



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



Bundesnetzagentur

BNetzA-CAB-18/21-19

 **TESTED
IN GERMANY**

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Test report no.: **20/03-0028**

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Location of test facility:



STC Germany GmbH
Ohmstrasse 1
84160 Frontenhausen
Germany

1. Client information

Name: DALI A/S
Address: Dali Allé 1, 9610 Norager, Denmark
Name of contact: Søren Johnsen
Telephone: +4522760349
Fax: -/
E-mail: sjo@dali.dk

2. Equipment under test (EUT)

2.1 Identification of the EUT

Equipment: Control preamplifier and source selection hub for DALI wireless speaker systems
Model: DALI SOUND HUB COMPACT
Brand name: DALI
Serial no.: -/
Manufacturer: DALI Audio Manufacturing (Ningbo) Co., Ltd
Building 2, No. 1188, Zhongguan Road
Zhenhai, Ningbo, China. 315221
Country of origin: China
Power rating: AC-Adaptor: DY9812-090130-19920C
100-240 V ~ ; 50/60 Hz ; 0.35 A max.
9 V = ; 1.3 A
Highest frequency generated or used in the device or on which the device operates or tunes: 5875 MHz
Date Sample Received: 9.03.2020
Tests were performed: 4.05.2020 -19.05.2020

2.2 Additional information about the EUT:

The unintentional function of the DALI SOUND HUB COMPACT is approved over sDoC procedure. DALI SOUND HUB COMPACT contains a modular approved RF module (KLEERNET) with following ID's FCC ID: ZUC-DWAM83TB / IC: 23522- DWAM83TB, the permissive change class 2 for frequency range 5150-5250MHz of the integrated RF module is pending.

Bluetooth Low Energy 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:	2AFD2-SHC		
IC:	20247-SHC		
HVIN:	360156-SHC		
Cables:	AC-Adaptor-DC cable:	141 cm	
	IR-cable:	147 cm	
Approx. Size (l x w x h):	(21.0 x 12.9 x 3.1) cm		
Test conditions:	<p>The "Control preamplifier and source selection hub for DALI wireless speaker systems – DALI SOUND HUB COMPACT" (= equipment under test – EUT) had been tested, where applicable, in the following modes:</p> <ol style="list-style-type: none"> (1) Bluetooth 5.0: Tx mode GFSK (FHSS) 2402.0 MHz (2) Bluetooth 5.0: Tx mode GFSK (FHSS) 2441.0 MHz (3) Bluetooth 5.0: Tx mode GFSK (FHSS) 2480.0 MHz (4) Bluetooth 5.0: Tx mode $\pi/4$-DQPSK 2402.0 MHz (5) Bluetooth 5.0: Tx mode $\pi/4$-DQPSK 2441.0 MHz (6) Bluetooth 5.0: Tx mode $\pi/4$-DQPSK 2480.0 MHz (7) Bluetooth 5.0: Tx mode 8DPSK 2402.0 MHz (8) Bluetooth 5.0: Tx mode 8DPSK 2441.0 MHz (9) Bluetooth 5.0: Tx mode 8DPSK 2480.0 MHz <p>controlled by a test software with maximum RF-output power and different data rate in order to find the worst case.</p> <p>as well as in normal operation mode with an active connection to Wireless Speaker via 5 GHz (5.2 GHz and 5.8 GHz) in following modes.</p> <ol style="list-style-type: none"> (10) Audio in (RCA) Input mode with 1 kHz sinus signal (11) Optical Input mode with 1 kHz sinus file playing (12) HDMI mode with color bar signal with moving element and 1 kHz sinus signal (13) Bluetooth mode Smartphone connected to EUT and audio file 1kHz playing <p>During tests a Monitor was connected to the EUT via HDMI and a 5 GHz wireless connection to the speaker's (DALI OBERON 7C) was established. The EUT was powered with 120 V~ 50/60Hz, as well as 240 V~ 50/60 Hz.</p>		
Additional information:	Conducted RF Measurements were carried out on a temporary SMA socket		
RF Module Model Number:	JS-BTM343		
Frequency range:	2.400 GHz – 2.483,5 GHz		
Operating frequencies:	2.402 GHz – 2.480 GHz		
Module Transmission Type:	Bluetooth 5.0 (FHSS)		
Modulation:	GFSK	$\pi/4$ -DQPSK	8DPSK
Date Rates:	1 MBit/s	2 MBit/s	3 MBit/s
Channel separation:	1 MHz	1 MHz	1 MHz
Number of channels:	79	79	79
Spurious Emissions: radiated lowest margin to limit	QP 39.0 dB μ V/m @ 3 m	QP 38.5 dB μ V/m @ 3 m	QP 39.3 dB μ V/m @ 3 m
Environmental conditions during tests:	Ambient temperature:	20 °C	
	Relative humidity	40 %	
	Atmospheric pressure	965 mbar	

Antenna specification:	<p>Bluetooth: Model: Printed PCB Antenna Gain: max. 2.1 dBi Type: <input type="checkbox"/> External (with accessible antenna socket) <input checked="" type="checkbox"/> Internal (integrated, PCB antenna)</p>
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 5.0

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	42	2444
1	2403	43	2445
2	2404	44	2446
3	2405	45	2447
4	2406	46	2448
5	2407	47	2449
6	2408	48	2450
7	2409
8	2410	70	2472
9	2411	71	2473
...	...	72	2474
36	2438	73	2475
37	2439	74	2476
38	2440	75	2477
39	2441	76	2478
40	2442	77	2479
41	2443	78	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:	
§ 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 7.8.7	20 dB 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 7.8.5	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 7.8.3	Number of Operating Channel	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
§15.247	RSS-247 issue 2	ANSI 63.10 Section 7.8.2	Carrier Frequency Separation	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
§15.247	RSS-247 issue 2	ANSI 63.10 Section 7.8.6	Band Edges Measurement	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
§15.247	RSS-247 issue 2	ANSI 63.10 Section 7.8.4	Occupancy Time (Dwell time)	<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. 20/03-0028.

- 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 May 11, 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 7.2

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 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

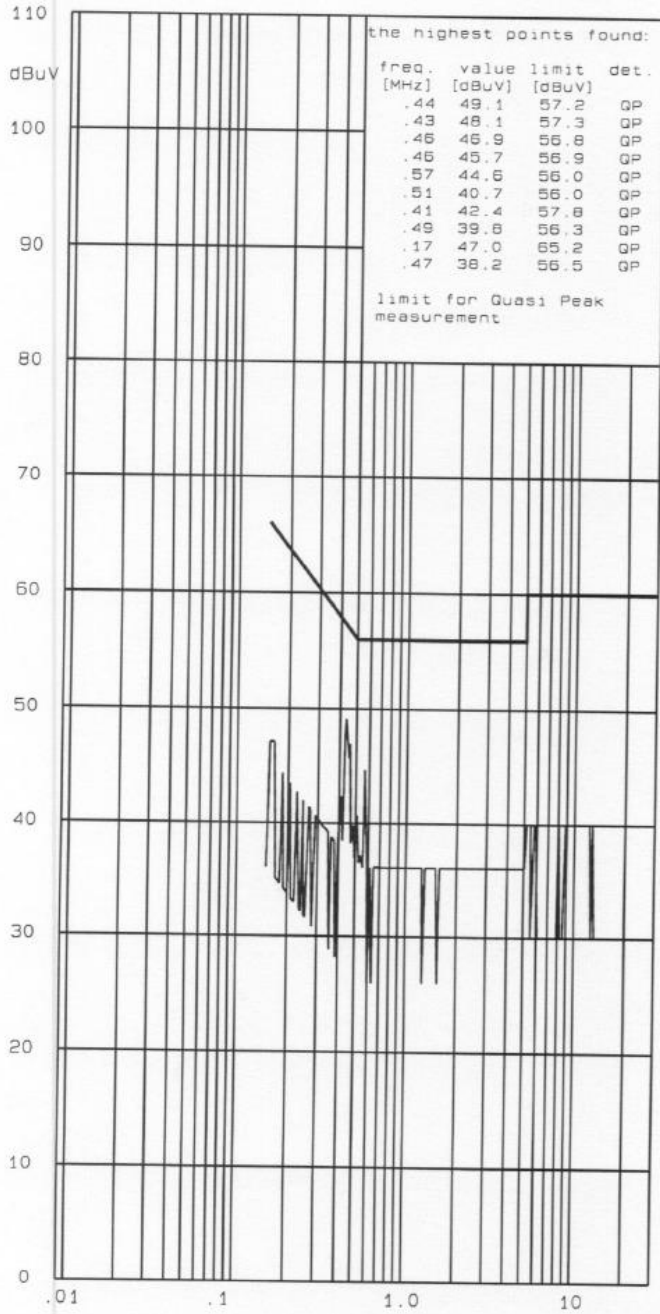
Measurement performed on 08.05.2020

As worst cases the mode No.: 11 with an input voltage of 120 V / 60 Hz was found and documented in this report. Additional the Bluetooth mode No.: 13 is also documented in this report.

