



RF – TEST REPORT

- FCC Part 15.407, RSS-247 -

Type / Model Name : S2

Product Description : Radio Module 802.11a/b/n/ac & BLE

Applicant : BSH Hausgeräte GmbH

Address : Carl-Wery-Straße 34

81739 München

Manufacturer : BSH Hausgeräte GmbH

Address : Carl-Wery-Straße 34

81739 München

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

POSITIVE

Test Report No. : **80086512-03 Rev_4**

24. November 2022

Date of issue



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

Contents

1	<u>TEST STANDARDS</u>	<u>3</u>
2	<u>EQUIPMENT UNDER TEST</u>	<u>4</u>
2.1	Information provided by the Client	4
2.2	Sampling	4
2.3	General remarks	4
2.4	Photo documentation of the EUT – Detailed photos see ATTACHMENT A	4
2.5	Equipment category	4
2.6	Short description of the equipment under test (EUT)	4
2.7	Variants of the EUT	4
2.8	Operation frequency and channel plan	5
2.9	Transmit operating modes	5
2.10	Antenna	6
2.11	Power supply system utilised	6
2.12	Peripheral devices and interface cables	6
2.13	Determination of worst-case conditions for final measurement	7
3	<u>TEST RESULT SUMMARY</u>	<u>8</u>
3.1	Final assessment	8
4	<u>TEST ENVIRONMENT</u>	<u>9</u>
4.1	Address of the test laboratory	9
4.2	Environmental conditions	9
4.3	Statement of the measurement uncertainty	9
4.4	Conformity Decision Rule	10
4.5	Measurement protocol for FCC and IC	10
5	<u>TEST CONDITIONS AND RESULTS</u>	<u>13</u>
5.1	Conducted emission	13
5.2	Emission Bandwidth (26 dB down)	18
5.3	Maximum conducted output power	20
5.4	Peak power spectral density	23
5.5	Undesirable emissions	26
5.6	Antenna application	51
6	<u>USED TEST EQUIPMENT AND ACCESSORIES</u>	<u>52</u>

ATTACHMENT A as separate supplement

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September 2020)

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 2020)

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 15.212	Modular transmitters

FCC Rules and Regulations Part 15, Subpart E – Unlicensed National Information Infrastructure Devices (September 2020)

Part 15, Subpart E, Section 15.407	Operation within the bands 5.15 - 5.25 GHz, 5.25 - 5.35 GHz, 5.47 - 5.725 GHz and 5.725 - 5.85 GHz
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 789033 D02 v02r01	Guidelines for compliance testing of UNII-Devices Part 15, Subpart E, December 14, 2017.

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 his/her instructions.

2.3 General remarks

This report covers the emissions of the Module "SMB" (FCC ID:2AHES-SMB / IC: 21152-SMB) in combination with the host device S2.

Performed tests:

- AC powerline conducted Emissions
- RF output power
- PSD
- Transmitter unwanted emissions, radiated

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

2.5 Equipment category

WLAN - Client

2.6 Short description of the equipment under test (EUT)

The EUT is a communication module for assembling into household devices. The firmware does not support ad-hoc modes and gives the user no possibility to choose the channel for data transmission or power setting. The EUT is compatible with IEEE 802.11b, g, a, n, ac Standard and 802.15. It supports the 2.4 GHz and 5 GHz frequency band and supports no beam forming.

Tested sample:	:	1 radiated sample
Serial number	:	80012189140000440335000000242
SW	:	BSH Embedded Linux Platform (SMM S2 core) - debug [HWTEST] 40.0.0-204-g45fedbf \n \l
WLAN Firmware version	:	1.28 RC0.0 w\0: Apr 15 2021 03:04:08 version 7.45.234 (4ca95bb CY WLTEST) FWID 01-67595eaa
Tested sample:	:	1 conducted sample
Serial number	:	80012189140000440335000000240
SW	:	BSH Embedded Linux Platform (SMM S2 core) - debug [HWTEST] 40.0.0-204-g45fedbf \n \l
WLAN Firmware version	:	1.28 RC0.0 w\0: Apr 15 2021 03:04:08 version 7.45.234 (4ca95bb CY WLTEST) FWID 01-67595eaa

2.7 Variants of the EUT

- S2-V01
- S2-V02

2.8 Operation frequency and channel plan

The operating frequency is 5150 MHz to 5350 MHz and 5470 MHz to 5850 MHz (U-NII-1, U-NII-2A, U-NII-2C, U-NII-3).

Channel plan: WLAN Standard 802.11

a / n HT20 / ac VHT20:

Channel	Frequency (MHz)
36	5180
40	5200
44	5220
48	5240
52	5260
56	5280
60	5300
64	5320
100	5500
104	5520
108	5540
112	5560
116	5580
120	5600
124	5620
128	5640
132	5660
136	5680
140	5700
144	5720
149	5745
153	5765
157	5785
161	5805
165	5825

n HT40 / ac VHT40:

Channel	Frequency (MHz)
38	5190
46	5230
54	5270
62	5310
102	5510
110	5550
118	5590
126	5630
134	5670
142	5710
151	5755
159	5795

ac VHT80:

Channel	Frequency (MHz)
42	5210
58	5290
106	5530
122	5610
138	5690
155	5775

2.9 Transmit operating modes

The module uses OFDM modulation and is capable to provide following data rates:

- 802.11a 54, 48, 36, 24, 18, 12, 9, 6 Mbps (Mbps = megabits per second)
- 802.11n HT20, MCS 0 – 7
- 802.11n HT40, MCS 0 – 7
- 802.11ac VHT20, MSC 0 - 9
- 802.11ac VHT40, MSC 0 - 9
- 802.11ac VHT80, MSC 0 – 9

2.10 Antenna

The following antenna shall be used with the EUT:

Number	Characteristic	Model number	Plug	Frequency range (GHz)	Gain (dBi)
1	Omni	PCB antenna (Ant0)	-	5	5.83
2	Omni	PCB antenna (Ant1)	-	5	6.84

2.11 Power supply system utilised

Power supply voltage, V_{nom} : 5 V_{DC}

2.12 Peripheral devices and interface cables

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

- USB to serial converter cable Model : _____
- Laptop Model : _____
- _____ -

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.

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:

Technology	Available channels	Tested channels	Modulation	Modulation type	Data rate (Mbps)
802.11n HT20	36 - 140	36, 64, 100, 140	OFDM	BPSK	MCS=0 (BW=20 MHz)
802.11n HT40	38 - 134	38, 62, 102, 134	OFDM	BPSK	MCS=0 (BW=40 MHz)
802.11ac VHT80	42 - 122	42, 58, 106, 122	OFDM	BPSK	MCS=0 (BW=80 MHz)

2.13.1 Test jig

No test jig is used.

2.13.2 Test software

The test software is controlled by a terminal program (PuTTY) and a set of commands. The test software allows to set the EUT into RX and TX continuous modulated mode, set different channel and allows free power setting.

3 TEST RESULT SUMMARY

UNII device uses the operating band 5150 MHz - 5725 MHz:

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS Gen, 8.8	AC power line conducted emissions	Passed
15.407(a)	RSS-247, 6.2.1.1	EBW, OBW 99 %	Not tested ¹
15.407(a)	RSS-247, 6.2.1.1	Output power	Passed
15.407(a)	RSS-247, 6.2.1.1	PSD	Passed
15.407(b)	RSS-247, 6.2.1.2	Undesirable emissions	Passed
15.205(a)	RSS-Gen, 8.10	Emissions in restricted bands	Passed
15.407(g)	RSS-Gen, 6.11	Transmitter frequency stability	Not tested ¹
15.407(h)(1)	RSS-247, 6.2.1.1	TPC	Not tested ¹
15.407(a)	-	Antenna requirement	Passed

¹ Not tested because used module is already compliant.

The mentioned RSS Rule Parts in the above table are related to:

RSS-Gen, Issue 5 + Amendment 1, March 2019

RSS-247, Issue 2, February 2017

3.1 Final assessment

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

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

Testing commenced on : 19 August 2021

Testing concluded on : 24 September 2021

Checked by:



Klaus Gegenfurtner
2022.11.25 07:56:43
+01'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:



Lukas Scheuermann
2022.11.24 17:11:56
+01'00'

Lukas Scheuermann
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: 15 - 35 °C

Humidity: 30 - 60 %

Atmospheric pressure: 86 - 106 kPa

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

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 IC

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".

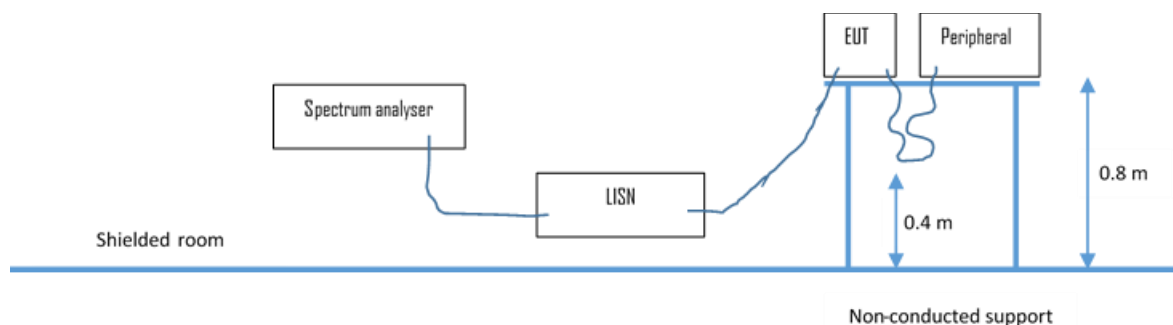
4.5.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.5.3 Details of test procedures

4.5.3.1 Conducted emission

Test setup according ANSI C63.10



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

To convert between dB μ V and μ V, the following conversions apply:

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

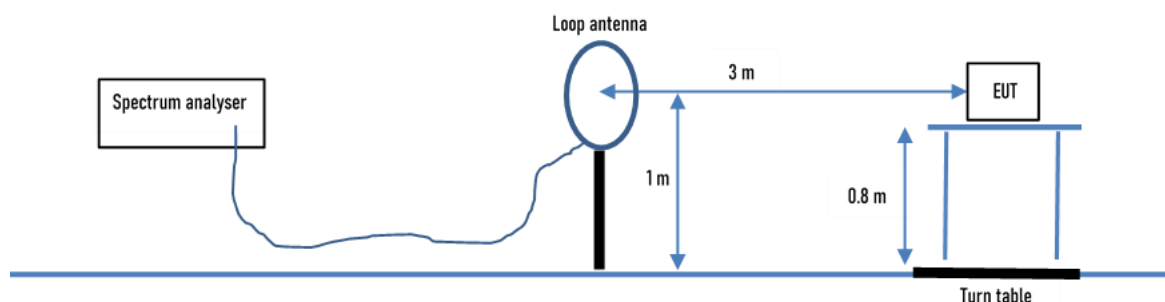
$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

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 μ H (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.

4.5.3.2 Radiated emission

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

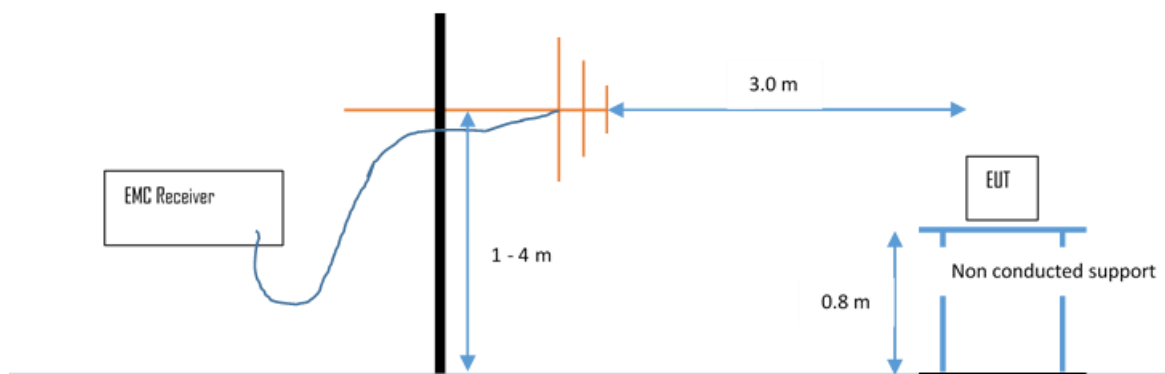
Test setup according ANSI C63.10



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:

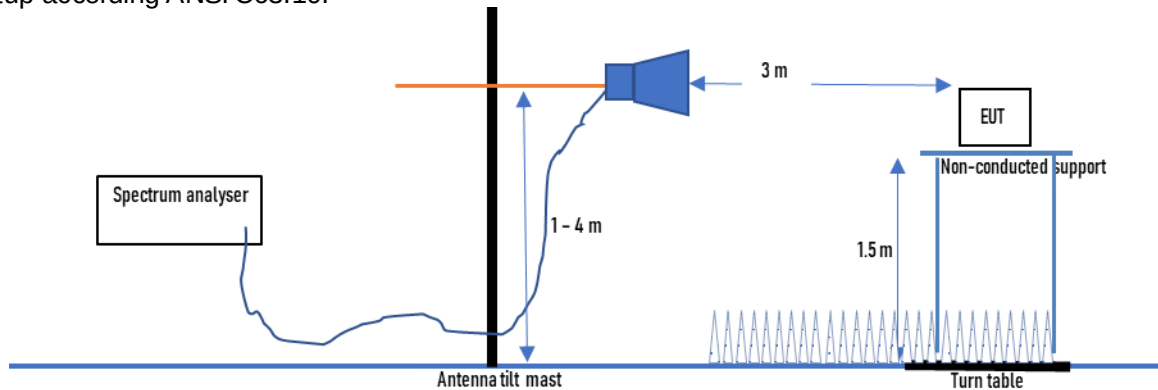
30 MHz – 1000 MHz: RBW: 120 kHz

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

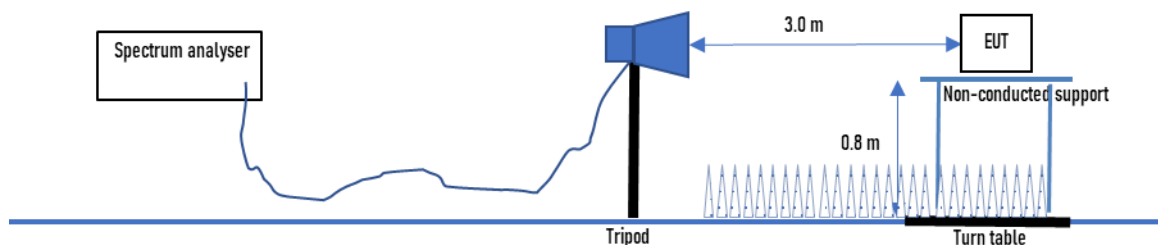
4.5.3.2.3 Anechoic chamber 1 (1000 MHz – 18000 MHz)

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 centre, 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 are adopted.

5 TEST CONDITIONS AND RESULTS

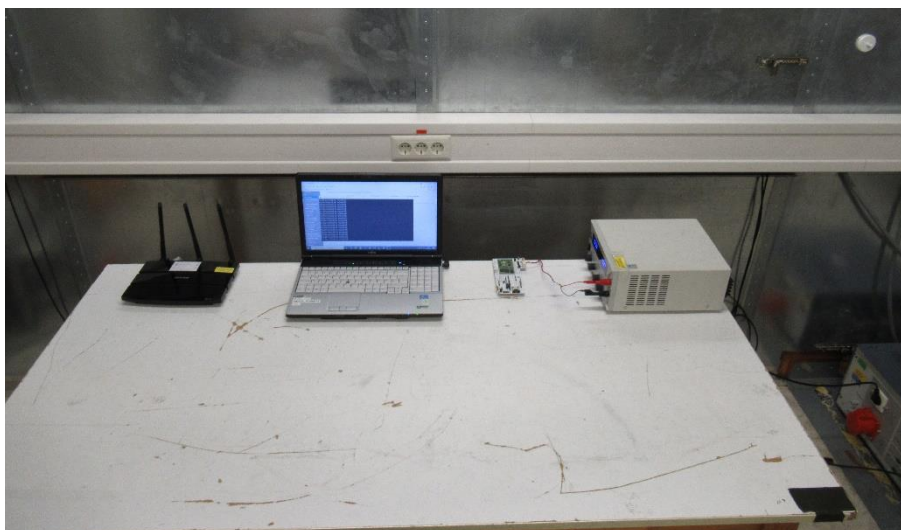
5.1 Conducted emission

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 15C, 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 in the following table.

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

5.1.4 Description of Measurement

The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a line impedance stabilization network (LISN) with 50Ω/50 μH (CISPR 16) characteristics. 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 emissions are re-measured using a tuned receiver with quasi-peak and average detection and recorded.

