

ISED CABid: ES1909
Lab. Company Number: 4621A

Test Report No:
NIE: 67003RRF.012

Partial Test Report

USA FCC 15.31(h), 22, 24, 27, 15.209, 15.247, 15.407
CANADA RSS-132, RSS-133, RSS-199, RSS-247,
RSS-Gen

(*) Identification of item tested	Telematic Control Unit (TCU) with wireless technologies, used in automotive industry
(*) Trademark	VW
(*) Model and /or type reference	TKCMOD12E00
Other identification of the product	FCC ID: T8GCONMOD Contains FCC ID: LHJ-FE5NA0020 IC: 6434A-CONMOD Contains IC: 2807E-FE5NA0020
(*) Features	GSM, UMTS, LTE, 5G, GNSS, Wi-Fi, BTLE, BT_EDR HW version: C2.3 SW version: X152
Applicant	HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH BECKER-GOERING-STR. 16 76307 KARLSBAD, GERMANY
Test method requested, standard	USA FCC Part 15.31(h) (10-1-21 Edition): Measurement standard. USA FCC Part 15.209 (10-1-21 Edition): Radiated emission limits; general requirements. USA FCC Part 15.247 (10-1-21 Edition): Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.407 (10-1-21 Edition): Unlicensed National Information Infrastructure (U-NII) Devices. General technical requirements. Band U-NII-3 (5725 MHz – 5850 MHz). USA FCC Part 22 (10-1-21 Edition). Public Mobile Services. USA FCC Part 24 (10-1-21 Edition): Personal Communications Services. USA FCC Part 27 (10-1-21 Edition). Miscellaneous Wireless Communications Services. CANADA RSS-247 Issue 2, Feb. 2017. CANADA RSS-Gen. Issue 5, Amendment 2, Feb. 2021. CANADA RSS-132 Issue 3, Jan. 2013. CANADA RSS-133 Issue 6, Jan. 2018.

	CANADA RSS-199 Issue 3, Dec. 2016. - Emission limitations radiated with simultaneous transmissions. Guidance for Performing Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid Systems Devices Operating Under Section 15.247 of the FCC Rules. 558074 D01 Meas Guidance v05r02 dated April 2, 2019. Guidance for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec. 14, 2017. Measurement Guidance for Certification of Licensed Digital Transmitters. 971168 D01 Power Meas License Digital Systems v03r01 dated April 9, 2018. ANSI C63.26-2015. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices. ANSI C63.26-2015. IEEE/ANSI Standard for Testing of Transmitters Used in Licensed Radio Services.
Approved by (name / position & signature)	Rafael López Martín EMC Consumer & RF Lab. Manager
Date of issue	2022-12-21
Report template No.	FDT08_24 (*) "Data provided by the client"

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Competences and guarantees

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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 has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification 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 at the time of performance of the test.

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

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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 $\leq \pm 5.35$ 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 $\leq \pm 4.32$ 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 $\leq \pm 5.51$ 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 of the model TKCMOD12E00 is 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, 5G, GNSS, Wifi (a, b, g, n, ac), Bluetooth Low Energy (BTLE) and Bluetooth EDR.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples undergoing test have been selected by: The client.

- Sample S/01 is composed of the following elements:

Control No.	Description	Model	Serial No.	Date of reception
67003B/070	Telematics Control Unit	TKCMOD12E00	358845890061449	2021/11/30
67003B/014	GNSS Antenna	--	--	2021/09/07
67003B/015	BT_WLAN 3 Antenna	--	--	2021/09/07
67003B/016	LTE 4 Antenna	--	--	2021/09/07
67003B/017	BT_WLAN 2 Antenna	--	--	2021/09/07
67003B/018	BT_WLAN 1 Antenna	--	--	2021/09/07
67003B/019	LTE 3 Antenna	--	--	2021/09/07
67003B/020	BTLE Antenna Combiner (BT_LE 1)	--	--	2021/09/07
67003B/021	BT_LE 1 Antenna	--	--	2021/09/07
67003B/022	BT_LE 1 Antenna	--	--	2021/09/07
67003B/023	LTE 1 Antenna	--	--	2021/09/07
67003B/024	LTE 2 Antenna	--	--	2021/09/07

Auxiliary elements used with Sample S/01:

Control No.	Description	Model	Serial No.	Date of reception
67003B/027	ETH (H-MTD) Cable	--	--	2021/09/07
67003B/063	Housing	--	--	2021/11/30
67003B/066	Battery	--	--	2021/11/30

Sample S/01 has undergone the following test(s): The tests indicated in the Appendix A.

Test sample description

Ports..... :	Port name and description	Cable				
		Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾	
		RF connector – code	[]	[X]	[]	
		RF connector – code	[X]	[X]	[]	
Supplementary information to the ports..... :	.....					
Rated power supply :	Voltage and Frequency		Reference poles			
	[X]	DC: +12Vdc	L1	L2	L3	N	PE
Rated Power..... :	12V DC					
Clock frequencies..... :	25MHz;26MHz;32,768kHz;49,58MHz;					
Other parameters :	See Technical description					
Software version..... :	X152					
Hardware version :	C2.3					
Dimensions in cm (W x H x D) ... :	.....					
Mounting position :	[]	Table top equipment				
	[]	Wall/Ceiling mounted equipment				
	[]	Floor standing equipment				
	[]	Hand-held equipment				
	[X]	Other: automotive telematics control unit				
Modules/parts..... :	Module/parts of test item		Type		Manufacturer	
						
Accessories (not part of the test item) :	Description		Type		Manufacturer	
	Cable Harness		.....		.....	
	2G/3G4G/5G Antenna		.....		Hirschmann/ Molex	
	eCall button/LED		.....		.....	
	SOS Loudspeaker		.....		.....	
	Wake-up unit Box		.....		.....	
Documents as provided by the applicant..... :	Description		File name		Issue date	
	Technical Description		.....		.....	

⁽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)	2022-08-08
Date (finish)	2022-10-04

Document history

Report number	Date	Description
67003RRF.012	2022-12-21	First release.

Environmental conditions

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

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

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

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

Remarks and comments

The tests have been performed by the technical personnel: Miguel Angel Torres.

Used instrumentation:

Radiated Measurements:

	Last Calibration	Due Calibration
1. Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N/A	N/A
2. Shielded Room ETS LINDGREN S101	N/A	N/A
3. Biconical/Log Antenna 30 MHz - 6 GHz ETS LINDGREN 3142E	2020/04	2023/04
4. EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2021/11	2023/11
5. RF Preamplifier, G>38dB 30MHz-6GHz BONN ELEKTRONIK BLNA 0360-01N	2022/06	2023/06
6. Attenuator 3dB, 2W, DC-18GHz, TECHNIWAVE TWTS2G	2022/04	2023/04
7. Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2022/05	2024/05
8. Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2019/11	2022/11
9. Multi-device Controller FRANKONIA FC-06	N/A	N/A
10. RF Preamplifier, 40 dB ,1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2022/07	2023/07
11. Pre-Amplifier G>30dB 17-40GHz BONN ELEKTRONIK BLMA 1840-4A	2022/11	2023/11
12. Horn Antenna 18-40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2020/05	2023/05

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 PARAGRAPH		
Requirement – Test case	Verdict	Remark
FCC 15.31 (h), FCC 15.209 (a), 15.247 (d), 15.407 (b), FCC 22.917, 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-199 4.5	P	(1)
<u>Supplementary information and remarks:</u> (1) Only co-location radiated spurious emission test was requested.		

Appendix A: Test results

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Radiated emissions FCC 15.209 (a), 15.247 (d), 15.407 (b), 22.917 RSS-199 4.5, RSS-Gen 8.9, RSS-247 5.5, 6.2.1.2, 6.2.2.2, 6.2.3.2 & 6.2.4.2.....15

TEST CONDITIONS

(*): Data provided by the Applicant.

POWER SUPPLY (*):

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

ANTENNA (*):

Type of Antennas: External.

Configuration antennas used (#2) on this test report have been chosen according to results of Radiated Spurious Emission spot-check as worst-case.

Regarding BT EDR, BLE, Wi-Fi, configuration #2 have been used as worst-case too.

