



Test report

according to ISO/IEC 17025:2017

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

ISED
(Inovation, 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



Bundesnetzagentur

BNetzA-CAB-15/21-19

TESTED
IN GERMANY

STC Germany GmbH
Ohmstrasse 1
84160 Frontenhausen, Germany
Tel.: + 49 (0) 8732 6381
Fax: + 49 (0) 8732 2345
E-mail: grstc@stc.group

Test report no.: **20/01-0031**

Page 1 of 50 pages

Table of contents

1. Client information	3
2. Equipment under test (EUT)	3
3. Description of the Equipment under test and test conditions	4
4. Performed measurements and results.....	6
5. Antenna requirement.....	7
6. AC Mains conducted emissions	8
7. Radiated emission measurements	14
8. Operation within the band 902-928 MHz, 2400-2483,5 MHz and 5725-5850 MHz	24
9. Test equipment.....	41
10. Test Setups	43
11. Measurement uncertainty	47
12. Photos setup	48
13. Conclusions.....	49
14. Photos of tested sample	50

Location of test facility:



STC Germany GmbH
Ohmstrasse 1
84160 Frontenhausen
Germany

1. Client information

Name: **Vestel Elektronik Sanayi ve Ticaret A.Ş.**
Address: **Organize Sanayi Bolgesi 45030, Yunusemre/MANISA/Turkey**
Name of contact: **Mr. Andac Pamuk**
Telephone: **+90 236 2332582**
Fax: **+90 236 2332584**
E-mail: **Andac.pamuk@vestel.com.tr**

2. Equipment under test (EUT)

2.1 Identification of the EUT

Equipment: **WIFI+BT Combo Module**
Model: **17WFM25**
Brand name: **-/-**
Serial no.: **-/-**
Manufacturer: **Vestel Elektronik San ve Tic. A.S.,
Organize Sanayi Bölgesi,
Vestel City, High-End,
45030 MANISA, TURKEY**
Country of origin: **TURKEY**
Power rating: **4.75 V – 5.25 V nominal 5 V = via USB**
Highest frequency generated or used in the device or on which the device operates or tunes (MHz): **5.825 GHz**
Date Sample Received: **16.01.2020**
Tests were performed: **05.03.2020 – 18.06.2020**

2.2 Additional information about the EUT:

The EUT can also operate simultaneously as 2.4 GHz or 5 GHz Wifi module.
The 2.4 GHz / 5 GHz is not documented in this Report.

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:	2AVQS-17WFM25
IC:	25888-17WFM25
HVIN:	080419R4
Firmware version:	V0.5.0.0, Wi-Fi Component: V1.1.0
Software to control EUT:	Media Tek BT Tool (Version: W1746)
Power:	4.75 V – 5.25 V nominal 5 V = via USB
Cables:	USB cable 100 cm Cable to test adaptor 30 cm
Approx. Size (l x w x h):	(70 x 25 x 4.5) mm
Test conditions:	<p>The “WIFI+BT Combo Module – 17WFM25” (= equipment under test – EUT) had been tested, where applicable with test software Media Tek BT Tool and with maximal RF-output in the following modes:</p> <p>(1) Bluetooth Low Energy: Tx mode GFSK 2402.0 MHz (2) Bluetooth Low Energy: Tx mode GFSK 2440.0 MHz (3) Bluetooth Low Energy: Tx mode GFSK 2480.0 MHz</p> <p>The tested configuration represents (based on the product specification) with the tested operation modes the worst case.</p>
RF Module Model Number:	17WFM25
Frequency range:	2.400 GHz – 2.483,5 GHz
Type of modulation:	Bluetooth Low Energy BLE
Operating frequencies [MHz]:	2402-2480
99-% Power Bandwidth [MHz]:	1.03
Emission classification:	735KF1D
Transmission protocol:	GFSK
Data Rates:	1 MBit/s
Channel separation:	2 MHz
Number of channels:	40
Spurious Emissions: radiated lowest margin to limit	51.69 dB μ V/m @ 3 m
Environmental conditions during tests:	Ambient temperature: 20 °C Relative humidity 40 % Atmospheric pressure 965 mbar
Antenna specification:	Model: Printed PCB Antenna Gain: max. 0.29 dBi Type: <input type="checkbox"/> External (with accessible antenna socket) <input checked="" type="checkbox"/> Internal (integrated, PCB antenna)
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**Bluetooth Low Energy**

Channel	Frequency (MHz)	Channel	Frequency (MHz)
37	2402	18	2442
0	2404	19	2444
1	2406	20	2446
2	2408	21	2448
3	2410	22	2450
4	2412	23	2452
5	2414	24	2454
6	2416	25	2456
7	2418	26	2458
8	2420	27	2460
9	2422	28	2462
10	2424	29	2464
38	2426	30	2466
11	2428	31	2468
12	2430	32	2470
13	2432	33	2472
14	2434	34	2474
15	2436	35	2476
16	2438	36	2478
17	2440	39	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 11.9.1.1	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. 20/01-0031.

- 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 23, 2020

Remark: -/-

5. Antenna requirement

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart B, § 15.203 Conducted limits

Test conditions and configuration of EUT

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

Module has on board printed antennas with the given gain values below.

Onboard PCB Antennas Ant 0 + Ant 1

Oboard Antennas:

Antenna	Type	Gain (2.4 GHz) (dBi)
PCB Onboard	Ant 0	3.4
PCB Onboard	Ant 1	2.12

Requirements:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

Usage with PCB antennas There is no external antenna, the antenna gain max =3.4dBi
User is unable to remove or change the Antenna

6. 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 with conditions as mentioned under "Test conditions" in clause 3 above.

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 EUT, 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

Measruement performed on 17.03.2020

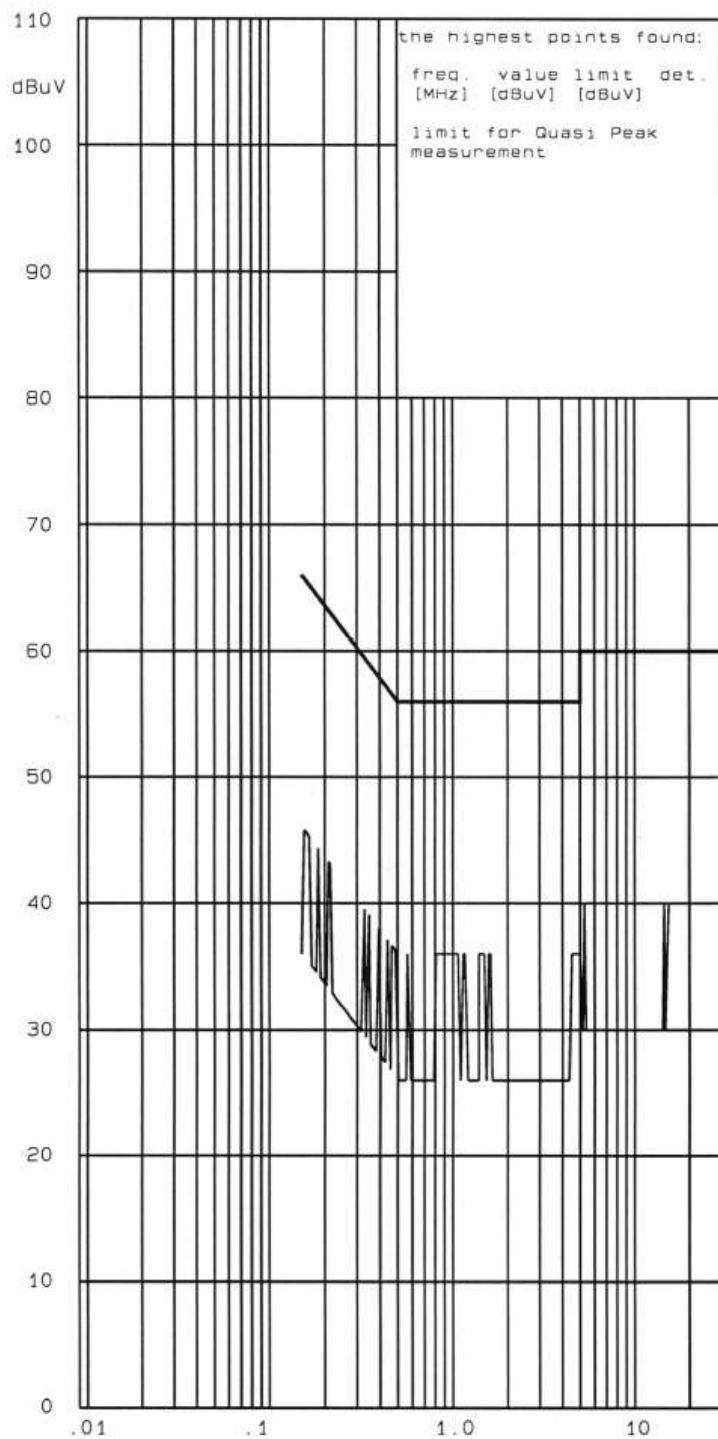
As worst cases the mode No.: 2 with conditions as mentioned under "Test conditions" in clause 3 was found and documented in this report.

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC Part 15.207 / RSS-Gen

Cabin 1



Ref.-No.: 20/01-0031

Product: Trans.-/Rec.-System

Sample: 02

Date: 17 Mar 2020

Operator: b1

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-Z5

Connected sets:

Host PC (stc)

Operating mode:

TX BTLE
GFSK
CH.19 (2440MHz)
Tested on N

RFI suppression parts:

* two dB safety margin for
type approval recommendedResult: pass fail []

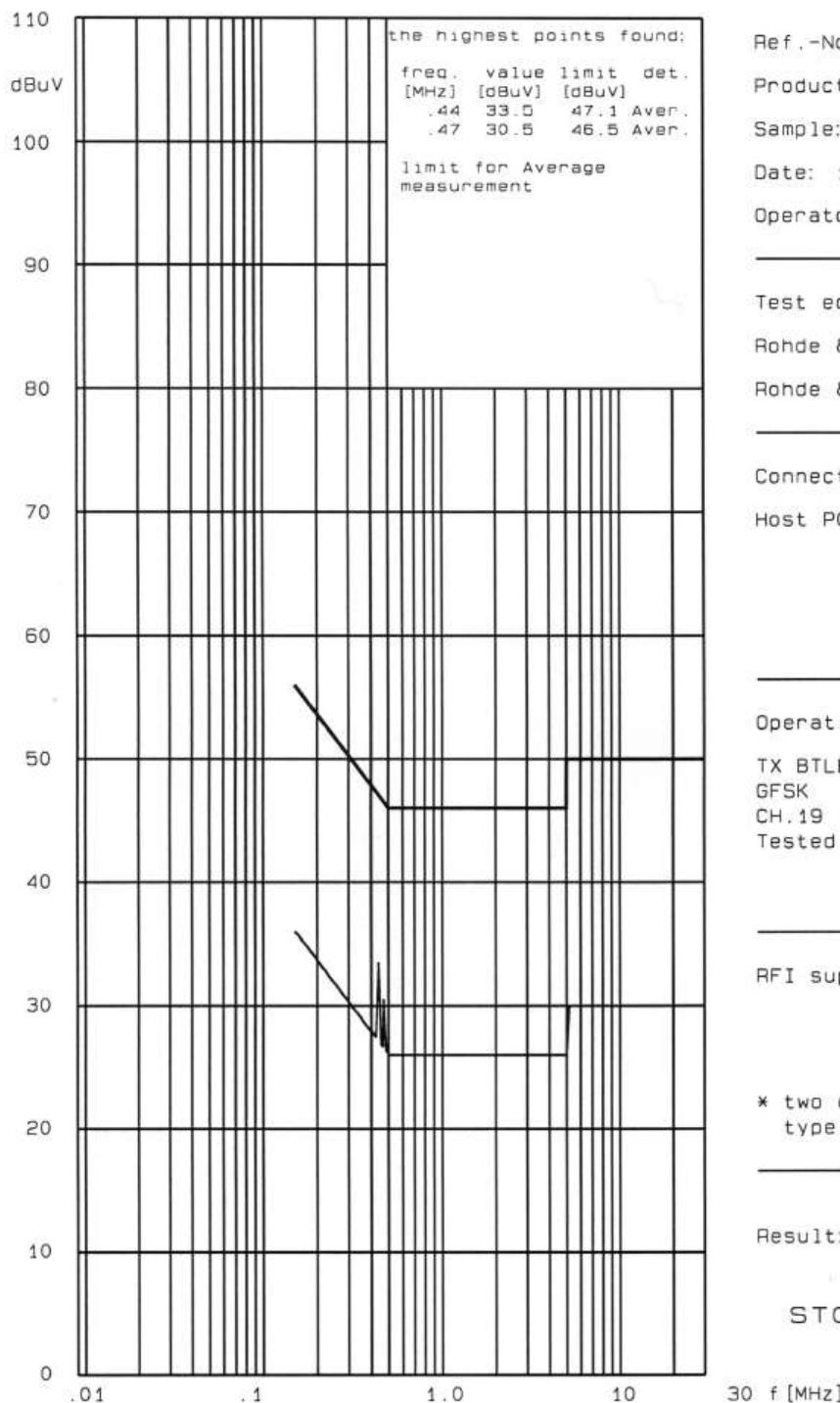
STC Germany GmbH

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC Part 15.207 / RSS-Gen

Cabin 1



Ref.-No.: 20/01-0031

Product: Trans.-/Rec.-System

Sample: 02

Date: 17 Mar 2020

Operator: b1

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-Z5

Connected sets:

Host PC (stc)

Operating mode:

TX BTLE

GFSK

CH.19 (2440MHz)

Tested on N

RFI suppression parts:

* two dB safety margin for type approval recommended

Result: pass fail []

