



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**

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.: **20/01-0029**

Page 1 of 79 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.	AC Mains conducted emissions	7
6.	Radiated emission measurements	13
7.	Operation within the band 902-928 MHz, 2400-2483,5 MHz and 5725-5850 MHz	19
8.	Test equipment	70
9.	Test Setups	72
10.	Measurement uncertainty	76
11.	Photos setup	77
12.	Conclusions	78
13.	Photos of tested sample	79

Location of test facility:



STC Germany GmbH
Ohmstrasse 1
84160 Frontenhausen
Germany

1. Client information

Name: Vestel Elektronik San ve Tic. A.S.
Address: Organize Sanayi Bölgesi
Vestel City, High-End
45030 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: Bluetooth Module (Bluetooth 4.2 without Bluetooth low energy)
Model: 17BT02
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): 2.48 GHz
Date Sample Received: 16.01.2020
Tests were performed: 17.02.2020 – 25.06.2020

2.2 Additional information about the EUT:

-/

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-17BT02		
IC:	25888-17BT02		
HVIN:	240419R1		
Power:	4,75 V – 5,25 V nominal 5 V = via USB		
Cables:	Cable to test adaptor 75 cm USB cable 100 cm		
Approx. Size (l x w x h):	(42 x 12 x 8) mm		
Test conditions:	<p>The “Bluetooth Module (Bluetooth 4.2 without Bluetooth low energy) – 17BT02” (= equipment under test – EUT) had been tested, where applicable, in the following modes:</p> <ol style="list-style-type: none"> (1) Bluetooth 4.2: Tx mode GFSK 2402.0 MHz (2) Bluetooth 4.2: Tx mode GFSK 2441.0 MHz (3) Bluetooth 4.2: Tx mode GFSK 2480.0 MHz (4) Bluetooth 4.2: Tx mode $\pi/4$-DQPSK 2402.0 MHz (5) Bluetooth 4.2: Tx mode $\pi/4$-DQPSK 2441.0 MHz (6) Bluetooth 4.2: Tx mode $\pi/4$-DQPSK 2480.0 MHz (7) Bluetooth 4.2: Tx mode 8DPSK 2402.0 MHz (8) Bluetooth 4.2: Tx mode 8DPSK 2441.0 MHz (9) Bluetooth 4.2: Tx mode 8DPSK 2480.0 MHz <p>with controlled by a test software with maximum RF-output power and different data rate in order to find the worst case.</p>		
Additional information:	-/-		
RF Module Model Number:	17BT02		
Frequency range:	2.400 GHz – 2.483,5 GHz		
Operating frequencies:	2.402 GHz – 2.480 GHz		
Module Transmission Type:	Bluetooth 4.2 (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	37.2 dB μ V/m @ 3 m	37.4 dB μ V/m @ 3 m	37.9 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. 0.84 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 4.2**

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:	
				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 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. 20/01-0029.

- 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. 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. EUT active – Transmitting 8DPSK in hopping mode
2. EUT active – Transmitting $\pi/4$ -DQPSK in hopping mode
3. EUT active – Transmitting GFSK in hopping mode
4. EUT active – Receiving

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 (Laptop), 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		

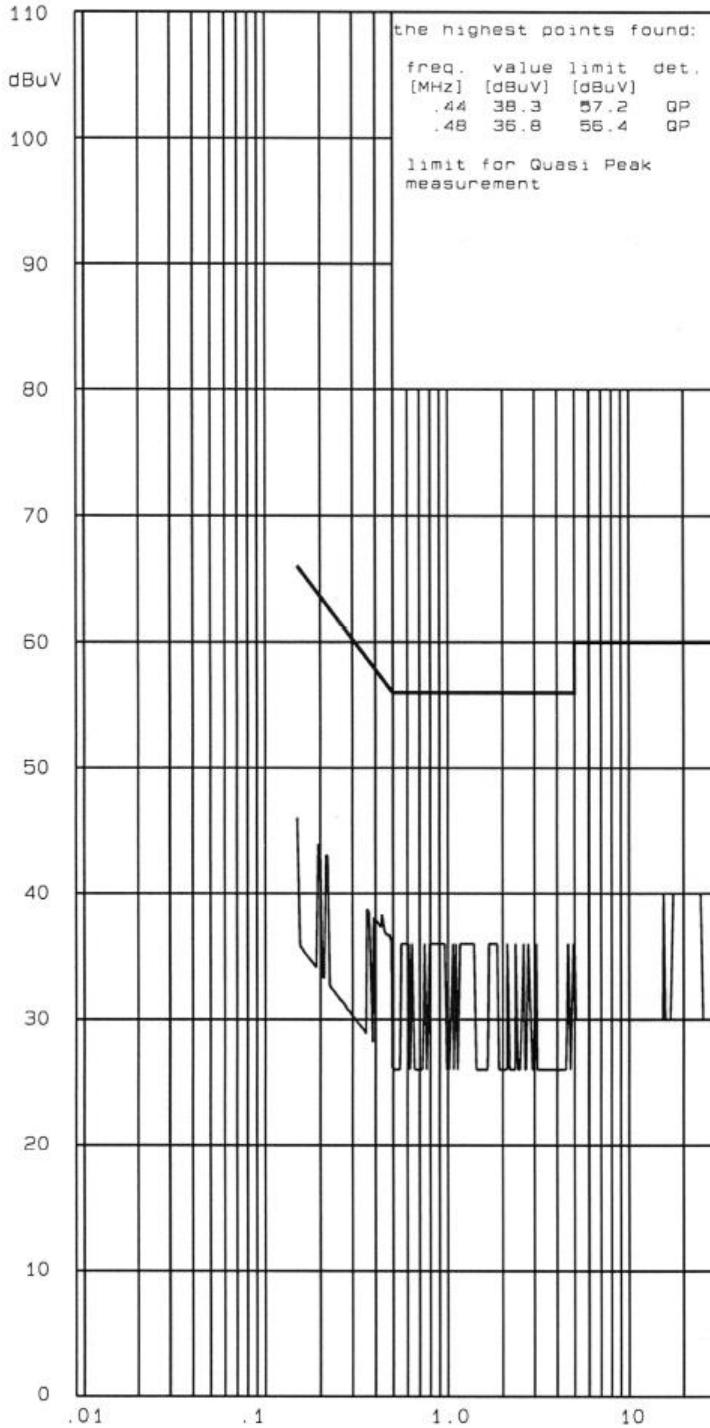
Measurement

Measurement performed on 24.02.2020

As worst cases the mode No. 1. with Transmitting 8DPSK in hopping mode 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.: 20/01-0029
Product: Trans./Rec.System
Sample: 01
Date: 24 Feb 2020
Operator: Ta

Test equipment:
Rohde & Schwarz ESHS 30
Rohde & Schwarz ESH 2-25

Connected sets:
Input Voltage 120 V / 60 Hz
Host Laptop

Operating mode:
Trans./Rec.System active
Transmitting
BPSK / Hopping mode
Tested on N

RFI suppression parts:

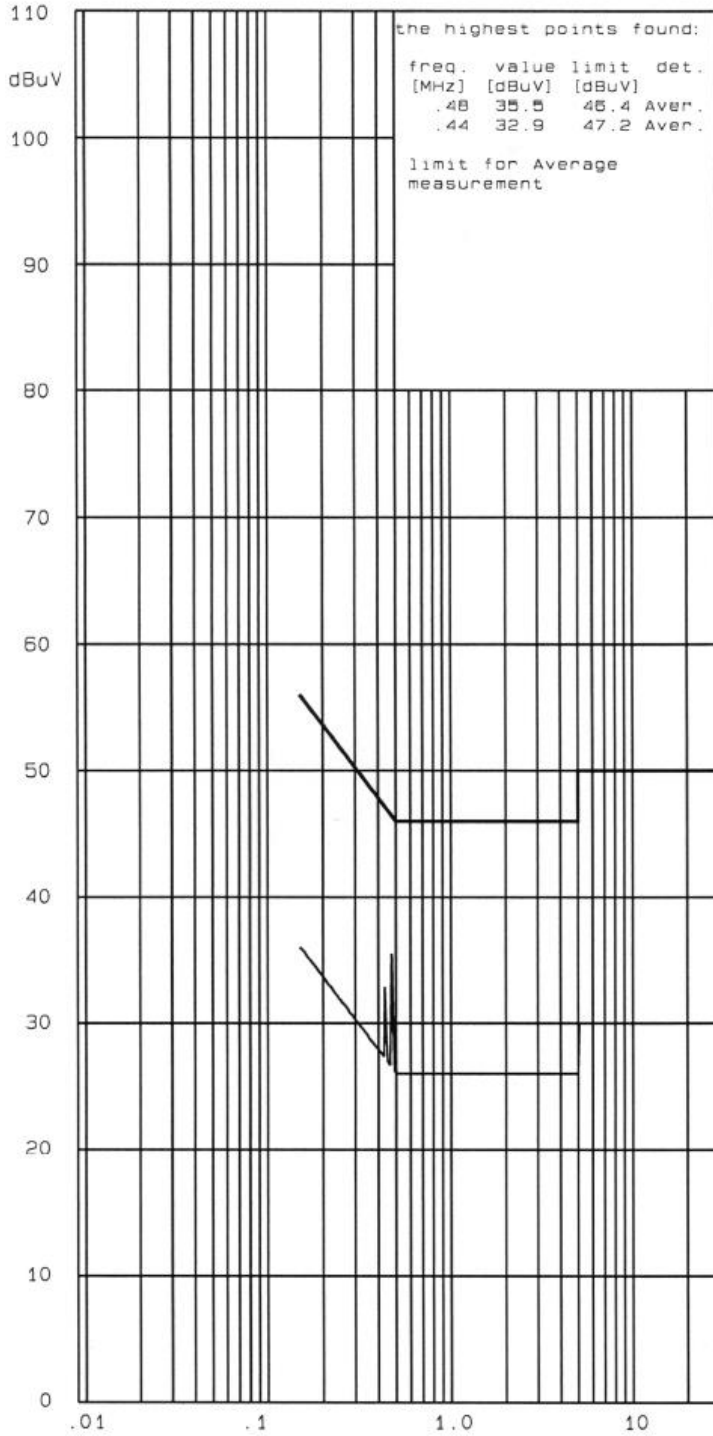
* two dB safety margin for
type approval recommended

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.: 20/01-0029

Product: Trans./Rec.System

Sample: 01

Date: 24 Feb 2020

Operator: Ta

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-Z5

Connected sets:

Input Voltage 120 V / 60 Hz
Host Laptop

Operating mode:

Trans./Rec.System active
Transmitting
BPSK / Hopping mode
Tested on N

RFI suppression parts:

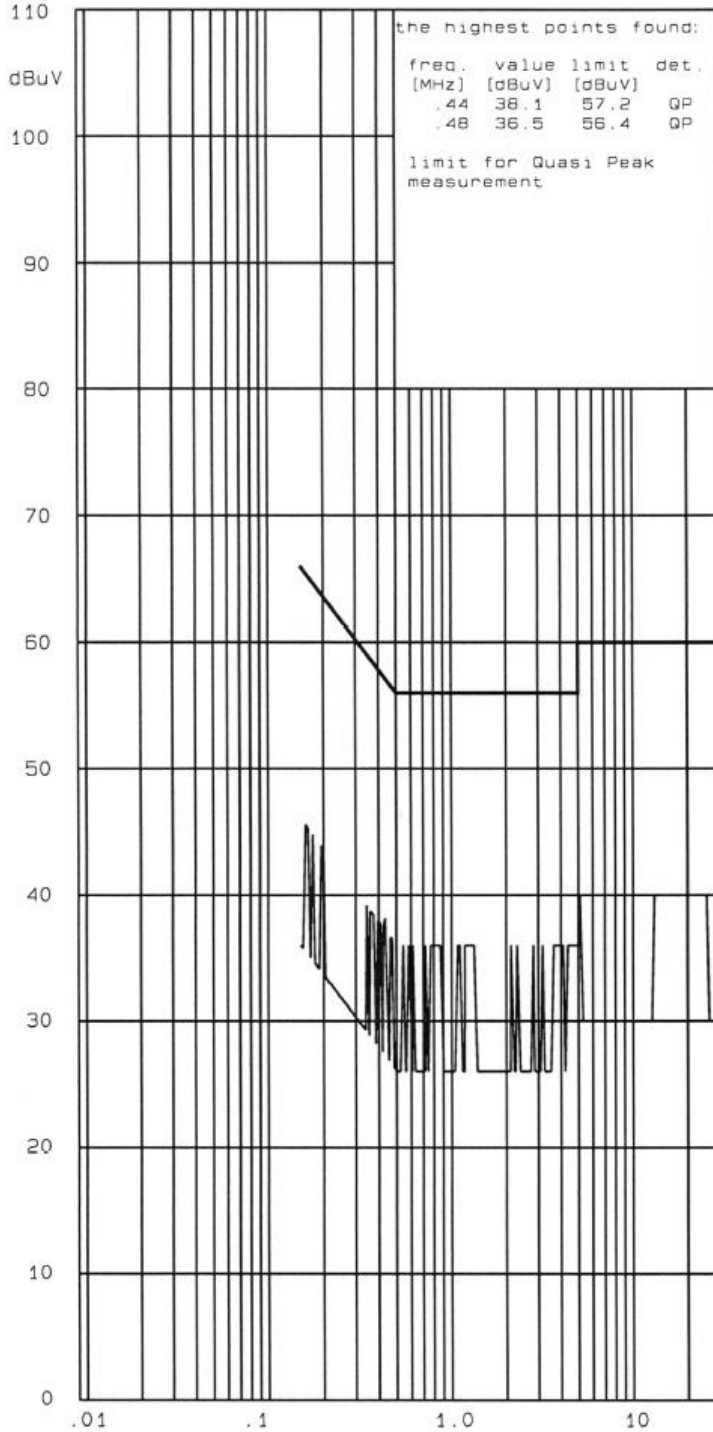
* two dB safety margin for
type approval recommended

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.: 20/01-0029

Product: Trans./Rec.System

Sample: 01

Date: 24 Feb 2020

Operator: Ta

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-Z5

Connected sets:

Input Voltage 120 V / 60 Hz
Host Laptop

Operating mode:

Trans./Rec.System active
Transmitting
BPSK / Hopping mode
Tested on L1

RFI suppression parts:

* two dB safety margin for
type approval recommended

Result: pass fail []

