	1
NICCI NFC Controller PCBA	F000043	I2C Bus serial	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

EUT Sensor Frontend PCBA:

Type (AC/DC)	Voltage	Frequency	Current	Power
DC	5V	--	< 1A	

4.2.2.2 Earthing and Grounding connections [4]

Type	Task	Connected to	Test E/I/NA
None			

[4] Safety ground, functional earth, specific ground connections

4.2.2.3 Communication [5] and signal [6] ports

Type	Bit rate/frequency/ Signal	Task	Connected to
None	--		

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 / Subsystem	Highest clock frequency
I^2C-Bus serial	400 kHz
NFC	13.56 MHz
Q1 Quartz Crystal	20.00 MHz
Crystal Oscillator	27.12 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

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

6 Signaling, monitoring and control ports

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 [7] C/L
NICCI NFC Controller PCBA (F000043)	Provide power supply and communicate with EUT	C
Adapter cable	Adapter cable for power supply of NICCI NFC Controller PCBA and EUT	C
Power supply	Supplies NICCI NFC Unit	L

4.3 Deviations from Standard

None

[7] 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 (Thick-ness: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 ab-sorbers	Without ab-sorbers
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		VCCI-listed until Oct. 2019, Reg. No. R-2623, G-266			VCCI-listed until Oct. 2019, Reg. No. C-2866 & No. T-1942
Specials	***Emission*:** ***30 – 1000 MHz (d = 10 m)*** - NSA acc. to: ・ 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: ・ 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: ・ 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. IEC/EN 61000-4-3	***Immunity:*** Field uniformity 80 – 6000 MHz acc. IEC/EN 61000-4-3	***Immunity:*** Field uniformity 80 – 6000 MHz acc. IEC/EN 61000-4-3		

FCC (Federal Communication Commission): Recognition by Bundesnetzagentur (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.**
Designation No. for **RRA** (Radio Research Agency) in **Korea; EU0145**

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 meas-

urements 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. Measurement was done on the DC port.

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):	23.4	23.5
Rel. Humidity (%):	28.6	27.1

Operation mode (see 4.1.3)	
☒ 1	☒ 2

Test configuration (see 4.1.4)				
☐ 1	☐ 2	☒ 3	☒ 4	☒ 5

6.1.4 Test Configuration

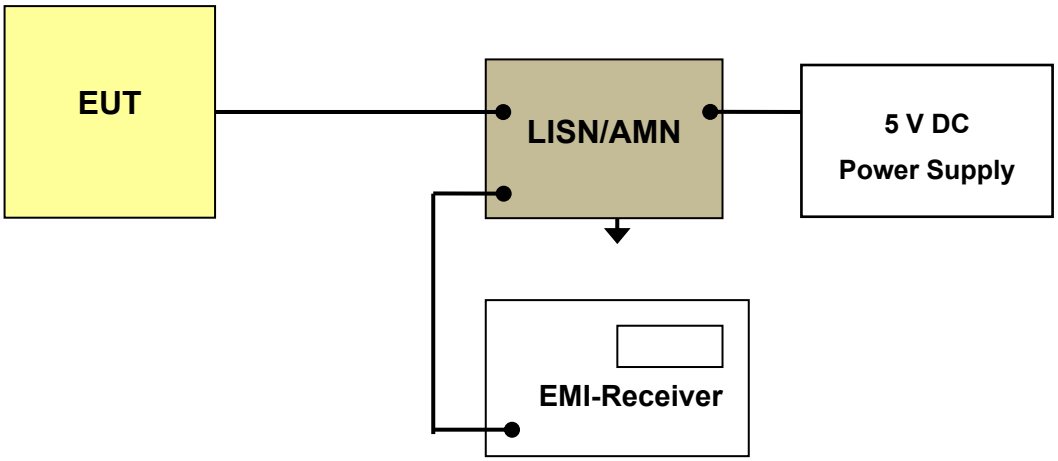


Figure 6-1: Test Configuration – Conducted Emissions (150 kHz – 30 MHz)

Photographs of the EUT setup for conducted emission measurement are shown on page 48 of this report.

6.1.5 Test instruments and accessories

ID	Description	Manufacturer	Model	Serial No.	Status	Cal. date	Cal. due
P1100	EMI receiver	R&S	ESPI-3	100024	cal	Apr 04, 2018	Apr 2020
P0323	EMI receiver	R&S	ESS	845637/012	cal	Apr 05, 2018	Apr 2020
P1338	LISN (integrated pulse limiter P0491)	R&S	ESH3-Z5	891733/024	cal	Apr 03, 2018	Apr 2020
P1203	power supply	Sorensen	SGA60/ 83D	0551A00019	cnn		
P1596	Multimeter / True RMS	Fluke	MM	86800096	cal	Jun 04, 2018	Jun 2020
P1917	Data logger for humidity and temperature (MZ6)	testo AG	testo 175 H1	40342579	cal	Aug 19, 2017	Aug 2020
P0977	test chamber 6	Siemens			chk	Feb 22, 2019	Feb 2020

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

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 10.35.10 (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 starting on page 37 of this report.

Result table Neutral line (5 V DC) – Configuration 4:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
2.378000	---	32.90	46.00	13.10	1000.0	9.000	N	GND	10
2.378000	33.54	---	56.00	22.46	1000.0	9.000	N	GND	10
13.506000	---	11.25	50.00	38.75	1000.0	9.000	N	GND	11
13.506000	29.46	---	60.00	30.54	1000.0	9.000	N	GND	11
13.562000	51.33	---	60.00	8.67	1000.0	9.000	N	GND	11
13.562000	---	51.53	50.00	-1.53	1000.0	9.000	N	GND	11
13.630000	22.10	---	60.00	37.90	1000.0	9.000	N	GND	11
13.630000	---	7.97	50.00	42.03	1000.0	9.000	N	GND	11
27.122000	---	24.11	50.00	25.89	1000.0	9.000	N	GND	11
27.122000	24.66	---	60.00	35.34	1000.0	9.000	N	GND	11

Result table Phase line (5 V DC) – Configuration 4:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
2.378000	---	33.16	46.00	12.84	1000.0	9.000	L1	GND	10
13.562000	---	26.35	50.00	23.65	1000.0	9.000	L1	GND	11
27.122000	25.66	---	60.00	34.34	1000.0	9.000	L1	GND	11

Result table Neutral line (5 V DC) – Configuration 3:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
2.386000	20.41	---	56.00	35.59	1000.0	9.000	N	GND	10
2.386000	---	12.19	46.00	33.81	1000.0	9.000	N	GND	10
13.546000	---	8.68	50.00	41.32	1000.0	9.000	N	GND	11
13.562000	---	50.60	50.00	-0.60	1000.0	9.000	N	GND	11
13.562000	51.87	---	60.00	8.13	1000.0	9.000	N	GND	11
27.122000	25.05	---	60.00	34.95	1000.0	9.000	N	GND	11

Result table Phase line (5 V DC) – Configuration 3:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
2.378000	---	30.87	46.00	15.13	1000.0	9.000	L1	GND	10
13.562000	---	22.14	50.00	27.86	1000.0	9.000	L1	GND	11
27.122000	25.25	---	60.00	34.75	1000.0	9.000	L1	GND	11

Result table Neutral line (5 V DC) – Configuration 5:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
2.378000	---	32.21	46.00	13.79	1000.0	9.000	N	GND	10
2.378000	36.93	---	56.00	19.07	1000.0	9.000	N	GND	10
13.562000	---	42.16	50.00	7.84	1000.0	9.000	N	GND	11
13.562000	43.93	---	60.00	16.08	1000.0	9.000	N	GND	11

Result table Phase line (5 V DC) – Configuration 5:

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
2.386000	---	13.29	46.00	32.71	1000.0	9.000	L1	GND	10
2.386000	30.89	---	56.00	25.11	1000.0	9.000	L1	GND	10
13.558000	---	36.66	50.00	13.34	1000.0	9.000	L1	GND	11
13.558000	37.62	---	60.00	22.38	1000.0	9.000	L1	GND	11

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.

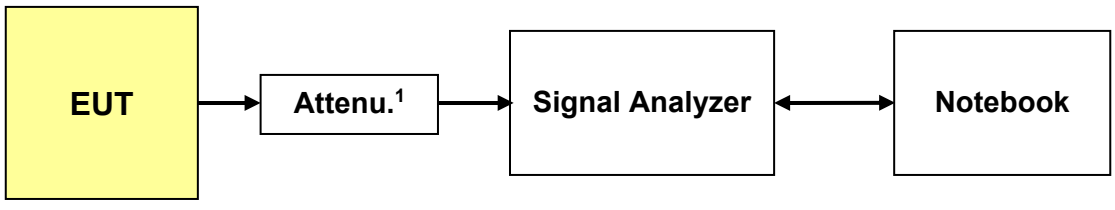
Climatic condition during test

Temperature (°C): 20.0
Rel. Humidity (%): 22.0

Operation mode (see 4.1.3)	
☐ 1	☒ 2

Test configuration (see 4.1.4)				
☐ 1	☒ 2	☐ 3	☐ 4	☐ 5

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 49 of this report.

6.2.5 Test instruments and accessories

ID	Description	Manufacturer	Model	Serial No.	Status	Cal. date	Cal. due
P1845	Spectrum Analyzer	R&S	FSU26	100169	cal	Apr 06, 2018	Apr 2020
P1740	Frequency Standard	Datum GmbH	MRT Telecom Rub.	3768 / 002	cal	Mar 07, 2018	Mar 2020
P2334	attenuator	Weinschel Corp	Type N, 20 dB, dc-12.4 GHz	BJ5525	ind	-	-
P1550	GPIB-USB-HS Interface	National Instruments		113405	cnn	-	-
P1576	Heating Cabinet	Binder	MKT 115	11-19448	cal	Sep 07, 2018	Sep 2019
P1596	Multimeter / True RMS	Fluke	MM	86800096	cal	Jun 04, 2018	Jun 2020
P0395	power supply	Gossen	24K16R8	1958	ind		
O0852	Multimeter, digital	GMC-Instruments	METRAHIT EXTRA	TH1654	cal	Aug 10, 2018	Aug 2019
O0847	Multimeter, digital	GMC-Instruments	METRAHIT EXTRA	TH1633	cal	Aug 08, 2018	Aug 2019

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

6.2.6 Test Procedure and Results

The 20dB 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 starting on pages 40 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 2

Carrier Frequency	Occupied Bandwidth		Result
[MHz]	[Hz]		
	-20 dB	99%	
13.56	26.910	23.220	compliant
Measurement Uncertainty:			±48kHz

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

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 6-3: 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.