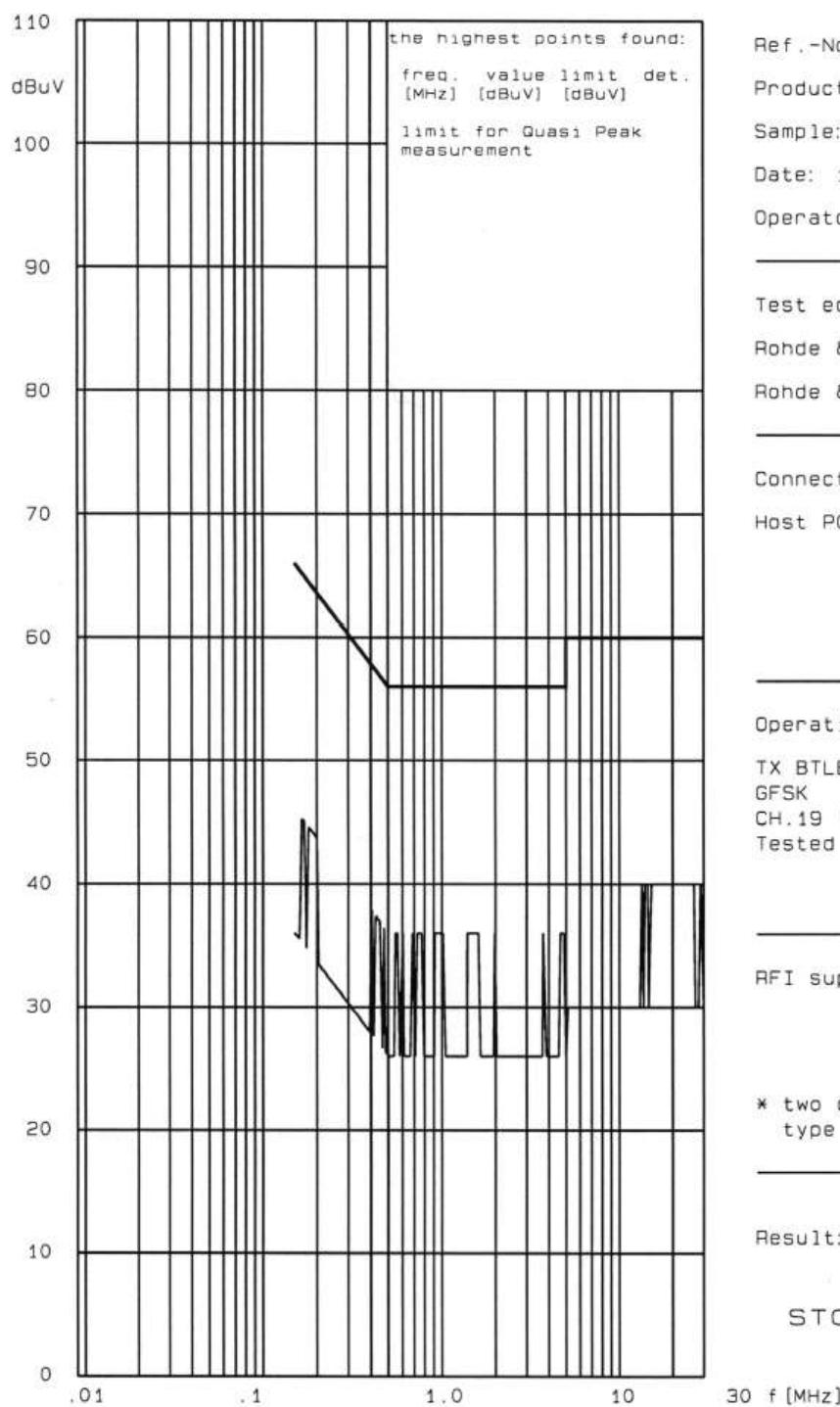
STC Germany GmbH

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC Part 15.207 / RSS-Gen

Cabin 1



Ref.-No.: 20/01-0031

Product: Trans.-/Rec.-System

Sample: 02

Date: 17 Mar 2020

Operator: b1

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-Z5

Connected sets:

Host PC (stc)

Operating mode:

TX BTLE
GFSK
CH.19 (2440MHz)
Tested on L1

RFI suppression parts:

* two dB safety margin for
type approval recommendedResult: pass fail []

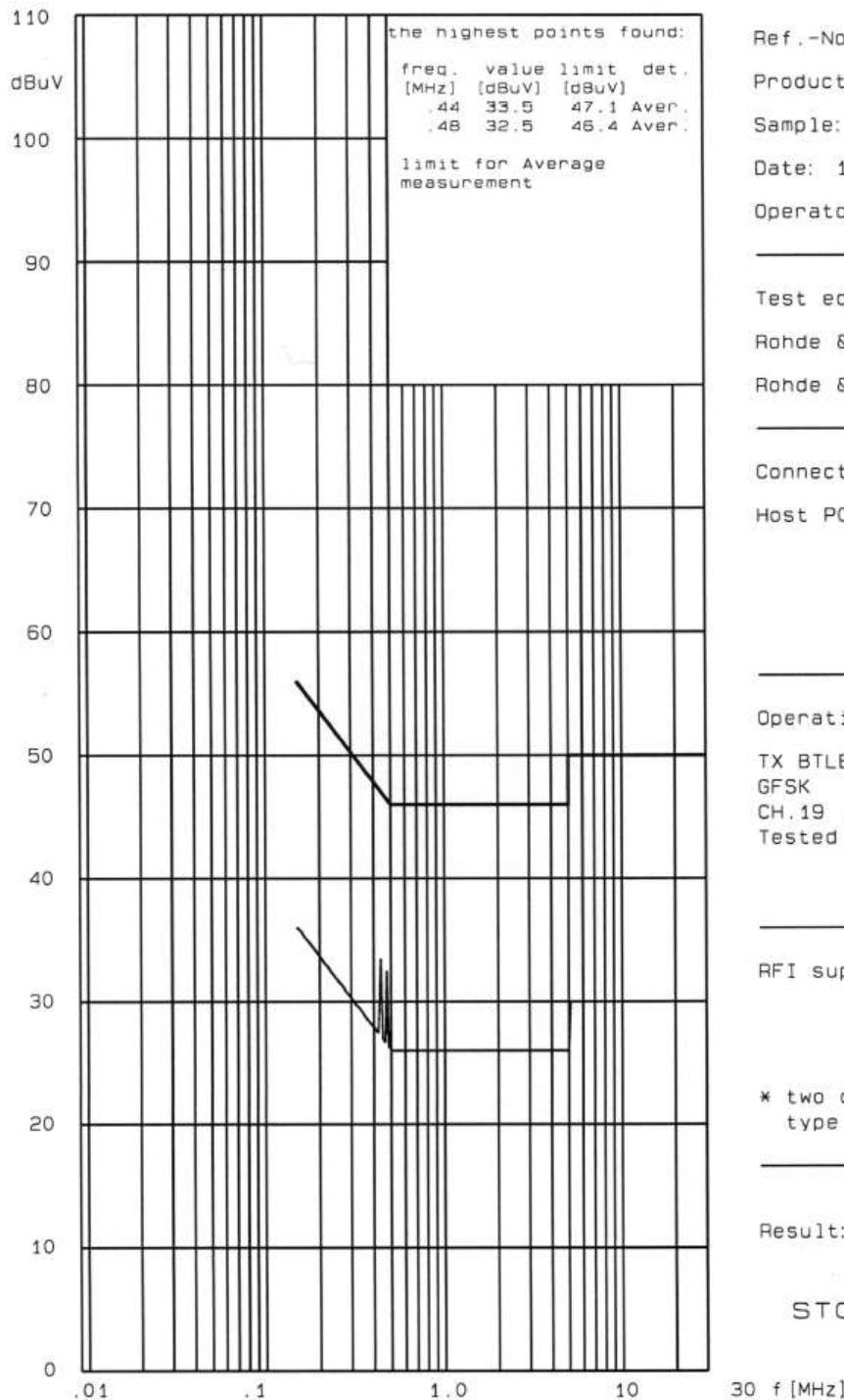
STC Germany GmbH

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC Part 15.207 / RSS-Gen

Cabin 1



Ref.-No.: 20/01-0031

Product: Trans.-/Rec.-System

Sample: 02

Date: 17 Mar 2020

Operator: bl

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-Z5

Connected sets:

Host PC (stc)

Operating mode:

TX BTLE

GFSK

CH.19 (2440MHz)

Tested on L1

RFI suppression parts:

* two dB safety margin for type approval recommended

Result: pass fail []

STC Germany GmbH

Remarks:

Composition of the measurement value:

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

M_{Value} = Measurement Value

M_{Rec} = Reading value of test receiver

C_{Loss} = Cable loss between Receiver and LISN

$LISN_{\text{cor}}$ = LISN correction factor.

Sample calculation:

$$40.8 \text{ dB}\mu\text{V} = 40.1 \text{ dB}\mu\text{V} + 0.3 \text{ dB} + 0.4 \text{ dB}$$

Result 0.15 MHz – 30 MHz

Results

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

7. 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 9 kHz to 40 GHz was investigated as the highest frequency generated in the EUT is 5.825 GHz.

Test conditions and configuration of EUT

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

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 conditions as mentioned under "Test conditions" in clause 3 were 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: 12.03.2020 and 16.03.2020

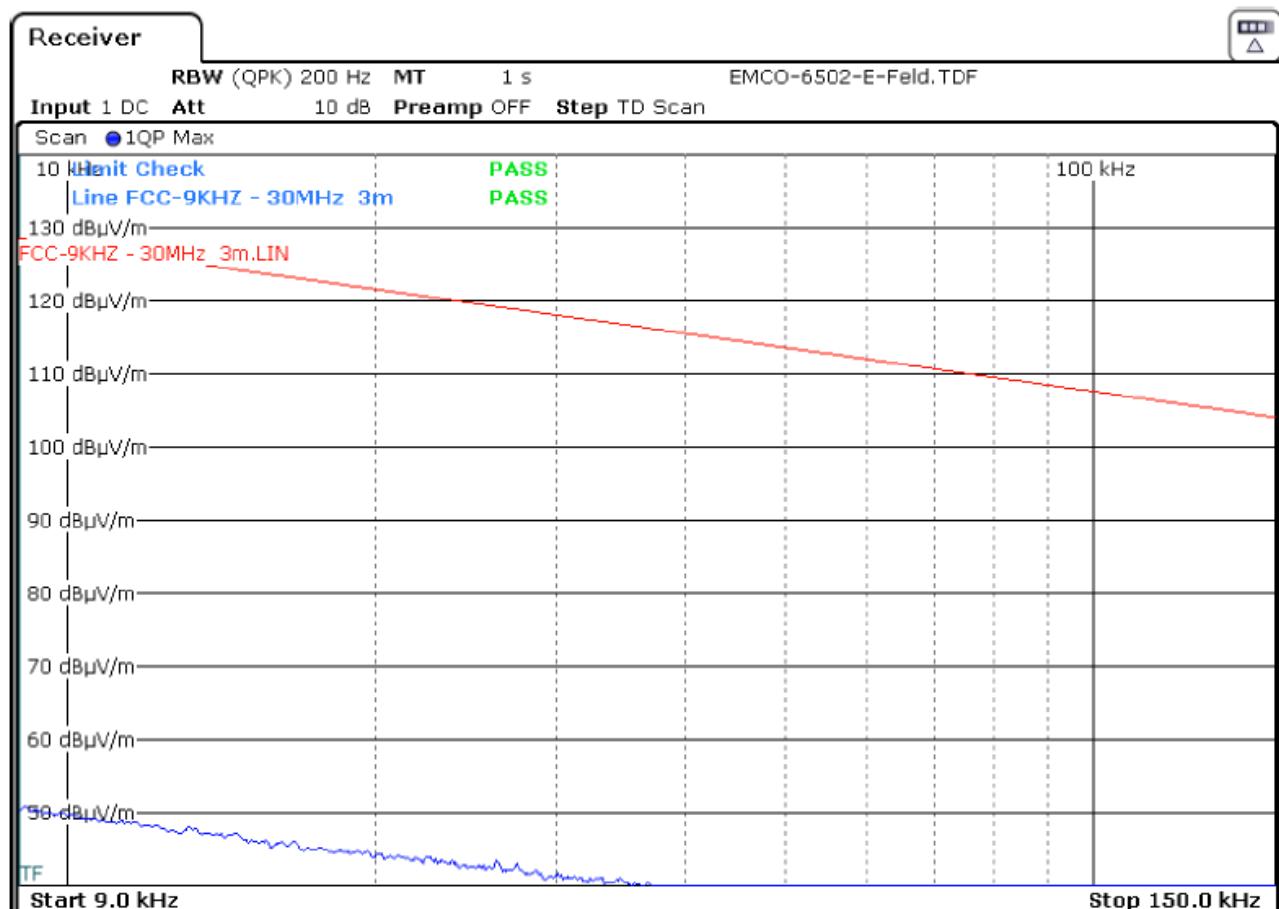
Result 9 kHz – 30 MHz

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).

