



RF - TEST REPORT

- FCC Part 15.247, RSS-247 -

Type / Model Name : SPB228-D

Product Description : Combined WLAN/BT module

Applicant : H&D Wireless AB

Address : Färögatan 33

164 51 KISTA, SWEDEN

Manufacturer : H&D Wireless AB

Address : Färögatan 33

164 51 KISTA, SWEDEN

Test Result according to the standards
listed in clause 1 test standards:

POSITIVE

Test Report No. : **80113315-00 Rev_0**

20. January 2022

Date of issue



Deutsche
Akkreditierungsstelle
D-PL-12030-01-03
D-PL-12030-01-04

FCC ID: XO2-SPB228D

IC: 8713A-SPB228D

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ATTACHMENT A as separate supplement

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September 2019)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (September 2019)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
Part 15, Subpart C, Section 15.247	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz

ANSI C63.10: 2013 Testing Unlicensed Wireless Devices

ETSI TR 100 028 V1.3.1: 2001-03 Electromagnetic Compatibility and Radio Spectrum Matters (ERM);
Uncertainties in the Measurement of Mobile Radio Equipment
Characteristics—Part 1 and Part 2

KDB 558074 D01 v05 Guidance for compliance measurements on DTS; FHSS and hybrid
system devices operating under Section 15.247 of the FCC rules,
April 2, 2019.

KDB 996369 D04 MODULAR TRANSMITTER INTEGRATION GUIDE—
GUIDANCE FOR HOST PRODUCT MANUFACTURERS

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2 EQUIPMENT UNDER TEST

2.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

2.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according to his/her instructions.

2.3 Photo documentation of the EUT – Detailed photos see ATTACHMENT A

2.4 General remarks

According to the customer the WLAN/BT5 module SPB228-D (FCC ID: XO2-SPB228D, IC ID: 8713A-SPB228D) is fully tested and approved according to the FCC Part 15C, section 15.247. This test report shows the further compliance to the FCC Part 15C, section 15.247 after integration into a mobile handheld computer M2SmartSE. Therefore, the re-test is partly done to the following requirements, only.

- RF output power (radiated) (FCC Part 15C, section 15.207(a))
- Emission bandwidth (FCC Part 15C, section 15.247(a)(2))
- Radiated emissions in restricted bands (FCC Part 15C, section 15.205(a))
- Spurious emissions (FCC Part 15C, section 15.209(a))
- Antenna application (FCC Part 15C, section 15.203)

2.5 Equipment type

BLE device and WLAN Client

2.6 Short description of the equipment under test (EUT)

The EUT is a combined WLAN/BT5 2x2 MU-MIMO module SPB228-D (802.11 ac/a/b/g/n, BLE 5.0). It is integrated into a mobile handheld computer M2SmartSE for mobile acquisition and transmission of data with WLAN/BT. The M2SmartSE can be charged in a docking station.

Number of tested samples: 1
Serial number: 1911 01 (M2SmartSE: 193600000151)
Firmware version WLAN/BT: 16.68.10.p16

2.7 Variants of the EUT

There are no variants.

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2.8 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel plan BLE

Channel	Frequency	Channel	Frequency
0	2402	20	2442
1	2404	21	2444
2	2406	22	2446
3	2408	23	2448
4	2410	24	2450
5	2412	25	2452
6	2414	26	2454
7	2416	27	2456
8	2418	28	2458
9	2420	29	2460
10	2422	30	2462
11	2424	31	2464
12	2426	32	2466
13	2428	33	2468
14	2430	34	2470
15	2432	35	2472
16	2434	36	2474
17	2436	37	2476
18	2438	38	2478
19	2440	39	2480

Note: the marked frequencies are determined for final testing.

Channel plan WLAN Standard 802.11b, g, n HT 20:

Channel	Frequency (MHz)
1	2412
2	2417
3	2422
4	2427
5	2432
6	2437
7	2442
8	2447
9	2452
10	2457
11	2462

Note: the marked frequencies are determined for final testing.

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Channel plan WLAN Standard 802.11n HT 40:

Channel, HT40 up	Channel, HT40 down	Frequency (MHz)
1 up	5 down	2422
2 up	6 down	2427
3 up	7 down	2432
4 up	8 down	2437
5 up	9 down	2442
6 up	10 down	2447
7 up	11 down	2452

Note: The marked frequencies are determined for final testing.

2.9 Transmit operating modes

The EUT use DSSS or OFDM modulation and may operate under operating mode 2 and provide following data rates with auto-fall-back:

- | | | |
|-----------------|-----------------------------------|------------------------------|
| - 802.11b mode | 11, 5.5, 2, 1 Mbps | (Mbps = megabits per second) |
| - 802.11g mode | 54, 48, 36, 24, 18, 12, 9, 6 Mbps | (Mbps = megabits per second) |
| - 802.11n HT20, | MCS 0 - 15 | |
| - 802.11n HT40, | MCS 0 - 15 | |

2.10 Antenna

The following antennas shall be used with the EUT:

Number	Characteristic	Model number	Plug	Frequency range (MHz)	Gain (dBi)
A	omnidirectional	W3006 Pulse LarsenAntenna	MHF4L	2400-2485	1.8
				5150-5850	4.5
B	omnidirectional	1001932PT AVX ethertronics	MHF4L	2400-2485	2.5
				5150-5825	4.4

2.11 Power supply system utilised

- | | | |
|------------------------------------|---|-----------------------------|
| Power supply voltage | : | 3.8 V/DC (battery pack) |
| Power supply voltage (alternative) | : | 15.0 V/DC (docking station) |

2.12 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- | | |
|--------------------------|--|
| - <u>Docking station</u> | Model : <u>DS2Smart, ACD Elektronik GmbH</u> |
| - Notebook EPC-0776 | Model : Latitude E6400, DELL |

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2.13 Determination of worst case conditions for final measurement

Measurements are made in all three orthogonal axes and the settings of the EUT are changed to locate at which position and at what setting of the EUT produce the maximum of the emissions.

The tests are carried out in the following frequency band:

2400 MHz – 2483.5 MHz

Preliminary tests are performed to find the worst case mode from all possible combinations between available modulations and data rates. The maximum output power depends on used data rate.

For the final test the following channels and test modes are selected:

BLE	Available channel	Tested channels	Power setting	Modulation	Data rate
802.15.1	0 to 39	0, 19, 39	6.5	GFSK	1 Mbps

Path A (antenna A):

WLAN	Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
802.11b	1 to 11	1, 6, 11	16	DSSS	DBPSK	11 Mbps
802.11n HT20	1 to 11	1, 6, 11	16	OFDM	BPSK	MCS7
802.11n HT40	1up to 7up	1up, 4up, 7up	16	OFDM	BPSK	MCS7

Path B (antenna B):

WLAN	Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
802.11b	1 to 11	1, 6, 11	13	DSSS	DBPSK	11 Mbps
802.11n HT20	1 to 11	1, 6, 11	13	OFDM	BPSK	MCS7
802.11n HT40	1up to 7up	1up, 4up, 7up	10	OFDM	BPSK	MCS7

Path A + B:

WLAN	Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
802.11b	1 to 11	11	10	DSSS	DBPSK	11 Mbps
802.11n HT20	1 to 11	11	10	OFDM	BPSK	MCS7
802.11n HT40	1up to 7up	7up	7	OFDM	BPSK	MCS7

2.13.1 Test jig

No test jig used.

2.13.2 Test software

The test software for the EUT provides free power setting, the special test mode TX continuous mode, modulated. The EUT was set with test modulation to transmit data during the tests with a maximum duty cycle (x) from an internal packet generator.

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Test software scripts:

BTLE Tx, ch 19

80
225 0
234
116 1
114 1
16 6.5
125 19 37 0

802.11b, ch6, 11Mbps, 16dBm path A only

35
10 1 1
30 0
112 0
12 6
22 0 6 16 0
35 1 4 1 100 400

802.11b, ch6, 11Mbps, 13dBm path B only

35
10 2 2
30 0
112 0
12 6
22 1 6 13 0
35 1 4 1 100 400

802.11b, ch11, 11Mbps, 10dBm path A+B

35
10 3 3
30 0
112 0
12 11
22 3 11 10 0
35 1 4 1 100 400

802.11n, ch6, MCS7, 20MHz, 16dBm path A only

35
10 1 1
30 0
112 0
12 6
22 0 6 16 2
35 1 22 1 100 F00

802.11n, ch6, MCS7, 20MHz, 13dBm path B only

35
10 2 2
30 0
112 0
12 6
22 1 6 13 2
35 1 22 1 100 F00

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802.11n, ch11, MCS7, 20MHz, 10dBm path A+B

35
10 3 3
30 0
112 0
12 11
22 3 11 10 2
35 1 22 1 100 F00

802.11n, ch4+8, MCS7, 40MHz, 16dBm path A only

35
10 1 1
30 0
112 1
12 4
22 0 4 16 2
35 1 22 1 100 F00

802.11n, ch4+8, MCS7, 40MHz, 10dBm path B only

35
10 2 2
30 0
112 1
12 4
22 1 4 10 2
35 1 22 1 100 F00

802.11n, ch7+11, MCS7, 40MHz, 7dBm path A+B

35
10 3 3
30 0
112 1
12 7
22 3 7 7 2
35 1 22 1 100 F00

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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3 TEST RESULT SUMMARY

BLE and WLAN device using digital modulation:

Operating in the 2400 MHz – 2483.5 MHz:

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS-Gen, 8.8	AC power line conducted emissions	passed
15.247(b)(3)	RSS-247, 5.4(d)	Maximum peak conducted output power	passed
15.247(a)(2)	RSS-247, 5.2(a)	-6 dB EBW	passed
15.247(d)	RSS-247, 5.5	Unwanted emission, radiated	passed
15.247(d)	RSS-Gen, 8.10	Emissions in restricted bands	passed
15.203	-	Antenna requirement	passed

The mentioned RSS Rule Parts in the above table are related to:
 RSS-Gen, Issue 5 + Amendment 1 + Amendment 2, February 2021
 RSS-247, Issue 2, February 2017

3.1 Final assessment

The equipment under test fulfils the requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 10 December 2020

Testing concluded on : 18 January 2022

Checked by:

Tested by:

 Klaus Gegenfurtner
 Teamleader Radio

 Sabine Kugler
 Radio Team

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

**CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY**

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	<u>15-35 °C</u>
Humidity:	<u>30-60 %</u>
Atmospheric pressure:	<u>86-106 kPa</u>

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor $k = 2$. The true value is located in the corresponding interval with a probability of 95 %. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 2011 + A1 / 2014 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
AC power line conducted emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
EBW and OBW	2400 MHz to 30000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Output power ERP, radiated	1000 MHz to 7000 MHz	95%	± 2.71 dB
Field strength of the fundamental	1000 MHz to 7000 MHz	95%	± 2.71 dB
Power spectral density	2400 MHz to 3000 MHz	95%	± 0.62 dB
Spurious Emissions, conducted	9 kHz to 10000 MHz	95%	± 2.15 dB
Spurious Emissions, conducted	10000 MHz to 40000 MHz	95%	± 3.47 dB
Spurious Emissions, radiated	9 kHz to 30 MHz	95%	± 3.53 dB
Spurious Emissions, radiated	30 MHz to 1000 MHz	95%	± 4.44 dB
Spurious Emissions, radiated	1000 MHz to 30000 MHz	95%	± 2.34 dB
Spurious Emissions, radiated	30000 MHz to 40000 MHz	95%	± 5.13 dB

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4.4 Conformity Decision Rule

The conformity decision rule is based on the ILAC G8 published at the time of reporting.

4.5 Measurement protocol for FCC and ISCED

4.5.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

FCC: DE 0011

ISED: DE0009

4.5.2 General Standard information

The test methods used comply with ANSI C63.10 - "Testing Unlicensed Wireless Devices".

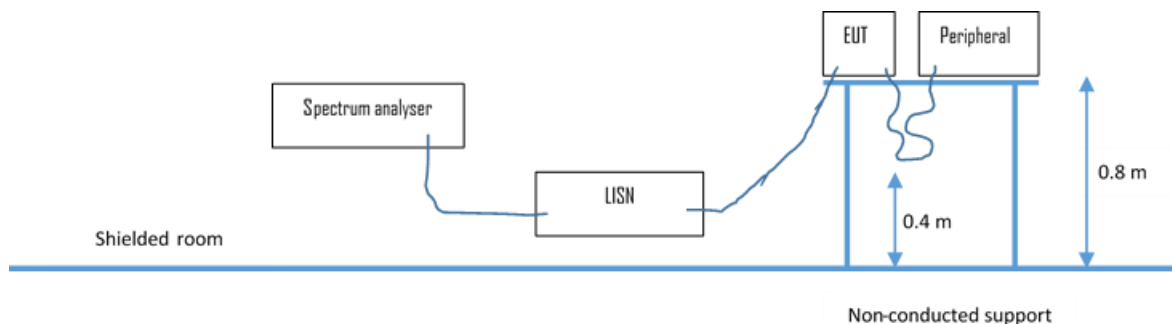
4.5.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions.

4.5.3 Details of test procedures

4.5.3.1 Conducted emission

Test setup according ANSI C63.10



The final level, expressed in dBμV, is arrived at by taking the reading directly from the Spectrum analyser. This level is compared to the limit.

To convert between dBμV and μV, the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with 50 Ω / 50 μH (CISPR 16) characteristics. The receiver is protected by means of an impedance matched pulse limiter connected directly to the RF input. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emission is re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

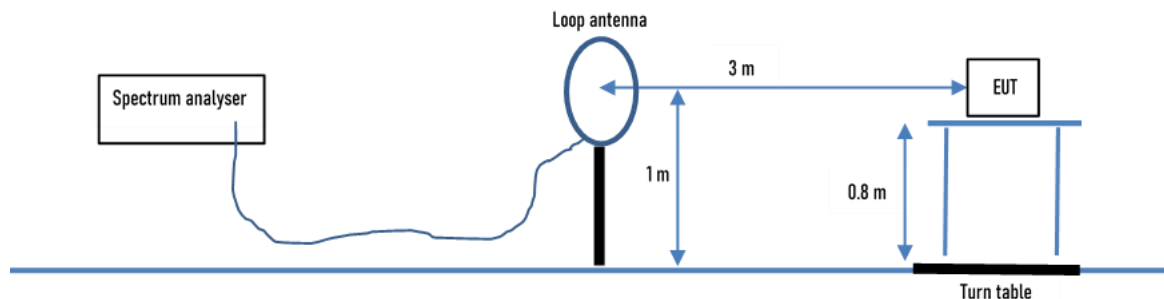
FCC ID: XO2-SPB228D

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4.5.3.2 Radiated emission

4.5.3.2.1 OATS1 test site (9 kHz - 30 MHz):

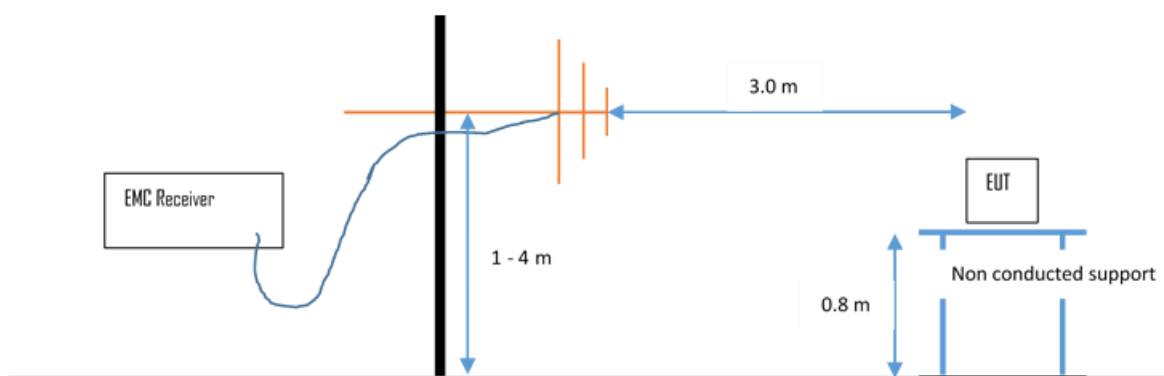
Test setup according ANSI C63.10



Emissions from the EUT are measured in the frequency range of 9 MHz to 30 MHz using a tuned receiver and a calibrated loop antenna. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied along the site axis and the EUT is rotated 360 degrees.

4.5.3.2.2 OATS1 test site (30 MHz - 1 GHz):

Test setup according ANSI C63.10.



Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees. The final level in dBμV/m is calculated by taking the reading from the EMI receiver (Level dBμV) and adding the correction factors and cable loss factor (dB). The FCC limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:

30 MHz – 1000 MHz: RBW: 120 kHz

Example:

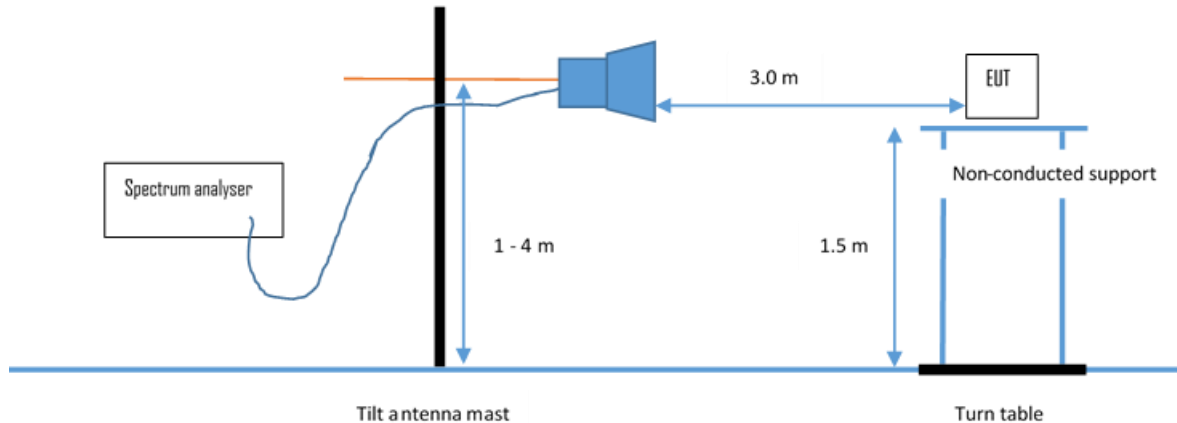
Frequency (MHz)	Level (dBμV)	+	Factor (dB)	=	Level (dBμV/m)	-	Limit (dBμV/m)	=	Delta (dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	=	-2.4

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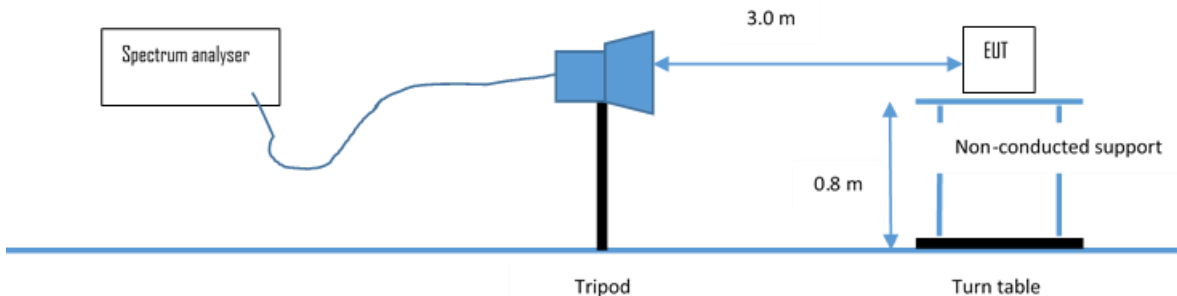
4.5.3.2.3 Anechoic chamber 1 (1000 MHz – 18000 MHz)

Test setup according ANSI C63.10.



Radiated emissions from the EUT are measured in the frequency range 1 GHz up to 18 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 1.5 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the center, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements.

4.5.3.2.4 Anechoic chamber 1 (18 GHz – 40 GHz)



Emissions from the EUT are measured in the frequency range 18 GHz up to 40 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 0.8 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the center, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty. The limit is adopted.

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5 TEST CONDITIONS AND RESULTS

5.1 AC power line conducted emissions

For test instruments and accessories used see section 6 Part A 4.

5.1.1 Description of the test location

Test location: Shielded Room S2

5.1.2 Photo documentation of the test set-up



5.1.3 Applicable standard

According to FCC Part 15, Section 15.207(a):

Except as shown in paragraphs (b) and (c) of this Section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits under FCC 15.207(a).

5.1.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10 described under item 4.4.3. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

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5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin -14.2 dB at 0.677 MHz

Limit according to FCC Part 15, Section 15.207(a):

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

The requirements are **FULFILLED**.

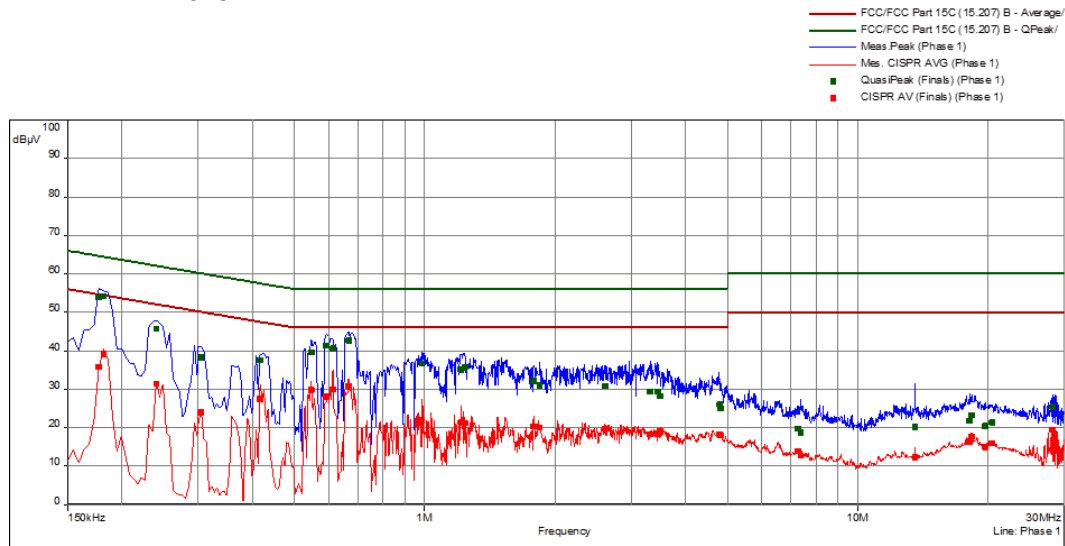
Remarks: For detailed test result please refer to following test protocols

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5.1.6 Test protocol

Test point: L1
Operation mode: BLE TX continuous
Remarks: None

Result: passed



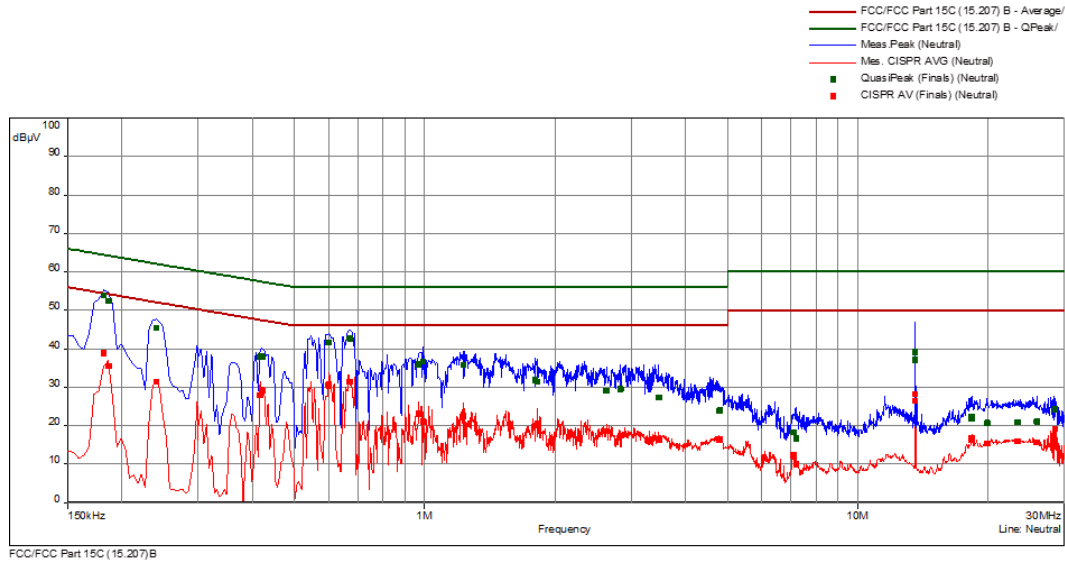
FCC/FCC Part 15C (15.207)B

freq	S	QP	margin	limit	AV	margin	limit	line	corr
MHz		dB(μV)	dB	dB	dB(μV)	dB	dB		dB
0.177	1	53.9	-10.7	64.6	35.8	-18.8	54.6	Phase 1	10.1
0.182	1	54.3	-10.2	64.4	39.2	-15.3	54.4	Phase 1	10.1
0.240	1	45.8	-16.3	62.1	31.4	-20.7	52.1	Phase 1	10.1
0.305	2	38.3	-21.8	60.1	24.1	-26.1	50.1	Phase 1	10.1
0.417	2	37.5	-20.0	57.5	27.5	-20.0	47.5	Phase 1	10.2
0.548	2	39.7	-16.3	56.0	29.8	-16.2	46.0	Phase 1	10.2
0.593	2	41.5	-14.6	56.0	28.1	-17.9	46.0	Phase 1	10.2
0.614	3	40.6	-15.4	56.0	30.0	-16.0	46.0	Phase 1	10.2
0.668	3	42.6	-13.4	56.0	30.9	-15.1	46.0	Phase 1	10.2
0.987	3	36.7	-19.3	56.0	22.0	-24.0	46.0	Phase 1	10.2
1.214	4	35.2	-20.8	56.0	21.4	-24.6	46.0	Phase 1	10.2
1.236	4	35.7	-20.3	56.0	21.3	-24.7	46.0	Phase 1	10.2
1.785	4	32.1	-23.9	56.0	20.4	-25.7	46.0	Phase 1	10.3
1.844	4	31.1	-25.0	56.0	20.0	-26.0	46.0	Phase 1	10.3
2.607	5	30.9	-25.2	56.0	19.7	-26.3	46.0	Phase 1	10.3
3.318	5	29.4	-26.6	56.0	18.3	-27.7	46.0	Phase 1	10.4
3.444	5	29.4	-26.6	56.0	18.4	-27.7	46.0	Phase 1	10.4
3.503	5	28.2	-27.8	56.0	19.1	-26.9	46.0	Phase 1	10.4
4.805	6	26.0	-30.0	56.0	18.3	-27.7	46.0	Phase 1	10.4
4.818	6	25.1	-30.9	56.0	18.1	-27.9	46.0	Phase 1	10.4
7.271	6	19.9	-40.2	60.0	14.0	-36.1	50.0	Phase 1	10.6
7.397	6	18.7	-41.3	60.0	12.8	-37.2	50.0	Phase 1	10.6
13.547	7	20.2	-39.8	60.0	12.3	-37.7	50.0	Phase 1	11.1
18.137	7	21.8	-38.2	60.0	16.4	-33.6	50.0	Phase 1	11.4
18.321	7	23.4	-36.7	60.0	17.8	-32.2	50.0	Phase 1	11.4
19.682	8	20.5	-39.5	60.0	15.0	-35.0	50.0	Phase 1	11.4
20.415	8	21.4	-38.6	60.0	15.9	-34.1	50.0	Phase 1	11.5
28.110	8	25.5	-34.5	60.0	19.5	-30.5	50.0	Phase 1	11.7

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

Test point: N
Operation mode: BLE TX continuous
Remarks: None

Result: passed

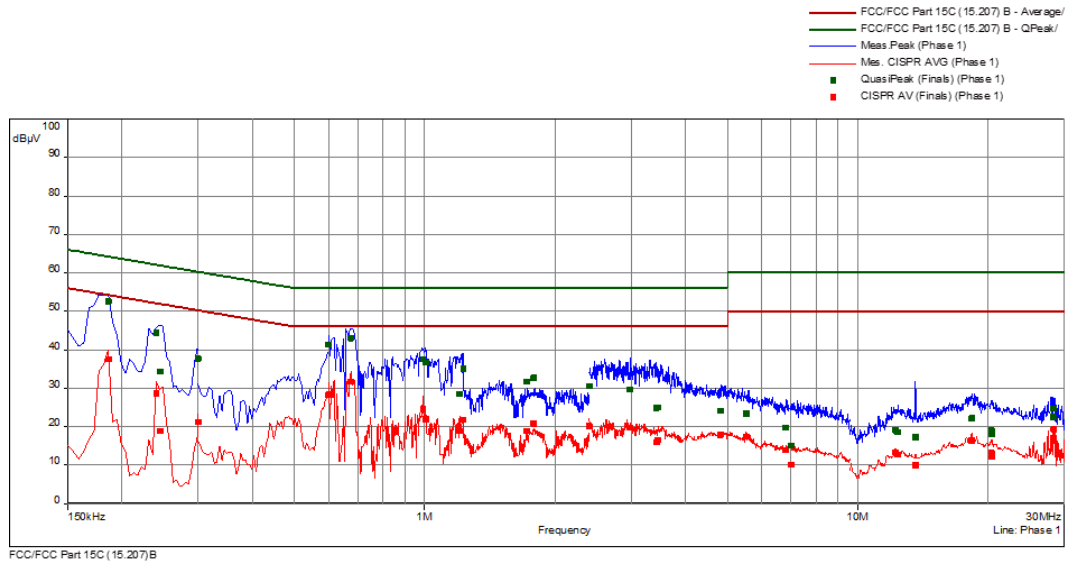


freq	S	QP	margin	limit	AV	margin	limit	line	corr
MHz		dB(μV)	dB	dB	dB(μV)	dB	dB		dB
0.182	9	53.9	-10.5	64.4	38.9	-15.5	54.4	Neutral	10.1
0.186	9	52.4	-11.8	64.2	35.5	-18.7	54.2	Neutral	10.1
0.240	9	45.5	-16.6	62.1	31.4	-20.7	52.1	Neutral	10.1
0.417	10	37.9	-19.6	57.5	27.9	-19.6	47.5	Neutral	10.2
0.422	10	37.9	-19.5	57.4	29.3	-18.2	47.4	Neutral	10.2
0.600	10	41.7	-14.3	56.0	30.7	-15.3	46.0	Neutral	10.2
0.600	11	41.6	-14.4	56.0	30.5	-15.5	46.0	Neutral	10.2
0.672	11	42.7	-13.3	56.0	31.5	-14.5	46.0	Neutral	10.2
0.969	11	36.0	-20.0	56.0	23.1	-22.9	46.0	Neutral	10.2
0.992	11	36.7	-19.3	56.0	21.0	-25.0	46.0	Neutral	10.2
1.227	12	35.9	-20.1	56.0	22.5	-23.5	46.0	Neutral	10.2
1.803	12	31.9	-24.1	56.0	20.0	-26.0	46.0	Neutral	10.3
1.821	12	31.5	-24.6	56.0	20.4	-25.6	46.0	Neutral	10.3
2.630	13	29.1	-26.9	56.0	18.7	-27.4	46.0	Neutral	10.3
2.832	13	29.5	-26.5	56.0	17.4	-28.6	46.0	Neutral	10.3
3.467	13	27.3	-28.7	56.0	16.5	-29.5	46.0	Neutral	10.4
4.800	14	24.0	-32.0	56.0	16.5	-29.5	46.0	Neutral	10.4
4.805	14	24.0	-32.0	56.0	16.2	-29.8	46.0	Neutral	10.4
7.104	14	18.3	-41.7	60.0	12.4	-37.6	50.0	Neutral	10.6
7.203	14	16.7	-43.3	60.0	10.0	-40.0	50.0	Neutral	10.6
13.560	15	39.2	-20.8	60.0	28.2	-21.8	50.0	Neutral	10.9
13.565	15	37.3	-22.8	60.0	26.5	-23.6	50.0	Neutral	10.9
18.321	15	22.4	-37.6	60.0	16.9	-33.1	50.0	Neutral	11.2
18.330	15	21.9	-38.1	60.0	16.4	-33.6	50.0	Neutral	11.2
19.880	16	20.8	-39.2	60.0	15.5	-34.6	50.0	Neutral	11.2
23.367	16	21.0	-39.0	60.0	16.0	-34.0	50.0	Neutral	11.3
25.896	16	21.1	-38.9	60.0	15.8	-34.3	50.0	Neutral	11.2
28.466	16	24.3	-35.7	60.0	19.2	-30.8	50.0	Neutral	11.1