Mode No.: 11

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz
acc. FCC 15.207 / RSS-Gen
Cabin 1



Ref.-No.: 20/03-0028
Product: Trans.-Rec.-System
Sample: 01
Date: 8 May 2020
Operator: Ji/Gi

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

Connected sets:
Input Voltage 120 V / 60 Hz
Host CD-Player
Host TV
Speakers (Oberon 7c)

Operating mode:
Optical CD in
Audio file 1 kHz playing
Speaker Output 12.5 %
Tested on N

RFI suppression parts:

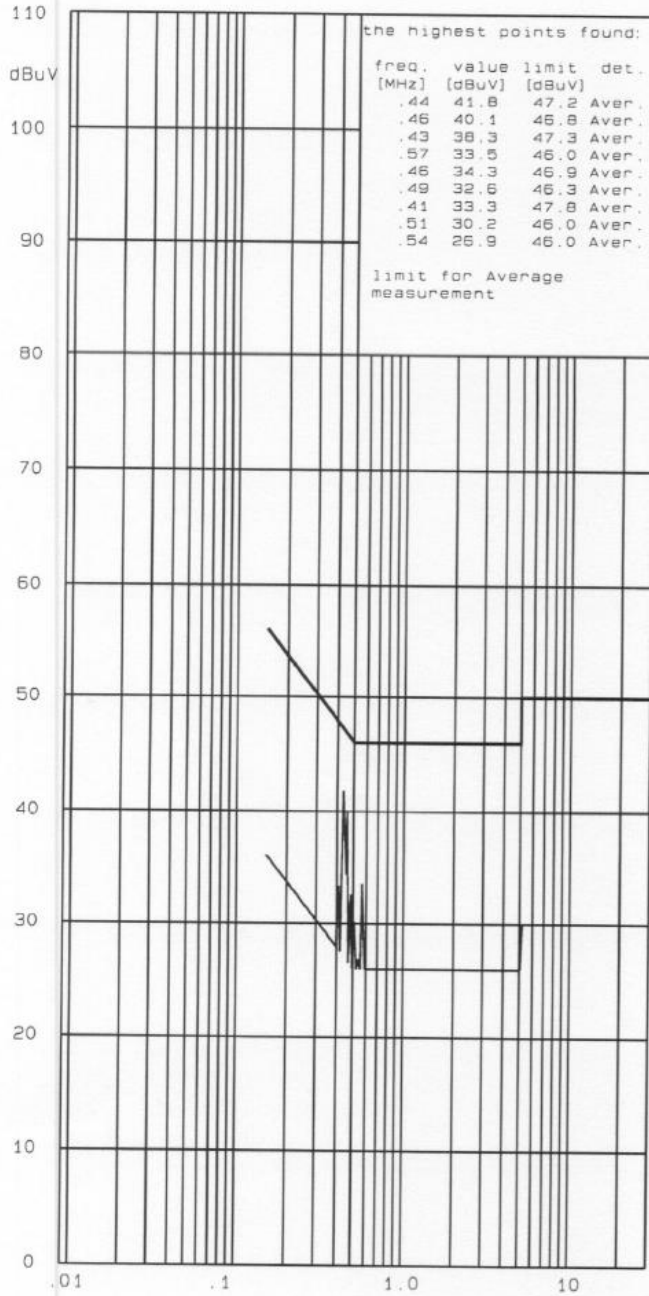
* two dB safety margin for
type approval recommended

Result: pass [] fail []

STC Germany GmbH

IT 1/2

Interference Voltage 150 KHz - 30 MHz
acc. FCC 15.207 / RSS-Gen
Cabin 1



Ref.-No.: 20/03-0028

Product: Trans.-Rec.-System

Sample: 01

Date: 8 May 2020

Operator: Ji/Gi

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-25

Connected sets:

Input Voltage 120 V / 60 Hz

Host CD-Player

Host TV

Speakers (Oberon 7c)

Operating mode:

Optical CD in

Audio file 1 kHz playing

Speaker Output 12.5 %

Tested on N

RFI suppression parts:

* two dB safety margin for type approval recommended

Result: pass [] fail []

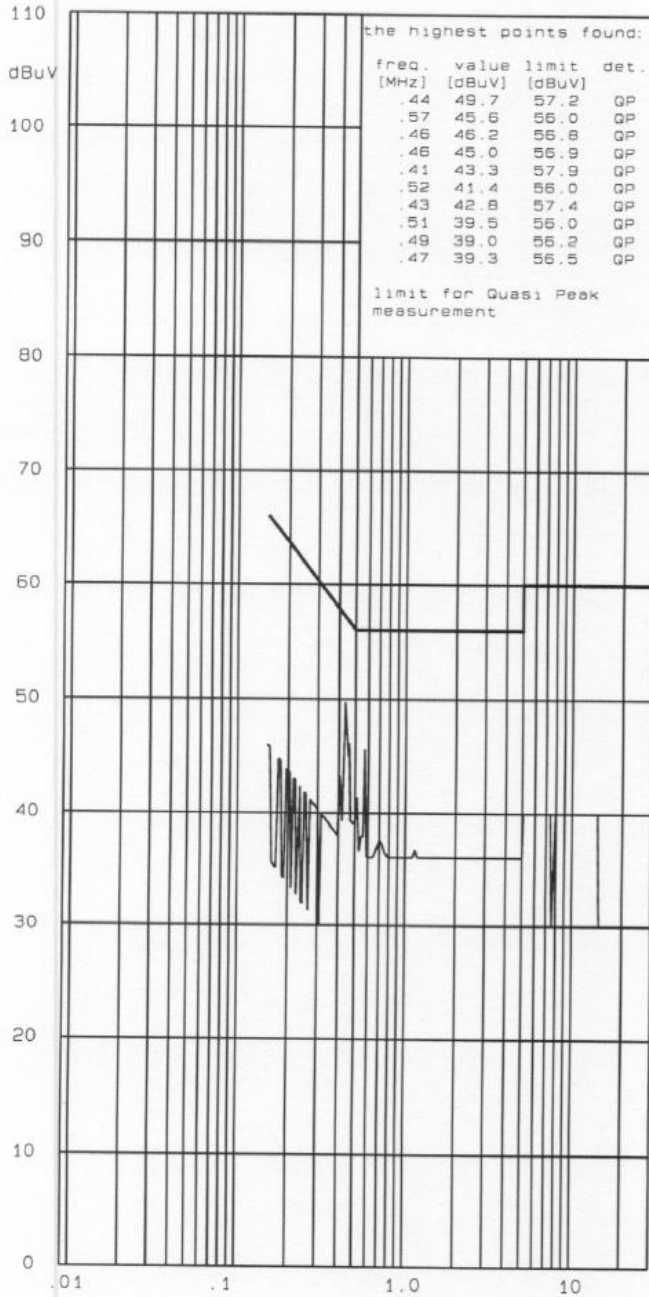
STC Germany GmbH

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC 15.207 / RSS-Gen

Cabin 1



Ref.-No.: 20/03-0028
Product: Trans.-Rec.-System
Sample: 01
Date: 8 May 2020
Operator: J1/G1

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

Connected sets:
Input Voltage 120 V / 60 Hz
Host CD-Player
Host TV
Speakers (Oberon 7c)

Operating mode:
Optical CD in
Audio file 1 kHz playing
Speaker Output 12.5 %
Tested on L1

RFI suppression parts:

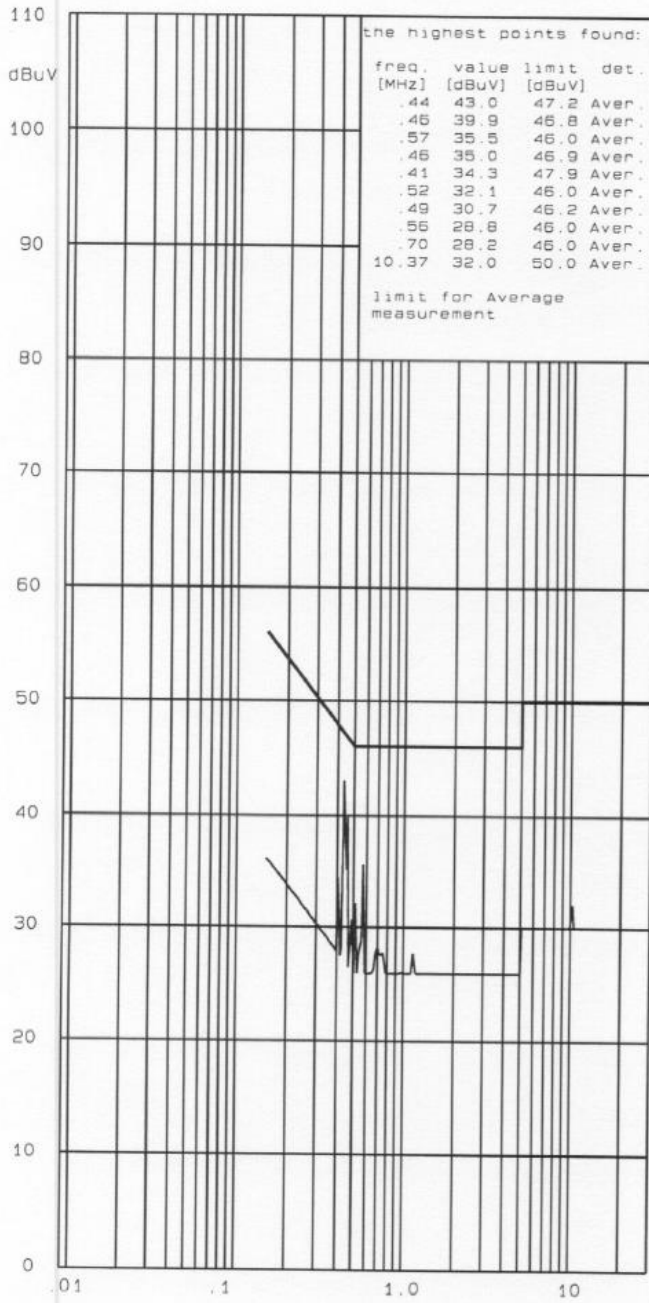
* two dB safety margin for
type approval recommended

Result: pass [] fail []

STC Germany GmbH

IT 1/2

Interference Voltage 150 KHz - 30 MHz
acc. FCC 15.207 / RSS-Gen
Cabin 1



Ref.-No.: 20/03-0028
Product: Trans.-Rec.-System
Sample: 01
Date: 8 May 2020
Operator: Ji/Gi

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

Connected sets:
Input Voltage 120 V / 60 Hz
Host CD-Player
Host TV
Speakers (Oberon 7c)

Operating mode:
Optical CD in
Audio file 1 kHz playing
Speaker Output 12.5 %
Tested on L1

RFI suppression parts:

* two dB safety margin for type approval recommended

Result: pass fail

STC Germany GmbH

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)
0.44	48.9	QP	N	0.10	0.10	49.1	57.2	Pass
0.43	47.9	QP	N	0.10	0.10	48.1	57.3	Pass
0.46	46.7	QP	N	0.10	0.10	46.9	56.8	Pass
0.57	44.4	QP	N	0.10	0.10	44.6	56.0	Pass
0.51	40.5	QP	N	0.10	0.10	40.7	56.0	Pass
0.41	42.2	QP	N	0.10	0.10	42.4	57.8	Pass
0.44	41.8	AV	N	0.10	0.10	41.8	47.2	Pass
0.46	39.9	AV	N	0.10	0.10	40.1	46.2	Pass
0.43	38.1	AV	N	0.10	0.10	38.3	47.3	Pass
0.57	33.3	AV	N	0.10	0.10	33.5	46.0	Pass
0.49	32.4	AV	N	0.10	0.10	32.6	46.3	Pass
0.41	33.1	AV	N	0.10	0.10	33.3	47.8	Pass
0.44	49.5	QP	L1	0.10	0.10	49.7	57.2	Pass
0.57	45.4	QP	L1	0.10	0.10	45.6	56.0	Pass
0.46	46.0	QP	L1	0.10	0.10	46.2	56.8	Pass
0.41	43.1	QP	L1	0.10	0.10	43.3	57.9	Pass
0.52	41.2	QP	L1	0.10	0.10	41.4	56.0	Pass
0.43	42.6	QP	L1	0.10	0.10	42.8	57.4	Pass
0.44	42.8	AV	L1	0.10	0.10	43.0	47.2	Pass
0.46	39.7	AV	L1	0.10	0.10	39.9	46.8	Pass
0.57	35.3	AV	L1	0.10	0.10	35.5	46.0	Pass
0.41	34.1	AV	L1	0.10	0.10	34.3	47.9	Pass
0.52	31.9	AV	L1	0.10	0.10	32.1	46.0	Pass
0.49	30.5	AV	L1	0.10	0.10	30.7	46.2	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]