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 Subpart C § 15.209**ESTC**Ref.-No.: **20/01-0031**

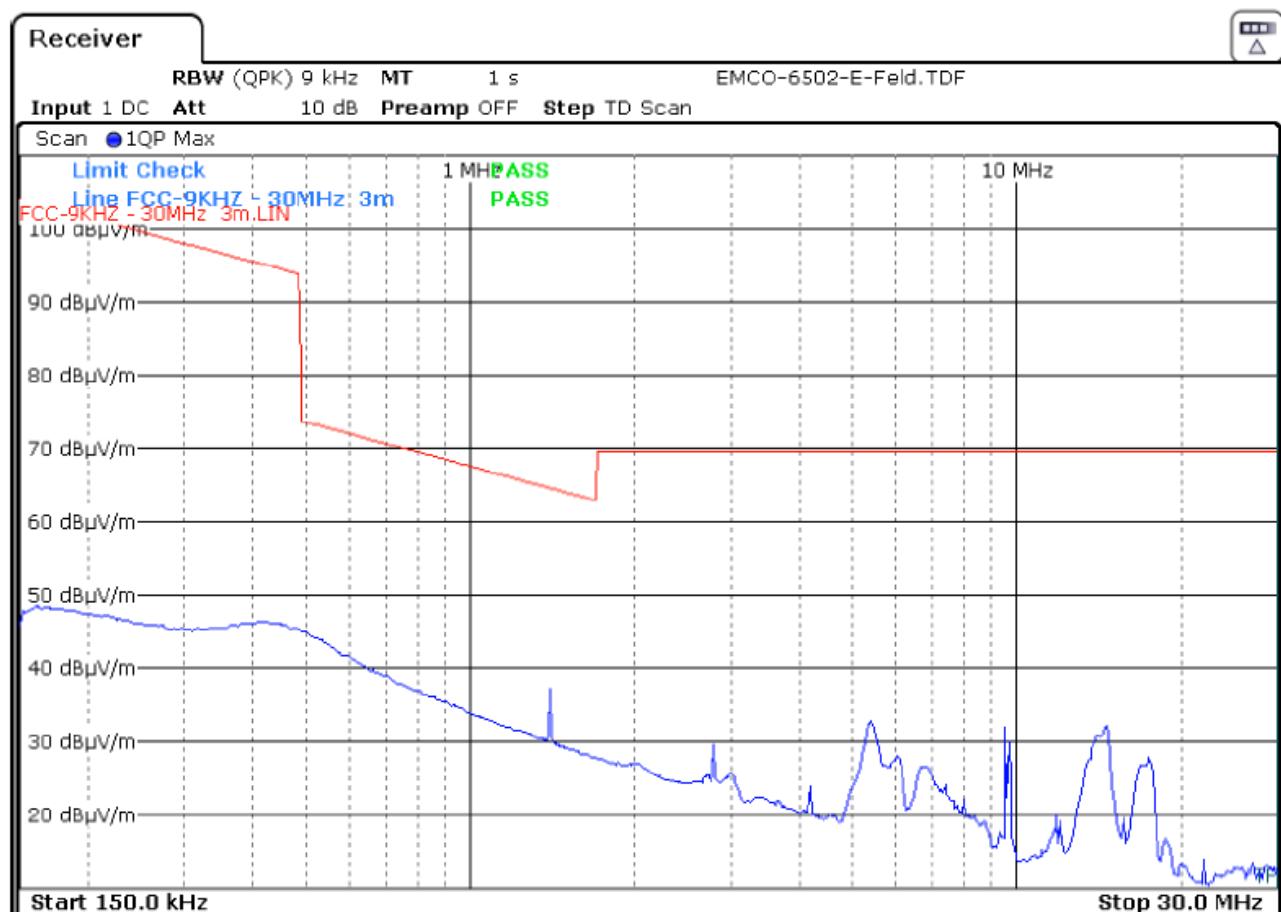
Operation mode: Tx BTLE; GFSK; CH.19 (2440MHz)

Position X (9kHz - 150kHz)

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

TESTED
IN GERMANY**IT 3/4**
Interference radiation (9kHz – 30MHz)
acc.FCC Subpart C § 15.209**TESTED**
IN GERMANYRef.-No.: **20/01-0031**

Operation mode: Tx BTLE; GFSK; CH.19 (2440MHz)

Position X (150kHz – 30MHz)

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

Summery result for frequency range 9 kHz - 30 MHz to show compliance with RSS-Gen limits:

Function	Freq.	Measured Value @ 3m	Conversion to magnetic field ^{Note 1}		Limit @ 3m		Margin	Result
	[MHz]	[dB μ V/m]	[dB μ A/m]	[μ A/m]	[dB μ A/m]	[μ A/m]		
Transmitting	0.009 – 0.490	< 50.0	< -1.5	-/-	77 - 42.3	-/-	>20	Pass
	0.490 – 1.705	< 47.0	< -4.5	-/-	22.3 - 11.5	-/-	>20	Pass
	1.705 - 30	< 34.0	< -17.5	-/-	18	-/-	>20	Pass

Note 1: Conversion E-field to H-Field:
 $x \text{ [dB}\mu\text{V/m]} - 51.5 = y \text{ [dB}\mu\text{A/m]}$

Conversion [dB μ A/m] in [μ A/m]
 $10^y \text{ [dB}\mu\text{A/m]} / 20 = z \text{ [μ A/m]}$

Remarks:

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

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

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:

$$38.2 \text{ dB}\mu\text{V} = 18.3 \text{ dB}\mu\text{V} + 0.1 \text{ dB} + 19.8 \text{ dB}$$

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

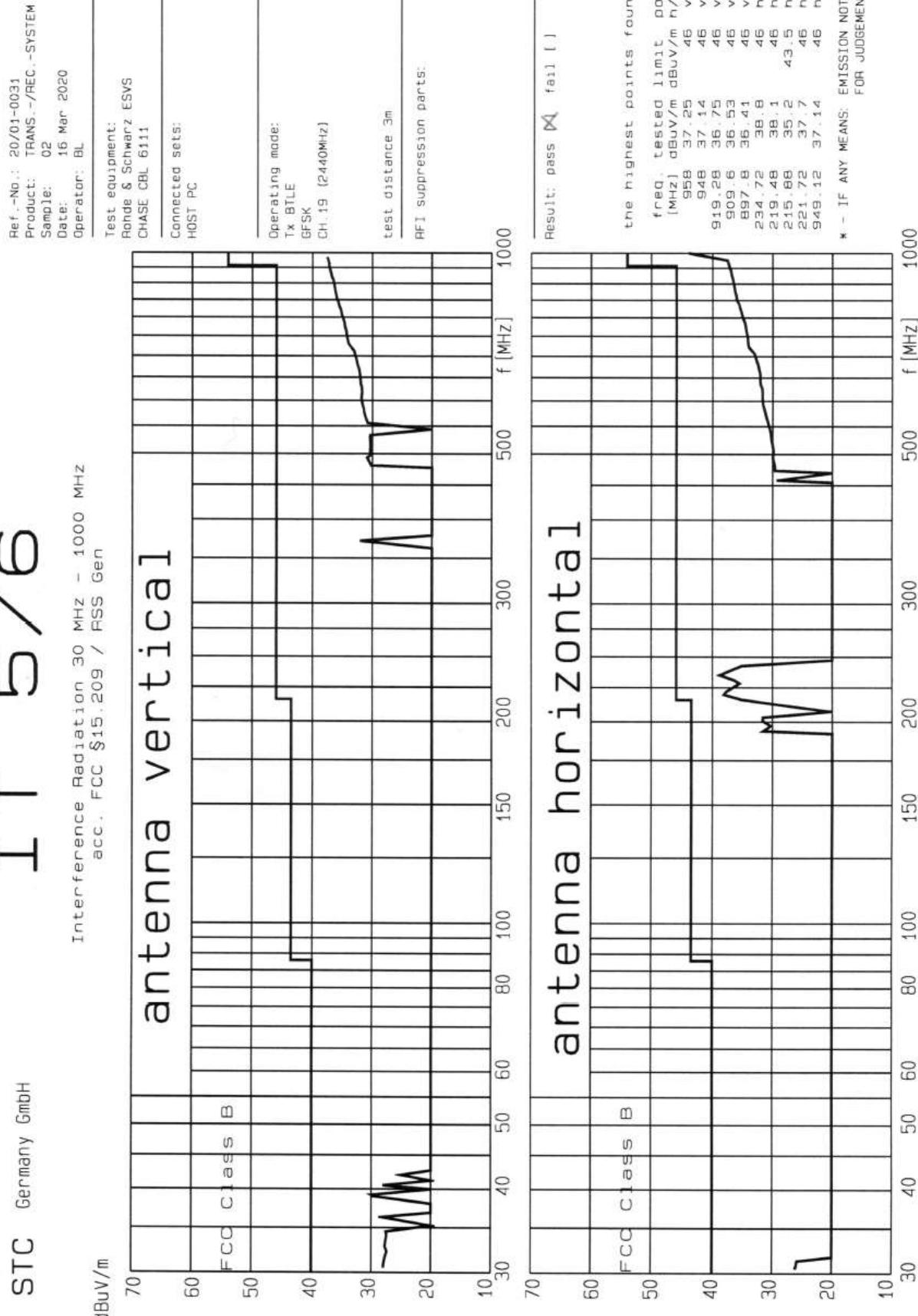
Result 30 MHz – 1000 MHz

Mode No.: 2 with Bluetooth Low Energy: Tx mode GFSK 2440.0 MHz

IT 5/6

STC Germany GmbH

Interference Radiation 30 MHz – 1000 MHz
acc. FCC §15.209 / RSS Gen



Remarks:

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

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

 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:

$$38.7 \text{ dB}\mu\text{V} = 18.3 \text{ dB}\mu\text{V} + 0.6 \text{ dB} + 19.8 \text{ dB}$$

Result 1 GHz – 7 GHz

Mode No.: 2 with Bluetooth Low Energy: Tx mode GFSK 2440.0 MHz

TESTED
IN GERMANYIT 5/6
Interference radiation
acc. to FCC § 15.209 / RSS-Gen

TESTED

Ref.-No.: 20/01-0031

Product: Transmitting/Receiving System

Sample: 02

Date: 12.03.2020

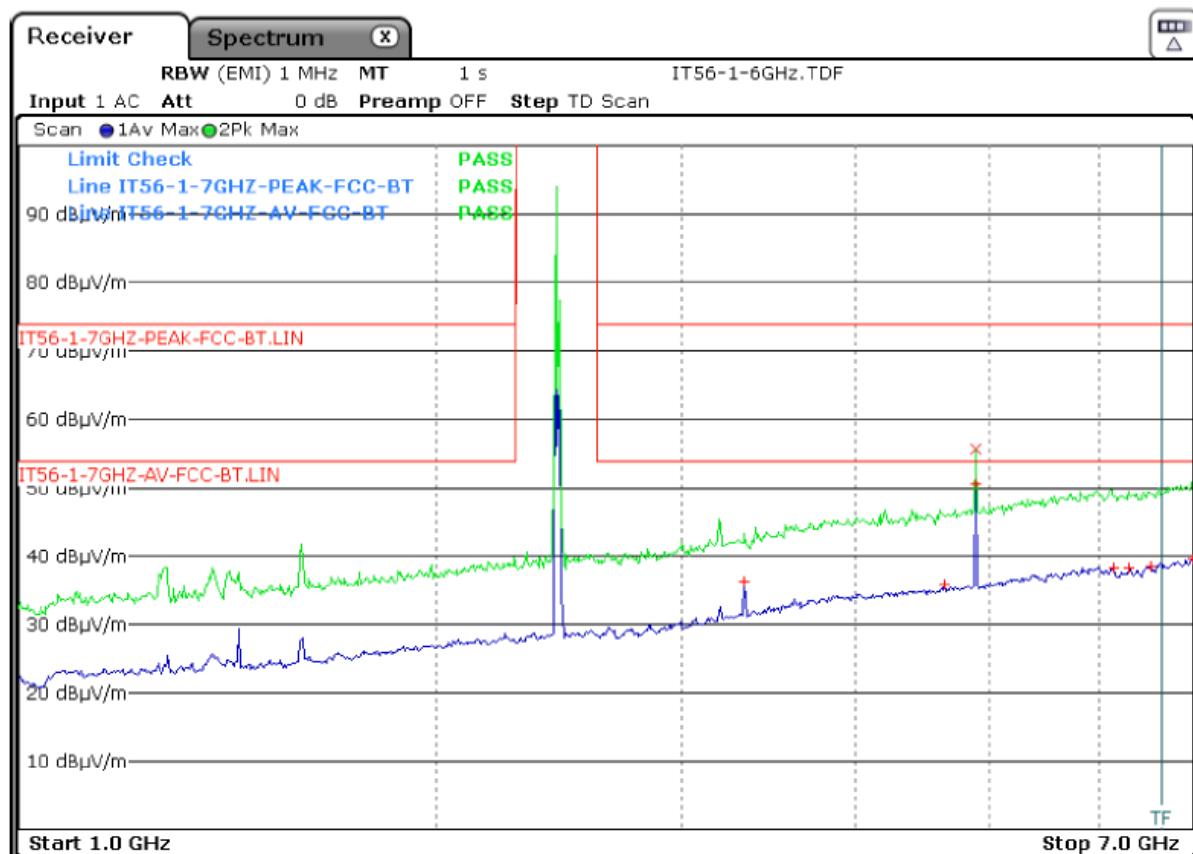
Operator: BI

pass fail

Remarks:

Result:

Operation mode: Tx BTLE / GFSK / CH.19 (2440MHz)

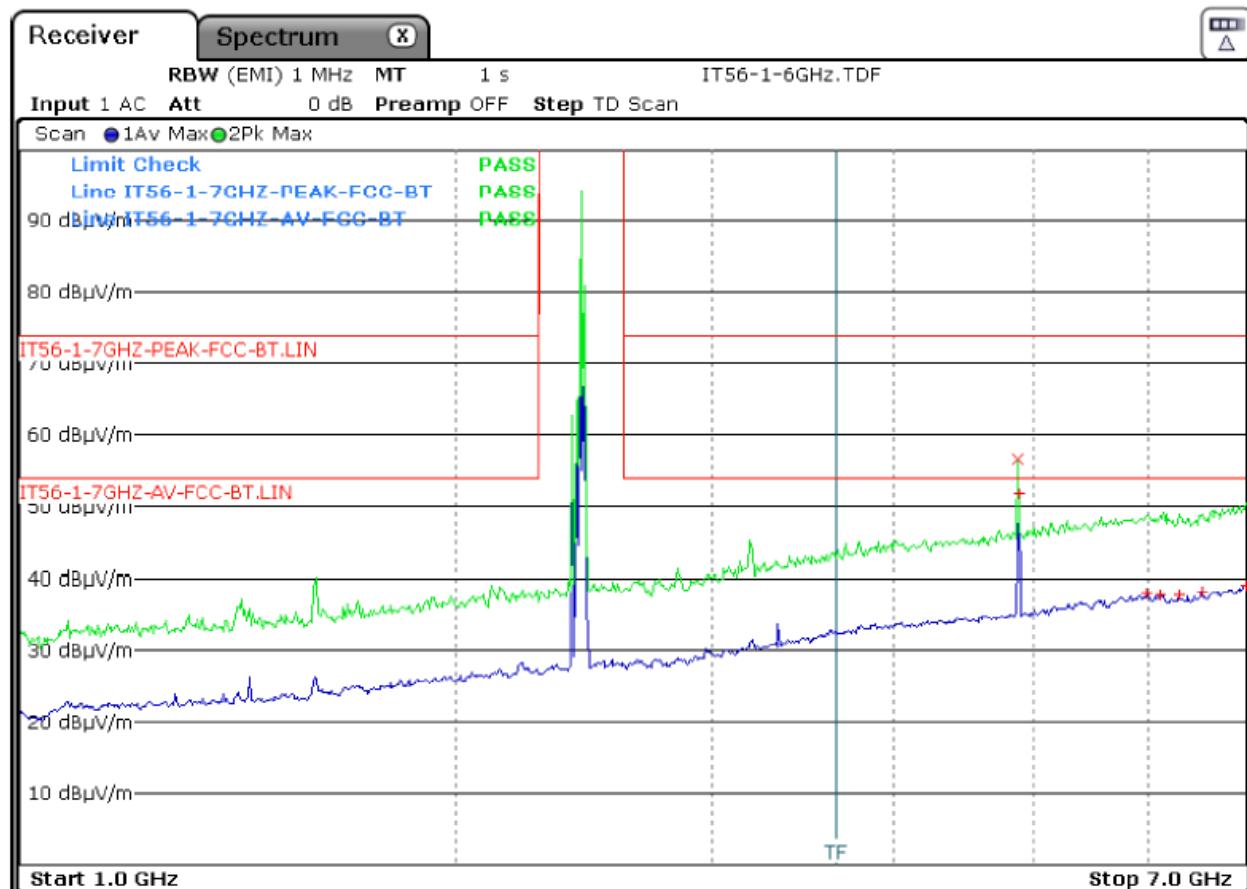


Polarisation: V									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
4,8800	50,67	-3,33	54,00	pass	4,8798	55,58	-18,42	74,00	pass
6,9998	39,57	-14,43	54,00	pass					
6,5348	38,51	-15,49	54,00	pass					
6,3010	38,32	-15,68	54,00	pass					
6,1465	38,20	-15,80	54,00	pass					
3,3308	36,31	-17,69	54,00	pass					

