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United States of America

FCC LISTED, REGISTRATION NUMBER: 2764.01

ISED LISTED REGISTRATION NUMBER: 23595-1

Test Report No:
4180ERM.004

Partial Test Report

USA FCC Part 15.247, 15.209, & CANADA RSS-247, RSS-Gen

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices.

(*) Identification of item tested	Infotainment Head Unit
(*) Trademark	BMW
(*) Model and /or type reference	IDC23H
Other identification of the product	FCC ID: T8GIDC23H IC:6434A-IDC23H Hw version: 5.2.1 Sw version: 24-03-420
(*) Features	Bluetooth classic; BLE; Wi-Fi 2.4GHz; Wi-Fi 5GHz; GNSS
Manufacturer	HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH BECKER-GOERING-STR. 16 76307 KARLSBAD GERMANY
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 15.209 (10-1-20 Edition): Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 amendment 1 (March 2019). 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. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	See Appendix A & B
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 Manager, email=domingo.galvez@dekra.com, c=US
Date of issue	11-08-2023
Report template No	FDT08_23 (*) “Data provided by the client”

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Acronyms

Acronym ID	Acronym Description
	Emission Bandwidth
# of Tx Chains	Number of Transmission Chains
Equipment	Equipment Type
Freq	Frequency
In band Peak Lvl	In band Peak Level
Lvl	Level
MP	Measurement Point
Mod	Modulation
Occ Ch BW	Occupied Channel Bandwidth
PSD	Power Spectrum Density
Peak Power	Maximum Peak Conducted Output Power
Port	Active Port

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.

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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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General conditions

1. This report is only referred to the item that has undergone the test.
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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
RF Power and PSD	2402-2483	0.88	dB
Occupied Bandwidth		1.87	%
Dwell Time		0.01	%
Band Edge		0.64	dB
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

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 Infotainment Head Unit to be installed in vehicle with the main functionalities: Navigation, USB, voice recognition and several interfaces to the vehicle and Bluetooth / WLAN.

   The Head-unit provides different interfaces like: AR-CAM input, Video-out APIX3 (for the connection of an external Display), 3 USB interfaces.

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 undergoing test have been selected by: The client.

Sample S/01 is composed of the following elements:

Id	Control Number	Description	Model	Serial Nº	Date of Reception	Application
S/01	4180/02	Automotive infotainment head unit	IDC23H	HBB444P93HM9TG	8/28/2023	Element Under Test
S/01	4180/04	Harness	-	-	8/28/2023	Accessory
S/01	4180/06	Quad mate AXZ - High speed Fakra to SMA (male)	-	-	8/28/2023	Accessory
S/01	4180/10	BR-Adapter (Automotive converter Ethernet BroadR-Reach)	-	-	8/28/2023	Accessory
S/01	4180/12	Power Plug cable for BR-Adapter	-	-	8/28/2023	Accessory
S/01	4180/13	HSD (male) to OABR cable	-	-	8/28/2023	Accessory

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

Sample S/02 is composed of the following elements and accessories:

Id	Control Number	Description	Model	Serial Nº	Date of Reception	Application
S/02	4180/02	Automotive infotainment head unit	IDC23H	HBB444P93HM9TG	8/28/2023	Element Under Test
S/02	4180/04	Harness	-	-	8/28/2023	Accessory
S/02	4180/06	Quad mate AXZ - High speed Fakra to SMA (male)	-	-	8/28/2023	Accessory
S/02	4180/08	Antenna	1/4 wave coax	-	8/28/2023	Element Under Test
S/02	4180/10	BR-Adapter (Automotive converter Ethernet BroadR-Reach)	-	-	8/28/2023	Accessory
S/02	4180/12	Power Plug cable for BR-Adapter	-	-	8/28/2023	Accessory
S/02	4180/13	HSD (male) to OABR cable	-	-	8/28/2023	Accessory

Sample S/02 was used for the 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/DCS/HUD/DFE		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 .....:	24-03-420						
Hardware version.....:	5.2.1						
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: Automotive*					
Modules/parts .....:	Module/parts of test item		Type		Manufacturer		
	No Data Provided						
Accessories (not part of the test	Description		Type		Manufacturer		

item) .....:	No Data Provided		
Documents as provided by the applicant.....:	Description	File name	Issue date
	Declaration Equipment Data	FDT30_18 DeclaratEquipmData_HAR_IDC23H_HW5.2_2023-07-28	09/12/2023
Copy of marking plate:			
No Data Provided			

Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH
Becker-Goering-Str. 16
76307 Karlsbad
Germany

Testing period and place

Test Location	DEKRA Certification Inc.
Date (start)	08-30-2023
Date (finish)	10-12-2023

Document history

Report number	Date	Description
4180ERM.004	11-08-2023	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. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

Remarks and comments

The tests have been performed by the technical personnel: Juliana Cherry and Qi Zhang

List of equipment used during the test

Conducted Measurements

CONTROL NUMBER	DESCRIPTION	Serial No	LAST CALIBRATION	NEXT CALIBRATION
1039	Fsv40 Signal Analyzer 40GHz	101627	2022-11-01	2024-11-01
1041	SMB100A Signal Generator	180180	2022-10-06	2024-10-06
1042	SMBV100A Vector Signal Generator	262575	2022-03-16	2024-03-16
1107	Ethernet SNMP Thermometer	60038026952	2022-08-16	2024-10-18
1313	Wireless Measurement Software R&S WMS32	-	N/A	N/A

Radiated Measurements

CONTROL NUMBER	DESCRIPTION	Serial No	LAST CALIBRATION	NEXT CALIBRATION
878	Power supply (AMETEK / PROG-DC-PS)	1707A01783	N/A	N/A
1012	ESR26 Emi Test Receiver	101478	2022-04-12	2024-04-12
1014	FSV40 Signal Analyzer 40ghz	101626	2022-08-01	2024-08-01
1056	3116C Double-Ridged Waveguide Horn Antenna 18-40 GHz	213179	2023-02-23	2026-02-23
1058	3115 Double-Ridged Waveguide Horn Antenna 1-18 GHz	211373	2023-06-26	2026-06-26
1064	3142E Biconilog Antenna	208587	2021-12-13	2024-12-13
1108	Ethernet SNMP Thermometer- CR Room	60038026954	2022-10-18	2024-10-18
1111	Ethernet SNMP Thermometer	60038026577	2022-10-18	2024-10-18
1179	SEMI-ANECHOIC CHAMBER	F169021	N/A	N/A
1314	Wireless Measurement Software R&S Emc32	1040-OT102236	N/A	N/A
1461	Low Noise Preamplifier (1-18GHz)	2213857B	2022-06-01	2024-06-01

Testing verdicts

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

Summary

Bluetooth EDR

Requirement – Test case	FCC PART 15 PARAGRAPH / RSS-247	Verdict	Remark
RSS-247 5.1 (b) / FCC 15.247 (a) (1) 20 dB Bandwidth		N/M	Refer 2z
RSS-247 5.1 (b) / FCC 15.247 (a) (1) Carrier Frequency Separation		N/M	Refer 2
RSS-247 5.1 (d) / FCC 15.247 (a) (1) (iii) Time of Occupancy (Dwell Time)		N/M	Refer 2
RSS-247 5.1 (d) / FCC 15.247 (a) (1) (iii) Number of hopping channels		N/M	Refer 2
RSS-247 5.4 (b) / FCC 15.247 (b) (1) Maximum Peak Conducted output power & Antenna gain		P	N/A
RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter) - Conducted		N/M	Refer 2
FCC 2.1049 / 99dBw Occupied Channel Bandwidth 99%		N/M	Refer 2
RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Conducted		N/M	Refer 2
RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Radiated		P	Refer 1

Supplementary information and remarks:

1. The results show the worst case 8-DPSK modulation
2. Only Partial testing has been requested

Wi-Fi 2.4GHz

Requirement – Test case	FCC PART 15 PARAGRAPH / RSS-247	Verdict	Remark
RSS-247 5.2 (a) / FCC 15.247 (a) (2) 6 dB Bandwidth		N/M	Refer 2
RSS-247 5.2 (b) / FCC 15.247 (e) Power spectral density		N/M	Refer 2
RSS-247 5.4 (d) e.i.r.p		N/M	Refer 2
RSS-247 5.4 (d) / FCC 15.247 (b) (1) Maximum Average Conducted output Power		P	N/A
RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter) - Conducted		N/M	Refer 2
FCC 2.1049 / Occupied Channel Bandwidth 99%		P	Refer 2
RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Conducted		N/M	Refer 2
RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Radiated		P	Refer 1

Supplementary information and remarks:

1. The results show the worst case.
2. Only Partial testing has been requested.

Appendix A: Test results. Bluetooth Classic (BR & EDR)

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PRODUCT INFORMATION

Information	Description
Modulation	GFSK, π/4-DQPSK, 8-DPSK
Adaptive	Non-Adaptive Equipment
Operation mode 1:	
Operating Frequency Range	2400 – 2483.5 MHz
Nominal Channel Bandwidth	1 MHz
RF Output Power	4 dBm
Extreme operating conditions	-40 ºC to +65 ºC
- Temperature range	
Antenna type	1/4 wave coax
Antenna gain	-2.5 dBi
Nominal Voltage	
- Supply Voltage	12 Vdc
- Type of power source	DC voltage
Equipment type	Bluetooth Classic (BR & EDR)
Geo-location capability	Yes

TEST CONDITIONS

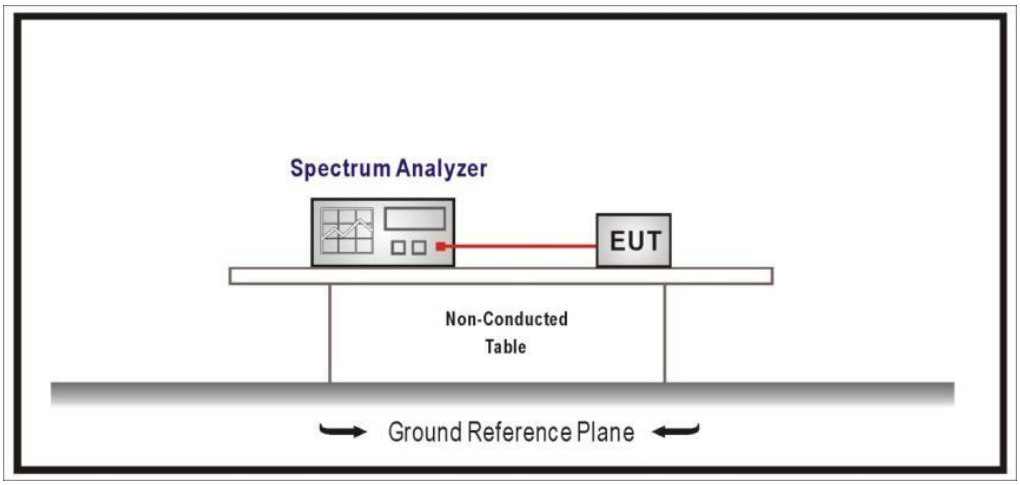
(*): Data provided by the client.