Maximum Declared Gain for BT EDR: +3.00 dBi
Maximum Declared Gain for BLE: +1.80 dBi
Maximum Declared Gain for 2.4 GHz WLAN: +0.11 dBi
Maximum Declared Gain for 5 GHz WLAN: +5.00 dBi
Maximum Declared Gain for Cellular:

Band	Maximum Declared Antenna Gain	Type of Antenna
2G 850	+1.71 dBi	External
2G 1900	+5.20 dBi	External
LTE 41	+6.24 dBi	External

TEST FREQUENCIES:

CELLULAR		
Band:	2G 850	
Frequency Range:	824 – 849 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz) / Configuration
	High: 251	848,8
Band:	2G 1900	
Frequency Range:	1850 – 1910 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz) / Configuration
	Middle: 661	1880
Band:	LTE Band 41	
Frequency Range:	2496 – 2690 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	39750	2593 MHz (BW 20 MHz, RB Size 1, RB Offset 0, Narrowband=0, QPSK)

	WLAN 2.4 GHz (IEEE 802.11 bgn2040) / DTS	
Mode:	802.11 n20: index MCS0 (SISO)	
Channel Bandwidth:	20 MHz	
Frequency Range:	2400 MHz to 2483.5 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	High: 11	2462

	WLAN 5 GHz (IEEE 802.11 anac204080) / U-NII	
Mode:	802.11 n20: index MCS0 (SISO)	
Channel Bandwidth:	20 MHz	
Frequency Range:	5725 MHz to 5850 MHz (U-NII-3)	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 157	5785

	Bluetooth EDR / FHSS	
Mode:	Enhanced Data Rate (8DPSK - 3DH5)	
Channel Spacing:	1 MHz	
Frequency Range:	2402 MHz to 2480 MHz	
Transmit Channels	Channel	Channel Frequency (MHz)
	Low: 0	2402

	Bluetooth Low Energy / DTS	
Mode:	GFSK - 1DH5	
Channel Spacing:	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 mode 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, the EUT was configured to transmit packets continuously with the highest possible rate via iperf commands. Test channel and modulation were configured as required.

Selected Transmission Modes for each Radio:

The following configurations were selected based on preliminary testing that identified those corresponding to the worst-cases:

* Cellular 2G 850: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in: Cellular 2G 850 / High Channel in GPRS mode configuration.

* Cellular 2G 1900: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in: Cellular 2G 1900 / Middle Channel in GPRS mode configuration.

* Cellular LTE 41: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in: Cellular 41 / Middle Channel in QPSK mode configuration.

* Bluetooth Basic Rate: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 8DPSK mode because its power is higher than the other modes.

* Bluetooth Low Energy: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in GFSK because its power is higher than the other modes.

* WLAN 2.4 GHz: Transmitter radiated spurious emissions tests were performed with the EUT transmitting on Middle Channel in 802.11 n20 (index MCS0) / High Channel configuration as this combination was found to be the worst-case for spurious emissions compared with all the other WLAN 2.4 GHz modes.

* WLAN 5 GHz U-NII-3: Transmitter radiated spurious emissions tests were performed with the EUT transmitting on in 802.11 a20 (6 Mbps) / Middle Channel configuration as this combination was found to be the worst-case for spurious emissions compared with all the other WLAN 5 GHz modes.

Simultaneous Transmission Modes tested (as worst case):

* **Co-Location mode BT EDR, WLAN 2.4 GHz, WLAN 5 GHz U-NII-3, 2G 850, BLE**, with the EUT configured to simultaneously transmit three signals at maximum output power:
BT EDR 8DPSK ChLow + WLAN 2.4 GHz n20 ChHigh + WLAN 5 GHz a20 U-NII-3 ChMid + 2G 850 GPRS ChHigh + BLE 2 Mbps ChLow.

* **Co-Location mode BT EDR, WLAN 2.4 GHz, WLAN 5 GHz, 2G 1900, BLE**, with the EUT configured to simultaneously transmit three signals at maximum output power:
BT EDR 8DPSK ChLow + WLAN 2.4 GHz n20 ChHigh + WiFi 5G a20 U-NII-3 ChMid + 2G 1900 GPRS ChHigh + BLE 2 Mbps ChLow.

* **Co-Location mode BT EDR, WLAN 2.4 GHz, WLAN 5 GHz, LTE 41, BLE**, with the EUT configured to simultaneously transmit three signals at maximum output power:
BT EDR 8DPSK ChLow + WLAN 2.4 GHz n20 ChHigh + WLAN 5 GHz a20 U-NII-3 ChMid + LTE 41 QPSK + BLE 2 Mbps ChMiddle.

Radiated emissions

FCC 15.209 (a), 15.247 (d), 15.407 (b), 22.917

RSS-199 4.5, RSS-Gen 8.9, RSS-247 5.5, 6.2.1.2, 6.2.2.2, 6.2.3.2 & 6.2.4.2

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
960 - 25000	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 5.725–5.85 GHz band: All emissions shall be limited to a level of –27 dBm/MHz (68.23 dBµV/m at 3 m distance) at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

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:

- i. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least $43 + 10 \log_{10} P$ (watts).
- 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 $43 + 10 \log_{10} P$ (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

Measurement Limit:

According to the specification the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least $43 + 10 \log (P)$ dB. P in Watts.

At P_o transmitting power the specified minimum attenuation becomes $43+10\log (P_o)$ and the level in dBm relative P_o becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log (P_o \text{ in mWatts}) - 30] = -13 \text{ dBm}$$

2G 1900. FCC §2.1053 & §24.238 / RSS-133 Issue 6 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 Issue 6 Clause 6.5:

i. In the 1.0 MHz bands immediately outside and adjacent to the equipment's operating frequency block, the emission power per any 1% of the emission bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least $43 + 10 \log_{10} p$ (watts).

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 $43 + 10 \log_{10} p$ (watts). If the measurement is performed using 1% of the emission bandwidth, power integration over 1.0 MHz is required.

LTE 41. FCC §2.1053 & §27.53 (m) (4) / RSS-199 Issue 3 Clause 4.5 (b):

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 than $43 + 10 \log (P)$ 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. $55 + 10 \log_{10} p$ at X MHz and beyond from the channel edges

In addition, the attenuation shall not be less than $43 + 10 \log_{10} p$ on all frequencies between 2490.5 MHz and 2496 MHz, and $55 + 10 \log_{10} p$ 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.

At P_o transmitting power, the specified minimum attenuations become:

$$P_o \text{ (dBm)} - [55 + 10 \log (P_o \text{ in mW}) - 30] = -25 \text{ dBm}$$

$$P_o \text{ (dBm)} - [43 + 10 \log (P_o \text{ in mW}) - 30] = -13 \text{ dBm}$$

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 co-located 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 measuring antenna height and polarization. The maximum meter reading was recorded. Measurements were made in both horizontal and vertical planes of polarization.

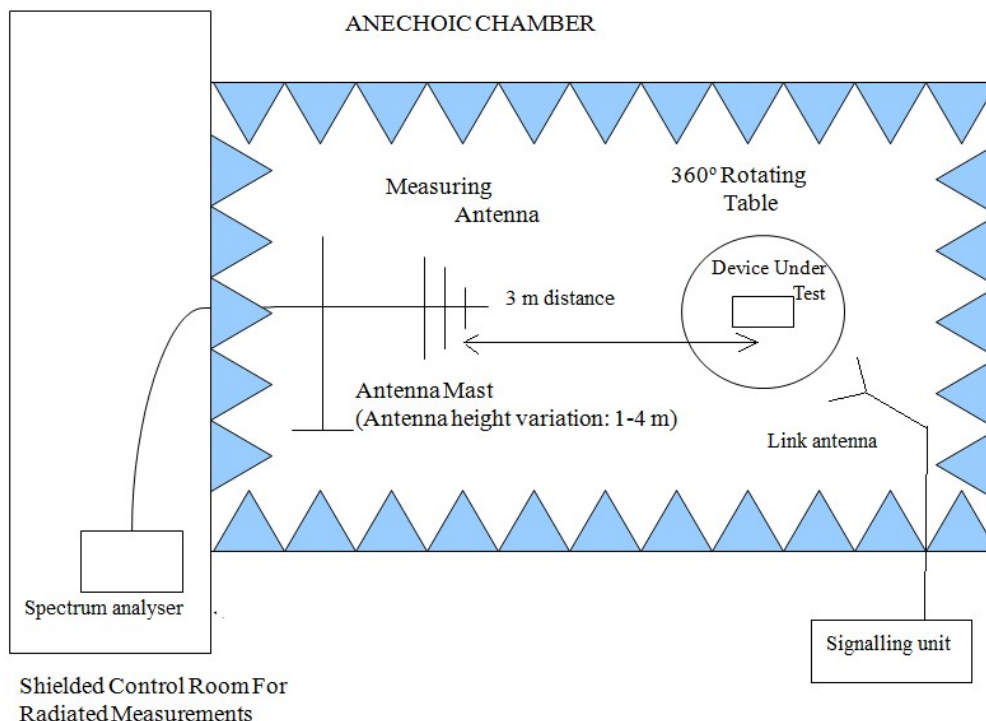
The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

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.

