REPORT

issued by an Accredited Testing Laboratory

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Date
2018-11-28
Rev. 1:2018-12-07

Reference
8P07436-F1

Page
1 (98)

FCC ID: 2ADEFAT-DG2

Airtame ApS
Att: Kendra Bannister
Kuglegårdsvej 1
1434 Copenhagen K
Danmark

Equipment Authorization measurements on 5150-5250 MHz RLAN

FCC ID: 2ADEFAT-DG2

Rev.1 2018-12-07: The following pages have been revised; 24, 29, 30 and 52.
Page 24: Added text: 'Additionally, test in MIMO operating mode was done according 662911 D01 Multiple Transmitter Output v02r01.E.1.'.
Page 29: In the end of the heading 'Limit' replaced 26 dBm with correct value 24 dBm.
Page 30: Added text: 'Additionally, test in MIMO operating mode was done according 662911 D01 Multiple Transmitter Output v02r01.E.2.a.'.
Page 52: replaced CAV level value and Peak level value at frequency 5350.40 in the table with each other.
Page 52: In the column 'Limit (dBm)' in the table replaced '-27 (PK)' with '-41.2 (CAV)' for frequencies 5148.90 MHz and 5350.40 MHz.

Test object

Product name: Airtame 2
Product model of Airtame 2: AT-DG2
Product number: 18
HW Revision: Airtame_DG2_V7_RB
FW Revision: 3.3.0

RISE Research Institutes of Sweden AB
Electronics - EMC

Performed by

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Testing
ISO/IEC 17025

Table of Content

Summary

Standard	Compliant	Remarks
FCC 47 CFR Part 15 E 15.407 Operation within the band 5150-5250 MHz KDB 789033, D02 General U-NII Test Procedures New Rules v02r01, December 14, 2017		
15.407 (a) (1) (ii) (iv), Maximum conducted output power	Yes	
15.407 (a) (1) (ii) (iv), Maximum power spectral density	Yes	
15.407 (b) (1) Maximum emission outside of the frequency bands of operation	Yes	
15.407 (b) (6) Unwanted emission below 1 GHz; according 15.209	Yes	
15.407 (b) (7) Unwanted emission in the restricted bands	Yes	
15.407 (b) (6) Conducted emission AC; according 15.207	Yes	
15.407 (c) Automatic discontinue transmission	-	Note 1
15.407 (f) Radiation exposure; §1.1307 (b), §2.1091, §2.1093	Yes	Note 2
15.407 (g) Frequency stability	Yes	
15.407 (h) Transmit Power Control (TPC) and Dynamic Frequency Selection (DFS)	N/A	Note 3
15.407 (i) Security features	-	Note 1
Duty cycle measurements	N/A	Note 4
Band edge: f low= 5150 MHz f high = 5250 MHz	Yes	Note 5
26 dB Bandwidth	N/A	Note 6
99% Occupied bandwidth	N/A	Note 7

Note 1: See in separate document provided by client.

Note 2: See in separate document, REPORT-ANNEX, AT-DG2 RF exposure

Note 3: DFS and TPC functionality are not required for this frequency band, 5150 MHz to 5250 MHz.

Note 4: There is not particular requirement, but information is needed for choosing applicable RF output power test method and for correction of data.

Note 5: This is part of the requirement for maximum emission outside of the frequency bands of operation

Note 6: There is not particular requirement, but information is needed for configuration of instruments and for assessment if operating channel is inside allowed frequency band

Note 7: There is not particular requirement, but information is needed for configuration of instruments and as alternative for assessment if operating channel is inside allowed frequency band

Commission

The tests were performed to verify that the electromagnetic emission from the test object meets the requirements of FCC Part 15E.

Manufacturer representative

Kendra Bannister
Kuglegårdsvej 1
1434 Copenhagen K
Danmark

Test object

The AT-DG2, 5 GHz RLAN provides wireless connection and transfer of huge amount of data including high definition video stream.
The device will be used as indoor access point and/or client.
The test object could be configured in different ways. For these measurements devices were configured for test mode with duty cycle as high as possible. Duty cycle varied from 92% to 99% depending of mode, configuration, modulation and bandwidth. Samples used during tests:

- 8 (only for justification test for worst case positioning)
- 18

A special test software ‘mfg’-manufacturing cypress-chip firmware and a tool from cypress called ‘wl’ was used in the test objects to achieve test mode and high duty cycle transmission. Device under test was configured by the python script on the separate PC.

Transceiver:	CYW89342CRFB4G
Antennas:	PCB printed antennas
Antenna gain	
Chain 1	2.5 dBi
Chain 2	6 dBi
Frequencies used during test:	
	5180 MHz 5190 MHz 5210 MHz 5220 MHz 5230 MHz 5240 MHz
Output power, max, setting	17 dBm/p17, but maximum accepted setting can be seen in each subtest.
Frequency bandwidth:	20 MHz 40 MHz 80 MHz
Modulations:	Standards 802.11a, 802.11n and 802.11ac with modulations BPSK, QPSK, 16-QAM, 64-QAM and 256-QAM; MSC0 to MSC8
Max declared duty cycle in normal operation:	< 95%
Duty cycle during test:	See in the respective sub-tests
Supply voltage to AT-DG2:	5 V±2%, feeding from PSU (normal use) feeding from PoE adapter (test) Extreme voltage: ±15% of nominal voltage

During the test, the test object was powered by 5 V DC from PoE adapter. Power adapter was powered by 48 V DC from PoE injector which was powered by 120 V AC/60 Hz supply. PoE injector and power adapter were used instead to power supply, PSU, to be able to control device under test to different modes, channels, power, BW and modulations.

Radiated tests:
During radiated tests only AT-DG2, PoE adapter and monitor were placed in the anechoic chamber. PoE injector, router and PC were outside the chamber.

Conducted tests:
Conducted emission was done by powering test device from PoE injector via PoE adapter. PoE adapter was powered to the 120 V AC supply.
Environmental test with voltage variation was done with variation of 120 V AC for ±15%, instead for variation of 5 V DC due to practical reasons.

The test items were delivered to RISE 2018-09-03, 2018-09-17 and 2018-11-05.

Testing was carried by Ermin Pasalic at 2018-09-03—2018-11-23.

Operational test mode

The following were set in the EUT, if not otherwise stated.

Initial conducted power measurement and radiated spurious measurement were performed with maximum output power (setting 17 dBm/p17). During edge test it was needed to tune down output power to meet edge requirements. Se maximum acceptable power classes for different bandwidths to comply with edge requirement which consider also variation due to temperature. Rest of the tests were done with power setting 9 dBm/p9.

In the table below you can find maximum acceptable power class to comply with all requirements:

	Max overall acceptable power class
Ch 36	8 dBm/p8
Ch 38	5 dBm/p5
Ch 42	6 dBm/p6
Ch 46	9 dBm/p9
Ch 48	9 dBm/p9

Tx power dBm: 14.4 dBm total in MIMO mode
Tx power dBm: 11.5 dBm per chain in SISO mode
Channel BW: 20 MHz / 40 MHz / 80 MHz

For duty cycle measurements results see: Duty cycle measurements.

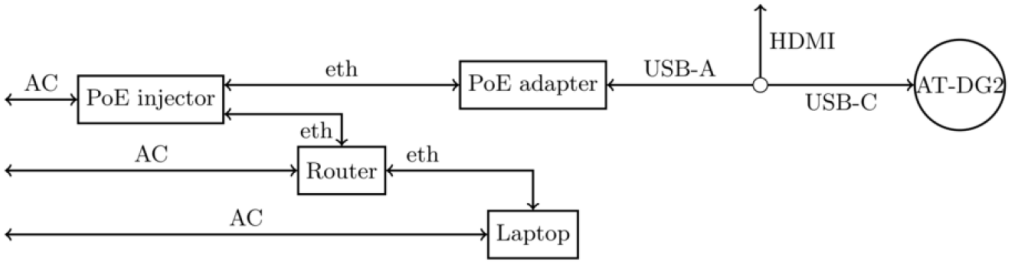
Justification measurements were performed of the different WiFi standards, different modulation and coding index – MCS and different antenna configuration. Justification were also performed of different placements of DUT and the worst case channel through different frequency bands. The presented results in the reports were judged to represent a worst case scenario based on the justification measurement.
The worst case according justification tests was 802.11ac, MCS0 and 20 MHz BW in MIMO mode.
Regarding placement of DUT, laying placement was the worst case.
The channel 48 showed highest emission levels through the frequency bands.

Connected equipment during the test

According to ANSI C63.10.2013, clause 5.10.7

PoE injector, AXIS T8120 15W MDSPN 1P, model: 5026-001-01	Client equipment
PoE adapter, model: AT-PoE, FCC ID: 2ADEFTAT-PoE	Client equipment
Router, NetgearAC1900 Smart WiFi Router Model: R7000	Client equipment
HP Laptop Model: 14-bp092no, ProdID 2GG01EA#UUW	Client equipment
Lenovo ThinkVision LCD monitor, Type/Model A16270QP0	RISE equipment

Test setup - DUT with auxiliary equipment



DUT consists of AT-DG2 and PoE adapter.

Cabling during tests:

AT-DG2 port	Cable type	Termination / use
USB C	Aircord 0.2 m; branch USB C	Cable splitter (to PoE adapter via one branch with USB A connector and to the Monitor via second branch with HDMI connector)

PoE adapter	Cable type	Termination / use
USB-A	Aircord 0.85 m; branch USB A	Cable splitter (to AT-DG2 via one branch with USB C connector and to the Monitor via second branch with HDMI connector)
LAN	Cat 5, 1.0 m (conductive tests) Cat 5, 3.0 m (radiated tests)	PoE injector

Measurement equipment

Measurement equipment	RISE number	Calibration Due
Semi anechoic chamber, Edison	504114	2021-08
Test site Galvani	15:117	-
Computer Lenovo ThinkCentre	-	-
Software R&S EMC32, ver.9.15.00	503889	-
EMI test receiver R&S ESU 26	902210	2019-07
Signal Analyser R&S FSQ26	BX50694	2019-07
Signal Analyser R&S ESI40	503125	2019-07
Antenna Schaffner CBL 6143	504079	2021-08
Low Noise Amplifier Miteq	504160	2019-01
Step attenuator Narda743-60	BX41644	2019-11
Coaxial cable	BX50672	2019-10
Coaxial cable	504102	2019-03
Coaxial cable	504103	2019-03
Coaxial cable	504104	2019-03
Coaxial cable	900678	2019-05
Coaxial cable	504162	2019-01
120 V AC/60 Hz AC Power source HP 6813B	503091	2019-09
DC power supply TTI	502786	-
DC power supply HP E3632A	503170	-
Multimeter Fluke 83	501522	2019-06
Multimeter Fluke 85III	503418	2019-06
Temperature and humidity meter Testo 625	503498	2019-05
Test site Marconi	15:121	-
Software R&S WMS32, ver.10.40.10	-	-
Switching box with RF power meters R&S OSP120 with OSP-B157W8	BX60313	2020-07
Coaxial cable	BX81424	2019-05
Coaxial cable	BX81436	2019-05
Coaxial cable	BX50685	2019-05
EMI test receiver R&S ESU 40	901385	2019-07
Antenna ETS-Lindgren 3115 Tesla	902175	2021-07
Standard gain horn, 18-26 GHz, 20240-20	503674	2021-01
Standard gain horn, 26-40 GHz, 22240-20	503674	2021-01
Low Noise Amplifier Miteq, 18-26.5 GHz	503285	2019-01
Low Noise Amplifier Miteq 18-40 GHz	503278	2018-12
Semi anechoic chamber, Tesla	503881	2019-12
Software R&S EMC32, ver.9.15.00	BX62351	-
Standard gain horn, 8-12.75 GHz	503939	-
Standard gain horn, 12.75-18 GHz	503900	-
Low Noise Amplifier Miteq	901545	2019-01

Huber Suhner antenna cable N-N	BX62218	2019-09
Coaxial cable	503697	2019-01
6 dB Dämpare	BX61530	2019-07
Coaxial cable	503508	2019-09
Coaxial cable	503509	2019-09
Coaxial cable	504206	2019-07
Coaxial cable	900679	2019-01
Temperature and humidity meter Testo 625	504188	2019-05
LISN Schwarzbeck NNLA 8120	BX70761	2019-04
LISN Schwarzbeck NNBL 8226-2	902060	2020-02
Limiter, EM-7600	BX42883	2019-09
Temperature scope	503360	2021-02
Temperature and humidity meter Testo 625	504203	2019-05
Temperature and humidity meter Testo 625, with wire sensor 2A	504117	2019-05
Coaxial cable	900226	2019-09
Coaxial cable	504035	2019-02
Coaxial cable	503274	2019-02

Test facility

The used semi-anechoic chambers are compliant with ANSI C63.4.

References

Measurements were done according to relevant parts of the following standards:

ANSI 63.10-2013
eCFR 47, part 15 C
eCFR 47, part 15 E
KDB 447498 D01 General RF Exposure Guidance v06
KDB 789033 D02 General U-NII Test Procedures New Rules v02r01; Dec. 14, 2017

Uncertainties

Measurement and test instrument uncertainties are described in the quality assurance documentation ”SP-QD 10885”. The uncertainties are calculated with a coverage factor k=2 (95% level of confidence). The measurement uncertainties can be found in the table below:

Method	**Uncertainty**
Duty cycle	1.3 %
Maximum peak conducted power	1 dB
Restricted bands of operation:	
Radiated emission, 30 – 1000 MHz	4.8/5.6 dB (V/H-pol)
Radiated emission, 1 – 40 GHz	2.6 dB
Conducted 26 dBc	2 %
Power spectral density	1.3 dB
RF Safety	1 dB
99 % Occupied bandwidth	2.0 %
Band edge, restricted bands, radiated	4.8/5.6 dB (V/H-pol)
Band edge, 99 % OBW	2.0 %

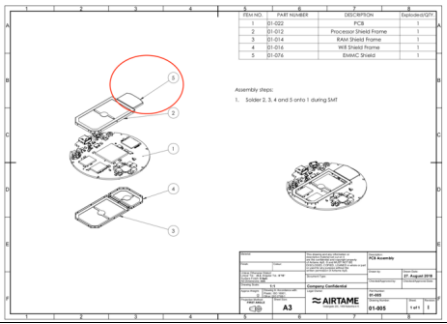
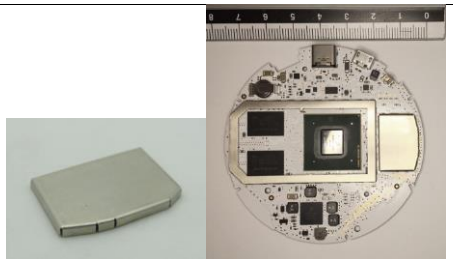
Compliancy evaluation is based on a shared risk principle with respect to the measurement uncertainty.

The test results in this report apply only to the particular Equipment Under Test (EUT) as declared in the report.

Modifications of the device

Some modifications of the test device were necessary to comply with requirements for Maximum emission outside of the frequency bands of operation, Unwanted emission below 1 GHz and for Conducted emission AC.

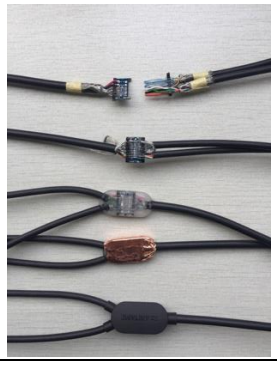
- EMMC shielding
  EMMC shielding was added over EMMC in order to improve emissions performance. See an image of this implantation below:

Aircord	
	
PCB Assembly showing shielding and position	01-076_EMMC Shield, mounted on PCB

  The device without EMMC shielding was used only at initial tests for judgement about worst case position. Our assessment is that implementation of the EMMC shielding could not negatively impact performances.

- Aircord
  The Aircord was modified with improved shielding. Copper tape was added to the splitter part of the cable, and the cable heads were modified to have shielding added. A PCB was also custom-designed for the splitter to minimize emissions from high

frequency HDMI signals. This will only improve performance in terms of emissions.
See images of these implementations in production below:

			
USB-C	Splitter	HDMI	USB-Type A

Modified aircord was used for radiated emission tests below 1 GHz, conducted emission AC test, output power, PSD, EBW and OBW tests.
For all other tests, duty cycle, radiated emission test over 1 GHz and frequency stability test the original aircord, (without modifications), was used.
Our assessment is that implemented modifications on the aircord would not negatively impact performance.

- PoE injector
  PoE injector had to be replaced by different model due to experienced problem during radiated emission test below 1 GHz and conducted emission AC test.
  The model of the latest used power injector is AXIS T8120 15W MDSPN 1P, model: 5026-001-01.
  Initially used power injector was of model: GP-D480-050G.
  Our assessment is that using another model of power injector would not negatively impact performance.
  In addition, power injector is not supplied with the product.

- PoE to USB adapter
  During certification, Airtame supplied the latest revision of HW of the own product, the model: AT-PoE which is a PoE to USB adaptor. PoE Module Hardware Rev 1.3.
  The difference between this revision and earlier PoE to USB revisions is that additional filtering had been added (common mode choke).
  Our assessment is that implemented modifications on the PoE to USB adapter would not negatively impact performance.

Test participants

Alvin Sipraga, Airtame, Copenhagen, Danmark (partly present)
Søren Bøgeskov Nørgaard, RTX A/S Noerresundby, Danmark (partly present)

Test results

Duty cycle measurements

Date	Temperature	Humidity
2018-11-14	22 °C ± 3 °C	29 % ± 5 %
2018-11-15	21 °C ± 3 °C	35 % ± 5 %

Test setup and procedure

The measurements were performed according to ANSI C63.10 clause 12.2 and the KDB 789033 D02 Dec. 14, 2017 II.B.2.a).

Conducted measurements were performed on units with the temporary antenna connectors, with transmission below 98% of duty cycle and with normal modulation.

Test set-up photos during the tests can be found in the photo section in the separate document, REPORT-ANNEX, REPORT-ANNEX, AT-DG2 Photos.

Measurement equipment	RISE number
Test site Marconi	15:121
Software R&S WMS32, ver.10.40.10	-
Signal Analyser R&S FSQ26	BX50694
Switching box with RF power meters R&S OSP120 with OSP-B157W8	BX60313
Coaxial cable	BX81424
Coaxial cable	BX81436
Coaxial cable	BX50685
120 V AC/60 Hz AC Power source HP 6813B	503 091
Multimeter Fluke 85 III	503 418
Temperature and humidity meter Testo 625	503 498

MIMO		802.11.ac/ MCS0			
T_{nom} 20°C V_{nom} 120 V AC					
f [MHz]	BW [MHz]	Pulse period [ms]	Pulse width [ms]	Duty Cycle [%]	Correction [dB]
5180	20	0.71	0.7	98.6	0.06
5220	20	0.71	0.69	97.2	0.12
5240	20	0.71	0.7	97.7	0.10
5190	40	0.38	0.37	95.7	0.19
5230	40	0.38	0.37	95.7	0.19
5210	80	0.21	0.19	92.3	0.35

SISO 2, (chain 2 – 6 dBi antenna gain)		802.11.ac/MCS0			
T_{nom} 20°C V_{nom} 120 V AC					
f [MHz]	BW [MHz]	Pulse period [ms]	Pulse width [ms]	Duty Cycle [%]	Correction [dB]
5180	20	1.36	1.34	98.5	0.07
5240	20	1.36	1.35	99.2	0.03
5190	40	0.69	0.67	98.5	0.07
5210	80	0.35	0.33	94.3	0.25

Results

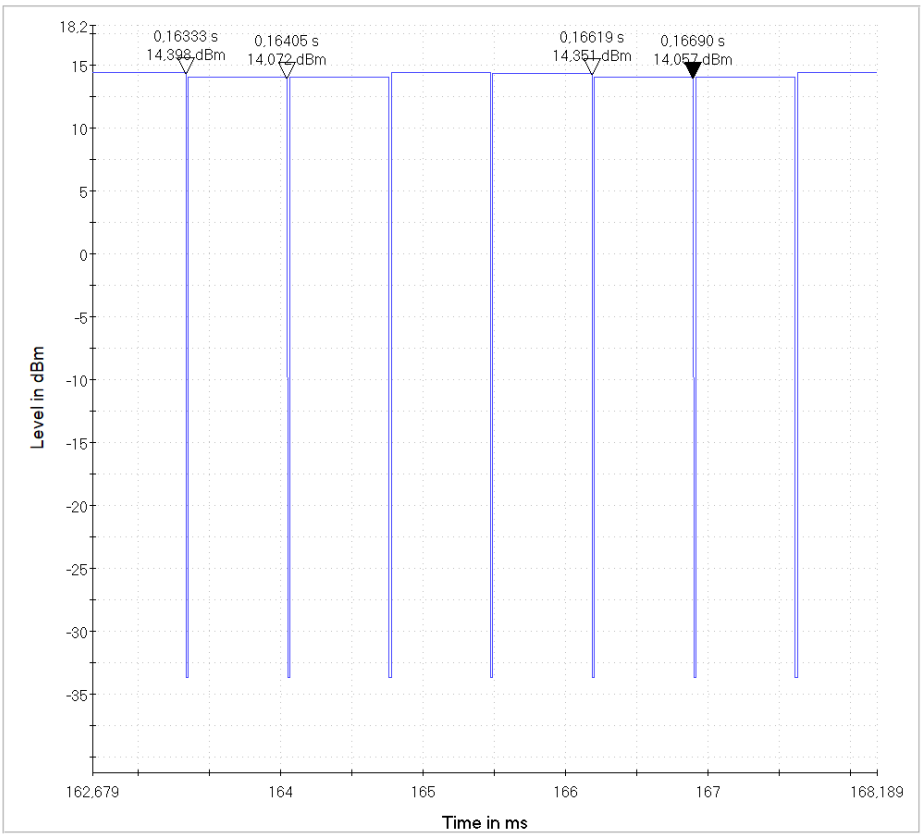
The duty cycle measurements can be found in the diagrams below:

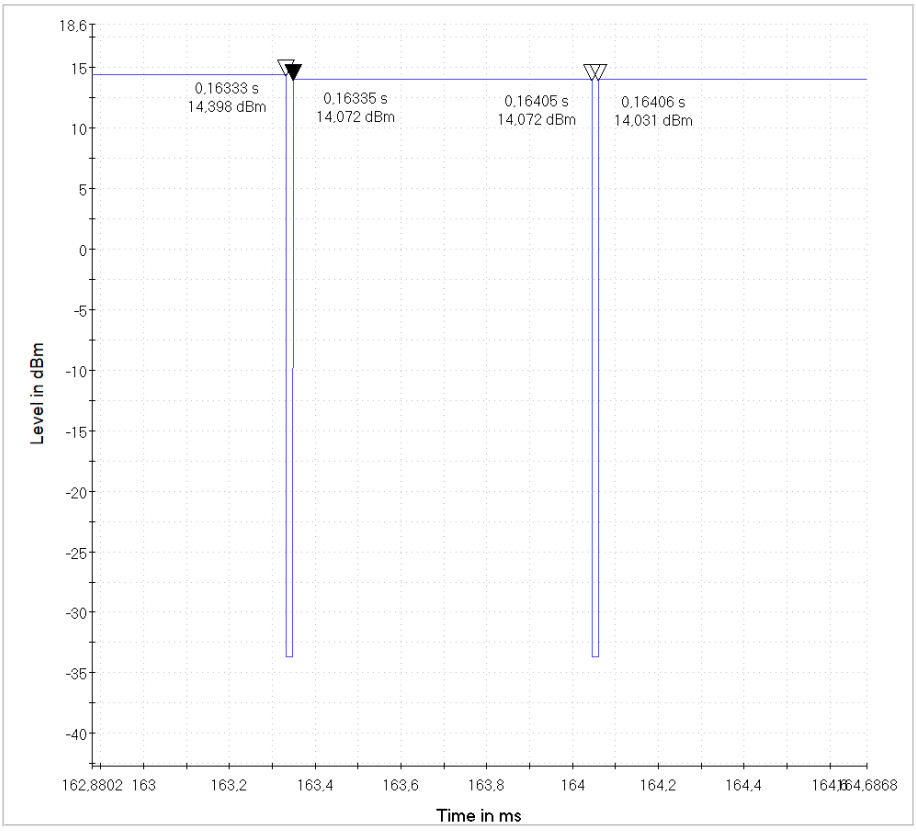
Diagram 1:	5180 MHz, 20 MHz BW, MIMO
Diagram 2:	5220 MHz, 20 MHz BW, MIMO
Diagram 3:	5240 MHz, 20 MHz BW, MIMO
Diagram 4:	5190 MHz, 40 MHz BW, MIMO
Diagram 5:	5230 MHz, 40 MHz BW, MIMO
Diagram 6:	5210 MHz, 80 MHz BW, MIMO
Diagram 7:	5180 MHz, 20 MHz BW, SISO 2
Diagram 8:	5240 MHz, 20 MHz BW, SISO 2
Diagram 9:	5190 MHz, 40 MHz BW, SISO 2
Diagram 10:	5210 MHz, 80 MHz BW, SISO 2