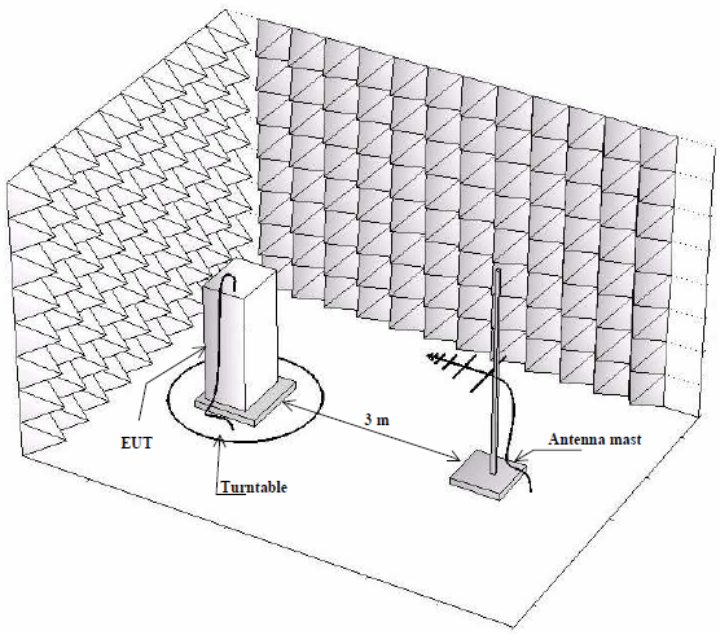


Figure 6-3: Test Configuration – Radiated Emissions

Photographs of the EUT in the anechoic chamber are shown on page 50 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 10.40.10 (R&S)

Instruments and accessories

ID	Description	Manufacturer	Model	Serial No.	Status	Cal. date	Cal. due
P0311	antenna	Chase	CBL6111	2409	cal	Mar 30, 2018	Mar 2021
P0338	test chamber 3	Siemens			chk	Feb 22, 2019	Feb 2020
P1303	Mast (MZ3)	innco GmbH	MA 4660-XPET		cnn		
P1304	Controller	innco GmbH	CO 3000	CO3000/915	cnn		
P1326	EMI receiver	R&S	ESU26	100058	cal	Apr 05, 2018	Apr 2020
P1299	video camera MZ3	Pontis		6410703001	ind		
P1809	multimeter, digital (MZ01)	GMC-I Gossen-Metrawatt GmbH	METRAHIT2+	XF2334	cal	May 08, 2018	May 2019
P2374	Power Supply	Gopher Technology	CPS 6005 II		ind		
P1914	Data logger for humidity and temperature (MZ3)	testo AG	testo 175 H1	40342576	cal	Aug 19, 2017	Aug 2020

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): 22.7 – 23.5
Rel. Humidity (%): 27.7 – 25.6

6.3.5.1.1 Results for configuration 1

Operation mode (see 4.1.3)	
☒ 1	☐ 2

Test configuration (see 4.1.4)				
☒ 1	☐ 2	☐ 3	☐ 4	☐ 5

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 45 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/m)
39.942500	11.61	40.00	28.39	15000.0	120.000	255.0	V	304.0	14
73.844000	10.16	40.00	29.84	15000.0	120.000	150.0	V	145.0	7
176.324500	12.44	43.50	31.06	15000.0	120.000	116.0	V	5.0	10
178.846500	13.38	43.50	30.12	15000.0	120.000	100.0	V	324.0	10
183.502500	16.32	43.50	27.18	15000.0	120.000	110.0	V	333.0	9
488.179500	26.74	46.00	19.26	15000.0	120.000	221.0	H	18.0	19

6.3.5.1.2 Results for configuration 2

Operation mode (see 4.1.3)	
☐ 1	☒ 2

Test configuration (see 4.1.4)				
☐ 1	☒ 2	☐ 3	☐ 4	☐ 5

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 46 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/m)
63.319500	7.32	40.00	32.68	15000.0	120.000	104.0	V	288.0	6
145.284500	10.31	43.50	33.19	15000.0	120.000	150.0	V	5.0	12
216.919000	18.87	46.00	27.13	15000.0	120.000	250.0	V	5.0	10

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

Phenomena	Reference	Test Specification	Criteria	Verdict [8]
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): 21.0 – 20.9
Rel. Humidity (%): 53.4 – 48.1

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 NFC 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 10 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 10 meters by calculation as given in Annex A.

Test location: semi anechoic chamber No. 1

EMC-Test-SW: EMC32 version 10.50.00 (R&S)

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

8 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	Description	Manufacturer	Model	Serial No.	Status	Cal. date	Cal. due
P2062	EMI receiver	R&S	ESR26	101417	cal	Feb 07, 2018	Feb 2020
P1140	Controller	innco GmbH	CO 3000	CO3000/916	cnn		
P1366	video camera MZ1	Pontis		6411135018	ind		
P2134	coax cable 1.5m (Receiver-rack MZ1)	Suhner	S 07212 BD		chk	Aug 17, 2018	Aug 2019
P0073	antenna	R&S	HFH2-Z2	891847/8	cal	Jan 24, 2018	Jan 2020
P2373	Power Supply	Gopher Technology	CPS 6005 II		ind		
P1809	multimeter, digital (MZ01)	GMC-I Gossen-Metrawatt GmbH	METRAHIT2+	XF2334	cal	May 08, 2018	May 2019
P1912	Data logger for humidity and temperature (MZ1)	testo AG	testo 175 H1	40342580	cal	Aug 18, 2017	Aug 2020
P0336	test chamber 1	Siemens			chk	Feb 22, 2019	Feb 2020

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

Photo documentation of the test set-up:

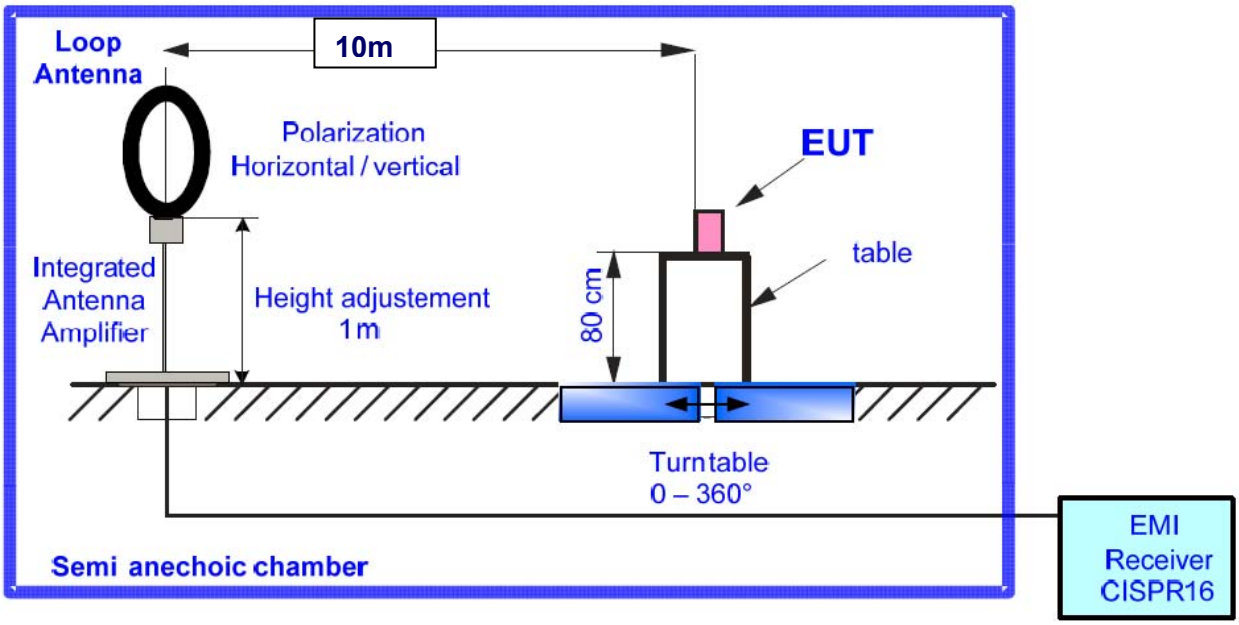


Figure 6-4: test setup for Radiated disturbances 9 kHz to 30 MHz

6.3.5.2.1 Results for configuration 1

Operation mode (see 4.1.3)	
☒ 1	☐ 2

Test configuration (see 4.1.4)				
☒ 1	☐ 2	☐ 3	☐ 4	☐ 5

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 41 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/m)
13.560700	-25.71	42.04	67.75	15000.0	0.200	V	90.0	-31

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/m)
13.560700	-38.19	42.04	80.23	15000.0	0.200	H	1.0	-31

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

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)
0.017925	1.82	50.1	48.28	15000.0	0.200	V	292.0	-30
0.975528	-25.43	-4.6	20.83	15000.0	9.000	V	157.0	-32
1.637816	-26.48	-9.3	17.18	15000.0	9.000	V	337.0	-32

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

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)
1.613330	-26.44	-9.1	17.34	15000.0	9.000	H	302.0	-32
1.658804	-26.60	-9.6	17.00	15000.0	9.000	H	23.0	-32
1.693784	-26.60	-9.9	16.70	15000.0	9.000	H	122.0	-32

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

Test configuration (see 4.1.4)				
☐ 1	☒ 2	☐ 3	☐ 4	☐ 5

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 42 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/m)
13.560700	-27.74	42.04	69.78	15000.0	0.200	V	91.0	-31

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

Worst case has been evaluated to be with loop antenna vertical polarized. Thus no measurement for loop antenna horizontal polarized has been made.

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

Test configuration (see 4.1.4)				
☐ 1	☐ 2	☒ 3	☐ 4	☐ 5

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 42 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/m)
13.560700	-38.28	42.04	80.32	15000.0	0.200	V	79.0	-31

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/m)
13.560700	-42.32	42.04	84.36	15000.0	0.200	H	28.0	-31

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

Frequency (MHz)	QuasiPeak (dBµA/m)	Limit (dBµA/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)
1.606334	-26.44	-9.0	17.44	15000.0	9.000	V	292.0	-32
1.679792	-26.53	-9.8	16.73	15000.0	9.000	V	221.0	-32

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

Test configuration (see 4.1.4)				
☐ 1	☐ 2	☐ 3	☒ 4	☐ 5

Result:

Verdict:	**compliant**

The following table shows the measured radiated emissions. Plots of the measurements are included on page 43 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/m)
13.560700	-40.07	42.04	82.11	15000.0	0.200	V	85.0	-31

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

Worst case has been evaluated to be with loop antenna vertical polarized. Thus no measurement for loop antenna horizontal polarized has been made.

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:

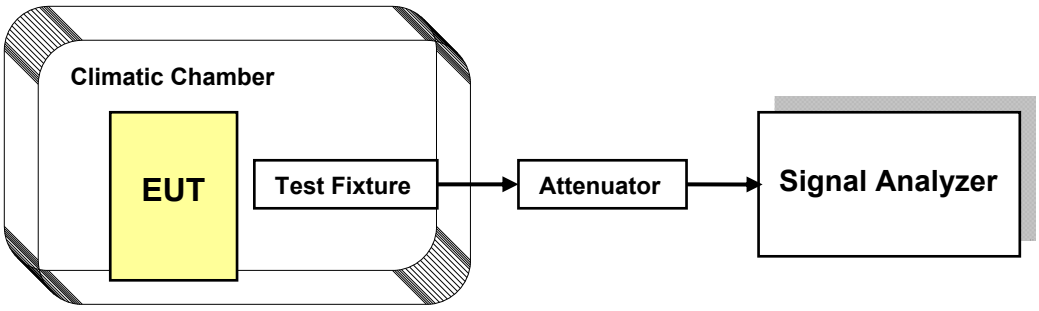


Figure 6-5: Test Configuration – Frequency Stability with temperature variation

Frequency Stability with Voltage Variation:

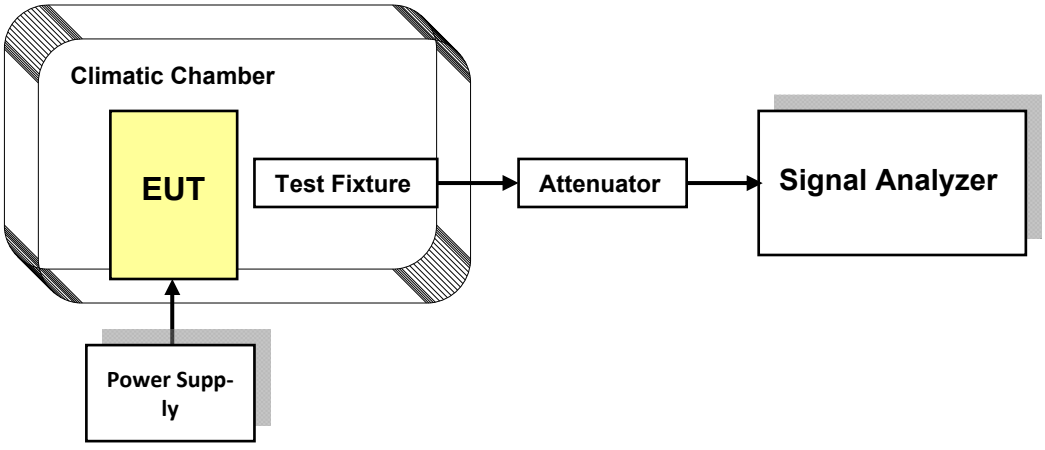


Figure 6-6: Test Configuration – Frequency Stability with voltage variation

6.4.5 Test instruments and accessories

ID	Description	Manufacturer	Model	Serial No.	Status	Cal. date	Cal. due
P1845	Spectrum Analyzer	R&S	FSU26	100169	cal	Apr 06, 2018	Apr 2020
P1740	Frequency Standard	Datum GmbH	MRT Telecom Rub.	3768 / 002	cal	Mar 07, 2018	Mar 2020
P2334	attenuator	Weinschel Corp	Type N, 20 dB, dc-12.4 GHz	BJ5525	ind		
P1550	GPIB-USB-HS Interface	National Instruments		113405	cnn		
P1576	Heating Cabinet	Binder	MKT 115	11-19448	cal	Sep 07, 2018	Sep 2019
P1596	Multimeter / True RMS	Fluke	MM	86800096	cal	Jun 04, 2018	Jun 2020
P0395	power supply	Gossen	24K16R8	1958	ind		
O0852	Multimeter, digital	GMC-Instruments	METRAHIT EXTRA	TH1654	cal	Aug 10, 2018	Aug 2019
O0847	Multimeter, digital	GMC-Instruments	METRAHIT EXTRA	TH1633	cal	Aug 08, 2018	Aug 2019

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

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 2

Operation mode (see 4.1.3)	
☐ 1	☒ 2

Test configuration (see 4.1.4)				
☐ 1	☒ 2	☐ 3	☐ 4	☐ 5

Carrier Frequency: 13.56 MHz						
Supply Voltage (DC)	**Ambient Temperature**	**Frequency Deviation**		**Maximum allowed Deviation**		**Result**
[V]	**[°C]**	**[Hz]**	**[ppm]**	**[Hz]**	**[ppm]**	
5V	-20	-591.64	-43.63	±1356	±100	compliant
	-10	-616.66	-45.48	±1356	±100	compliant
	0	-617.77	-45.56	±1356	±100	compliant
	+10	-600.52	-44.29	±1356	±100	compliant
	+20	-567.31	-41.84	±1356	±100	compliant
	+30	-537.13	-39.61	±1356	±100	compliant
	+40	-520.79	-38.41	±1356	±100	compliant
	+50	-519.43	-38.31	±1356	±100	compliant
Measurement Uncertainty:					±3.6 Hz	

Table 6-4: 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	-583,55	-43.03	±1356	±100	compliant
5.00		-567.31	-41.84	±1356	±100	compliant
5.75		-562.65	-41.49	±1356	±100	compliant
Measurement Uncertainty:					±3.6 Hz	

Table 6-5: 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.

7 Test Data and Screenshots

7.1 Spectral Plots

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

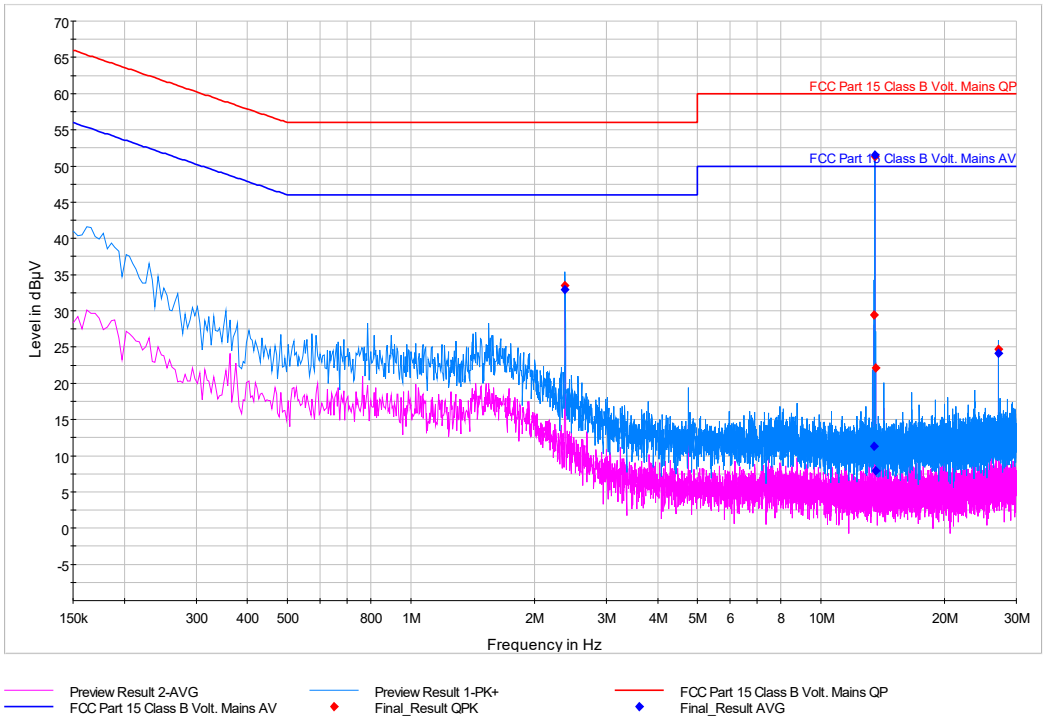


Figure 7-1: Conducted Emissions (150 kHz – 30 MHz), Neutral line – Configuration 4 (5 V DC)

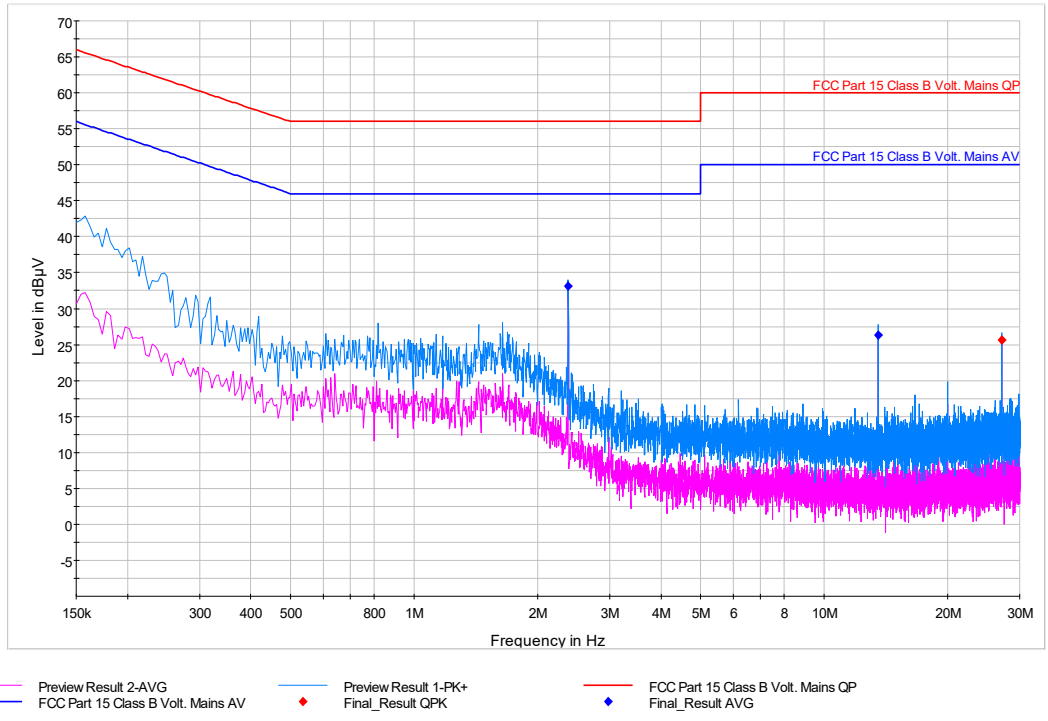


Figure 7-2: Conducted Emissions (150 kHz – 30 MHz), Phase Line – Configuration 4 (5 V DC)

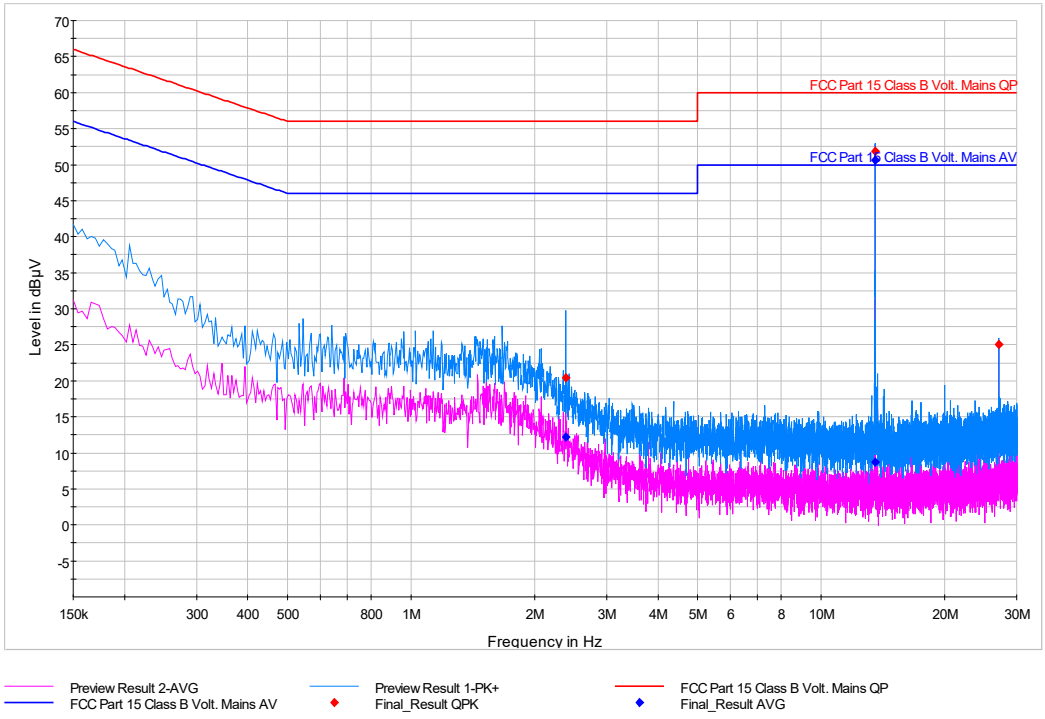


Figure 7-3: Conducted Emissions (150 kHz – 30 MHz), Neutral line – Configuration 3 (5 V DC)

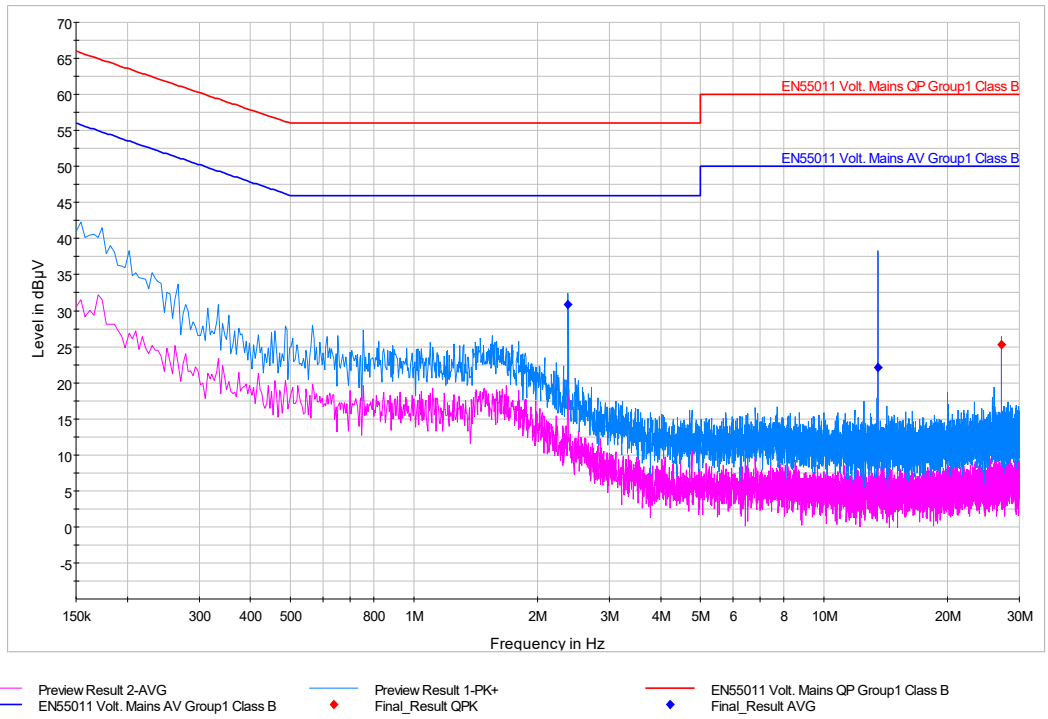


Figure 7-4: Conducted Emissions (150 kHz – 30 MHz), Phase Line – Configuration 3 (5 V DC)

