# Index

# Acronyms

| Acronym ID | Acronym Description |
|---|---|
| # of Tx Chains | Number of Transmission Chains |
| Detector | Detector used |
| Equipment | Equipment Type |
| Freq | Frequency |
| Freq Rng | Frequency Range |
| MP | Measurement Point |
| Mod | Modulation |
| Pol | Polarization |
| Unwanted Freq | Unwanted Emissions Frequency |
| Unwanted Lvl | Unwanted Emissions Level |

# Competences and guarantees

DEKRA Testing and Certification is a testing laboratory accredited by the National Accreditation Body (ENAC - Entidad Nacional de Acreditación) to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification is an FCC-recognized accredited testing laboratory with appropriate scope of accreditation that covers the performed tests in this report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory, CABid: ES1909, Company Number: 4621A, with the appropriate scope of accreditation that covers the performed tests in this report.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification S.A.U. has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification S.A.U. at the time of performance of the test.

DEKRA Testing and Certification S.A.U. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.



# General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
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4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification S.A.U. and the Accreditation Bodies.

# Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

The total uncertainty of the measurement system for the radiated emissions of the EUT from 30 MHz to 1 GHz is: Measurement uncertainty ≤ ±5.35 dB (with factor k=2).

The total uncertainty of the measurement system for the radiated emissions of the EUT from 1 to 17 GHz is: Measurement uncertainty ≤ ±4.32 dB (with factor k=2).

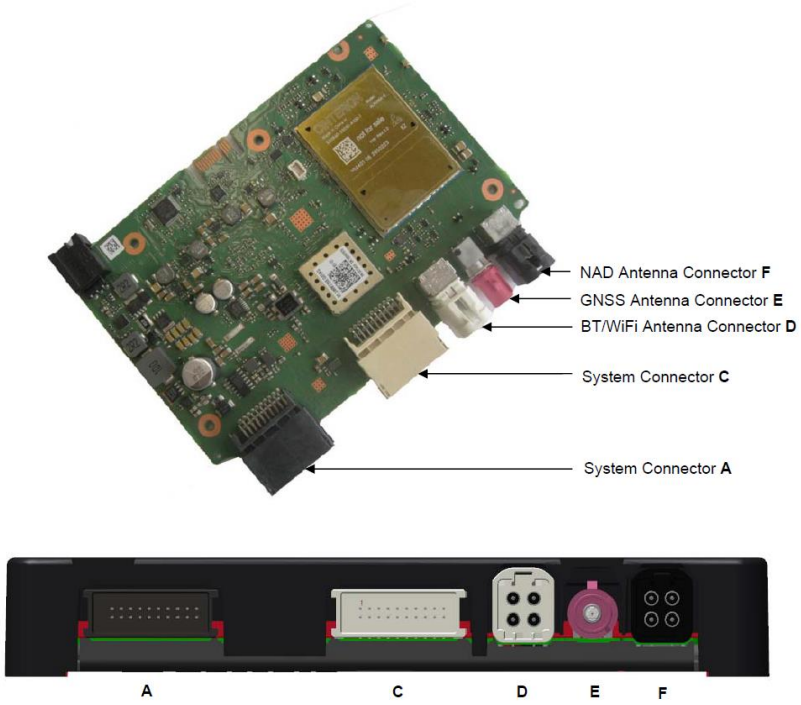
The total uncertainty of the measurement system for the radiated emissions of the EUT from 17 to 40 GHz is: Measurement uncertainty ≤ ±5.51 dB (with factor k=2).

# Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").

2. The sample consists of a Telematics control unit with wireless technologies, used in automotive, equipped with one modem, OEM. This unit was designed for automotive usage and contains the following features: GSM, UMTS, LTE, GNSS, Wifi (a, b, g, n, ac), Bluetooth Low Energy (BTLE) and Bluetooth EDR.



3. Declaration of Comparability

# Declaration of Comparability

**HARMAN BECKER**
**Automotive Systems GmbH**
**Becker-Göring-Str. 16**
**D-76307 Karlsbad, Germany**

**declares under our sole responsibility, that the product**

| | | |
|---|---|---|
| **Description of object** | : | Telematic system with BT, WLAN, GNSS, GSM, UMTS, LTE |
| **Brand/ Customer** | : | VW-Group / VW AG/ Audi |
| **Model name**<br>**Variant** | : | CONBOX-HIGH RD<br>A970, A971, A972, A973, A974, A975, A976, A977, A978, A979, A980, A981, A982, A983, A984, P114, P115, P119 |
| **Hardware / Software version** | : | 045 / 0489 **(corresponds CL37)** |

**is comparable to:**

| | | |
|---|---|---|
| **Description of object** | : | Telematic system with BT, WLAN, GNSS, GSM, UMTS, LTE |
| **Customer / Brand** | : | VW-Group / VW AG/ Audi |
| **Model**<br>**Variant** | : | CONBOX-HIGH RD<br>A970, A971, A972, A973, A974, A975, A976, A977, A978, A979, A980, A981, A982, A983, A984, P114, P115, P119 |
| **Hardware / SW** | : | 045 / 0494 **(corresponds CL37)** |

We declare as authorized responsible person, that the products above have HW and SW changes which have no impact for the certification activities.

The HW version used on CONBOX-HIGH RD will have the same schematics, the same layout, with the same BT/WLAN-Module and the same country specific NAD module and the HW index will remain 045.

The application SW will be changed to 0494 version. These SW changes do not impact the following parameters: used frequency ranges / used frequency bands, the used modulation type, the maximum RF power, the circumstances under which the transmitter operates, the basic frequency and/or stabilizing circuitry, frequency multiplication stages, the basic modulator circuitry or maximum RF power, the field strength ratings, slew rates for clocking of output pins and drivers.

More details about the HW/SW updates are included in: "CON-BOX-HIGH-RD_temp_test_20230120".

In conclusion, we can say the new SW/HW configuration do not influence the type-approval for all variants (listed above) on CONBOX-High RD - Cluster 37 (045/0494).

**Declared by:** **checked by: Thomas Roesch (S-PM) / 28.03.2023**

**Mr. STOICA Iulian, Product Compliance Expert**

| Bucharest | 28.03.2023 | |
|---|---|---|
| **(Place)** | **(Date)** | **(Signature)** |

**Mr. OLTEANU Marius, Product Compliance Expert.**

| Bucharest | 28.03.2023 | |
|---|---|---|
| **(Place)** | **(Date)** | **(Signature)** |

**HW Changes on TCU side**

From HW perspective, the main modifications are :
- replacing of unnecessary coupling capacitors C5940/C5941 220nF in PCIe bus with 0 Ohm resistors
- coupling capacitors are already on Qisda NXP module, therefore not needed on main PCB
- no change is made on the layout of main PCB.

The HW version used on CONBOX-HIGH RD will have the same schematics, the same layout, with the same BT/WLAN-Module and the same country specific NAD module and the HW index will remain 045.

**SW Changes on TCU side**

From SW perspective, the main updates are :
- change of BT/Wifi driver
- change of PCIe speed

There have been:
- No changes of the used frequency ranges / bands
- No changes of the used modulation type
- No changes of the maximum RF power
- No changes of the circumstances under which the transmitter operates
- No changes of the basic frequency and/or stabilizing circuitry
- No changes of the frequency multiplication stages
- No changes of the basic modulator circuitry or maximum RF power
- No changes of the field strength ratings
- No changes of slew rates for clocking of output pins and drivers

# Usage of samples

Samples undergoing test have been selected by: The client.

| Id | Control Number | Description | Model | Serial No. | Date of Reception | Application |
|---|---|---|---|---|---|---|
| S/01 | 72779_3 | Telematic control unit | CONBOX HIGH RD | 351998105022826 | 2022-10-17 | Element Under Test |
| S/01 | 72779_6 | Harness | -- | -- | 2022-10-17 | Element Under Test |
| S/01 | 72779_67 | Antenna VW ConBox | -- | -- | 2022-10-17 | Element Under Test |
| S/01 | 72779_68 | Antenna VW ConBox | -- | -- | 2022-10-17 | Element Under Test |
| S/01 | 72779_69 | Antenna VW ConBox | -- | -- | 2022-10-17 | Element Under Test |
| S/01 | 72779_70 | Antenna VW ConBox | -- | -- | 2022-10-17 | Element Under Test |
| S/01 | 72779_14 | Power cable | -- | -- | 2022-10-17 | Auxiliary element |
| S/01 | 72779_49 | OABR_Converter PCB Board | -- | -- | 2022-10-17 | Auxiliary element |
| S/01 | 72779_56 | GPS antenna | -- | -- | 2022-10-17 | Auxiliary element |
| S/01 | 72779_58 | Fakra 4 to 1 cable | -- | -- | 2022-10-17 | Auxiliary element |
| S/01 | 72779_59 | Ethernet cable | -- | -- | 2022-10-17 | Auxiliary element |
| S/01 | 72779_66 | Antenna cable 4 to 1 | -- | -- | 2022-10-17 | Auxiliary element |

Notes referenced to samples during the project:

| Id | Type |
|---|---|
| S/01 | Sample used for radiated tests |

# Test sample description

<table>
<tr><td rowspan="5">Ports……..:</td><td colspan="2" rowspan="2">Port name and description</td><td colspan="4">Cable</td></tr>
<tr><td>Specified max length [m]</td><td>Attached during test</td><td>Shielded</td><td>Coupled to patient(3)</td></tr>
<tr><td colspan="2">RF connector – code</td><td></td><td>☐</td><td>☒</td><td>☐</td></tr>
<tr><td colspan="2">RF connector – code</td><td></td><td>☒</td><td>☒</td><td>☐</td></tr>
<tr><td colspan="2">RF connector – code</td><td></td><td>☒</td><td>☐</td><td>☐</td></tr>
<tr><td>Supplementary information to the ports……..:</td><td colspan="6"></td></tr>
<tr><td rowspan="3">Rated power supply ..... :</td><td colspan="2" rowspan="2">Voltage and Frequency</td><td colspan="5">Reference poles</td></tr>
<tr><td>L1</td><td>L2</td><td>L3</td><td>N</td><td>PE</td></tr>
<tr><td>☐</td><td>AC:</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>☒</td><td colspan="5">DC: 12V car battery (4.8 VDC inside of TCU)</td></tr>
<tr><td>Rated Power..... :</td><td colspan="6">12V DC</td></tr>
<tr><td>Clock frequencies..... :</td><td colspan="6">25MHz; 26MHz; 32,768kHz; 49,58MHz;</td></tr>
<tr><td>Other parameters ..... :</td><td colspan="6">See Technical description</td></tr>
<tr><td>Software version..... :</td><td colspan="6">0494</td></tr>
<tr><td>Hardware version ..... :</td><td colspan="6">045</td></tr>
<tr><td>Dimensions in cm (W x H x D) ... :</td><td colspan="6">--</td></tr>
<tr><td rowspan="5">Mounting position ..... :</td><td>☐</td><td colspan="5">Table top equipment</td></tr>
<tr><td>☐</td><td colspan="5">Wall/Ceiling mounted equipment</td></tr>
<tr><td>☐</td><td colspan="5">Floor standing equipment</td></tr>
<tr><td>☐</td><td colspan="5">Hand-held equipment</td></tr>
<tr><td>☒</td><td colspan="5">Other: automotive telematics control unit</td></tr>
<tr><td rowspan="3">Modules/parts..... :</td><td colspan="3">Module/parts of test item</td><td>Type</td><td colspan="2">Manufacturer</td></tr>
<tr><td colspan="3">--</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">--</td><td>-</td><td colspan="2">-</td></tr>
<tr><td rowspan="5">Accessories (not part of the test item) ..... :</td><td colspan="3">Description</td><td>Type</td><td colspan="2">Manufacturer</td></tr>
<tr><td colspan="3">Cable Harness</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">2G/3G/4G/5G Antenna</td><td>-</td><td colspan="2">Hirschmann/ Molex</td></tr>
<tr><td colspan="3">eCall button/LED</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">SOS Loudspeaker</td><td>-</td><td colspan="2">-</td></tr>
<tr><td rowspan="2">Documents as provided by the applicant ..... :</td><td colspan="3">Wake-up unit Box</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="3">Description</td><td>File name</td><td colspan="2">Issue date</td></tr>
<tr><td colspan="3">Technical Description</td><td>-</td><td colspan="2">-</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="7"></td></tr>
</table>

