Test report

according to ISO/IEC 17025:2017

FCC
(Federal Communications Commission)
Test Firm Registration Number: 768032
Designation Number DE0022

Electromagnetic compatibility

e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C

Intentional Radiators

DAkkS Deutsche Akkreditierungsstelle
D-PL-17379-01-01
D-PL-17379-01-02
D-PL-17379-01-03

Bundesnetzagentur
BNetzA-CAB-18/21-19

TESTED IN GERMANY

STC Germany GmbH
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Test report no.: **20/05-0043**

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Location of test facility:

STC TESTED IN GERMANY

STC Germany GmbH
Ohmstrasse 1
84160 Frontenhausen
Germany

1. Client information

Name:	Fabman GmbH
Address:	Haussteinstrasse 4/2 1020 WIEN AUSTRIA
Name of contact:	Roland Stelzer
Telephone:	+4313084666
Fax:	-/-
E-mail:	contact@fabman.io

2. Equipment under test (EUT)

2.1 Identification of the EUT

Equipment:	Fabman Bridge V2
Model:	FB-V2
Brand name:	Fabman
Serial no.:	FB-V2-2020-05-0001
Manufacturer:	Fabman GmbH
Country of origin:	AUSTRIA
Power rating:	AC 100V-240V 50/60Hz
Highest frequency generated or used in the device or on which the device operates or tunes (MHz):	2462 MHz
Date Sample Received:	26.05.2020
Tests were performed:	02.07.2020 – 22.07.2020

2.2 Additional information about the EUT:

The “Fabman Bridge V2 - FB-V2” (= equipment under test – EUT can also operate simultaneously as 2.4 GHz Wifi module. The 2.4 GHz part is not documented in this Report.

The EUT contains a modular approved RF module (Wi-Fi & Bluetooth) with the following ID’s:

FCC-ID 2AC7Z-ESPWROOM32D.

The Bluetooth function is disabled by firmware.

To duplicate parts of this test report needs the written confirmation of the test laboratory.

The test results relate only to the above mentioned test sample(s).

3. Description of the Equipment under test and test conditions

FCC-ID:	2AV37-FB-V2
IC ID:	-/-
HVIN:	-/-
Power:	AC 100V-240V 50/60Hz
Cables:	AC: 187 cm
Approx. Size (l x w x h):	(11.5 x 10.0 x 5.3) cm
Test conditions:	The “Fabman Bridge V2 – FB-V2” (= equipment under test – EUT) is a RFID reader operating on frequency 13.56 MHz and had been tested in following modes: (1) NFC active, WLAN active (ping), Load switching ON/OFF operation with 120 V~ 60 Hz The tested configuration represents (based on the product specification) with the tested operation modes the worst case.
Additional information:	-/-
Operating temperature range:	0°C to 40°C
Operating frequencies:	13.56 MHz
Number of channels	1
Type of modulation:	ASK
Spurious Emissions: radiated lowest margin to limit	35.74 dBµV/m @ 940.48 MHz
Environmental conditions during tests:	Ambient temperature: 20 °C Relative humitity 40 % Atmospheric pressure 965 mbar
Antenna specification:	Model: Printed PCB Antenna Gain: -/- Type: ☐ External (with accessible antenna socket) ☒ Internal (integrated, PCB antenna)
Test standard:	- e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.225: Operation within the band 13.110-14.010 MHz

4. Performed measurements and results

The complete list of measurements required in e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C is given below.

Standard:	**Test Method:**		**Test requirements:**			
			applicable:		**fulfilled:**	
			Yes	**No**	**Yes**	**No**
§ 15.207	ANSI 63.10	AC Mains Conducted Emissions	☒	☐	☒	☐
§ 15.209	ANSI 63.10	Radiated Emissions	☒	☐	☒	☐
§ 15.225	ANSI 63.10	Field strength of any emissions within the band 13.110 – 14.010 MHz	☒	☐	☒	☐
§ 15.225	ANSI 63.10	Transmitter frequency stability	☒	☐	☒	☐
§ 15.215	ANSI 63.10	20 dB Bandwidth	☒	☐	☒	☐
§ 15.247	ANSI 63.10	Band Edges Measurement	☒	☐	☒	☐

All required / applicable tests according to the following standards were performed under Ref-No. 20/05-0043.

- e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C with test Method according to ANSI C63.10-2013
- e-CFR data is current as of February 04, 2021

Remark: -/-

5. AC Mains conducted emissions

Applied standards
-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.207 Conducted limits

Test site
Measurements of conducted emission from EUT was made in the shielded chamber (DC - 10GHz) located in the test facility.

Test equipment and test set up
Test equipment used for conducted measurements on Mains as given in clause Test equipment of this report.
Test setup used for conducted measurements on Mains as given in clause Test setups of this report.

Detector function selection and bandwidth
In conducted emissions measurement CISPR quasi-peak- and average-detector were used.
The bandwidth of the detector of instrument is 10 kHz over the frequency range of 150 kHz to 30 MHz.

Frequency range to be scanned
For conducted emission measurements, the spectrum in the range of 150 kHz to 30 MHz was investigated.

Test conditions and configuration of EUT
The EUT was configured and operated with conditions as mentioned under “Test conditions” in clause 3 of this report.

All modes are investigated by operating the EUT in a range of typical modes of operation, with typical cable positions, and with a typical system equipment configuration and arrangement. For each mode of operation and for each ac power current-carrying conductor, cable manipulation are performed within the range of likely configurations. The highest values measured are shown in the table below. The corresponding configuration is shown in the “Photo(s) of test setup”.
The EUT was placed on a 80 cm high non metallic table.
Measurements were performed on the AC terminals of the mains plug , on neutral (N)- and live (L1)-wire had been performed.

Requirements

Frequency Range [MHz]	Quasi-Peak Limits [dBµV]	Average Limits [dBµV]
0.15 - 0.5	66 to 56 Note 1	56 to 46 Note 1
0.5 - 5.0	56	46
5.0 - 30.0	60	50
Note 1: The level decreases linearly with the logarithm of the frequency		

Measurement

Measurement performed on 22.07.2020

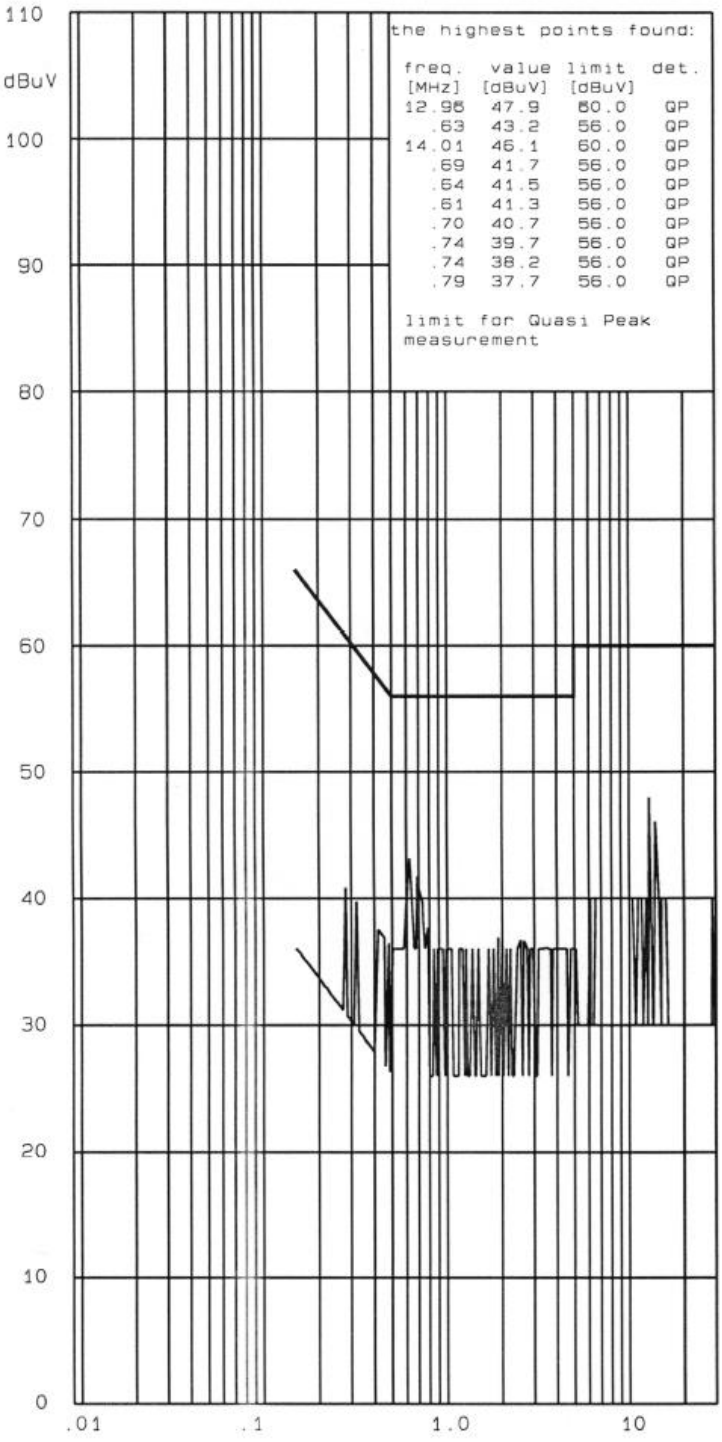
As worst cases the mode No. (1) with NFC active, WLAN active (ping), Load switching ON/OFF operation with 120 V~ 60 Hz was found and documented in this report.

I T 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC Subpart C 15.207

Cabin 1



the highest points found:

freq. [MHz]	value [dBuV]	limit [dBuV]	det.
12.98	47.9	60.0	QP
.63	43.2	56.0	QP
14.01	46.1	60.0	QP
.69	41.7	56.0	QP
.64	41.5	56.0	QP
.61	41.3	56.0	QP
.70	40.7	56.0	QP
.74	39.7	56.0	QP
.74	38.2	56.0	QP
.79	37.7	56.0	QP

limit for Quasi Peak measurement

Ref.-No.: 20/05-0043

Product: Control Unit

Sample: 01

Date: 22 Jul 2020

Operator: Ji/Gi

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-Z5

Connected sets:

Input Voltage 120 V / 60 Hz
Resistive load 2000 W

Operating mode:

Load switch on/off
NFC active
W-LAN active/ping
Tested on N

RFI suppression parts:

* two dB safety margin for type approval recommended

Result: pass [X] fail [ ]

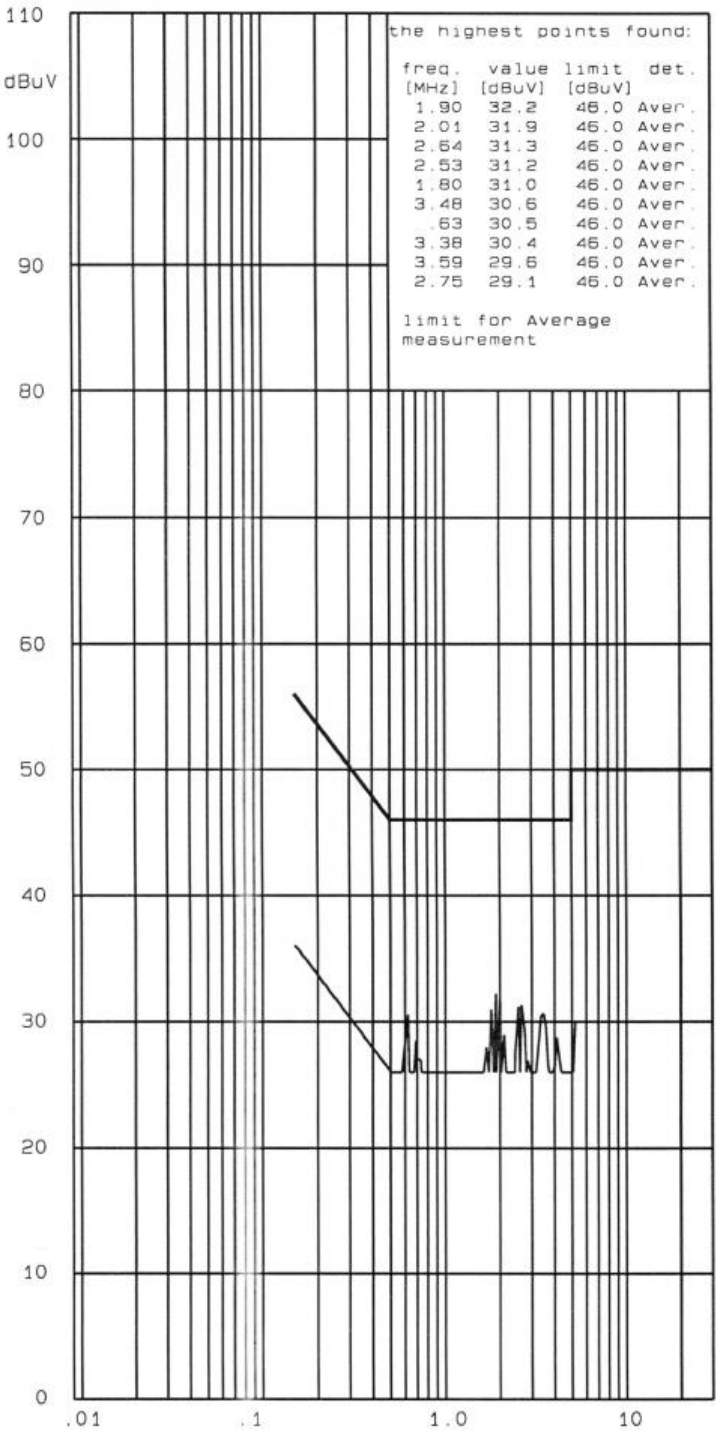
STC Germany GmbH

I T 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC Subpart C 15.207

Cabin 1



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Input Voltage 120 V / 60 Hz
Resistive load 2000 W

Operating mode:

Load switch on/off
NFC active
W-LAN active/ping
Tested on N

RFI suppression parts:

* two dB safety margin for type approval recommended

Result: pass ⋈ fail [ ]

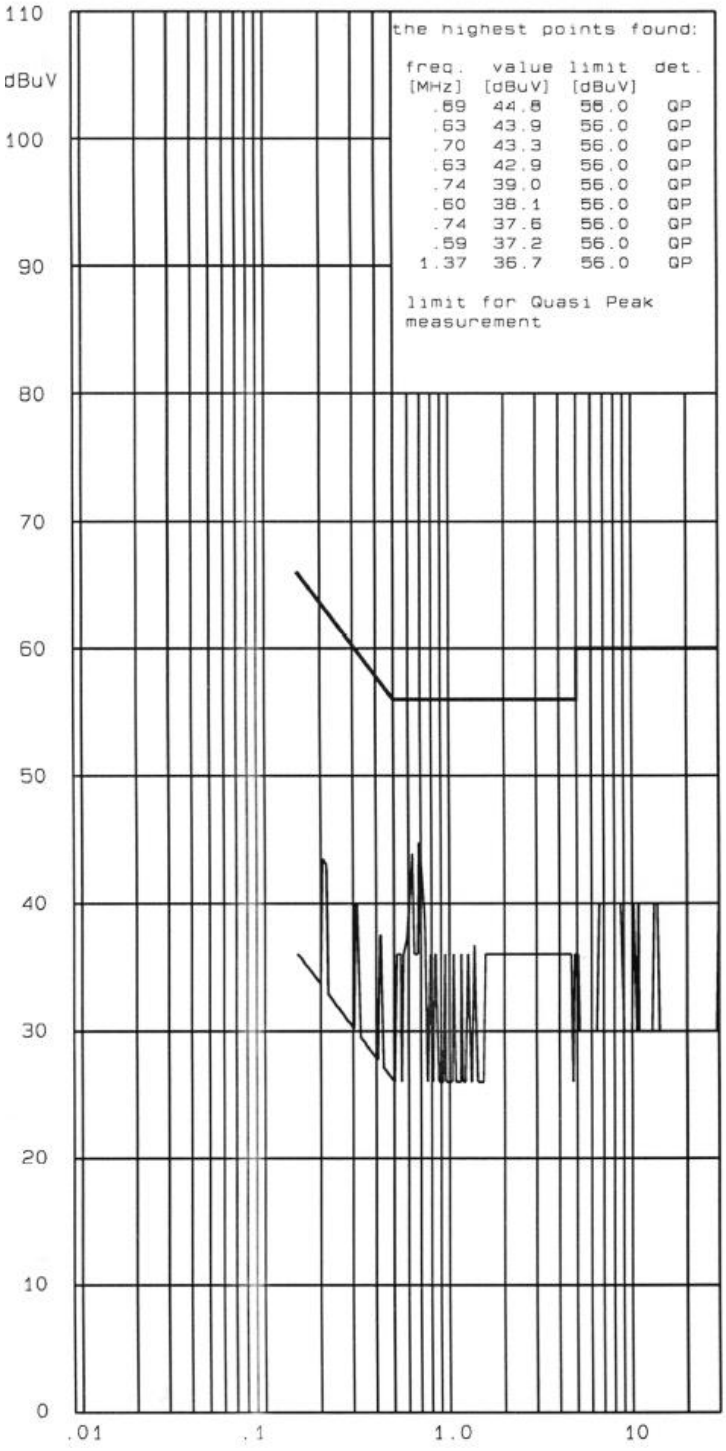
STC Germany GmbH

I T 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC Subpart C 15.207

Cabin 1



Ref.-No.: 20/05-0043

Product: Control Unit

Sample: 01

Date: 22 Jul 2020

Operator: Ji/Gi

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-Z5

Connected sets:

Input Voltage 120 V / 60 Hz
Resistive load 2000 W

Operating mode:

Load switch on/off
NFC active
W-LAN active/ping
Tested on L1

RFI suppression parts:

* two dB safety margin for type approval recommended

Result: pass ⋈ fail [ ]

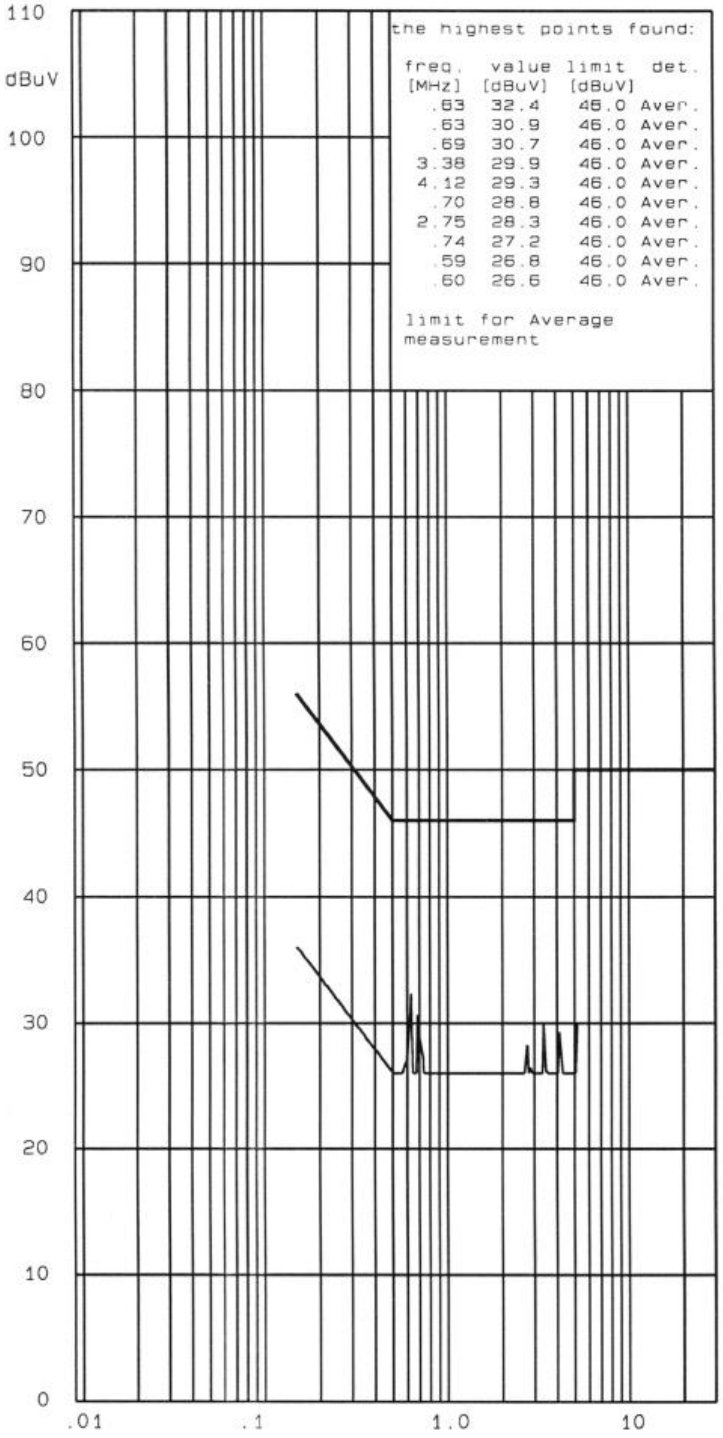
STC Germany GmbH

I T 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC Subpart C 15.207

Cabin 1



Ref.-No.: 20/05-0043

Product: Control Unit

Sample: 01

Date: 22 Jul 2020

Operator: Ji/Gi

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-Z5

Connected sets:

Input Voltage 120 V / 60 Hz
Resistive load 2000 W

Operating mode:

Load switch on/off
NFC active
W-LAN active/ping
Tested on L1

RFI suppression parts:

* two dB safety margin for type approval recommended

Result: pass [X] fail [ ]

STC Germany GmbH

Remarks:
Composition of the measurement value:

$$\mathbf{M_{Value} = M_{Rec} + C_{Loss} + LISN_{cor}}$$

M_{Value}	= Measurement Value
M_{Rec}	= Reading value of test receiver
C_{Loss}	= Cable loss between Receiver and LISN
$LISN_{cor}$	= LISN correction factor.

Sample calculation:

40.8 dBµV = 40.1 dBµV + 0.3 dB + 0.4 dB

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **Conducted Emission**.

6. Radiated emission measurements

Test site
Measurement of radiated emissions from EUT was made in the semi-anechoic chamber SAC3 (DC to 40 GHz) located in the test facility.

Test equipment and test set up
Test equipment used for radiated measurements as given in clause Test equipment of this report.
Test setup used for radiated measurements as given in clause Test Setups of this report.

Detector function selection and bandwidth
In radiated emissions measurement, an EMI test receiver with CISPR detectors was used.

Frequency range	Resolution Bandwidth
9KHz – 150kHz (Quasi Peak & Average* Detector)	200Hz
150KHz – 30MHz (Quasi Peak & Average* Detector)	9kHz
30MHz – 1GHz (Quasi Peak Detector)	120kHz
Above 1GHz (Peak & Average Detector)	1MHz

*Average Detector only in specified frequency range.

Antennas
Measurements were made using a calibrated loop antenna in the range 9 kHz – 30 MHz, as well as a calibrated bilog antenna in the range of 30 to 1000 MHz to determine the emission characteristics of the EUT. Measurements were also made for both horizontal and vertical polarization in a SAC .
The horizontal distance between the receiving antenna and the EUT was 3 meters.
In the range of 1 GHz to 26 GHz measurements were made using a calibrated horn antenna to determine the emission characteristics of the EUT. Measurements were also made for both horizontal and vertical polarization in a SAC with floor absorbers. The horizontal distance between the receiving antenna and the EUT was 3 meters.

Frequency range to be scanned
For radiated emissions measurements, the spectrum in the range of 9kHz MHz to 26 GHz was investigated as the highest frequency generated/used in the EUT is 2.462 GHz.

Test conditions and configuration of EUT

The EUT was configured and operated with conditions as mentioned under “Test conditions” in clause 3.

During test the EUT was operated as specified in the technical intstruction of the EUT. For frequencies below 1000 MHz the EUT was placed on a 80 cm and for frequencies above 1000 MHz the EUT was placed on a 150 cm high non metallic table placed on the turntable. The EUT was rotated and the antenna height was varied between 1 m to 4 m to find the maximum RF energy generated from EUT. The procedure according to ANSI C63.10:2013 is used and all modes are investigated by operating the EUT in a range of typical modes of operation, with typical cable positions, and with a typical system equipment configuration and arrangement. For each mode of operation, cable manipulation are performed within the range of likely configurations. The highest values measured are shown in the table below.

Remarks Correction factor included antenna factor and cable attenuation.

Applied standards
-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.209 Radiated emission limits

Requirements:

acc. e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.209 Radiated emission limits

Frequency MHz	Limits [µV/m] Quasi-peak	Limits [dBµV/m] Quasi-peak	Limits [µV/m] Average	Limits [dBµV/m] Average	Test distance [m]
0.009 – 0.090	-/-	-/-	2400/F (kHz)	48.5 – 28.5	300
0.090 - 0.110	2400/F (kHz)	28.5 – 26.8	-/-	-/-	300
0.110 – 0.490	-/-	-/-	2400/F (kHz)	26.8 – 13.8	300
0.490 - 1.705	24000/F (kHz)	33.8 – 23.0	-/-	-/-	30
1.705 - 30.0	30	29.5	-/-	-/-	30

acc. e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.209 Radiated emission limits

Frequency MHz	Limits [µV/m] Quasi-peak	Limits [dBµV/m] Quasi-peak	Limits [µV/m] Average	Limits [dBµV/m] Average	Test distance [m]
30 - 88	100	40	-/-	-/-	3
88 - 216	150	43.5	-/-	-/-	3
216 - 960	200	46	-/-	-/-	3
960 - 1000	500	54	-/-	-/-	3
Above 1000	-/-	-/-	500 / 5000	54 / 74	3

Measurements

The Measurement was performed on: 02.07.2020

Result 9 kHz – 30 MHz

In the frequency range 9 kHz – 30 MHz the EUT had been scanned in a distance of 3 m and the Limit were corrected to the test distance of 3 m using a factor with 40 dB/decade acc. to § 15.31 (f)(2).

As worst cases the mode No. (1) with NFC active, WLAN active (ping), Load switching ON/OFF operation with 120 V~ 60 Hz was found and documented in this report.
Only the worst case of the X,Y and Z axis measurement is documented in this report.

TESTED IN GERMANY

IT 3/4

Interference radiation (9kHz – 30MHz)

acc.FCC § 15.209

STC

Ref.-No.: 20/05-0043

Product: Control Unit

Sample: 01

Date: 02.07.2020

Operator: BI

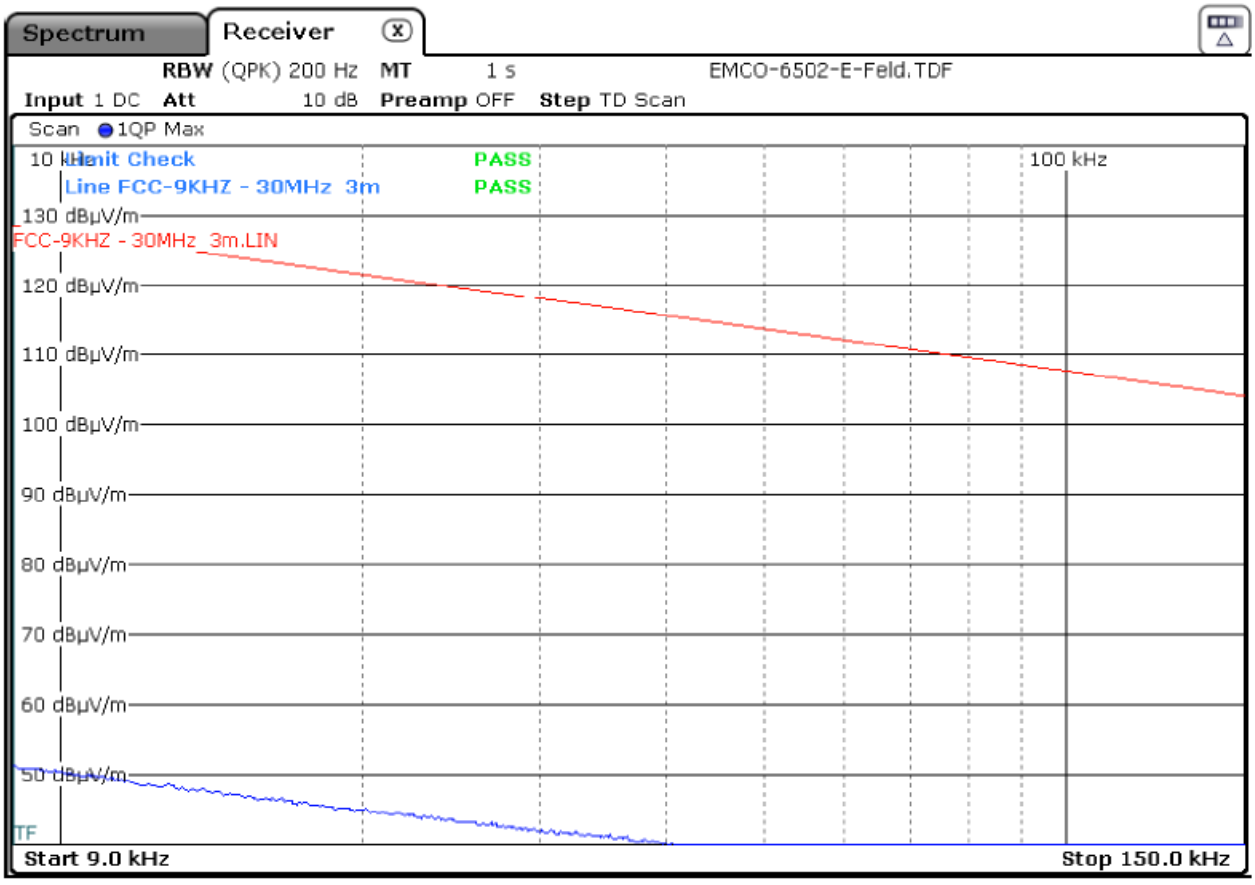
Remarks: Input Voltage: 120V/60Hz

pass fail

Result: ☒ ☐

Operation mode: Load switch ON/OFF; NFC active; W-LAN/Ping

Position X (9kHz - 150kHz)



Position: X									
		Detector QP							
Frequ. [MHz]	**Level [dBµV/m]**	**Margin to Limit [dB]**	**Limit [dBµV/m]**	**Result**					
9kHz-150kHz	-/-	>20	-/-	**pass**					

TESTED IN GERMANY

IT 3/4

Interference radiation (9kHz – 30MHz)