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

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

$$\mu\text{V} = 10^{(\text{dB}\mu\text{V}/20)}$$

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

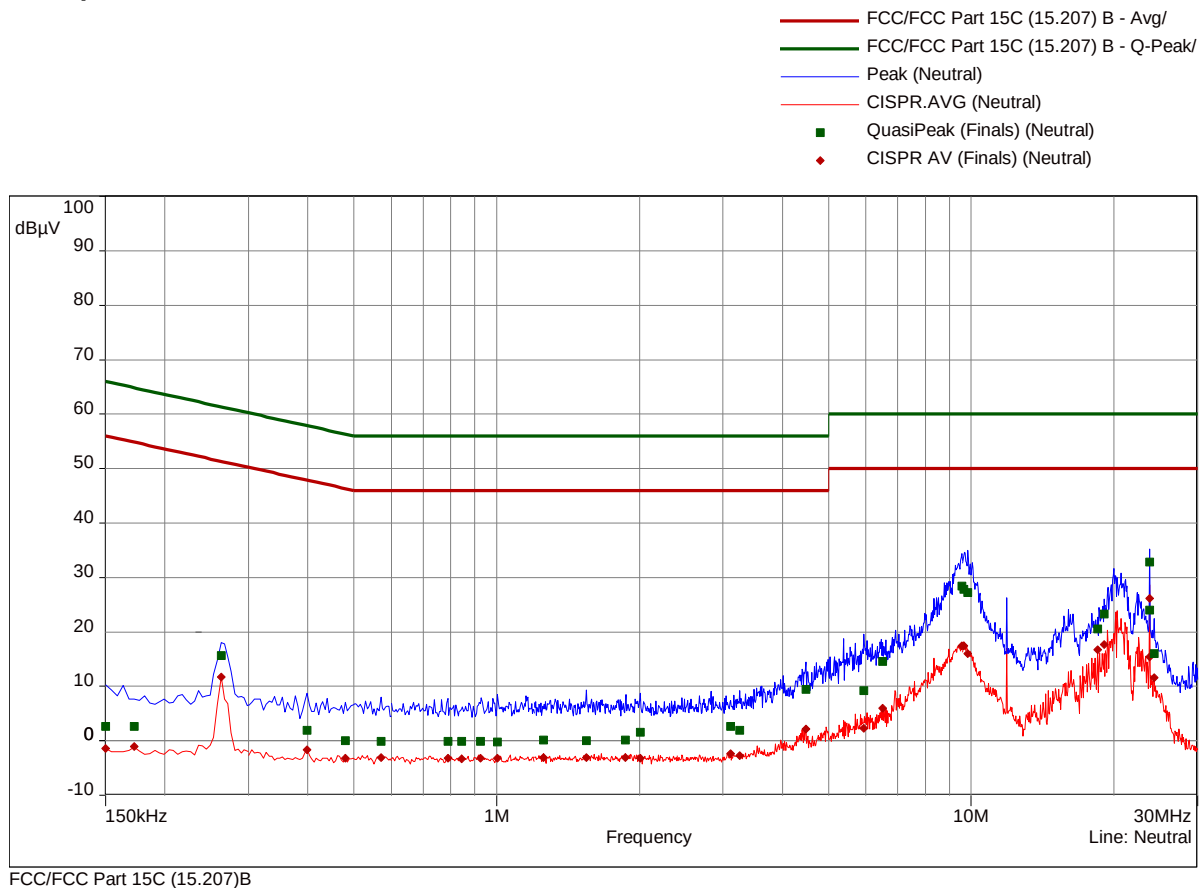
Min. limit margin -23.39 dB at 23.7675 MHz

The requirements are **FULFILLED**.

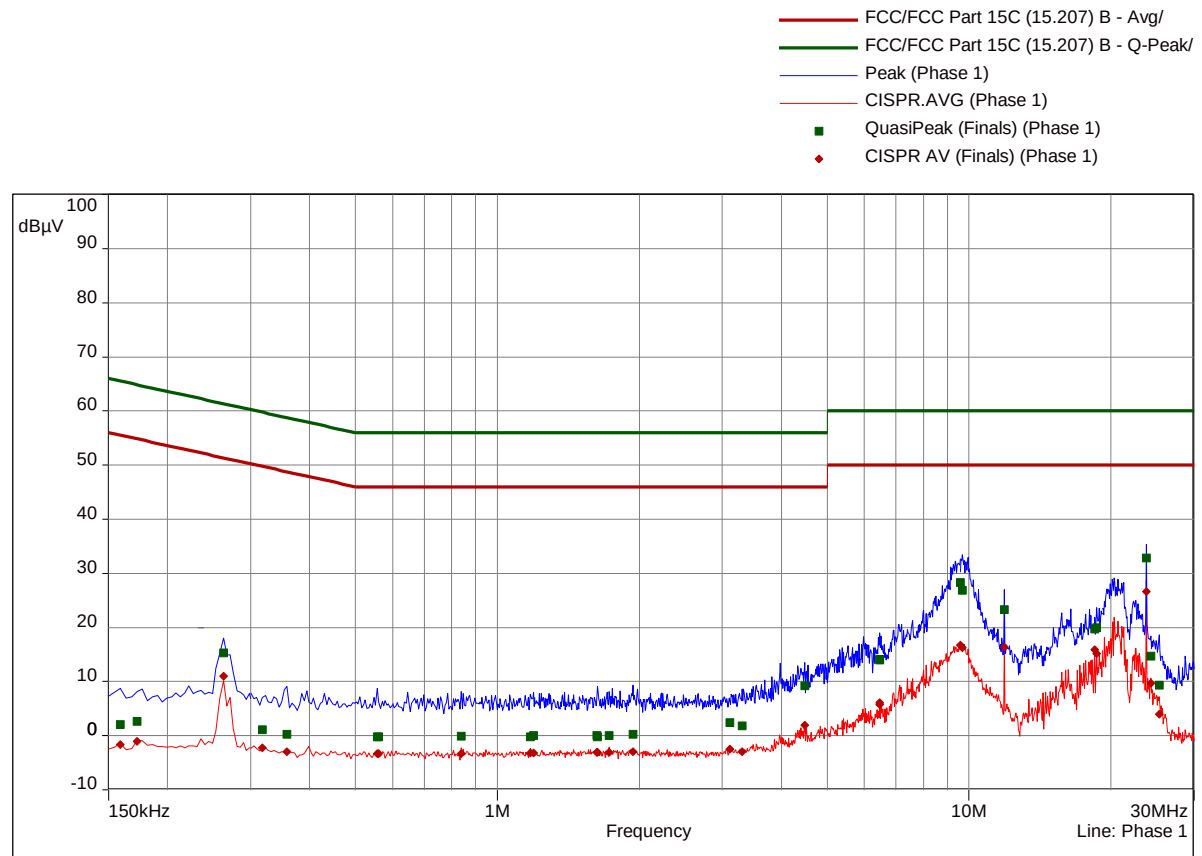
Remarks: For detailed test result please see following test protocols.

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.

5.1.6 Test protocol



FCC/FCC Part 15C (15.207)B



FCC/FCC Part 15C (15.207)B

freq	SR	QP	margin	limit	AV	margin	limit	line	RBW	Measure time	corr
MHz		dBμV	dB	dBμV	dBμV	dB	dBμV		Hz	sec	dB
0.159	1	2.02	-63.49	65.52	-1.69	-57.20	55.52	Phase 1	9k	1.00	10.10
0.1725	1	2.65	-62.19	64.84	-1.09	-55.93	54.84	Phase 1	9k	1.00	10.10
0.2625	1	15.25	-46.10	61.35	11.01	-40.34	51.35	Phase 1	9k	1.00	10.13
0.318	2	1.14	-58.62	59.76	-2.20	-51.96	49.76	Phase 1	9k	1.00	10.14
0.3585	2	0.32	-58.45	58.76	-2.97	-51.74	48.76	Phase 1	9k	1.00	10.15
0.5565	2	-0.19	-56.19	56.00	-3.25	-49.25	46.00	Phase 1	9k	1.00	10.16
0.561	2	-0.19	-56.19	56.00	-3.27	-49.27	46.00	Phase 1	9k	1.00	10.16
0.8385	3	-0.09	-56.09	56.00	-3.29	-49.29	46.00	Phase 1	9k	1.00	10.19
1.176	3	-0.21	-56.21	56.00	-3.23	-49.23	46.00	Phase 1	9k	1.00	10.23
1.194	3	0.02	-55.98	56.00	-3.17	-49.17	46.00	Phase 1	9k	1.00	10.23
1.6275	4	-0.01	-56.01	56.00	-3.03	-49.03	46.00	Phase 1	9k	1.00	10.27
1.632	4	-0.16	-56.16	56.00	-3.10	-49.10	46.00	Phase 1	9k	1.00	10.27
1.7265	4	0.07	-55.93	56.00	-3.10	-49.10	46.00	Phase 1	9k	1.00	10.27
1.938	4	0.21	-55.79	56.00	-3.01	-49.01	46.00	Phase 1	9k	1.00	10.27
3.111	5	2.46	-53.54	56.00	-2.48	-48.48	46.00	Phase 1	9k	1.00	10.35
3.3045	5	1.82	-54.18	56.00	-2.93	-48.93	46.00	Phase 1	9k	1.00	10.35
4.479	5	9.22	-46.78	56.00	1.94	-44.06	46.00	Phase 1	9k	1.00	10.42
6.4605	6	14.15	-45.85	60.00	6.12	-43.88	50.00	Phase 1	9k	1.00	10.56
6.465	6	13.95	-46.05	60.00	5.78	-44.22	50.00	Phase 1	9k	1.00	10.56
9.5745	6	28.35	-31.65	60.00	16.79	-33.21	50.00	Phase 1	9k	1.00	10.72
9.6675	7	26.83	-33.17	60.00	16.31	-33.69	50.00	Phase 1	9k	1.00	10.72
11.8815	7	23.35	-36.65	60.00	16.43	-33.57	50.00	Phase 1	9k	1.00	10.92
18.4425	7	19.73	-40.27	60.00	15.88	-34.12	50.00	Phase 1	9k	1.00	11.39
18.6315	7	19.93	-40.07	60.00	15.23	-34.77	50.00	Phase 1	9k	1.00	11.40
23.7675	8	32.85	-27.15	60.00	26.61	-23.39	50.00	Phase 1	9k	1.00	11.63
24.276	8	14.72	-45.28	60.00	9.71	-40.29	50.00	Phase 1	9k	1.00	11.65
25.302	8	9.36	-50.64	60.00	4.02	-45.98	50.00	Phase 1	9k	1.00	11.68

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.

freq	SR	QP	margin	limit	AV	margin	limit	line	RBW	Measure time	corr
MHz		dBμV	dB	dBμV	dBμV	dB	dBμV		Hz	sec	dB
0.15	9	2.65	-63.35	66.00	-1.37	-57.37	56.00	Neutral	9k	1.00	10.09
0.1725	9	2.66	-62.18	64.84	-1.10	-55.94	54.84	Neutral	9k	1.00	10.11
0.2625	9	15.65	-45.70	61.35	11.69	-39.66	51.35	Neutral	9k	1.00	10.13
0.399	10	1.90	-55.97	57.87	-1.67	-49.54	47.87	Neutral	9k	1.00	10.15
0.48	10	0.03	-56.31	56.34	-3.16	-49.50	46.34	Neutral	9k	1.00	10.16
0.57	10	-0.04	-56.04	56.00	-3.08	-49.08	46.00	Neutral	9k	1.00	10.17
0.789	11	-0.09	-56.09	56.00	-3.24	-49.24	46.00	Neutral	9k	1.00	10.19
0.843	11	-0.09	-56.09	56.00	-3.31	-49.31	46.00	Neutral	9k	1.00	10.19
0.924	11	-0.08	-56.08	56.00	-3.20	-49.20	46.00	Neutral	9k	1.00	10.20
1.005	11	-0.15	-56.15	56.00	-3.15	-49.15	46.00	Neutral	9k	1.00	10.20
1.254	12	0.11	-55.89	56.00	-3.07	-49.07	46.00	Neutral	9k	1.00	10.24
1.5465	12	-0.01	-56.01	56.00	-3.05	-49.05	46.00	Neutral	9k	1.00	10.27
1.866	12	0.14	-55.86	56.00	-3.09	-49.09	46.00	Neutral	9k	1.00	10.27
2.0055	12	1.60	-54.40	56.00	-3.18	-49.18	46.00	Neutral	9k	1.00	10.27
3.111	13	2.67	-53.33	56.00	-2.35	-48.35	46.00	Neutral	9k	1.00	10.35
3.2505	13	1.99	-54.01	56.00	-2.77	-48.77	46.00	Neutral	9k	1.00	10.35
4.479	13	9.41	-46.59	56.00	2.18	-43.82	46.00	Neutral	9k	1.00	10.41
5.9385	14	9.25	-50.75	60.00	2.26	-47.74	50.00	Neutral	9k	1.00	10.50
6.501	14	14.58	-45.42	60.00	6.05	-43.95	50.00	Neutral	9k	1.00	10.54
9.57	14	28.45	-31.55	60.00	17.50	-32.50	50.00	Neutral	9k	1.00	10.66
9.6585	15	27.81	-32.19	60.00	17.50	-32.50	50.00	Neutral	9k	1.00	10.66
9.825	15	27.24	-32.76	60.00	16.04	-33.96	50.00	Neutral	9k	1.00	10.66
18.4425	15	20.52	-39.48	60.00	16.70	-33.30	50.00	Neutral	9k	1.00	11.19
19.0545	15	23.27	-36.73	60.00	17.63	-32.37	50.00	Neutral	9k	1.00	11.22
23.7585	16	23.99	-36.01	60.00	15.46	-34.54	50.00	Neutral	9k	1.00	11.26
23.763	16	32.78	-27.22	60.00	26.13	-23.87	50.00	Neutral	9k	1.00	11.26
24.276	16	16.07	-43.93	60.00	11.62	-38.38	50.00	Neutral	9k	1.00	11.26

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.

5.2 Emission Bandwidth (26 dB down)

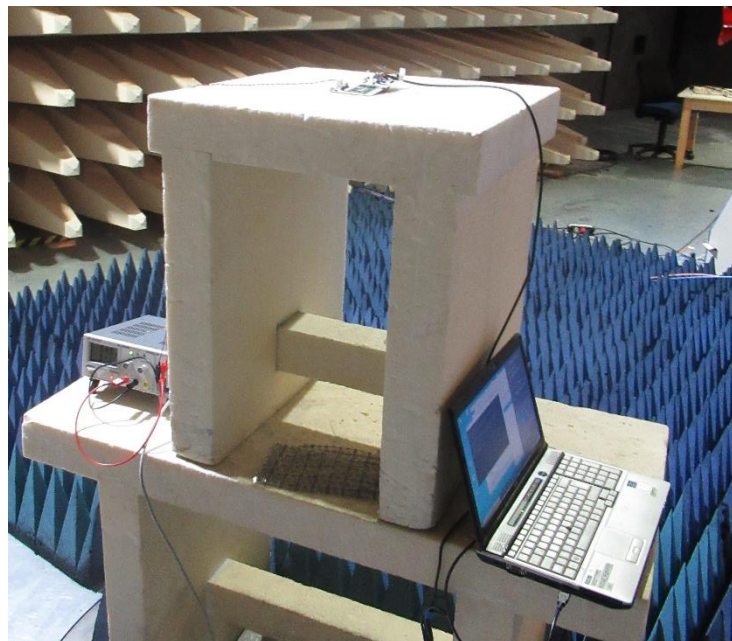
For test instruments and accessories used see section 6 Part **CPR 3**.

5.2.1 Description of the test location

Test location: Anechoic chamber 1

5.2.2 Photo documentation of the test set-up

Test setup radiated measurement:



5.2.3 Description of Measurement

The 26 dB down bandwidth is measured radiated using a spectrum analyser and following the procedures according the KDB 789033, item C. The spectrum analyser function "n-dB-down" is used to determine the bandwidth.

5.2.4 Test result

EBW measurement and power limit calculation:

802.11n, HT20, MCS0		
Channel	Frequency	EBW
	MHz	MHz
CH36	5180	21.10
CH64	5320	23.94
CH100	5500	21.06
CH140	5700	22.94
CH144	5720	29.33
CH149	5745	21.30
CH165	5825	22.70

802.11n, HT40, MCS0		
Channel	Frequency	EBW
	MHz	MHz
CH38	5190	40.52
CH62	5310	40.28
CH102	5510	40.76
CH134	5670	60.34
CH142	5710	53.23
CH151	5755	38.76
CH159	5795	69.13

802.11ac, VHT80, MCS0		
Channel	Frequency	EBW
	MHz	MHz
CH42	5210	80.88
CH58	5290	81.68
CH106	5530	81.36
CH122	5610	134.27
CH138	5690	87.46
CH155	5775	78.80

The requirements are **FULFILLED**.

Remarks: None.

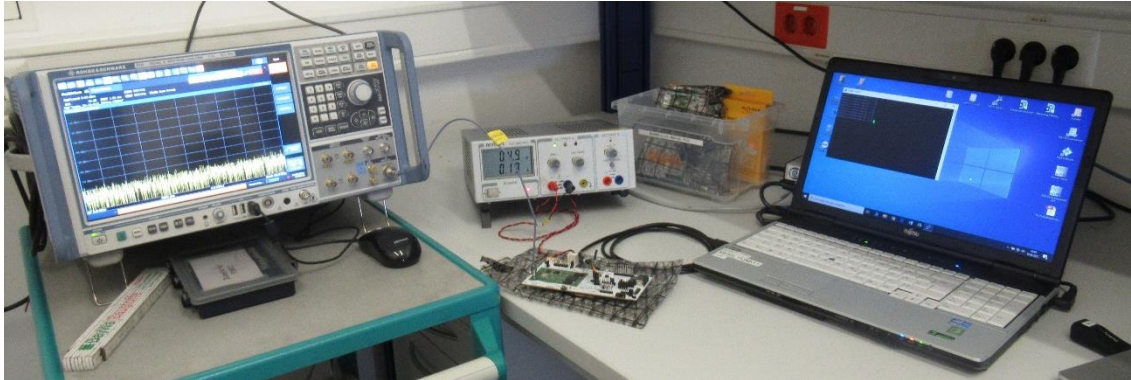
5.3 Maximum conducted output power

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

5.3.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.3.2 Photo documentation of the test set-up



5.3.3 Applicable standard

According to FCC Part 15E, Section 15.407(a):

The maximum conducted output power over the frequency band of operation shall not exceed the effective values. If transmitting antennas of directional gain are greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.3.4 Description of Measurement

The output power is measured radiated using a spectrum analyser. The EUT has a constant duty cycle and is smaller than 98% due to hardware limitations. Therefore, the procedure according the KDB 789033; item E 2e) Method SA-2 Alternative is used. The EUT is set in TX continuous mode with a maximum duty cycle. The output power is integrated across the channel bandwidth and a power offset according to duty cycle is applied.

