DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29507456

ISED CABid: ES1909

Lab. Company Number: 4621A

Test Report No:
68365RRF.005

Partial Test Report

USA FCC 15.31(h), 24, 15.209, 15.247
CANADA RSS-133, RSS-247, RSS-Gen

(*) Identification of item tested	Telematic Control Unit, used in automotive industry
(*) Trademark	VOLVO
(*) Model and /or type reference	TCAM2
Other identification of the product	FCC ID: T8GTCAM2 IC: 6434A-TCAM2
(*) Features	Features: BLE, LTE, 5G, GNSS, TMPS, SDARS HW version: D0 SW version: 04-08-2022-master-TCAM2-A_Homologation
Manufacturer	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 24 (10-1-21 Edition): Personal Communications Services. CANADA RSS-247 Issue 2 (Feb. 2017). CANADA RSS-Gen. Issue 5, Amendment 1 (Mar. 2019) + Amendment 2 (Feb. 2021). CANADA RSS-133 Issue 6, Amendment (Jan. 2018). 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 Apr. 2, 2019. Measurement Guidance for Certification of Licensed Digital Transmitters. 971168 D01 Power Meas License Digital Systems v03r01 dated April 9, 2018. 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)	José Manuel Gómez Galván EMC Consumer & RF Lab. Manager  Firmado digitalmente por 53680346W JOSE MANUEL GOMEZ (C:A29507456)
Date of issue	2023-04-03
Report template No.	FDT08_24 (*) “Data provided by the client”

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 S.A.U. 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 S.A.U. is an FCC-recognized accredited testing laboratory with appropriate scope of accreditation that covers the performed tests in this report.

DEKRA Testing and Certification S.A.U. 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.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
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 of the model TCAM2 is a Telematics Control Unit with eCall technologies, used in automotive, equipped with eCall modem. The project name TCAM2 has the meaning “Telematic Connectivity Antenna Module” and thus describes the key features of this device as Communication and Data Interface. This unit was designed for automotive usage and contains the following features: GSM/UMTS/LTE/5G, BTLE and TPMS receiver.

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.

Id	Control Number	Description	Model	Serial Nº	Date of Reception	Application
S/01	68365_215.1	Telematic Control Unit	TCAM2	353802740010527	2023-03-24	Element Under Test
S/01	68365_210.1	Harness	--	--	2023-03-24	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="2">Ports…… :</td><td 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></td><td>.....</td><td>.....</td><td>[ ]</td><td>[ ]</td><td>[ ]</td></tr>
<tr><td>Supplementary information to the ports…… :</td><td colspan="5">.....</td></tr>
<tr><td rowspan="4">Rated power supply .....:</td><td colspan="2" rowspan="2">Voltage and Frequency</td><td colspan="4">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>[X]</td><td colspan="5">DC: 12V car battery / alternator (4,5 V ≤ UB ≤ 18 V; UB typical: 12V)</td></tr>
<tr><td>Rated Power .....:</td><td colspan="6">12V DC</td></tr>
<tr><td>Clock frequencies.....:</td><td colspan="6">.....</td></tr>
<tr><td>Other parameters .....:</td><td colspan="6">See Technical description</td></tr>
<tr><td>Software version .....:</td><td colspan="6">04-08-2022-master-TCAM2-A_Homologation</td></tr>
<tr><td>Hardware version .....:</td><td colspan="6">D0</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>[X]</td><td colspan="5">Other: automotive telematics control unit</td></tr>
<tr><td rowspan="2">Modules/parts.....:</td><td colspan="3">Module/parts of test item</td><td>Type</td><td>Manufacturer</td></tr>
<tr><td colspan="3">.....</td><td>.....</td><td>.....</td></tr>
<tr><td rowspan="3">Accessories (not part of the test item) .....:</td><td colspan="3">Description</td><td>Type</td><td>Manufacturer</td></tr>
<tr><td colspan="3">Cable Harness</td><td>.....</td><td>.....</td></tr>
<tr><td colspan="3">.....</td><td>.....</td><td>.....</td></tr>
<tr><td rowspan="3">Documents as provided by the applicant .....:</td><td colspan="3">Description</td><td>File name</td><td>Issue date</td></tr>
<tr><td colspan="3">Technical Description</td><td>.....</td><td>.....</td></tr>
<tr><td colspan="3">.....</td><td>.....</td><td>.....</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)	2023-03-27
Date (finish)	2023-03-28

Document history

Report number	Date	Description
68365RRF.005	2023-04-03	First release.

