

Test Report

Product	Telematics unit for mounting on forklifts
Name and address of the applicant	Toyota Material Handling, Inc. 5559 Inwood Drive, Columbus IN 47201, USA
Name and address of the manufacturer	Toyota Material Handling, Inc. 5559 Inwood Drive, Columbus IN 47201, USA
Model	DHUnx
Rating	External DC supply (12-48 V _{DC})
Trademark	TOYOTA
Serial number	2117000000251
Additional information	WiFi, BT Classic, BLE, WCDMA, LTE
Tested according to	Parts of FCC Part 15.247 Digital Transmission Systems Parts of ISED Canada RSS-247, Issue 2 Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Order number	433049
Tested in period	2021-09-15 to 2021-10-26 and 2022-03-25
Issue date	2022-03-29
Name and address of the testing laboratory	 Instituttveien 6 Kjeller, Norway www.nemko.com CAB Number: FCC: NO0001 ISED: NO0470   An accredited technical test executed under the Norwegian accreditation scheme
 Prepared by [Frode Sveinsen]  Approved by [G.Suhanthakumar]	
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Revision history

Revision	Date	Comment	Sign
00	2022-02-24	First edition	FS
01	2022-03-29	New power measurements with RMS detector	FS



THIS TEST REPORT APPLIES ONLY TO THE ITEM(S) AND CONFIGURATIONS TESTED.

Deviations from, additions to, or exclusions from the test specifications are described in "Summary of Test Data".

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1 INFORMATION

1.1 Test Item

Name	Toyota
Model/version	DHUnx
FCC ID	2A226-TELETMH01
ISED ID	27732-TELETMH01
Serial number	2117000000251
Hardware identity and/or version	Rev. B
Software identity and/or version	dv_b1_2021-05-05
Frequency Range	2412 – 2462 MHz
Number of Channels	11 (7 channels for HT40)
Operating Modes	802.11 b/g/n (only 20 MHz Mode)
Type of Modulation	DSSS / OFDM
Conducted Output Power	802.11b: 0.0383 W 802.11g: 0.0246 W 802.11n HT20: 0.0249 W 802.11n HT40: 0.0191 W
Antenna Connector	Quad MiniFakra
Antenna Type	Molex Antenna, P/N: 2144500750 (P/N is for version with 750mm cable length, longer cables may also be used) Antenna element LTE1: Rx/Tx Antenna element LTE2: Rx Only Antenna element WiFi/BT: Rx/Tx 2.4GHz WiFi/BT/BLE and 5GHz WiFi Antenna element GNSS: Rx Only GNSS/GPS
Antenna Diversity Supported	Not for WiFi
Smart Antennas Supported	No
Power Source	External DC Supply (12-48V _{DC} , supplied through MX23 connector)
Interfaces	MX23 Connector HSD Connector (100TX Ethernet)

Description of Test Item

The EUT is a telematics unit with radio modules for BT/BLE/WiFi and Mobile (WCDMA/LTE). Both radio modules are certified radio modules. The EUT also contains a GPS receiver.

This test report covers only additional radiated tests for the new antennas.

1.2 Normal test conditions

Temperature:	20 - 24 °C
Relative humidity:	20 - 50 %
Normal test voltage:	24V DC (2x 12V lead acid batteries, Fiamm FG20451)

The EUT was powered from two fully charged batteries during all tests.

The values are the limit registered during the test period.

1.3 Test Engineer(s)

Frode Sveinsen

1.4 Antenna Requirement

Does the EUT have detachable antenna(s)?	☒ YES	☐ NO
If detachable, is the antenna connector(s) non-standard?	☒ YES	☐ NO
Antenna Connector: Quad MiniFakra		

Requirement: FCC 15.203, 15.204

1.5 EUT Operating Modes

Description of operating modes	Radiated Emissions and Power Line Conducted Emissions were performed with the EUT set to transmit at the channel with the highest output power as worst-case scenario.
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1.6 Radio Modules

Data for radio modules				
Manufacturer	Model No	Identification	Original Test Report	Technology
Quectel	FC20	FCC ID: XMR201703FC20 IC: 10224A-201703FC20 P/N: FC20-Q73	Siemic 16050028-FCC-R3 TA R2105A0465-R2	BT Classic
			Siemic 16050028-FCC-R4 TA R2105A0465-R1	BT Low Energy
			Siemic 16050028-FCC-R1 TA R2105A0465-R1	WLAN
			Siemic 16050028-FCC-R2 TA R2105A0465-R3	UNII 2TX
			TA R2105A0465-R4V1	DFS
Quectel	EG25	FCC ID: XMR201903EG25G IC: 10224A-201903EG25G P/N: EG25GGB-256-SGNS	SGS HR/2019/1001601 SGS HR/2019/1001603	WCDMA/LTE

1.7 Power Levels

	Bitrate	Channels	Power Setting
802.11b	1M	1 to 11	18
	11M	1 to 11	18
802.11g	6M	1 to 11	17
	54M	1 to 8	15
	54M	9 to 11	14
802.11n HT20	MCS0	1 to 11	16
	MCS7	1 to 10	15
	MCS7	11	14
802.11n HT40	MCS0	3 to 8	15
	MCS0	9	13
	MCS7	3 to 8	14
	MCS7	9	11

Power levels were as shown above.

Levels with red text were reduced, all other levels are the default values from the module manufacturer.

1.8 Comments

All ports were populated during spurious emission measurements.

This test report covers only selected tests for new antennas, all other tests are covered by the original Test Report.

2 TEST REPORT SUMMARY

2.1 General

All measurements are traceable to national standards.

The tests were conducted for demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and ISSED RSS-247 Issue 2 and RSS-GEN Issue 5.

Tests were performed in accordance with ANSI C63.4-2014 and ANSI C63.10-2013.

Radiated tests were performed in a semi-anechoic chamber at measuring distances of 3m.

A description of the test facility is on file with the FCC and ISSED.

☒ New Submission	☒ Production Unit
☐ Class II Permissive Change	☐ Pre-production Unit
DTS Equipment Code	☐ Family Listing

2.2 Test Summary

Name of test	FCC Part 15 reference	RSS-247 Issue 2, RSS-GEN Issue 5 reference	ANSI C63.10-2013 Reference	Result
Supply Voltage Variations	15.31(e)	6.11 (RSS-GEN)	5.13	Complies
Antenna Requirement	15.203	6.8 (RSS-GEN)	5.8	Complies
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2 / 8.8 (RSS-GEN)	6.2	N/A
Occupied Bandwidth (99% BW)	N/A	6.7 (RSS-GEN)	6.9.3	N/T
DTS Bandwidth	15.247(a)(2)	5.2 (1) (RSS-247)	11.8 Option 2	N/T
Peak Power Output	15.247(b)	5.4 (RSS-247)	11.9.1.1	Complies
Power Spectral Density	15.247(d)	5.2 (2) (RSS-247)	11.10.2 PKPSD (DTS)	N/T
Spurious Emissions (Antenna Conducted)	15.247(c)	5.5 (RSS-247)	6.7 11.11 (DTS)	N/T
Spurious Emissions (Radiated)	15.247(c) 15.109(a) 15.209(a)	5.5 (RSS-247) 7.3 (RSS-GEN) 8.9 (RSS-GEN)	6.3, 6.5, 6.6, 6.10 11.12, 11.13 (DTS)	Complies

3 TEST RESULTS

3.1 Output Power

FCC Part 15.247 (b)

ISED Canada RSS-247 Issue 2, Clause 5.4

Measurement procedure: ANSI C63.10-2013 Clause 11.9.1.2

Test Results: Complies

Measurement Data:

Carrier Frequency	Field Strength, dBμV/m @3m							
	802.11b 1M	802.11b	802.11g 6M	802.11g	802.11n	802.11n	802.11n	802.11n
	1M	11M	6M	54M	HT20 MCS0	HT20 MCS7	HT40 MCS0	HT40 MCS7
2412 MHz	109.8	109.3	108.0	105.6	106.9	105.3		
2422 MHz							106.9	103.3
2437 MHz	113.0	112.6	110.9	107.9	109.9	107.3	108.2	104.5
2452 MHz							108.4	102.0
2462 MHz	112.8	112.2	111.0	108.0	109.6	106.1		
Carrier Frequency	Peak EIRP, dBm							
	802.11b 1M	802.11b	802.11g 6M	802.11g	802.11n	802.11n	802.11n	802.11n
	1M	11M	6M	54M	HT20 MCS0	HT20 MCS7	HT40 MCS0	HT40 MCS7
2412 MHz	14.6	14.1	12.8	10.3	11.7	10.1		
2422 MHz							11.7	8.0
2437 MHz	17.7	17.3	15.7	12.7	14.7	12.0	13.0	9.2
2452 MHz							13.2	6.8
2462 MHz	17.6	16.9	15.7	12.7	14.4	10.8		
Carrier Frequency	Conducted Power, dBm							
	802.11b 1M	802.11b	802.11g 6M	802.11g	802.11n	802.11n	802.11n	802.11n
	1M	11M	6M	54M	HT20 MCS0	HT20 MCS7	HT40 MCS0	HT40 MCS7
2412 MHz	11.9	11.4	10.1	7.6	9.0	7.4		
2422 MHz							9.0	5.3
2437 MHz	15.0	14.6	13.0	10.0	12.0	9.3	10.3	6.5
2452 MHz							10.5	4.1
2462 MHz	14.9	14.2	13.0	10.0	11.7	8.1		

Output Power reported is Maximum Average Power measured radiated.

The Integrated Band Power Method with RMS detector and Trace Averaging (SA1) was used, Ref ANSI C63.10-2013.

Radiated Power was calculated from measured Field Strength using the method described in FCC KDB 412172 D01.

Conducted Power = Radiated Power – Declared Antenna Gain

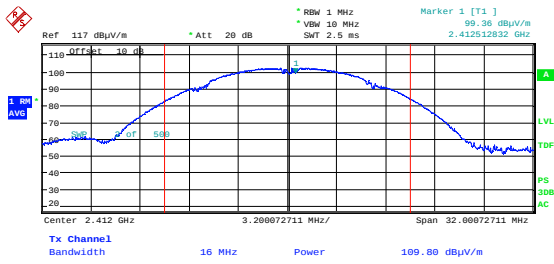
See attached plots.

Requirements:

The maximum peak output power shall not exceed the following limits:

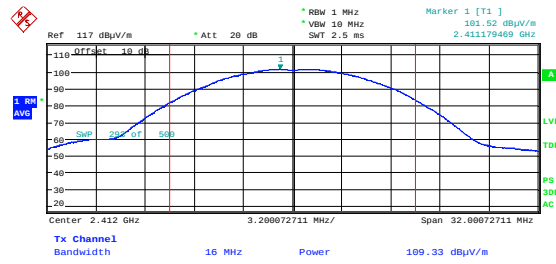
For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt (30 dBm)

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.



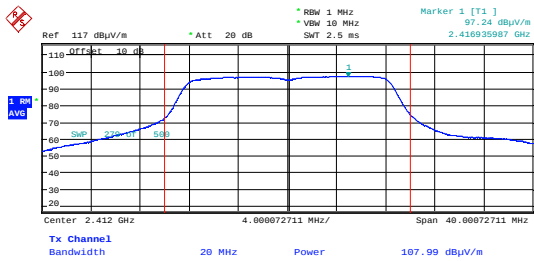
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Maximum Field Strength, 2412 MHz, 802.11b 1M



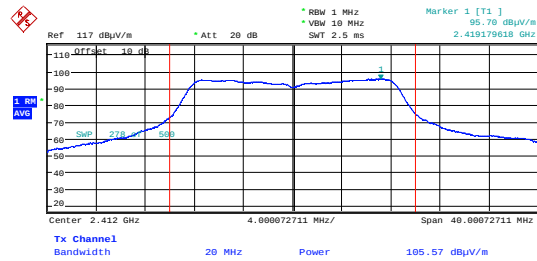
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Maximum Field Strength, 2412 MHz, 802.11b 11M



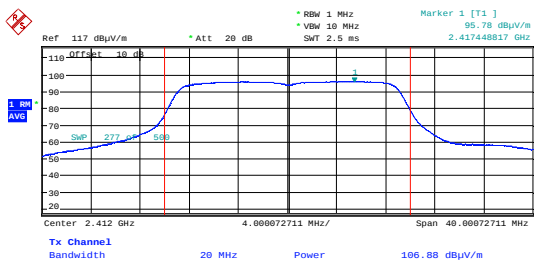
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Maximum Field Strength, 2412 MHz, 802.11g 6M



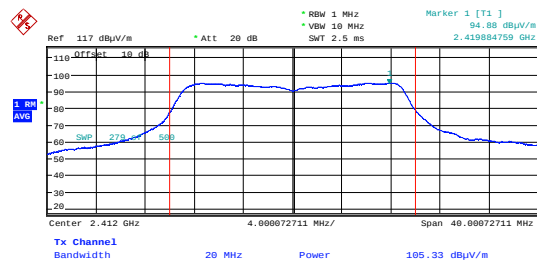
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Maximum Field Strength, 2412 MHz, 802.11g 11M



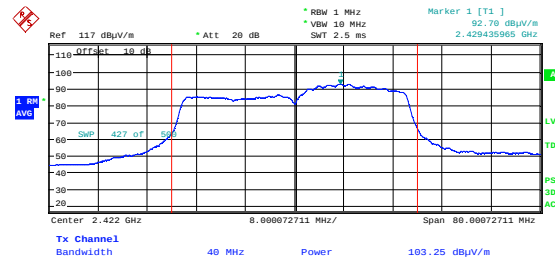
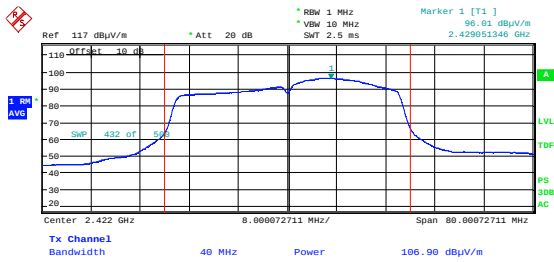
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Maximum Field Strength, 2412 MHz, 802.11n HT20 MCS0



Date: 25.MAR.2022 15:58:33

Maximum Field Strength, 2412 MHz, 802.11n HT20 MCS5

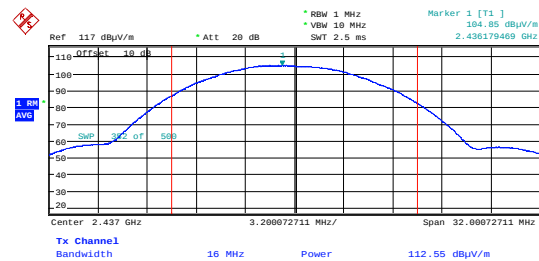
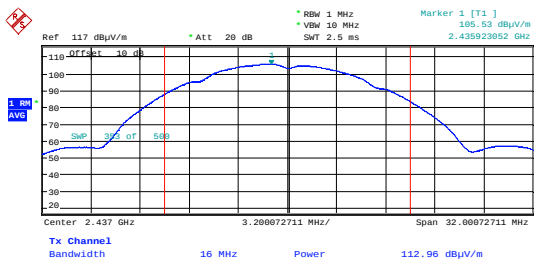