(3) Only for Medical Equipment

# Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH
BECKER-GOERING-STR. 16
76307 KARLSBAD GERMANY

# Testing period and place

| | |
|---|---|
| **Test Location** | DEKRA Testing and Certification S.A.U. |
| **Date (start)** | 2022-12-01 |
| **Date (finish)** | 2022-12-02 |

# Document history

| Report number | Date | Description |
|---|---|---|
| 72779RRF.010 | 2022-12-12 | First release. |
| 72779RRF.010A1 | 2023-04-27 | Second release. Modification due to typos. |

# Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

| | |
|---|---|
| **Temperature** | Min. = 15 ºC<br>Max. = 35 ºC |
| **Relative humidity** | Min. = 20 %<br>Max. = 75 % |

In the semi-anechoic chamber, the following limits were not exceeded during the test:

| | |
|---|---|
| **Temperature** | Min. = 15 ºC<br>Max. = 35 ºC |
| **Relative humidity** | Min. = 20 %<br>Max. = 75 % |

# Remarks and comments

The tests have been performed by the technical personnel: Rafael Fernández Martín and Miguel Manuel López.

Used instrumentation:

| Control No. | Equipment | Model | Manufacturer | Next Calibration |
|---|---|---|---|---|
| 4825 | SEMIANECHOIC ABSORBER LINED CHAMBER IV | FACT 3 200 STP | ETS LINDGREN | 2023-08-28 |
| 4826 | SHIELDED ROOM | S101 | ETS LINDGREN | N/A |
| 4578 | HYBRID BILOG ANTENNA 30MHz-6GHz | 3142E | ETS LINDGREN | 2023-04-30 |
| 6142 | PRE-AMPLIFIER G>38dB 30MHz-6GHz | BLNA 0360-01N | BONN ELEKTRONIK | 2023-06-16 |
| 4716 | SIGNAL AND SPECTRUM ANALYZER 2Hz-50GHz | FSW50 | ROHDE AND SCHWARZ | 2024-08-12 |
| 6496 | HORN ANTENNA 1-18GHz | BBHA 9120 D | SCHWARZBECK MESS-ELEKTRONIK | 2023-08-24 |
| 5705 | PRE-AMPLIFIER G>40dB 1-18 GHz | BLMA 0118-1M | BONN ELEKTRONIK | 2023-07-21 |
| 4657 | HORN ANTENNA 18-40GHz | BBHA 9170 | SCHWARZBECK | 2023-05-05 |
| 8856 | PRE-AMPLIFIER G>30dB 18-40GHz | BLMA 1840-4A | BONN ELEKTRONIK | 2023-11-02 |
| 6165 | EMI TEST RECEIVER 9kHz-7GHz | ESR7 | ROHDE AND SCHWARZ | 2023-11-08 |
| 6092 | DC POWER SUPPLY 30V/5A | KEYSIGHT TECHNOLOGIES | U8002A | N/A |
| 7758 | DIGITAL MULTIMETER | FLUKE | 175 | 2023-11-14 |
| 4848 | SOFTWARE FOR EMC/RF TESTING | EMC32 | ROHDE AND SCHWARZ | N/A |

# Testing verdicts

| | |
|---|---|
| Not applicable: | N/A |
| Pass: | P |
| Fail: | F |
| Not measured: | N/M |

# Summary

| FCC 15, 22, 24, 27 / CANADA RSS-132, RSS-133, RSS-199, RSS-247, RSS-Gen | | | |
|---|---|---|---|
| **Requirement – Test case** | | **Verdict** | **Remark** |
| FCC 15.31 (h), 15.209 (a), 15.247 (d), 15.407 (b), FCC 22.917, FCC 24.238, FCC 27.53 / RSS-Gen 8.9, RSS-247 5.5, 6.2.1.2, 6.2.2.2, 6.2.3.2 & 6.2.4.2, RSS-132 5.5, RSS-133 6.5, RSS-199 4.5 | Emission limitations radiated (Transmitter) | P | (1), (2) |
| Supplementary information and remarks:<br>(1) Only radiated simultaneous transmission spurious emission test was requested.<br>(2) Radiated measurements were performed in the worst-case of combination between different capabilities of the equipment. | | | |

# **Appendix A:** Test results.

# INDEX

# TEST CONDITIONS

(*): Data provided by the client.

POWER SUPPLY (*):

| | |
|---|---|
| Vnominal: | 12 Vdc |
| Type of Power Supply: | External DC (vehicle battery) |

ANTENNA (*):

| | |
|---|---|
| Type of Antennas: | External antenna |
| Maximum Declared Gain for BT EDR: | +0.11 dBi |
| Maximum Declared Gain for BLE: | +0.11 dBi |
| Maximum Declared Gain for 2.4 GHz WLAN: | +0.11 dBi |
| Maximum Declared Gain for 5 GHz WLAN: | +2.38 dBi |
| Maximum Declared Gain for Cellular: | +6.60 dBi |

TEST FREQUENCIES (*):

| | CELLULAR | |
|---|---|---|
| | | |
| Band: | 2G 850 | |
| Frequency Range: | 824 – 849 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Low: 128 | 824.2 |
| | | |
| Band: | 2G 1900 | |
| Frequency Range: | 1850 – 1910 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | High: 810 | 1909.8 |
| | | |
| Band: | LTE Band 7 | |
| Frequency Range: | 2500 – 2570 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Low: 20850 | 2510 MHz<br>(BW 20 MHz, RB Size 1, RB Offset 0, QPSK) |

| | | |
|---|---|---|
| | WLAN 2.4 GHz (IEEE 802.11 b/g/n20) / DTS | |
| Mode: | 802.11 g: 6Mbps (SISO) | |
| Channel Bandwidth: | 20 MHz | |
| Frequency Range: | 2400 MHz to 2483.5 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | CH3 | 2422 |

| | | |
|---|---|---|
| | WLAN 5 GHz (IEEE 802.11 a/n/ac 20/40/80) / U-NII | |
| Mode: | 802.11 n20: index MCS0 (SISO) | |
| Channel Bandwidth: | 20 MHz | |
| Frequency Range: | 5150 MHz to 5250 MHz (U-NII-1) | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | CH40 | 5200 |

| | | |
|---|---|---|
| | Bluetooth EDR / FHSS | |
| Mode: | Basic Data Rate (GFSK – 1-DH5) | |
| Channel Bandwidth: | 1 MHz | |
| Frequency Range: | 2402 MHz to 2480 MHz | |
| Transmit Channels | Channel | Channel Frequency (MHz) |
| | CH30 | 2432 |

| | | |
|---|---|---|
| | Bluetooth Low Energy / DTS | |
| Mode: | GFSK - 1DH5 | |
| Channel Bandwidth: | 1 MHz | |
| Frequency Range: | 2402 MHz to 2480 MHz | |
| Transmit Channels | Channel | Channel Frequency (MHz) |
| | Low: 0 | 2402 |

The test set-up was made according to the general provisions of FCC 558074 D01 15.247 Meas Guidance v05r02 dated April 2, 2019.

The EUT was tested in the following operating modes during the transmitter tests:

For cellular technologies, the EUT was controlled by a communication tester to transmit at maximum power on the test channels and modes as required.

For WLAN and Bluetooth, the EUT was configured to transmit continuously on the test channels and modes as required.

**Selected Transmission Mode for each Radio:**

The following configurations were selected based on preliminary testing that identified these modes as the worst cases:

* Cellular 2G 850: Cellular 2G 850 / Low Channel, GPRS mode configuration.

* Cellular 2G 1900: Cellular 2G 1900 / High Channel, GPRS mode configuration.

* Cellular LTE 7: LTE Band 7 / Low Channel, QPSK mode configuration.

* Bluetooth Low Energy: GFSK 1 Mbps / Low Channel configuration.

According to the information provided by the manufacturer, the following configurations were selected as the worst cases:

* Bluetooth BR/EDR: GFSK (DH-5) / CH30 (2432 MHz) configuration.

* WLAN 2.4 GHz: 802.11g (6 Mbps) / CH3 (2422 MHz) configuration.

* WLAN 5 GHz U-NII-1: 802.11 n20 (HT20 MCS0 index) / CH40 (5200 MHz) configuration.

**TESTED SIMULTANEOUS TRANSMISSION MODES:**

*** BLE 1 Mbps Low Channel (2402 MHz) + Wi-Fi 2.4GHz 802.11g Channel 3 (2422 MHz) + Wi-Fi 5GHz 802.11n20 U-NII-1 Channel 40 (5200 MHz)**, with the EUT configured to simultaneously transmit all these signals at maximum output power.

*** BT EDR GFSK (DH5) Channel 30 (2432 MHz) + Wi-Fi 2.4GHz 802.11g Channel 3 (2422 MHz) + Wi-Fi 5GHz 802.11n20 U-NII-1 Channel 40 (5200 MHz)**, with the EUT configured to simultaneously transmit all these signals at maximum output power.

*** BLE 1 Mbps Low Channel (2402 MHz) + Wi-Fi 2.4GHz 802.11g Channel 3 (2422 MHz) + Wi-Fi 5GHz 802.11n20 U-NII-1 Channel 40 (5200 MHz) + 2G 850 GPRS Low Channel (824.2 MHz)**, with the EUT configured to simultaneously transmit all these signals at maximum output power.

*** BT EDR GFSK (DH5) Channel 30 (2432 MHz) + Wi-Fi 2.4GHz 802.11g Channel 3 (2422 MHz) + Wi-Fi 5GHz 802.11n20 U-NII-1 Channel 40 (5200 MHz) + 2G 850 GPRS Low Channel (824.2)**, with the EUT configured to simultaneously transmit all these signals at maximum output power.

*** BLE 1 Mbps Low Channel (2402 MHz) + Wi-Fi 2.4GHz 802.11g Channel 3 (2422 MHz) + Wi-Fi 5GHz 802.11n20 U-NII-1 Channel 40 (5200 MHz) + 2G 1900 GPRS High Channel (1909.8 MHz)**, with the EUT configured to simultaneously transmit all these signals at maximum output power.

*** BT EDR GFSK (DH5) Channel 30 (2432 MHz) + Wi-Fi 2.4GHz 802.11g Channel 3 (2422 MHz) + Wi-Fi 5GHz 802.11n20 U-NII-1 Channel 40 (5200 MHz) + 2G 1900 GPRS High Channel (1909.8)**, with the EUT configured to simultaneously transmit all these signals at maximum output power.

*** BLE 1 Mbps Low Channel (2402 MHz) + Wi-Fi 2.4GHz 802.11g Channel 3 (2422 MHz) + Wi-Fi 5GHz 802.11n20 U-NII-1 Channel 40 (5200 MHz) + LTE Band 7 QPSK Low Channel (2510 MHz)**, with the EUT configured to simultaneously transmit all these signals at maximum output power.