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

Test point: L1
Operation mode: WLAN 2.4 GHz TX continuous
Remarks: None

Result: passed

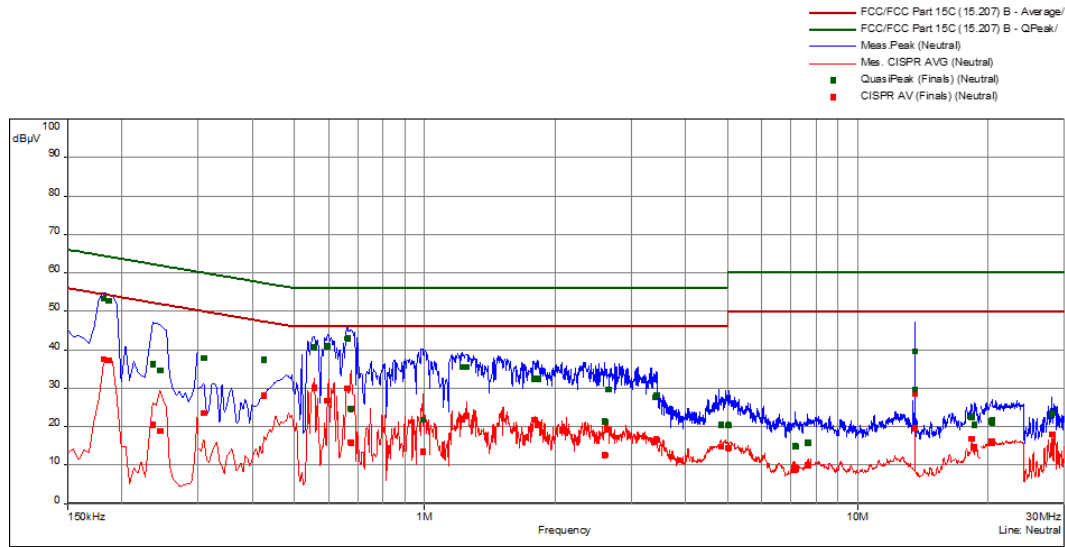


freq	S	QP	margin	limit	AV	margin	limit	line	corr
MHz	R	dB(μV)	dB	dB	dB(μV)	dB	dB		dB
0.186	1	52.7	-11.5	64.2	37.5	-16.7	54.2	Phase 1	10.1
0.240	1	44.5	-17.6	62.1	28.7	-23.4	52.1	Phase 1	10.1
0.245	1	34.4	-27.6	61.9	18.9	-33.1	51.9	Phase 1	10.1
0.300	2	37.7	-22.5	60.2	21.3	-29.0	50.2	Phase 1	10.1
0.600	2	41.4	-14.6	56.0	28.4	-17.6	46.0	Phase 1	10.2
0.677	3	43.1	-12.9	56.0	31.8	-14.2	46.0	Phase 1	10.2
0.992	3	37.5	-18.5	56.0	24.6	-21.4	46.0	Phase 1	10.2
1.005	3	36.7	-19.3	56.0	22.0	-24.0	46.0	Phase 1	10.2
1.205	4	28.6	-27.4	56.0	18.9	-27.1	46.0	Phase 1	10.2
1.227	4	35.1	-20.9	56.0	21.9	-24.1	46.0	Phase 1	10.2
1.727	4	31.8	-24.2	56.0	18.9	-27.1	46.0	Phase 1	10.3
1.785	4	32.7	-23.3	56.0	20.9	-25.1	46.0	Phase 1	10.3
2.400	5	30.6	-25.4	56.0	20.1	-25.9	46.0	Phase 1	10.3
2.981	5	29.8	-26.2	56.0	19.8	-26.2	46.0	Phase 1	10.4
3.426	5	25.0	-31.0	56.0	16.0	-30.0	46.0	Phase 1	10.4
3.462	5	25.1	-31.0	56.0	16.6	-29.4	46.0	Phase 1	10.4
4.823	6	24.1	-31.9	56.0	17.9	-28.1	46.0	Phase 1	10.4
5.529	6	23.5	-36.5	60.0	17.5	-32.5	50.0	Phase 1	10.5
6.825	6	19.9	-40.1	60.0	13.9	-36.1	50.0	Phase 1	10.6
7.005	6	15.1	-44.9	60.0	10.2	-39.8	50.0	Phase 1	10.6
12.210	7	19.2	-40.8	60.0	13.3	-36.7	50.0	Phase 1	11.0
12.381	7	18.6	-41.4	60.0	12.8	-37.2	50.0	Phase 1	11.0
13.596	7	17.3	-42.7	60.0	10.0	-40.0	50.0	Phase 1	11.1
18.321	7	22.2	-37.8	60.0	16.4	-33.6	50.0	Phase 1	11.4
20.330	8	18.0	-42.0	60.0	12.3	-37.8	50.0	Phase 1	11.5
20.357	8	19.0	-41.0	60.0	13.2	-36.8	50.0	Phase 1	11.5
28.268	8	22.5	-37.5	60.0	17.2	-32.8	50.0	Phase 1	11.7
28.272	8	24.8	-35.2	60.0	19.3	-30.7	50.0	Phase 1	11.7

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

Test point: N
Operation mode: WLAN 2.4 GHz TX continuous
Remarks: None

Result: passed



FCC/ICC Part 15C (15.207) B

freq	S	QP	margin	limit	AV	margin	limit	line	corr
MHz	R	dB(μV)	dB	dB	dB(μV)	dB	dB		dB
0.182	9	53.3	-11.2	64.4	37.6	-16.8	54.4	Neutral	10.1
0.186	9	52.7	-11.5	64.2	37.3	-16.9	54.2	Neutral	10.1
0.236	9	36.3	-25.9	62.3	20.6	-31.7	52.3	Neutral	10.1
0.245	9	34.6	-27.3	61.9	18.9	-33.0	51.9	Neutral	10.1
0.309	10	37.8	-22.2	60.0	23.5	-26.5	50.0	Neutral	10.1
0.426	10	37.4	-19.9	57.3	28.1	-19.2	47.3	Neutral	10.2
0.557	10	40.6	-15.4	56.0	30.1	-15.9	46.0	Neutral	10.2
0.597	10	40.9	-15.1	56.0	26.8	-19.2	46.0	Neutral	10.2
0.663	11	42.9	-13.1	56.0	30.0	-16.0	46.0	Neutral	10.2
0.677	11	24.7	-31.3	56.0	15.8	-30.2	46.0	Neutral	10.2
0.992	11	21.8	-34.2	56.0	13.5	-32.5	46.0	Neutral	10.2
1.218	12	35.6	-20.4	56.0	22.0	-24.0	46.0	Neutral	10.2
1.250	12	35.5	-20.5	56.0	22.8	-23.2	46.0	Neutral	10.2
1.794	12	32.6	-23.4	56.0	21.8	-24.2	46.0	Neutral	10.3
1.826	12	32.5	-23.5	56.0	20.5	-25.6	46.0	Neutral	10.3
2.603	13	21.4	-34.6	56.0	12.6	-33.4	46.0	Neutral	10.3
2.652	13	29.7	-26.3	56.0	19.2	-26.8	46.0	Neutral	10.3
3.408	13	27.7	-28.3	56.0	16.2	-29.8	46.0	Neutral	10.4
3.435	13	28.2	-27.8	56.0	16.7	-29.3	46.0	Neutral	10.4
4.836	14	20.6	-35.4	56.0	14.9	-31.1	46.0	Neutral	10.4
5.034	14	20.4	-39.6	60.0	14.4	-35.6	50.0	Neutral	10.4
7.176	14	15.0	-45.1	60.0	8.9	-41.1	50.0	Neutral	10.6
7.671	14	15.9	-44.1	60.0	10.0	-40.0	50.0	Neutral	10.6
13.556	15	29.7	-30.3	60.0	19.7	-30.3	50.0	Neutral	10.9
13.560	15	39.7	-20.3	60.0	28.6	-21.4	50.0	Neutral	10.9
18.321	15	22.5	-37.5	60.0	16.9	-33.1	50.0	Neutral	11.2
18.636	15	20.5	-39.5	60.0	14.8	-35.2	50.0	Neutral	11.2
20.361	16	21.7	-38.3	60.0	16.3	-33.7	50.0	Neutral	11.3
20.402	16	21.2	-38.8	60.0	15.8	-34.2	50.0	Neutral	11.3
28.056	16	23.5	-36.6	60.0	18.0	-32.0	50.0	Neutral	11.2

FCC ID: XO2-SPB228D

IC: 8713A-SPB228D

5.2 Maximum peak conducted output power

For test instruments and accessories used see section 6 Part **CPR 3**.

5.2.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.2.2 Photo documentation of the test set-up



EUT orientation:



5.2.3 Applicable standard

According to FCC Part 15, Section 15.247 (b)(3):

For systems using digital modulation in the 2400 – 2483.5 MHz and 5725 – 5850 MHz bands, the maximum peak output power of the transmitter shall not exceed 1 Watt. The limit is based on transmitting antennas of directional gain that do not exceed 6 dBi.

5.2.4 Description of Measurement

The maximum peak conducted output power is measured using a peak power meter following the procedure set out in ANSI C63-10, item 11.9.1.1. The EUT is set in TX continuous mode while measuring.

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

5.2.5 Test result

Measurement of radiated output power:

BLE:

802.15.1, 1 Mbps, P6.5		Test results radiated			
		Fieldstrength E (dBμV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH0					
T_{nom}	V_{nom}	100.8	5.5	36.0	-30.5
Middle frequency: CH19					
T_{nom}	V_{nom}	102.1	6.8	36.0	-29.2
Highest frequency: CH39					
T_{nom}	V_{nom}	102.0	6.7	36.0	-29.3

WLAN:

802.11b, 11 Mbps, P16		Test results radiated			
Path A (Ant A)		Fieldstrength E (dBμV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH1					
T_{nom}	V_{nom}	106.7	11.5	36.0	-24.5
Middle frequency: CH6					
T_{nom}	V_{nom}	106.4	11.1	36.0	-24.9
Highest frequency: CH11					
T_{nom}	V_{nom}	107.4	12.1	36.0	-23.9

802.11b, 11 Mbps, P16		Test results radiated			
Path B (Ant B)		Fieldstrength E (dBμV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH1					
T_{nom}	V_{nom}	111.8	16.6	36.0	-19.4
Middle frequency: CH6					
T_{nom}	V_{nom}	112.7	17.4	36.0	-18.6
Highest frequency: CH11					
T_{nom}	V_{nom}	114.2	18.9	36.0	-17.1

802.11b, 11 Mbps, P10		Test results radiated			
Path A+B		Fieldstrength E (dBμV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
CH11					
T_{nom}	V_{nom}	108.5	13.2	36.0	-22.8

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

802.11n HT20, MCS7, P16		Test results radiated			
Path A (Ant A)		Fieldstrength E (dBμV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH1					
T_{nom}	V_{nom}	114.1	18.8	36.0	-17.2
Middle frequency: CH6					
T_{nom}	V_{nom}	113.6	18.3	36.0	-17.7
Highest frequency: CH11					
T_{nom}	V_{nom}	113.5	18.2	36.0	-17.8

802.11n HT20, MCS7, P16		Test results radiated			
Path B (Ant B)		Fieldstrength E (dBμV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH1					
T_{nom}	V_{nom}	118.1	22.9	36.0	-13.1
Middle frequency: CH6					
T_{nom}	V_{nom}	118.2	22.9	36.0	-13.1
Highest frequency: CH11					
T_{nom}	V_{nom}	118.6	23.3	36.0	-12.7

802.11n HT20, MCS7, P10		Test results radiated			
Path A+B		Fieldstrength E (dBμV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
CH11					
T_{nom}	V_{nom}	116.0	20.7	36.0	-15.3

802.11n HT40, MCS7, P16		Test results radiated			
Path A (Ant A)		Fieldstrength E (dBμV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH1up					
T_{nom}	V_{nom}	113.7	18.4	36.0	-17.6
Middle frequency: CH4up					
T_{nom}	V_{nom}	113.5	18.2	36.0	-17.8
Highest frequency: CH7up					
T_{nom}	V_{nom}	113.5	18.3	36.0	-17.7

802.11n HT40, MCS7, P16		Test results radiated			
Path B (Ant B)		Fieldstrength E (dBμV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH1up					
T_{nom}	V_{nom}	118.1	22.9	36.0	-13.1
Middle frequency: CH4up					
T_{nom}	V_{nom}	118.4	23.1	36.0	-12.9
Highest frequency: CH7up					
T_{nom}	V_{nom}	118.6	23.3	36.0	-12.7

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

802.11n HT40, MCS7, P7		Test results radiated			
Path A+B		Fieldstrength E (dBμV/m)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)
CH7up					
T_{nom}	V_{nom}	112.1	16.9	36.0	-19.1

Calculated peak conducted output power:

For calculation the following formula is used: $A = P - G$;

Where:

A is peak conducted output power

P is the output power as EIRP

G is the antenna gain

BLE:

802.15.1, 1 Mbps, P6.5		Test results conducted				
		P (dBm)	G (dBi)	A (dBm)	EIRP Limit (dBm)	Margin (dB)
Lowest frequency: CH0						
T_{nom}	V_{nom}	5.5	2.5	3.0	36.0	-33.0
Middle frequency: CH19						
T_{nom}	V_{nom}	6.8	2.5	4.3	36.0	-31.7
Highest frequency: CH39						
T_{nom}	V_{nom}	6.7	2.5	4.2	36.0	-31.8

WLAN:

802.11b, 11 Mbps, P16		Test results conducted				
Path A (Ant A)		P (dBm)	G (dBi)	A (dBm)	Limit (dBm)	Margin (dB)
Lowest frequency: CH1						
T_{nom}	V_{nom}	11.5	1.8	9.7	30.0	-20.3
Middle frequency: CH6						
T_{nom}	V_{nom}	11.1	1.8	9.3	30.0	-20.7
Highest frequency: CH11						
T_{nom}	V_{nom}	12.1	1.8	10.3	30.0	-19.7

802.11b, 11 Mbps, P16		Test results conducted				
Path B (Ant B)		P (dBm)	G (dBi)	A (dBm)	Limit (dBm)	Margin (dB)
Lowest frequency: CH1						
T_{nom}	V_{nom}	16.6	2.5	14.1	30.0	-15.9
Middle frequency: CH6						
T_{nom}	V_{nom}	17.4	2.5	14.9	30.0	-15.1
Highest frequency: CH11						
T_{nom}	V_{nom}	18.9	2.5	16.4	30.0	-13.6

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

802.11b, 11 Mbps, P10		Test results conducted				
Path A+B		P (dBm)	G (dBi)	A (dBm)	Limit (dBm)	Margin (dB)
CH11						
T_{nom}	V_{nom}	13.2	4.3	8.9	30.0	-21.1

802.11n HT20, MCS7, P16		Test results conducted				
Path A (Ant A)		P (dBm)	G (dBi)	A (dBm)	Limit (dBm)	Margin (dB)
Lowest frequency: CH1						
T_{nom}	V_{nom}	18.8	1.8	17.0	30.0	-13.0
Middle frequency: CH6						
T_{nom}	V_{nom}	18.3	1.8	16.5	30.0	-13.5
Highest frequency: CH11						
T_{nom}	V_{nom}	18.2	1.8	16.4	30.0	-13.6

802.11n HT20, MCS7, P16		Test results conducted				
Path B (Ant B)		P (dBm)	G (dBi)	A (dBm)	Limit (dBm)	Margin (dB)
Lowest frequency: CH1						
T_{nom}	V_{nom}	22.9	2.5	20.4	30.0	-9.6
Middle frequency: CH6						
T_{nom}	V_{nom}	22.9	2.5	20.4	30.0	-9.6
Highest frequency: CH11						
T_{nom}	V_{nom}	23.3	2.5	20.8	30.0	-9.2

802.11n HT20, MCS7, P10		Test results conducted				
Path A+B		P (dBm)	G (dBi)	A (dBm)	Limit (dBm)	Margin (dB)
CH11						
T_{nom}	V_{nom}	20.7	4.3	16.4	30.0	-13.6

802.11n HT40, MCS7, P16		Test results conducted				
Path A (Ant A)		P (dBm)	G (dBi)	A (dBm)	Limit (dBm)	Margin (dB)
Lowest frequency: CH1up						
T_{nom}	V_{nom}	18.4	1.8	16.6	30.0	-13.4
Middle frequency: CH4up						
T_{nom}	V_{nom}	18.2	1.8	16.4	30.0	-13.6
Highest frequency: CH7up						
T_{nom}	V_{nom}	18.3	1.8	16.5	30.0	-13.5

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

802.11n HT40, MCS7, P16		Test results conducted				
Path B (Ant B)		P (dBm)	G (dBi)	A (dBm)	Limit (dBm)	Margin (dB)
Lowest frequency: CH1up						
T_{nom}	V_{nom}	22.9	2.5	20.4	30.0	-9.6
Middle frequency: CH4up						
T_{nom}	V_{nom}	23.1	2.5	20.6	30.0	-9.4
Highest frequency: CH7up						
T_{nom}	V_{nom}	23.3	2.5	20.8	30.0	-9.2

802.11n HT40, MCS7, P7		Test results conducted				
Path A+B		P (dBm)	G (dBi)	A (dBm)	Limit (dBm)	Margin (dB)
CH7up						
T_{nom}	V_{nom}	16.9	4.3	12.6	30.0	-17.4

Peak Power Limit according to FCC Part 15, Section 15.247 (b)(3):

Frequency (MHz)	Conducted Power Limit	
	(dBm)	(Watt)
2400-2483.5	30	1.0

Frequency (MHz)	Radiated Limit (EIRP)	
	(dBm)	(Watt)
2400-2483.5	36	4.0

The requirements are **FULFILLED**.

Remarks: None

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

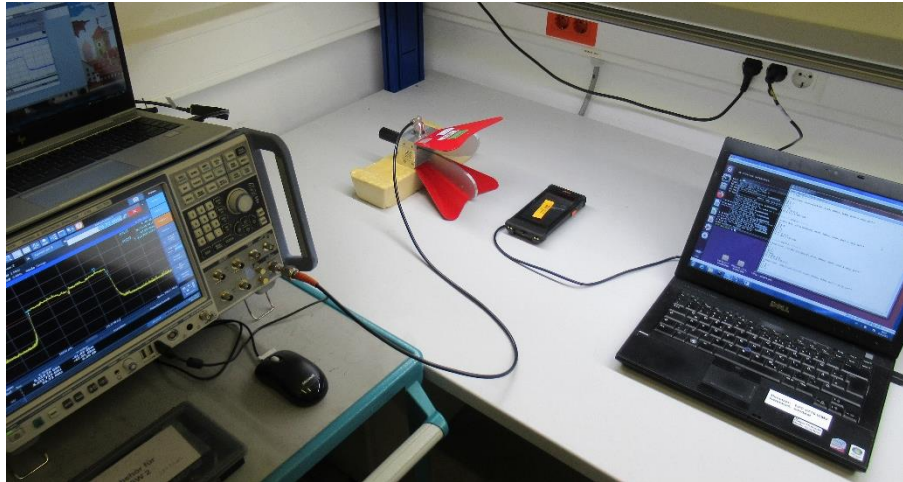
5.3 Emission bandwidth

For test instruments and accessories used see section 6 Part **MB**.

5.3.1 Description of the test location

Test location: Shielded Room S6

5.3.2 Photo documentation of the test set-up



5.3.3 Applicable standard

According to FCC Part 15, Section 15.247(a)(2):

Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 – 2483.5 MHz and 5725 – 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

5.3.4 Description of Measurement

The bandwidth was measured at an amplitude level reduced from the reference level of a modulated channel by a ratio of -6 dB. The reference level is the level of the highest signal amplitude observed at the transmitter at either the fundamental frequency or the first order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. An alternative is to use the bandwidth measurement of the analyser.

Spectrum analyser settings for EBW:

RBW: 100 kHz, VBW: 300 kHz, Detector: Max peak, Sweep time: 5 s, Span: 2 EBW;

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

5.3.5 Test result

6dB bandwidth

Path	Modulation	Power set	Channel	Centre frequency (MHz)	6 dB EBW (MHz)
A	b, 11 Mbps	16	CH11	2462	9.899
A	n HT20, MCS-7	16	CH11	2462	17.623
A	n HT40, MCS-7	16	CH7up	2452	36.381
B	b, 11 Mbps	13	CH11	2462	10.489
B	n HT20, MCS-7	13	CH11	2462	17.288
B	n HT40, MCS-7	10	CH7up	2452	34.512
A+B	b, 11 Mbps	10	CH11	2462	8.779
A+B	n HT20, MCS-7	10	CH11	2462	17.643
A+B	n HT40, MCS-7	7	CH7up	2452	35.451

Limit according to FCC Part 15, Section 15.247(a)(2):

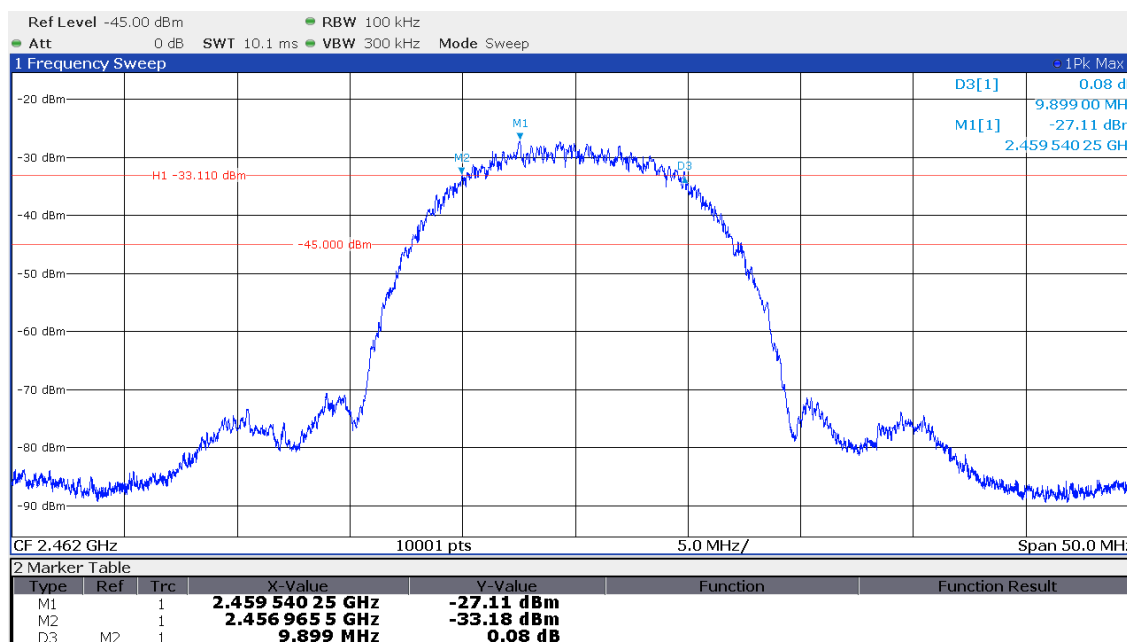
Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

The requirements are **FULFILLED**.

Remarks: For detailed test result please see the following test protocols

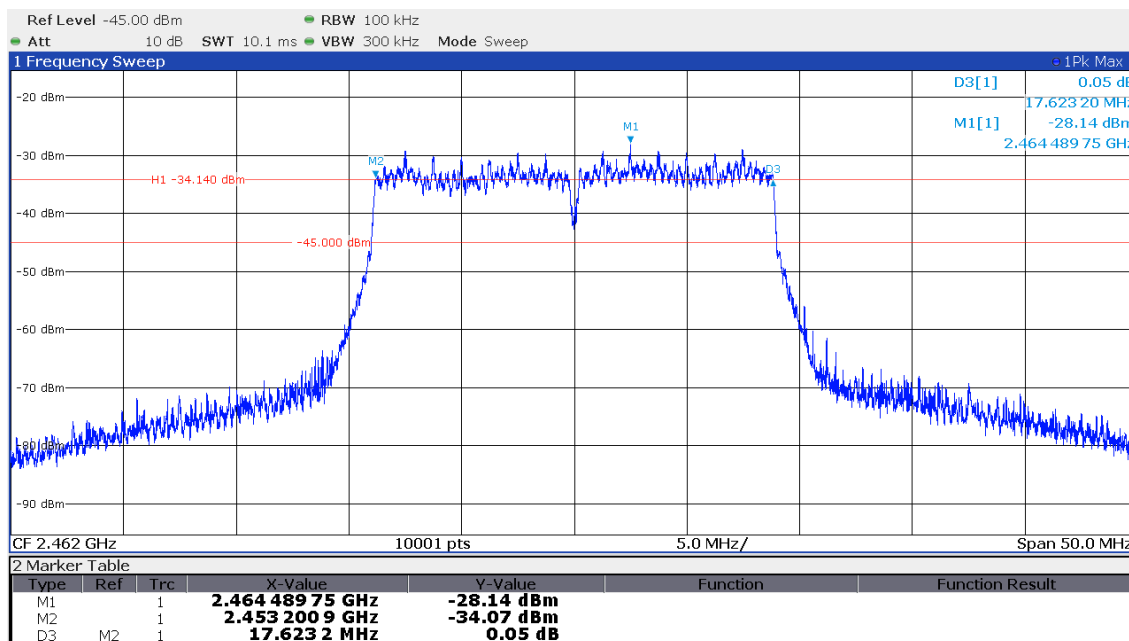
5.3.6 Test protocols

WLAN Standard 802.11b, 11 Mbps, P16, Path A - Ant A, CH11

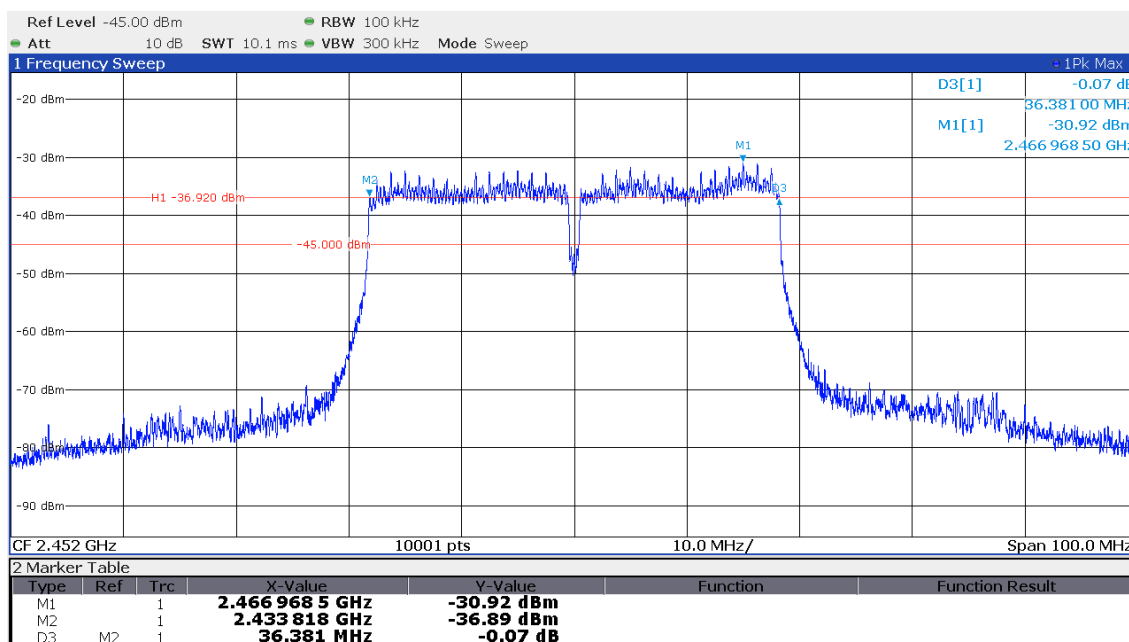


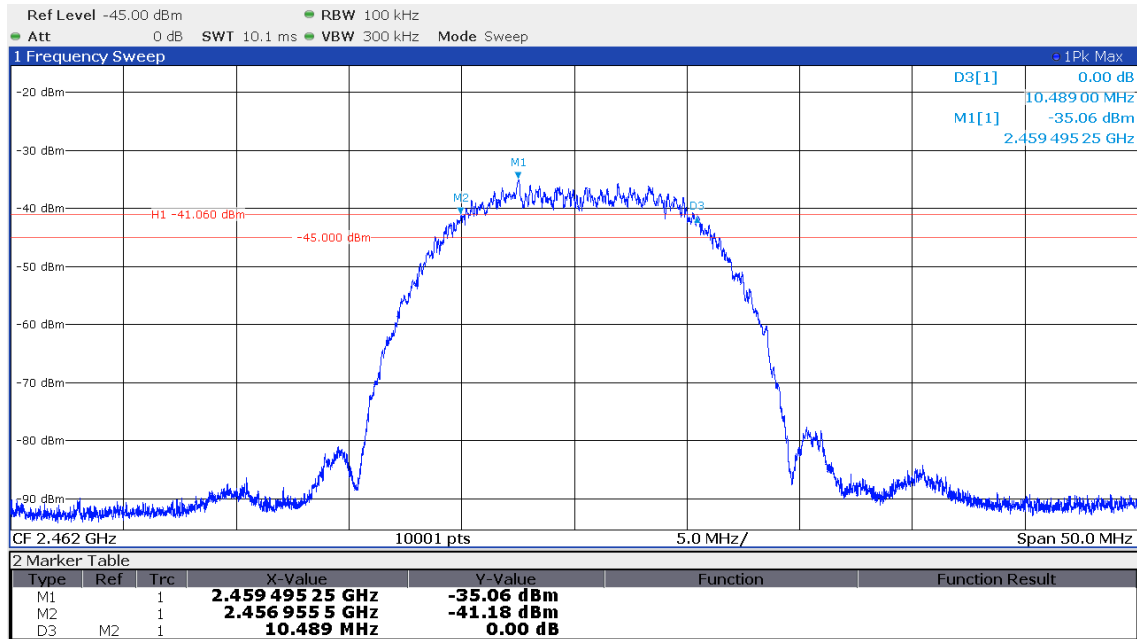
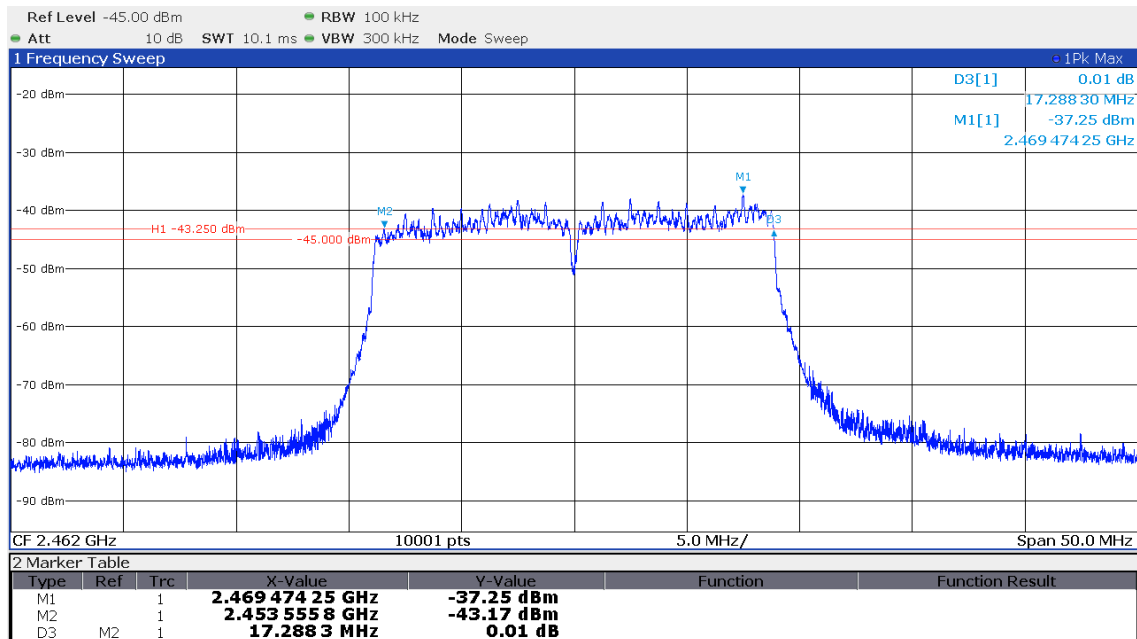
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

