



Test report

according to ISO/IEC 17025:2017

FCC

(Federal Communications Commission)

Test Firm Registration Number: 768032

Designation Number DE0022

ISED

(Innovation, Science and Economic Development)

CAB identifier: DE0012

ISED#: 6155A

Electromagnetic compatibility

Intentional Radiators



Deutsche
Akkreditierungsstelle
D-PL-17379-01-00
D-PL-17379-01-02
D-PL-17379-01-03



BNetzA-CAB-18/21-19

 **TESTED
IN GERMANY**

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Test report no.: **18/11-0061b**

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Location of test facility:



STC Germany GmbH
Ohmstrasse 1
84160 Frontenhausen
Germany

1. Client information

Name: Viessmann Elektronik GmbH
Address: Beetwiese 2; 35108 Allendorf; Germany
Name of contact: Mr. Michael Weppler
Telephone: +49 6452 70 2577
Fax: +49 6452 70 5577
E-mail: WepM@viessmann.com

2. Equipment under test (EUT)

2.1 Identification of the EUT

Equipment: RF MODUL
Model: TCU 200
Brand name: Viessmann
Serial no.: #24, #23, #12, #15, #14, #16, #18, #19
Manufacturer: Viessmann Elektronik GmbH
Beetwiese 2, 35108 Allendorf; Germany
Country of origin: Germany
Power rating: nominal 24 V =, +/- 10 %
Highest frequency generated or used
in the device or on which the device
operates or tunes (MHz): 2.48 GHz
Date Sample Received: 29.11.2018
Tests were performed: 10.01.2019 – 06.04.2020

2.2 Additional information about the EUT:

The EUT has an additional RF-function (W-LAN) which is reported in the
STC FCC-ISED report No.: 18/11-0061a

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:	2AIZ9-RF0119
IC:	21680-RF0119
HVIN:	RF Modul TCU 200
Power:	nominal 24 V =, +/- 10 %
Cables:	USB cable to PC (programming) 13 cm USB to PCB (Ribbon) 18 cm USB cable 100 cm DC cable 135 cm
Approx. Size (l x w x h):	(60 x 90 x 11) mm
Test conditions:	<p>The "RF-module – TCU 200" (= equipment under test – EUT) had been tested, where applicable with test software Node Test and with maximum RF-output power in the following modes:</p> <ol style="list-style-type: none"> (1) Ping/Pong communication with ZigBee stick (2) Continues TX on lowest, middle and highest Channel (3) Continues Tx (802.11b 20MHz) / ZigBee active PING/PONG communication with ZigBee stick <p>The tested configuration represents (based on the product specification) with the tested operation modes the worst case.</p>
Additional information:	Conducted RF Measurements were carried out on a temporary SMA socket
Type of modulation (ITU designation):	2M26G1D
Operating frequencies:	2.405 GHz – 2.480 GHz
Transmission protocol:	ZigBee
Channel separation:	5 MHz
Number of channels:	16 - See below
Operating temperature range:	0 °C ... +60 °C
Operating voltage range:	24 V =, +/- 10 %
Output power:	radiated: -/- dBm (normal conditions) conducted: 9.39 dBm (normal conditions)
Environmental conditions during tests:	Ambient temperature: 20 °C Relative humidity 40 % Atmospheric pressure 965 mbar
Antenna specification:	Model: Printed PCB Antenna Gain: max. 2dB Type: <input type="checkbox"/> External (with accessible antenna socket) <input checked="" type="checkbox"/> Internal (integrated, PCB antenna 24 mm)
Test standard:	<ul style="list-style-type: none"> - e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247: Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz - RSS-247 issue 02 February 2017 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices

Channel List**ZigBee:**

Channel	Frequency (MHz)	Channel	Frequency (MHz)
11	2405	19	2445
12	2410	20	2450
13	2415	21	2455
14	2420	22	2460
15	2425	23	2465
16	2430	24	2470
17	2435	25	2475
18	2440	26	2480

4. Performed measurements and results

The complete list of measurements required in e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 is given below.

Standard:	Standard:	Test Method:		Test requirements:			
				applicable:		fulfilled:	
				yes	no	yes	no
§ 15.207	RSS-Gen issue 5	ANSI 63.10 Section 6.2	AC Mains Conducted Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
§ 15.209	RSS-Gen issue 5	ANSI 63.10 Section 6.3 - 6.6	Radiated Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
§15.247	RSS-247 issue 2	ANSI 63.10 Section 11.8.1	6 dB DTS Bandwidth	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
§15.247	RSS-247 issue 2	ANSI 63.10 Section 11.9.1	Output Power of Fundamental Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
§15.247	RSS-247 issue 2	ANSI 63.10 Section 11.10.2	Maximum Power Spectral Density	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
§15.247	RSS-247 issue 2	ANSI 63.10 Section 11.13.2	Band Edges Measurement Out-of-Band Emission	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	RSS-Gen issue 5	ANSI 63.10 Section 6.9.3	99% Power Bandwidth	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

All required / applicable tests according to the following standards were performed under Ref-No. 18/11-0061.

- e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 with test Method according to ANSI C63.10-2013

- RSS-247 issue 02 February 2017 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

- e-CFR data is current as of June 22, 2020

Remark: -/-

5. AC Mains conducted emissions

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.207 Conducted limits
-RSS-Gen issue 05 section 8.8

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 under following operation modes:

1. Ping/Pong communication with ZigBee stick
2. Continues TX

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 Host AC-Adaptor, on neutral (N)- and live (L1)-wire had been performed.

Requirements

Frequency Range [MHz]	Quasi-Peak Limits [dB μ V]	Average Limits [dB μ V]
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		

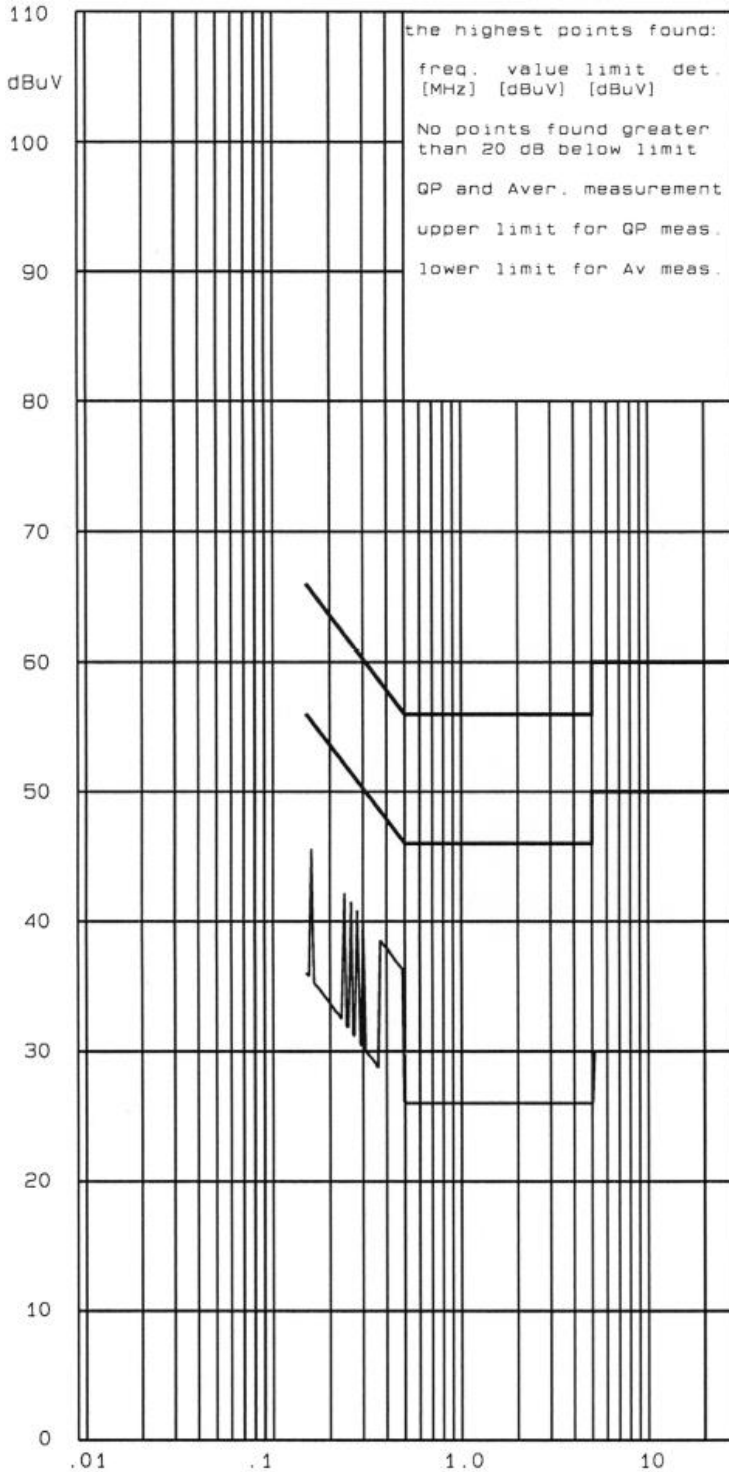
Measurement

Measurement performed on 08.01.2019

As worst cases the Ping/Pong communication with ZigBee stick powered by 120V~ / 60 Hz was found and documented in this report.

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz
acc. FCC PART 15.107 (a) Class B
ICES-003



Ref.-No.: 18/11-0061
Product: Transm./Receiv.Sys
Sample: 07
Date: 8 Jan 2019
Operator: Gi

Test equipment:
Rohde & Schwarz ESHS 30
Rohde & Schwarz ESH 2-Z5

Connected sets:
Input Voltage 120 V / 60 Hz
AC-Adaptor SUN-1200200

Operating mode:
ZigBee active
Comm. with ping signal
with ZigBee-Stick
Tested on N

RFI suppression parts:

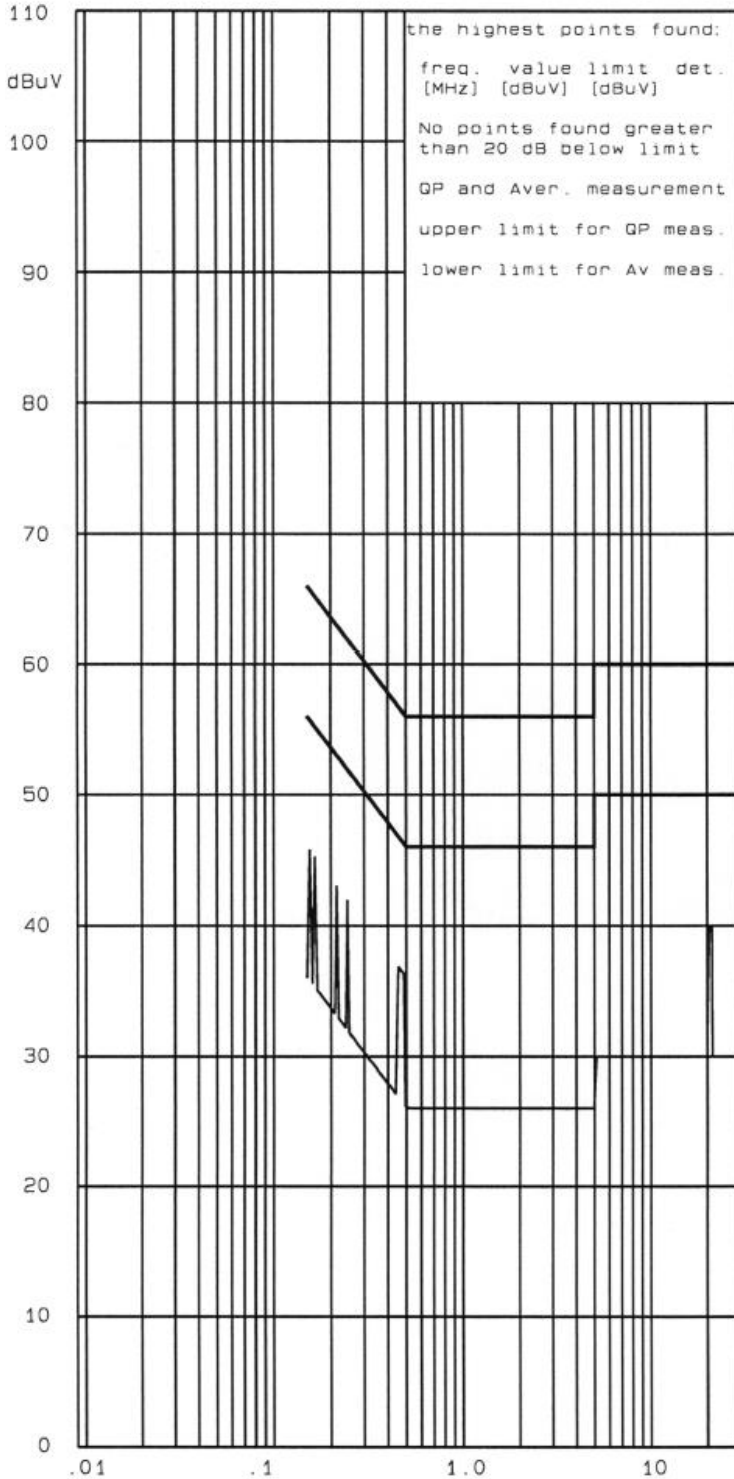
* two dB safety margin for type approval recommended

Result: pass fail

PKM electronic GmbH
Frontenhausen

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz
acc. FCC PART 15.107 (a) Class B
ICES-003



Ref.-No.: 18/11-0061
Product: Transm./Receiv.Sys
Sample: 07
Date: 8 Jan 2019
Operator: Gi

Test equipment:
Rohde & Schwarz ESHS 30
Rohde & Schwarz ESH 2-Z5

Connected sets:
Input Voltage 120 V / 60 Hz
AC-Adaptor SUN-1200200

Operating mode:
ZigBee active
Comm. with ping signal
with ZigBee-Stick
Tested on L1

RFI suppression parts:

* two dB safety margin for
type approval recommended

Result: pass fail

PKM electronic GmbH
Frontenhausen

The six highest emissions for each port (L/N)/detector are as following:

Frequency [MHz]	Reading of test receiver [dB μ V]	Detector	Port	loss of cable between LISN and test receiver [dB]	LISN correction [dB]	AC power line conducted emission [dB μ V]	Limit [dB μ V]	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
-/-	-/-	QP	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	N	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	QP	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	L1	0.10	0.10	-/-	-/-	Pass
-/-	-/-	AV	L1	0.10	0.10	-/-	-/-	Pass

- (1) = test frequency
- (2) = Reading of test receiver in dB μ V without correction factors
- (3) = used detector
- (4) = tested port Phase (live, L1) or Neutral (N)
- (5) = loss of cable between LISN and test receiver in dB
- (6) = correction factor of LISN in dB
- (7) = Reading of test receiver [dB μ V] (2) + loss of cable between Line impedance stabilisation network (LISN) and test receiver (dB) (5) + LISN correction [dB] (6)
- (8) = relevant limit in dB μ V
- (9) = comparison between Limit [dB μ V] (7) / (8) and AC power line conducted emission [dB μ V]

Result 0.15 MHz – 30 MHz

All emissions in the frequency range 0.15 MHz – 30 MHz are at least 20 dB below the relevant limit.

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 that have 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 specify 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.

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. 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 in the EUT is 2.480 GHz.

Test conditions and configuration of EUT

The EUT was configured and operated under following operation modes:

1. Ping/Pong communication with ZigBee stick
2. Continues Tx
3. EUT continues Tx (802.11b 20MHz) / ZigBee active communication with PING/PONG

During test the EUT was operated as specified in the user manual of the EUT. For frequencies below 1000 MHz the EUT was placed on a 80 cm and for frequencies above 1000 MHz the RF Transmitter modul 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.