TESTED
IN GERMANYIT 5/6
Interference radiation
acc. to FCC § 15.209 / RSS-GenTESTED
IN GERMANY

Ref.-No.: 20/01-0031

Operation mode: Tx BTLE / GFSK / CH.19 (2440MHz)



Polarisation: H									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dB μ V/m]	Margin to Limit [dB]	Limit [dB μ V/m]	Result	Frequ. [GHz]	Level [dB μ V/m]	Margin to Limit [dB]	Limit [dB μ V/m]	Result
4,8798	51,69	-2,31	54,00	pass	4,8795	56,47	-17,53	74,00	pass
6,9968	39,21	-14,79	54,00	pass					
6,5373	38,22	-15,78	54,00	pass					
5,9838	38,03	-15,97	54,00	pass					
6,1178	37,87	-16,13	54,00	pass					
6,2933	37,83	-16,17	54,00	pass					

Remarks:

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

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

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:

$$39.7 \text{ dB}\mu\text{V} = 53.01 \text{ dB}\mu\text{V} + 0.9 \text{ dB} + 24.19 \text{ dB} - 38.4 \text{ dB}$$

Result 7GHz – 40GHz

All emissions in the frequency range 7 GHz – 40 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.

8. 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

8.1. 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

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: 05.03.2020

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** measurements.

8.2. Output Power of Fundamental Emissions

Maximum Peak 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 exceed: 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

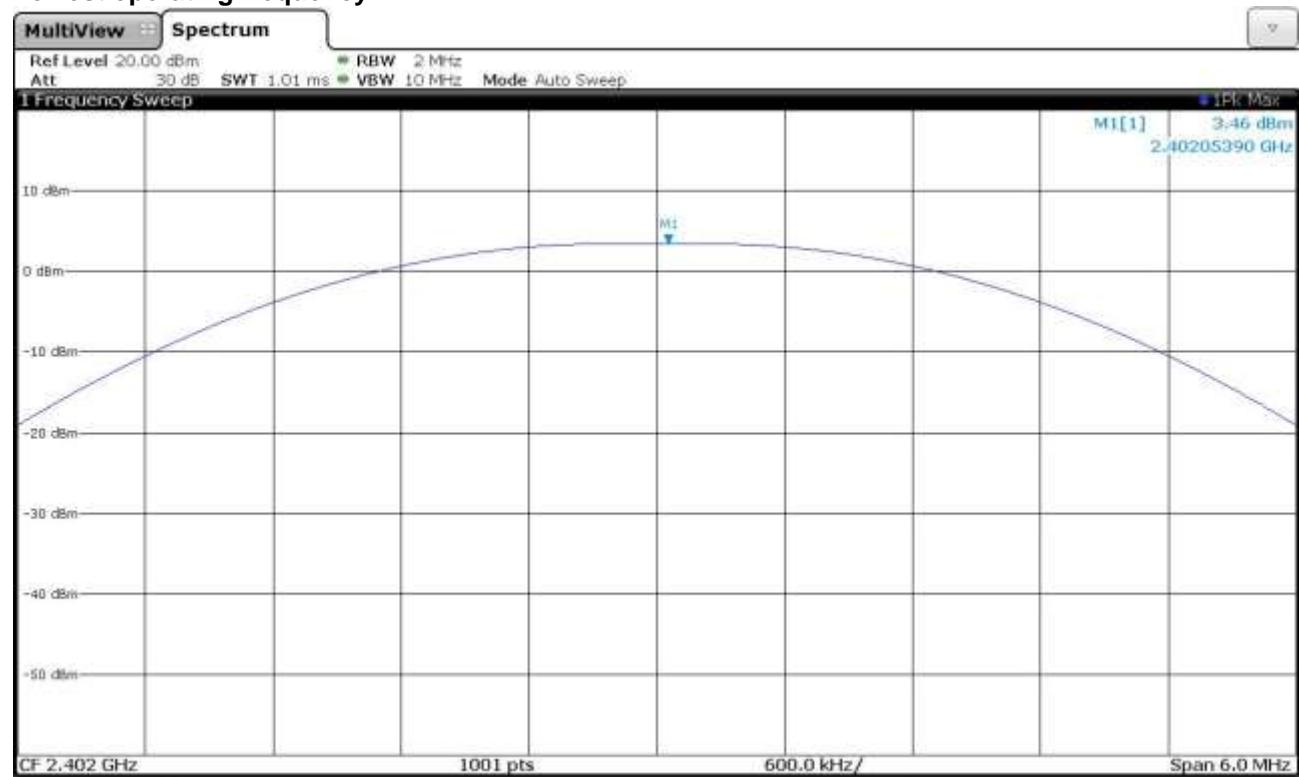
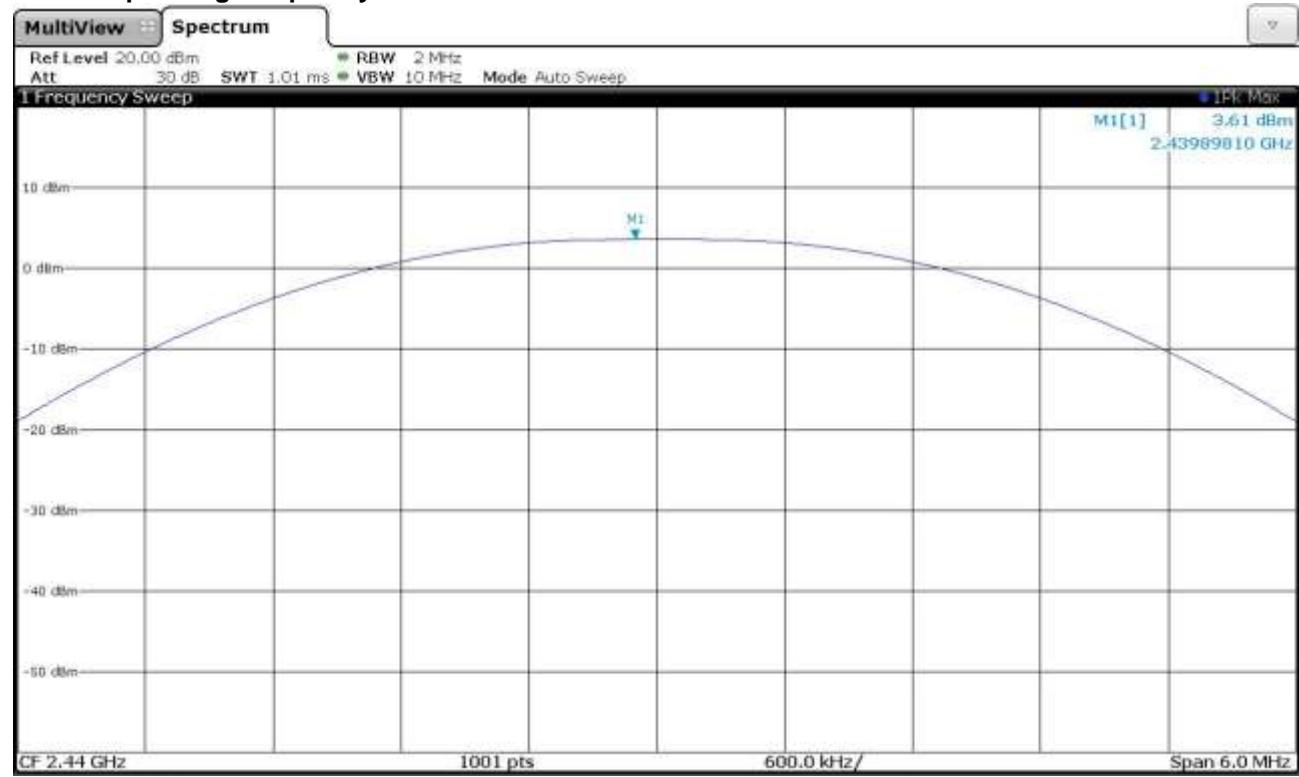
Test equipment used for conducted measurements as given in clause Test equipment of this report.
Test setup used for conducted measurements as given in clause Test setups of this report.

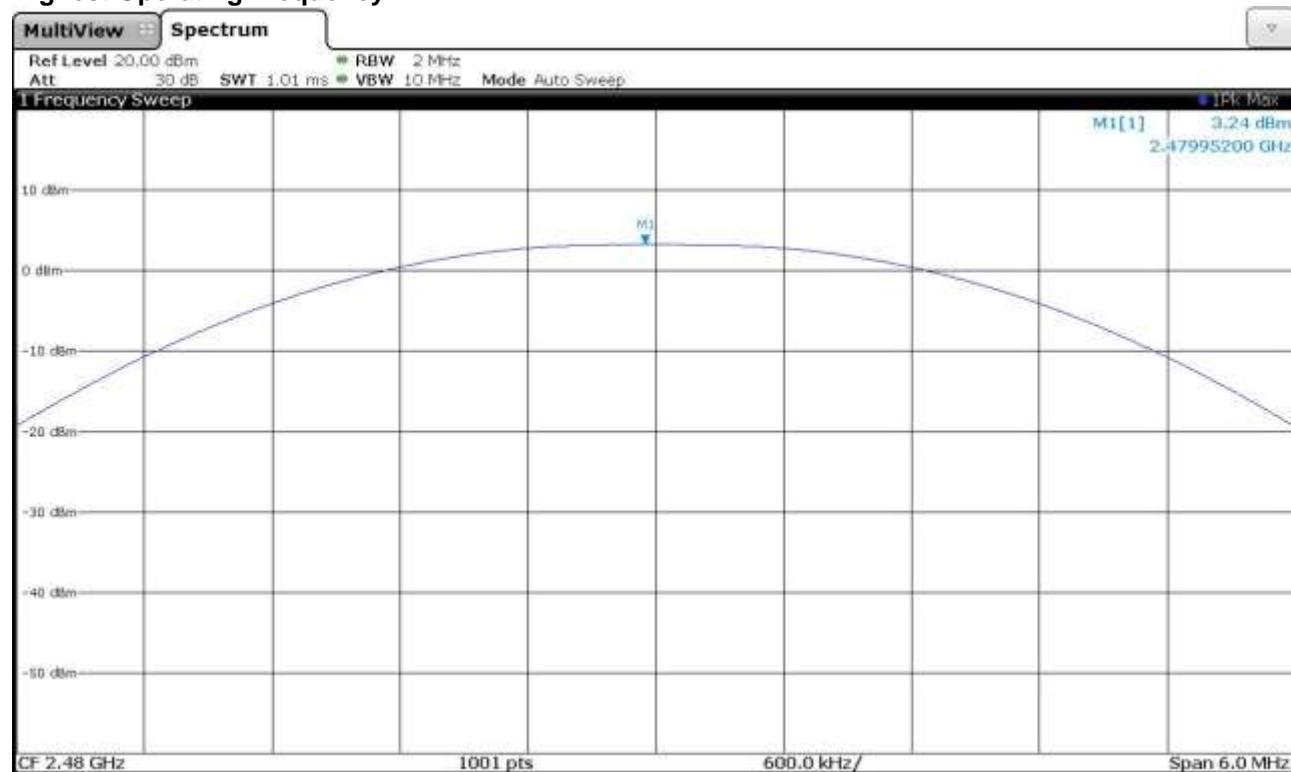
Description

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: 05.03.2020

Lowest operating frequency**Middle Operating Frequency**

Highest Operating Frequency**Maximum output power conducted measurement:**

Channel	Frequency [MHz]	Reading of Analyzer [dBm]	Cable Loss [dB]	Output Power		Limit		Result
				[dBm]	[mW]	[dBm]	[mW]	
37	2402	3.46	1.2	4.66	2.92	30	1000	Pass
17	2440	3.61	1.2	4.81	3.03	30	1000	Pass
39	2480	3.24	1.2	4.44	2.78	30	1000	Pass

Calculated EIRP:

Channel	Frequency [MHz]	Output conducted		Output Power EIRP	
		[dBm]	[mW]	[dBm]	[mW]
37	2402	4.66	2.92	4.95	3.13
17	2440	4.81	3.03	5.10	3.24
39	2480	4.44	2.78	4.73	2.97

Formula: [Conducted RF power] + [Antenna gain] = [EIRP]

Antenna Gain: max. 0.29 dBi

Results

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

8.3. 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.