Spectrum analyser settings:

RBW: 1 MHz, VBW: 3 MHz, Sweep time: auto, Detector: RMS, Trace: Average;

5.3.5 Test result

UNII-1; FCC §15.407 (a)(1)(iv)					
Modulation	Channel	Frequency	Measured Conducted TX Power	Conducted Tx-Power Limit	Margin
		MHz	dBm	dBm	dB
n HT20, MCS7	CH36	5180	5.5	24.0	-18.5
n HT40, MCS7	CH38	5190	4.5	24.0	-19.5
ac VHT80, MCS7	CH42	5210	5.3	24.0	-18.7

UNII-2A; FCC §15.407 (a)(2)					
Modulation	Channel	Frequency	Measured Conducted TX Power	Conducted Tx-Power Limit	Margin
		MHz			
n HT20, MCS7	CH64	5320	9.4	24.0	-14.6
n HT40, MCS7	CH62	5310	7.8	24.0	-16.2
ac VHT80, MCS7	CH58	5290	7.7	24.0	-16.3

UNII-2C; FCC §15.407 (a)(2)					
Modulation	Channel	Frequency	Measured Conducted TX Power	Conducted Tx-Power Limit	Margin
		MHz			
n HT20, MCS7	CH100	5500	9.5	24.0	-14.5
	CH140	5700	9.7	24.0	-14.3
	CH144	5720	9.7	24.0	-14.3
n HT40, MCS7	CH102	5510	8.3	24.0	-15.7
	CH134	5670	8.3	24.0	-15.7
	CH142	5710	8.4	24.0	-15.6
ac VHT80, MCS7	CH106	5530	8.6	24.0	-15.4
	CH122	5610	8.4	24.0	-15.6
	CH138	5690	8.5	24.0	-15.5

UNII-3; FCC §15.407 (a)(3)(i) RSS-247 6.2.4.1					
Modulation	Channel	Frequency	Measured Conducted TX Power	Conducted Tx-Power Limit	Margin
		MHz	dBm	dBm	dB
n HT20, MCS7	CH149	5745	10.3	30.0	-19.7
	CH165	5825	10.2	30.0	-19.8
n HT40, MCS7	CH151	5755	8.5	30.0	-21.5
	CH159	5795	8.5	30.0	-21.5
ac VHT80, MCS7	CH155	5775	8.7	30.0	-21.4

Peak power limit according to FCC Part 15E, Section 15.407(a), Client Device:

Frequency (MHz)	Conducted Peak Power Limit	Radiated Power Limit
	(dBm)	(dBm)
5150-5250	24 dBm	30
5250-5350	24 dBm OR 11 dBm + 10 log(EBW)	30
5470-5725	24 dBm OR 11 dBm + 10 log(EBW)	30
5725-5850	30 dBm	36

Note: The lower limit applies.

The requirements are **FULFILLED**.

Remarks: None.

5.4 Peak power spectral density

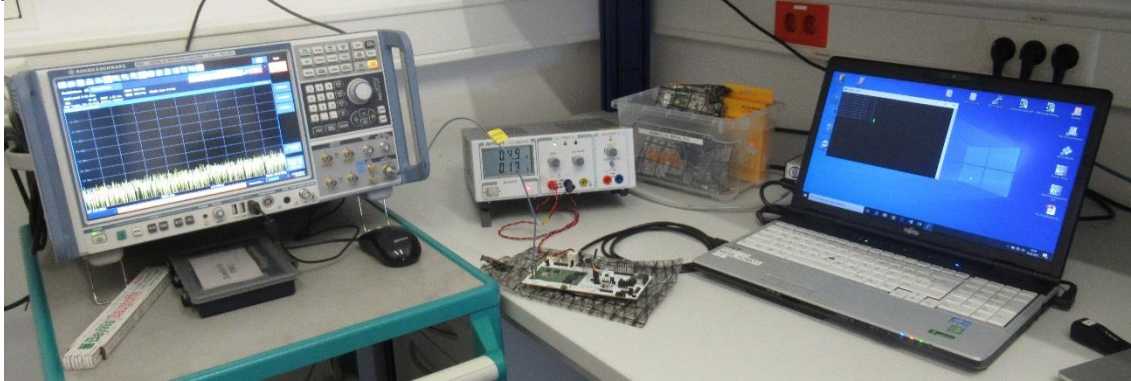
For test instruments and accessories used see section 6 Part **CPR 3**.

5.4.1 Description of the test location

Test location: Anechoic chamber 1
Test distance: 3 m

5.4.2 Photo documentation of the test set-up

Test setup radiated measurement:



5.4.3 Applicable standard

According to FCC Part 15E, Section 15.407(a):

For the defined operating bands the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than the appropriate limit in any 1 MHz band during any time interval of continuous transmission.

5.4.4 Description of Measurement

The output power is measured radiated using a spectrum analyser. The EUT has a constant duty cycle and is smaller than 98% due to hardware limitations. Therefore, the procedure according the KDB 789033; item E 2e) Method SA-2 Alternative is used. The EUT is set in TX continuous mode with a maximum duty cycle. The output power is integrated across the channel bandwidth and a power offset according to duty cycle is applied. The marker function "Marker to Peak" is used to set at peak power spectral density.

Spectrum analyser settings:

Channel power measurement function, TX channel bandwidth equal to OBW;

RBW: 1 MHz, VBW: 3 MHz, Sweep time: auto, Detector: RMS, Trace: Average;

5.4.5 Test result

Conducted Measurement				
802.11n, HT20, MCS0				
Channel	Frequency	Measured Conducted PSD	Conducted PSD Limit	Margin
	MHz	dBm	dBm	dB
CH36	5180	2.0	11	-9.1
CH64	5320	2.7	11	-8.3
CH100	5500	2.5	11	-8.5
CH140	5700	2.6	11	-8.4
CH144	5720	2.6	11	-8.4
CH149	5745	3.7	30	-26.3
CH165	5825	5.8	30	-24.2

Conducted Measurement				
802.11n, HT40, MCS0				
Channel	Frequency	Measured Conducted PSD	Conducted PSD Limit	Margin
	MHz	dBm	dBm	dB
CH38	5190	-1.7	11	-12.7
CH62	5310	-4.1	11	-15.1
CH102	5510	-0.9	11	-11.9
CH134	5670	-0.1	11	-11.1
CH142	5710	-0.5	11	-11.5
CH151	5755	-0.7	30	-30.7
CH159	5795	4.6	30	-25.4

Conducted Measurement				
802.11ac, VHT80, MCS0				
Channel	Frequency	Measured Conducted PSD	Conducted PSD Limit	Margin
	MHz	dBm	dBm	dB
CH42	5210	-4.7	11	-15.7
CH58	5290	-6.3	11	-17.3
CH106	5530	-1.9	11	-12.9
CH122	5610	-2.0	11	-13.0
CH138	5690	-2.0	11	-13.0
CH155	5775	-2.9	30	-32.9

Peak power spectral density limit according to FCC Part 15E, Section 15.407(a):

Frequency (MHz)	Conducted PSD limit (dBm/MHz)
5150-5250	11 dBm
5250-5350	11 dBm
5470-5725	11 dBm
5725-5850	30 dBm

The requirements are **FULFILLED**.

Remarks: None.

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.

5.5 Undesirable emissions

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

5.5.1 Description of the test location

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

5.5.2 Photo documentation of the test set-up

Open area test site

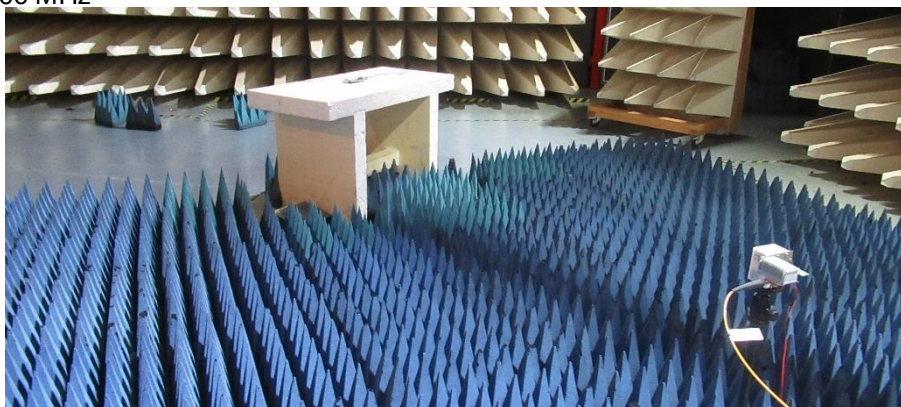


Anechoic chamber

Test Setup 1000 MHz < f < 18000 MHz



Test Setup f > 18000 MHz



5.5.3 Applicable standard

According to FCC Part 15E, Section 15.407(b):

For transmitters operating in the defined bands shall not exceed the appropriate emission limit outside of the operating bands.

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) (see Section 15.205(c)).

5.5.4 Description of Measurement

Undesirable emissions are measured using a spectrum analyser and following the procedures according to the KDB 789033, item G. If the emission level of the EUT in peak mode complies with the average limit then testing will be stopped and peak values of the EUT will be reported, otherwise, the emission will be measured in average mode again and reported. Up from 8 GHz a HP filter is used.

Spectrum analyser settings values:

30 MHz – 1000 MHz: RBW: 120 kHz

1000 MHz – 40 GHz: RBW: 1 MHz, VBW: 3 MHz, Sweep: Auto, Detector function: Max Peak

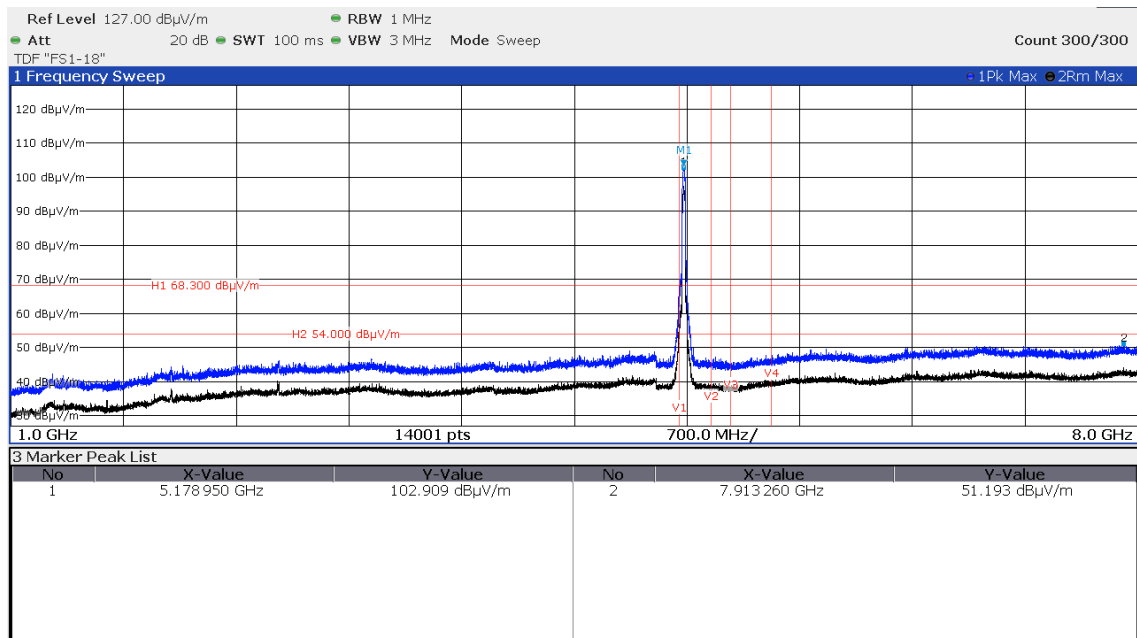
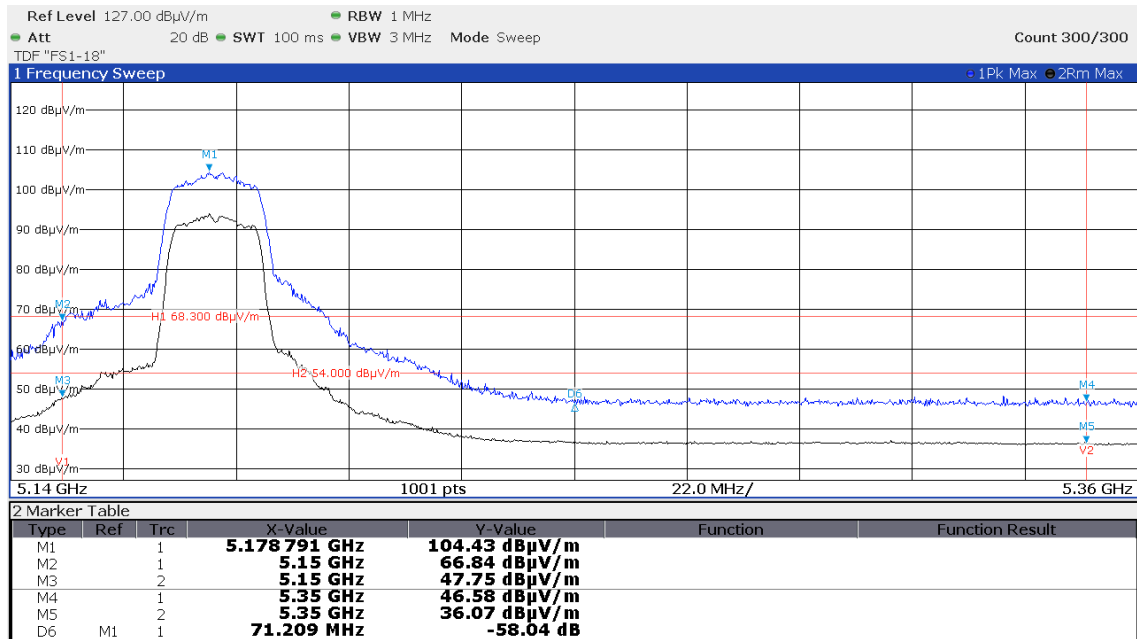
5.5.5 Test result

5.5.5.1 Emissions f < 1000 MHz:

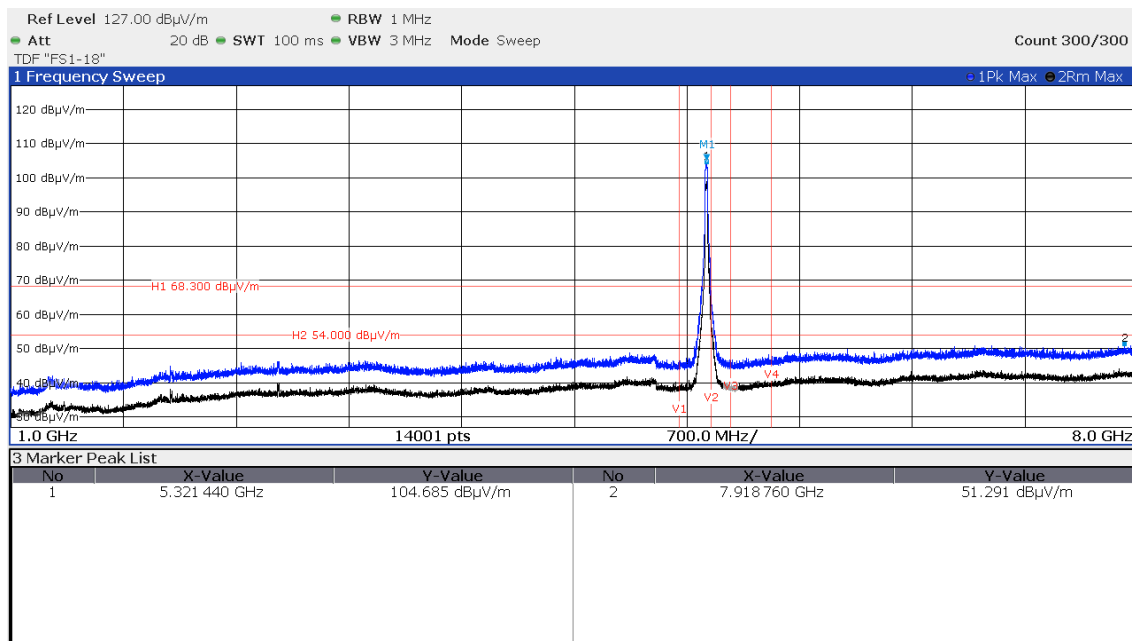
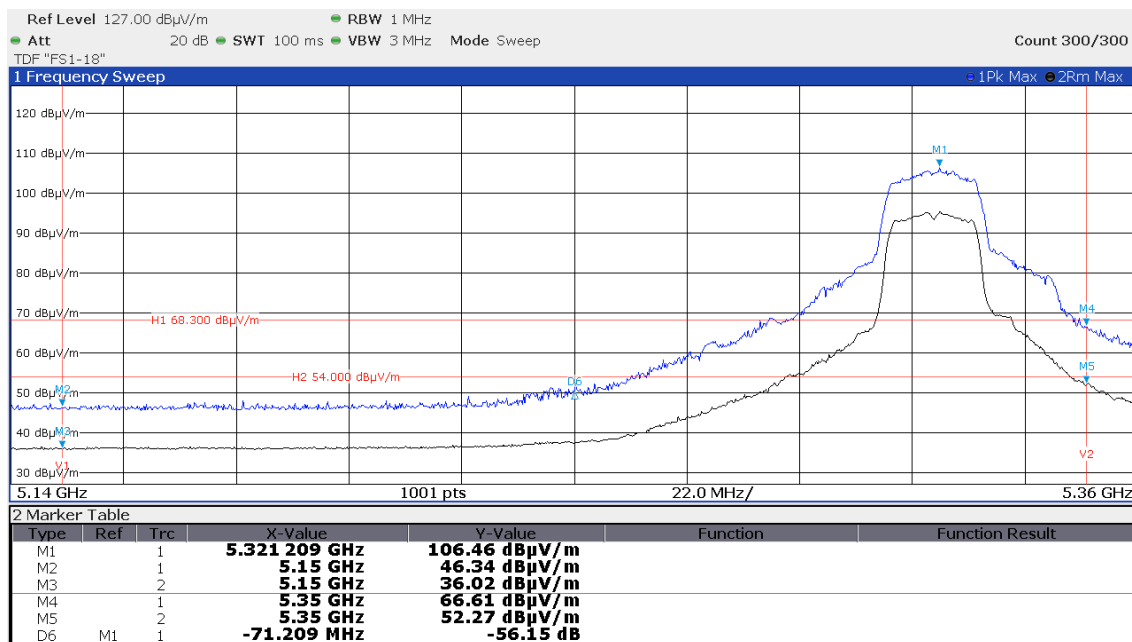
Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
43.00	12.4	4.0	17.6	18.3	30.0	22.3	40.0	-10.0
48.00	20.8	14.4	17.8	18.6	38.6	33.0	40.0	-1.4
71.00	8.5	3.9	15.6	16.1	24.1	20.0	40.0	-15.9
120.00	7.8	8.1	17.4	16.9	25.2	25.0	43.5	-18.3
143.00	2.3	-0.9	19.3	18.4	21.6	17.5	43.5	-21.9
191.00	1.1	4.2	17.5	16.9	18.6	21.1	43.5	-22.4
214.00	5.4	7.0	17.4	17.0	22.8	24.0	43.5	-19.5
235.00	2.8	6.0	18.2	18.0	21.0	24.0	46.0	-22.0
287.00	3.6	3.2	19.8	20.2	23.4	23.4	46.0	-22.6
335.00	4.4	2.3	21.3	21.7	25.7	24.0	46.0	-20.3
362.00	0.6	-0.1	22.1	22.4	22.7	22.3	46.0	-23.3
660.00	-2.5	-2.1	29.1	29.6	26.6	27.5	46.0	-18.5
830.00	-1.1	-1.0	31.9	32.2	30.8	31.2	46.0	-14.8