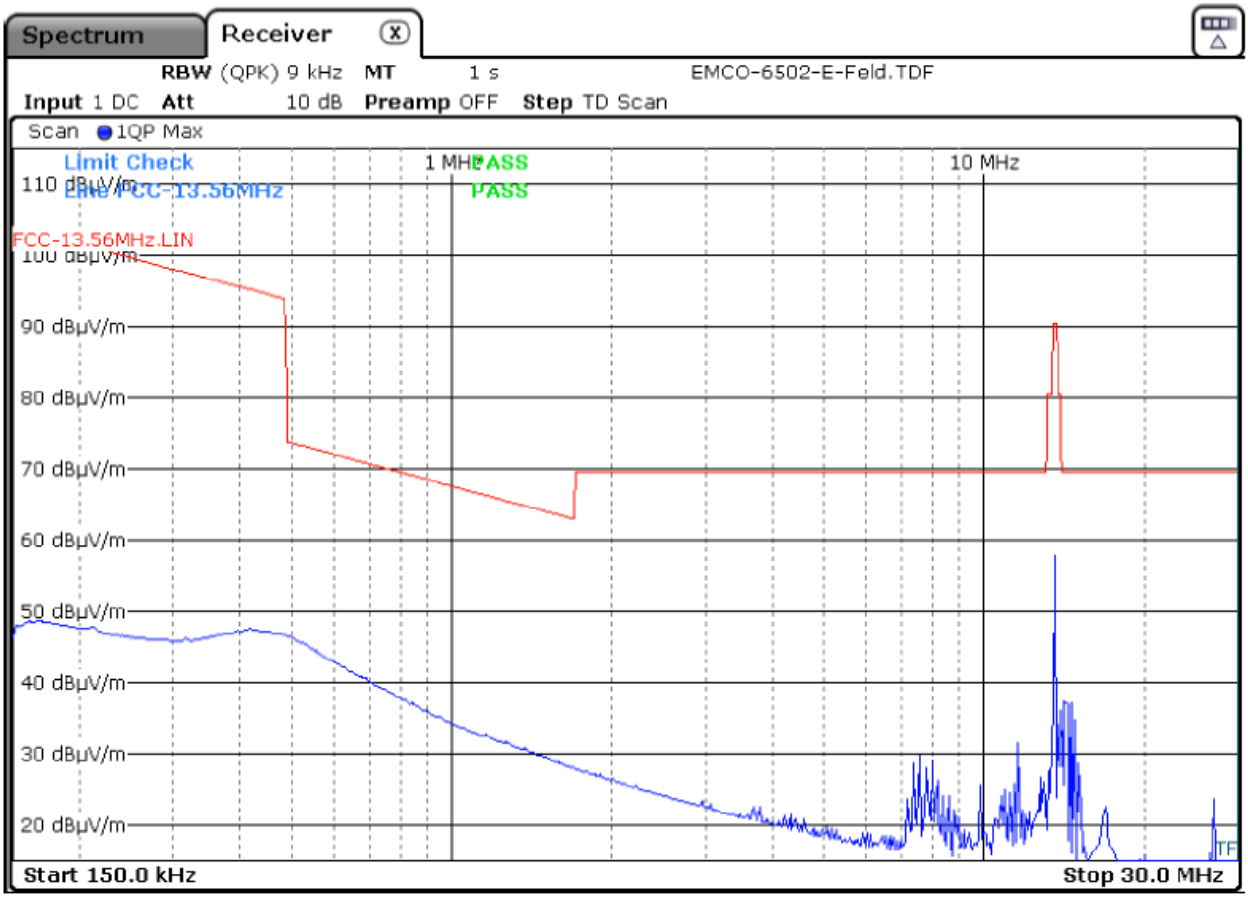
acc.FCC § 15.209

STC

Ref.-No.: 20/05-0043

Operation mode: Load switch ON/OFF; NFC active; W-LAN/Ping

Position X (150kHz – 30MHz)



Position: X									
		Detector QP							
Frequ. [MHz]	**Level [dBµV/m]**	**Margin to Limit [dB]**	**Limit [dBµV/m]**	**Result**					
150kHz-30MHz	-/-	>20	-/-	**pass**					

TESTED IN GERMANY

IT 3/4

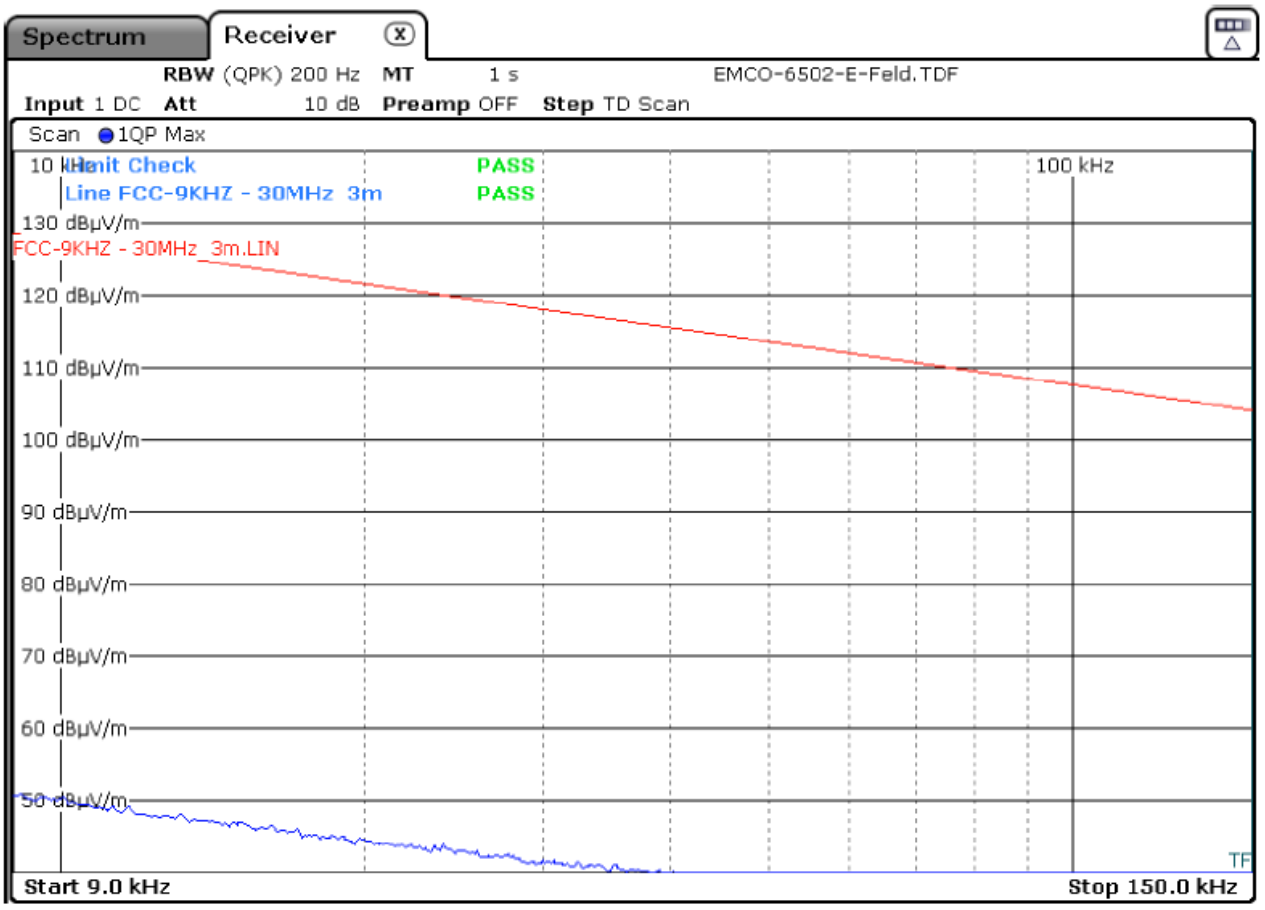
Interference radiation (9kHz – 30MHz)

acc.FCC § 15.209

Ref.-No.: 20/05-0043

Operation mode: Load switch ON/OFF; NFC active; W-LAN/Ping

Position Y (9kHz - 150kHz)



Position: Y									
		Detector QP							
Frequ. [MHz]	**Level [dBµV/m]**	**Margin to Limit [dB]**	**Limit [dBµV/m]**	**Result**					
9kHz-150kHz	-/-	>20	-/-	**pass**					

TESTED IN GERMANY

IT 3/4

Interference radiation (9kHz – 30MHz)

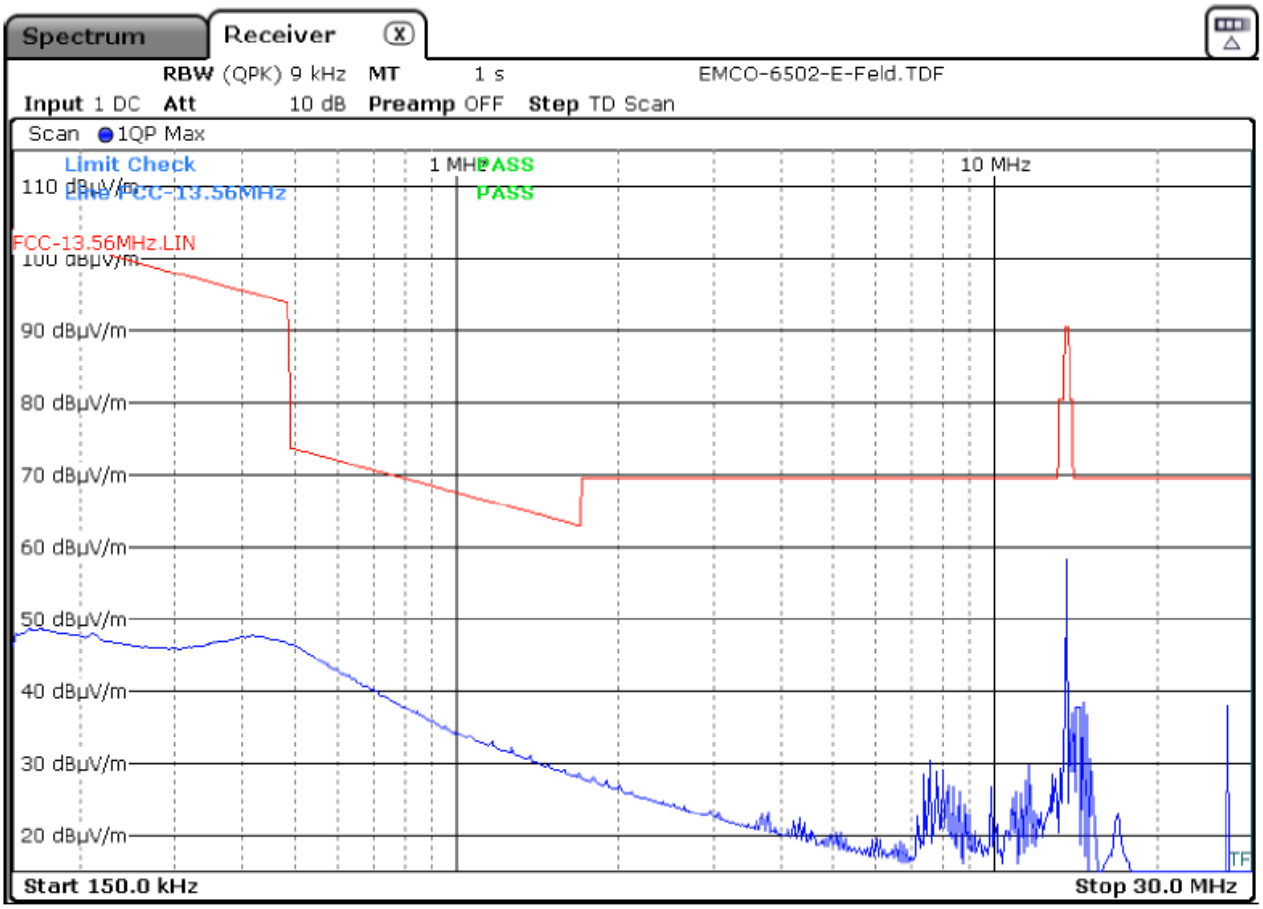
acc.FCC § 15.209

STC

Ref.-No.: 20/05-0043

Operation mode: Load switch ON/OFF; NFC active; W-LAN/Ping

Position Y (150kHz – 30MHz)



Position: Y									
		Detector QP							
Frequ. [MHz]	**Level [dBµV/m]**	**Margin to Limit [dB]**	**Limit [dBµV/m]**	**Result**					
150kHz-30MHz	-/-	>20	-/-	**pass**					

TESTED IN GERMANY

IT 3/4

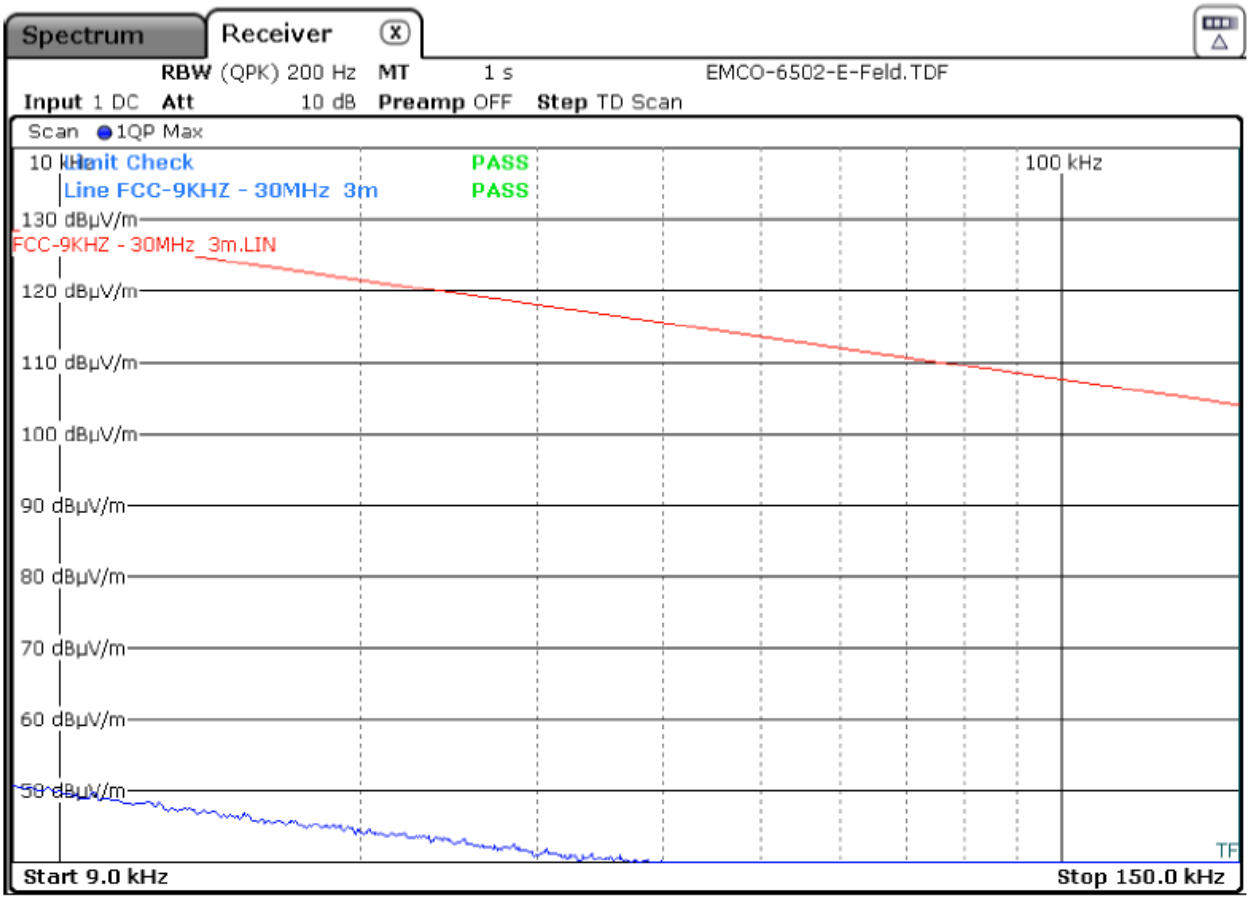
Interference radiation (9kHz – 30MHz)

acc.FCC § 15.209

Ref.-No.: 20/05-0043

Operation mode: Load switch ON/OFF; NFC active; W-LAN/Ping

Position Z (9kHz - 150kHz)



Position: Z										
		Detector QP								
Frequ. [MHz]	**Level [dBµV/m]**	**Margin to Limit [dB]**	**Limit [dBµV/m]**	**Result**						
9kHz-150kHz	-/-	>20	-/-	**pass**						

TESTED IN GERMANY

IT 3/4

Interference radiation (9kHz – 30MHz)