Date: 25.MAR.2022 16:17:34

Date: 25.MAR.2022 16:24:18

Maximum Field Strength, 2422 MHz, 802.11n HT40 MCS0

Maximum Field Strength, 2422 MHz, 802.11n HT40 MCS7

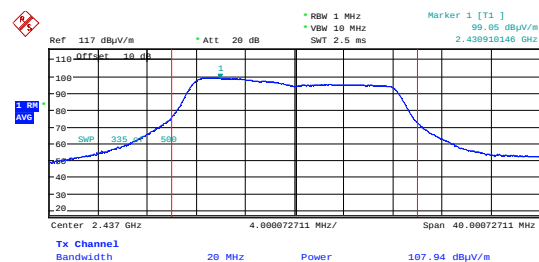
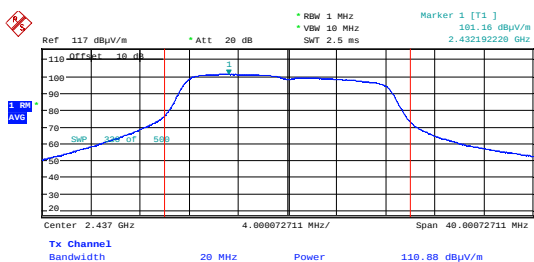


Date: 25.MAR.2022 16:01:00

Date: 25.MAR.2022 16:04:00

Maximum Field Strength, 2437 MHz, 802.11b 1M

Maximum Field Strength, 2437 MHz, 802.11b 11M

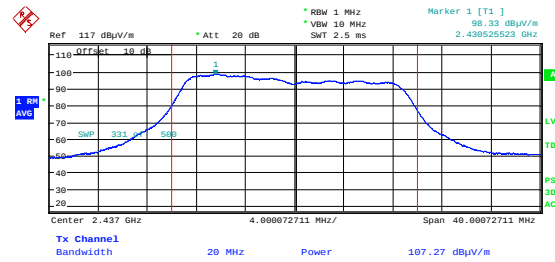
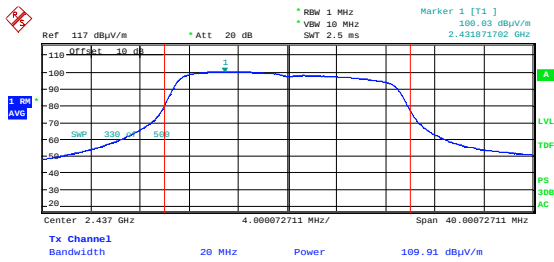


Date: 25.MAR.2022 15:34:59

Date: 25.MAR.2022 15:39:38

Maximum Field Strength, 2437 MHz, 802.11g 6M

Maximum Field Strength, 2437 MHz, 802.11g 54M

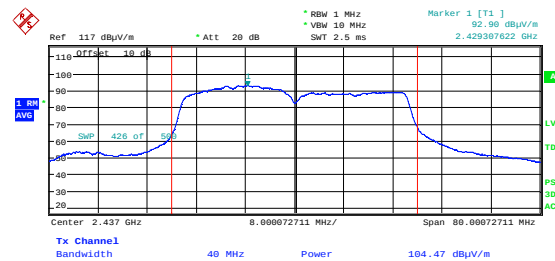
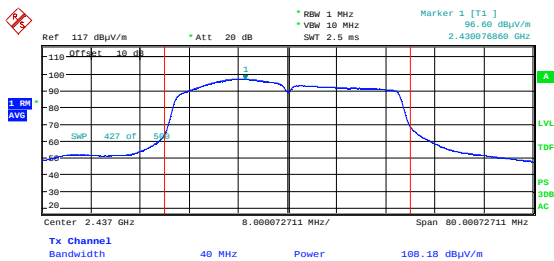


Date: 25.MAR.2022 15:55:03

Date: 25.MAR.2022 15:57:56

Maximum Field Strength, 2437 MHz, 802.11n HT20 MCS0

Maximum Field Strength, 2437 MHz, 802.11n HT20 MCS7

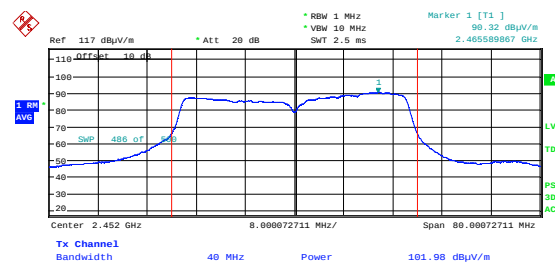
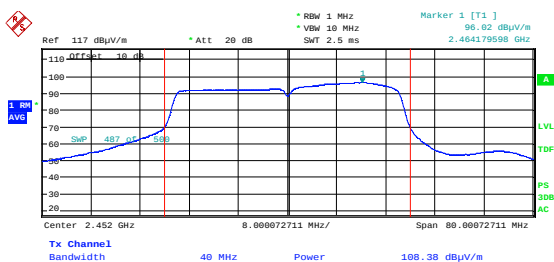


Date: 25.MAR.2022 16:18:28

Date: 25.MAR.2022 16:23:24

Maximum Field Strength, 2437 MHz, 802.11n HT40 MCS0

Maximum Field Strength, 2437 MHz, 802.11n HT40 MCS7

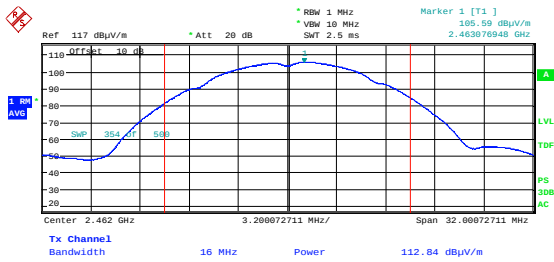


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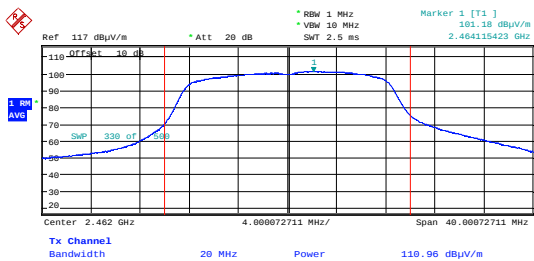
Maximum Field Strength, 2452 MHz, 802.11n HT40 MCS0

Maximum Field Strength, 2452 MHz, 802.11n HT40 MCS7



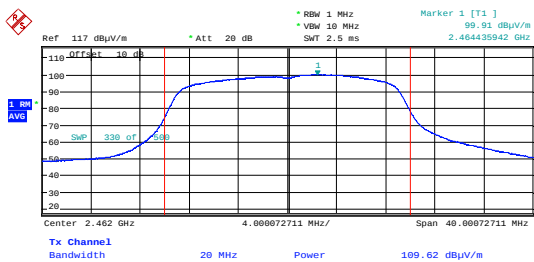
Date: 25.MAR.2022 16:01:52

Maximum Field Strength, 2462 MHz, 802.11b 1M



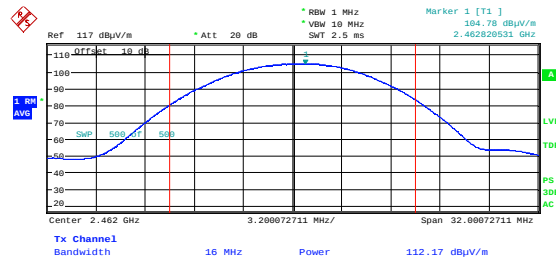
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Maximum Field Strength, 2462 MHz, 802.11g 6M



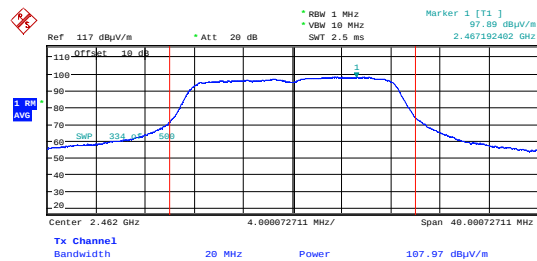
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Maximum Field Strength, 2462 MHz, 802.11n HT20 MCS0