Test engineer: Ermin Pasalic

Complies?	N/A

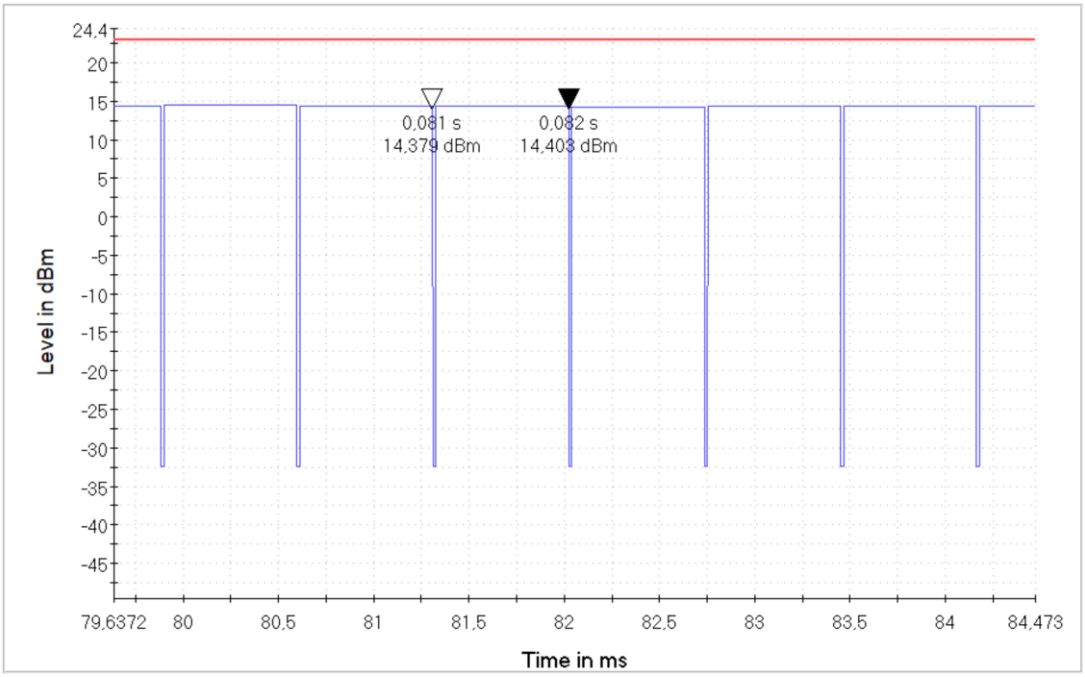
Diagram 1

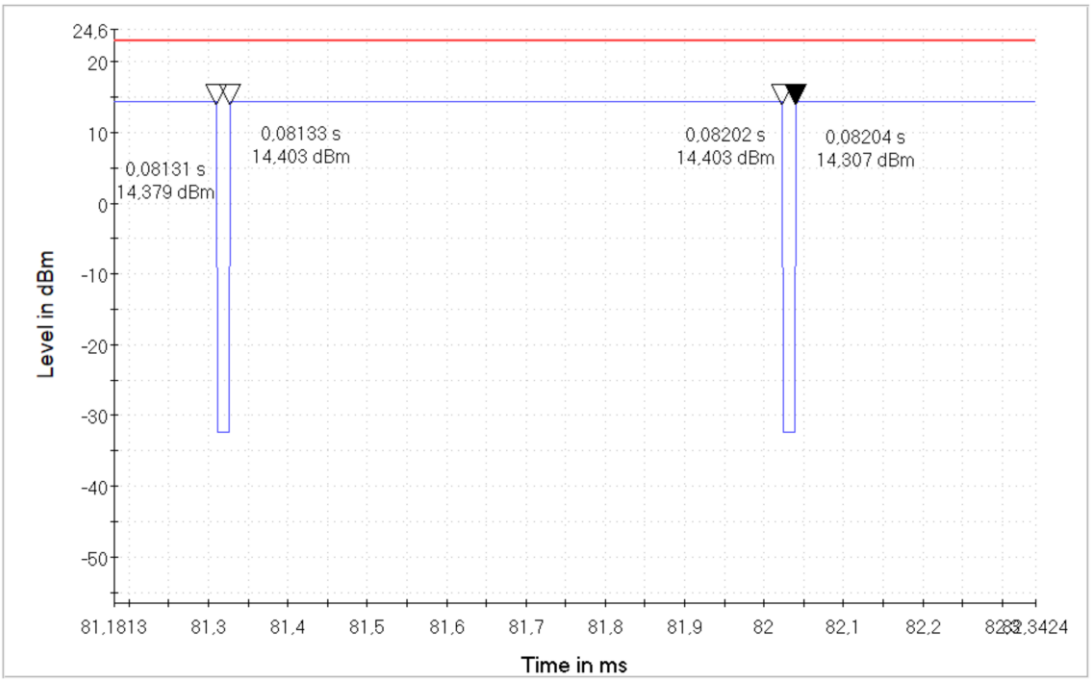




DUT operating at 5180 MHz and 20 MHz BW, MIMO; Duty cycle

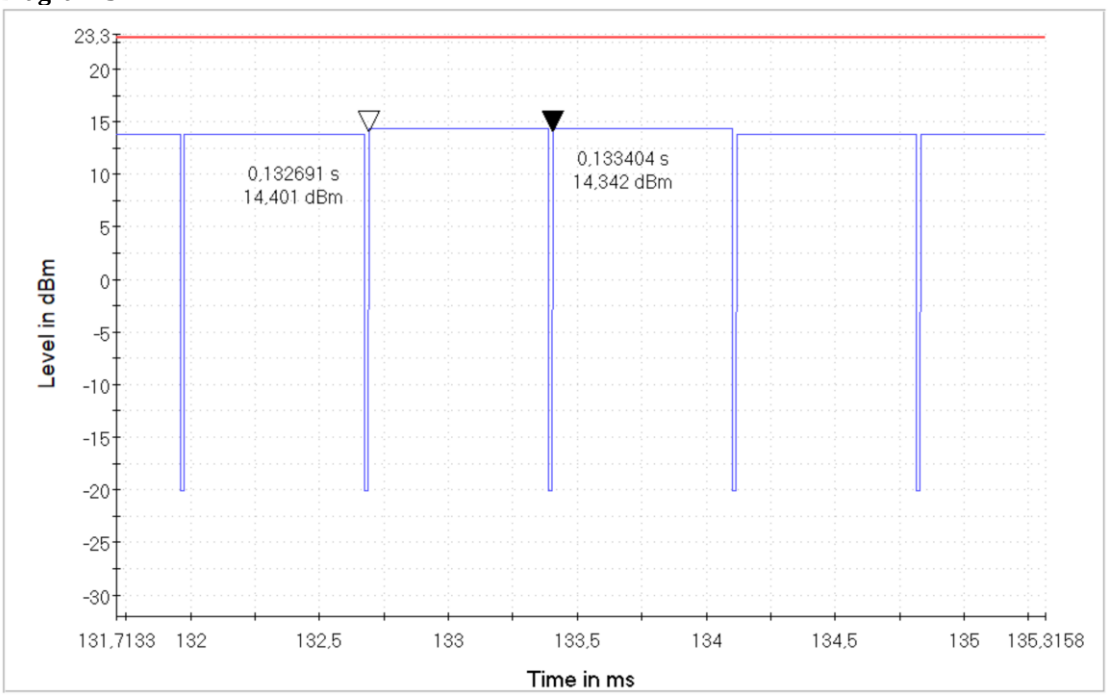
Diagram 2

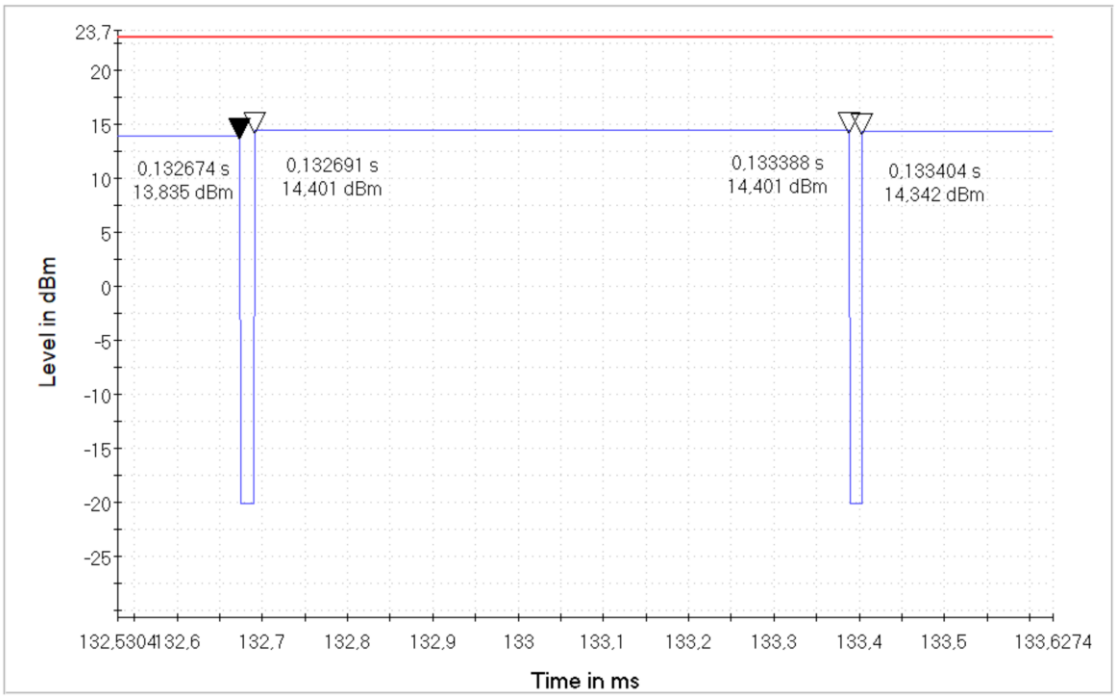




DUT operating at 5220 MHz and 20 MHz BW, MIMO; Duty cycle

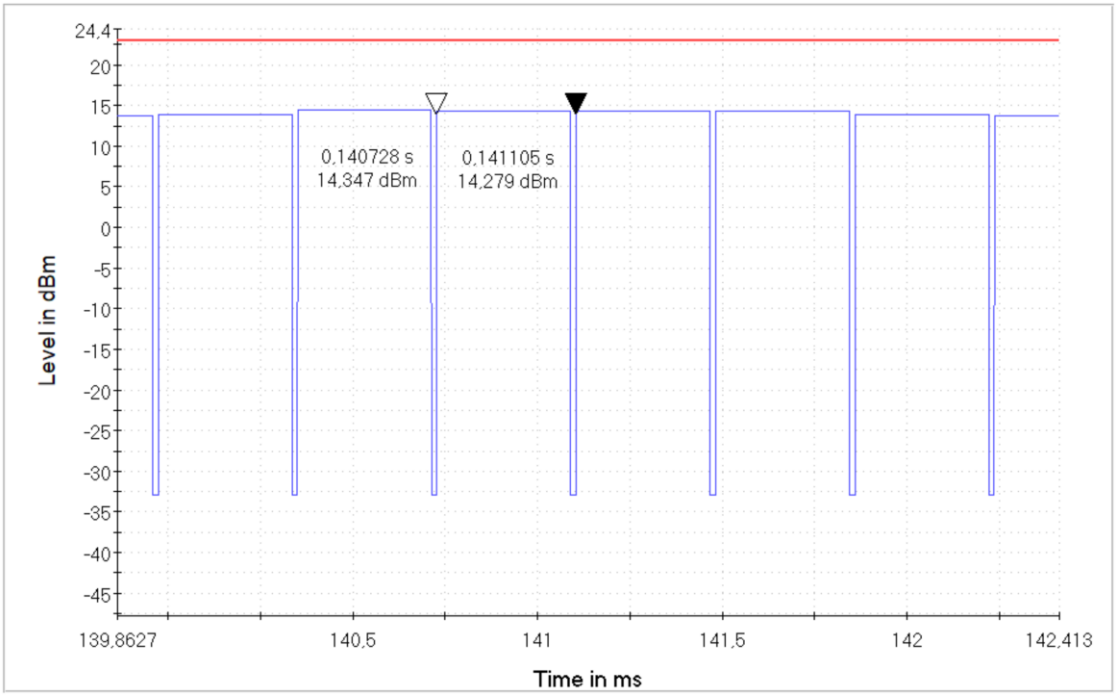
Diagram 3

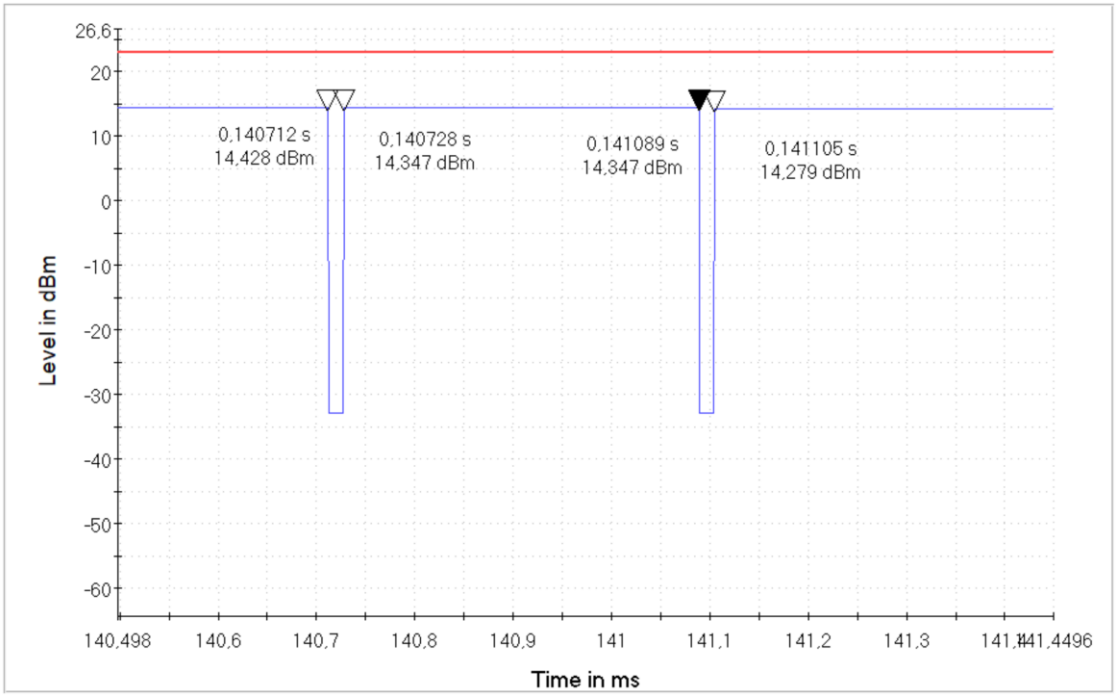




DUT operating at 5240 MHz and 20 MHz BW, MIMO; Duty cycle

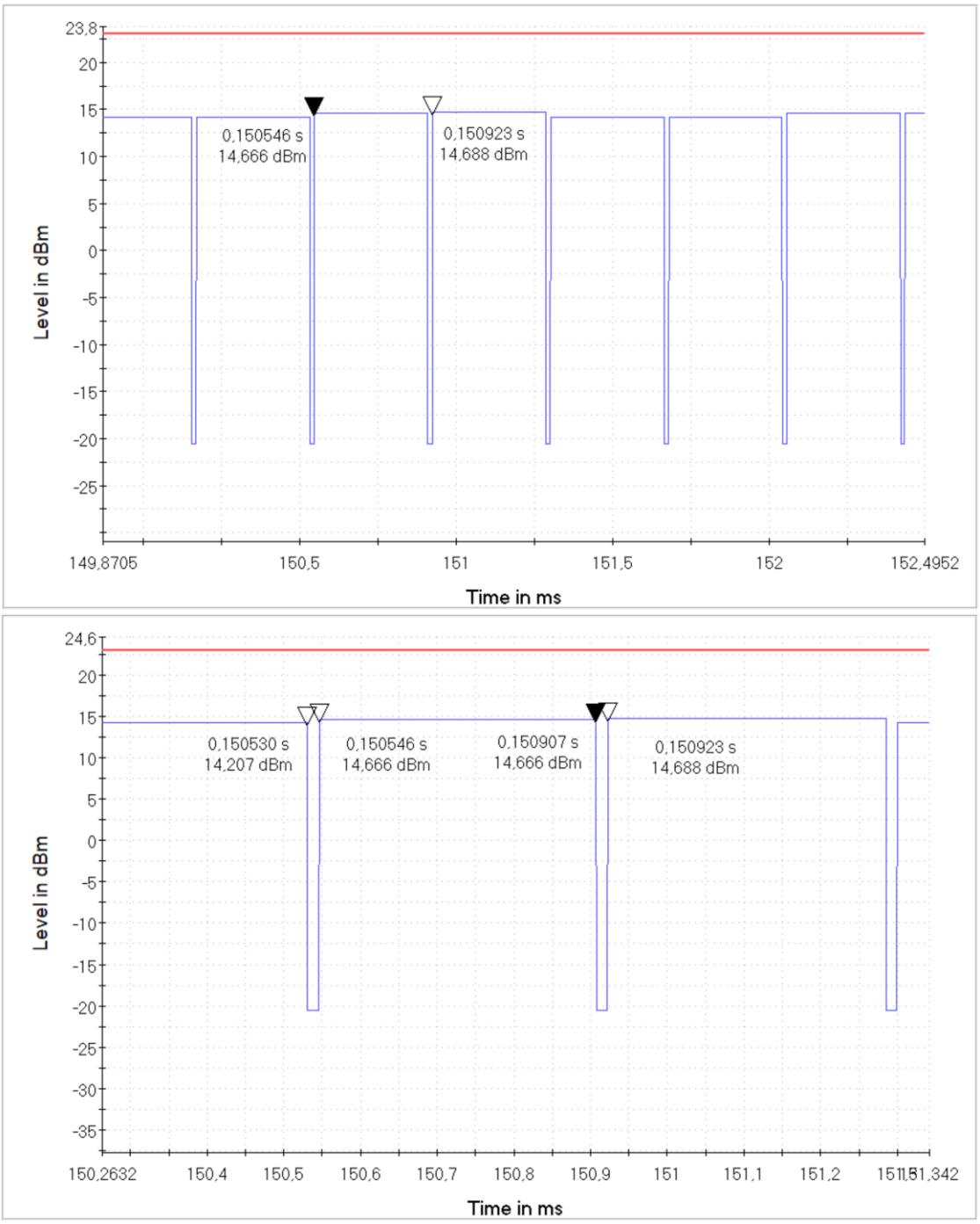
Diagram 4





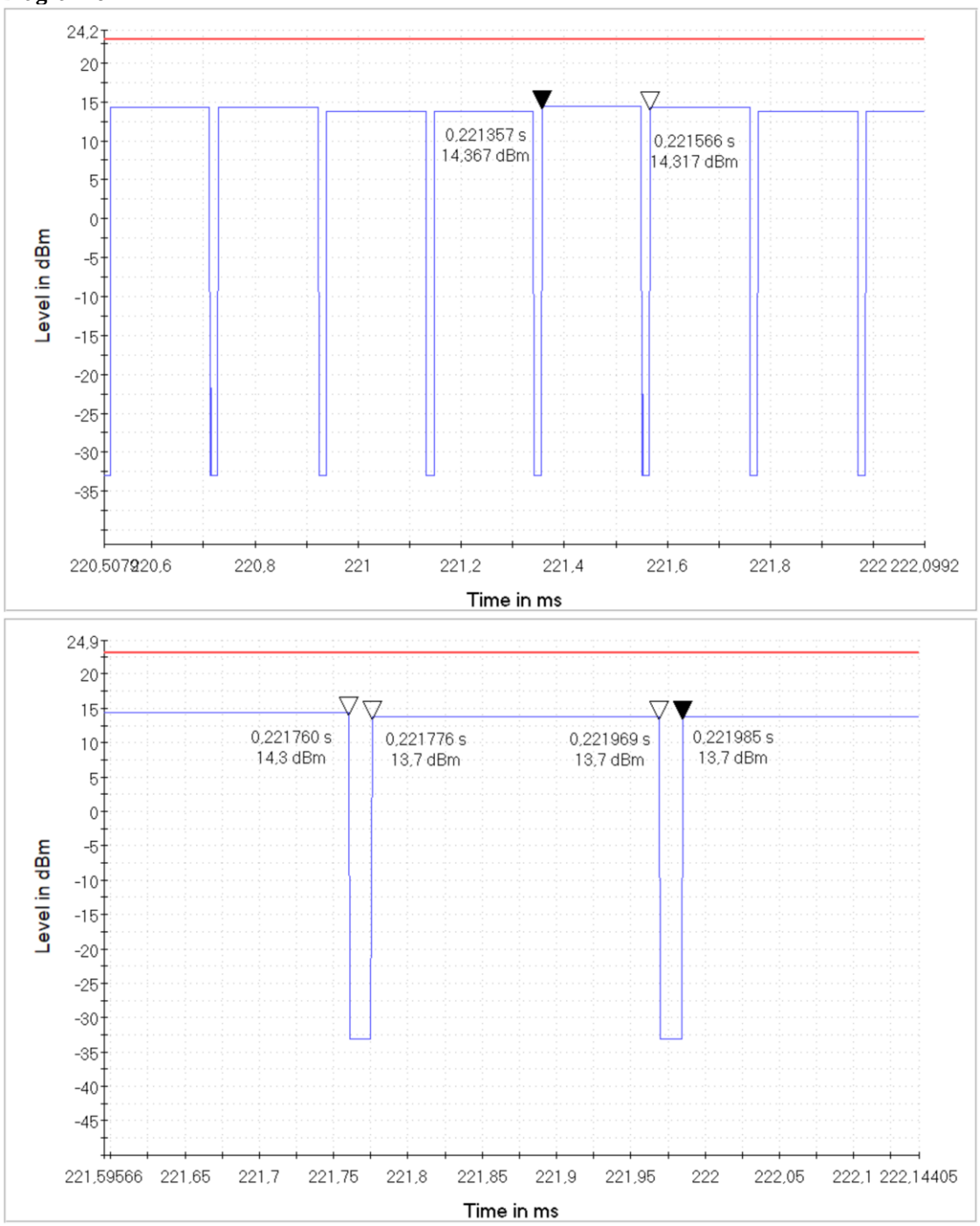
DUT operating at 5190 MHz and 40 MHz BW, MIMO; Duty cycle

Diagram 5



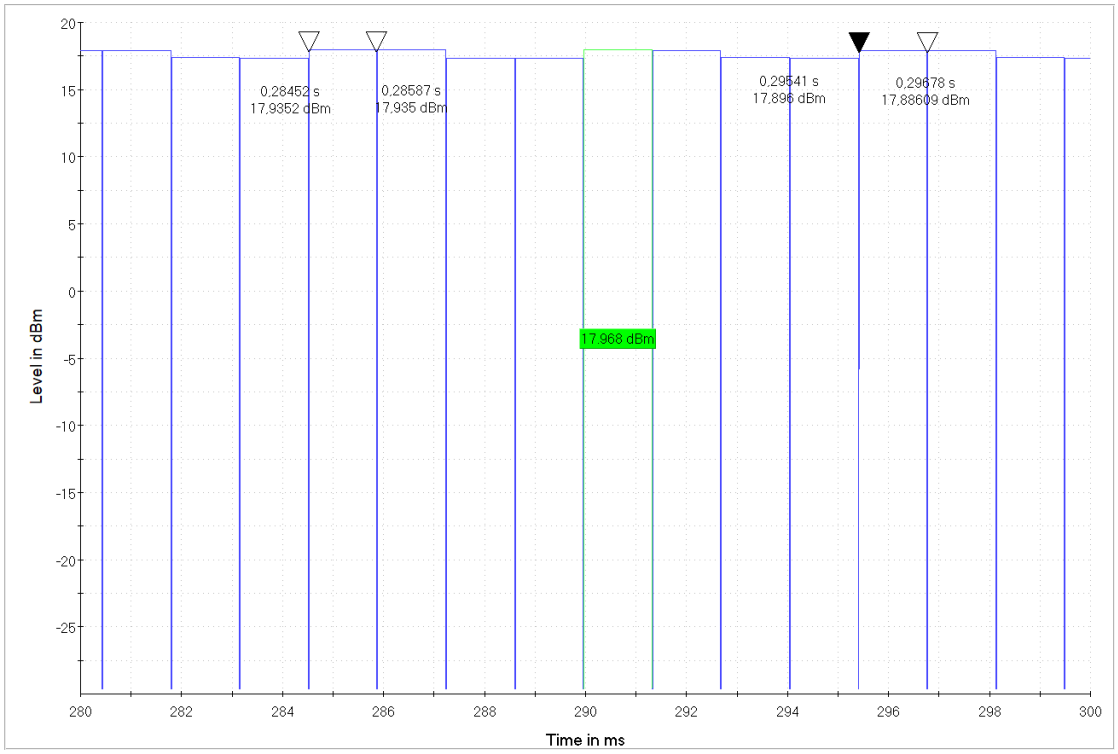
DUT operating at 5230 MHz and 40 MHz BW, MIMO; Duty cycle

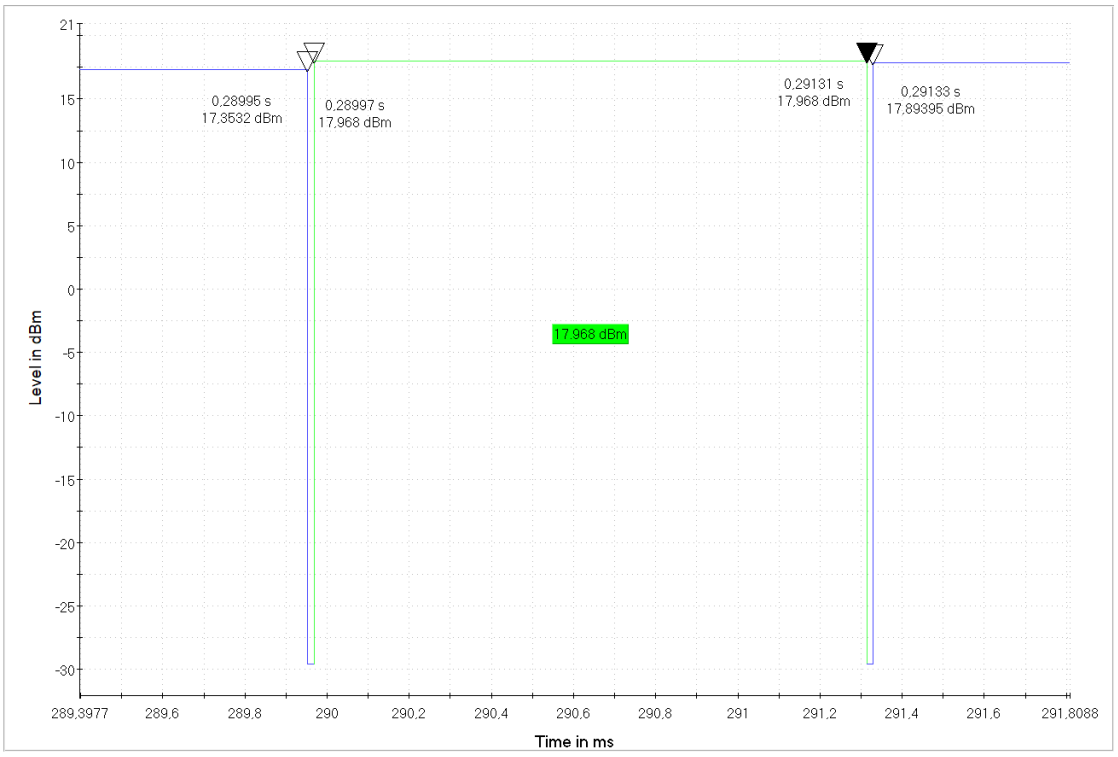
Diagram 6



DUT operating at 5210 MHz and 80 MHz BW, MIMO; Duty cycle

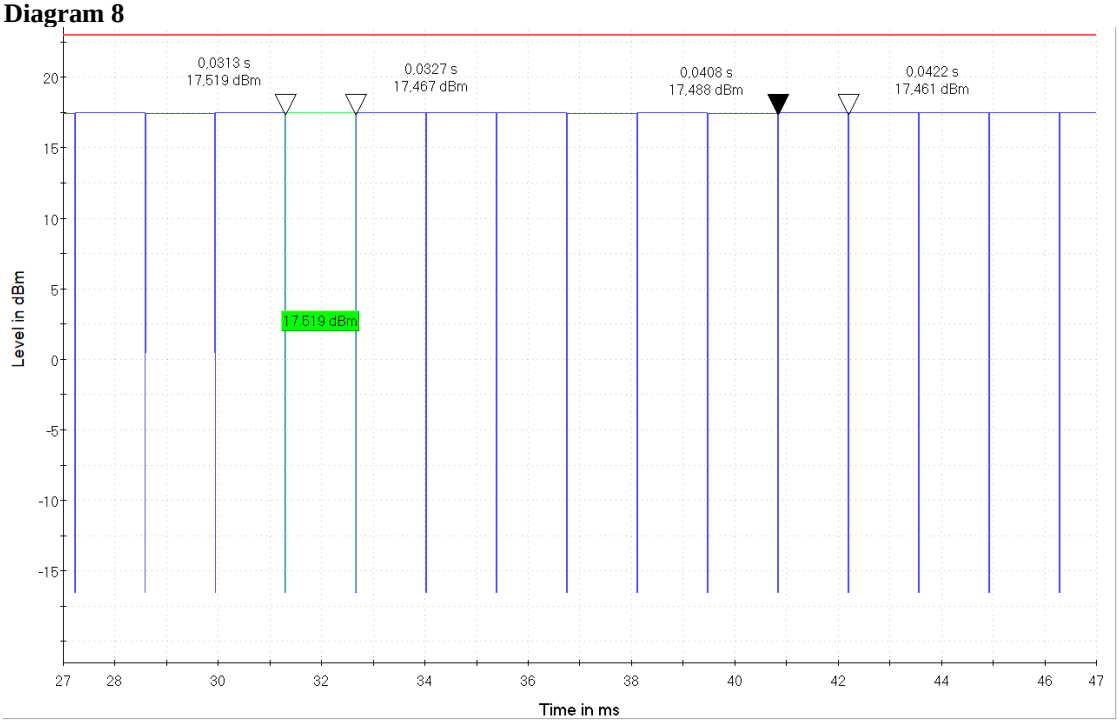
Diagram 7

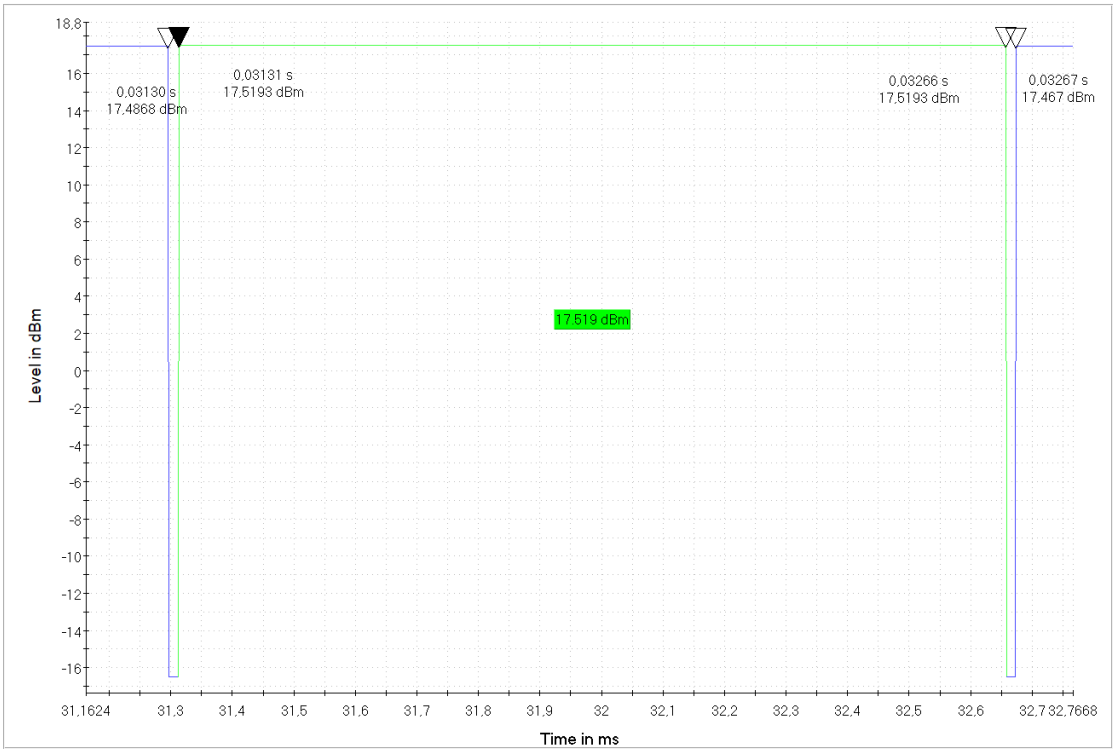




DUT operating at 5180 MHz and 20 MHz BW, SISO 2; Duty cycle

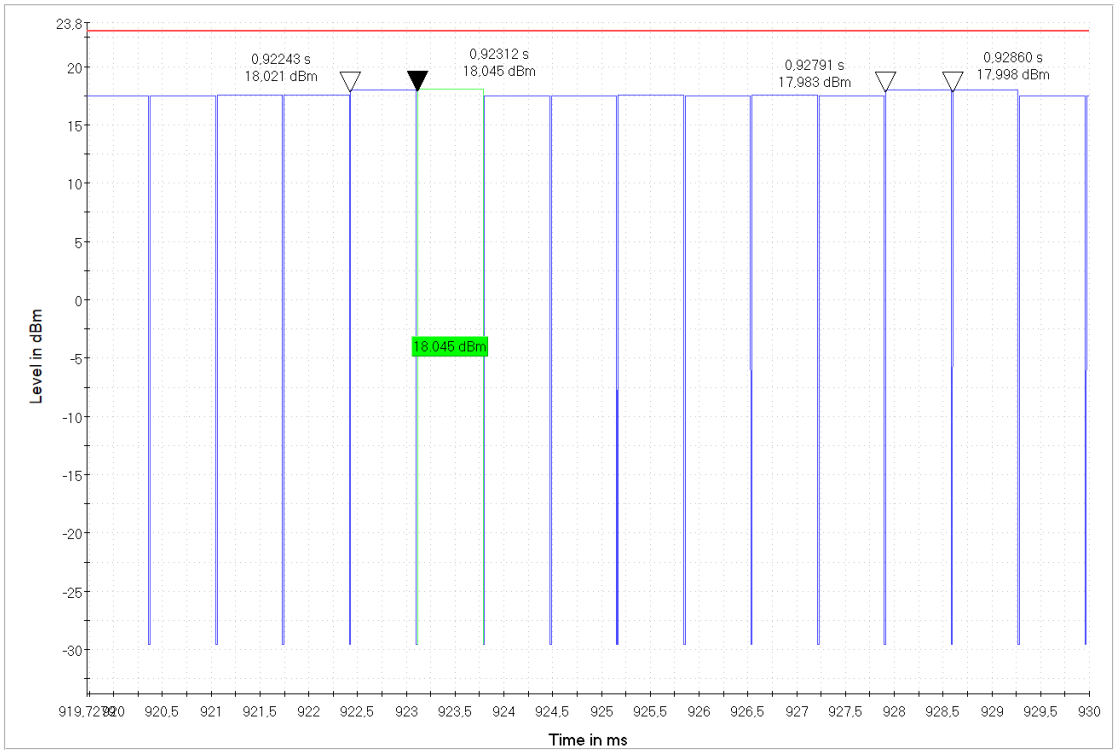
Diagram 8

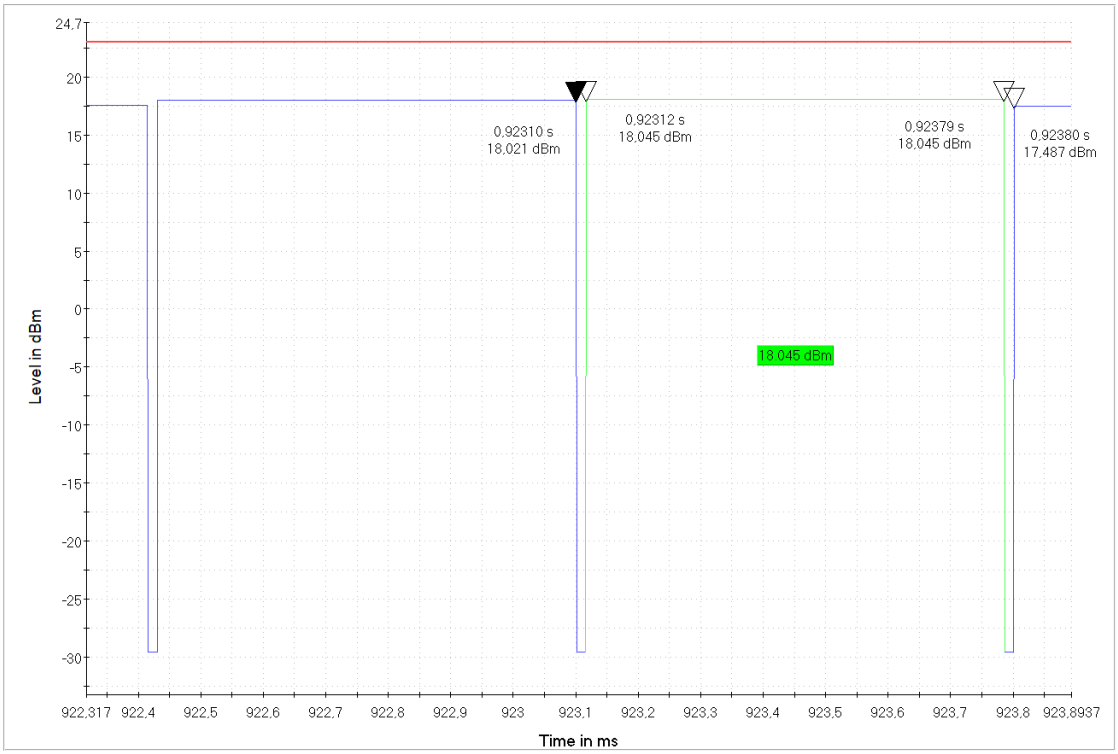




DUT operating at 5240 MHz and 20 MHz BW, SISO 2; Duty cycle

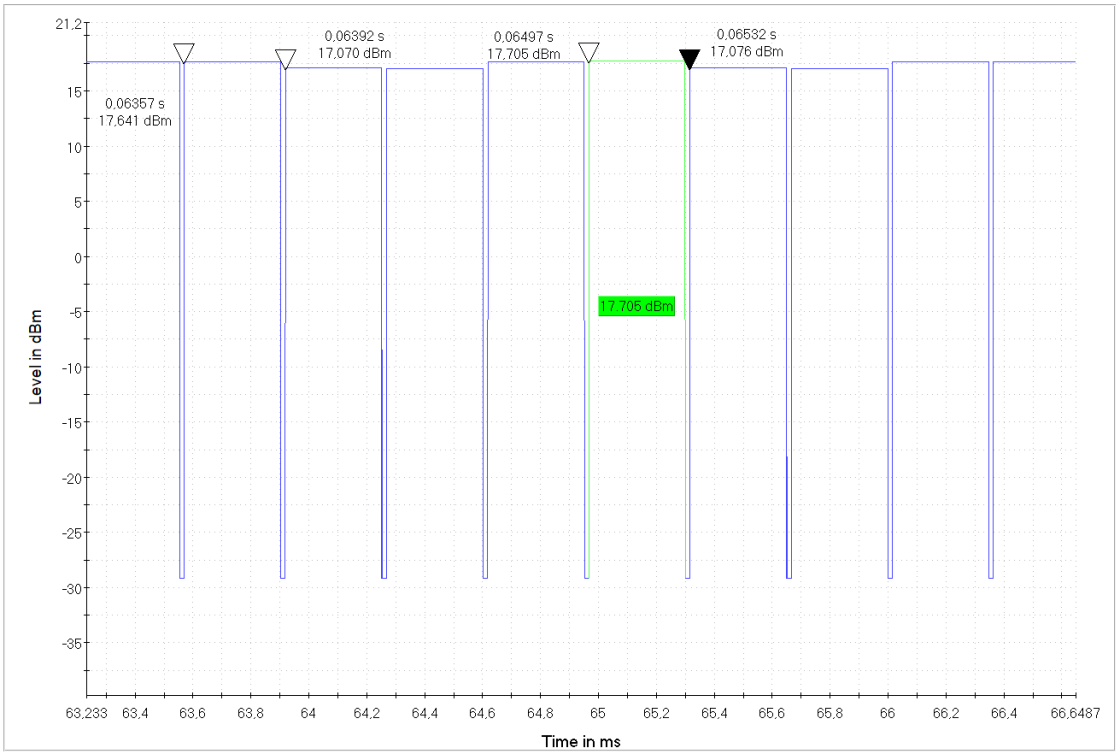
Diagram 9

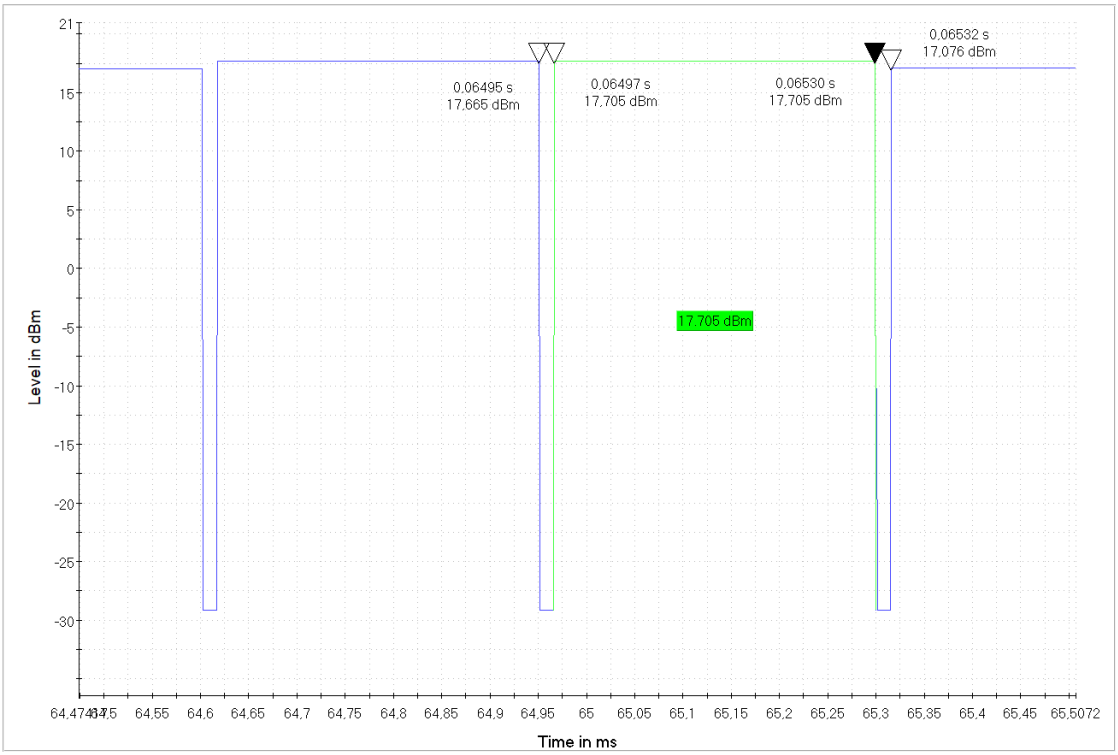




DUT operating at 5190 MHz and 40 MHz BW, SISO 2; Duty cycle

Diagram 10





DUT operating at 5210 MHz and 80 MHz BW, SISO 2; Duty cycle

Maximum conducted output power measurements according to FCC 47 CFR part 15.407 (a) (1) (ii) and (iv)

Date	Temperature	Humidity
2018-11-14	22 °C ± 3 °C	29 % ± 5 %
2018-11-15	21 °C ± 3 °C	35 % ± 5 %

Test setup and procedure

The measurements were performed according to ANSI C63.10 clause 12.3 and KDB 789033 D02 General UNII Test Procedures New Rules v02r01 Dec. 14, 2017 II.E.3.b). Additionally, test in MIMO operating mode was done according 662911 D01 Multiple Transmitter Output v02r01.E.1.

Conducted measurements were performed on units with the temporary antenna connectors, with transmission below 98% of duty cycle and with normal modulation.

Test set-up photos during the tests can be found in the photo section in the separate document, REPORT-ANNEX, AT-DG2 Photos.

Measurement equipment	RISE number
Test site Marconi	15:121
Computer Lenovo ThinkCentre	-
Software R&S WMS32, ver.10.40.10	-
Switching box with RF power meters R&S OSP120 with OSP-B157W8	BX60313
Coaxial cable	BX81424
Coaxial cable	BX81436
Coaxial cable	BX50685
Temperature and humidity meter Testo 625	504 117
120 V AC/60 Hz AC Power source HP 6813B	503 091
Multimeter Fluke 85 III	503 418
Temperature and humidity meter Testo 625	503 498

Results

MIMO	802.11ac		
T_{nom} 20°C	V_{nom} 120 V AC		
	Max conducted output power (RMS detector – gated power meter)		
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz	f = 5210 MHz BW = 80 MHz
MCS0	14.4	14.1	13.9
MCS1	14.3	14.3	13.8
MCS2	14.2	14	13.7
MCS3	14	14	13.7
MCS4	14	13.9	13.7
MCS5	14	13.9	13.7
MCS6	13.9	13.9	13.7
MCS7	13.8	13.9	13.7
MCS8	13.8	13.8	13.6
MCS9	NA, Note	NA, Note	NA, Note

Note: DUT doesn't support MCS9

SISO 1 (chain 1, 2.5 dBi antenna gain)	802.11ac		
T_{nom} 20°C	V_{nom} 120 V AC		
	Max conducted output power (RMS detector – gated power meter)		
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz	f = 5210 MHz BW = 80 MHz
MCS0	11.2	10.8	10.6
MCS1	11.2	10.8	10.6
MCS2	11.3	10.9	10.6
MCS3	11	10.8	10.5
MCS4	11	10.7	10.6
MCS5	11	10.8	10.5
MCS6	10.9	10.7	10.5
MCS7	11	10.7	10.5
MCS8	10.8	10.7	10.5

SISO 2, (chain 2 – 6 dBi antenna gain)	802.11ac		
T_{nom} 20°C	V_{nom} 120 V AC		
	Max conducted output power (RMS detector – gated power meter)		
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz	f = 5210 MHz BW = 80 MHz
MCS0	11.4	11.6	11.1
MCS1	11.5	11.3	11.1
MCS2	11.3	11.4	11.1
MCS3	11	11.3	10.9
MCS4	11	11.4	10.9
MCS5	11	11.3	10.9
MCS6	10.9	11.2	10.9
MCS7	10.9	11.3	10.9
MCS8	10.9	11.3	10.9

SISO 1, (chain 1 – 2.5 dBi antenna gain)	802.11n	
T_{nom} 20°C	V_{nom} 120 V AC	
	Max conducted output power (RMS detector – gated power meter)	
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz
MCS0	11.2	10.9
MCS1	11.2	10.9
MCS2	11.2	11
MCS3	11	10.8
MCS4	11	10.7
MCS5	10.9	10.8
MCS6	11	10.8
MCS7	11	10.6

SISO 2, (chain 2 – 6 dBi antenna gain)		802.11n
T_{nom} 20°C		V_{nom} 120 V AC
	Max conducted output power (RMS detector – gated power meter)	
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz
MCS0	11.5	11.6
MCS1	11.4	11.6
MCS2	11.4	11.5
MCS3	11.2	11.6
MCS4	11.1	11.5
MCS5	7.3	11.4
MCS6	11.1	11.4
MCS7	11.1	11.4

SISO 1 (chain 1 – 2.5 dBi antenna gain)		802.11a
T_{nom} 20°C		V_{nom} 120 V AC
	Max conducted output power (RMS detector – gated power meter)	
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz
54 Mbps	10.9	10.8
48 Mbps	10.9	10.7
36 Mbps	10.9	10.8

SISO 2, (chain 2 – 6 dBi antenna gain)		802.11a
T_{nom} 20°C		V_{nom} 120 V AC
	Max conducted output power (RMS detector – gated power meter)	
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz
54 Mbps	11.2	11.5
48 Mbps	11.1	11.5
36 Mbps	11.2	11.5

Conducted output power as function of voltage variation

MIMO		802.11ac	
T_{nom} 20°C	MSC0		Power setting: p9
	Max conducted output power (RMS detector – gated power meter)		
	f = 5180 MHz BW = 20 MHz	f = 5220 MHz BW = 20 MHz	f = 5240 MHz BW = 20 MHz
$V_{85\% nom}$ 102 V AC	14.3	14.4	14.5
V_{nom} 120 V AC	14.4	14.3	14.5
$V_{115\% nom}$ 138 V AC	14.2	14.2	14.4

MIMO		802.11ac	
T_{nom} 20°C	MSC0		Power setting: p9
	Max conducted output power (RMS detector – gated power meter)		
	f = 5190 MHz BW = 40 MHz	f = 5230 MHz BW = 40 MHz	f = 5210 MHz BW = 80 MHz
$V_{85\% nom}$ 102 V AC	14.2	14.5	14.0
V_{nom} 120 V AC	14.2	14.6	14.0
$V_{115\% nom}$ 138 V AC	14.2	14.5	14.0

SISO 2, (chain 2 – 6 dBi antenna gain)		802.11ac	
T_{nom} 20°C	MSC0		Power setting: p9
	Max conducted output power (RMS detector – gated power meter)		
	f = 5180 MHz BW = 20 MHz	f = 5220 MHz BW = 20 MHz	f = 5240 MHz BW = 20 MHz
$V_{85\% nom}$ 102 V AC	11.4	11.8	11.4
V_{nom} 120 V AC	11.7	11.7	11.6
$V_{115\% nom}$ 138 V AC	11.5	11.6	11.5

SISO 2, (chain 2 – 6 dBi antenna gain)		802.11.ac	
T_{nom} 20°C	MSC0		Power setting: p9
	Max conducted output power (RMS detector – gated power meter)		
	f = 5190 MHz BW = 40 MHz	f = 5230 MHz BW = 40 MHz	f = 5210 MHz BW = 80 MHz
$V_{85\% nom}$ 102 V AC	11.7	11.9	11.4
V_{nom} 120 V AC	11.7	11.8	11.4
$V_{115\% nom}$ 138 V AC	11.5	11.9	11.4

Note : According 47CFR 15.31(e), for intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage.