As worst cases the mode. No. 2 with Ping/Pong communication with ZigBee and the mode No. 3 with continues Tx (802.11b 20MHz) / ZigBee active communication with PING/PONG powered by 120V~ / 60 Hz was found and documented in this report.

Remarks:

-Correction factor included antenna factor and cable attenuation.
 -In the frequency range 1 GHz – 7 GHz the Band Reject Filter 2,4 GHz (ID11243) was used to attenuate the fundamental emission.

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.209 Radiated emission limits
 -RSS-Gen issue 05 section 8.9

Requirements

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

Frequency MHz	Limits [μ V/m] Quasi-peak	Limits [dB μ V/m] Quasi-peak	Limits [μ V/m] Average	Limits [dB μ V/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. RSS-Gen issue 05 section 8.9

Frequency MHz	Limits [μ A/m] Quasi-peak	Limits [dB μ A/m] Quasi-peak	Limits [μ A/m] Average	Limits [dB μ A/m] Average	Test distance [m]
0.009 – 0.090	-/-	-/-	6.37/F (kHz)	-3 – -23.0	300
0.090 - 0.110	6.37/F (kHz)	-23.0 – -24.7	-/-	-/-	300
0.110 – 0.490	-/-	-/-	6.37/F (kHz)	-24.7 – -37.7	300
0.490 - 1.705	63.7/F (kHz)	-17.7 – -28.5	-/-	-/-	30
1.705 - 30.0	0.08	-22	-/-	-/-	30

acc. e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.209 Radiated emission limits and RSS-Gen issue 05 section 8.9

Frequency MHz	Limits [μ V/m] Quasi-peak	Limits [dB μ V/m] Quasi-peak	Limits [μ V/m] Average	Limits [dB μ V/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	54	3

Measurements

The Measurement was performed on: 10.01.2019, 30.01.2020 and 01.04.2020

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 was corrected to the test distance of 3 m using a factor of 40 dB/decade.

All emissions in the frequency range 9 kHz – 30 MHz are at least 20 dB below the relevant limit.

Result 30 MHz – 1000 MHz

Operation Mode: Mode No.: 2 with Ping/Pong communication with ZigBee stick

Ref.-No.: 18/11-0061
 Product: TRANS.-/REC.-SYSTEM
 Sample: 07 (#18)
 Date: 10 Jan 2019
 Operator: BL

Test equipment:
 Rohde & Schwarz ESYS
 CHASE CBL 6111

Connected sets:
 INPUT VOLTAGE: 120V/50Hz

Operating mode:
 Zigbee ACTIVE
 COMMUNICATION WITH PING/PONG
 VIA Zigbee STICK

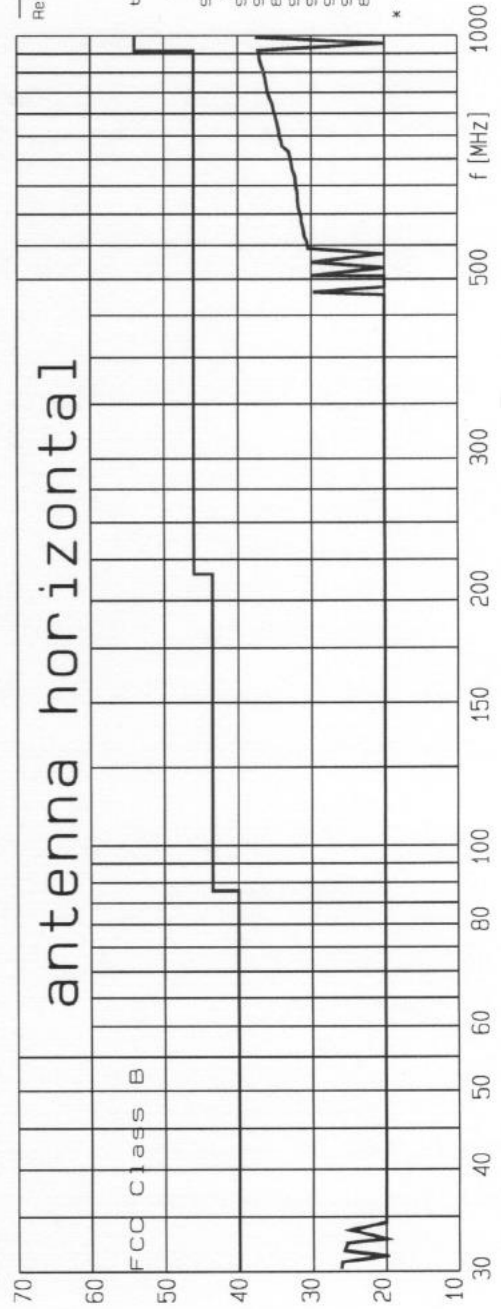
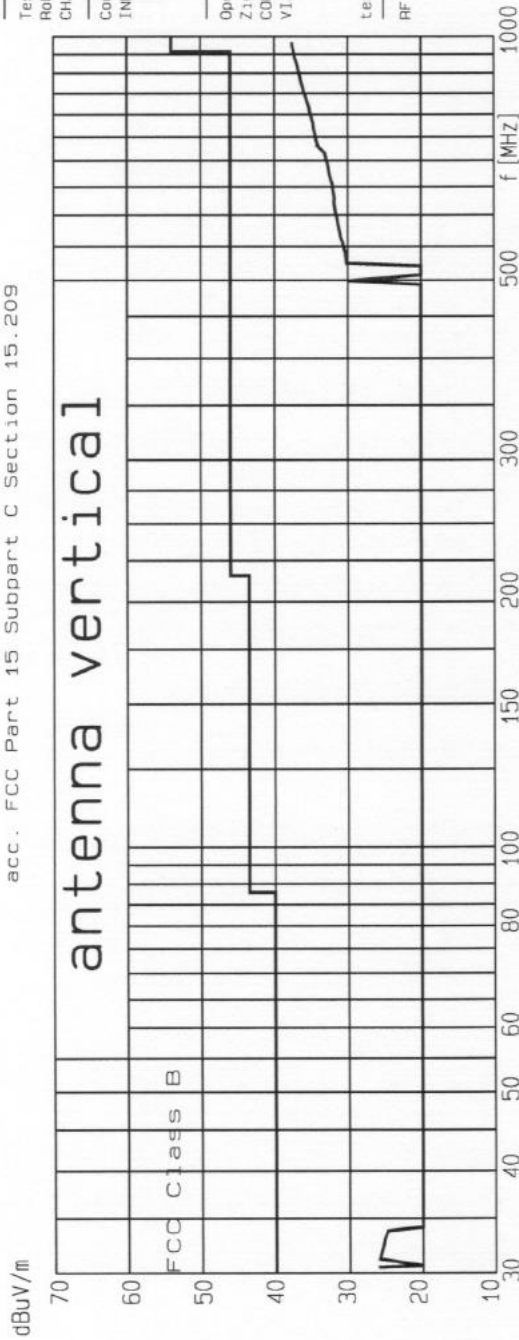
test distance 3m

RFI suppression parts:

IT 5/6

STC Germany GmbH

Interference Radiation 30 MHz – 1000 MHz
 acc. FCC Part 15 Subpart C Section 15.209



Result: pass fail

the highest points found:

freq. [MHz]	tested dBuV/m	limit dBuV/m	pol. h/v
950.04	37.29	46	v
937.6	37.16	46	v
913.72	36.77	46	v
916.52	36.77	46	v
889.24	36.47	46	v
957.96	37.19	46	h
947.48	37.1	46	h
931.52	37.02	46	h
913.24	36.69	46	h
897.28	36.42	46	h

* - IF ANY MEANS: EMISSION NOT COUNTED FOR JUDGEMENT

The six highest emissions for each polarization (H/V) in the frequency range 30 MHz – 1000 MHz are as following:

Frequency [MHz]	Detector	Antenna polarization	Radiated emission [dB μ V/m]	Radiated emission [μ V/m]	Limit [dB μ V/m] (3 m)	Limit [μ V/m] (3 m)	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
950,04	QP	V	37,29	73,20	46,00	200	Pass
937,60	QP	V	37,16	72,11	46,00	200	Pass
913,72	QP	V	36,77	68,94	46,00	200	Pass
916,52	QP	V	36,77	68,94	46,00	200	Pass
889,24	QP	V	36,47	66,60	46,00	200	Pass
-/-	QP	V	-/-	-/-	-/-	-/-	-/-
957,96	QP	H	37,19	72,36	46,00	200	Pass
947,48	QP	H	37,10	71,61	46,00	200	Pass
931,52	QP	H	37,02	70,96	46,00	200	Pass
913,24	QP	H	36,69	68,31	46,00	200	Pass
897,28	QP	H	36,42	66,22	46,00	200	Pass
-/-	QP	H	-/-	-/-	-/-	-/-	-/-

- (1) = test frequency
- (2) = used detector - quasi peak (QP), peak, average (AV)
- (3) = polarization of the test antenna (Horizontal/Vertical)
- (4) = Reading of test receiver [dB μ V] + correction factor
- (5) = $10^{((\text{Radiated emission [dB}\mu\text{V/m] (5)})/20)}$
- (6) = relevant limit in dB μ V/m
- (7) = relevant limit in μ V/m
- (8) = comparison between Limit [dB μ V/m] (6) and Radiated emission [dB μ V/m] (4)

Operation Mode: Mode No.: 3 with 802.11b 20MHz / ZigBee active communication with PING/PONG

Ref.-No.: 18/11-0061
 Product: TRANS.-/REC.-SYSTEM
 Sample: 07 (#1B)
 Date: 10 Jan 2019
 Operator: BL

Test equipment:
 Rohde & Schwarz ESVS
 CHASE CBL 6111

Connected sets:
 INPUT VOLTAGE 120/60Hz

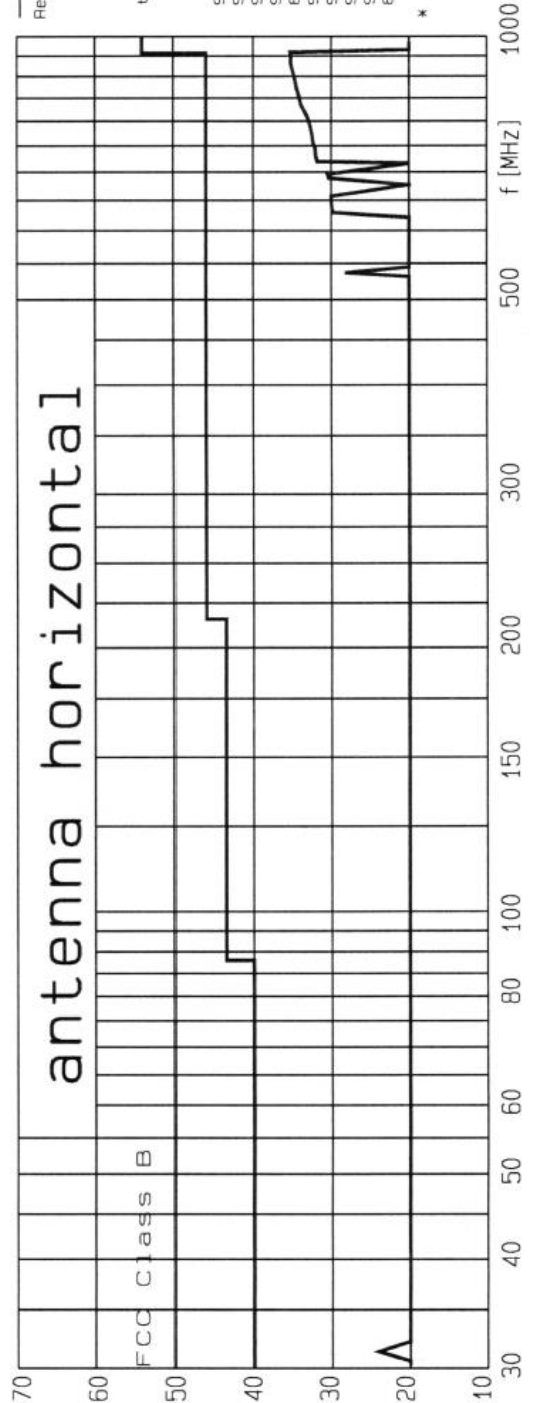
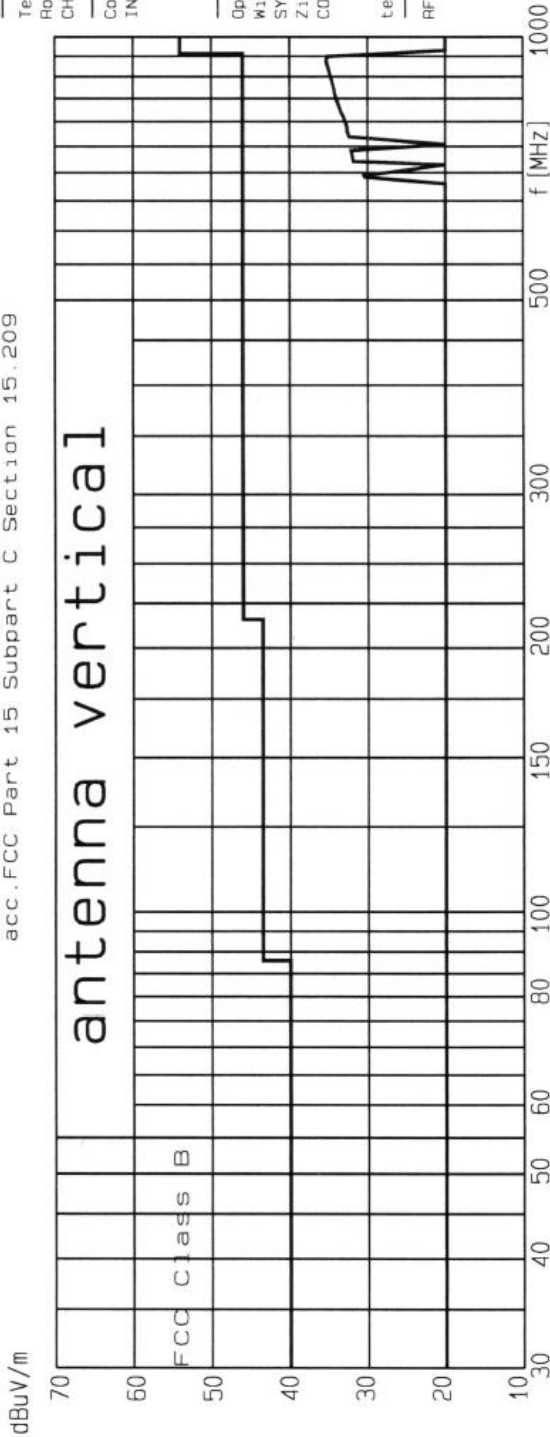
Operating mode:
 WiFi Tx CH.11 802.11b
 SYSTEM BW 20MHz
 Zigbee ACTIVE
 COM. WITH PING/PONG

test distance 3m
 RFI suppression parts:

IT 5/6

Interference Radiation 30 MHz - 1000 MHz
 acc.FCC Part 15 Subpart C Section 15.209

STC Germany GmbH



Result: pass fail ()

the highest points found:

freq. [MHz]	tested dBuV/m	limit dBuV/m	pol. h/v
937.16	35.32	45	v
949.12	35.16	45	v
922.12	35.08	45	v
902.64	34.82	45	v
890.32	34.6	45	v
958.76	35.26	45	h
931.08	35.19	45	h
944.76	35.17	45	h
908.24	34.87	45	h
886.64	34.58	45	h