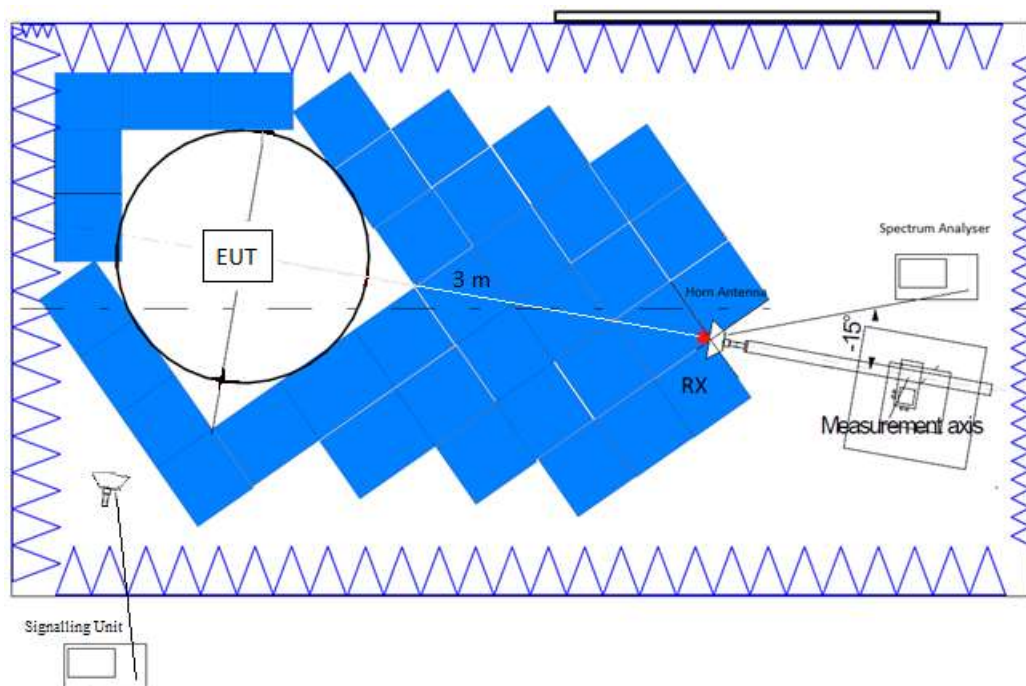
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can transmit simultaneously).

Test setup

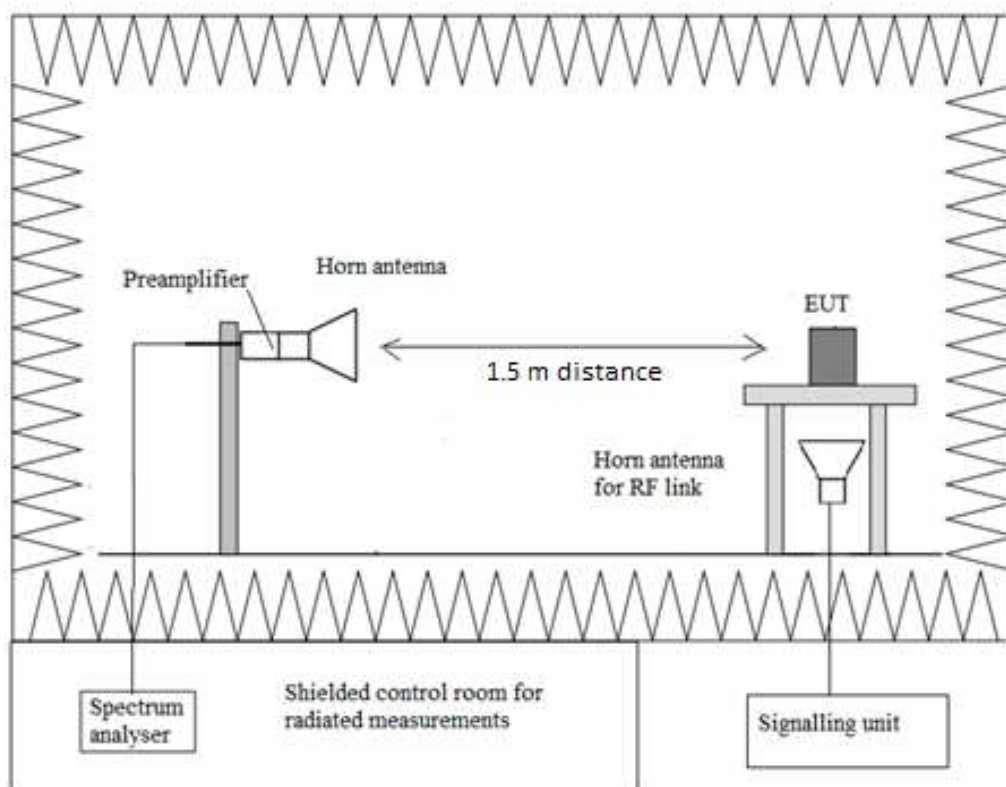
Radiated measurements below 1 GHz.



Radiated measurements between 1 GHz and 17 GHz.



Radiated measurements above 17 GHz.



Results

• Co-Location mode BT EDR, WLAN 2.4 GHz, WLAN 5 GHz U-NII-3, 2G 850:

QPSK & 16QAM:

A preliminary scan determined the QPSK modulation in the High Channel as the worst-case.

BT EDR:	Low Channel (2402 MHz). 8DPSK.
WLAN 2.4 GHz:	High Channel (2462 MHz). 802.11 n20. BW: 20 MHz.
WLAN 5 GHz:	Middle Channel (5785 MHz). 802.11 a20. BW: 20 MHz.
2G 850:	High Channel (848.8 MHz). GPRS.
BLE:	Low Channel (2402 MHz). 2 Mbps.

LIMIT: The spurious frequencies were measured at 3 meter. The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBµV/m)
30 MHz to 8.49 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm} \rightarrow 82.23 \text{ dBµV/m}$
8.49 GHz to 26 GHz	Peak	74 dBµV/m
26 GHz to 40 GHz	Peak	68.23 dBµV/m
26 GHz to 40 GHz	Peak	74 dBµV/m (*)
8.49 GHz to 40 GHz	Average	54 dBµV/m (*)

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

Frequency range 30 MHz – 1 GHz

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (MHz)	E.I.R.P (dBm)	Polarization	Detector
875.966100	66.05	V	Peak
893.794700	63.21	V	Peak