5.5.5.2 Emission 1 GHz – 8 GHz

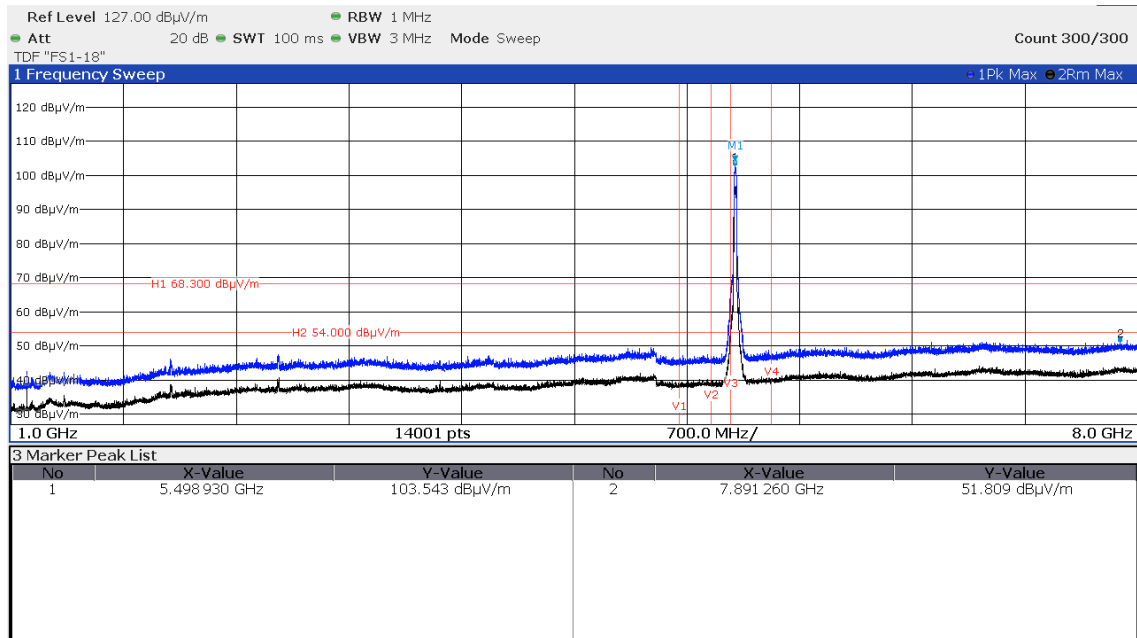
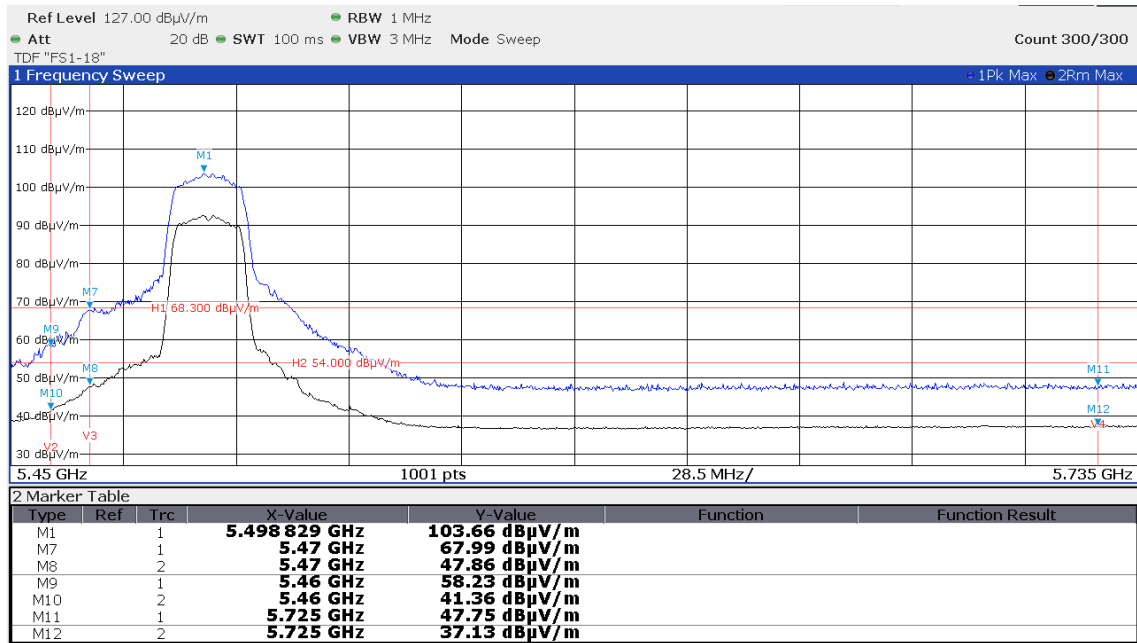
5.5.5.2.1 WLAN Standard 802.11n HT20 - MCS-0 CH36



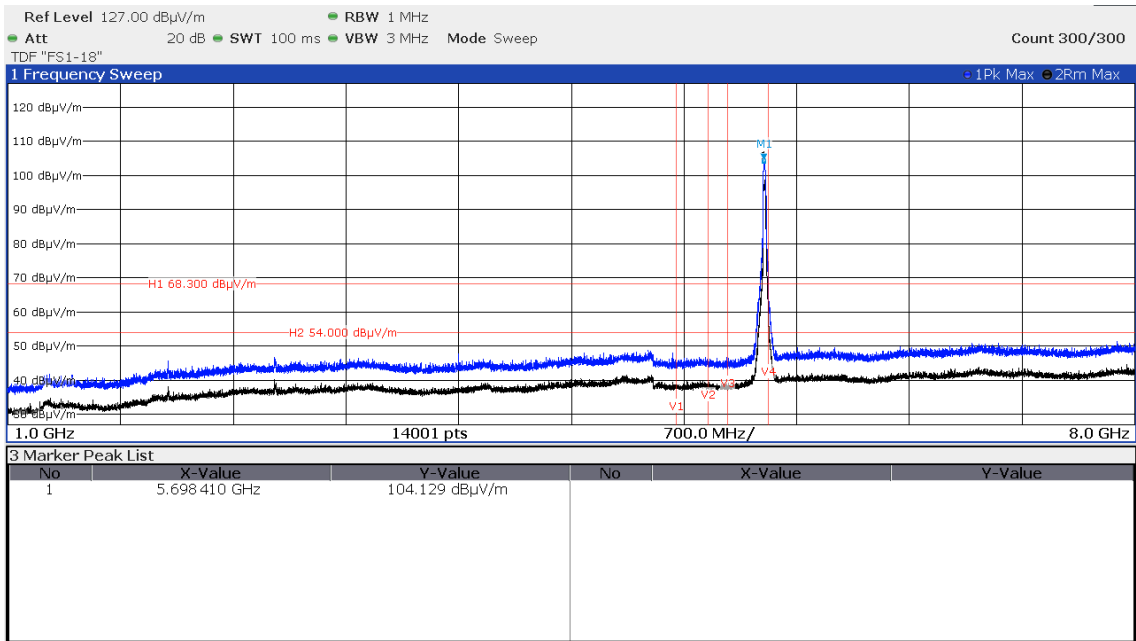
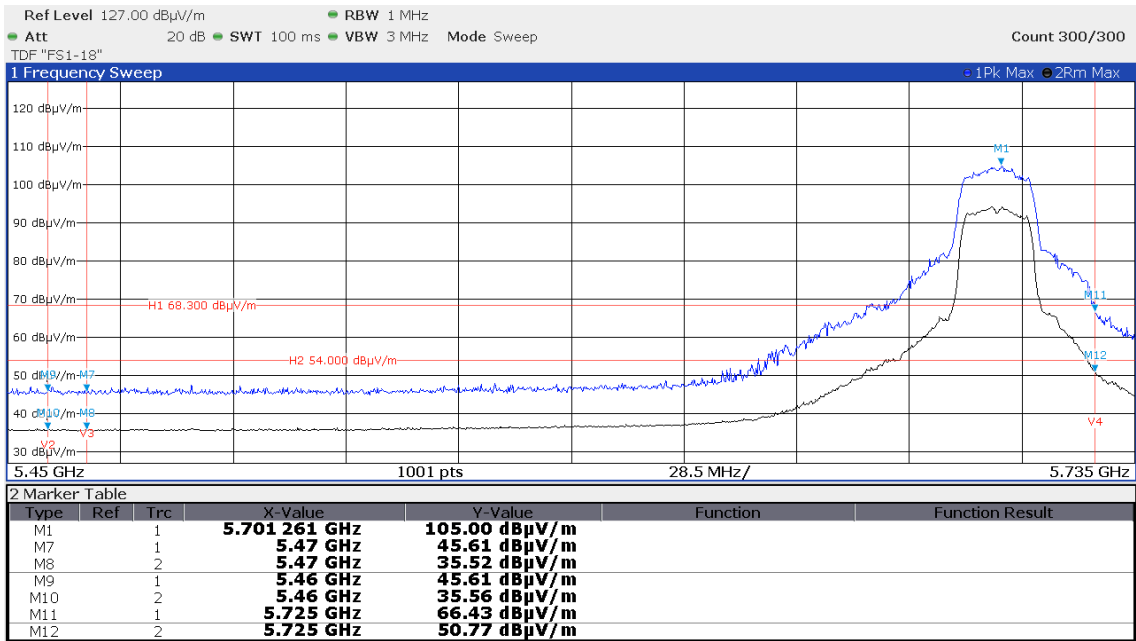
CH64



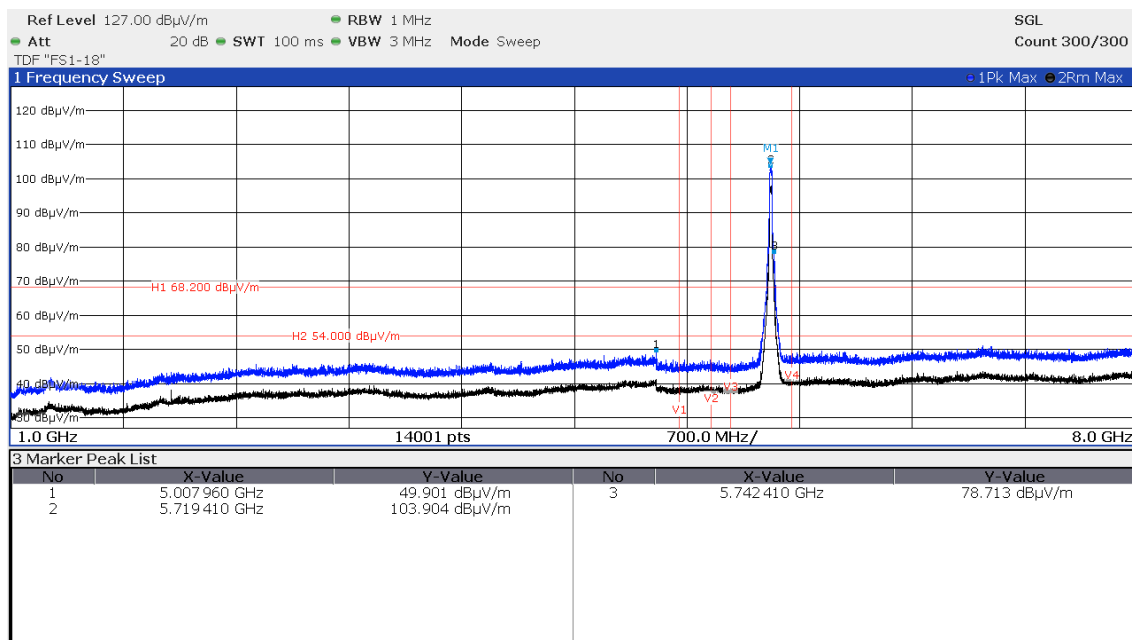
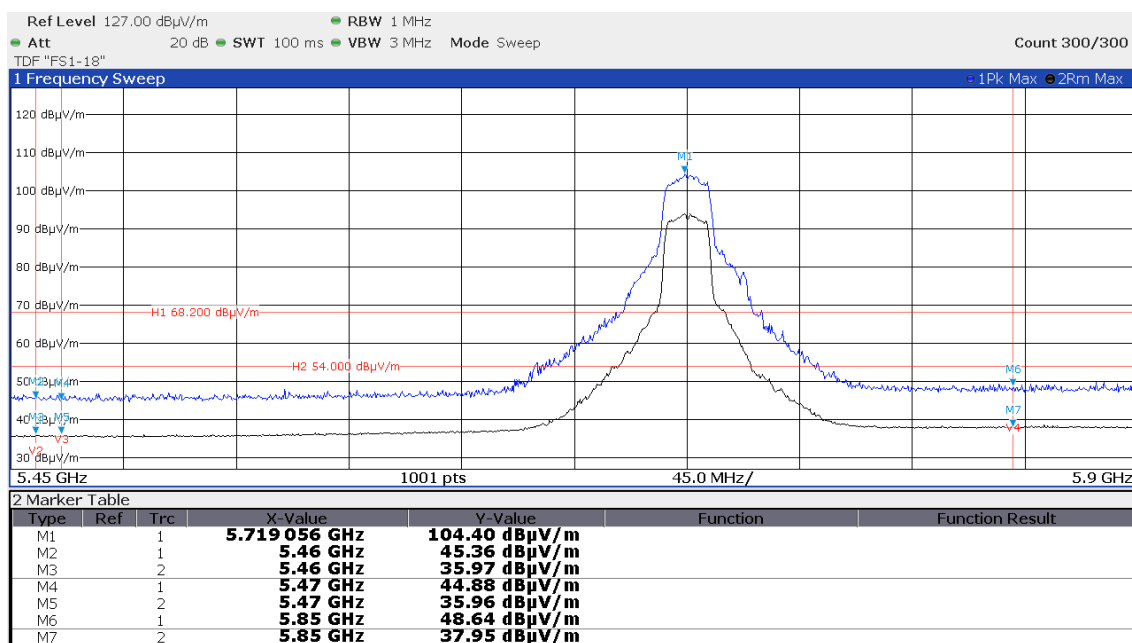
CH100



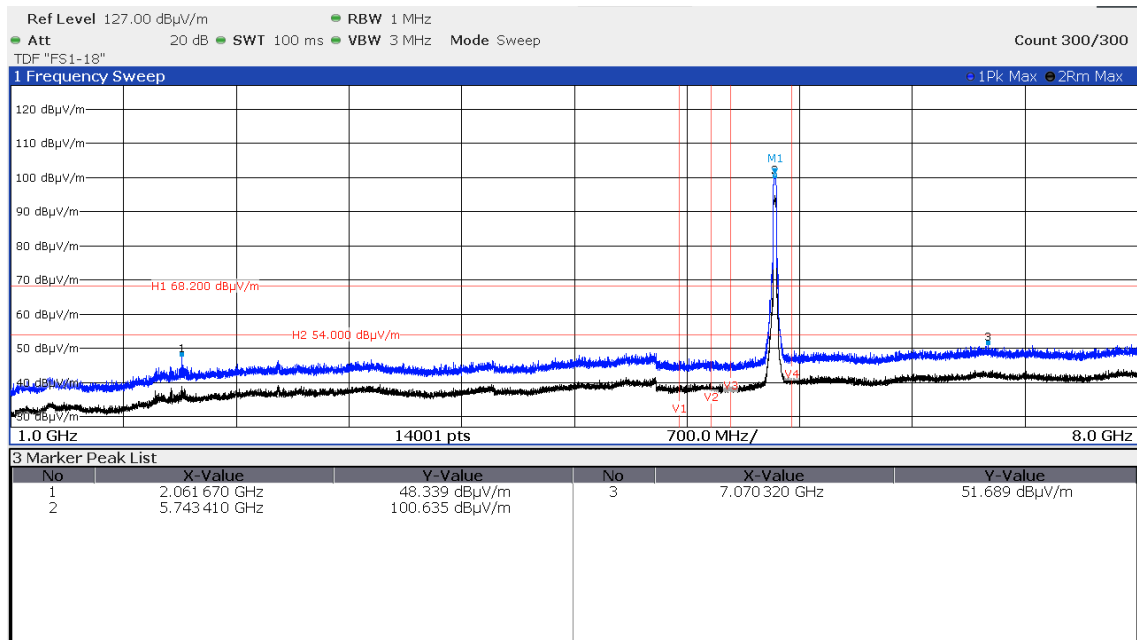
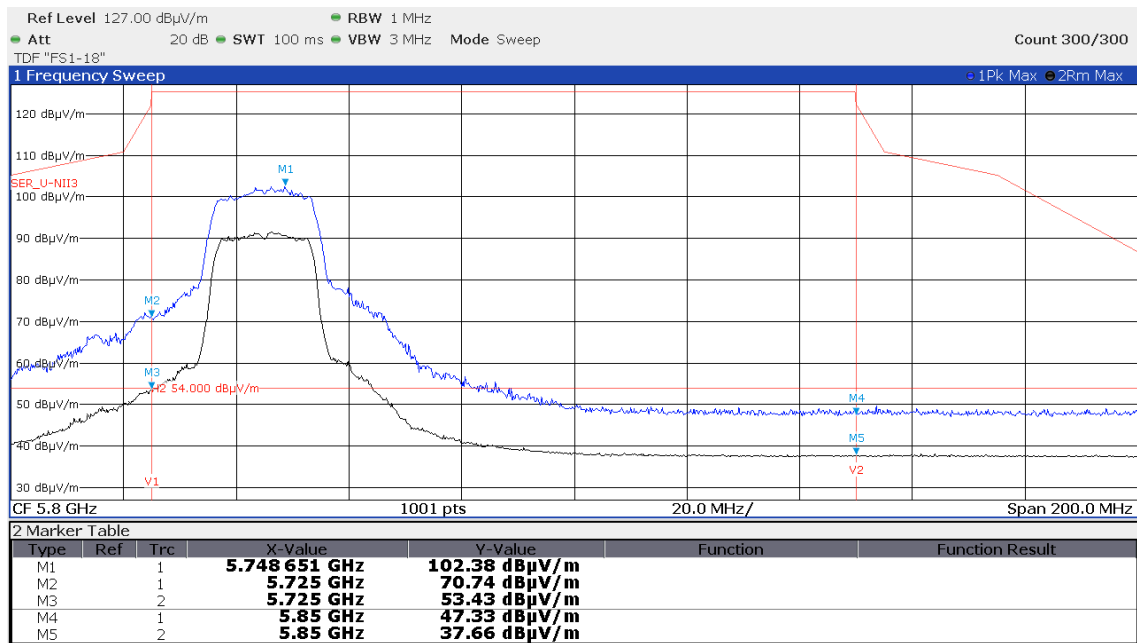
CH140



