DEKRA Certification, Inc.
405 Glenn Dr. Suite 12,
Sterling, VA 20164
United States of America

FCC LISTED, REGISTRATION NUMBER: 2764.01

ISED LISTED REGISTRATION NUMBER: 23595-1

Test report No:
3154ERM.011

Partial Test report

USA FCC Part 15.247, 15.407 15.209, 15.207
CANADA RSS-247, RSS-Gen

(*) Identification of item tested	Infotainment Head Unit
(*) Trademark	Garmin
(*) Model and /or type reference tested	MGU22
Other identification of the product	FCC ID: IPH-03910 IC: 1792A-03910
(*) Features	USB2.0 (3 ports), HS-CAN, 100BaseT1(OABR), 1000BaseT1(GBit), Bluetooth, WLAN 802.11ax,u MIMO (2.4GHz/5GHz), APIX2 &APIX3 displaylink (HDCP2.3), FPD-Link III, GNSS
Manufacturer	Garmin International, Inc. 1200 E. 151st Street Olathe, Kansas 66062, USA
Test method requested, standard	USA FCC Part 15.247, 10-1-20 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz USA FCC Part 15.407 10-1-20 Edition : Unlicensed National Information Infrastructure Devices. General technical requirements. USA FCC Part 15.209 10-1-20 Edition: Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 (April 2018). 558074 D01 15.247 Meas Guidance v05r02. Guidance for Compliance Measurements on Digital Transmission Systems, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under section §15.247 of the FCC Rules ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Domingo Galvez EMC&RF Lab Manager Digitally signed by Domingo Galvez DN: cn=Domingo Galvez, o=DEKRA Certification Inc., ou=Regulatory Lab, email=dgalvez@dekra.com, c=US Date: 2021.12.03 16:44:03 -05'00'
Date of issue	12-03-2021
Report template No	FDT08_23 (*) "Data provided by the client"

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Competences and guarantees

DEKRA Certification Inc. is a testing laboratory accredited by A2LA (The American Association for Laboratory Accreditation), to perform the tests indicated in the Certificate 2764.01

DEKRA Certification Inc. is a testing laboratory competent to carry out the tests described in this report.

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

DEKRA Certification Inc. 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 Certification at the time of performance of the test.

DEKRA Certification Inc. 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 Certification Inc.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Certification Inc. and the Accreditation Bodies.

Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Certification internal document PODT000.

Test case	Frequency (MHz)	U (k=2)	Units
Radiated Spurious Emission	30-180	4.27	dB
	180-1000	3.14	dB
	1000-18000	3.30	dB
	18000-40000	3.49	dB

Data provided by the client

Automotive Infotainment Head Unit.

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

Usage of samples

Samples used for 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
2874/54	Garmin MGU 22 beam forming mode sample	MGU22	GAG100L0000124	06/28/2021
2874/68	Garmin MGU 22 non-beam forming mode sample	MGU22	GAG100L0000166	09/07/2021
2874/15	Antenna with Fakra Connector	--	--	03/26/2021

Sample S/01 is composed of the following accessories:

Control Nº	Description	Model	Serial Nº	Date of reception
2874/06	Harness	--	--	03/26/2021
2874/07	Ant Wave Fakra 5G-GNSS	--	8705915-04	03/26/2021
3171/08	BMW Antenna-DA Fakra 5G-GNSS	--	6520 8705915-04	03/05/2021
2874/12	OABR Connector cable	--	--	03/26/2021

1. Sample S/01 was used for the following test(s): All Radiated tests indicated in appendix A.

Test sample description

Ports…….. :	Port name and description		Cable				
			Specified length [m]	Attached during test	Shielded		
	BT/Wi-fi Antenna		2	☒	☐		
	USB1/2/3		2	☒	☐		
	Power		2	☒	☐		
	CID		2	☒	☐		
	AR-Cam		2	☒	☐		
	100 Base T1/1G Base T1/GPS		2	☒	☐		
Supplementary information to the ports……:	No Data Provided						
Rated power supply ..... ……:	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐
	☐	AC:	☐	☐	☐	☐	☐
	☒	DC: 8V to 16V					
	☐	DC:					
Rated Power .....:	No Data Provided						
Clock frequencies.....:	No Data Provided						
Other parameters .....:	No Data Provided						
Software version .....:	STS 20w47.2-1-80.5						
Hardware version .....:	5.1.5						
Dimensions in cm (W x H x D) ....:	No Data Provided						
Mounting position .....:	☐	*Tabletop equipment*					
	☐	*Wall/Ceiling mounted equipment*					
	☐	*Floor standing equipment*					
	☐	*Hand-held equipment*					
	☒	Other: Vehicle / Automotive use					
Modules/parts.....:	Module/parts of test item		Type		Manufacturer		
	No Data Provided						