Environmental conditions

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

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

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

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

Remarks and comments

The tests have been performed by the technical personnel: Pablo Redondo.

Used instrumentation:

Control No.	Equipment	Model	Manufacturer	Next Calibration
4825	SEMIANECHOIC ABSORBER LINED CHAMBER IV	FACT 3 200 STP	ETS LINDGREN	N/A
4826	SHIELDED ROOM	S101	ETS LINDGREN	N/A
4578	HYBRID BILOG ANTENNA 30MHz-6GHz	3142E	ETS LINDGREN	2023-04-30
6165	EMI TEST RECEIVER 9kHz-7GHz	ESR7	ROHDE AND SCHWARZ	2023-11-08
4611	HORN ANTENNA 1-18GHz	BBHA 9120 D	SCHWARZBECK MESS-ELEKTRONIK	2026-01-16
5705	PRE-AMPLIFIER G>40dB 1-18 GHz	BLMA 0118-1M	BONN ELEKTRONIK	2023-07-21
4716	SIGNAL AND SPECTRUM ANALYZER 2Hz-50GHz	FSW50	ROHDE AND SCHWARZ	2024-08-12
9555	DC POWER SUPPLY 30V/5A	HMP2020	ROHDE AND SCHWARZ	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), FCC 24.238 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-133 6.5	Emission limitations radiated (Transmitter)	P	(1)
Supplementary information and remarks: (1) Only radiated simultaneous transmission spurious emission test was requested.			

Appendix A: Test results.

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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 BLE:	+4.4 dBi
Maximum Declared Gain for Cellular:	

Band	Maximum Declared Antenna Gain	Type of Antenna
2G 1900	+6.55 dBi	External

TEST FREQUENCIES (*):

CELLULAR		
Band:	2G 1900	
Frequency Range:	1850 – 1910 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	High: 661	1880

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 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 1900: Cellular 2G 1900 / Middle Channel, EDGE mode configuration.

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

TESTED SIMULTANEOUS TRANSMISSION MODES:

*** BLE 1 Mbps Low Channel (2402 MHz) + 2G 1900 EDGE Middle Channel (1880 MHz)**, with the EUT configured to simultaneously transmit all these signals at maximum output power.

TEST CASES DETAILS

Emission limitations radiated (Transmitter)

Limits

BLE:

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.

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

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 26 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. For measurements above 17 GHz the measurement distance is reduced to 1.5 meters

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.

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 and the distance correction factor for measurements above 17 GHz performed at 1.5-meter distance.

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

Measurement Limit:

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

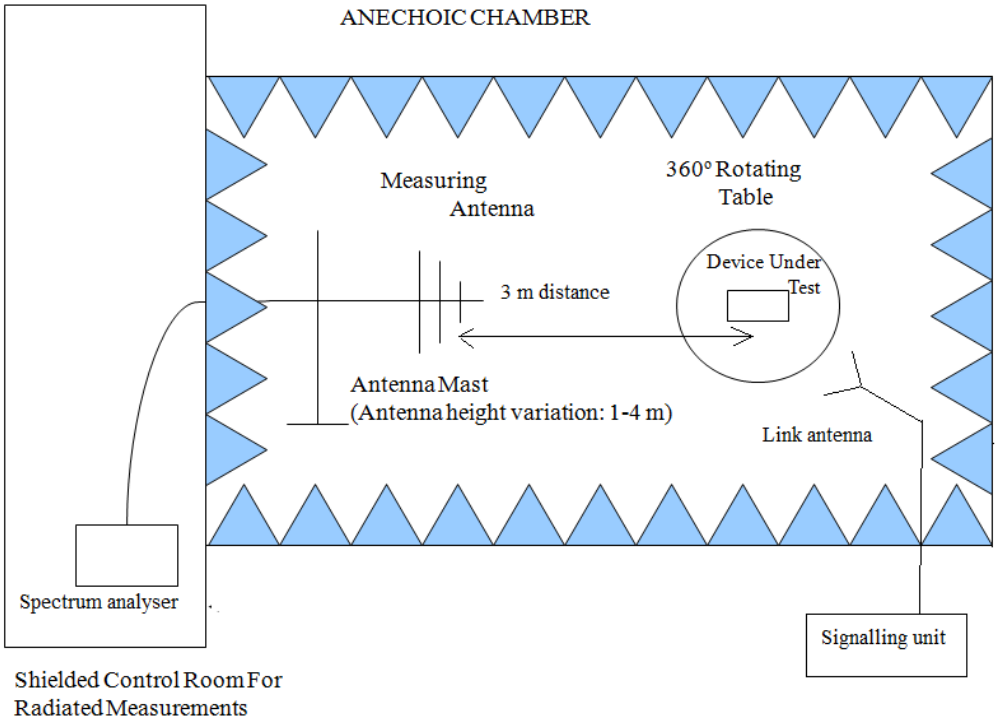
$$Po\ (dBm) - [43 + 10 \log (Po\ in\ mWatts) - 30] = -13\ dBm$$

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

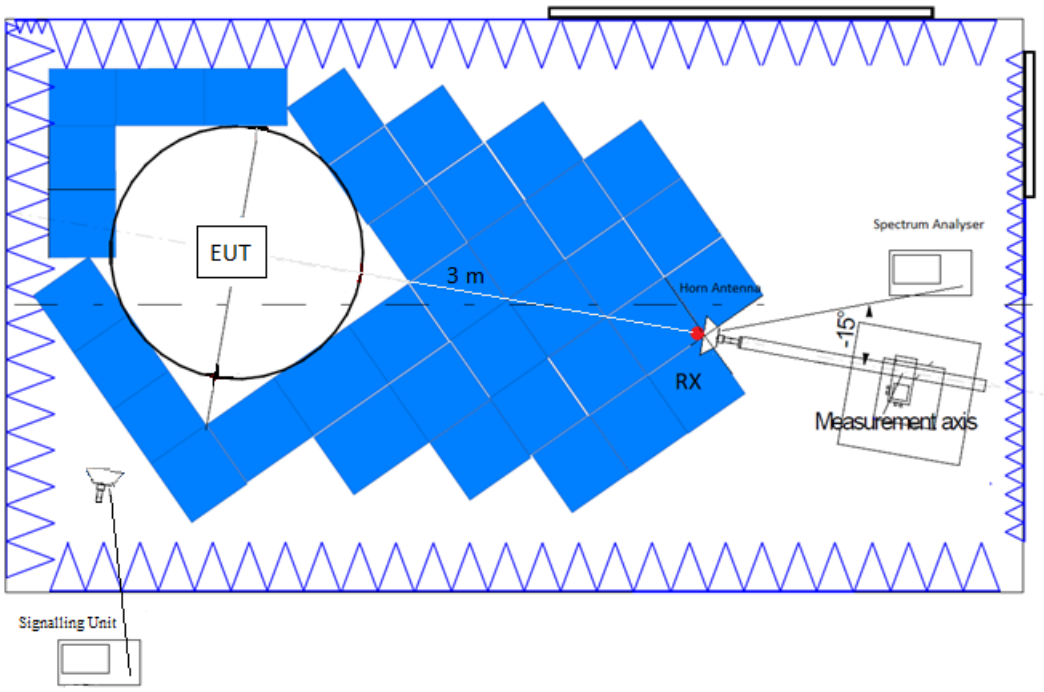
$$Po\ (dBm) - [55 + 10 \log (Po\ in\ mW) - 30] = -25\ dBm$$