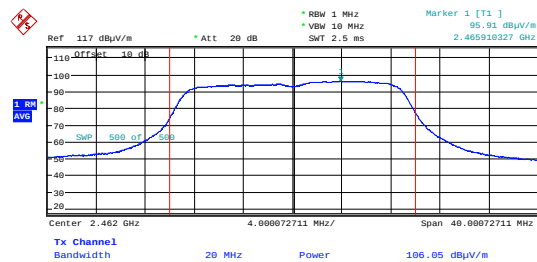
Date: 25.MAR.2022 16:10:05

Maximum Field Strength, 2462 MHz, 802.11b 11M



Date: 25.MAR.2022 15:51:56

Maximum Field Strength, 2462 MHz, 802.11g 54M



Date: 25.MAR.2022 16:15:04

Maximum Field Strength, 2462 MHz, 802.11n HT20 MCS7

3.2 Restricted Bands of operation

Restricted Bands of operation for FCC and ISSED are defined in FCC Part 15.205 and ISSED RSS-GEN, Issue 5 clause 8.10.

Generally, no fundamentals are allowed in the restricted bands and all emissions must comply with the limits in FCC 15.209 or RSS-GEN, Issue 5, clause 8.9.

FCC (MHz)	ISED (MHz)	FCC (GHz)	ISED (GHz)
0.090-0.110		0.96-1.24 1.3-1.427	0.96-1.427
0.495-0.505		1.435-1.6265	
2.1735-2.1905		1.6455-1.6465	
	3.020-3.026	1.660-1.710	
4.125-4.128		1.7188-1.7222	
4.17725-4.17775		2.2-2.3	
4.20725-4.20775		2.31-2.39	
	5.677-5.683	2.4835-2.5	
6.215-6.218		2.69-2.9	2.655-2.9
6.26775-6.26825		3.26-3.267	
6.31175-6.31225		3.332-3.339	
8.291-8.294		3.3458-3.358	
8.362-8.366		3.6-4.4	3.5-4.4
8.37625-8.38675		4.5-5.15	
8.41425-8.41475		5.35-5.46	
12.29-12.293		7.25-7.75	
12.51975-12.52025		8.025-8.5	
12.57675-12.57725		9.0-9.2	
13.36-13.41		9.3-9.5	
16.42-16.423		10.6-12.7	
16.69475-16.69525		13.25-13.4	
16.80425-16.80475		14.47-14.5	
25.5-25.67		15.35-16.2	
37.5-38.25		17.7-21.4	
73-74.6		22.01-23.12	
74.8-75.2		23.6-24.0	
108-121.94 123-138	108-138	31.2-31.8	
149.9-150.05		36.43-36.5	
156.52475-156.52525		Above 38.6	
156.7-156.9			
162.0125-167.17			
167.72-173.2			
240-285			
322-335.4			
399.9-410			
608-614			

Frequencies in **Bold** text are specific for FCC or ISSED, all other frequencies are common.

3.3 Radiated Emissions, Band Edge

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3 / 8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

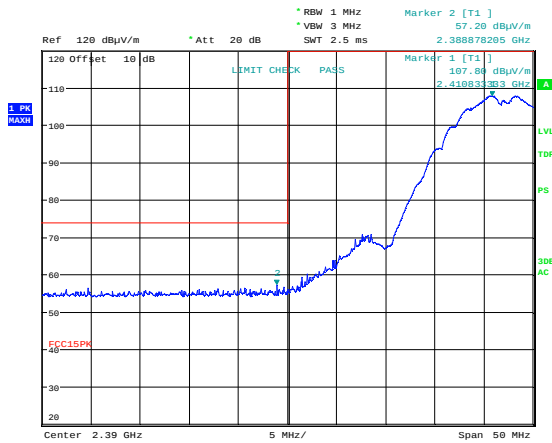
Test Results: Complies

Measurement Data:

Carrier Freq. (MHz)	Modulation and Bitrate	Measured field strength (dBμV/m)		Limit (dB)		Margin (dB)	
		Peak	Average	Pk	Av	Pk	Av
2412	11b 1M	57.2	44.9	74	54	16.8	9.1
	11b 11M	56.9	44.9	74	54	17.1	9.1
	11g 6M	62.9	47.7	74	54	11.1	6.3
	11g 54M	69.1	47.6	74	54	4.9	6.4
	11n HT20 MCS0	61.0	46.2	74	54	13.0	7.8
	11n HT20 MCS7	68.5	47.0	74	54	5.5	7.0
2422	11n HT40 MCS0	59.6	44.6	74	54	14.4	9.4
	11n HT40 MCS7	61.2	45.3	74	54	12.8	8.7
2447	11n HT40 MCS0	67.2	50.6	74	54	6.8	3.4
	11n HT40 MCS7	71.9	51.4	74	54	2.1	2.6
2452	11n HT40 MCS0	68.6	51.1	74	54	5.4	2.9
	11n HT40 MCS7	68.3	46.4	74	54	5.7	7.6
2462	11b 1M	58.6	47.3	74	54	15.4	6.7
	11b 11M	58.5	46.2	74	54	15.5	7.8
	11g 6M	63.6	49.5	74	54	10.4	4.5
	11g 54M	71.4	46.2	74	54	2.6	7.8
	11n HT20 MCS0	60.8	47.1	74	54	13.2	6.9
	11n HT20 MCS7	72.4	46.9	74	54	1.6	7.1

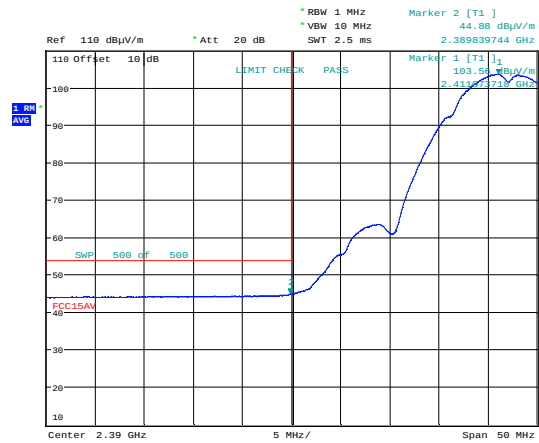
Average values were measured using trace averaging (SA1), Ref. ANSI C63.10-2013 (Duty Cycle ≈100%).

See attached plots.