WLAN Standard 802.11n HT20, MCS-7, P16, Path A - Ant A, CH11



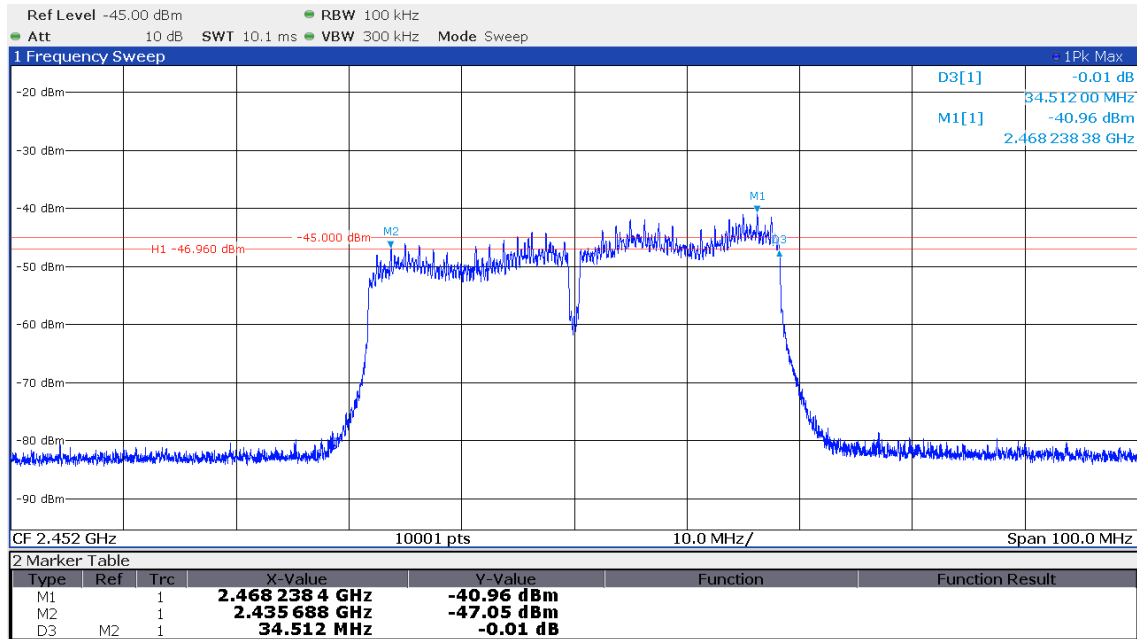
WLAN Standard 802.11n HT40, MCS-7, P16, Path A - Ant A, CH7up



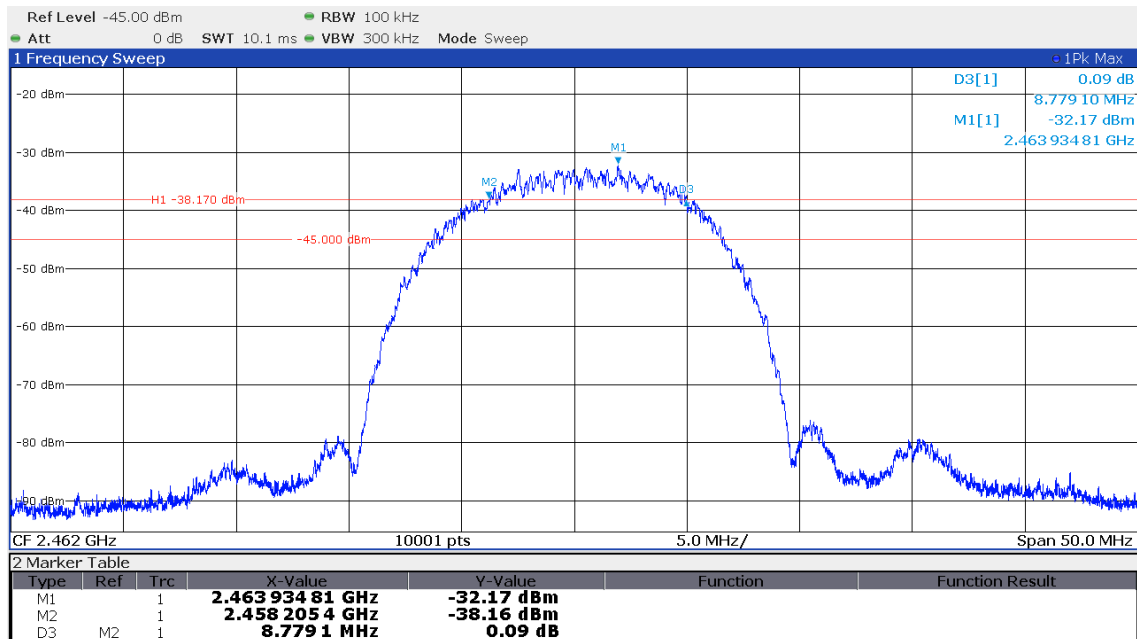
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D
WLAN Standard 802.11b, 11 Mbps, P13, Path B - Ant B, CH11

WLAN Standard 802.11n HT20, MCS-7, P13, Path B - Ant B, CH11


FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

WLAN Standard 802.11n HT40, MCS-7, P10, Path B - Ant B, CH7up

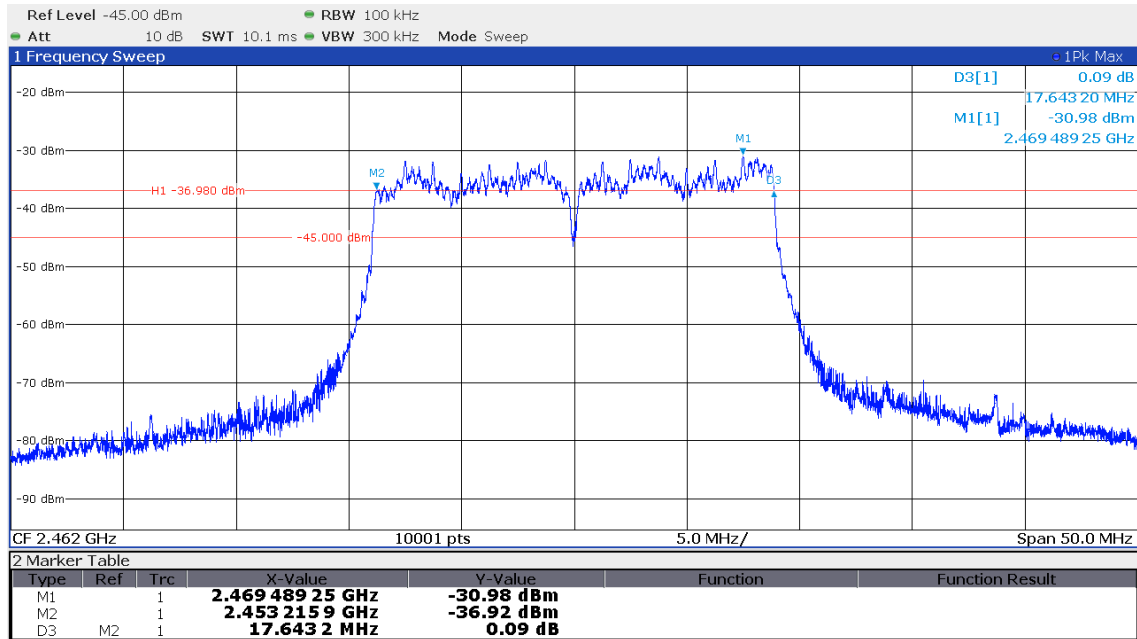


WLAN Standard 802.11b, 11 Mbps, P10, Path A+B - Ant A+B, CH11

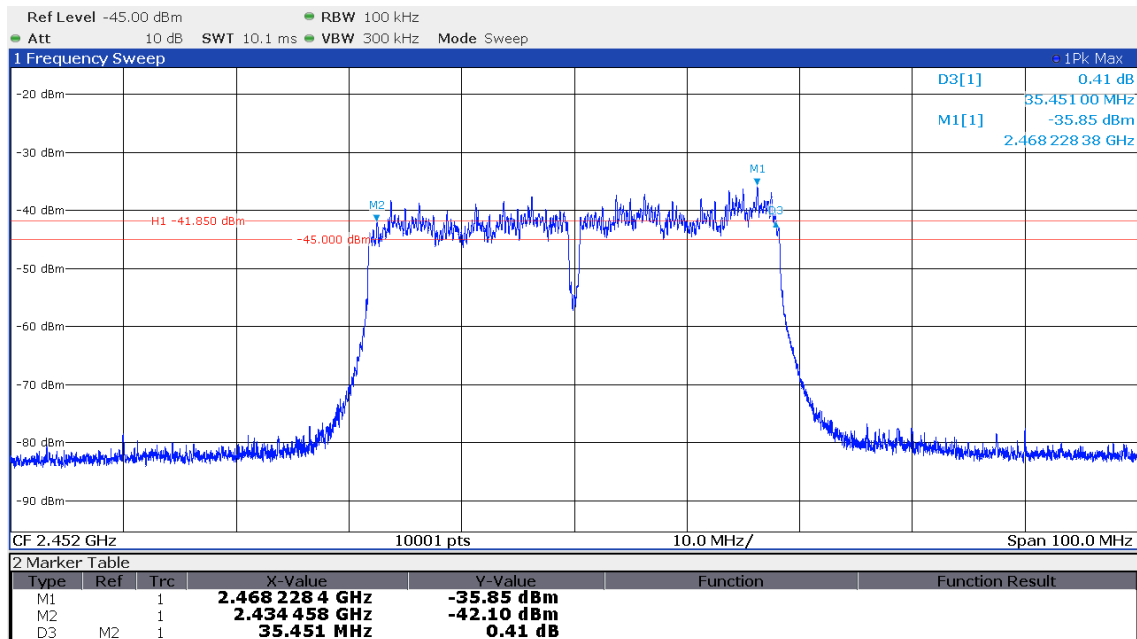


FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

WLAN Standard 802.11n HT20, MCS-7, P10, Path A+B - Ant A+B, CH11



WLAN Standard 802.11n HT40, MCS-7, P7, Path A+B - Ant A+B, CH7up



FCC ID: XO2-SPB228D

IC: 8713A-SPB228D

5.4 Unwanted emissions in restricted bands, radiated

For test instruments and accessories used see section 6 Part **SER 2**, **SER 3**.

5.4.1 Description of the test location

Test location: OATS 1
 Test location: Anechoic chamber 1
 Test distance: 3 m

5.4.2 Photo documentation of the test set-up

30 MHz – 1 GHz:



1 GHz – 18 GHz:



FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

18 GHz – 25 GHz:



5.4.3 Applicable standard

According to FCC Part 15, Section 15.205(a):

In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limit specified in Section 15.209(a).

5.4.4 Description of Measurement

The restricted bands are measured radiated. The span of the spectrum analyser is set wide enough to capture the restricted band and measure the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation. The restricted bands are measured falling emissions into it and the nearest restricted band are checked for emissions also the restricted band for the harmonics of the carrier.

Spectrum analyser settings:

30 MHz – 1000 MHz: RBW: 120 kHz

1000 MHz – 25 GHz: RBW: 1 MHz, VBW: 3 MHz, Sweep: Auto, Detector function: Max Peak

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D
5.4.1 Test result
f < 1000 MHz:

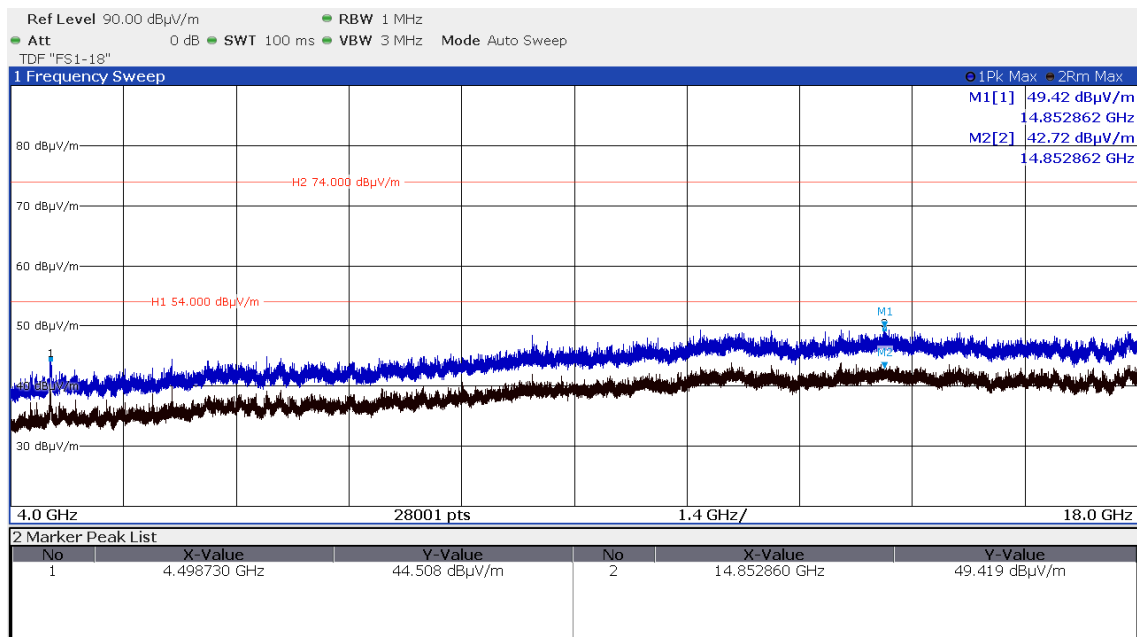
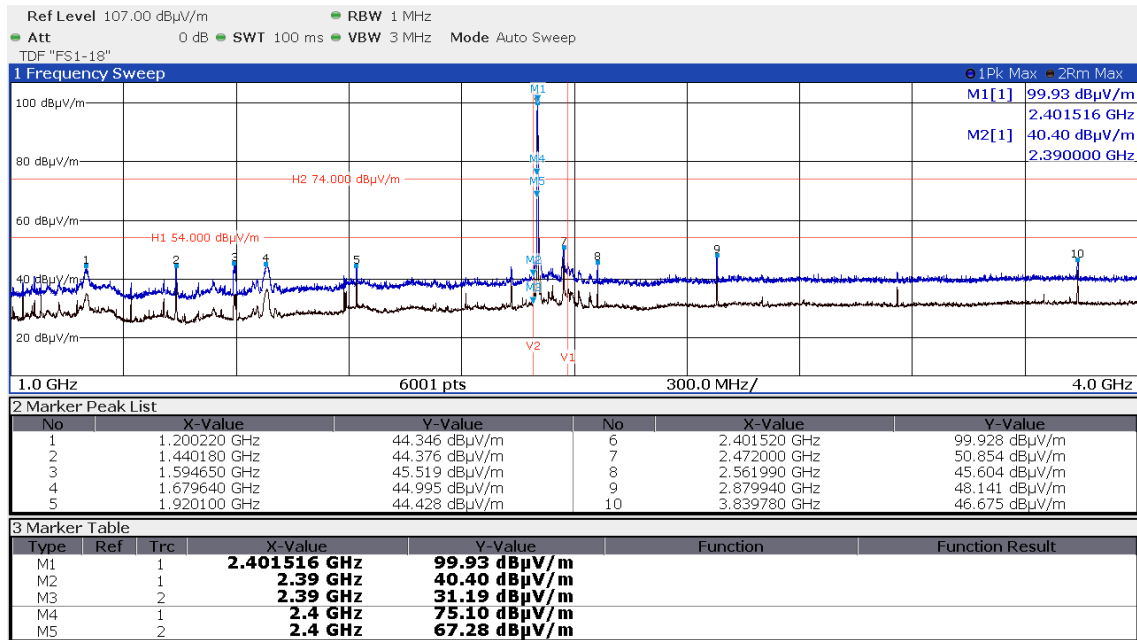
BLE:

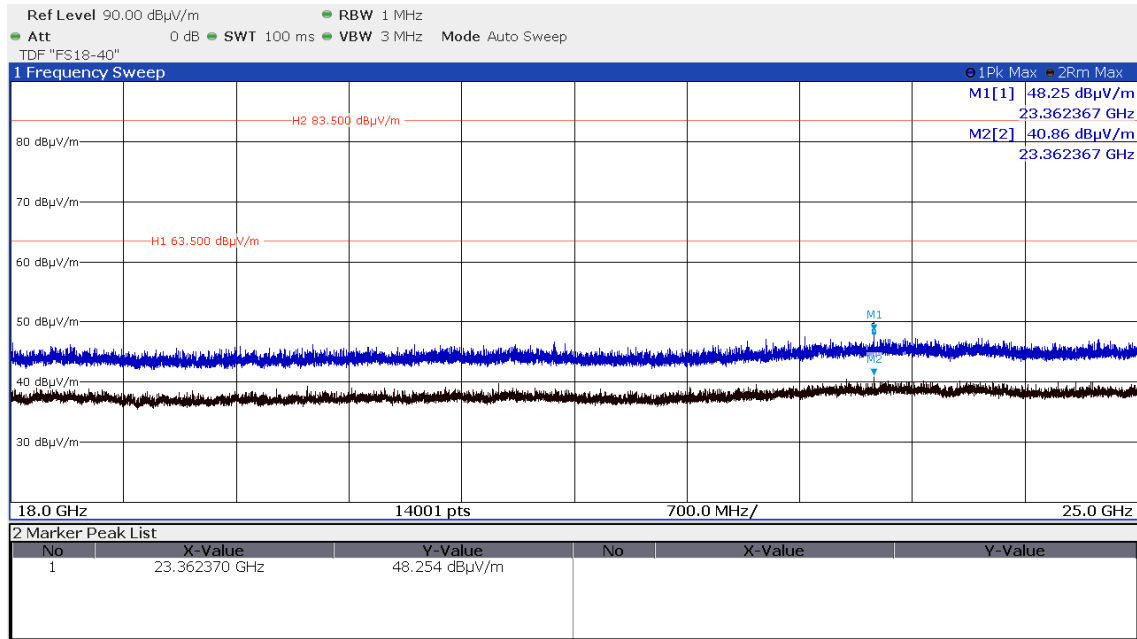
Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
44.00	4.8	-3.3	14.7	15.4	19.5	12.1	40.0	-20.5
106.00	4.2	3.8	13.0	12.0	17.2	15.8	43.5	-26.3
259.00	2.2	2.0	15.9	16.0	18.1	18.0	46.0	-27.9
352.80	-1.9	-1.6	18.8	19.1	16.9	17.5	46.0	-28.5
401.70	-2.7	-1.4	20.3	20.4	17.6	19.0	46.0	-27.0
603.80	-3.2	-2.6	25.1	25.4	21.9	22.8	46.0	-23.2
961.50	-2.6	-2.5	30.1	30.6	27.5	28.1	54.0	-25.9

WLAN 2.4 GHz:

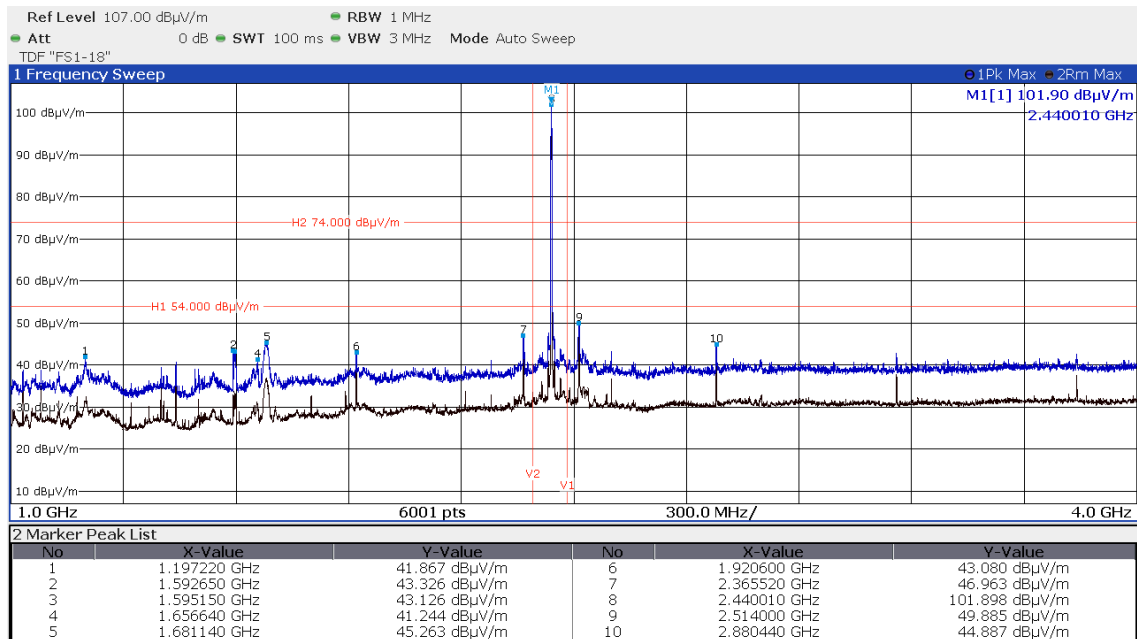
Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
44.00	13.7	-2.7	14.7	15.4	28.4	12.7	40.0	-11.6
102.60	10.8	0.6	12.7	11.5	23.5	12.1	43.5	-20.0
259.00	3.0	1.0	15.9	16.0	18.9	17.0	46.0	-27.1
300.00	0.7	5.9	17.2	17.6	17.9	23.5	46.0	-22.5
352.80	-2.5	-0.6	18.8	19.1	16.3	18.5	46.0	-27.5
600.20	-3.1	-2.7	25.0	25.3	21.9	22.6	46.0	-23.4
841.80	-0.3	0.4	28.8	29.2	28.5	29.6	46.0	-16.4

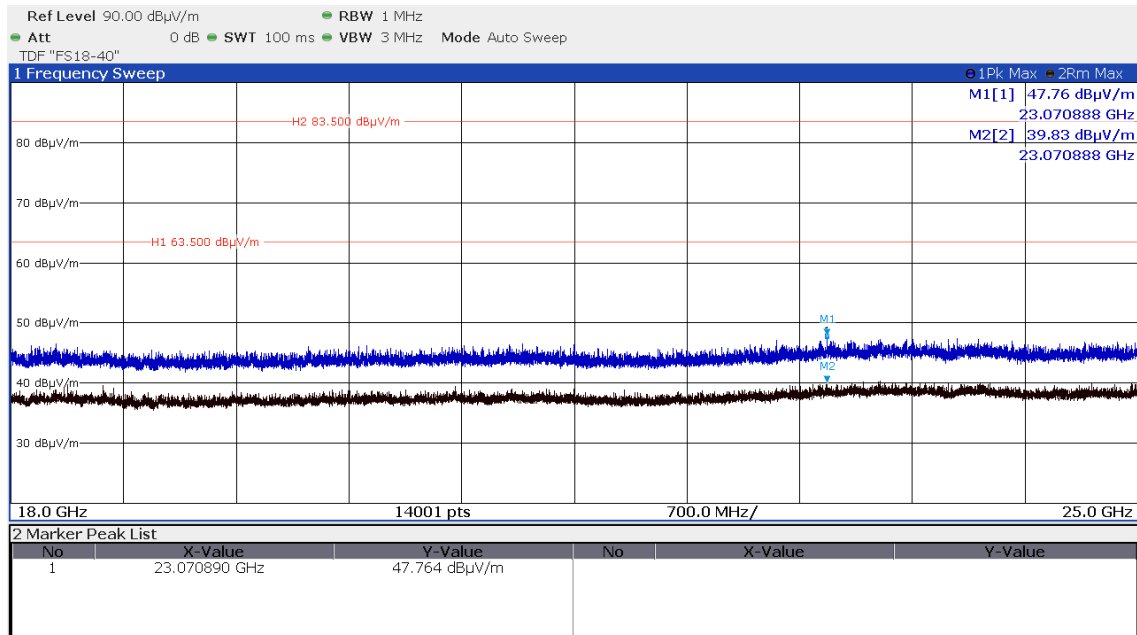
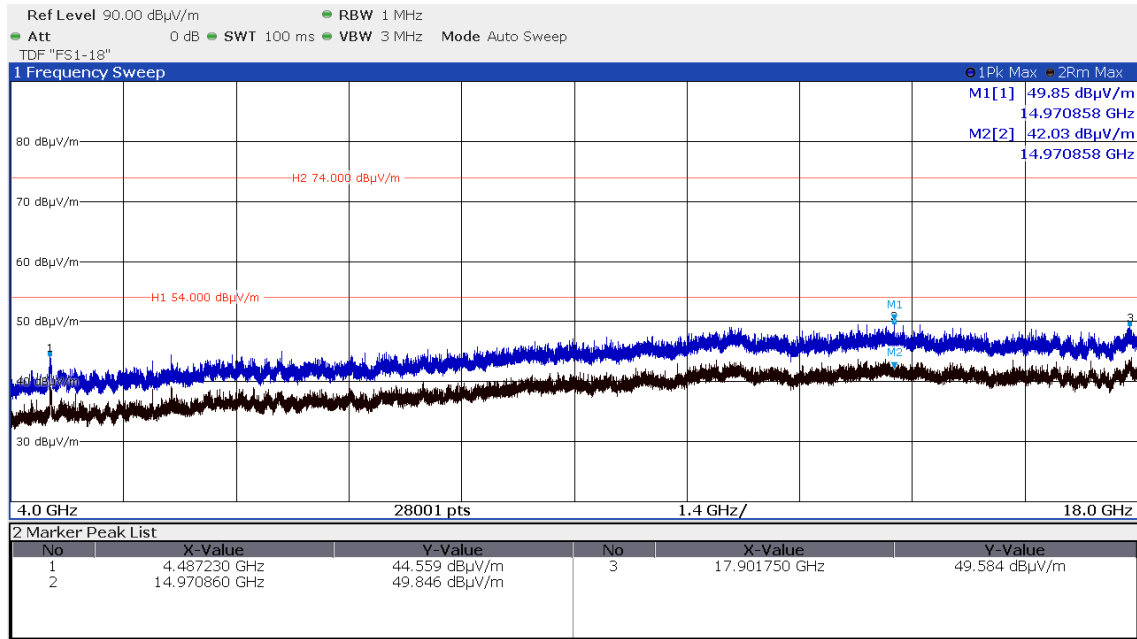
Note: No emissions from the EUT could be detected in this frequency range. The recorded values are noise values from the OATS.