Accessories (not part of the test item) .....:	Description	Type	Manufacturer
	USB drives		
	APIX 3 Box		
	AR-CAM		
	OptoLan-Gb		
	OptoLan- BCM89811		
	OptoCAN		
Documents as provided by the applicant .....:	Description	File name	Issue date
	Declaration Equipment Data	FDT30_18 Declaration Equipment Data_updated	05/19/2021
	Compliance Testing Guide		03/26/2021
	Labtool User Guide	88W9098_88Q9098_Labtool_User_Guide_v1	03/26/2021
	MGU Cabling		03/26/2021
	Static IP Windows Setup		03/26/2021

Copy of marking plate:

Identification of the client

Garmin International, Inc.
1200 E. 151st Street,
Olathe, Kansas 66062, USA.

Testing period and place

Test Location	DEKRA Certification, Inc.
Date (start)	04-15-2021
Date (finish)	11-01-2021

Document history

Report number	Date	Description
3154ERM.011	11-24-2021	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. = 30 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

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

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 30 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 30 % Max. = 60 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

Remarks and comments

The tests have been performed by the technical personnel: Nasir Khan, Koji Nishimoto & Lourdes Maria Valverde

Testing verdicts

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

Summary

FCC PART 15 PARAGRAPH / RSS-247 (Bluetooth EDR)					
Section	**15.247 Spec Clause**	**RSS Spec Clause**	**Test Description**	**Verdict**	**Remark**
-	§ 2.1049 & § 15.247 (a) (1)	RSS-247 5.1 (b)	20dB Emission Bandwidth, Occupied Bandwidth & Carrier Frequency Separation	N/M	Refer 1
-	§ 15.247 (a) (1) (iii)	RSS-247 5.1 (d)	Number of hopping channels	N/M	Refer 1
-	§ 15.247 (a) (1) (iii)	RSS-247 5.1 (d)	Time of Occupancy (Dwell Time)	N/M	Refer 1
-	§ 15.247 (b) (3)	RSS-247 5.4 (b)	Maximum peak conducted output power and antenna gain	N/M	Refer 1
-	§ 15.247 (d)	RSS-247 5.5	Band-edge conducted emissions compliance (Transmitter)	N/M	Refer 1
-	§ 15.247 (d)	RSS-247 5.5	Emission limitations Conducted (Transmitter)	N/M	Refer 1
A.1	§ 15.247 (d)	RSS-247 5.5	Emission limitations Radiated (Transmitter)	P	N/A

Supplementary information and remarks:

1) Only multi-transmitter radiated spurious emission test was requested.

FCC PART 15 PARAGRAPH (WIFI 2.4GHz)					
Section	**15.247 Spec Clause**	**RSS Spec Clause**	**Test Description**	**Verdict**	**Remark**
-	§ 2.1049 & §15.247 (a) (2)	RSS-247 5.2 (a)	99% Occupied Bandwidth & 6dB Bandwidth	N/M	Refer 1
-	§ 15.247 (b)	RSS-247 5.4 (d)	Maximum Output Power and antenna gain	N/M	Refer 1
-	§ 15.247 (d)	RSS-247 5.5	Band-edge conducted emissions compliance (Transmitter)	N/M	Refer 1
-	§ 15.247 (e)	RSS-247 5.2 (b)	Power Spectral Density	N/M	Refer 1
-	§15.247(d)	RSS-247 5.5	Emission limitations Conducted (Transmitter)	N/M	Refer 1
A.1	§15.247 (d)	RSS-247 5.5	Emission limitations Radiated (Transmitter)	P	N/A
Supplementary information and remarks: 1) Only multi-transmitter radiated spurious emission test was requested.					

FCC PART 15 PARAGRAPH / RSS-247 (WIFI 5GHz) 5.725 GHz -5.825 GHz Band					
Report Section	**15.407 Spec Clause**	**RSS Spec Clause**	**Test Description**	**Verdict**	**Remark**
	§ 15.403 KDB 789033 D02	RSS 247 6.2.4	26dB Emission Bandwidth & Occupied Bandwidth	N/M	Refer 1
	§ 15.407 (e)	RSS 247 6.2.4.1	6dB Bandwidth	N/M	Refer 1
	§ 15.407 (a)(3)	RSS 247 6.2.4.1	Power Limits. Maximum Output Power	N/M	Refer 1
	§ 15.407 (a)(3)	RSS-247 6.2.4.1	Maximum Power Spectral Density	N/M	Refer 1
	§ 15.407 (b)(4)	RSS-247 6.2.4.2	Band-edge conducted emissions compliance (Transmitter)	N/M	Refer 1
	§ 15.407 (b)(6) § 15.207	RSS-Gen 8.8	Emission limitations Conducted (Transmitter)	N/M	Refer 1
A.1	§ 15.407 (b)(4),(7) § 15.209 § 15.205	RSS-247 6.2.4.2 RSS-Gen 8.9 & 8.10	Undesirable radiated emissions (Transmitter)	P	N/A
	§ 15.407 (g)	RSS-Gen 6.11 & 8.11	Frequency Stability	N/M	Refer 1
Supplementary information and remarks: 1) Only multi-transmitter radiated spurious emission test was requested.					