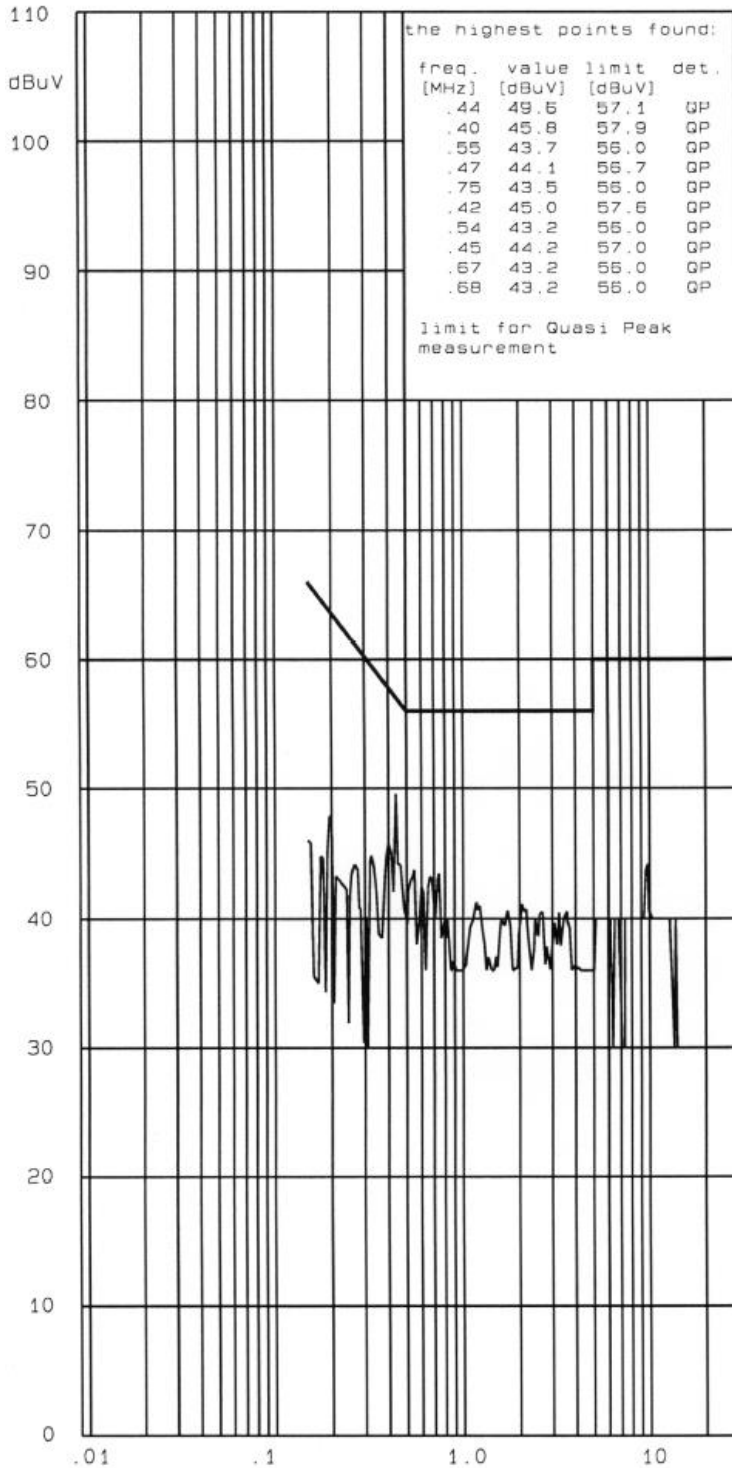
Mode No.: 13

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC 15.207 / RSS-Gen

Cabin 1



Ref.-No.: 20/03-0028

Product: Trans.-/Rec.-System

Sample: 01

Date: 7 May 2020

Operator: Ji/Gi

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-Z5

Connected sets:

Input Voltage 120 V / 60 Hz

Host CD-Player

Host TV

Speakers (Oberon 7c)

Operating mode:

Bluetooth con.

Audio file 1 kHz playing

Speaker Output 12.5%

Tested on N

RFI suppression parts:

* two dB safety margin for
type approval recommended

Result: pass fail

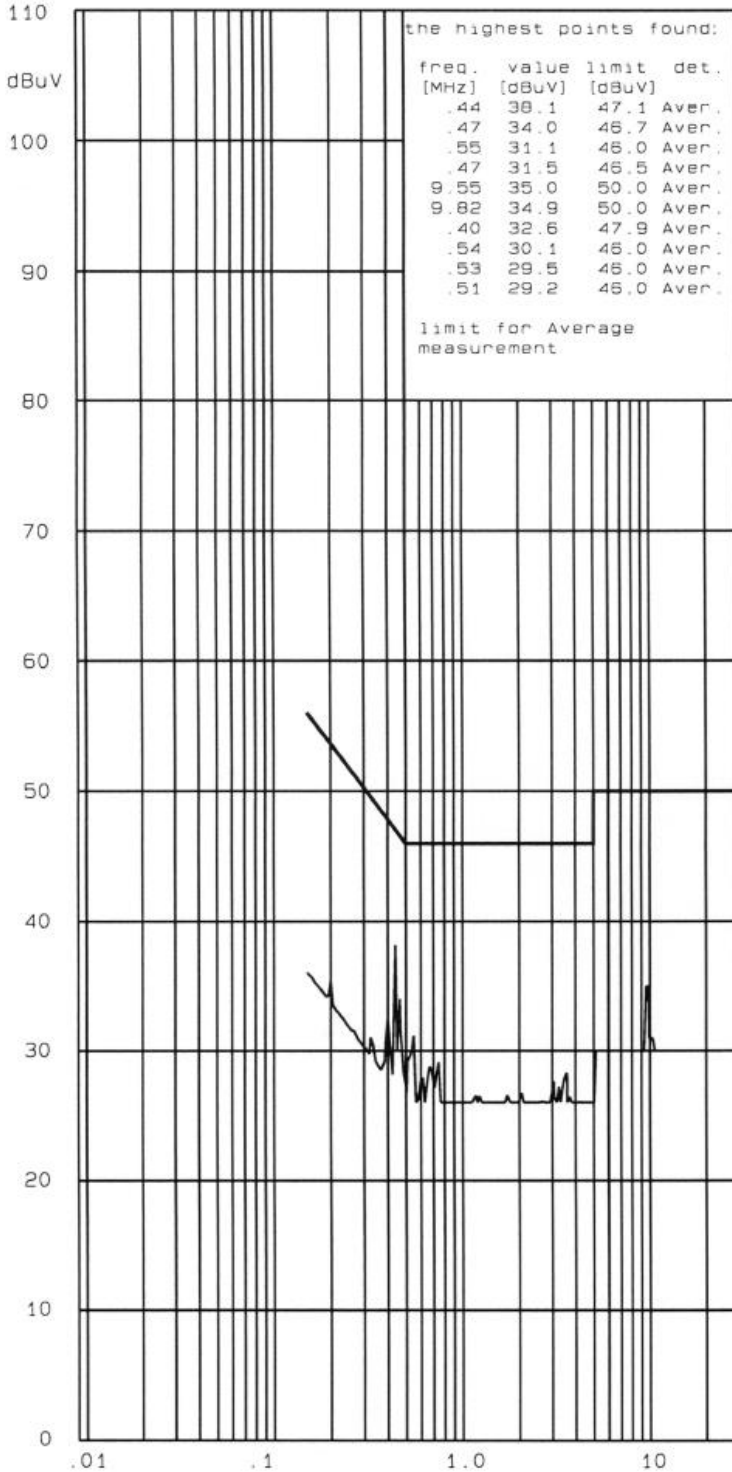
STC Germany GmbH

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC 15.207 / RSS-Gen

Cabin 1



Ref.-No.: 20/03-0028
 Product: Trans.-/Rec.-System
 Sample: 01
 Date: 7 May 2020
 Operator: Ji/Gi

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

Connected sets:
 Input Voltage 120 V / 60 Hz
 Host CD-Player
 Host TV
 Speakers (Oberon 7c)

Operating mode:
 Bluetooth con.
 Audio file 1 kHz playing
 Speaker Output 12.5%
 Tested on N

RFI suppression parts:

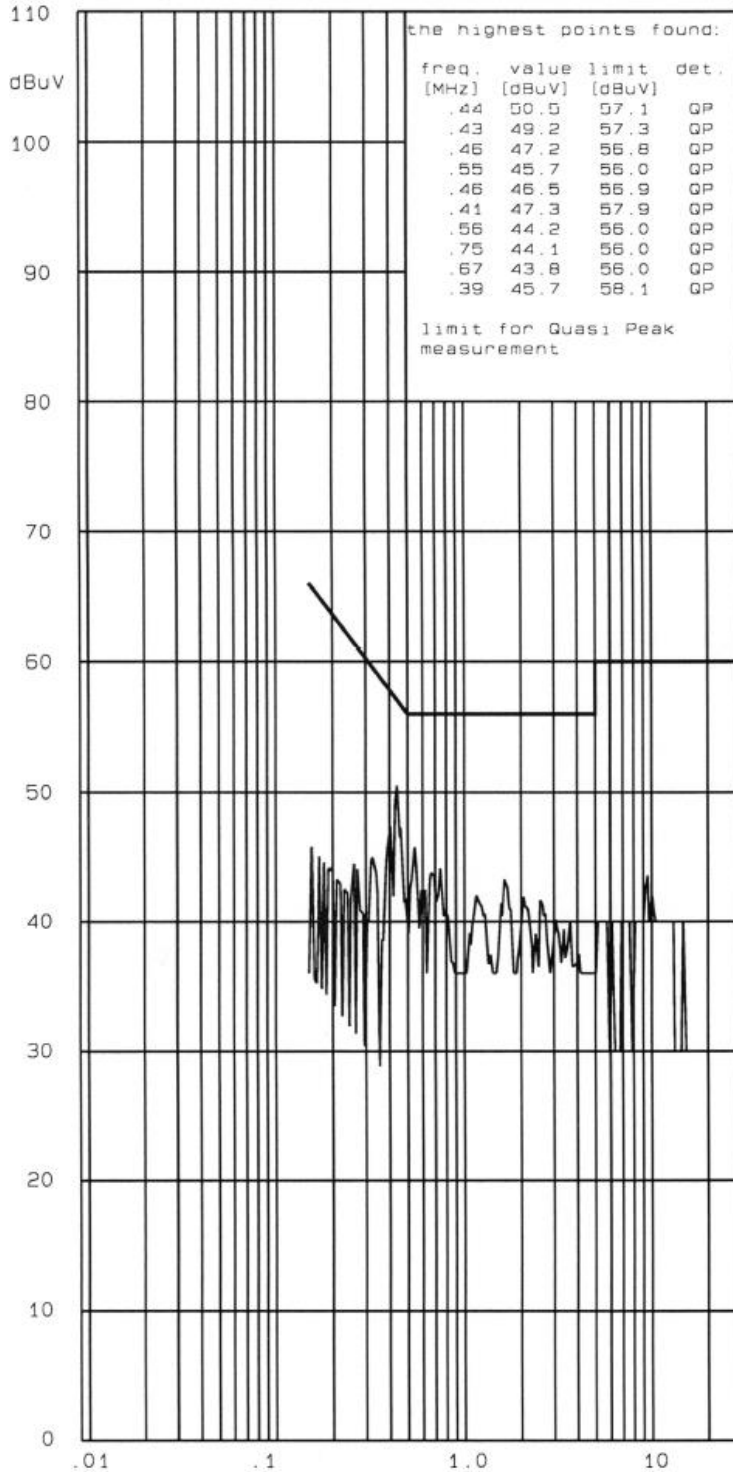
* two dB safety margin for type approval recommended

Result: pass fail

STC Germany GmbH

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz
acc. FCC 15.207 / RSS-Gen
Cabin 1



Ref.-No.: 20/03-0028
Product: Trans.-/Rec.-System
Sample: 01
Date: 7 May 2020
Operator: Ji/Gi

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

Connected sets:
Input Voltage 120 V / 60 Hz
Host CD-Player
Host TV
Speakers (Oberon 7c)

Operating mode:
Bluetooth con.
Audio file 1 kHz playing
Speaker Output 12.5%
Tested on L1

RFI suppression parts:

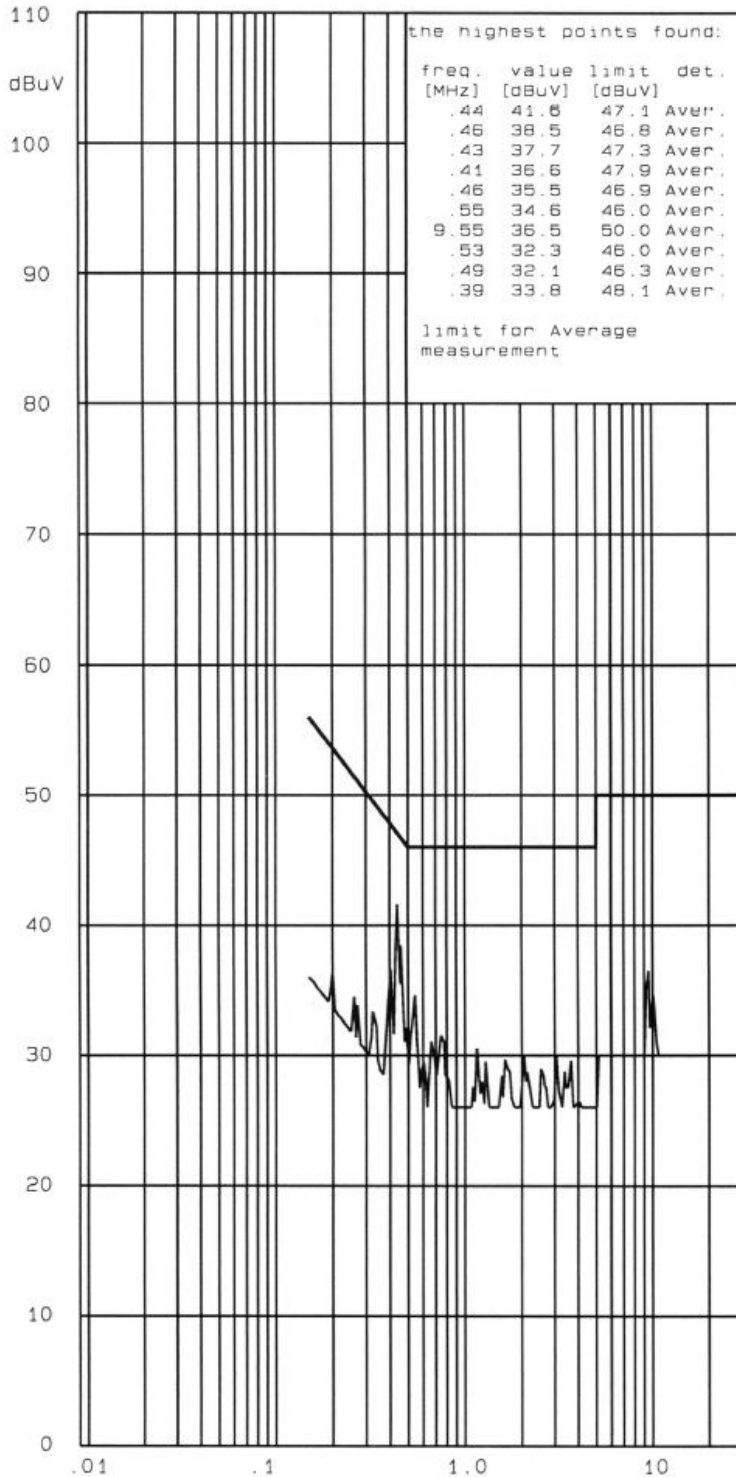
* two dB safety margin for
type approval recommended

Result: pass fail

STC Germany GmbH

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz
acc. FCC 15.207 / RSS-Gen
Cabin 1



Ref.-No.: 20/03-0028

Product: Trans.-/Rec.-System

Sample: 01

Date: 7 May 2020

Operator: Ji/Gi

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-Z5

Connected sets:

Input Voltage 120 V / 60 Hz

Host CD-Player

Host TV

Speakers (Oberon 7c)

Operating mode:

Bluetooth con.

Audio file 1 kHz playing

Speaker Output 12.5%

Tested on L1

RFI suppression parts:

* two dB safety margin for
type approval recommended

Result: pass [] fail []

STC Germany GmbH

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)
0.44	49.6	QP	N	0.10	0.10	49.8	57.1	Pass
0.40	45.8	QP	N	0.10	0.10	46.0	57.9	Pass
0.55	43.7	QP	N	0.10	0.10	43.9	56.0	Pass
0.47	44.1	QP	N	0.10	0.10	44.3	56.7	Pass
0.75	43.5	QP	N	0.10	0.10	43.7	56.0	Pass
0.42	45.0	QP	N	0.10	0.10	45.2	57.6	Pass
0.44	38.1	AV	N	0.10	0.10	38.3	47.1	Pass
0.47	34.0	AV	N	0.10	0.10	34.2	46.7	Pass
0.55	31.1	AV	N	0.10	0.10	31.3	46.0	Pass
0.47	31.5	AV	N	0.10	0.10	31.7	46.5	Pass
9.55	35.0	AV	N	0.30	0.20	35.2	50.0	Pass
9.82	34.9	AV	N	0.30	0.20	35.1	50.0	Pass
0.44	50.5	QP	L1	0.10	0.10	50.7	57.1	Pass
0.43	49.2	QP	L1	0.10	0.10	49.4	57.3	Pass
0.46	47.2	QP	L1	0.10	0.10	47.4	56.8	Pass
0.55	45.7	QP	L1	0.10	0.10	45.9	56.0	Pass
0.46	46.5	QP	L1	0.10	0.10	46.7	56.9	Pass
0.41	47.3	QP	L1	0.10	0.10	47.5	57.9	Pass
0.44	41.6	AV	L1	0.10	0.10	41.8	47.2	Pass
0.46	38.5	AV	L1	0.10	0.10	38.7	46.4	Pass
0.43	37.7	AV	L1	0.10	0.10	37.9	-/-	Pass
0.41	36.6	AV	L1	0.10	0.10	36.8	-/-	Pass
0.46	35.5	AV	L1	0.10	0.10	35.7	-/-	Pass
0.55	34.6	AV	L1	0.10	0.10	34.8	-/-	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]

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 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 in a SAC .

The horizontal distance between the receiving antenna and the EUT was 3 meters.

In the range of 1 GHz to 40 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 to 40 GHz was investigated as the highest frequency generated in the EUT is 5.875 GHz.

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

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.