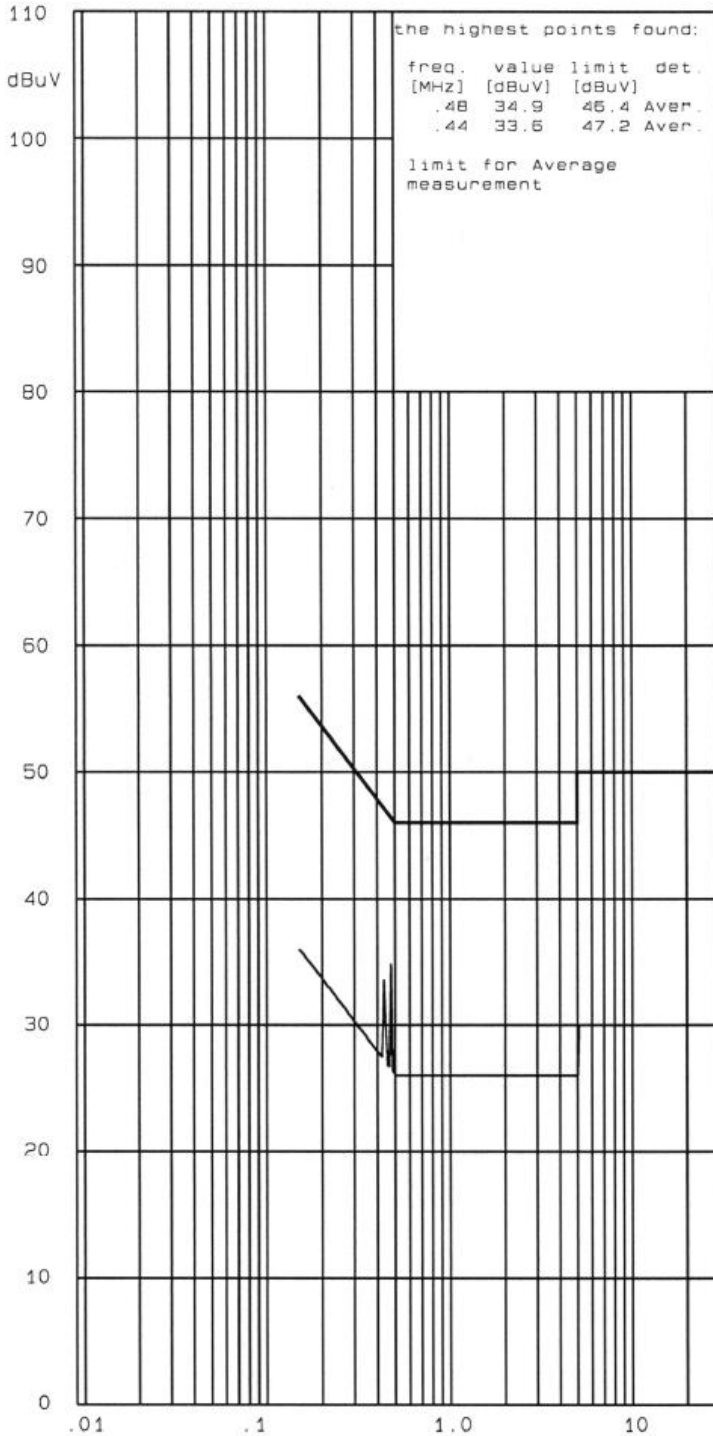
STC Germany GmbH

IT 1 / 2

Interference Voltage 150 KHz - 30 MHz

acc. FCC Part 15.207 / RSS-Gen

Cabin 1



Ref.-No.: 20/01-0029

Product: Trans./Rec.System

Sample: 01

Date: 24 Feb 2020

Operator: Ta

Test equipment:

Rohde & Schwarz ESHS 30

Rohde & Schwarz ESH 2-25

Connected sets:

Input Voltage 120 V / 60 Hz
Host Laptop

Operating mode:

Trans./Rec.System active
Transmitting
BPSK / Hopping mode
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	38.3	QP	N	0.10	0.10	38.5	57.2	Pass
0.48	36.8	QP	N	0.10	0.10	37.0	56.4	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
0.44	32.9	AV	N	0.10	0.10	33.1	47.2	Pass
0.48	35.5	AV	N	0.10	0.10	35.7	46.4	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
0.44	38.1	QP	L1	0.10	0.10	38.3	57.2	Pass
0.48	36.5	QP	L1	0.10	0.10	36.7	56.4	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
0.44	33.6	AV	L1	0.10	0.10	33.8	47.2	Pass
0.48	34.9	AV	L1	0.10	0.10	35.1	46.4	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]

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/used in the EUT is 2.480 GHz.

Test conditions and configuration of EUT

The EUT was configured and operated under following operation modes:

1. EUT active – Transmitting 8DPSK in single frequency mode
2. EUT active – Transmitting $\pi/4$ -DQPSK in single frequency mode
3. EUT active – Transmitting GFSK in single frequency mode
4. EUT active – Receiving

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. 1. Transmitting 8DPSK in single frequency mode was found and documented in this report.

Remarks:

-Correction factor included antenna factor and cable attenuation.

Applied standards

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C, § 15.209 Radiated emission limits
 -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 [$\mu\text{V}/\text{m}$] Quasi-peak	Limits [dB $\mu\text{V}/\text{m}$] Quasi-peak	Limits [$\mu\text{V}/\text{m}$] Average	Limits [dB $\mu\text{V}/\text{m}$] 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 [$\mu\text{A}/\text{m}$] Quasi-peak	Limits [dB $\mu\text{A}/\text{m}$] Quasi-peak	Limits [$\mu\text{A}/\text{m}$] Average	Limits [dB $\mu\text{A}/\text{m}$] 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 [$\mu\text{V}/\text{m}$] Quasi-peak	Limits [dB $\mu\text{V}/\text{m}$] Quasi-peak	Limits [$\mu\text{V}/\text{m}$] Average	Limits [dB $\mu\text{V}/\text{m}$] 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: 21.02.2020, 24.02.2020 and 25.06.2020

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).

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 No.: 1. Transmitting 8DPSK in single frequency

Ref.-No.: 20/01-0029
 Product: TRANS.-/REC.-SYSTEM
 Sample: 01
 Date: 25 Jun 2020
 Operator: TM

Test equipment:
 Rohde & Schwarz ESVS
 CHASE CBL 6111

Connected sets:
 HOST COMPUTER

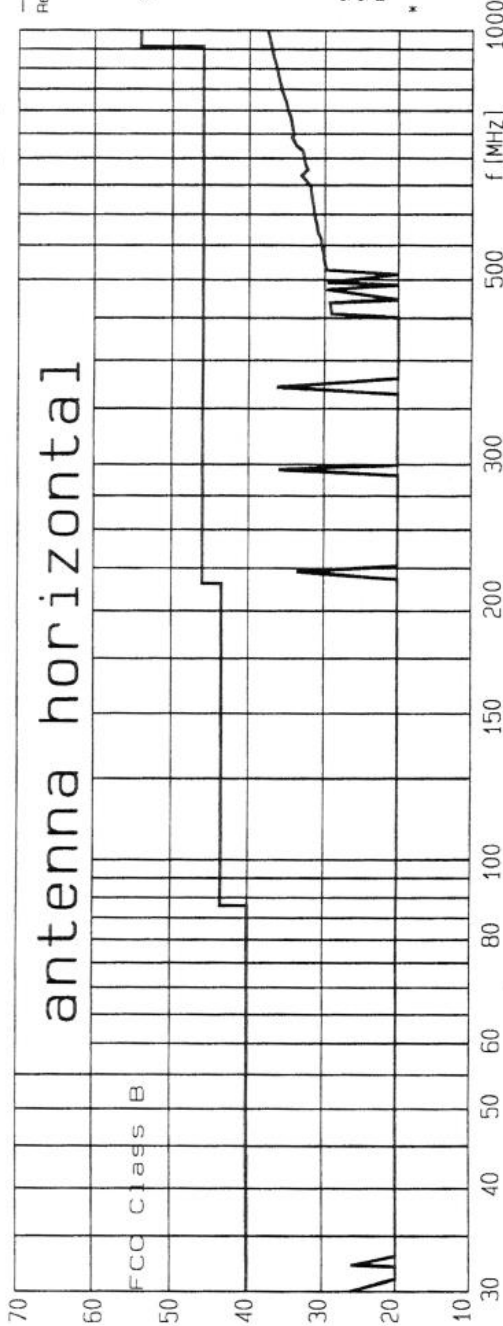
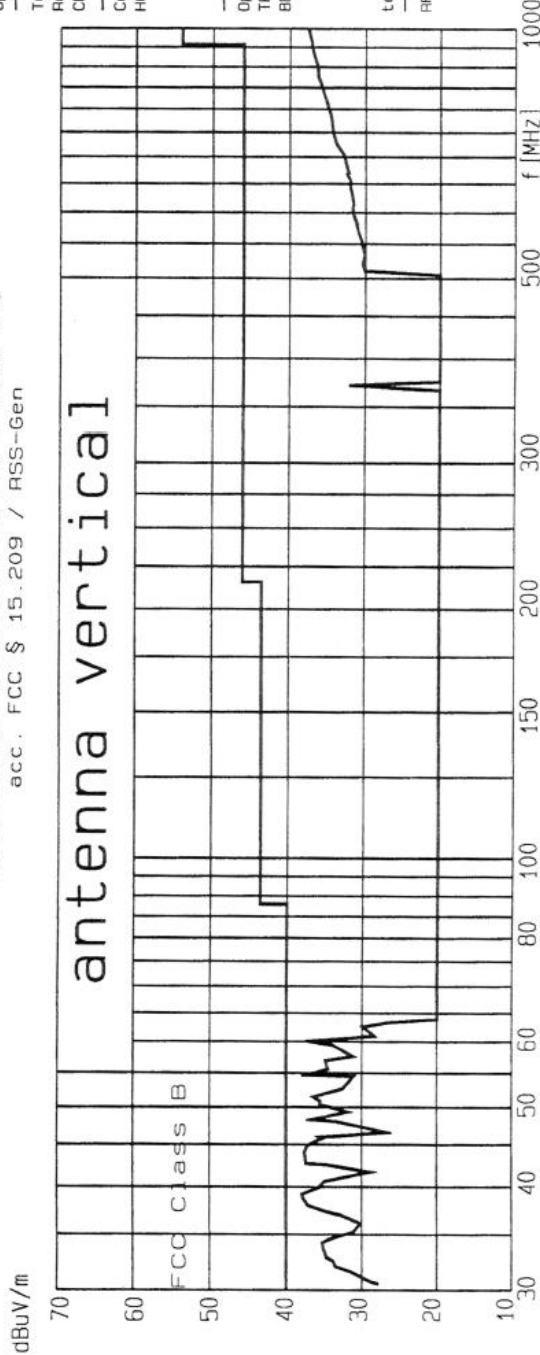
Operating mode:
 TRANSMITTING BT
 BDPK / 2480 MHz / SINGEL FREQ

test distance 3m

RFI suppression parts:

STC Germany GmbH
IT 5/6

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



Result: pass fail ()

the highest points found:

freq. [MHz]	tested dBuV/m	limit dBuV/m	pol. h/v
39.16	37.9	40	v
38.68	37.8	40	v
44.04	37.6	40	v
42.68	37.4	40	v
54.68	37.3	40	v
950.8	37.03	46	h
934.6	36.87	46	h
929.84	36.83	46	h
907.84	36.45	46	h
898.88	36.37	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)
39.16	QP	V	37.90	78.52	40.00	100	Pass
38.16	QP	V	37.80	77.62	40.00	100	Pass
44.04	QP	V	37.60	75.86	40.00	100	Pass
42.68	QP	V	37.40	74.13	40.00	100	Pass
54.68	QP	V	37.30	73.28	40.00	100	Pass
-/-	QP	V	-/-	-/-	-/-	-/-	-/-
950.80	QP	H	37.03	71.04	46.00	200	Pass
934.60	QP	H	36.87	69.74	46.00	200	Pass
929.84	QP	H	36.83	69.42	46.00	200	Pass
907.84	QP	H	36.45	66.45	46.00	200	Pass
898.88	QP	H	36.37	66.45	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)

Result 1 GHz – 7 GHz

Operation Mode No.: 1. Transmitting 8DPSK at single frequency



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



Ref.-No.: 20/01-0029

Product: Transmitting/Receiving System

Sample: 01

Date: 25.06.2020

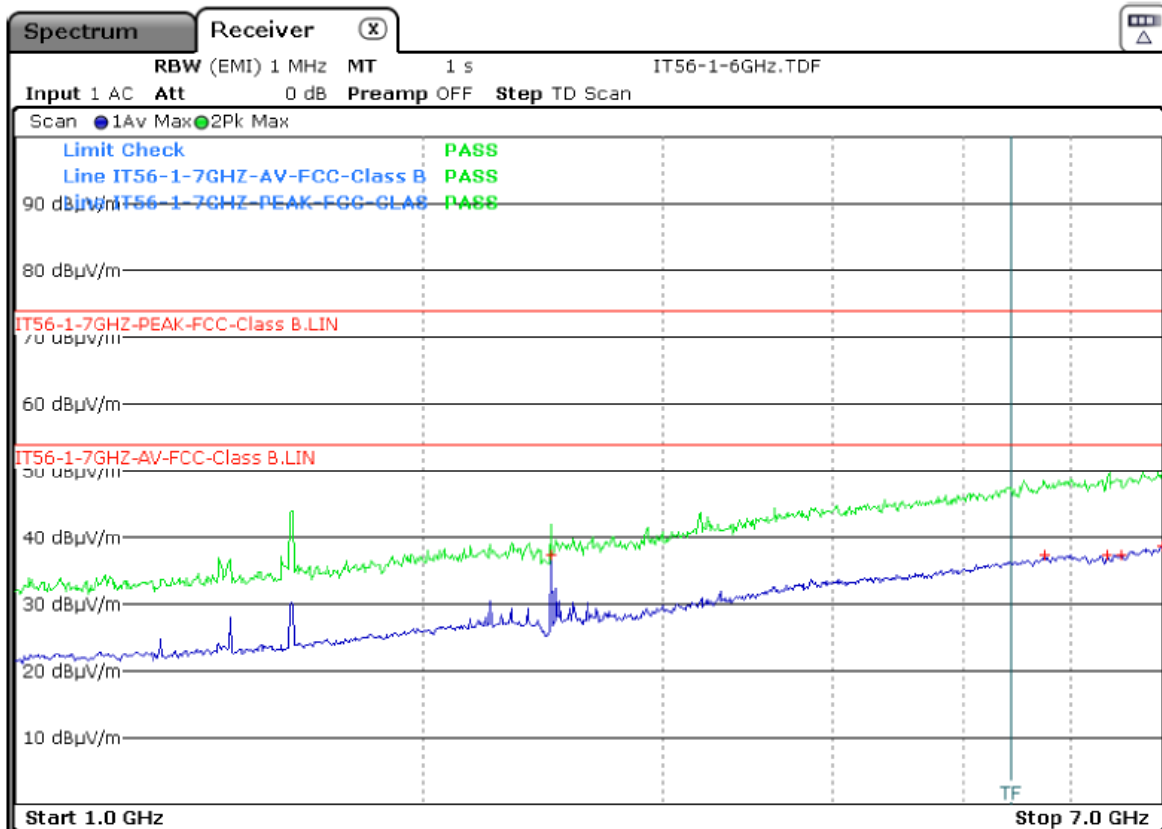
Operator: TM

Remarks: BSF (2.4GHz / 11243) connected

pass fail

Result:

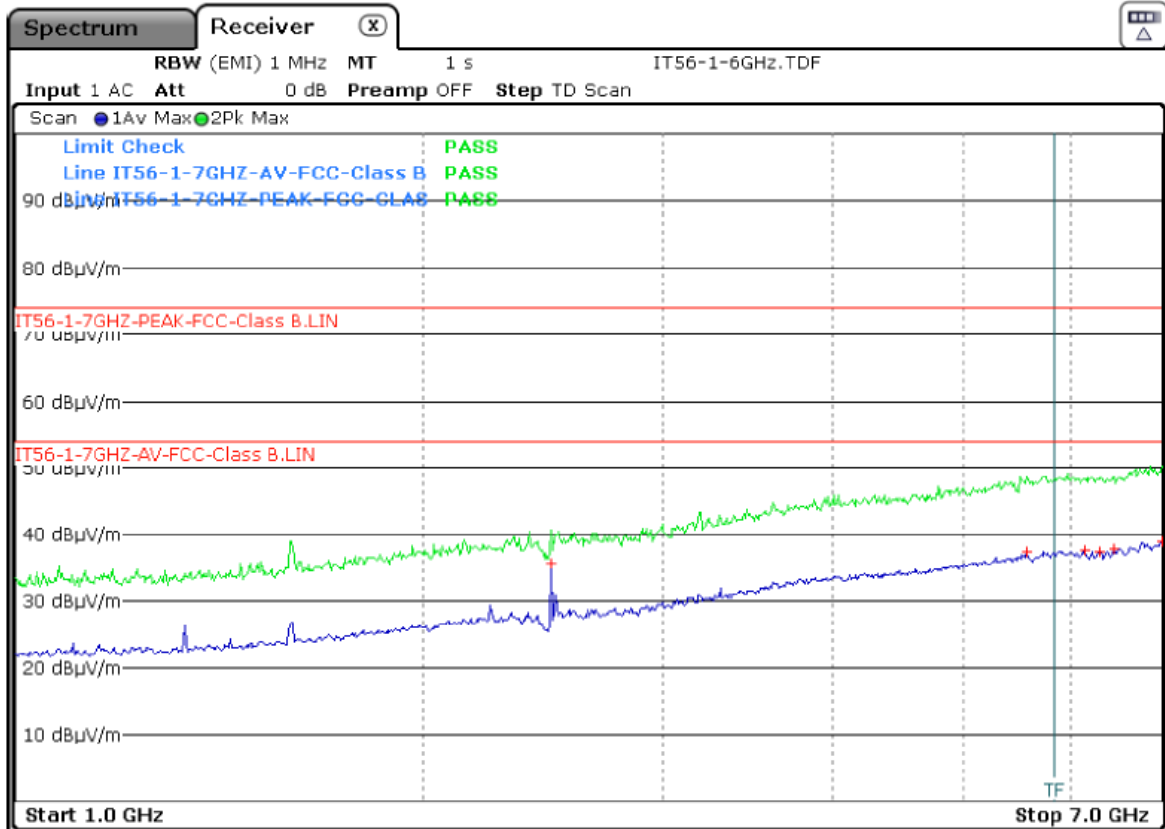
Operation mode: Tx BT / 8DPSK / 2480 MHz / Single Frequency



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
2,4800	37,46	N/A	N/A	pass	1 - 7	-/-	>20	74	pass
5,7288	37,42	-16,58	54,00	pass					
6,3773	37,41	-16,59	54,00	pass					
6,5328	37,49	-16,51	54,00	pass					
6,9998	38,61	-15,39	54,00	pass					

Ref.-No.: 20/01-0029

Operation mode: Tx BT / 8DPSK / 2480 MHz / Single Frequency



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
2,4800	35,60	N/A	N/A	pass	1 - 7	-/-	>20	74	pass
5,5718	37,29	-16,71	54,00	pass					
6,1433	37,57	-16,43	54,00	pass					
6,2993	37,50	-16,50	54,00	pass					
6,4588	37,78	-16,22	54,00	pass					
7,0000	38,99	-15,01	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. 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.

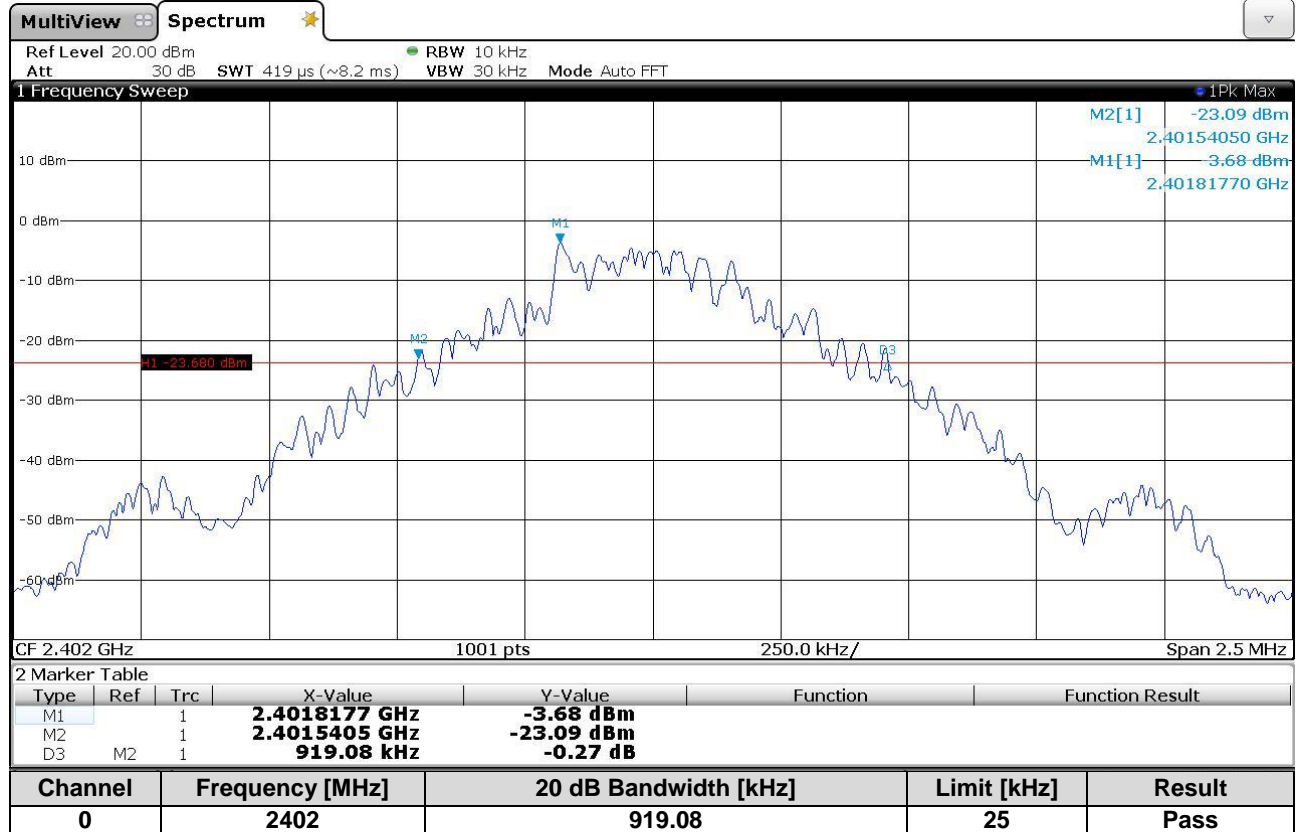
Description

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.