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D
f > 1000 MHz:
BLE:
CH0


FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

CH19


FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


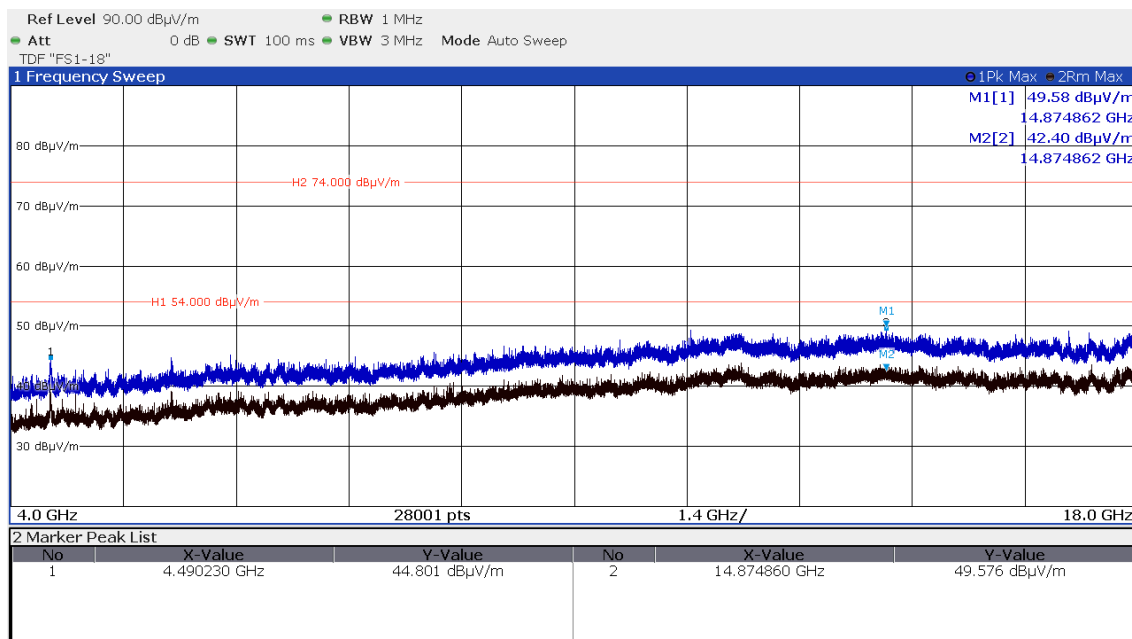
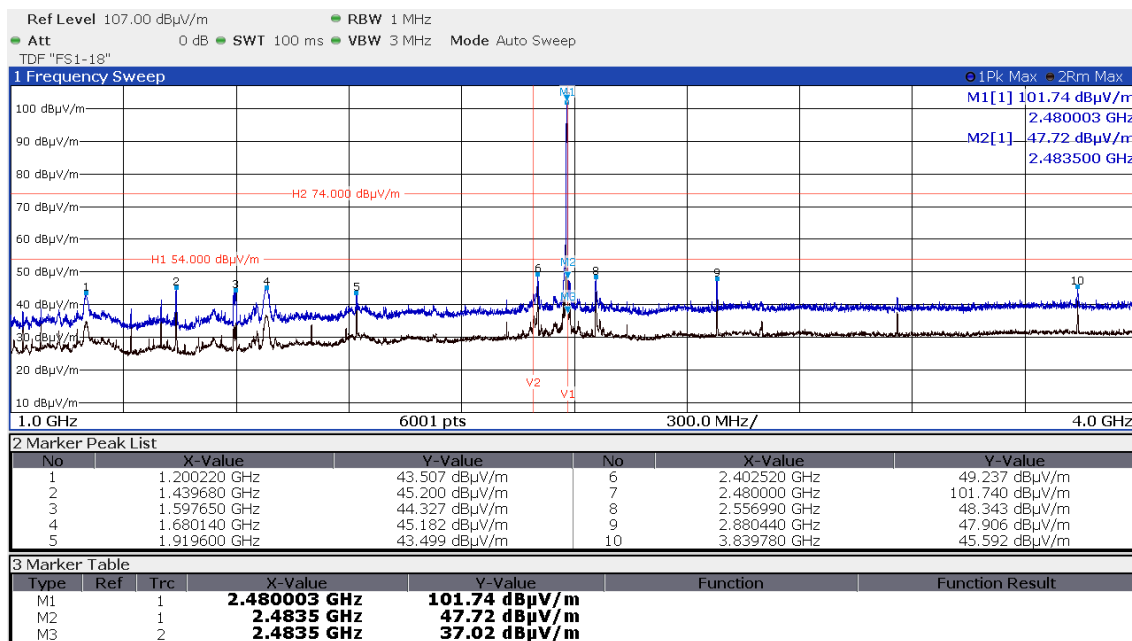
Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

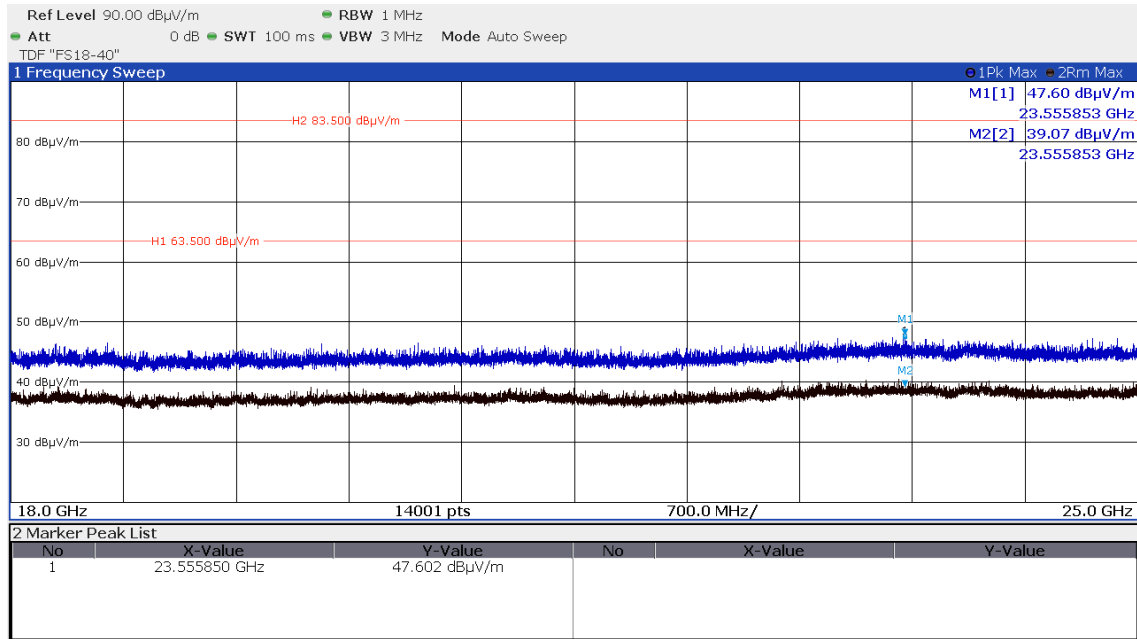
The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

FCC ID: XO2-SPB228D

IC: 8713A-SPB228D

CH39

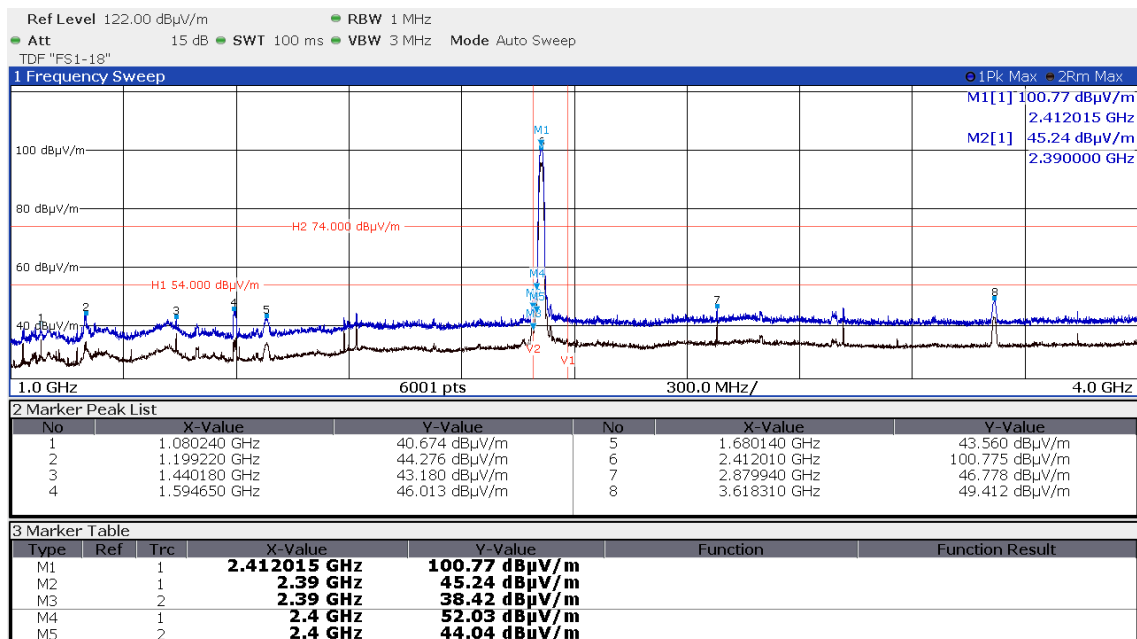


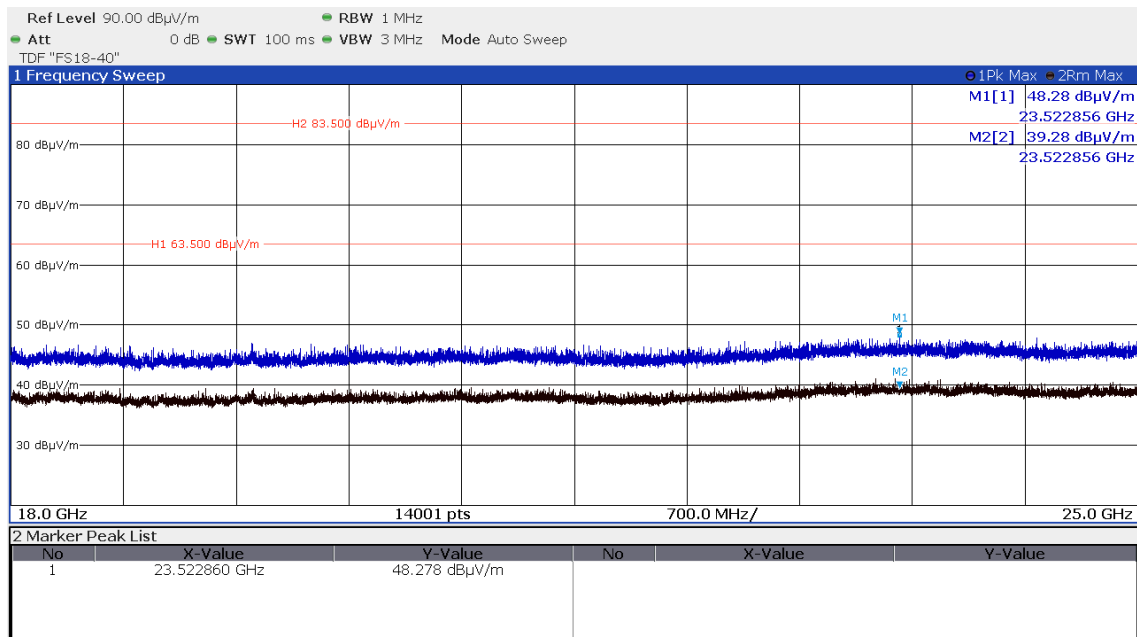
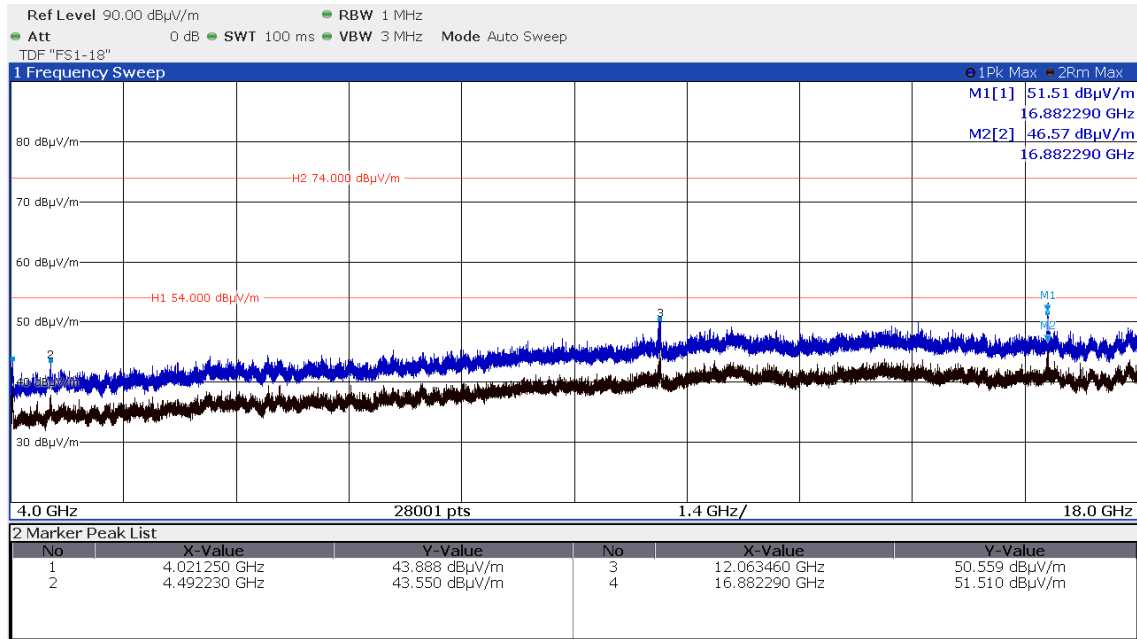
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

WLAN Standard 802.11b, 11 Mbps, P16, Path A - Ant A

CH1



FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


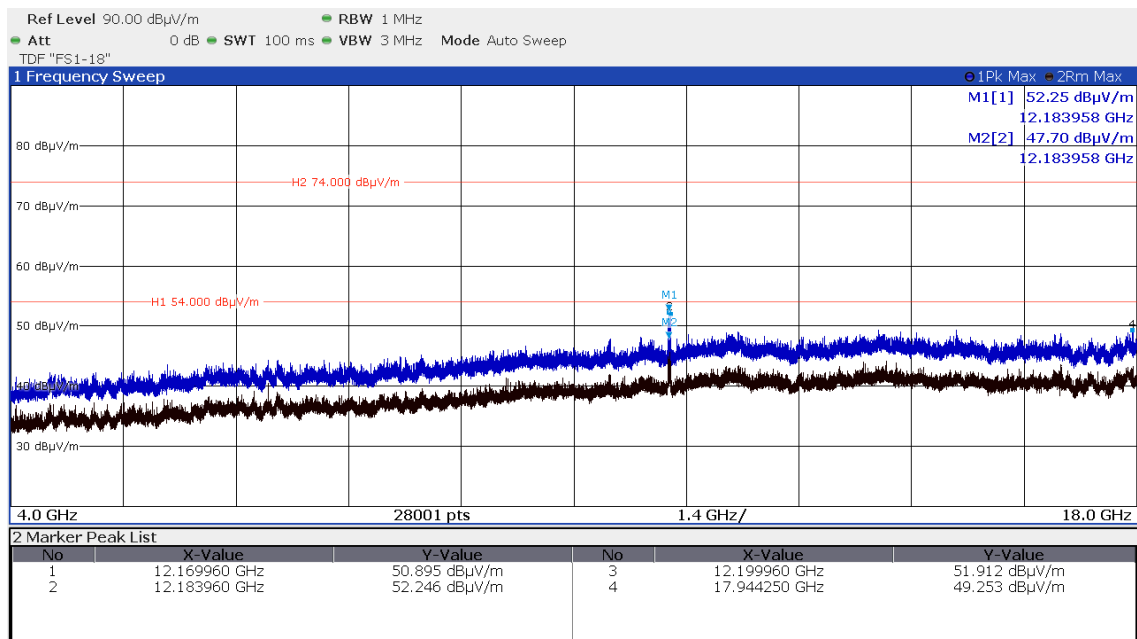
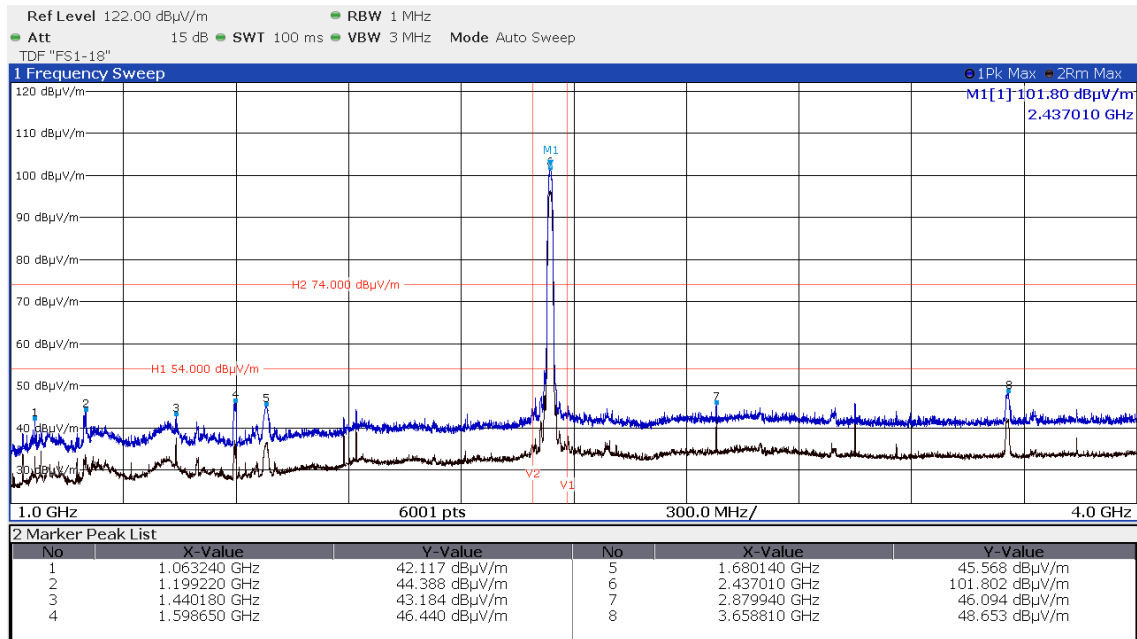
Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

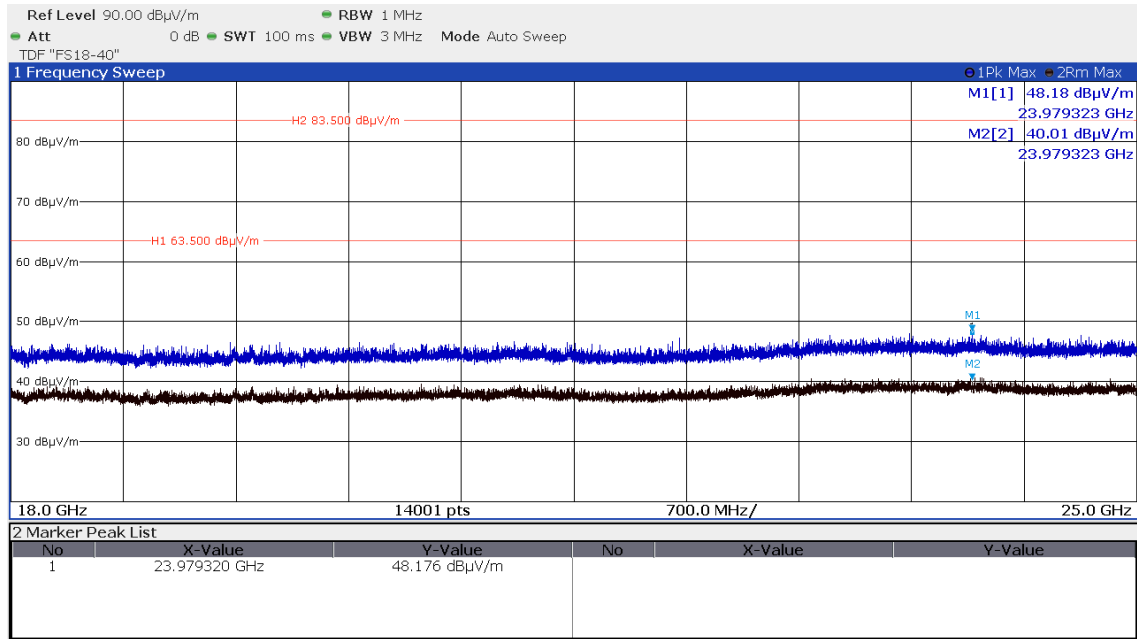
The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

FCC ID: XO2-SPB228D

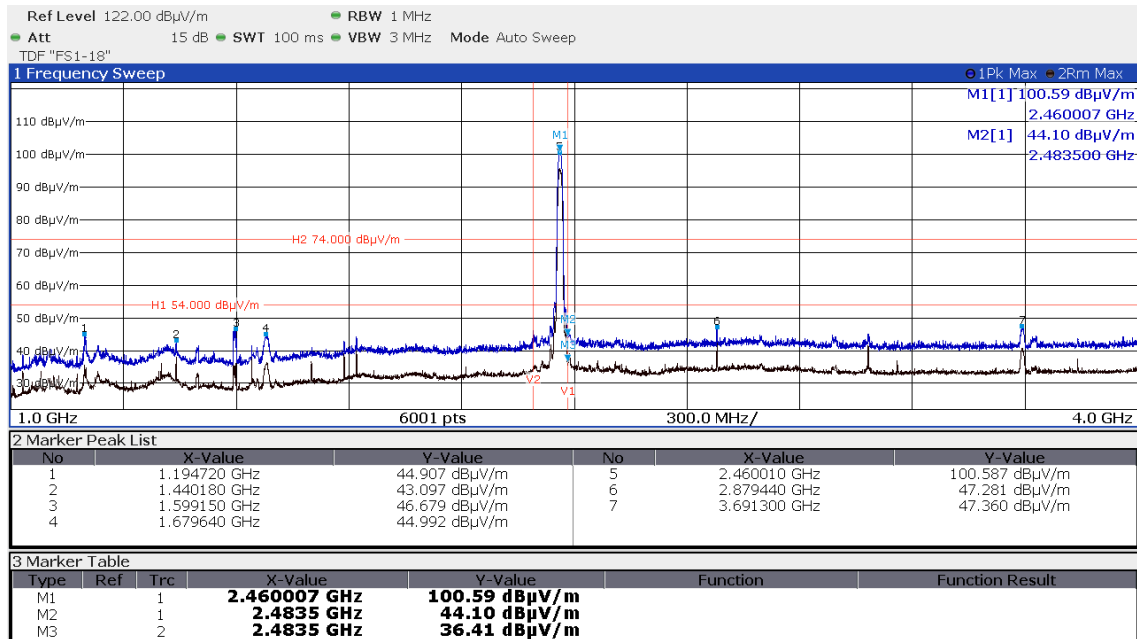
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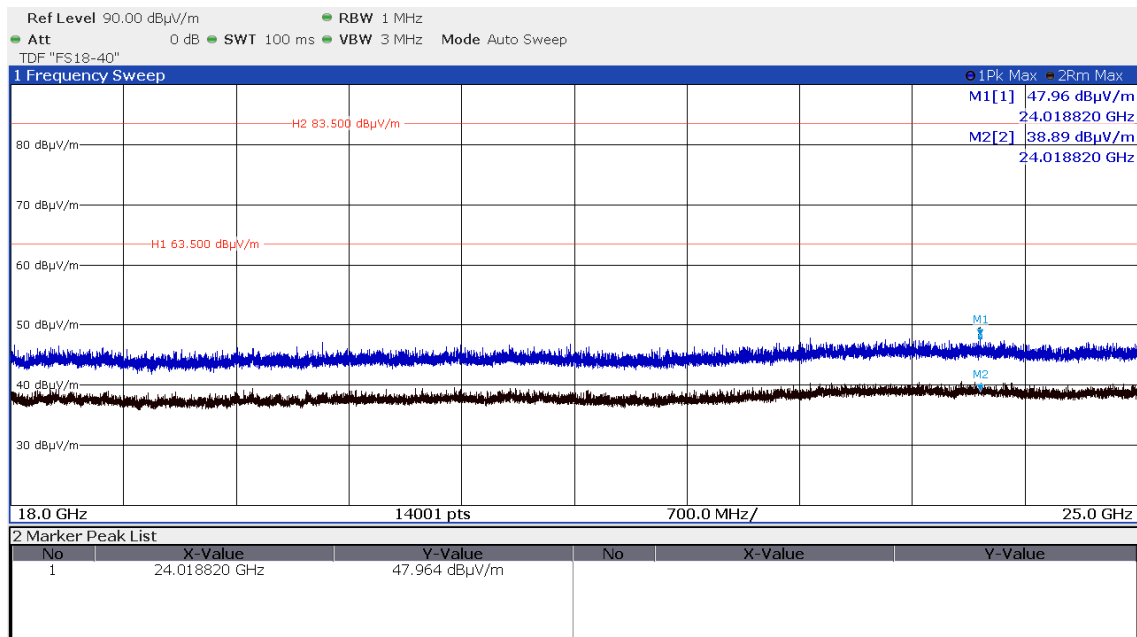
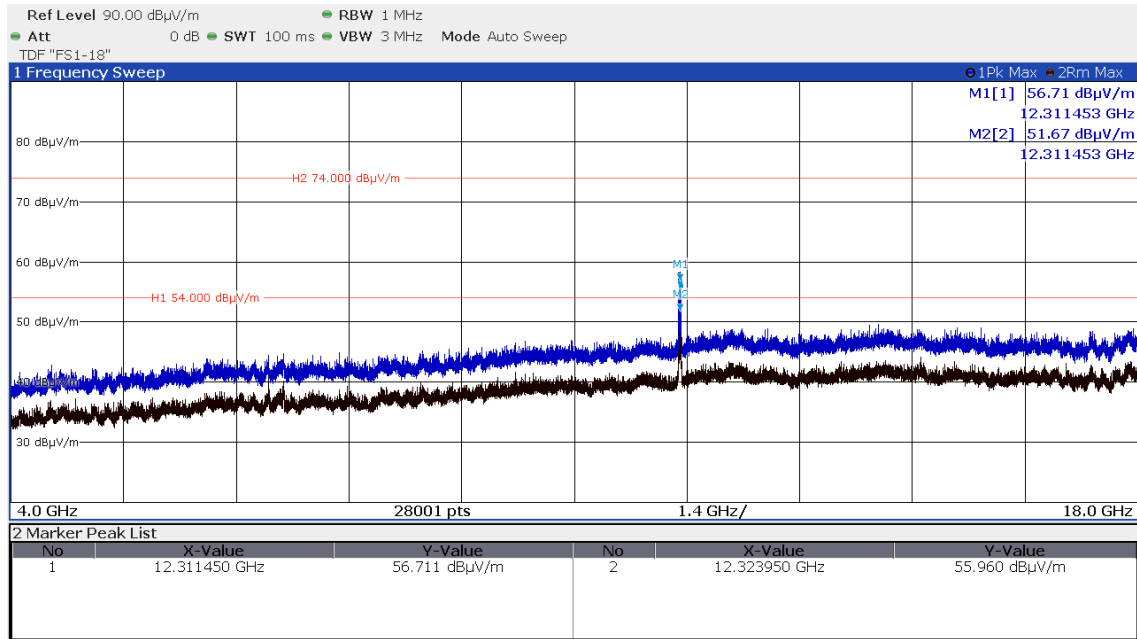
CH6



FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


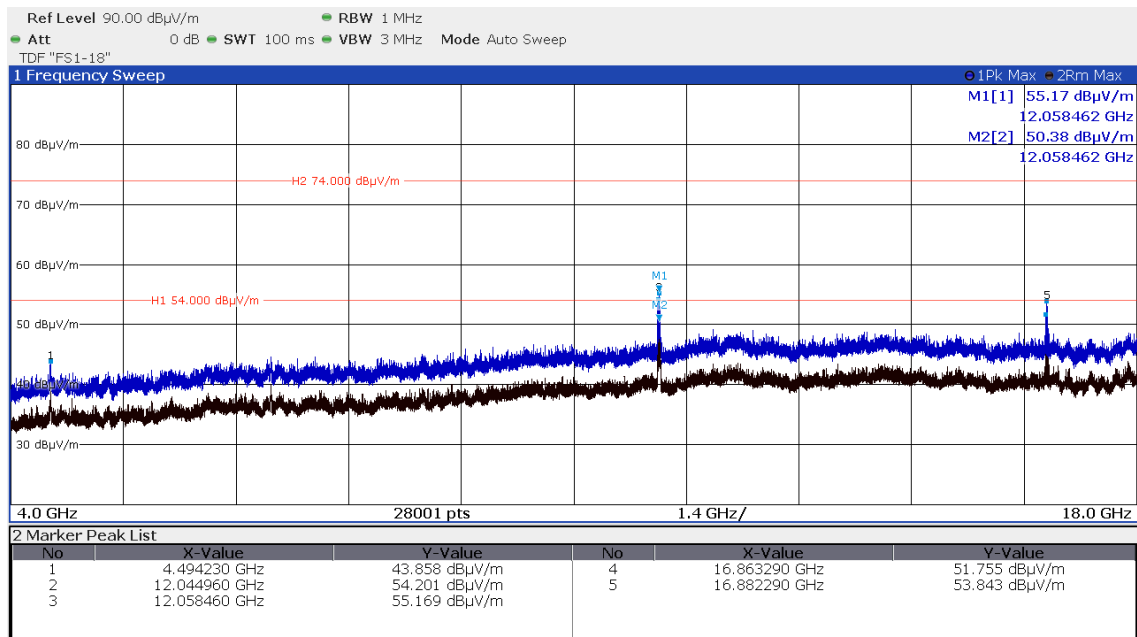
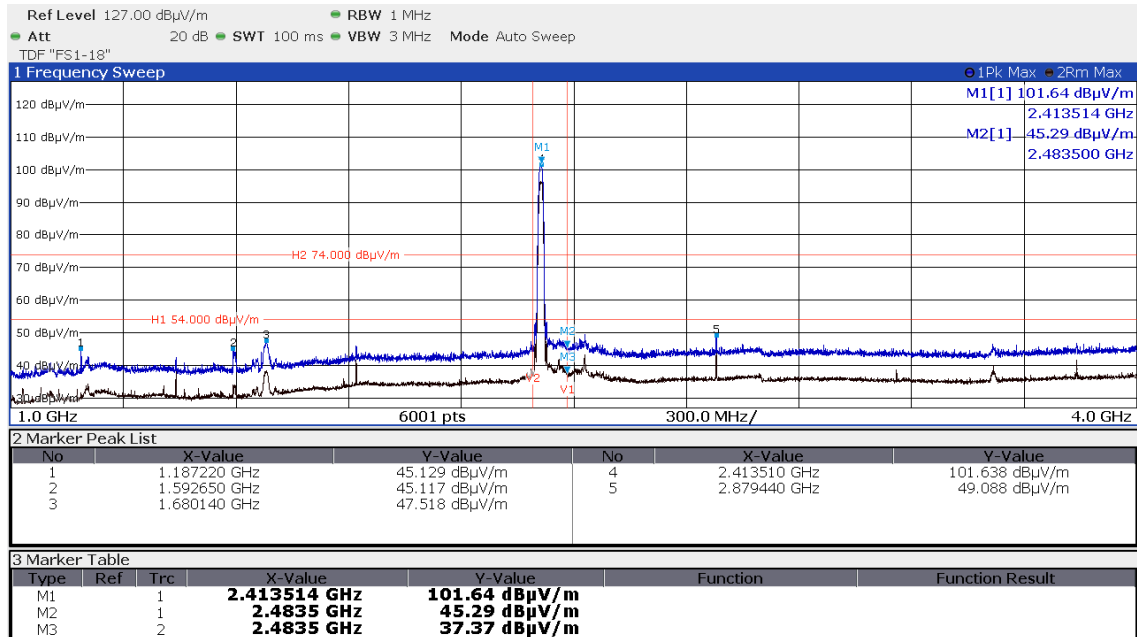
Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