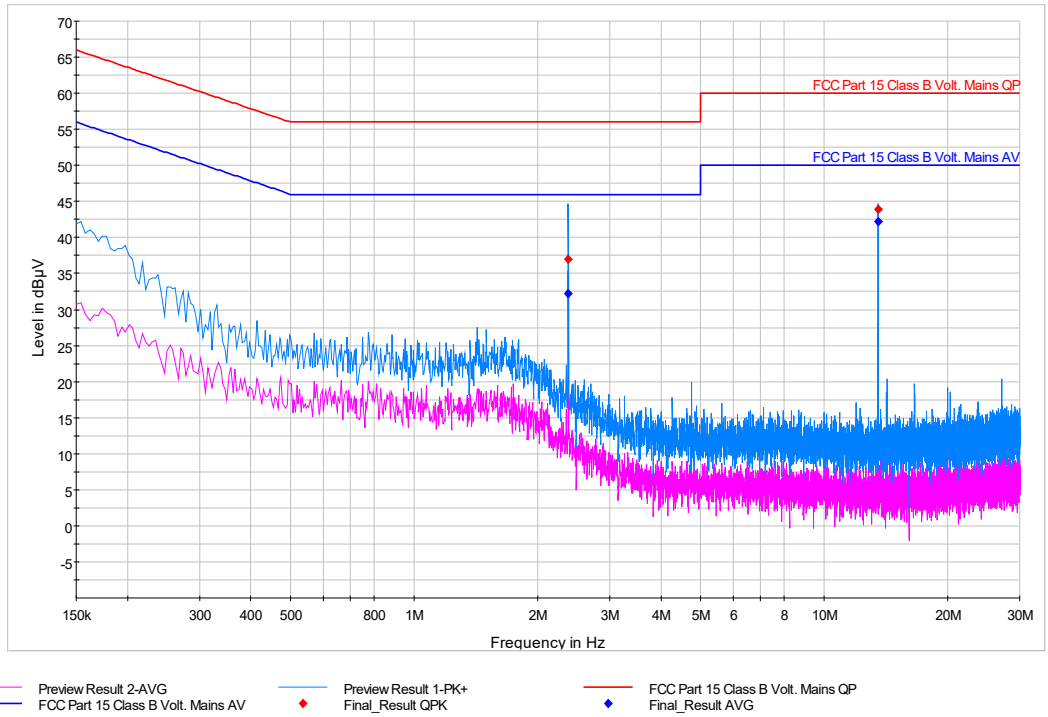


Figure 7-5: Conducted Emissions (150 kHz – 30 MHz), Neutral line – Configuration 5 (5 V DC)

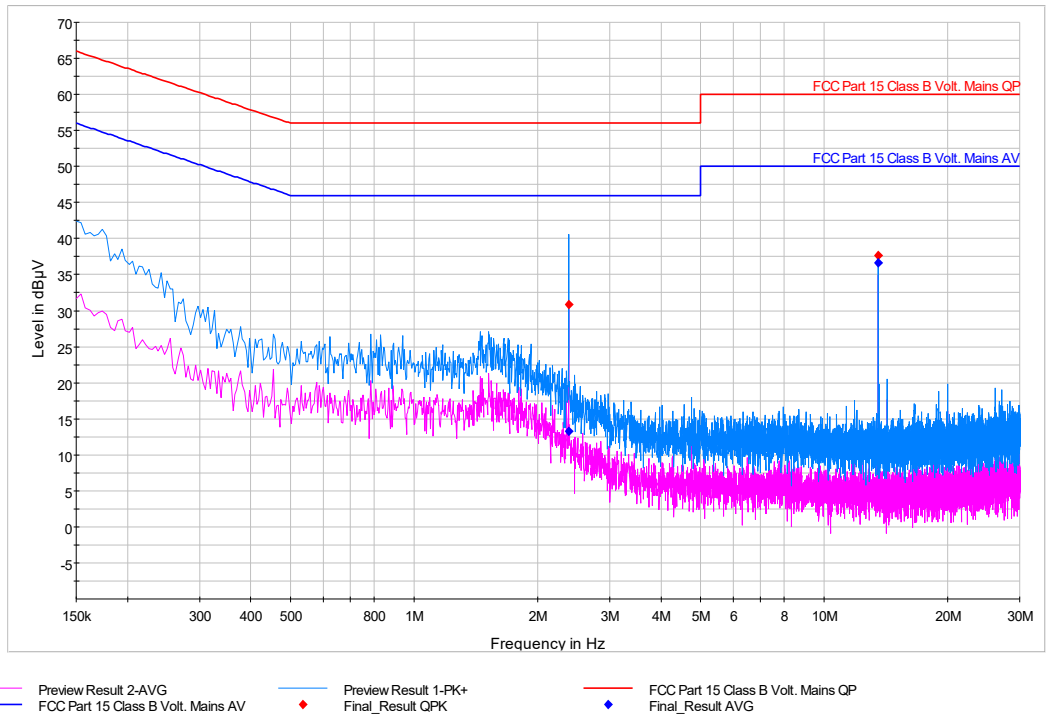


Figure 7-6: Conducted Emissions (150 kHz – 30 MHz), Phase Line – Configuration 5 (5 V DC)

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

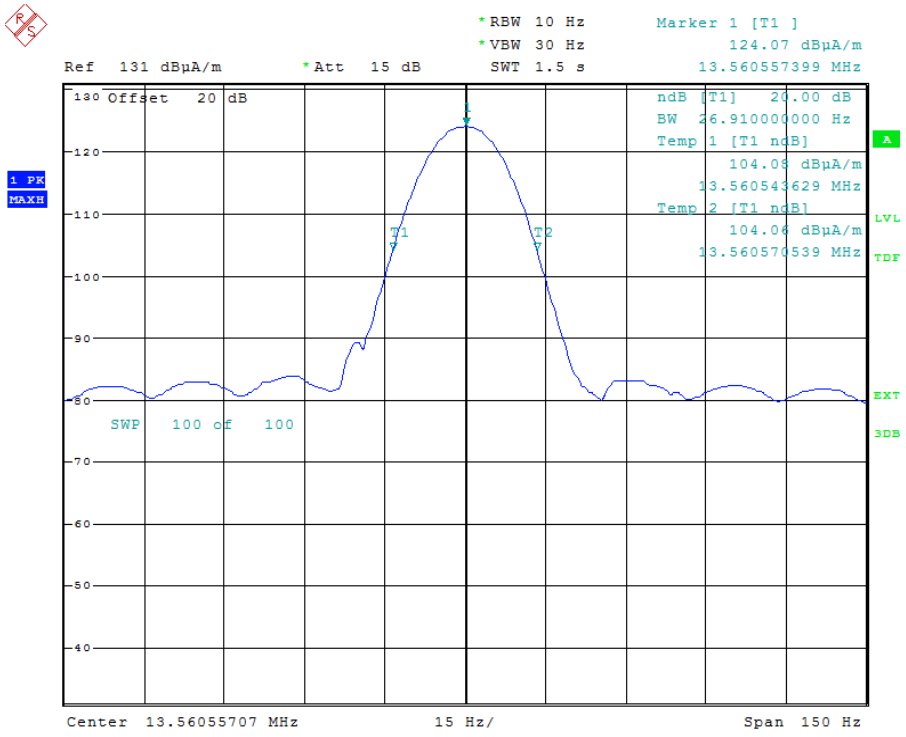


Figure 7-7: Occupied Bandwidth -20 dB (Carrier Frequency 13.56 MHz) – configuration 2

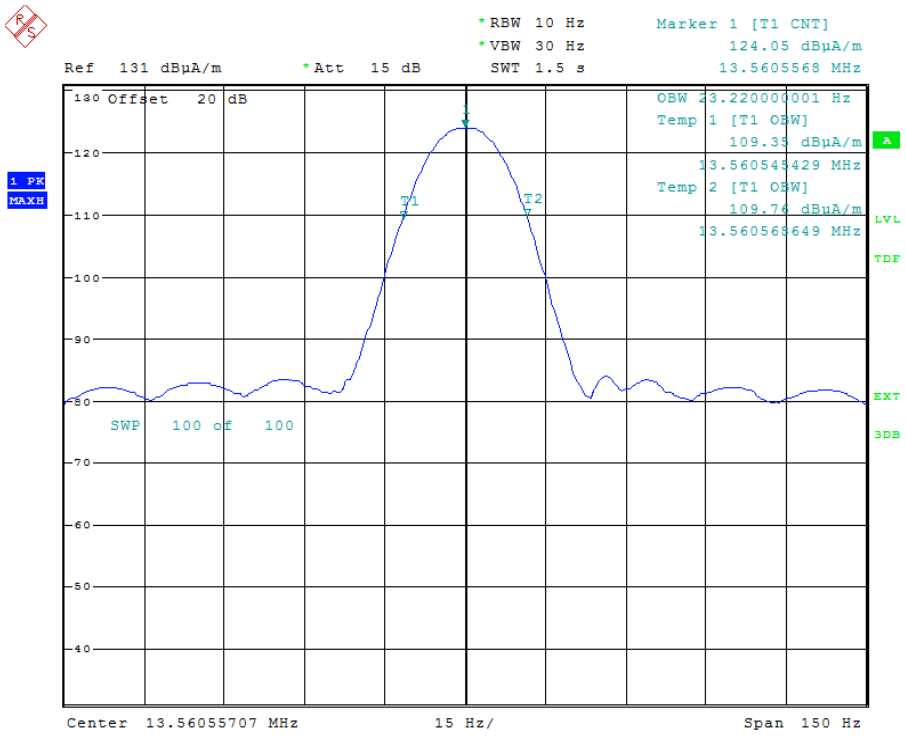


Figure 7-8: Occupied Bandwidth 99% (Carrier Frequency 13.56 MHz) – configuration 2