Frequency range 1 – 40 GHz

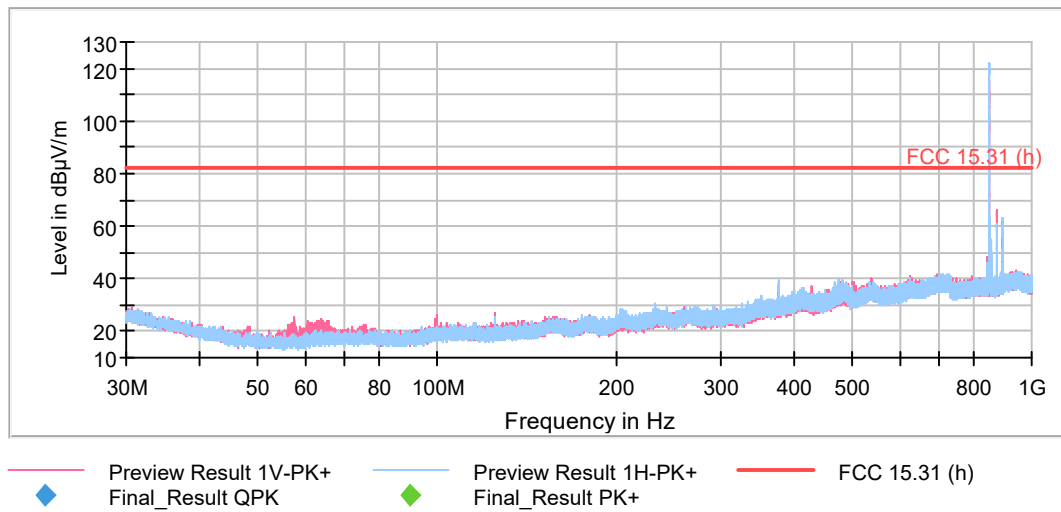
Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (MHz)	E.I.R.P (dBm)	Polarization	Detector
11564.968750	52.89	V	Peak
17357.468750	50.30	V	Peak

Verdict

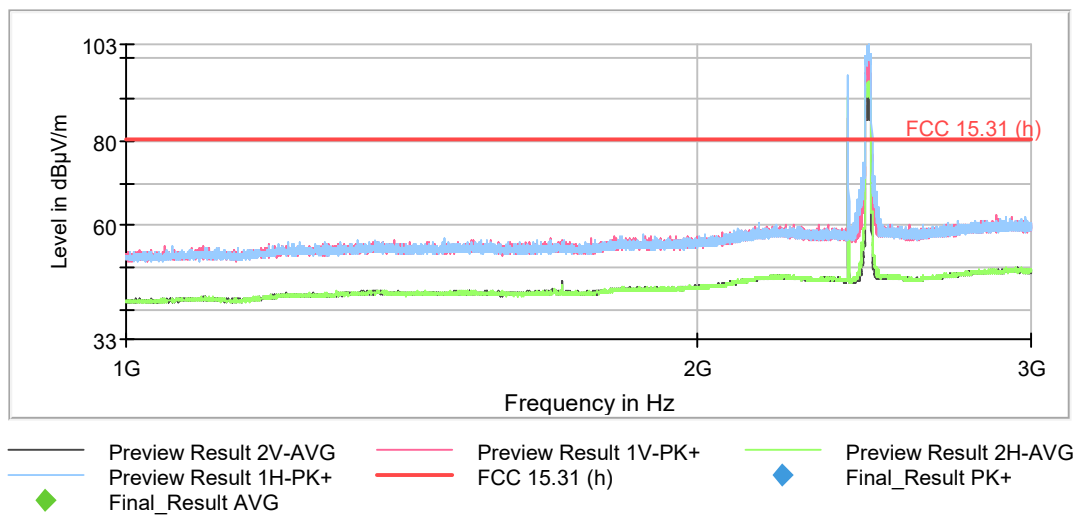
Pass

FREQUENCY RANGE 30 MHz – 1 GHz



The peak above the limit is the 2G 850 carrier frequency (848.8 MHz).

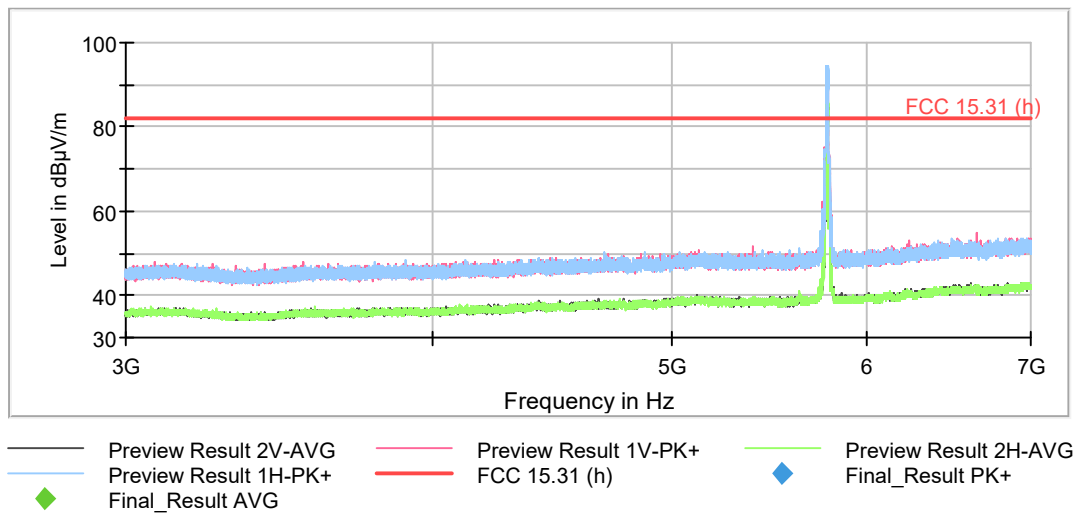
FREQUENCY RANGE 1 GHz – 7 GHz



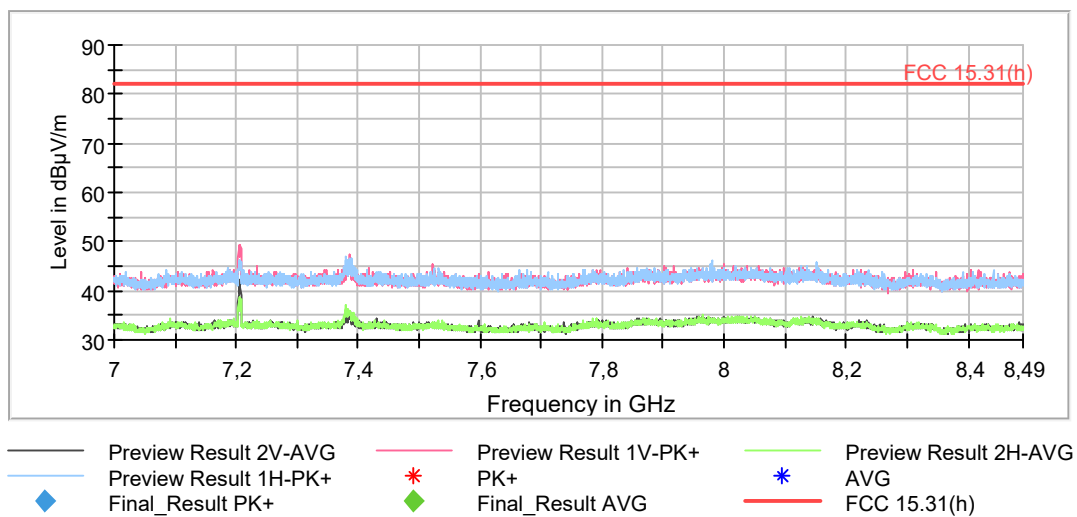
The peak above the limit on the left is the BT EDR carrier frequency (2402 MHz).

The peak above the limit on the left is the BLE carrier frequency (2402 MHz).