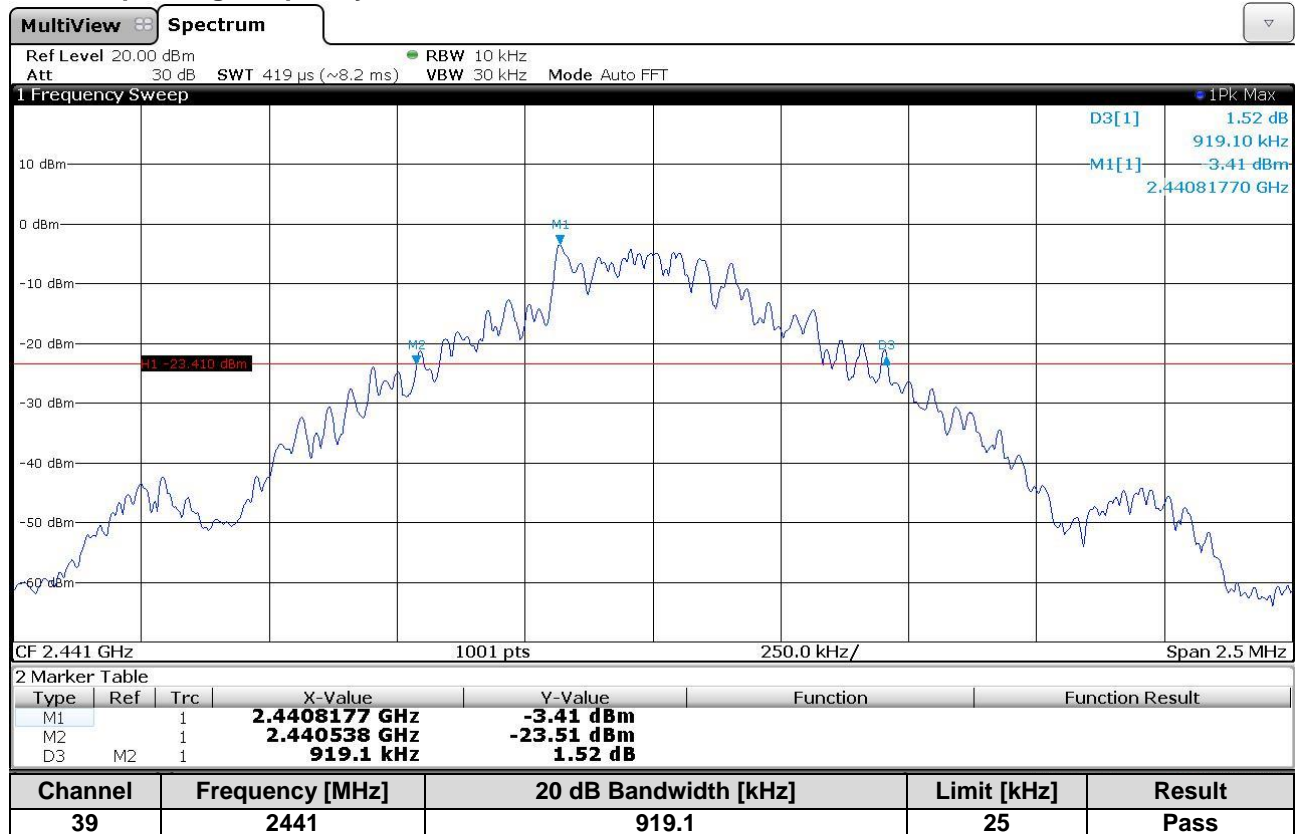
Measurement

The Measurement was performed on: 25.06.2020

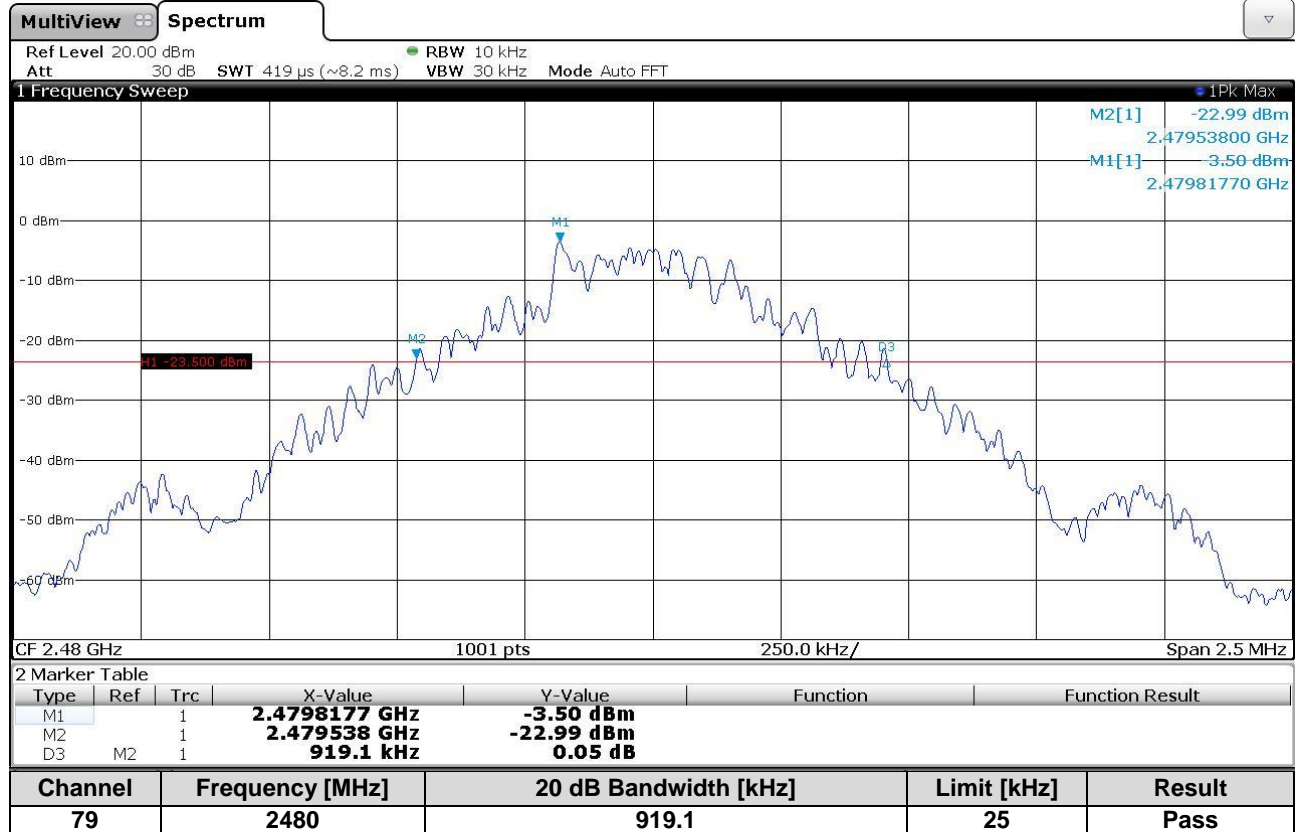
Lowest Operating Frequency – GFSK



Middle Operating Frequency - GFSK



Highest Operating Frequency - GFSK



Lowest Operating Frequency - $\pi/4$ DQPSK



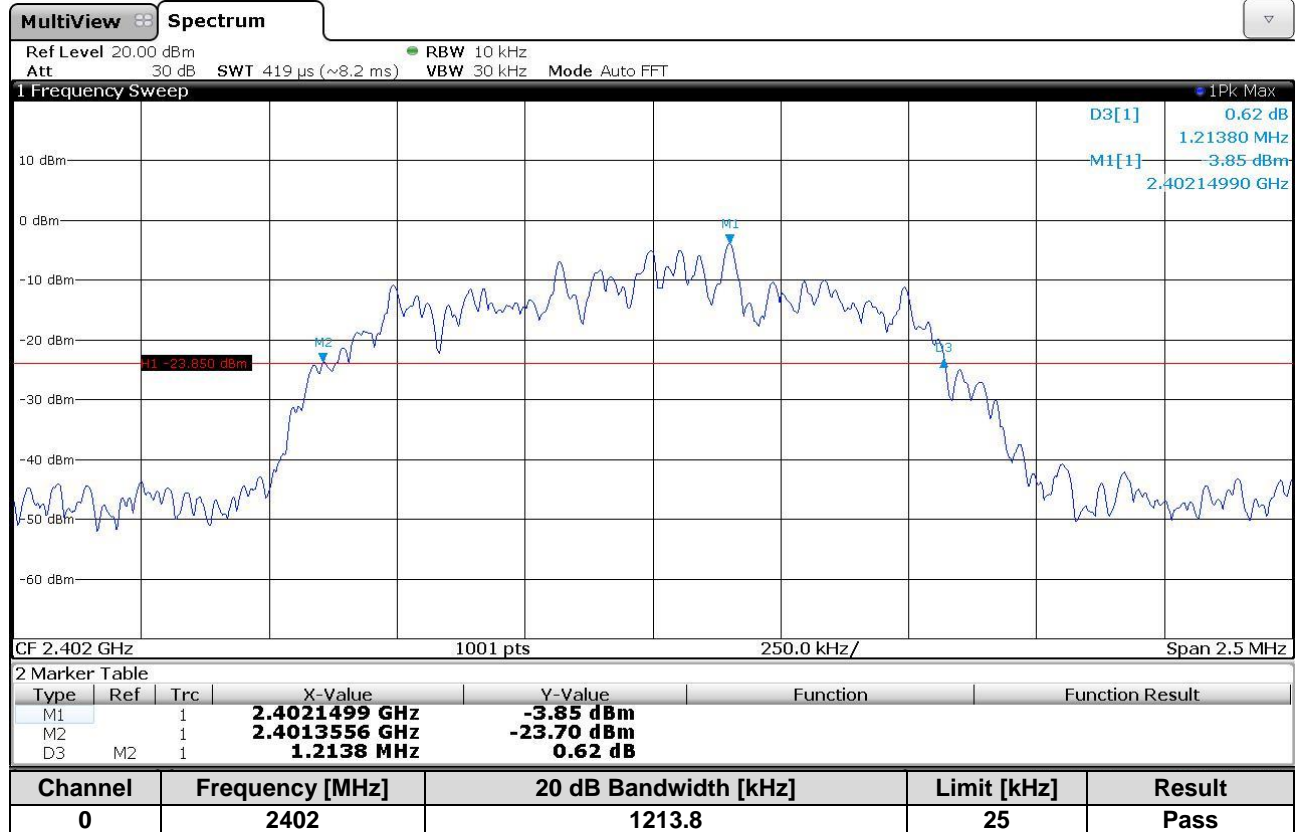
Middle Operating Frequency - $\pi/4$ DQPSK



Highest Operating Frequency - $\pi/4$ DQPSK



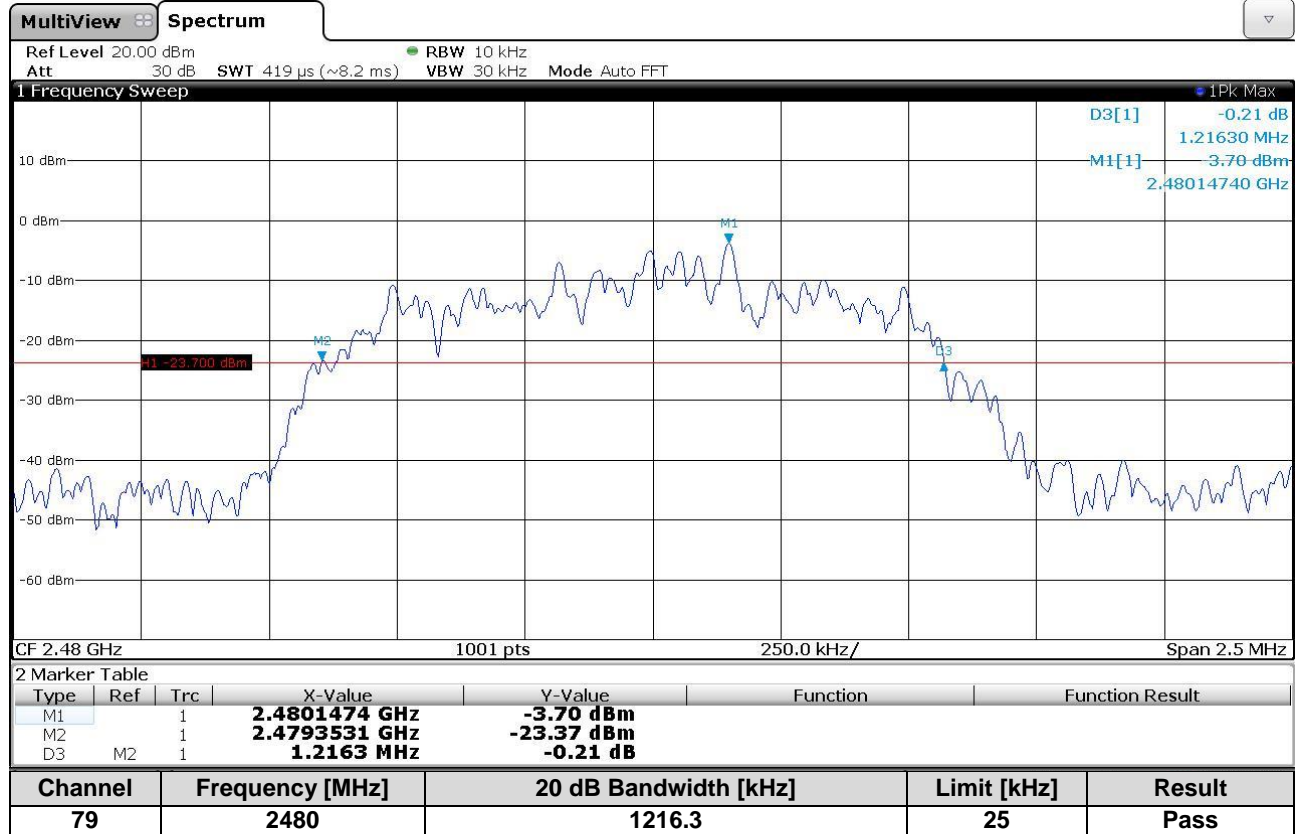
Lowest Operating Frequency - 8DPSK



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**.

7.2. 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) (1)
- RSS-247 Issue 2 section 5.4 (b)

Limits for Peak Output Power of Fundamental (EIRP)

For FHSS in the 2400 – 2483.5 MHz Band the maximum peak output power shall not exceeded the following limits:

For frequency hopping systems employing at least 75 hopping channels: 1 Watt

For frequency hopping systems employing less then 75 hopping channels: 0.125 Watt

The e.i.r.p shall not exceed 4 Watt.

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.