Limits

According to 47CFR 15.407(a)(1)(ii), for indoor access point, operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W, (30 dBm), provided the maximum antenna gain does not exceed 6 dBi.

According to 47CFR 15.407(a)(1)(iv), for client devices, operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW, (24 dBm), provided the maximum antenna gain does not exceed 6 dBi.

Test engineer: Ermin Pasalic

Complies?	Yes

Maximum power spectral density measurements according to FCC 47 CFR part 15.407 (a) (1) (ii) and (iv)

Date	Temperature	Humidity
2018-11-14	22 °C ± 3 °C	29 % ± 5 %
2018-11-15	21 °C ± 3 °C	35 % ± 5 %

Test setup and procedure

The measurements were performed according to ANSI C63.10 clause 12.5 and KDB 789033 D02 General UNII Test Procedures New Rules v02r01 Dec. 14, 2017 II.F.1 (II.E.2.f; SA-3). Additionally, test in MIMO operating mode was done according 662911 D01 Multiple Transmitter Output v02r01.E.2.a.

The conducted measurements were performed on units with the temporal antenna connectors, with transmission below 98% of duty cycle and with normal modulation.
The test was performed with RMS detector. Total power in the burst was measured with triggered power meter.

Test set-up photos during the tests can be found in the photo section in the separate document, REPORT-ANNEX, AT-DG2 Photos.

Measurement equipment	RISE number
Test site Marconi	15:121
Computer Lenovo ThinkCentre	-
Software R&S WMS32, ver.10.40.10	-
Spectrum analyser R&S FSQ 26	BX50694
Switching box with RF power meters R&S OSP120 with OSP-B157W8	BX60313
Coaxial cable	BX81424
Coaxial cable	BX81436
Coaxial cable	BX50685
Temperature and humidity meter Testo 625	504 117
120 V AC/60 Hz AC Power source HP 6813B	503 091
Multimeter Fluke 85 III	503 418
Temperature and humidity meter Testo 625	503 498

Results

MIMO	802.11ac		
T_{nom} 20°C	V_{nom} 120 V AC		
	Max power spectral density (SA-3)		
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz	f = 5210 MHz BW = 80 MHz
MCS0	3.8	0.6	-2.9
MCS1	3.5	0.8	-2.8
MCS2	3.4	0.7	-3.7
MCS3	2	0.8	-3.7
MCS4	2.1	0.6	-3.7
MCS5	2.1	0.7	-3.7
MCS6	2.2	0.6	-3.5
MCS7	2.3	0.6	-3.6
MCS8	2.2	0.5	-3.6
MCS9	NA, Note	NA, Note	NA, Note

Note: Device doesn't support MCS9

SISO 1 (chain 1 – 2.5 dBi antenna gain)	802.11ac		
T_{nom} 20°C	V_{nom} 120 V AC		
	Max power spectral density (SA-3)		
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz	f = 5210 MHz BW = 80 MHz
MCS0	0.4	-2.6	-6.4
MCS1	0.4	-2.7	-6.3
MCS2	0.4	-2.6	-6.3
MCS3	-0.9	-2.6	-7
MCS4	-0.9	-2.5	-6.8
MCS5	-0.9	-2.7	-6.8
MCS6	-0.9	-2.7	-6.7
MCS7	-0.8	-2.7	-6.7
MCS8	-0.9	-2.6	-6.6

SISO 2, (chain 2 – 6 dBi antenna gain)	802.11ac		
T_{nom} 20°C	V_{nom} 120 V AC		
	Max power spectral density (SA-3)		
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz	f = 5210 MHz BW = 80 MHz
MCS0	0.5	-1.9	-5.6
MCS1	0.5	-2.2	-5.6
MCS2	0.5	-2.2	-5.6
MCS3	-0.9	-2.2	-6.6
MCS4	-0.9	-2.1	-6.6
MCS5	-0.8	-2.2	-6.5
MCS6	-0.8	-2.2	-6.3
MCS7	-0.8	-2.2	-6.4
MCS8	-0.9	-2.1	-6.5

SISO 1, (chain 1 – 2.5 dBi antenna gain)	802.11n	
T_{nom} 20°C	V_{nom} 120 V AC	
	Max power spectral density (SA-3)	
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz
MCS0	0.4	-2.5
MCS1	0.4	-2.5
MCS2	0.4	-2.5
MCS3	-1.0	-2.5
MCS4	-0.9	-2.7
MCS5	-0.9	-2.6
MCS6	-0.8	-2.6
MCS7	-0.9	-2.5

SISO 2, (chain 2 – 6 dBi antenna gain)		802.11n
T_{nom} 20°C		V_{nom} 120 V AC
	Max power spectral density (SA-3)	
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz
MCS0	0.5	-2.1
MCS1	0.5	-2.1
MCS2	0.4	-2.2
MCS3	-0.9	-2.3
MCS4	-0.9	-2.2
MCS5	-0.8	-2.1
MCS6	-0.8	-2.2
MCS7	-0.8	-2.3

SISO 1 (chain 1 – 2.5 dBi antenna gain)		802.11a
T_{nom} 20°C		V_{nom} 120 V AC
	Max power spectral density (SA-3)	
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz
54 Mbps	-0.5	-2.3
48 Mbps	-0.4	-2.2
36 Mbps	-0.5	-2.1

SISO 2, (chain 2 – 6 dBi antenna gain)		802.11a
T_{nom} 20°C		V_{nom} 120 V AC
	Max power spectral density (SA-3)	
	f = 5180 MHz BW = 20 MHz	f = 5190 MHz BW = 40 MHz
54 Mbps	-0.4	-1.8
48 Mbps	-0.2	-1.8
36 Mbps	-0.4	-1.6

Power spectral density as function of voltage variation

MIMO		802.11ac	
T_{nom} 20°C	MSC0	Power setting: p9	
	Max power spectral density (SA-3)		
	f = 5180 MHz BW = 20 MHz	f = 5220 MHz BW = 20 MHz	f = 5240 MHz BW = 20 MHz
$V_{85\% nom}$ 102 V AC	3.5	3.3	3.5
V_{nom} 120 V AC	3.7	3.4	3.6
$V_{115\% nom}$ 138 V AC	3.5	3.3	3.5

MIMO		802.11ac	
T_{nom} 20°C	MSC0	Power setting: p9	
	Max power spectral density (SA-3)		
	f = 5190 MHz BW = 40 MHz	f = 5230 MHz BW = 40 MHz	f = 5210 MHz BW = 80 MHz
$V_{85\% nom}$ 102 V AC	0.7	0.8	-2.9
V_{nom} 120 V AC	0.7	0.9	-2.8
$V_{115\% nom}$ 138 V AC	0.7	0.7	-2.7

SISO 2, (chain 2 – 6 dBi antenna gain)		802.11ac	
T_{nom} 20°C	MSC0	Power setting: p9	
	Max power spectral density (SA-3)		
	f = 5180 MHz BW = 20 MHz	f = 5220 MHz BW = 20 MHz	f = 5240 MHz BW = 20 MHz
$V_{85\% nom}$ 102 V AC	0.5	0.7	0.5
V_{nom} 120 V AC	0.8	0.7	0.7
$V_{115\% nom}$ 138 V AC	0.5	0.6	0.6

SISO 2, (chain 2 – 6 dBi antenna gain)		802.11ac	
T_{nom} 20°C	MSC0		Power setting: p9
	Max power spectral density (SA-3)		
	f = 5190 MHz BW = 40 MHz	f = 5230 MHz BW = 40 MHz	f = 5210 MHz BW = 80 MHz
$V_{85\% nom}$ 102 V AC	-2.1	-1.7	-5.5
V_{nom} 120 V AC	-2.1	-1.7	-5.5
$V_{115\% nom}$ 138 V AC	-2.2	-1.8	-5.5

Note: No corrections of power spectral density, PSD, for duty cycle were done in upper tables because PSD measured by spectrum analyser is normalized to the power measured in the burst by OSP-B157W8 which is not impacted by duty cycle.

The measurements with RMS detector can be found in the diagrams below:

Diagram 1:	5180 MHz 20 MHz BW MIMO MSC0, Power spectral density
Diagram 2:	5220 MHz 20 MHz BW MIMO MSC0, Power spectral density
Diagram 3:	5240 MHz 20 MHz BW MIMO MSC0, Power spectral density
Diagram 4:	5190 MHz 40 MHz BW MIMO MSC0, Power spectral density
Diagram 5:	5230 MHz 40 MHz BW MIMO MSC0, Power spectral density
Diagram 6:	5210 MHz 80 MHz BW MIMO MSC0, Power spectral density
Diagram 7:	5180 MHz 20 MHz BW SISO 2 MSC0, Power spectral density
Diagram 8:	5220 MHz 20 MHz BW SISO 2 MSC0, Power spectral density
Diagram 9:	5240 MHz 20 MHz BW SISO 2 MSC0, Power spectral density
Diagram 10:	5190 MHz 40 MHz BW SISO 2 MSC0, Power spectral density
Diagram 11:	5230 MHz 40 MHz BW SISO 2 MSC0, Power spectral density
Diagram 12:	5210 MHz 80 MHz BW SISO 2 MSC0, Power spectral density

Note: the results in the diagrams are not corrected for duty cycle.

Limits

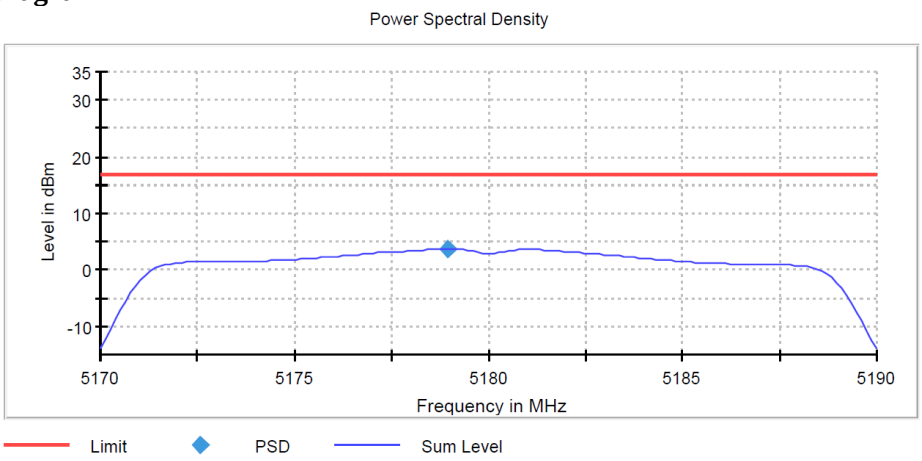
According to 47CFR 15.407(a)(1)(ii), for indoor access point, operating in the band 5.15-5.25 GHz, the maximum power spectral density shall not exceed 17 dBm in any 1 MHz band, provided that max antenna gain is 6 dBi.

According to 47CFR 15.407(a)(1)(iv), for client devices, operating in the band 5.15-5.25 GHz, the maximum power spectral density shall not exceed 11 dBm in any 1 MHz band provided that max antenna gain is 6 dBi.

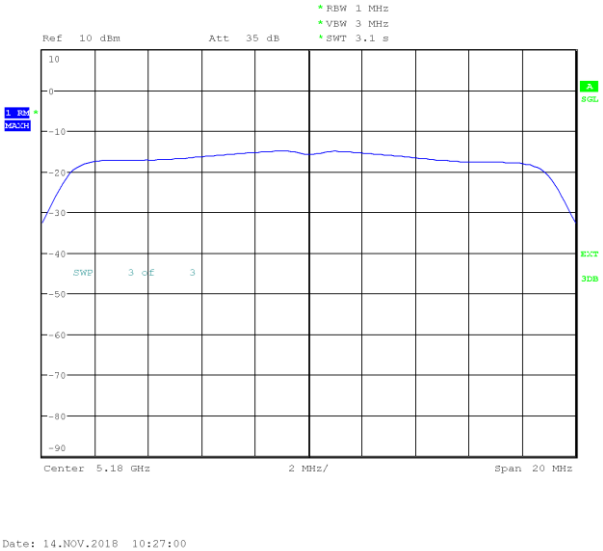
Test engineer: Ermin Pasalic

Complies?	Yes

Diagram 1

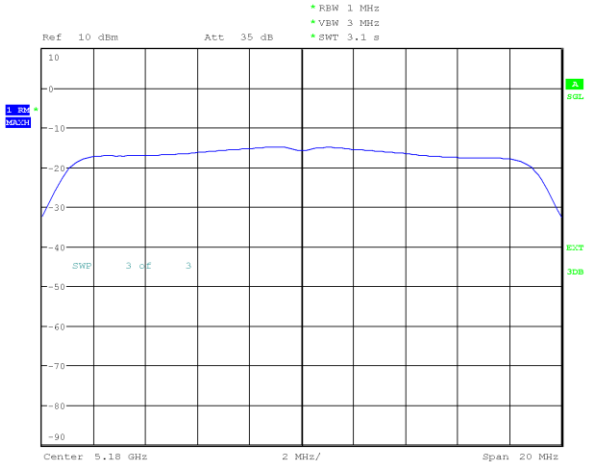


PSD – total



Date: 14.NOV.2018 10:27:00

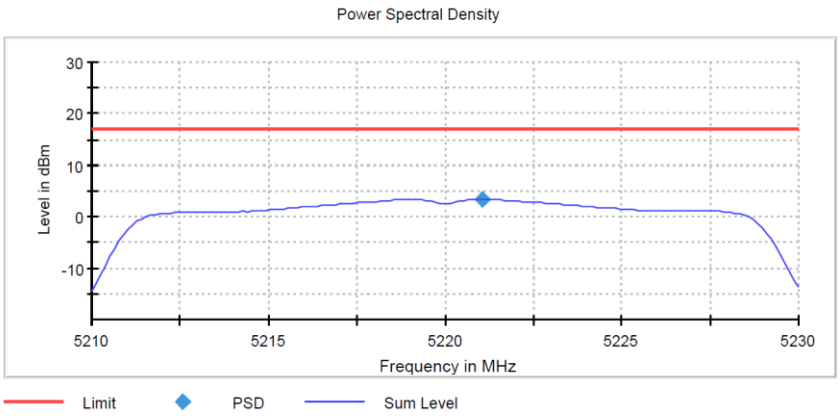
PSD – chain 1, 2.5 dBi antenna gain



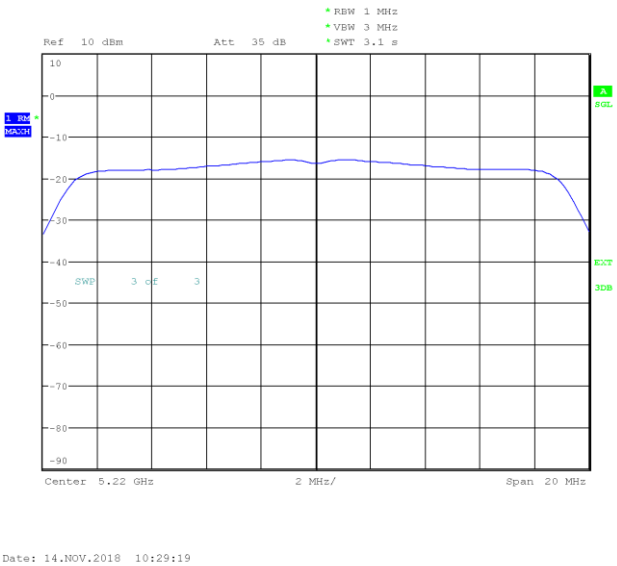
Date: 14.NOV.2018 10:27:46

PSD – chain 2, 6 dBi antenna gain
DUT operating at 5180 MHz 20 MHz BW MIMO MSC0,
Power spectral density

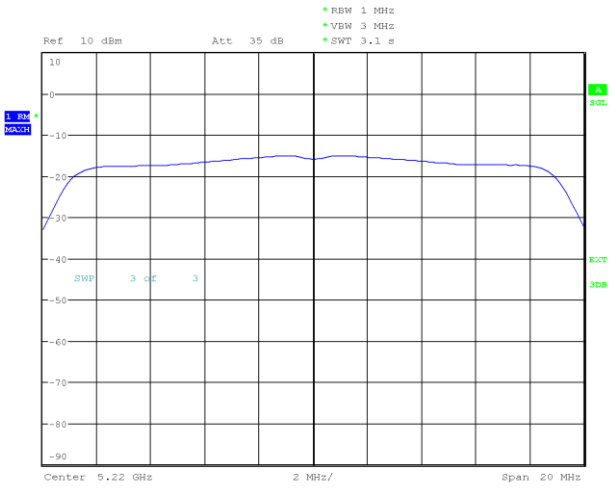
Diagram 2



PSD – total

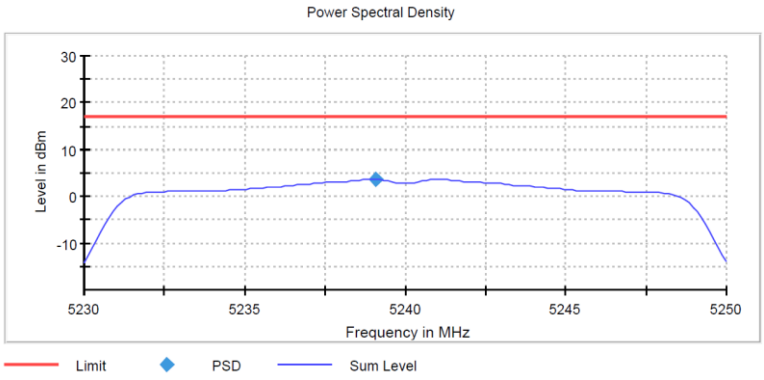


PSD – chain 1, 2.5 dBi antenna gain

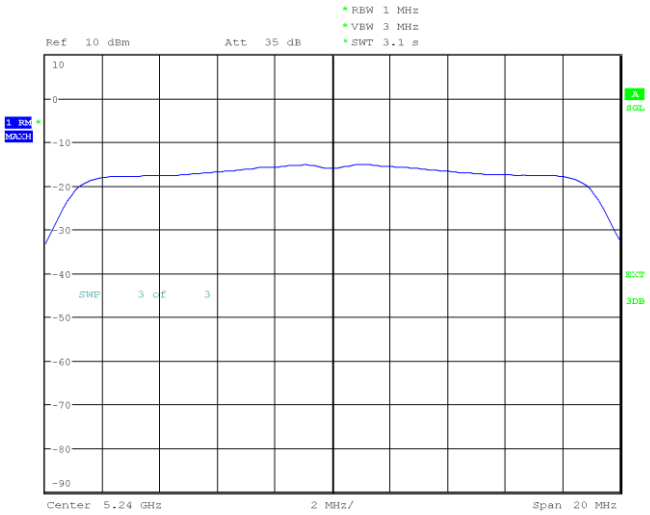


PSD – chain 2, 6 dBi antenna gain
DUT operating at 5220 MHz 20 MHz BW MIMO MSC0,
Power spectral density

Diagram 3



PSD – total



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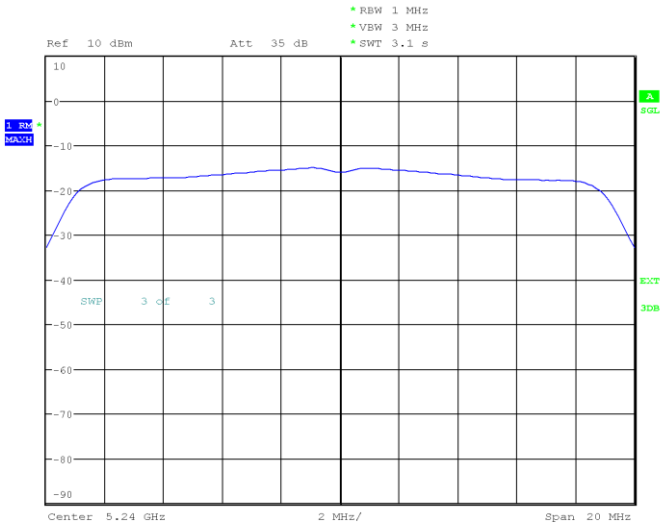
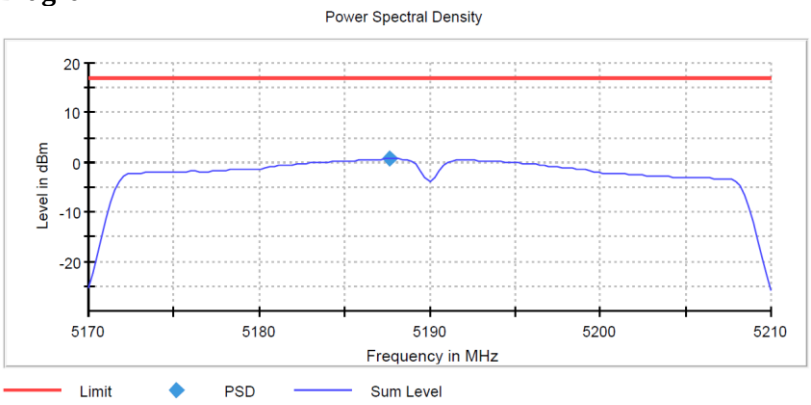
PSD – chain 1, 2.5 dBi antenna gain



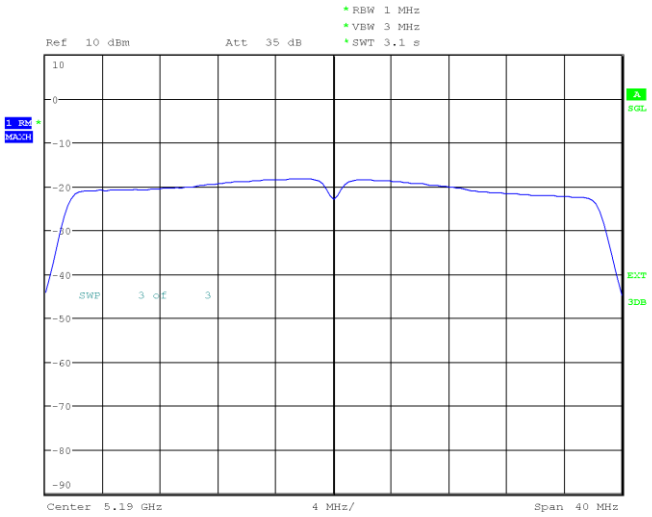
Date: 14.NOV.2018 10:32:15

PSD – chain 2, 6 dBi antenna gain
DUT operating at 5240 MHz 20 MHz BW MIMO MSC0,
Power spectral density

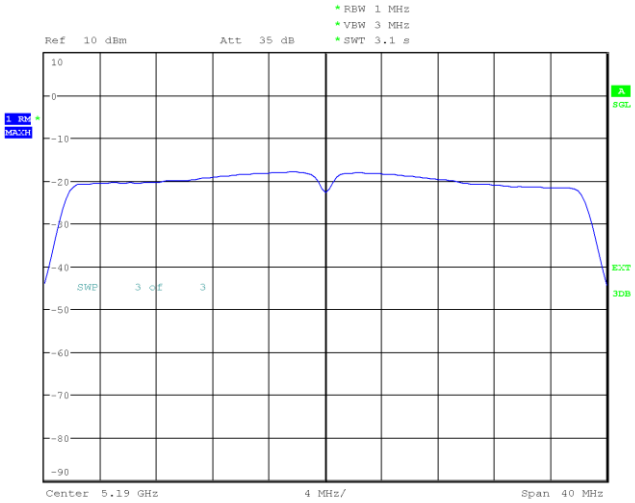
Diagram 4



PSD – total

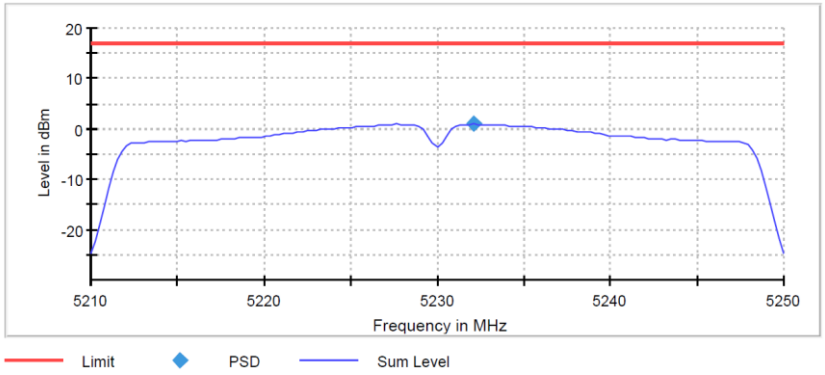


PSD – chain 1, 2.5 dBi antenna gain

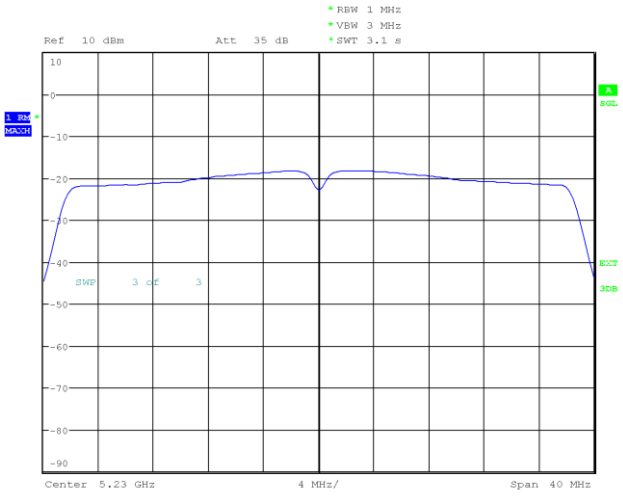


PSD – chain 2, 6 dBi antenna gain
DUT operating at 5190 MHz 40 MHz BW MIMO MSC0,
Power spectral density

Diagram 5

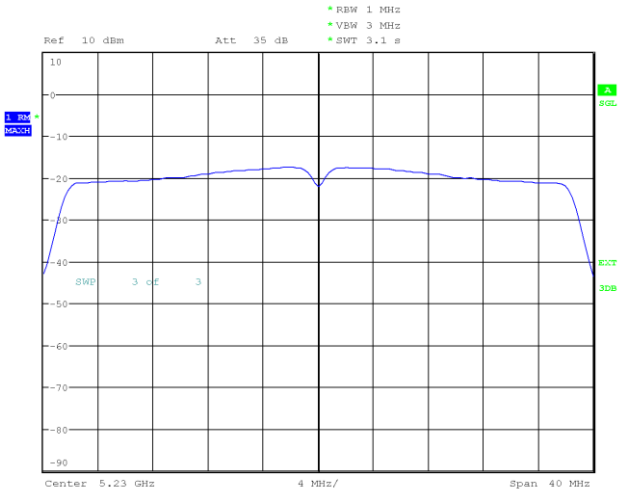


PSD – total



Date: 14.NOV.2018 10:37:28

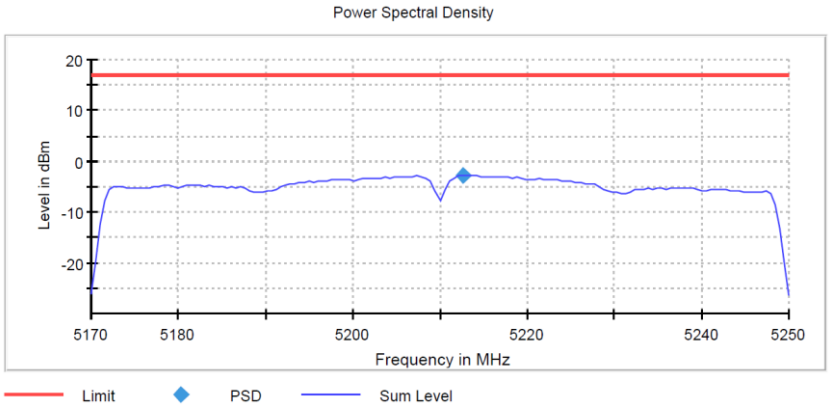
PSD – chain 1, 2.5 dBi antenna gain



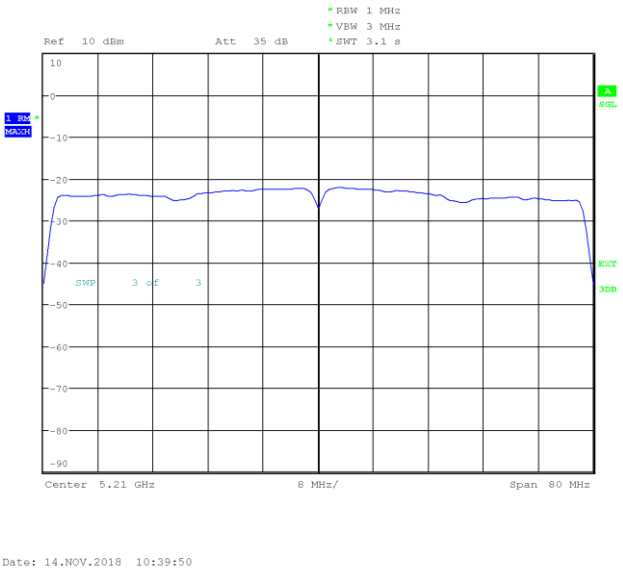
Date: 14.NOV.2018 10:38:12

PSD – chain 2, 6 dBi antenna gain
DUT operating at 5230 MHz 40 MHz BW MIMO MSC0,
Power spectral density

Diagram 6

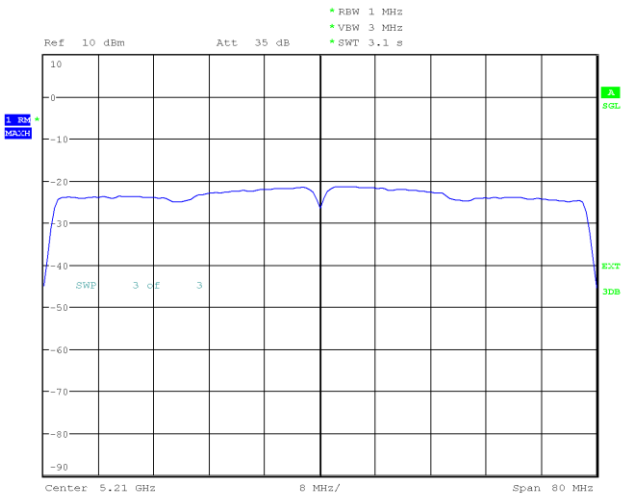


PSD – total



Date: 14.NOV.2018 10:39:50

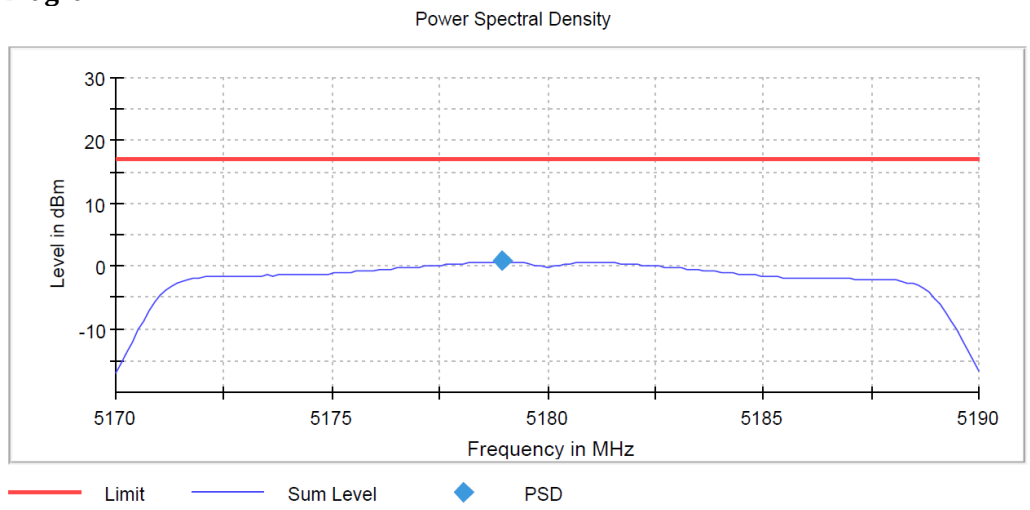
PSD – chain 1, 2.5 dBi antenna gain

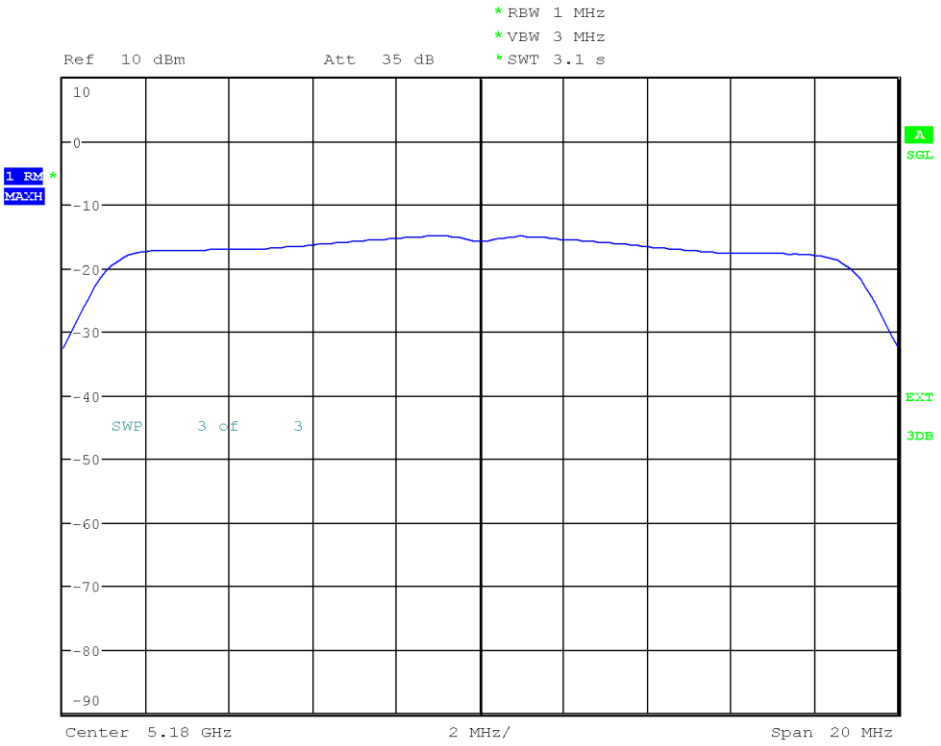


Date: 14.NOV.2018 10:40:34

PSD – chain 2, 6 dBi antenna gain
DUT operating at 5210 MHz 80 MHz BW MIMO MSC0,
Power spectral density