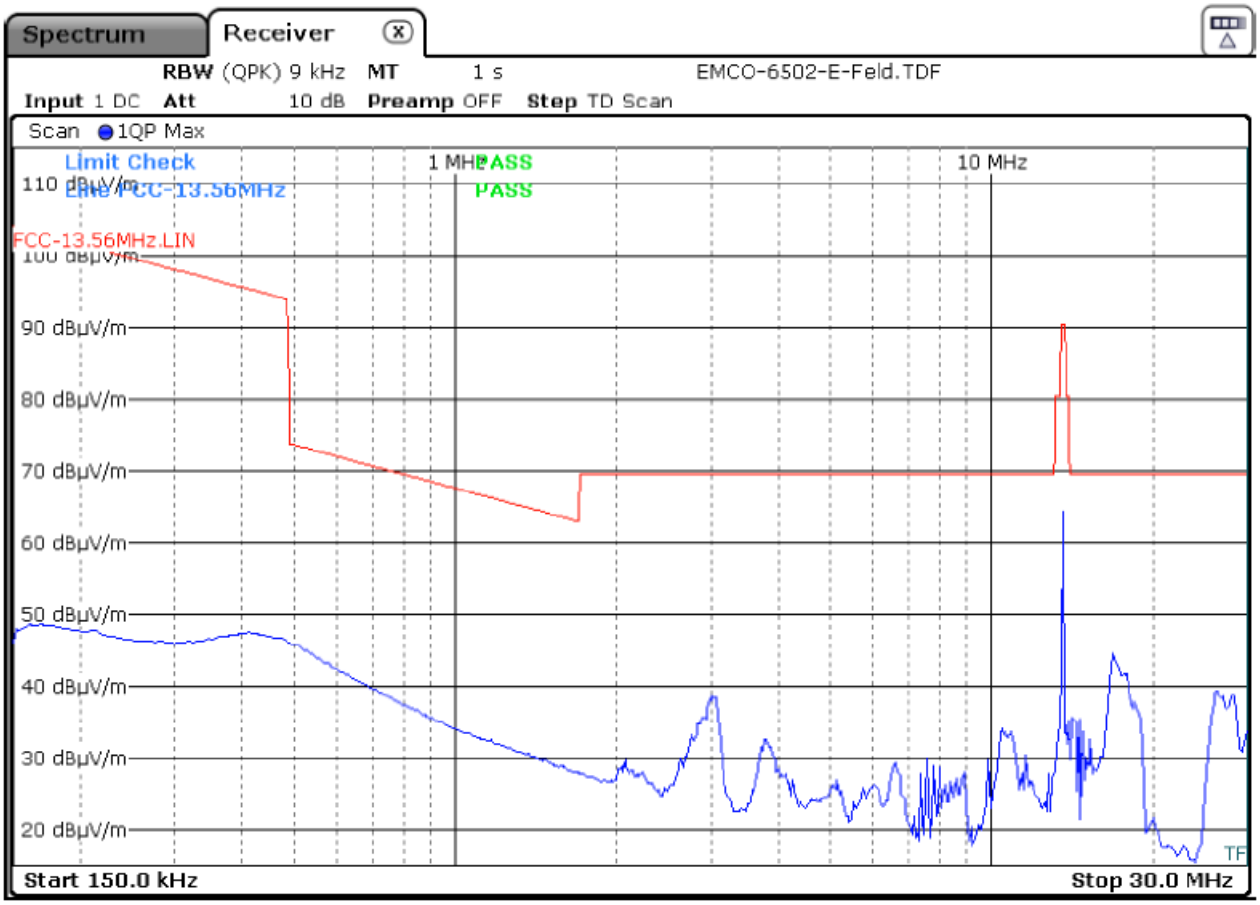
acc.FCC § 15.209

STC

Ref.-No.: 20/05-0043

Operation mode: Load switch ON/OFF; NFC active; W-LAN/Ping

Position Z (150kHz – 30MHz)



Position: Z									
		Detector QP							
Frequ. [MHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result					
150kHz-30MHz	-/-	>20	-/-	pass					

Remarks:
Composition of the measurement value (Freq.-range < 30 MHz):

$$\mathbf{M_{Value} = M_{Rec} + C_{Loss} + AF_{Rec}}$$

M_{Value}	= Measurement Value
M_{Rec}	= Reading value of test receiver
C_{Loss}	= Cable loss between Receiver and Antenna
AF_{Rec}	= Antenna factor.

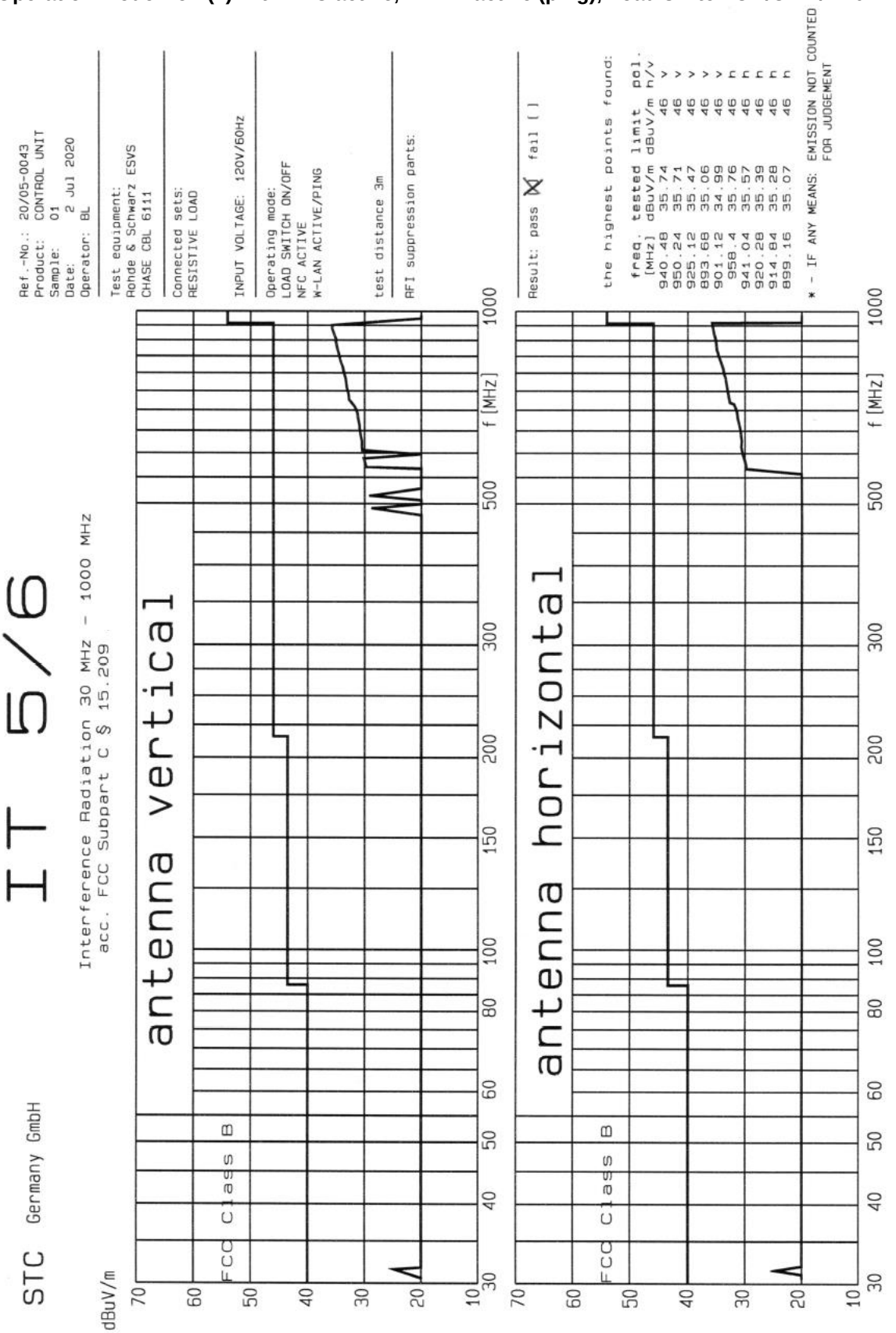
Sample calculation:

38.2 dBµV = 18.3 dBµV + 0.1 dB + 19.8 dB

All emissions in the frequency range 9 kHz – 30 MHz are at least 6 dB below the relevant limit.

Result 30 MHz – 1000 MHz

Operation Mode No.: (1) with NFC active, WLAN active (ping), Load switch ON/OFF / 120 V~ 60 Hz



Remarks:
Composition of the measurement value (Freq.-range 30 MHz – 1000 MHz):

$$\mathbf{M_{Value} = M_{Rec} + C_{Loss} + AF_{Rec}}$$

M_{Value}	= Measurement Value
M_{Rec}	= Reading value of test receiver
C_{Loss}	= Cable loss between Receiver and Antenna
AF_{Rec}	= Antenna factor.

Sample calculation:

38.7 dBµV = 18.3 dBµV + 0.6 dB + 19.8 dB

Result 1 GHz – 7 GHz

Operation Mode No.: (1) with NFC active, WLAN active (ping), Load switch ON/OFF / 120 V~ 60 Hz

TESTED IN GERMANY

IT 5/6

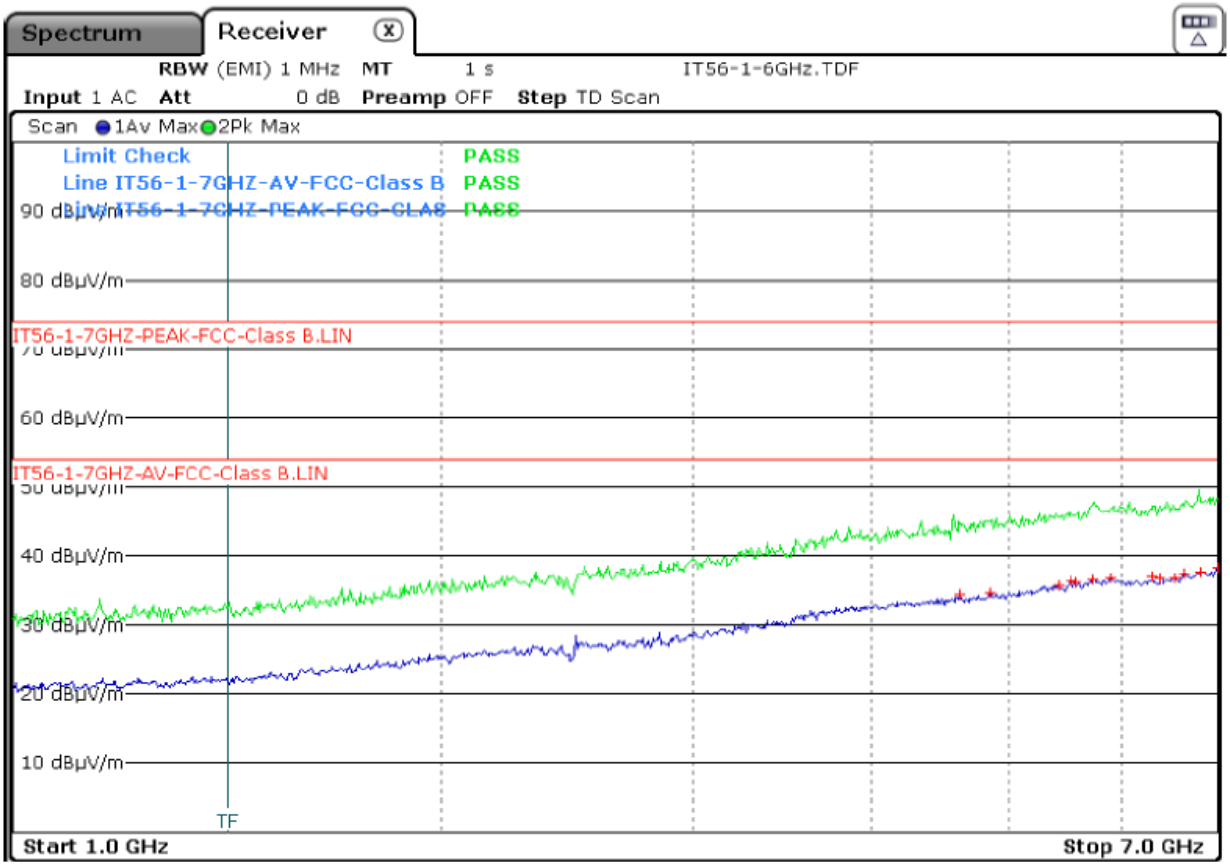
Interference radiation

acc. to FCC Subpart C §15.209

Ref.-No.:	20/05-0043
Product:	Control Unit
Sample:	01
Date:	02.07.2020
Operator:	BI
Remarks:	Input Voltage: 120V/60Hz; BSF (2.4GHz / 11243) con.

pass ☒ fail ☐ Result:

Operation mode: Load switch ON/OFF; NFC active; W-LAN/Ping



Polarisation: V									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
1 - 7	–/–	>20	54,00	pass	1 - 7	–/–	>20	74,00	pass

TESTED IN GERMANY

IT 5/6

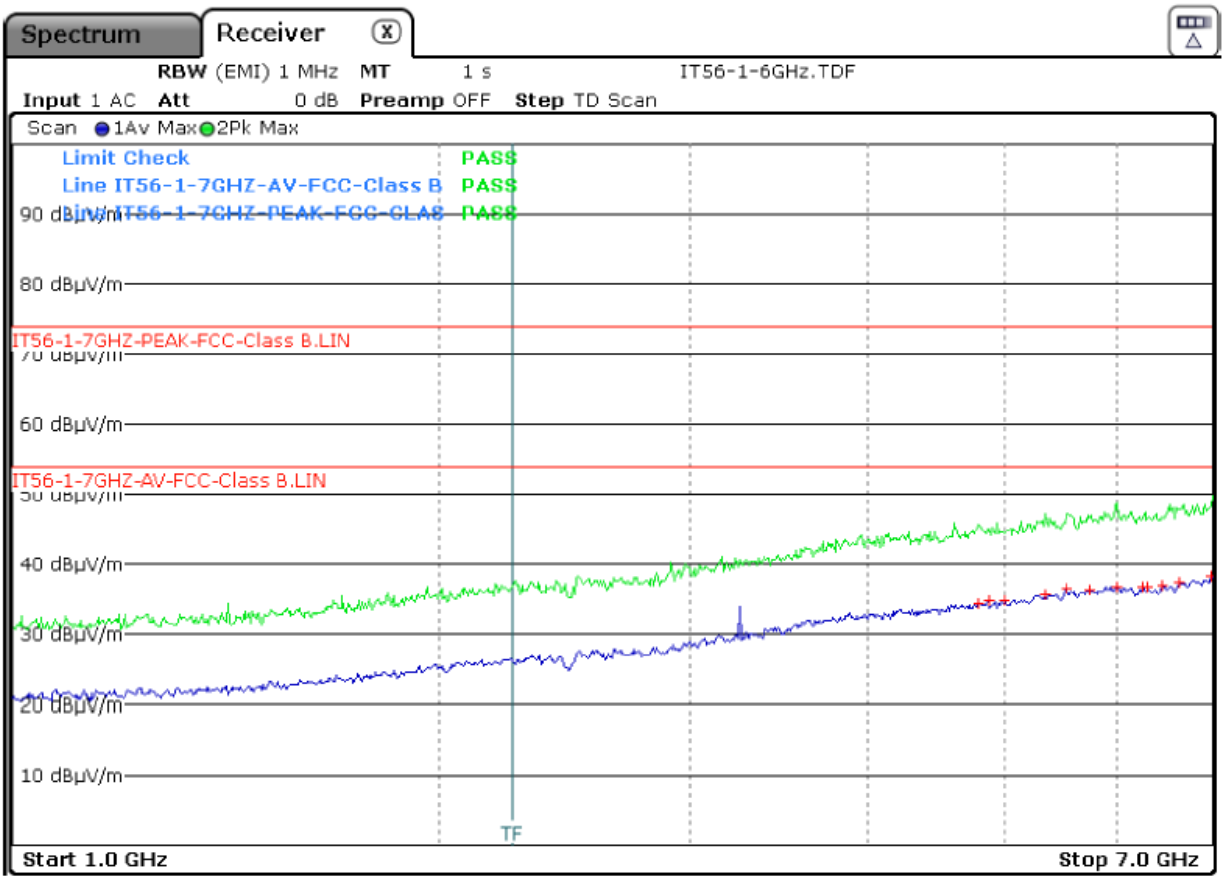
Interference radiation

acc. to FCC Subpart C §15.209

STC

Ref.-No.: 20/05-0043

Operation mode: Load switch ON/OFF; NFC active; W-LAN/Ping



Polarisation: H									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
1 - 7	--/--	>20	54,00	pass	1 - 7	--/--	>20	74,00	pass

Remarks:
Composition of the measurement value (Freq.-range 1 GHz – 7 GHz):

$$M_{Value} = M_{Rec} + C_{Loss} + AF_{Rec} - G_{Amp}$$

M_{Value}	= Measurement Value
M_{Rec}	= Reading value of test receiver
C_{Loss}	= Cable loss between Receiver and Antenna
AF_{Rec}	= Antenna factor.
G_{Amp}	= Gain Amplifier

Sample calculation:

39.7 dBµV = 53.01 dBµV + 0.9 dB + 24.19 dB -38.4 dB

Result 7GHz – 26GHz

All emissions in the frequency range 7 GHz - 26 GHz are at least 6 dB below the relevant limit.