Test setup

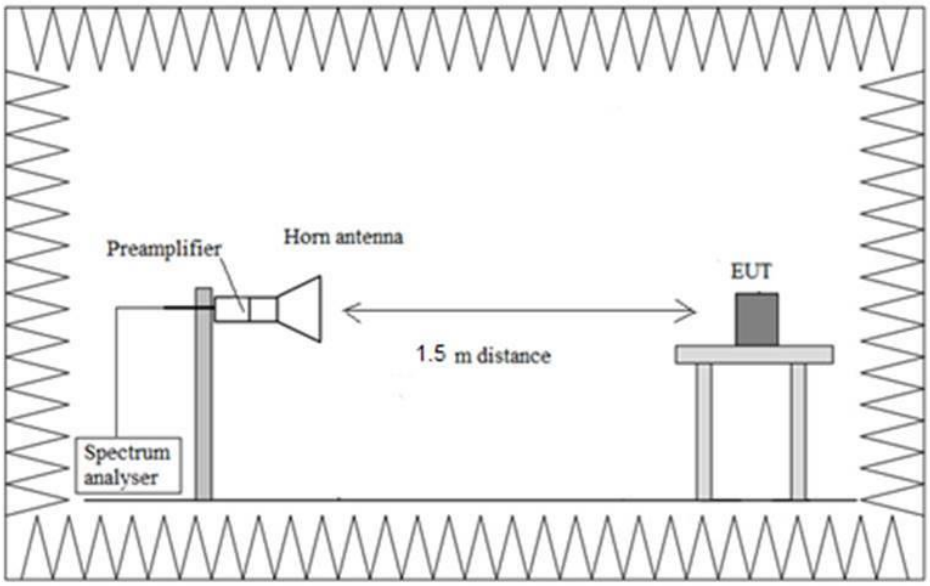
Radiated measurements below 1 GHz.



Radiated measurements between 1 GHz and 17 GHz.



Radiated measurements above 17 GHz.



Simultaneous transmission BLE, 2G 1900

BLE: Low Channel (2402 MHz), 1 Mbps.
2G 1900: Middle Channel (1880 MHz), EDGE.

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) dB = -13 dBm → 82.23 dBµV/m
19 GHz to 26 GHz	Peak	74 dBµV/m
19 GHz to 26 GHz	Average	54 dBµV/m (*)

(*) 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 – 26 GHz

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Polarization	Detector
3.7598	75.61	V	Peak
5.6397	68.02	V	Peak