* - IF ANY MEANS: EMISSION NOT COUNTED FOR JUDGEMENT

The six highest emissions for each polarization (H/V) in the frequency range 30 MHz – 1000 MHz are as following:

Frequency [MHz]	Detector	Antenna polarization	Radiated emission [dB μ V/m]	Radiated emission [μ V/m]	Limit [dB μ V/m] (3 m)	Limit [μ V/m] (3 m)	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
937.16	QP	V	35.32	58.34	46.00	200	Pass
949.12	QP	V	35.16	57.28	46.00	200	Pass
922.12	QP	V	35.08	56.75	46.00	200	Pass
902.64	QP	V	34.82	55.08	46.00	200	Pass
890.32	QP	V	34.60	53.70	46.00	200	Pass
-/-	QP	V	-/-	-/-	-/-	-/-	-/-
958.76	QP	H	35.26	57.94	46.00	200	Pass
931.08	QP	H	35.19	57.48	46.00	200	Pass
944.76	QP	H	35.17	57.35	46.00	200	Pass
908.24	QP	H	34.87	55.40	46.00	200	Pass
886.64	QP	H	34.58	53.58	46.00	200	Pass
-/-	QP	H	-/-	-/-	-/-	-/-	-/-

- (1) = test frequency
- (2) = used detector - quasi peak (QP), peak, average (AV)
- (3) = polarization of the test antenna (Horizontal/Vertical)
- (4) = Reading of test receiver [dB μ V] + correction factor
- (5) = $10^{((\text{Radiated emission [dB}\mu\text{V/m] (5)})/20)}$
- (6) = relevant limit in dB μ V/m
- (7) = relevant limit in μ V/m
- (8) = comparison between Limit [dB μ V/m] (6) and Radiated emission [dB μ V/m] (4)

Mode No.: 3 with 802.11b 20MHz / ZigBee active communication with PING/PONG



IT 5/6
Interference radiation
according to FCC §15.209 RSS-Gen



Ref.-No.: 18/11-0061

Product: Transmitting/Receiving System

Sample: 07 (#18)

Date: 01.04.2020

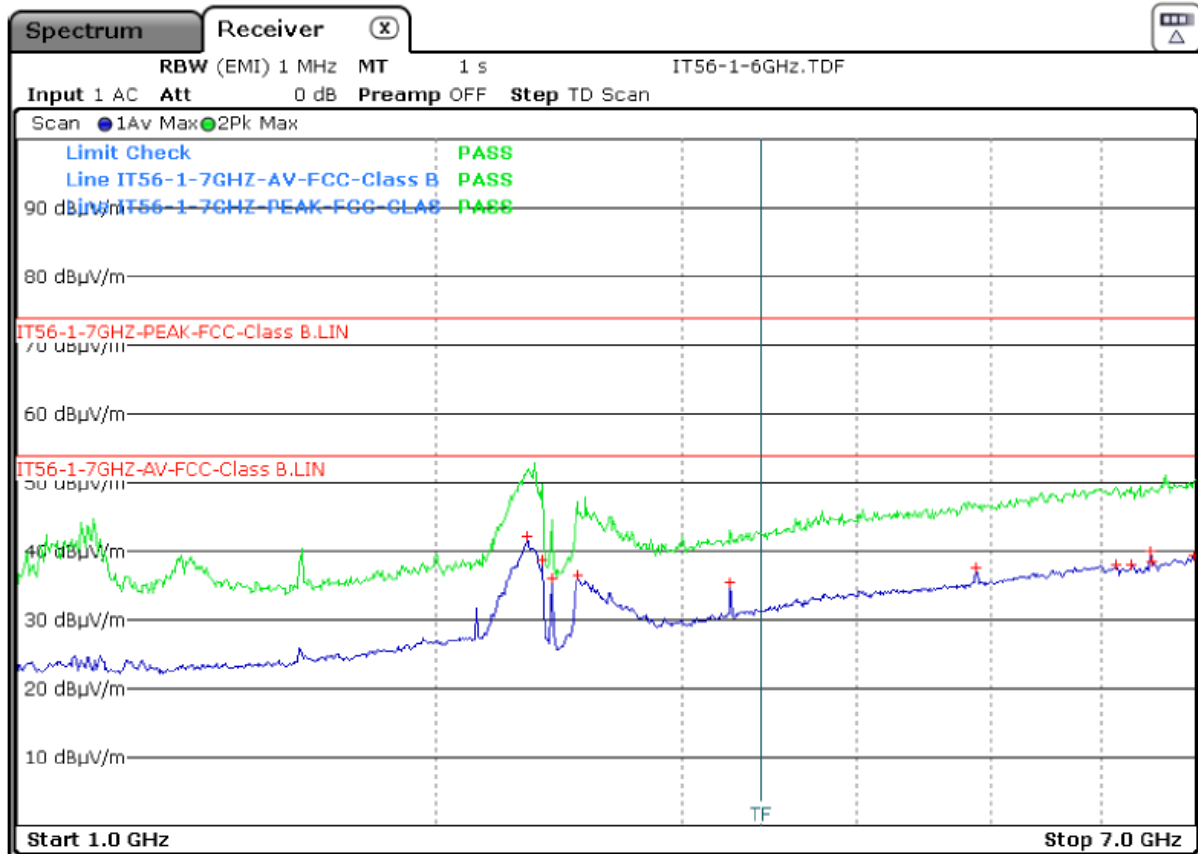
Operator: BI

pass fail

Remarks: All cables connected; Input Voltage System 24V/DC

Result:

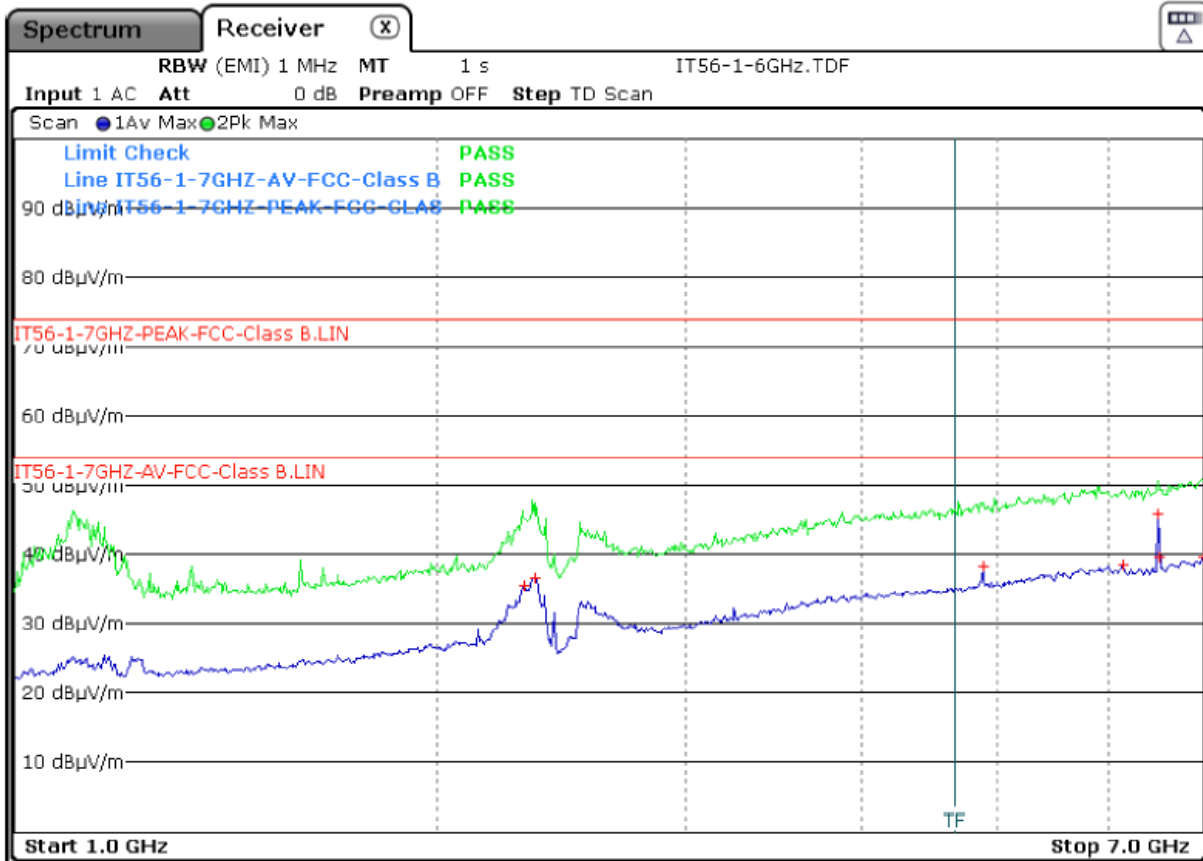
Operation mode: Tx Wifi (802.11b 20MHz/CH11 – 2462MHz); Zigbee (Communication with ping/pong)
Band Stop Filter 2,4GHz (ID11243) used



Polarisation: V									
Frequ. [GHz]	Detector Average				Detector Peak				
	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
2,3213	42,09	-11,91	54,00	pass	1 - 7	-/-	>20	74,00	pass
6,4988	39,91	-14,09	54,00	pass					
6,9883	39,28	-14,72	54,00	pass					
2,3828	38,74	-15,26	54,00	pass					
6,5118	38,57	-15,43	54,00	pass					
6,1453	37,98	-16,02	54,00	pass					

Ref.-No.: 18/11-0061

Operation mode: Tx Wifi (802.11b 20MHz/CH11 – 2462MHz); Zigbee (Communication with ping/pong)
Band Stop Filter 2,4GHz (ID11243) used



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
6,4988	45,84	-8,16	54,00	pass	1 - 7	--/--	>20	74,00	pass
6,9928	39,57	-14,43	54,00	pass					
6,5120	39,51	-14,49	54,00	pass					
6,1458	38,38	-15,62	54,00	pass					
4,8808	38,36	-15,64	54,00	pass					
2,3463	36,54	-17,46	54,00	pass					

Result 7GHz – 26GHz

All emissions in the frequency range 7 GHz – 26 GHz are at least 20 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 902-928 MHz, 2400-2483,5 MHz and 5725-5850 MHz

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247
-RSS-247 issue 2

7.1. 6 dB DTS Bandwidth Measurement

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 (a) (2)
-RSS-247 issue 2 Section 5.2 (a)

Limit

The minimum 6 dB bandwidth shall be at least 500 kHz.

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

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

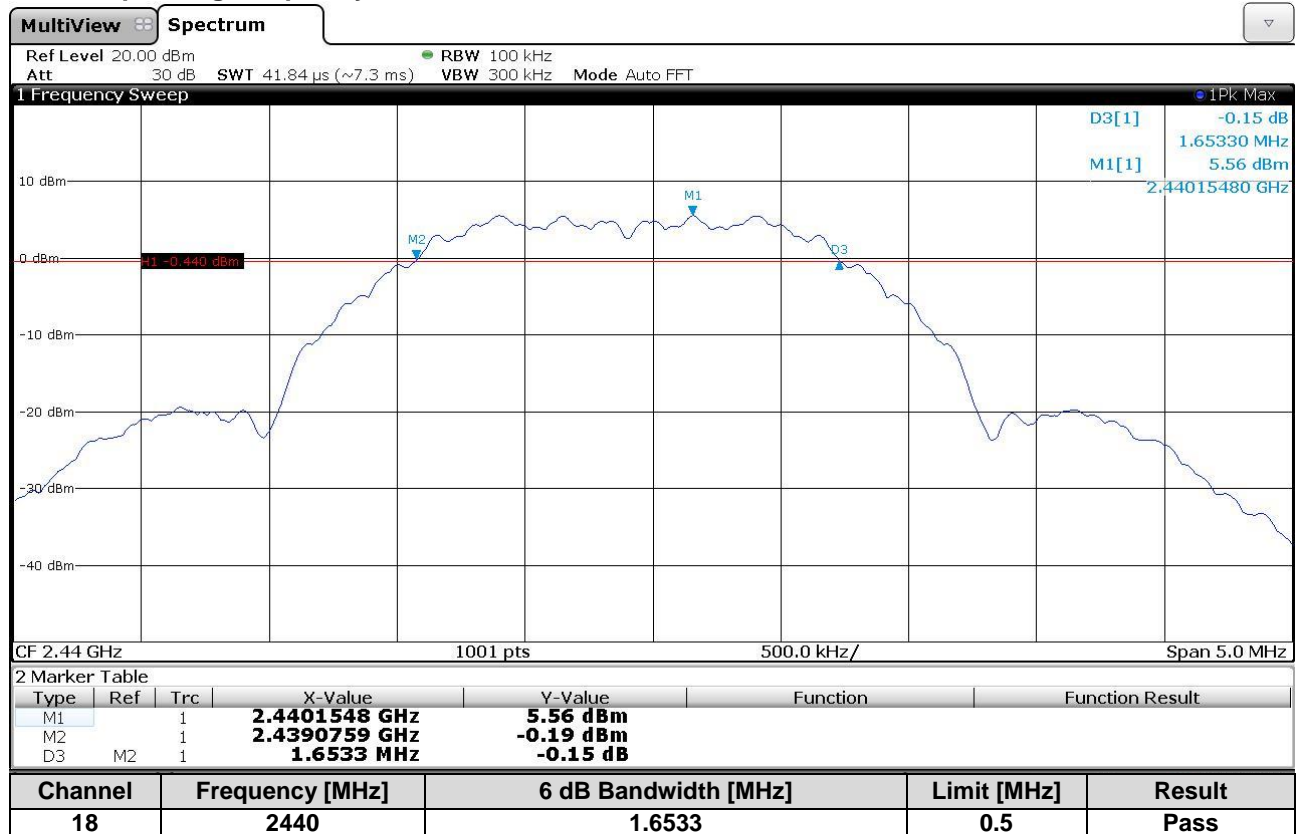
Measurement

The Measurement was performed on: 03.02.2020

Lowest operating frequency



Middle Operating Frequency



Highest Operating Frequency



Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **6 dB Bandwidth**.

7.2. Output Power of Fundamental Emissions

Maximum Conducted Output Power

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 (b) (3)
-RSS-247 Issue 2 section 5.4 (d)

Limits for Peak Output Power of Fundamental (EIRP)

The maximum peak conducted output power of the intentional radiator shall not exceeded: 1 Watt
As an alternative to the maximum peak conducted output power the (average) output power is measured to show compliance to the limit.

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.