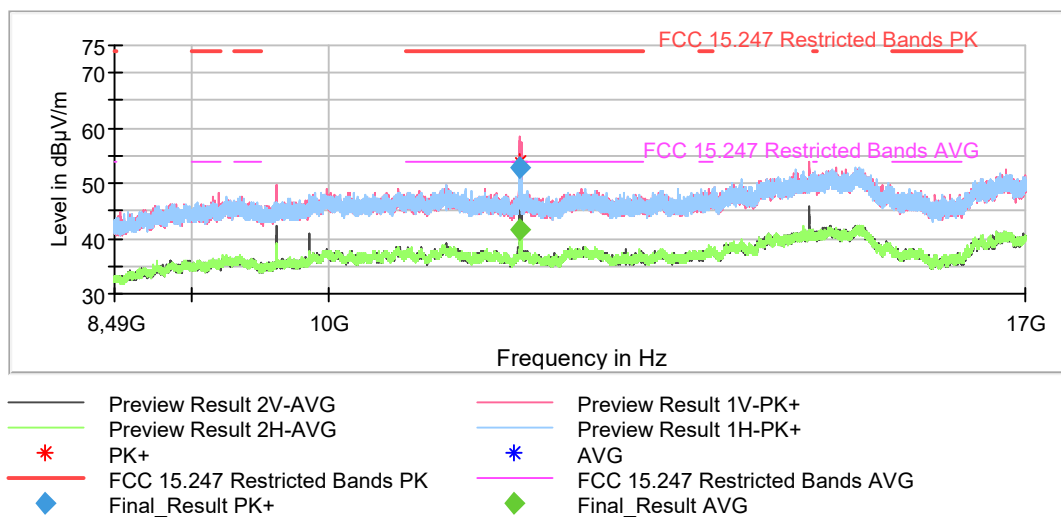
The peak above the limit on the left is the WLAN 2.4 GHz carrier frequency (2462 MHz).



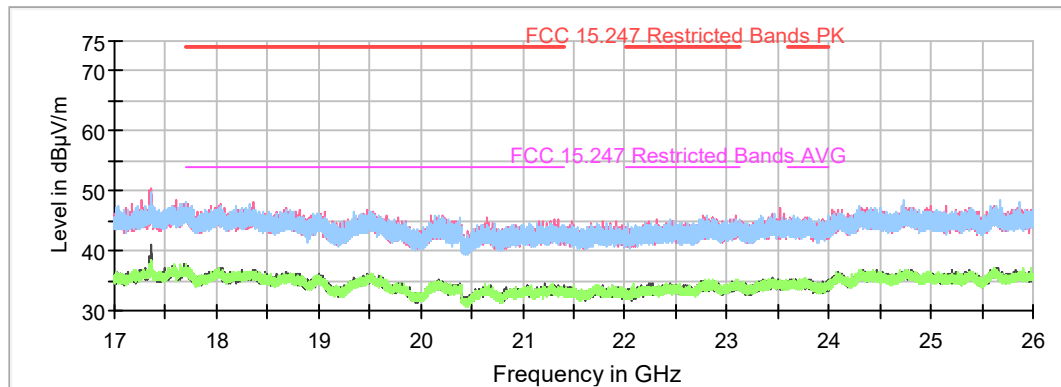
The peak above the limit on the right is the WLAN 5 GHz carrier frequency (5785 MHz).



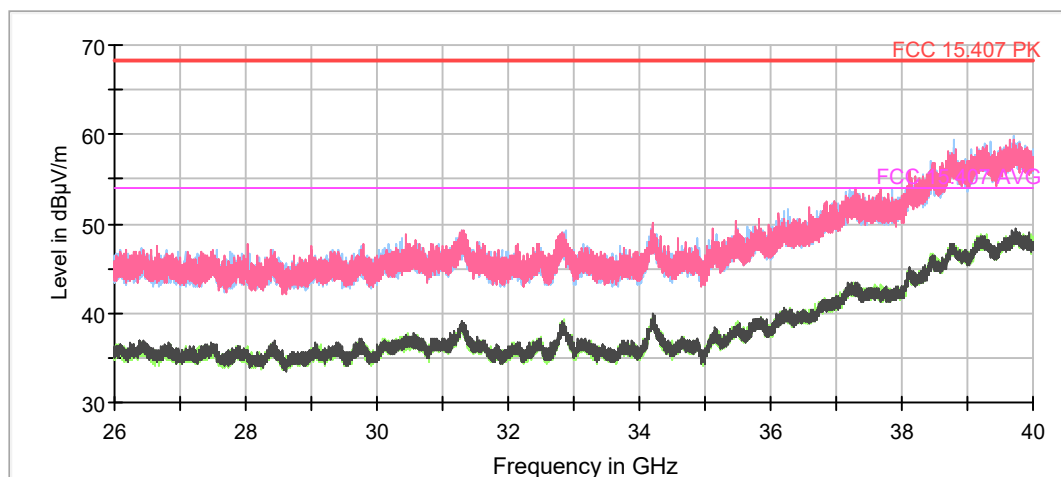
FREQUENCY RANGE 8.49 GHz – 17 GHz



FREQUENCY RANGE 17 GHz – 40 GHz



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



Preview Result 2H-AVG
 Preview Result 1V-PK+
 Preview Result 1H-PK+
 Preview Result 2V-AVG
 FCC 15.407 PK
 FCC 15.407 AVG
 Final_Result PK+
 Final_Result AVG

• **Co-Location mode BT EDR, WLAN 2.4 GHz, WLAN 5 GHz U-NII-3, 2G 1900, BLE:**

QPSK & 16QAM:

A preliminary scan determined the QPSK modulation in the High Channel as the worst-case.

BT EDR:	Low Channel (2402 MHz). 8DPSK.
WLAN 2.4 GHz:	High Channel (2462 MHz). 802.11 n20. BW: 20 MHz.
WLAN 5 GHz:	Middle Channel (5785 MHz). 802.11 n20. BW: 20 MHz.
2G 1900:	High Channel (1880 MHz). GPRS.
BLE:	Low Channel (2402 MHz). 2 Mbps.

LIMIT: The spurious frequencies were measured at 3 meter. The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBµV/m)
30 MHz to 19 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm} \rightarrow 82.23 \text{ dBµV/m}$
19 GHz to 26 GHz	Peak	74 dBµV/m
26 GHz to 40 GHz	Peak	68.23 dBµV/m
19 GHz to 40 GHz	Average	54 dBµV/m (*)

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

Frequency range 30 MHz – 1 GHz

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

Frequency range 1 GHz – 40 GHz

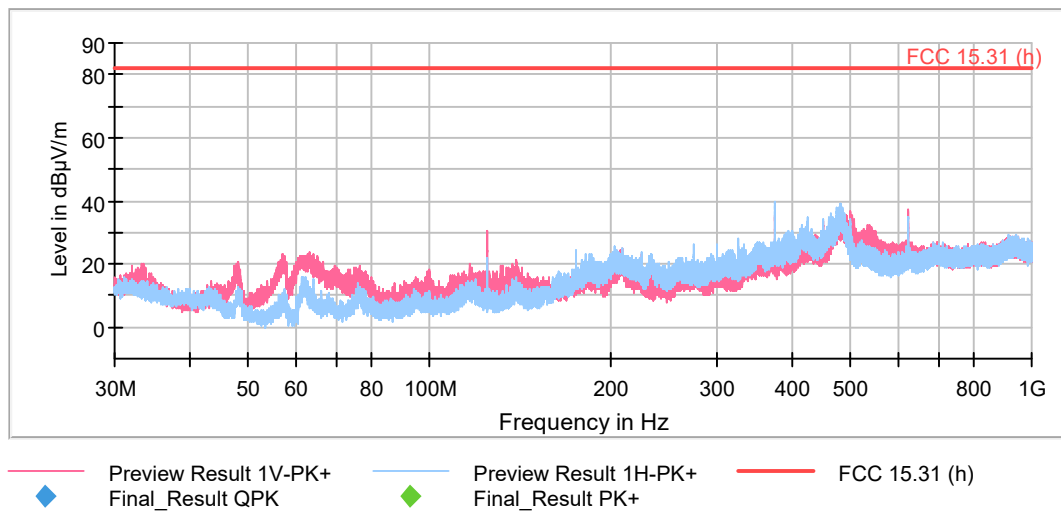
Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (MHz)	E.I.R.P (dBm)	Polarization	Detector
11569.037500	59.82	V	Peak
	47.08		Average
17356.062500	50.86	V	Peak