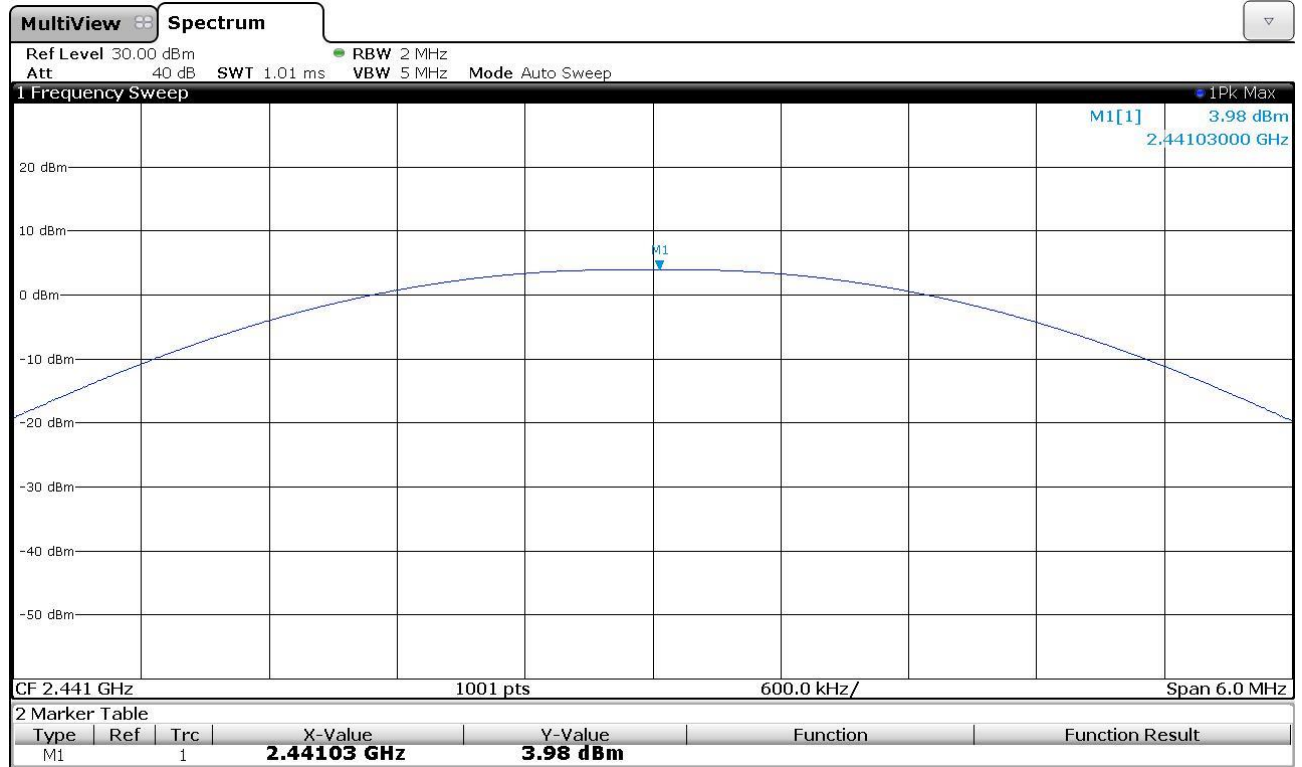
Measurement

The Measurement was performed on: 25.06.2020

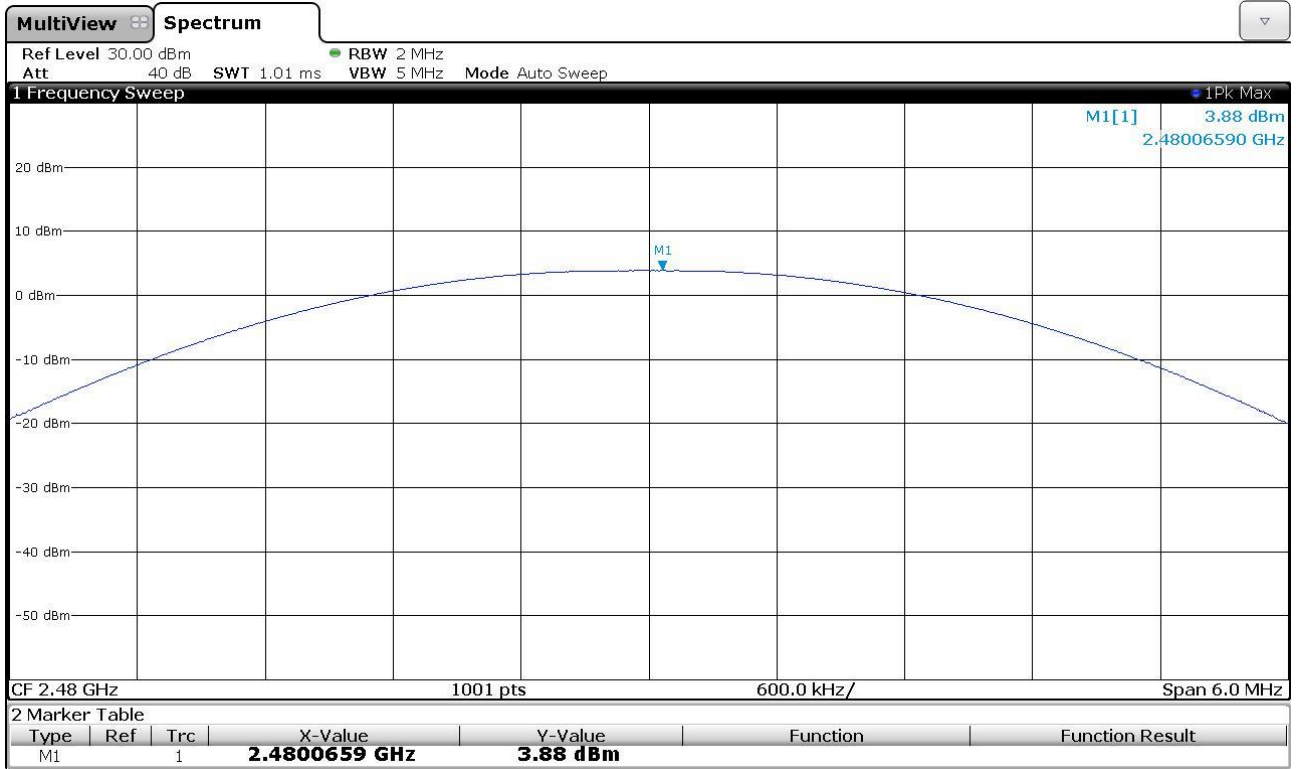
Lowest operating frequency – GFSK



Middle Operating Frequency – GFSK



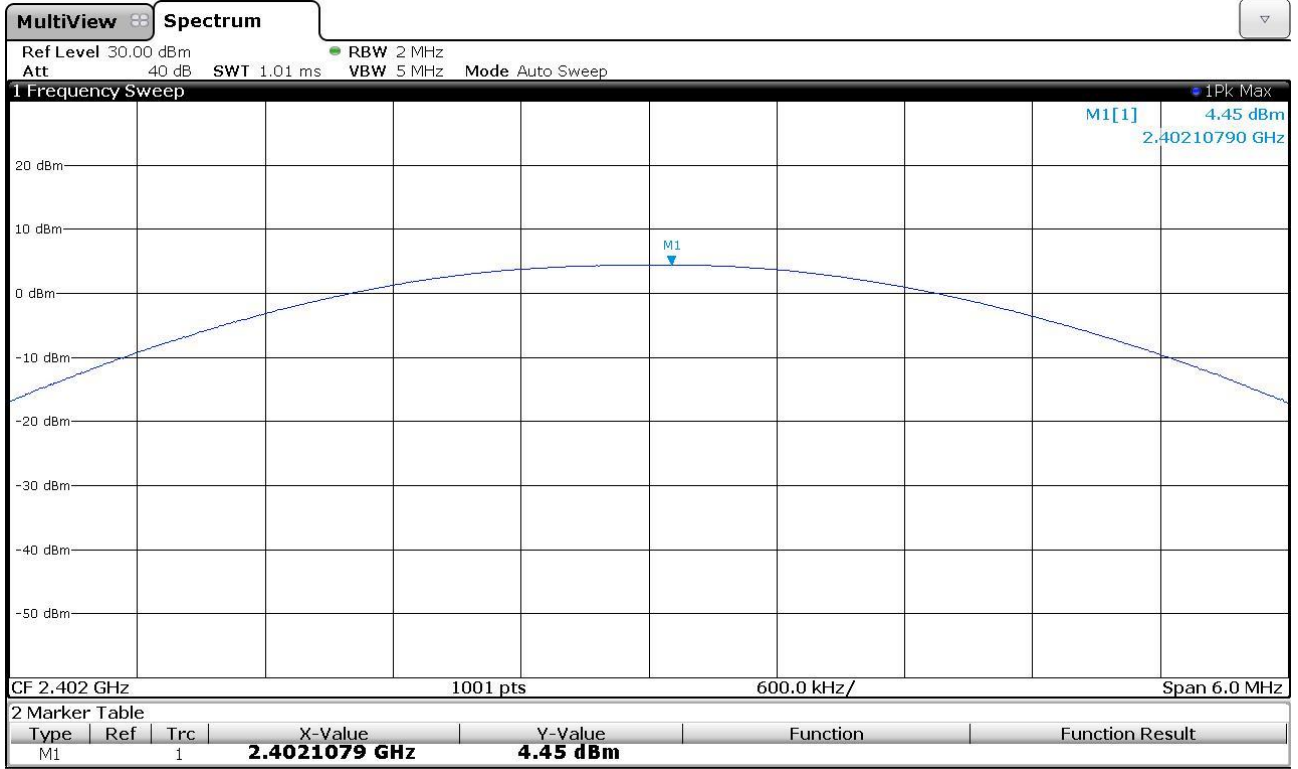
Highest Operating Frequency – GFSK



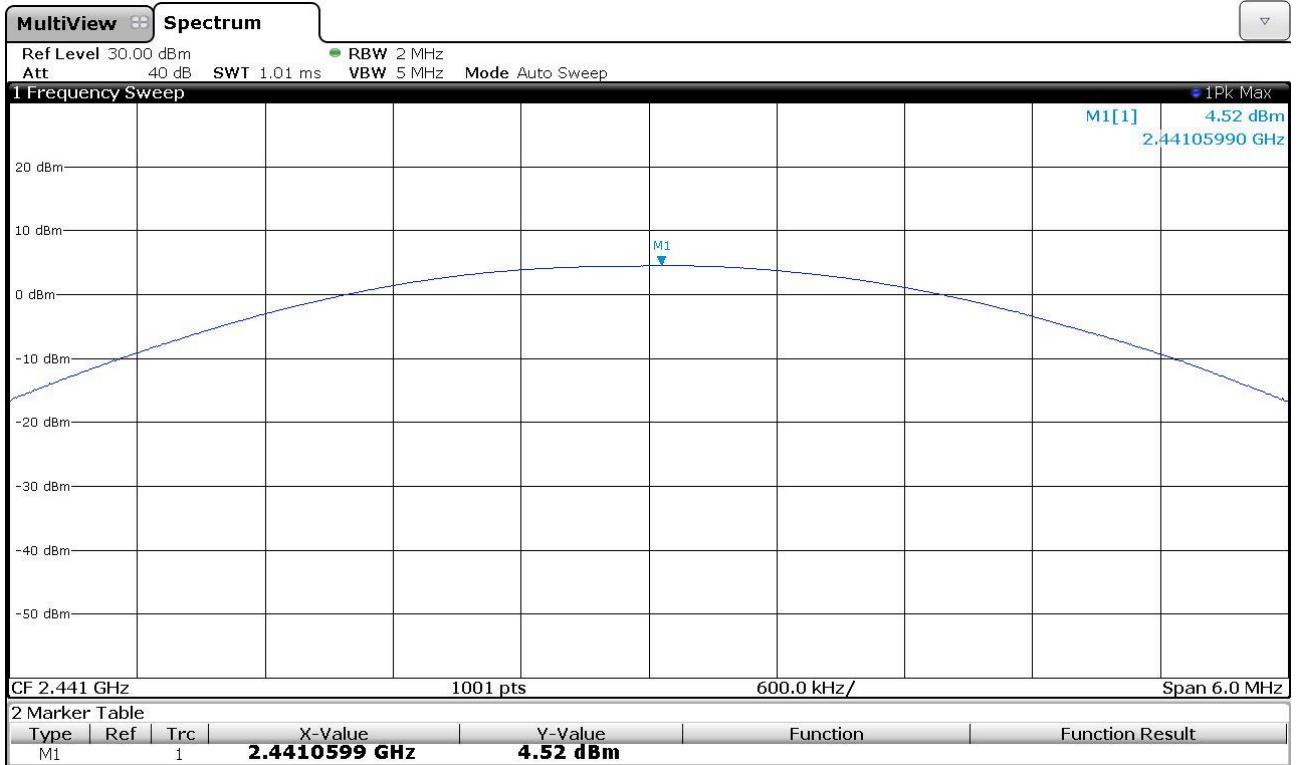
Maximum output power conducted measurement - GFSK

Channel	Frequency [MHz]	Reading of Analyzer [dBm]	Cable Loss [dB]	Output Power		Limit		Result
				[dBm]	[mW]	[dBm]	[mW]	
0	2402	3.79	1.2	4.99	3.16	30	1000	Pass
39	2441	3.98	1.2	5.18	3.30	30	1000	Pass
78	2480	3.88	1.2	5.08	3.22	30	1000	Pass

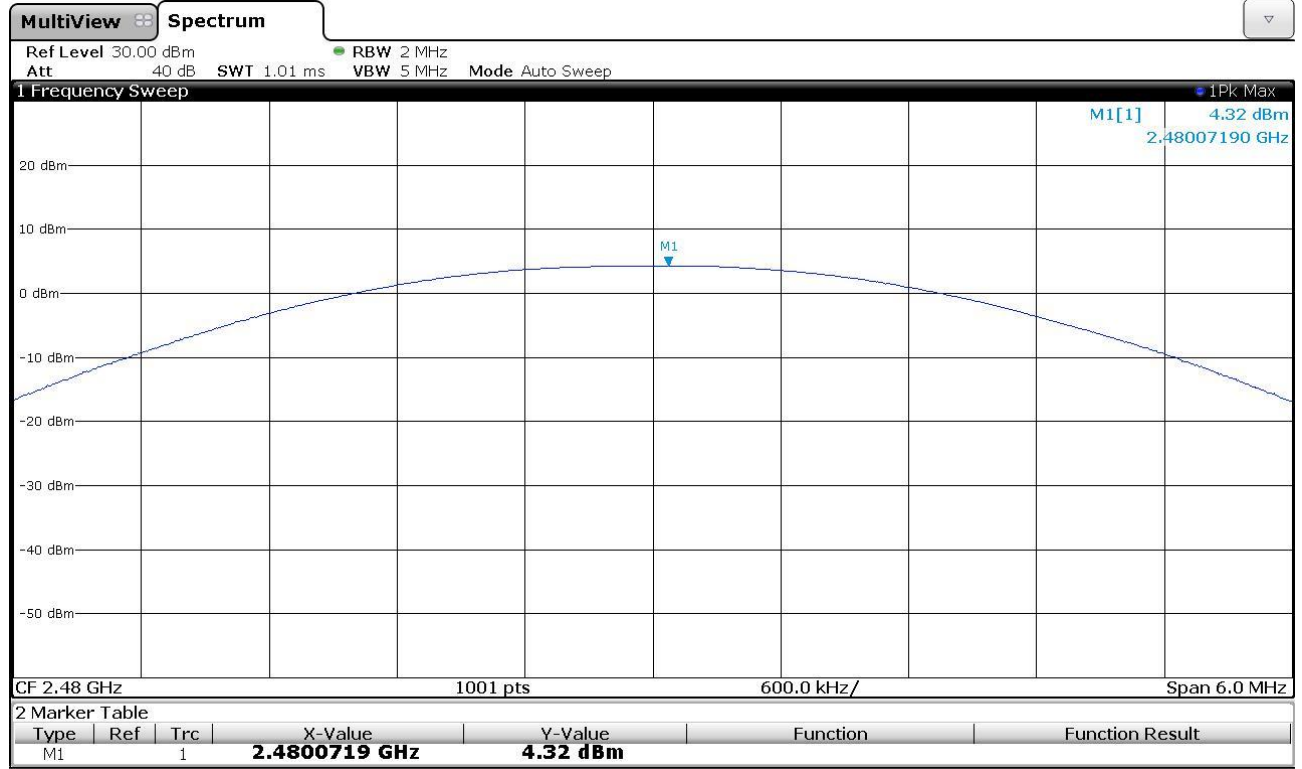
Lowest operating frequency – $\pi/4$ -DQPSK



Middle Operating Frequency – $\pi/4$ -DQPSK



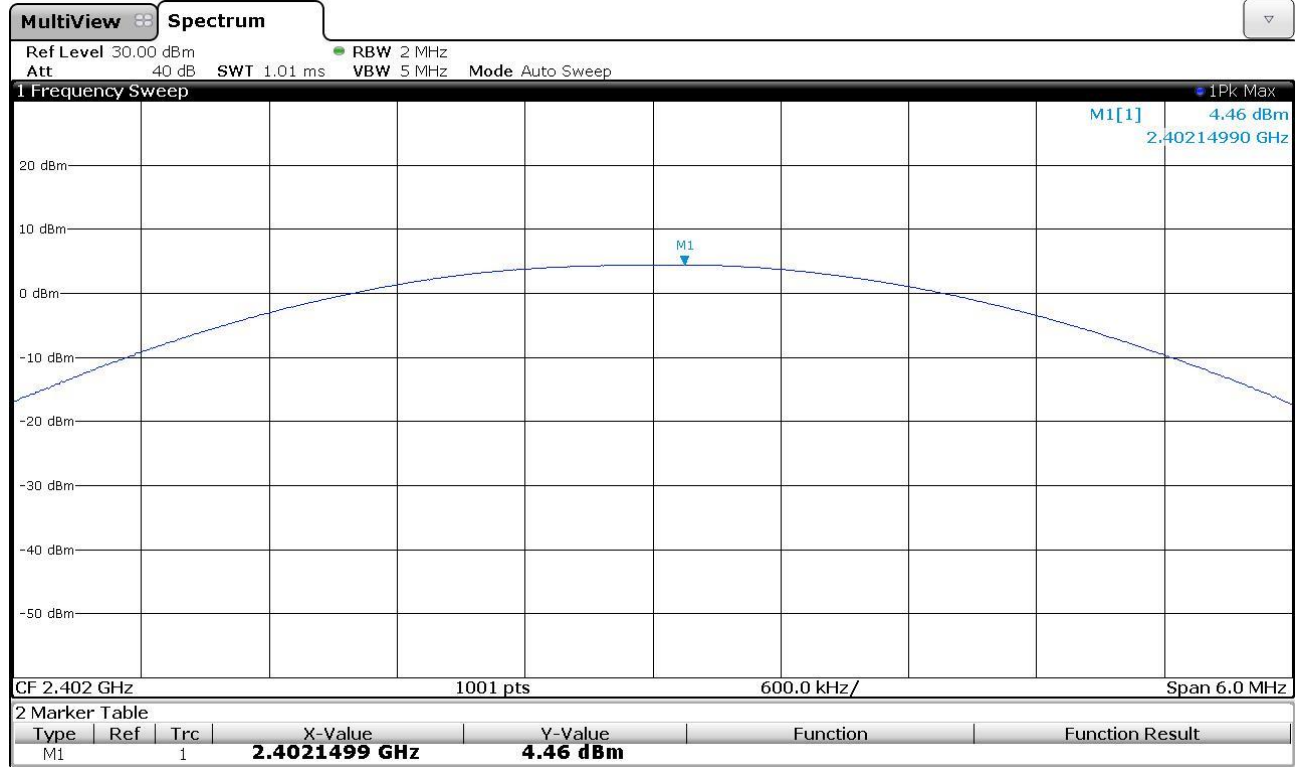
Highest Operating Frequency – $\pi/4$ -DQPSK



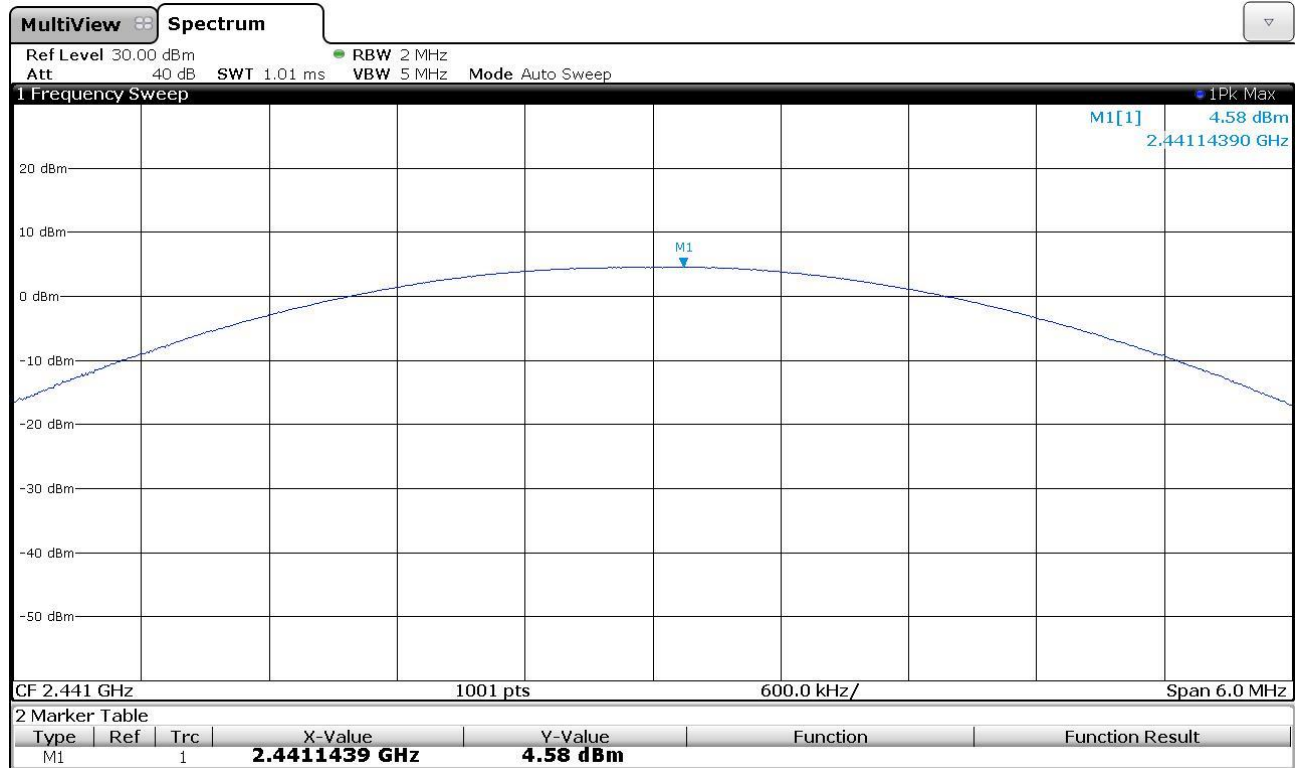
Maximum output power conducted measurement - $\pi/4$ -DQPSK

Channel	Frequency [MHz]	Reading of Analyzer [dBm]	Cable Loss [dB]	Output Power		Limit		Result
				[dBm]	[mW]	[dBm]	[mW]	
0	2402	4.45	1.2	5.65	3.67	30	1000	Pass
39	2441	4.52	1.2	5.72	3.73	30	1000	Pass
78	2480	4.32	1.2	5.52	3.56	30	1000	Pass