*** BT EDR GFSK (DH5) Channel 30 (2432 MHz) + Wi-Fi 2.4GHz 802.11g Channel 3 (2422 MHz) + Wi-Fi 5GHz 802.11n20 U-NII-1 Channel 40 (5200 MHz) + LTE Band 7 QPSK Low Channel (2510 MHz)**, with the EUT configured to simultaneously transmit all these signals at maximum output power.

# TEST CASES DETAILS

## FCC 15.209 (a), 15.247 (d), 15.407 (b), 22.917, 24.238, 27.53
## RSS-Gen 8.9, RSS-247 5.5 & 6.2.1.2, RSS-132 5.5, RSS-133 6.5, RSS-199 4.5

## Emission limitations radiated (Transmitter)

***Limits***

**BT EDR, BLE, WLAN 2.4 GHz, WLAN 5 GHz:**

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c) / RSS-Gen):

| Frequency Range (MHz) | Field strength (µV/m) | Field strength (dBµV/m) | Measurement distance (m) |
|---|---|---|---|
| 0.009 - 0.490 | 2400/F(kHz) | - | 300 |
| 0.490 - 1.705 | 24000/F(kHz) | - | 30 |
| 1.705 - 30.0 | 30 | - | 30 |
| 30 - 88 | 100 | 40 | 3 |
| 88 - 216 | 150 | 43.5 | 3 |
| 216 - 960 | 200 | 46 | 3 |
| Above 960 | 500 | 54 | 3 |

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit specified when measuring with peak detector function corresponding to 20 dB above the indicated values in the table above.

For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

RSS-247. Attenuation below the general field strength limits specified in RSS-Gen is not required.

**2G 850**. FCC §2.1053 & §22.917 / RSS-132 Issue 3 Clause 5.5:

FCC §22.917:

> (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

RSS-132 Clause 5.5:

> ii. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

**2G 1900.** FCC §2.1053 & §24.238 / RSS-133 Clause 6.5:

FCC §24.238:

> (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

RSS-133 Clause 6.5:

> ii. After the first 1.0 MHz, the emission power in any 1 MHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts). If the measurement is performed using 1% of the emission bandwidth, power integration over 1.0 MHz is required.

**LTE Band 7**. FCC §2.1053 & §27.53 / RSS-199 Clause 4.5:

FCC §27.53 (m):

> (4) For mobile digital stations, the attenuation factor shall be not less than 55 + 10 log (P) dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth. In addition, the attenuation factor shall not be less that 43 + 10 log (P) dB on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log (P) dB at or below 2490.5 MHz.

RSS-199 Clause 4.5:

> (b) for mobile subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least:
>
> iii. 55 + 10 log10 p at X MHz and beyond from the channel edges
>
> In addition, the attenuation shall not be less than 43 + 10 log10 p on all frequencies between 2490.5 MHz and 2496 MHz, and 55 + 10 log10 p at or below 2490.5 MHz.
>
> In (b), p is the transmitter power measured in watts and X is 6 MHz or the equipment occupied bandwidth, whichever is greater.

***Method***

The measurement was performed with the EUT inside a semi-anechoic chamber.

The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency of the combined radios up to 40 GHz.

The EUT was placed on a non-conductive stand at a 3-meter distance from the measuring antenna for measurements up to 17 GHz and at 1.5-meter distance for measurements above 17 GHz.

Detected emissions were maximized at each frequency by rotating the EUT and adjusting the height of the measuring antenna. The maximum meter reading was recorded. Measurements were made in both horizontal and vertical planes of polarization.

The field strength is calculated by adding a correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss, pre-amplifiers gain.

For radiated measurements above 17GHz performed at a distance closer than the distance specified in standard, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

These measurements have been performed in order to check the impact of the simultaneous transmission of all radio interfaces (that can transmit simultaneously).

Measurement Limit:

At Po transmitting power, the specified minimum attenuation 43+10log (Po) becomes:

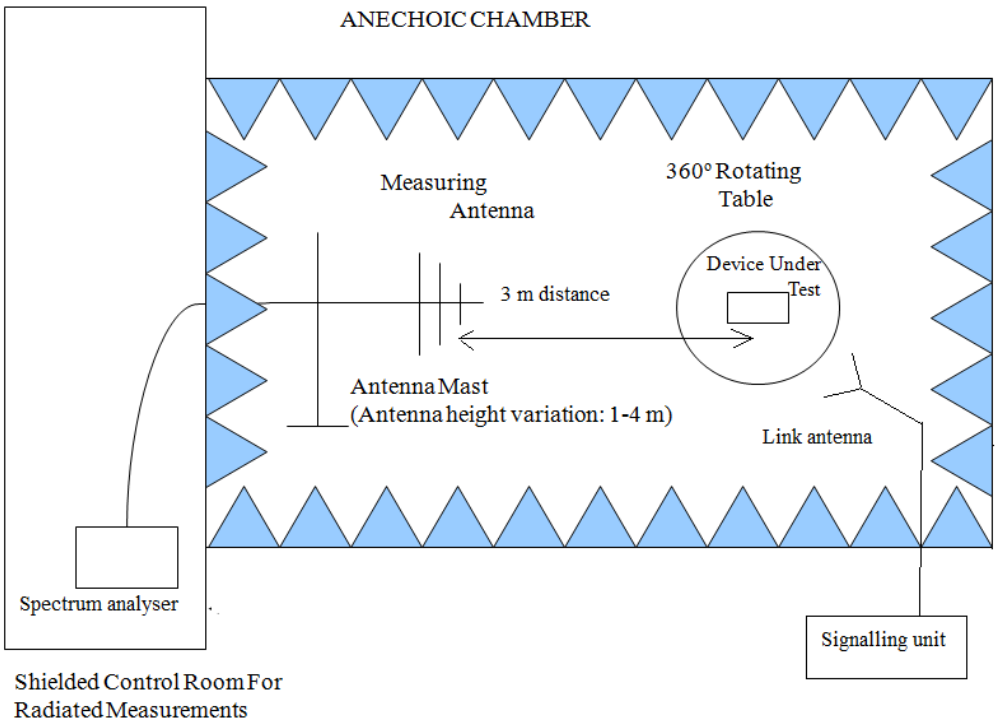
$$Po\ (dBm) – [43 + 10\ log\ (Po\ in\ mWatts) - 30] = -\ 13\ dBm$$

At Po transmitting power, the specified minimum attenuation 55+10log (Po) becomes:

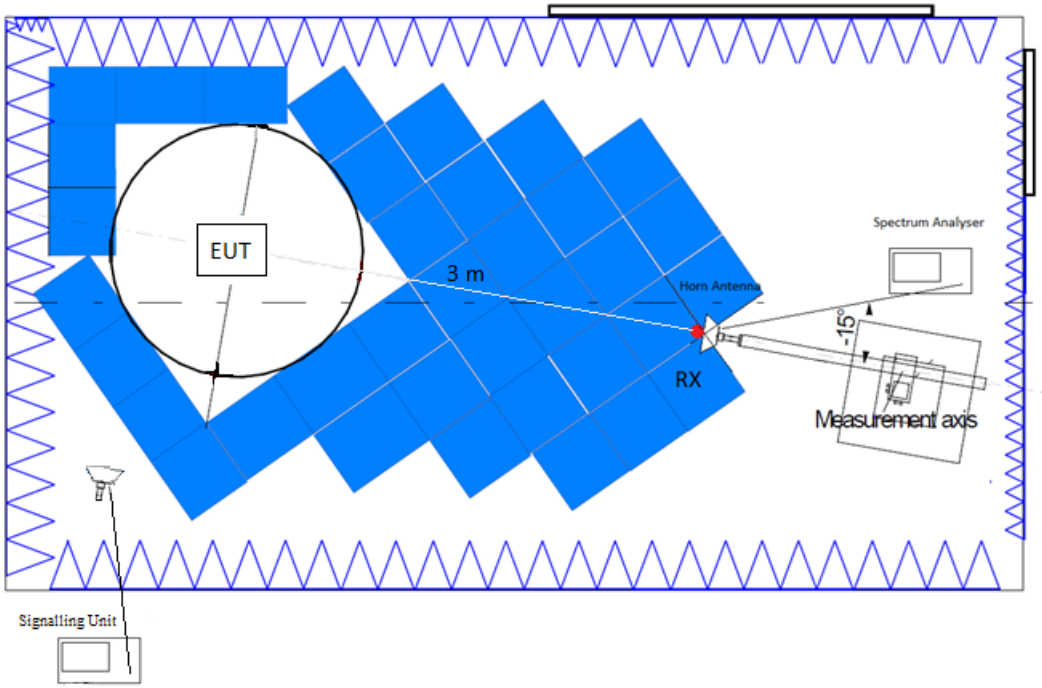
$$Po\ (dBm) – [55 + 10\ log\ (Po\ in\ mW) - 30] = -25\ dBm$$

***Test setup***

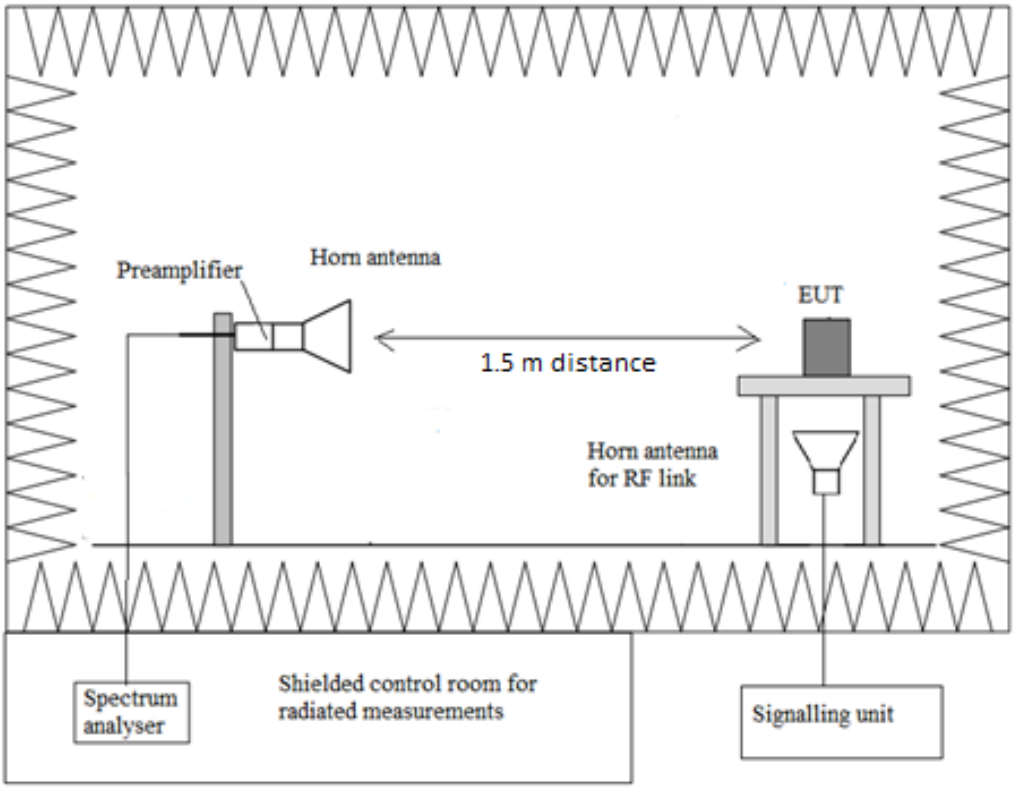
Radiated measurements below 1 GHz.