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **Radiated Emissions**.

7. Operation within the band 13.110 – 14.010 MHz

Applied standards
e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.225

7.1 Field strength of any emissions within the band 13.110 – 14.010 MHz

Applied standards
e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.225 (a) – (d)

Limit

(a) The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

(b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

(c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

(d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in § 15.209.

Test equipment and test set up
Test equipment used for radiated measurements as given in clause Test equipment of this report.
Test setup used for radiated measurements as given in clause Test setups of this report.

Measurement:

The Measurement was performed on: 02.07.2020

Result 13.110 – 14.010 MHz

In the frequency range 13.110 – 14.010 MHz the EUT had been scanned in a distance of 3 m and the Limit were corrected to the test distance of 3 m using a factor with 40 dB/decade acc. to § 15.31 (f)(2).

Only the worst case of the X,Y and Z axis measurement is documented in this report.

TESTED IN GERMANY

IT 3/4

Interference radiation (9kHz – 30MHz)

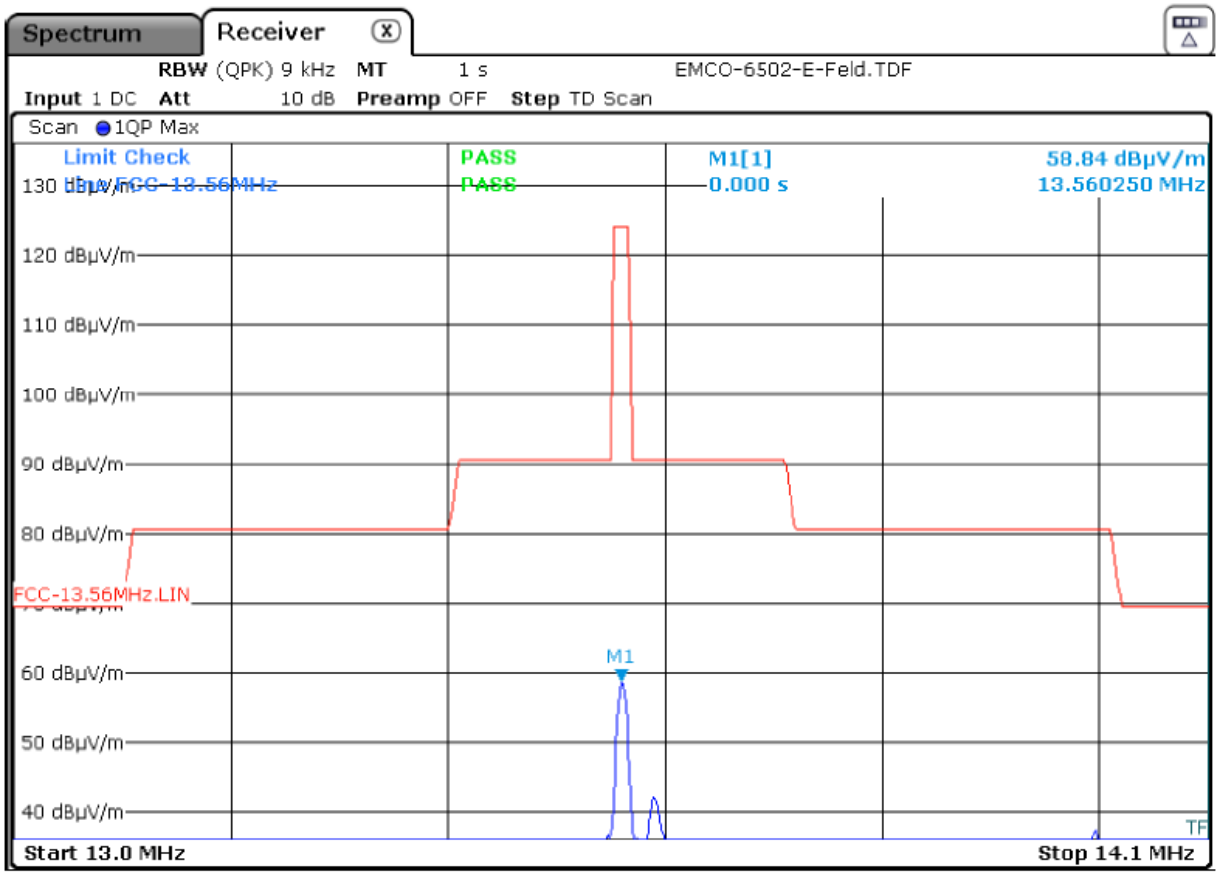
acc.FCC § 15.209

STC

Ref.-No.: 20/05-0043

Operation mode: Load switch ON/OFF; NFC active; W-LAN/Ping

Position X (13.56MHz)



Position: X									
		Detector QP							
Frequ. [MHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result					
13,56	58,84	>20	-/-	pass					

TESTED IN GERMANY

IT 3/4

Interference radiation (9kHz – 30MHz)

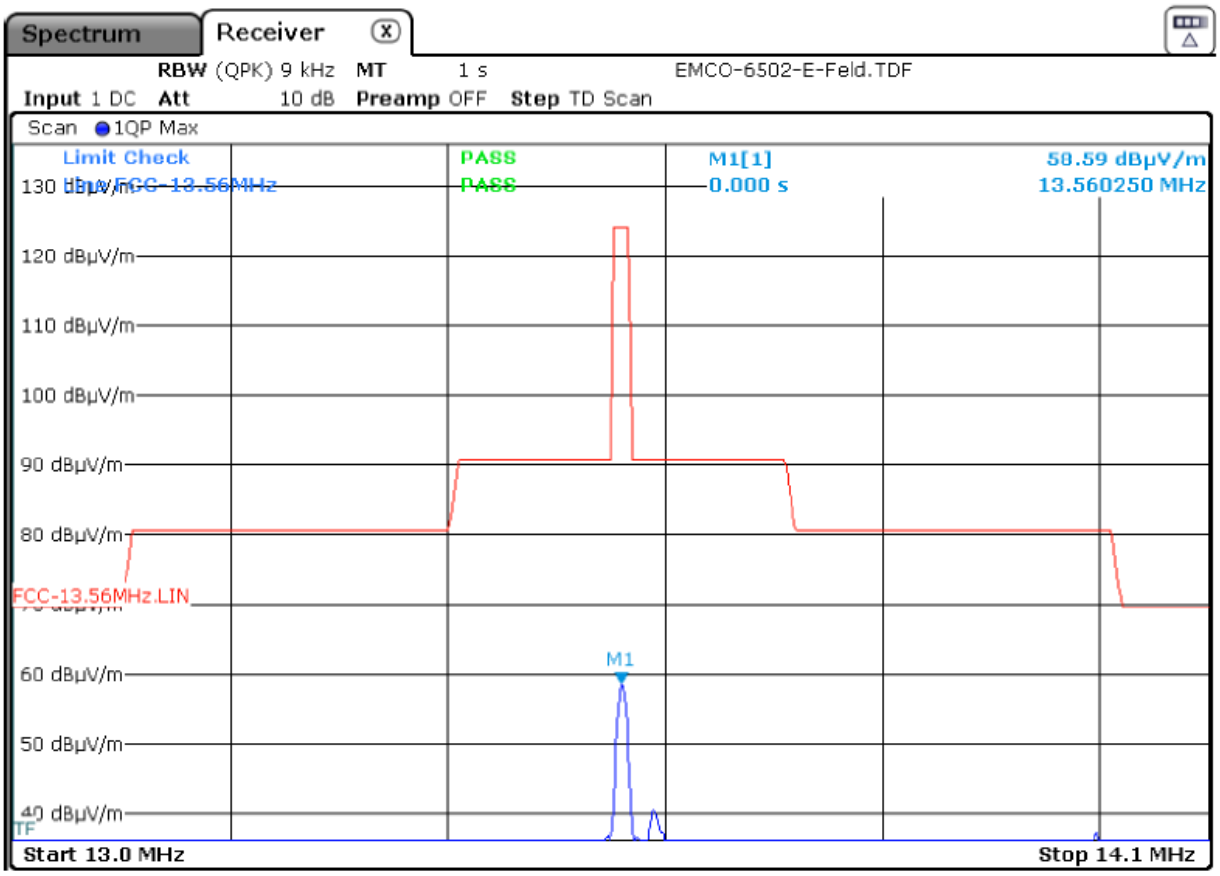
acc.FCC § 15.209

STC

Ref.-No.: 20/05-0043

Operation mode: Load switch ON/OFF; NFC active; W-LAN/Ping

Position Y (13.56MHz)



Position: X									
		Detector QP							
Frequ. [MHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result					
13.56	58,59	>20	-/-	pass					

TESTED IN GERMANY

IT 3/4

Interference radiation (9kHz – 30MHz)

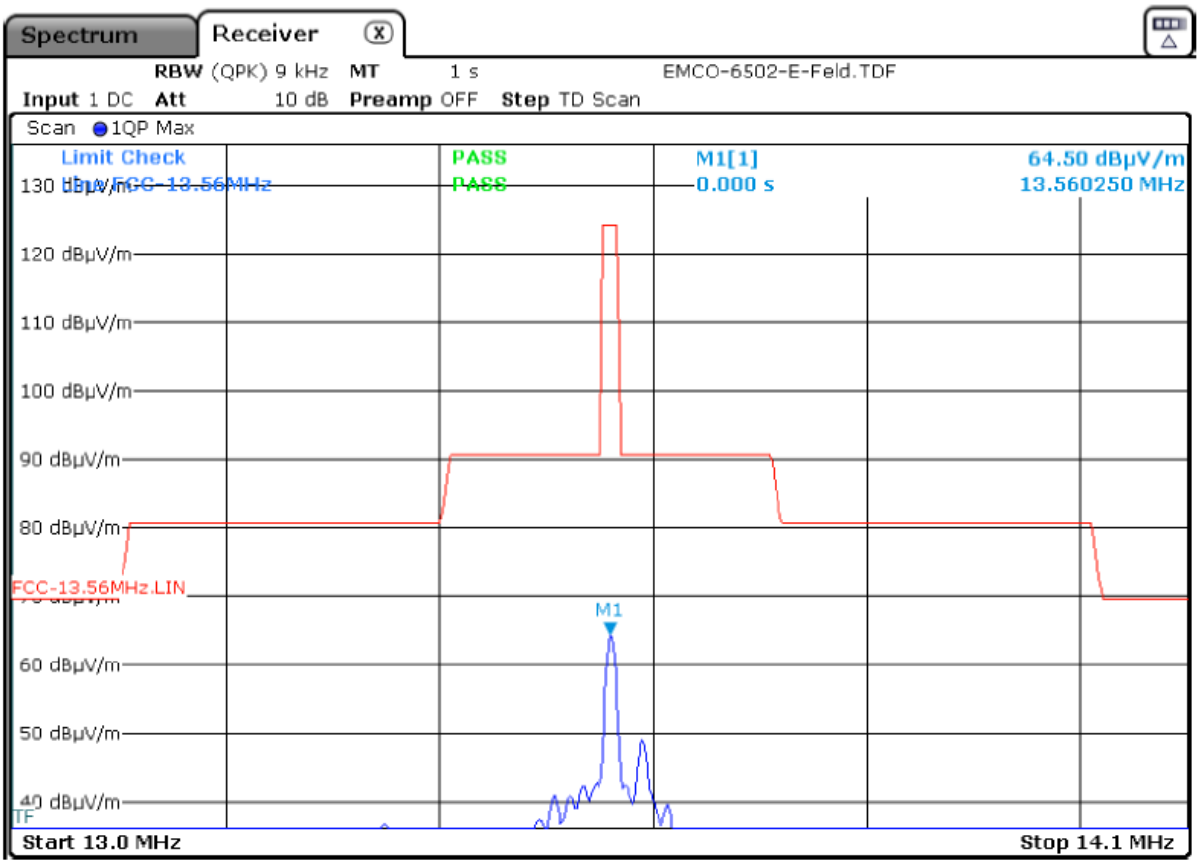
acc.FCC § 15.209

STC

Ref.-No.: 20/05-0043

Operation mode: Load switch ON/OFF; NFC active; W-LAN/Ping

Position Z (13.56MHz)



Position: Z									
		Detector QP							
Frequ. [MHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result					
13,56	64,5	>20	-/-	pass					

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements of **Field strength of any emissions within the band 13.110 – 14.010 MHz.**

7.2 Transmitter frequency stability

Applied standards
e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.225 (f)

Limit

(e) The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 degrees to + 50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

Test equipment and test set up
Test equipment used for conducted measurements as given in clause Test equipment of this report.
Test setup used for conducted measurements as given in clause Test setups of this report.

Description
Frequency stability is a measure of frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage.

Measurement:

The measurement was carried out on: 15.07.2020 according to the temperature conditions of the manual from 0° - 40°.

FCC 11

Frequency stability

§15.225

Ref.-No.: 20/05-0043

Product: Control Unit

Sample: 01

Date: 15.07.2020

Operator: Ro

Remarks: Input Voltage: 120V/60Hz

pass ☒ fail ☐

Operation mode: NFC/RFID 13,56 MHz

Test Equipment:
FSW 26 Analyzer ID: 11571
Inductive antenna ID: 11723

Temperature drift measurement:

Reference Frequency: 13.5603080 MHz @ 20°C Limit: ± 100 ppm = ±1.356 kHz										
Power Supply [V/AC]	Envir. Temp [°C]	Frequency Deviation Measured with Time Elapse								
		Start up [MHz]	Drift [ppm]	@2mins [MHz]	Drift [ppm]	@5mins [MHz]	Drift [ppm]	@10mins [MHz]	Drift [ppm]	Limit [ppm]
120	40	13.5602800	20.65	13.5602660	30.97	13.5602660	30.97	13.5602660	30.97	100
120	30	13.5603080	0.00	13.5602940	10.32	13.5602940	10.32	13.5602800	20.65	100
120	***20***	13.5603500	-30.97	13.5603360	-20.65	13.5603080	0.00	13.5603080	0.00	100
120	10	13.5603080	0.00	13.5602940	10.32	13.5603080	0.00	13.5603080	0.00	100
120	0	13.5603080	0.00	13.5603220	-10.32	13.5603360	-20.65	13.5603360	-20.65	100

Voltage drift measurement:

Reference Frequency: 13.56 MHz @ 20°C Limit: ± 100 ppm = ± 1.356 kHz										
Power Supply [V/AC]	Envir. Temp [°C]	Frequency Deviation Measured with Time Elapse								
		Start up [MHz]	Drift [ppm]	@2mins [MHz]	Drift [ppm]	@5mins [MHz]	Drift [ppm]	@10mins [MHz]	Drift [ppm]	Limit [ppm]
120	***20***	13.5603500	-30.97	13.5603360	-20.65	13.5603080	0.00	13.5603080	0.00	100
102	20	13.5603080	0.00	13.5603360	-20.65	13.5603360	-20.65	13.5603080	0.00	100
138	20	13.5603080	0.00	13.5603080	0.00	13.5602940	10.32	13.5602940	10.32	100

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **Transmitter frequency stability**.