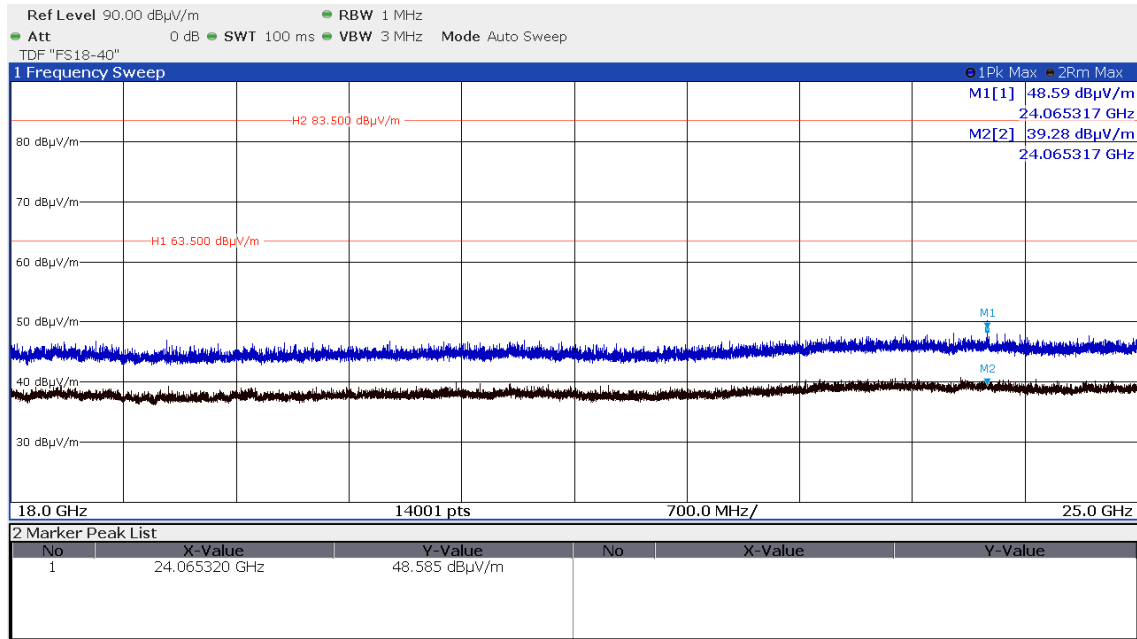
CH11


FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


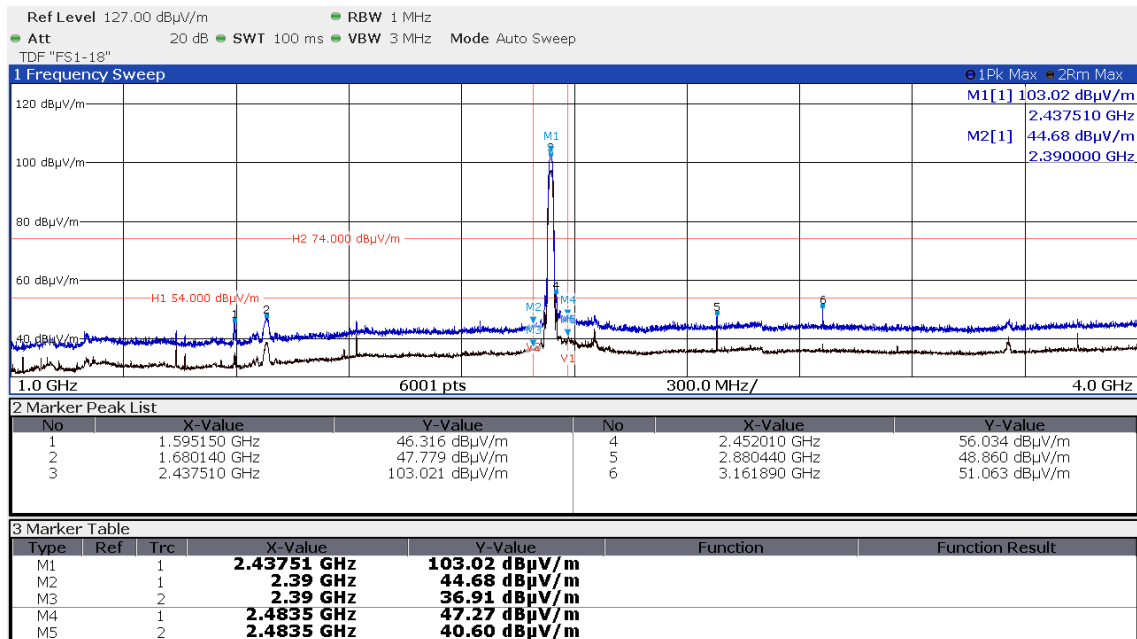
Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

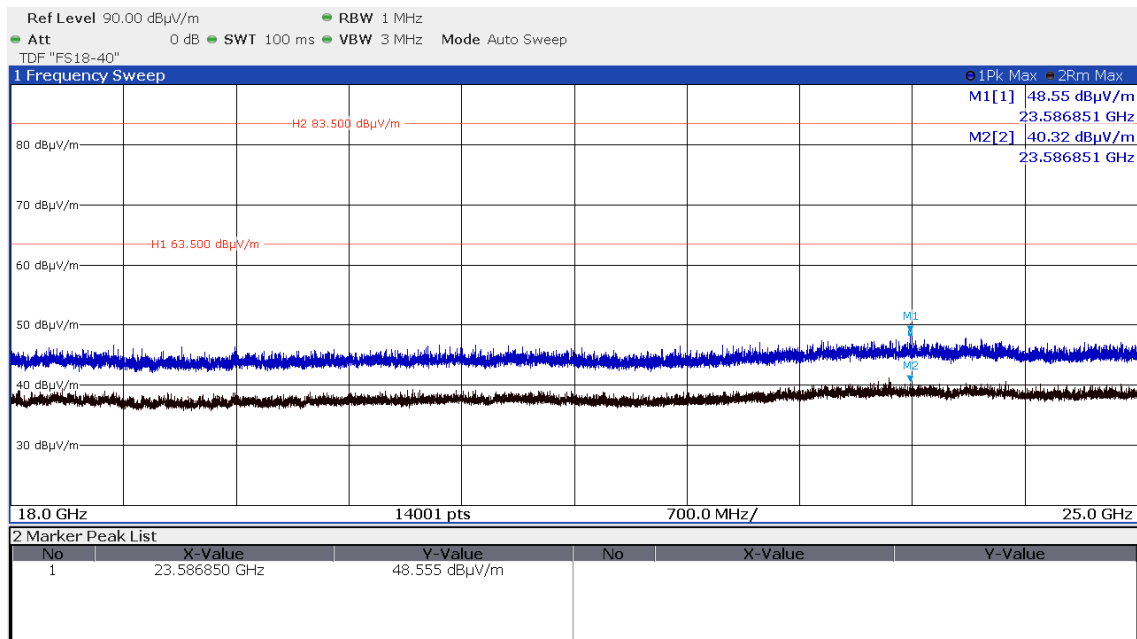
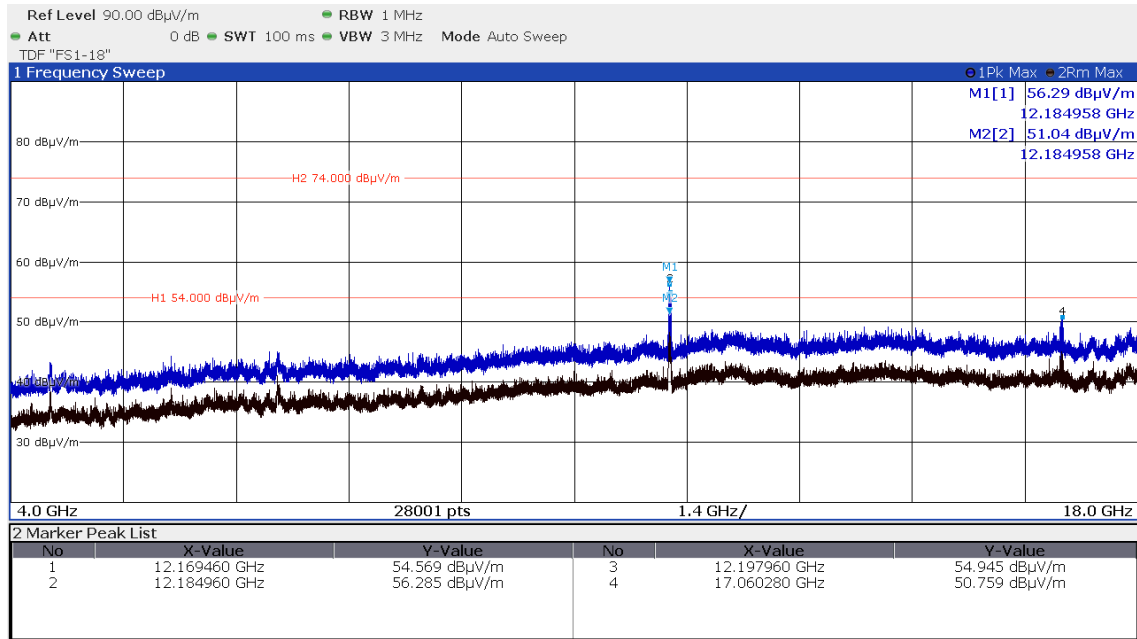
The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D
WLAN Standard 802.11b, 11 Mbps, P13, Path B - Ant B
CH1


FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


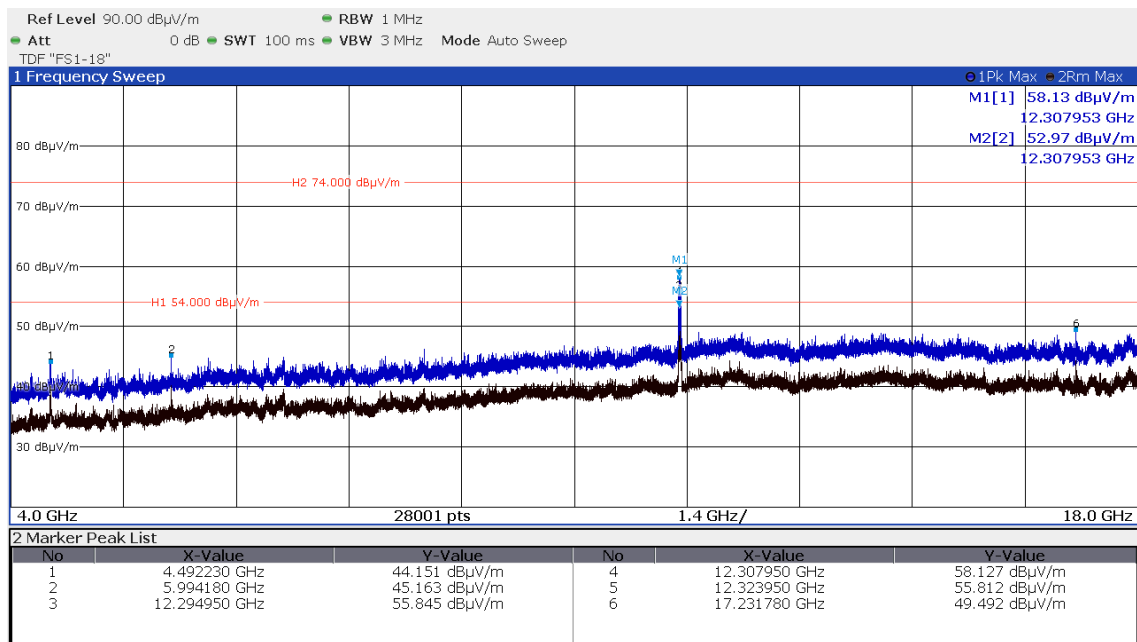
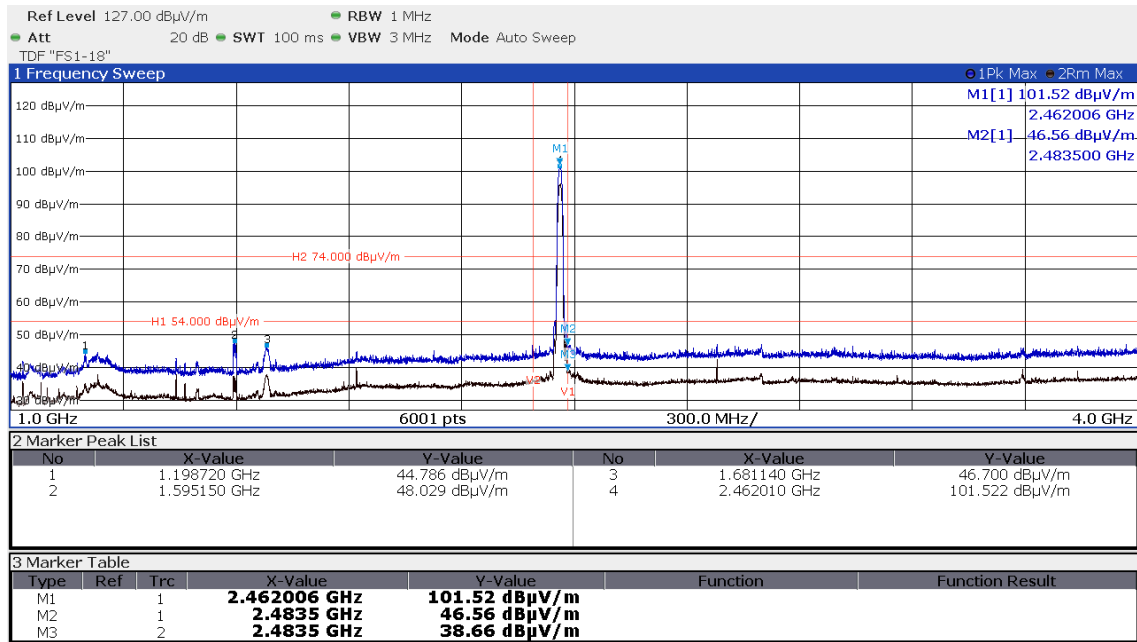
Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

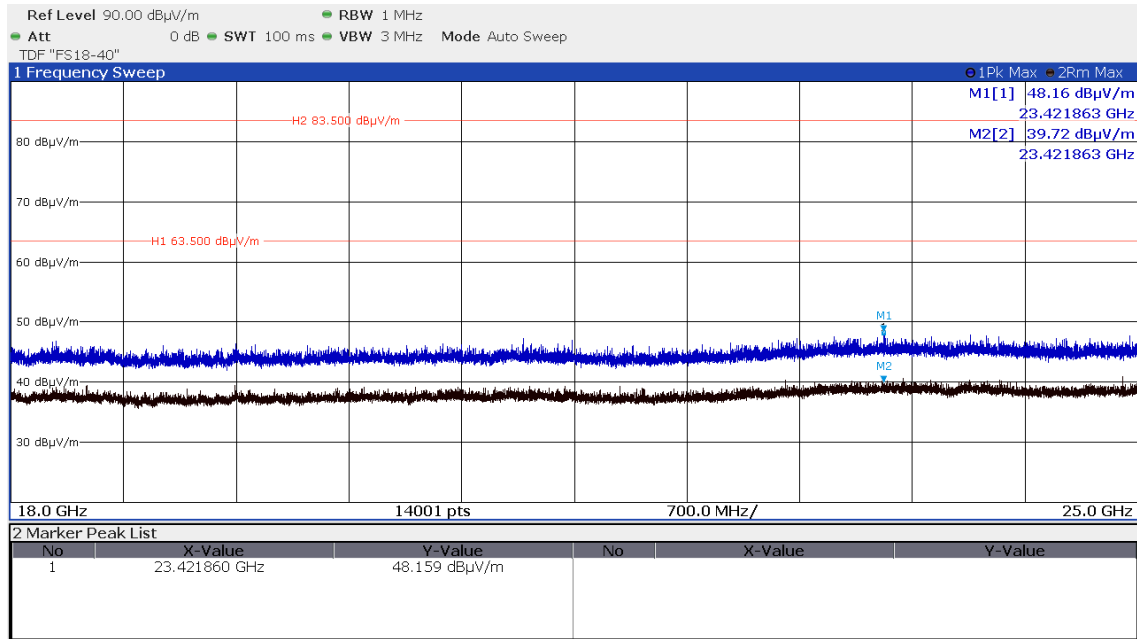
CH6


FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

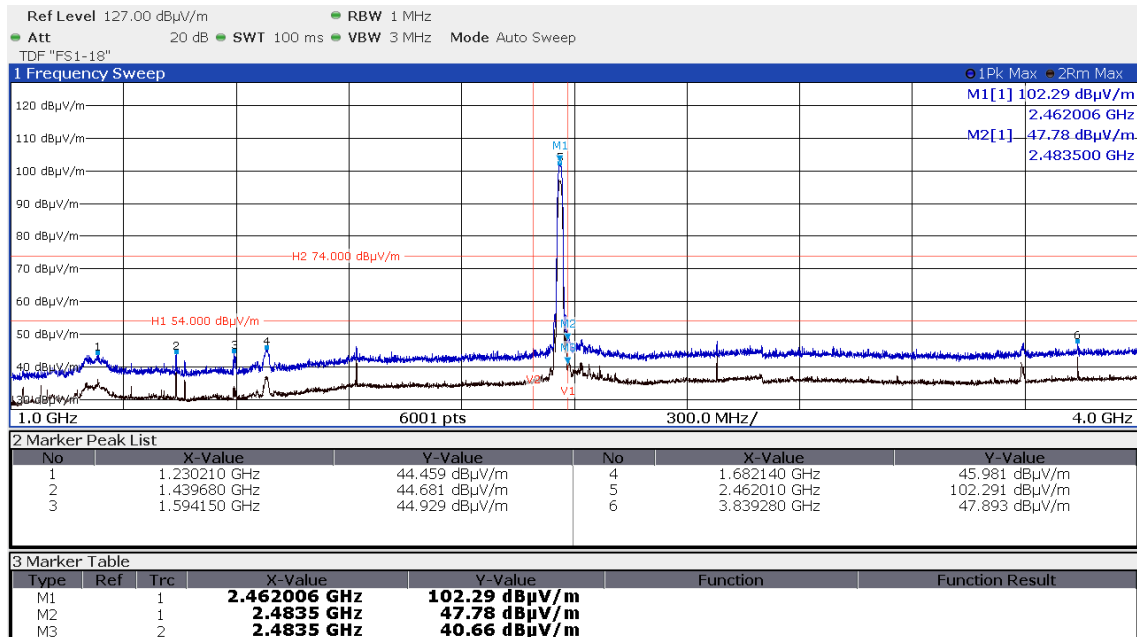
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D
CH11


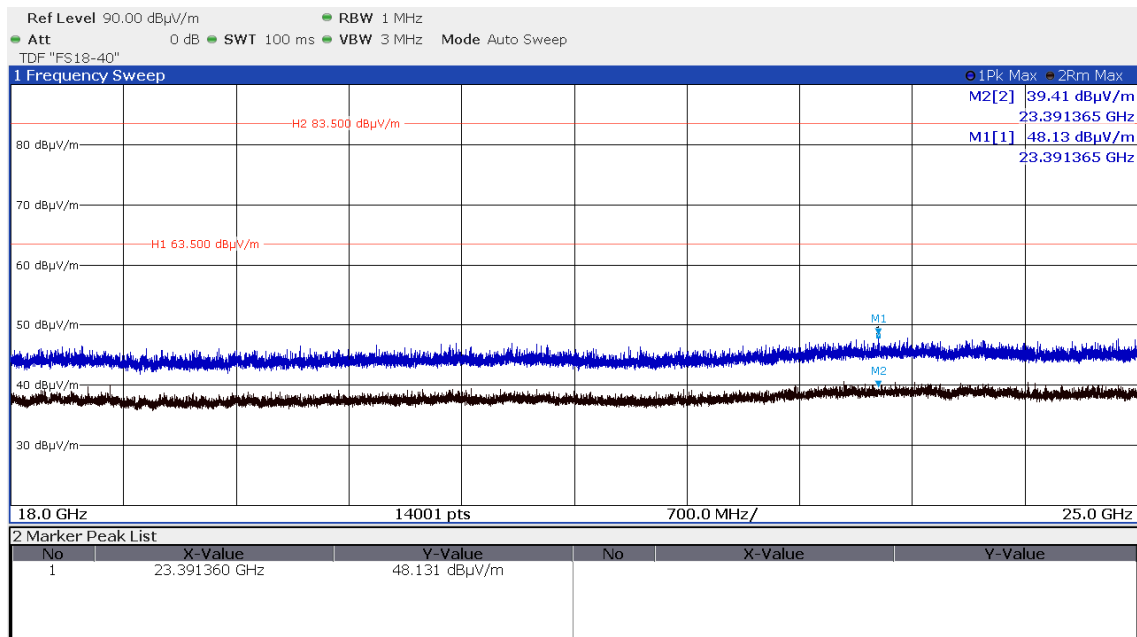
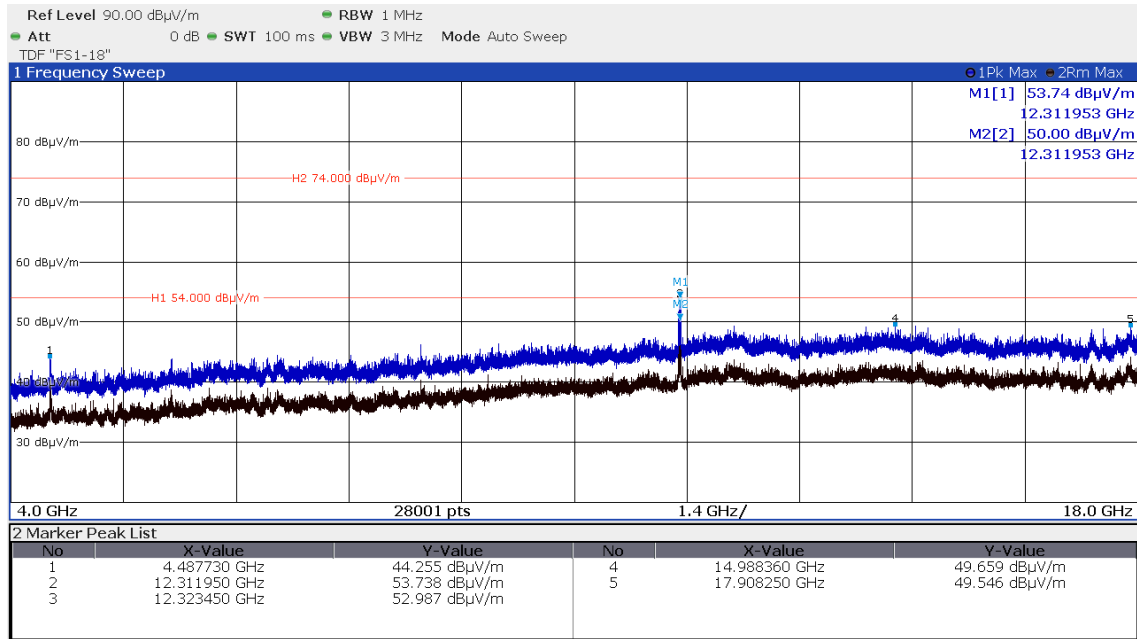
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

WLAN Standard 802.11b, 11 Mbps, P10, Path A+B

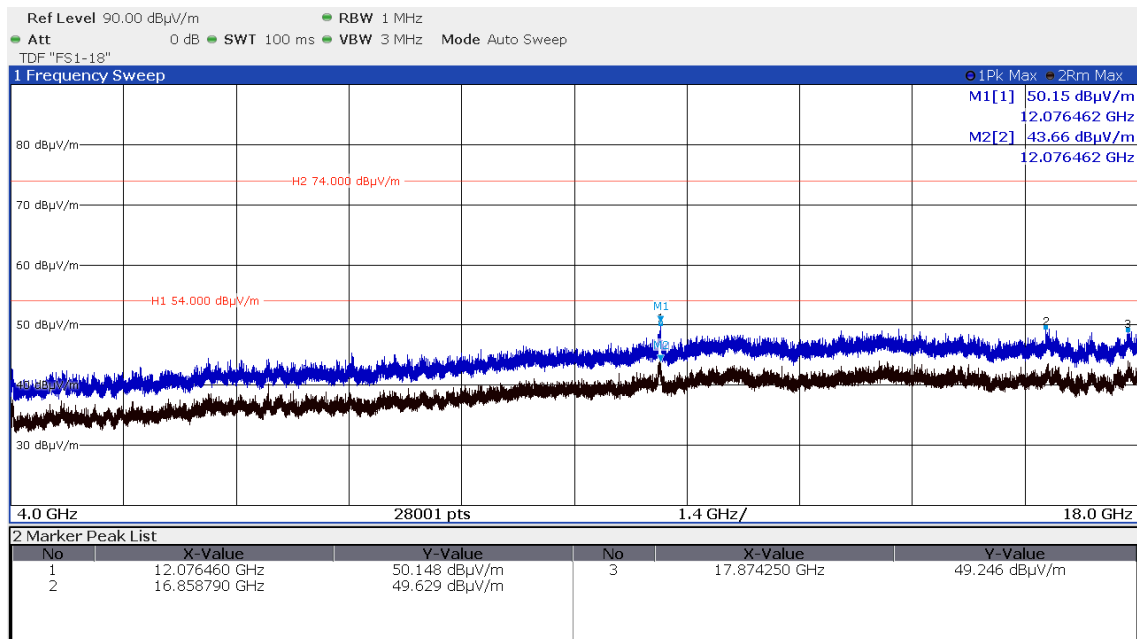
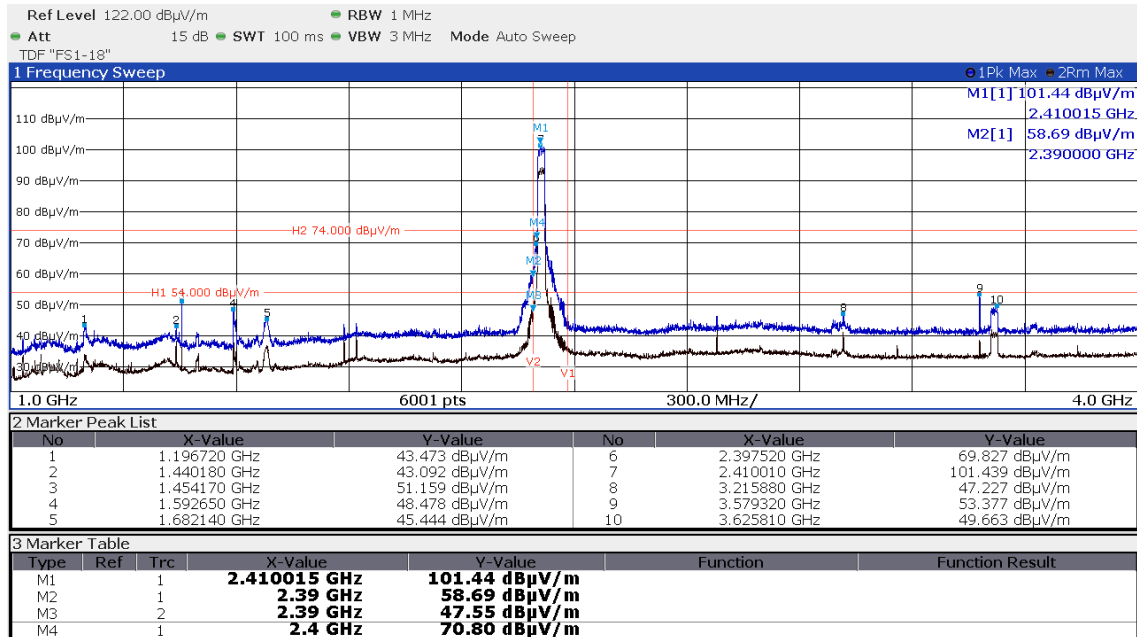
CH11



FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


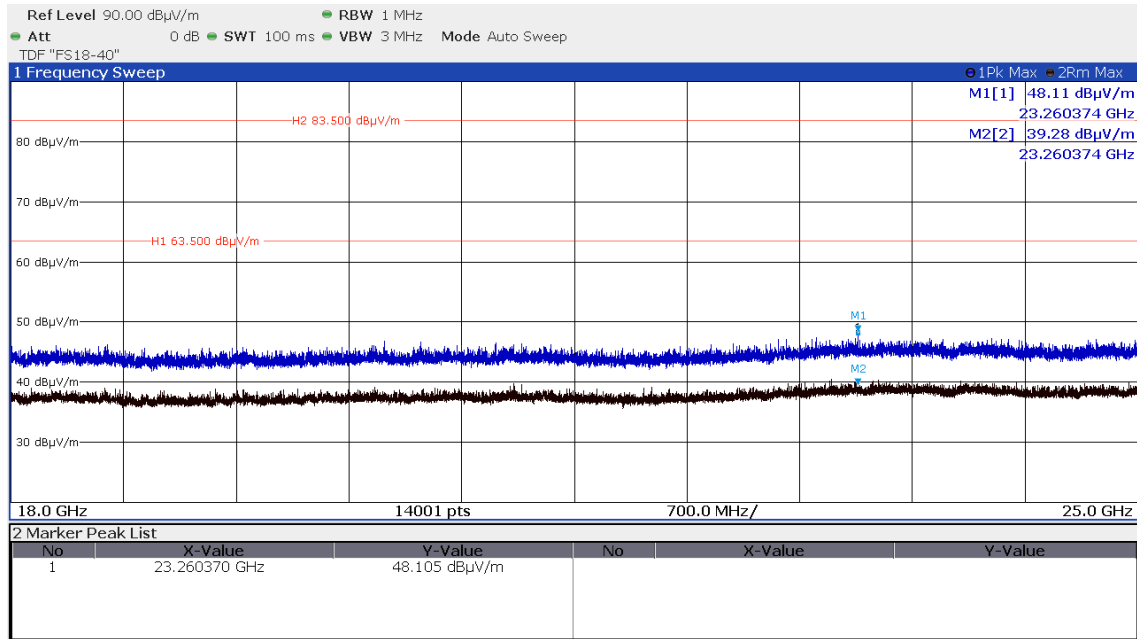
Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D
WLAN Standard 802.11n HT20, MSC7, P16, Path A - Ant A
CH1