Radiated measurements between 1 GHz and 17 GHz.




Radiated measurements above 17 GHz.



**Simultaneous transmission BLE, WLAN 2.4 GHz, WLAN 5 GHz U-NII-1**

| | |
|---|---|
| BLE: | Low Channel (2402 MHz), 1 Mbps. |
| WLAN 2.4 GHz: | CH3 (2422 MHz), 802.11 g. |
| WLAN 5 GHz: | CH40 (5200 MHz), 802.11 n20. |

The limit of the test is determined by:

| Frequency Range | Detector | Limit at 3m (dBµV/m) |
|---|---|---|
| 30 MHz to 88 MHz | Quasi-PK | 40 dBµV/m |
| 88 MHz to 216 MHz | Quasi -PK | 43.5 dBµV/m |
| 216 MHz to 960 MHz | Quasi -PK | 46 dBµV/m |
| 1 GHz to 40 GHz | PK | 68.23 dBµV/m (*) or 74 dBµV/m (**) |
| 1 GHz to 40 GHz | AVG | 54 dBµV/m (**) |

(*) Radiated emissions which fall in the non-restricted bands.
(**) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

***Results***

**Frequency range 30 MHz – 1 GHz**

Spurious frequencies found at less than 20 dB below the limit:

| Spurious Freq (MHz) | Emission Level (dBµV/m) | Pol | Detector |
|---|---|---|---|
| 674.9591 | 26.70 | V | Quasi-Peak |
| 774.9600 | 26.29 | H | Quasi-Peak |

**Frequency range 1 GHz – 40 GHz**

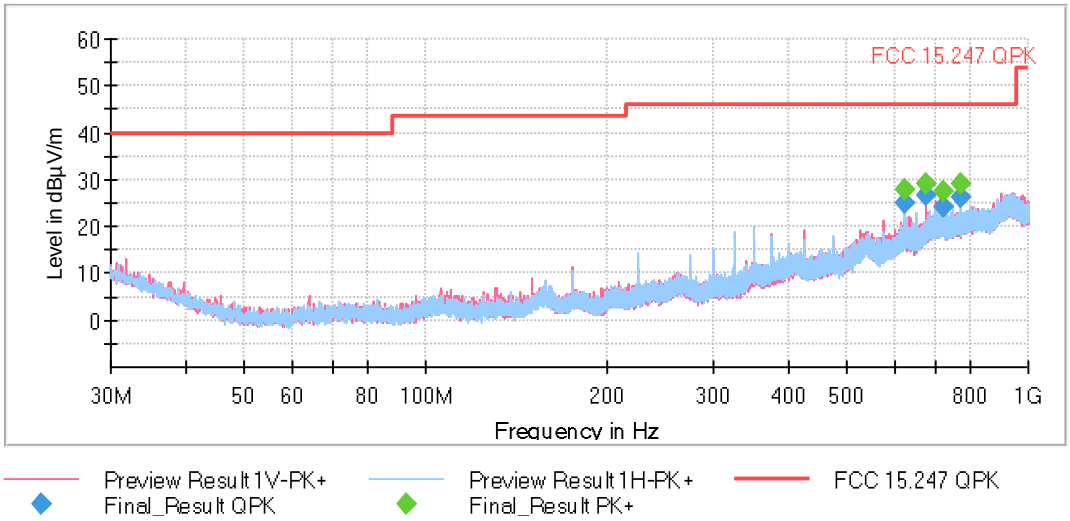
No spurious frequencies found close to the limit.

***Verdict***

Pass

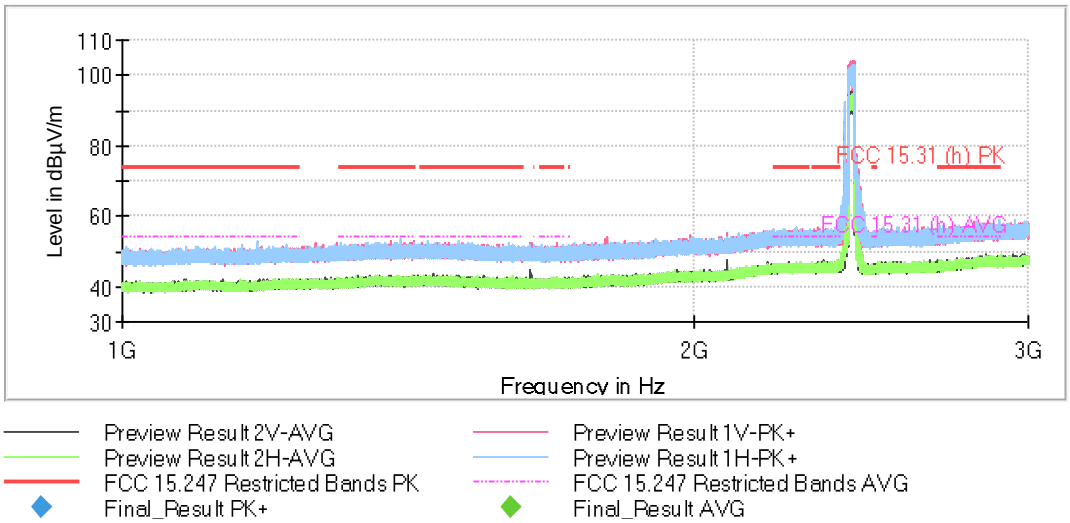
***Attachments***

**Frequency range 30 MHz – 1 GHz**




| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [ESR 7] | | | | | |
| 30 MHz - 1 GHz | 30,312 kHz | PK+ | 100 kHz | 1 s | 0 dB |

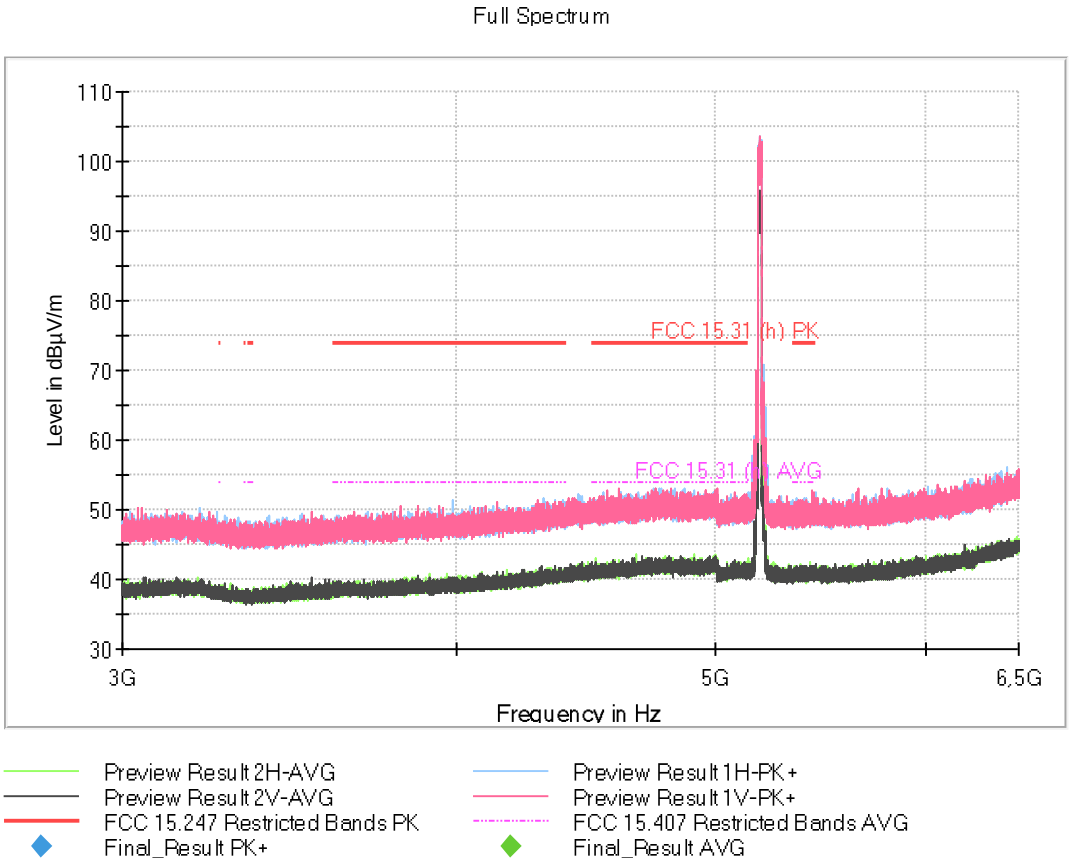
### Frequency range 1 GHz – 3 GHz




The peaks above the limit are the BLE and WLAN 2.4 GHz carrier frequencies.

| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 1 GHz - 3 GHz | 30,769 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

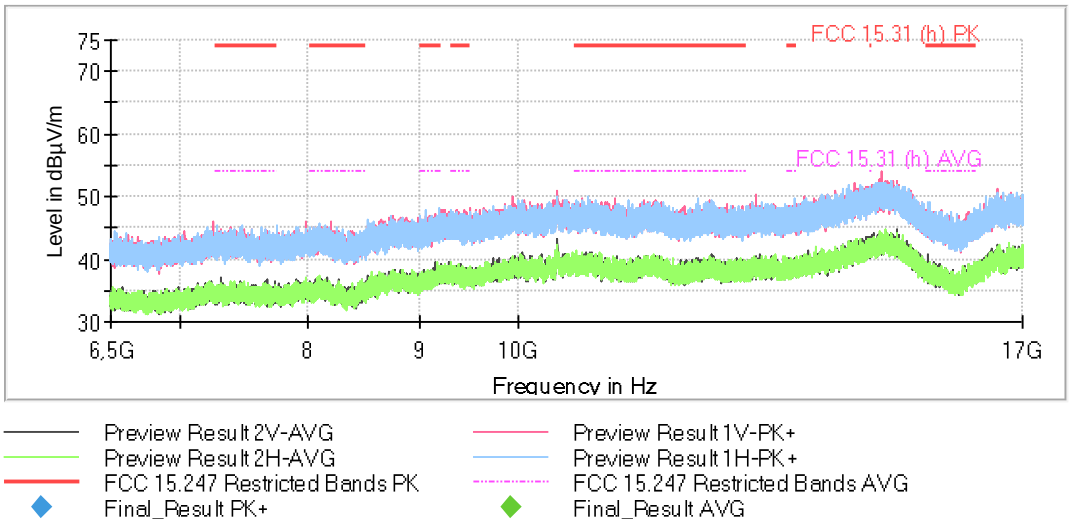
## Frequency range 3 GHz – 6.5 GHz




The peak above the limit is the WLAN 5 GHz U-NII-1 carrier frequency.