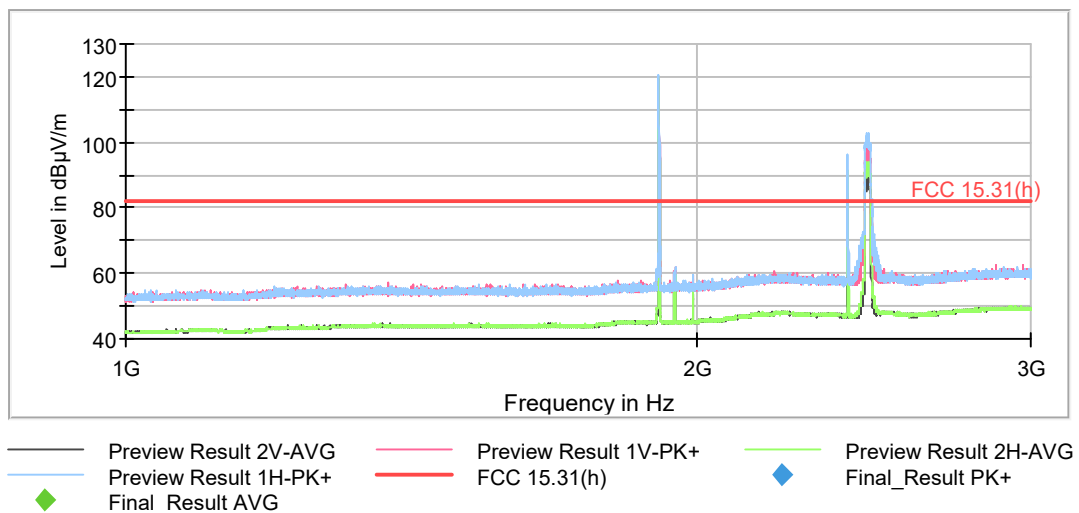
Verdict

Pass

FREQUENCY RANGE 30 MHz – 1 GHz



FREQUENCY RANGE 1 GHz – 7 GHz

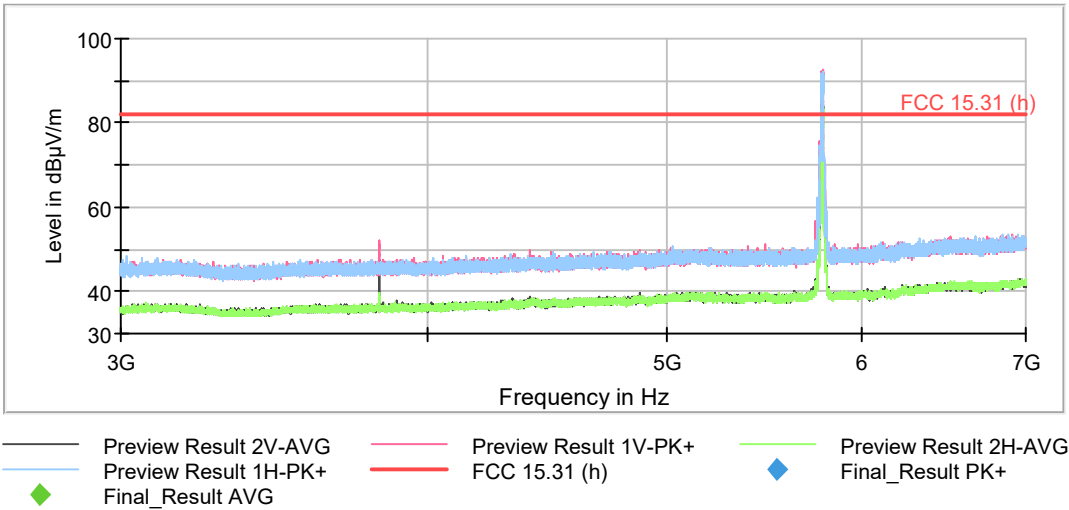


The peak above the limit on the left is the 2G 1900 carrier frequency (1909.8 MHz).

The peak above the limit on the left is the BT EDR carrier frequency (2402 MHz).

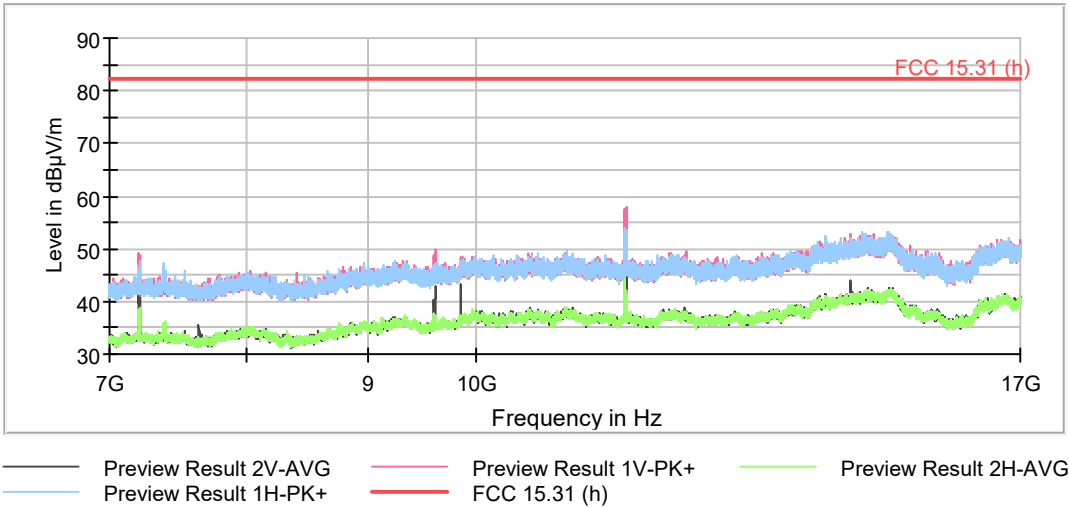
The peak above the limit on the left is the BLE carrier frequency (2402 MHz).

The peak above the limit in the middle is the WLAN 2.4 GHz carrier frequency of the (2462 MHz).