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

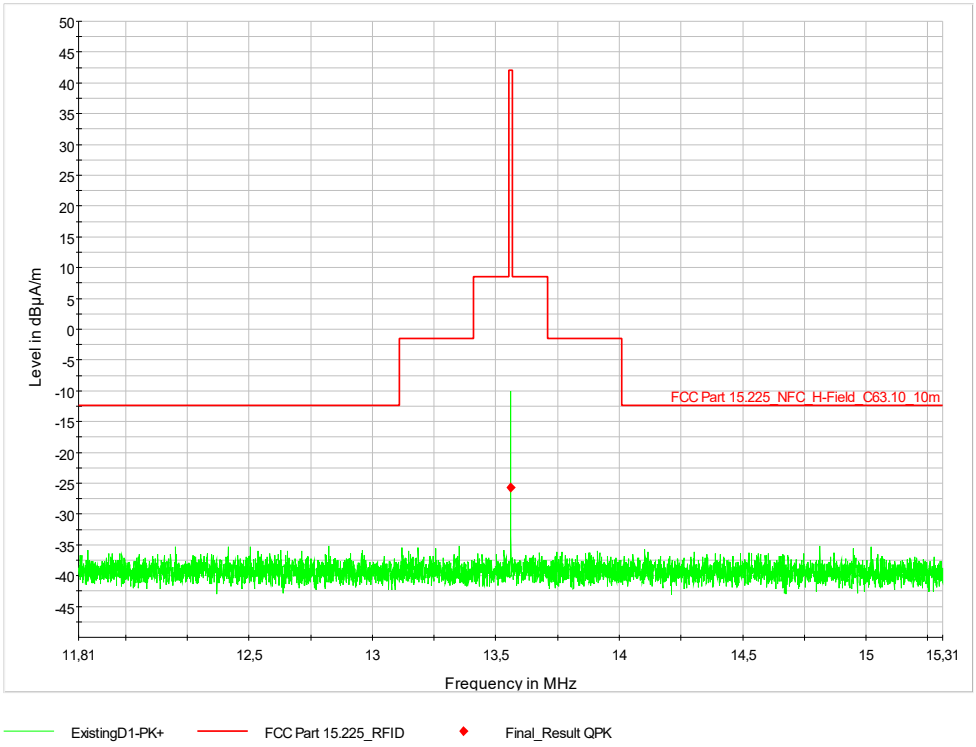


Figure 7-9: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 1; Vertical Polarization

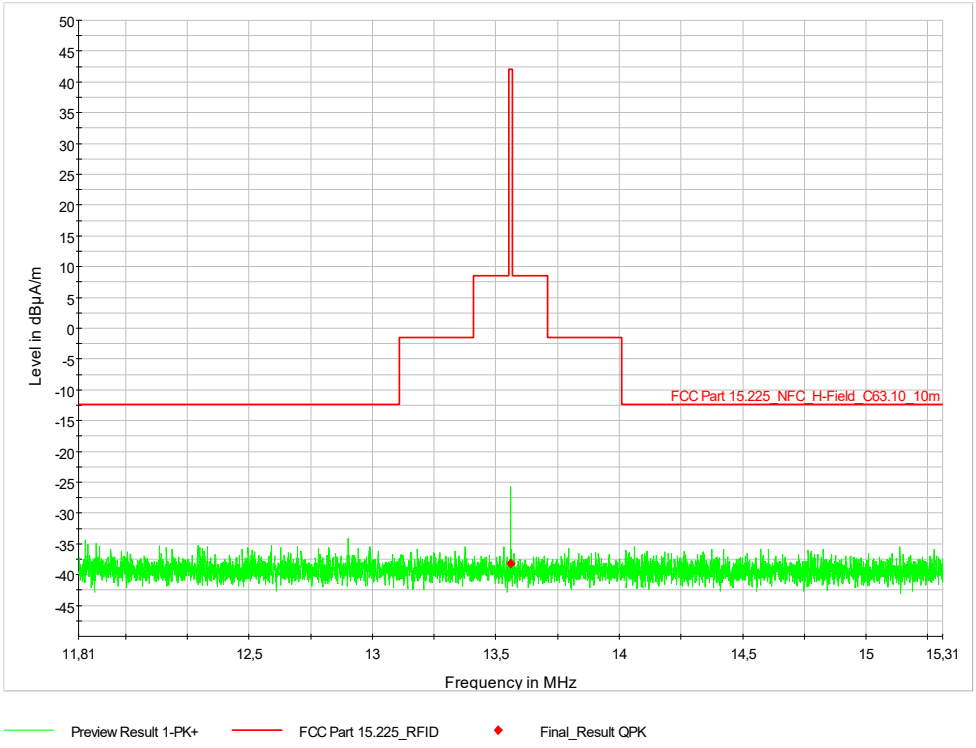


Figure 7-10: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 1; Horizontal Polarization

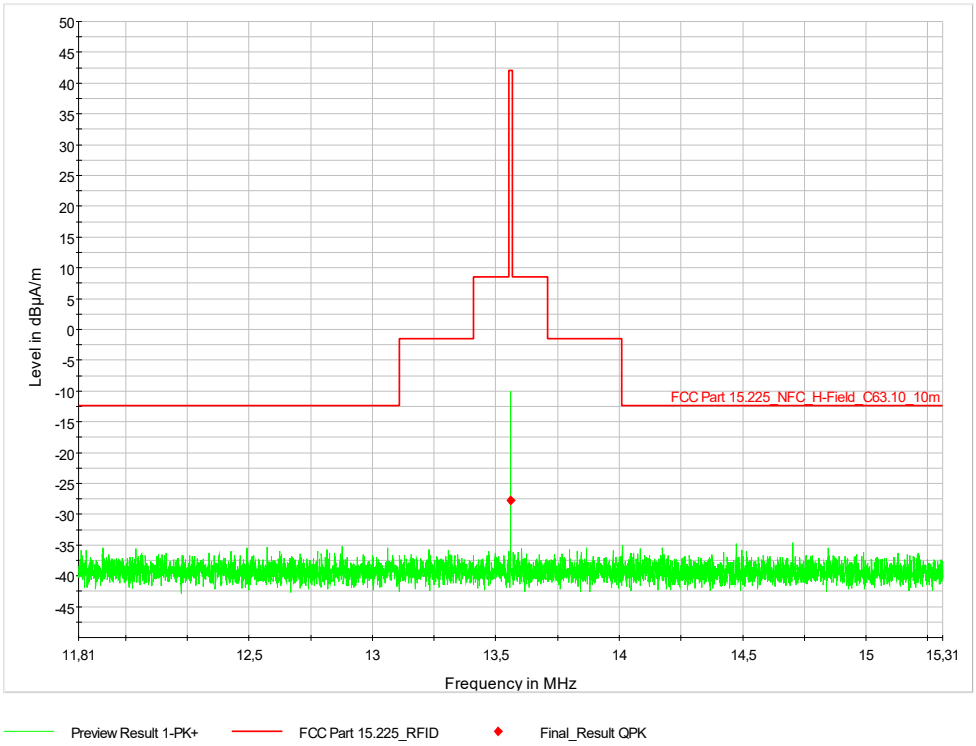


Figure 7-11: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 2; Vertical Polarization

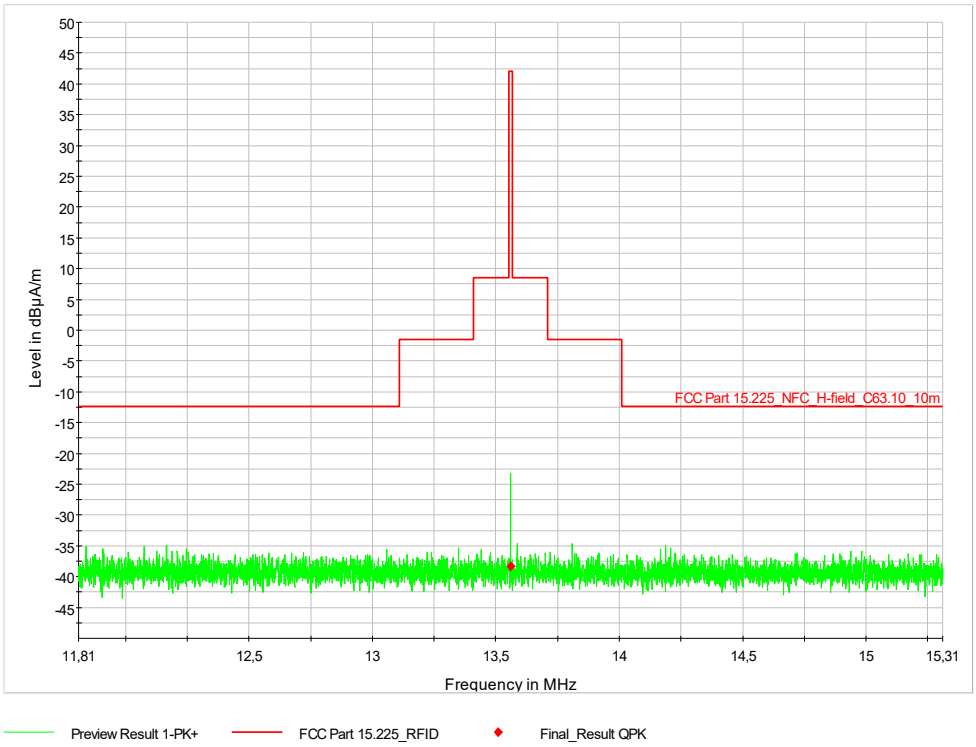


Figure 7-12: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 3; Vertical Polarization

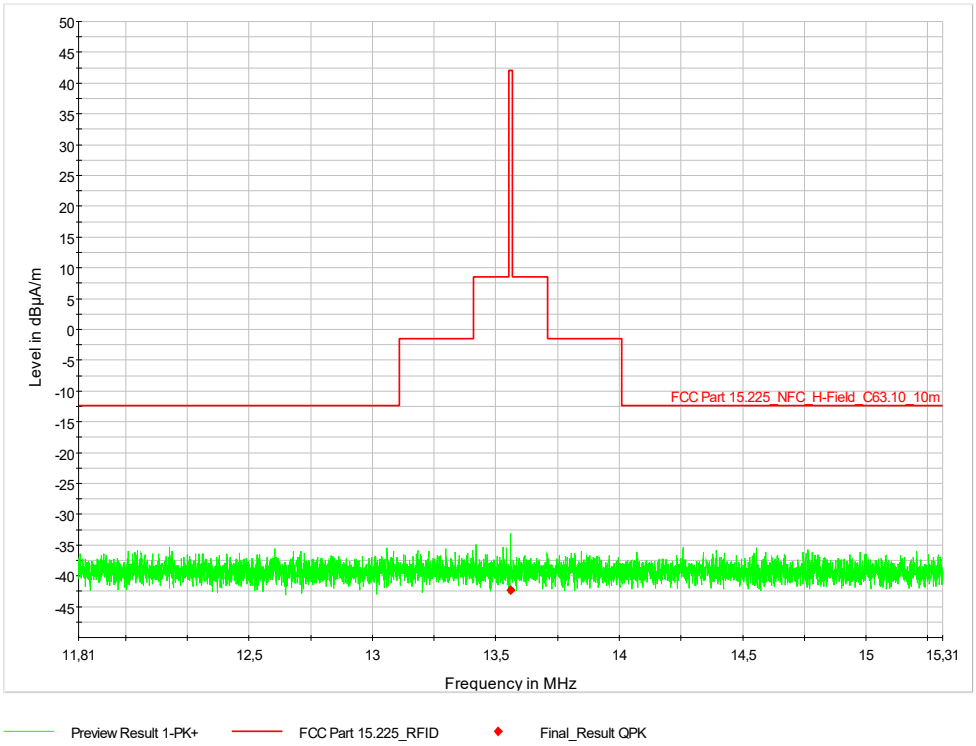


Figure 7-13: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 3; Horizontal Polarization