List of equipment used during the test

Radiated Measurements

CONTROL NUMBER	DESCRIPTION	MANUFACTURER	MODEL	LAST CALIBRATION	NEXT CALIBRATION
1179	Semi anechoic Absorber Lined Chamber	Frankonia	SAC 3 plus “L”	N/A	N/A
1065	Biconical Log antenna	ETS LINDGREN	3142E	2020/08	2023//08
1057	Double-ridge Waveguide Horn antenna 1-18 GHz	ETS LINDGREN	3115	2020/06	2023/06
1056	Double-ridge Waveguide Horn antenna 18-40 GHz	ETS LINDGREN	3116C	2020/01	2023/01
1039	Spectrum analyzer	Rohde & Schwarz	FSV40	2020/09	2022/09
1012	EMI TEST RECEIVER	Rohde & Schwarz	ESR 26	2019/12	2021/12
0982	RF pre-amplifier 18-40 GHz	Bonn Elektronik	BLMA 1840-1M	2020/11	2022/11
0981	RF pre-amplifier 1-18 GHz	Bonn Elektronik	BLMA 0118-2A	2020/11	2022/11
1111	ETHERNET SNMP THERMOMETER	HW GROUP	HWg-STE Plain	2020/08	2022/08

Appendix A: FCC Multi-transmitters Test Results

Appendix A Content

PRODUCT INFORMATION

Information	Description
Modulation	FHSS,DSSS and OFDM
Operation mode 1: Single Antenna Equipment	
- Operating Frequency Range	2402 – 2480 MHz 5150 – 5850 MHz
- Nominal Channel Bandwidth	20/40/80 MHz
- RF Output Power	Wi-Fi 2.4 GHz: 14 dBm Wi-Fi 5 GHz: 14 dBm
Extreme operating conditions	
- Temperature range	-40 ºC to +65 ºC
Antenna type	
Antenna gain	Wi-Fi 2.4 GHz: -2.5 dBi Wi-Fi 5 GHz: -2.8 dBi
Nominal Voltage	
- Supply Voltage	12 Vdc
- Type of power source	DC voltage
Equipment type	Bluetooth, Wi-Fi 2.4 GHz, and Wi-Fi 5 GHz
Geo-location capability	No

Description of Test Conditions

<table>
<tr><th>TEST CONDITIONS</th><th>DESCRIPTION</th></tr>
<tr><td>TC#01(1)</td><td>Power supply (V):
12 Vdc

Test Frequencies for Radiated tests:

<table>
<tr><th>Technology</th><th>Tested Frequency</th><th>BW</th><th>Modulation</th><th>Mode</th></tr>
<tr><td>Bluetooth</td><td>2480</td><td>20</td><td>FHSS</td><td>π/4-DQPSK</td></tr>
<tr><td>Wi-Fi 2.4 GHz MIMO</td><td>2437</td><td>40</td><td>OFDM</td><td>n mode</td></tr>
</table>
The test was performed with the equipment transmitting with Bluetooth and two Wi-Fi 2.4GHz radios simultaneously. These measurements have been performed in order to check the impact of the multi-transmitter of all radio interfaces that can be transmitting simultaneously.</td></tr>
<tr><td>TC#02(1)</td><td>Power supply (V):
12 Vdc

Test Frequencies for Radiated tests:

<table>
<tr><th>Technology</th><th>Tested Frequency</th><th>BW</th><th>Modulation</th><th>Mode</th></tr>
<tr><td>Bluetooth</td><td>2480</td><td>20</td><td>FHSS</td><td>π/4-DQPSK</td></tr>
<tr><td>Wi-Fi 5 GHz MIMO</td><td>5240</td><td>40</td><td>OFDM</td><td>ac mode</td></tr>
</table>
The test was performed with the equipment transmitting with Bluetooth and two Wi-Fi 5GHz radios simultaneously. These measurements have been performed in order to check the impact of the multi-transmitter of all radio interfaces that can be transmitting simultaneously.</td></tr>
</table>

Note (1): Preliminary scan was performed to determine the worst case between two SISO ports (2.4 GHz + 5 GHz) and MIMO (2.4 GHz or 5 GHz) ports. The following tables and plots show the results for the worst case in MIMO (2.4 GHz or 5 GHz) + BT.