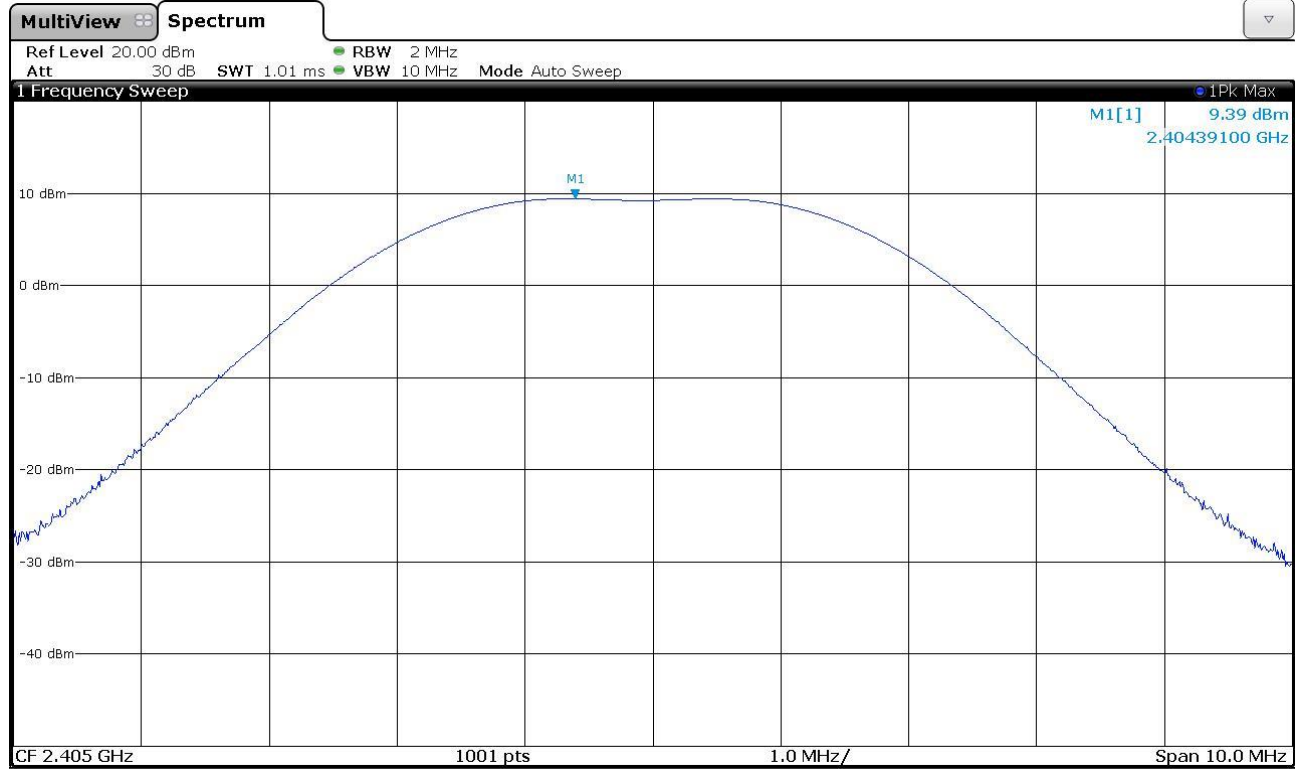
Description

For the conducted measurement, the RF output of the EUT was connected to the Analyzer. All the attenuation or cable loss will be added to the measured maximum output power. The results are recorded in Watt.

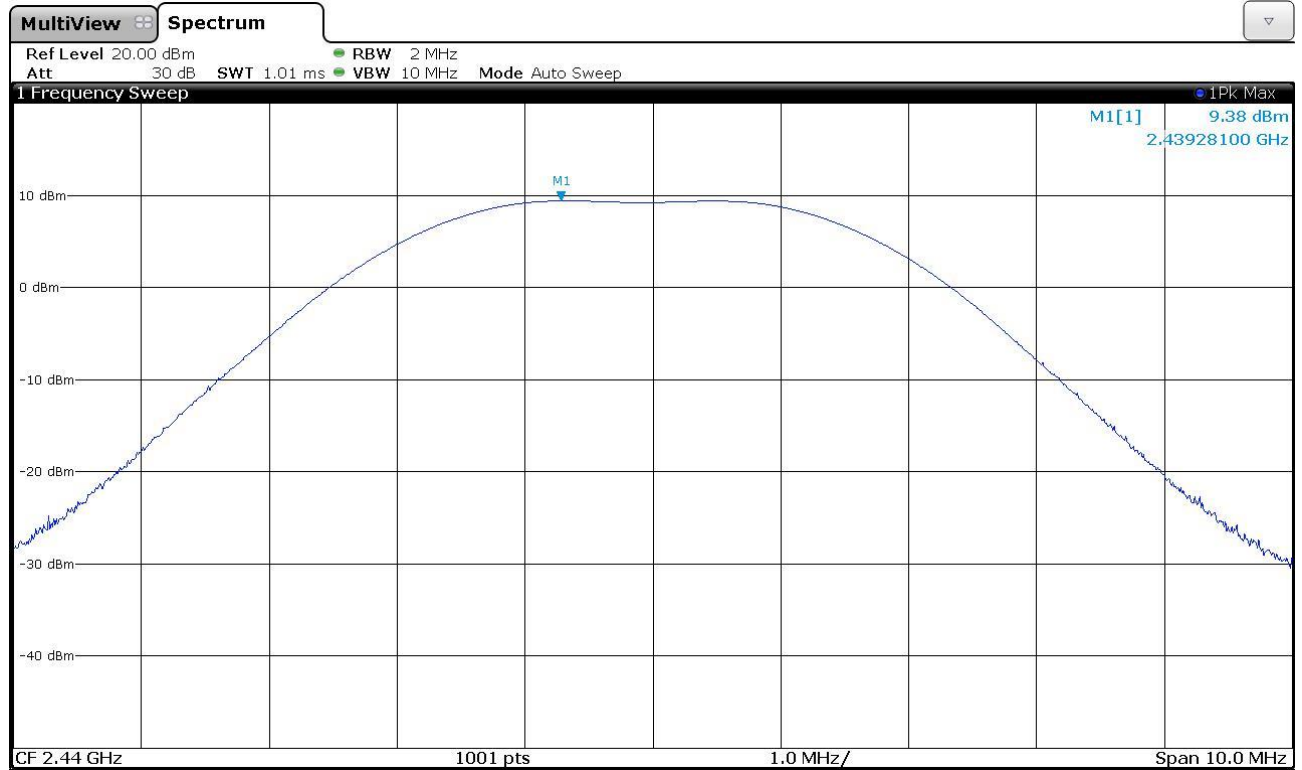
Measurement

The Measurement was performed on: 03.02.2020

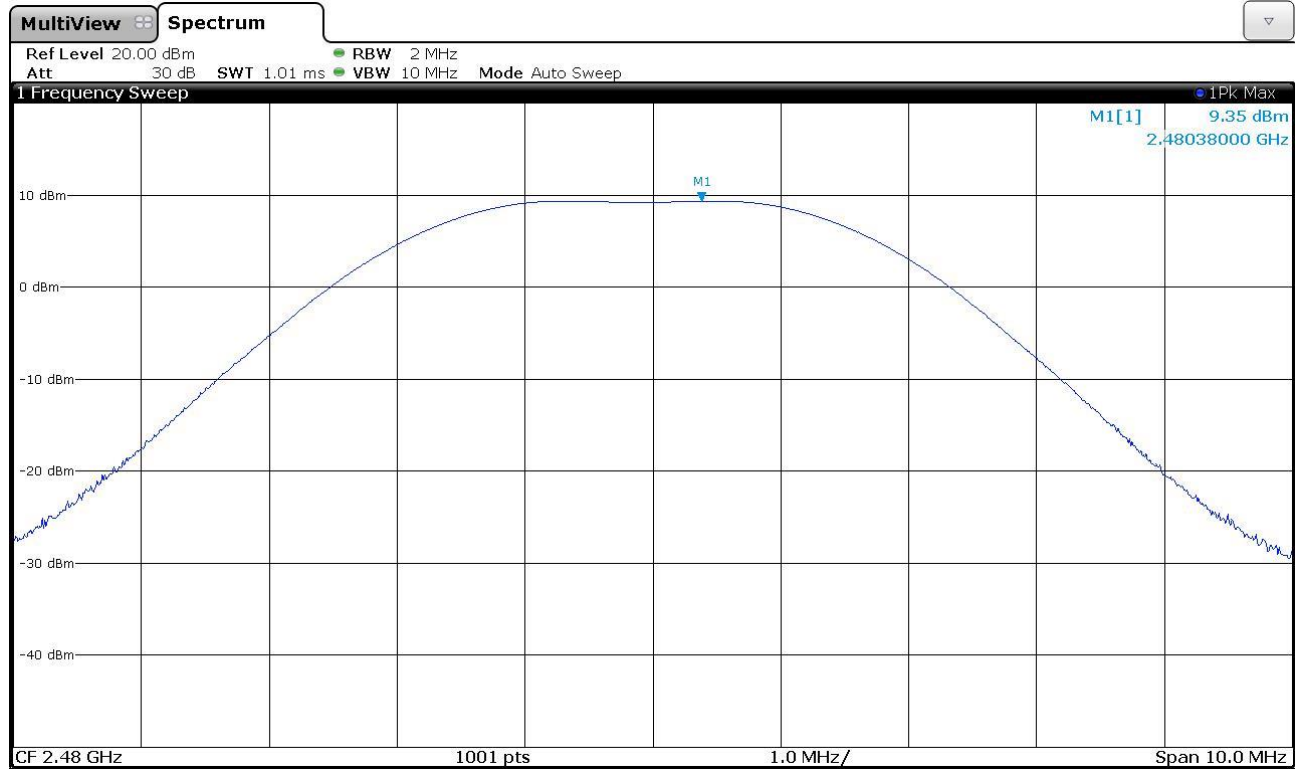
Lowest operating frequency



Middle Operating Frequency



Highest Operating Frequency



Maximum output power conducted measurement:

Channel	Frequency [MHz]	Output Power		Limit		Result
		[dBm]	[mW]	[dBm]	[mW]	
11	2405	9.39	8.69	30	1000	Pass
18	2440	9.38	8.67	30	1000	Pass
26	2480	9.35	8.61	30	1000	Pass

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements of **Output Power of Fundamental Emissions**.

7.3. Power Spectral Density

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 (e)
-RSS-247 issue 2 Section 5.2 (b)

Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

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 maximum peak conducted output power was used to determine compliance to the fundamental output power limit. So the maximum peak conducted PSD level is measured with a peak detector.

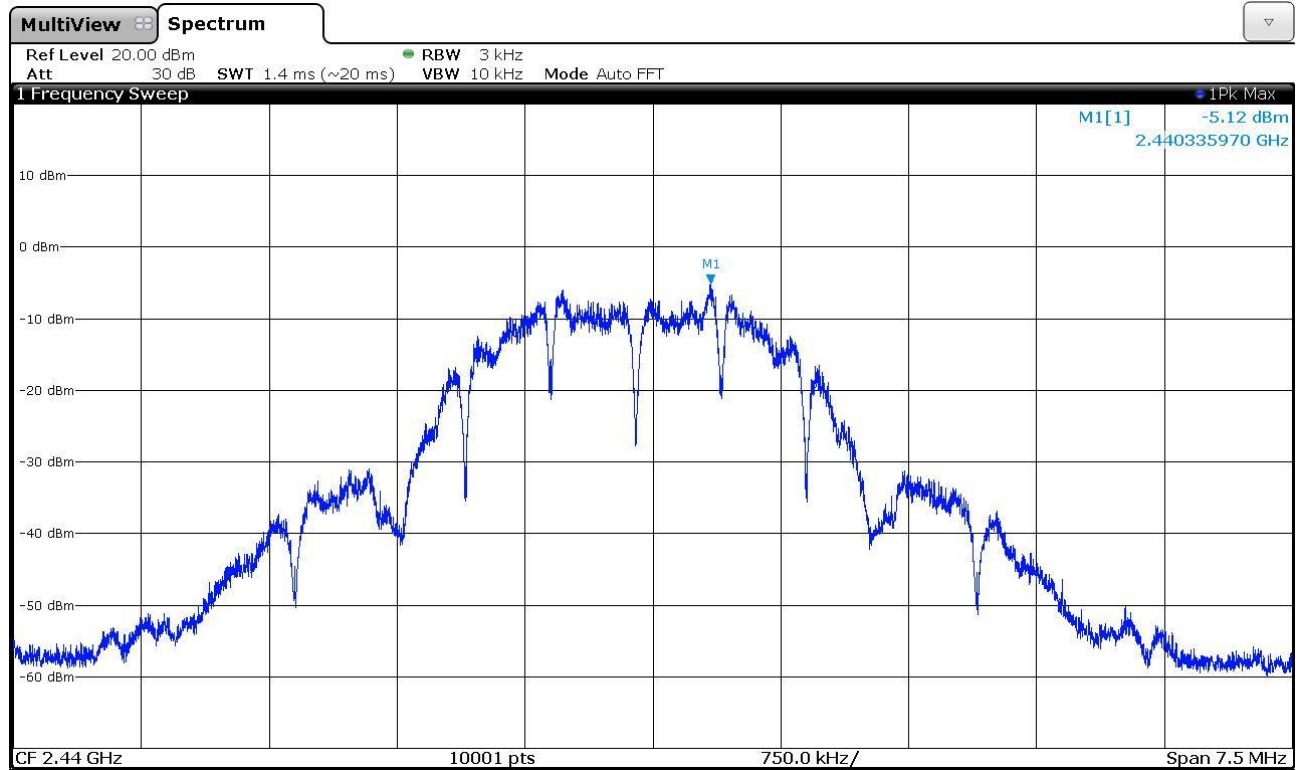
Measurement

The Measurement was performed on: 11.02.2020

Lowest operating frequency



Middle Operating Frequency



Highest Operating Frequency



Maximum power spectral density				
Channel	Frequency [MHz]	Power Spectral Density [dBm / 3 kHz]	Limit [dBm / 3 kHz]	Result
11	2405	-4.91	8	Pass
18	2440	-5.12	8	Pass
26	2480	-5.16	8	Pass

Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **Power Spectral Density**.

7.4. Band-Edges Measurement / Out of Band Emissions

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 (d)
-RSS-247 issue 2 Section 5.5

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 as well as in restricted bands of the RSS-Gen Issue 5 (see Section 8.10 Restricted Frequency Bands) and must also comply with the radiated emission limits specified in §15.209 Radiated emission limits as well as the limits specified in RSS-Gen Table 5.

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

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.

Detector function

For the measurement, an EMI test receiver that have CISPR peak and average detector was used.