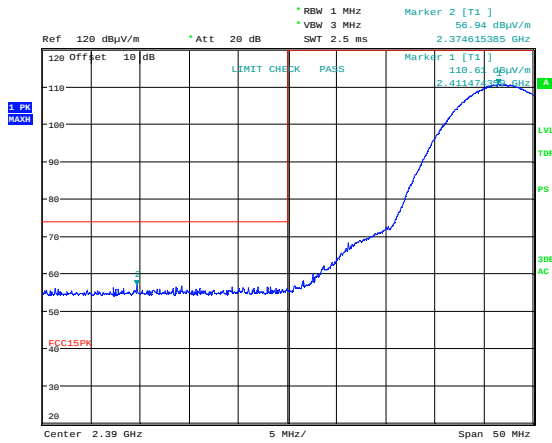
Date: 15. SEP. 2021 13:37:02

Lower Band Edge, 2412 MHz, 802.11b 1M, Peak



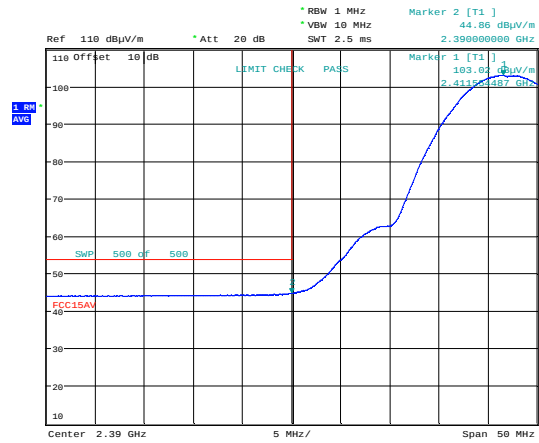
Date: 15. SEP. 2021 13:37:34

Lower Band Edge, 2412 MHz, 802.11b 1M, Average



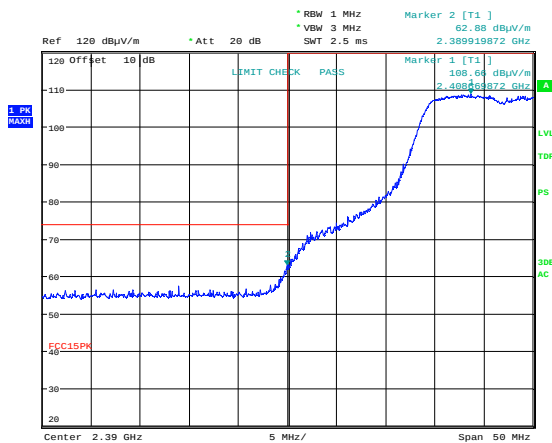
Date: 15. SEP. 2021 13:46:32

Lower Band Edge, 2412 MHz, 802.11b 11M, Peak



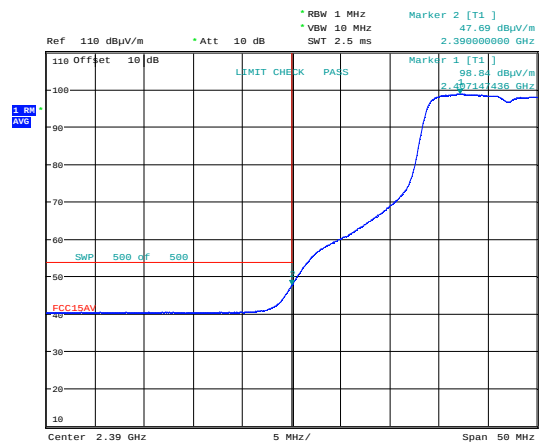
Date: 15. SEP. 2021 13:41:04

Lower Band Edge, 2412 MHz, 802.11b 11M, Average



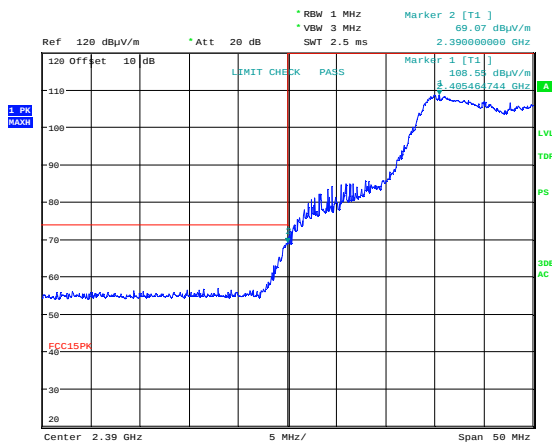
Date: 15. SEP. 2021 13:13:29

Lower Band Edge, 2412 MHz, 802.11g 6M, Peak



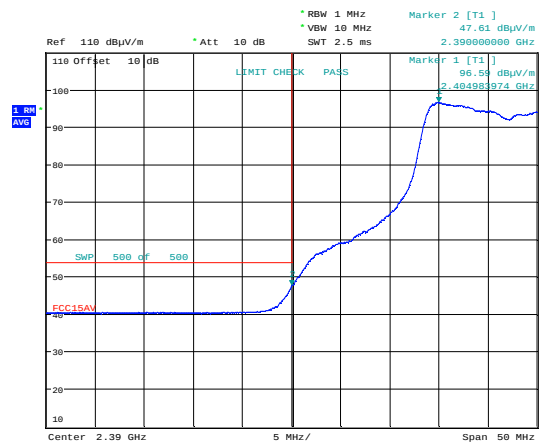
Date: 15. SEP. 2021 13:14:58

Lower Band Edge, 2412 MHz, 802.11g 6M, Average



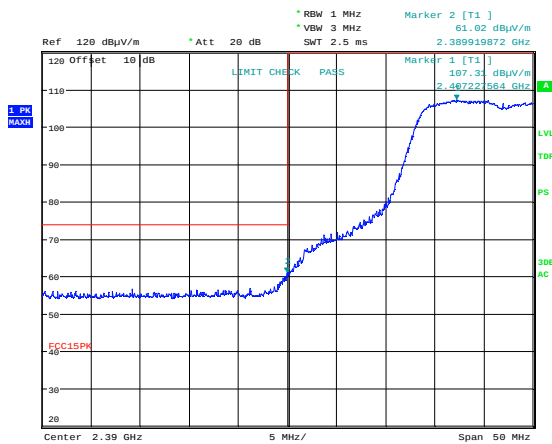
Date: 15. SEP. 2021 13:08:17

Lower Band Edge, 2412 MHz, 802.11g 54M, Peak



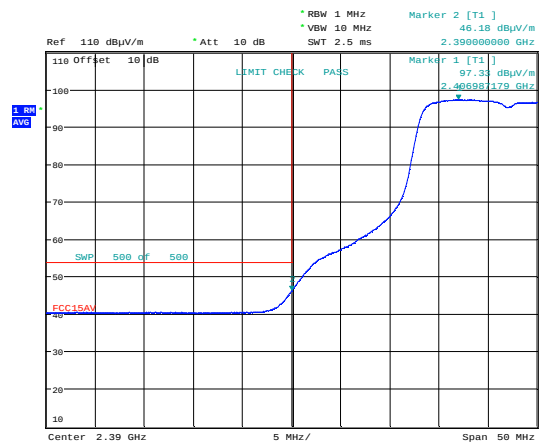
Date: 15. SEP. 2021 13:11:04

Lower Band Edge, 2412 MHz, 802.11g 54M, Average



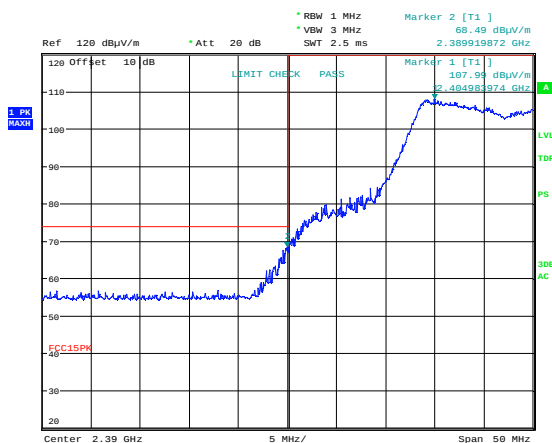
Date: 15. SEP. 2021 13:21:29

Lower Band Edge, 2412 MHz, 802.11n HT20 MCS0, Peak



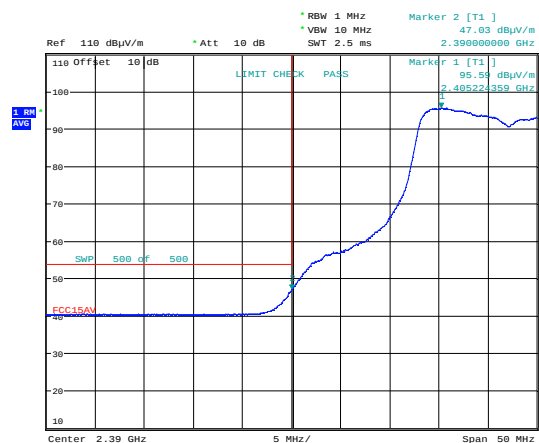
Date: 15. SEP. 2021 13:22:01