A.1: RADIATED EMISSIONS (Multi-Transmitters)

LIMITS:	Product standard:	Part 15 Subpart C §15.247, Part 15 Subpart E §15.407 and RSS-247
	Test standard:	Part 15 Subpart C §15.247 (d), Part 15 Subpart E §15.407 (b) (1) & (4) and RSS-Gen 8.9 and 8.10

LIMITS

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 corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

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

TEST SETUP

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at 3 m for the frequency range 30-1000 MHz (Bilog antenna) and 1-18 GHz (Double ridge horn antenna, and at 1m for the frequency range 18-40 GHz (Double ridge horn antenna).

For radiated emissions in the range 18-40 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

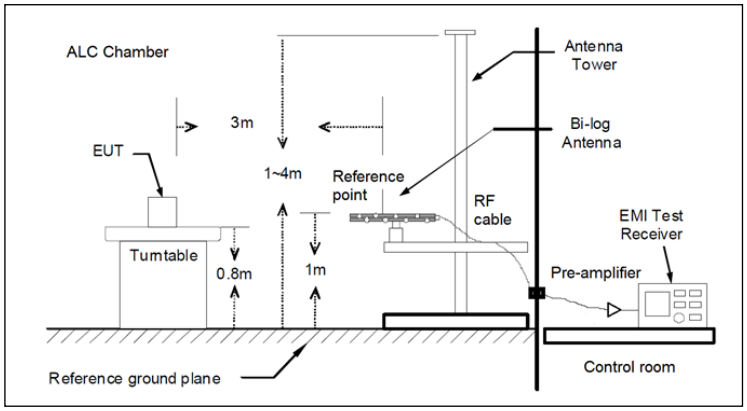
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

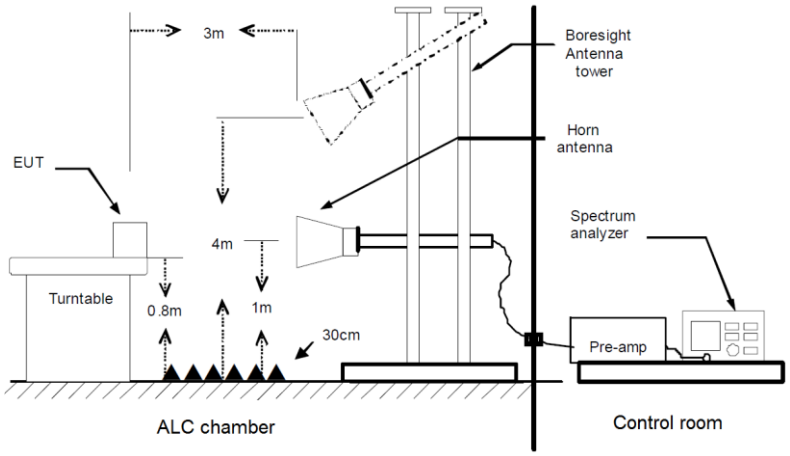
The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

TEST SETUP (CONT.)	