Measurement

The Measurement was performed on: 06.04.2020

Higher Band Edge - ZigBee CH. 26 - radiated



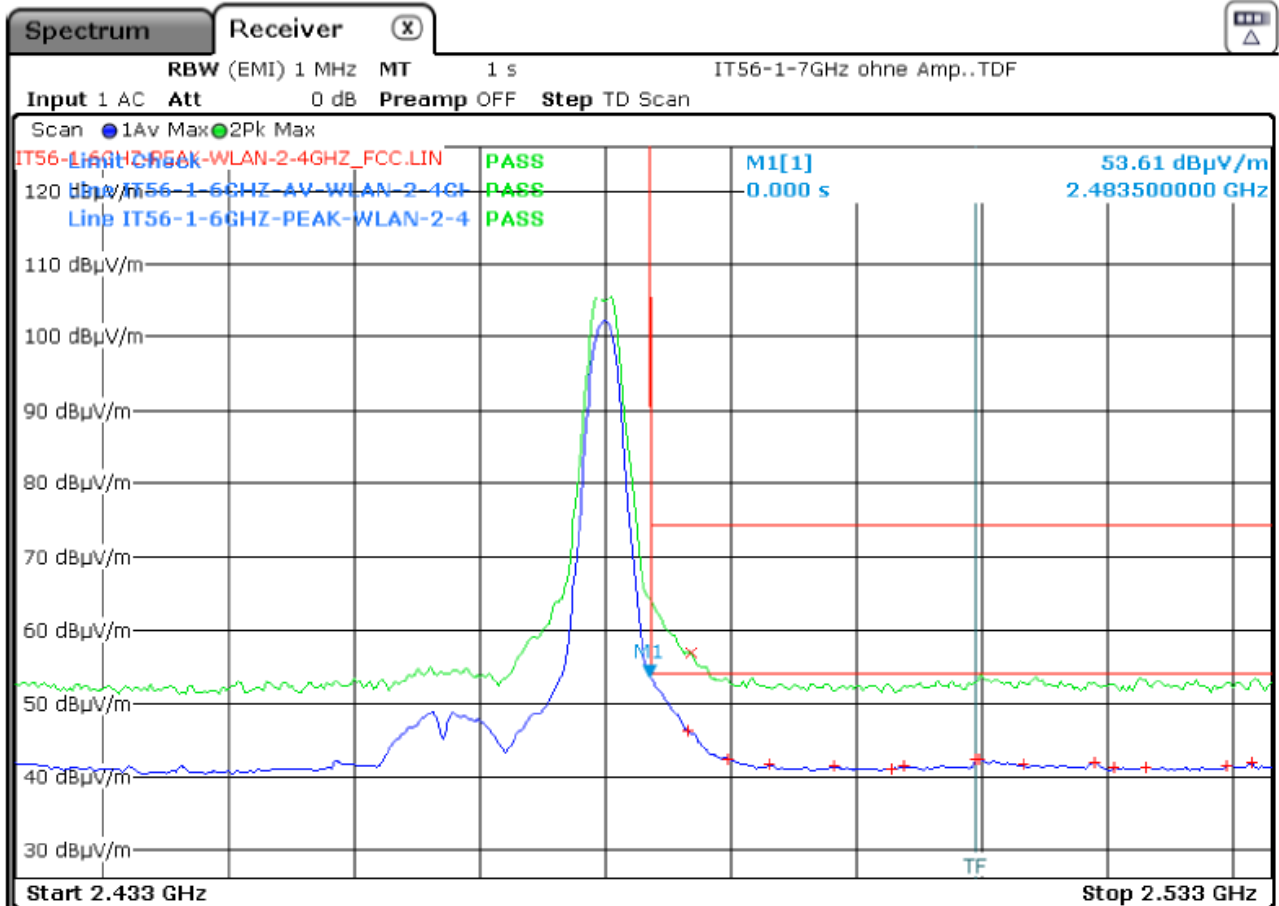
FCC 3
Band edge emission
according to



FCC §15.247, RSS-247, FCC §15.209 RSS-Gen

Ref.-No.: 18/11-0061

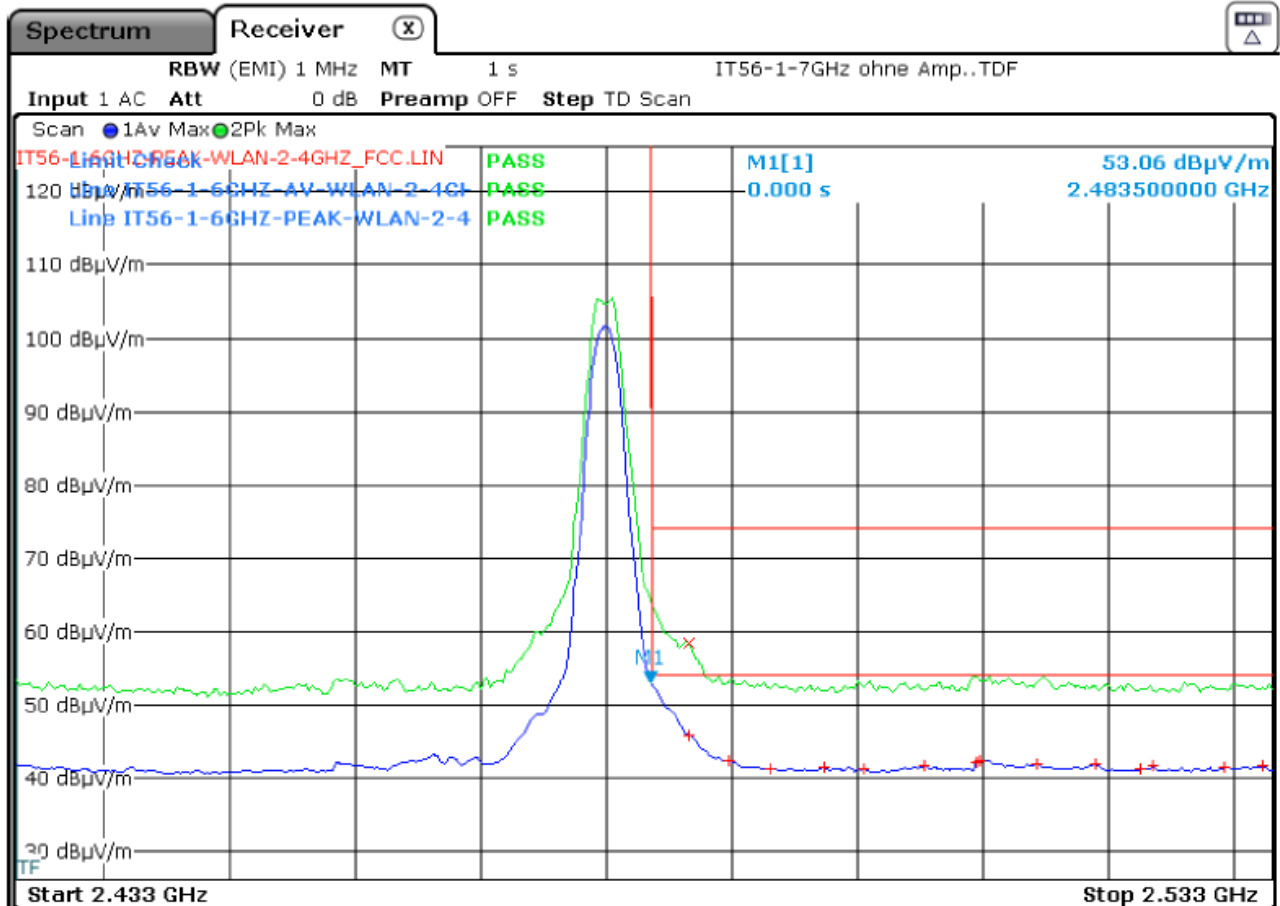
Operation mode: Zigbee CH.26; High edge



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
2,4835	53,61	-0,39	54,00	pass	2,4868	56,82	-17,18	74,00	pass
2,4865	46,22	-7,78	54,00	pass					
2,4898	42,40	-11,60	54,00	pass					
2,5098	42,28	-11,72	54,00	pass					
2,5095	42,21	-11,79	54,00	pass					
2,5190	41,92	-12,08	54,00	pass					

Ref.-No.: 18/11-0061

Operation mode: Zigbee CH.26; 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
2,4835	53,06	-0,94	54,00	pass	2,4865	58,46	-15,54	74,00	pass
2,4865	45,84	-8,16	54,00	pass					
2,5098	42,32	-11,68	54,00	pass					
2,4898	42,27	-11,73	54,00	pass					
2,5095	42,17	-11,83	54,00	pass					
2,5143	41,85	-12,15	54,00	pass					

Higher Band Edge - 802.11n 40MHz / HT MixMode – MCS=0; 6.5 MBps / ZigBee CH 26 - radiated



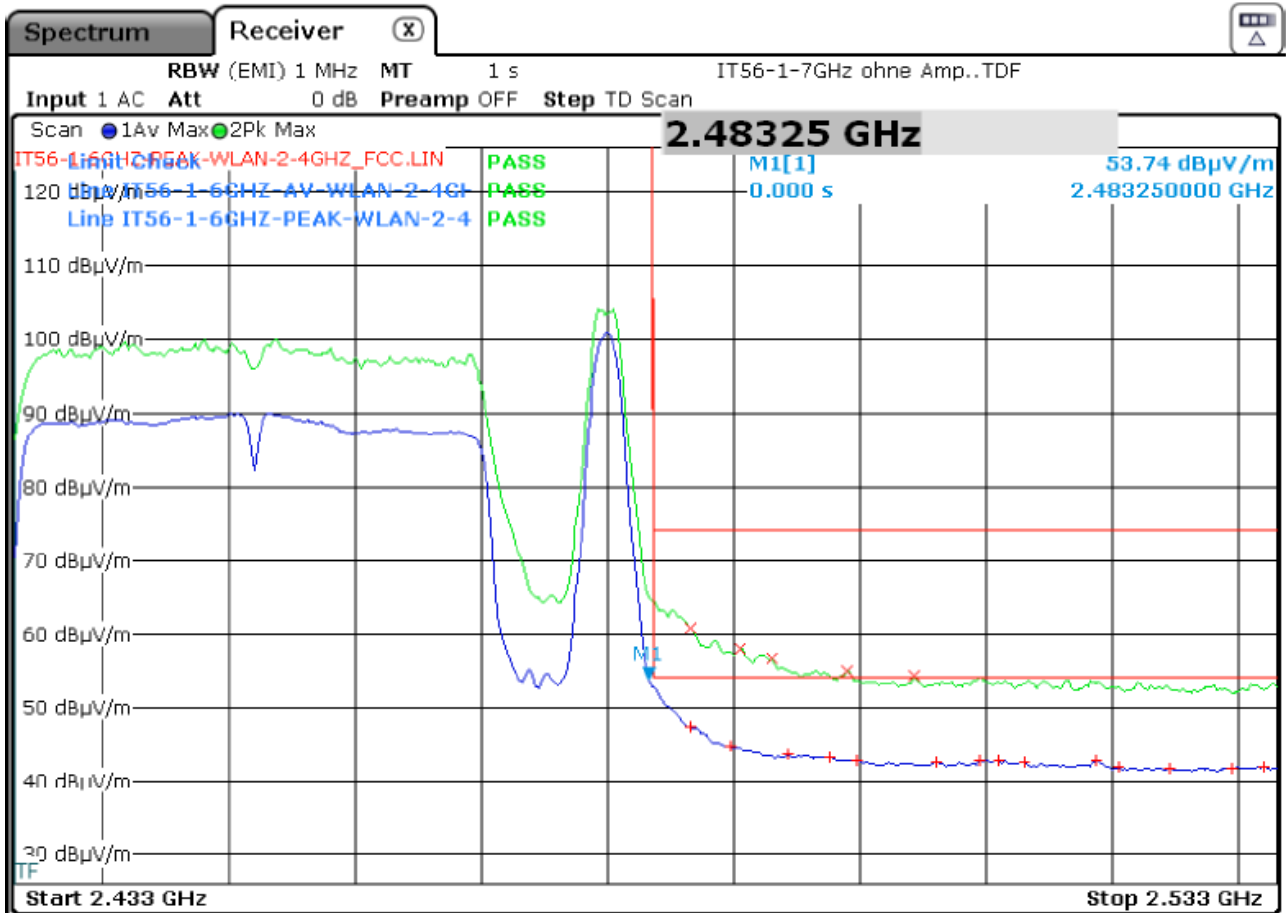
FCC 3
Band edge emission
according to



FCC §15.247, RSS-247, FCC §15.209 RSS-Gen

Ref.-No.: 18/11-0061

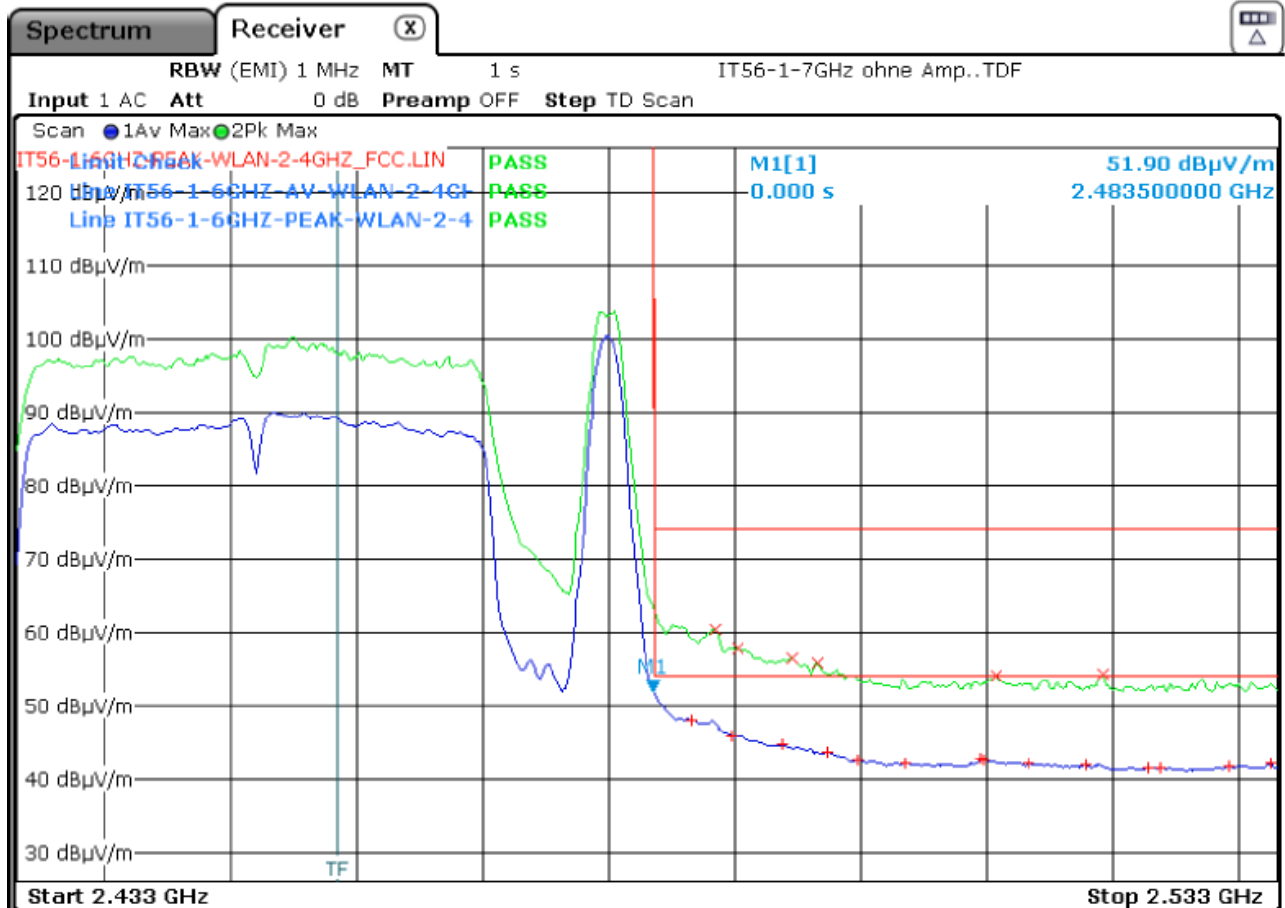
Operation mode: WLAN CH.09; BW = 40MHz; HT Mix Mode; 802.11n40; Power level 1E;
Zigbee CH.26; High edge



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
2,4835	53,74	-0,26	54,00	pass	2,4865	60,81	-13,19	74,00	pass
2,4865	47,25	-6,75	54,00	pass	2,4905	58,00	-16,00	74,00	pass
2,4898	44,64	-9,36	54,00	pass	2,4930	56,56	-17,44	74,00	pass
2,4943	43,59	-10,41	54,00	pass	2,4990	54,94	-19,06	74,00	pass
2,4975	43,22	-10,78	54,00	pass	2,5043	54,16	-19,84	74,00	pass
2,5110	42,70	-11,30	54,00	pass					

Ref.-No.: 18/11-0061

Operation mode: WLAN CH.09; BW = 40MHz; HT Mix Mode; 802.11n40; Power level 1E;
Zigbee CH.26; 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
2,4835	51,90	-2,10	54,00	pass	2,4885	60,38	-13,62	74,00	pass
2,4865	48,02	-5,98	54,00	pass	2,4903	57,78	-16,22	74,00	pass
2,4898	45,85	-8,15	54,00	pass	2,4945	56,41	-17,59	74,00	pass
2,4938	44,65	-9,35	54,00	pass	2,4965	55,71	-18,29	74,00	pass
2,4973	43,69	-10,31	54,00	pass	2,5193	54,16	-19,84	74,00	pass
2,5095	42,64	-11,36	54,00	pass	2,5108	54,07	-19,93	74,00	pass