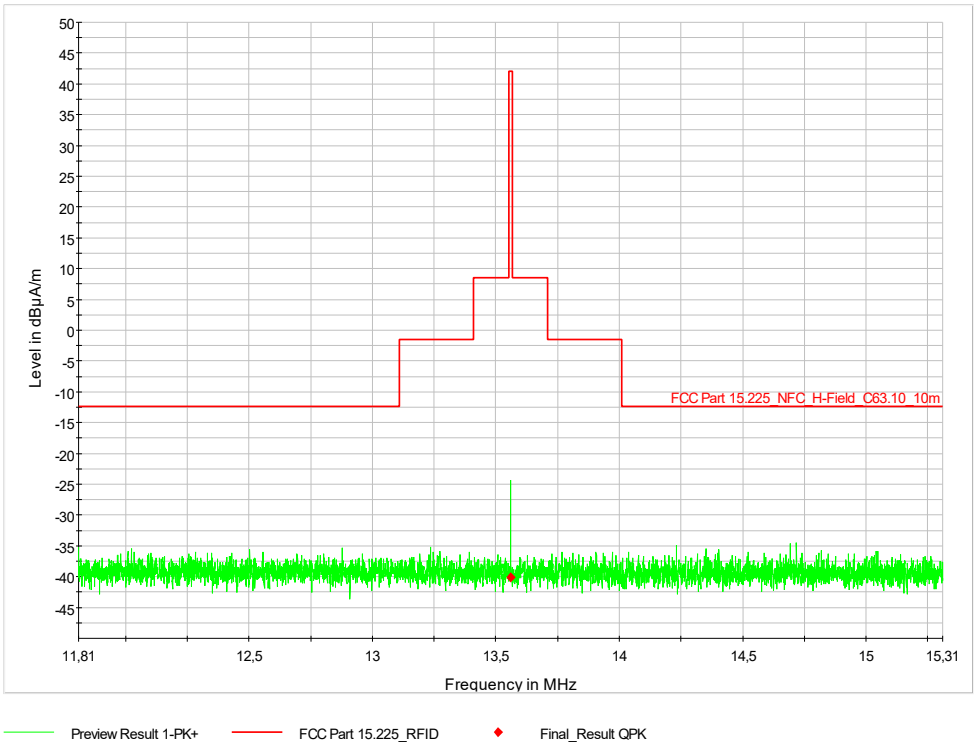


Figure 7-14: Radiated Emissions – 11.810 MHz to 15.310 MHz (§ 15.225a-c) – Configuration 4; Vertical Polarization

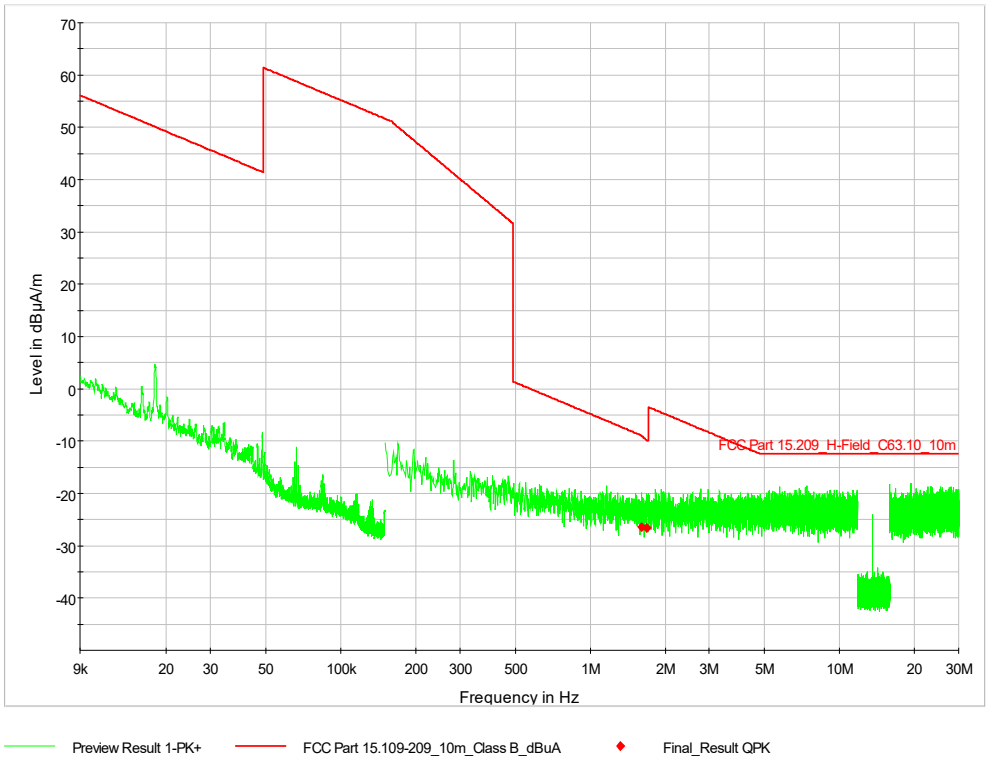


Figure 7-15: Radiated Emissions – 9 kHz to 30 MHz (§ 15.225d) – Configuration 3 Vertical polarization

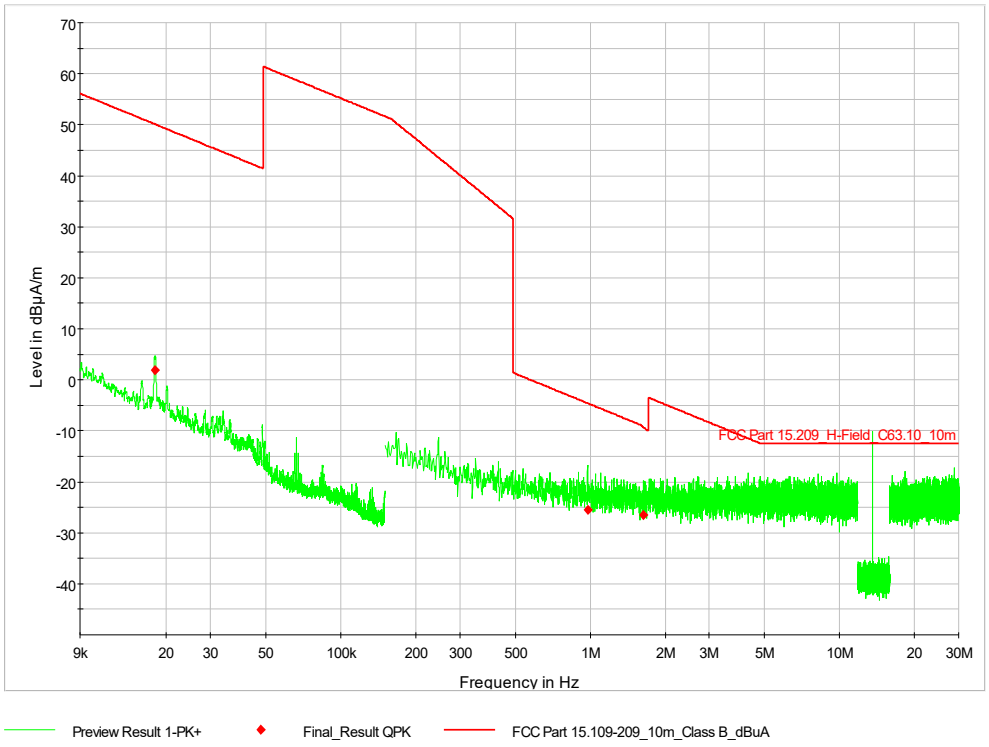


Figure 7-16: Radiated Emissions – 9 kHz to 30 MHz (§ 15.225d) – Configuration 1 Vertical polarization

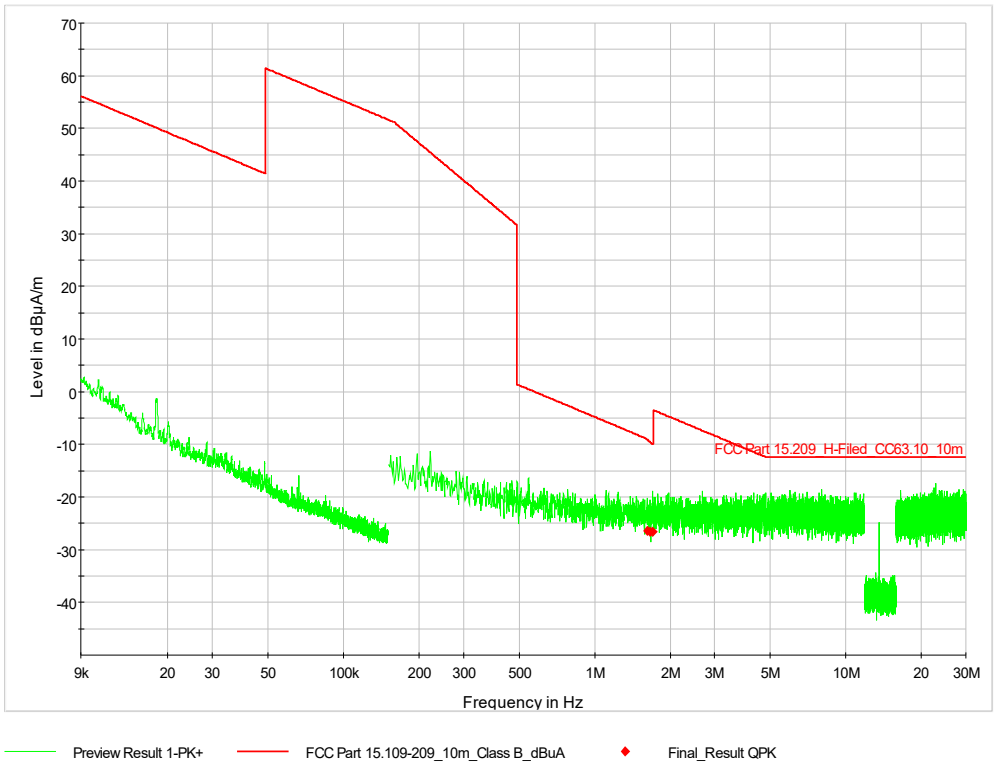


Figure 7-17: Radiated Emissions – 9 kHz to 30 MHz (§ 15.225d) – Configuration 1 Horizontal polarization

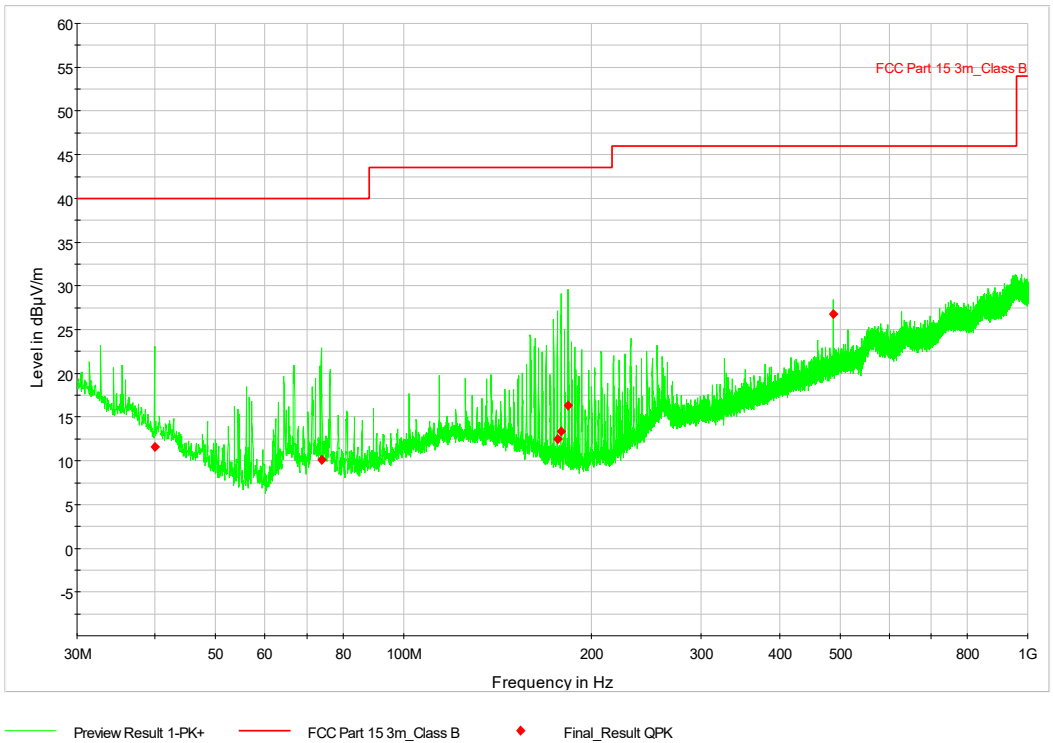


Figure 7-18: Radiated Emissions - 30 MHz to 1 GHz (§ 15.205, 15.209) – Configuration 1