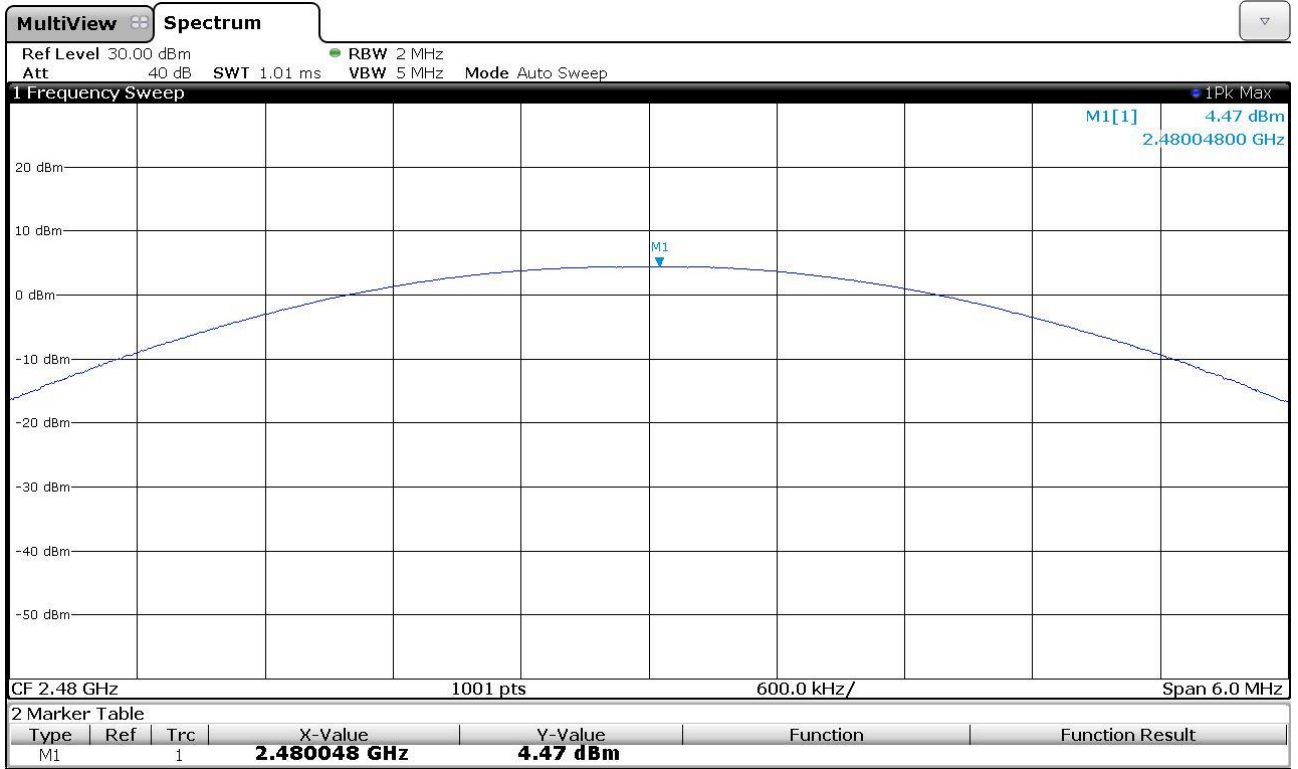
Lowest operating frequency – 8DPSK



Middle Operating Frequency – 8DPSK



Highest Operating Frequency – 8DPSK



Maximum output power conducted measurement - 8DPSK

Channel	Frequency [MHz]	Reading of Analyzer [dBm]	Cable Loss [dB]	Output Power		Limit		Result
				[dBm]	[mW]	[dBm]	[mW]	
0	2402	4.46	1.2	5.66	3.68	30	1000	Pass
39	2441	4.58	1.2	5.78	3.78	30	1000	Pass
78	2480	4.47	1.2	5.67	3.69	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. Number of Operating Channel

Applied standards

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

Limit

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

Test equipment and test set up

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

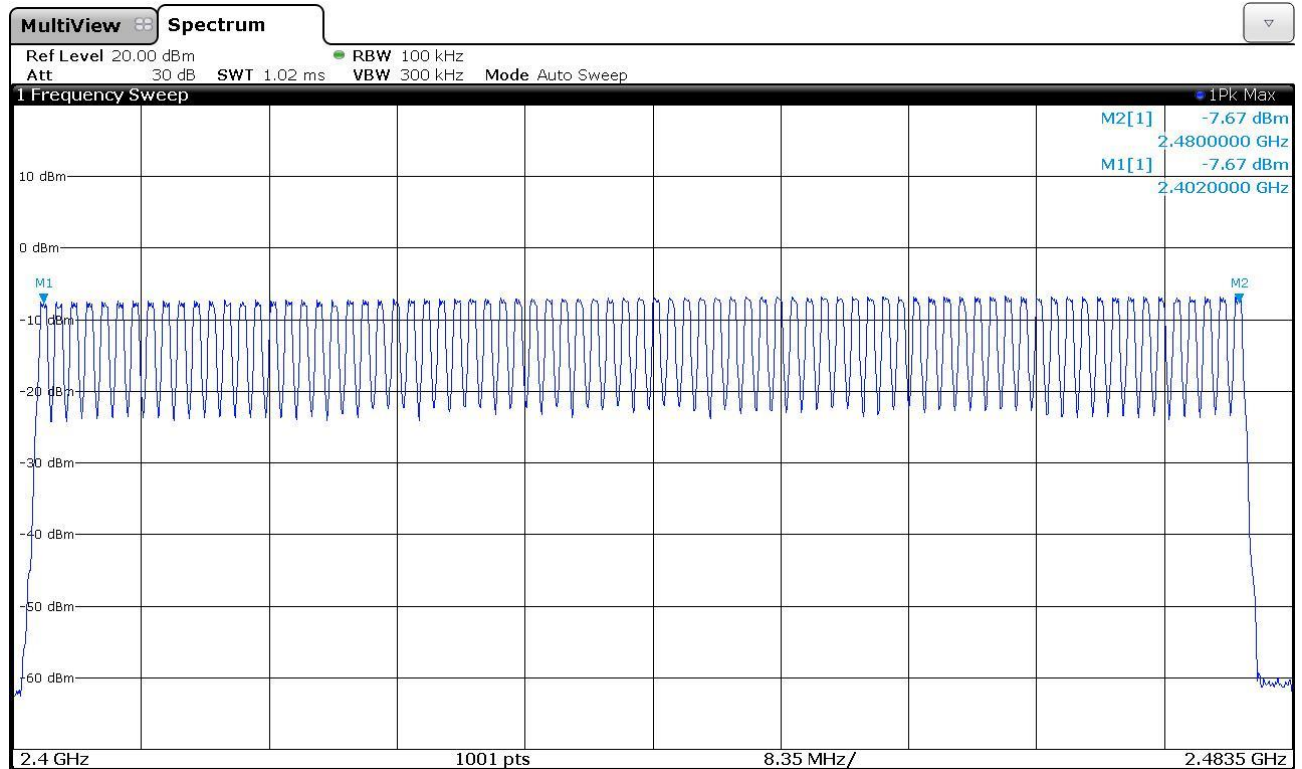
Description

Frequency range	Bandwidth	
2.4 GHz – 2.4835 GHz (Peak Detector)	RBW:	100 kHz
	VBW:	≥ RBW

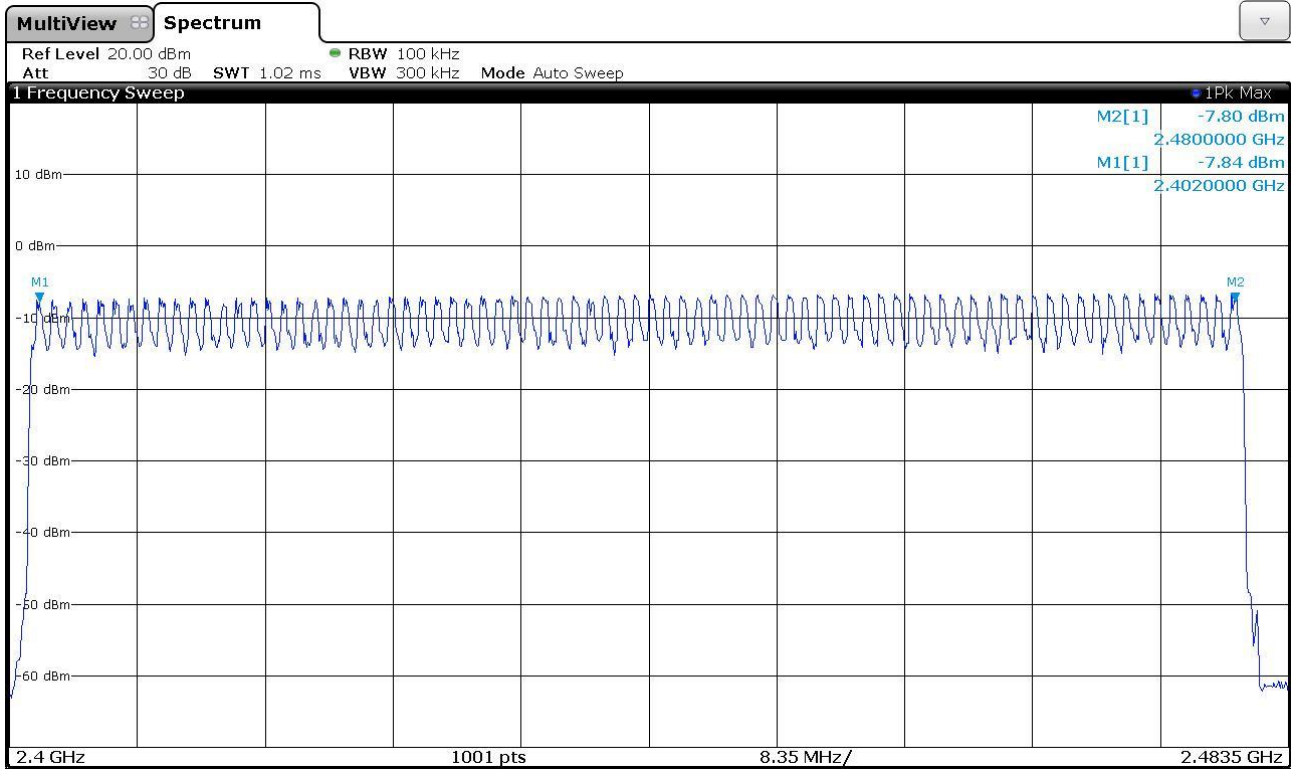
Measurement

The Measurement was performed on: 18.02.2020

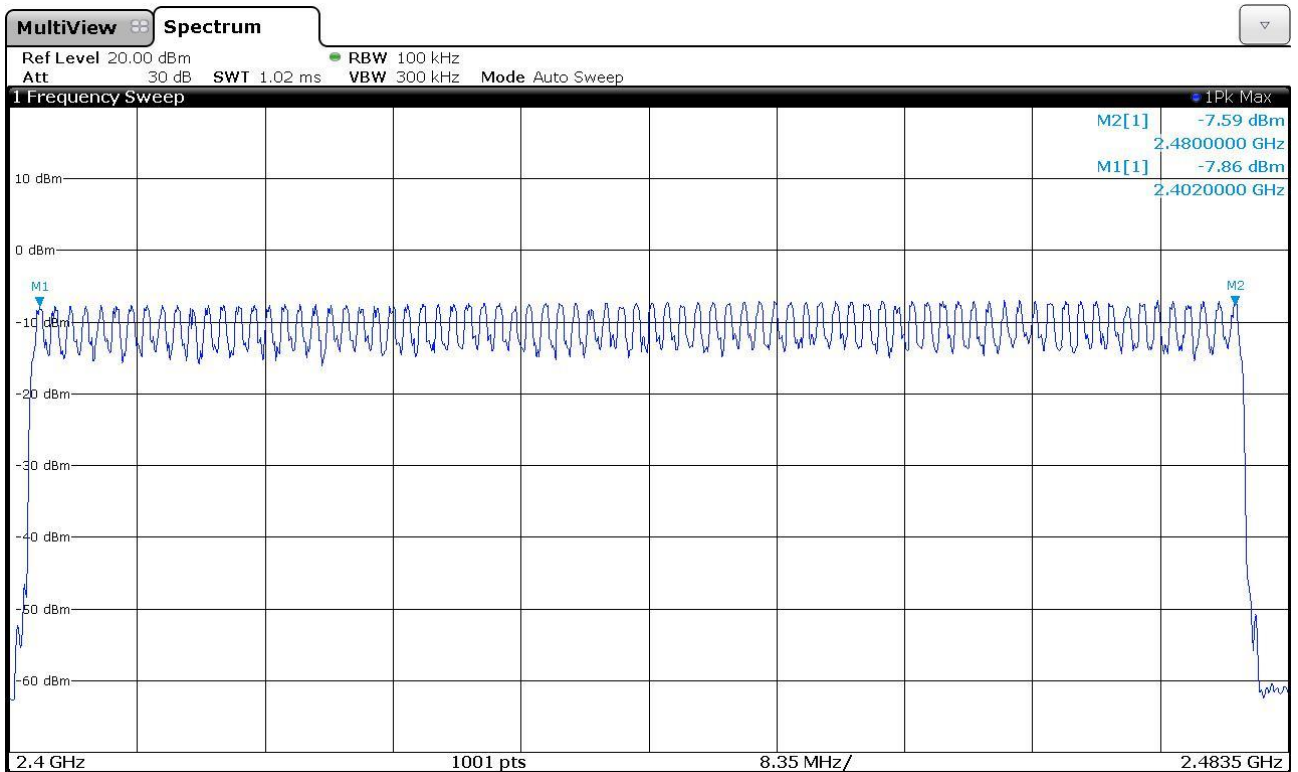
GFSK: 79 of 79 Channel



$\pi/4$ -DQPSK: 79 of 79 Channel



8DPSK: 79 of 79 Channel



Results

From the measurement data obtained, the tested sample was considered to have **COMPLIED** with the requirements for the **Number of Hopping Frequencies**.

7.4. Channel Center Frequency

Test Requirements:

Frequency hopping system in the 2400-2483.5MHz band shall use at least 79 (Channel 0 to 78) non-overlapping channels.

The EUT operates in according with the Bluetooth system specification within the 2400 - 2483.5 MHz frequency band. RF channels for Bluetooth systems are spaced 1 MHz and are ordered in channel number k. In order to comply with out-of-band regulations, a lower frequency guard band of 2.0 MHz and a higher frequency guard band of 3.5MHz is used.

The operating frequencies of each channel are as follows:

First RF channel start from 2400MHz + 2MHz guard band = 2402MHz

Frequency of RF Channel = $2402+(k+1)$ MHz, $k = 0, \dots, 78$ (Channel separation = 1MHz)

7.5. Carrier Frequency Separation

Test Requirements

-e-CFR Title 47 Chapter I Subchapter A Part 15 Subpart C §15.247 (a) (1)

-RSS-247 issue 2 Section 5.1 (b)

Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

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.