Lower Band Edge, 2412 MHz, 802.11n HT20 MCS0, Average



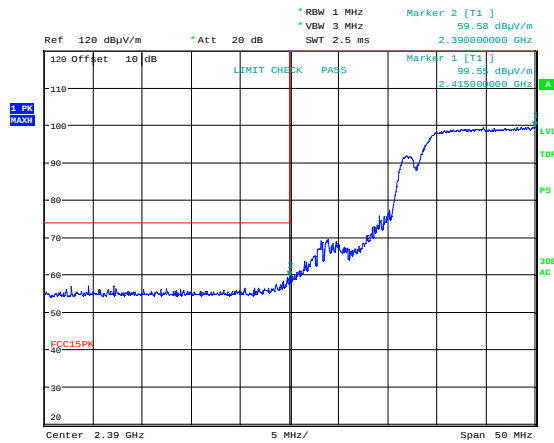
Date: 15. SEP. 2021 13:33:09

Lower Band Edge, 2412 MHz, 802.11n HT20 MCS7, Peak



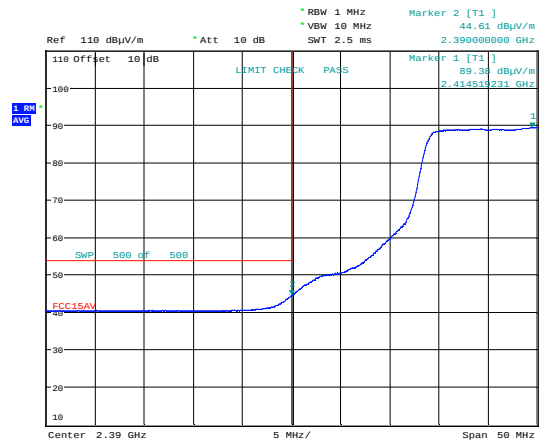
Date: 15. SEP. 2021 13:33:42

Lower Band Edge, 2412 MHz, 802.11n HT20 MCS7, Average



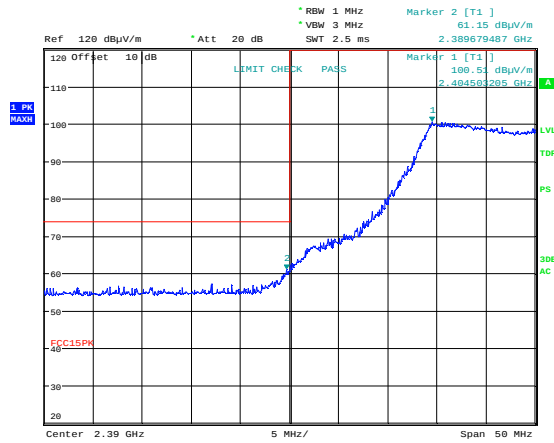
Date: 15. SEP. 2021 13:56:20

Lower Band Edge, 2422 MHz, 802.11n HT40 MCS0, Peak



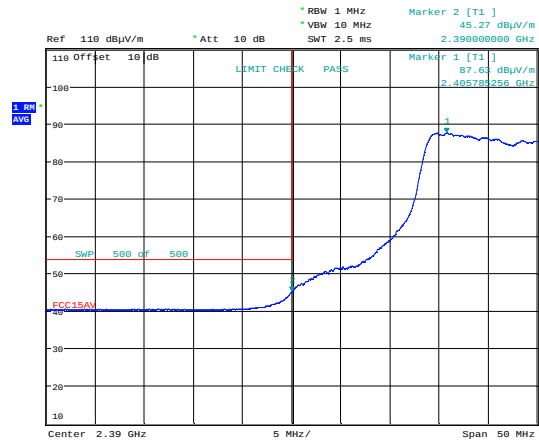
Date: 15. SEP. 2021 13:55:28

Lower Band Edge, 2422 MHz, 802.11n HT40 MCS0, Average



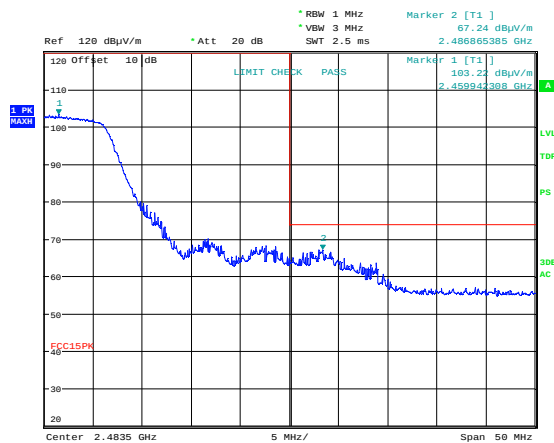
Date: 15. SEP. 2021 13:59:39

Lower Band Edge, 2422 MHz, 802.11n HT40 MCS7, Peak



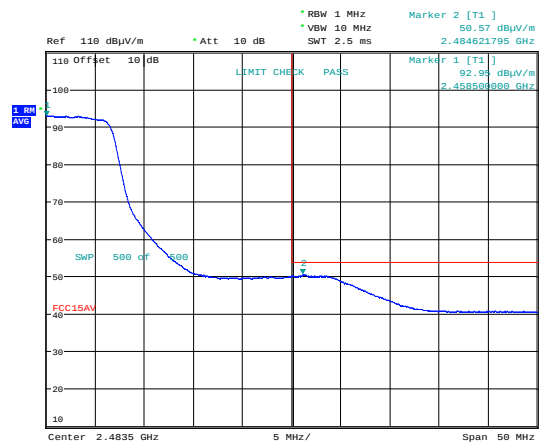
Date: 15. SEP. 2021 13:58:45

Lower Band Edge, 2422 MHz, 802.11n HT40 MCS7, Average



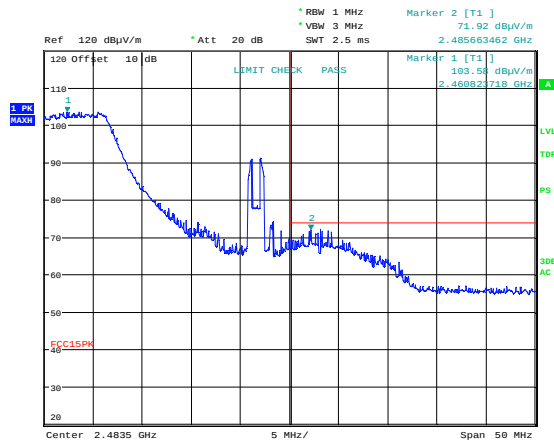
Date: 15. SEP. 2021 13:53:30

Upper Band Edge, 2447 MHz, 802.11n HT40 MCS0, Peak



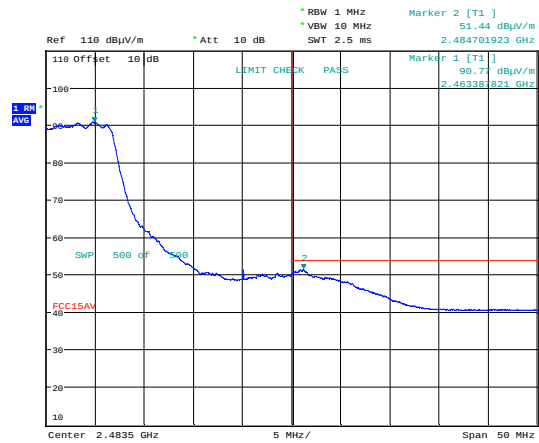
Date: 15. SEP. 2021 13:52:38

Upper Band Edge, 2447 MHz, 802.11n HT40 MCS0, Average



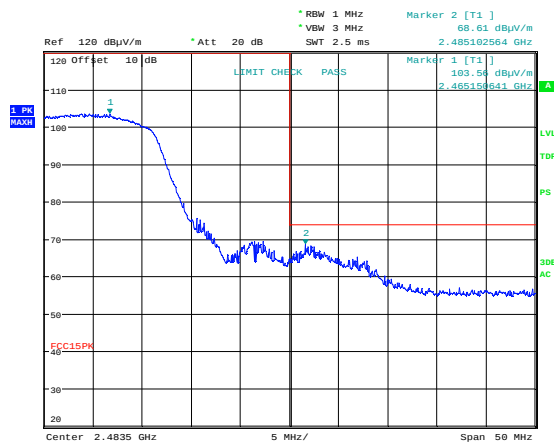
Date: 15. SEP. 2021 14:08:45

Upper Band Edge, 2447 MHz, 802.11n HT40 MCS7, Peak