Verdict

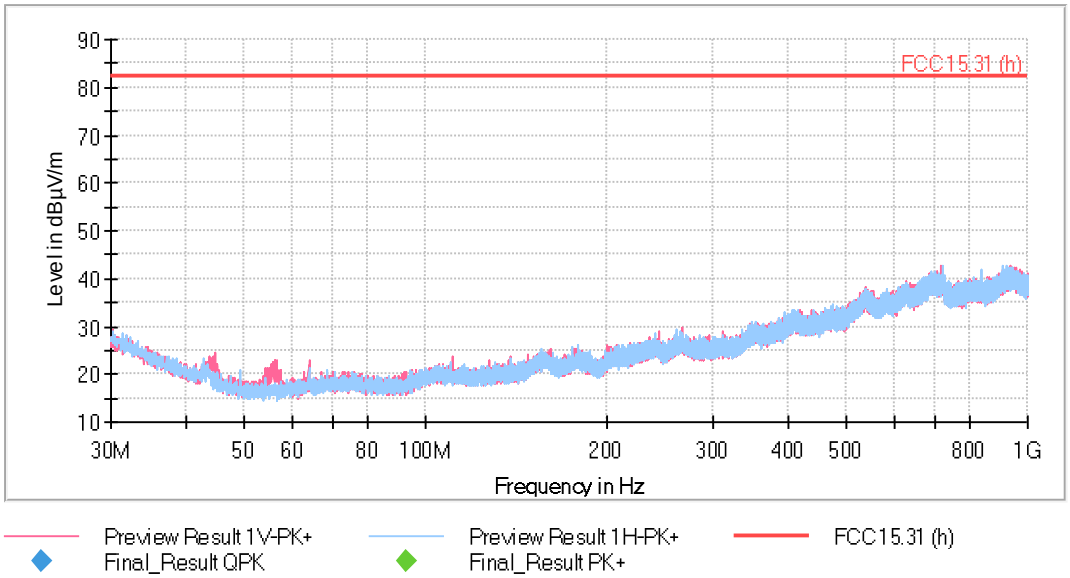
Pass

Attachments

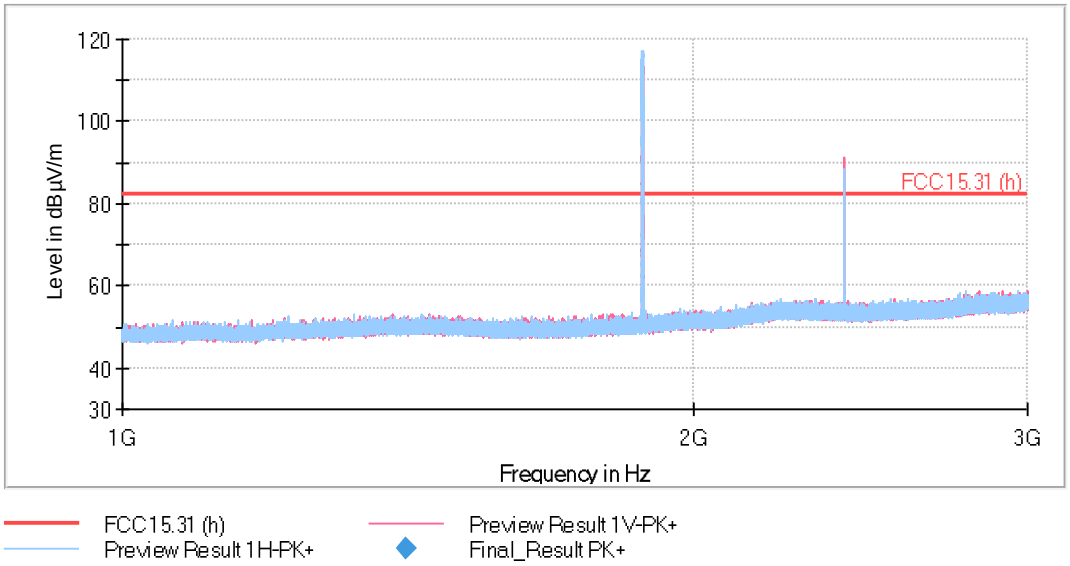
Spectrum Analyzer Parameters:

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
Receiver: [FSW 50]					
1 GHz - 3 GHz	30,769 kHz	PK+ ; AVG	1 MHz	1 s	0 dB
Receiver: [FSW 50]					
3 GHz - 17 GHz	140 kHz	PK+ ; AVG	1 MHz	1 s	0 dB
Receiver: [FSW 50]					
17 GHz - 26 GHz	300 kHz	PK+ ; AVG	1 MHz	1 s	0 dB