Detector function selection and bandwidth

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

Descripton

Frequency range wide enough to capture the peaks of two adjacent channels.
(Peak Detector)

Limits

GFSK:

The measured maximum bandwidth * $2/3$ = $919.1 \text{ kHz} * 2/3 = 612.7 \text{ kHz}$

$\pi/4$ DQPSK:

The measured maximum bandwidth * $2/3$ = $1188.8 \text{ kHz} * 2/3 = 792.5 \text{ kHz}$

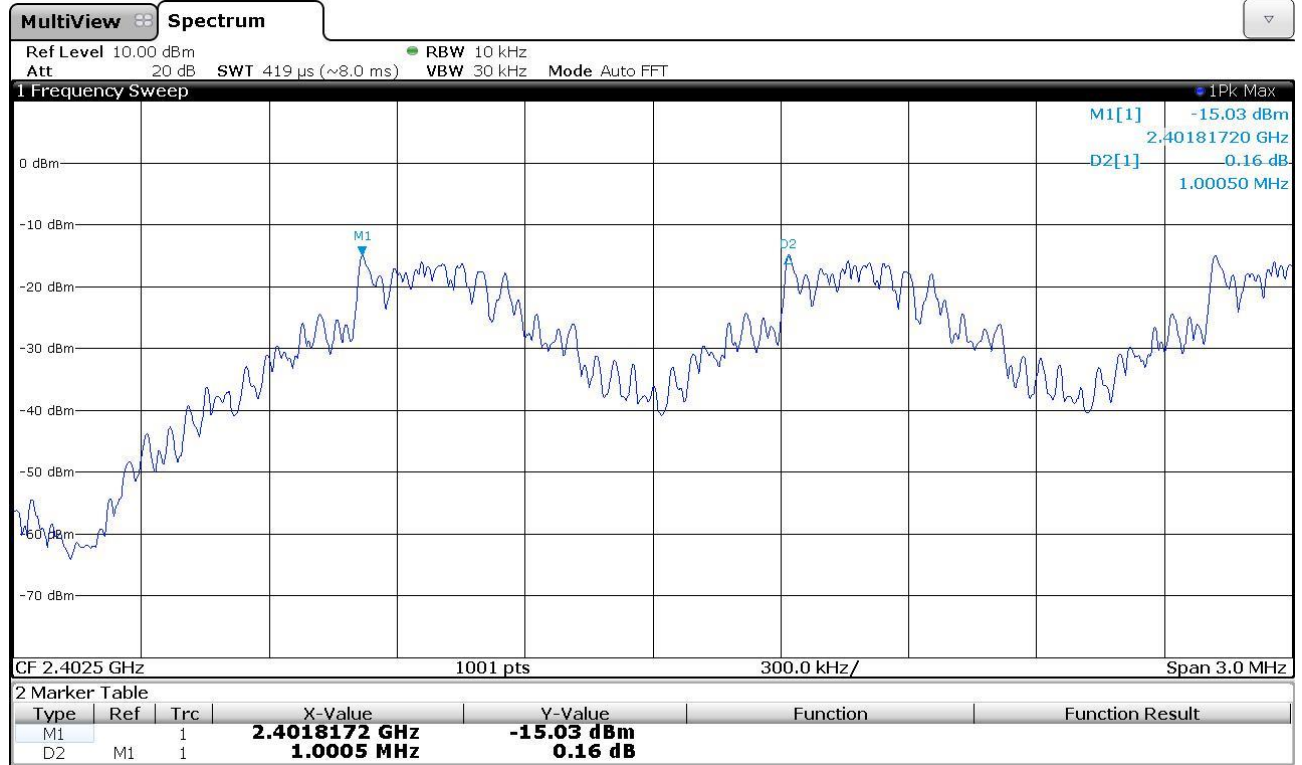
8DPSK:

The measured maximum bandwidth * $2/3$ = $1216.3 \text{ kHz} * 2/3 = 810.9 \text{ kHz}$

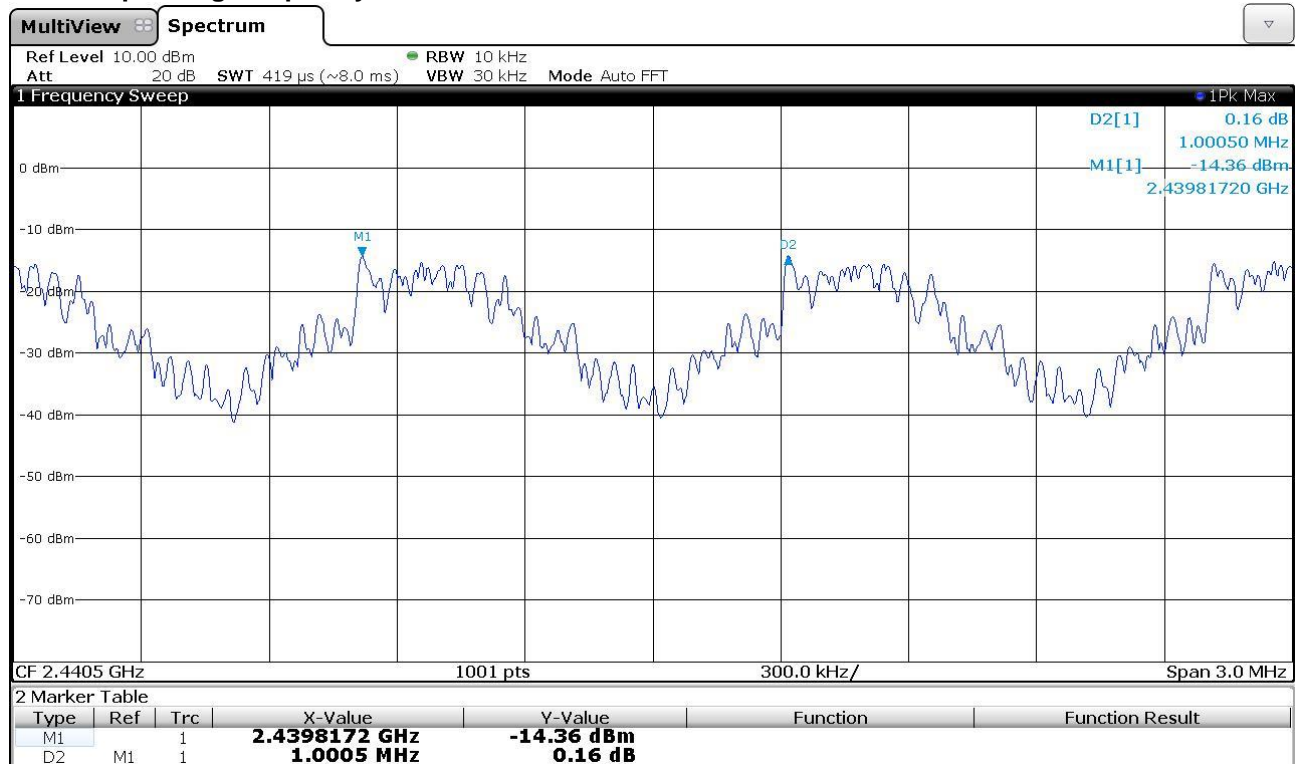
Measurement

The Measurement was performed on: 18.02.2020

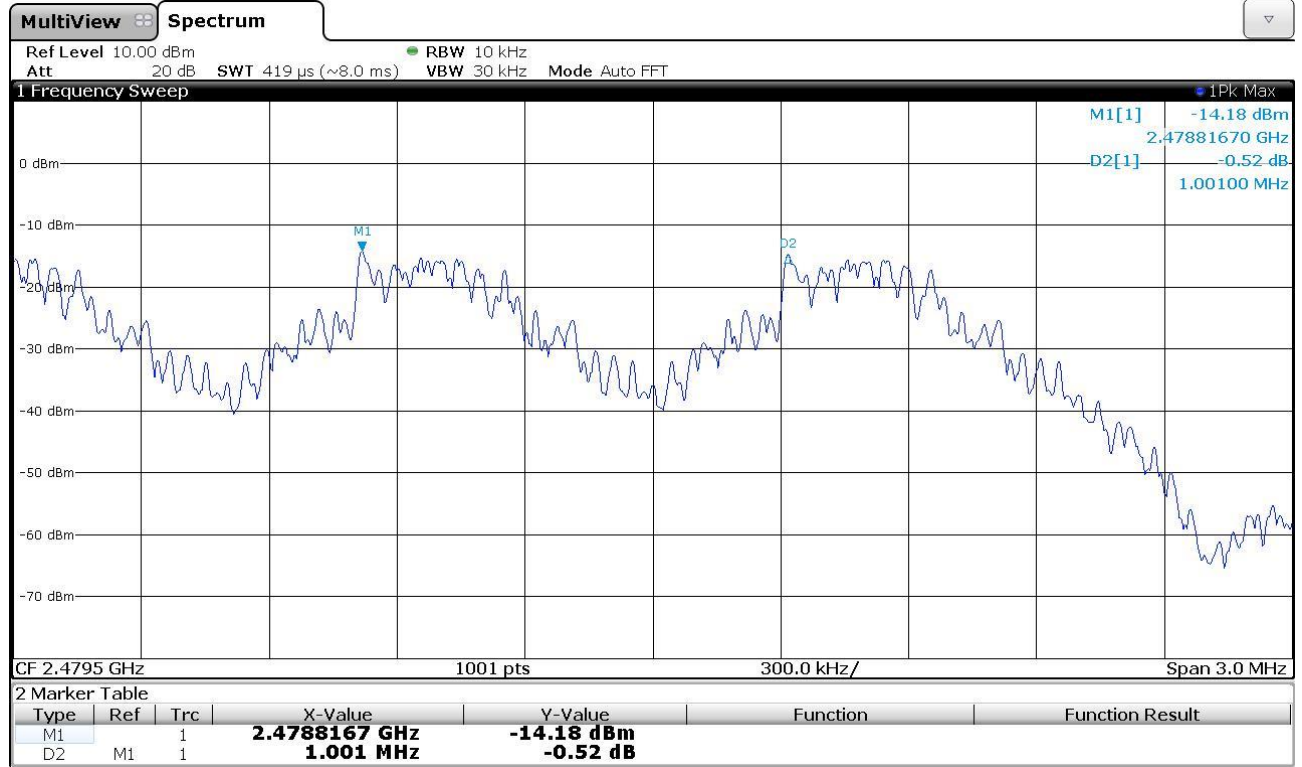
Lowest Operating Frequency – GFSK



Middle Operating Frequency – GFSK

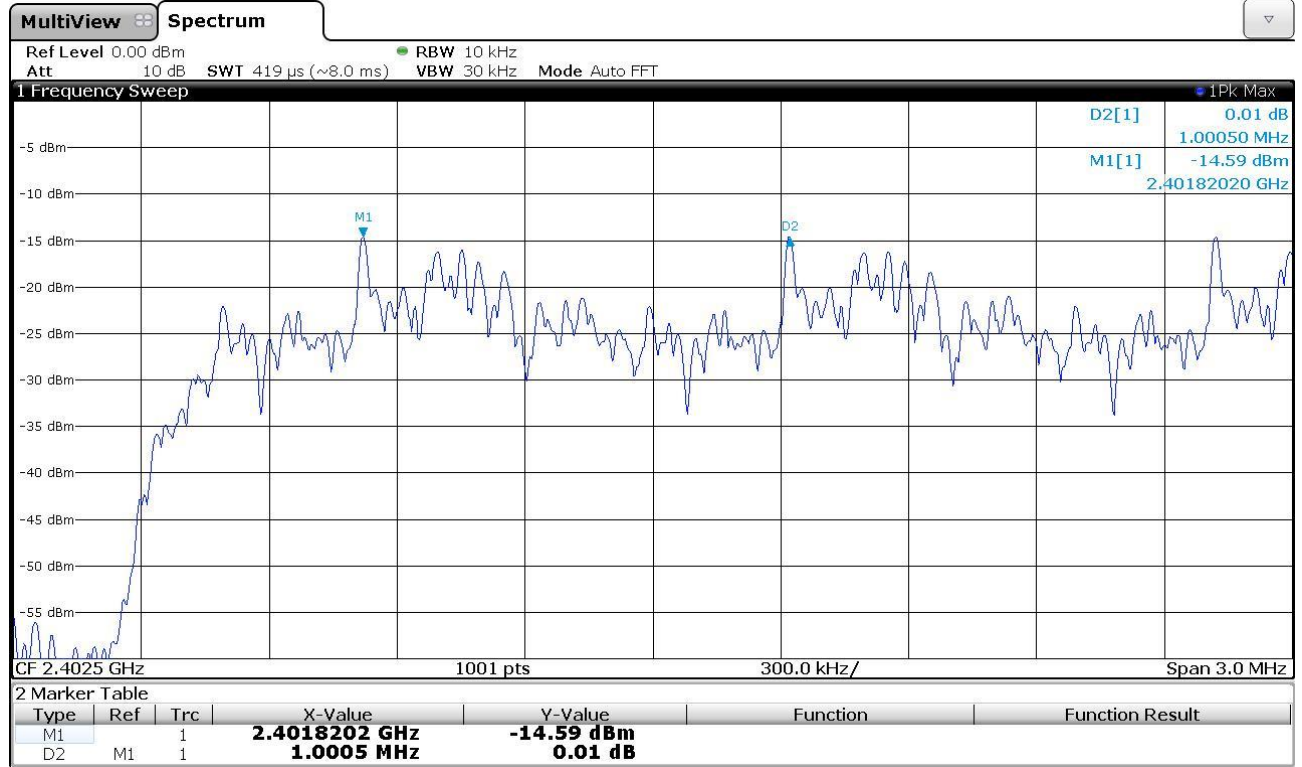


Highest Operating Frequency – GFSK

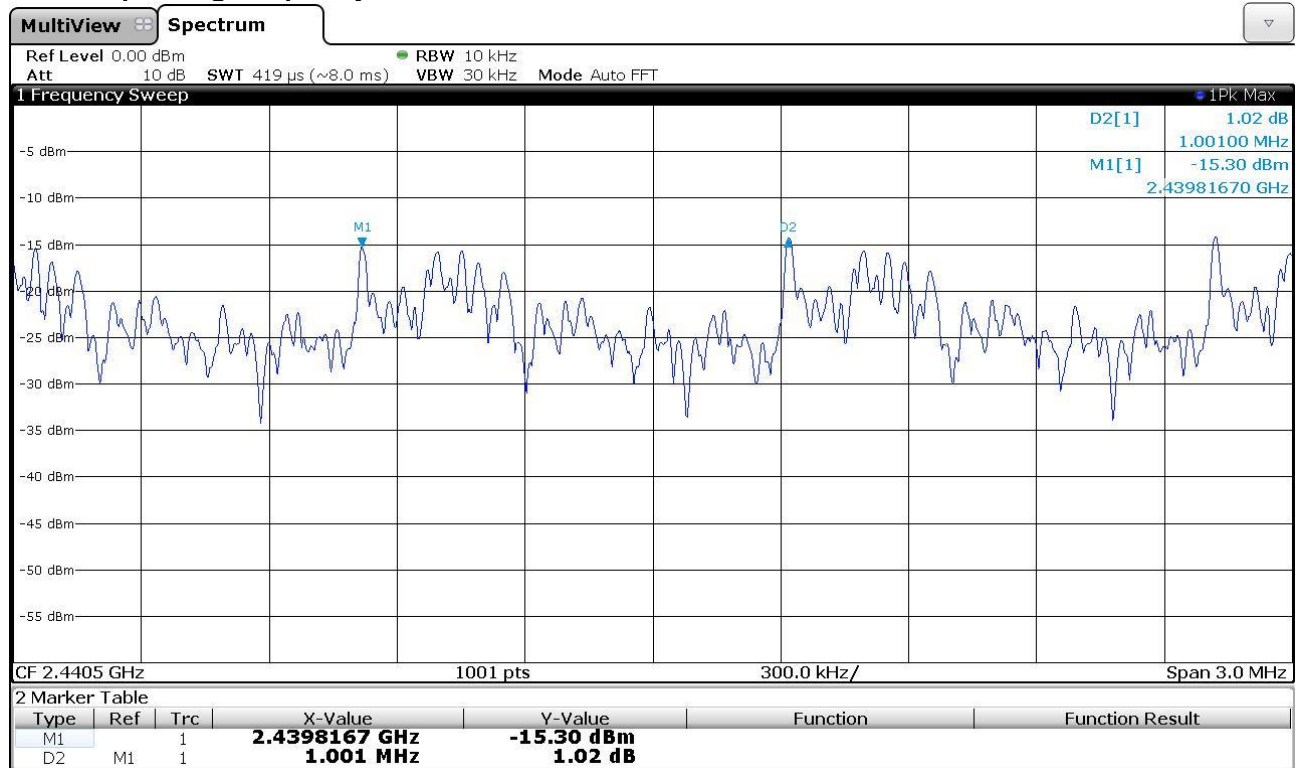


Summary of Channel separation measurements – GFSK			
Tested Channel	Channel separation [kHz]	Limit = 2/3 BW [kHz]	Result
Lowest	1000.5	> 612.7	Pass
Middle	1001.5	> 612.7	Pass
Highest	1001.0	> 612.7	Pass