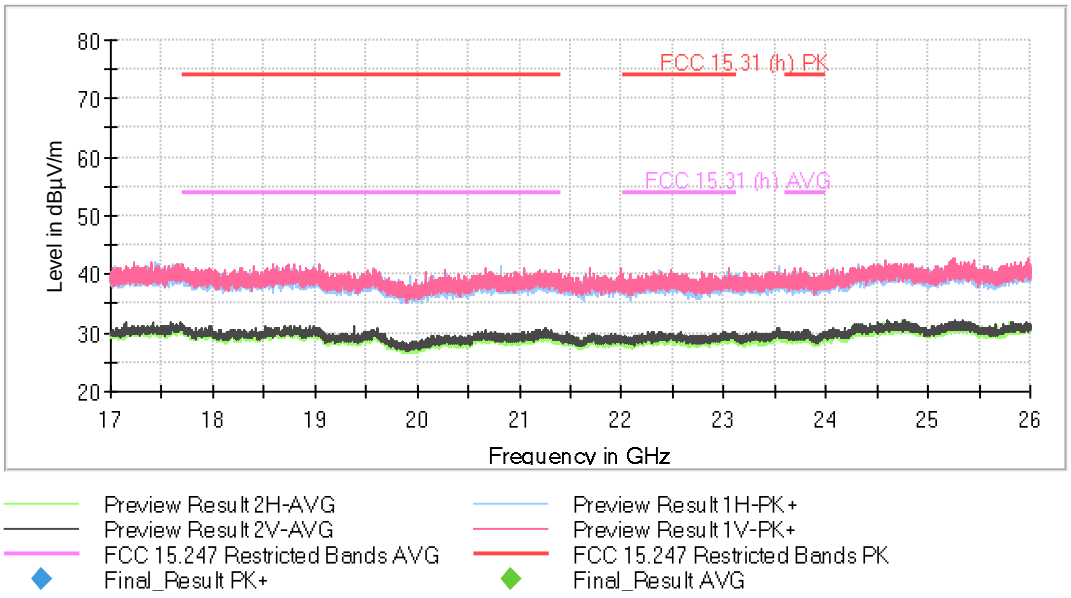
| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 1 GHz - 6,5 GHz | 100 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

## Frequency range 6.5 GHz – 17 GHz

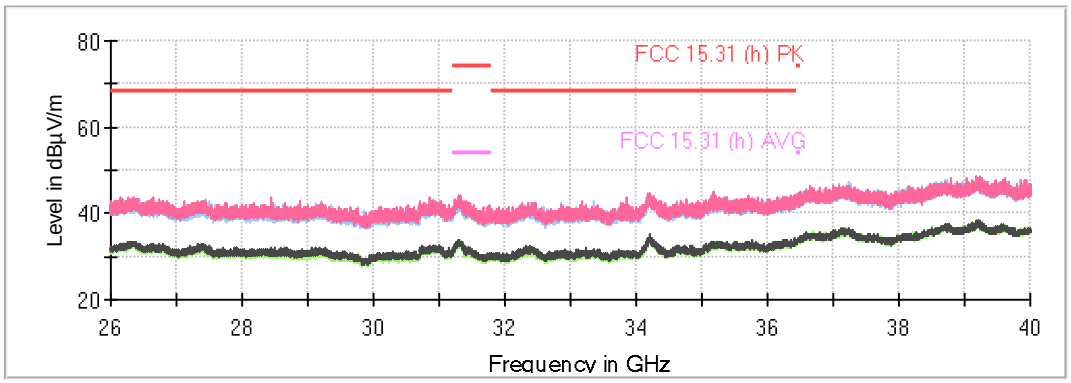



| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 3 GHz - 17 GHz | 140 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

## Frequency range 17 GHz – 40 GHz




Preview Result 2H-AVG
Preview Result 1H-PK+
Preview Result 2V-AVG
Preview Result 1V-PK+
FCC 15.247 Restricted Bands AVG
FCC 15.247 Restricted Bands PK
Final_Result PK+
Final_Result AVG




Preview Result 2H-AVG
Preview Result 1H-PK+
Preview Result 2V-AVG
Preview Result 1V-PK+
FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
FCC 15.407 Restricted Bands AVG
Final_Result PK+
Final_Result AVG

| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 17 GHz - 40 GHz | 766,667 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

**Simultaneous transmission BT EDR, WLAN 2.4 GHz, WLAN 5 GHz U-NII-1**

| | |
|---|---|
| BT EDR: | CH30 (2432 MHz), GFSK. |
| WLAN 2.4 GHz: | CH3 (2422 MHz), 802.11 g. |
| WLAN 5 GHz: | CH40 (5200 MHz), 802.11 n20. |

The limit of the test is determined by:

| Frequency Range | Detector | Limit at 3m (dBµV/m) |
|---|---|---|
| 30 MHz to 88 MHz | Quasi-PK | 40 dBµV/m |
| 88 MHz to 216 MHz | Quasi -PK | 43.5 dBµV/m |
| 216 MHz to 960 MHz | Quasi -PK | 46 dBµV/m |
| 1 GHz to 40 GHz | PK | 68.23 dBµV/m (*) or 74 dBµV/m (**) |
| 1 GHz to 40 GHz | AVG | 54 dBµV/m (**) |

(*) Radiated emissions which fall in the non-restricted bands.
(**) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

***Results***

**Frequency range 30 MHz – 1 GHz**

Spurious frequencies detected at less than 20 dB below the limit:

| Spurious Freq (MHz) | Emission Level (dBµV/m) | Pol | Detector |
|---|---|---|---|
| 174.9847 | 23.68 | V | Quasi-Peak |

**Frequency range 1 GHz – 40 GHz**

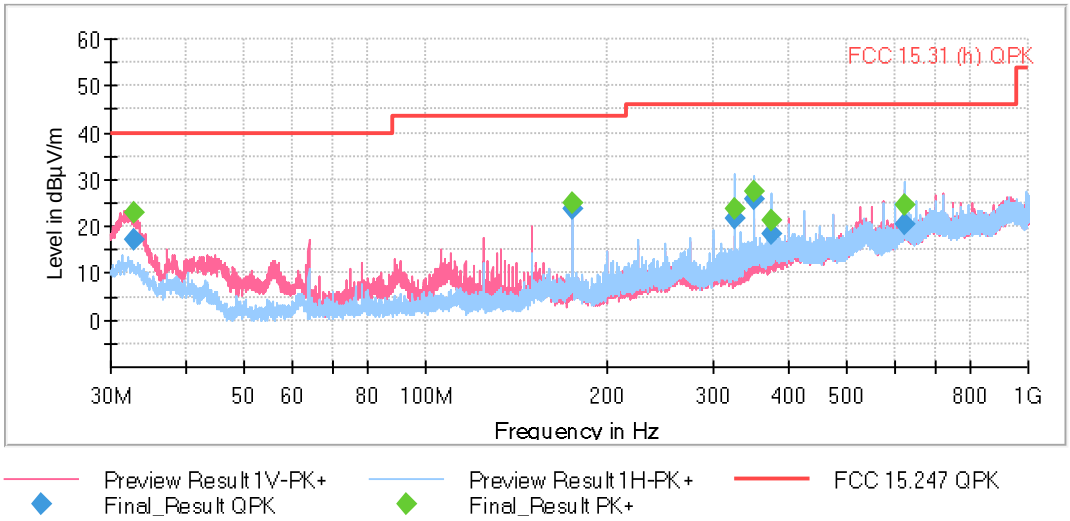
No spurious frequencies found close to the limit.

***Verdict***

Pass

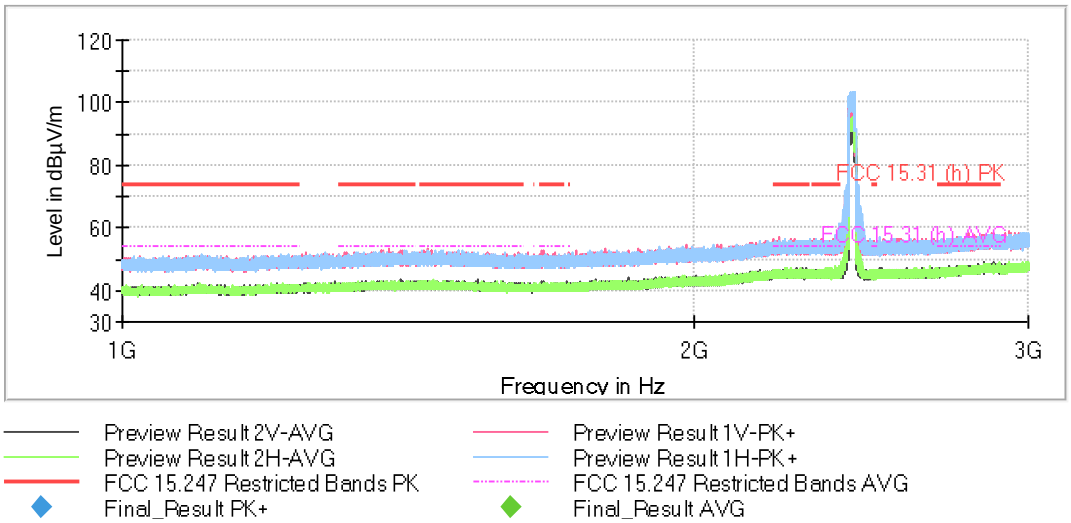
***Attachments***

**Frequency range 30 MHz – 1 GHz**




| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [ESR 7] | | | | | |
| 30 MHz - 1 GHz | 30,312 kHz | PK+ | 100 kHz | 1 s | 0 dB |

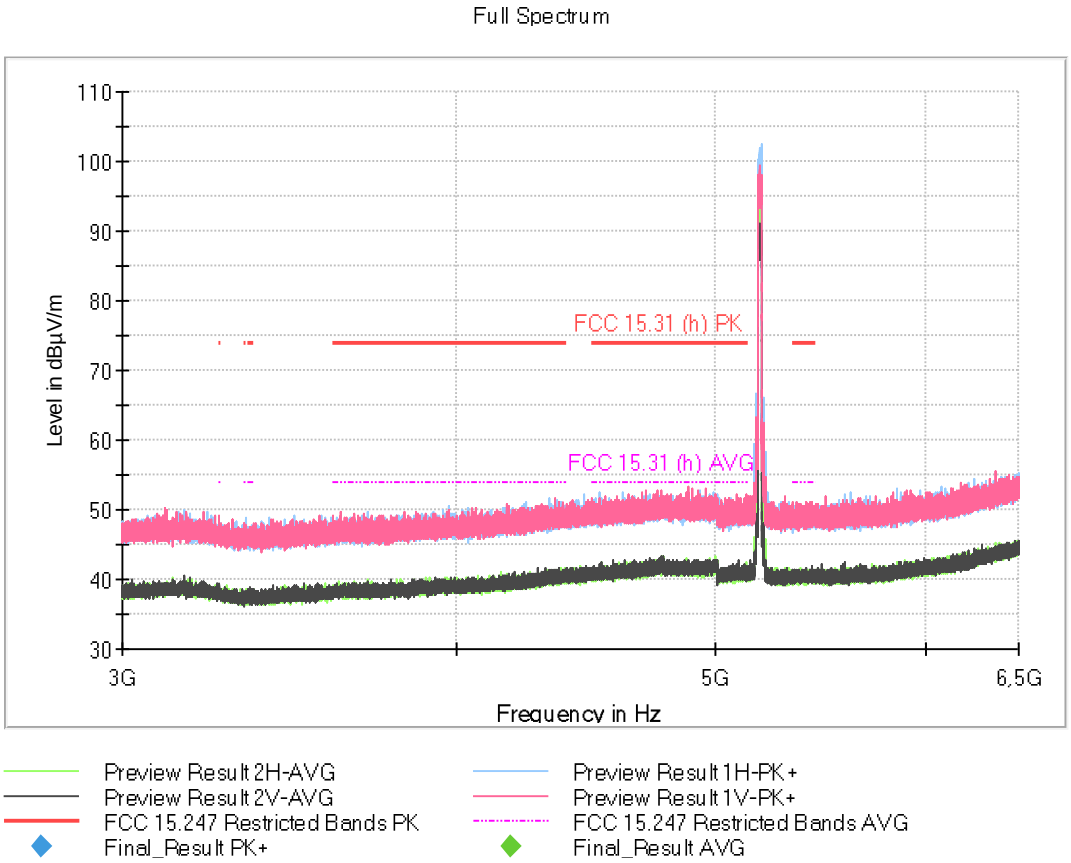
### Frequency range 1 GHz – 3 GHz




The peaks above the limit are the BT EDR and WLAN 2.4 GHz carrier frequencies.

| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 1 GHz - 3 GHz | 30,769 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

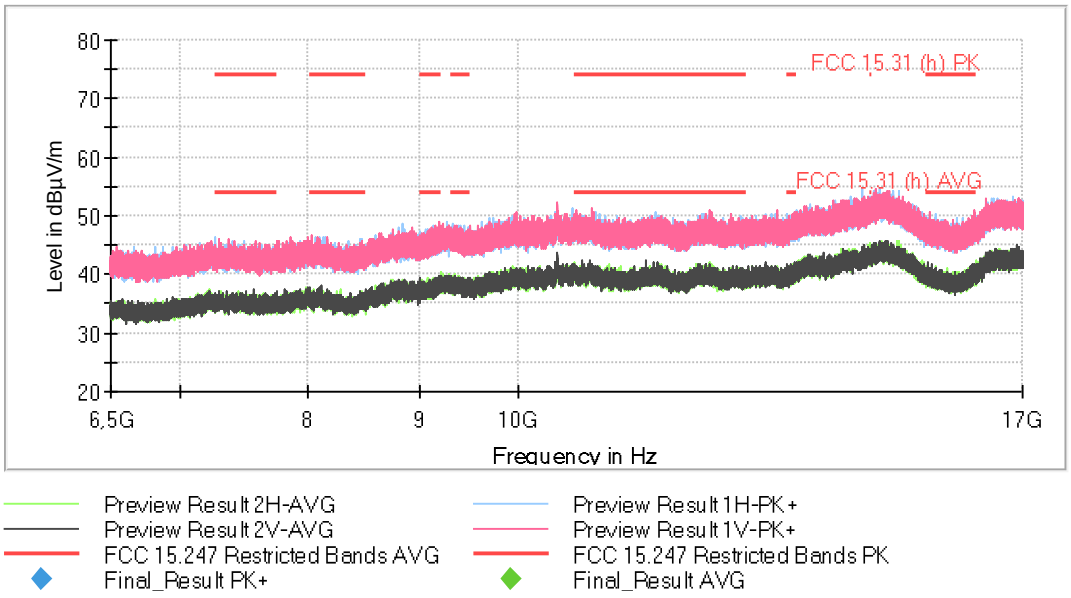
## Frequency range 3 GHz – 6.5 GHz




The peak above the limit is the WLAN 5 GHz U-NII-1 carrier frequency.

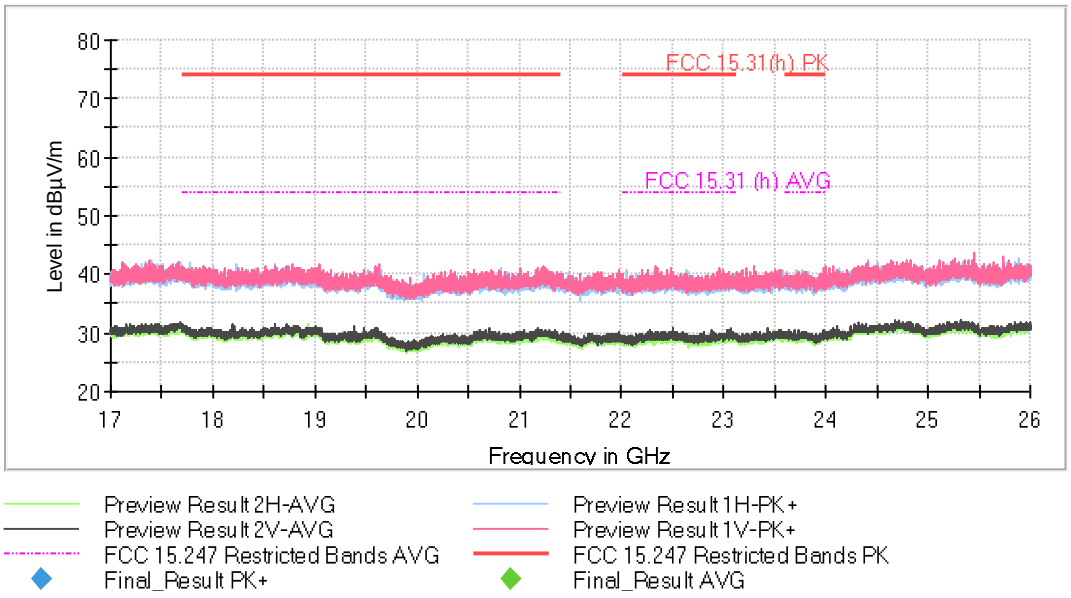
| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 1 GHz - 6,5 GHz | 100 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

## Frequency range 6.5 GHz – 17 GHz

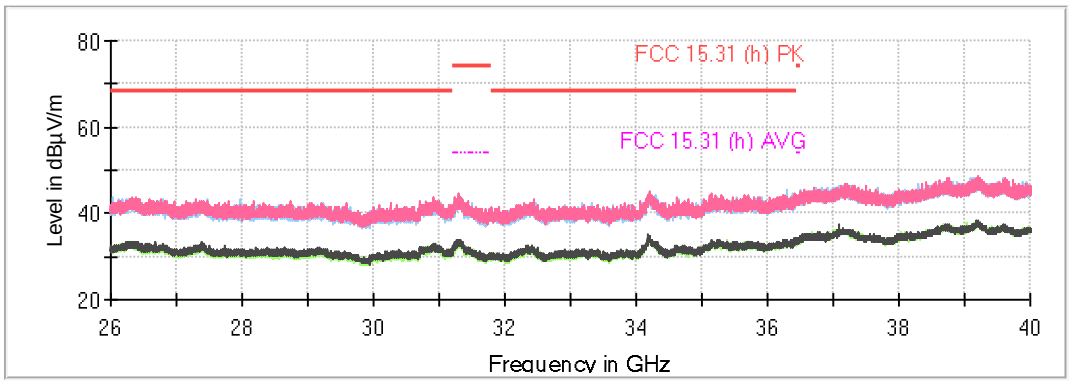



| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 6,5 GHz - 17 GHz | 105 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

## Frequency range 17 GHz – 40 GHz




Preview Result 2H-AVG
Preview Result 2V-AVG
FCC 15.247 Restricted Bands AVG
Final_Result PK+
Preview Result 1H-PK+
Preview Result 1V-PK+
FCC 15.247 Restricted Bands PK
Final_Result AVG




Preview Result 2H-AVG
Preview Result 1H-PK+
Preview Result 2V-AVG
Preview Result 1V-PK+
FCC 15.407 Restricted Bands PK UNII-1 and UNII-2
FCC 15.407 Restricted Bands AVG
Final_Result PK+
Final_Result AVG

| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 17 GHz - 40 GHz | 766,667 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

**Simultaneous transmission BLE, WLAN 2.4 GHz, WLAN 5 GHz U-NII-1, 2G 850**

| | |
|---|---|
| BLE: | Low Channel (2402 MHz), 1 Mbps. |
| WLAN 2.4 GHz: | CH3 (2422 MHz), 802.11 g. |
| WLAN 5 GHz: | CH40 (5200 MHz). 802.11 n20. |
| 2G 850: | Low Channel (824.2 MHz), GPRS. |

The limit of the test is determined by:

| Frequency Range | Detector | Limit at 3m (dBµV/m) |
|---|---|---|
| 30 MHz to 8.49 GHz | Peak | 43 + 10 log (P) dB = -13 dBm → 82.23 dBµV/m |
| 8.49 GHz to 40 GHz | Peak | 68.23 dBµV/m (*) or 74 dBµV/m (**) |
| 8.49 GHz to 40 GHz | Average | 54 dBµV/m (**) |

(*) Radiated emissions which fall in the non-restricted bands.
(**) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

***Results***

**Frequency range 30 MHz – 1 GHz**

No spurious frequencies at less than 20 dB below the limit.

**Frequency range 1 GHz – 40 GHz**

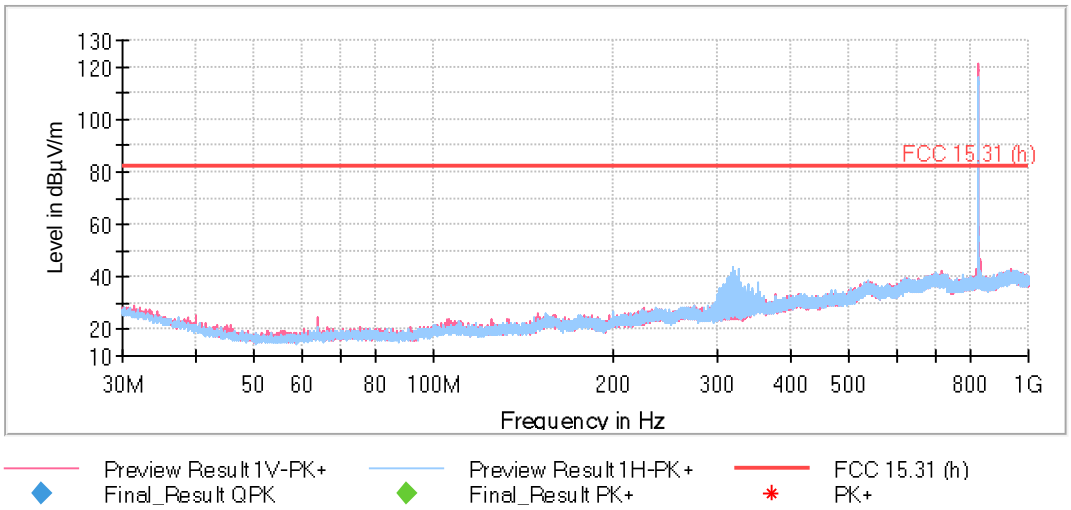
No spurious frequencies at less than 20 dB below the limit.