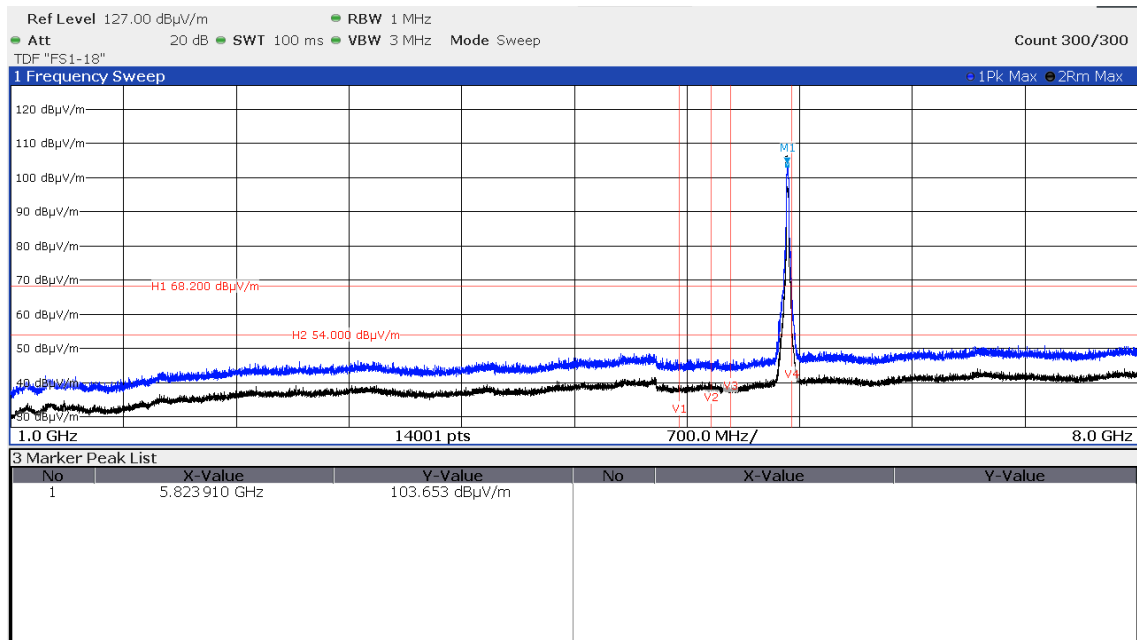
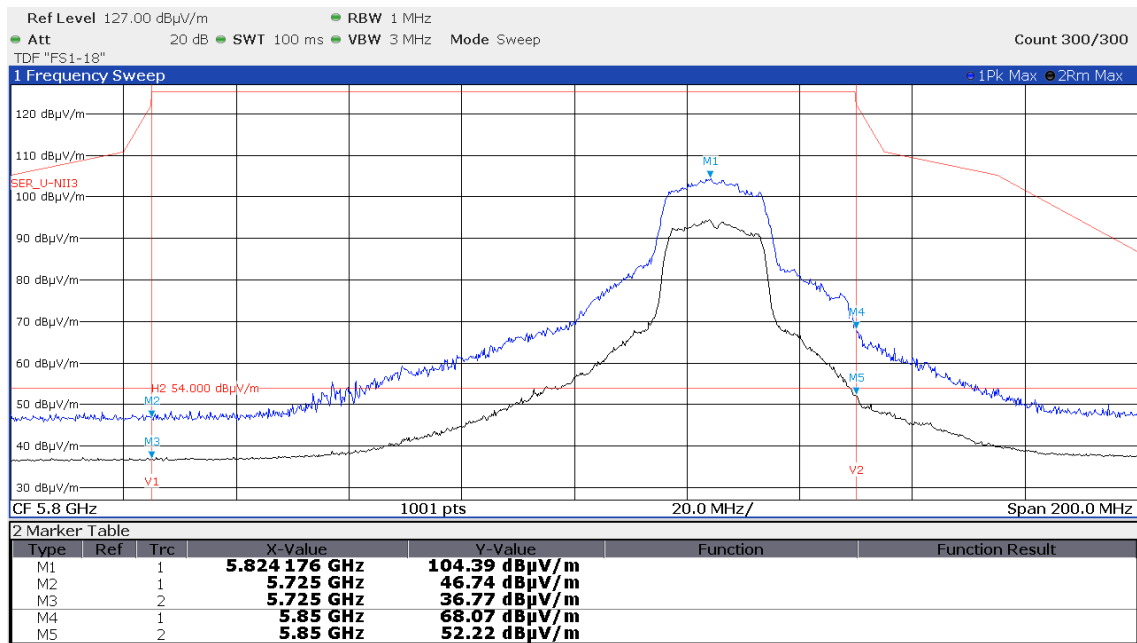
CH144



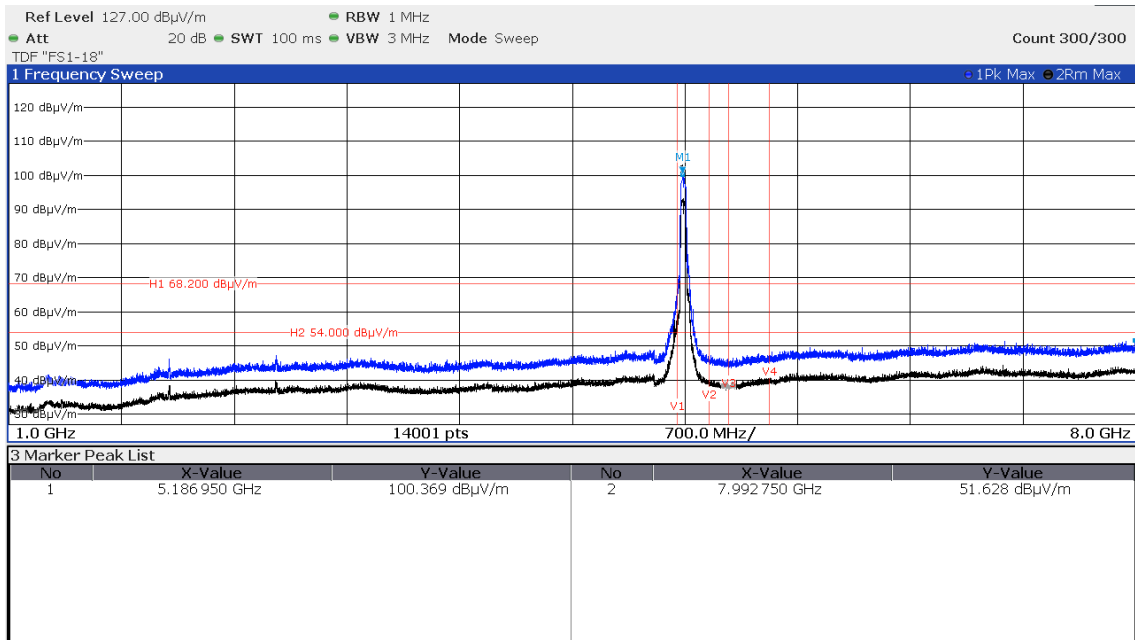
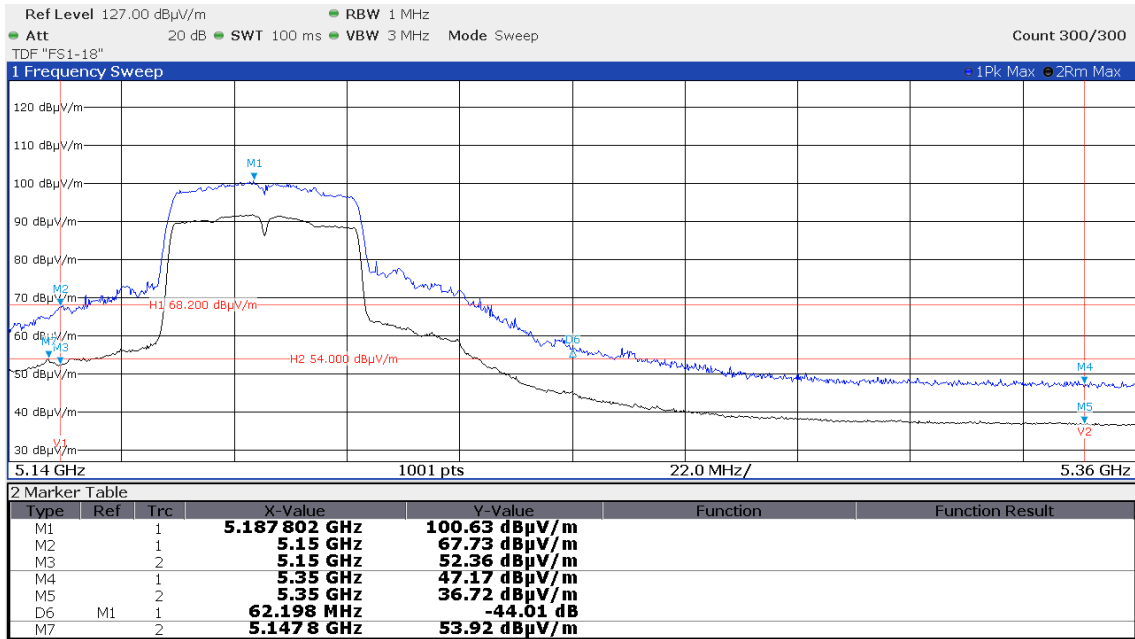
CH149



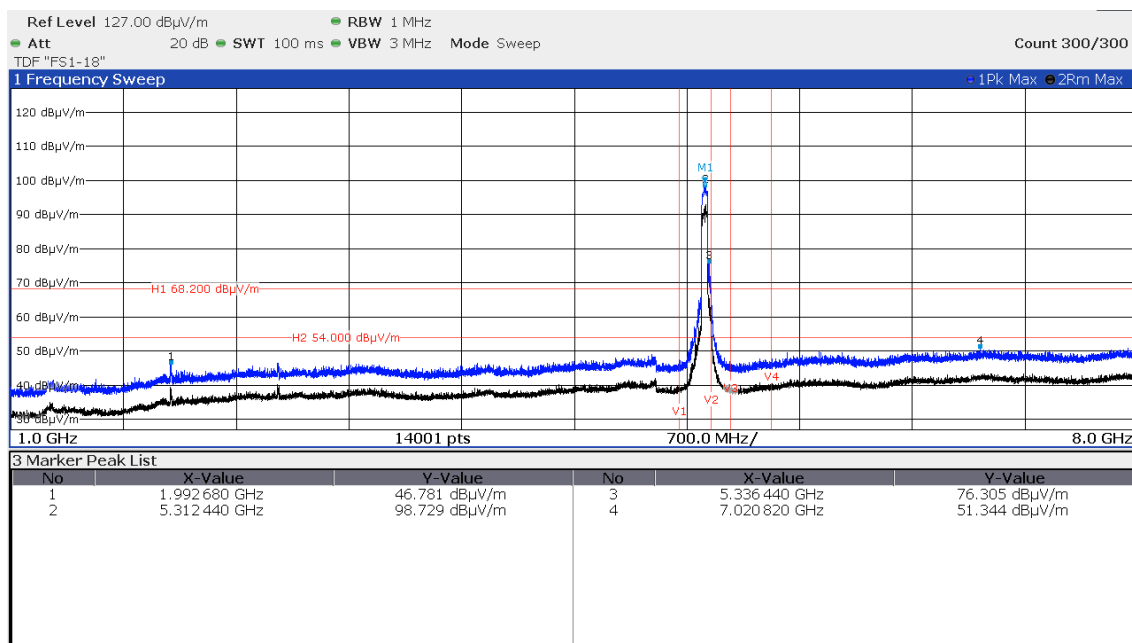
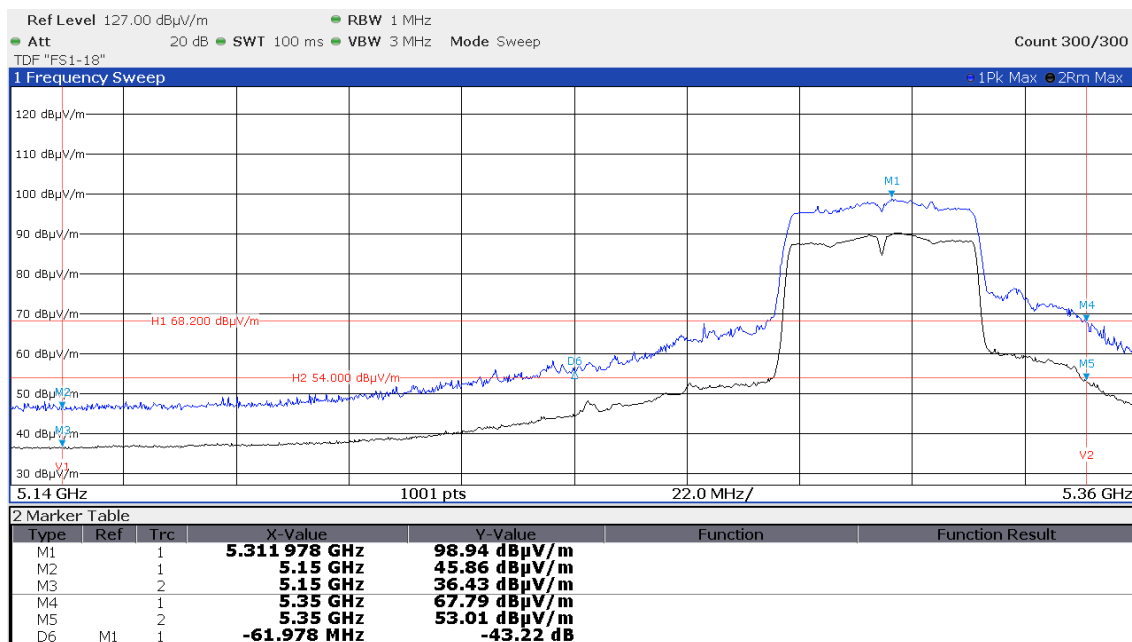
CH165



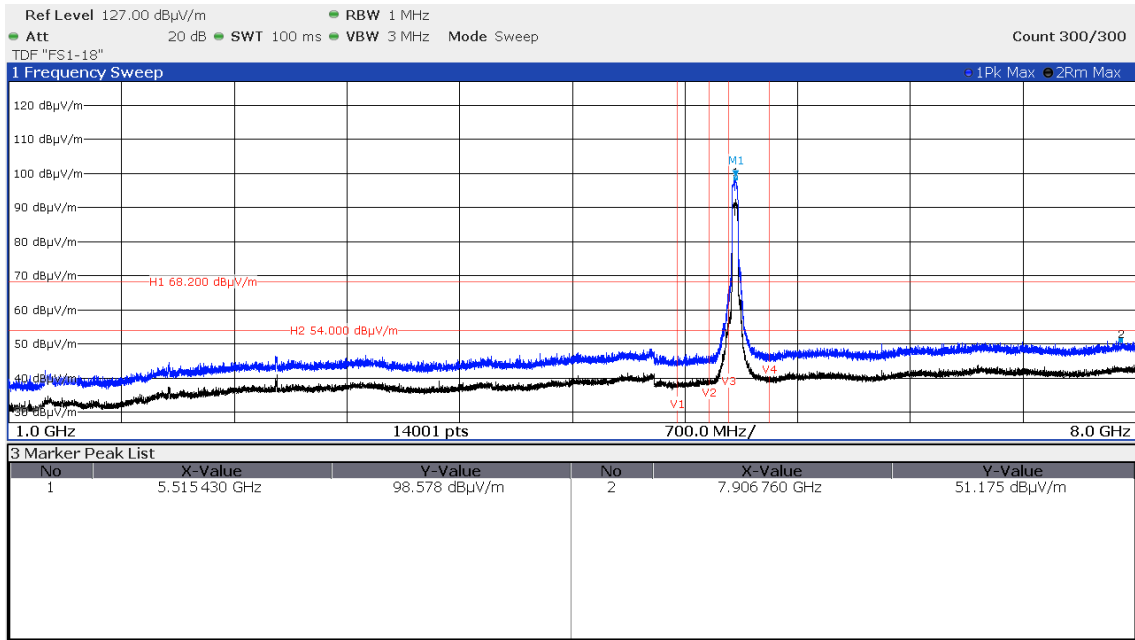
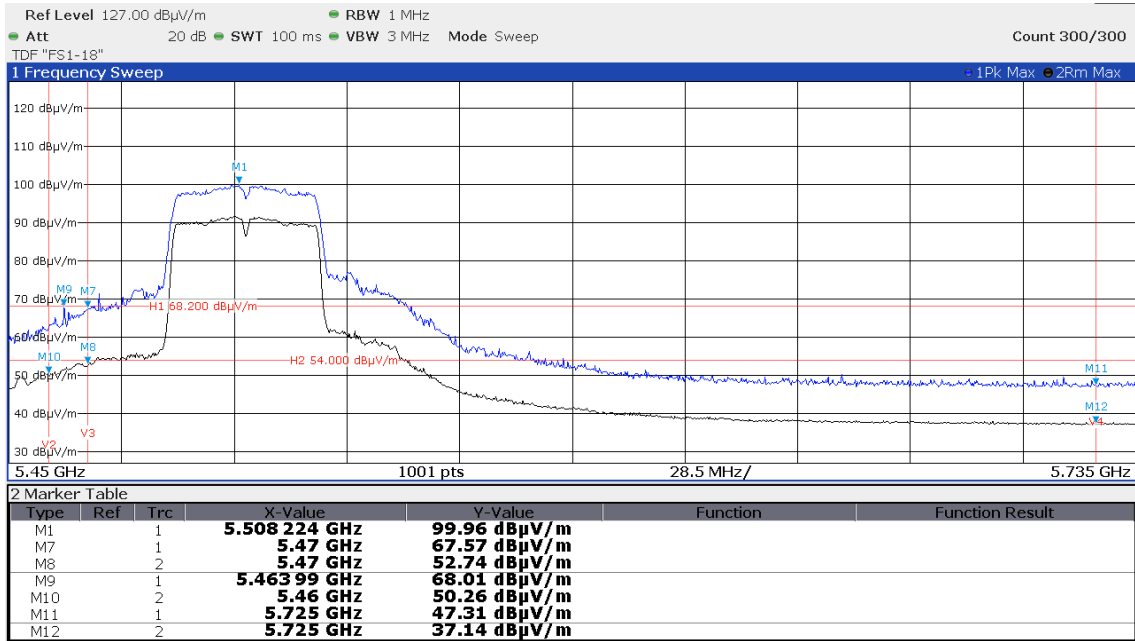
5.5.5.2.2 WLAN Standard 802.11n HT40 - MCS-0
CH38