TEST CONDITIONS	DESCRIPTION
TC#01	Power supply (V): $V_{nominal}$ = 12 Vdc Modulation: GFSK Test Frequencies for conducted tests: Lowest range: 2402 MHz
TC#02	Power supply (V): $V_{nominal}$ = 12 Vdc Modulation: π/4-DQPSK Test Frequencies for Conducted tests: Lowest range: 2402 MHz
TC#03	Power supply (V): $V_{nominal}$ = 12 Vdc Modulation: 8-DPSK Test Frequencies for Conducted/Radiated tests: Lowest range: 2402 MHz

See the comparison table between previous test results (test report 3428ERM.009A4) and test results with the new sample shown in this test report below:

Modulation	Frequency (MHz)	Maximum conducted power (dBm)		Delta
		IDC23H - 3669 (test report 3669ERM.006A1)	IDC23H - 4180	
GFSK	2402	0.6	0.9	0.3
π/4-DQPSK	2402	2.7	2.9	0.2
8-DPSK	2402	2.9	3.2	0.3

CONDUCTED MEASUREMENTS:



RADIATED MEASUREMENTS:

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 1m for the frequency range 18 GHz- 26 GHz (Double ridge horn antenna).

For radiated emissions in the range 18 - 26 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.

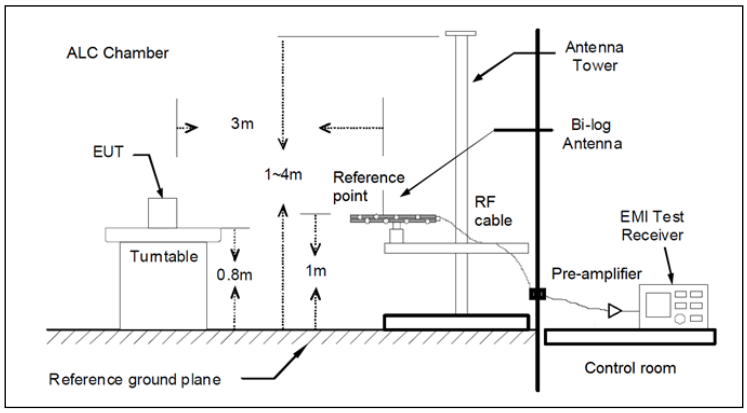


Fig A1: Radiated measurements Setup f < 1 GHz

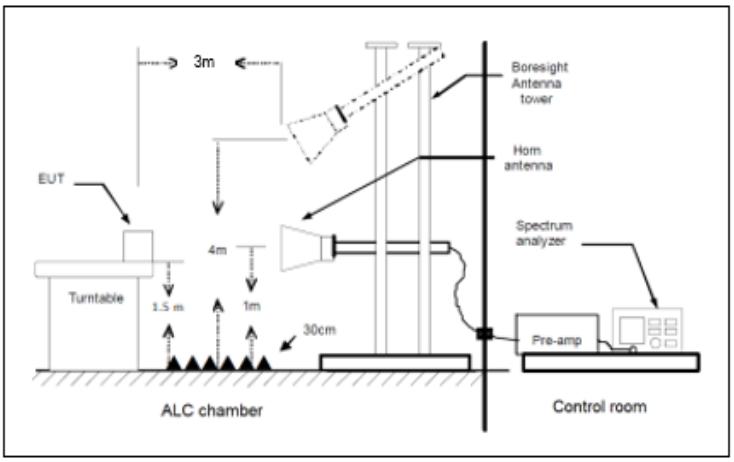


Fig A2: Radiated measurements setup f > 1-18 GHz

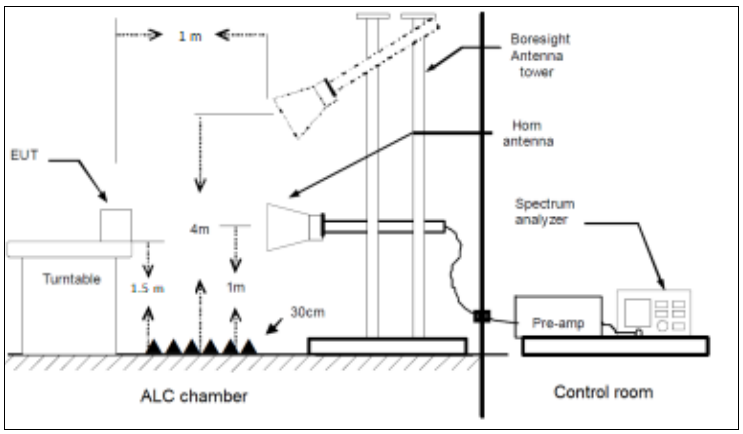


Fig A3: Radiated measurements setup f > 18 GHz

TEST CASE DETAILS

RSS-247 5.4 (b) / FCC 15.247 (b) (1) Maximum Peak Conducted & Antenna gain

Limits

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels: 1 watt (30 dBm). The e.i.r.p. shall not exceed 4 W (RSS-247).

Maximum declared antenna gain: -2.5 dBi

Modulation: BT (GFSK 1-DH5)
Results

Freq (MHz)	# of Tx Chains	Port	Peak Power (dBm)	Maximum EIRP power (dBm)
2402.00000	1	1	0.9	-1.6

Modulation: BT (π/4 DQPSK 2-DH5)
Results

Freq (MHz)	# of Tx Chains	Port	Peak Power (dBm)	Maximum EIRP power (dBm)
2402.00000	1	1	2.9	0.4

Modulation: BT (8DPSK 3-DH5)
Results

Freq (MHz)	# of Tx Chains	Port	Peak Power (dBm)	Maximum EIRP power (dBm)
2402.00000	1	1	3.2	0.7

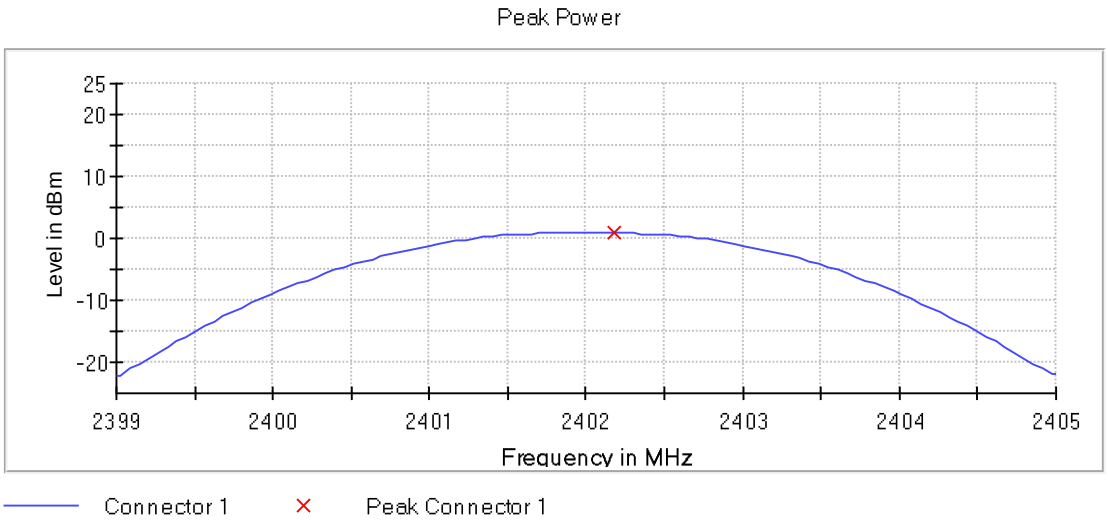
Verdict

Pass

Attachments

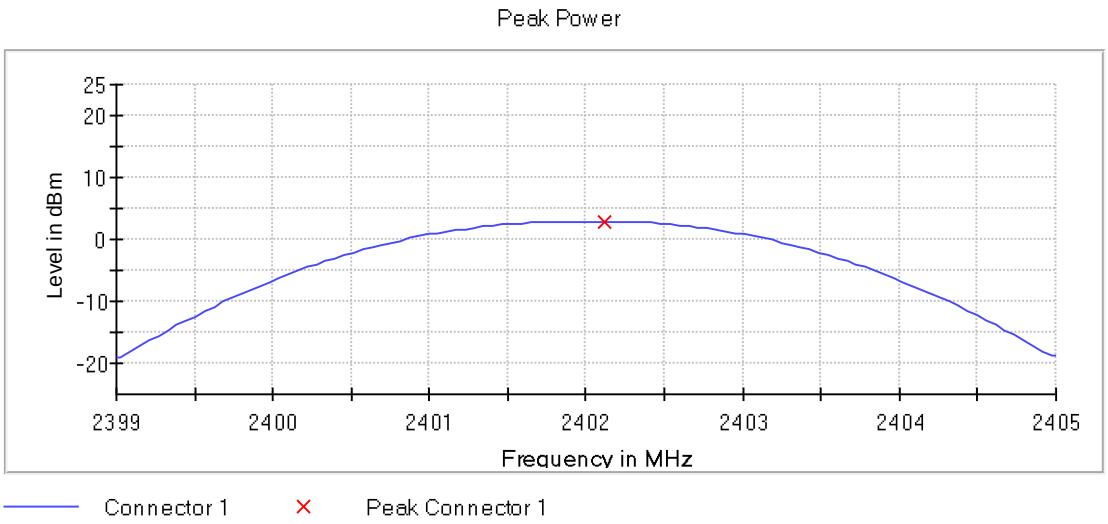
Frequency MHz = 2402.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS), Modulation = BT (GFSK 1-DH5), Number of Transmission Chains = 1,