Diagram 7

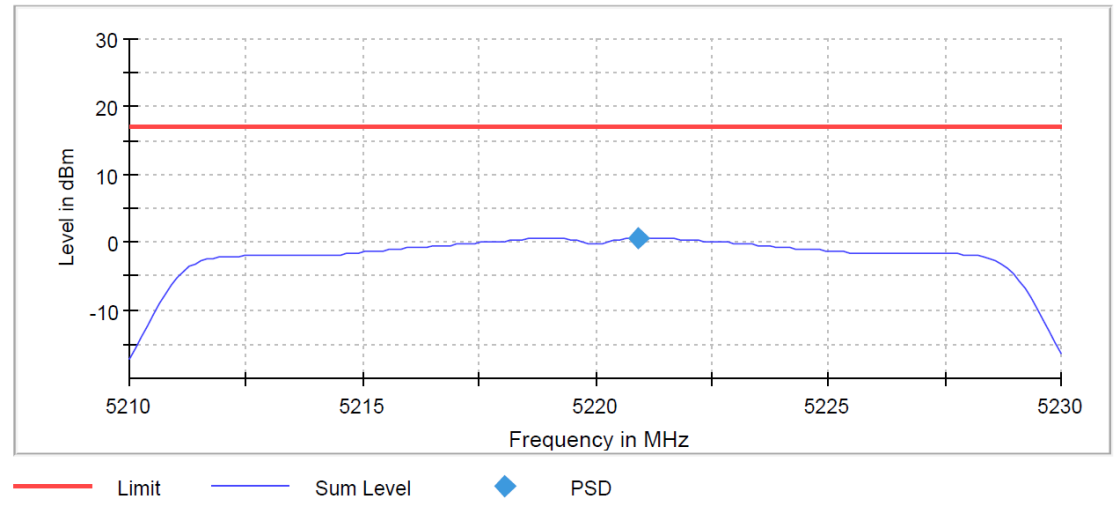


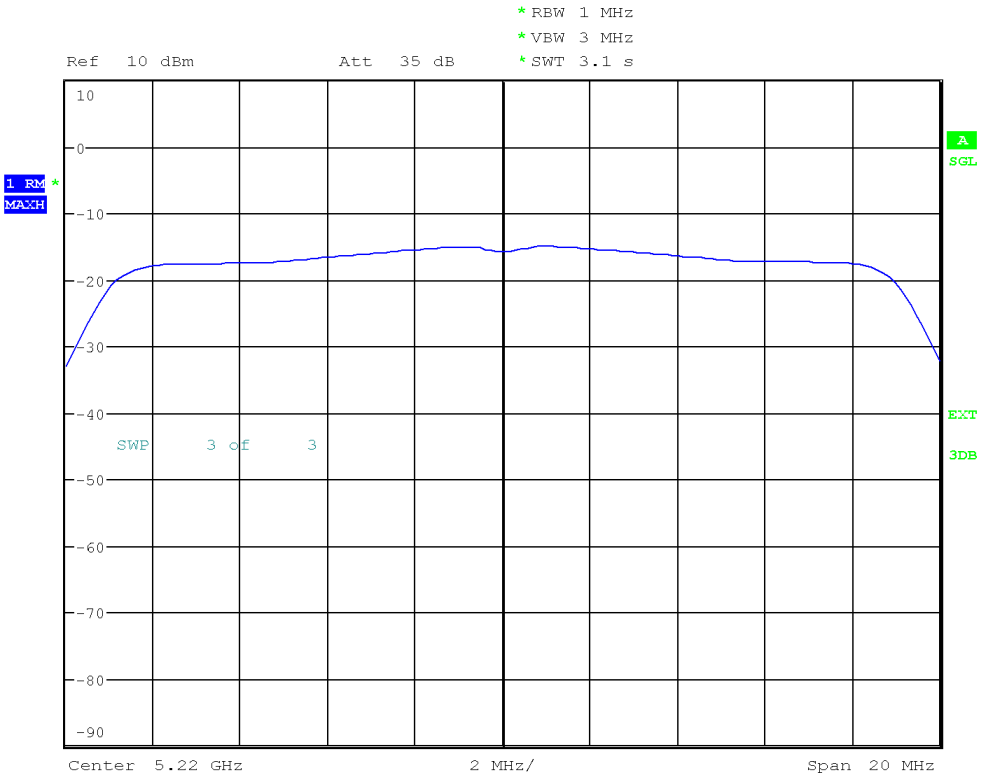


Date: 14.NOV.2018 12:41:45

DUT operating at 5180 MHz 20 MHz BW MSC0 SISO 2, 6 dBi antenna gain
Power spectral density

Diagram 8

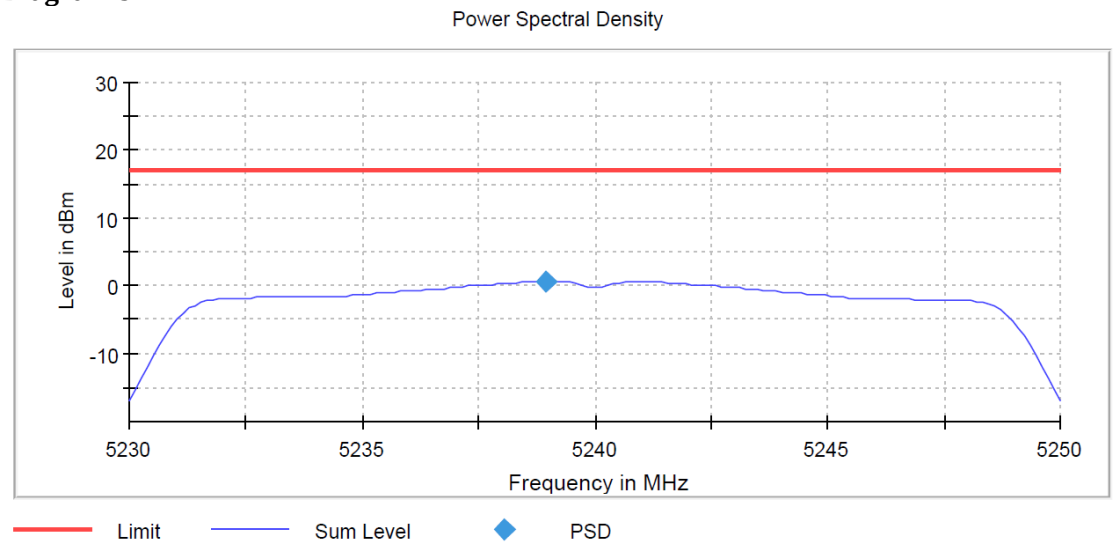


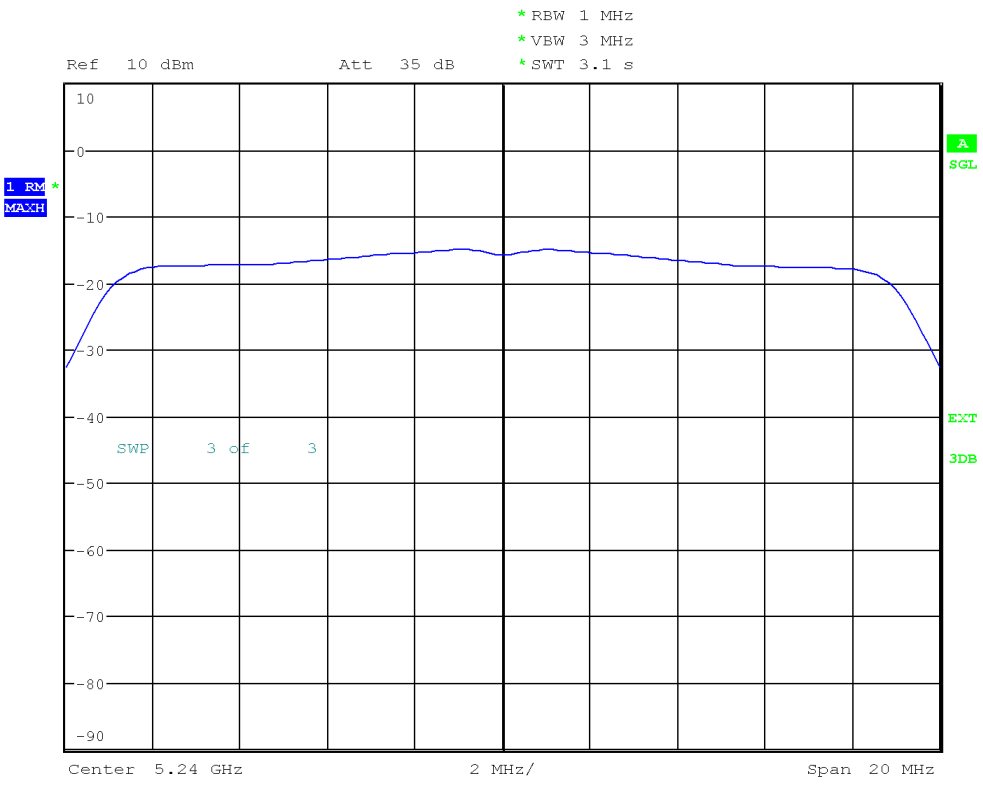


Date: 14.NOV.2018 12:43:00

DUT operating at 5220 MHz 20 MHz BW MSC0 SISO 2, 6 dBi antenna gain
Power spectral density

Diagram 9

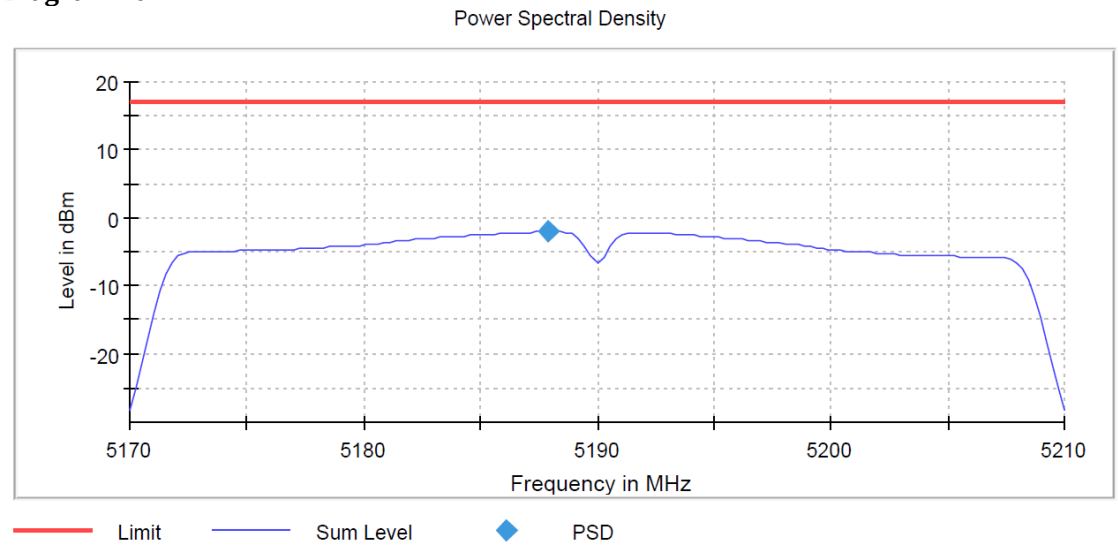


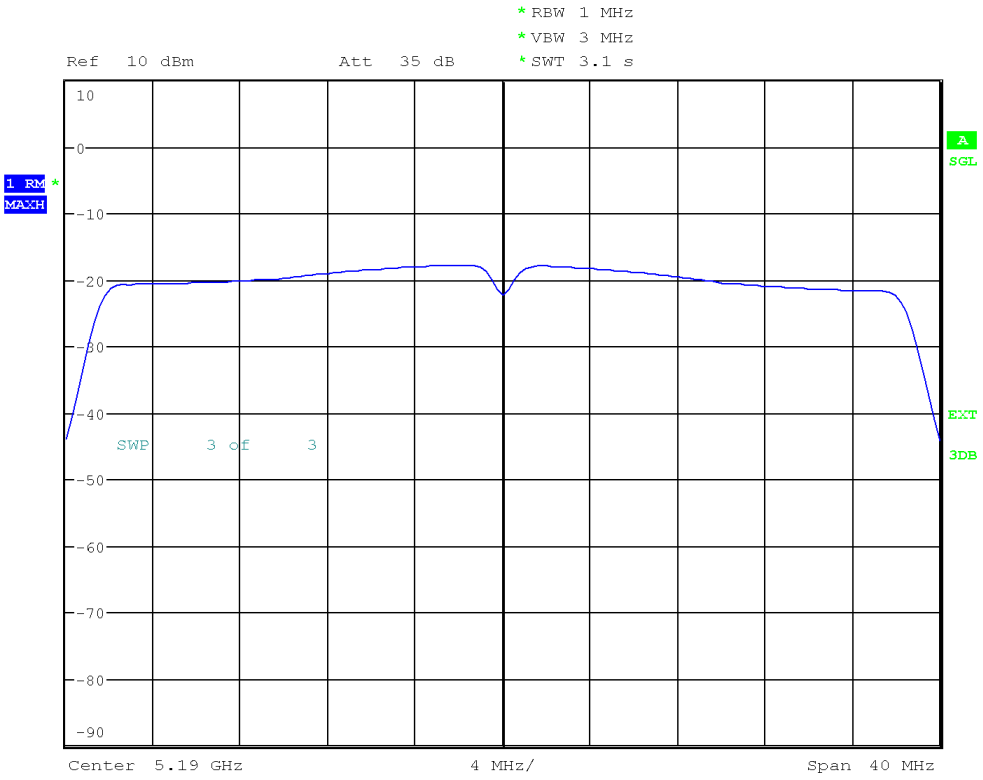


Date: 14.NOV.2018 12:44:16

DUT operating at 5240 MHz 20 MHz BW MSC0 SISO 2, 6 dBi antenna gain
Power spectral density

Diagram 10

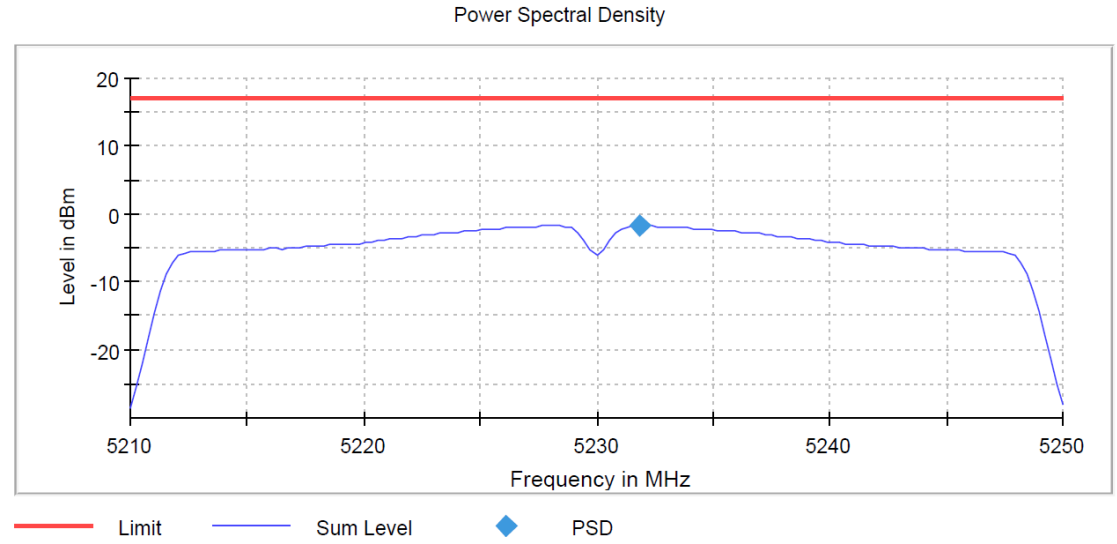


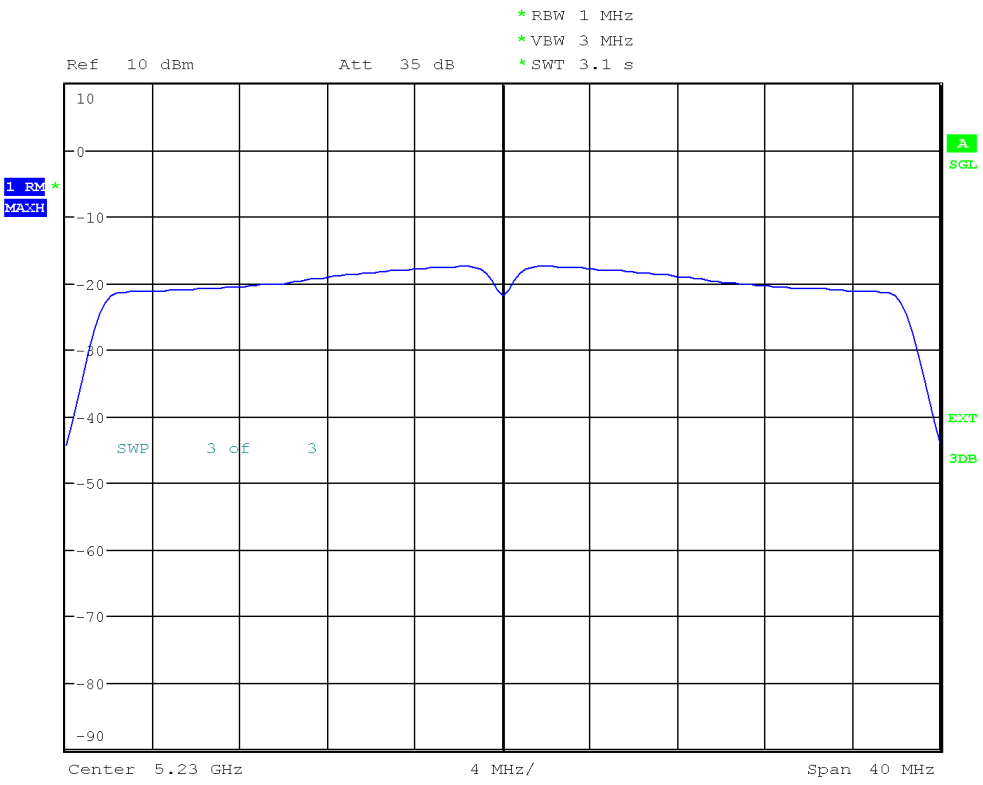


Date: 14.NOV.2018 12:45:39

DUT operating at 5190 MHz 40 MHz BW MSC0 SISO 2, 6 dBi antenna gain
Power spectral density

Diagram 11

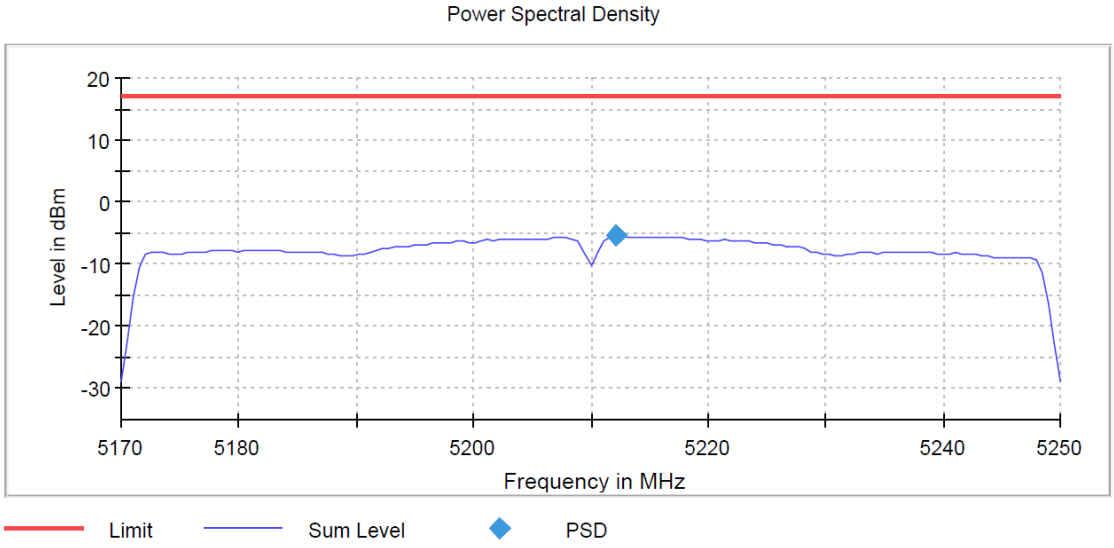


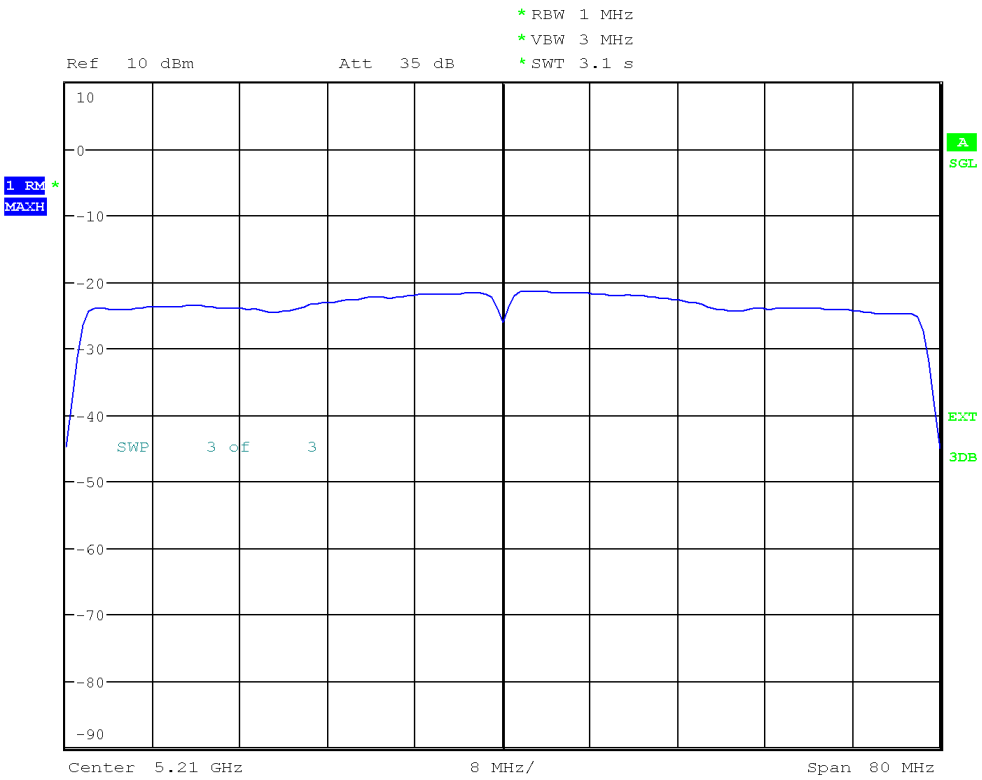


Date: 14.NOV.2018 12:47:00

DUT operating at 5230 MHz 40 MHz BW MSC0 SISO 2, 6 dBi antenna gain
Power spectral density

Diagram 12





Date: 14.NOV.2018 12:48:29

DUT operating at 5210 MHz 80 MHz BW MSC0 SISO 2, 6 dBi antenna gain
Power spectral density

Maximum emission outside of the frequency bands of operation according to FCC 47 CFR part 15.407 (b) (1) and Unwanted emission in the restricted bands according to FCC 47 CFR part 15.407 (b) (7)

Date	Temperature	Humidity
2018-10-18	22°C ± 3 °C	48 % ± 5 %
2018-10-19	22°C ± 3 °C	34 % ± 5 %
2018-10-21	22°C ± 3 °C	44 % ± 5 %
2018-10-31	23°C ± 3 °C	32 % ± 5 %
2018-11-01	22°C ± 3 °C	35 % ± 5 %
2018-11-05	23°C ± 3 °C	38 % ± 5 %
2018-11-06	22°C ± 3 °C	34 % ± 5 %

Test setup and procedure

The measurements were performed according to ANSI C63.10 clause 12.7 and KDB 789033 D02 General UNII Test Procedures New Rules v02r01 Dec. 14, 2017 II.G.1-6.

The measurements were performed on units with the integral antennas, with transmission below 98% of duty cycle and with normal modulation.
During test a LCD monitor was connected to DUT and data stream was transferred from DUT to the terminal.

The test of radiated emission was performed in a semi anechoic chamber. The measurements were performed with both horizontal and vertical polarizations of the antenna. The antenna distance during the measurements in frequency range 30 MHz to 18 GHz was 3.0 m.
The antenna distance during the measurements in frequency range 18 GHz to 40 GHz was 1.0 m.
The EUT height above the reference ground plane was 0.8 m in the frequency range 30-1000 MHz and 1.5 m in the frequency range 1-40 GHz.

The measurement procedure is as follows:

1. A pre-measurement is performed with peak detector. In addition in the frequency range 1 to 8.2 GHz, premeasurement was done with RMS detector, too, due to insufficient dynamic. For measurement < 1 GHz the test object is measured in eight directions with the antenna at three heights, 1.0 m, 1.5 m and 2.0. For measurement between 1 GHz – 40 GHz the test object is measured in seventeen directions with the antenna at one height, 1.5 m.

2. For measurements in the frequency range 1 – 18 GHz, RF absorbers were covering an floor area to comply with site validation requirements according to CISPR 16-1-4:2010.

3. If the emission is close or above the limit during the pre-measurement, the test object is scanned 360 degrees and the antenna height scanned from 1 to 4 m for maximum response. Then the emission is measured with the quasi-peak detector on frequencies below 1 GHz and with the average/peak detector above 1 GHz.

The following RBW were used:
30 MHz-1 GHz: RBW=120 kHz
1-40 GHz: RBW=1 MHz
Number of sweep points and sweep time was set to fulfil need for trace stability and measured point per pixel.

Test set-up photos during the tests can be found in the photo section in the separate document, REPORT-ANNEX, AT-DG2 Photos.

Measurement equipment	RISE number
Semi anechoic chamber, Edison	504114
Computer Lenovo ThinkCentre	-
Software R&S EMC32, ver.9.15.00	503889
EMI test receiver R&S ESU 26	902210
EMI test receiver R&S ESU 40	901385
EMI test receiver R&S ESI 40	503125
Antenna Schaffner CBL 6143	504079
Antenna ETS-Lindgren 3115	902175
Standard gain horn, 18-26 GHz, 20240-20	503674
Standard gain horn, 26-40 GHz, 22240-20	503674
Low Noise Amplifier Miteq, 0.1-18 GHz	504160
Low Noise Amplifier Miteq, 18-26.5 GHz	503285
Low Noise Amplifier Miteq 18-40 GHz	503278
Step attenuator Narda743-60	BX41644
Coaxial cable	BX50672
Coaxial cable	504102
Coaxial cable	504103
Coaxial cable	504104
Coaxial cable	504162
Multimeter Fluke 83	501522
Temperature and humidity meter Testo 625	504117
Semi anechoic chamber, Tesla	503881
Software R&S EMC32, ver.9.15.00	BX62351
EMI test receiver R&S ESU 40	901385
Antenna ETS-Lindgren 3115	902175
Standard gain horn, 8-12.75 GHz	503939
Standard gain horn, 12.75-18 GHz	503900
Low Noise Amplifier Miteq	901545
Huber Suhner antenna cable N-N	BX62218
Coaxial cable	503697
Coaxial cable	BX61530
Coaxial cable	503508
Coaxial cable	503509
Coaxial cable	504206
Coaxial cable	900679
Coaxial cable	900226
Coaxial cable	504035
Coaxial cable	503274
Temperature and humidity meter Testo 625	504188

Results

The pre-measurement emission spectra for the worst case configuration can be found in the diagrams below:

Diagram 1:	Ambient, 30-1000 MHz, vertical and horizontal polarization
Diagram 2:	30-1000 MHz, MIMO 5180 MHz, BW 20 MHz, MCS1, p17 vertical and horizontal polarization
Diagram 3:	Ambient, 1-8.2 GHz, vertical and horizontal polarization
Diagram 4:	1-8.2 GHz, MIMO 5240 MHz, BW 20 MHz, MCS1, p17 vertical and horizontal polarization
Diagram 5:	Ambient, 8.2-12.75 GHz, vertical and horizontal polarization
Diagram 6:	8.2-12.75 GHz, MIMO 5240 MHz, BW 20 MHz, MCS1, p17 vertical and horizontal polarization
Diagram 7:	Ambient, 12.75-18 GHz, vertical and horizontal polarization
Diagram 8:	12.75 GHz-18 GHz, MIMO 5240 MHz, BW 20 MHz, MCS1, p17 vertical and horizontal polarization
Diagram 9:	Ambient, 18-26.5 GHz, vertical and horizontal polarization
Diagram 10:	18 GHz-26.5, MIMO 5240 MHz, BW 20 MHz, MCS1, p17 vertical and horizontal polarization
Diagram 11:	Ambient, 26.5-40 GHz, vertical and horizontal polarization
Diagram 12:	26.5-40, MIMO 5240 MHz, BW 20 MHz, MCS1, p17 vertical and horizontal polarization

Note 1: Worst-case plots are attached.
Note 2: The results in the diagrams are not corrected for duty cycle.

Final measurements

Frequency (MHz)	QP level (dBµV/m)	CAV level (dBµV/m)	Peak level (dBµV/m)	Corr (dB)	Limit (dBµV/m)	Height (m)	Azimuth (deg)	Polarization
30.75	29.8	N/A	35.0	28.4	40	1.72	8	Vertical
189.84	34.7	N/A	36.3	17.9	43.5	1.82	207	Horizontal
374.09	38.2	N/A	40.3	22.2	46	1	164	Horizontal
770.08	40.1	N/A	43.7	27.8	46	1.27	223	Vertical
855.66	28.5	N/A	41.6	28.5	46	1.95	222	Horizontal
924.12	40.5	N/A	44.0	28.9	46	1.05	356	Vertical

Below 1 GHz, quasi peak is applied.
Note: Values of CAV level and peak level in the upper table are corrected for duty cycle off 96.2%, (0.16dB), applicable for channel at 5180 MHz, 20 MHz bandwidth and MCS1.

Frequency (MHz)	CAV level (dBm)	Peak level (dBm)	Corr (dB)	Limit (dBm)	Height (m)	Azimuth (deg)	Polarization
5091.70	-49.2	-36.8	-54.4	-41.2 (CAV)	1.19	218	Vertical
5148.90	-44.9	-28.2	-54.3	-41.2 (CAV)	1.50	142	Vertical
5350.40	-42.9	-31.5	-53.9	-41.2 (CAV)	1.0	139	Horizontal
5390.70	-50.0	-37.7	-53.8	-41.2 (CAV)	1.46	223	Vertical
10479.94	-50.3	-35.9	-102.7	-27 (PK)	1.52	322	Vertical
15719.84	-59.0	-45.9	-97.5	-41.2 (CAV)	2.21	93	Vertical

Average power, CAV, is used for compliance above 1 GHz in the restricted bands, (corresponding class B)
In the restricted bands is peak limit 20 dB higher than CAV limit.
Outside restricted bands, peak limit of -27 dBm is applied.

Note: Values of CAV level and peak level in the upper table are corrected for duty cycle off 96.2 %, (0.16dB), applicable for channel at 5240 MHz, 20 MHz bandwidth and MCS1.

Conversion from the field to eirp and vice versa was done according ANSI C63.10 Annex G and KDB 789033 D02 General UNII Test Procedures New Rules v02r01 II.G.1, respectively.

Remark

Justification measurements were performed of the different antenna configurations, frequency bandwidth, MCS index, channel and placement. The presented results in the reports was judged to represent a worst case scenario based on the justification measurement.

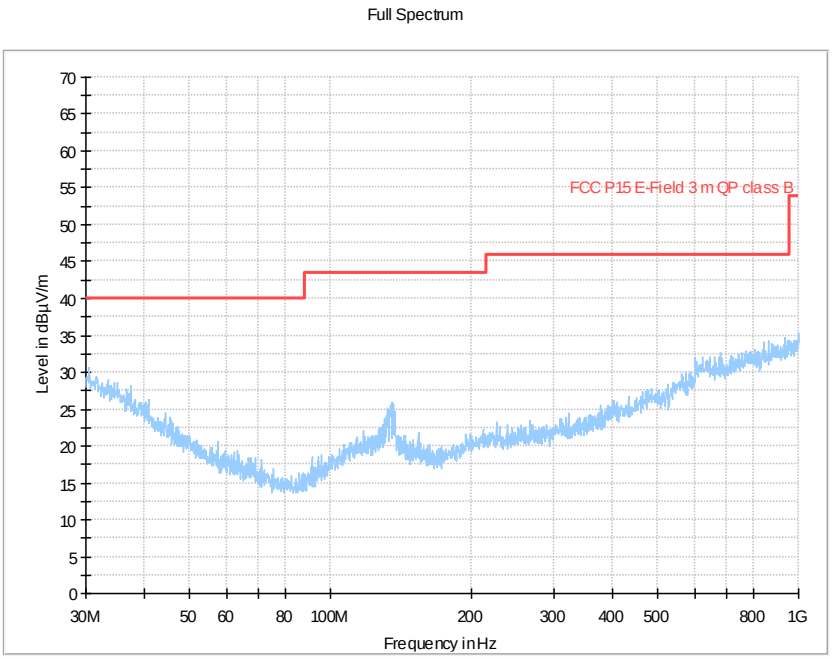
Limits

According to 47CFR 15.407(b), e.i.r.p. of the emission produced by the intentional radiator shall be below -27 dBm outside the frequency band in which the 5 GHz WiFi radiator is operating for frequencies over 1 GHz and except restricted bands defined in §15.205 as shown in paragraph 15.407(b)(7).
Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits based on the field strength, specified in Section 15.209(a).
Below 1 GHz applies general field strength limits set in §15.209.

Test engineer: Ermin Pasalic

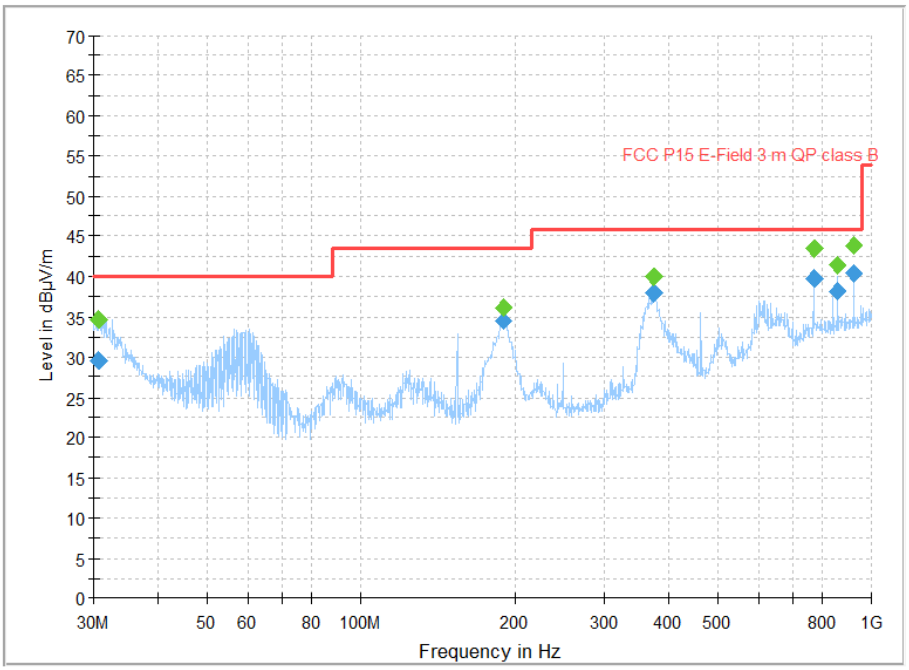
Complies?	Yes

Diagram 1



Ambient, 30-1000 MHz, vertical and horizontal polarization

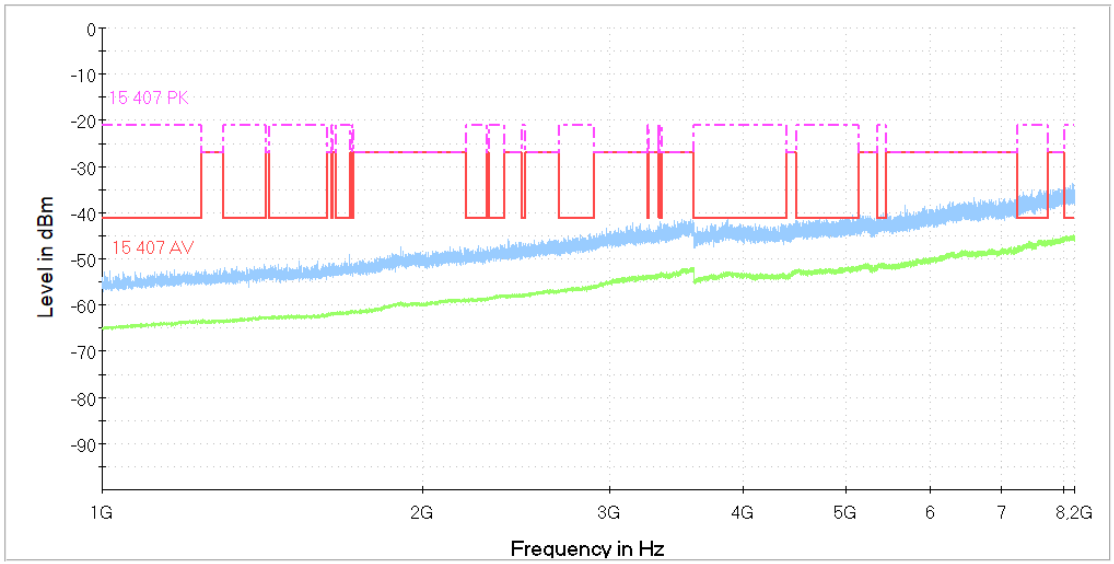
Diagram 2



30-1000 MHz, MIMO 5180 MHz, BW 20 MHz, MCS1, p17 vertical and horizontal polarization

Note: blue dots present E-field level measured by quasi peak detector. They compares to the limit for compliance.
The green dots present field measured by peak detector. There is no requirement for peak level.
The blue trace is measured E-field by peak detector in the pre-test.