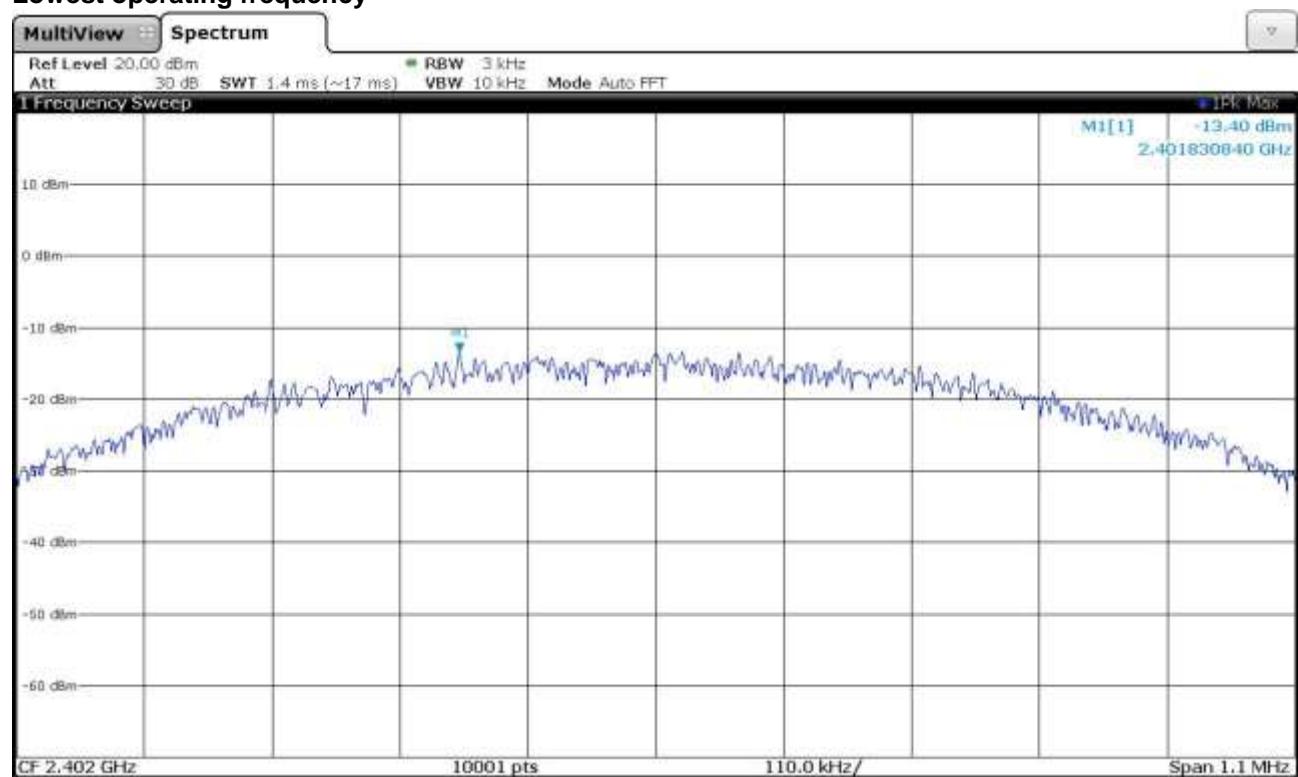
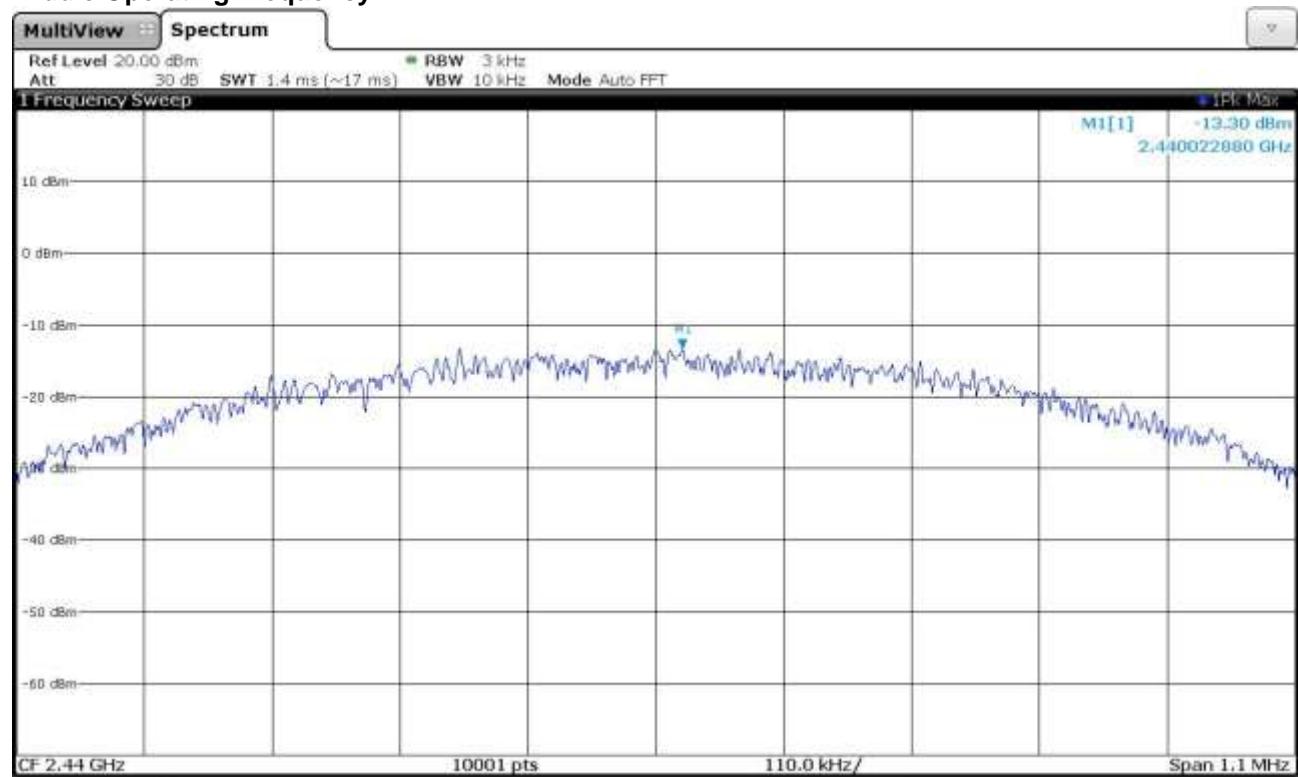
Test equipment and test set up

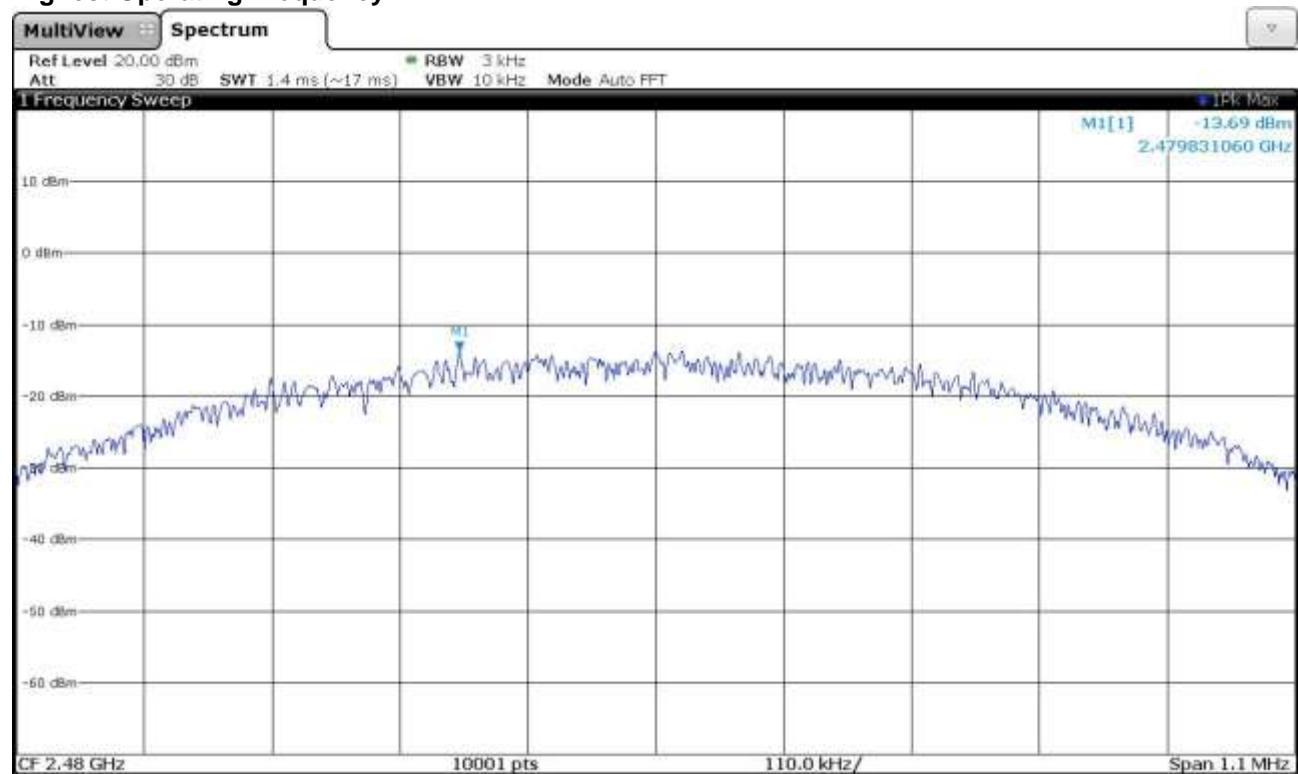
Test equipment used for conducted measurements as given in clause Test equipment of this report.
Test setup used for conducted measurements as given in clause Test setups of this report.

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.

The Measurement was performed on: 05.03.2020

Lowest operating frequency**Middle Operating Frequency**

Highest Operating Frequency**Maximum power spectral density**

Channel	Frequency [MHz]	Reading of Analyzer [dBm / 3 kHz]	Cable Loss [dB]	Power Spectral Density [dBm / 3 kHz]	Limit [dBm / 3 kHz]	Result
37	2402	-13.40	1.2	-12.20	8	Pass
17	2440	-13.30	1.2	-12.10	8	Pass
39	2480	-13.69	1.2	-12.49	8	Pass

Results

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

8.4. 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

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 requirements 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 requirements 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 restricted Band

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

Band Edge for non restricted Band

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

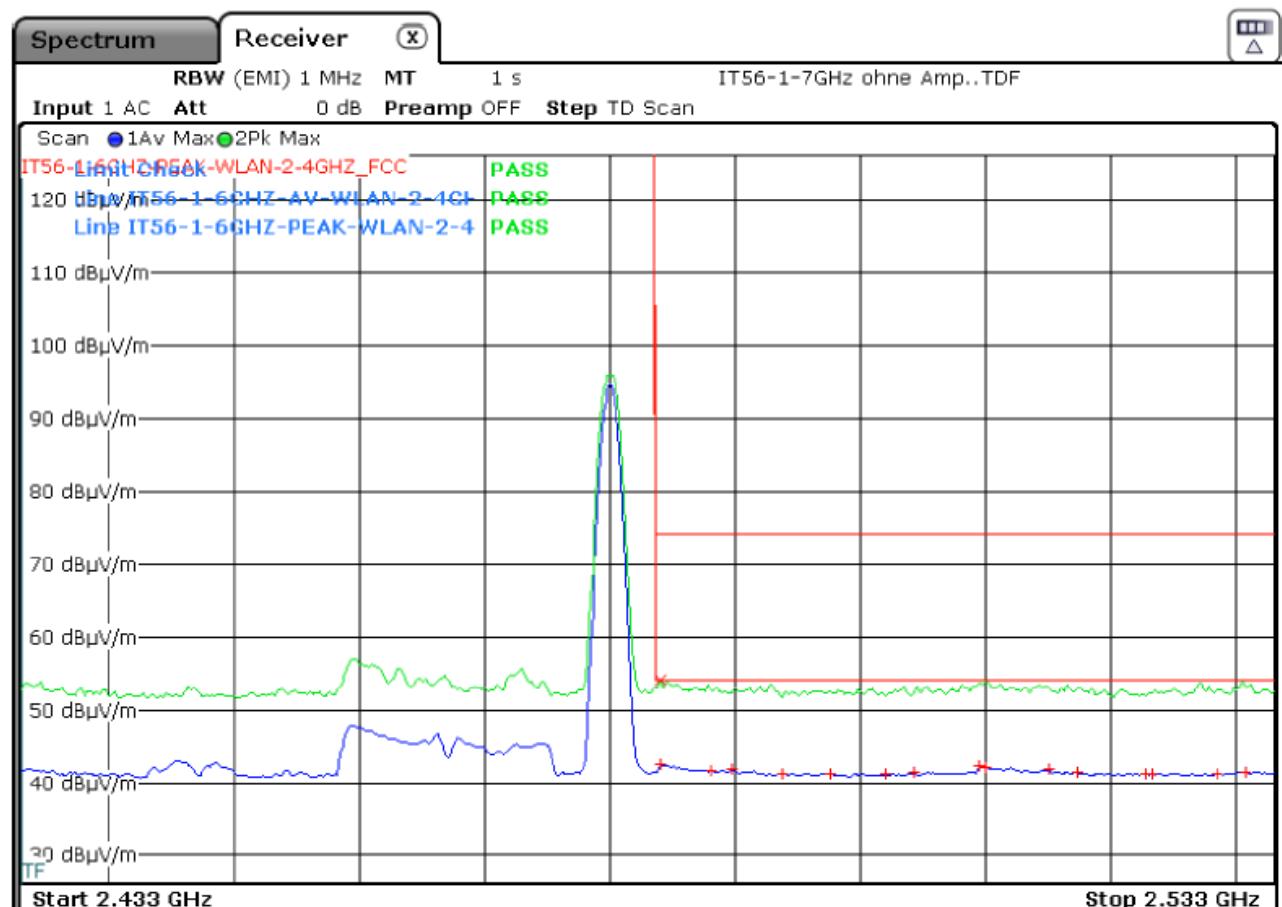
Measurement

The Measurement was performed on: 18.06.2020

TESTED
IN GERMANYFCC 3
Band edge emissionTESTED
IN GERMANYaccording to
FCC §15.247, RSS-247, FCC §15.209 RSS-Gen