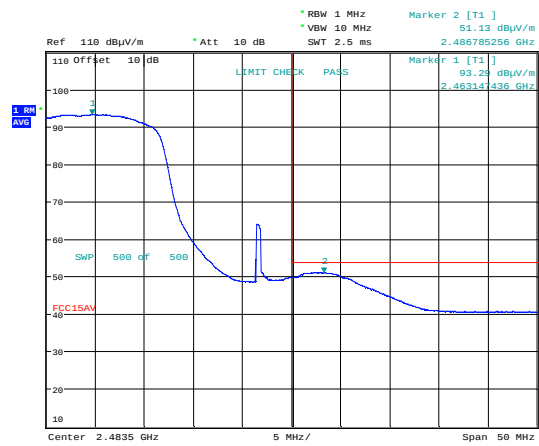
Date: 15. SEP. 2021 14:09:20

Upper Band Edge, 2447 MHz, 802.11n HT40 MCS7, Average



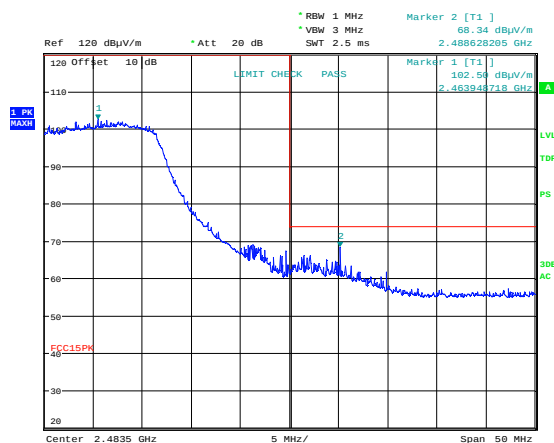
Date: 15. SEP. 2021 13:50:54

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS0, Peak



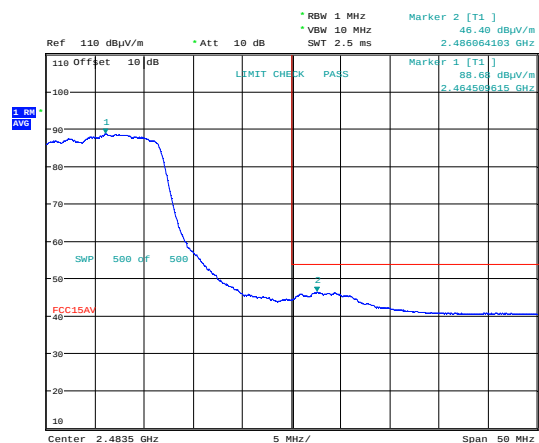
Date: 15. SEP. 2021 13:50:03

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS0, Average



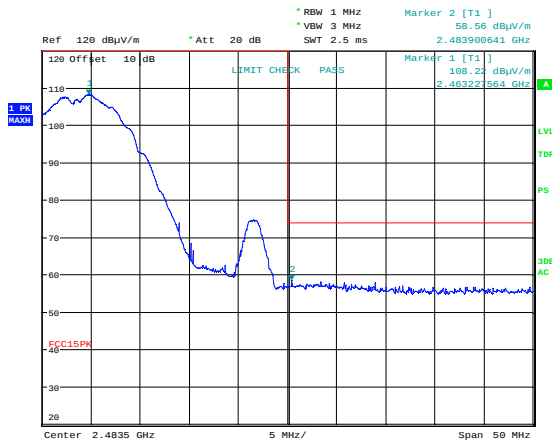
Date: 15. SEP. 2021 14:06:57

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS7, Peak



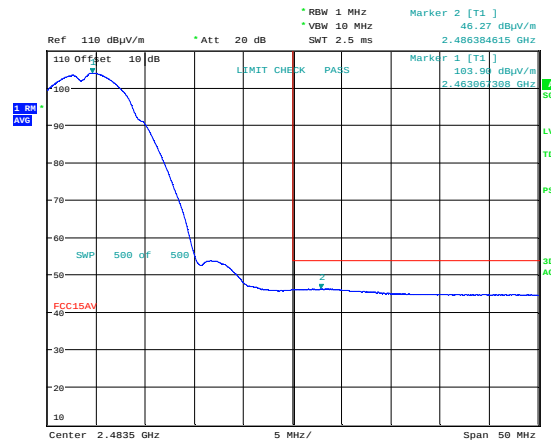
Date: 15. SEP. 2021 14:07:35

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS7, Average



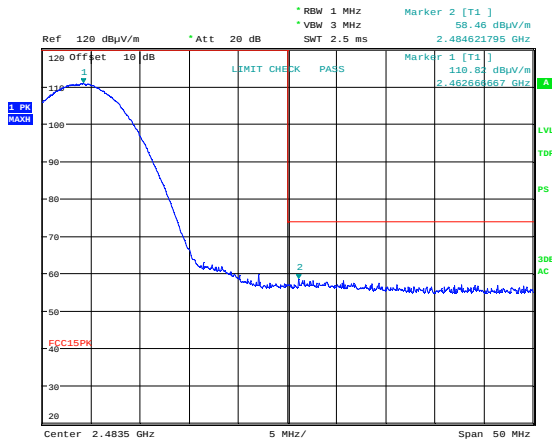
Date: 15. SEP. 2021 13:45:37

Upper Band Edge, 2462 MHz, 802.11b 1M, Peak



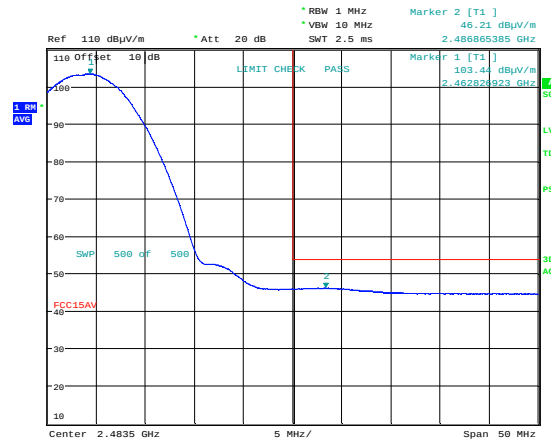
Date: 15. SEP. 2021 13:46:09

Upper Band Edge, 2462 MHz, 802.11b 1M, Average



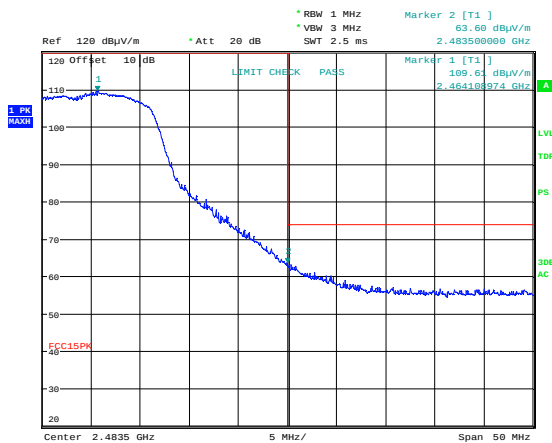
Date: 15. SEP. 2021 13:43:26

Upper Band Edge, 2462 MHz, 802.11b 11M, Peak



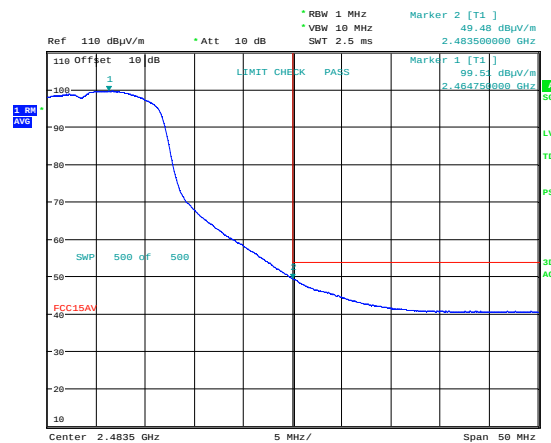
Date: 15. SEP. 2021 13:43:57

Upper Band Edge, 2462 MHz, 802.11b 11M, Average



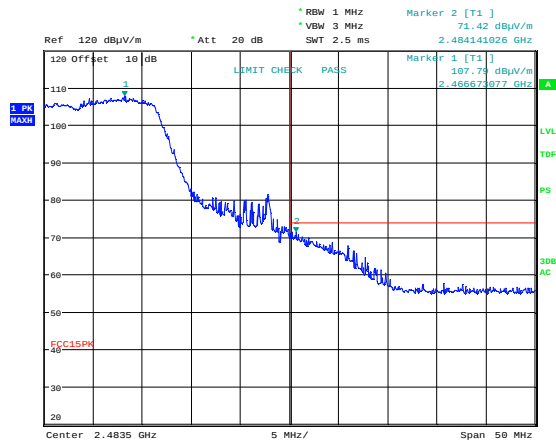