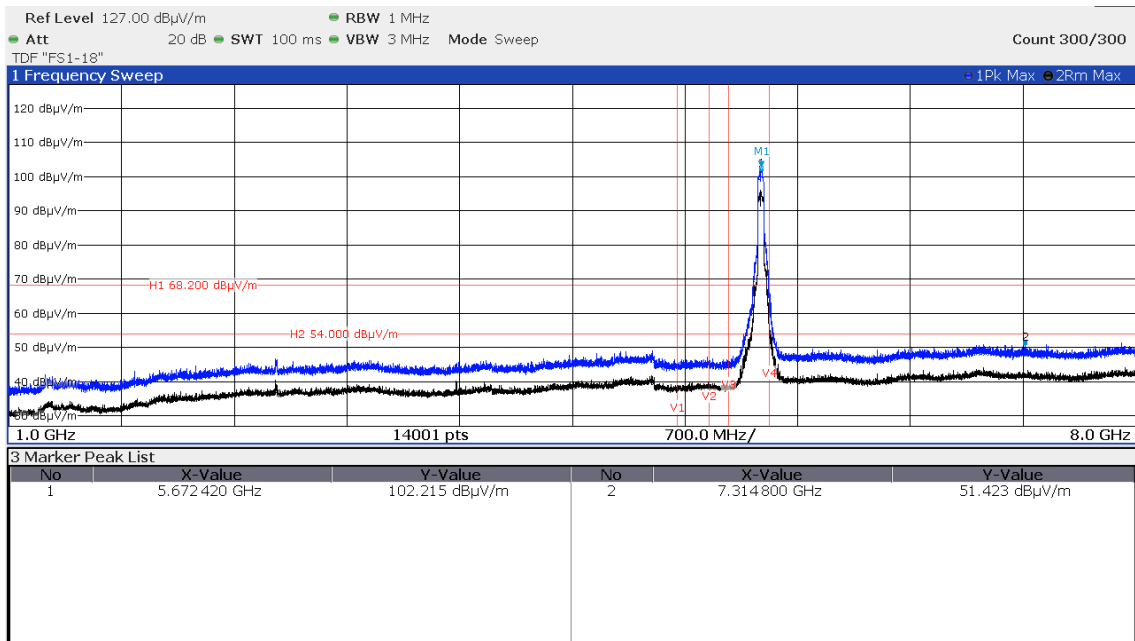
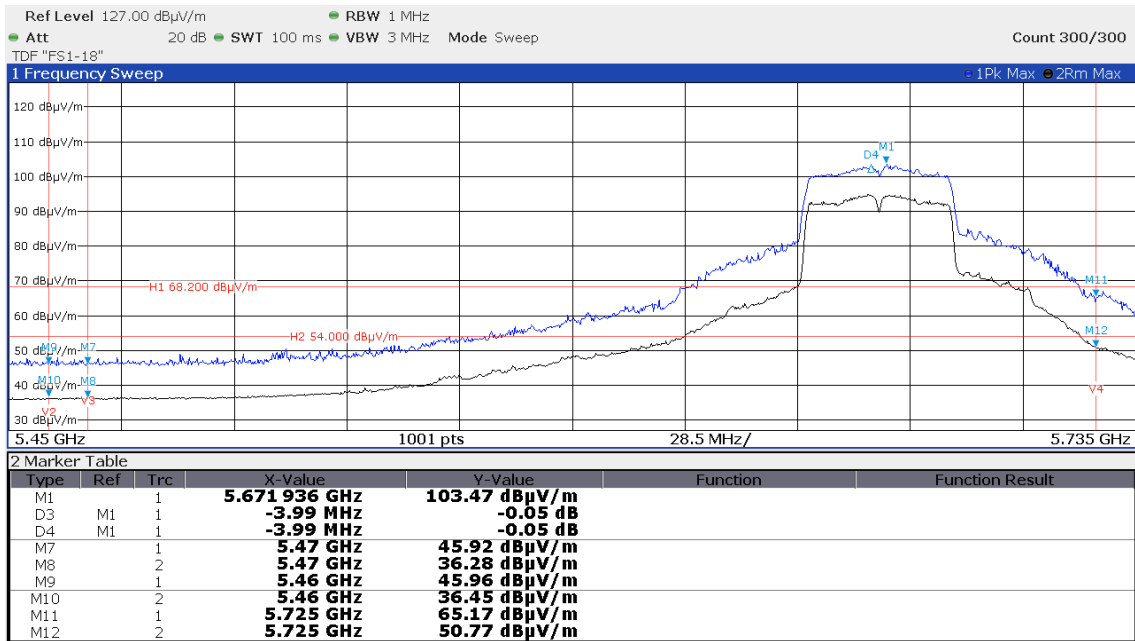
CH62



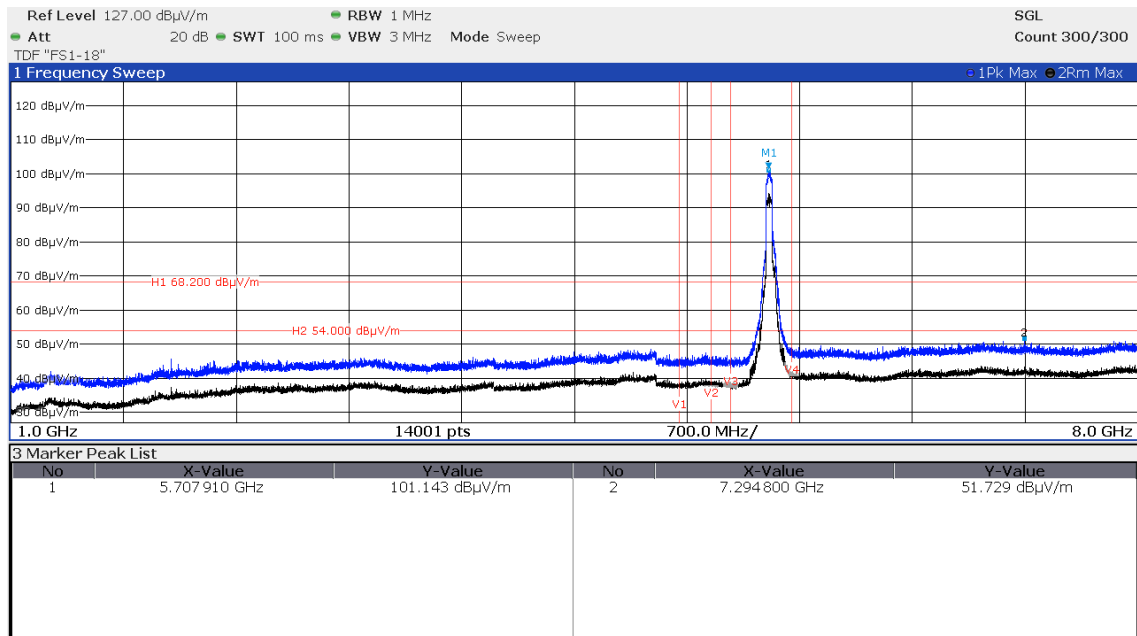
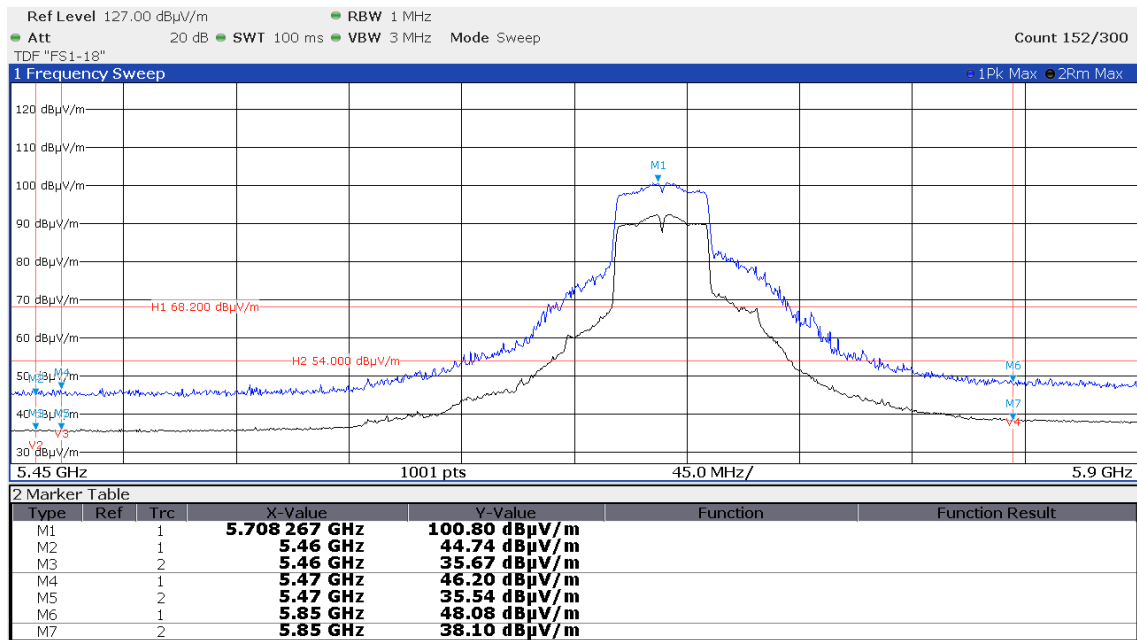
CH102



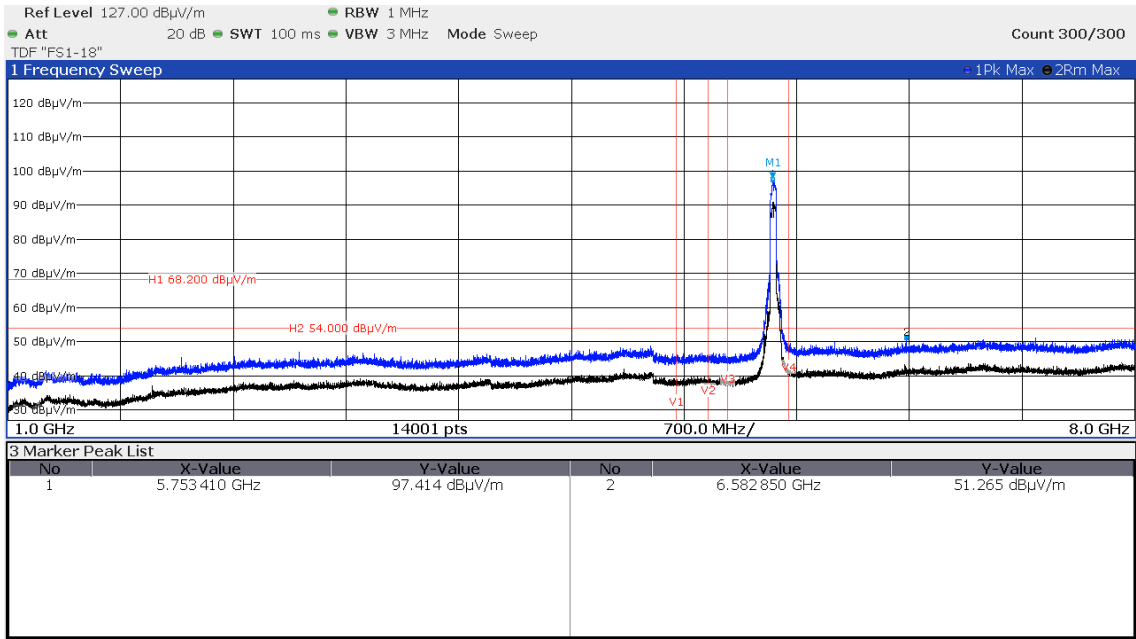
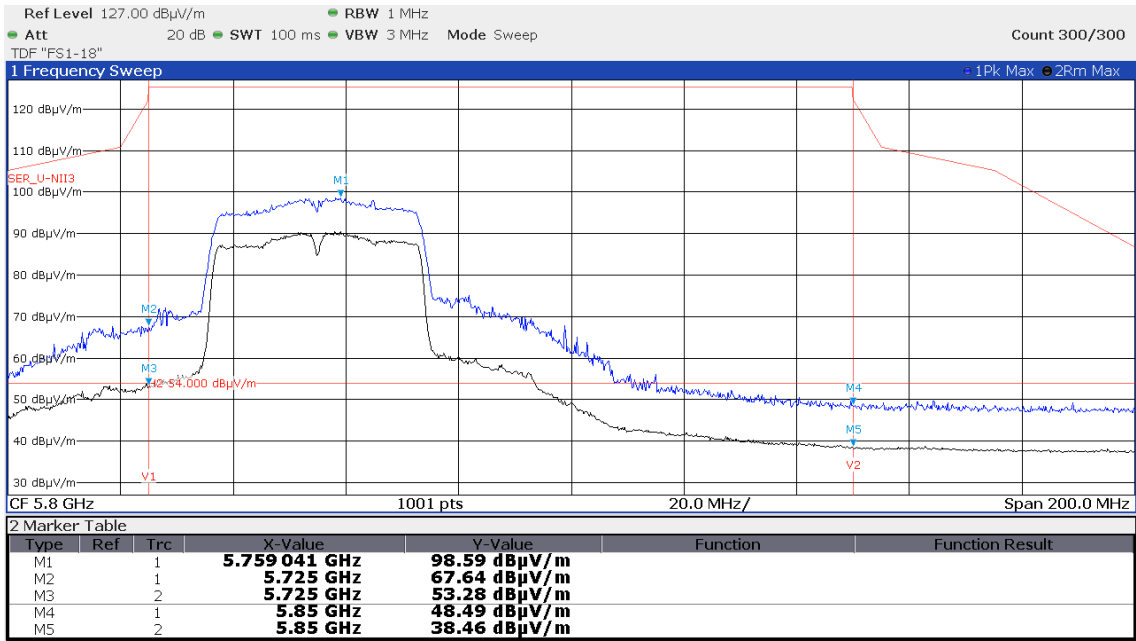
CH134



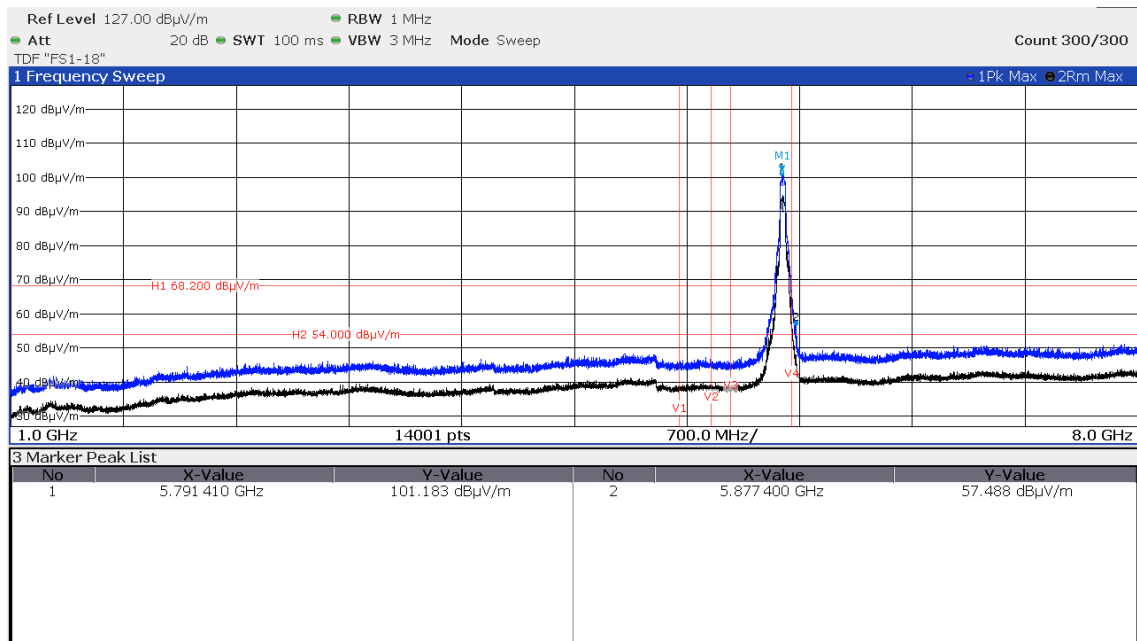
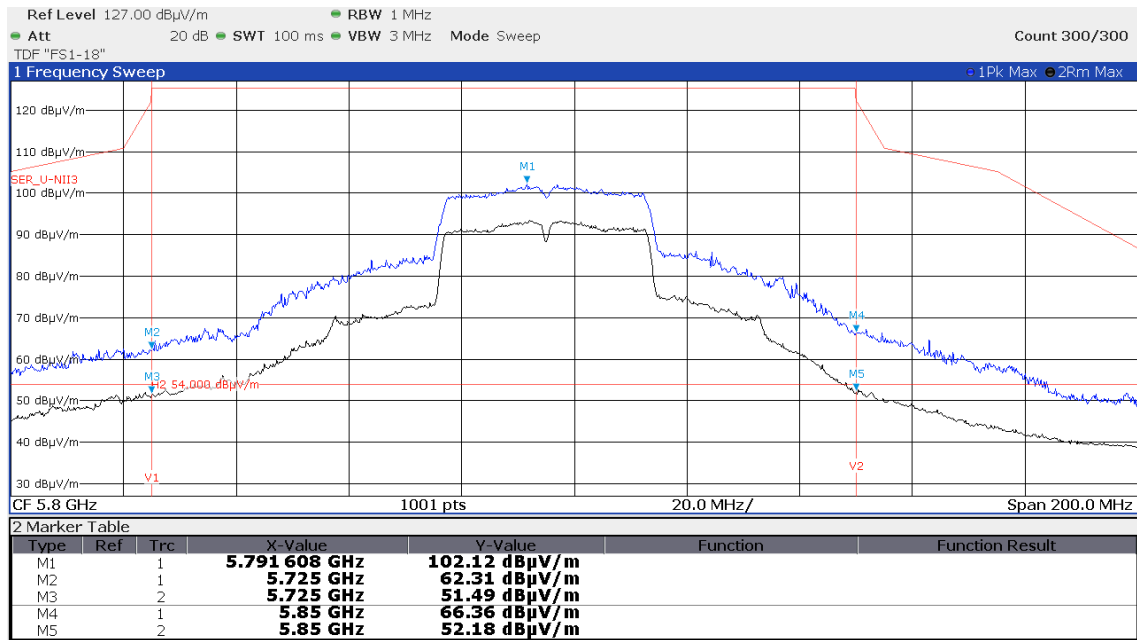
CH142