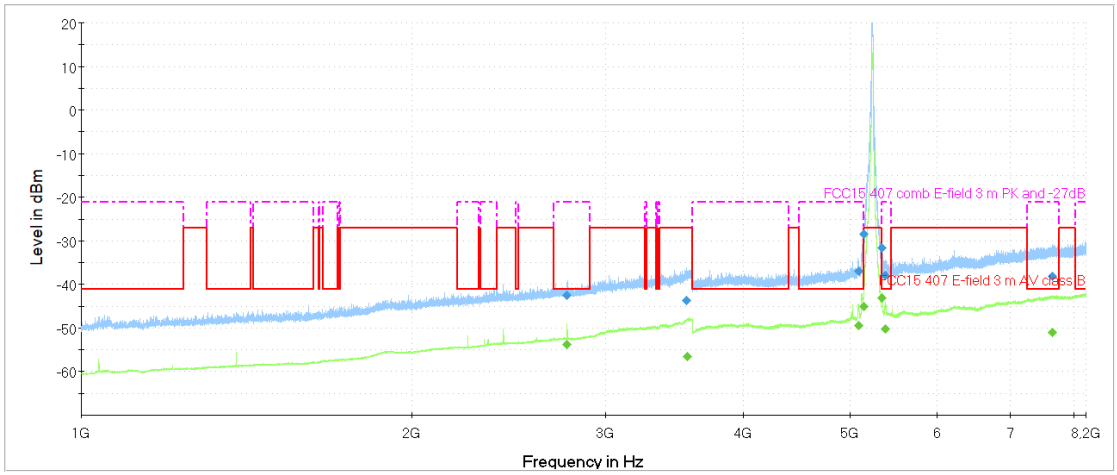
Diagram 3



Ambient, 1-8.2 GHz, vertical and horizontal polarization

Note: blue trace is emission measured by peak detector, green trace is emission measured by RMS detector.
In addition to the peak detector, RMS detector was used in pre-test to improve dynamic.
Limit lines cover requirements in the restricted and no-restricted frequency bands.

Diagram 4



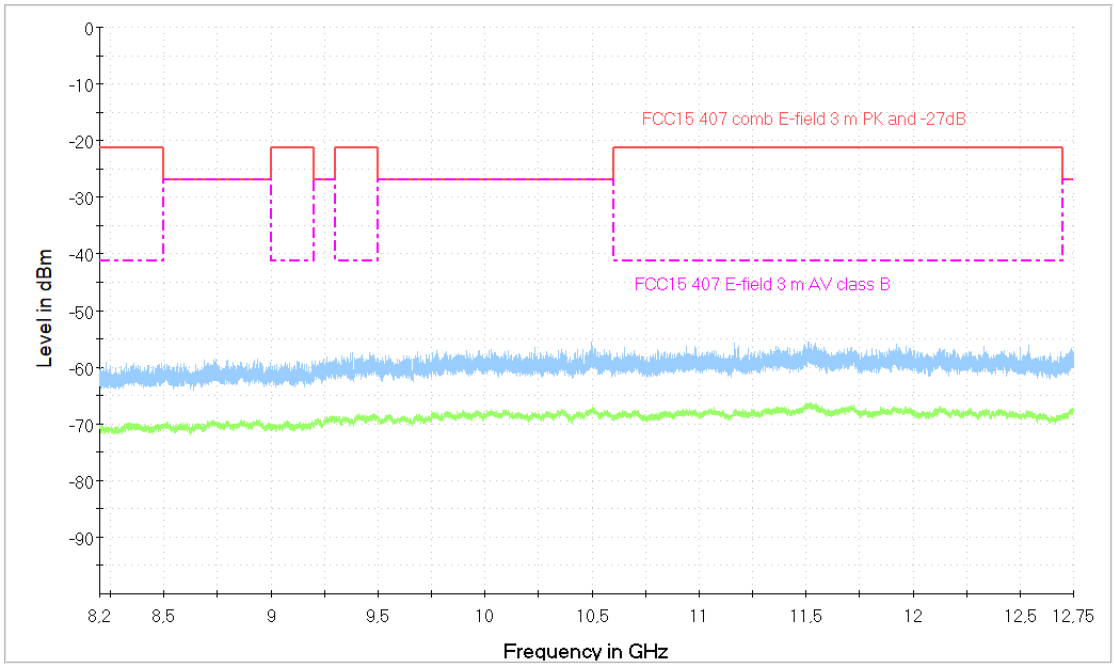
1-8.2 GHz, MIMO 5240 MHz, BW 20 MHz, MCS1, p17 vertical and horizontal polarization

Note 1: levels over limits are in the band 5150 MHz to 5250 MHz. Levels at the edge will be presented in the particular chapter; ‘Band edge measurements according to 47CFR 2.1049’, on pages 91-99.

Note 2: blue dots present field level measured by peak detector. They compares to the peak limit, (pink line) for compliance. The green dots present field measured by average detector. They compares to the average limit, (red line) for compliance.

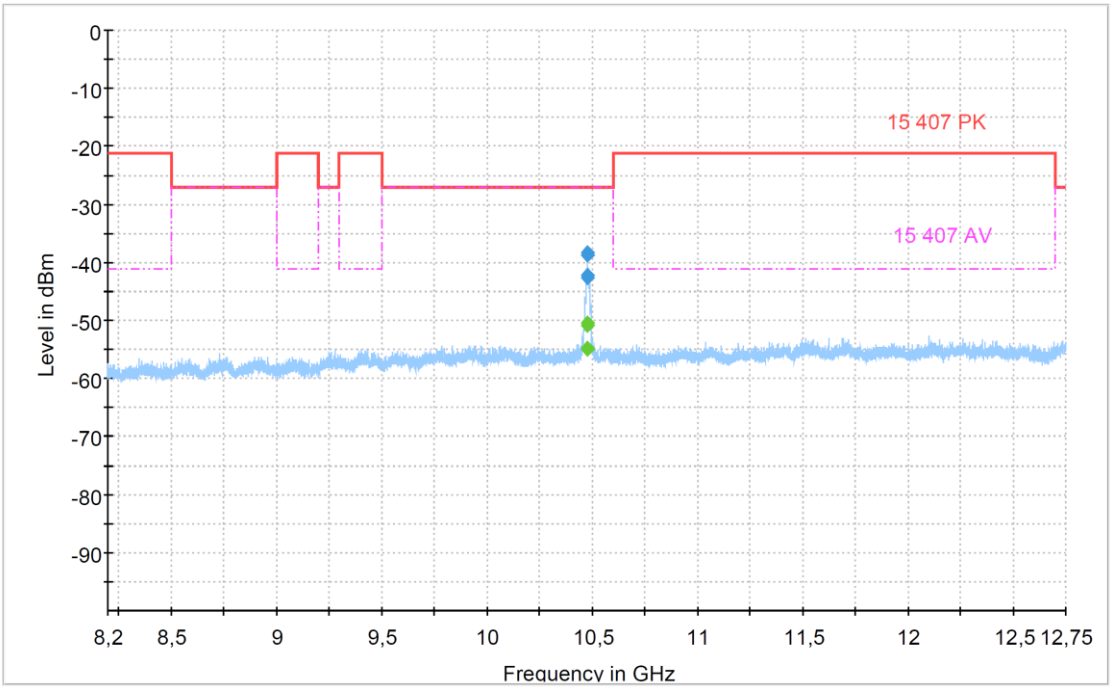
Note 2 applies to diagrams 4 to 8 in this chapter.

Diagram 5



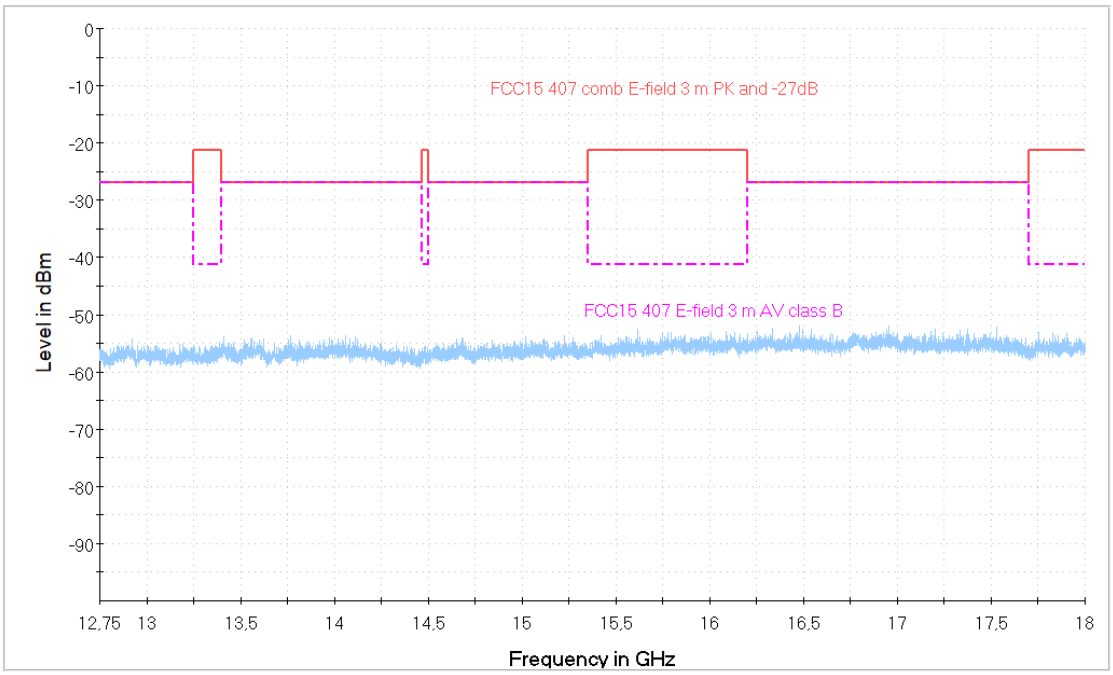
Ambient, 8.2-12.75 GHz, vertical and horizontal polarization

Diagram 6



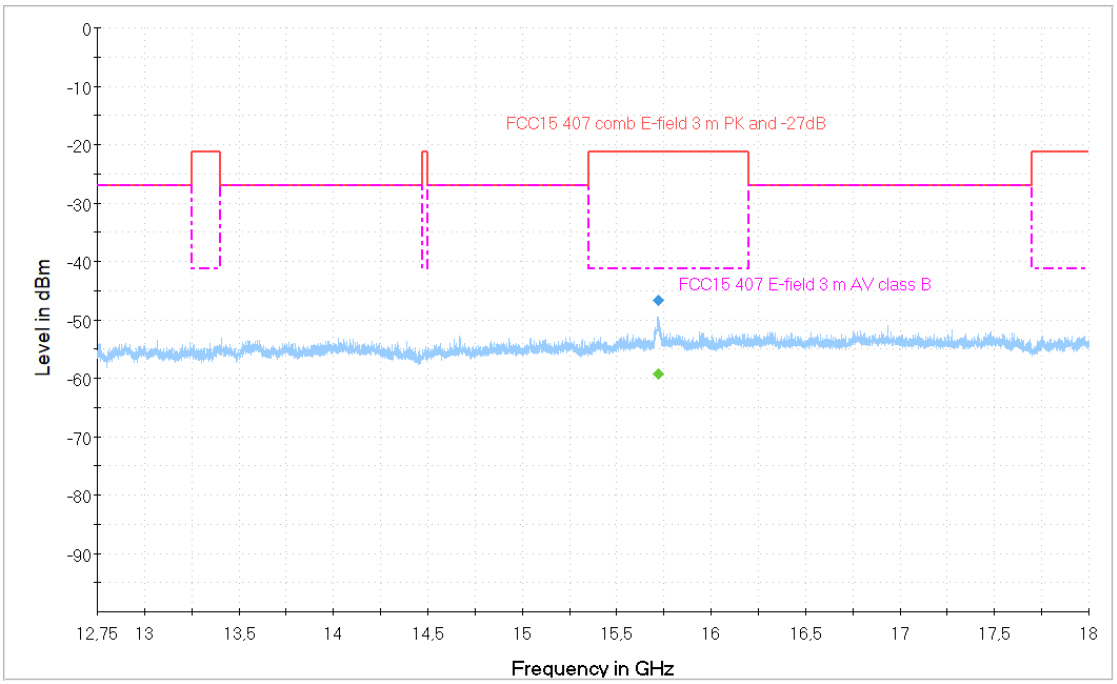
8.2-12.75 GHz, MIMO 5240 MHz, BW 20 MHz, MCS1, p17 vertical and horizontal polarization

Diagram 7



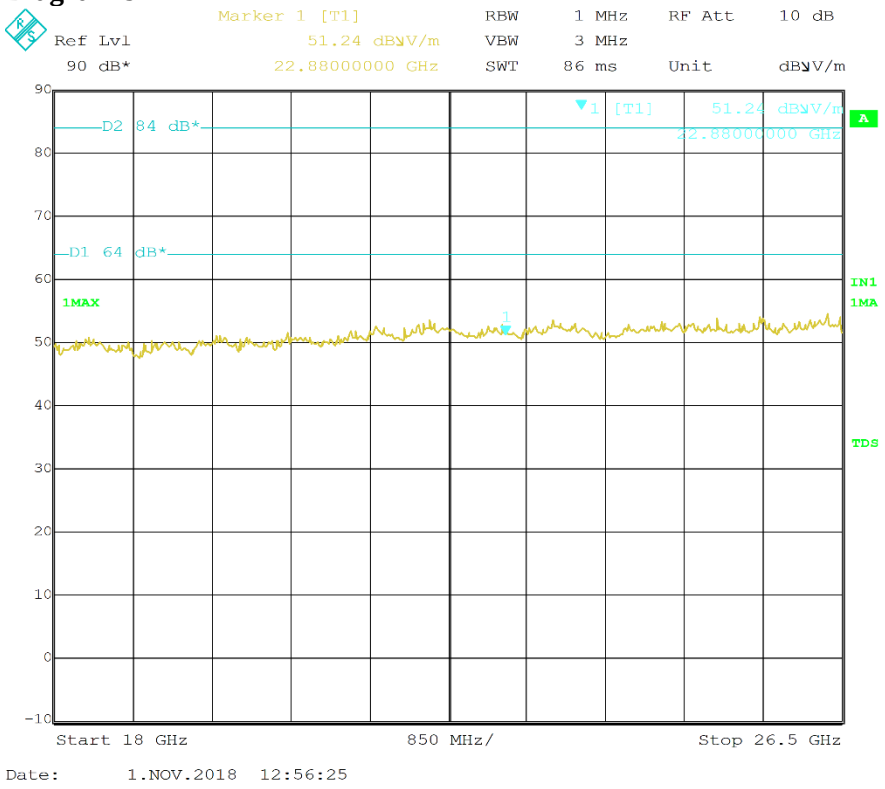
Ambient, 12,75-18 GHz, vertical and horizontal polarization

Diagram 8

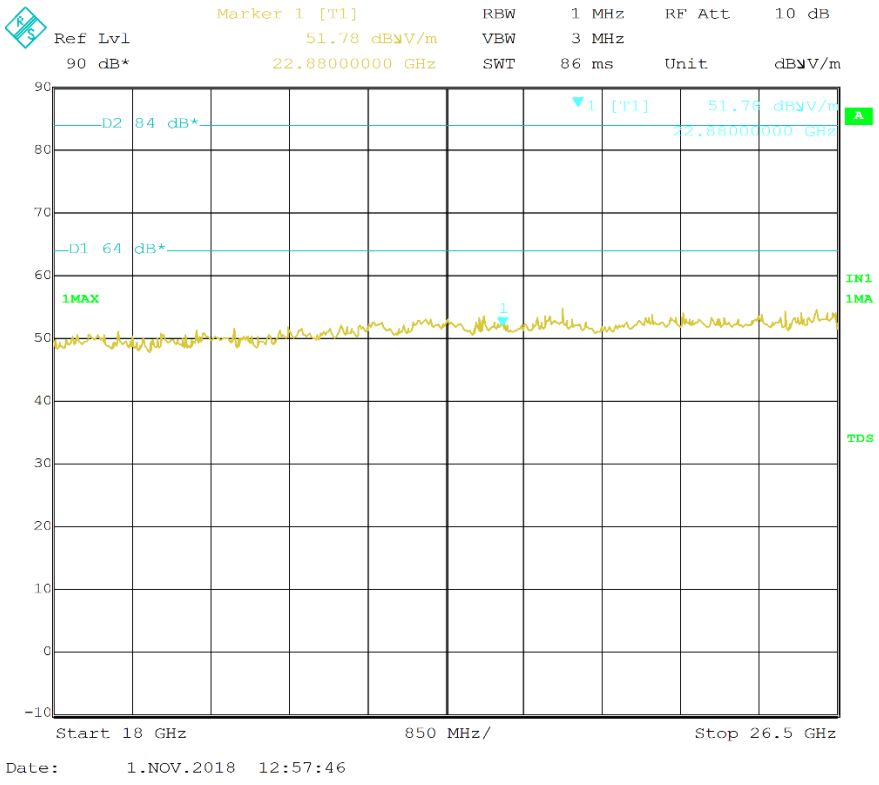


12.75-18 GHz, MIMO 5240 MHz, BW 20 MHz, MCS1, p17 vertical and horizontal polarization

Diagram 9

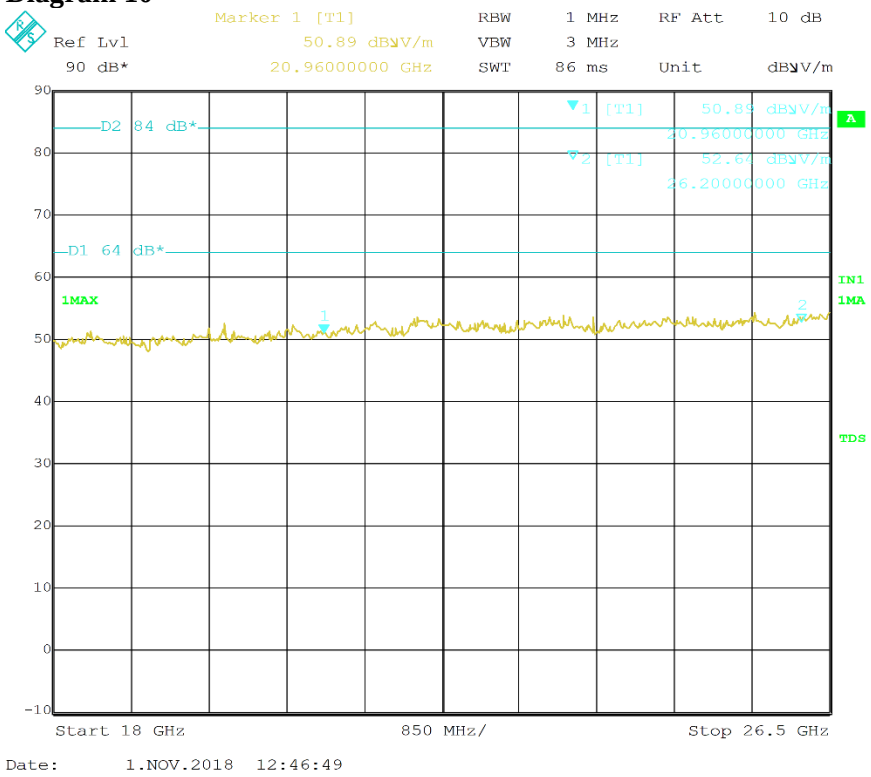


Ambient, 18-26,5 GHz, vertical polarization



Ambient, 18-26,5 GHz, horizontal polarization

Diagram 10

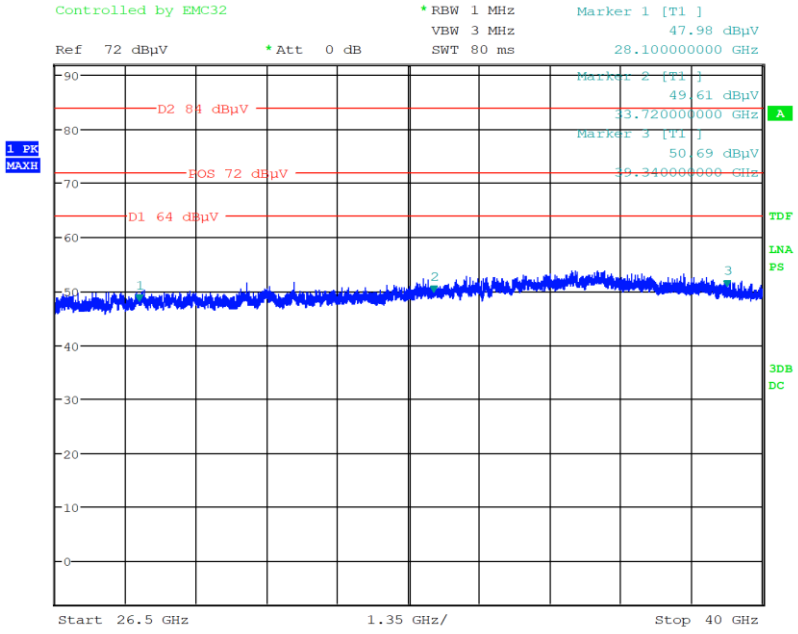


18 -26.5 GHz, MIMO 5240 MHz, BW 20 MHz, MCS1, p17 horizontal polarization

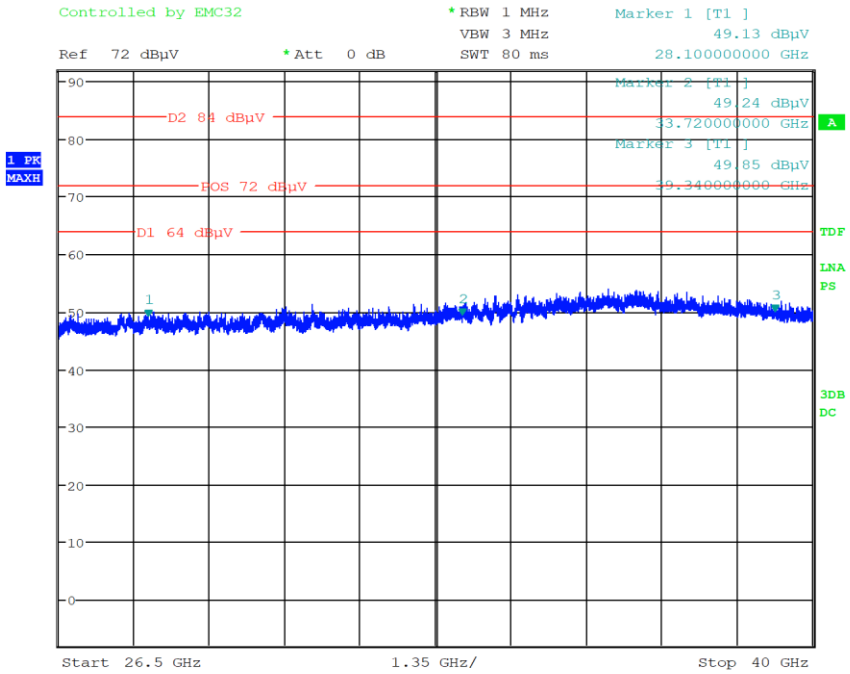
Note: in the range 18-26.5 GHz spurious emission is tested by measurement of E-field at 1 m. E.I.R.P. limit of -27 dBm/MHz is converted to the field measured at 1 m and presented in the diagrams as D1 64 dB, (blue line). D1 64 dB is used for compliance assessment. D2 84 dB, (blue line), is informative.

Yellow trace is E-field measured at 1 m distance by peak detector.

Diagram 11

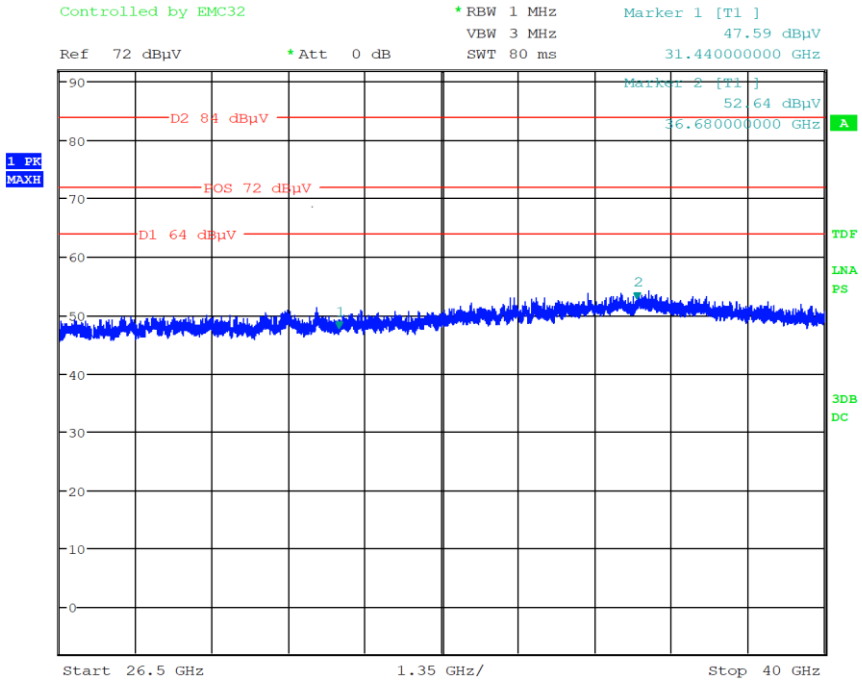


Ambient, 26,5-40 GHz, vertical polarization



Ambient, 26,5-40 GHz, horizontal polarization

Diagram 12



Date: 1.NOV.2018 14:10:33

26.5-40 GHz, MIMO 5240 MHz, BW 20 MHz, MCS1, p17 horizontal polarization

Note: in the range 26.5-40 GHz spurious emission is tested by measurement of E-field at 1 m. E.I.R.P. limit of -27 dBm/MHz is converted to the field measured at 1 m and presented in the diagrams as D1 64 dBµV, (red line). D1 64 dBµV is used for compliance assessment.
D2 84 dBµV, (red line), is informative.
The blue trace is E-field measured at 1 m distance by peak detector.

Conducted emission according to FCC 47 CFR part 15.407 (b) (6) and FCC 47 CFR part 15.207

Date	Temperature	Humidity
2018-11-06	22°C ± 3 °C	34 % ± 5 %

Test setup and procedure

The measurements were performed according to ANSI C63.10 clause 6.

The measurements were performed on units with the integral antennas and with transmission below 98% of duty cycle and with normal modulation.
Measurements were performed on the AC side of PoE injector. PoE injector is auxiliary equipment providing the PoE to USB adapter with 48 V DC, which subsequently powers the DUT with 5 V DC.
During test a LCD monitor was connected to DUT and data stream was transferred from DUT to the terminal.

Test set-up photos during the tests can be found in the photo section in the separate document, REPORT-ANNEX, AT-DG2 Photos.

Measurement equipment	RISE number
Semi anechoic chamber, Edison	504114
Computer Lenovo ThinkCentre	-
Software R&S EMC32, ver.9.15.00	503889
EMI test receiver R&S ESU 26	902210
LISN Schwarzbeck NNLA 8120	BX70761
LISN Schwarzbeck NNBL 8226-2	902060
Limiter, EM-7600	BX42883
Coaxial cable	BX50672
Coaxial cable	504102
Coaxial cable	504103
Coaxial cable	504104
Multimeter Fluke 83	501522
Temperature and humidity meter Testo 625	504117

Results

The conducted emission spectra can be found in the diagrams below:

Diagram 1:	120 V AC, Ambient, neutral terminal, PoE active
Diagram 2:	120 V AC, Ambient, phase terminal, PoE active
Diagram 3:	120 V AC, 5180 MHz, neutral terminal
Diagram 4:	120 V AC, 5180 MHz, phase terminal
Diagram 5:	120 V AC, 5220 MHz, neutral terminal
Diagram 6:	120 V AC, 5220 MHz, phase terminal
Diagram 7:	120 V AC, 5240 MHz, neutral terminal
Diagram 8:	120 V AC, 5240 MHz, phase terminal

Limits

According to 47CFR 15.207,

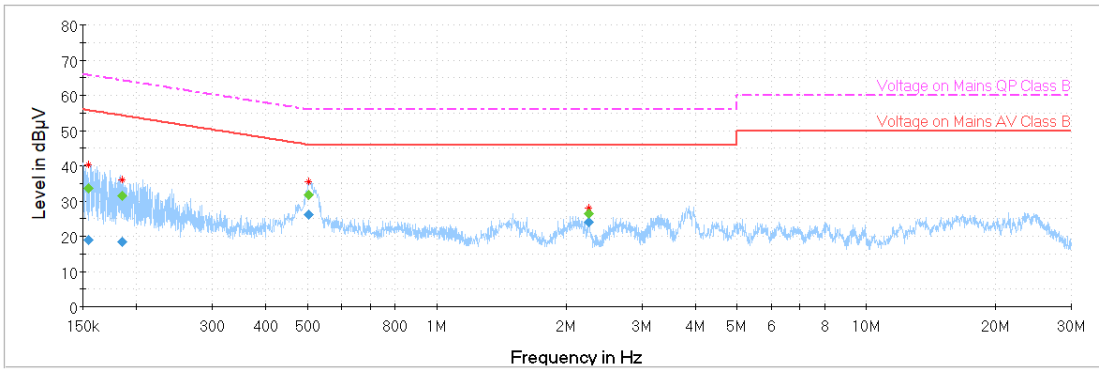
Frequency (MHz)	**Quasi-peak value (dBµV)**	**Average value (dBµV/m)**
0.15-0.5	66-56*	56-46*
0.5-5	56	46
5-30	60	50

*=Decreases with the logarithm of the frequency

Test engineer: Ermin Pasalic

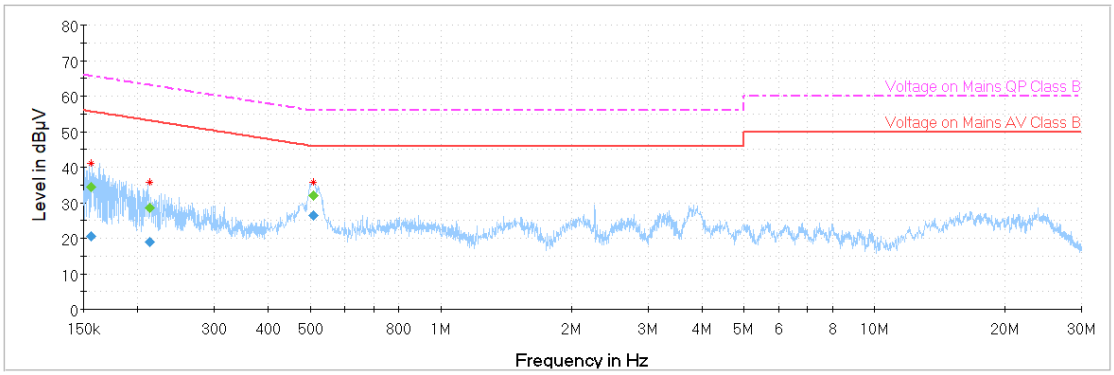
Complies?	Yes

Diagram 1:



120 V AC, Ambient, neutral terminal, PoE active

Diagram 2:

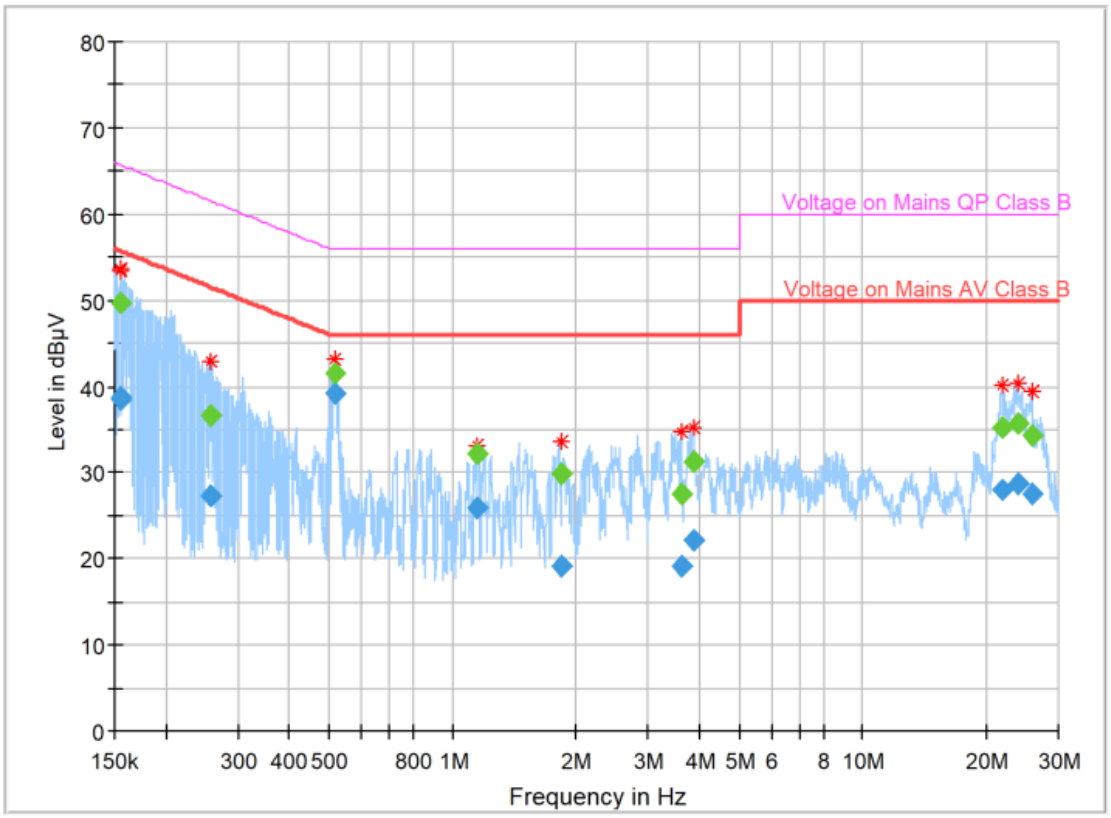


120 V AC, Ambient, phase terminal, PoE active

Note: Blue trace is emission measured with peak detector in the pre-test.
Red dots are emission levels measured with peak detector in the pre-test.
Blue dots are emission levels measured by average detector in final test. Blue dots shall be compared to red limit line, Voltage on Mains AV Class B.
Green dots are emission levels measured by quasi peak detector in final test. Green dots shall be compared to the pink limit line, Voltage on Mains QP Class B.

The blue dots together with the red limit line and green dots together with the pink limit line shall be used for compliance assessment.
This note is applicable on all diagrams in this chapter.