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: 04.5.2020 and 19.05.2020

Result 9 kHz – 30 MHz

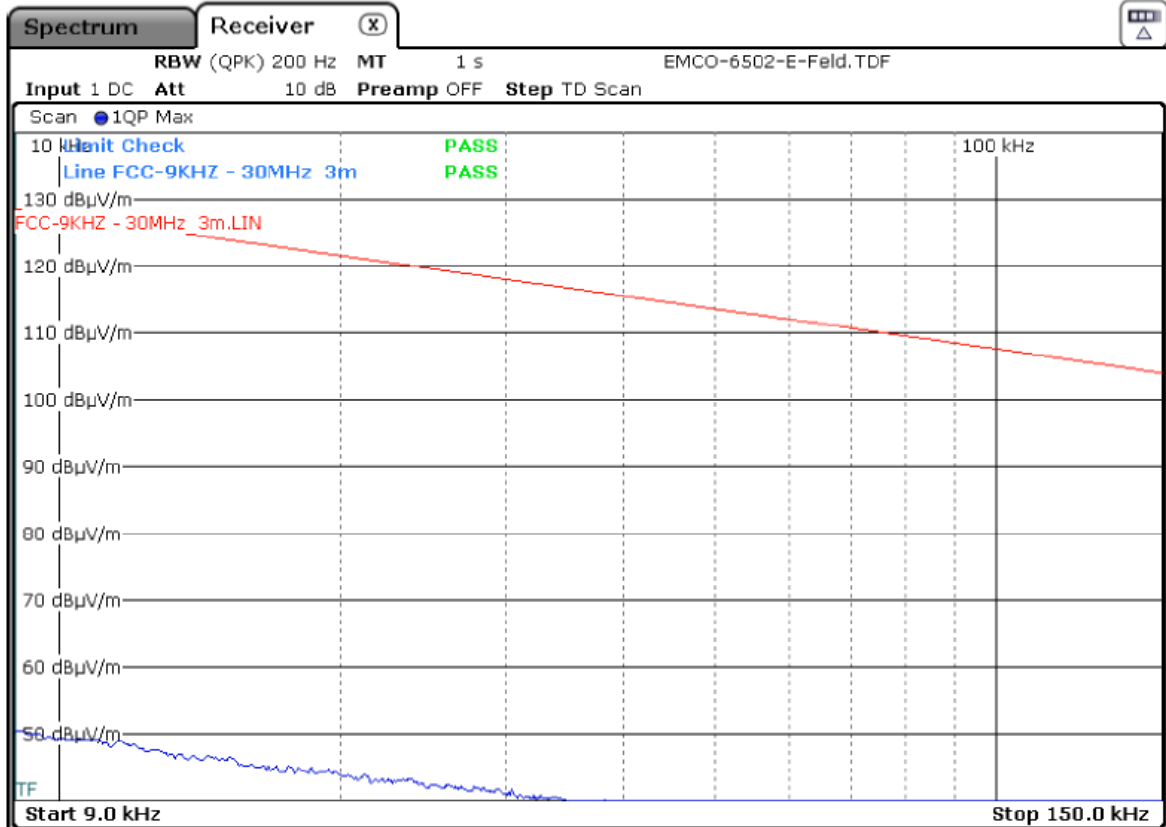
In the frequency range 9 kHz – 30 MHz the EUT had been scanned in a distance of 3 m and the Limit were corrected to the test distance of 3 m using a factor with 40 dB/decade acc. to § 15.31 (f)(2).

As worst cases the mode No.: 13 with an input voltage of 120 V / 60 Hz was found and documented in this report.

Ref.-No.: 20/03-0028

Operation mode: BT connected; Audio File playing 1kHz; Speaker output 12,5%

Position X (9kHz - 150kHz)

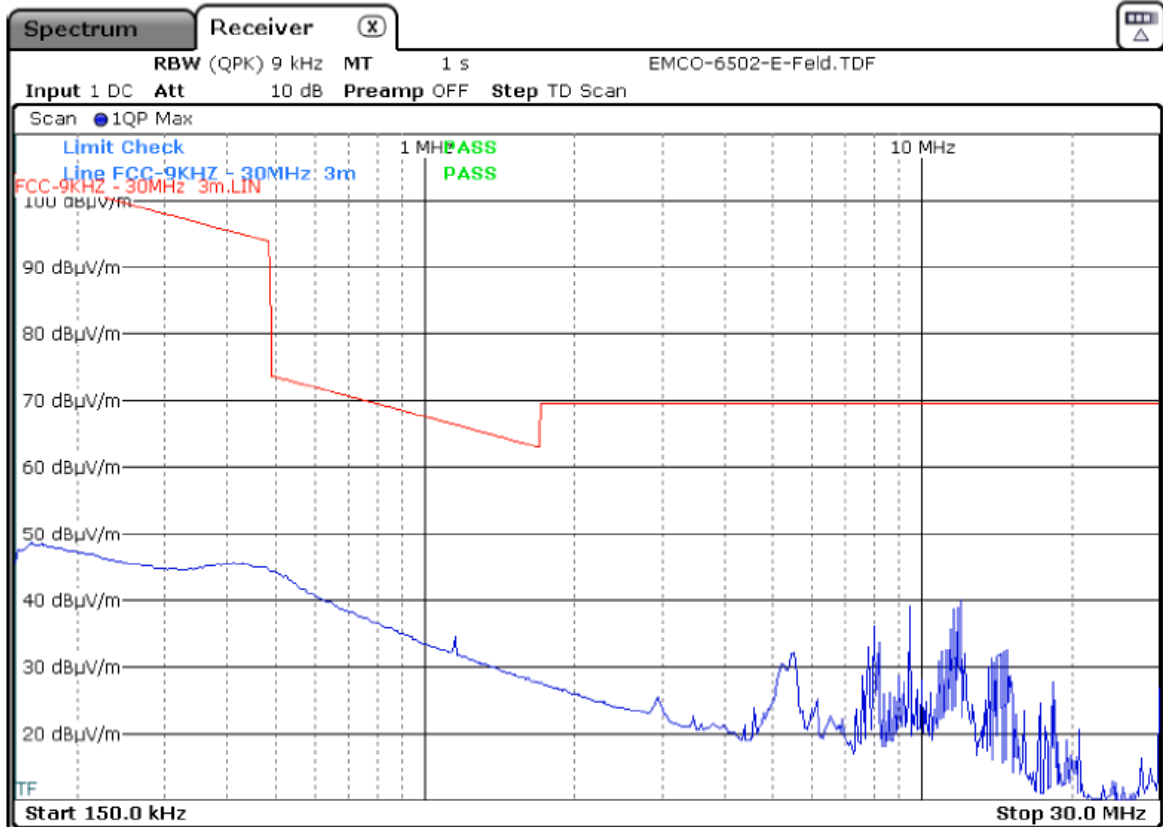


Position: X				
Detector QP				
Frequ. [MHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
9kHz-150kHz	-/-	>20	-/-	pass

Ref.-No.: 20/03-0028

Operation mode: BT connected; Audio File playing 1kHz; Speaker output 12,5%

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

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

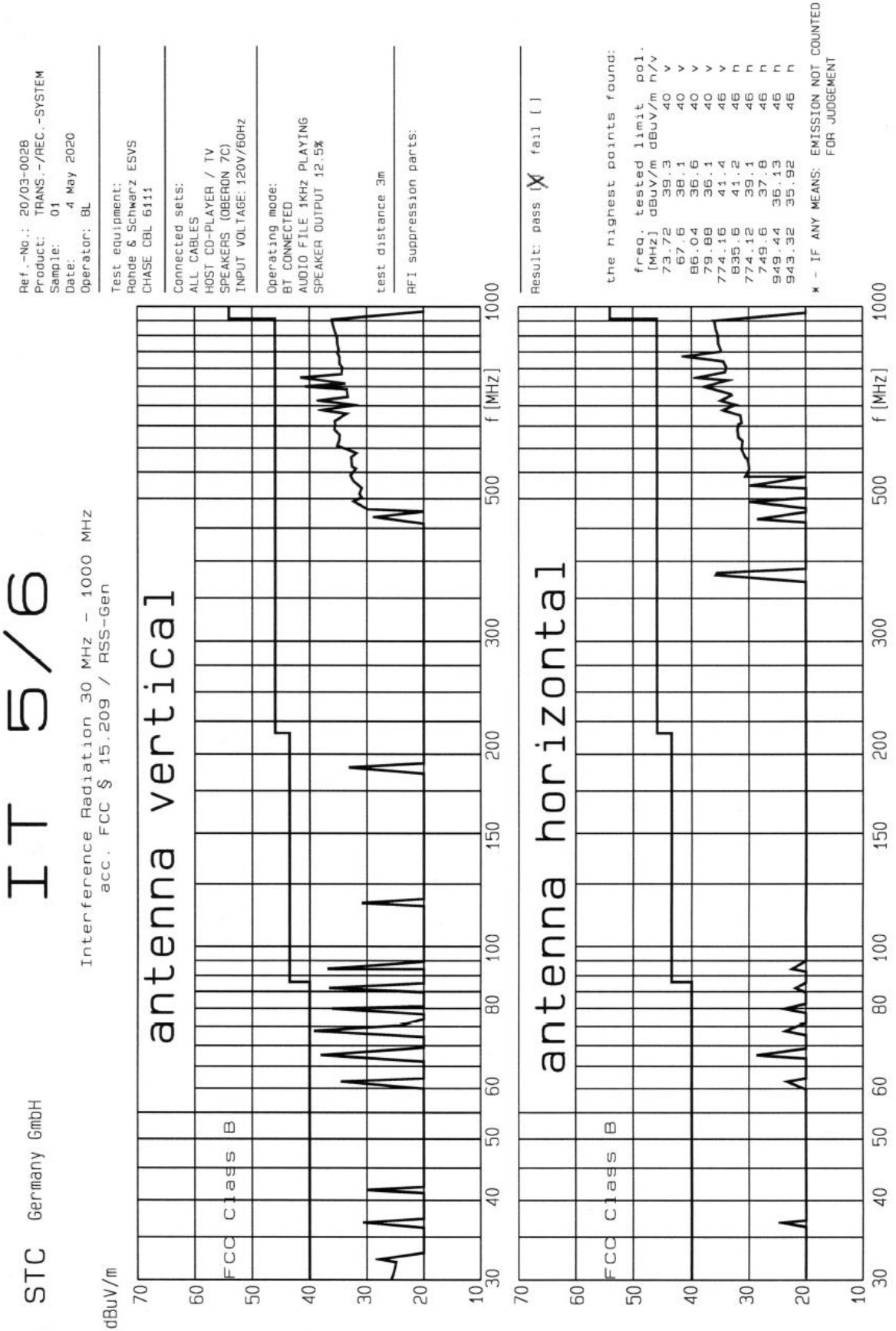
Function	Freq.	Measured Value @ 3m	Conversion to magnetic field ^{Note 1}		Limit @ 3m		Margin	Result
	[MHz]		[dBµV/m]	[dBµA/m]	[µA/m]	[dBµA/m]		
Bluetooth connected – Audio file 1 kHz playing	0.009 – 0.490	< 73.8	< 22.3	-/-	77 - 42.3	-/-	>20	pass
	0.490 – 1.705	< 43.0	< -8.5	-/-	22.3 - 11.5	-/-	>20	pass
	1.705 - 30	< 49.5	< -2.0	-/-	18	-/-	>20	pass

Note 1: Conversion E-field to H-Field:
 $x \text{ [dBµV/m]} - 51.5 = y \text{ [dBµA/m]}$

Conversion [dBµA/m] in [µA/m]
 $10^{(y \text{ [dBµA/m]} / 20)} = z \text{ [µA/m]}$

Result 30 MHz – 1000 MHz

As worst cases the mode No. 6. with Bluetooth connected – Audio file 1 kHz playing was found and documented in this report.