Lower Band Edge - 802.11n 40MHz / HT MixMode – MCS=0; 6.5 MBps / ZigBee CH 11 - radiated



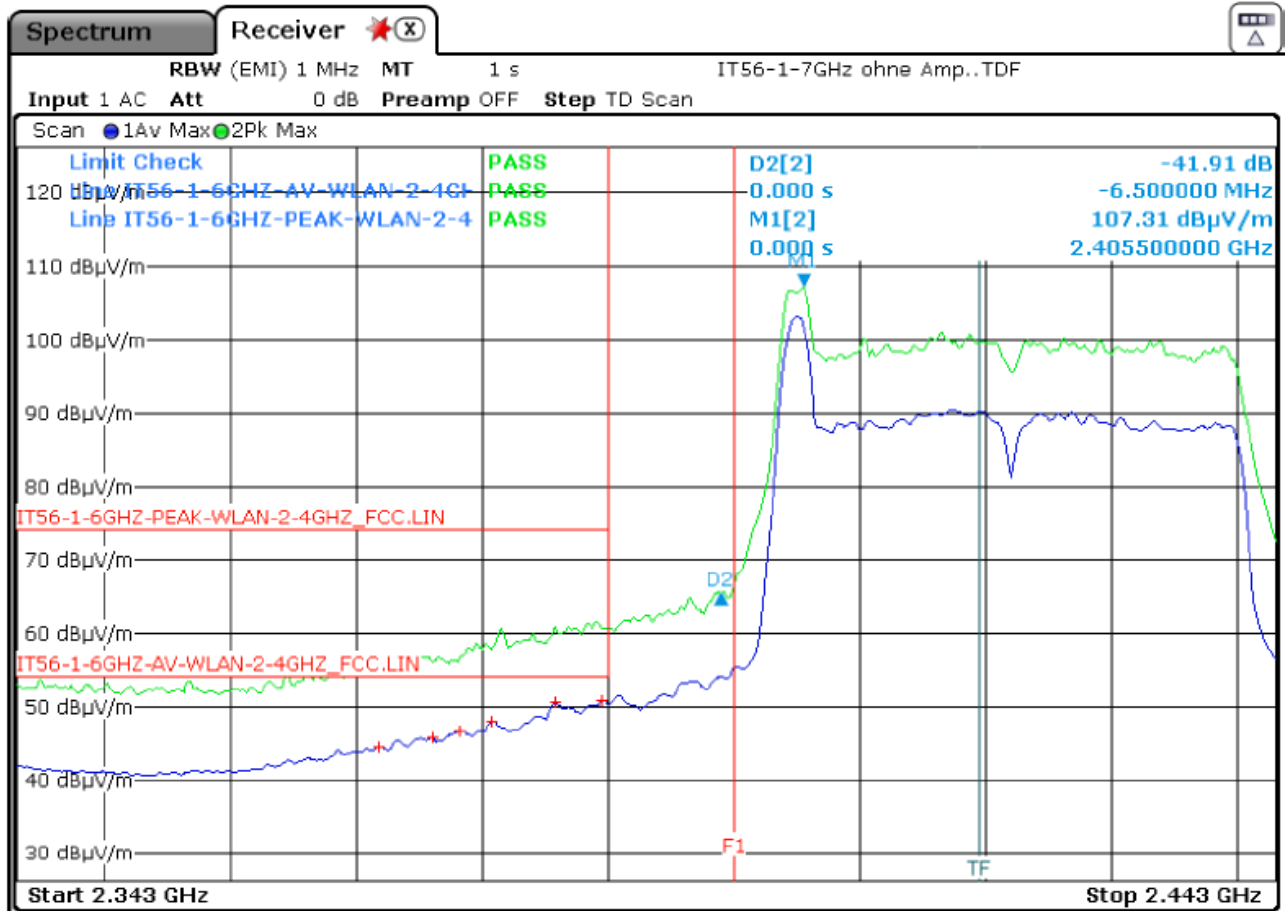
FCC 3
Band edge emission
according to



FCC §15.247, RSS-247, FCC §15.209 RSS-Gen

Ref.-No.: 18/11-0061

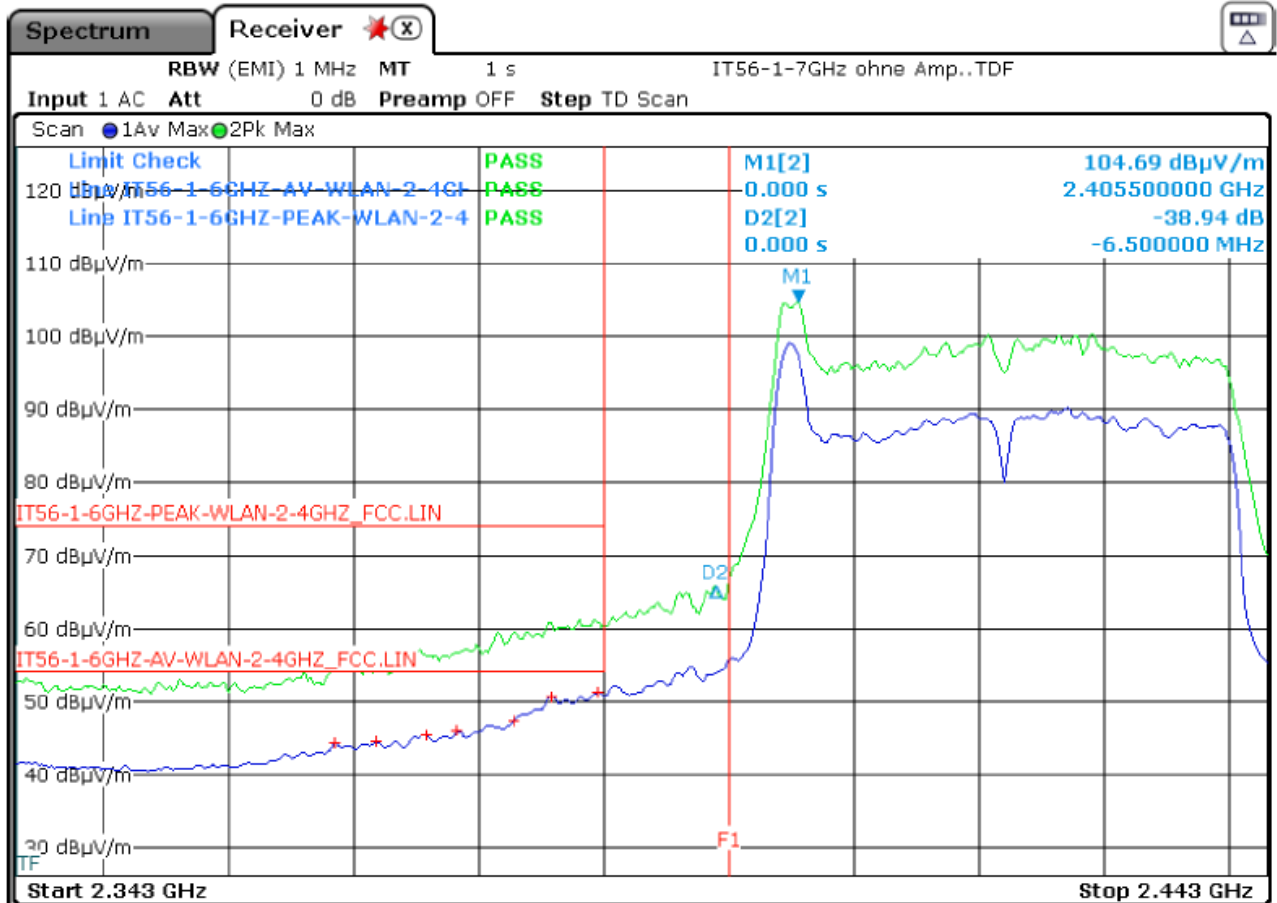
Operation mode: WLAN CH.03; BW = 40MHz; HT Mix Mode; 802.11n40; Power level 1E;
Zigbee CH.11; Low edge



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	50,70	-3,30	54,00	pass	all emissions are 10dB below limit				pass
2,3858	50,54	-3,46	54,00	pass					
2,3808	47,92	-6,08	54,00	pass					
2,3783	46,75	-7,25	54,00	pass					
2,3760	45,77	-8,23	54,00	pass					
2,3718	44,44	-9,56	54,00	pass					

Ref.-No.: 18/11-0061

Operation mode: WLAN CH.03; BW = 40MHz; HT Mix Mode; 802.11n40; Power level 1E;
Zigbee CH.11; 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
2,3895	51,13	-2,87	54,00	pass	all emissions are 10dB below limit				pass
2,3858	50,67	-3,33	54,00	pass					
2,3828	47,23	-6,77	54,00	pass					
2,3783	45,93	-8,07	54,00	pass					
2,3758	45,29	-8,71	54,00	pass					
2,3718	44,38	-9,62	54,00	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**.

7.5. 99% Power Bandwidth

Applied standards

-RSS-Gen issue 5 Section 6.7

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

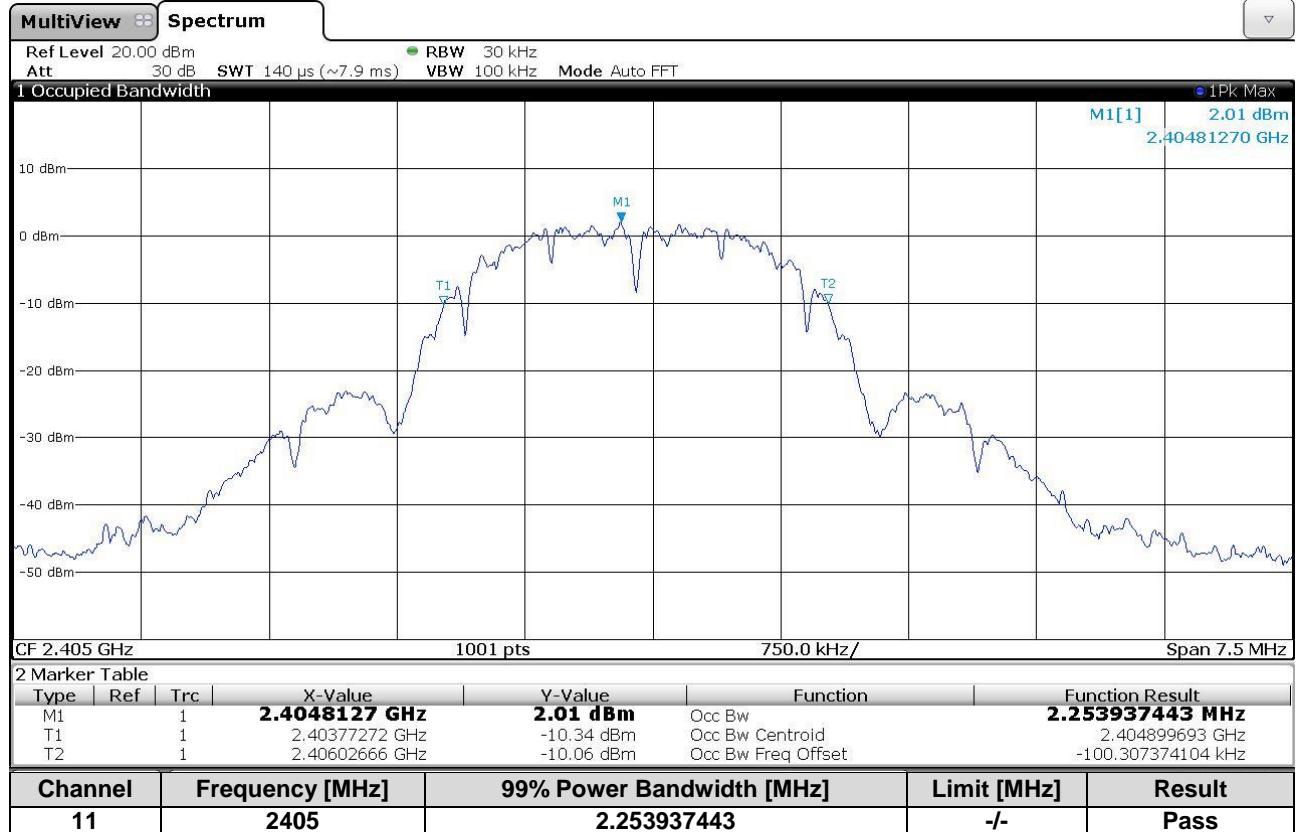
The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

The 99% power bandwidth function of the instrument was used for the measurement.