Diagram 3:

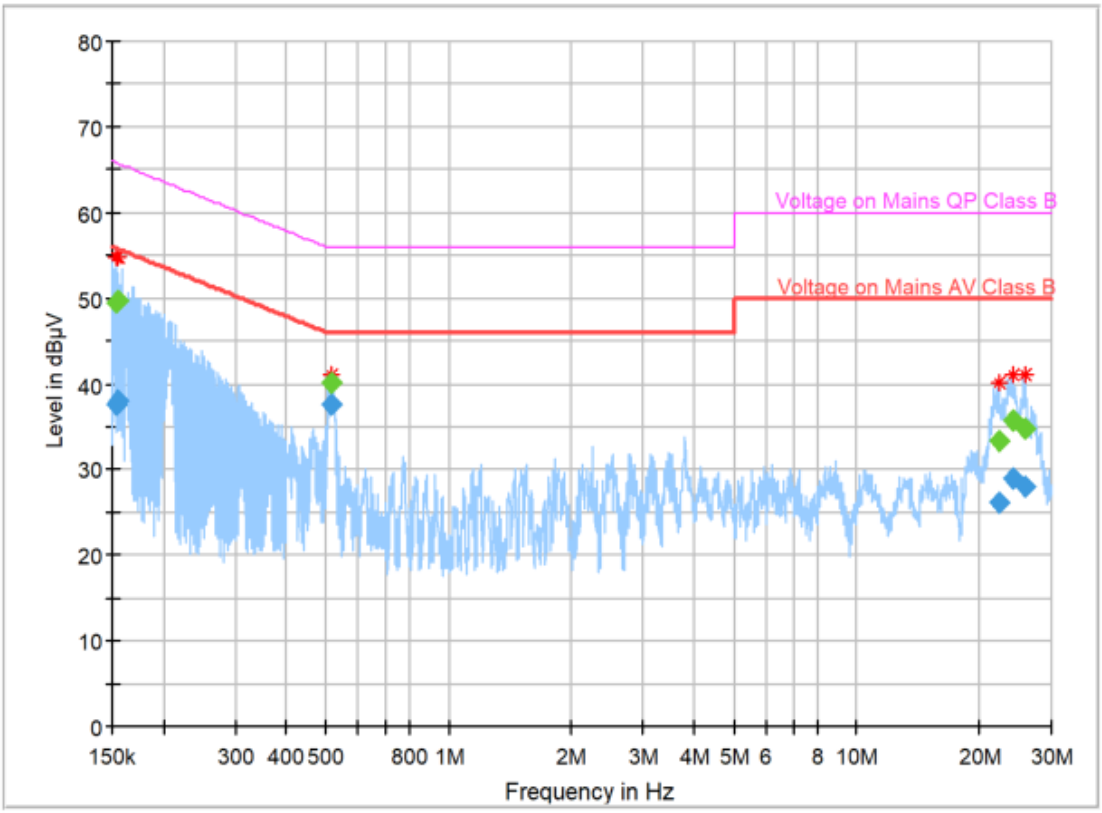


Final_Result

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.154441	38.54	---	55.76	17.22	5000.0	9.000	N	9.9
0.154441	---	49.70	65.76	16.06	5000.0	9.000	N	9.9
0.155627	38.68	---	55.69	17.01	5000.0	9.000	N	9.9
0.155627	---	49.73	65.69	15.97	5000.0	9.000	N	9.9
0.155945	38.65	---	55.68	17.03	5000.0	9.000	N	9.9
0.155945	---	49.66	65.68	16.01	5000.0	9.000	N	9.9
0.257484	27.33	---	51.51	24.18	5000.0	9.000	N	9.9
0.257484	---	36.71	61.51	24.81	5000.0	9.000	N	9.9
0.519696	39.21	---	46.00	6.79	5000.0	9.000	N	9.9
0.519696	---	41.54	56.00	14.46	5000.0	9.000	N	9.9
1.147877	25.88	---	46.00	20.12	5000.0	9.000	N	9.9
1.147877	---	32.23	56.00	23.77	5000.0	9.000	N	9.9
1.835289	19.14	---	46.00	26.87	5000.0	9.000	N	9.9
1.835289	---	29.88	56.00	26.12	5000.0	9.000	N	9.9
3.604183	19.02	---	46.00	26.98	5000.0	9.000	N	10.0
3.604183	---	27.42	56.00	28.58	5000.0	9.000	N	10.0
3.856410	22.19	---	46.00	23.81	5000.0	9.000	N	10.0
3.856410	---	31.27	56.00	24.73	5000.0	9.000	N	10.0
21.853870	28.10	---	50.00	21.90	5000.0	9.000	N	10.9
21.853870	---	35.14	60.00	24.86	5000.0	9.000	N	10.9
23.925136	28.72	---	50.00	21.28	5000.0	9.000	N	11.1
23.925136	---	35.62	60.00	24.38	5000.0	9.000	N	11.1
25.782156	27.50	---	50.00	22.50	5000.0	9.000	N	11.2
25.782156	---	34.22	60.00	25.78	5000.0	9.000	N	11.2

120 V AC, 5180 MHz, neutral terminal

Diagram 4:

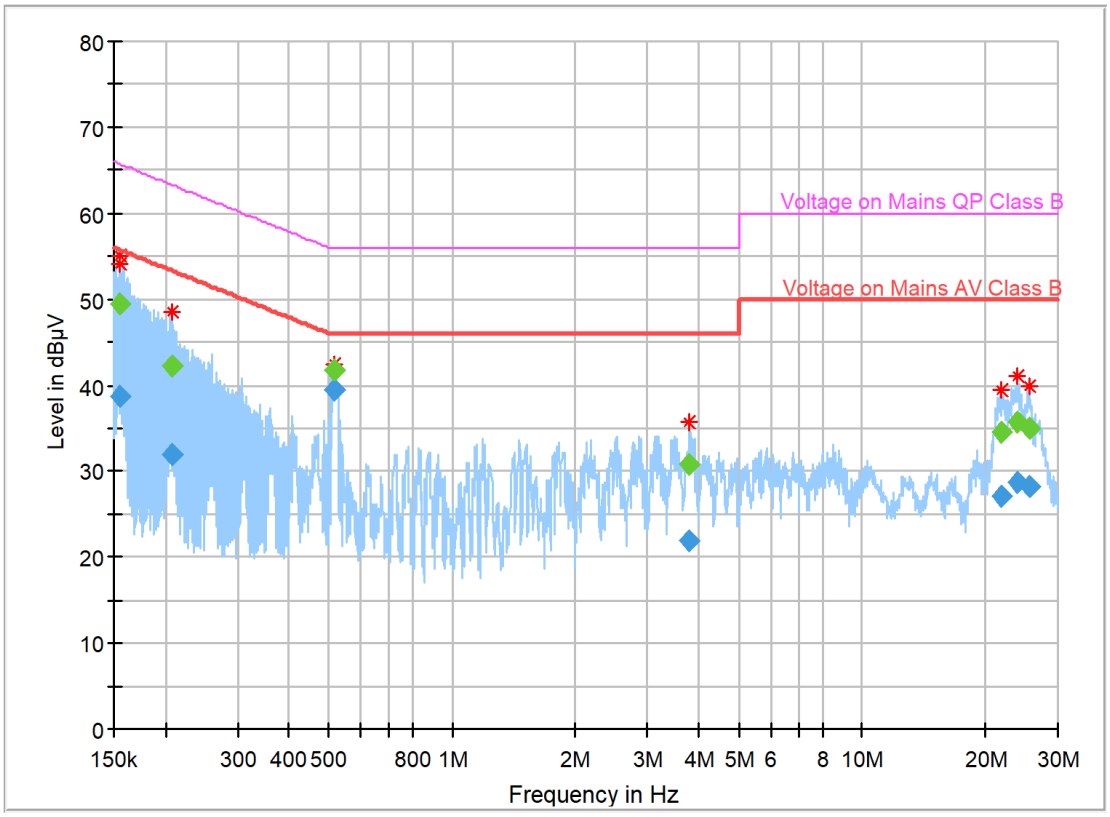


Final_Result

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.153676	---	49.43	65.80	16.37	5000.0	9.000	L1	9.9
0.153676	37.47	---	55.80	18.33	5000.0	9.000	L1	9.9
0.155194	---	49.77	65.72	15.95	5000.0	9.000	L1	9.9
0.155194	37.98	---	55.72	17.73	5000.0	9.000	L1	9.9
0.518999	---	40.18	56.00	15.82	5000.0	9.000	L1	9.9
0.518999	37.65	---	46.00	8.35	5000.0	9.000	L1	9.9
22.401328	---	33.31	60.00	26.69	5000.0	9.000	L1	10.9
22.401328	26.07	---	50.00	23.93	5000.0	9.000	L1	10.9
24.229952	---	35.64	60.00	24.36	5000.0	9.000	L1	11.0
24.229952	28.85	---	50.00	21.15	5000.0	9.000	L1	11.0
25.840048	---	34.81	60.00	25.19	5000.0	9.000	L1	11.2
25.840048	28.08	---	50.00	21.92	5000.0	9.000	L1	11.2

120 V AC, 5180 MHz, phase terminal

Diagram 5:

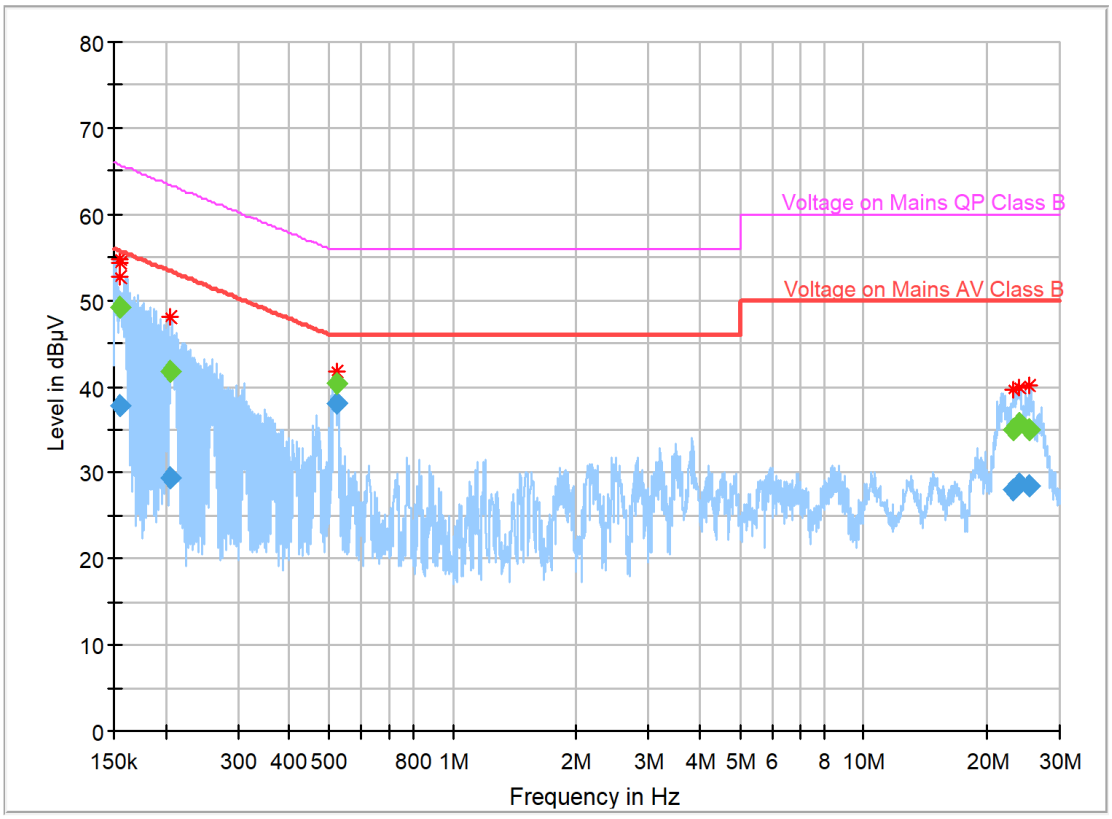


Final_Result

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.155470	---	49.56	65.70	16.15	5000.0	9.000	N	9.9
0.155470	38.63	---	55.70	17.07	5000.0	9.000	N	9.9
0.155819	38.60	---	55.68	17.08	5000.0	9.000	N	9.9
0.155819	---	49.47	65.68	16.21	5000.0	9.000	N	9.9
0.155861	38.61	---	55.68	17.07	5000.0	9.000	N	9.9
0.155861	---	49.51	65.68	16.17	5000.0	9.000	N	9.9
0.206948	---	42.26	63.33	21.06	5000.0	9.000	N	9.9
0.206948	31.85	---	53.33	21.48	5000.0	9.000	N	9.9
0.519119	---	41.71	56.00	14.29	5000.0	9.000	N	9.9
0.519119	39.52	---	46.00	6.48	5000.0	9.000	N	9.9
3.797452	---	30.86	56.00	25.14	5000.0	9.000	N	10.0
3.797452	21.90	---	46.00	24.10	5000.0	9.000	N	10.0
21.835713	---	34.42	60.00	25.58	5000.0	9.000	N	10.9
21.835713	27.06	---	50.00	22.94	5000.0	9.000	N	10.9
23.960818	---	35.69	60.00	24.31	5000.0	9.000	N	11.1
23.960818	28.76	---	50.00	21.24	5000.0	9.000	N	11.1
25.499840	---	34.95	60.00	25.05	5000.0	9.000	N	11.2
25.499840	28.33	---	50.00	21.67	5000.0	9.000	N	11.2

120 V AC, 5220 MHz, neutral terminal

Diagram 6:

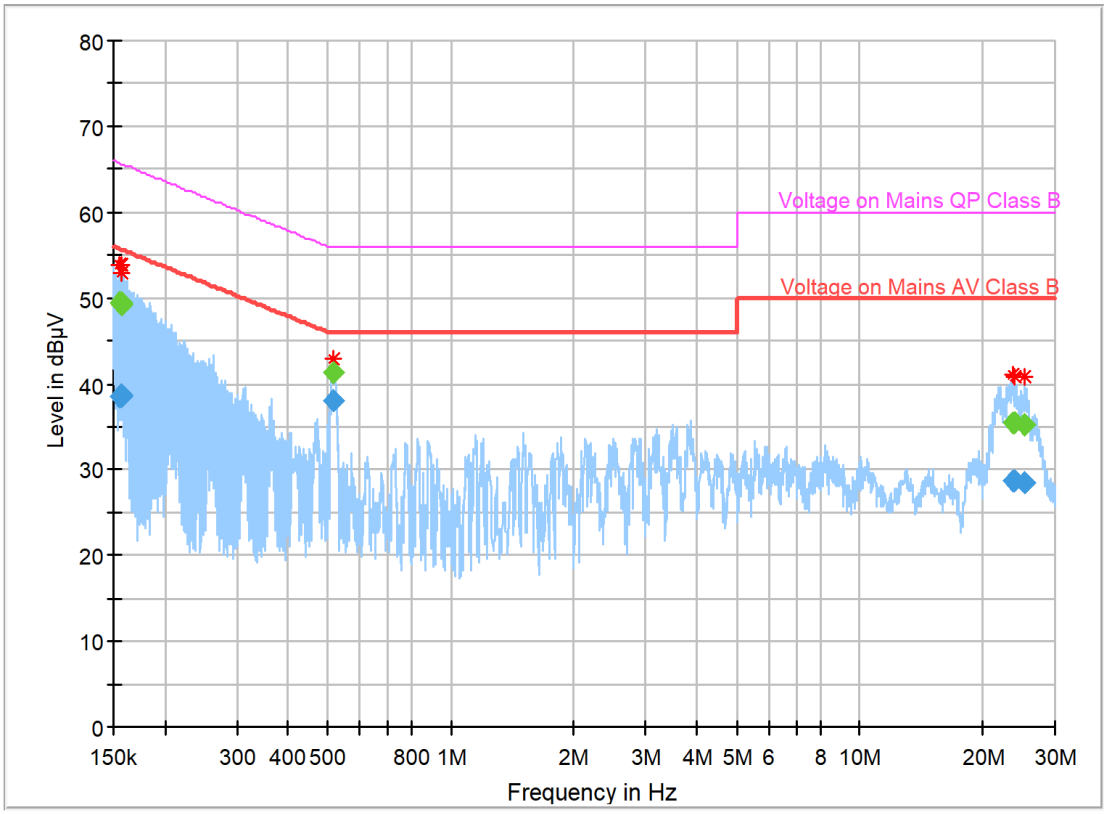


Final_Result

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.155445	---	49.23	65.70	16.48	5000.0	9.000	L1	9.9
0.155445	37.83	---	55.70	17.87	5000.0	9.000	L1	9.9
0.155466	37.85	---	55.70	17.85	5000.0	9.000	L1	9.9
0.155466	---	49.27	65.70	16.44	5000.0	9.000	L1	9.9
0.155531	37.84	---	55.70	17.86	5000.0	9.000	L1	9.9
0.155531	---	49.24	65.70	16.46	5000.0	9.000	L1	9.9
0.206167	---	41.83	63.36	21.52	5000.0	9.000	L1	9.9
0.206167	29.41	---	53.36	23.95	5000.0	9.000	L1	9.9
0.520388	---	40.39	56.00	15.61	5000.0	9.000	L1	9.9
0.520388	38.00	---	46.00	8.00	5000.0	9.000	L1	9.9
23.277818	---	34.99	60.00	25.01	5000.0	9.000	L1	11.1
23.277818	27.90	---	50.00	22.10	5000.0	9.000	L1	11.1
23.841370	---	35.58	60.00	24.42	5000.0	9.000	L1	11.0
23.841370	28.80	---	50.00	21.20	5000.0	9.000	L1	11.0
25.399316	---	35.09	60.00	24.91	5000.0	9.000	L1	11.1
25.399316	28.42	---	50.00	21.58	5000.0	9.000	L1	11.1

120 V AC, 5220 MHz, phase terminal

Diagram 7:

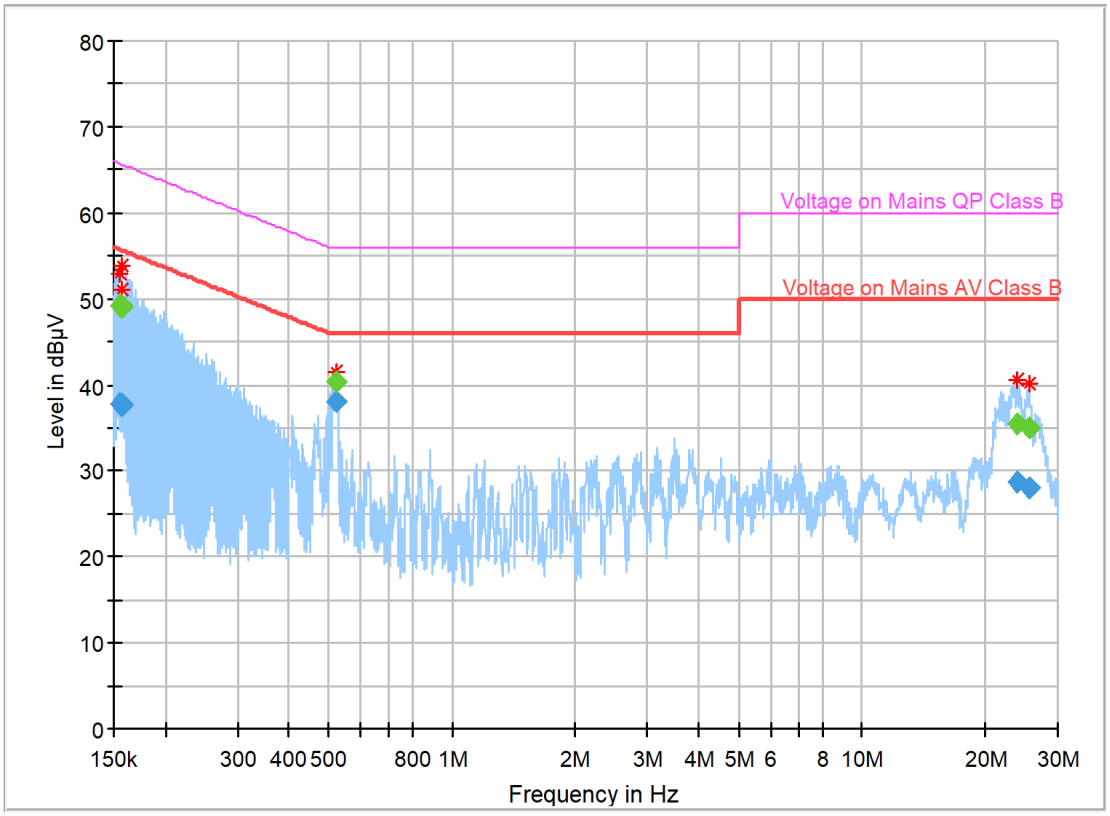


Final_Result

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.155713	---	49.35	65.69	16.34	5000.0	9.000	N	9.9
0.155713	38.57	---	55.69	17.12	5000.0	9.000	N	9.9
0.156072	38.62	---	55.67	17.05	5000.0	9.000	N	9.9
0.156072	---	49.36	65.67	16.31	5000.0	9.000	N	9.9
0.156442	38.57	---	55.65	17.09	5000.0	9.000	N	9.9
0.156442	---	49.32	65.65	16.33	5000.0	9.000	N	9.9
0.517909	---	41.35	56.00	14.65	5000.0	9.000	N	9.9
0.517909	37.99	---	46.00	8.01	5000.0	9.000	N	9.9
23.559615	---	35.49	60.00	24.51	5000.0	9.000	N	11.0
23.559615	28.68	---	50.00	21.32	5000.0	9.000	N	11.0
23.973133	---	35.46	60.00	24.54	5000.0	9.000	N	11.1
23.973133	28.69	---	50.00	21.31	5000.0	9.000	N	11.1
25.348101	---	35.14	60.00	24.86	5000.0	9.000	N	11.2
25.348101	28.41	---	50.00	21.59	5000.0	9.000	N	11.2

120 V AC, 5240 MHz, neutral terminal

Diagram 8:



Final_Result

Frequency (MHz)	CAverage (dBµV)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.155664	37.83	---	55.69	17.87	5000.0	9.000	L1	9.9
0.155664	---	49.20	65.69	16.49	5000.0	9.000	L1	9.9
0.156361	37.75	---	55.66	17.90	5000.0	9.000	L1	9.9
0.156361	---	49.12	65.66	16.54	5000.0	9.000	L1	9.9
0.156726	---	48.96	65.64	16.68	5000.0	9.000	L1	9.9
0.156726	37.63	---	55.64	18.00	5000.0	9.000	L1	9.9
0.521021	---	40.38	56.00	15.62	5000.0	9.000	L1	9.9
0.521021	38.01	---	46.00	7.99	5000.0	9.000	L1	9.9
23.848034	---	35.41	60.00	24.59	5000.0	9.000	L1	11.0
23.848034	28.72	---	50.00	21.28	5000.0	9.000	L1	11.0
25.636735	---	34.97	60.00	25.03	5000.0	9.000	L1	11.1
25.636735	28.05	---	50.00	21.95	5000.0	9.000	L1	11.1

120 V AC, 5240 MHz, phase terminal

Frequency stability according to FCC 47 CFR part 15.407 (g)

Date	Temperature	Humidity
2018-11-14	22 °C ± 3 °C	29 % ± 5 %
2018-11-15	21 °C ± 3 °C	35 % ± 5 %

Procedure

According §15.4707(g) it shall be ensured that frequency stability of device is such that an emission is maintained within the band of operation under all conditions of normal operation. In the KDB 789033 D02 General UNII Test Procedures New Rules v02r01 it is not suggested particular test procedure to verify frequency stability.

At the lower edge, 5150 MHz, we measured power level. At the higher band edge, 5250 MHz, it is accepted due to practical reasons, according KDB 789033 D02 General UNII Test Procedures New Rules v02r01 to test 26 dB EBW or alternatively 99 % OBW for compliance instead for power level.

Maximum power level is measured at lower band edge, 5150 MHz, and below at each temperature step. This test was performed in conducted mode on unit with the temporary antenna connectors, with transmission below 98% of duty cycle and with normal modulation. Difference between power level at each temperature and power level at rooms temperature, was added to the power level from edge test in radiated mode. The highest level was compared to the limit for compliance.

99% OBW was measured at each temperature step. If high edge of 99 % OBW was lower than 5250 MHz for all temperatures, it was considered that device comply at high band edge.

Test was done at temperatures 50 °C , 40 °C, 30 °C, 20 °C, 10 °C and 0 °C.

The manufacturer declared temperature range between 5 °C and 30 °C.

Test was done with bandwidth 20 MHz, 40 MHz and 80 MHz and with power class 9.

DUT complied with the requirements after tuning of output power.

- for 20 MHz BW, maximum applicable power class was 8 dBm/p8
- for 40 MHz BW, maximum applicable power class was 5 dBm/p5
- for 80 MHz BW, maximum applicable power class was 6 dBm/p6

Measurement equipment	RISE number
Semi anechoic chamber, Edison	504114
Computer Lenovo ThinkCentre	-
Software R&S EMC32, ver.9.15.00	503889
EMI test receiver R&S ESU 26	902210
Antenna ETS-Lindgren 3115	902175
Step attenuator Narda743-60	BX41644
Coaxial cable	BX50672
Coaxial cable	504102
Coaxial cable	504103
Coaxial cable	504104
Multimeter Fluke 83	501522
Temperature and humidity meter Testo 625, with wire sensor 2A	504117
Temperature chamber	503360
Test site Marconi	15:121
Spectrum analyser R&S FSQ 26	BX50694
Coaxial cable	BX81424
Coaxial cable	BX81436
Coaxial cable	BX50685
120 V AC/60 Hz AC Power source HP 6813B	503 091
DC power supply HP E3632A	503 170
Multimeter Fluke 85 III	503 418
Temperature and humidity meter Testo 625	504117

Results

Lower band edge, 5150 MHz; ch 36

	Ch 36; 5180 MHz, 20 MHz BW			
	AV [dBm]	Diff [dB]	PK [dB]	Diff [dB]
50	-53.3	-0.2	-32.7	-2.4
40	-52.7	0.6	-31.8	-1.5
30	-52.9	0.4	-30.2	0.1
20	**-53.3**	**0**	**-30.3**	**0**
10	-53.0	0.3	-31.4	-1.1
0	-52.6	0.7	-32.4	-2.1
Power level in radiated mode; 8 dBm/p8 [dBm]	-45.7	-45.0 Note 1	-22.6	-22.5 Note 2
LIMIT [dBm]	-41.2	-41.2	-21.2	-21.2

Lower band edge, 5150 MHz; ch 38

	Ch 38; 5190 MHz, 40 MHz BW			
	AV [dBm]	Diff [dB]	PK [dB]	Diff [dB]
50	-49.9	2	-31.0	3.6
40	-51.1	0.8	-34.4	0.2
30	-49.5	2.4	-31.1	3.5
20	**-51.9**	**0**	**-34.6**	**0**
10	-50.7	1.2	-37.8	-3.2
0	-53.1	-1.2	-34.0	0.6
Power level in radiated mode; 5 dBm/p5 [dBm]	-46.2	-43.8 Note 1	-27.8	-24.2 Note 2
LIMIT [dBm]	-41.2	-41.2	-21.2	-21.2

Lower band edge, 5150 MHz; ch 42

	Ch 42; 5230 MHz, 80 MHz BW			
	AV [dBm]	Diff [dB]	PK [dB]	Diff [dB]
50	-48.6	0	-32.5	-0.1
40	-49.2	-0.6	-32.8	-0.4
30	-49.0	-0.4	-33.2	-0.8
20	**-48.6**	**0**	**-32.4**	**0**
10	-48.5	0.1	-31.7	0.7
0	-49.8	-1.2	-34.2	-1.8
Power level in radiated mode; 6 dBm/p6 [dBm]	-41.9	-41.8 Note 1	-24.2	-23.5 Note 2
LIMIT [dBm]	-41.2	-41.2	-21.2	-21.2

Note 1: The highest AV level at lower edge including temperature variation
Note 2: The highest peak level at lower edge including temperature variation

Higher band edge, 5250 MHz

Temperature [°C]	99 % OBW - high edge [MHz]			Limit [MHz]
	Ch 48 5240 MHz 20 MHz BW	Ch 46 5230 MHz 40 MHz BW	Ch 42 5210 MHz 80 MHz BW	
50	5248.94	5248.08	5247.79	5250
40	5248.89	5248.06	5247.76	5250
30	5248.92	5248.08	5247.86	5250
20	5248.92	5248.08	5247.89	5250
10	5248.95	5248.08	5247.82	5250
0	5248.95	5248.09	5247.89	5250

Note: High edge of 26 dB EBW was not considered in the climate test because, it was clear from test in rooms temperature that higher edge of EBW was higher than limit of 5250 MHz.

Remark

Test procedure according ANSI C63.10 clause 6.8.1 suggests measurement of frequency to verify frequency stability.
There is not requirement in the standard for maximum frequency variation and we think it is not enough to test just frequency of this type of wideband equipment, 5 GHz RLAN, and be sure from this test if all emission is maintained within the band of operation or not. We have to link frequency variation to the parameters related to the edge. Requirement for the power level at the band edge is set in the standard.
We think much more reliable test is power level test at the edges.

Limits

According to 47CFR 15.407 (g) the device shall achieve such frequency stability that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user manual.

Test engineer: Ermin Pasalic

Complies?	Yes

26 dB bandwidth measurements according to KDB 789033 D02 General UNII Test Procedures New Rules v02r01 Dec. 14, 2017 II.C.1.

Date	Temperature	Humidity
2018-11-14	22 °C ± 3 °C	29 % ± 5 %

Test setup and procedure

The measurements were performed according to ANSI C63.10 cl. 12.4.1/6.9.2 and KDB 789033 D02 General UNII Test Procedures New Rules v02r01 Dec. 14, 2017 II.C.1.

Conducted measurements were performed on units with the temporary antenna connectors, with transmission below 98% of duty cycle and with normal modulation.

Test set-up photos during the tests can be found in the photo section in the separate document, REPORT-ANNEX, AT-DG2 Photos.

Measurement equipment	RISE number
Test site Marconi	15:121
Spectrum analyser R&S FSQ 26	BX50694
Coaxial cable	BX81424
Coaxial cable	BX81436
Coaxial cable	BX50685
120 V AC/60 Hz AC Power source HP 6813B	503 091
DC power supply HP E3632A	503 170
Multimeter Fluke 85 III	503 418
Temperature and humidity meter Testo 625	503 498

Results

SISO 2 (chain 2 – 6 dBi antenna gain)			802.11ac	
T_{nom} 20°C, V_{nom} 120 V AC				
f [MHz]	BW [MHz]	EBW left [MHz]	EBW right [MHz]	EBW [MHz]
5180	20	5168.8	5191.2	22.4
5220	20	5209.0	5231.2	22.2
5240	20	5229.0	5251.0	22.0
5190	40	5169.7	5210.0	40.3
5230	40	5209.7	5250.3	40.5
5210	80	5167.4	5252.6	85.2

The 26 dB BW measurements can be found in the diagrams below:

Diagram 1:	5180 MHz 20 MHz BW, 26 dB EBW
Diagram 2:	5220 MHz 20 MHz BW, 26 dB EBW
Diagram 3:	5240 MHz 20 MHz BW, 26 dB EBW
Diagram 4:	5190 MHz 40 MHz BW, 26 dB EBW
Diagram 5:	5230 MHz 40 MHz BW, 26 dB EBW
Diagram 6:	5210 MHz 80 MHz BW, 26 dB EBW

Limits

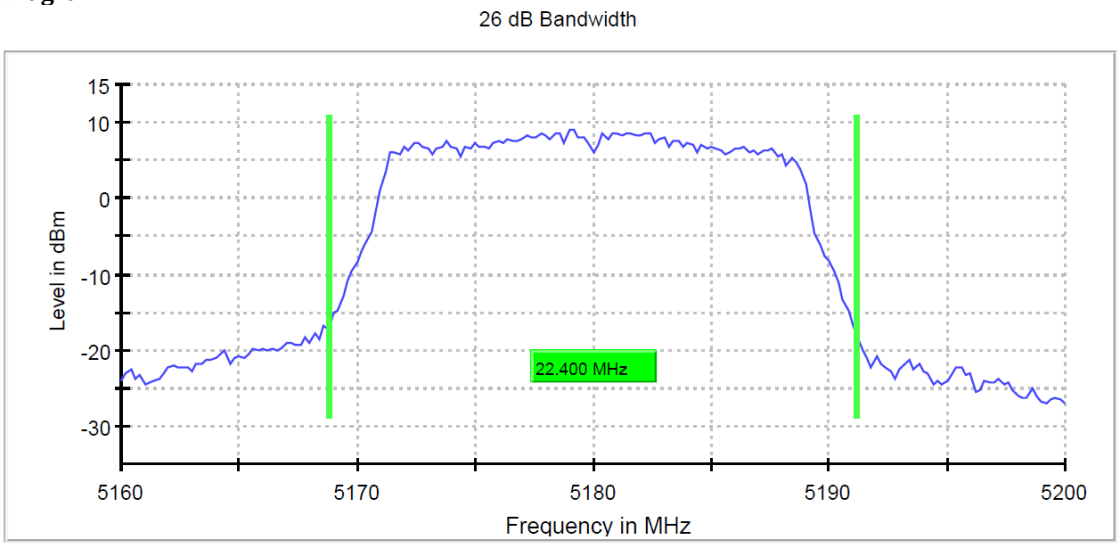
No limits specified in the §15.407.

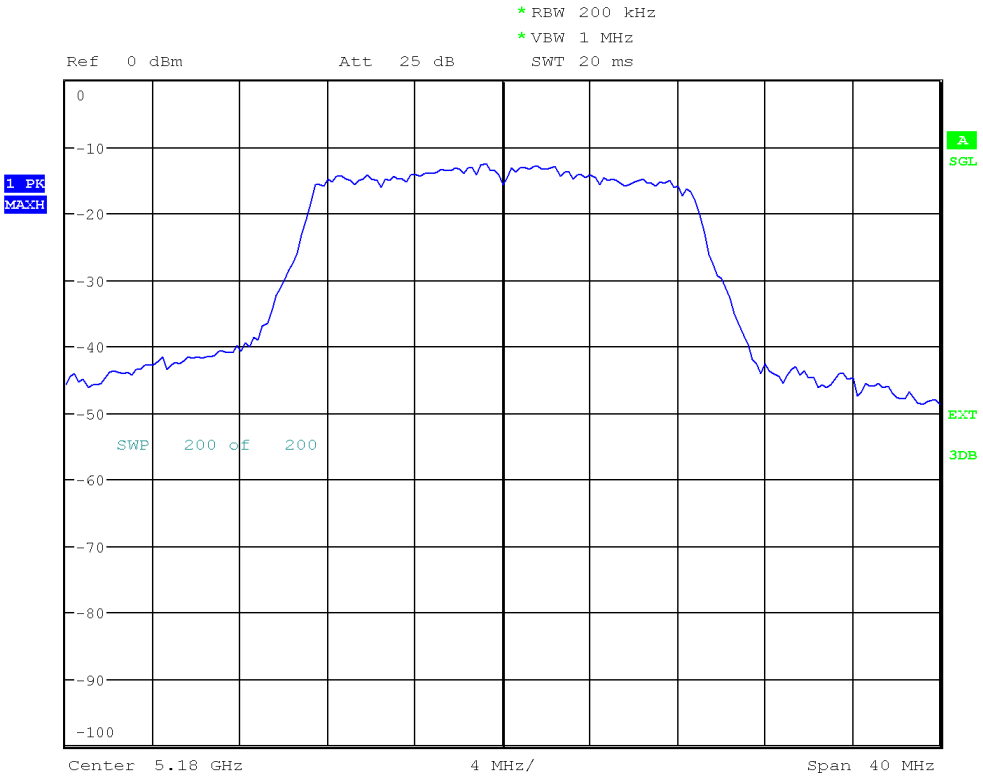
Note: There is not particular requirement, but information is needed for configuration of instruments and for assessment if operating channel is inside allowed frequency band.