8. 20 dB Bandwidth

Aplied standards
e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.215 (c)

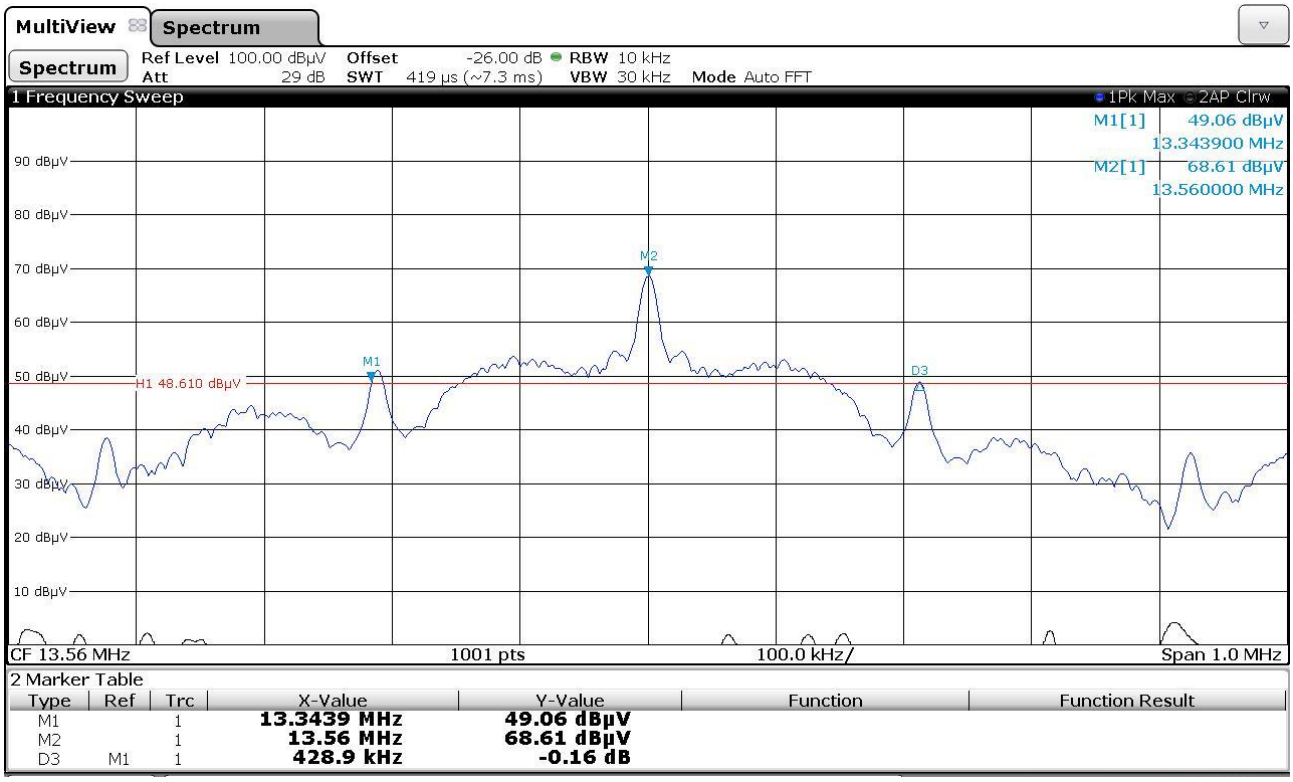
Limit
(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the 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. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Test equipment and test set up
Test equipment used for conducted measurements as given in clause Test equipment of this report.
Test setup used for conducted measurements as given in clause Test setups of this report.

Description
The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency. Once the reference level is established, the equipment is conditioned with typical modulating signal to produce the worst-case (i.e. the widest) bandwidth.

Measurement:

The Measurement was performed on: 15.07.2020



EUT Frequency (MHz)	20 dB OBW lower (f_L) frequency [MHz]	20 dB OBW upper (f_H) frequency [MHz]	20 dB Bandwidth [kHz]	Limit lower (f_L) frequency [MHz]	Limit upper (f_H) frequency [MHz]	Result	Comment
13.56	**13.3439**	**13.7719**	**428.9**	**13.110**	**14.010**	**Pass**	**-/-**

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **20 dB Bandwidth**.

9. Band-Edges Measurement / Out of Band Emissions

Applied standards
-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 (d)

Limit
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 30 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. Emissions which fall in the restricted bands, as defined in §15.205 Restricted Bands of operation and must also comply with the radiated emission limits specified in §15.209 Radiated emission limits.

Test equipment and test set up
Test equipment used for Band Edge measurements as given in clause Test equipment of this report.
Test setup used for Band Edge measurements as given in clause Test setups of this report.

Description
For restricted Bands:
The Emission must comply with the radiated emission limits. Measured with Average and Peak detector.

For non restricted Bands:
The band edge is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

The measurements are initially carried out according to the requirements for restricted bands, as these requirements are more stringent. If the limit value is exceeded in a non-restricted band according to the restricted band specifications, the measurement is repeated again with requirments for non restricted bands in order to prove the conformity.

Note: It was not necessary to carry out a re-test for non restricted band requirments for the tested EUT.

Detector function selection and bandwidth
For the measurement, an EMI test receiver that have CISPR peak detector as well as average detector were used.

Band Edge for restriced Band

Frequency range:	**Bandwidth**	
See measurement graph	RBW:	1 MHz
	VBW:	3 MHz

Band Edge for non resticted Band

Frequency range:	**Bandwidth**	
See measurement graph	RBW:	100 kHz
	VBW:	300 kHz

Measurement

The Measurement was performed on: 02.07.2020

TESTED IN GERMANY

FCC 3

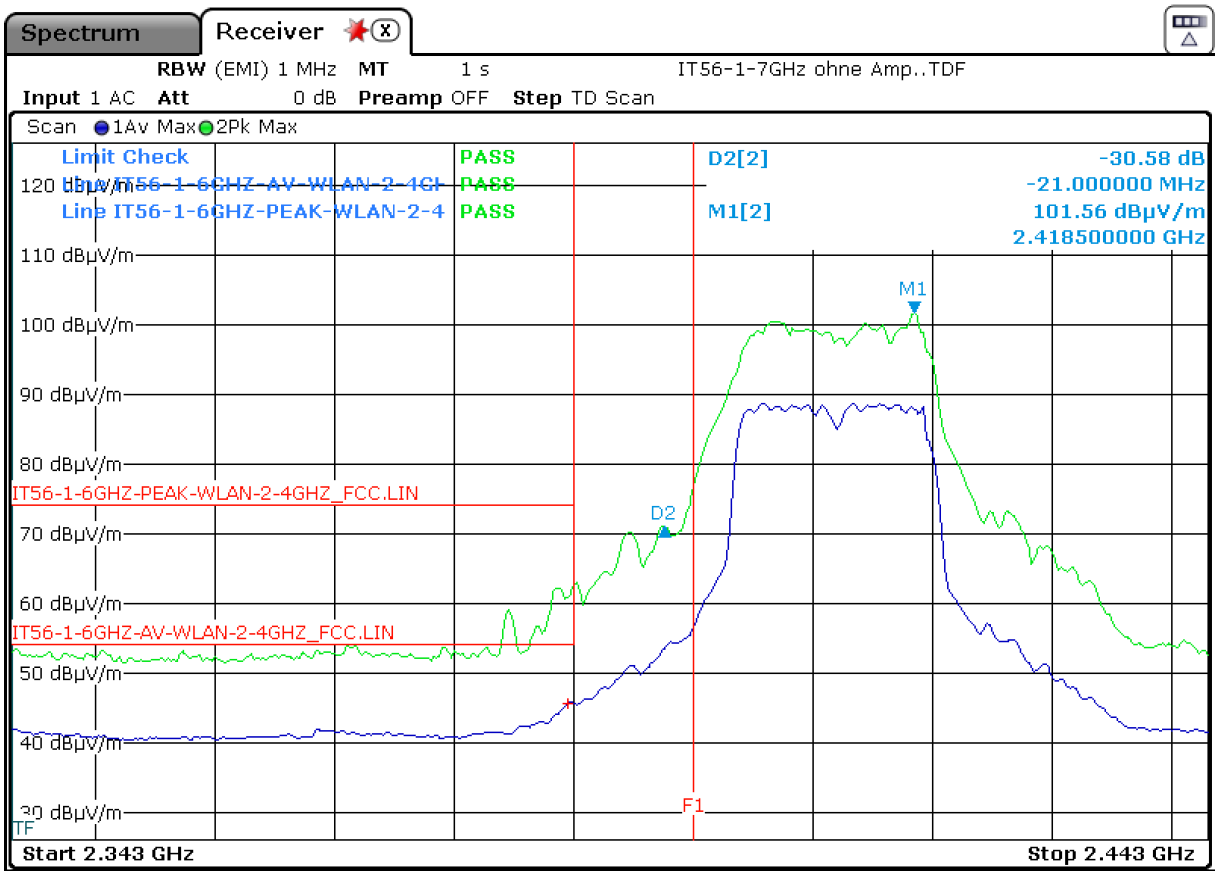
Band edge emission
according to
FCC §15.247, FCC §15.209

STC

Ref.-No.: 20/05-0043
Product: Control Unit
Sample: 01
Date: 02.07.2020
Operator: BI
Remarks: Input Voltage: 120V/60Hz

pass ☒ fail ☐
Result:

Operation mode: WLAN (11g) CH.1; Low Edge



Polarisation: V									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
2,3895	45,60	-8,40	54,00	pass	all emissions are 10dB below limit				pass

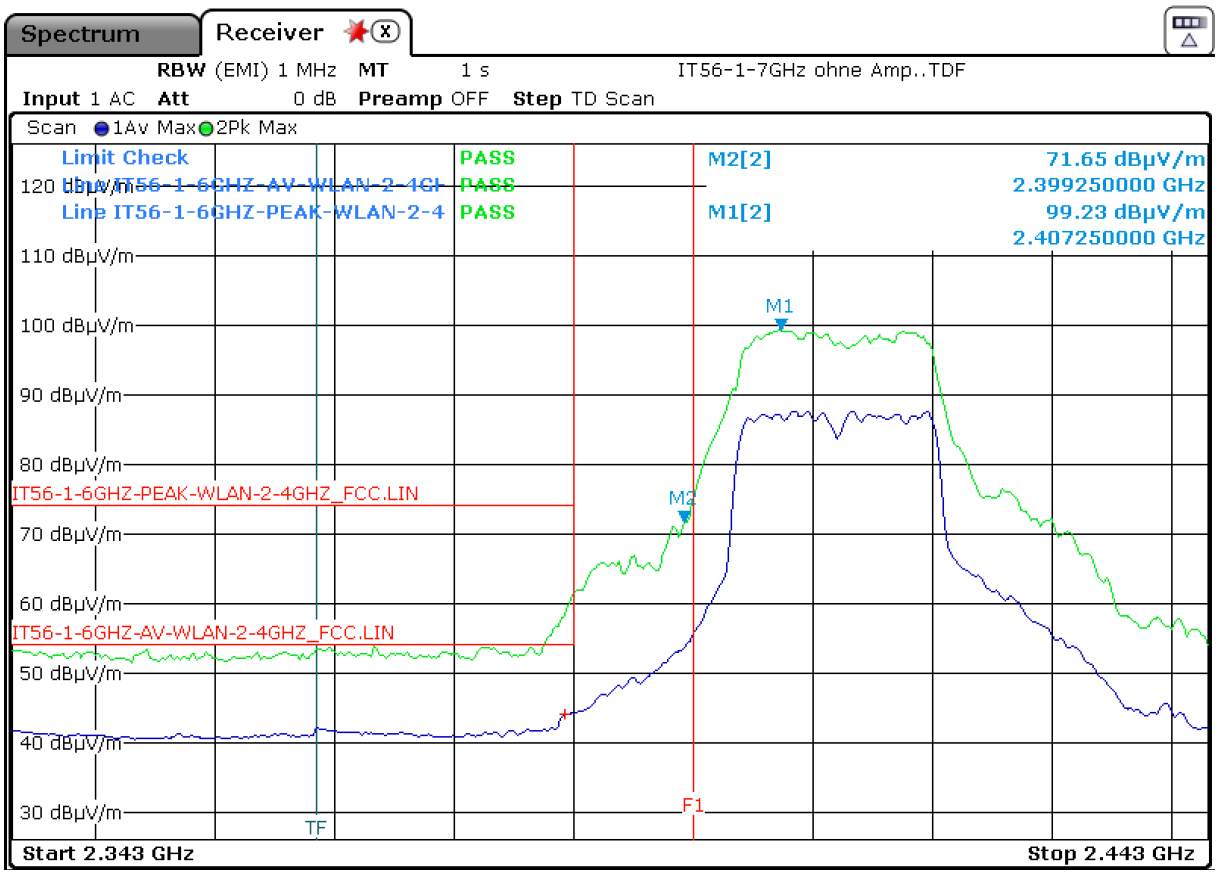
TESTED IN GERMANY

FCC 3

Band edge emission
according to
FCC §15.247, FCC §15.209

STC

Ref.-No.: 20/05-0043
Operation mode: WLAN (11g) CH.1; Low Edge



Polarisation: H									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
all emissions are 10dB below limit				pass	all emissions are 10dB below limit				pass