Images:



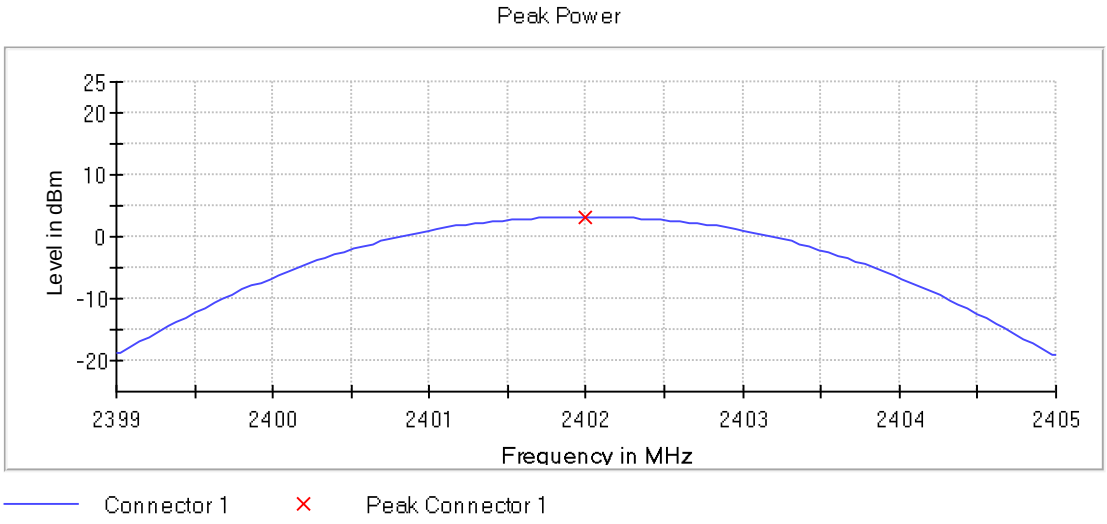
Frequency MHz = 2402.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS), Modulation = BT (π/4 DQPSK 2-DH5), Number of Transmission Chains = 1,

Images:



Frequency MHz = 2402.00000, Equipment Type = Frequency Hopping Spread Spectrum systems (DSS), Modulation = BT (8DPSK 3-DH5), Number of Transmission Chains = 1,

Images:



RSS-247 5.5 / FCC 15.247 (d) EMISSION LIMITATIONS RADIATED (TRANSMITTER) - Radiated

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

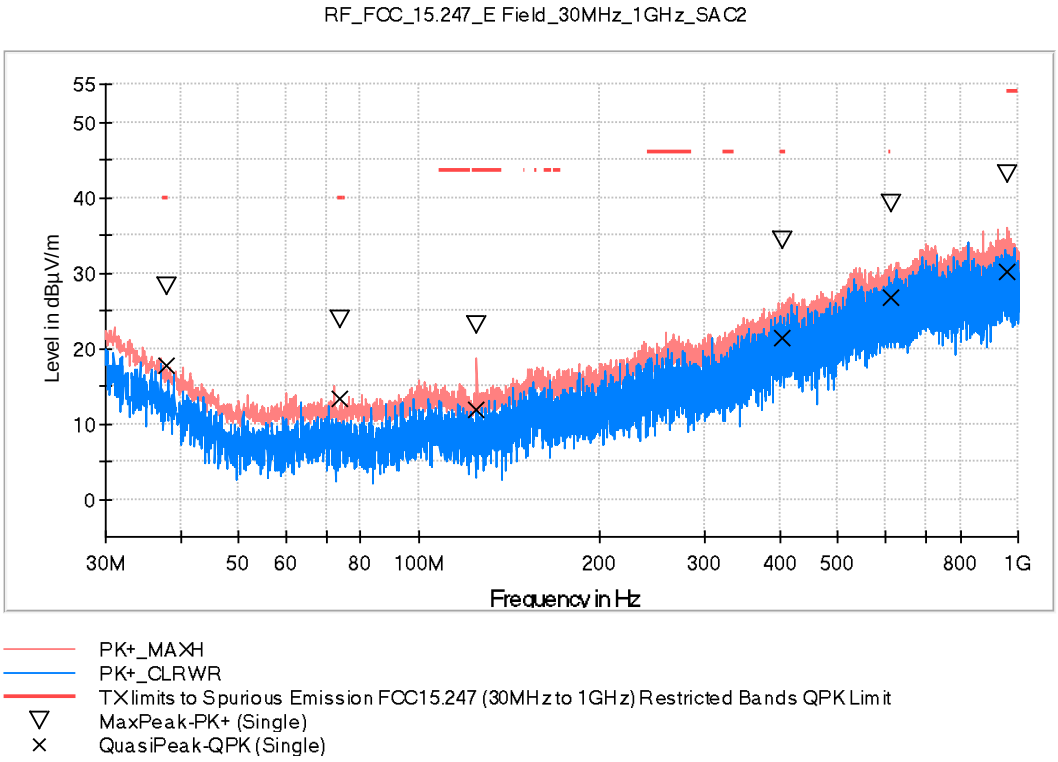
Verdict

Pass

Results

Frequency range 30 MHz – 1000 MHz

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



Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Pol	Margin - QPK (dB)	Limit - QPK (dBµV/m)
37.905500	28.2	17.6	H	22.4	40.0
73.747000	23.8	13.4	V	26.6	40.0
124.963000	23.0	11.8	V	31.8	43.5
404.226000	34.2	21.5	H	24.6	46.0
613.552000	39.2	26.6	V	19.4	46.0
960.909000	43.0	30.0	H	24.0	54.0

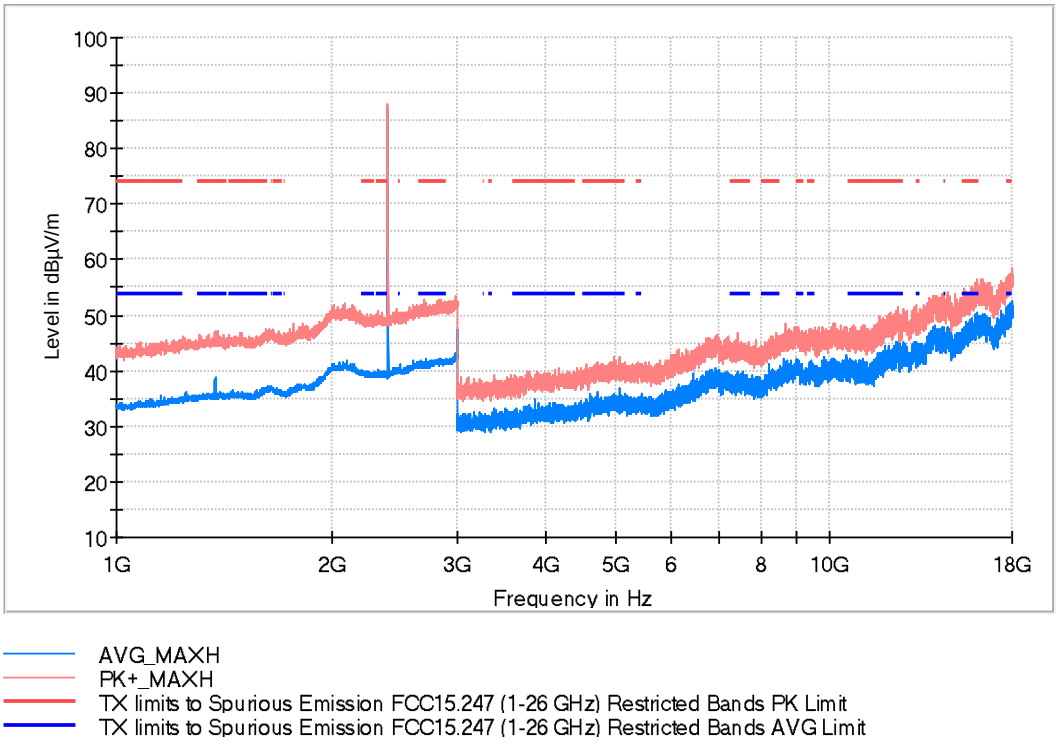
Frequency range 1 GHz – 26 GHz

The results in the following plots and tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.5 GHz.

Modulation: BT (8DPSK)

Frequency range 1 - 18 GHz

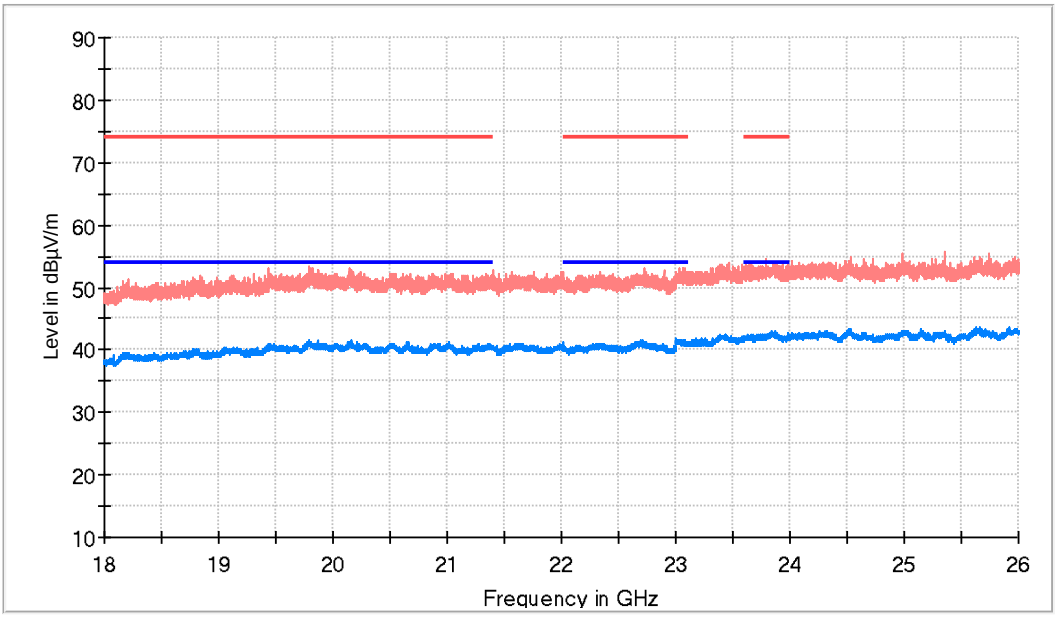
Lowest Channel



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)	Comment
1375.000000	47.3	38.9	V	15.1	54.0	
2402.500000	88.0	85.9	H	---	---	Fundamental
17958.00000	57.1	52.6	H	1.4	54.0	