Test engineer: Ermin Pasalic

Complies?	N/A

Diagram 1

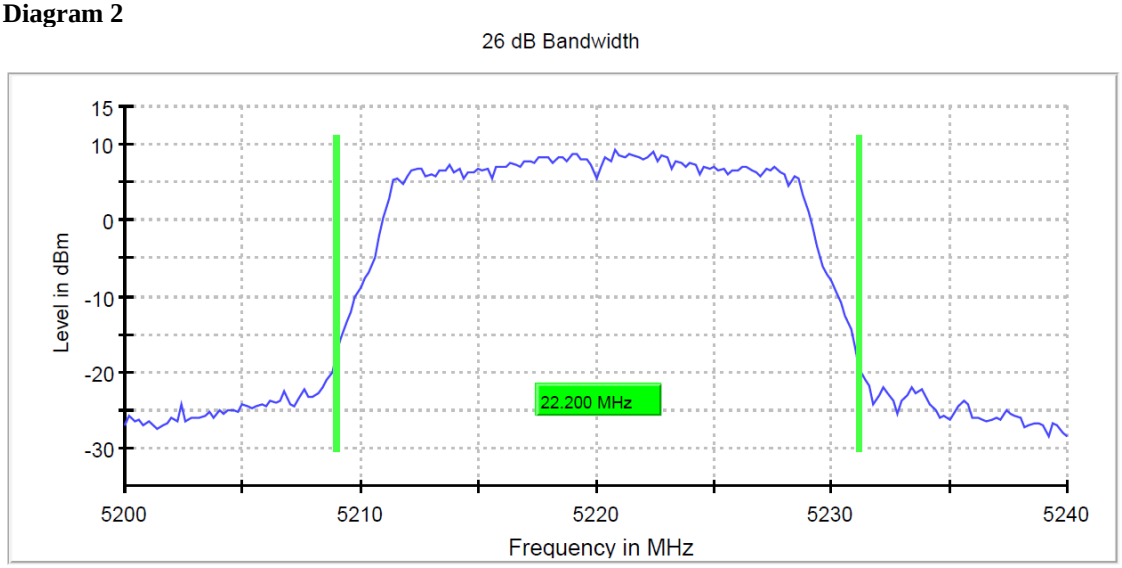


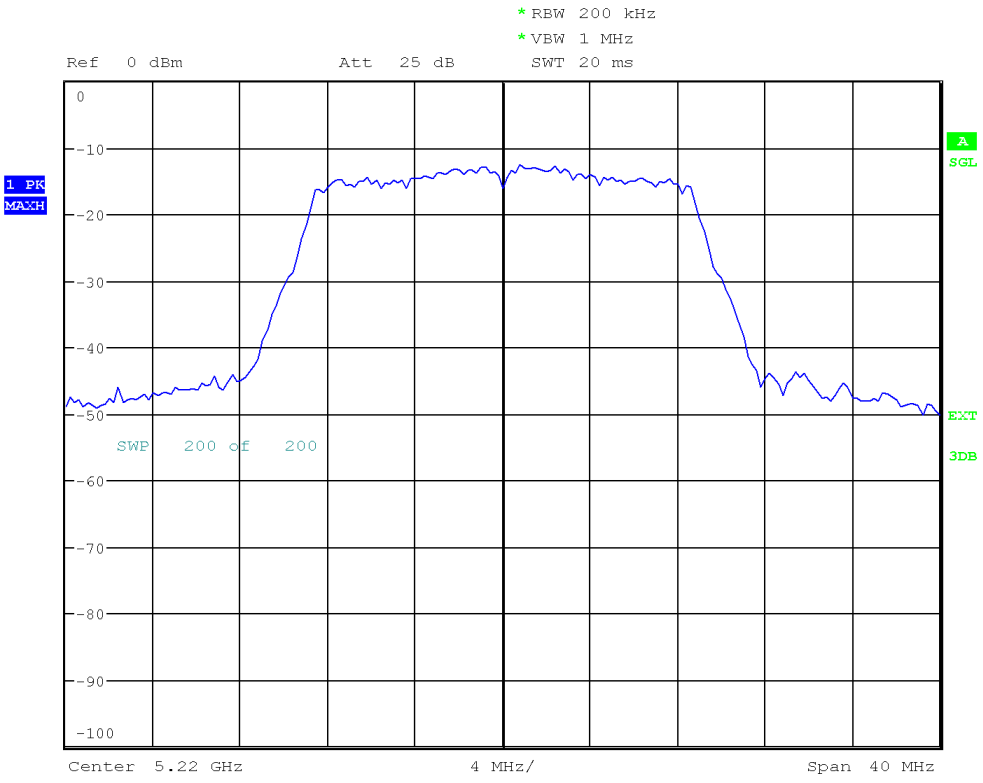


Date: 14.NOV.2018 15:35:47

DUT operating at 5180 MHz and 20 MHz BW; 26 dB EBW

Diagram 2

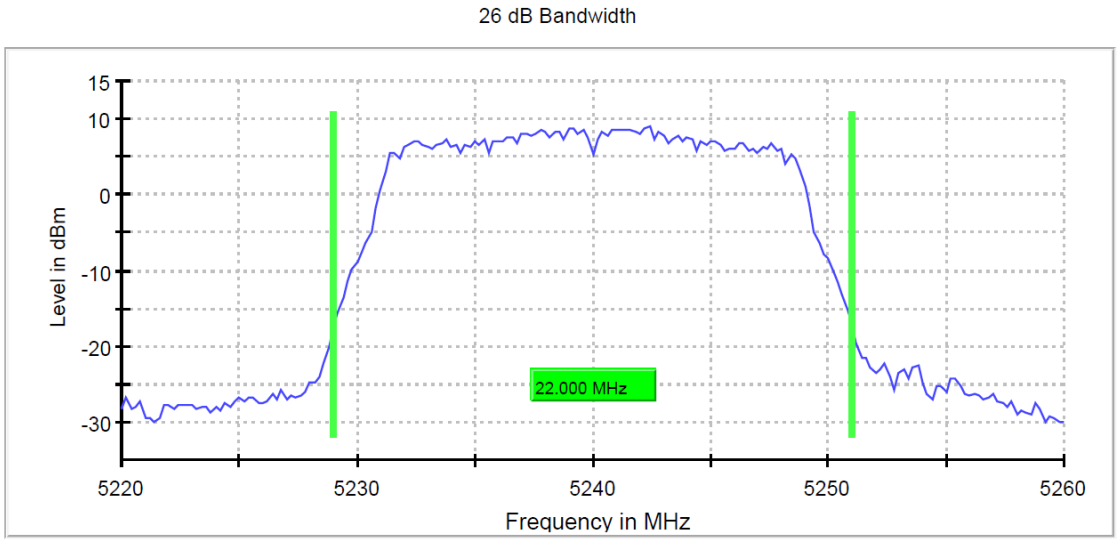


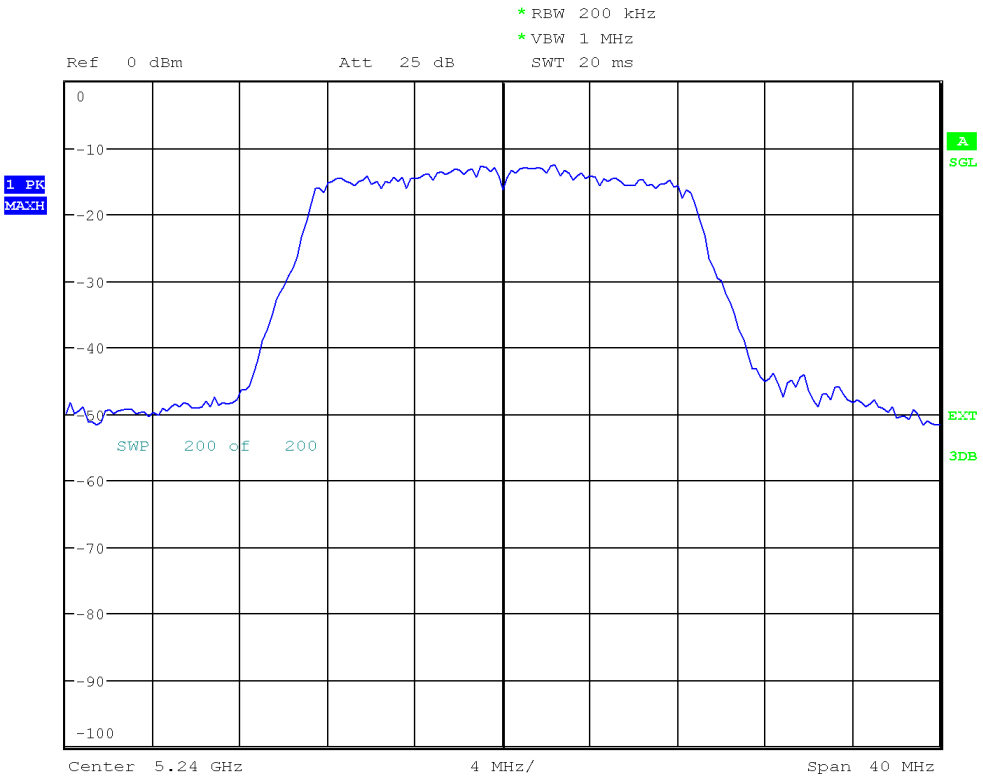


Date: 14.NOV.2018 15:43:27

DUT operating at 5220 MHz and 20 MHz BW; 26 dB EBW

Diagram 3

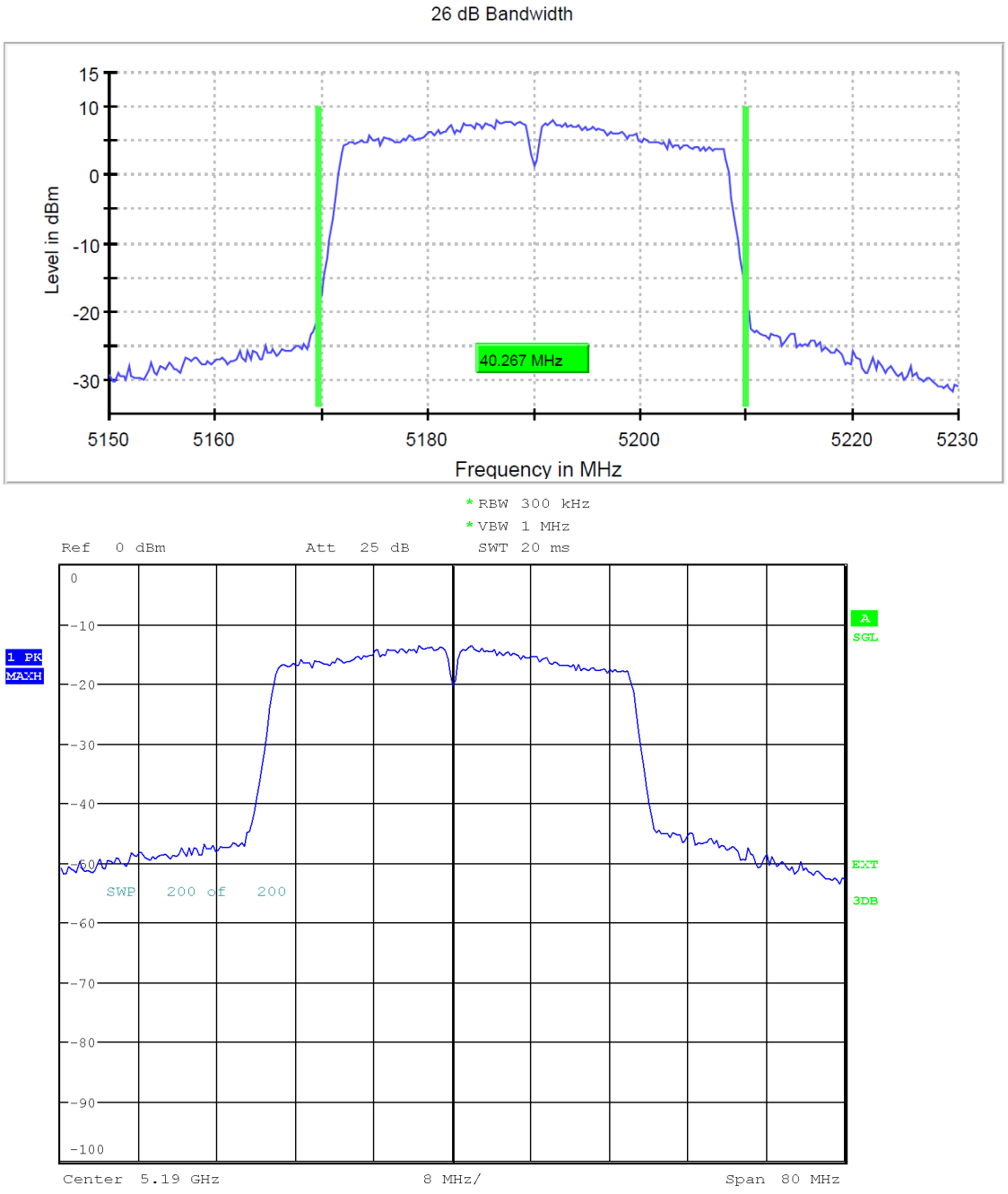




Date: 14.NOV.2018 15:51:41

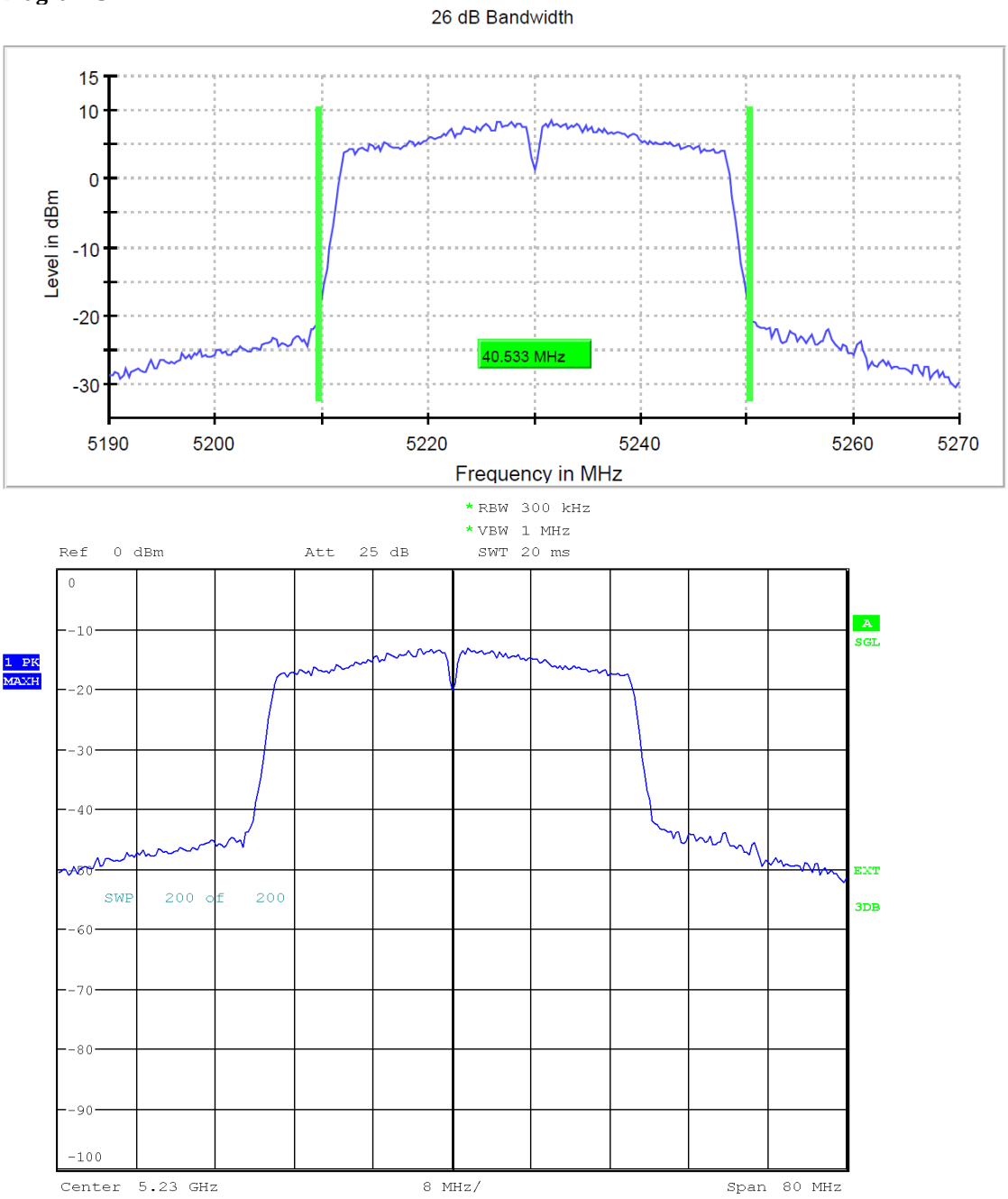
DUT operating at 5240 MHz and 20 MHz BW; 26 dB EBW

Diagram 4



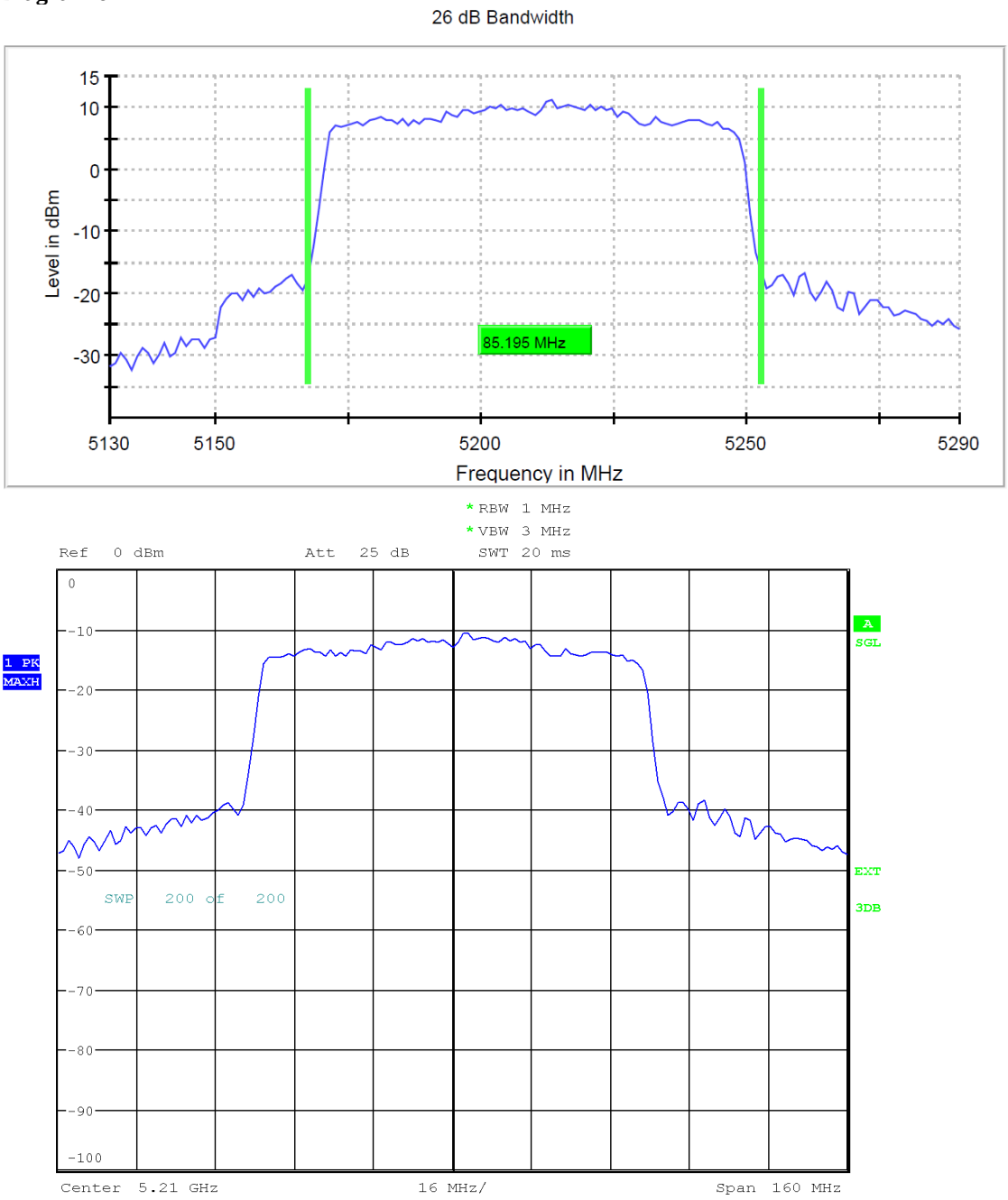
DUT operating at 5190 MHz and 40 MHz BW; 26 dB EBW

Diagram 5



DUT operating at 5230 MHz and 40 MHz BW; 26 dB EBW

Diagram 6



DUT operating at 5210 MHz and 80 MHz BW; 26 dB EBW

99% occupied bandwidth - OBW measurements according to 47CFR 2.1049

Date	Temperature	Humidity
2018-11-14	22 °C ± 3 °C	29 % ± 5 %

Test setup and procedure

The measurements were performed according to ANSI C63.10, clause 12.4.2/6.9.3 and KDB 789033 D02 General UNII Test Procedures New Rules v02r01 Dec. 14, 2017 II.D

Conducted measurements were performed on units with the temporary antenna connectors, with transmission below 98% of duty cycle and with normal modulation.

The test was performed with max peak detector.

Test set-up photos during the tests can be found in the photo section in the separate document, REPORT-ANNEX, AT-DG2 Photos.

Measurement equipment	RISE number
Test site Marconi	15:121
Spectrum analyser R&S FSQ 26	BX50694
Coaxial cable	BX81424
Coaxial cable	BX81436
Coaxial cable	BX50685
120 V AC/60 Hz AC Power source HP 6813B	503 091
DC power supply HP E3632A	503 170
Multimeter Fluke 85 III	503 418
Temperature and humidity meter Testo 625	503 498

Results

SISO 2 (chain 2 – 6 dBi antenna gain)			802.11ac	
T_{nom} 20°C V_{nom} 120 V AC				
f [MHz]	BW [MHz]	OBW left [MHz]	OBW right [MHz]	OBW [MHz]
5180	20	5170.8	5189.0	18.2
5220	20	5211.0	5229.2	18.2
5240	20	5231.0	5249.0	18.0
5190	40	5171.9	5208.1	36.3
5230	40	5211.9	5248.1	36.3
5210	80	5172.0	5247.9	75.9

The 99% OBW measurements can be found in the diagrams below:

Diagram 1:	5180 MHz 20 MHz BW, 99% OBW
Diagram 2:	5220 MHz 20 MHz BW, 99% OBW
Diagram 3:	5240 MHz 20 MHz BW, 99% OBW
Diagram 4:	5190 MHz 40 MHz BW, 99% OBW
Diagram 5:	5230 MHz 40 MHz BW, 99% OBW
Diagram 6:	5210 MHz 80 MHz BW, 99% OBW

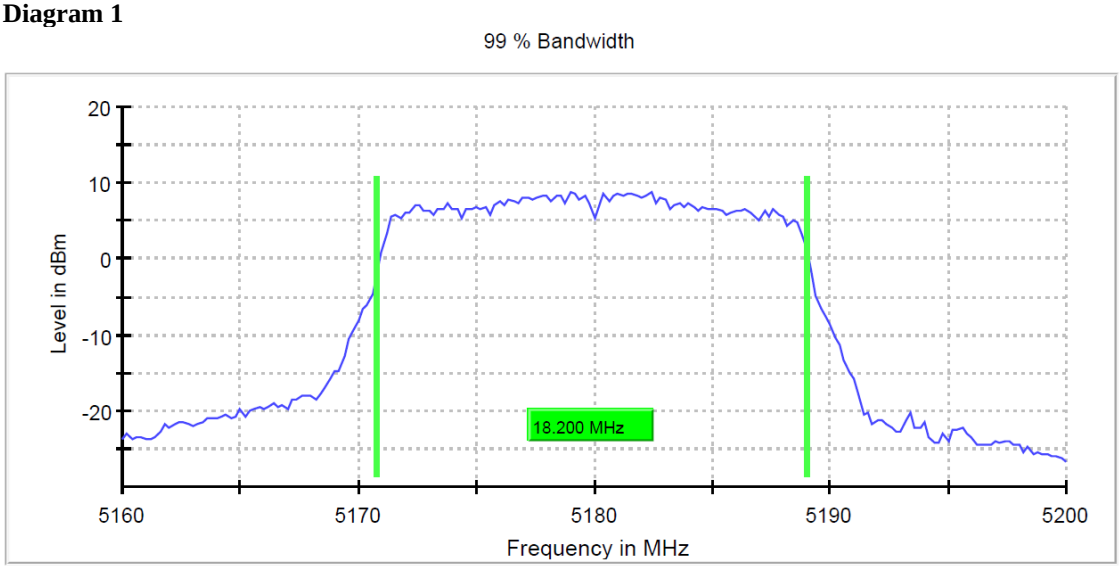
Limits

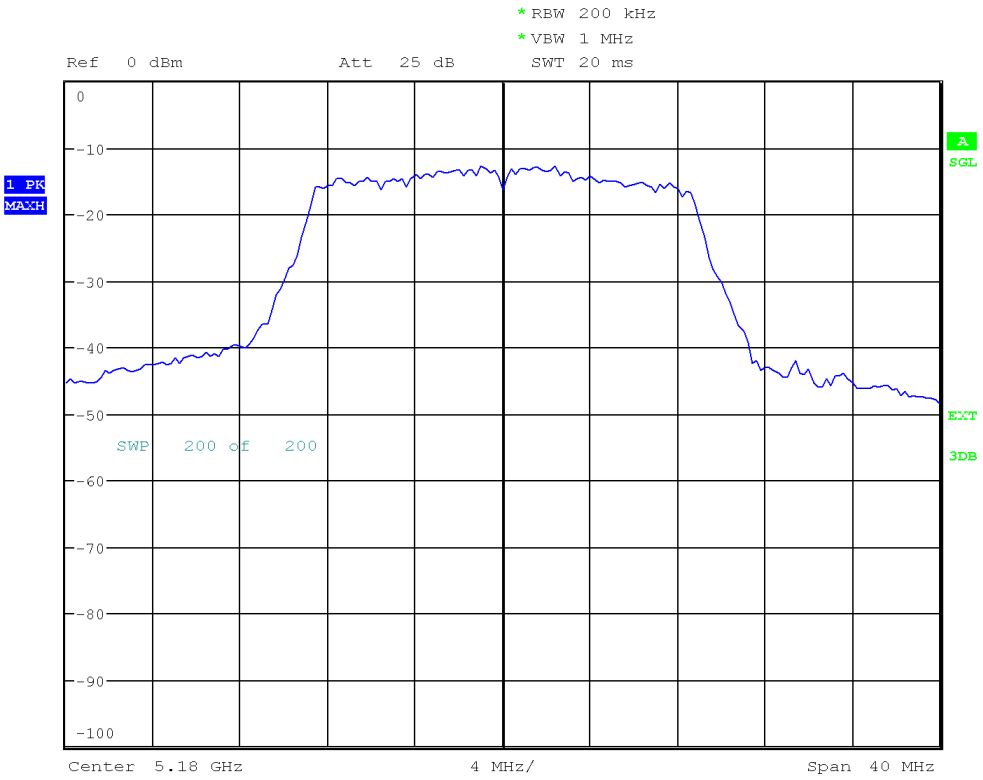
No limits specified in the §15.407 except as alternative limit for unwanted emissions in the U-NII-2A from devices operating in U-NII-1, according KDB 789033 D02 General UNII Test Procedures New Rules v02r01 Dec. 14, 2017 III.B.2.a)(i).
According this alternative limit, higher edge of 99 % OBW shall be below 5250 MHz.