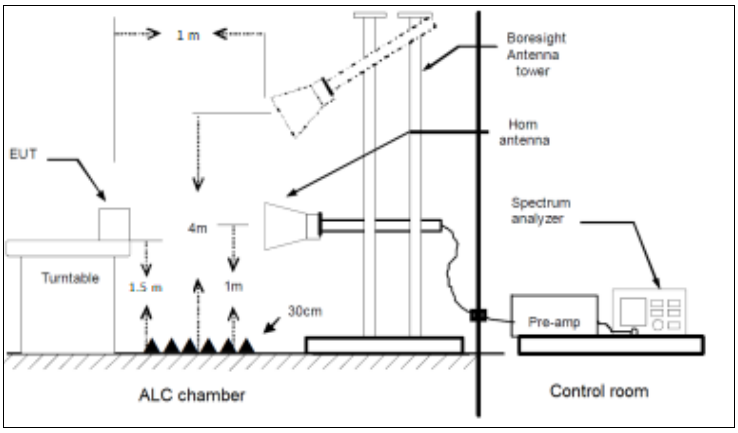
Radiated measurements Setup f < 1 GHz



Radiated measurements setup 1 GHz < f < 18 GHz



Radiated measurements setup f > 18 GHz

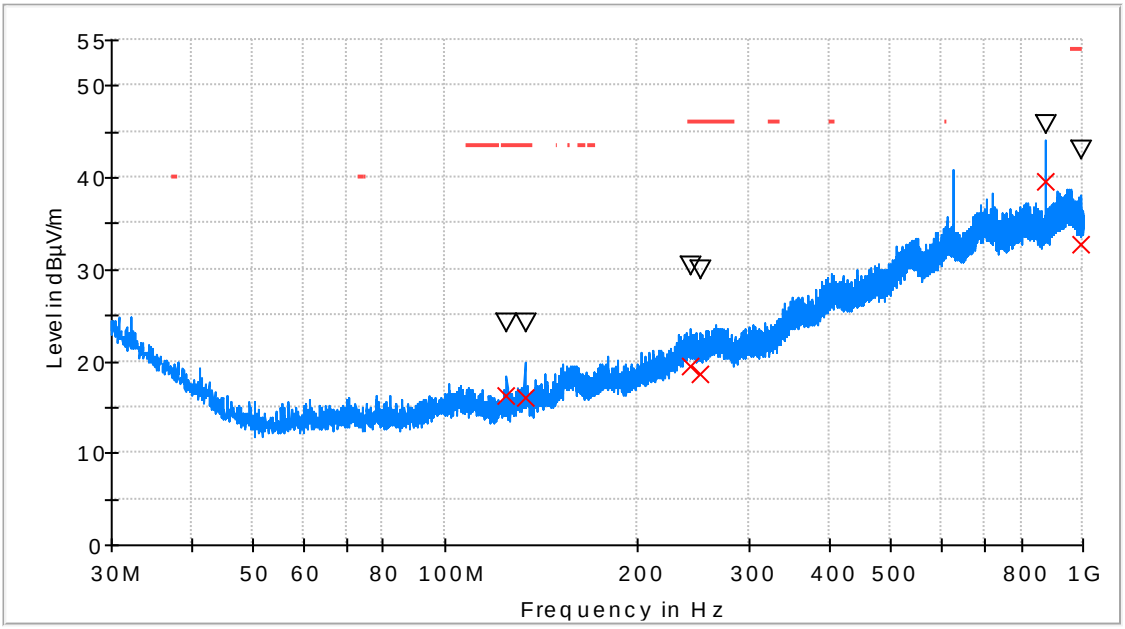


TESTED SAMPLES:	S/01
TESTED CONDITIONS MODES:	TC#01
TEST RESULTS:	PASS

Frequency range 30 MHz – 1000 MHz

The spurious emissions below 1 GHz do not depend on the operating channel and mode selected in the EUT.

RF_FCC_15.247_E Field_30MHz_1GHz

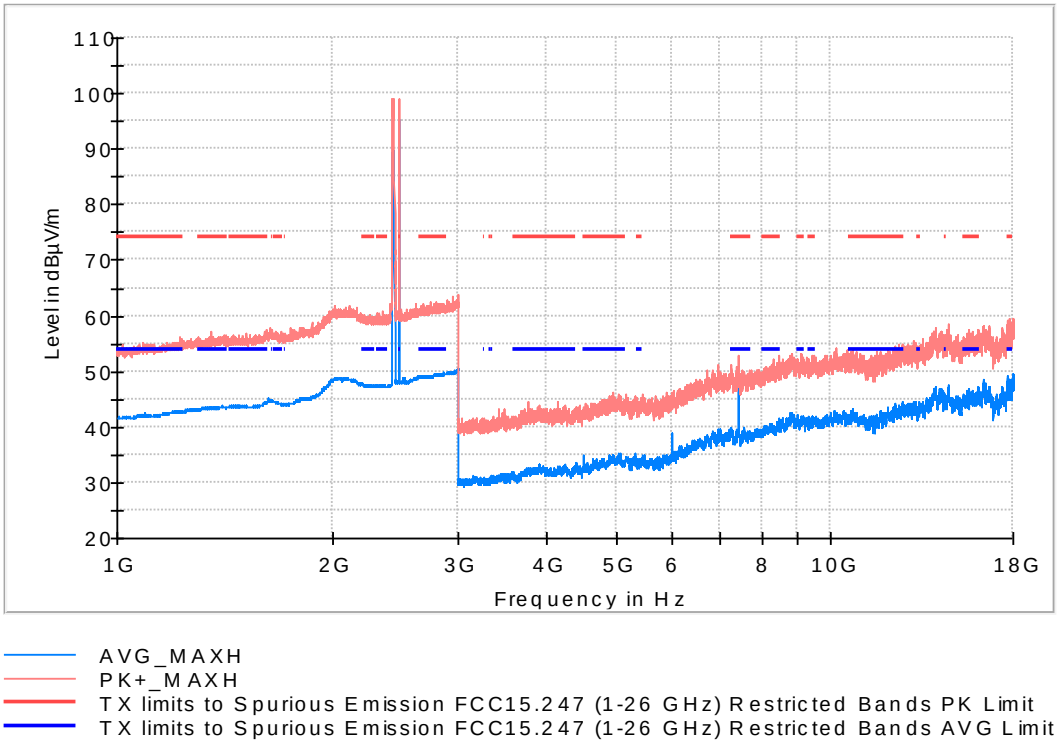


PK+_MAXH
TX limits to Spurious Emission FCC15.247 (30MHz to 1GHz) Restricted Bands QPK Lir
MaxPeak-PK+ (Single)
QuasiPeak-QPK (Single)

Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Pol	Margin - QPK (dB)	Limit - QPK (dBµV/m)
125.011500	24.1	16.2	V	27.4	43.5
133.305000	24.2	16.0	V	27.5	43.5
242.963500	30.5	19.5	V	26.5	46.0
251.790500	30.0	18.6	V	27.4	46.0
875.064000	45.8	39.7	H	---	---
993.452500	43.1	32.7	V	21.3	54.0

TEST RESULTS (Cont.):	

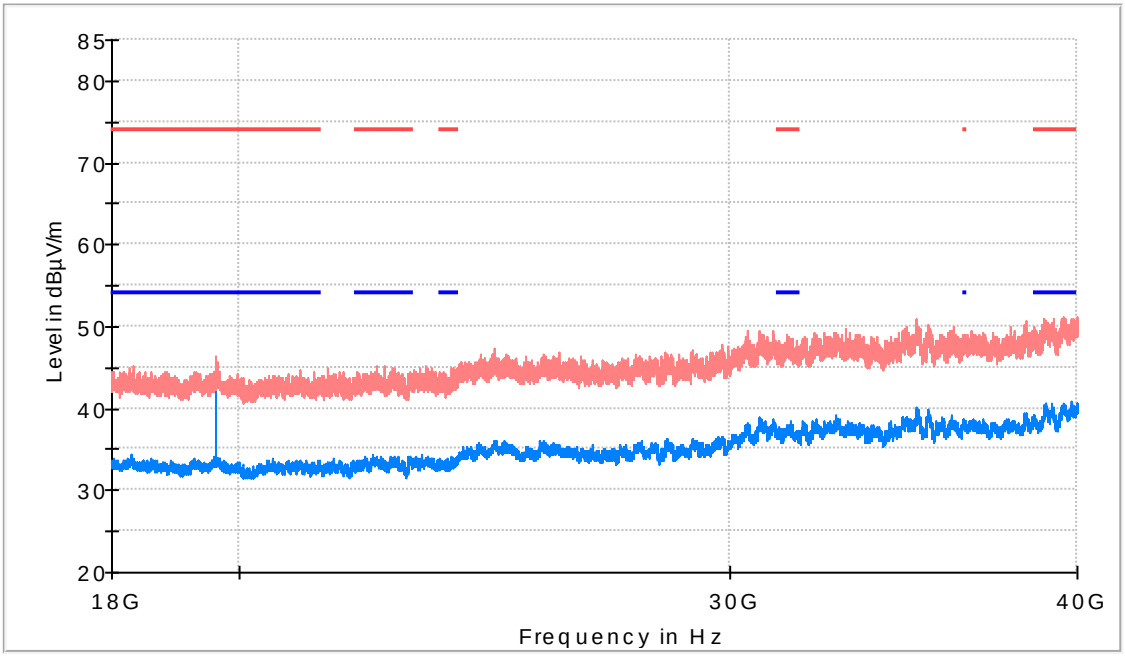
FREQUENCY RANGE: 1-18 GHz



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)	Comment
2445.000000	99.2	89.7	H	---	---	Wi-Fi Fundamental
2480.000000	98.9	95.5	H	---	---	BT Fundamental
7439.000000	52.2	44.2	H	9.8	54.0	