Ref.-No.: 20/01-0031

Operation mode: BT; Low Energy; High Edge



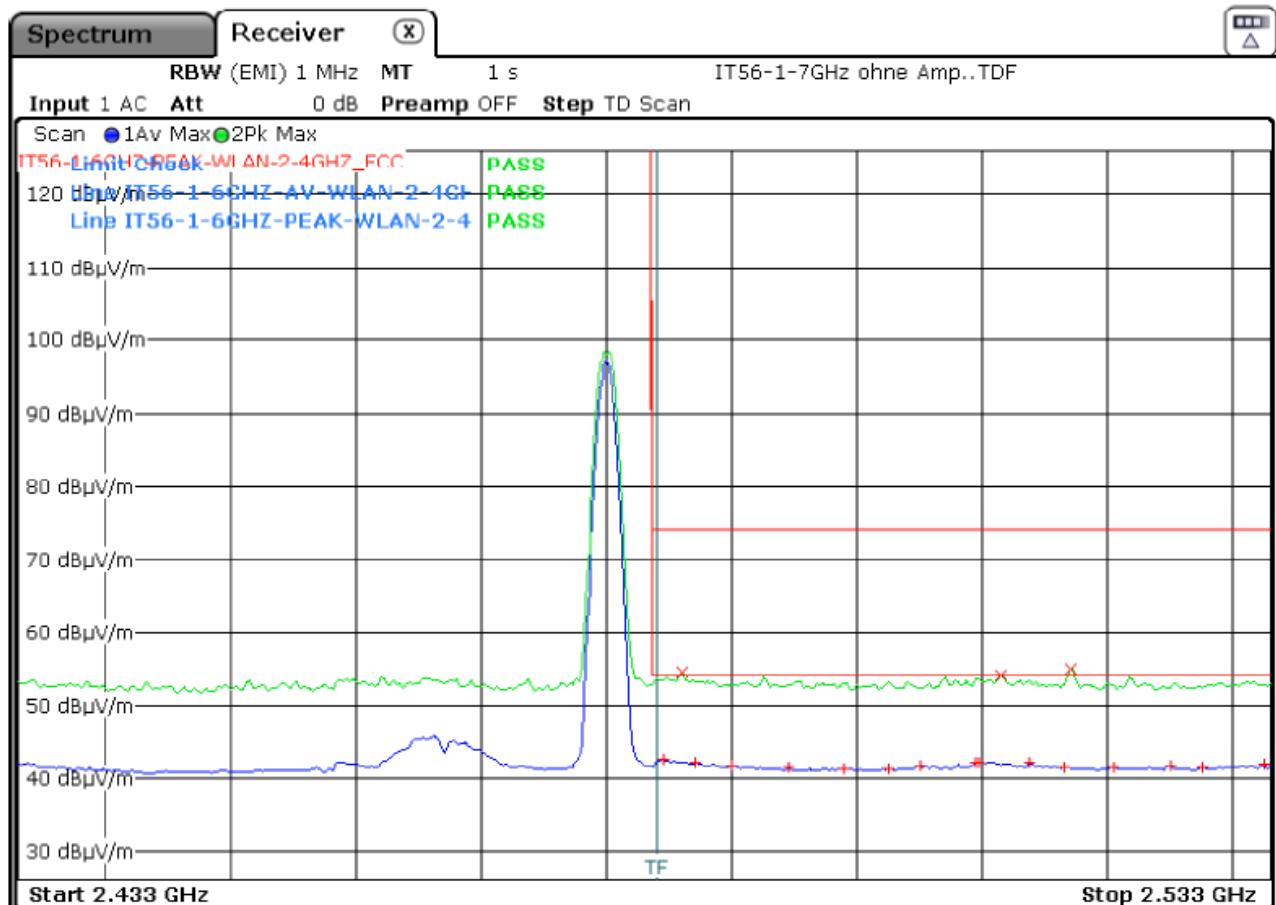
Polarisation: V									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dB μ V/m]	Margin to Limit [dB]	Limit [dB μ V/m]	Result	Frequ. [GHz]	Level [dB μ V/m]	Margin to Limit [dB]	Limit [dB μ V/m]	Result
2,4840	42,56	-11,44	54,00	pass	2,4840	54,04	-19,96	74,00	pass
2,5095	42,21	-11,79	54,00	pass					
2,5100	42,19	-11,81	54,00	pass					
2,4898	41,85	-12,15	54,00	pass					
2,5150	41,79	-12,21	54,00	pass					
2,4880	41,72	-12,28	54,00	pass					

TESTED
IN GERMANYFCC 3
Band edge emission
according toTESTED
IN GERMANY

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

Ref.-No.: 20/01-0031

Operation mode: BT; Low Energy; High Edge



Polarisation: H									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dB μ V/m]	Margin to Limit [dB]	Limit [dB μ V/m]	Result	Frequ. [GHz]	Level [dB μ V/m]	Margin to Limit [dB]	Limit [dB μ V/m]	Result
2,4845	42,45	-11,55	54,00	pass	2,5170	54,99	-19,01	74,00	pass
2,5098	42,19	-11,81	54,00	pass	2,4860	54,44	-19,56	74,00	pass
2,5095	42,12	-11,88	54,00	pass	2,5115	54,01	-19,99	74,00	pass
2,4870	42,01	-11,99	54,00	pass					
2,5138	41,99	-12,01	54,00	pass					
2,5325	41,79	-12,21	54,00	pass					

TESTED
IN GERMANY

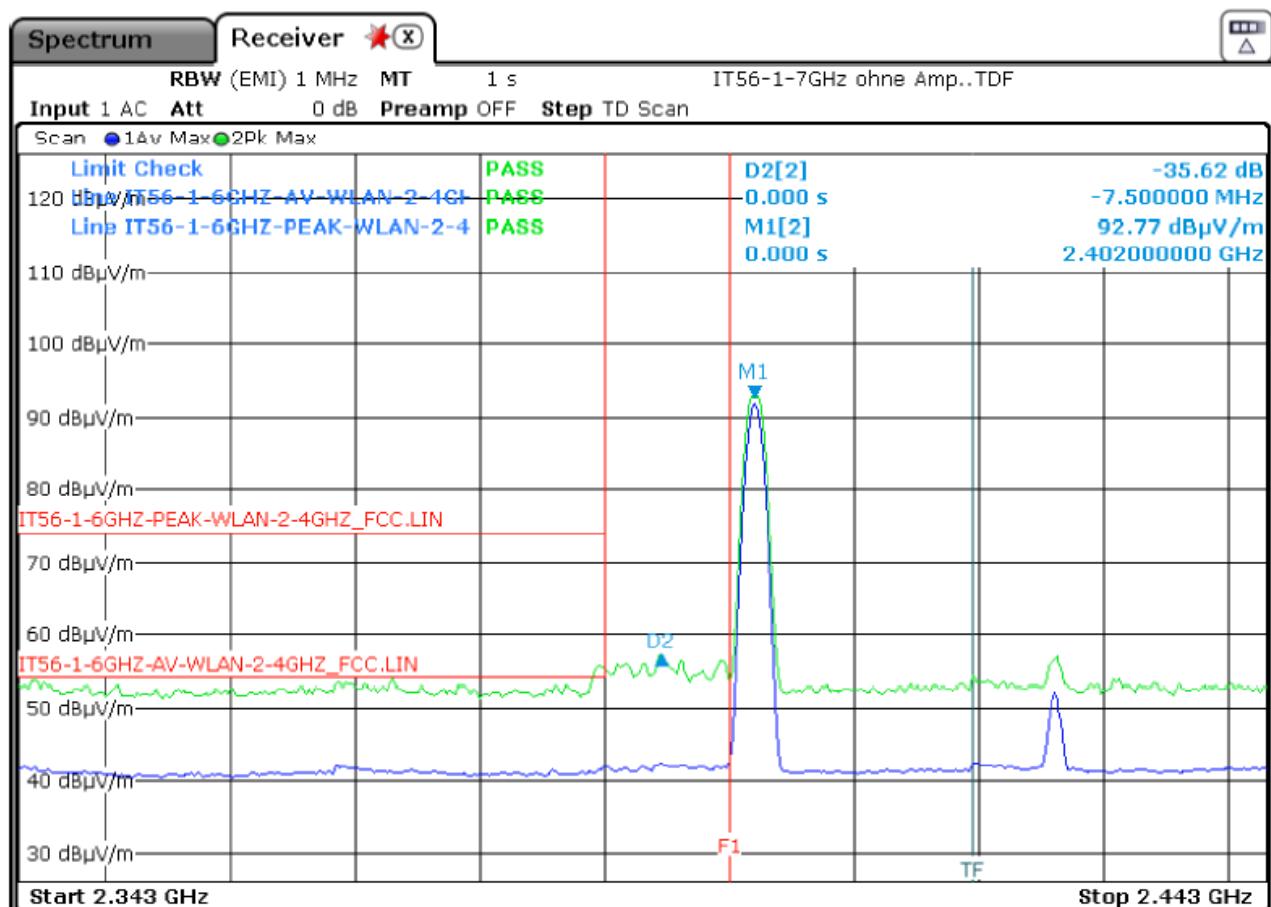
FCC 3

Band edge emission

ESTC

Ref -No : 20/01-0031

Operation mode: BT; Low Energy; Low Edge



TESTED
IN GERMANY

FCC 3

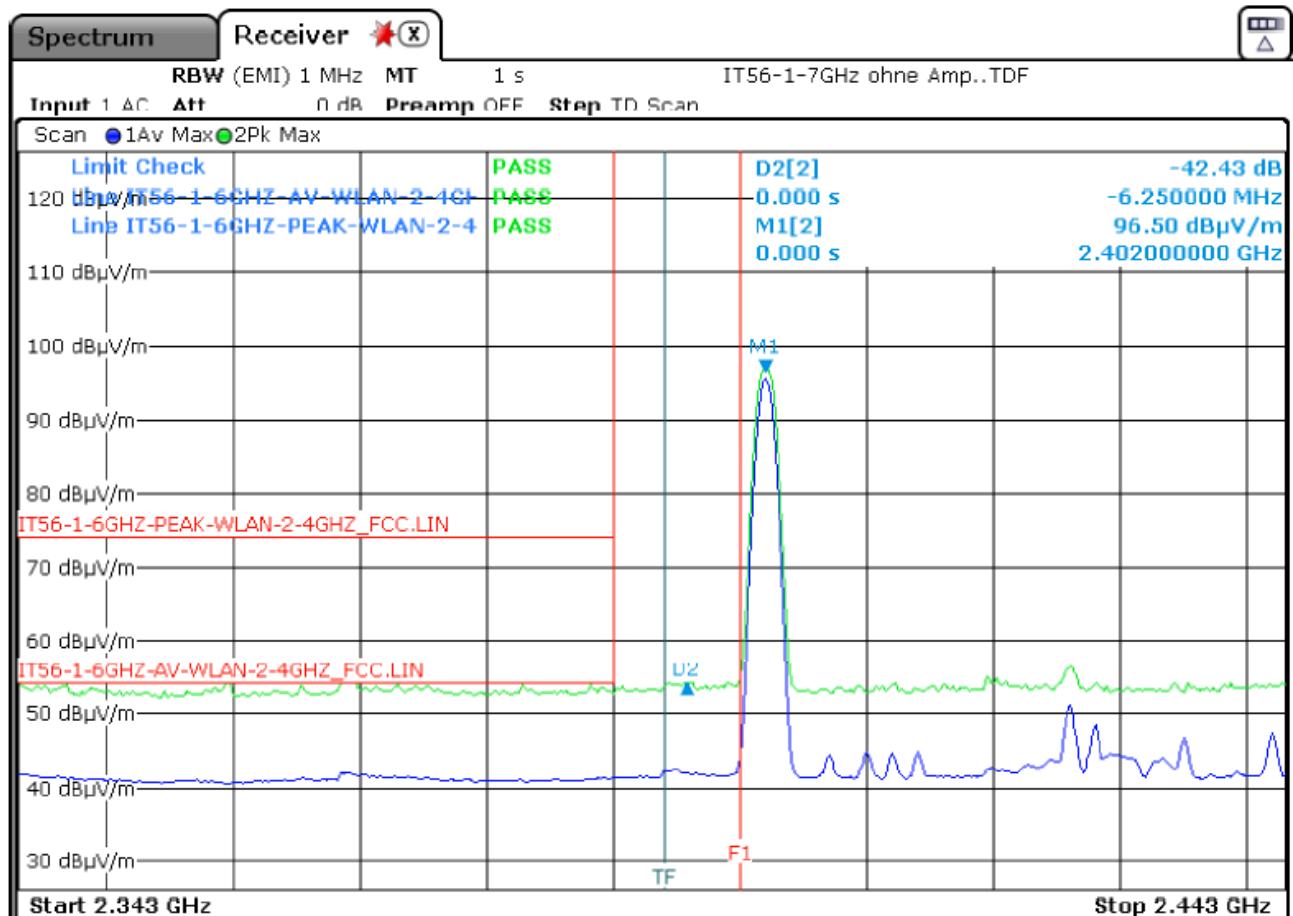
Band edge emission according to

ESTC

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

Ref.-No.: 20/01-0031

Operation mode: BT; Low Energy; Low Edge



8.5. 99% Power Bandwidth

Applied standards

-RSS-Gen issue 5 Section 6.7

Test equipment and test set up

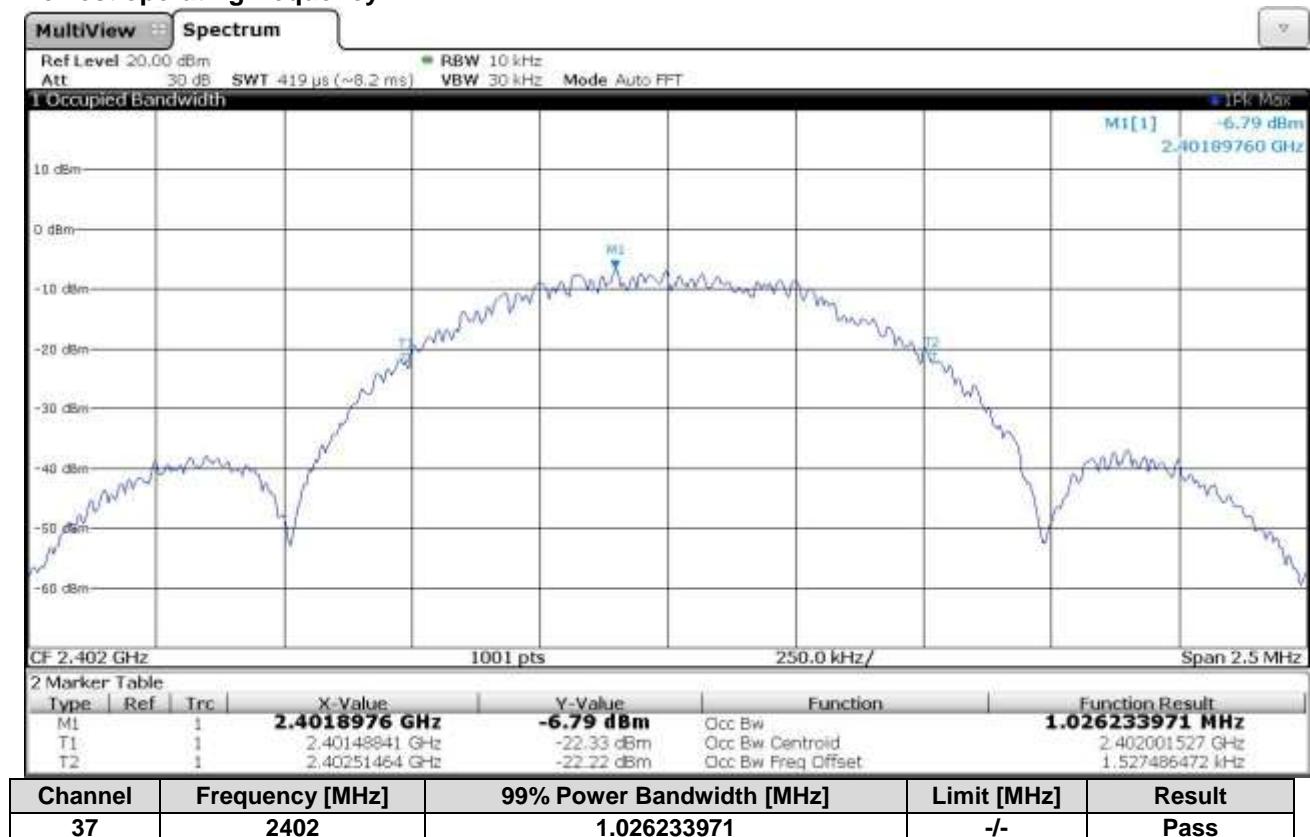
Test equipment used for conducted measurements as given in clause Test equipment of this report.
Test setup used for conducted measurements as given in clause Test setups of this report.