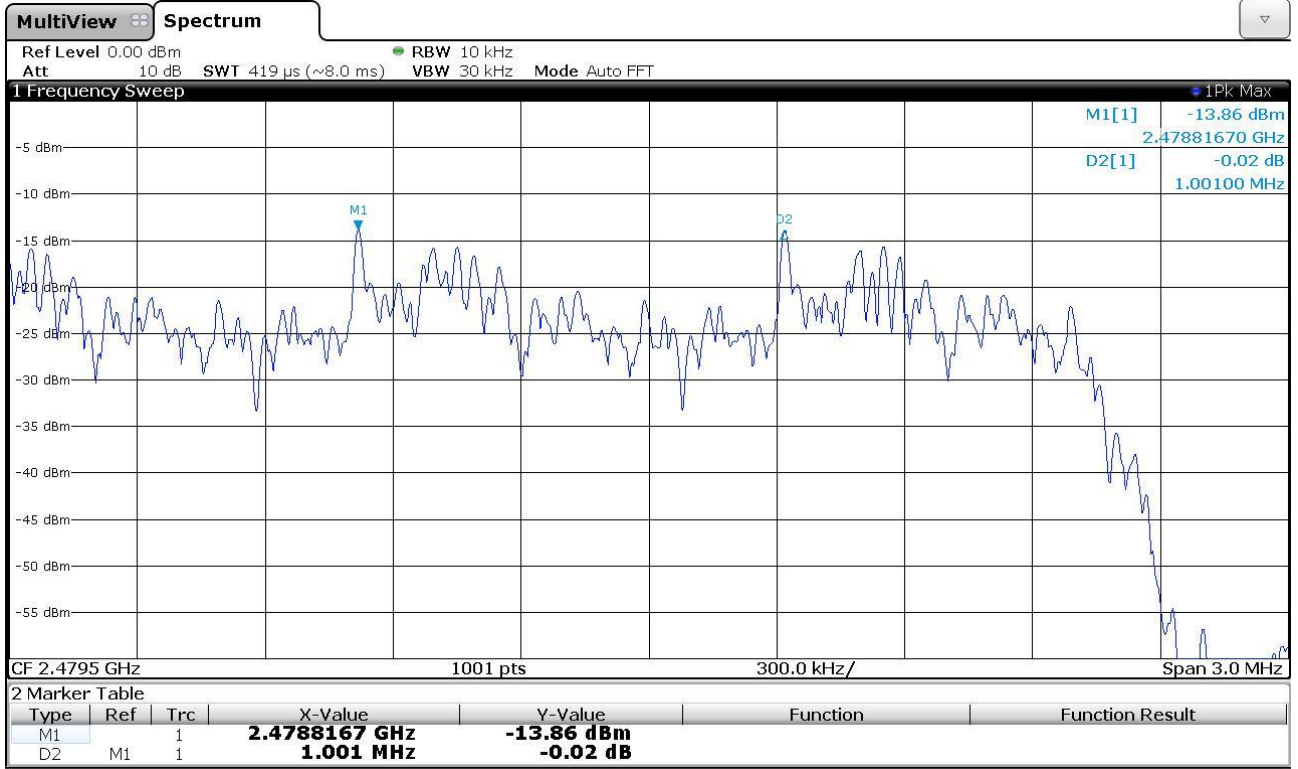
Lowest Operating Frequency – $\pi/4$ DQPSK



Middle Operating Frequency – $\pi/4$ DQPSK



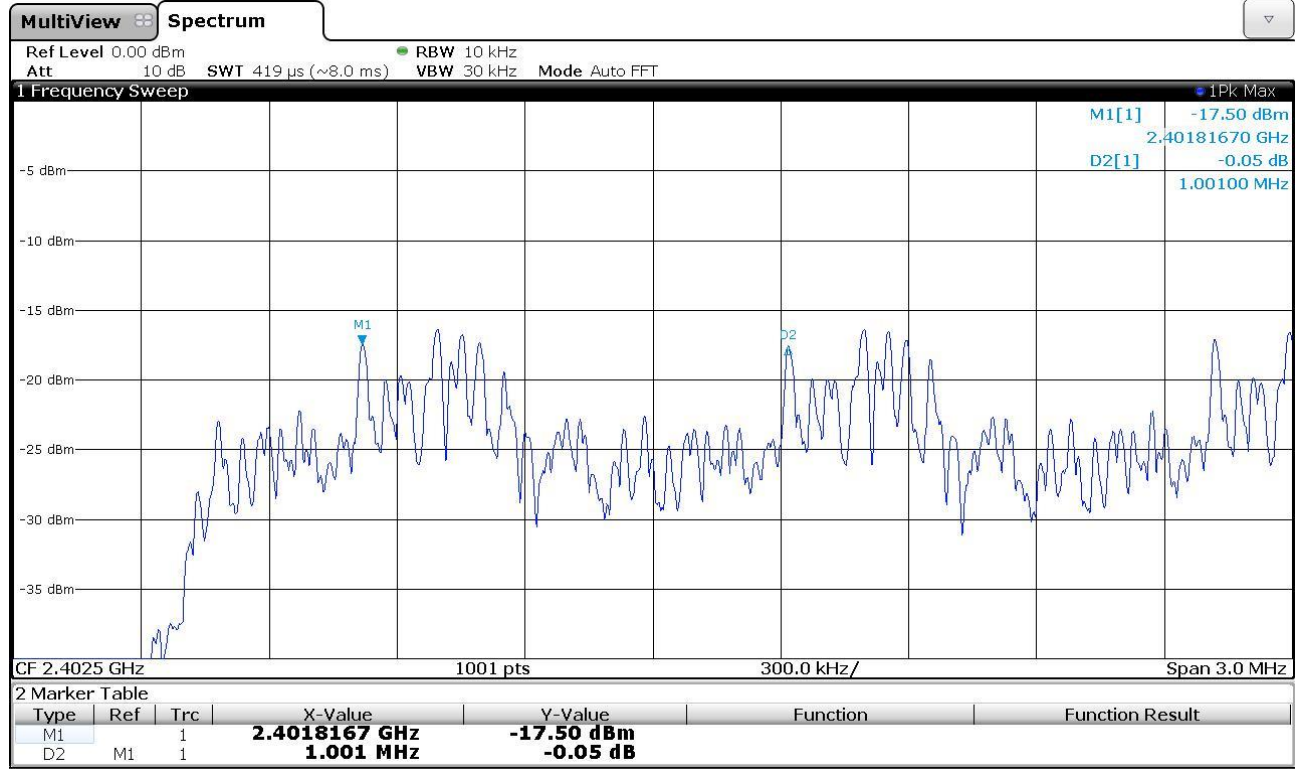
Highest Operating Frequency – $\pi/4$ DQPSK



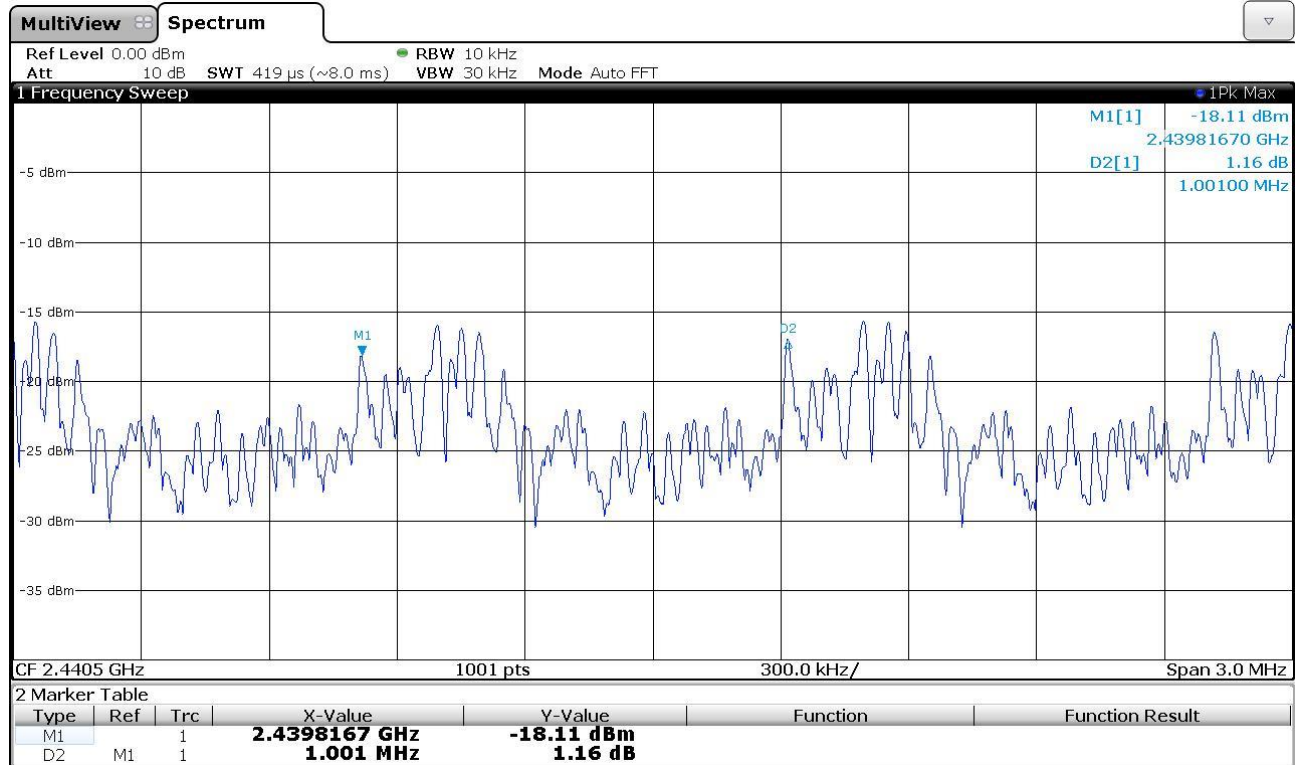
Summary of Channel separation measurements – $\pi/4$ DQPSK

Tested Channel	Channel separation [kHz]	Limit = 2/3 BW [kHz]	Result
Lowest	1000.5	> 792.5	Pass
Middle	1001.0	> 792.5	Pass
Highest	1001.0	> 792.5	Pass

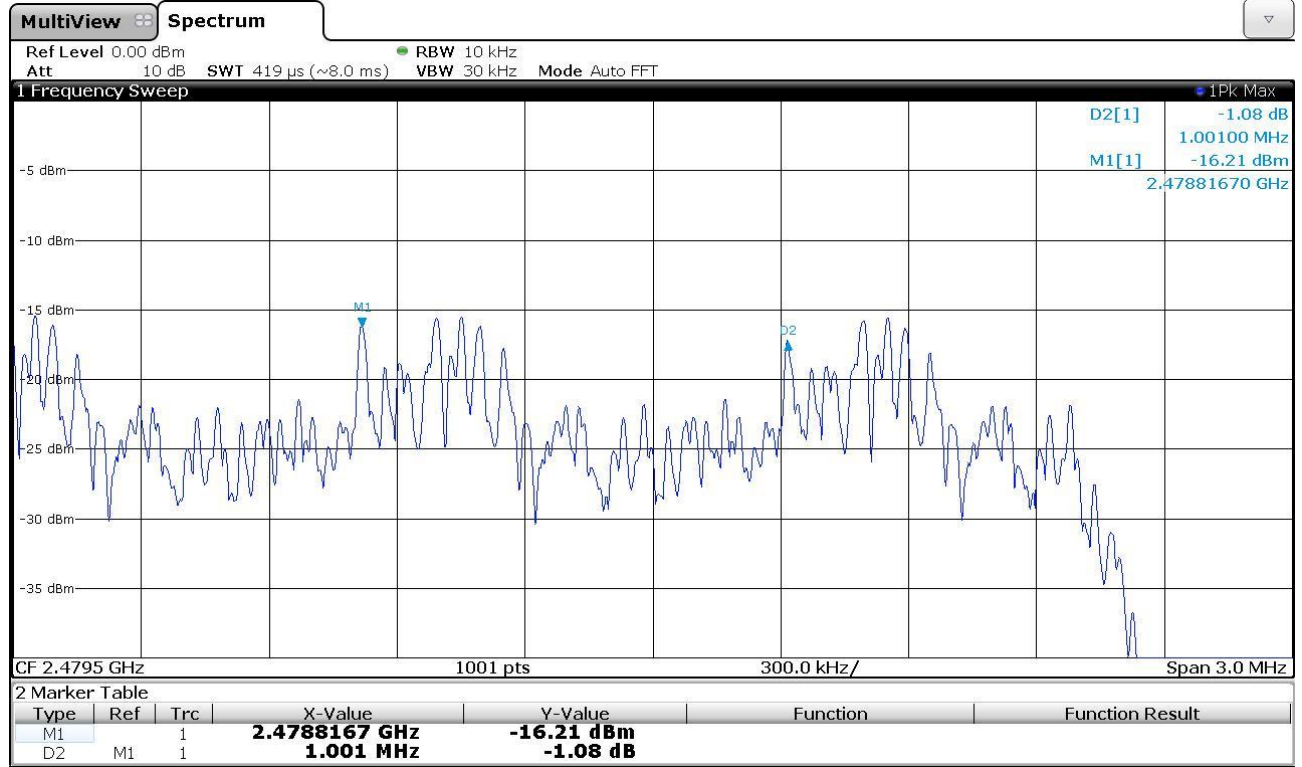
Lowest Operating Frequency – 8DPSK



Middle Operating Frequency – 8DPSK



Highest Operating Frequency – 8DPSK



Summary of Channel separation measurements – 8DPSK

Tested Channel	Channel separation [kHz]	Limit = 2/3 BW [kHz]	Result
Lowest	1001.0	> 810.9	Pass
Middle	1001.0	> 810.9	Pass
Highest	1001.0	> 810.9	Pass