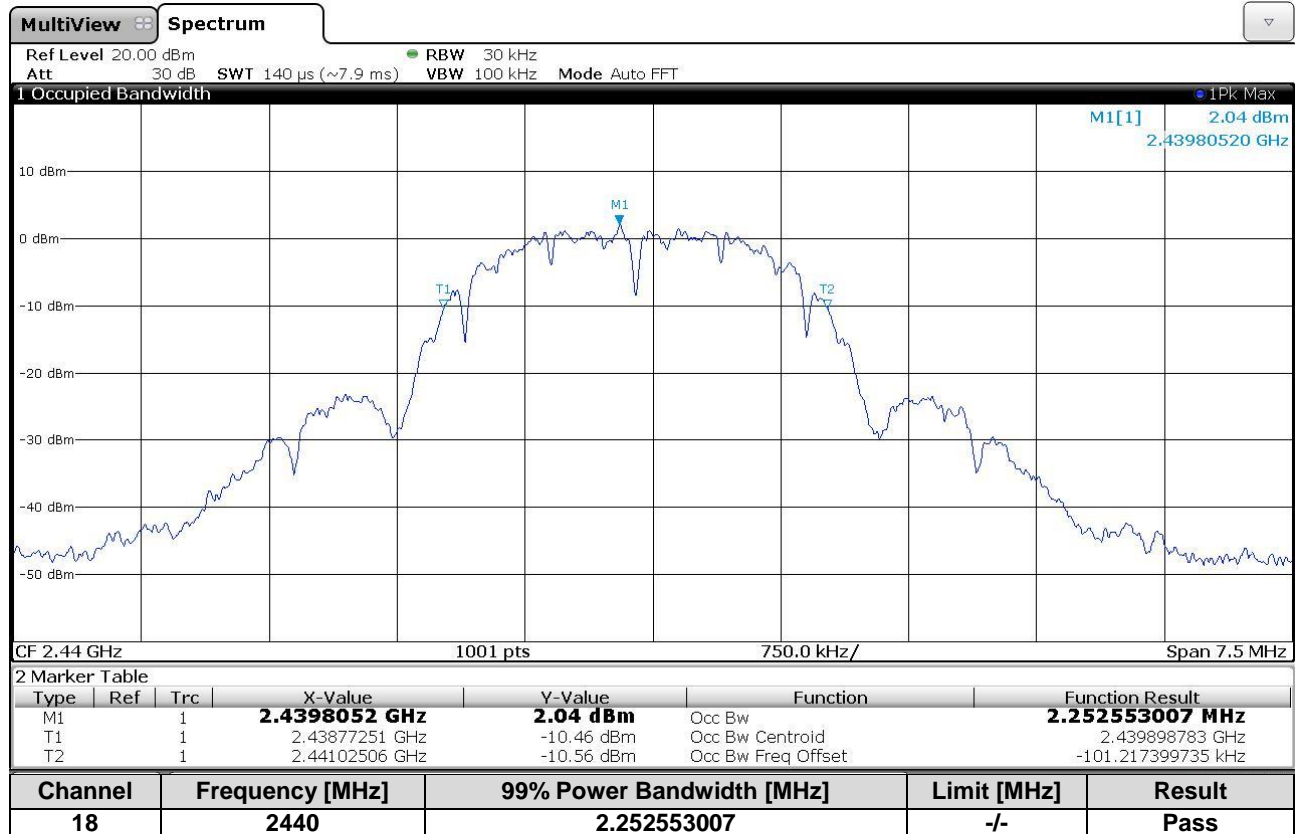
Measurement

The Measurement was performed on: 11.02.2020

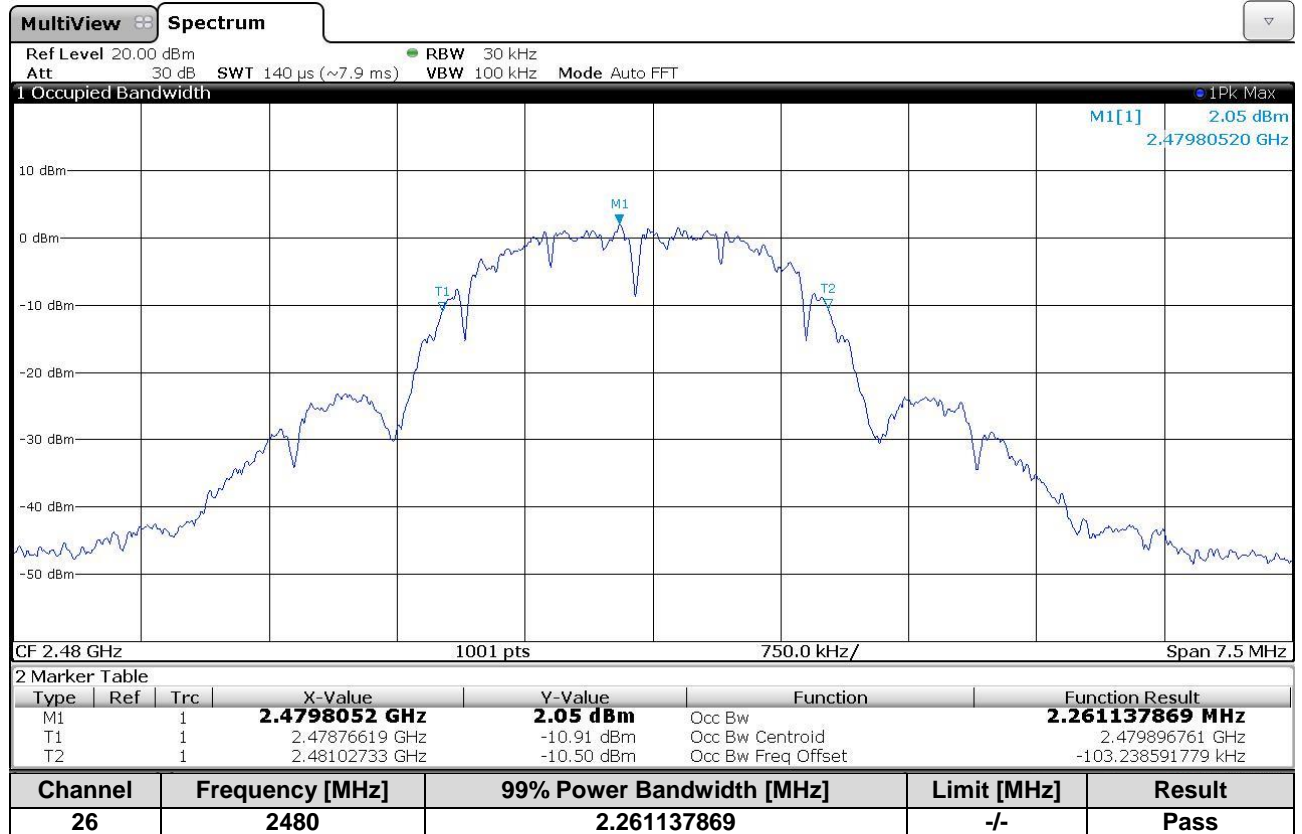
Lowest operating frequency



Middle Operating Frequency



Highest Operating Frequency



Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **99% Power Bandwidth**.

8. 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	2016 – Mar.	3 years
					2019 – Mar.	3 years
Software	PKM	PKM U5/6	-/-	V1.01.03	-/-	-/-
Line impedance stabilisation network (LISN)	Rohde & Schwarz	ESH2-Z5	10139	879675/028	2017 – Okt.	3 years
					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	2017-Mar.	3 years
					2020-April	3 years
Antenna 9 kHz – 30 MHz	EMCO	6502	10546	2018	2017-Nov.	3 years
Antenna 30 MHz – 1 GHz	Chase	CBL6111C	10022	1064	2017-Jan.	2 years
					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	BBHA91706 21	2017-Jan.	2 years
					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	2017 - May	3 years
					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	2016-March	3 years
					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	2016-March	3 years
					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

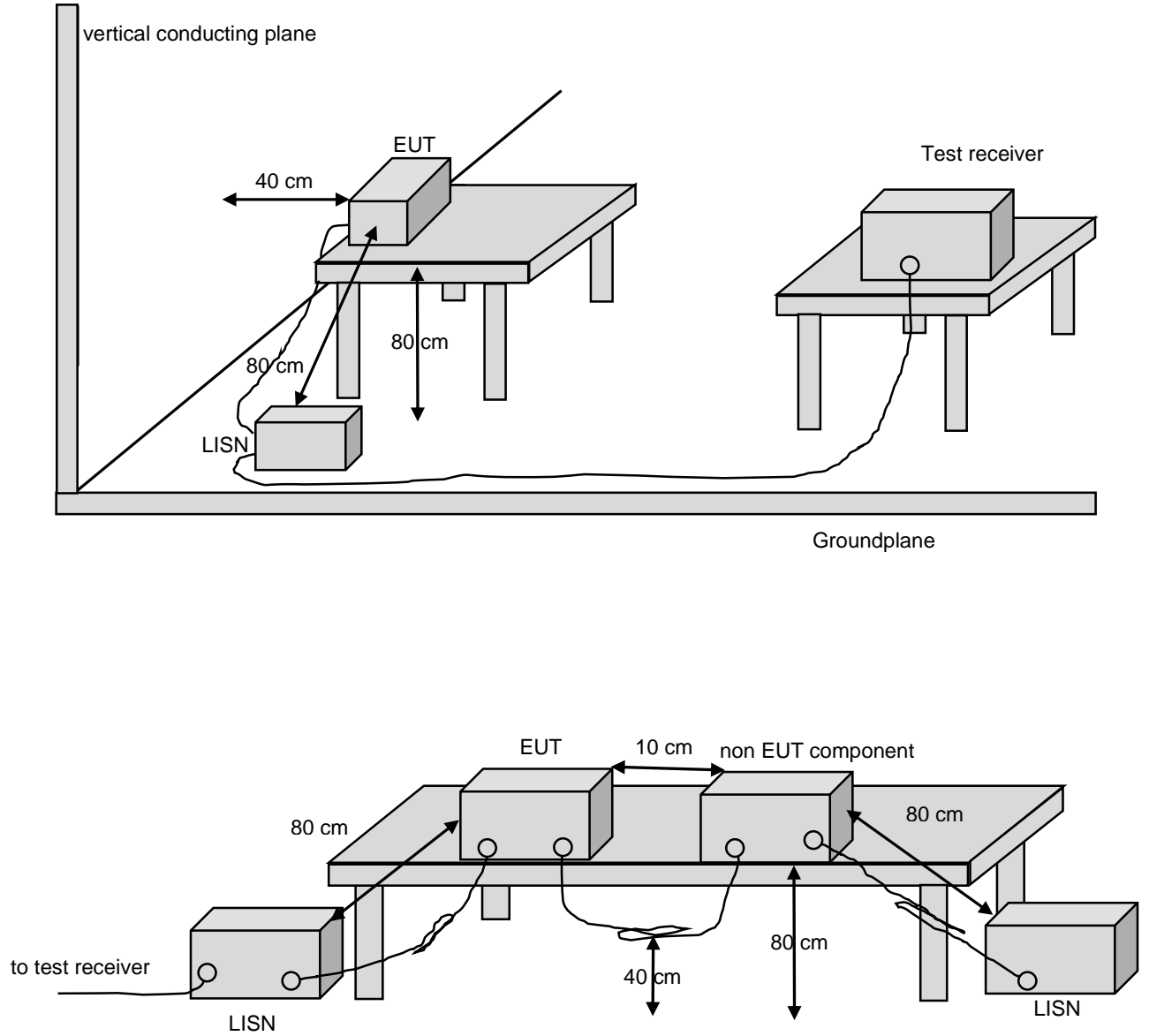
All measurements were made with measuring instruments, including any accessories that may affect test results, calibrated according to the requests of ISO/IEC 17025 according to which the test site is accredited from DAkkS. Measurement of conducted mais emissions was made with instruments conforming to American National Standard Specification, ANSI C63.4-2014.

Test equipment to support EUT functions:

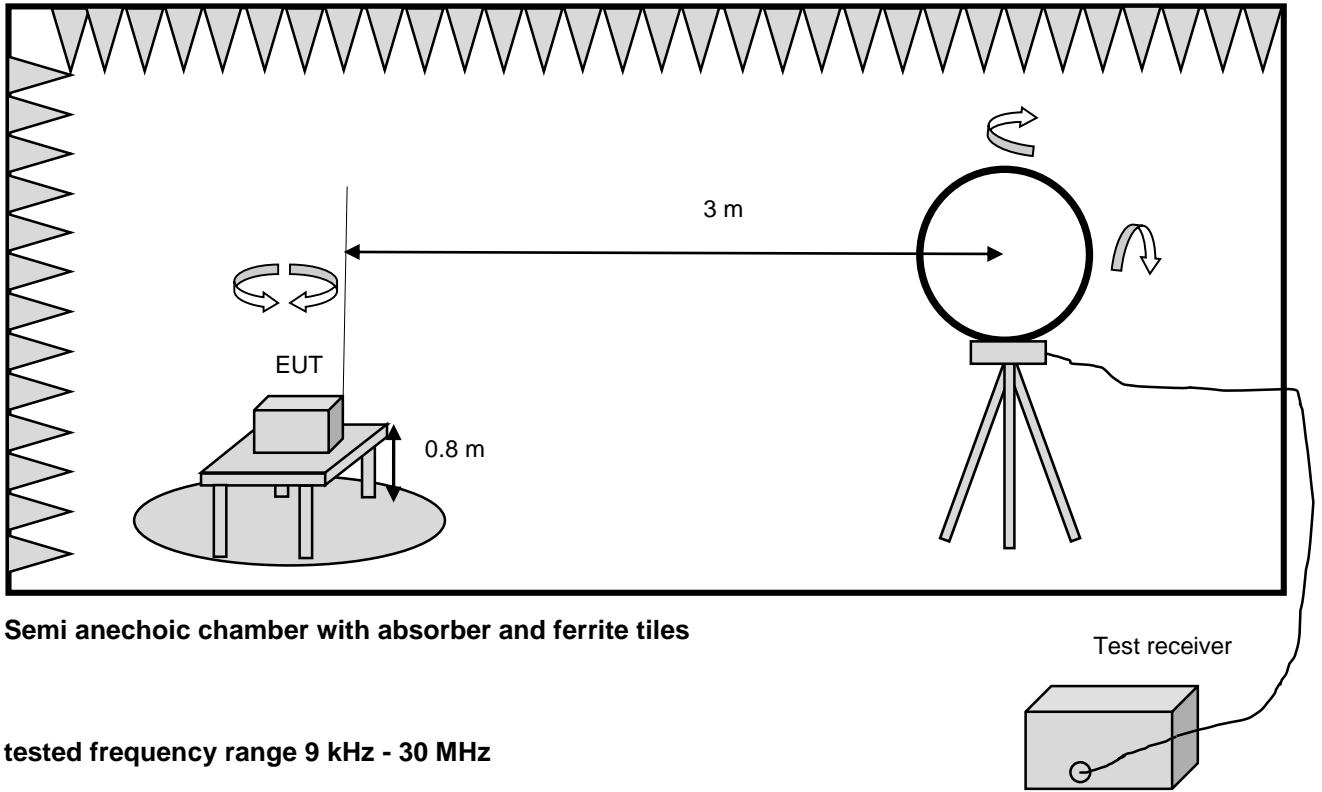
Kind of equipment	Manufacturer	Type	Ident no.
Laptop	HP	EliteBook	11742
AC-Adaptor 120 V ~ / 24 V=	-/-	AC1200200	-/-
Router	AVM	Fritz!Box 4020	Client
ZigBee Stick	-/-	ZM3588S-USB-LR	Client