Frequency range 18 - 26 GHz

Lowest Channel

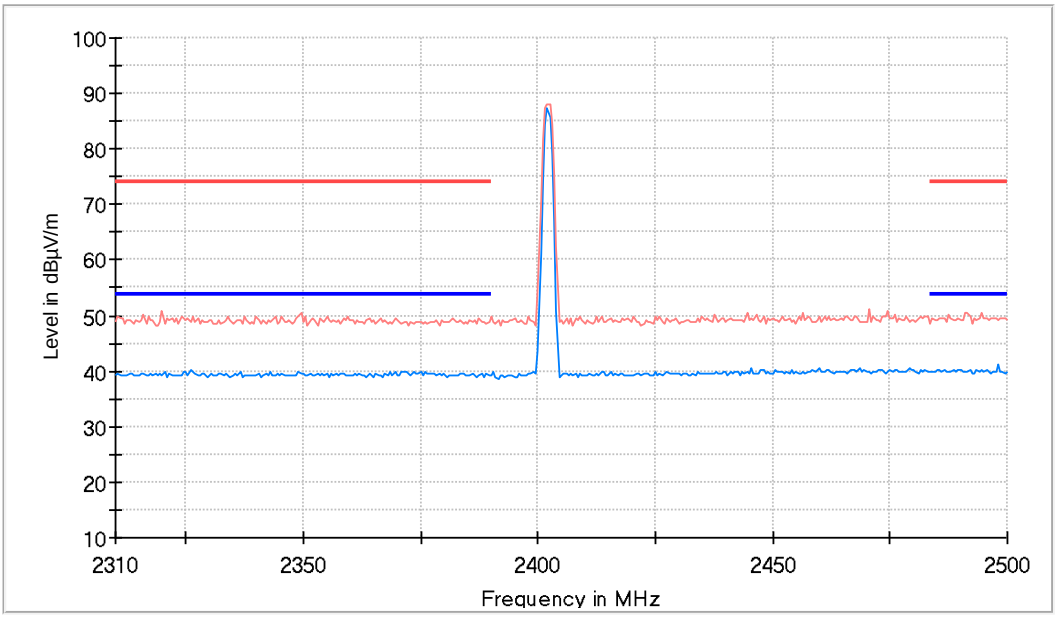


AVG_MAXH
PK+_MAXH
TX limits to Spurious Emission FCC15.247 (1-26 GHz) Restricted Bands PK Limit
TX limits to Spurious Emission FCC15.247 (1-26 GHz) Restricted Bands AVG Limit

Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)
19795.000000	53.2	41.2		12.8	54.0
23068.000000	53.2	41.0		13.0	54.0
23784.500000	54.7	42.1		11.9	54.0

Restricted Bands (2.31 GHz - 2.5 GHz)

Lowest Channel



AVG_MAXH
PK+_MAXH
TX limits to Spurious Emission FCC15.247 (1-26 GHz) Restricted Bands PK Limit
TX limits to Spurious Emission FCC15.247 (1-26 GHz) Restricted Bands AVG Limit

Measurements

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	48.5 kHz	PK+	100 kHz	1 s	20 dB
1 GHz - 3 GHz	500 kHz	PK+ ; AVG	1 MHz	0.1 s	20 dB
3 GHz - 18 GHz	500 kHz	PK+ ; AVG	1 MHz	0.1 s	20 dB
18 GHz - 26 GHz	500 kHz	PK+ ; AVG	1 MHz	1 s	20 dB

Appendix B: Test results. Wi-Fi 2.4GHz

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PRODUCT INFORMATION

Information	Description
Modulation	DSSS, OFDM, MIMO-OFDM
Maximum RF Output Power	13 dBm
Operation mode	
- Operating Frequency Range	2400 – 2483.5 MHz
- Nominal Channel Bandwidth	20 MHz 40 MHz
Extreme operating conditions	
- Temperature range	-40 ºC to +65 ºC
Antenna type	1/4 wave coax
Antenna gain	-2.5 dBi
Nominal Voltage	
- Supply Voltage	12 Vdc
- Type of power source	DC voltage
Equipment type	Wi-Fi 2.4 GHz b/g/n/ax
Geo-location capability	No

TEST CONDITIONS

TEST CONDITIONS	DESCRIPTION
TC#01(1) **(b mode)**	Power supply (V): $V_{nominal}$ = 12 Vdc Channel Bandwidth: 20 MHz Test Frequencies for Conducted/Radiated tests (**Radio B & Radio A MIMO**): Middle channel: 2437 MHz
TC#02(1) **(g mode)**	Power supply (V): $V_{nominal}$ = 12 Vdc Channel Bandwidth: 20 MHz Test Frequencies for Conducted/Radiated tests (**Radio B & Radio A MIMO**): Middle channel: 2437 MHz
TC#03(1) **(n mode)**	Power supply (V): $V_{nominal}$ = 12 Vdc Channel Bandwidth: 20 MHz Test Frequencies for Conducted/Radiated tests (**Radio A + B MIMO**): Middle channel: 2437 MHz Channel Bandwidth: 40 MHz Test Frequencies for Conducted/Radiated tests (**Radio A + B MIMO**): Lowest channel: 2422 MHz

TEST CONDITIONS	DESCRIPTION
TC#04(1) **(ax mode non-beam forming)**	Power supply (V): $V_{nominal}$ = 12 Vdc Channel Bandwidth: 20 MHz Test Frequencies for Conducted/Radiated tests (**Radio A + B MIMO**): Middle channel: 2437 MHz Channel Bandwidth: 40 MHz Test Frequencies for Conducted/Radiated tests (**Radio A + B MIMO**): Middle channel: 2437 MHz

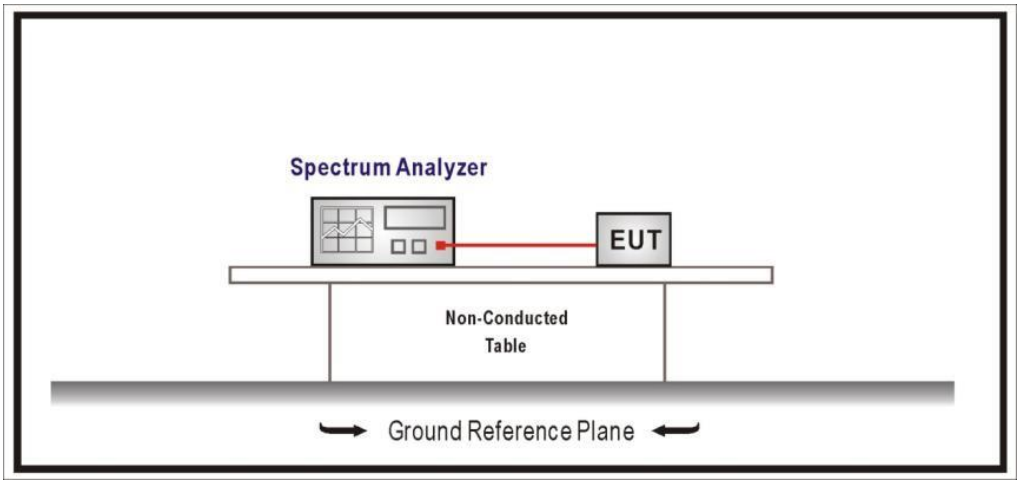
Note (1): For spurious emissions for OFDM modes 802.11g, 802.11n20 and 802.11ax20 a preliminary scan was performed to determine the worst case. The following tables and plots show the results for the worst case in DSSS modulation (802.11b) and OFDM modulation (802.11g).

The data rates of 11Mb/s for 802.11b, 54Mb/s for 802.11g, MCS7 for 802.11n20, 802.11 ax were selected based on preliminary testing that identified those rates corresponding to the worst cases.

See below the comparison table between previous test results (test report 3669ERM.006A1 and test results with the new sample shown in this test report:

Bandwidth (MHz)	Mode	Frequency (MHz)	Maximum conducted power (dBm)		Delta
			IDC23H - 3669 (test report3669ERM.006A1)	IDC23H - 4180	
20	b	2437	14.4	15.6	1.2
	g	2437	9.1	9.9	0.9
	n	2437	9.3	10.5	1.2
	ax	2437	12.6	12.9	0.3
40	n	2422	9.8	10.8	1.0
	ax	2437	12.0	12.0	0.0

CONDUCTED MEASUREMENTS:



RADIATED MEASUREMENTS:

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 1m for the frequency range 18 GHz- 26 GHz (Double ridge horn antenna).

For radiated emissions in the range 18 - 26 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.