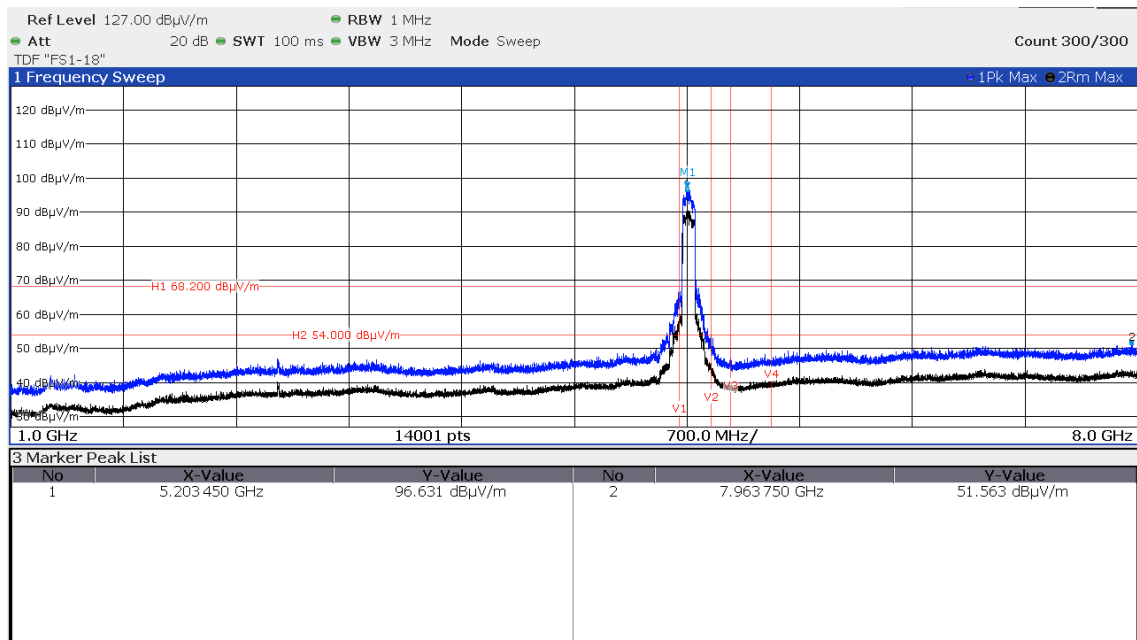
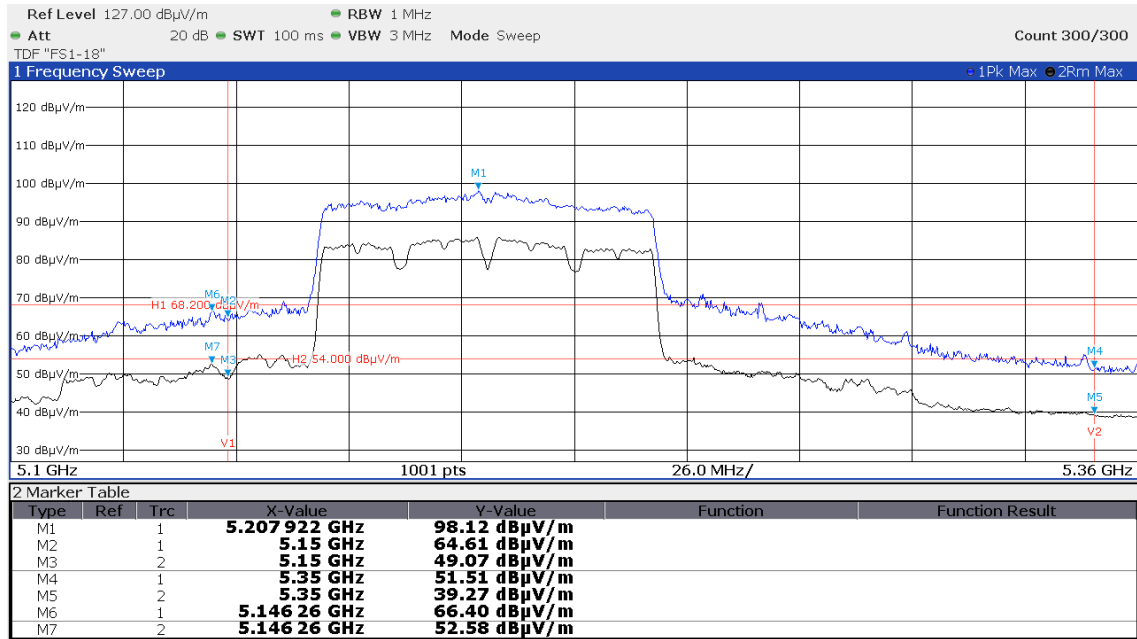
CH151



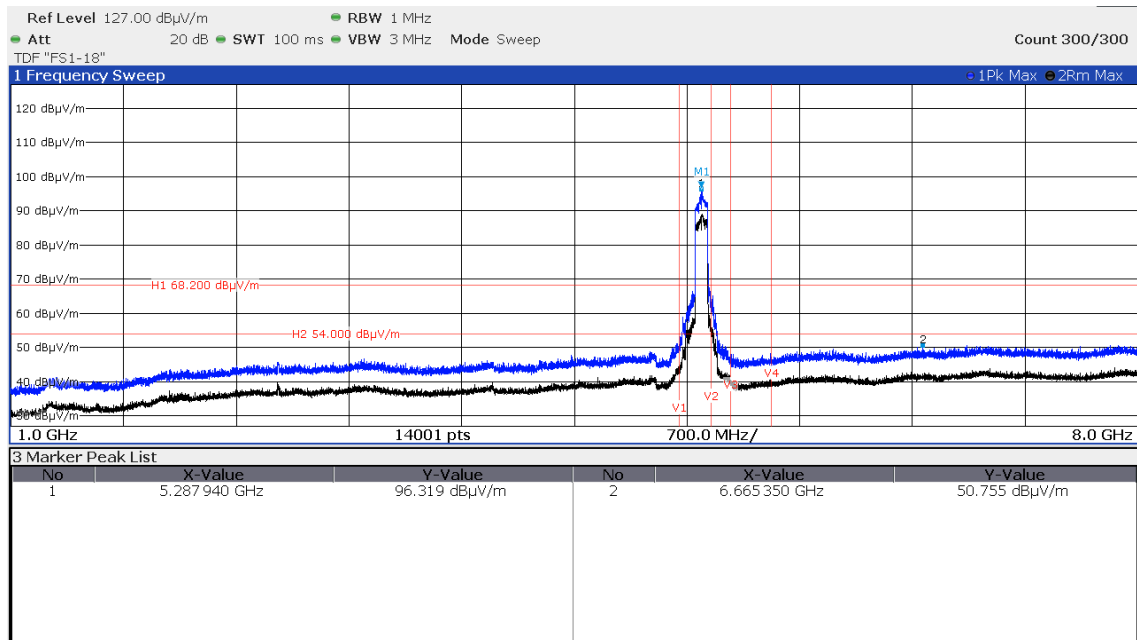
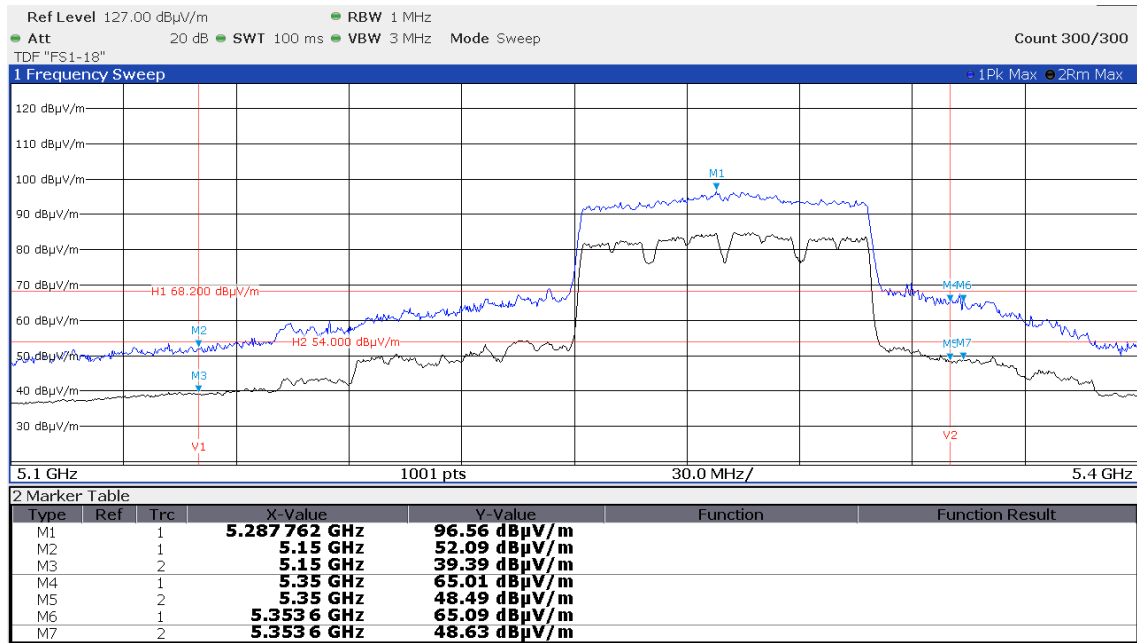
CH159



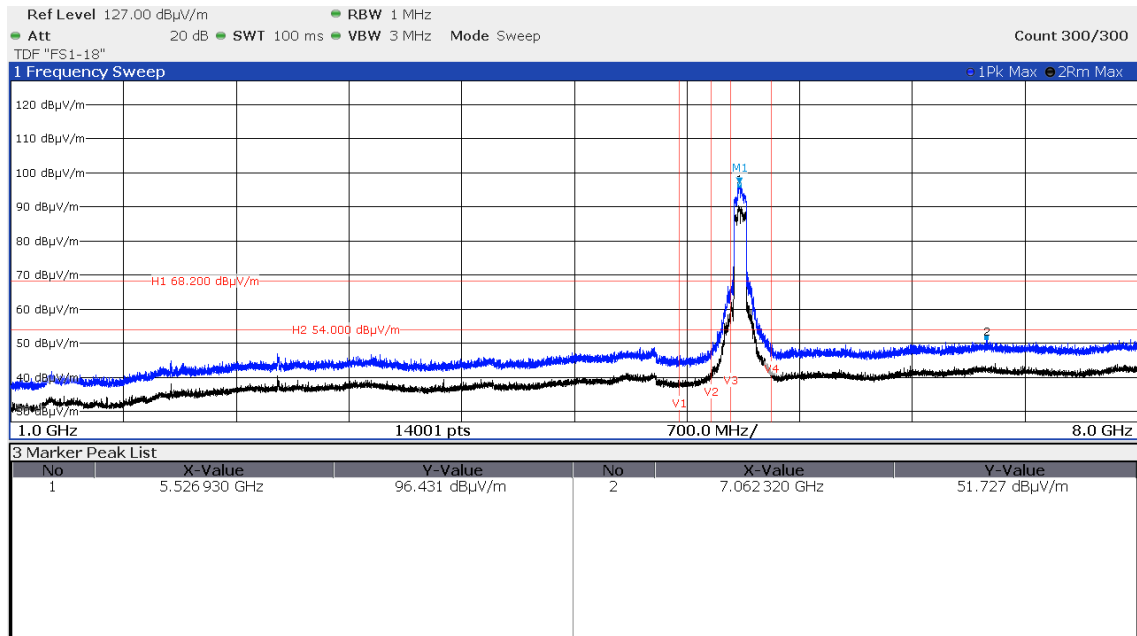
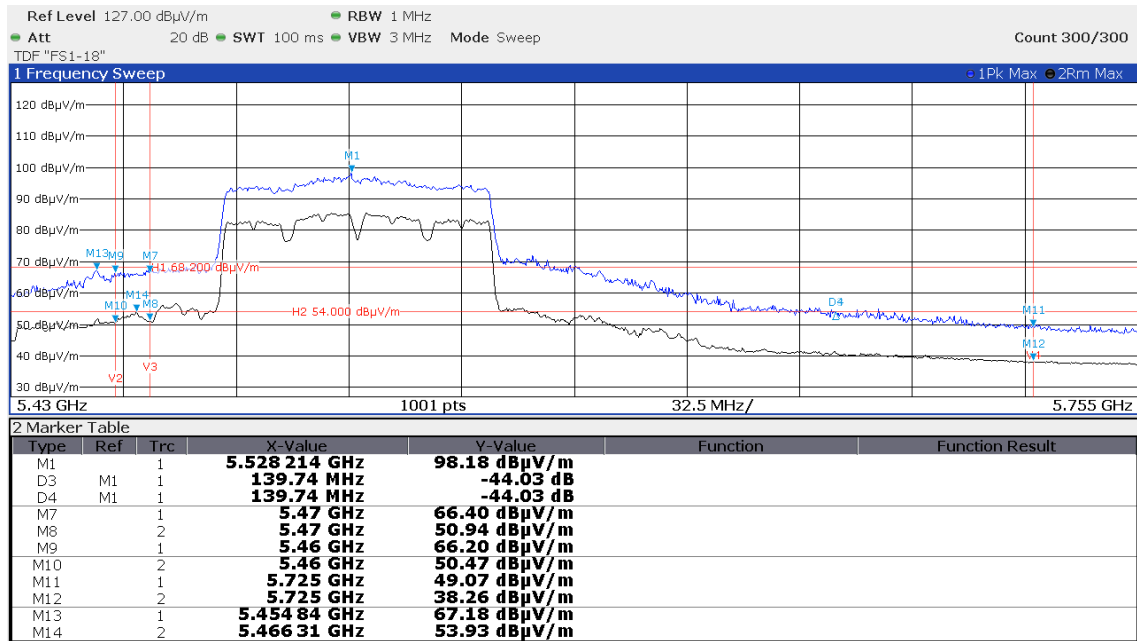
5.5.5.2.3 WLAN Standard 802.11ac VHT80 - MCS-0 CH42



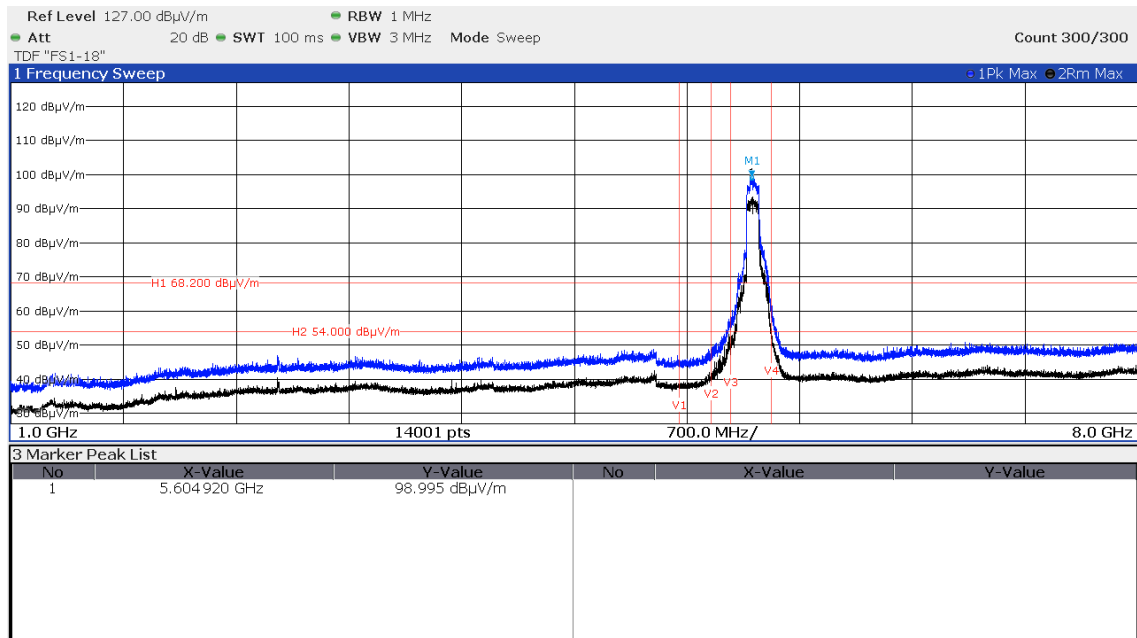
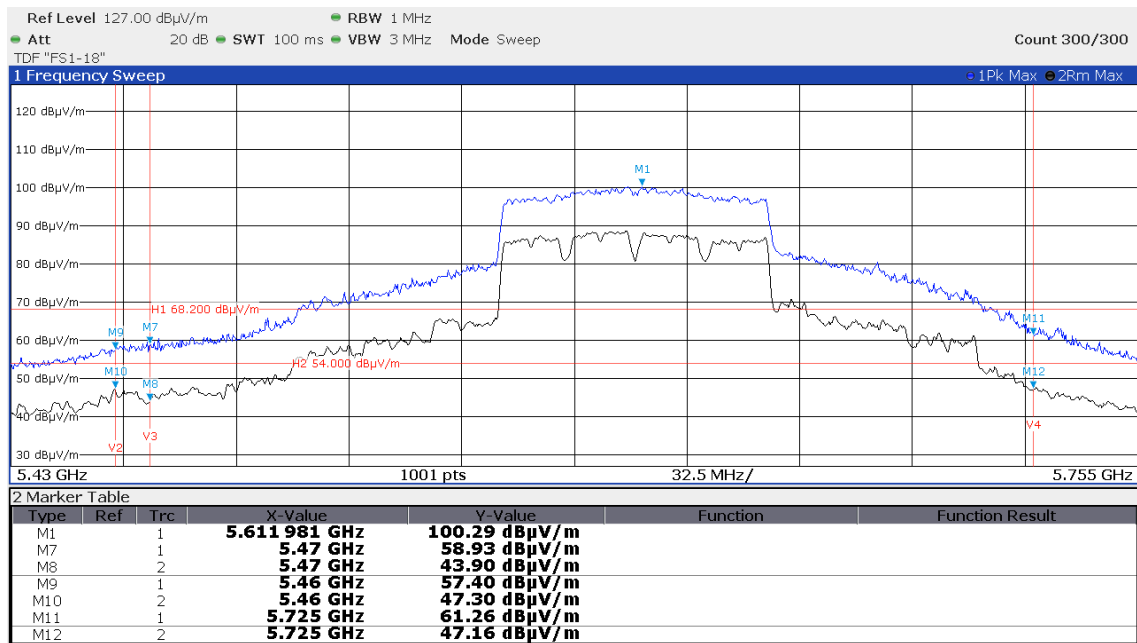
CH58