Description

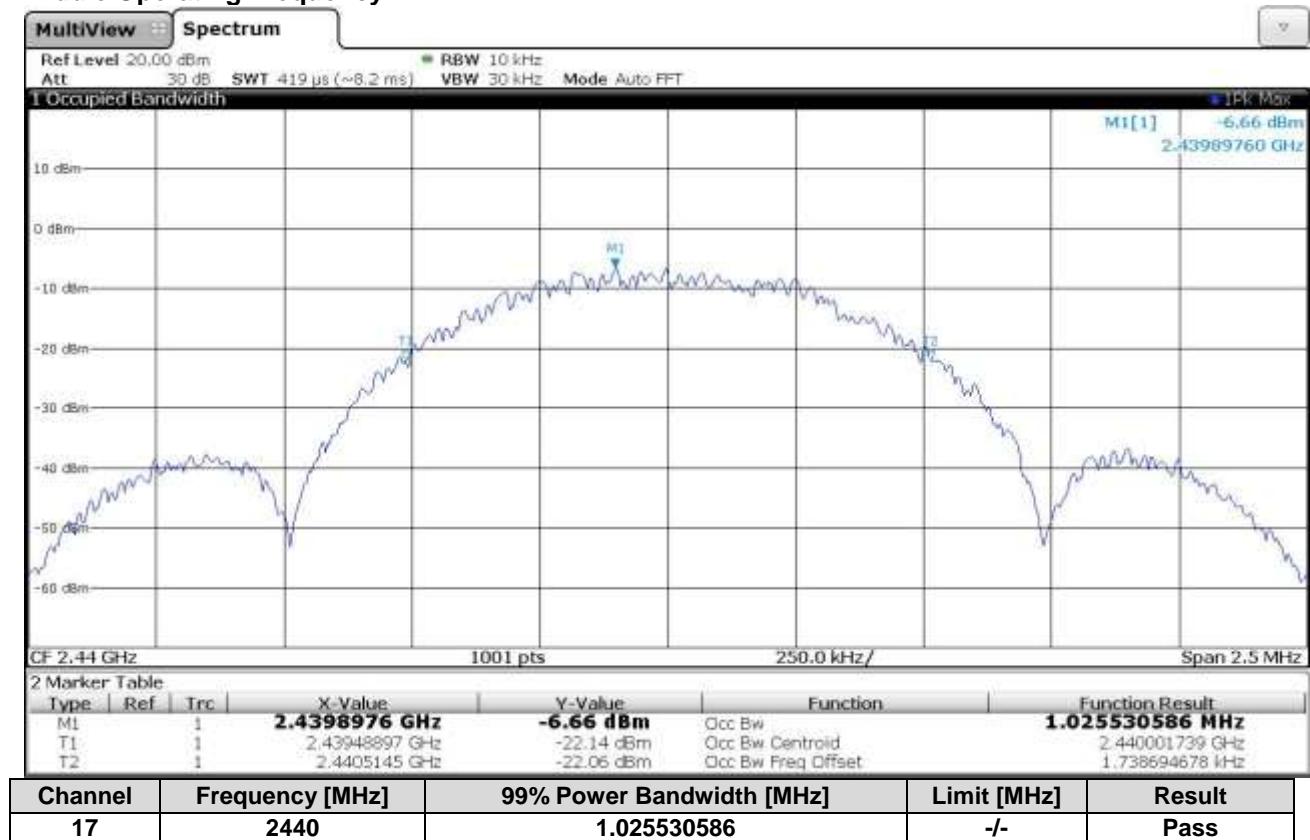
The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.
The 99% power bandwidth function of the instrument was used for the measurement.

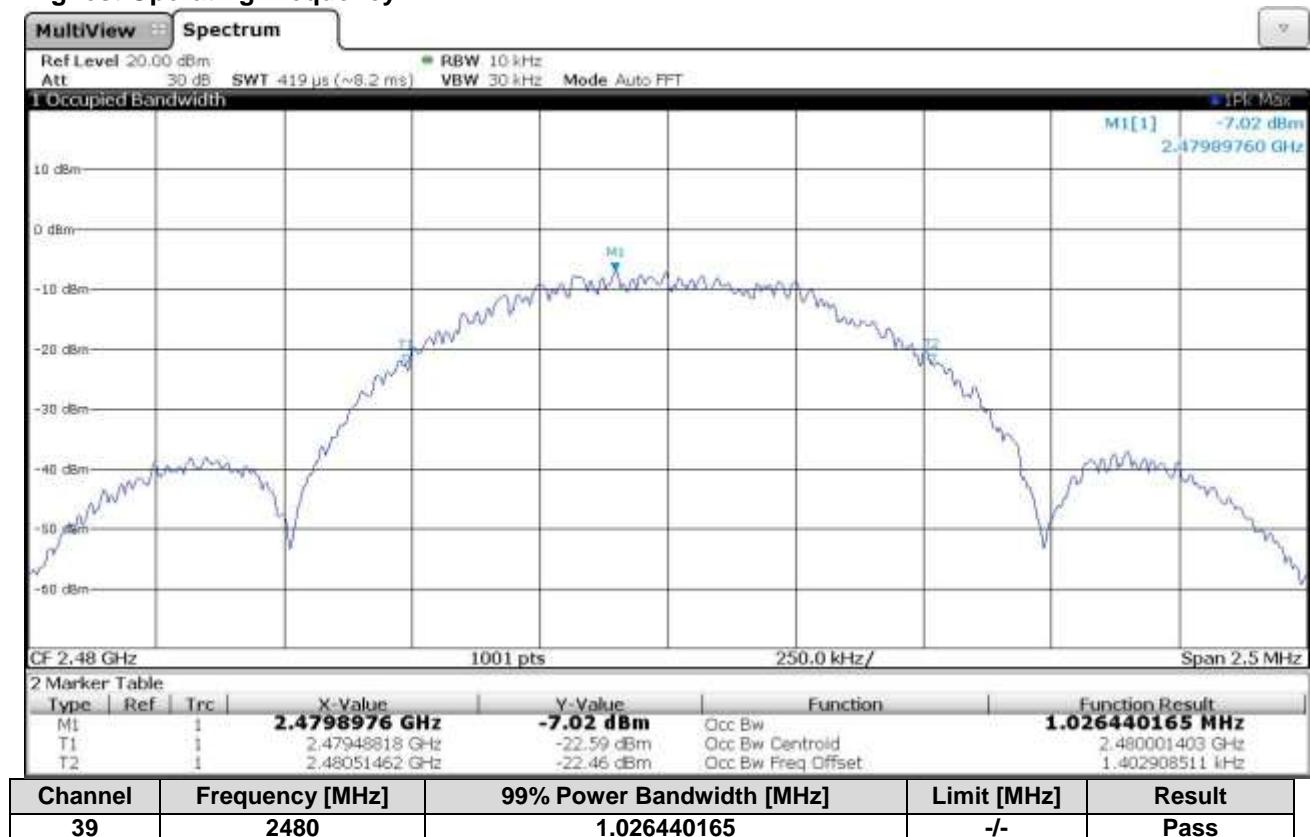
The Measurement was performed on: 05.03.2020

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**.

9. Test equipment

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
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	BBHA91706 21	2019-Dec.	3 years
Broadband-Preamplifier 1-18 GHz	Schwarzbeck	BBV9718	11231	9718-002	2017-Oct.	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	-/-	-/-	-/-
Above 26 GHz Substitution procedure						
Spectrum Analyzer	Rohde & Schwarz	FSMS 26	10481	839014/004	-/-	-/-
Spectrum-Analyzer Display	Rohde & Schwarz	FSMS 26	10482	838509/010	-/-	-/-
Harmonic Mixer	Rohde & Schwarz	FS-Z40	10779	842529/003	-/-	-/-
Harmonic Mixer LO-Amp.	Rohde & Schwarz	FS-Z30	10780	624413/005	-/-	-/-
Phase3 Ultra Low Loss Cable Assembly	TECH-INTER	GC12-K1K1-197	11718	1GVT4 19047702 001	-/-	-/-
Preamplifier 18 - 40 GHz	CERNEX	CBM18403523	11679	29711	2019 - July	3 years
A-INFO Braodband Horn Antenna	EMCO Elektronik GmbH	LB-180400-KF	11716	J211060840	-/-	-/-
Signal-Generator 100 KHz - 40 GHz	Rohde & Schwarz	SMB100A	11563	177769	2019-Jan.	3 years
Broadband-Hornantenne 15 - 26,5 (40) GHz	Schwarzbeck	BBHA 9170	11580	BBHA91706 21	2019-Dec.	3 years

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

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	-/-	-/-

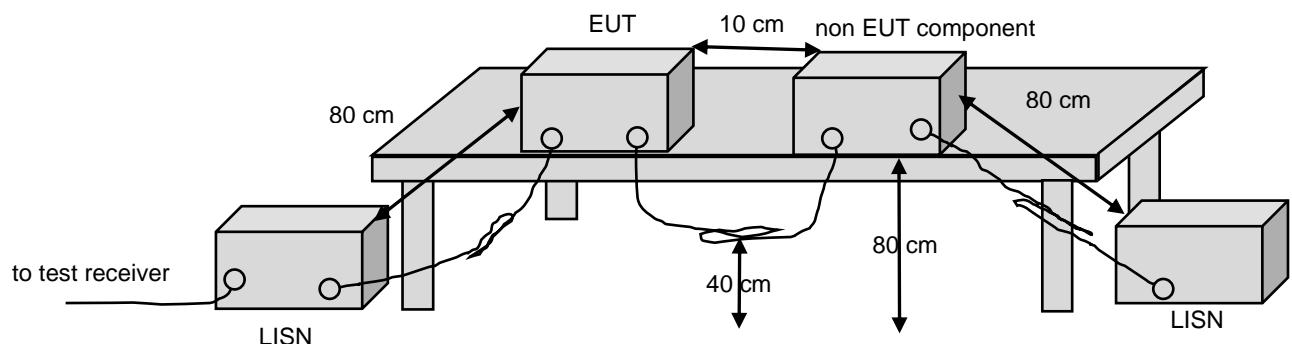
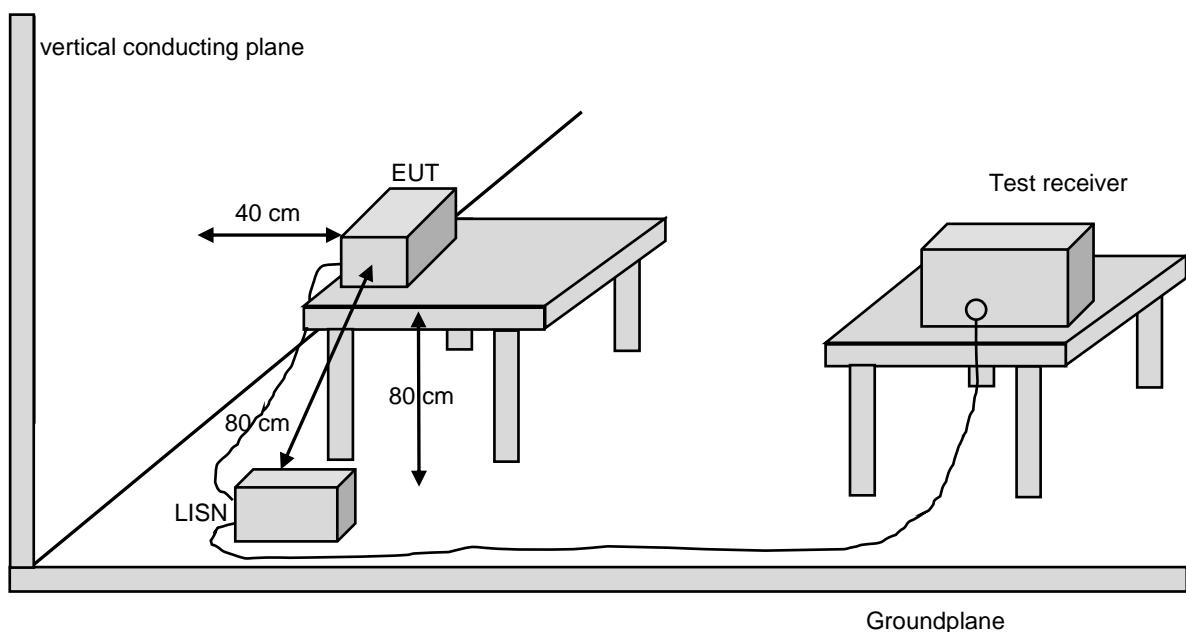
All measurements were made with measuring instruments, including any accessories that may affect test results, calibrated according to the requests of ISO/IEC 17025 according to which the test site is accredited from DAkkS. Measurement of conducted mains emissions was made with instruments conforming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