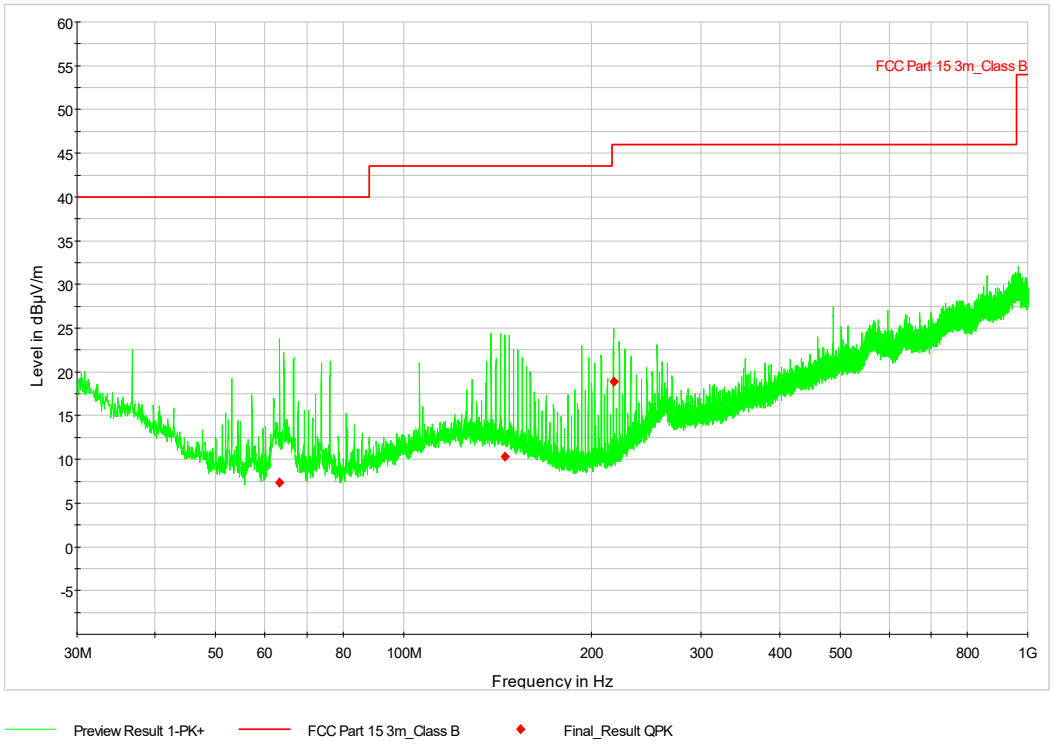


Figure 7-19: Radiated Emissions - 30 MHz to 1 GHz (§ 15.205, 15.209) – Configuration 2

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

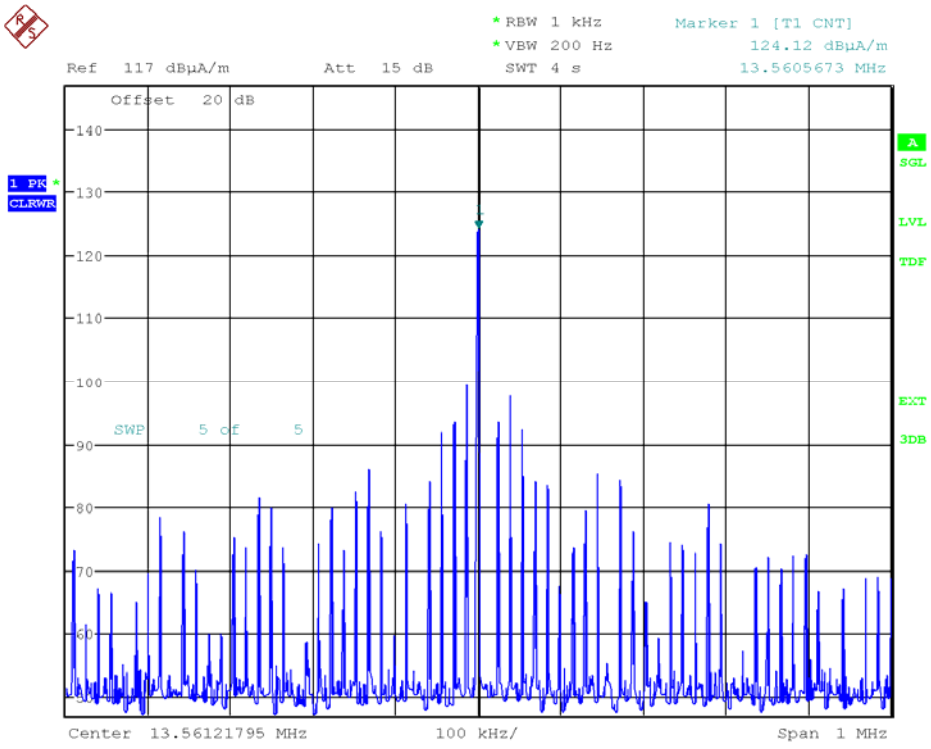


Figure 7-20: Frequency stability – 20°C / 5 V at startup – Configuration 2

7.2 Test Setups

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

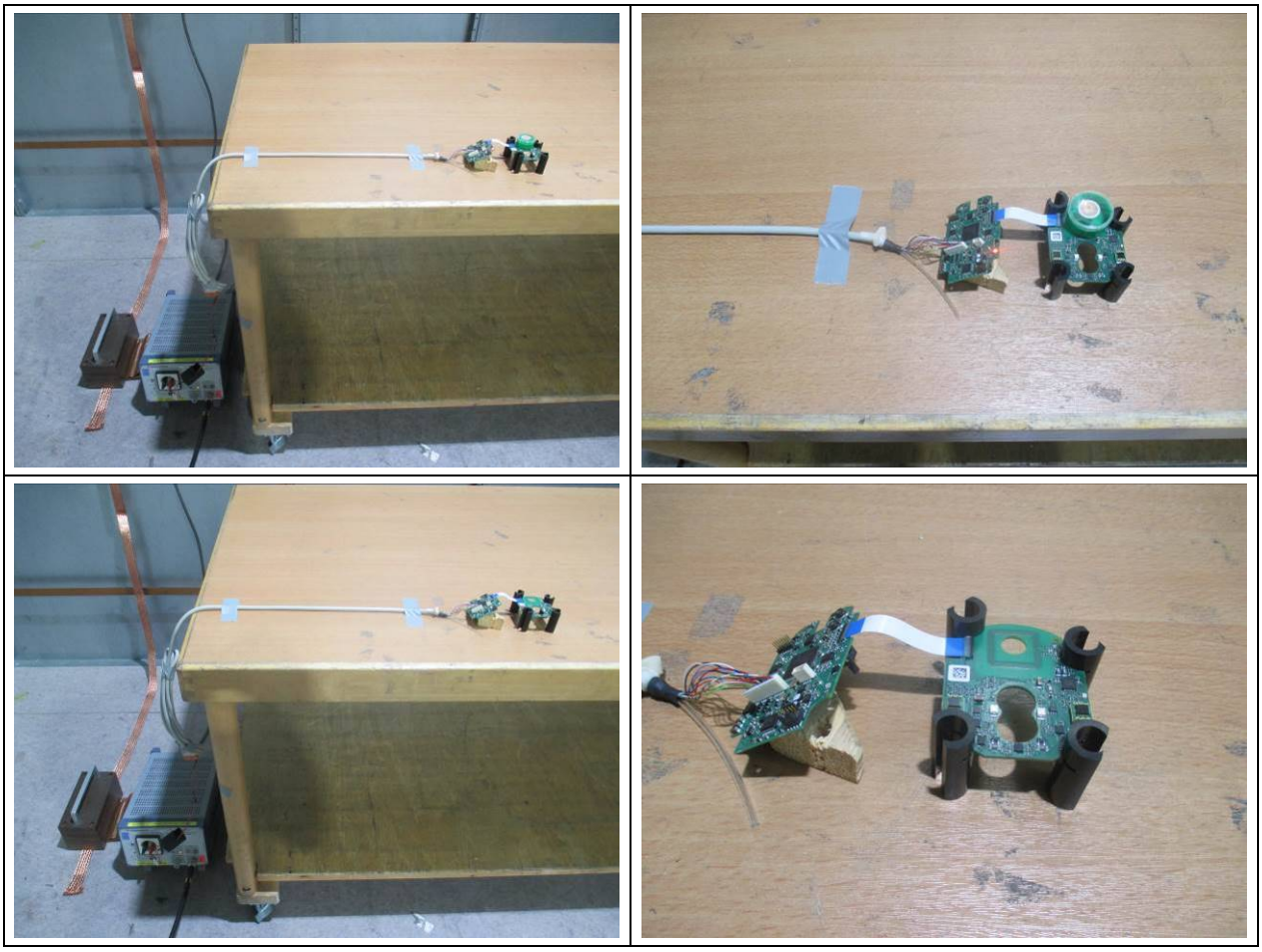


Figure 7-21: Test Setup Conducted Emissions (150 kHz – 30 MHz) – Configurations 3, 4, 5

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

Figure 7-22: Test Setup Occupied Bandwidth – Configuration 2

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

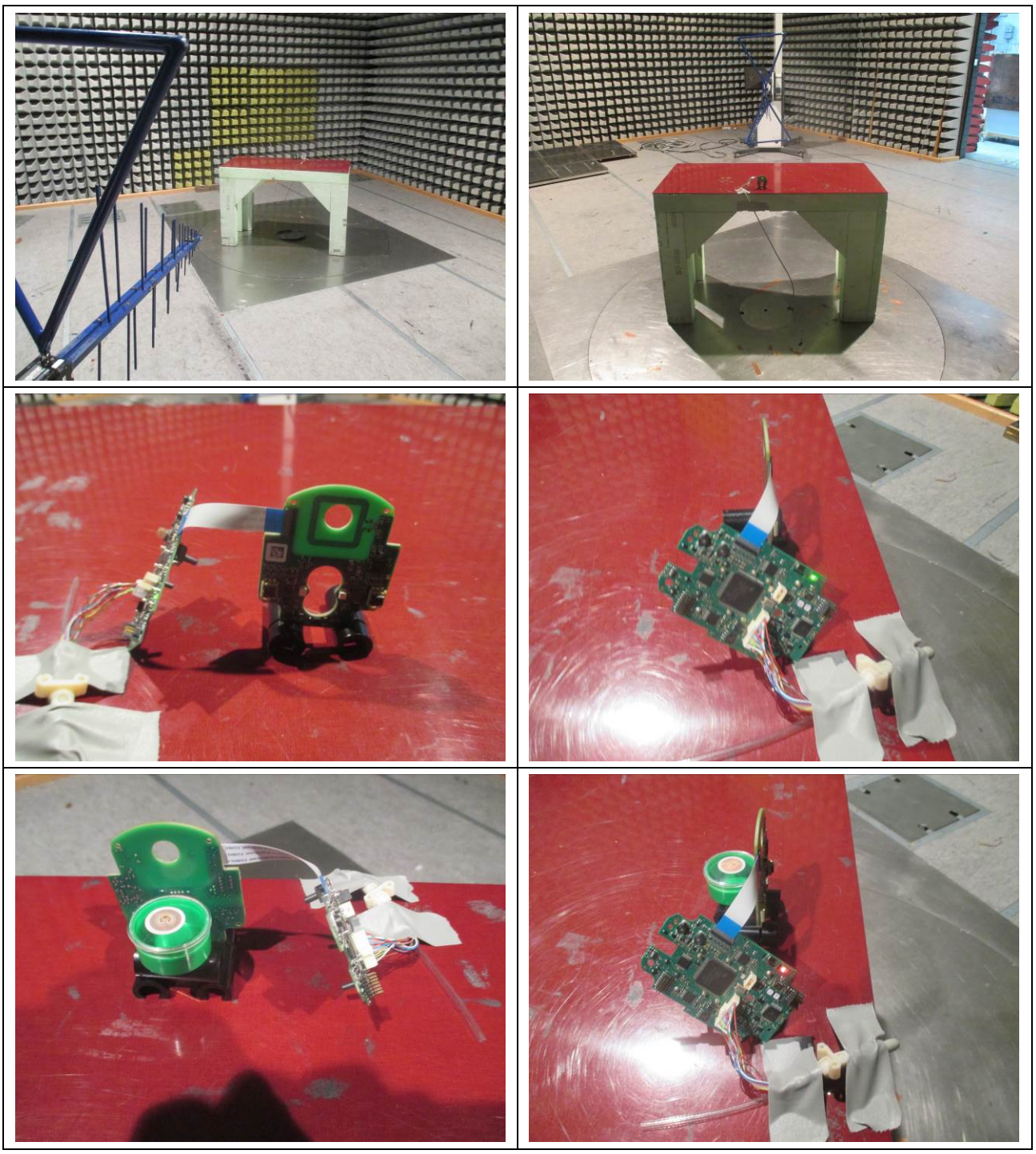
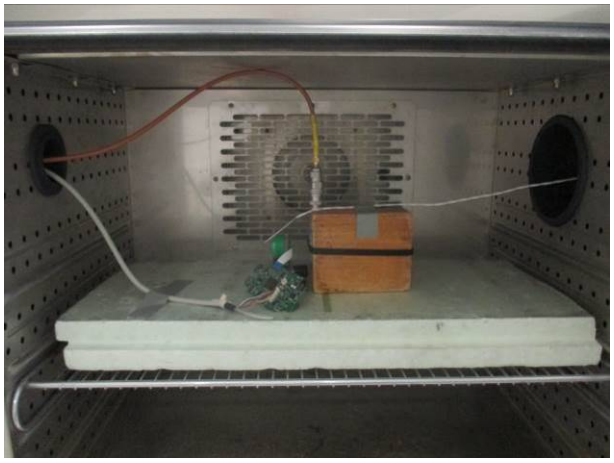