Frequency range 30 MHz – 1 GHz

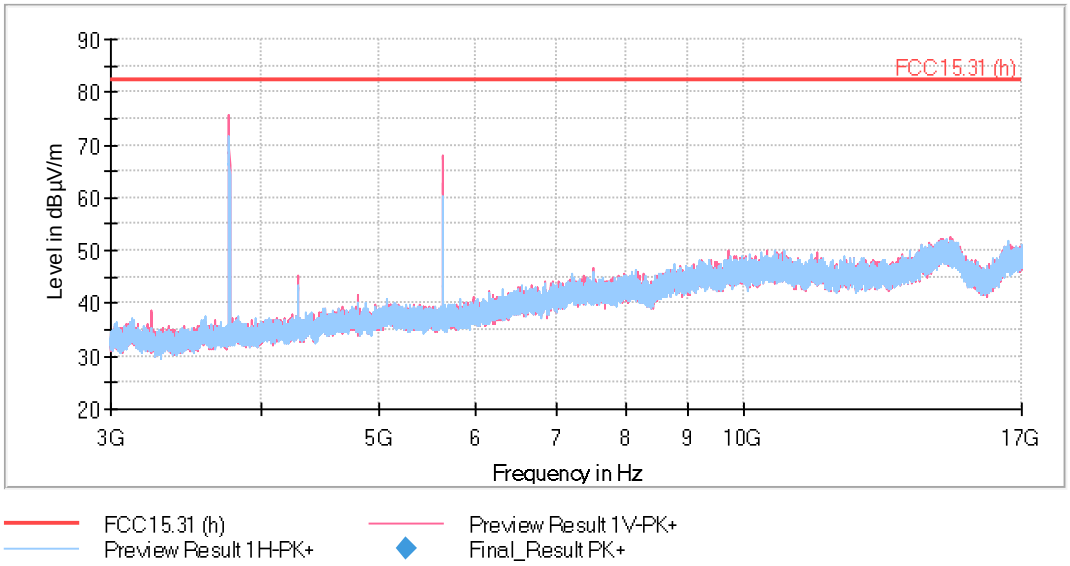


Frequency range 1 GHz – 3 GHz

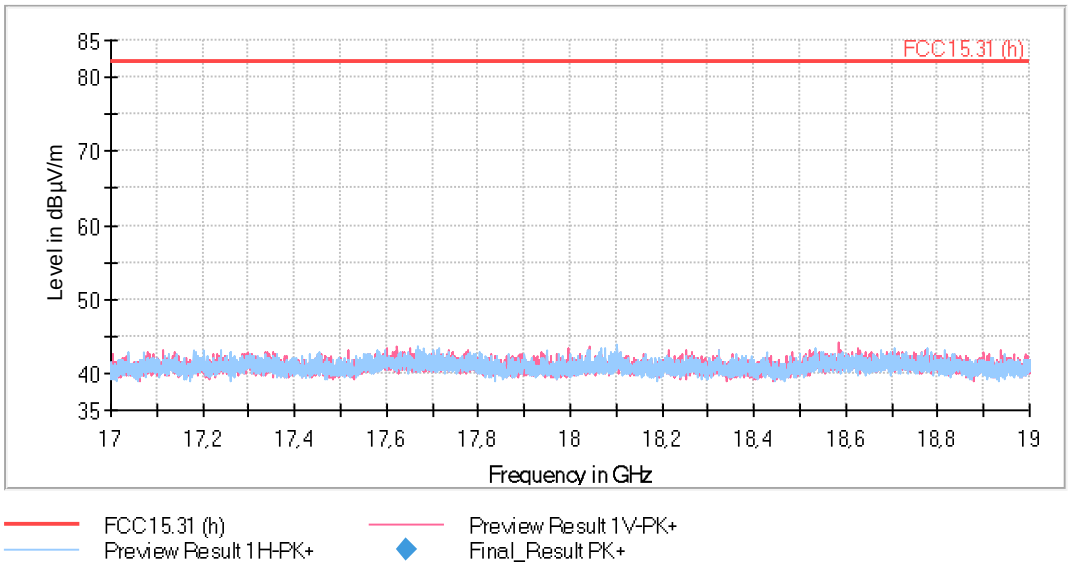


The peak on the left above the limit is the 2G 1900 carrier frequency.
The peaks on the right above the limit are the BLE carrier frequency.

Frequency range 3 GHz – 17 GHz



Frequency range 17 GHz – 19 GHz



Frequency range 19 GHz – 26 GHz