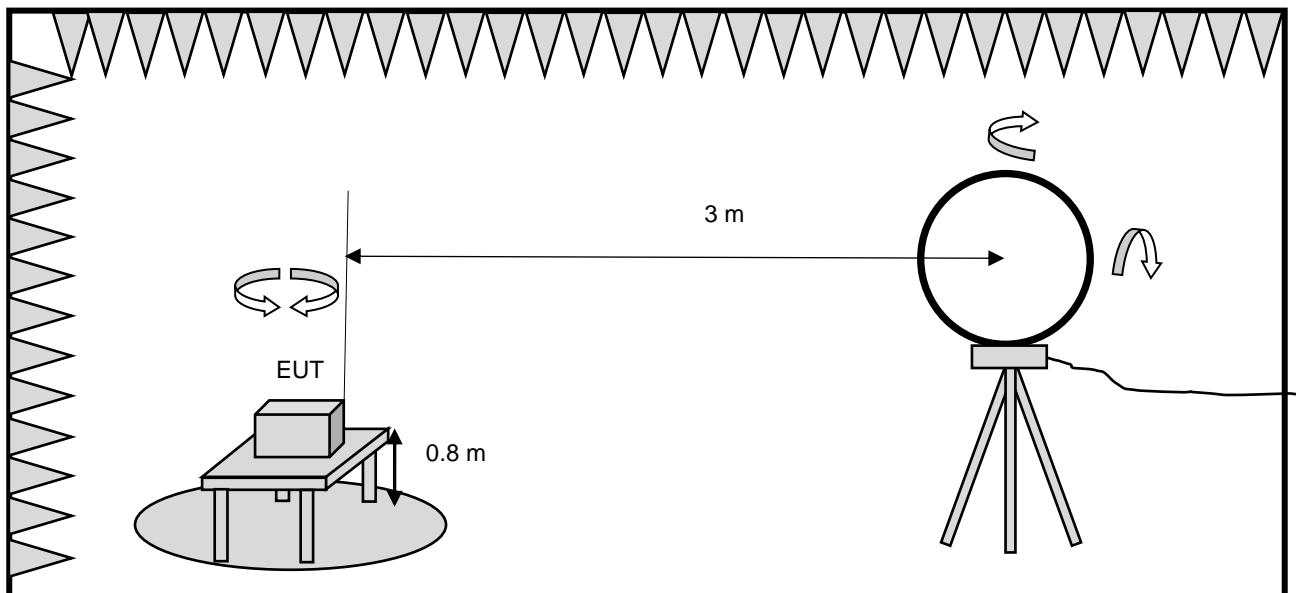
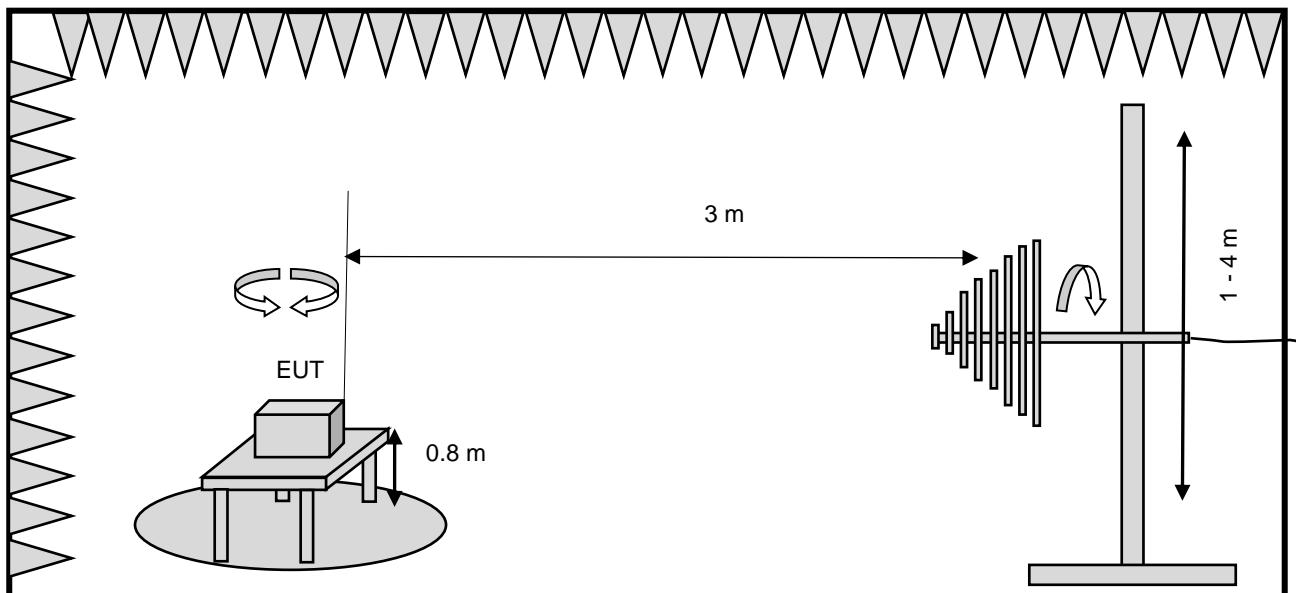
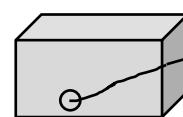
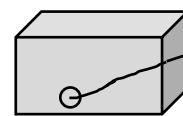
Test equipment to support EUT functions:

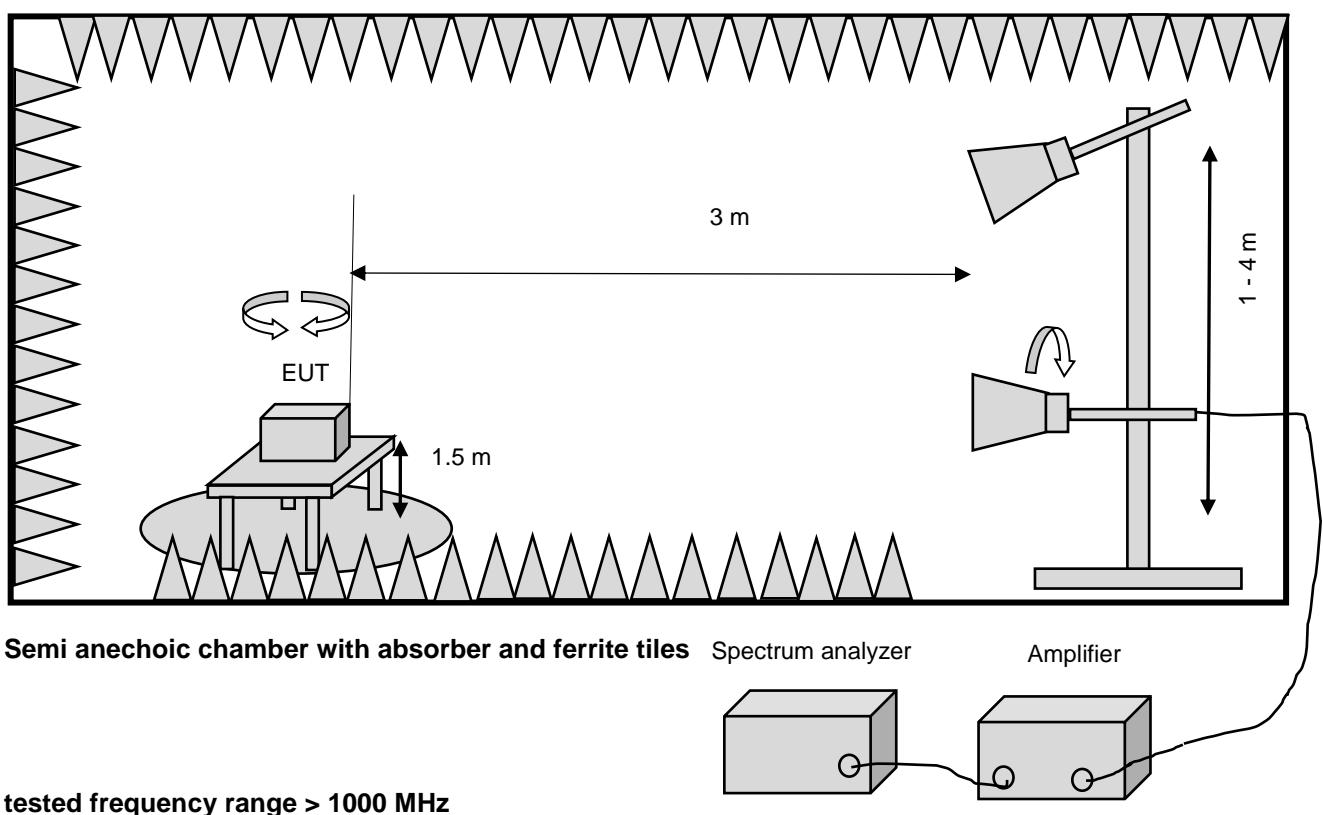
Kind of equipment	Manufacturer	Type	Ident no.
Laptop	DELL	Inspiron	11488
AC-Adaptor [Laptop/EUT]	DELL	DA130PE1-00	Part of 11488
Test Adaptor Board	Vestel (Client)	17TEST02	Client
Software	Provided by Vestel (Client)	Media Tek BT Tool	-/-

10. Test Setups

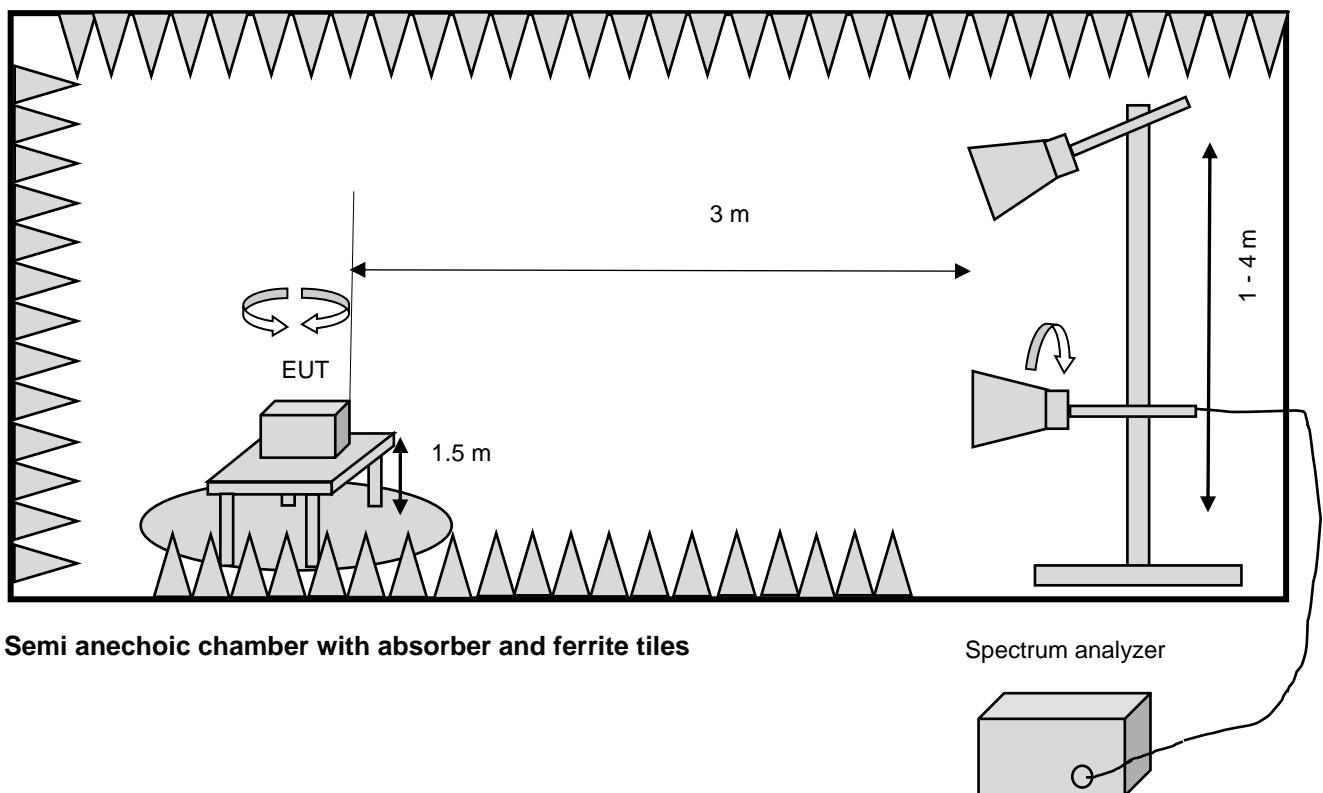
Block diagram Conducted Mains emissions

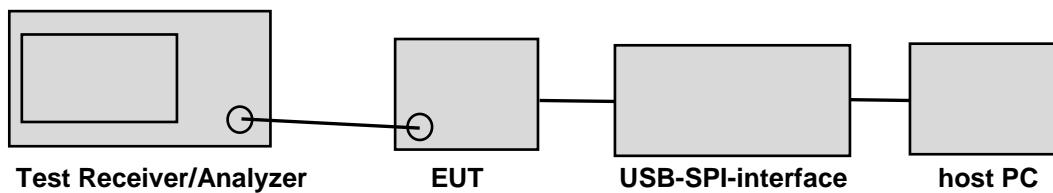


Block diagram Radiated emissions**Semi anechoic chamber with absorber and ferrite tiles****tested frequency range 9 kHz - 30 MHz****Test receiver****Semi anechoic chamber with absorber and ferrite tiles****tested frequency range 30 MHz - 1000 MHz****Test receiver**



Block diagram Band Edge emissions



Block diagram for conducted measurements

11. 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	-/-
Radiated disturbance (electric field strength in the SAC) 26.5 GHz to 40 GHz	3.1 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).

12. Photos setup

Refer to "0031-fcc-ised-photos test setup.pdf" file

13. 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.

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

none

15.12.2020
Erstellt am/prepared on

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


(Unterschrift/signature)

15.12.2020
Freigabe am/released on

K. Simon, Deputy Head of Laboratory
(Name/name / Stellung/position)


(Unterschrift/signature)

14. Photos of tested sample

Refer to "0031-fcc-ised-ext-photos.pdf" file

End of test report