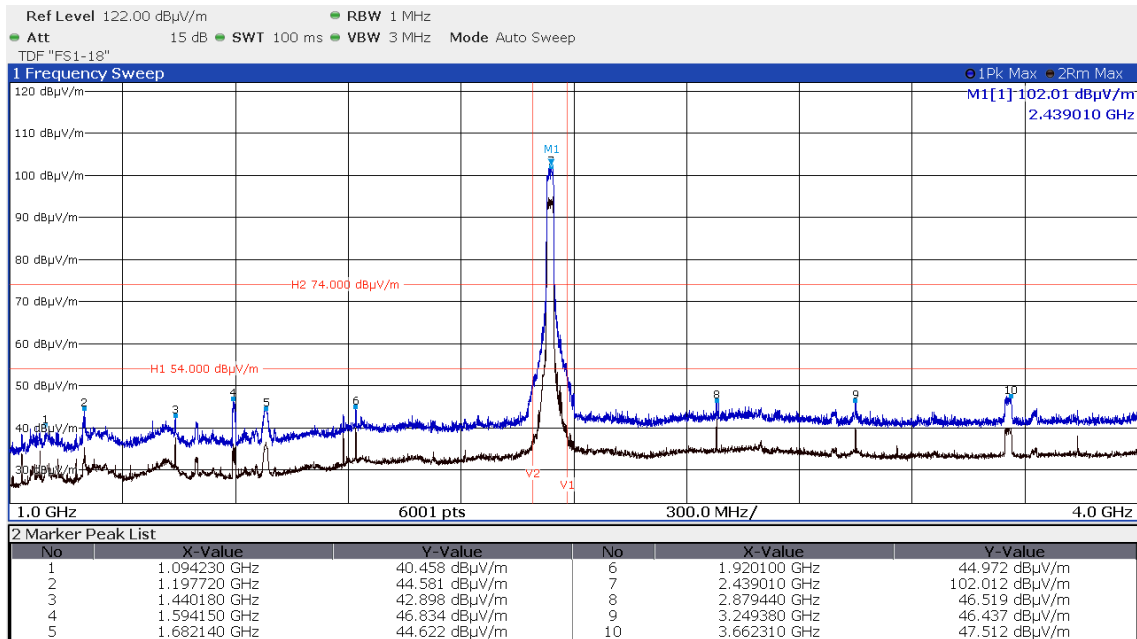
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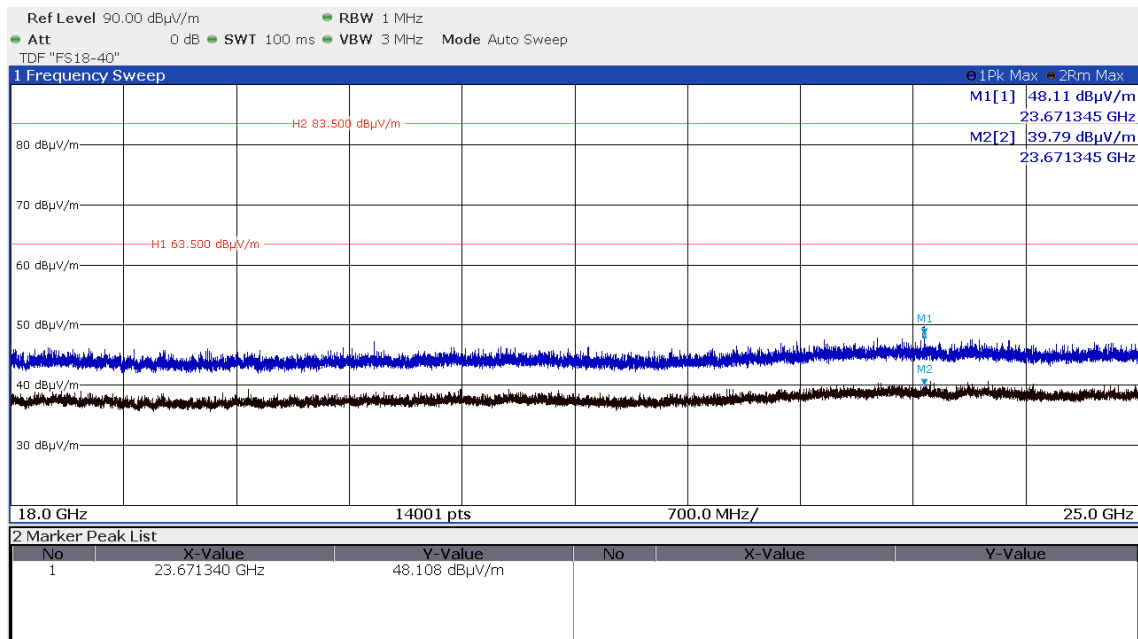
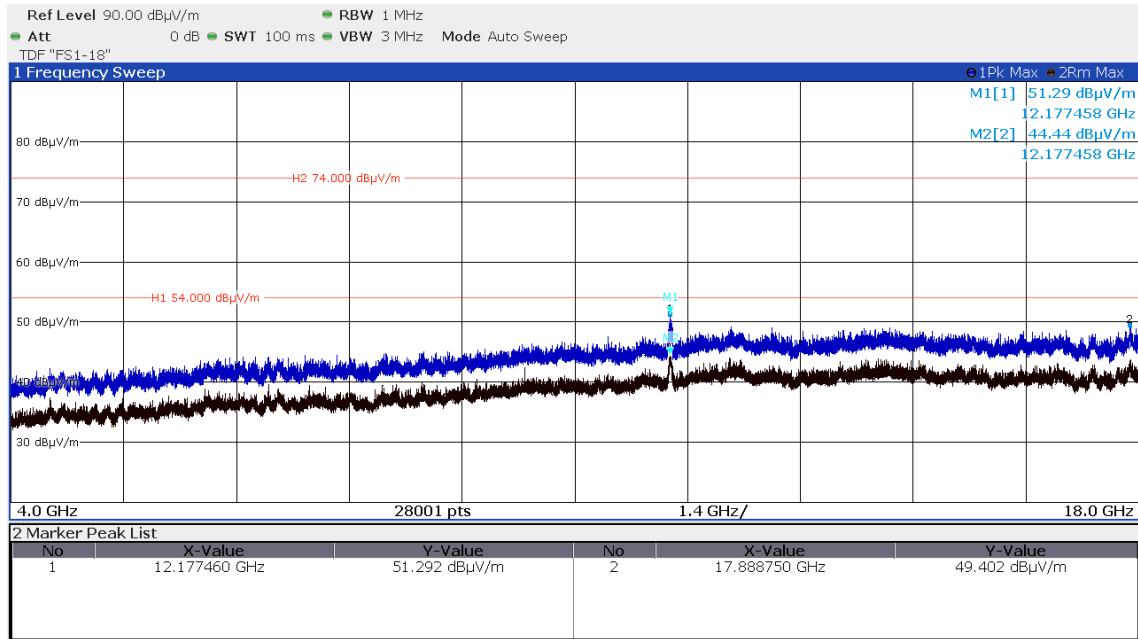
IC: 8713A-SPB228D



Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

CH6



FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


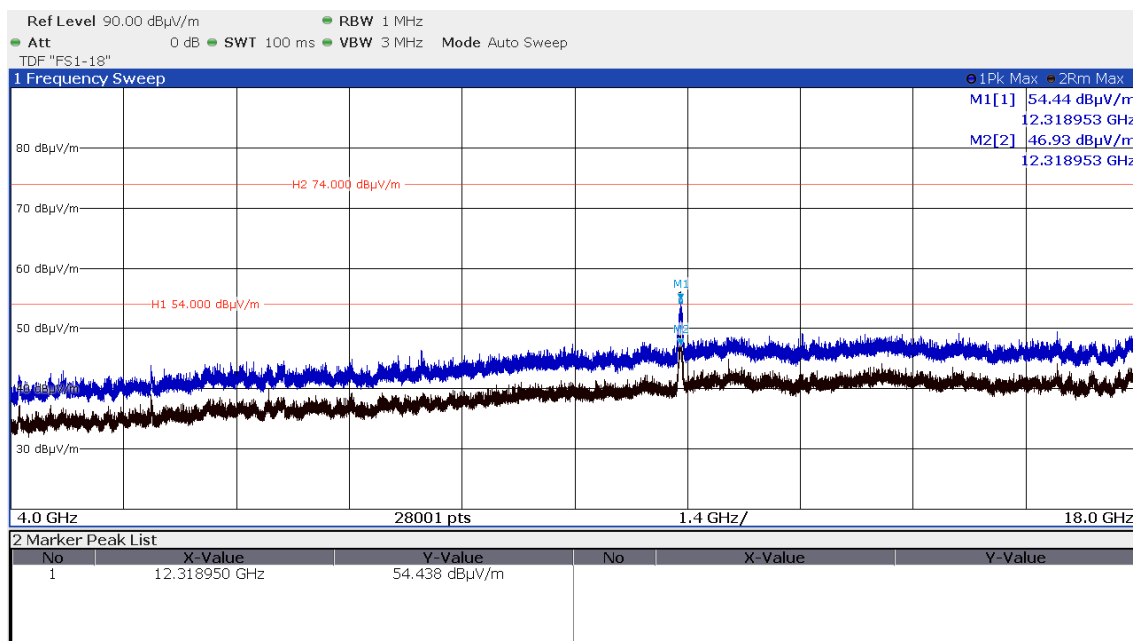
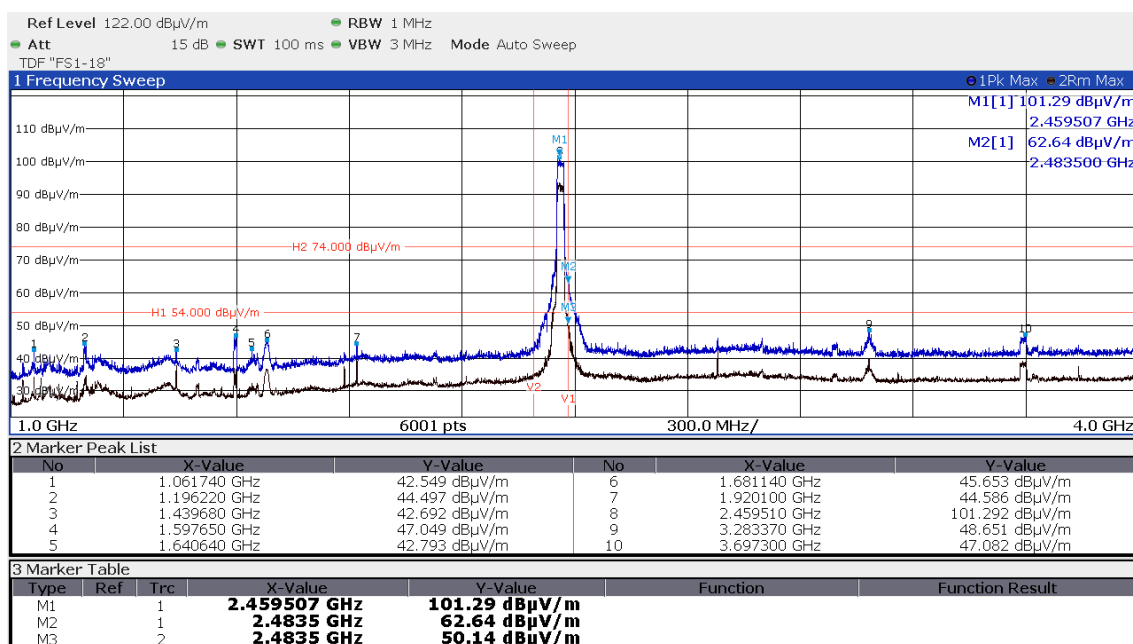
Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

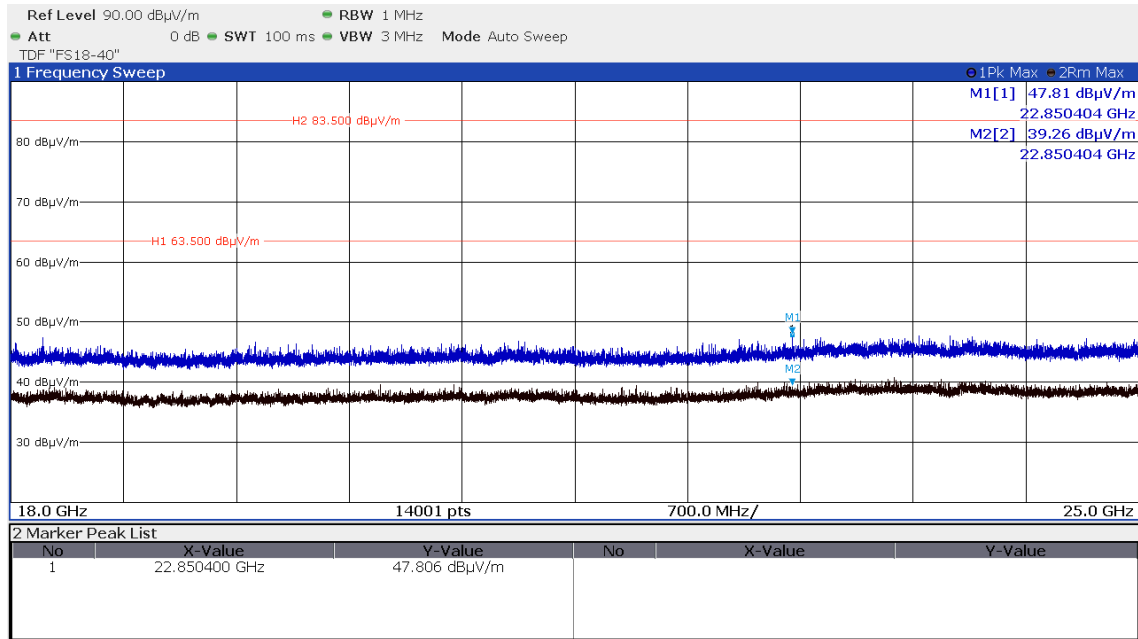
The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

FCC ID: XO2-SPB228D

IC: 8713A-SPB228D

CH11

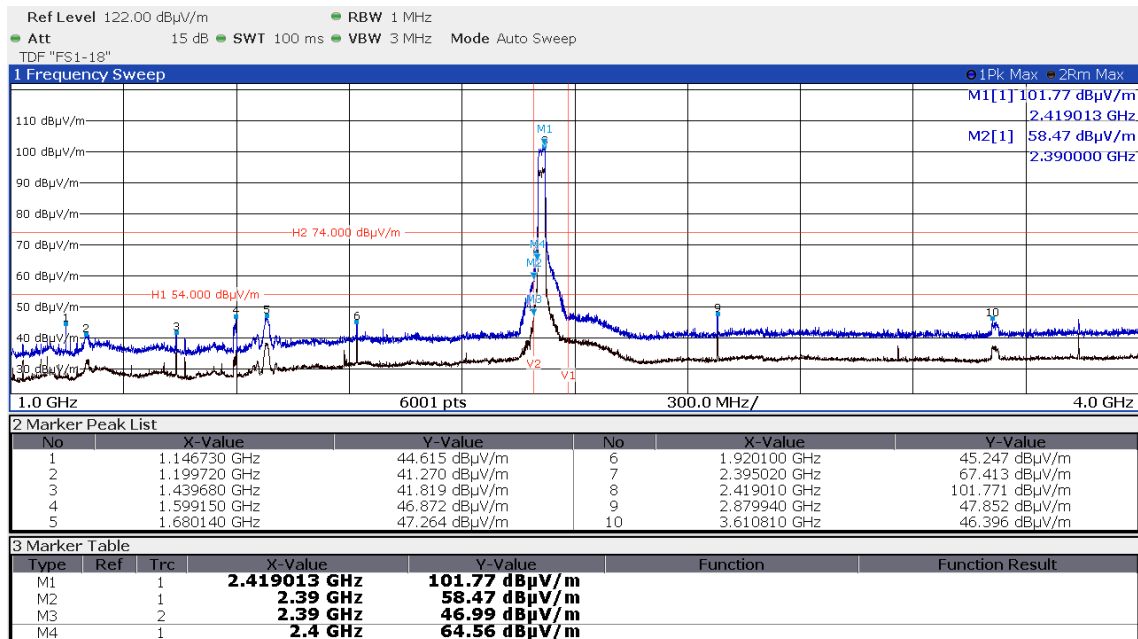


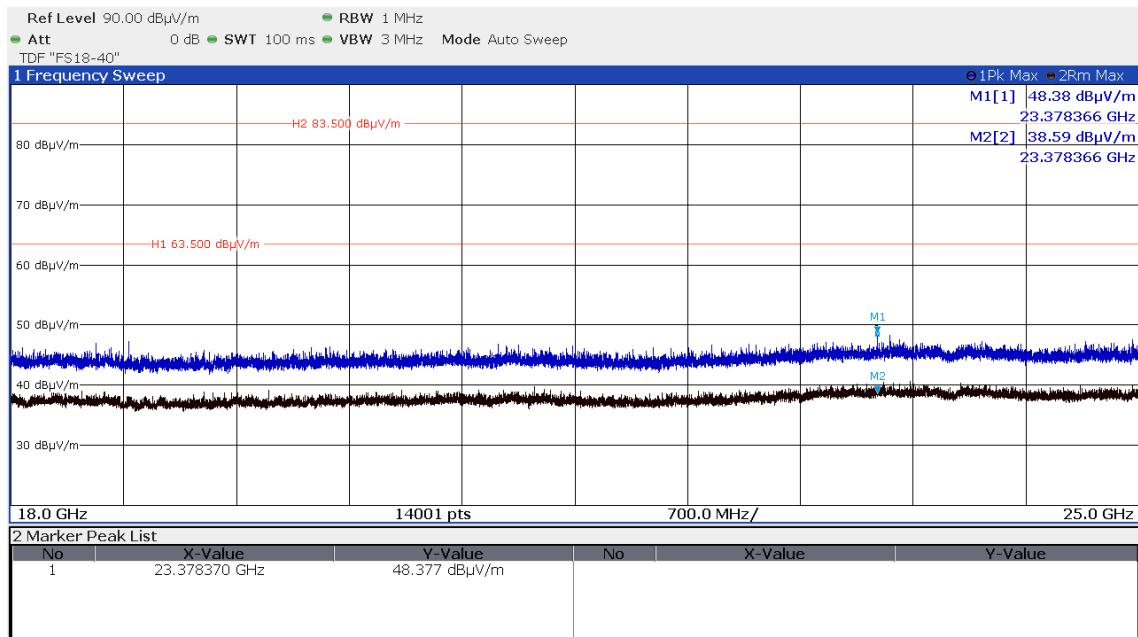
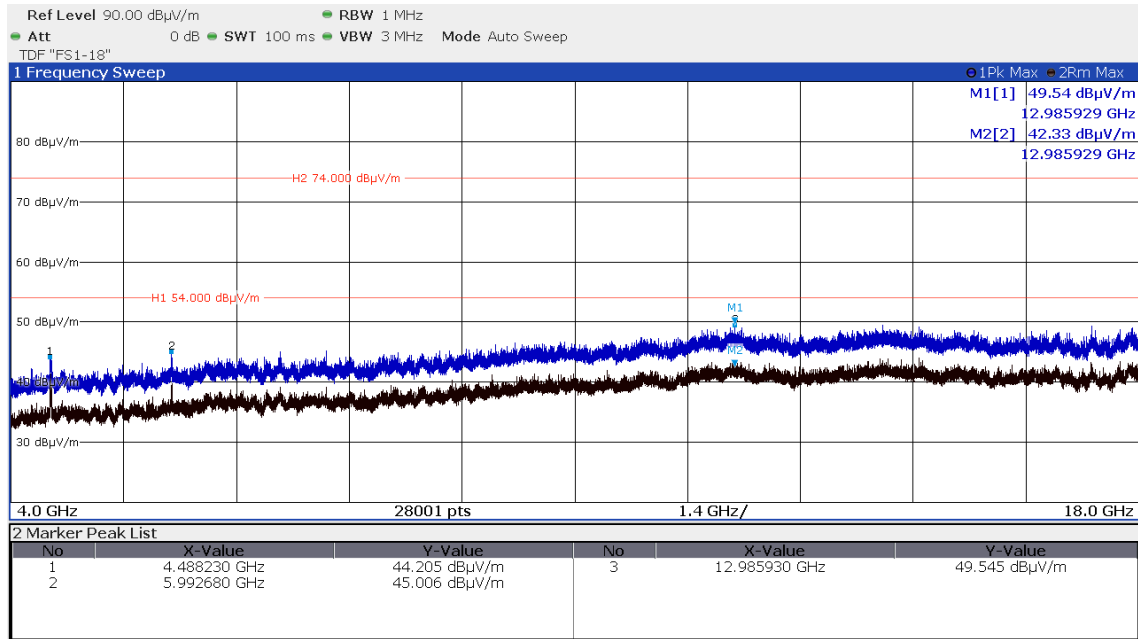
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

WLAN Standard 802.11n HT20, MSC7, P13, Path B - Ant B

CH1



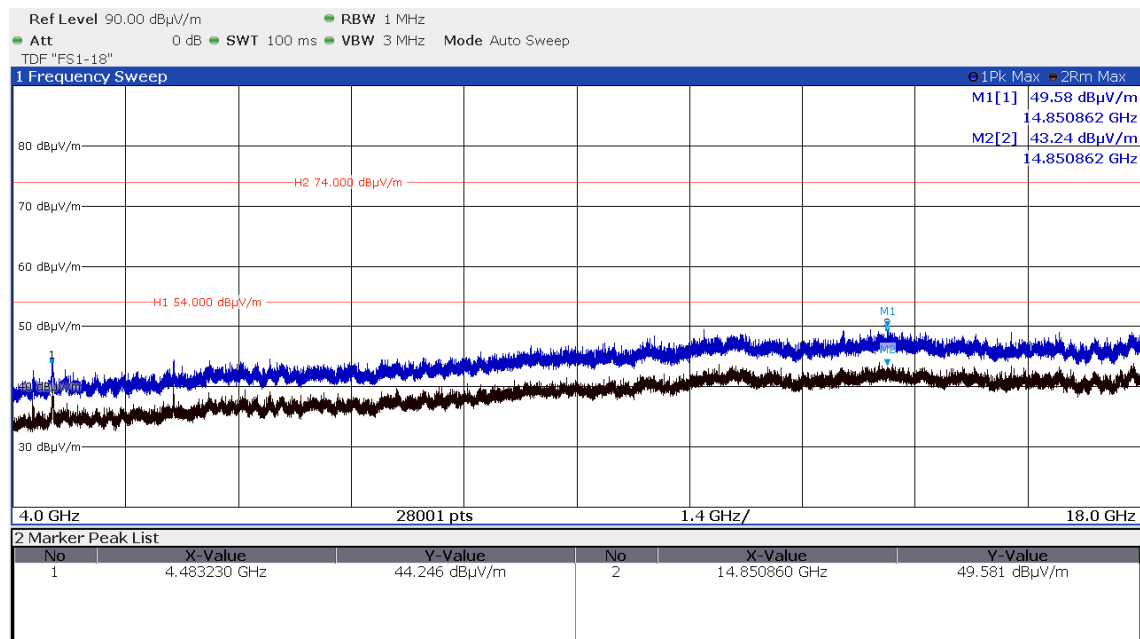
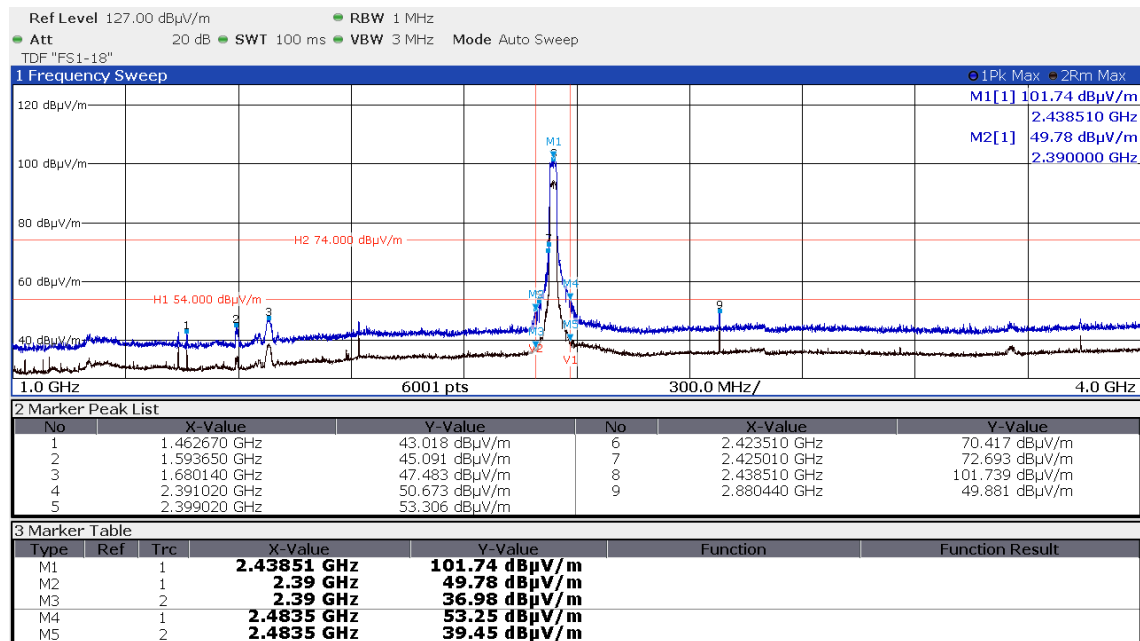
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


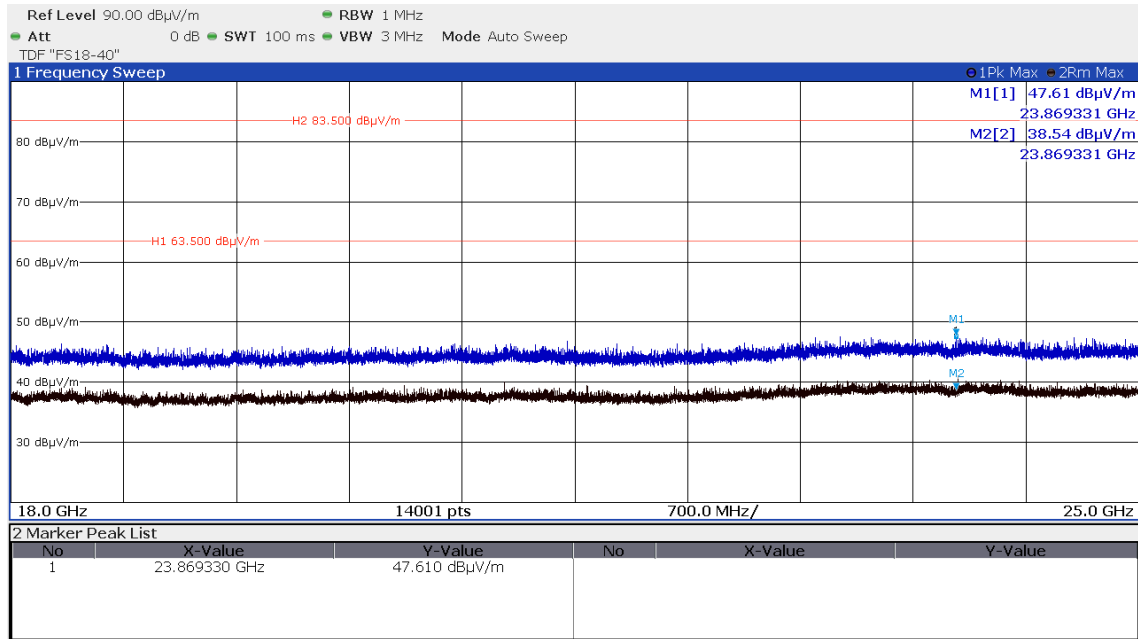
Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

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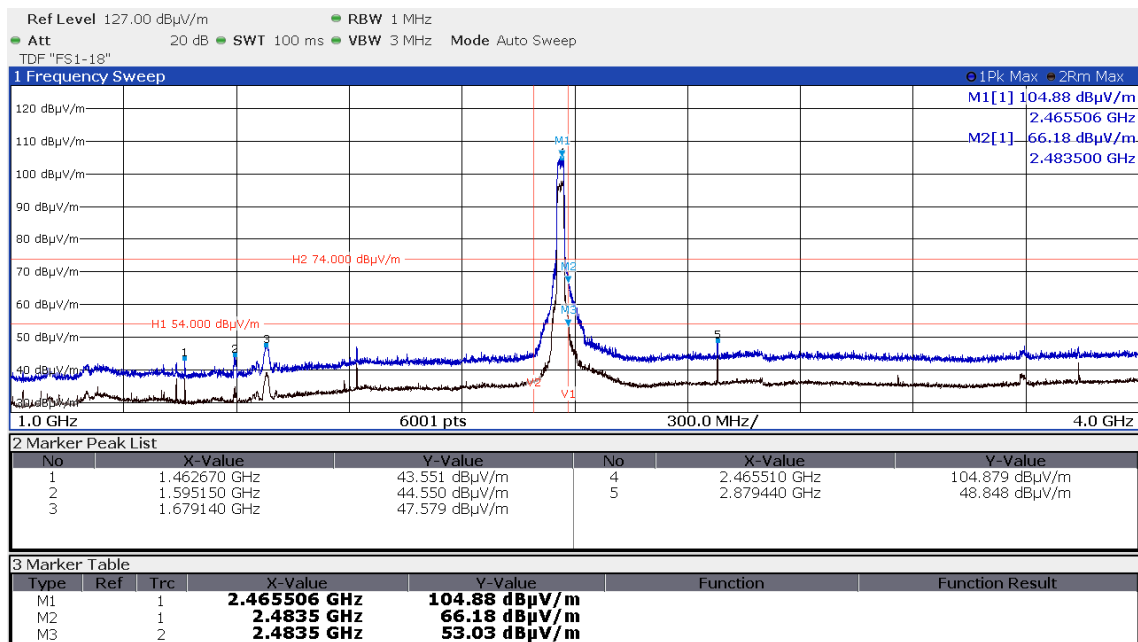
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

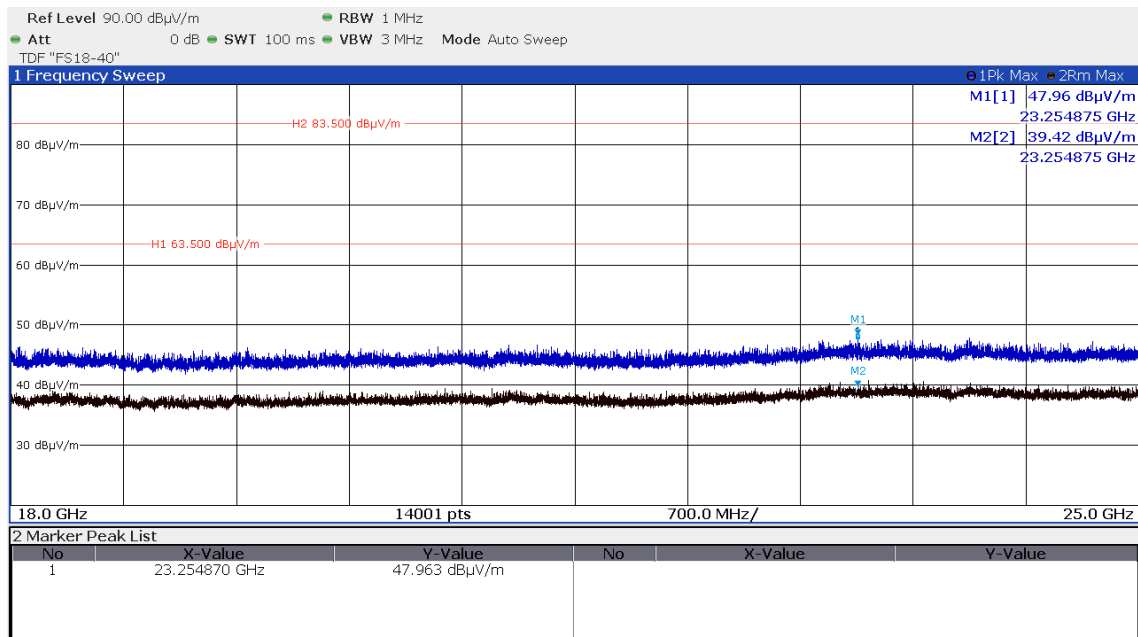
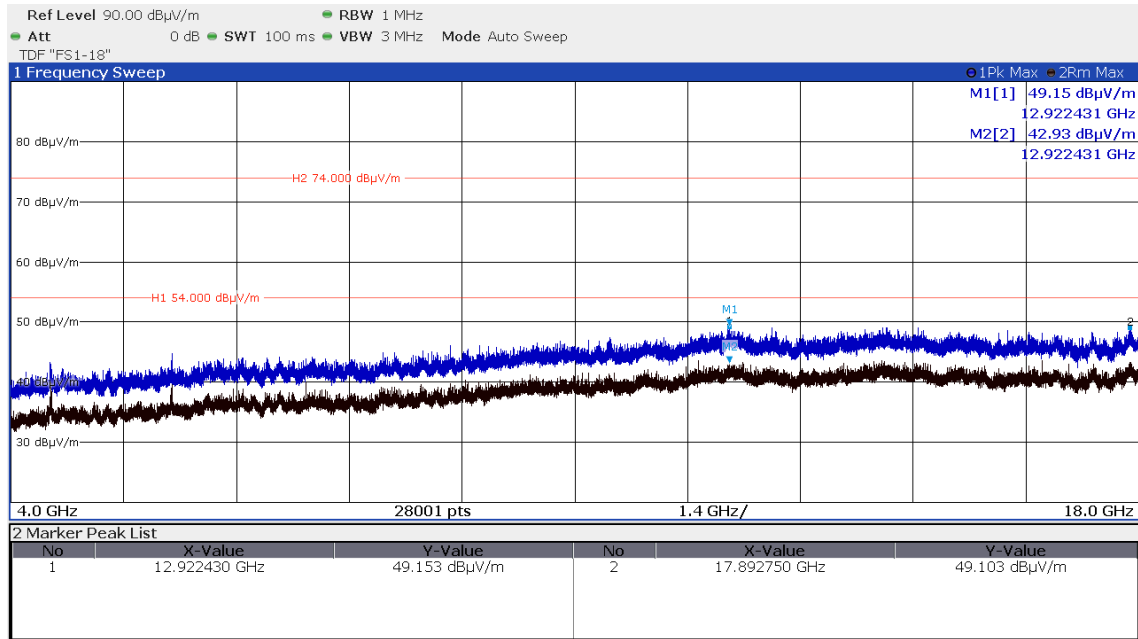
CH6



FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


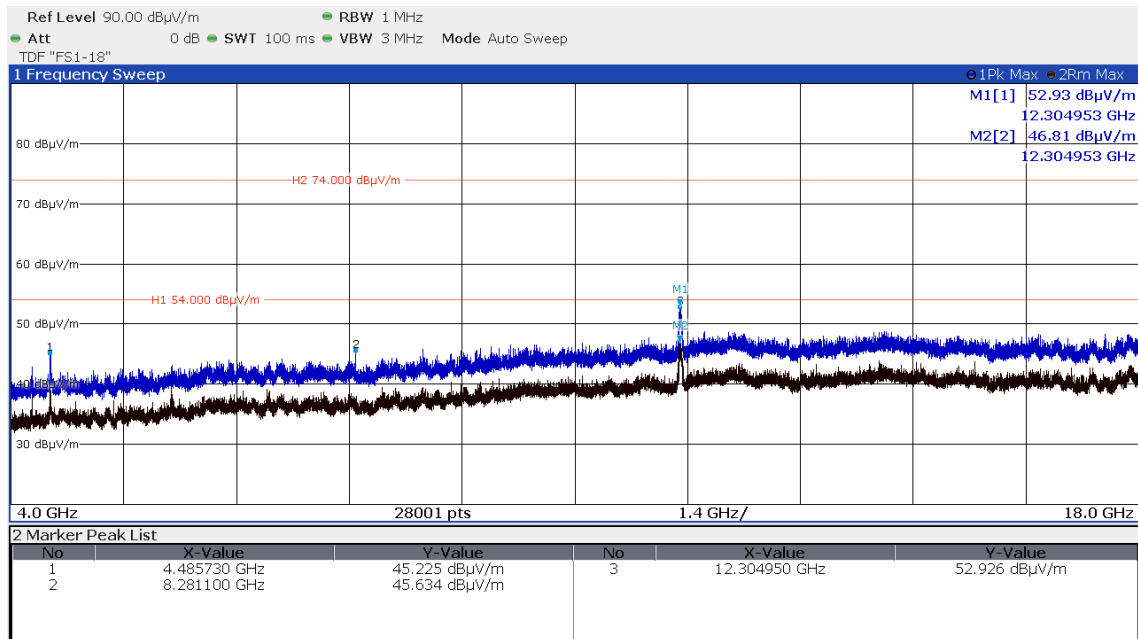
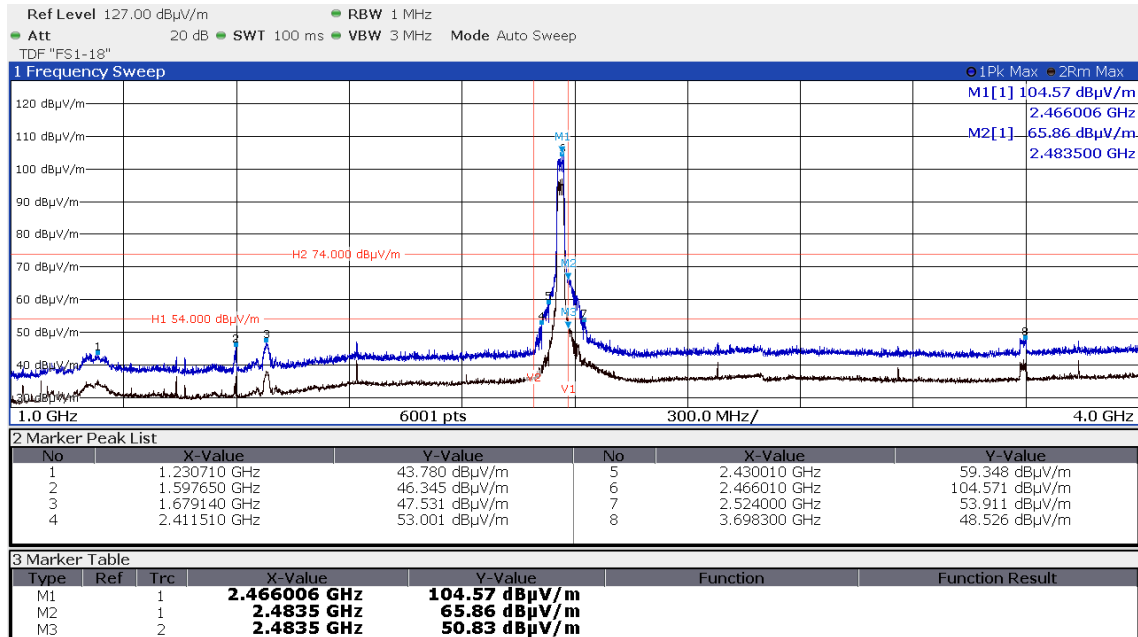
Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

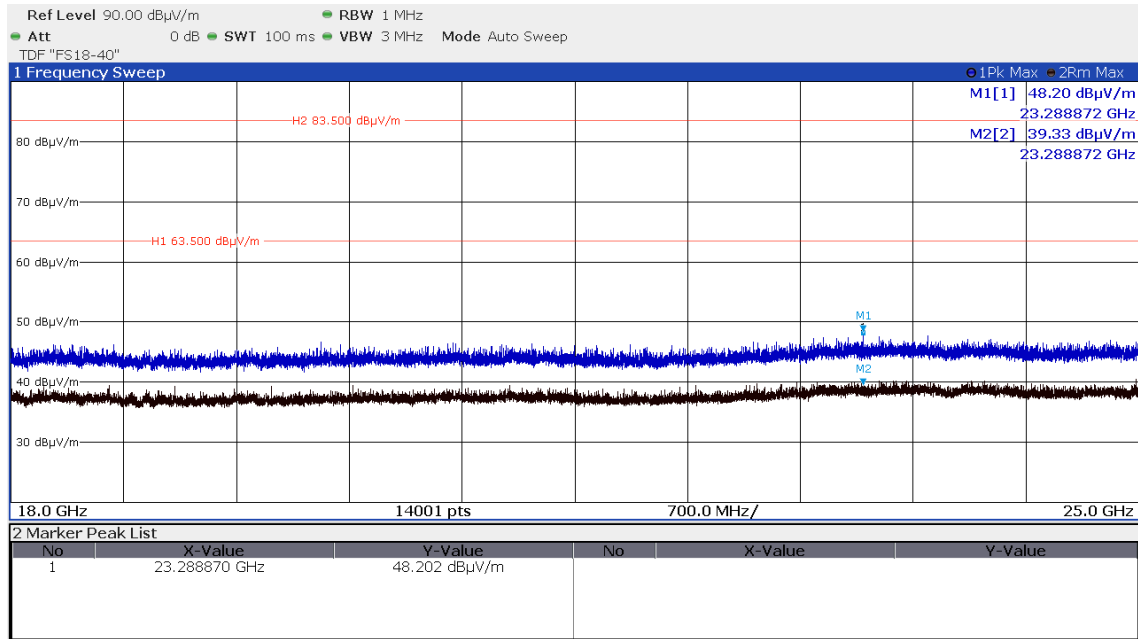
CH11


FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

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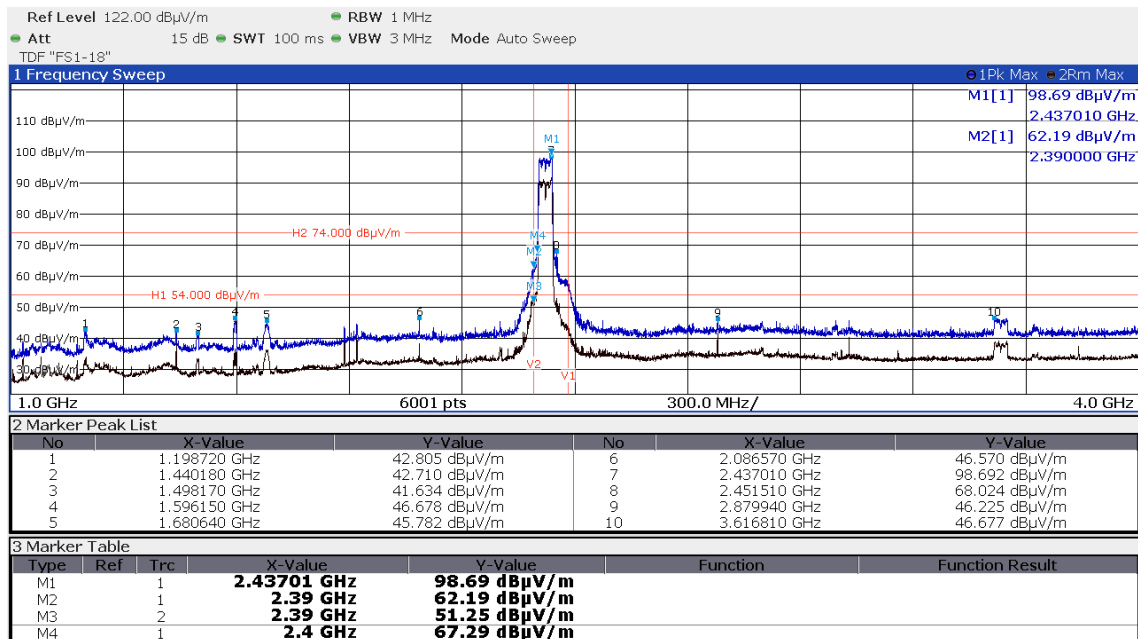
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D
WLAN Standard 802.11n HT20, MSC7, P10, Path A+B
CH11


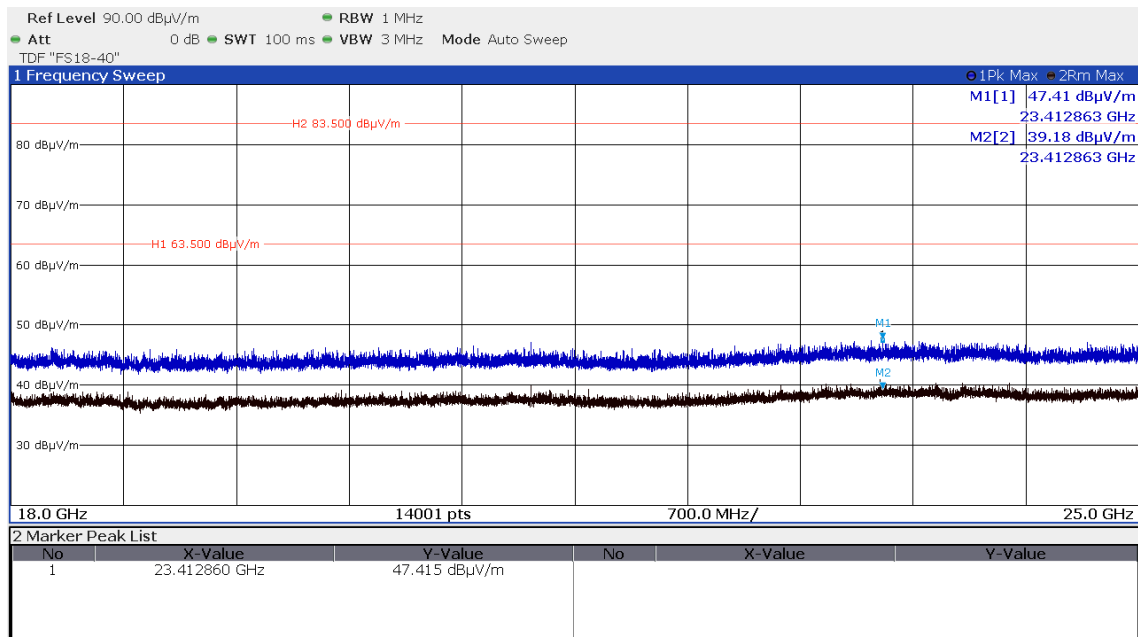
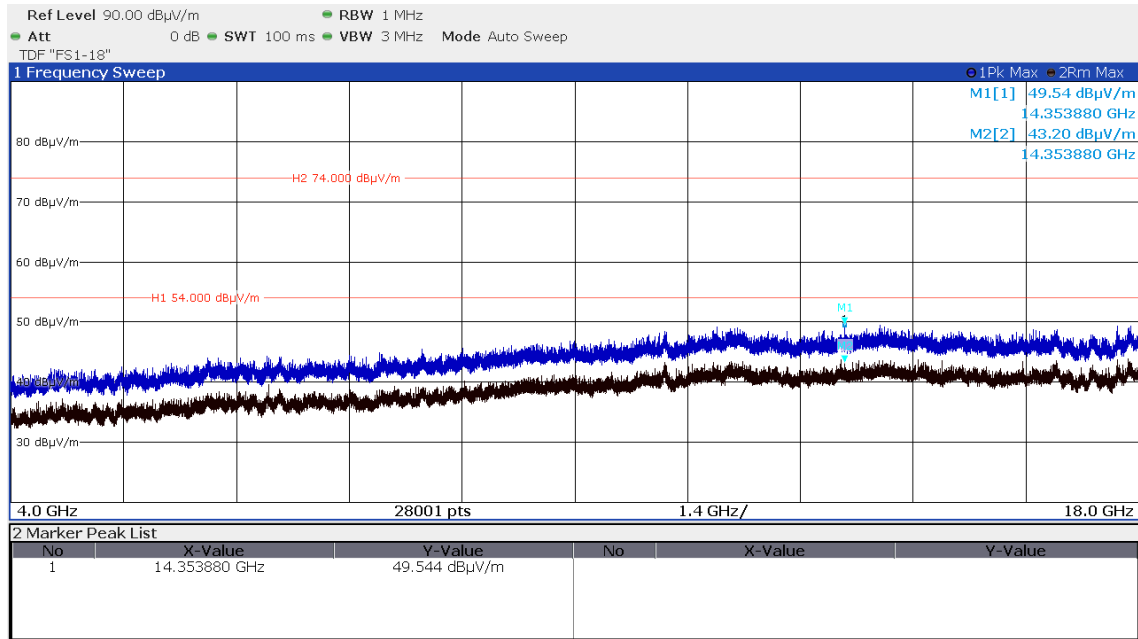
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

WLAN Standard 802.11n HT40, MSC7, P16, Path A - Ant A

CH1up



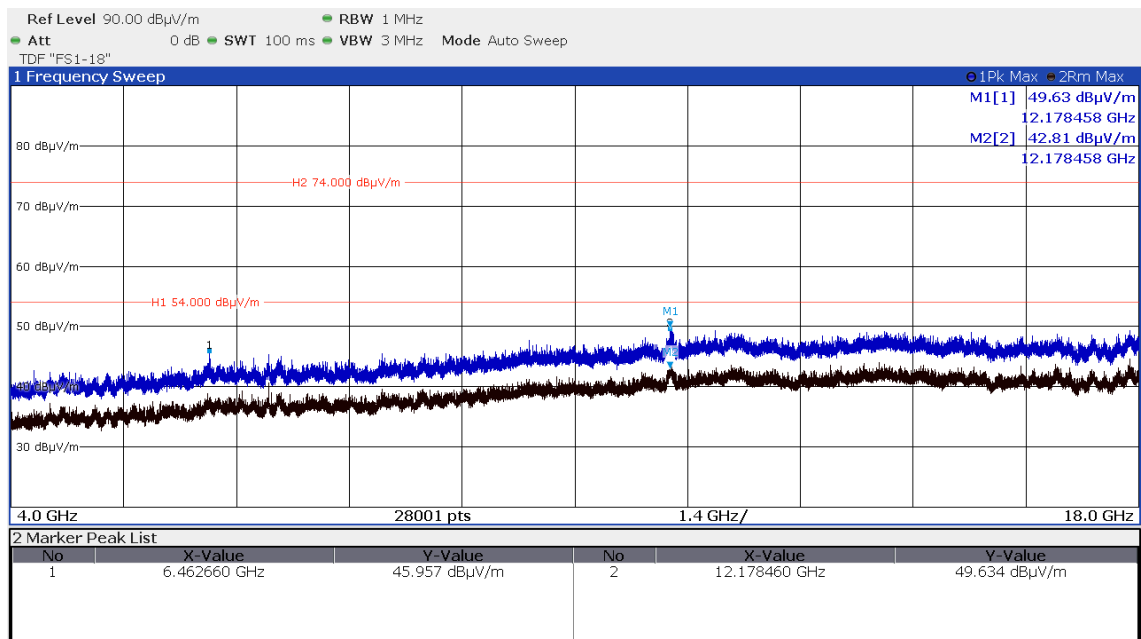
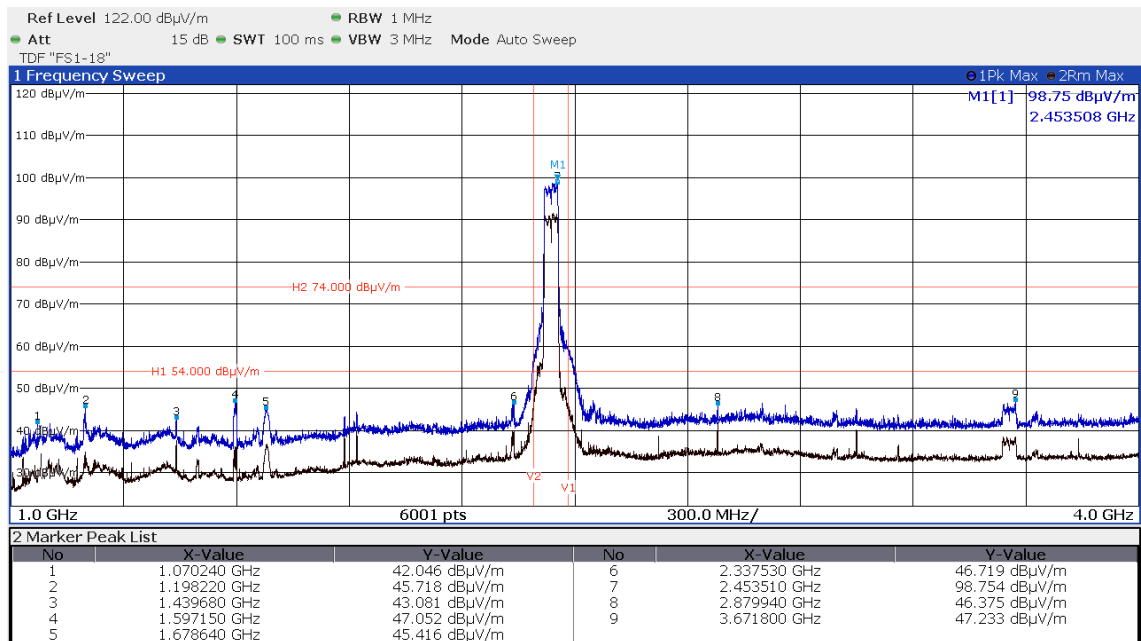
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


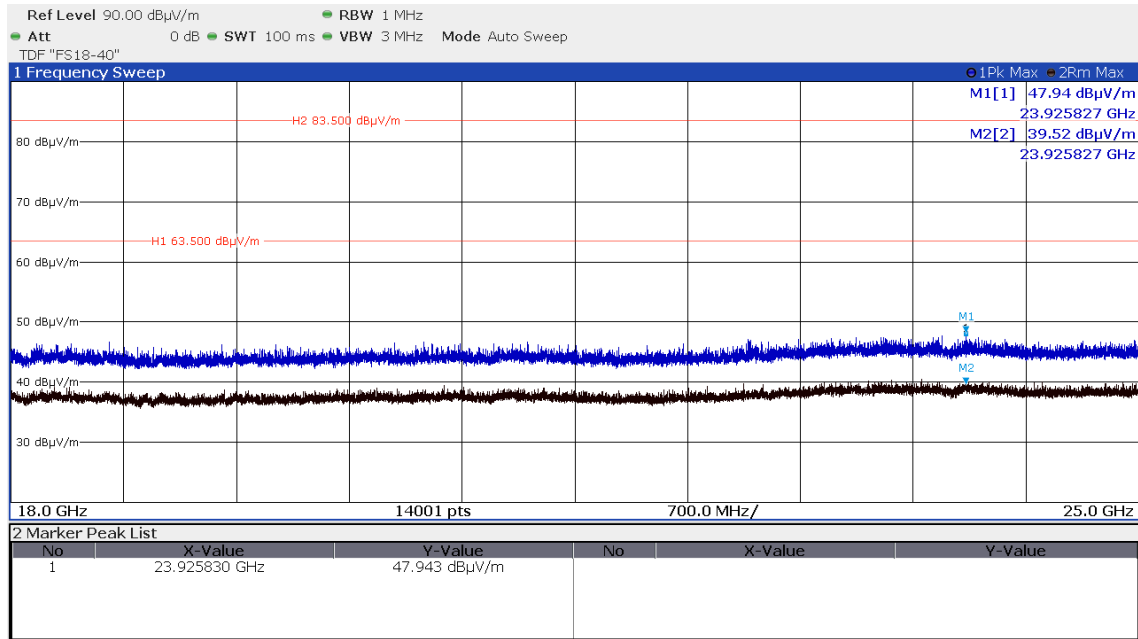
Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

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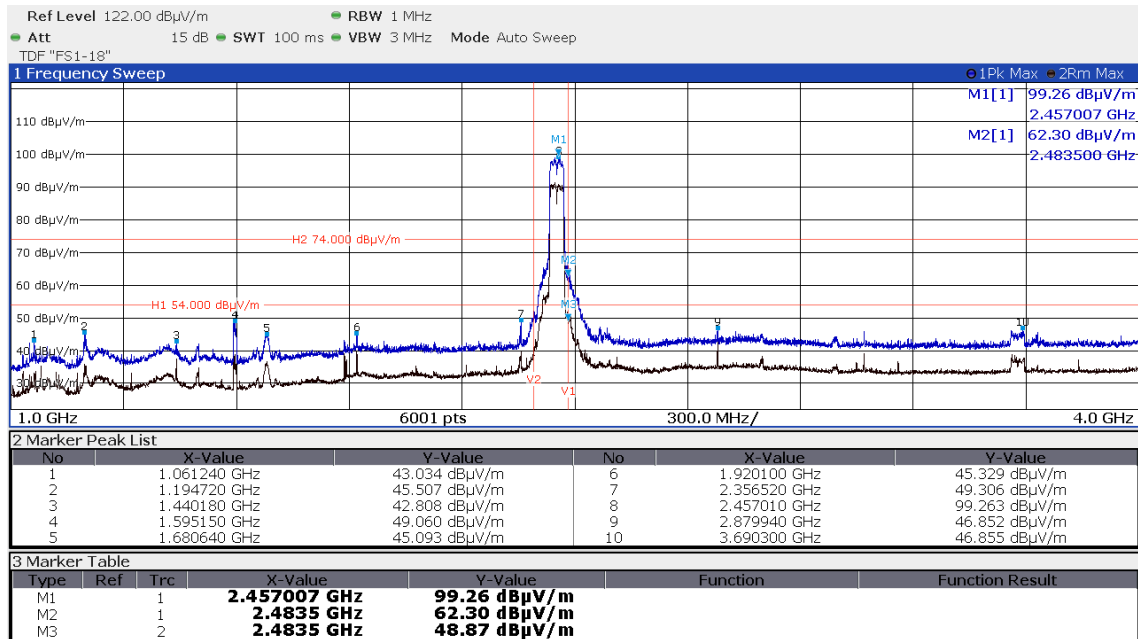
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

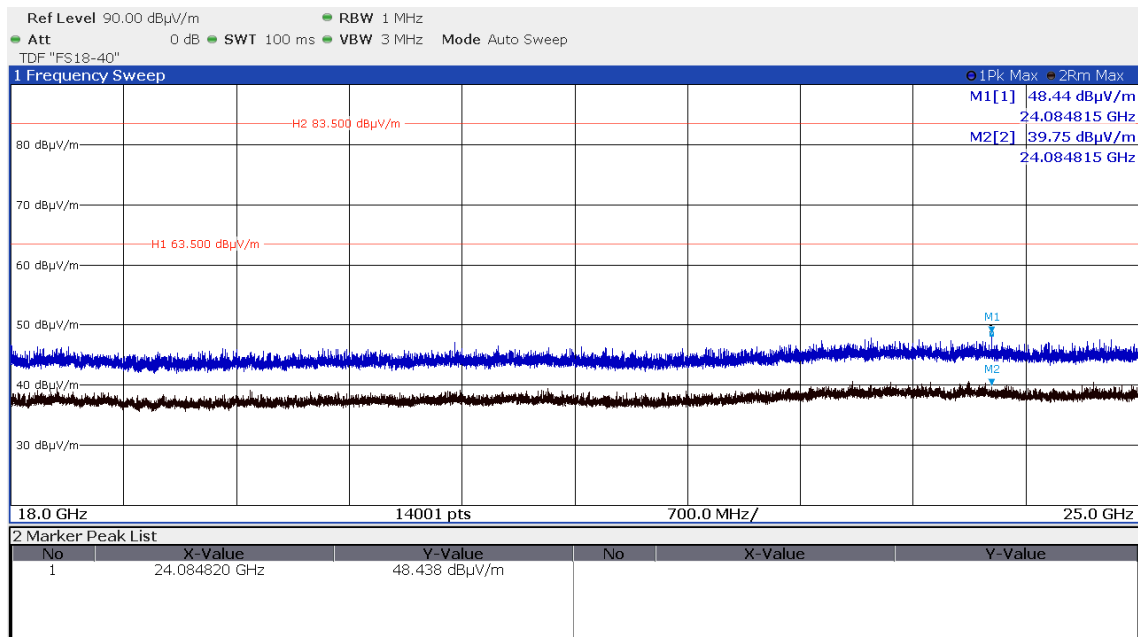
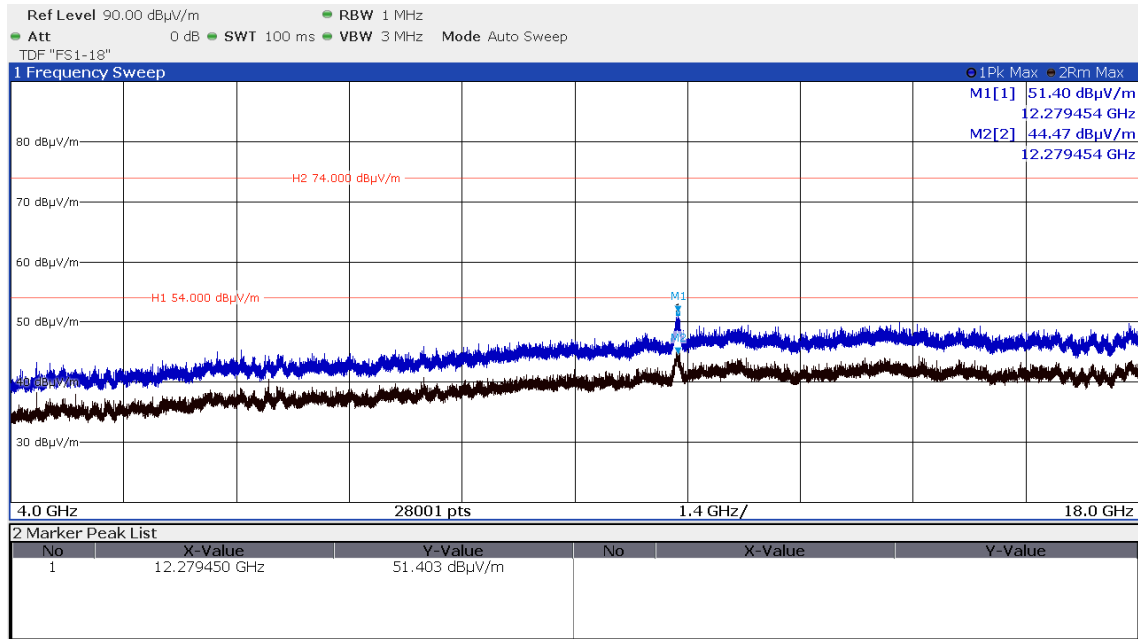
CH4up



FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

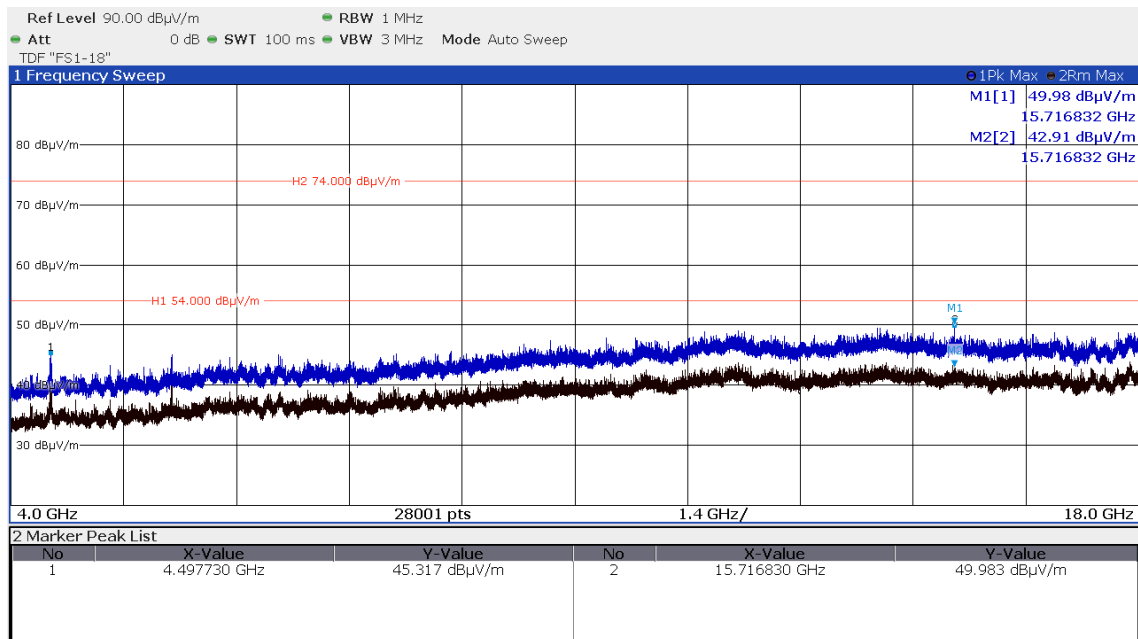
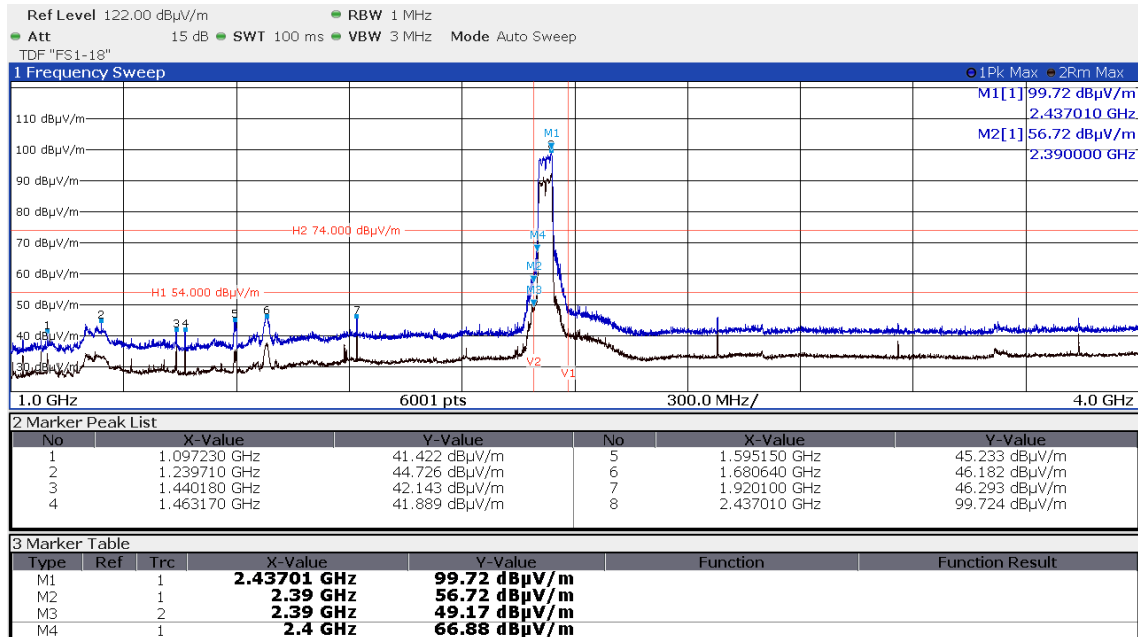
CH7up


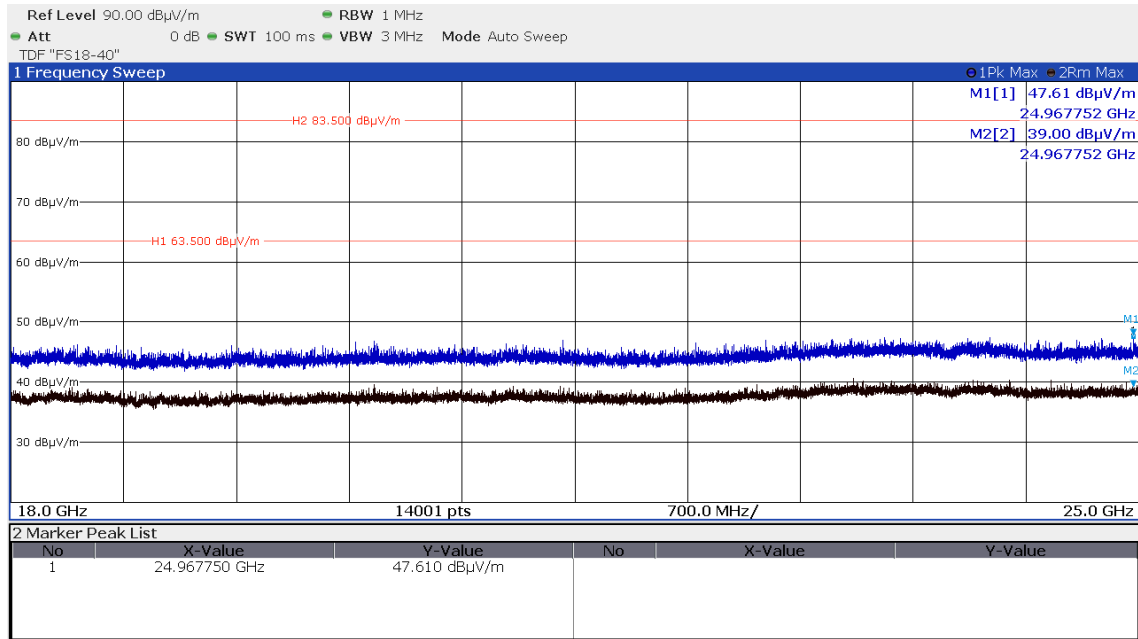
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

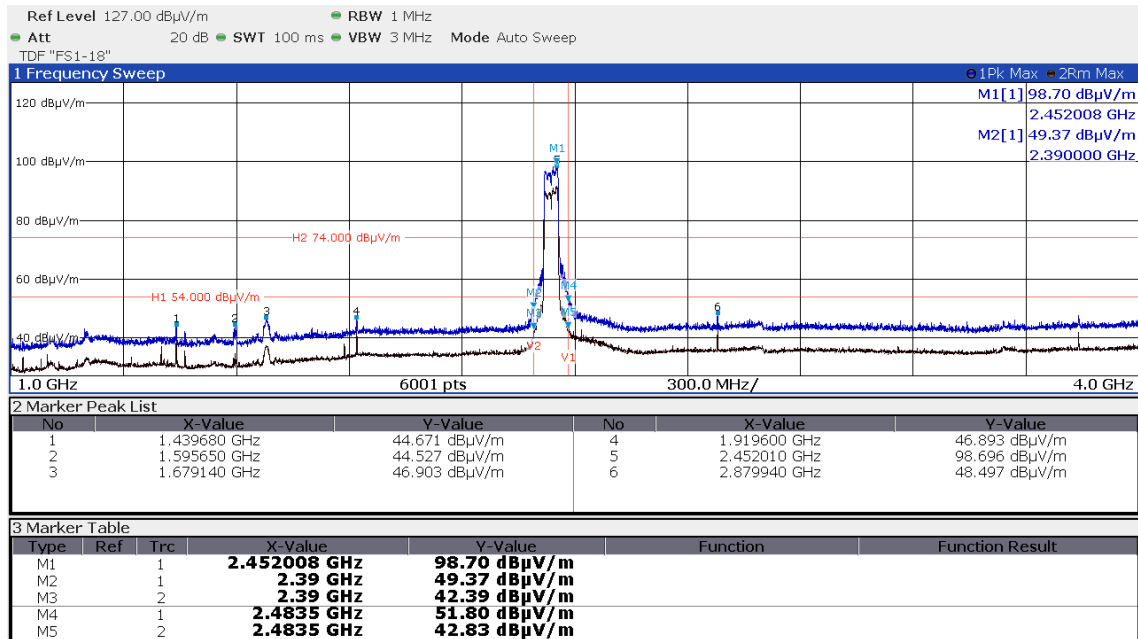
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D
WLAN Standard 802.11n HT40, MSC7, P10, Path B - Ant B

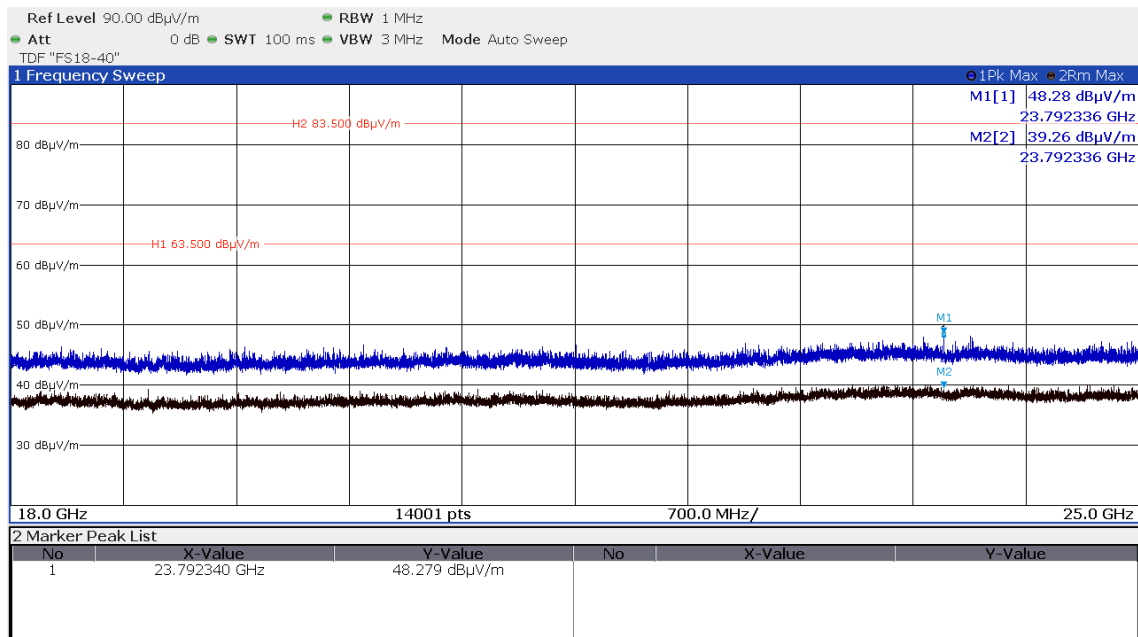
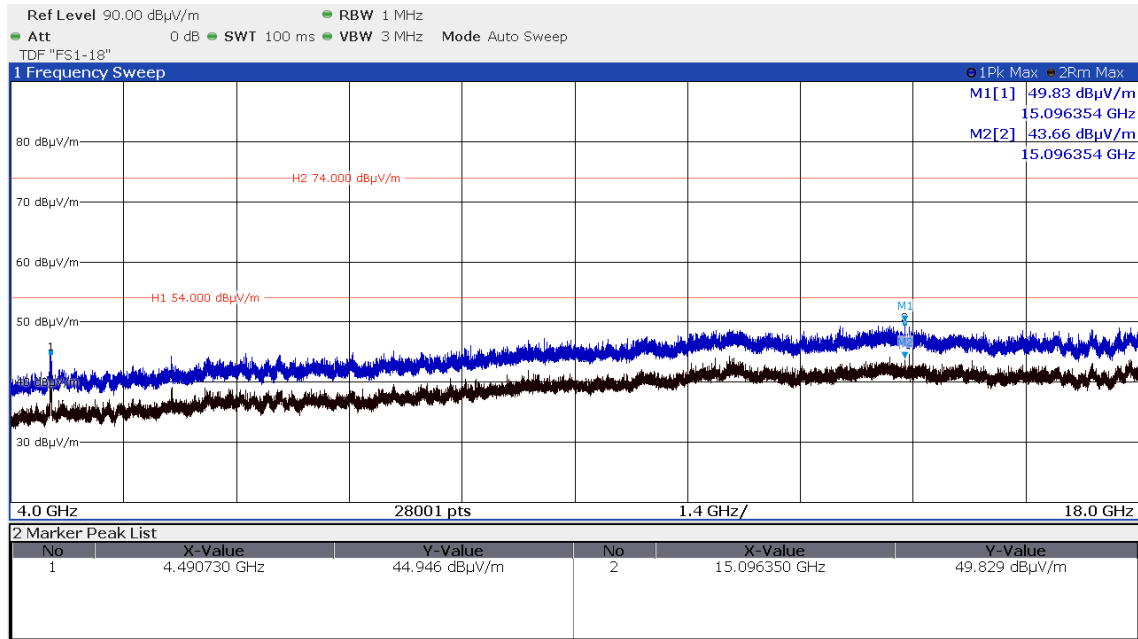
CH1up



FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

CH4up


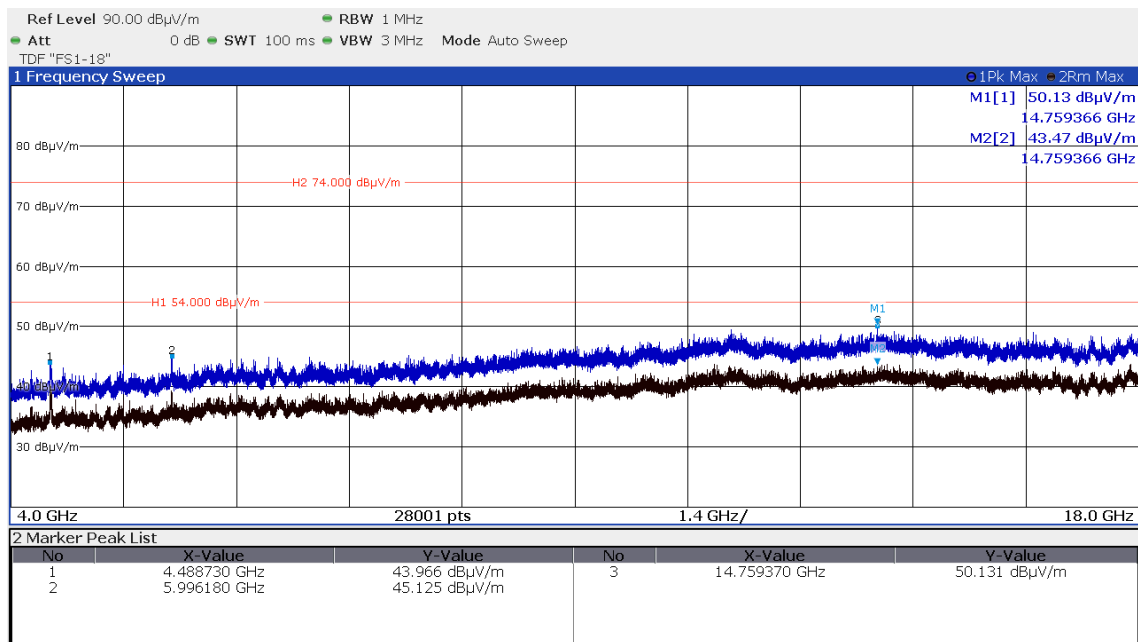
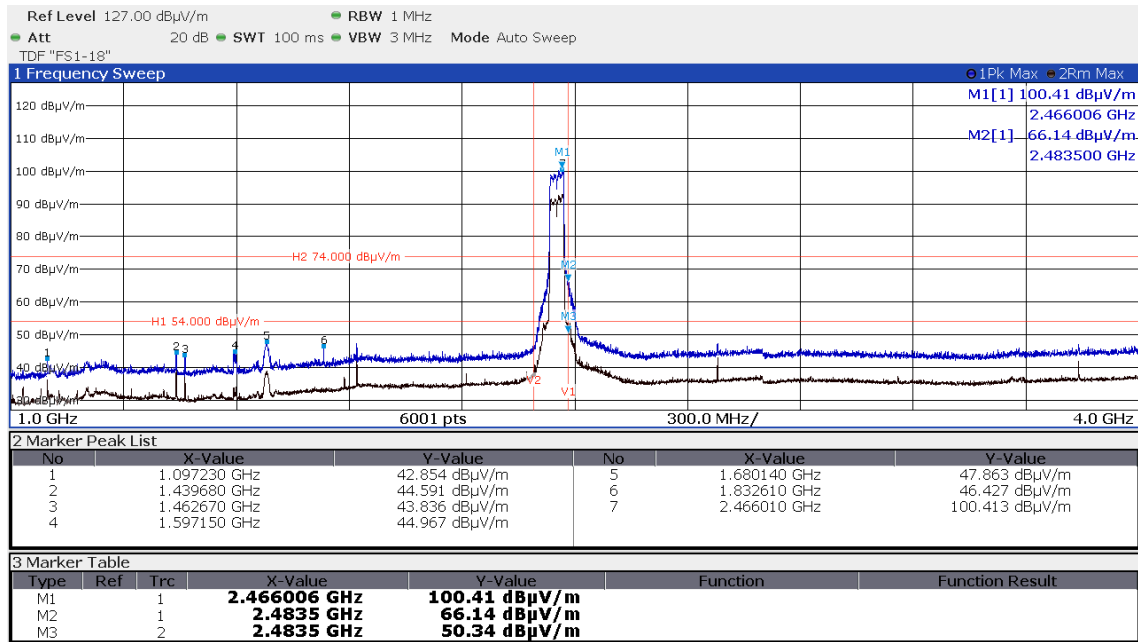
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


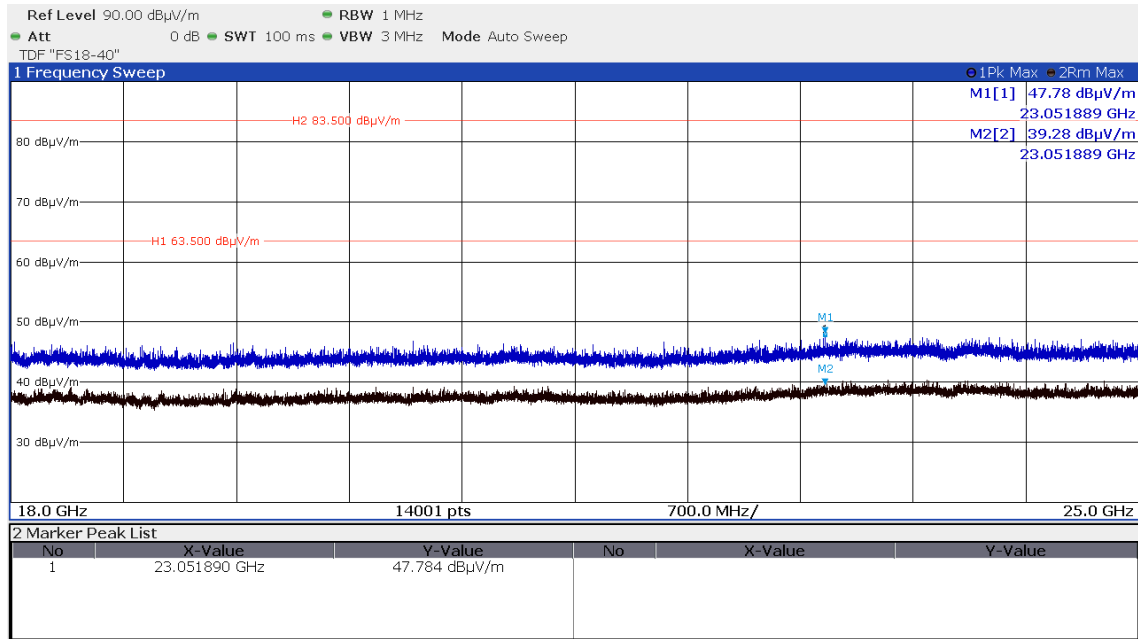
Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

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FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

CH7up

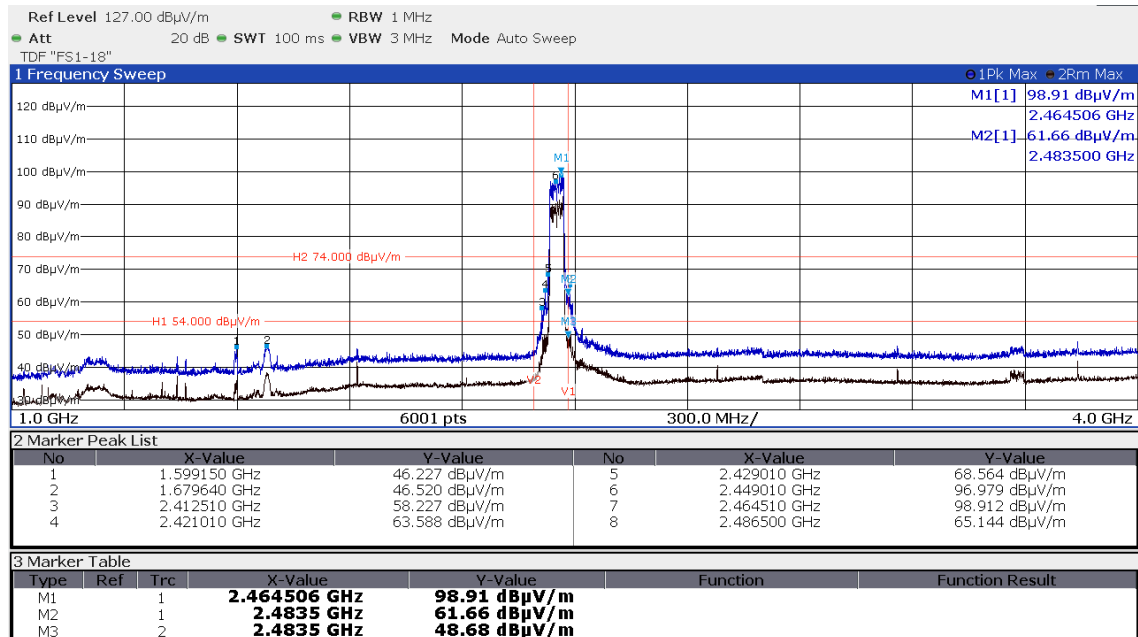


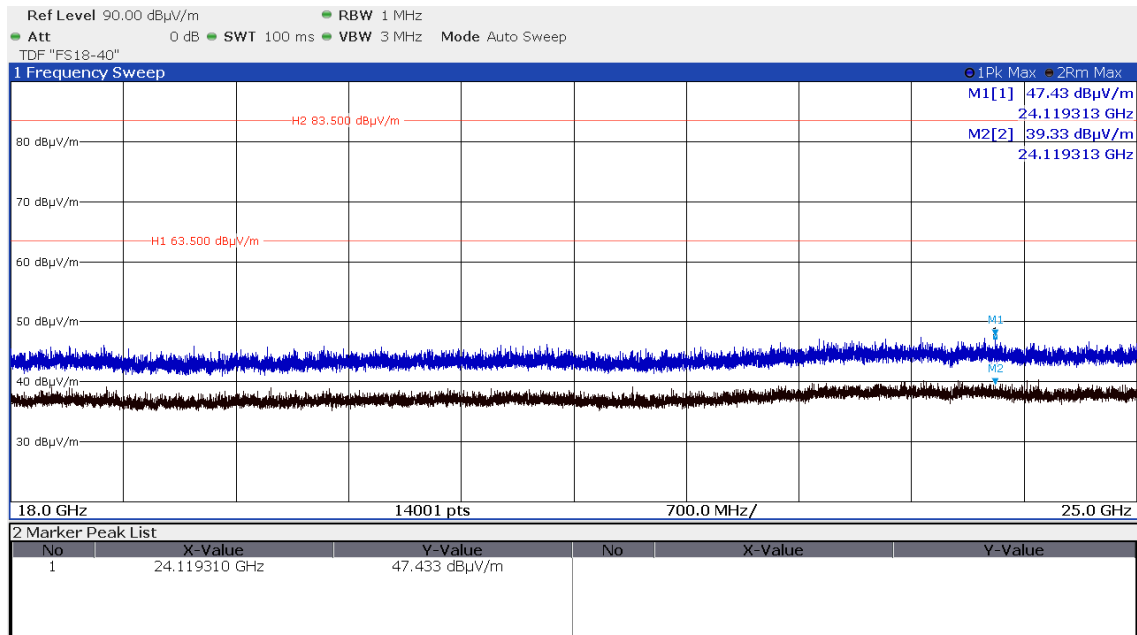
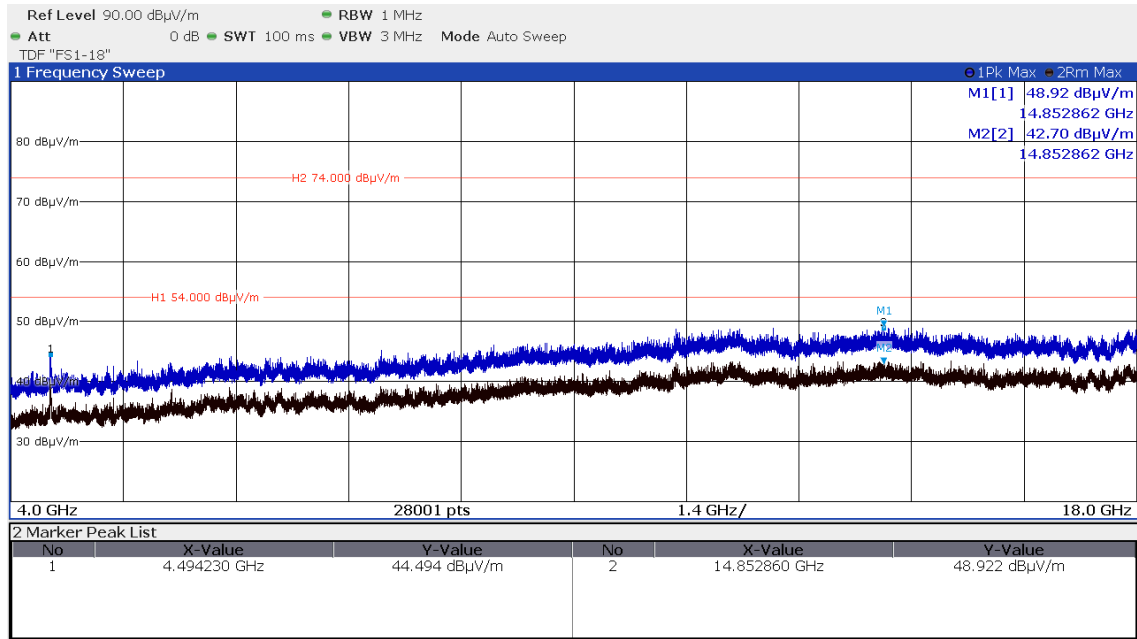
FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

WLAN Standard 802.11n HT40, MSC7, P7, Path A+B

CH7up



FCC ID: XO2-SPB228D
IC: 8713A-SPB228D


Note: The measurement distance for 18 – 25 GHz frequency range was changed to 1 m therefore the limit lines are adjusted and increased by 9.5 dB.

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

Radiated limits according to FCC Part 15 Section 15.209(a) for spurious emissions which fall in restricted bands:

Frequency (MHz)	Field strength of spurious emissions		Measurement distance
	($\mu\text{V/m}$)	$\text{dB}(\mu\text{V/m})$	(metres)
0.009-0.490	2400/F (kHz)		300
0.490-1.705	24000/F (kHz)		30
1.705-30	30	29.5	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

RSS-Gen, Table 6 – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	12.57675 - 12.57725	399.9 - 410	7.250 - 7.750
0.495 - 0.505	13.36 - 13.41	608 - 614	8.025 – 8.500
2.1735 - 2.1905	16.42 - 16.423	960 - 1427	9.0 - 9.2
3.020 - 3.026	16.69475 - 16.69525	1435 - 1626.5	9.3 - 9.5
4.125 - 4.128	16.80425 - 16.80475	1645.5 - 1646.5	10.6 - 12.7
4.17725 - 4.17775	25.5 - 25.67	1660 - 1710	13.25 - 13.4
4.20725 - 4.20775	37.5 - 38.25	1718.8 - 1722.2	14.47 - 14.5
5.677 - 5.683	73 - 74.6	2200 - 2300	15.35 - 16.2
6.215 - 6.218	74.8 - 75.2	2310 - 2390	17.7 - 21.4
6.26775 - 6.26825	108 – 138	2483.5 - 2500	22.01 - 23.12
6.31175 - 6.31225	149.9 - 150.05	2655 - 2900	23.6 - 24.0
8.291 - 8.294	156.52475 - 156.52525	3260 – 3267	31.2 - 31.8
8.362 - 8.366	156.7 - 156.9	3332 - 3339	36.43 - 36.5
8.37625 - 8.38675	162.0125 - 167.17	3345.8 - 3358	Above 38.6
8.41425 - 8.41475	167.72 - 173.2	3500 - 4400	
12.29 - 12.293	240 – 285	4500 - 5150	
12.51975 - 12.52025	322 - 335.4	5350 - 5460	

FCC ID: XO2-SPB228D

IC: 8713A-SPB228D

The requirements are **FULFILLED**.

Remarks: The measurement was performed up to the 10th harmonic.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

FCC ID: XO2-SPB228D

IC: 8713A-SPB228D

5.5 Antenna application

5.5.1 Applicable standard

According to FCC Part 15C, Section 15.203:

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. The manufacturer may design the unit that broken antennas can be replaced by the user, but the use of a standard antenna jack is prohibited.

The EUT has integrated PCB antennas. No other antennas can be used with the device.

All supplied antennas meet the requirements of part 15.203 and 15.204.

5.5.2 Antenna requirements

According to FCC Part 15C, Section 15.247(b)(4):

The conducted output power limit specified in paragraph (b) of 15.247 is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2) and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Defacto EIRP-Limit:

$$P_{out} = 30 - (G_x - 6);$$

The EUT uses antennas smaller than 6 dBi. No defacto limit results.

Remarks: No power reduction results from the defacto limit.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

FCC ID: XO2-SPB228D
IC: 8713A-SPB228D

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
A 4	BAT-EMC 3.19.1.24	01-02/68-13-001				
	ESCI	02-02/03-15-001	24/06/2021	24/06/2020		
	ESH 2 - Z 5	02-02/20-05-004	31/10/2021	31/10/2019	05/05/2021	05/11/2020
	N-4000-BNC	02-02/50-05-138				
	N-1500-N	02-02/50-05-140				
	ESH 3 - Z 2	02-02/50-05-155	13/11/2022	13/11/2019	10/05/2021	10/11/2020
	6430	02-02/50-13-014				
CPR 3	FSW43	02-02/11-15-001	02/04/2021	02/04/2020		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	18/06/2021	18/06/2020		
	18N-20	02-02/50-17-003				
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				
	BAT-EMC 3.19.1.24	02-02/68-13-001				
SER 2	ESVS 30	02-02/03-05-006	15/07/2021	15/07/2020		
	VULB 9168	02-02/24-05-005	18/12/2021	18/12/2020		
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
SER 3	FSW43	02-02/11-15-001	02/04/2021	02/04/2020		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	LNA-40-18004000-33-5P	02-02/17-20-002				
	3117	02-02/24-05-009	18/06/2021	18/06/2020		
	BBHA 9170	02-02/24-05-013	19/05/2023	19/05/2020	14/01/2021	14/01/2020
	18N-20	02-02/50-17-003				
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				
	KMS116-GL140SE-KMS116-	02-02/50-20-026				
	BAT-EMC 3.19.1.24	02-02/68-13-001				
MB	FSW43	02-02/11-21-001	08/04/2022	08/04/2021		
	3117	02-02/24-20-007	09/11/2022	09/11/2021		

Note: A4, CPR3, SER2, SER3 performed between 10/12/2020 and 26/01/2021, MB performed on 18/01/2022.

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