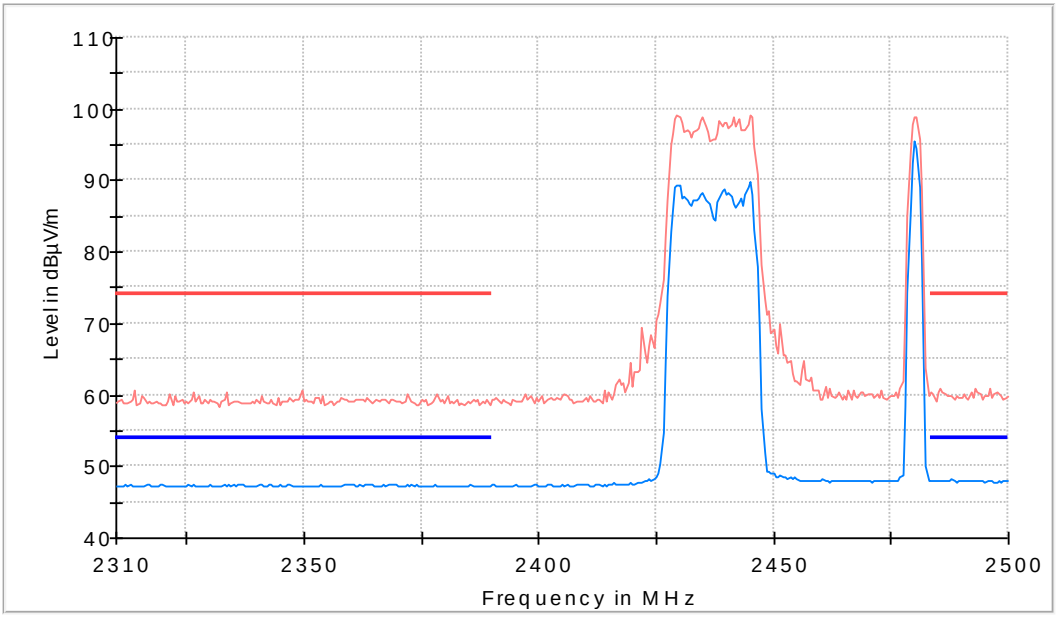
TEST RESULTS (Cont.):	

FREQUENCY RANGE: 18-40 GHz



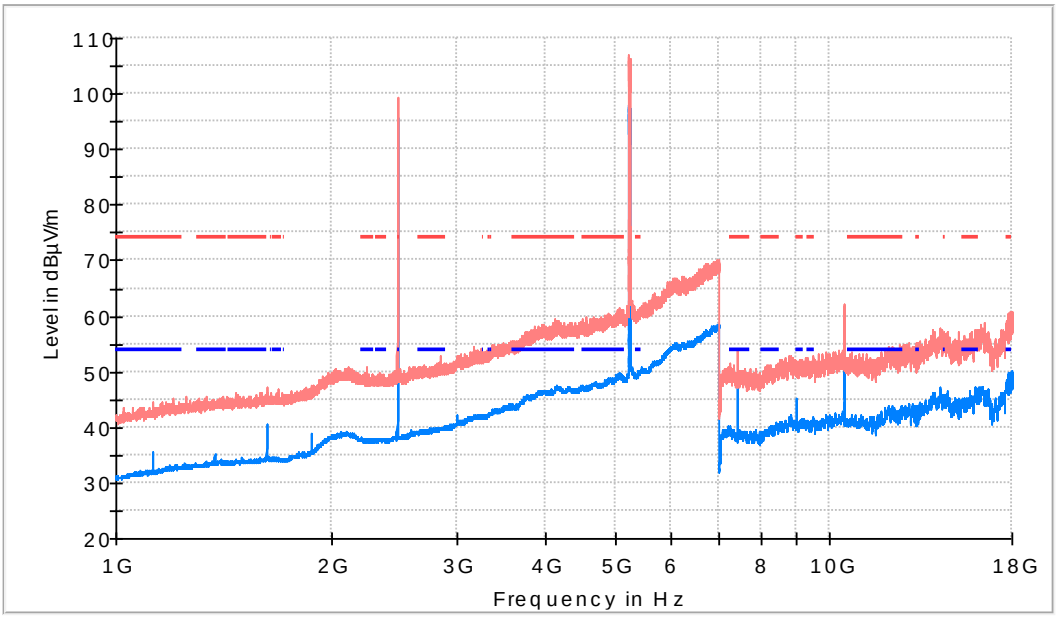
Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)
19615.625000	46.3	43.9	V	10.1	54.0
39837.062500	49.1	40.8	V	13.2	54.0

TEST RESULTS (Cont.):	Restricted bands (2.31 GHz – 2.5 GHz)