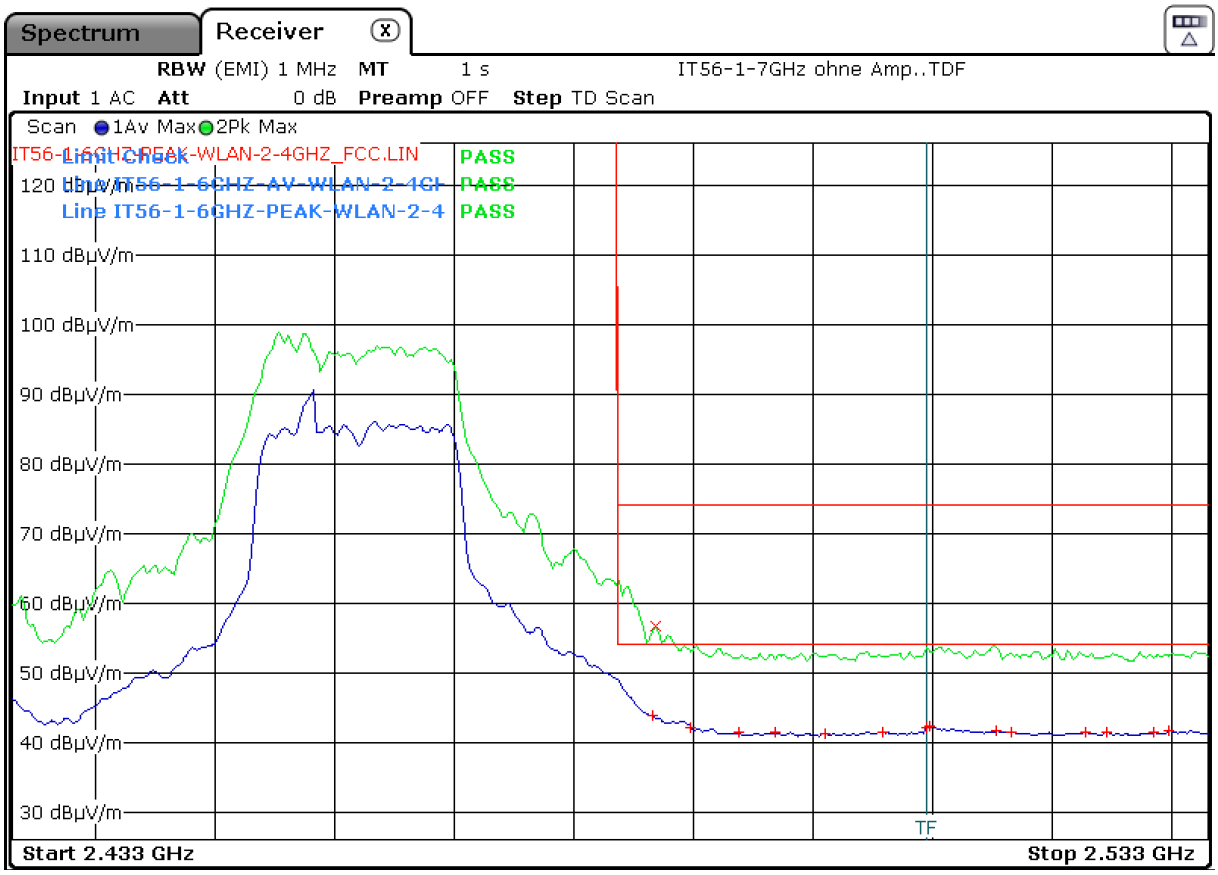
TESTED IN GERMANY

FCC 3

Band edge emission
according to
FCC §15.247, FCC §15.209

STC

Ref.-No.: 20/05-0043
Operation mode: WLAN (11g) CH.11; High Edge



Polarisation: V									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
2,4865	43,74	-10,26	54,00	pass	2,4868	56,70	-17,30	74,00	pass
2,5098	42,33	-11,67	54,00	pass					
2,4898	42,14	-11,86	54,00	pass					
2,5095	42,12	-11,88	54,00	pass					
2,5153	41,62	-12,38	54,00	pass					
2,5298	41,56	-12,44	54,00	pass					

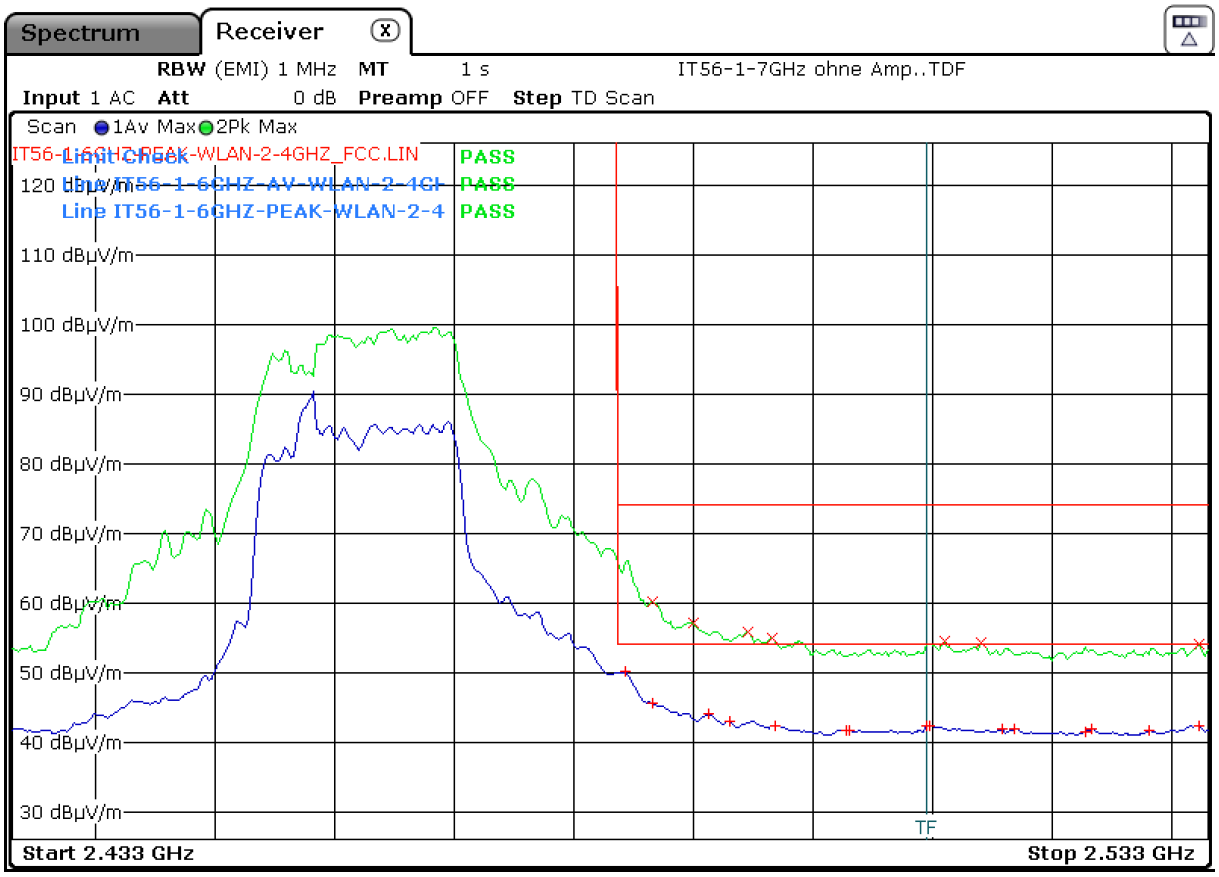
TESTED IN GERMANY

FCC 3

Band edge emission
according to
FCC §15.247, FCC §15.209

Ref.-No.: 20/05-0043

Operation mode: WLAN (11g) CH.11; High Edge



Polarisation: H									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
2,4843	50,03	-3,97	54,00	pass	2,4865	60,03	-13,97	74,00	pass
2,4865	45,58	-8,42	54,00	pass	2,4900	57,08	-16,92	74,00	pass
2,4913	43,95	-10,05	54,00	pass	2,4945	55,85	-18,15	74,00	pass
2,4930	43,05	-10,95	54,00	pass	2,4965	54,82	-19,18	74,00	pass
2,4968	42,41	-11,59	54,00	pass	2,5110	54,47	-19,53	74,00	pass
2,5098	42,34	-11,66	54,00	pass	2,5140	54,21	-19,79	74,00	pass

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **Band Edges / Out of Band Emission**.

10. Test equipment

Test equipment used for Conducted Mains emissions:

Kind of equipment	Manufacturer	Type	Ident no.	Serial no.	Calibrated on (y-m)	Calibration interval
Test-Receiver	Rohde & Schwarz	ESHS30	10571	842053/008	2019 – Mar.	3 years
Software	PKM	PKM U5/6	-/-	V1.01.03	-/-	-/-
Line impedance stabilisation network (LISN)	Rohde & Schwarz	ESH2-Z5	10139	879675/028	2019 – Jan.	3 years
Shielded room	Siemens	(6,2 x 4,7 x 3,3) m (l x w x h) DC – 10 GHz	10113	1	-/-	-/-

Test equipment used for radiated Measurements:

Kind of equipment	Manufacturer	Type	Ident no.	Serial no.	Calibrated on (y-m)	Calibration interval
Signal Spectrum Analyzer 2Hz – 26.5 GHz	Rohde & Schwarz	FSW 26 Instrument FW 2.60	11571	102047	2019-Jan.	3 years
ESR7 EMI Testreceiver 7GHz	Rohde & Schwarz	ESR7	11676	101694	2018-March	3 years
Test-Receiver	Rohde & Schwarz	ESVS30	10572	833825/010	2020-April	3 years 3 years
Antenna 9 kHz – 30 MHz	EMCO	6502	10546	2018	2017-Nov.	3 years
Antenna 30 MHz – 1 GHz	Chase	CBL6111C	10022	1064	2019-Dec.	3 years
Antenna 1GHz – 18 GHz	Electro Metric	RGA50/60	10273	2753	2017-Nov.	3 years
Broadband-Hornantenne 15 - 26,5 (40) GHz	Schwarzbeck	BBHA 9170	11580	BBHA9170621	2019-Dec.	3 years
Broadband-Preamplifier 1 - 18 GHz	Schwarzbeck	BBV9718	11231	9718-002	2017-Okt.	3 years
Preamplifier 18 - 40 GHz	CERNEX	CBM18403523	11679	29711	2019 - July	3 years
Cable	el-spec GmbH	FlexCore-SMA11-SMA11-8000-ARM	11625	-/-	2017-Dec.	3 years
Shielded room/Chamber	Frankonia	SAC3 "SEMI-ANECHOIC-CHAMBER"	11609	004/16	2019-March	3 years
Band Reject Filter	Telemeter	BRF-2450-150-7-N (0441)	11243	-/-	-/-	-/-

Test equipment used for Band Edge Measurements:

Kind of equipment	Manufacturer	Type	Ident no.	Serial no.	Calibrated on (y-m)	Calibration interval
ESR7 EMI Testreceiver 7GHz	Rohde & Schwarz	ESR7	11676	101694	2018-March	3 years
Antenna 1GHz – 18 GHz	Electro Metric	RGA50/60	10273	2753	2017-Nov.	3 years
Cable	el-spec GmbH	FlexCore-SMA11-SMA11-8000-ARM	11625	-/-	2017-Dec.	3 years
Shielded room/Chamber	Frankonia	SAC3 "SEMI-ANECHOIC-CHAMBER"	11609	004/16	2019-March	3 years

Test equipment used for conducted measurements:

Kind of equipment	Manufacturer	Type	Ident no.	Serial no.	Calibrated on (y-m)	Calibration interval
Signal Spectrum Analyzer 2Hz – 26.5 GHz	Rohde & Schwarz	FSW 26 Instrument FW 2.60	11571	102047	2019 - Jan.	3 years
EMI-Test-Receiver	Rohde & Schwarz	ESR7 Instrument FW 3.36	11505	101103	2017 - Nov.	3 years
Automatisation unit RF switch and power meter	Rohde & Schwarz	OSP120 and OSP B157	11573	101282	2017 - Dec.	3 years
Cable	el-spec GmbH	FlexCore-SMA11-SMA11-8000-ARM	11625	-/-	2017 - Dec.	3 years

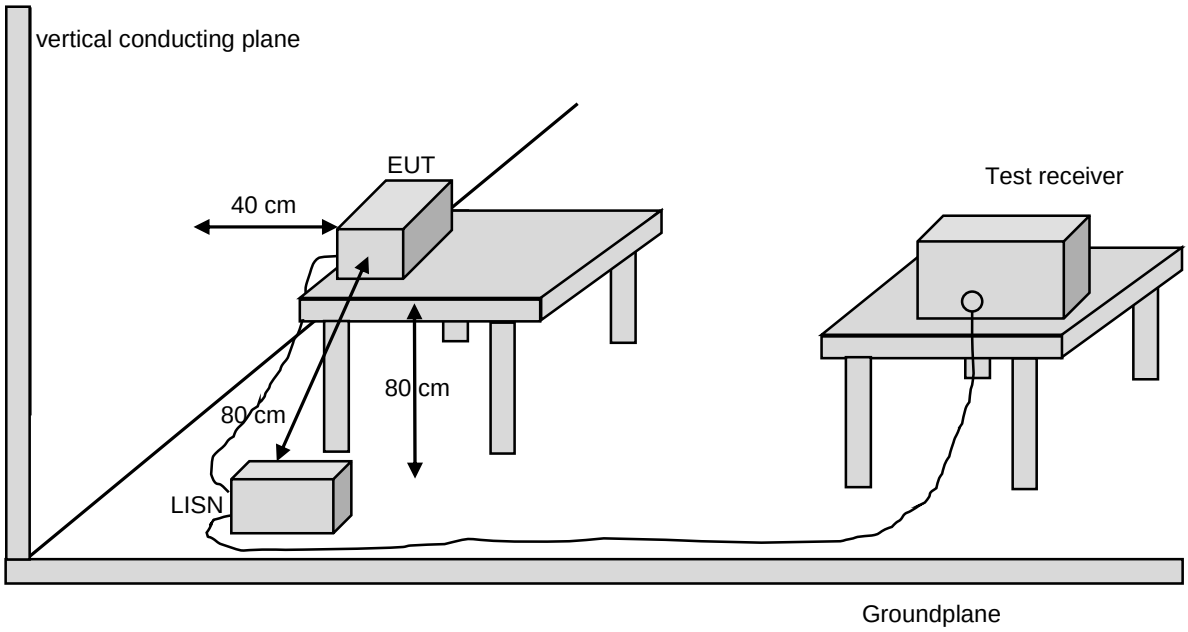
All measurements were made with measuring instruments, including any accessories that may affect test results, calibrated according to the requests of ISO/IEC 17025 according to which the test site is accredited from DAkkS. Measurement of conducted mains emissions was made with instruments conforming to American National Standard Specification, ANSI C63.10-2013.

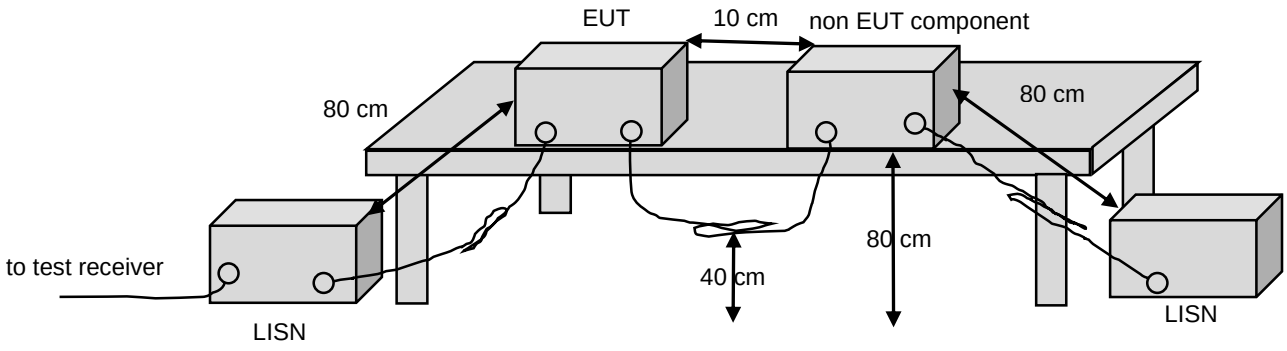
Test equipment to support EUT functions:

Kind of equipment	Manufacturer	Type	Ident no.
-/-	-/-	-/-	-/-
-/-	-/-	-/-	-/-
-/-	-/-	-/-	-/-