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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 [dBµV/m]	Radiated emission [µV/m]	Limit [dBµV/m] (3 m)	Limit [µV/m] (3 m)	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
73.72	QP	V	39.3	92.26	40.00	100	Pass
67.6	QP	V	38.1	80.35	40.00	100	Pass
86.04	QP	V	36.6	67.61	40.00	100	Pass
79.88	QP	V	36.1	63.83	40.00	100	Pass
744.16	QP	V	41.4	117.49	46.00	200	Pass
-/-	QP	V	-/-	-/-	-/-	-/-	-/-
835.6	QP	H	41.2	114.82	46.00	200	Pass
774.12	QP	H	39.1	90.16	46.00	200	Pass
749.6	QP	H	37.8	77.62	46.00	200	Pass
949.44	QP	H	36.13	64.05	46.00	200	Pass
943.32	QP	H	35.92	62.52	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 [dBµV] + correction factor
- (5) = $10^{((\text{Radiated emission [dBµV/m]} (4))/20)}$
- (6) = relevant limit in dBµV/m
- (7) = relevant limit in µV/m
- (8) = comparison between Limit [dBµV/m] (6) and Radiated emission [dBµV/m] (4)

Result 1 GHz – 7 GHz

As worst cases the mode No. 9 Bluetooth single Frequency transmission at 2480 MHz 8DPSK was found and documented in this report. Additional the Audio in (RCA) – Audio file 1 kHz playing mode No.: 13 is also documented in this report.

Mode No.: 9



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Interference radiation

acc.FCC Subpart C § 15.209/RSS-Gen



Ref.-No.: 20/03-0028

Product: Transmitting/Receiving System

Sample: 03

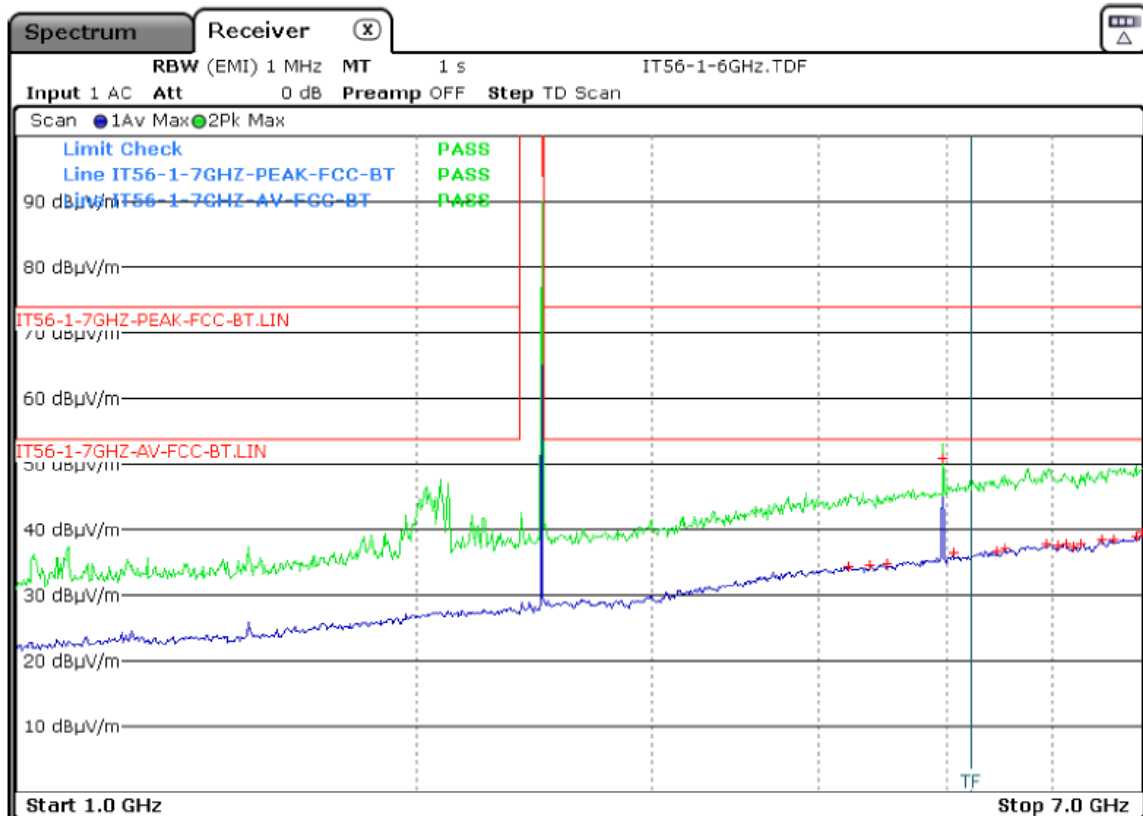
Date: 19.05.2020

Operator: BI

Remarks:

Result: pass fail

Operation mode: Tx BT CH.79 (2480MHz); 8DPSK; Output power: max.

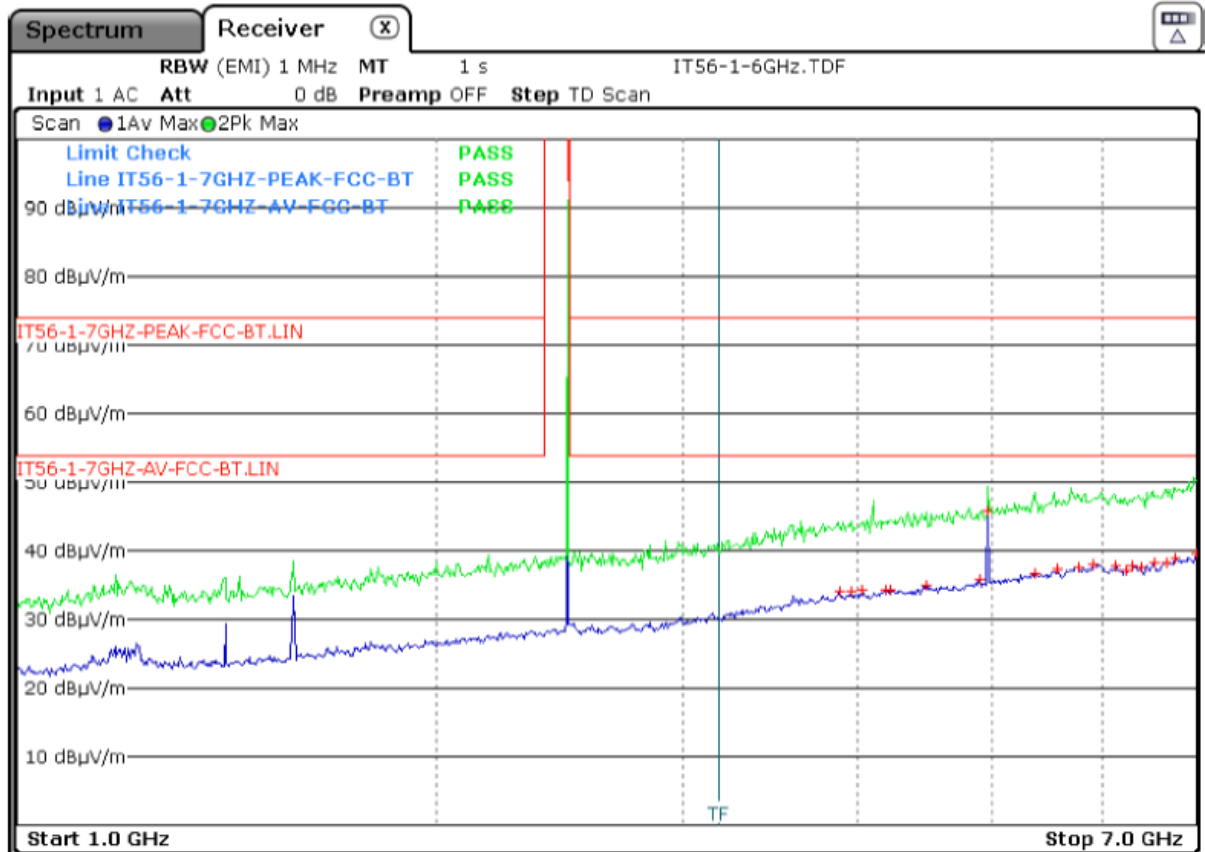


Polarisation: V									
Detector Average					Detector Peak				
Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result	Frequ. [GHz]	Level [dBµV/m]	Margin to Limit [dB]	Limit [dBµV/m]	Result
4,9598	50,77	-3,23	54,00	pass	1 - 7	-/	>20	74	pass
6,9950	39,57	-14,43	54,00	pass					
6,9233	38,95	-15,05	54,00	pass					
6,6668	38,57	-15,43	54,00	pass					
6,5333	38,49	-15,51	54,00	pass					
6,1435	37,93	-16,07	54,00	pass					

Note: Measured without Band rejection filter ID: 11243

Ref.-No.: 20/03-0028

Operation mode: Tx BT CH.79 (2480MHz); 8DPSK; Output power: max.



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
4,9598	45,86	-8,14	54,00	pass	1 - 7	-/-	>20	74	pass
6,9915	39,51	-14,49	54,00	pass					
6,7610	39,02	-14,98	54,00	pass					
6,6593	38,32	-15,68	54,00	pass					
6,5280	38,16	-15,84	54,00	pass					
5,9130	38,01	-15,99	54,00	pass					

Note: Measured without Band rejection filter ID: 11243

Mode No.:13



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Interference radiation
acc. to FCC § 15.209 / RSS-Gen