Figure 7-23: Test Setup Radiated Emission 30 MHz – 1 GHz – Configurations 1, 2

Figure 7-24: Test Setup Radiated Emission 9 kHz – 30 MHz – Configuration 1, 2, 3, 4

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



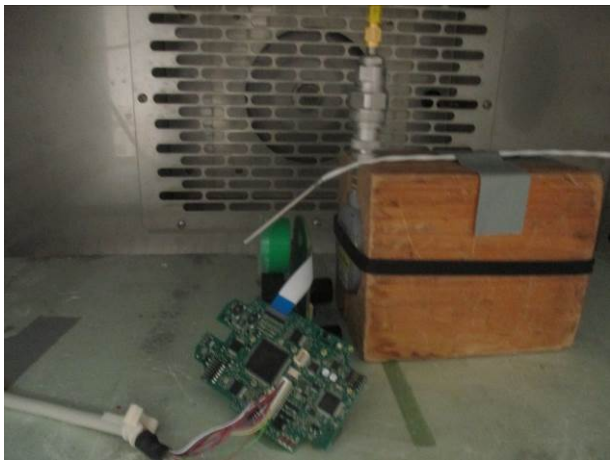


Figure 7-25: Test Setup – Frequency Stability with voltage or/and Temperature variation – Configuration 2

7.3 Photographs of EUT and accessories

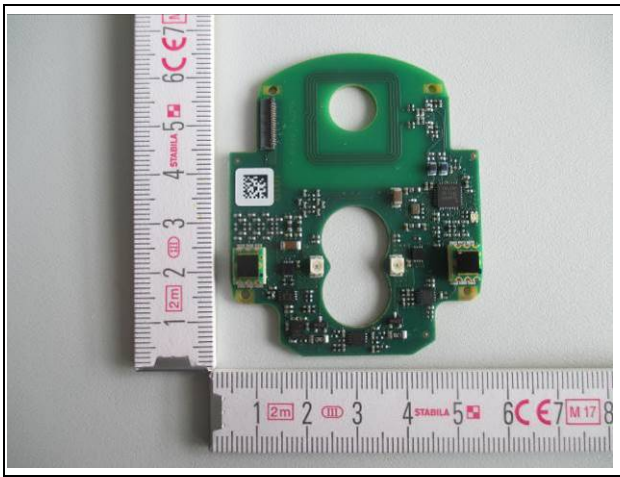
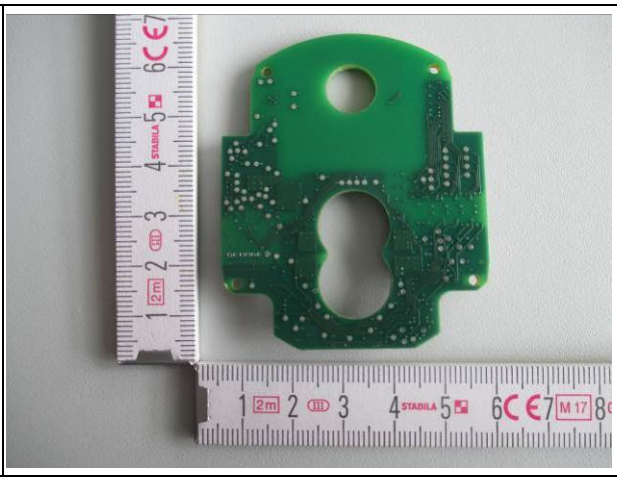
	
Front view Sensor Frontend PCBA (F000044)	*Rear view Sensor Frontend PCBA (F000044)*

Figure 7-26: NICCI NFC Unit

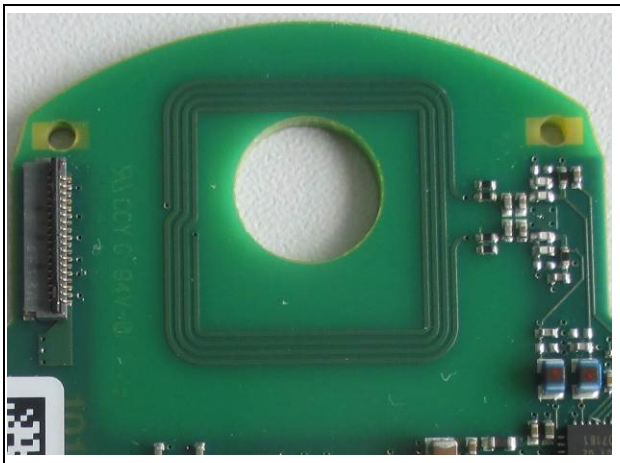
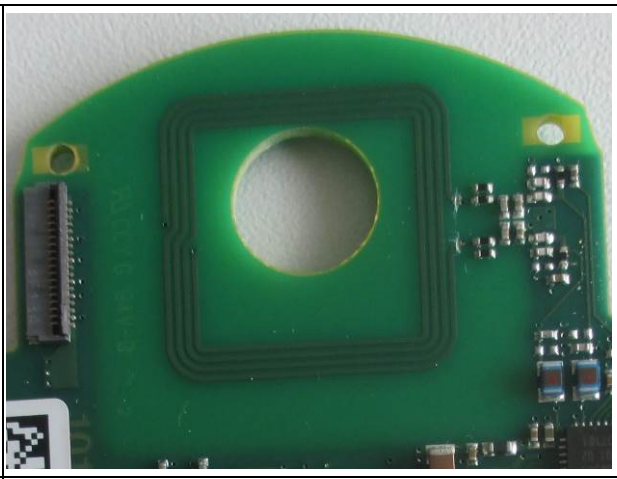
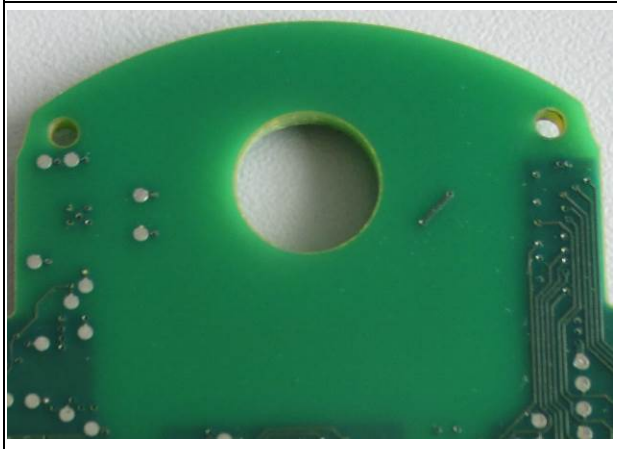
	
Front view of Sensor Frontend PCBA with integral antenna	*Front view of Sensor Frontend PCBA with Dummy Load*
	
Rear view of Sensor Frontend PCBA with integral antenna	*Rear view of Sensor Frontend PCBA with Dummy Load*

Figure 7-27: NICCI NFC Unit **- Differences between real Module and Dummy Load**

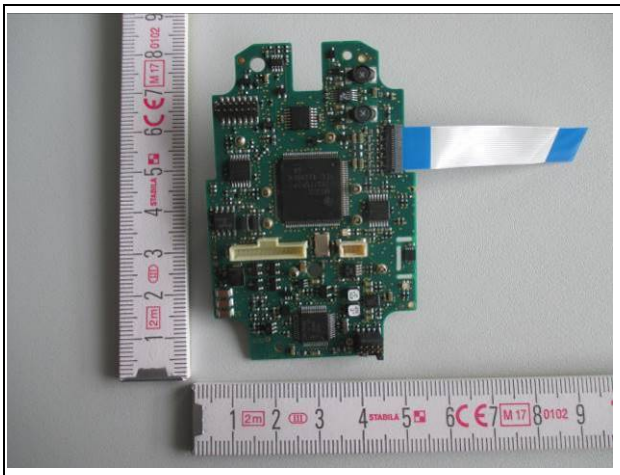
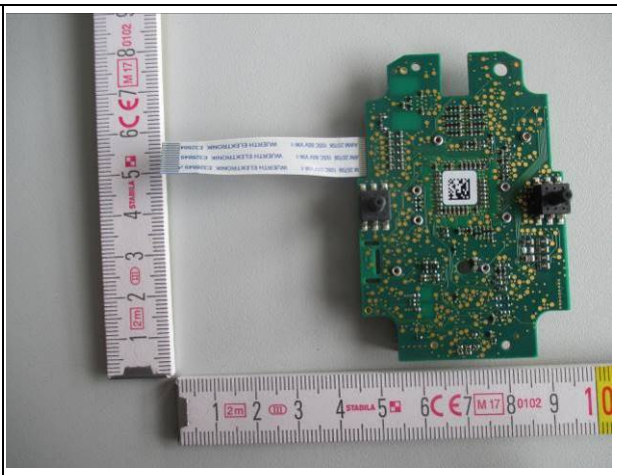
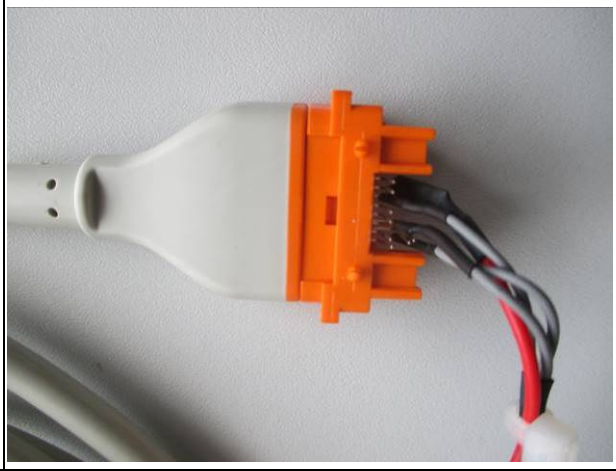
	
Front view of Controller PCBA (F000043)	*Rear view of Controller PCBA (F000043)*
	
Connection adapter cable for power supply	*Connector*
	
Front view of tag (ICODE DNA)	*Rear view of tag (ICODE DNA)*

Figure 7-28: 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 specified limit distances.

Since measurement has been made with a loop antenna at a measurement distance of 10 meters the compliance limit was extrapolated from the respective limit distances to 10 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} [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

8 Disclaimer

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