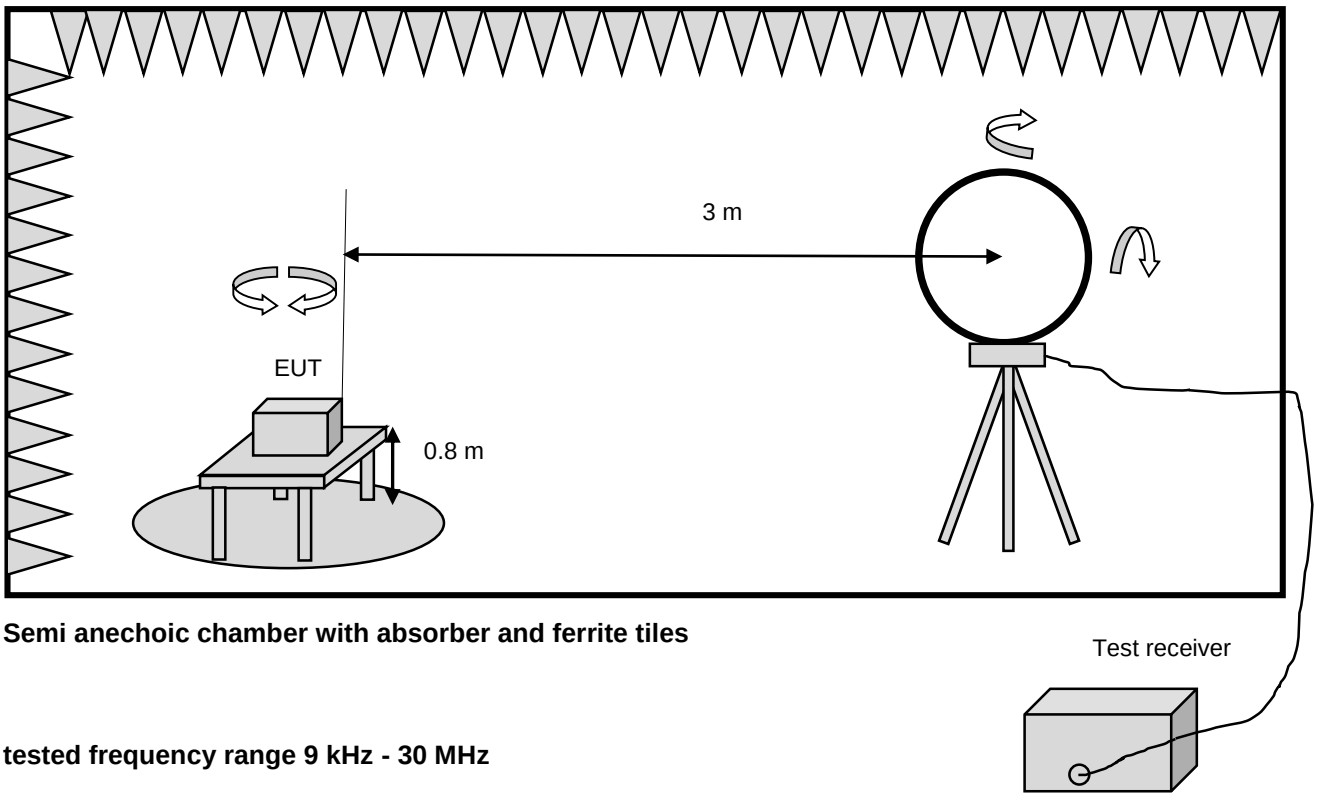
11. Test setups

Block diagram Conducted Mains emissions



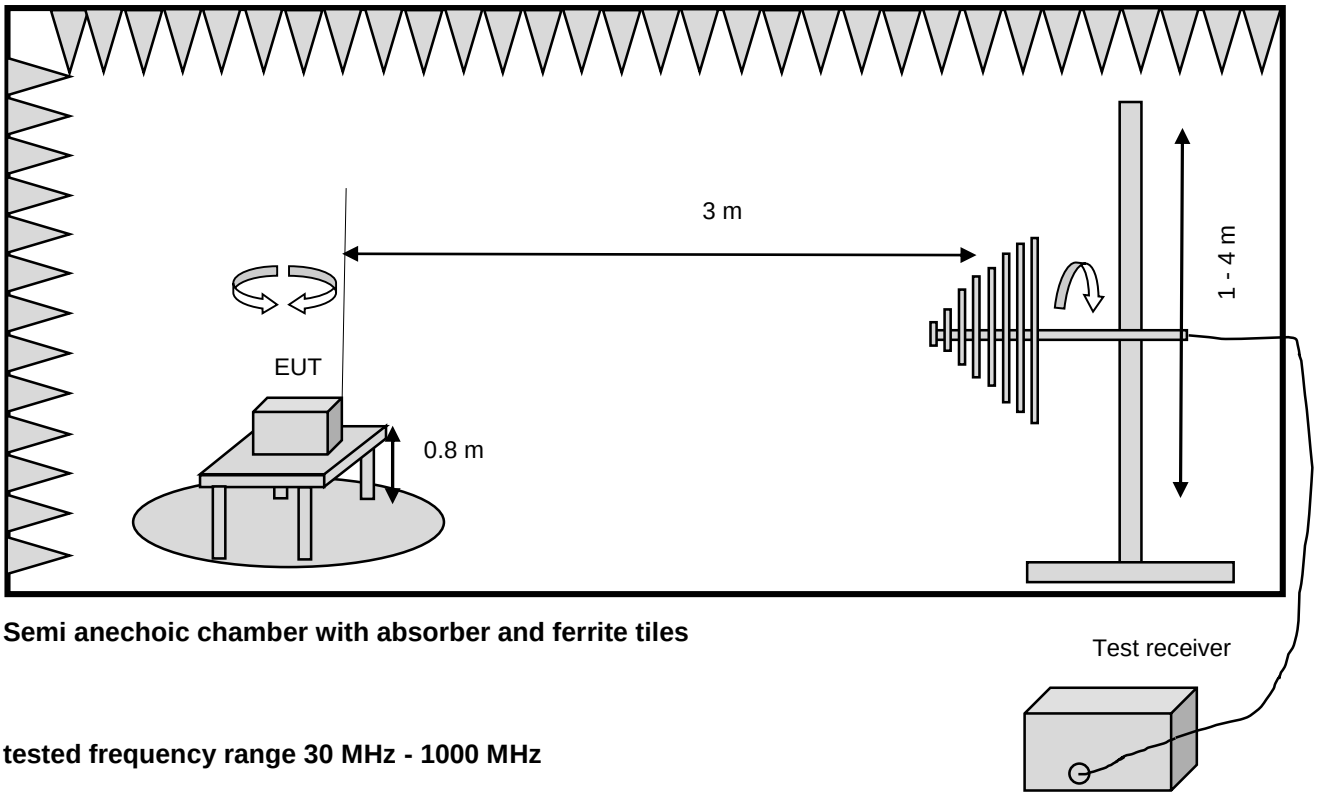


Block diagram Radiated emissions



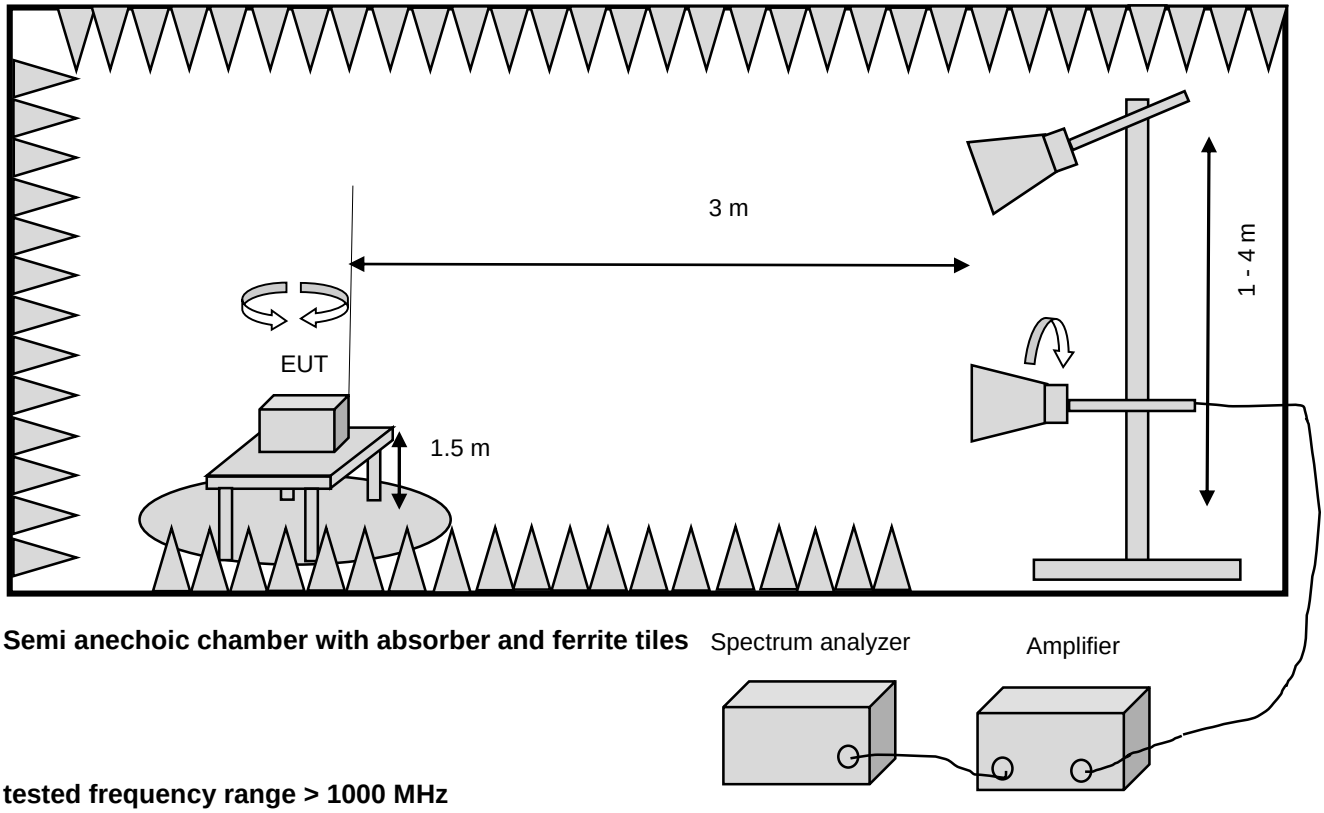
Semi anechoic chamber with absorber and ferrite tiles

tested frequency range 9 kHz - 30 MHz



Semi anechoic chamber with absorber and ferrite tiles

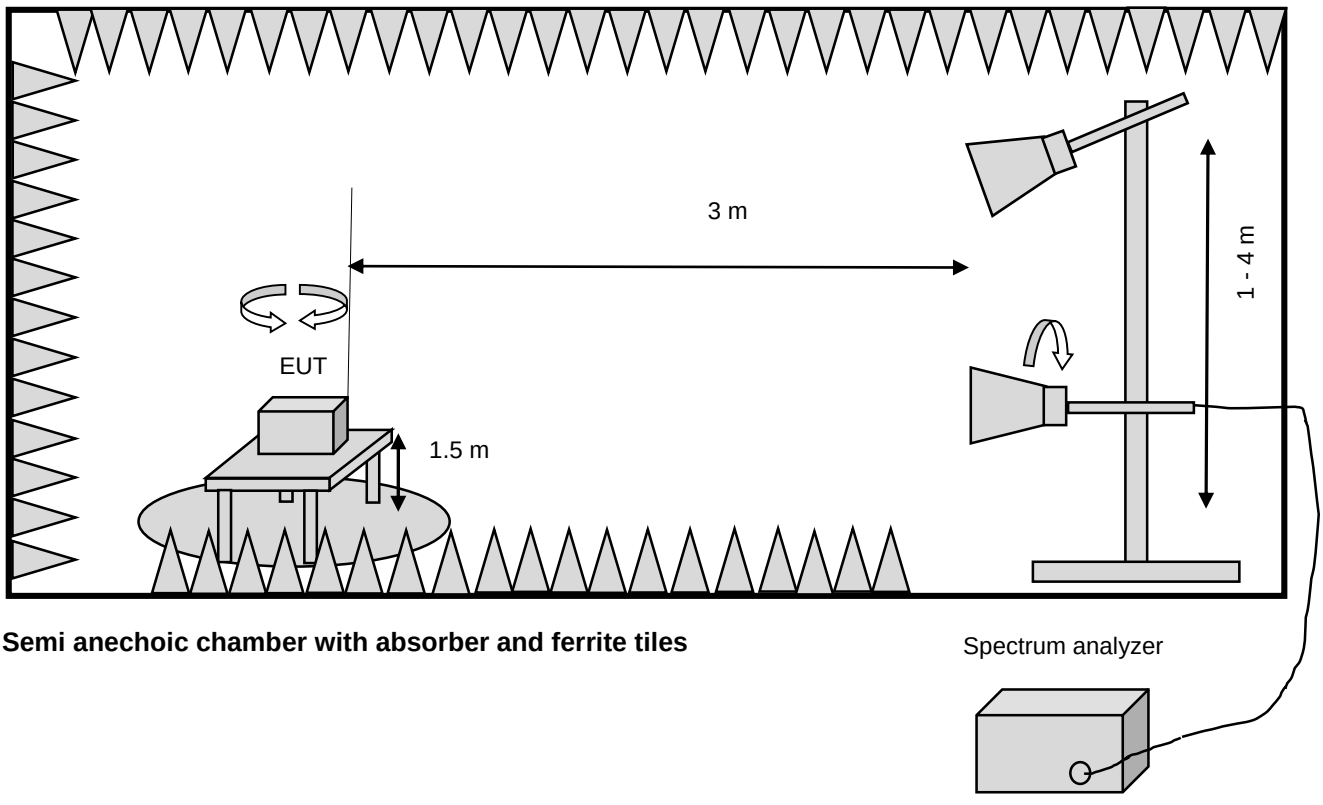
tested frequency range 30 MHz - 1000 MHz



Semi anechoic chamber with absorber and ferrite tiles

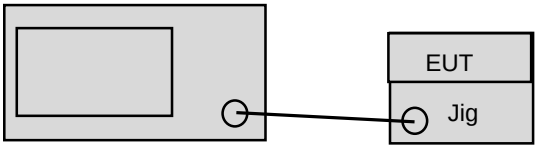
tested frequency range > 1000 MHz

Block diagram Band Edge emisions



Semi anechoic chamber with absorber and ferrite tiles

Block diagram for conducted measurements



Test Receiver/Analyzer **EUT**

12. Measurement uncertainty

according to *CISPR 16-4-2 Edition 2.0 2011-06*

Measurement	**calculated uncertainty U_{lab}**	**Specified CISPR uncertainty according CISPR 16-4-2 Edition 2.0 2011-06, table 1 U_{CISPR}**
Conducted disturbance at mains port using AMN 9 kHz – 150 kHz	3.6 dB	3.8 dB
Conducted disturbance at mains port using AMN 150 kHz – 30 MHz	3.2 dB	3.4 dB
Magn. fieldstrength 9kHz - 30MHz	3.4 dB	-/-
Radiated disturbance (electric field strength in the SAC) 30 MHz to 1 000 MHz	4.7 dB	6.3 dB
Radiated disturbance (electric field strength in the SAC) 1 GHz to 26.5 GHz	4.1 dB	-/-

Measurement	**calculated uncertainty U_{lab}**	**Maximum measurement uncertainty**
Channel Bandwidth	±1.17 %	±5 %
RF output power, conducted	±1.36 dB	±1.5 dB
Power Spectral Density, conducted	±1.99 dB	±3 dB
Unwanted Emissions, conducted	±1.71 dB	±3 dB
All emissions, radiated	±4.8 dB	±6 dB
Temperature	±0.72 °C	±3 °C
Supply voltages	±0.76 % (DC up to 40V) ±1.74 % (AC 50Hz up to 400V)	±3 %
Time	±0.012 %	±5 %

The measurement uncertainty describes the overall uncertainty of the given measured value during the operation of the EUT in the above mentioned way.

The measurements uncertainty was calculated in accordance with CISPR 16-4-2 Edition 2.0 2011-06.

The measurement uncertainty was given with a confidence of 95 % (k = 2).

13. Photos setup

Refer to “0043-fcc-ised-photos test setup.pdf” file

14. Conclusions

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the relevant §15.225 Operation within the band 13.110 – 14.010 MHz.

Following specific modifications and/or special attributes are necessary to pass the above mentioned requirements:

none

09.02.2021	M. Beindl, Laboratory Engineer	
Erstellt am/*prepared on*	**(Name/***name* / **Stellung/***position***)**	**(Unterschrift/***signature***)**
09.02.2021	K. Simon, Head of Laboratory	
Freigabe am/released *on*	**(Name/***name* / **Stellung/***position***)**	**(Unterschrift/***signature***)**

15. Photos of tested sample

Refer to “0043-fcc-ised-ext-photos.pdf” file.

End of test report