Ref.-No.: 20/03-0028

Product: Transmitting/Receiving System

Sample: 01

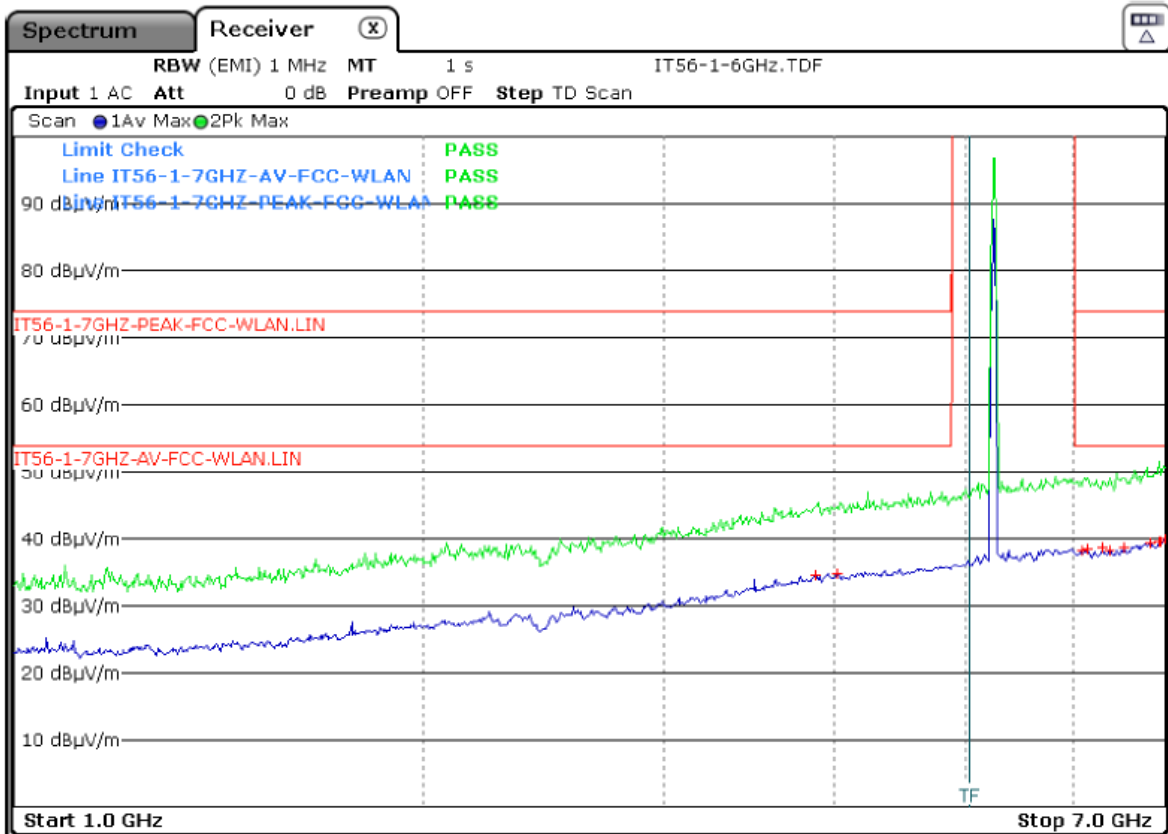
Date: 05.05.2020

Operator: BI

Remarks: All cables connected; BSF 2,4GHz connected (11244);
Host CD-Player/TV; Speakers (Oberon 7C);
Input Voltage 120V/60Hz

Result: pass fail

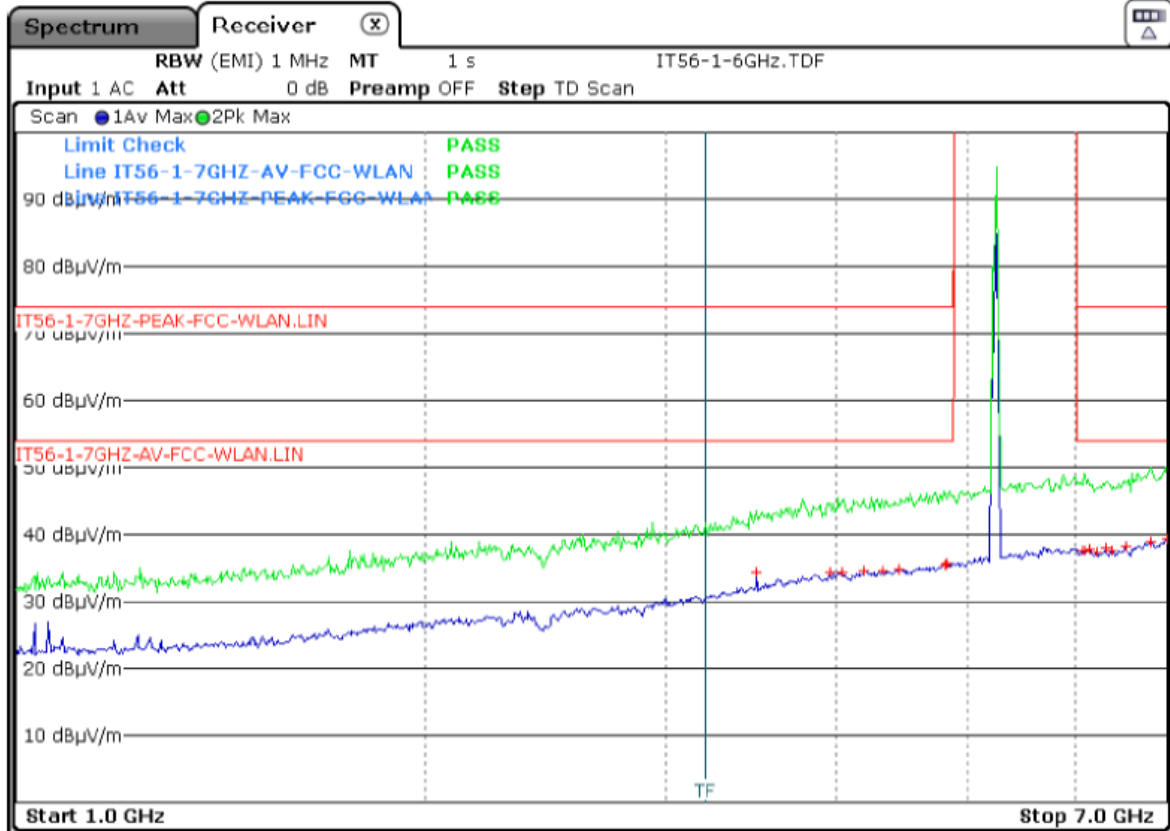
Operation mode: Audio IN (RCA); Audio File 1kHz playing; Speaker output 12,5%



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
6,9978	40,08	-13,92	54,00	pass	1 - 7	-/-	>20	74,00	pass
6,9253	39,64	-14,36	54,00	pass					
6,9480	39,63	-14,37	54,00	pass					
6,8225	39,24	-14,76	54,00	pass					
6,2983	38,64	-15,36	54,00	pass					
6,5340	38,60	-15,40	54,00	pass					

Ref.-No.: 20/03-0028

Operation mode: Audio IN (RCA); Audio File 1kHz playing; Speaker output 12,5%



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
6,9965	39,41	-14,59	54,00	pass	1 - 7	-/-	>20	74,00	pass
6,8103	38,92	-15,08	54,00	pass					
6,5313	38,21	-15,79	54,00	pass					
6,3043	38,10	-15,90	54,00	pass					
6,1378	37,75	-16,25	54,00	pass					
6,1023	37,67	-16,33	54,00	pass					

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**.

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. 20 dB Spectrum Bandwidth Measurement

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 (a) (1)
-RSS-247 issue 2 Section 5.1 (a)

Limit

The minimum 20 dB bandwidth shall be at least 25 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.