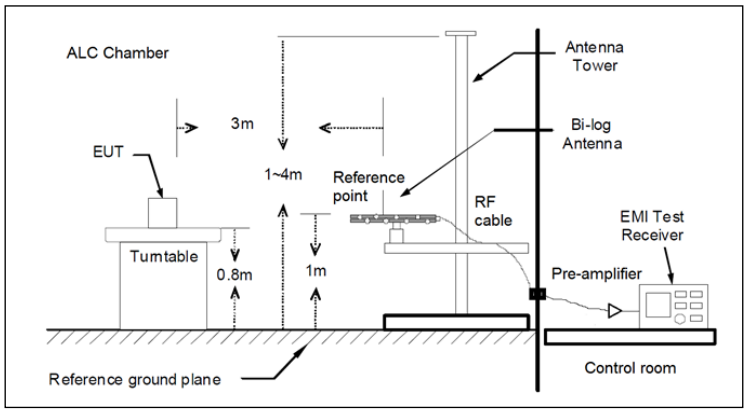


Fig A1: Radiated measurements Setup f < 1 GHz

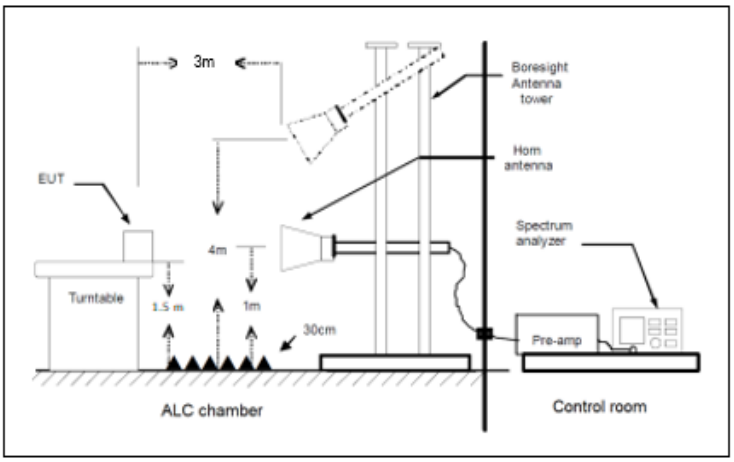


Fig A2: Radiated measurements setup f > 1-18 GHz

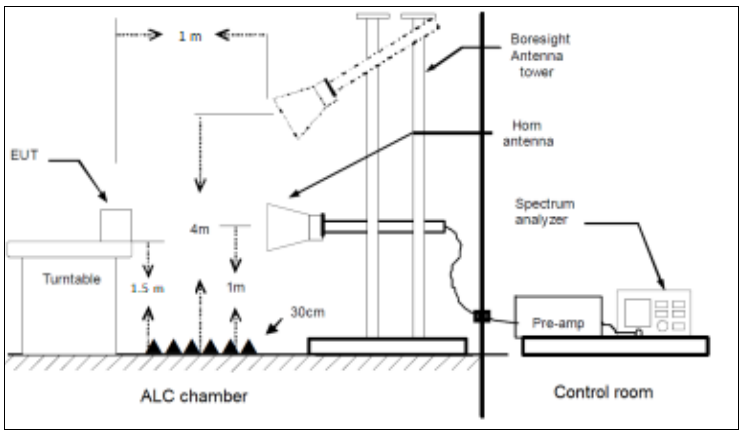


Fig A3: Radiated measurements setup f > 18 GHz

TEST CASES DETAILS

RSS-247 5.4 (a) / FCC 15.247 (b) (1) Maximum Average Conducted Output Power

Limits

For systems using digital modulation in the 2400 -2483.5 MHz band: 1 watt (30 dBm).

The e.i.r.p. shall not exceed 4 W (36 dBm) (RSS-247).

Results

Antenna gain: -2.5 dBi

Modulation: 802.11b

Freq (MHz)	BW (MHz)	E.I.R.P. (dBm)
2437.00000	20	13.1

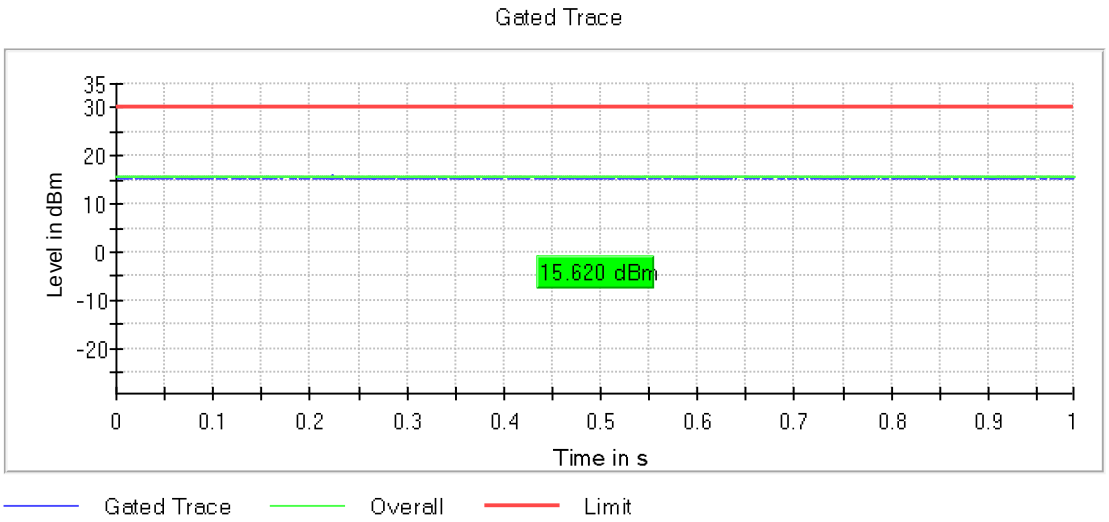
Verdict

Pass

Attachments

Frequency MHz = 2437.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 1, Modulation = 802.11b , Number of Transmission Chains = 2,

Images:



Antenna gain: -2.5 dBi

Modulation: 802.11g
Results

Freq (MHz)	BW (MHz)	E.I.R.P. (dBm)
2437.00000	20	7.4

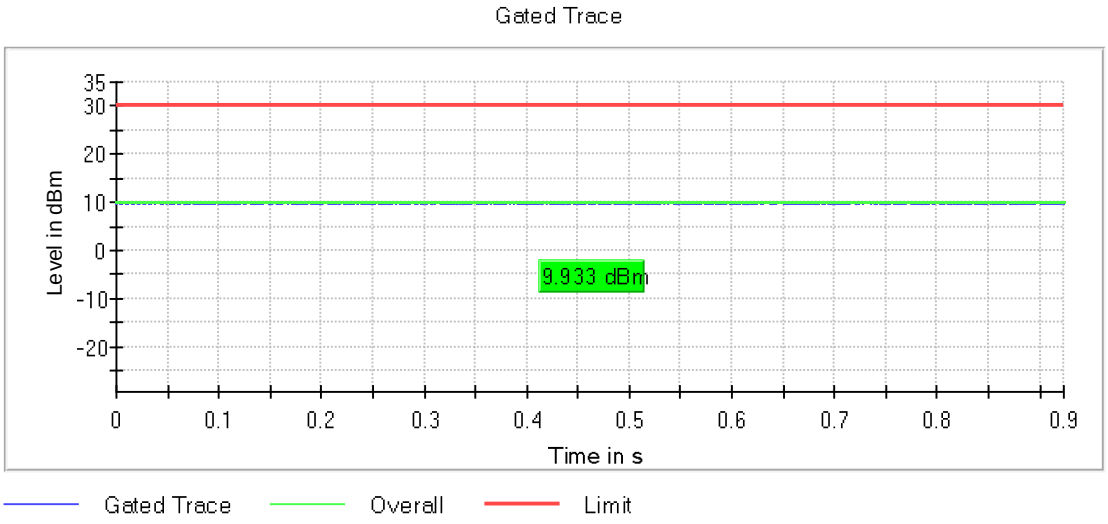
Verdict

Pass

Attachments

Frequency MHz = 2437.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 1, Modulation = 802.11g, Number of Transmission Chains = 2,

Images:



Antenna gain: -2.5 dBi

Modulation: 802.11n20
Results

Freq (MHz)	BW (MHz)	E.I.R.P. (dBm)
2437.00000	20	8.0

Modulation: 802.11n40
Results

Freq (MHz)	BW (MHz)	E.I.R.P. (dBm)
2422.00000	40	8.3

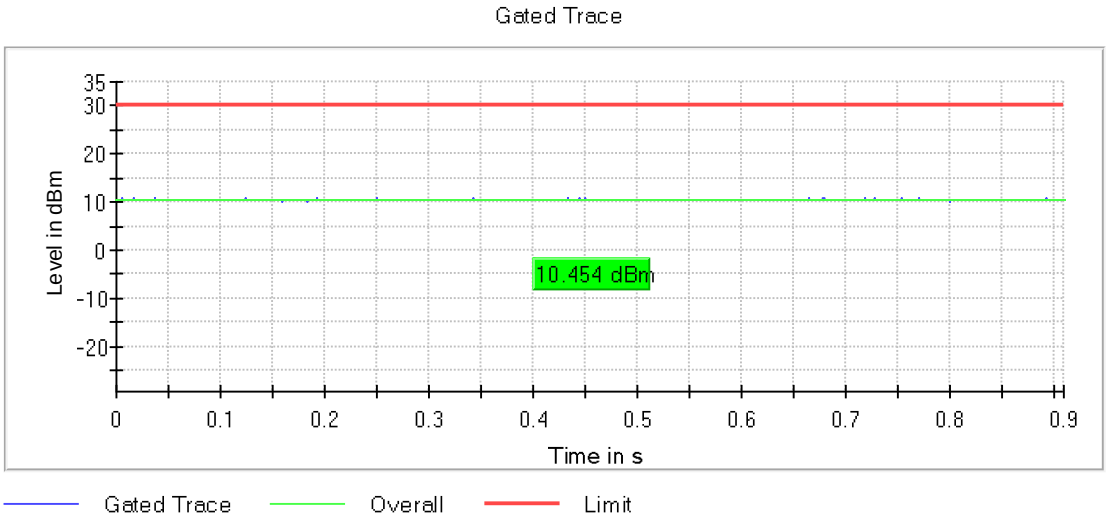
Verdict

Pass

Attachments

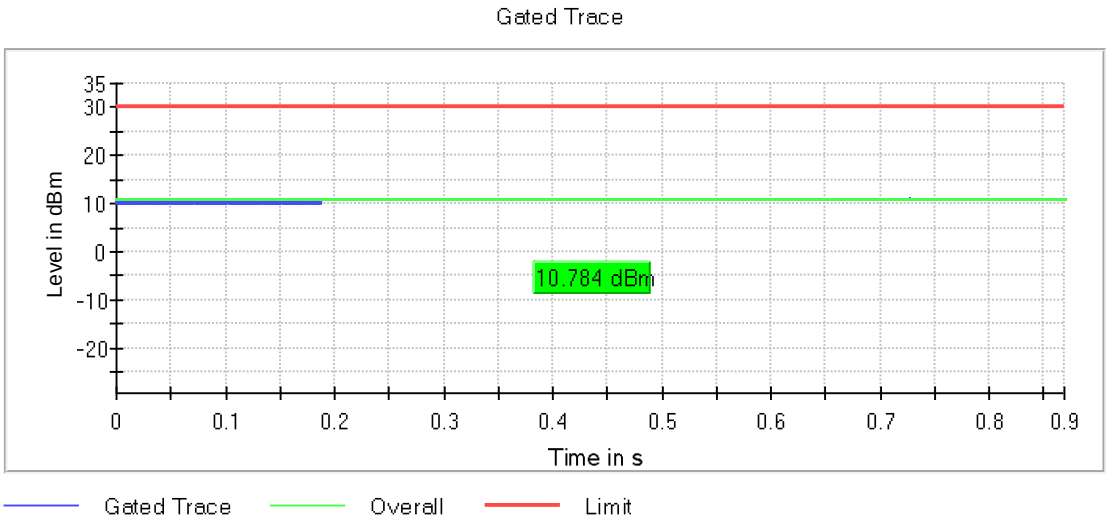
Frequency MHz = 2437.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 1, Modulation = 802.11n , Number of Transmission Chains = 2,