Test engineer: Ermin Pasalic

Complies?	Yes

Diagram 1

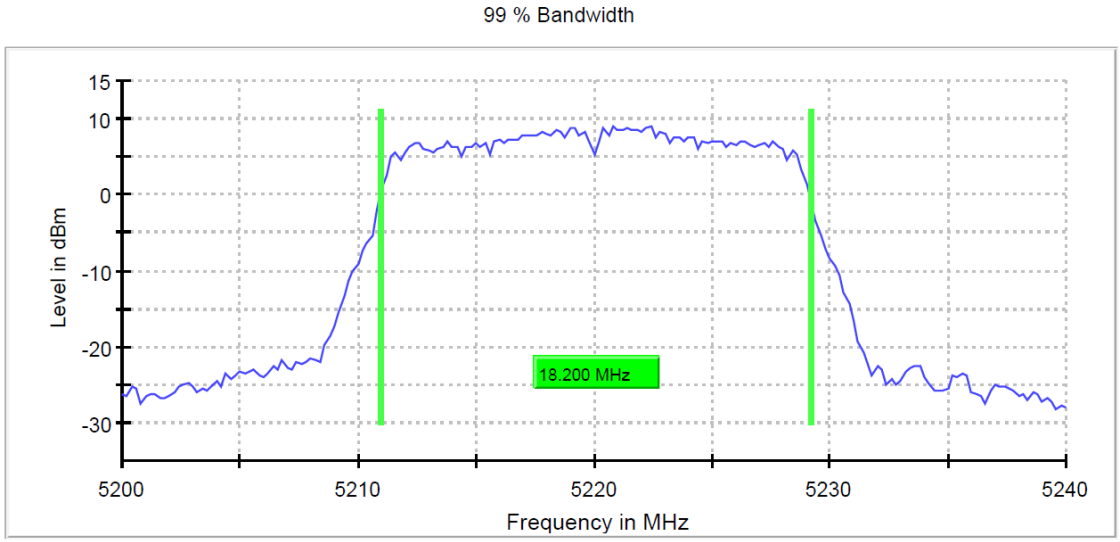


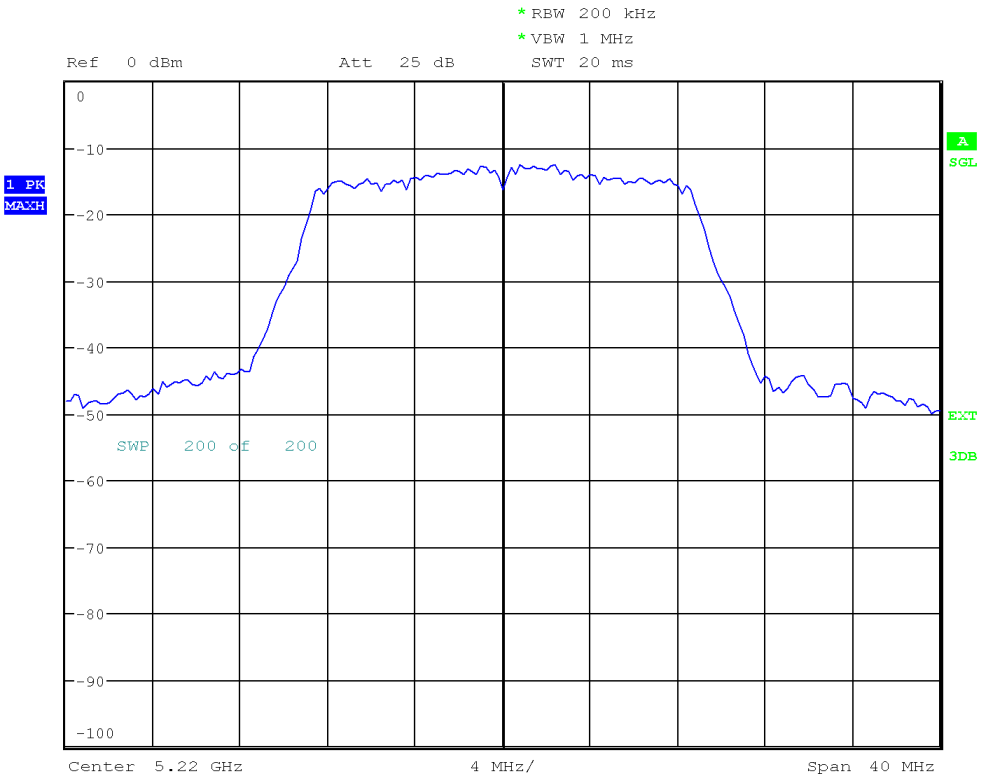


Date: 14.NOV.2018 15:38:23

DUT operating at 5180 MHz and 20 MHz BW; 99% OBW

Diagram 2

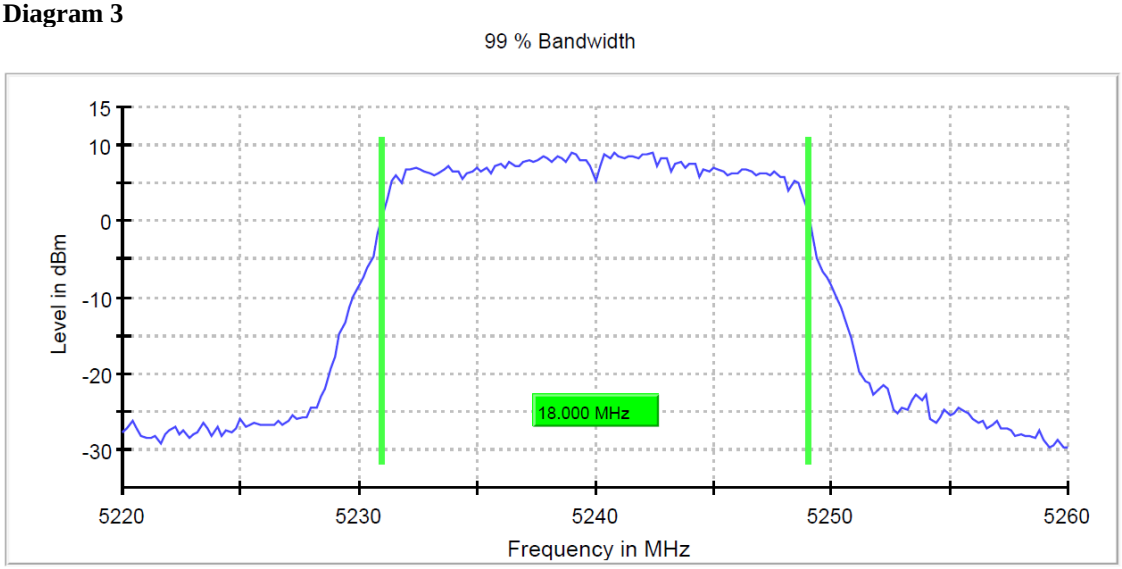


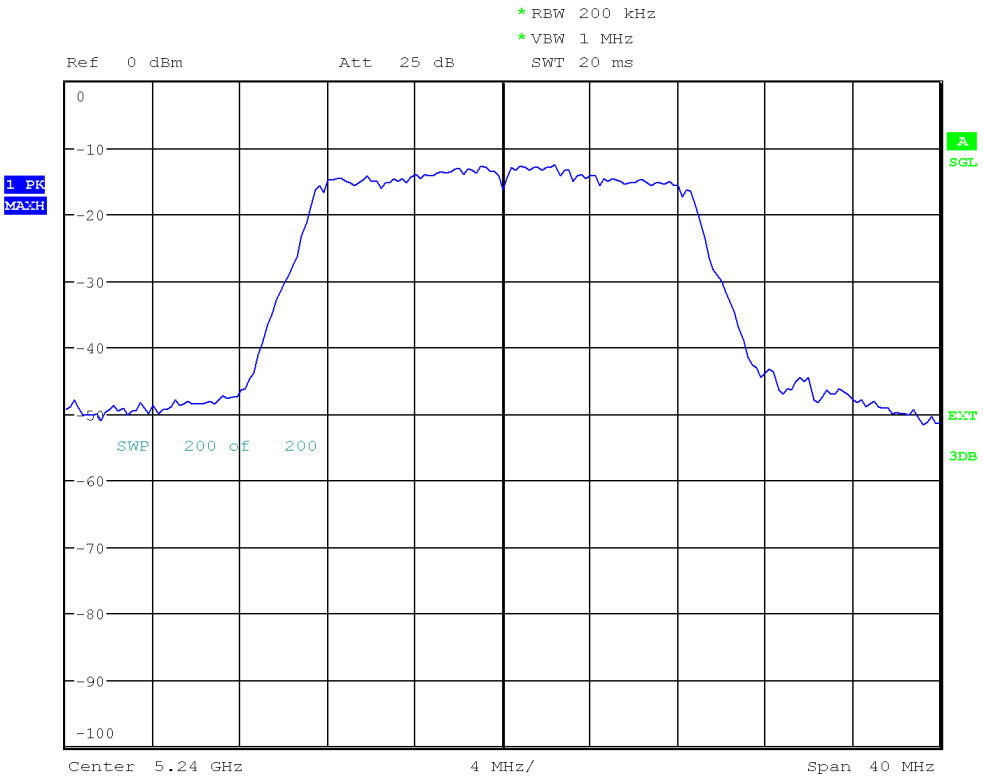


Date: 14.NOV.2018 15:47:26

DUT operating at 5220 MHz and 20 MHz BW; 99% OBW

Diagram 3

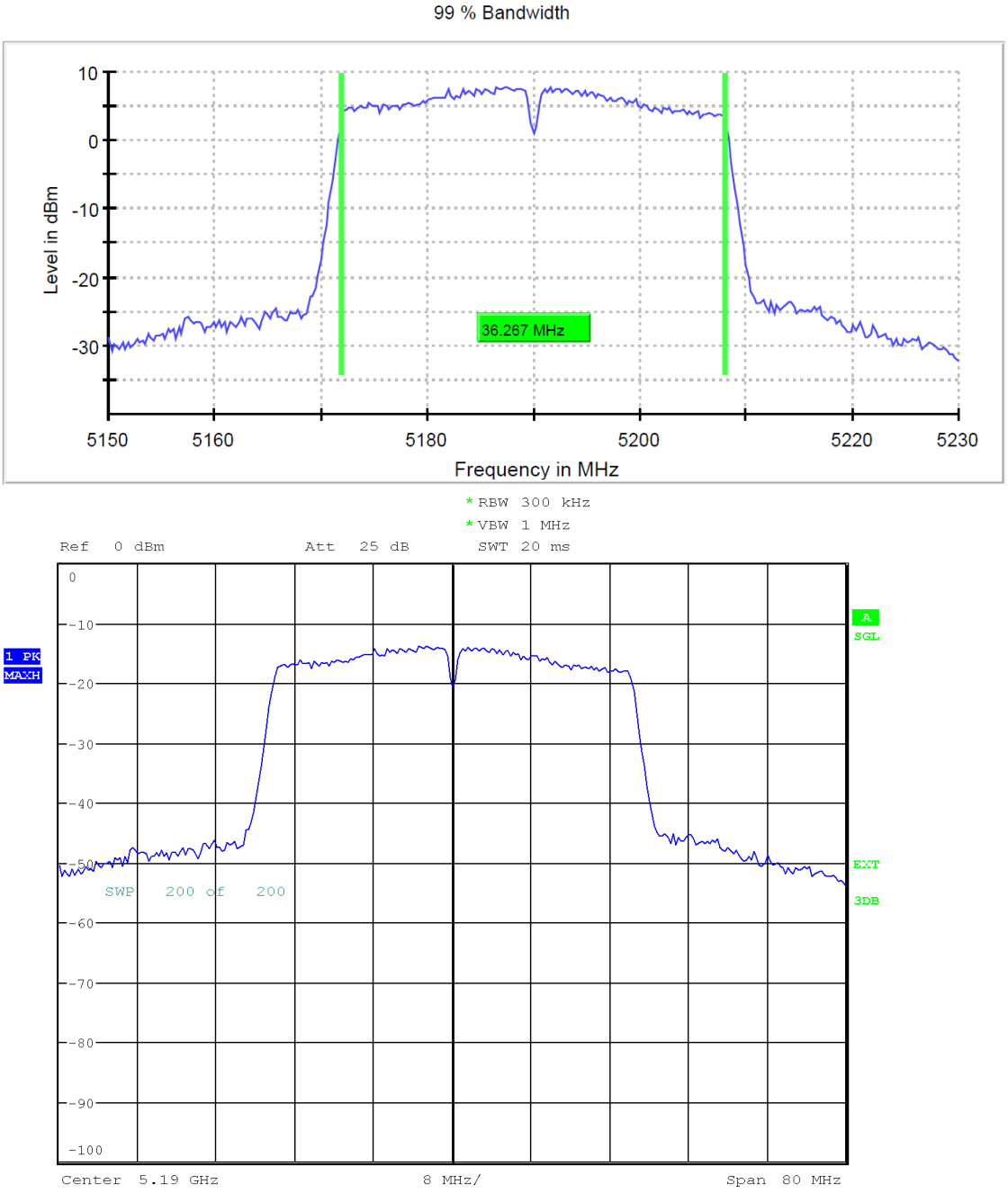




Date: 14.NOV.2018 15:58:33

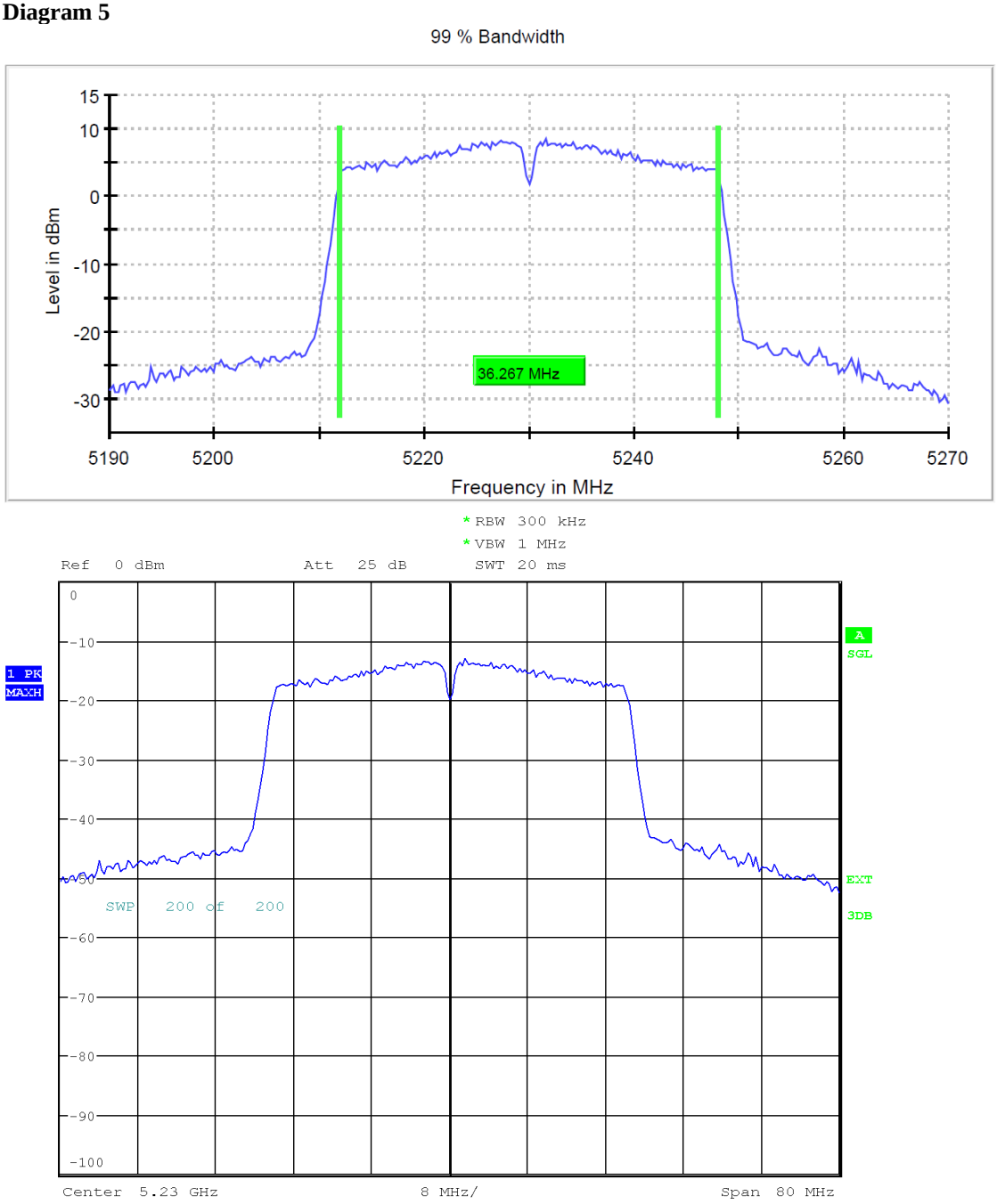
DUT operating at 5240 MHz and 20 MHz BW; 99% OBW

Diagram 4



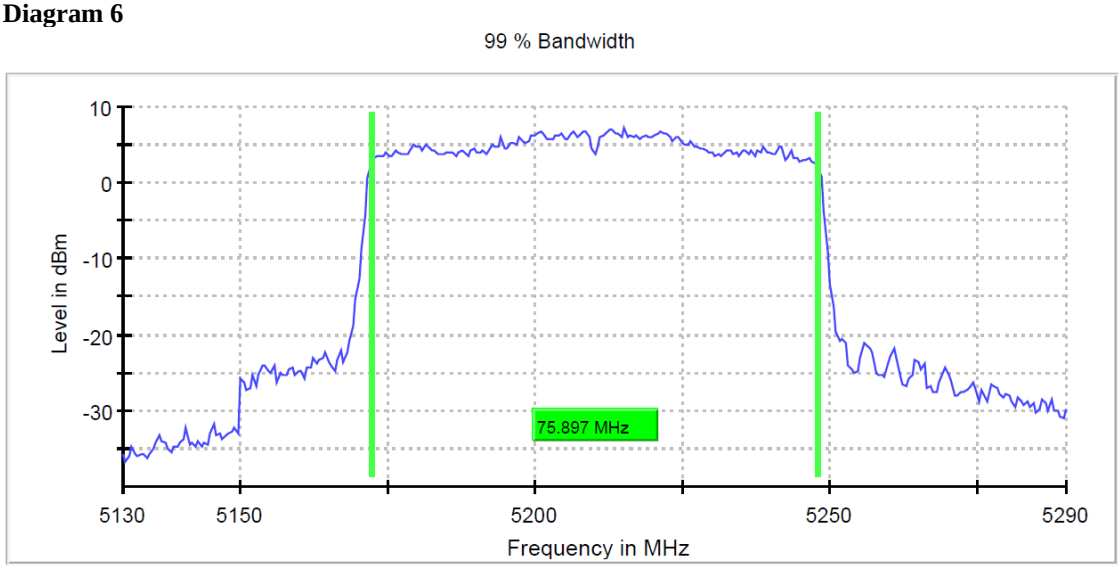
DUT operating at 5190 MHz and 40 MHz BW; 99% OBW

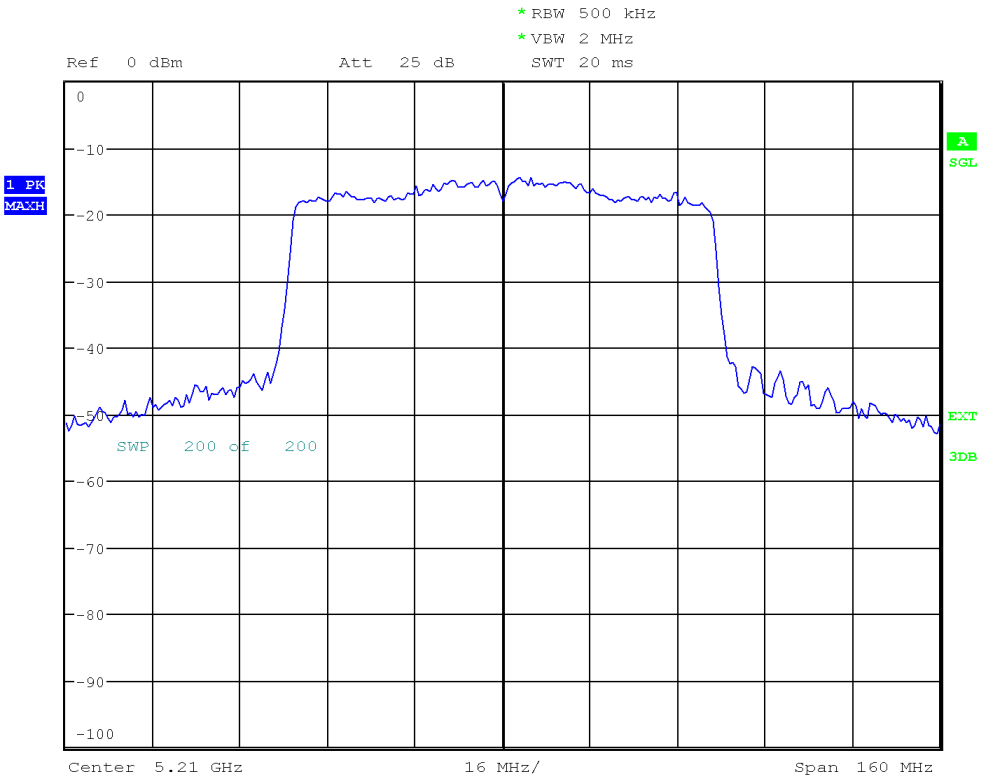
Diagram 5



DUT operating at 5230 MHz and 40 MHz BW; 99% OBW

Diagram 6





Date: 14.NOV.2018 16:45:22

DUT operating at 5210 MHz and 80 MHz BW; 99% OBW

Band edge measurements according to 47CFR 2.1049

Date	Temperature	Humidity
2018-11-06	22 °C ± 3 °C	34 % ± 5 %
2018-11-25	21 °C ± 3 °C	31 % ± 5 %

Test setup and procedure

The measurements were performed according to ANSI C63.10-2013, clause 12.7.4.4. and KDB 789033 D02 General UNII Test Procedures New Rules v02r01 Dec. 14, 2017 II.G.3.d.(ii), II.G.5, II.G.6 and III.B.2.a)(i).

Radiated measurements were performed on units with the integrated antennas with transmission below 98% of duty cycle and with normal modulation. The presented results of peak and average power in the table below are measured results with applied correction for duty. The results in the diagrams are not corrected for duty cycle.

Test set-up photos during the tests can be found in the photo section in the separate document, REPORT-ANNEX, AT-DG2 Photos.

Measurement equipment	RISE number
Semi anechoic chamber, Edison	504114
Computer Lenovo ThinkCentre	-
Software R&S EMC32, ver.9.15.00	503889
EMI test receiver R&S ESU 26	902210
Antenna ETS-Lindgren 3115	902175
Step attenuator Narda743-60	BX41644
Coaxial cable	BX50672
Coaxial cable	504102
Coaxial cable	504103
Coaxial cable	504104
Multimeter Fluke 83	501522
Temperature and humidity meter Testo 625	504117

Results

Operation band 5150-5250 MHz

MIMO		802.11ac					
T_{nom} 20°C V_{nom} 120 V AC		5150 MHz - edge					
f [MHz]	BW [MHz]	Peak [dBm]	Peak Limit [dBm]	Peak Margin [dB]	CAV [dBm]	CAV Limit [dBm]	CAV Margin [dB]
Ch 36, 5180 MHz; 8 dBm/p8	20	-22.6	-21.2	1.4	-45.7	-41.2	4.5
Ch 38, 5190 MHz; 5 dBm/p5	40	-27.8	-21.2	6.6	-46.2	-41.2	5.0
Ch 42, 5210 MHz; 6 dBm/p6	80	-24.2	-21.2	3.1	-41.9	-41.2	0.7

In the restricted bands peak limit is 20 dB higher than CAV limit.
The limit of -27 dBm/MHz according KDB 789033 D02 General UNII Test Procedures New Rules v02r01 Dec. 14, 2017 III.B.2.a)(i) at the edge 5150 MHz and just below is not applicable due to the restricted band.

Outside restricted bands, peak limit of -27 dBm is applied.

Note: Peak and CAV values in the upper table are corrected for duty cycle according following table:

Operating frequency, f and bandwidth, BW	Duty cycle [%]	Correction [dB]
5180 MHz, 20 MHz	98.6	0.06
5190 MHz, 40 MHz	95.7	0.19
5210 MHz, 80 MHz	92.3	0.35

Applicable restricted bands:
4500 – 5150 MHz
5350 – 5460 MHz

Operation band:
5150-5250 MHz

MIMO				802.11ac	
T_{nom} 20°C V_{nom} 120 V AC		5250 MHz - edge			
f [MHz]	BW [MHz]	EBW right [MHz]	OBW right [MHz]	Limit [MHz]	OBW Margin [MHz]
Ch 48, 5240 MHz; 13 dBm/p13	20	5251.02	**5249.46**	5250	0.54
Ch 46, 5230 MHz; 13 dBm/p13	40	5250.91	**5248.49**	5250	1.51
Ch 42, 5210 MHz; 13 dBm/p13	80	5250.84	**5248.25**	5250	1.75

The band edge measurements can be found in the diagrams below:

Diagram 1:	Ch 36, 5180 MHz 20 MHz BW, 8 dBm/p8, 5150 MHz-Band edge
Diagram 2:	Ch 38, 5190 MHz 40 MHz BW, 5 dBm/p5, 5150 MHz-Band edge
Diagram 3:	Ch 42, 5210 MHz 80 MHz BW, 6 dBm/p6, 5150 MHz-Band edge
Diagram 4:	Ch 48, 5240 MHz 20 MHz BW, p13, 5250 MHz-Band edge
Diagram 5:	Ch 46, 5230 MHz 40 MHz BW, p13, 5250 MHz-Band edge
Diagram 6:	Ch 42, 5210 MHz 80 MHz BW, p13, 5250 MHz-Band edge

Note: The results in the diagrams are not corrected for duty cycle.

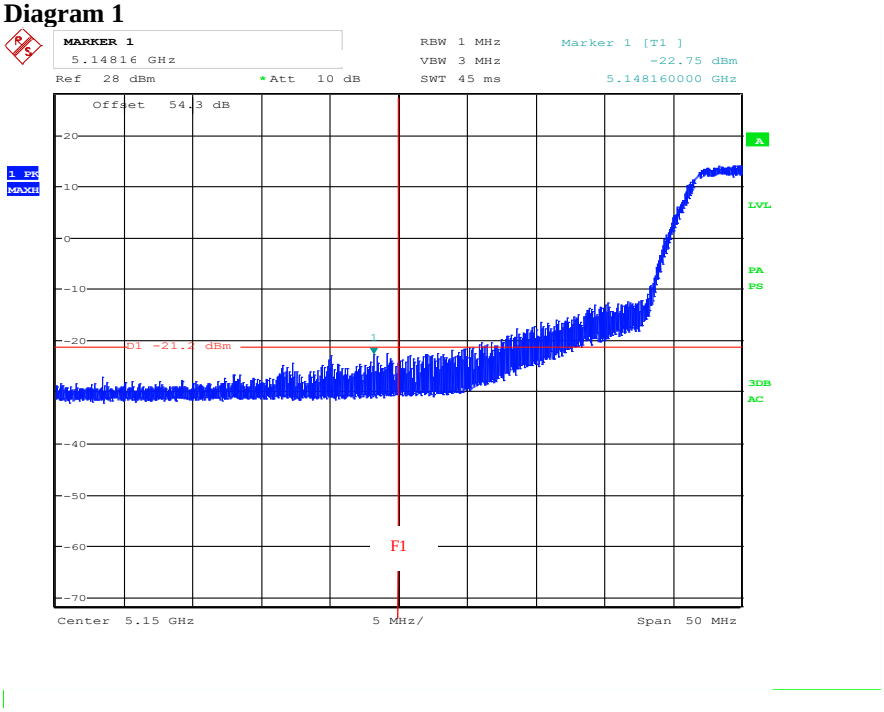
Limits

According to 47CFR 15.407(b), e.i.r.p. of the emission produced by the intentional radiator shall be below -27 dBm outside the frequency band in which the 5 GHz WiFi radiator is operating for frequencies over 1 GHz and except restricted bands defined in §15.205 as shown in paragraph 15.407(b)(7).
Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits based on the field strength, specified in Section 15.209(a).
According to KDB 789033 D02 General UNII Test Procedures New Rules v02r01 Dec. 14, 2017 III.B.2.a) (i) for devices operating in the 5.15-5.25 GHz band, the -27 dBm/MHz peak EIRP limit applies outside of the lower pair of U-NII bands. i.e., 5.15-5.35. However , any transmission that does not intentionally extend into the 5.25-5.35 GHz bund must be down 26 dB above 5.25 GHz per section 15.215 (c). As practical matter, the 99% bandwidth may be used in lieu of the 26 dB bandwidth. If the emission does intentionally extend into the 5.25-5.35 GHz band, DFS and TPC must be implemented per section 15.407(h).

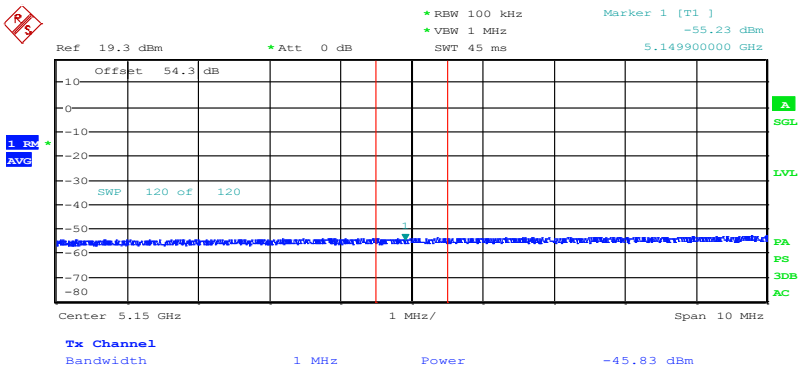
Test engineer: Ermin Pasalic

Complies?	Yes

Diagram 1

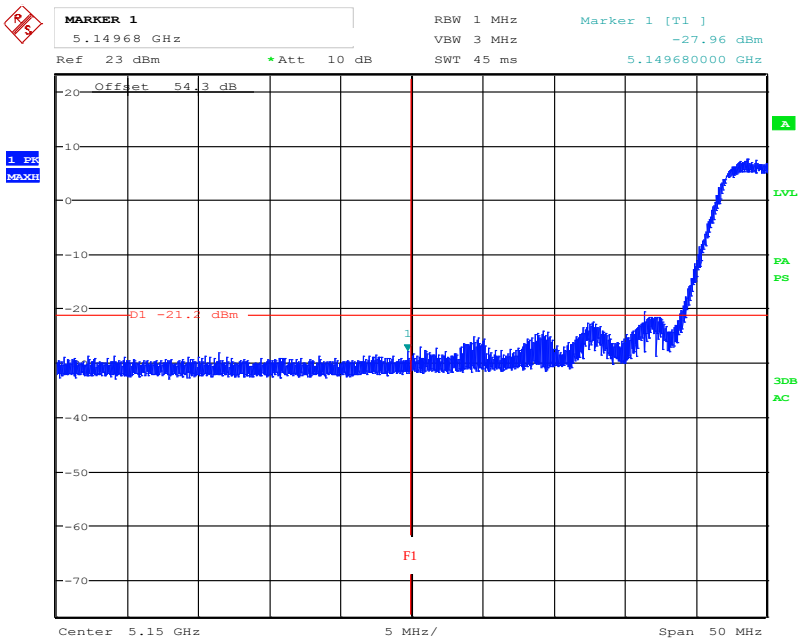


Note: the highest level for frequencies 5.15 GHz, (red line F1), and below shall be after correction below limit, -21.2 dBm. The highest value after correction can be seen in the table on the page 91.



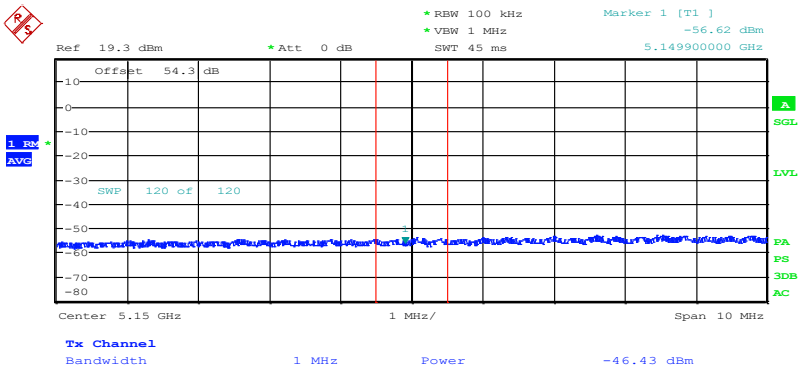
Ch 36, 5180 MHz 20 MHz BW, 8 dBm/p8, 5150 MHz-Band edge
Requirement is based on Average RMS power and peak power.

Diagram 2



Date: 25.NOV.2018 19:10:17

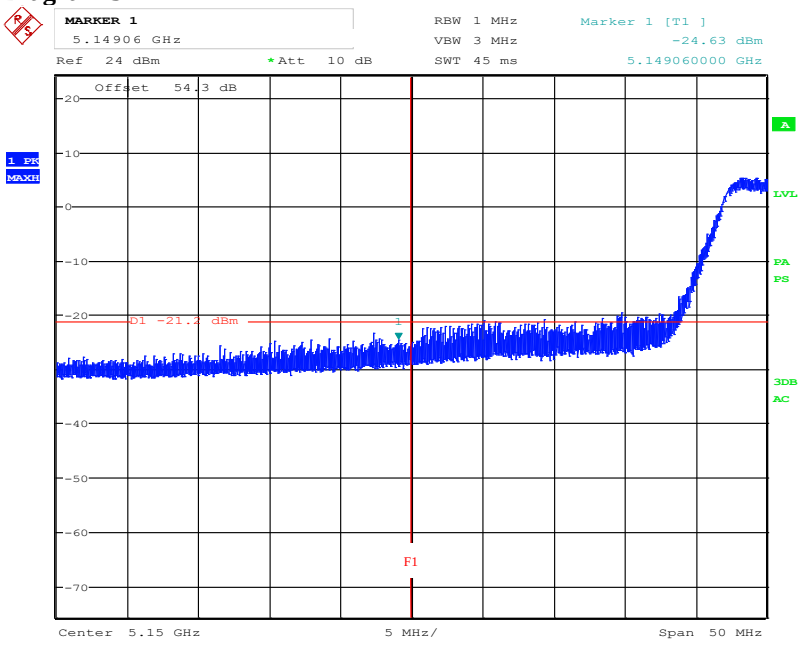
Note: the highest level for frequencies 5.15 GHz, (red line F1), and below shall be after correction below limit, -21.2 dBm. The highest value after correction can be seen in the table on the page 91.



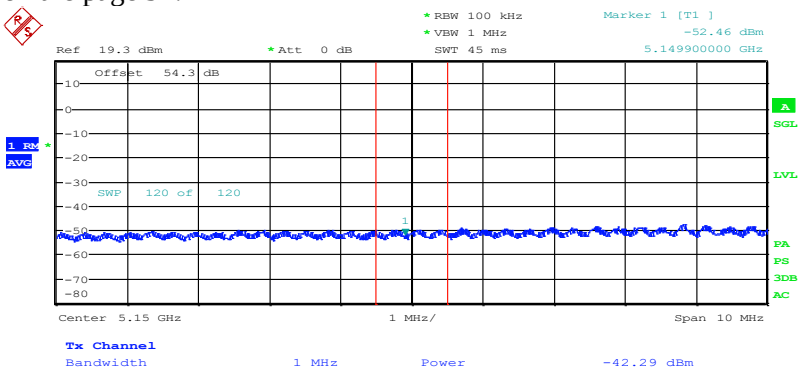
Date: 25.NOV.2018 19:11:55

Ch 38, 5190 MHz 40 MHz BW, 5 dBm/p5, 5150 MHz-Band edge
Requirement is based on Average RMS power and peak power

Diagram 3

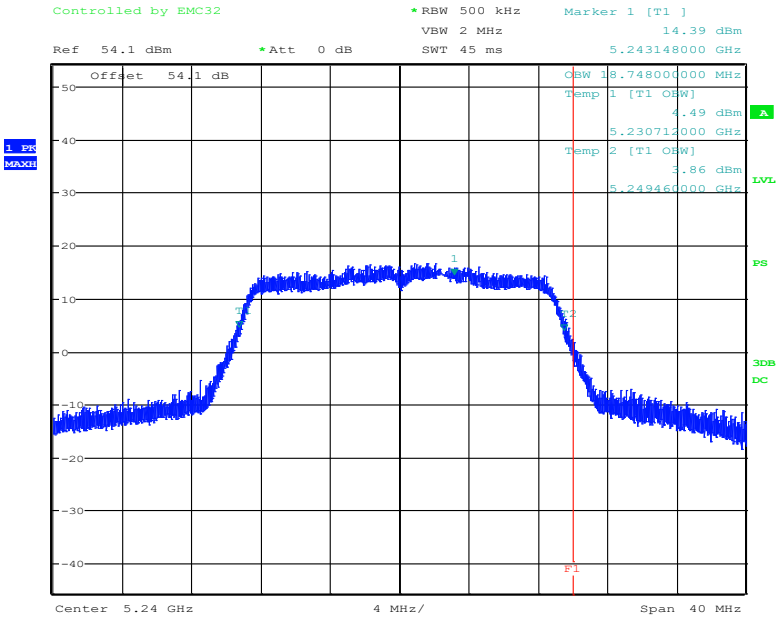


Note: the highest level for frequencies 5.15 GHz, (red line F1), and below shall be after correction below limit, -21.2 dBm. The highest value after correction can be seen in the table on the page 91.

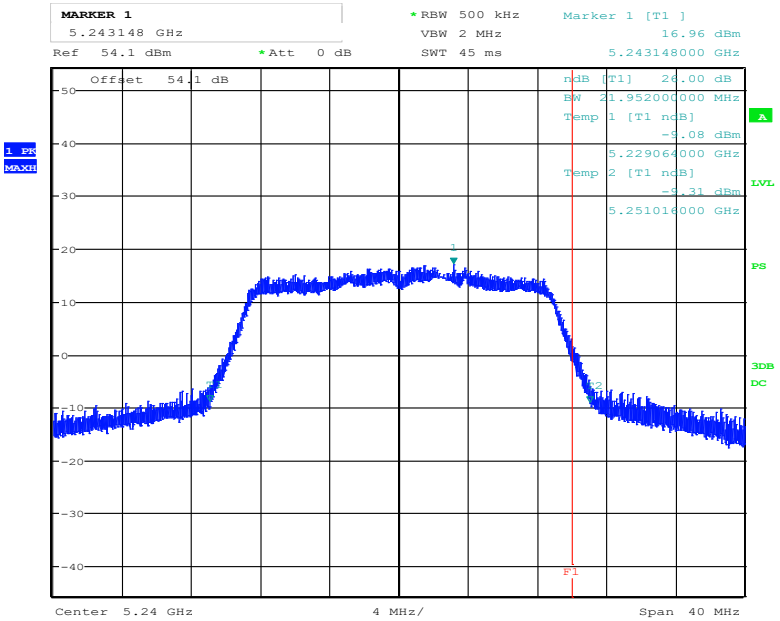


Ch 42, 5210 MHz 80 MHz BW, 6 dBm/p6, 5150 MHz-Band edge
Requirement is based on Average RMS power and peak power

Diagram 4



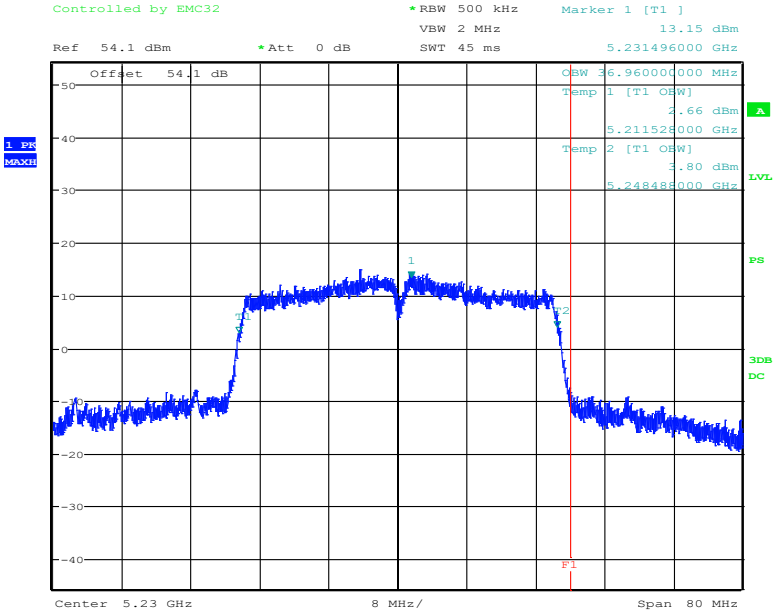
OBW; the higher edge of OBW – T2 shall be below 5250 MHz, (red line, F1)



According KDB, it is accepted, due to practical reasons, that higher edge of EBW falls over 5250 MHz, but higher edge of OBW shall fall below 5250 MHz for compliance.

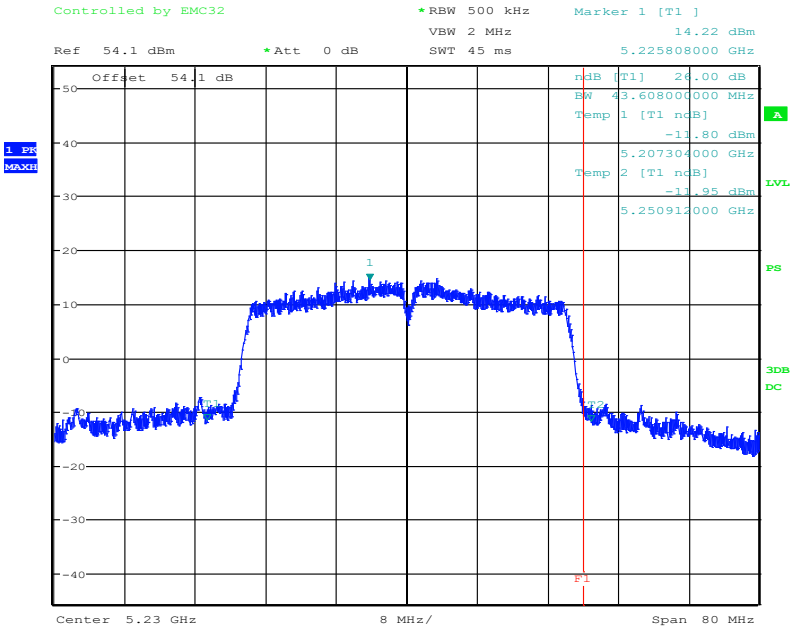
Ch 48, 5240 MHz 20 MHz BW, p13, 5250 MHz-Band edge

Diagram 5



Date: 6.NOV.2018 12:31:08

OBW; the higher edge of OBW – T2 shall be below 5250 MHz, (red line, F1)

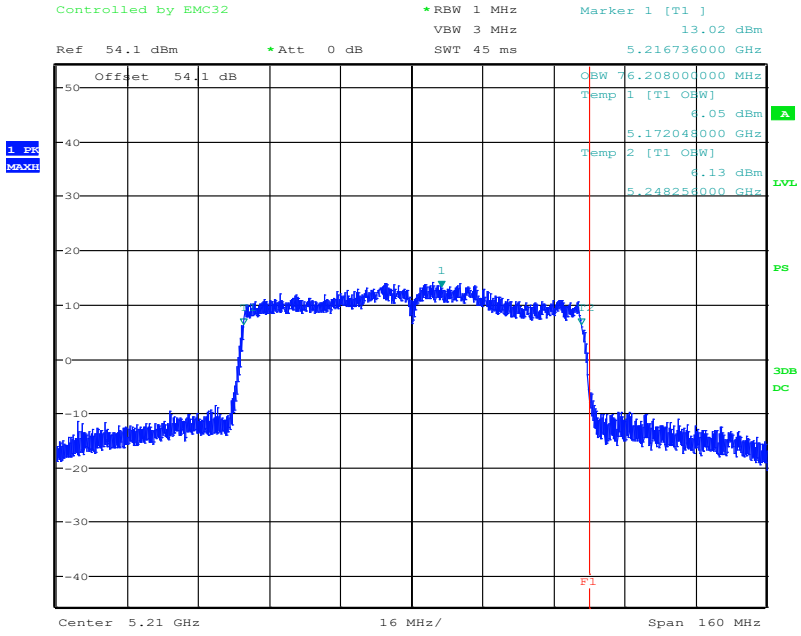


Date: 6.NOV.2018 12:32:21

According KDB, it is accepted, due to practical reasons, that higher edge of EBW falls over 5250 MHz, but higher edge of OBW shall fall below 5250 MHz for compliance.

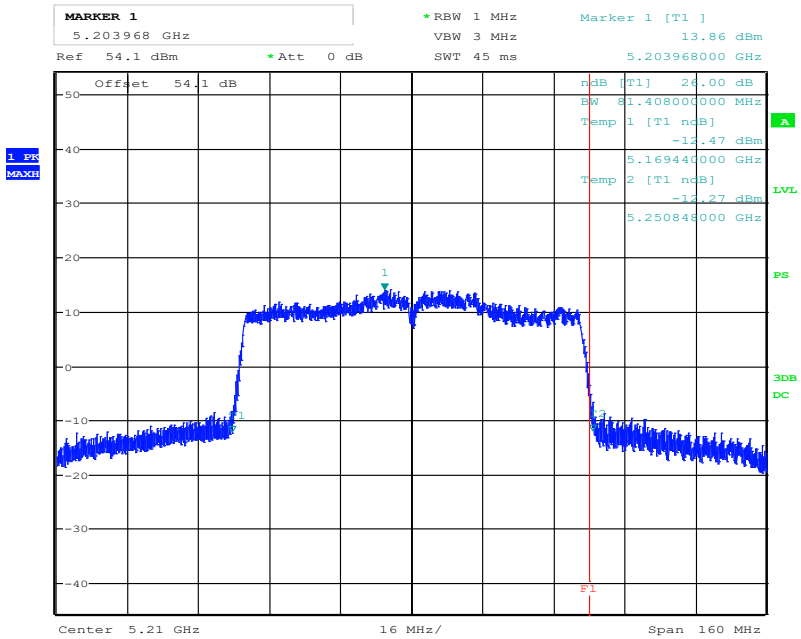
Ch 46, 5230 MHz 40 MHz BW, p13, 5250 MHz-Band edge

Diagram 6



Date: 6.NOV.2018 12:39:38

OBW; the higher edge of OBW – T2 shall be below 5250 MHz, (red line, F1)



Date: 6.NOV.2018 12:40:45

According KDB, it is accepted, due to practical reasons, that higher edge of EBW falls over 5250 MHz, but higher edge of OBW shall fall below 5250 MHz for compliance.

Ch 42, 5210 MHz 80 MHz BW, p13, 5250 MHz-Band edge