***Verdict***

Pass

***Attachments***

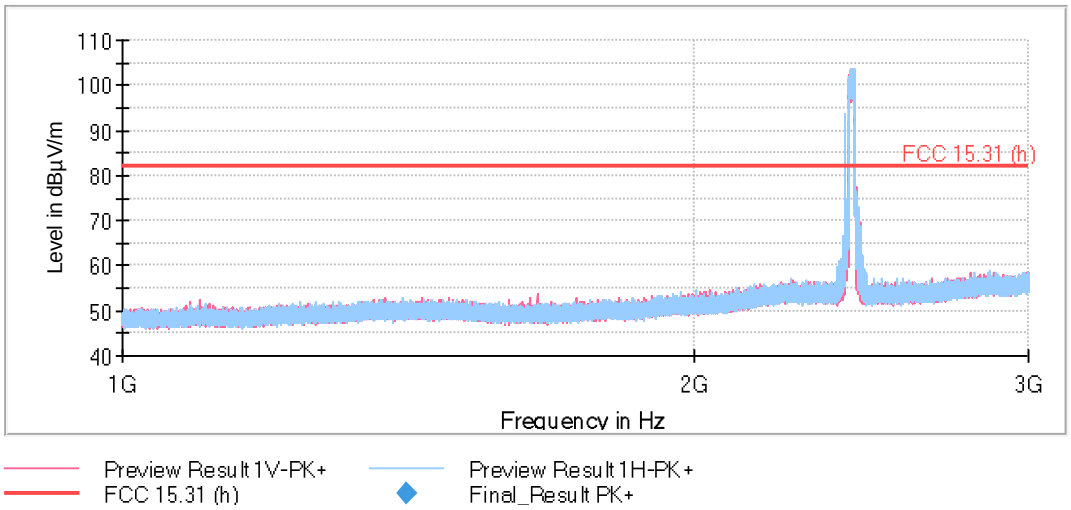
**Frequency range 30 MHz – 1 GHz**




The peak above the limit is the 2G 850 carrier frequency.

| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [ESR 7] | | | | | |
| 30 MHz - 1 GHz | 30,312 kHz | PK+ | 100 kHz | 1 s | 0 dB |

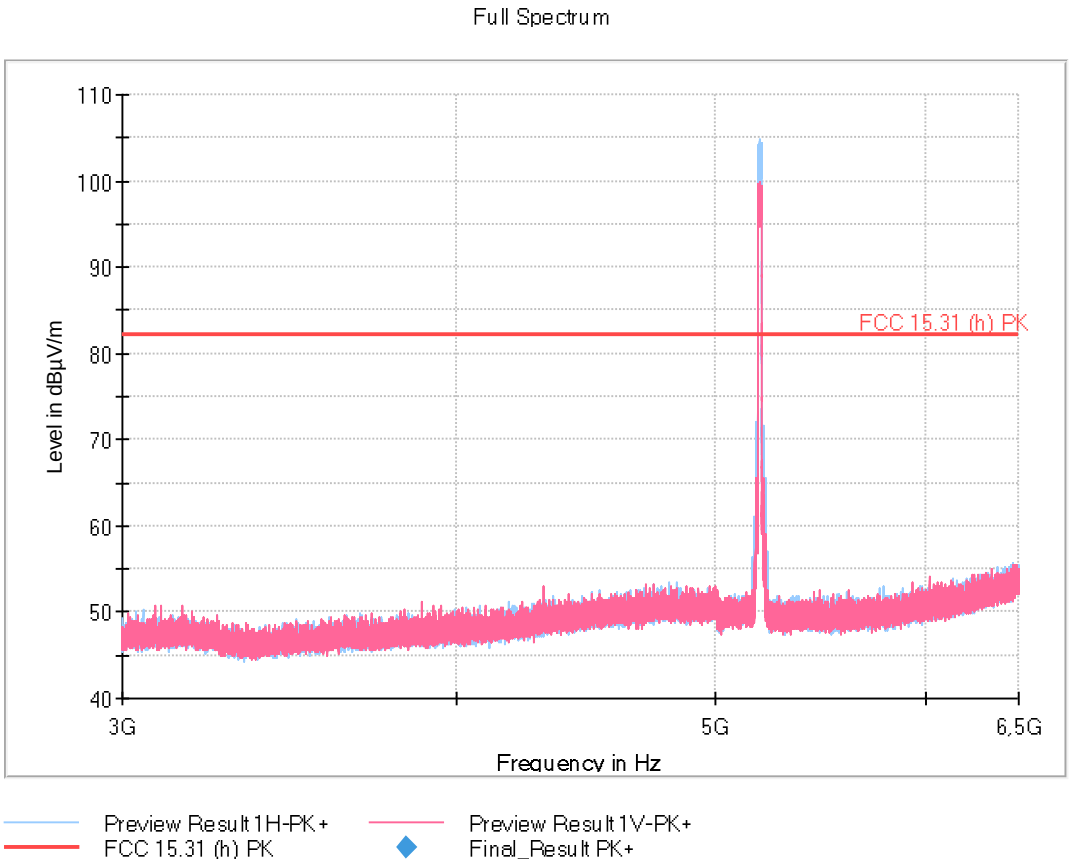
## Frequency range 1 GHz – 3 GHz




The peak above the limit are the BLE and WLAN 2.4 GHz carrier frequencies.

| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 1 GHz - 3 GHz | 30,769 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

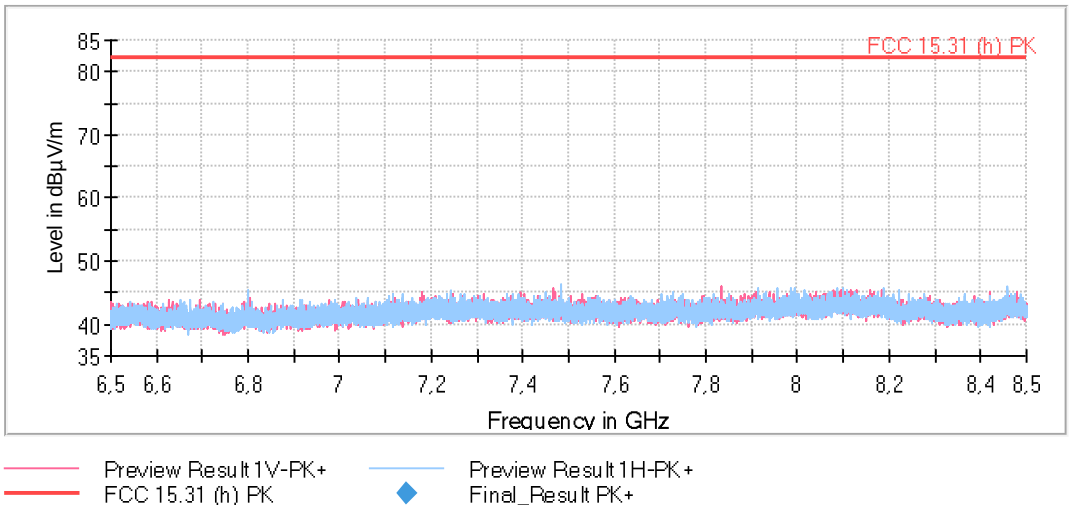
## Frequency range 3 GHz – 6.5 GHz




The peak above the limit is the WLAN 5 GHz U-NII-1 carrier frequency.

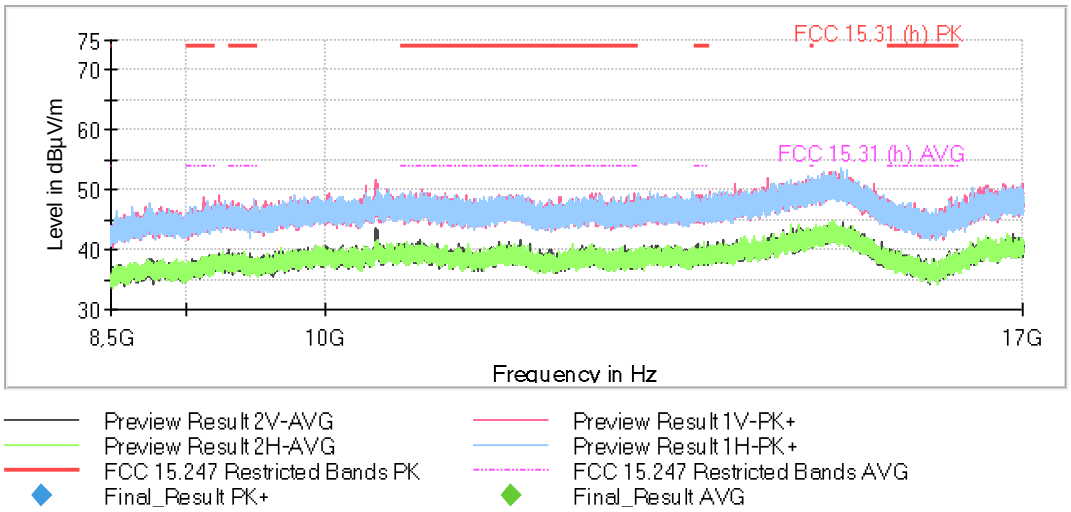
| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 1 GHz - 6,5 GHz | 100 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

## Frequency range 6.5 GHz – 8.5 GHz



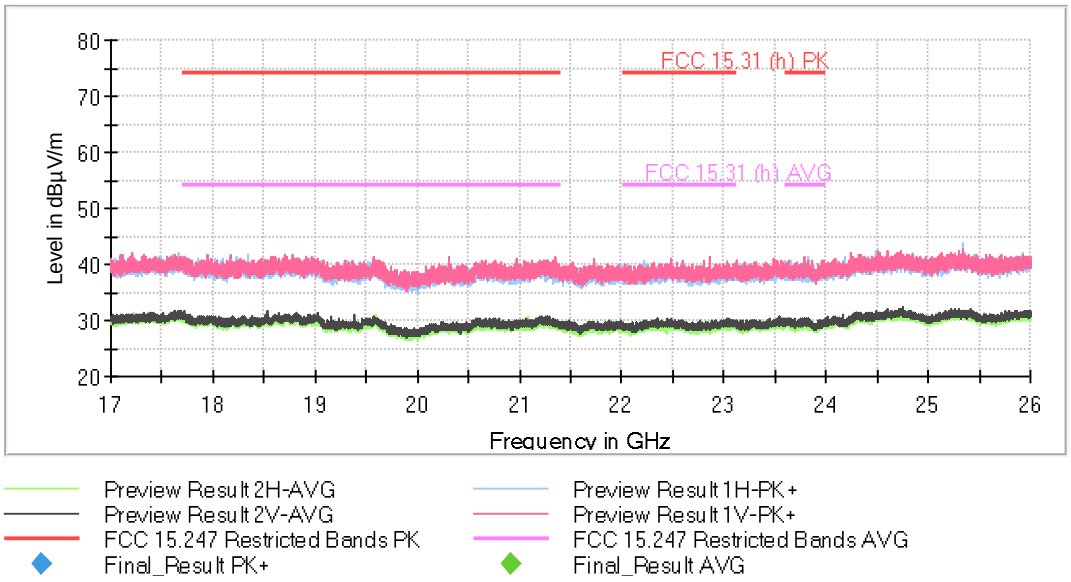

| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 3 GHz - 17 GHz | 140 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

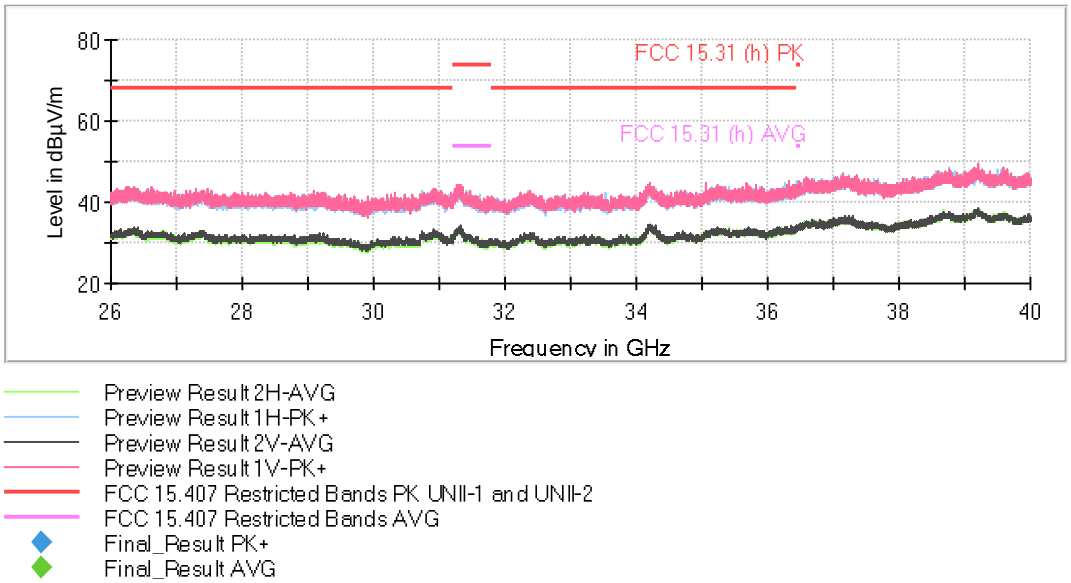
## Frequency range 8.5 GHz – 17 GHz




| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 3 GHz - 17 GHz | 140 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