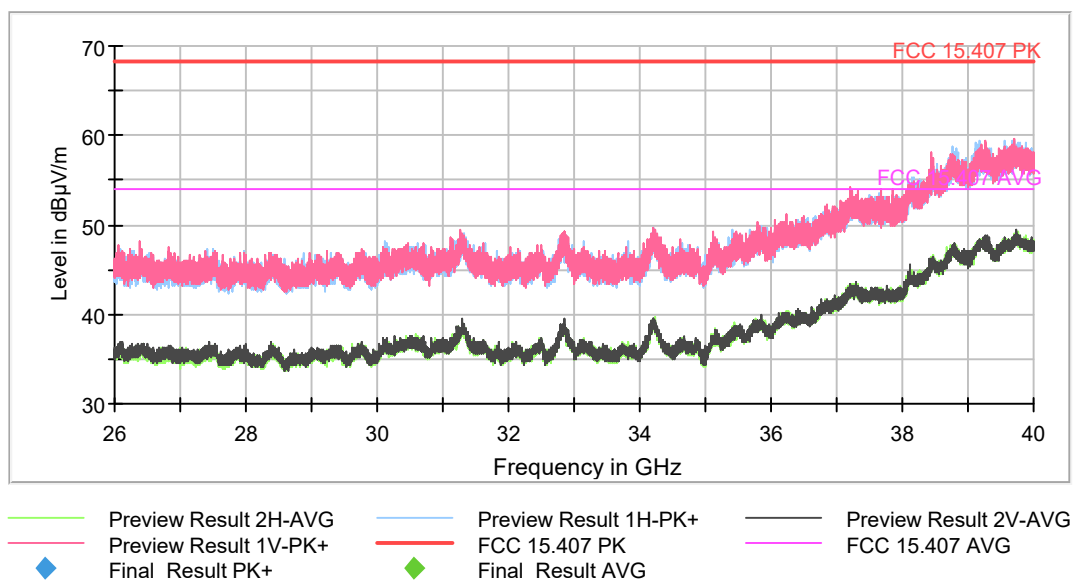
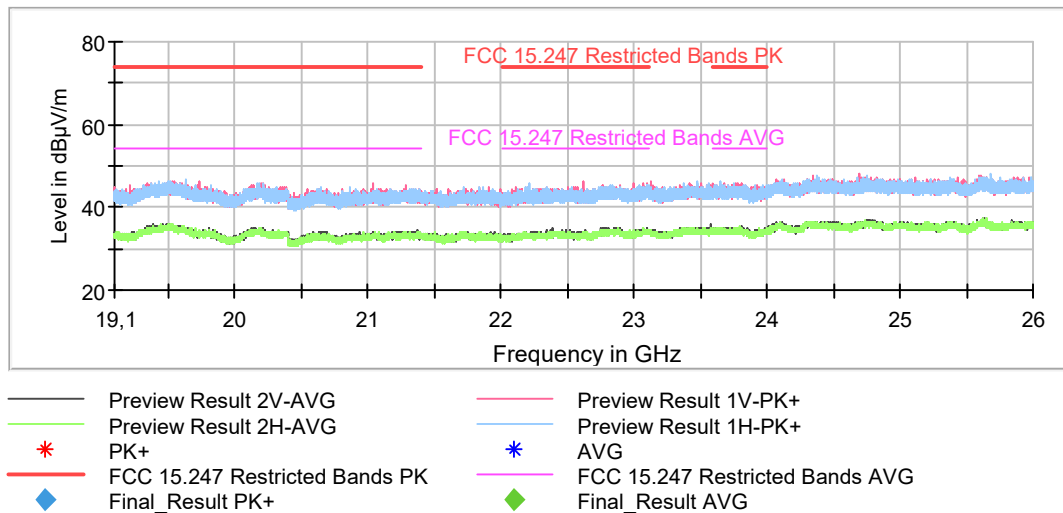
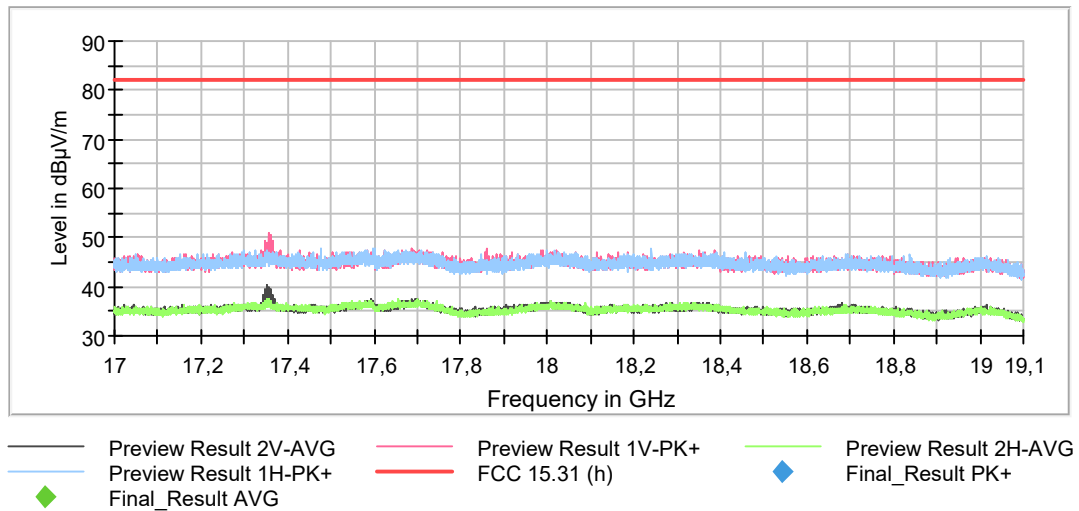


The peak above the limit is the WLAN 5 GHz carrier frequency (5785 MHz).

FREQUENCY RANGE 7 GHz – 17 GHz



FREQUENCY RANGE 17 GHz – 40 GHz



• **Co-location mode BT EDR, WLAN 2.4 GHz, WLAN 5 GHz U-NII-3, LTE 41, BLE:**

QPSK & 16QAM:

A preliminary scan determined the QPSK modulation in the High Channel as the worst-case.

BT EDR:	Low Channel (2402 MHz). 8DPSK.
WLAN 2.4 GHz:	High Channel (2462 MHz). 802.11 n20. BW: 20 MHz.
WLAN 5 GHz:	Middle Channel (5745 MHz). 802.11 n20. BW: 20 MHz.
LTE 41:	Middle Channel (2593 MHz). QPSK. BW 20 MHz. RB Size: 1. RB Offset: 0.
BLE:	Low Channel (2402 MHz). 2 Mbps.

LIMIT: The spurious frequencies were measured at 3 meter. The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBµV/m)
30 MHz to 1 GHz	Peak	$55 + 10 \log (P) \text{ dB} = -25 \text{ dBm} \rightarrow 70.23 \text{ dBµV/m}$
1 GHz to 26 GHz	Peak	74 dBµV/m
	Average	54 dBµV/m (*)
26 GHz to 40 GHz	Peak	68.23 dBµV/m
	Average	54 dBµV/m (*)

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

Frequency range 30 MHz – 1 GHz

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

Frequency range 1 GHz – 40 GHz

Spurious frequencies falling inside the restricted bands as defined in §15.205(a), with peak levels above the average limit (54 dBµV/m at 3 m), are measured with average detector for average compliance checking.

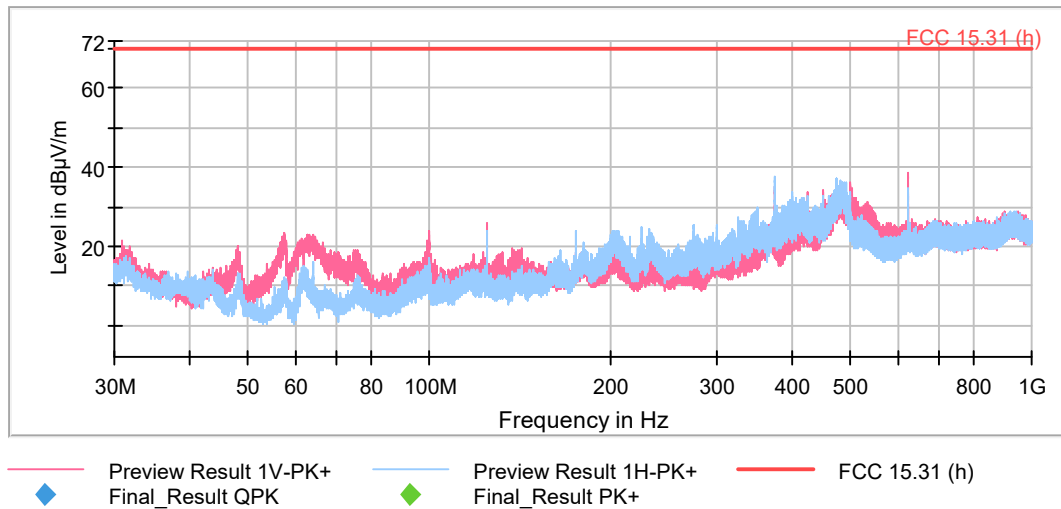
Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (MHz)	Emission Level (dBµV/m)	Polarization	Detector
11569.062500	55.81	V	Peak
17355.500000	49.25	V	Peak