The Measurement was performed on: 12.05.2020 and 13.05.2020

Lowest Operating Frequency - GFSK



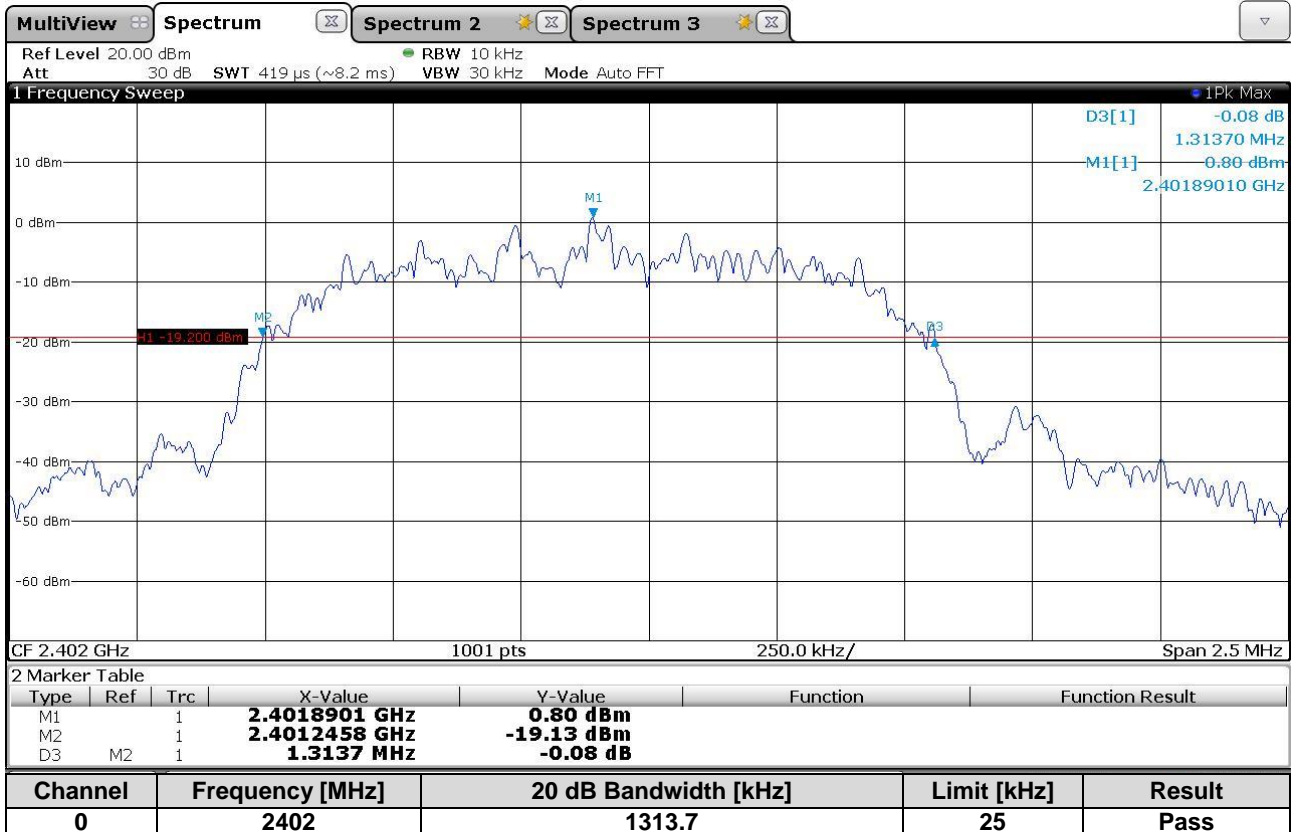
Middle Operating Frequency - GFSK



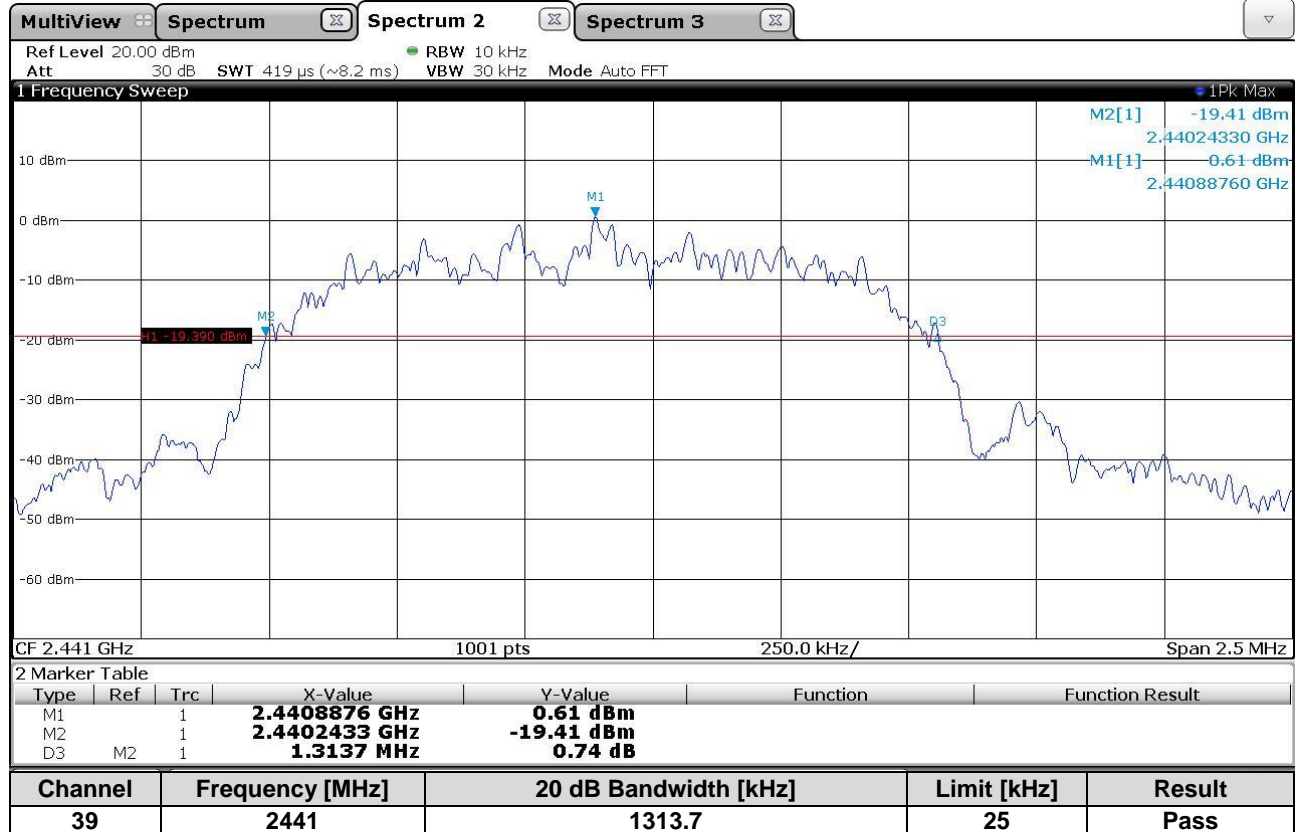
Highest Operating Frequency - GFSK



Lowest Operating Frequency - $\pi/4$ DQPSK



Middle Operating Frequency - $\pi/4$ DQPSK



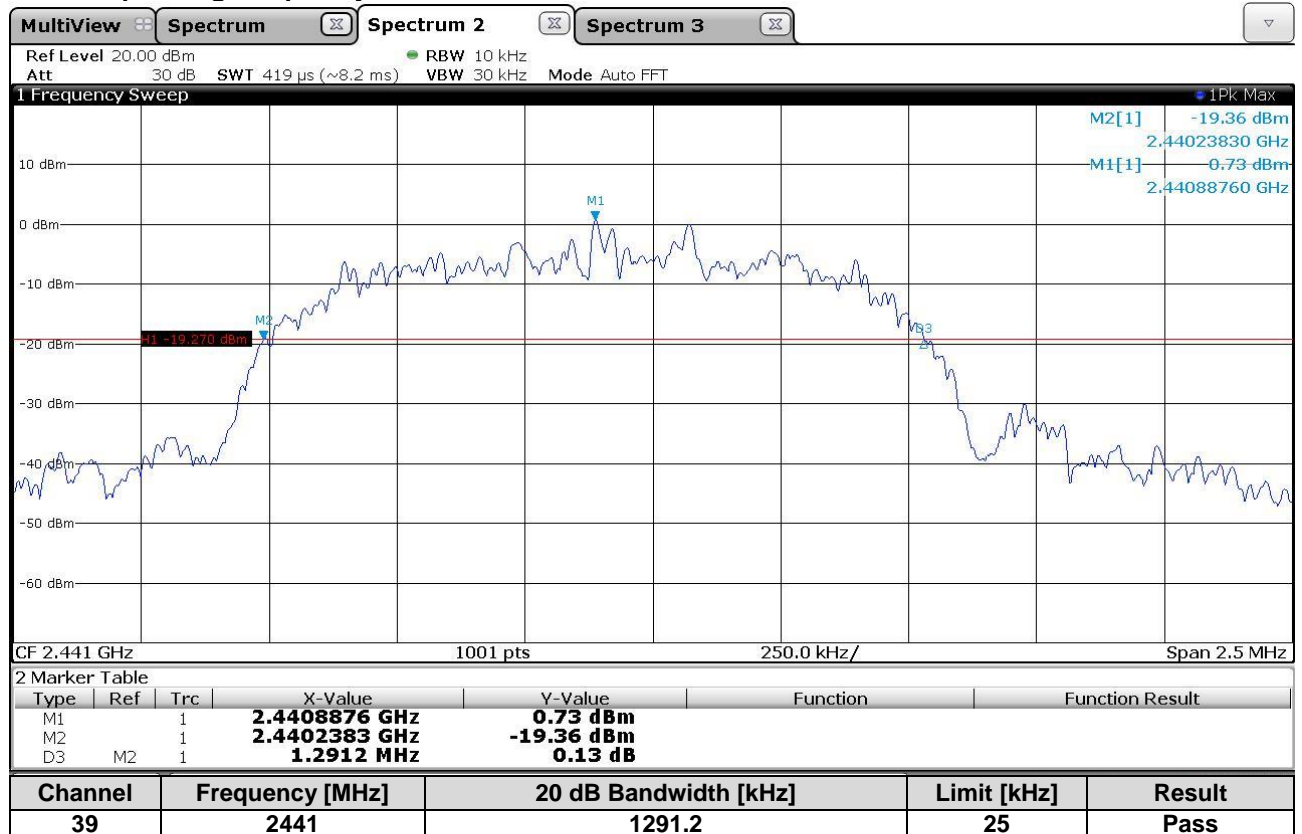
Highest Operating Frequency - $\pi/4$ DQPSK



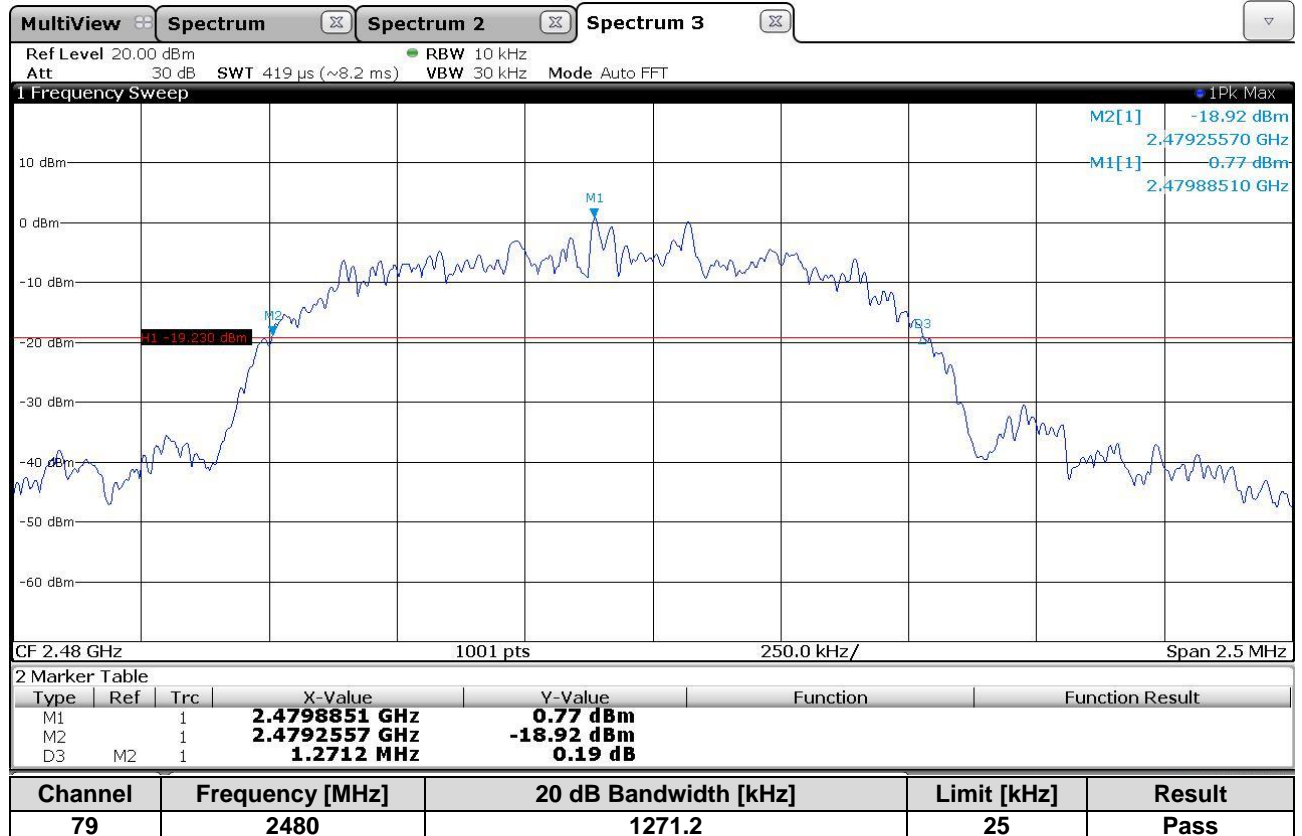
Lowest Operating Frequency - 8DPSK



Middle Operating Frequency - 8DPSK



Highest Operating Frequency - 8DPSK



Results

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