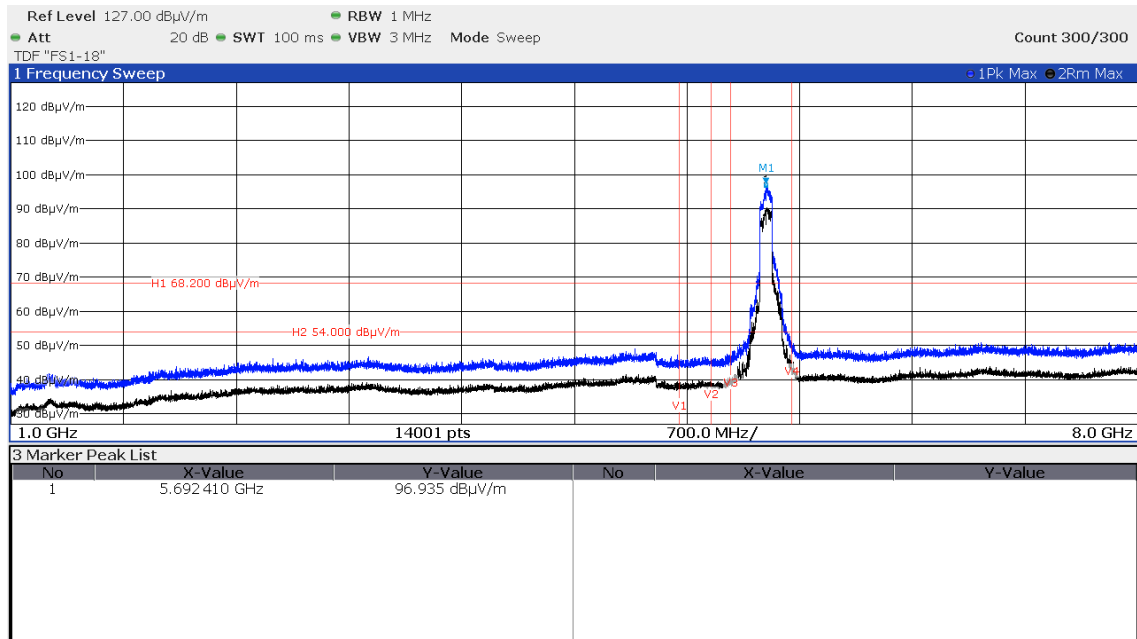
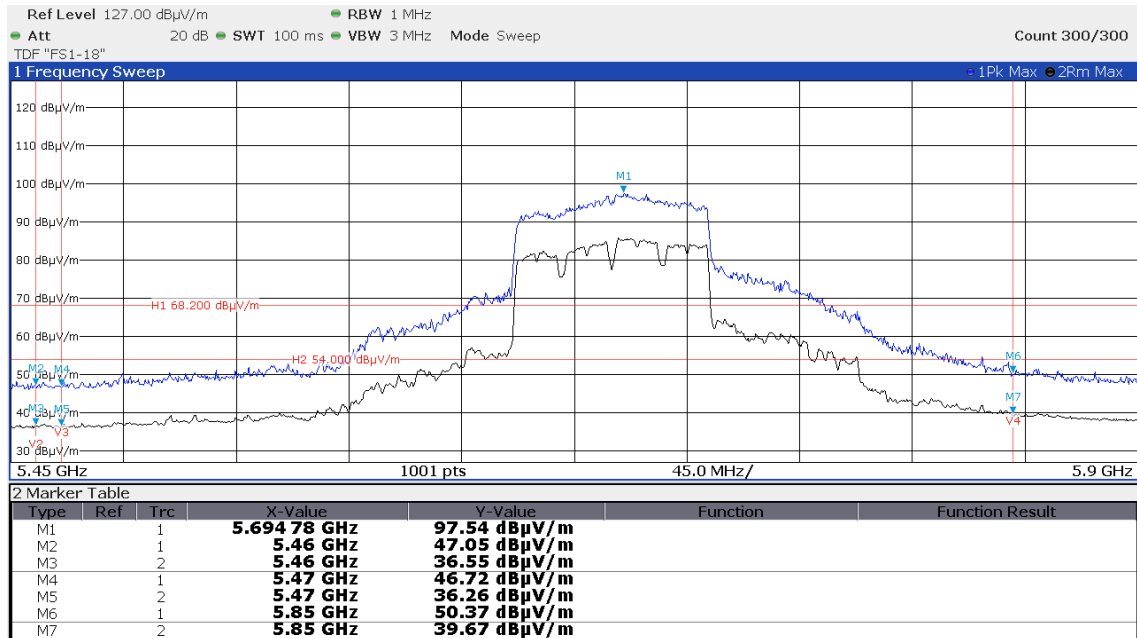
CH106



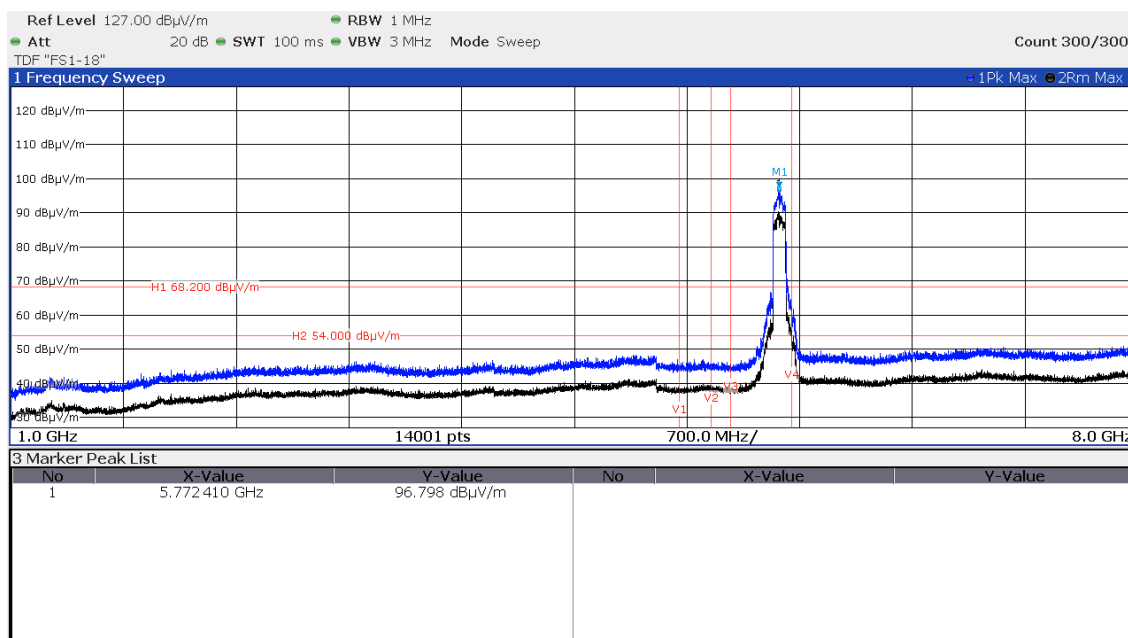
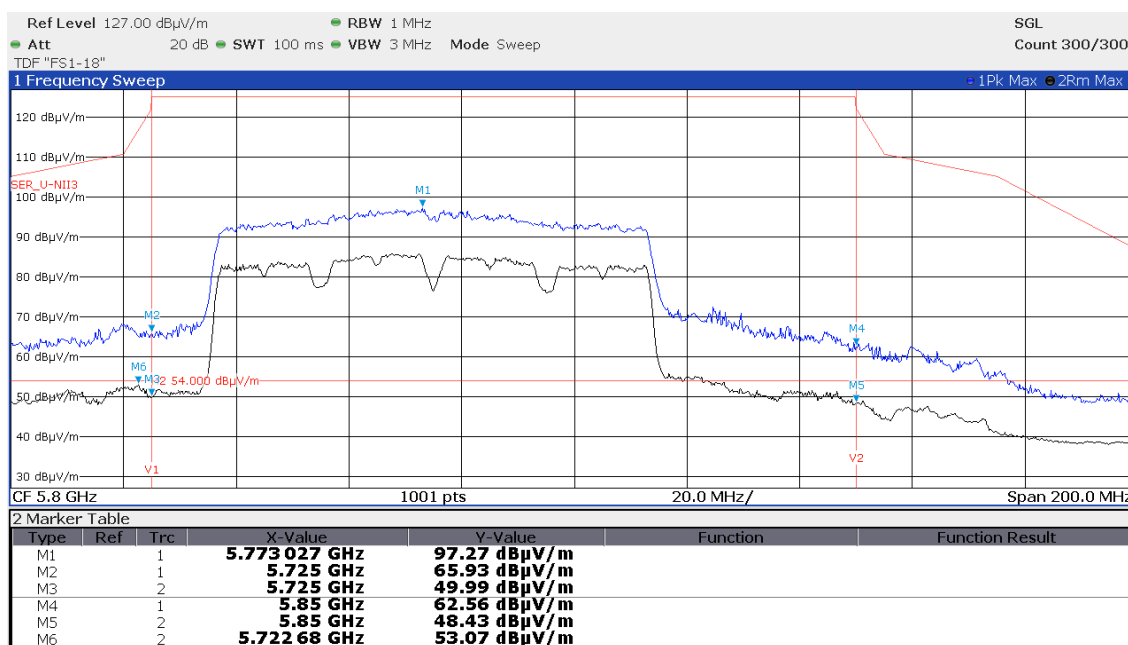
CH122



CH138



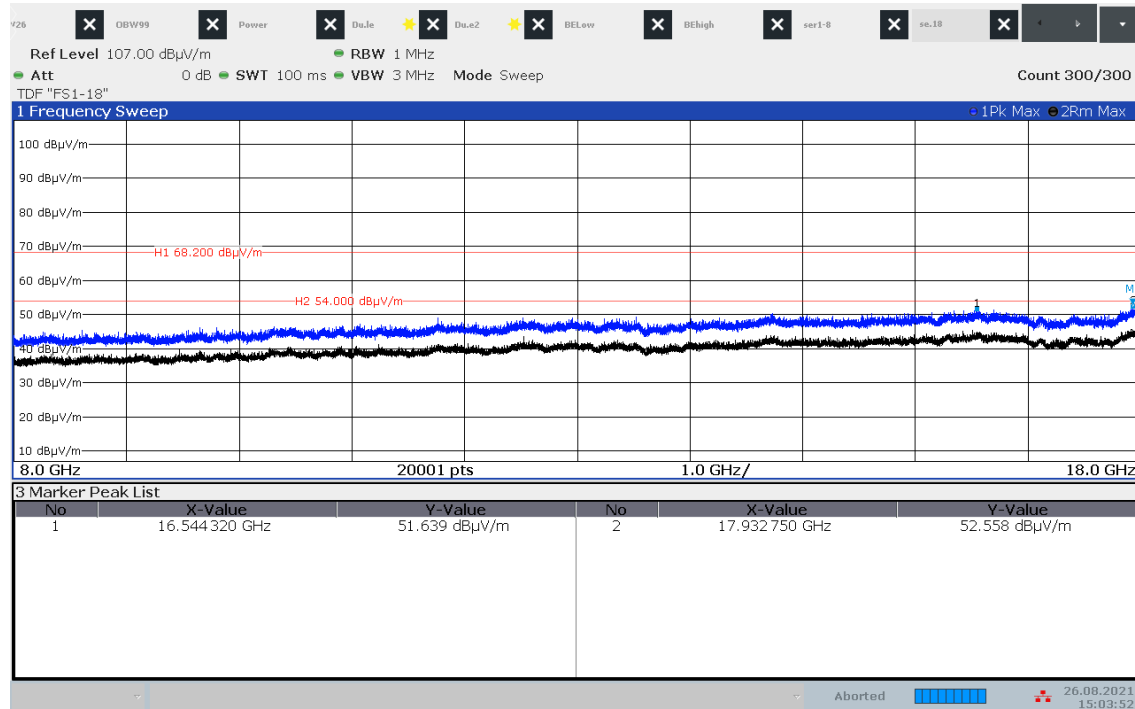
CH155



5.5.5.3 Emission 8 GHz – 40 GHz

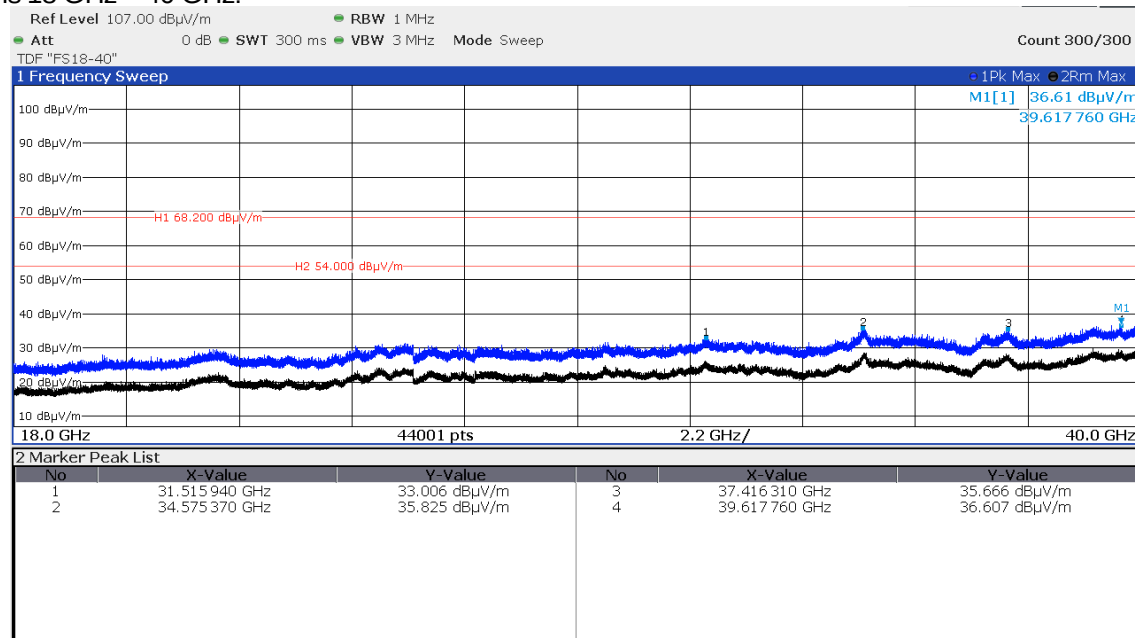
Emission 8 GHz – 40 GHz are identical on all channels and operation modes.

Emissions 8 GHz – 18 GHz:



15:03:52 26.08.2021

Emissions 18 GHz – 40 GHz:



Limit according to FCC Part 15E, Section 15.407(b) for undesirable emissions (peak):

Operating Frequency range	Undesirable emission limit, EIRP	Undesirable emission limit, EIRP
MHz	dBm/MHz	dB(μV/m)/MHz
5150 - 5250	-27.0	68.2
5250 - 5350	-27.0	68.2
5470 - 5725	-27.0	68.2
57250 - 5850	See 15.407(b)(4)	

Radiated limits according to FCC Part 15C, Section 15.209(a) (RMS):

Frequency	Field strength of spurious emissions		Measurement distance
(MHz)	(μV/m)	dB(μV/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

FCC Part 15C, Section 15.205, restricted bands of operation:

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	

The requirements are **FULFILLED**.

Remarks: The measurement was performed up to 40 GHz.

Only the worst case plots are listed.

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.

5.6 Antenna application

5.6.1 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.

5.6.2 Antenna requirements

According to FCC Part 15E, Section 15.407(a):

The conducted output power limit specified in paragraph (a) of 15.407 is based on the use of antennas with directional gains that do not exceed 6 dBi. 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 (a)(1), (a)(2) and (a)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds the effective value.

5.6.3 Defacto EIRP-Limit:

For the output power reduction of the used antennas see the following table. The limit is calculated as using following formula, $P_{out} = 30 - (G_x - 6)$;

Remarks: No power reduction results from the defacto limit.

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 3.20.0.23	01-02/68-13-001				
	ESCI	02-02/03-15-001	21/06/2022	21/06/2021		
	ESH 2 - Z 5	02-02/20-05-004	31/10/2021	31/10/2019	26/10/2021	26/04/2021
	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	26/10/2021	26/04/2021
CPR 3	FSW43	02-02/11-15-001	06/04/2022	06/04/2021		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	3117	02-02/24-05-009	28/06/2022	28/06/2021		
	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 3.20.0.23	02-02/68-13-001				
SER 2	ESVS 30	02-02/03-05-006	09/07/2022	09/07/2021		
	VULB 9168	02-02/24-05-005	18/12/2021	18/12/2020	07/07/2022	07/07/2021
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
	50F-003N 3dB	02-02/50-21-010				
SER 3	FSW43	02-02/11-15-001	06/04/2022	06/04/2021		
	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	28/06/2022	28/06/2021		
	BBHA 9170	02-02/24-05-013	19/05/2023	19/05/2020	04/02/2022	04/02/2021
	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 3.20.0.23	02-02/68-13-001				

-End of test report-

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.