TESTED SAMPLES:	S/01
TESTED CONDITIONS MODES:	TC#02
TEST RESULTS:	PASS

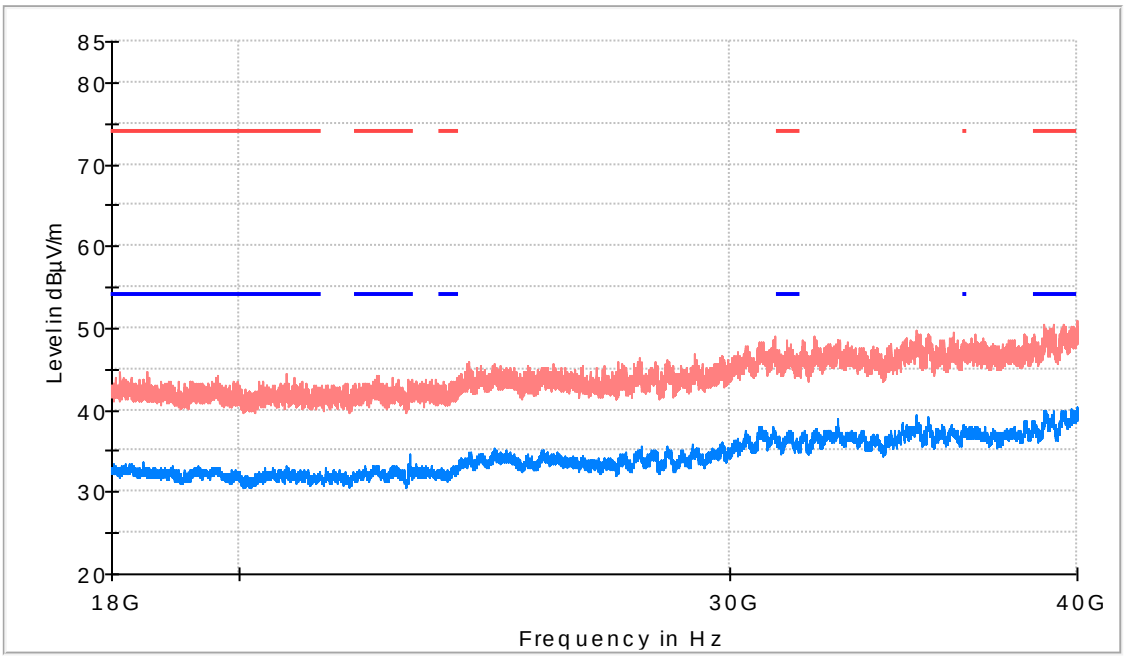
FREQUENCY RANGE: 1-18 GHz



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)	Comment
1625.000000	47.4	40.7	H	13.3	54.0	
2479.500000	99.1	95.3	H	---	---	BT Fundamental
5232.500000	107.1	96.7	H	---	---	Wi-Fi Fundamental
7440.000000	52.2	47.9	H	6.1	54.0	
10476.500000	62.1	47.5	V	---	---	

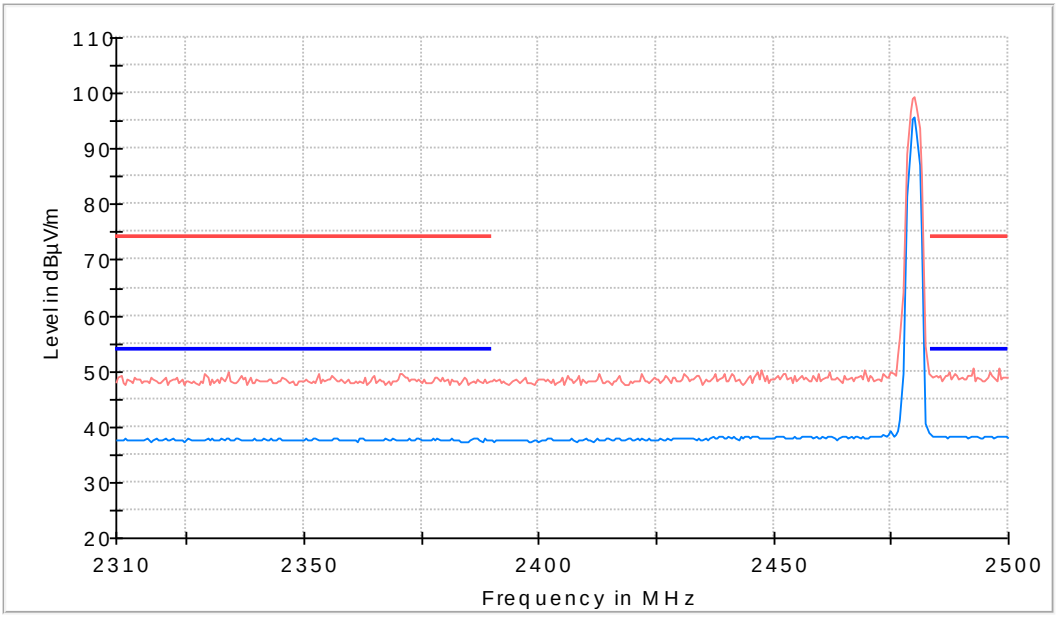
TEST RESULTS (Cont.):	

FREQUENCY RANGE: 18-40 GHz



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)
23019.437500	42.8	34.6	H	19.4	54.0
39998.625000	51.0	40.3	V	13.7	54.0

TEST RESULTS (Cont.):	Restricted bands (2.31 GHz – 2.5 GHz)



AVG_MAXH
PK+_MAXH
TX limits to Spurious Emission FCC15.407 (1GHz to 40 GHz) Restricted Bands PK Lim
TX limits to Spurious Emission FCC15.407 (1GHz to 40 GHz) Restricted Bands AVG Li