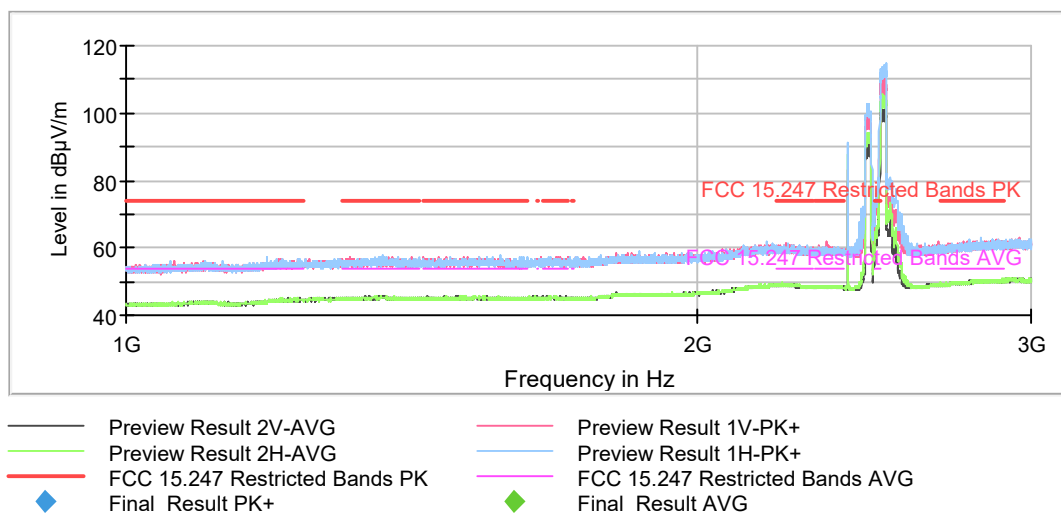
Verdict

Pass

FREQUENCY RANGE 30 MHz – 1 GHz



FREQUENCY RANGE 1 GHz – 7 GHz

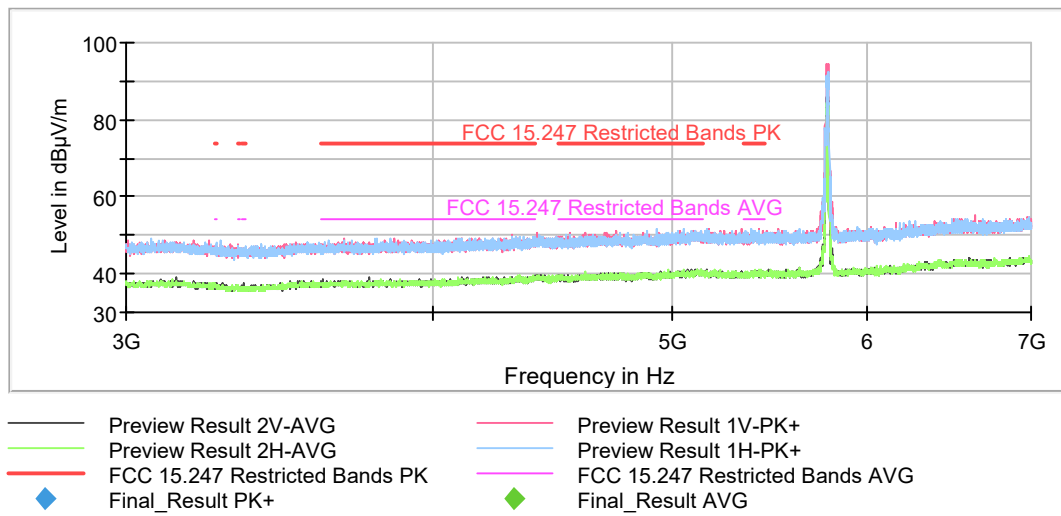


The peak above the limit on the left is the BT EDR carrier frequency (2402 MHz).

The peak above the limit on the left is the BLE carrier frequency (2402 MHz).

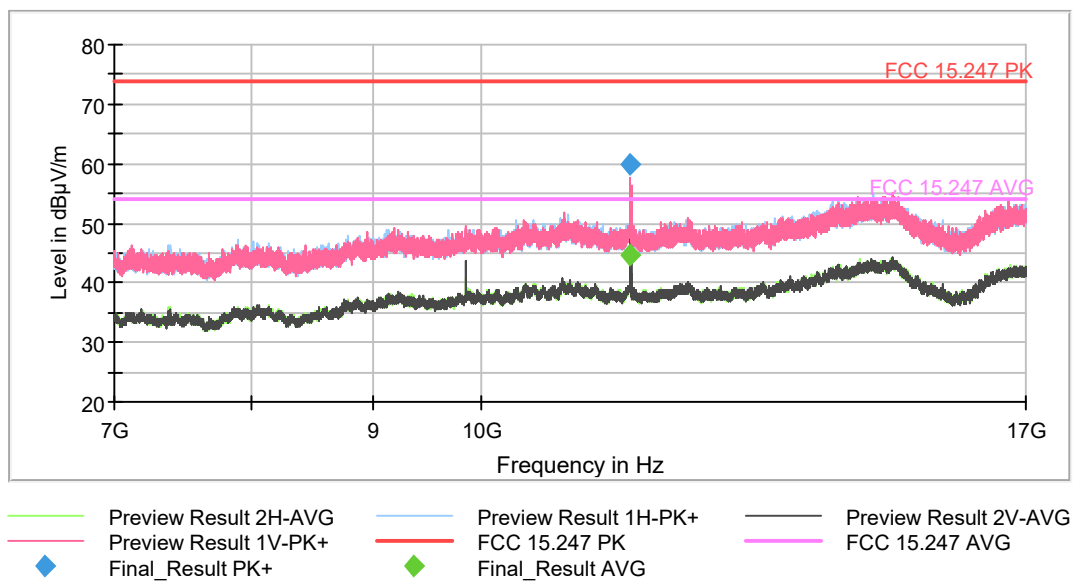
The peak above the limit on the left is the WLAN 2.4 GHz carrier Frequency (2462 MHz)

The peak above the limit on the right is the LTE 41 carrier frequency (2593 MHz)

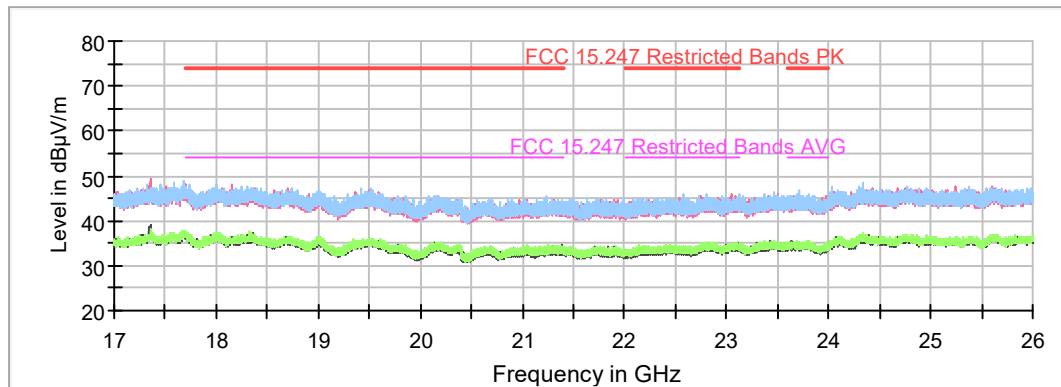


The peak above the limit is the WLAN 5 GHz carrier frequency (5785 MHz).

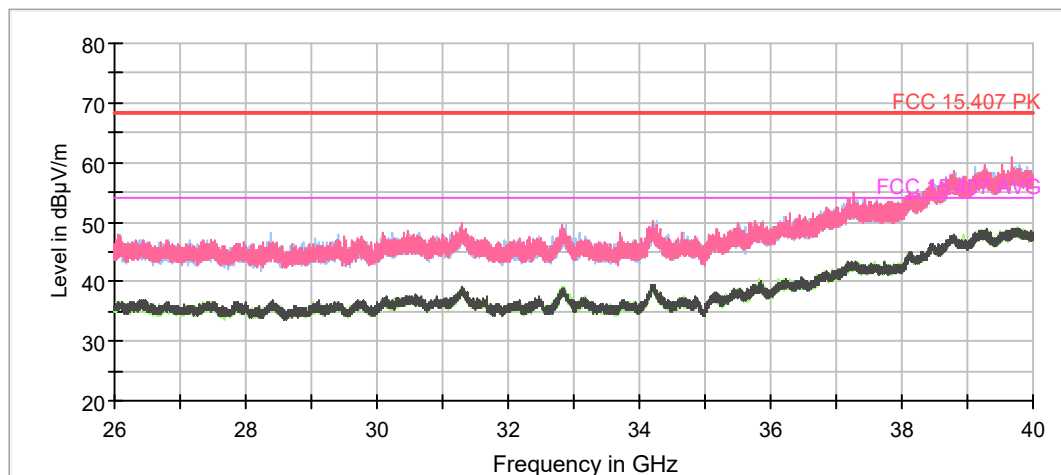
FREQUENCY RANGE 7 GHz – 17 GHz



FREQUENCY RANGE 17 GHz – 40 GHz



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



— Preview Result 2H-AVG
 — Preview Result 1V-PK+
 — Preview Result 1H-PK+
 — Preview Result 2V-AVG
 — FCC 15.407 PK
 — FCC 15.407 AVG
 ◆ Final_Result PK+
 ◆ Final_Result AVG