Images:



Frequency MHz = 2422.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 1, Modulation = 802.11n , Number of Transmission Chains = 2,

Images:



Antenna gain: -2.5 dBi

Modulation: 802.11ax HE20
Results

Freq (MHz)	BW (MHz)	E.I.R.P. (dBm)
2437.00000	20	10.4

Modulation: 802.11ax HE40
Results

Freq (MHz)	BW (MHz)	E.I.R.P. (dBm)
2437.00000	40	9.5

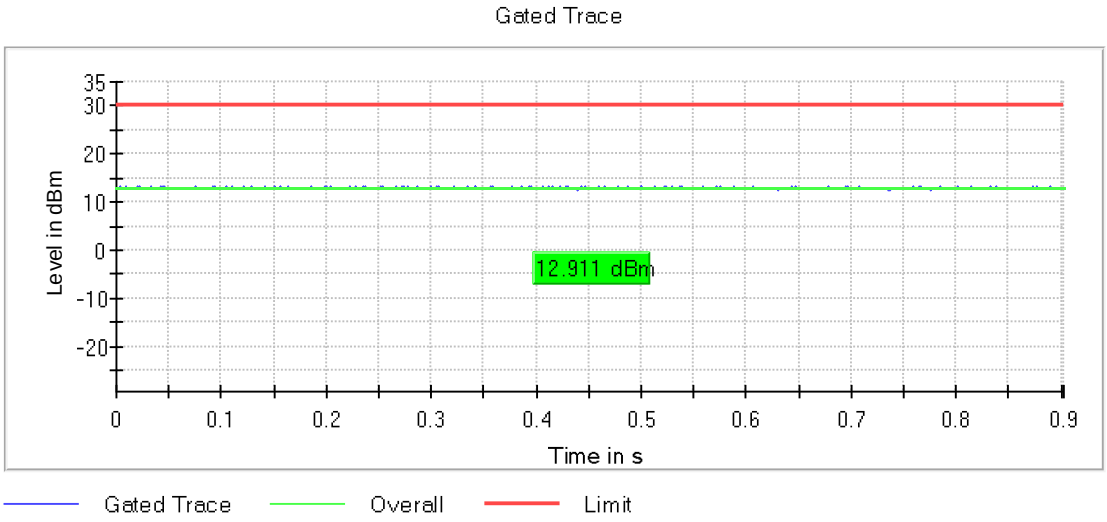
Verdict

Pass

Attachments

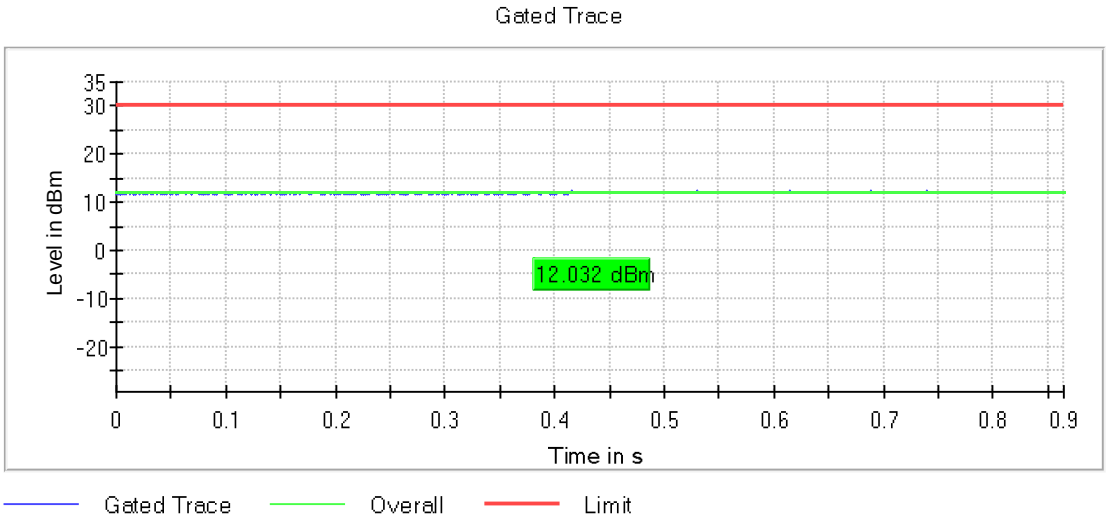
Frequency MHz = 2412.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 1, Modulation = 802.11ax HE SS1 MCS 8 (OFDM MCS8), Number of Transmission Chains = 2,

Images:



Frequency MHz = 2437.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 40, Modulation = 802.11ax HE SS1 MCS 8, Number of Transmission Chains = 2,

Images:



OSP PowerMeter settings

Setting	Instrument Value	Target Value
Measurement Time	**1.000 s**	**1.000 s**
Points	**1000000**	**1000000**
Time resolution	**1.000 µs**	**1.000 µs**

FCC 2.1049 / 99dBw Occupied Channel Bandwidth 99%

Limits

Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands.

Modulation: 802.11b

Results

Freq (MHz)	BW (MHz)	Occ Ch BW (MHz)
2437.00000	20	13.400

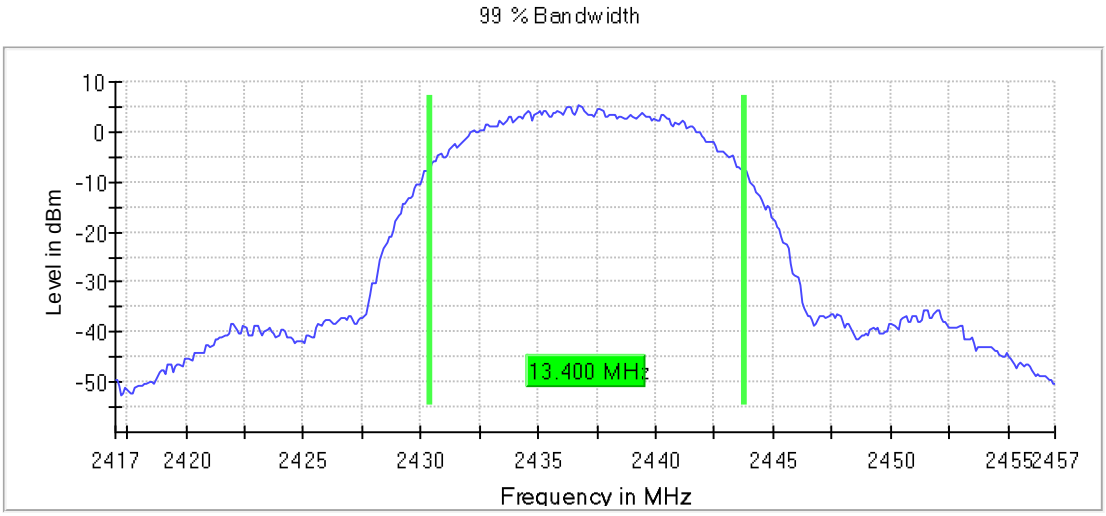
Verdict

Pass

Attachments

Frequency MHz = 2412.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 20, Modulation = 802.11b , Number of Transmission Chains = 1

Images:



Modulation: 802.11g
Results

Freq (MHz)	BW (MHz)	Occ Ch BW (MHz)
2437.00000	20	16.500

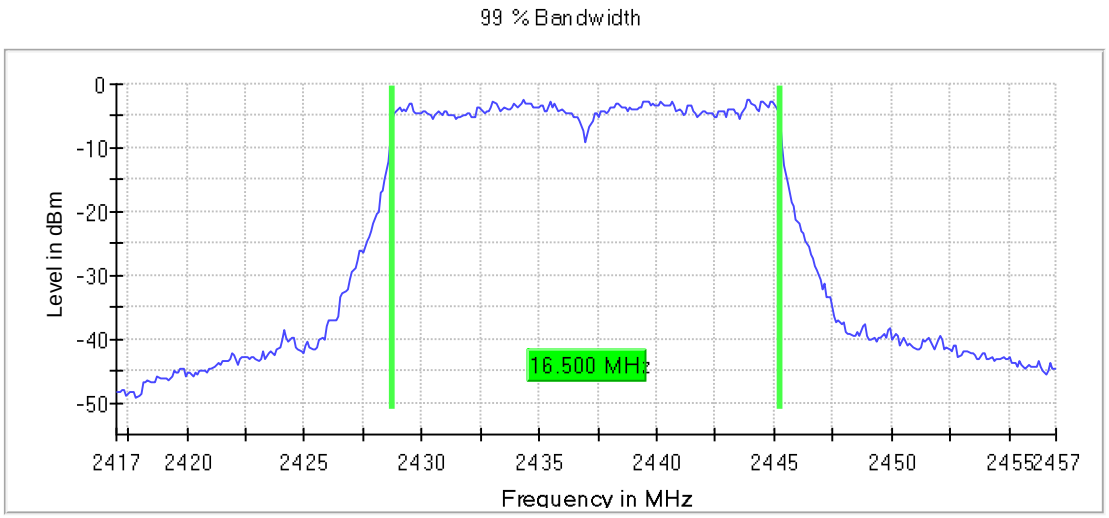
Verdict

Pass

Attachments

Frequency MHz = 2437.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 20, Modulation = 802.11g , Number of Transmission Chains = 2,

Images:



Modulation: 802.11n20
Results

Freq (MHz)	BW (MHz)	Occ Ch BW (MHz)
2437.00000	20	17.700

Modulation: 802.11n40
Results

Freq (MHz)	BW (MHz)	Occ Ch BW (MHz)
2422.00000	40	36.250

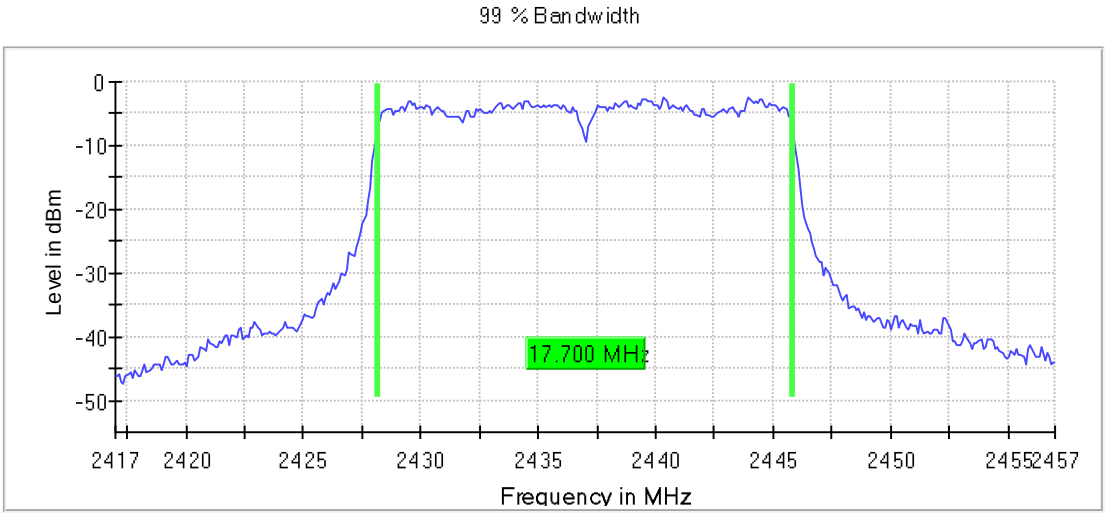
Verdict

Pass

Attachments

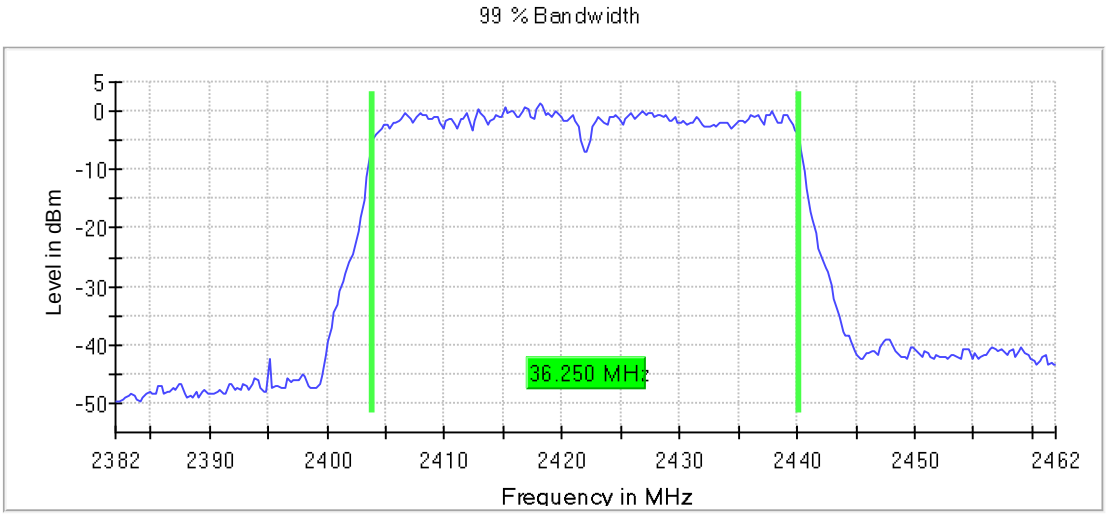
Frequency MHz = 2437.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 20, Modulation = 802.11n , Number of Transmission Chains = 2,

Images:



Frequency MHz = 2422.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 40, Modulation = 802.11n , Number of Transmission Chains = 2,

Images:



Modulation: 802.11ax HE20
Results

Freq (MHz)	BW (MHz)	Occ Ch BW (MHz)
2437.00000	20	18.900

Modulation: 802. 11ax HE40
Results

Freq (MHz)	BW (MHz)	Occ Ch BW (MHz)
2437.00000	40	37.750

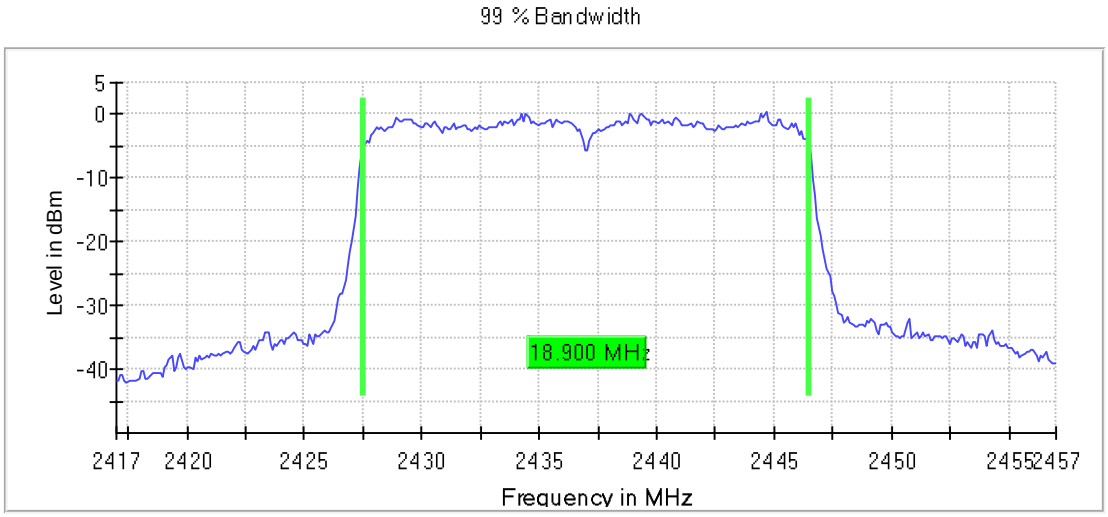
Verdict

Pass

Attachments

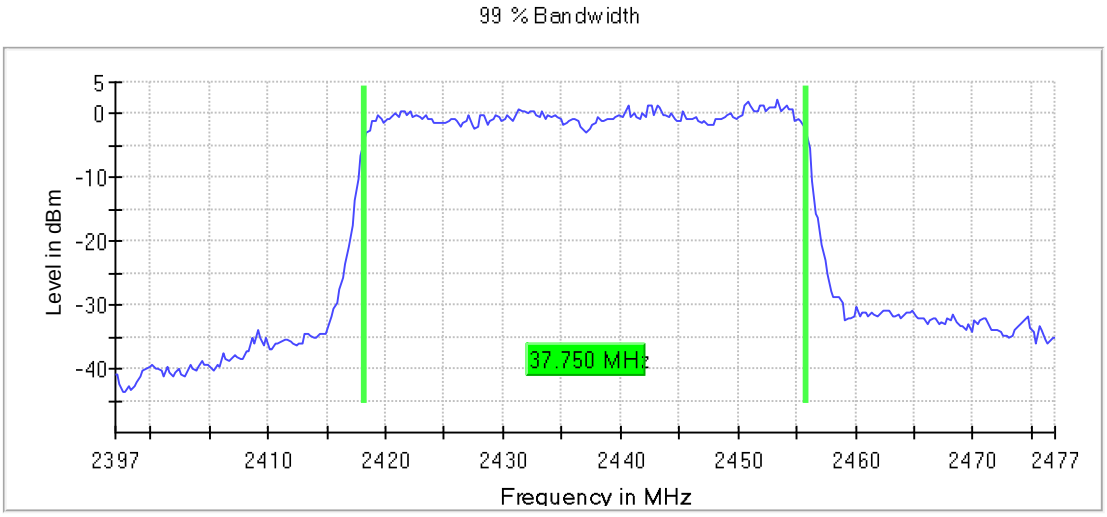
Frequency MHz = 2437.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 20, Modulation = 802.11ax HE SS1 MCS 8 (OFDM MCS8), Number of Transmission Chains = 2,

Images:



Frequency MHz = 2422.00000, Equipment Type = Digital Transmission System (DTS), Bandwidth MHz = 40, Modulation = 802.11ax HE SS1 MCS 8 (OFDM MCS8), Number of Transmission Chains = 2,

Images:



Measurement

Setting	Instrument Value	Instrument Value
Start Frequency	2.41700 GHz	2.39700 GHz
Stop Frequency	2.45700 GHz	2.47700 GHz
Span	40.000 MHz	80.000 MHz
RBW	200.000 kHz	>= 400.000 kHz
VBW	1.000 MHz	>= 1.500 MHz
SweepPoints	400	~ 320
Sweeptime	1.000 ms	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.30 dB	0.30 dB
Run	63 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.27 dB	0.30 dB

RSS-247 5.5 / FCC 15.247 (d) Emission Limitations Radiated (Transmitter)

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

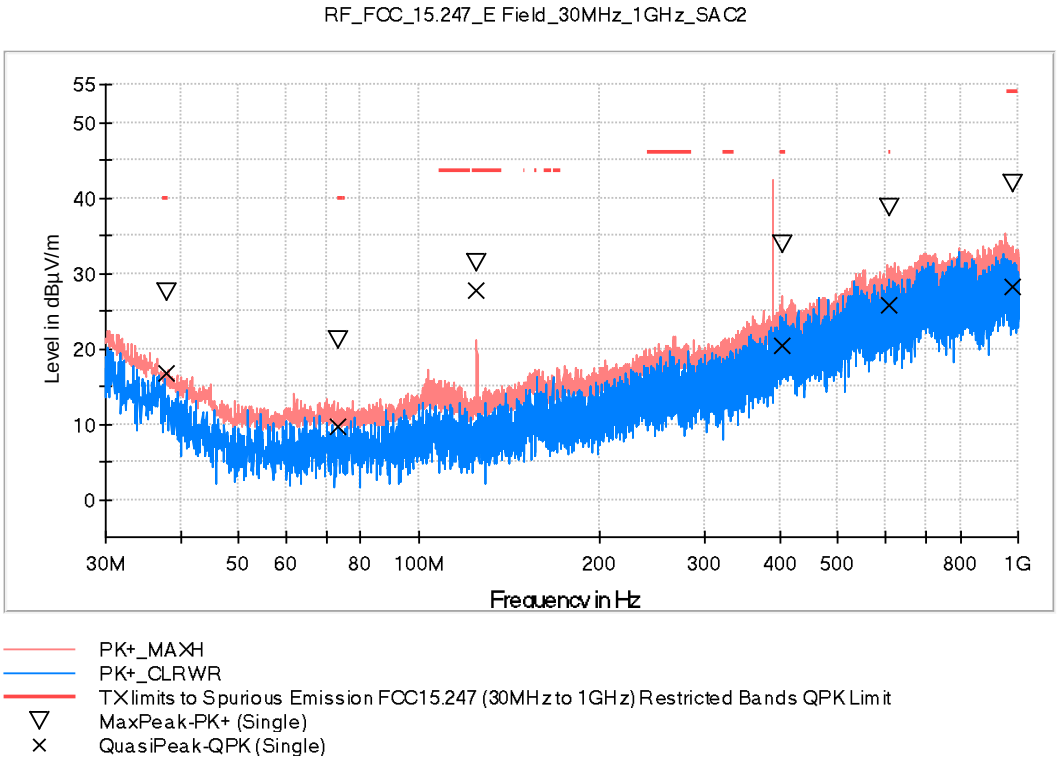
Verdict

Pass

Results

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.



Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Pol	Margin - QPK (dB)	Limit - QPK (dBµV/m)
37.954000	27.4	16.7	H	23.3	40.0
73.019500	21.1	9.6	H	30.4	40.0
124.963000	31.5	27.7	V	15.8	43.5
403.886500	33.7	20.5	V	25.5	46.0
609.623500	38.6	25.7	V	20.3	46.0
977.932500	41.9	28.2	V	25.8	54.0

Frequency range 1 GHz – 26 GHz

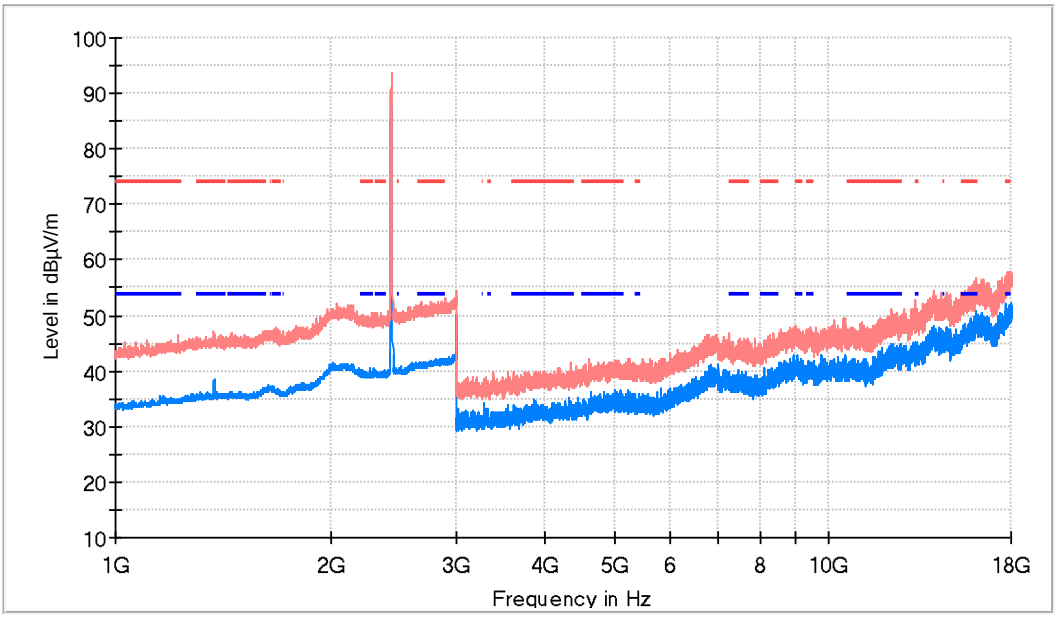
The results for the 802.11b worst operation mode selected for this range are shown below.

The results in the next tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz (see next plots). Please see the following results for worst operation mode selected for this range (1 Mbps).

Modulation: 802.11b

Frequency range: 1 – 18 GHz

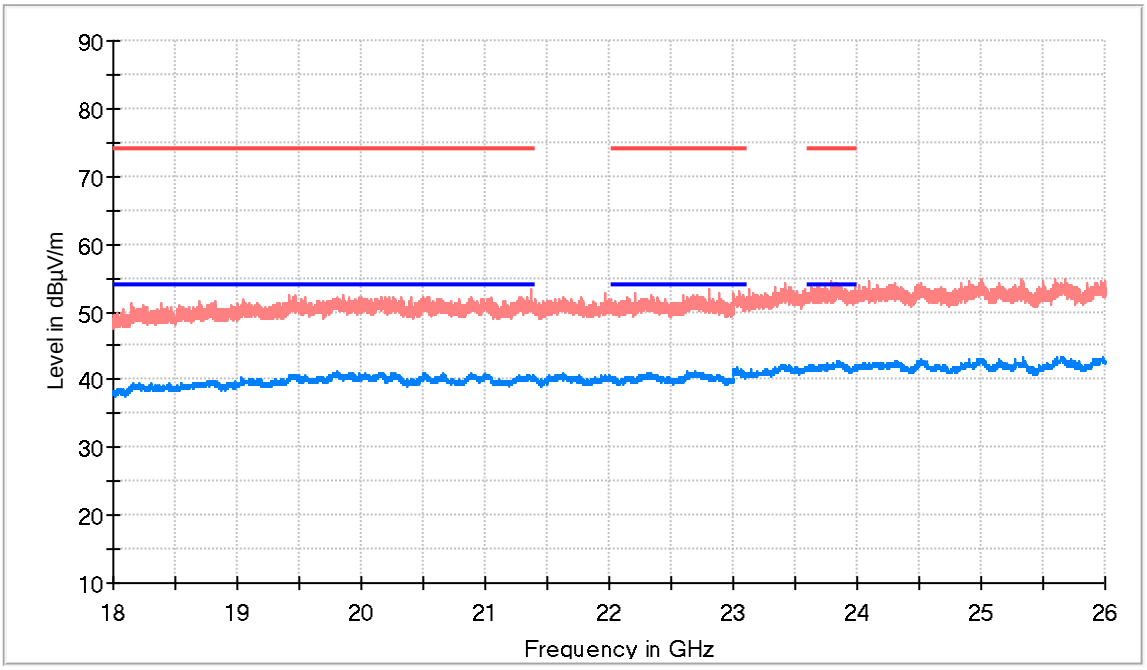
Lowest Channel



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)	Comment
1375.000000	46.5	38.6	H	15.4	54.0	
2438.000000	93.6	87.2	H	---	---	Fundamental
17966.500000	56.9	52.2	V	1.8	54.0	

Frequency range 18 - 26 GHz

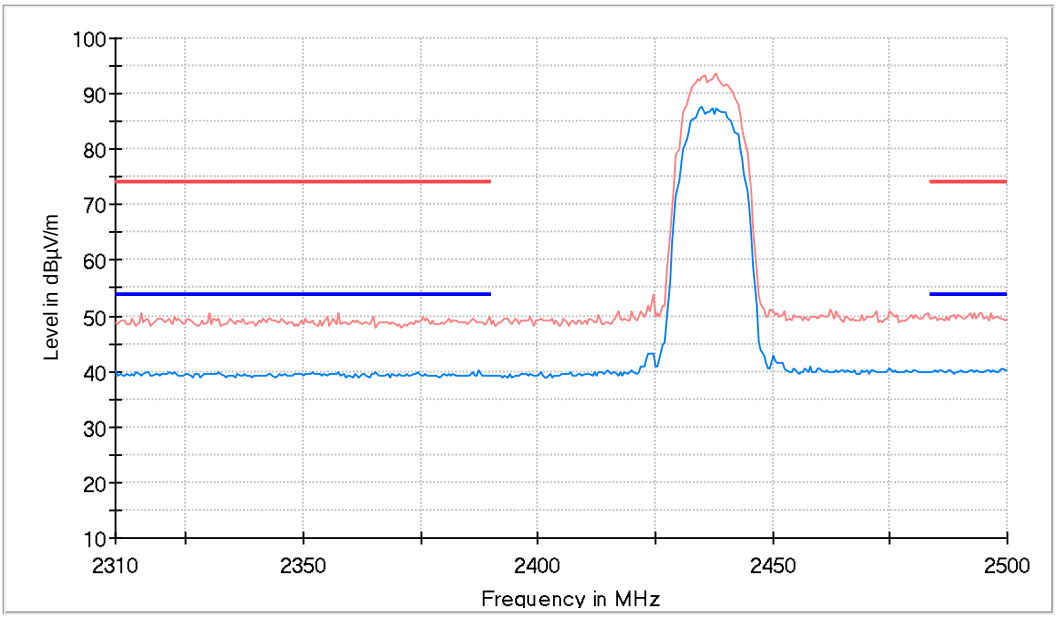
Lowest Channel



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)
18140.500000	51.2	38.7		15.3	54.0
21373.000000	53.3	40.2		13.8	54.0
23785.000000	54.6	42.1		11.9	54.0

Restricted Bands (2.31 GHz - 2.5 GHz)

Lowest Channel



AVG_MAXH
PK+_MAXH
TX limits to Spurious Emission FCC15.247 (1-26 GHz) Restricted Bands PK Limit
TX limits to Spurious Emission FCC15.247 (1-26 GHz) Restricted Bands AVG Limit

Measurements

Subrange	Step Size	Detectors	Bandwidth	Sweep Time	Preamp
30 MHz - 1 GHz	48.5 kHz	PK+	100 kHz	1 s	20 dB
1 GHz - 3 GHz	500 kHz	PK+ ; AVG	1 MHz	0.1 s	20 dB
3 GHz - 18 GHz	500 kHz	PK+ ; AVG	1 MHz	0.1 s	20 dB
18 GHz - 26 GHz	500 kHz	PK+ ; AVG	1 MHz	1 s	20 dB