9. Test Setups

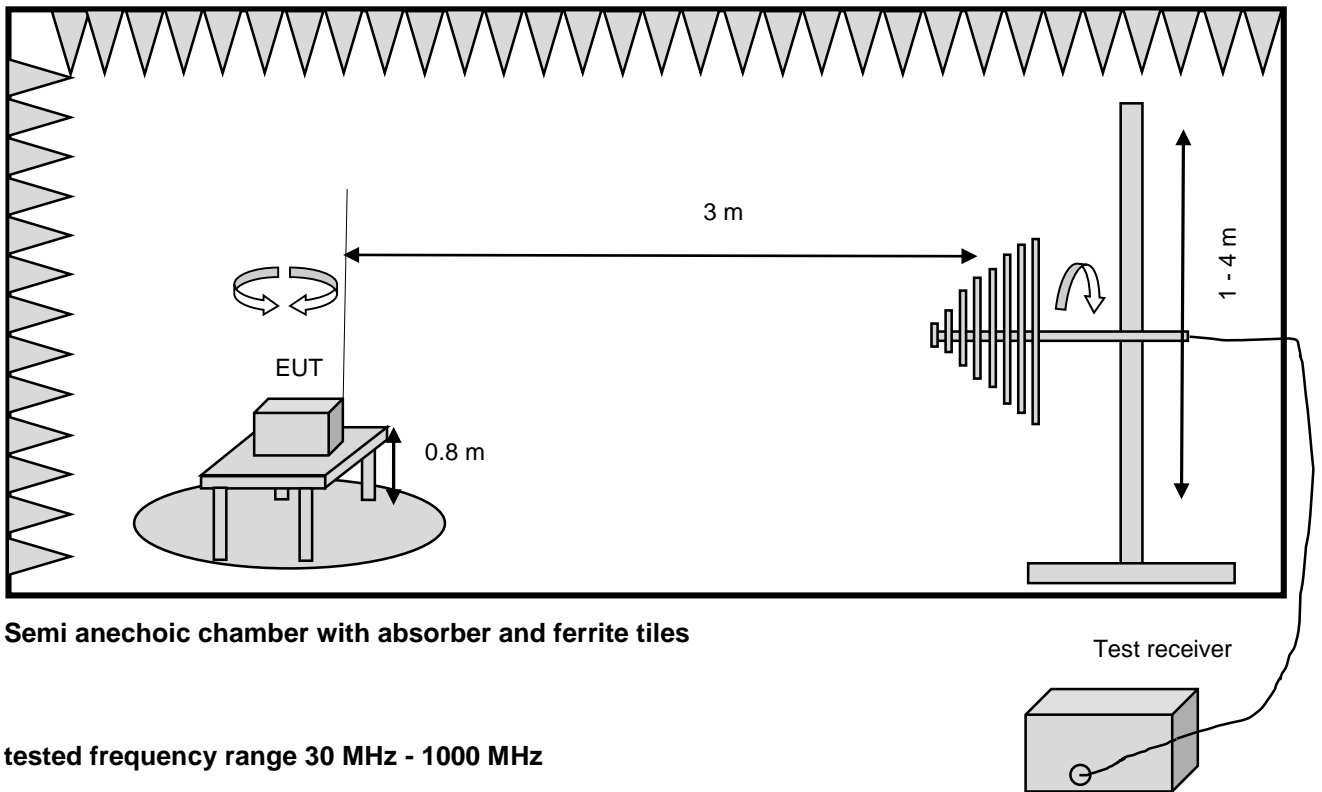
Block diagram Conducted Mains emissions

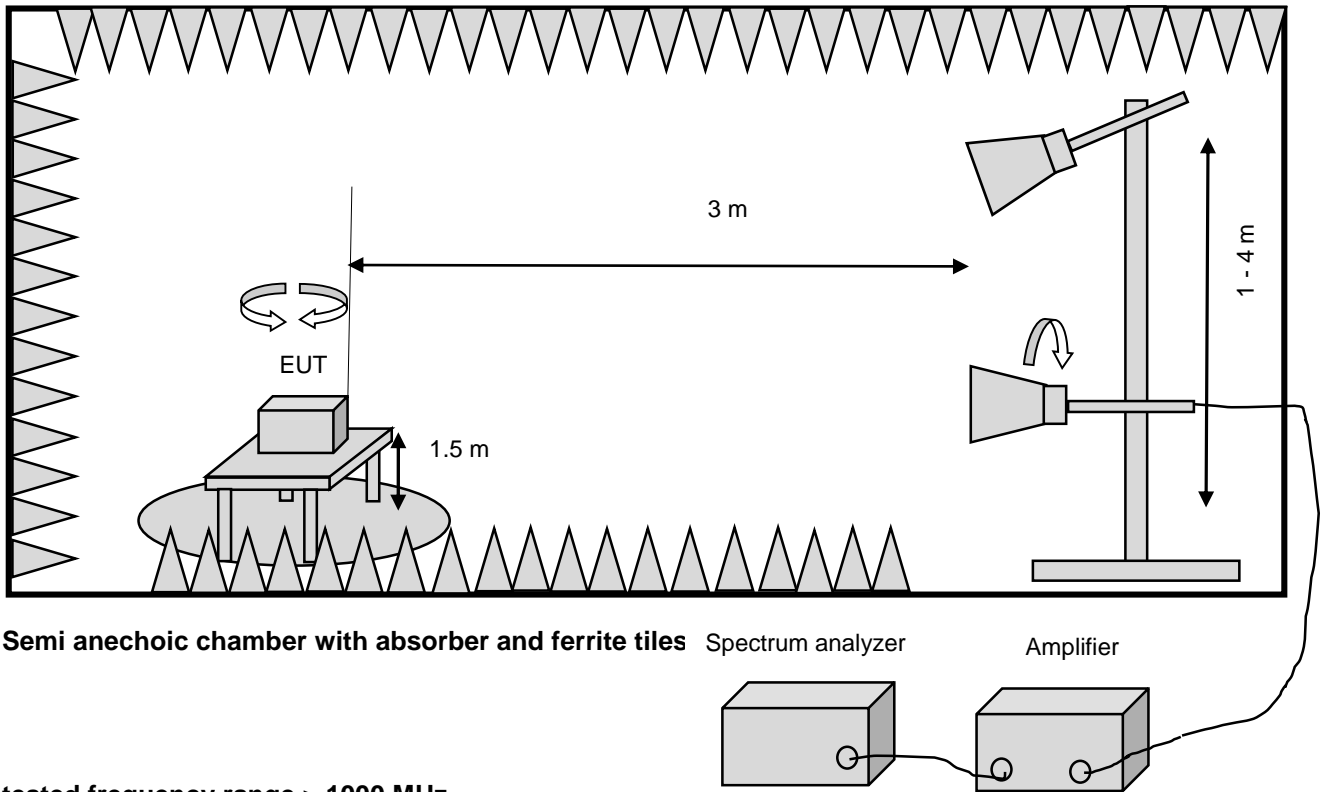


Block diagram Radiated emissions

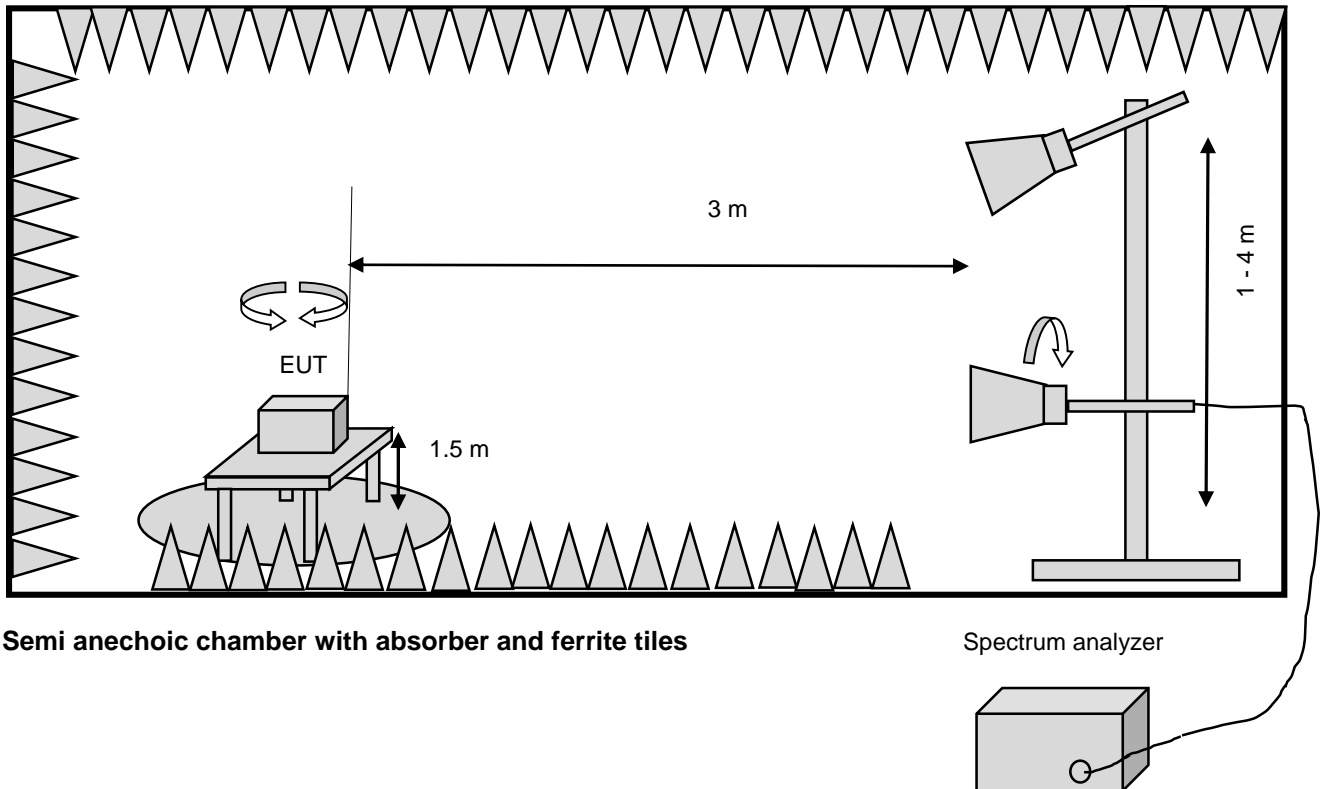


Block diagram Radiated emissions

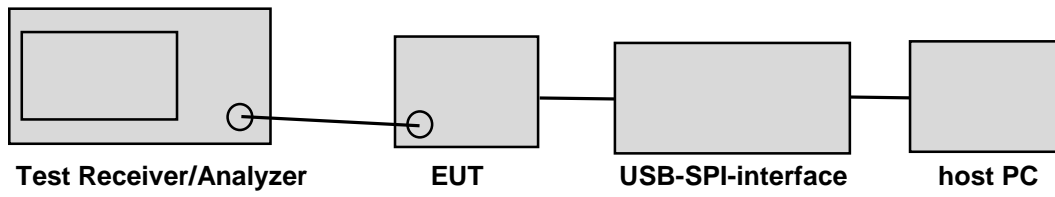




Block diagram Band Edge emissions



Block diagram for conducted measurements



10. 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 % ($k = 2$).

11. Photos setup

Refer to "0061-fcc-ised-photos test setup.pdf" file

12. Conclusions

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the relevant §15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the relevant RSS-247 issue 02 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices.

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

none

25.06.2020
Erstellt am/prepared on

M. Beindl, Laboratory Engineer
(Name/name / Stellung/position)

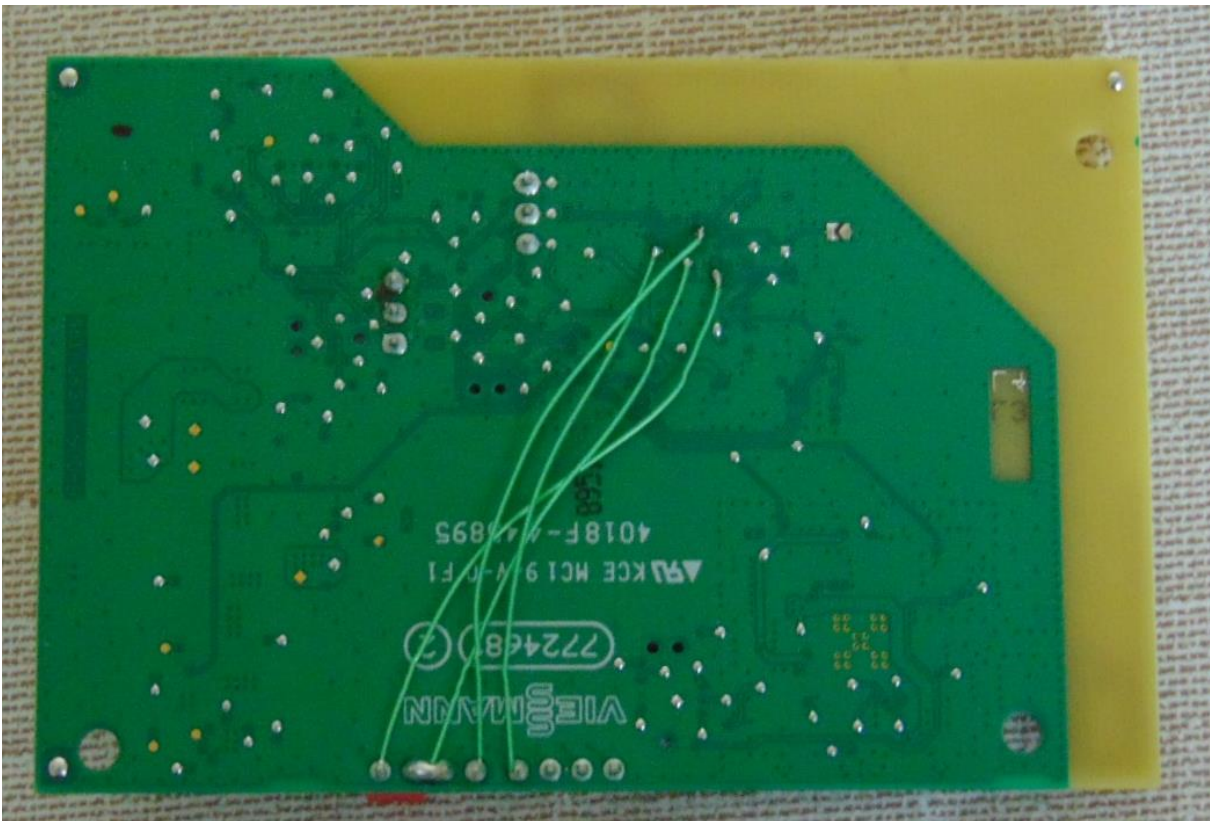
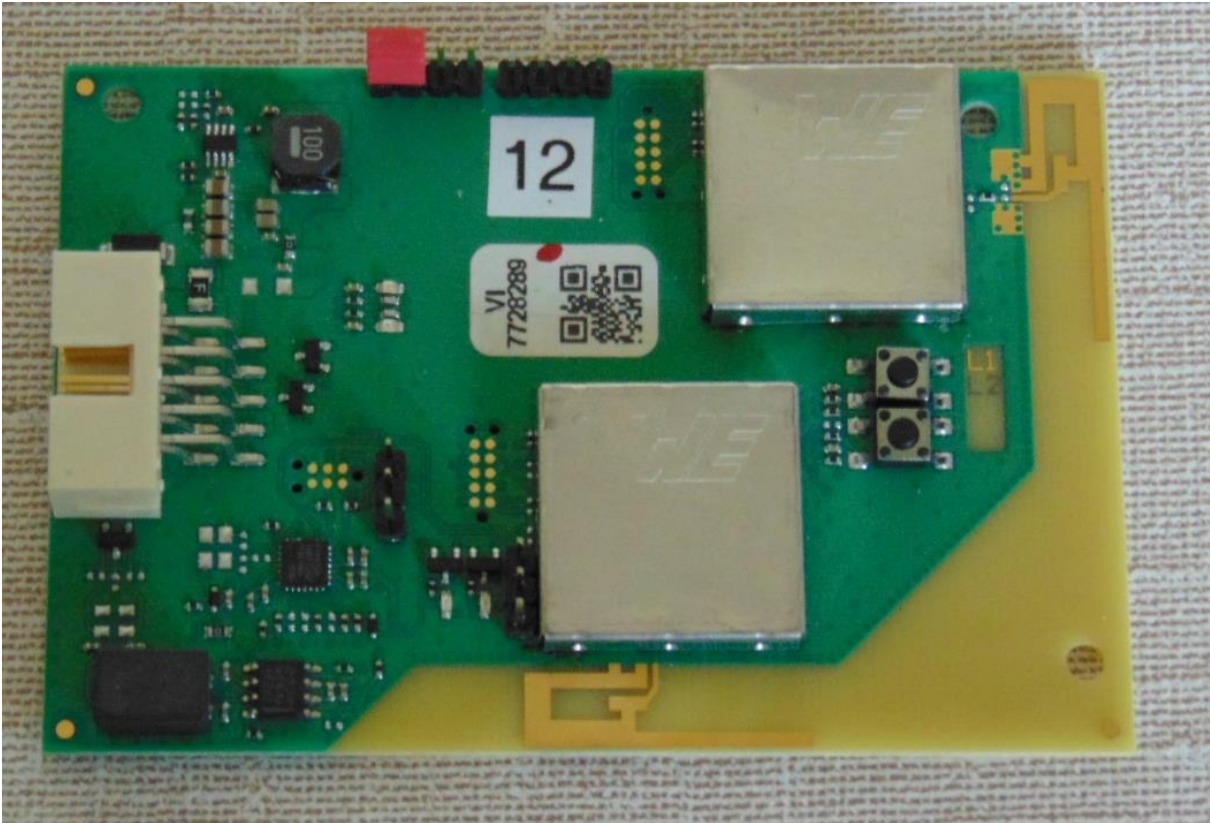

(Unterschrift/signature)

25.06.2020
Freigabe am/released on

A. Tropmann, Head of Laboratory
(Name/name / Stellung/position)


(Unterschrift/signature)

13. Photos of tested sample



End of test report