## Frequency range 17 GHz – 40 GHz




| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 17 GHz - 40 GHz | 766,667 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

**Simultaneous transmission BT EDR, WLAN 2.4 GHz, WLAN 5 GHz U-NII-1, 2G 850**

| | |
|---|---|
| BT EDR: | CH30 (2432 MHz), GFSK |
| WLAN 2.4 GHz: | CH3 (2422 MHz), 802.11 g. |
| WLAN 5 GHz: | CH40 (5200 MHz), 802.11 n20. |
| 2G 850: | Low Channel (824.2 MHz), GPRS. |

The limit of the test is determined by:

| Frequency Range | Detector | Limit at 3m (dBµV/m) |
|---|---|---|
| 30 MHz to 8.49 GHz | Peak | 43 + 10 log (P) dB = -13 dBm → 82.23 dBµV/m |
| 8.49 GHz to 40 GHz | Peak | 68.23 dBµV/m (*) or 74 dBµV/m (**) |
| 8.49 GHz to 40 GHz | Average | 54 dBµV/m (**) |

(*) Radiated emissions which fall in the non-restricted bands.
(**) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

***Results***

**Frequency range 30 MHz – 1 GHz**

No spurious frequencies at less than 20 dB below the limit.

**Frequency range 1 GHz – 40 GHz**

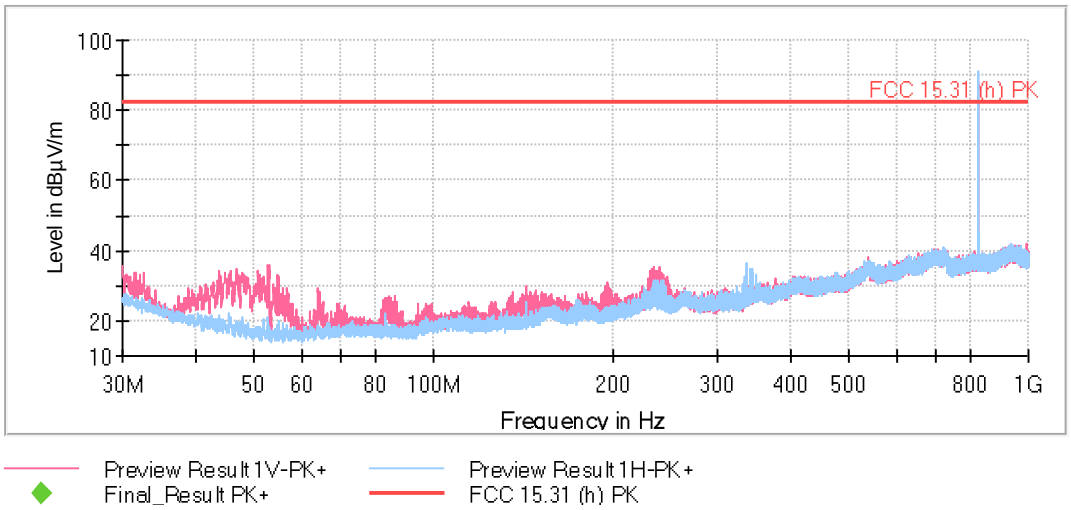
No spurious frequencies at less than 20 dB below the limit.

***Verdict***

Pass

***Attachments***

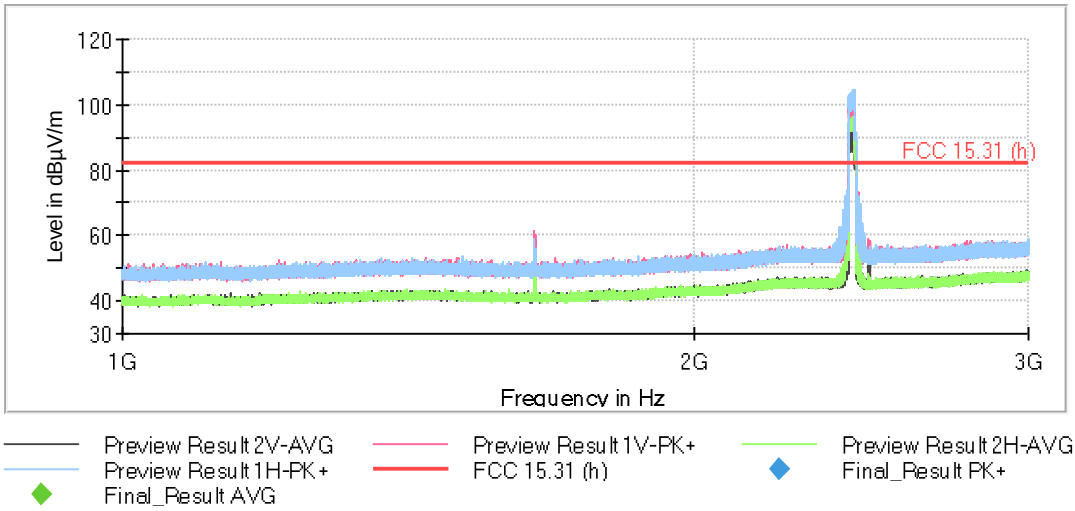
**Frequency range 30 MHz – 1 GHz**




The peak above the limit is the 2G 850 carrier frequency.

| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [ESR 7] | | | | | |
| 30 MHz - 1 GHz | 30,312 kHz | PK+ | 100 kHz | 1 s | 0 dB |

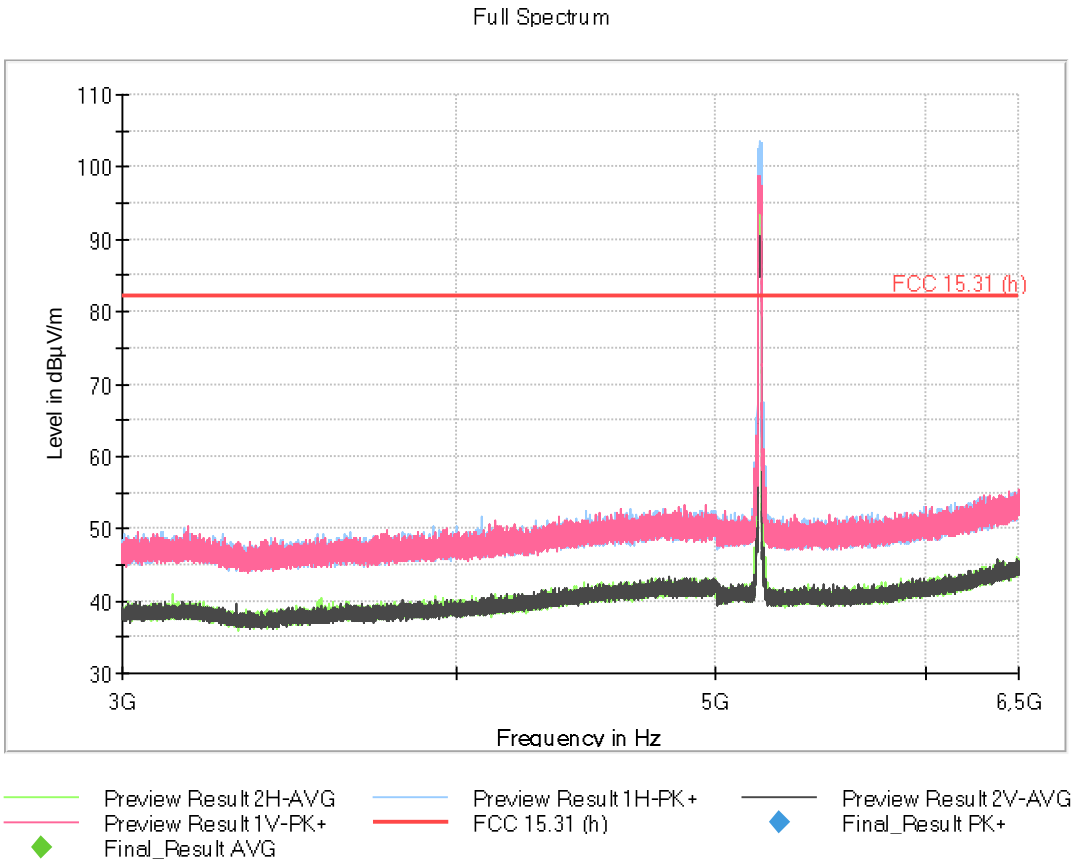
### Frequency range 1 GHz – 3 GHz




The peaks above the limit are the BT EDR and WLAN 2.4 GHz carrier frequencies.

| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 1 GHz - 3 GHz | 30,769 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

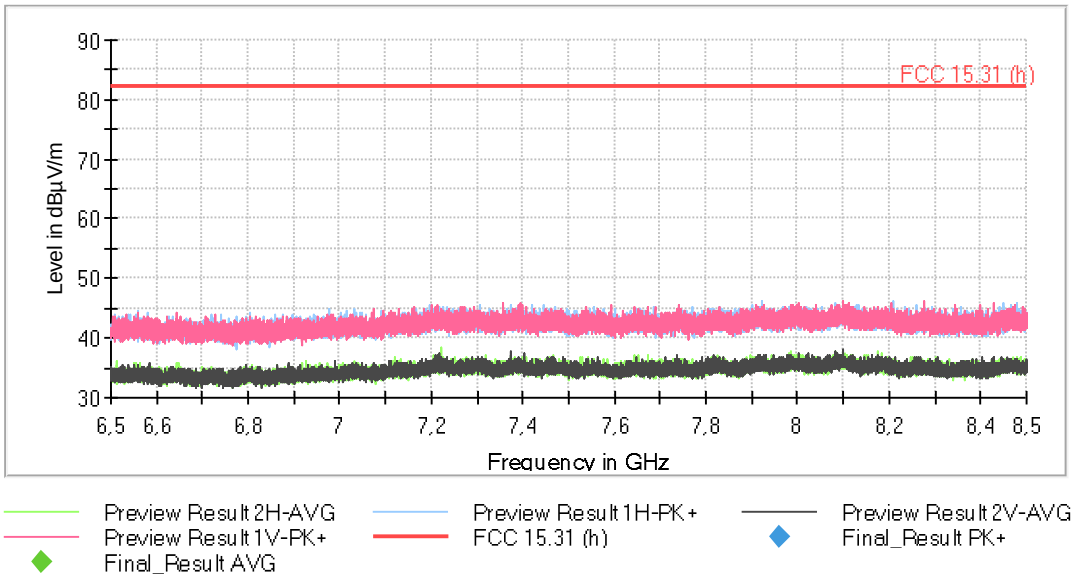
## Frequency range 3 GHz – 6.5 GHz




The peak above the limit is the WLAN 5 GHz U-NII-1 carrier frequency.

| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 1 GHz - 6,5 GHz | 100 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |

## Frequency range 6.5 GHz – 8.5 GHz







| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSW 50] | | | | | |
| 3 GHz - 17 GHz | 140 kHz | PK+ ; AVG | 1 MHz | 1 s | 0 dB |