Date: 15. SEP. 2021 13:17:03

Upper Band Edge, 2462 MHz, 802.11g 6M, Peak



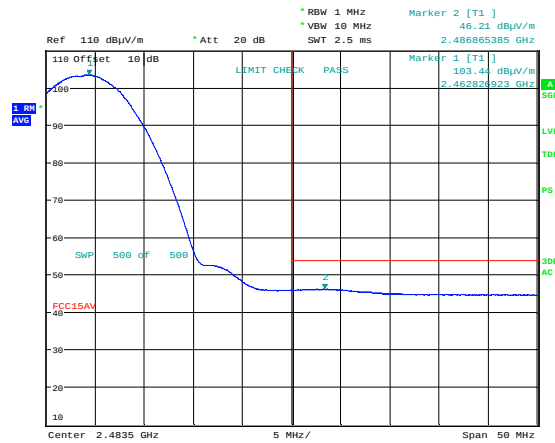
Date: 15. SEP. 2021 13:18:48

Upper Band Edge, 2462 MHz, 802.11g 6M, Average



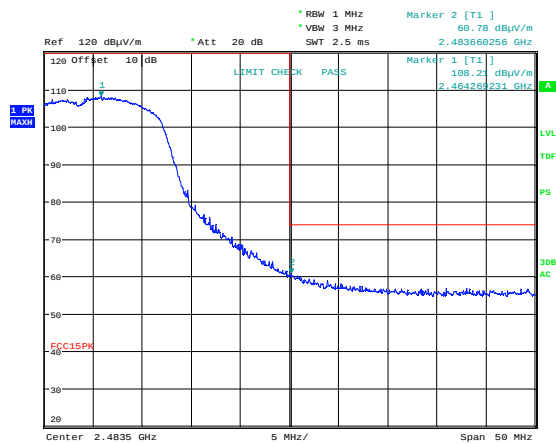
Date: 15. SEP. 2021 12:53:13

Upper Band Edge, 2462 MHz, 802.11g 54M, Peak



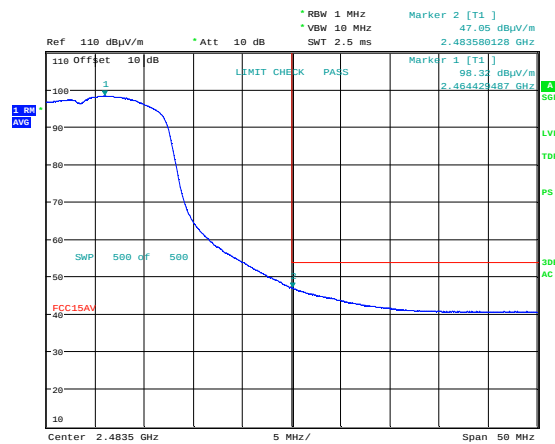
Date: 15. SEP. 2021 13:43:57

Upper Band Edge, 2462 MHz, 802.11g 54M, Average



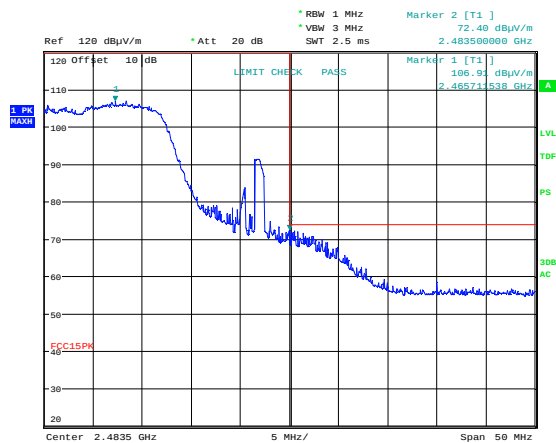
Date: 15. SEP. 2021 13:23:49

Upper Band Edge, 2462 MHz, 802.11n HT20 MCS0, Peak



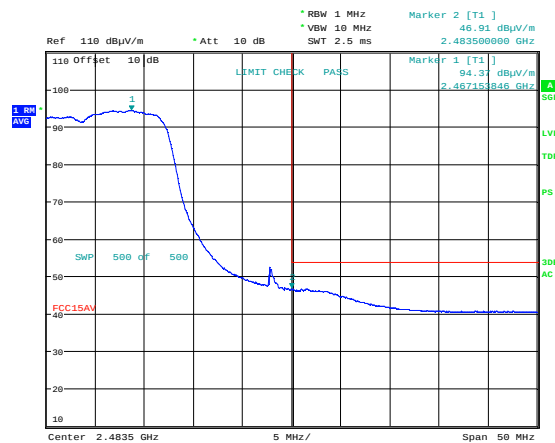
Date: 15. SEP. 2021 13:24:21

Upper Band Edge, 2462 MHz, 802.11n HT20 MCS0, Average



Date: 15. SEP. 2021 13:28:01

Upper Band Edge, 2462 MHz, 802.11n HT20 MCS7, Peak



Date: 15. SEP. 2021 13:27:10

Upper Band Edge, 2462 MHz, 802.11n HT20 MCS7, Average

3.4 Radiated Emissions, 30 -1000 MHz

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Detector: Peak Detector for Pre-scan (Measurements with Quasi-Peak Detector)

Measuring distance 3m

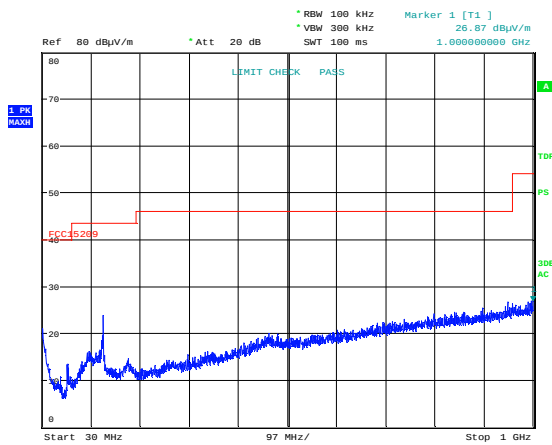
Tested in test mode with EUT transmitting on ch06.

Measured Frequency (MHz)	Carrier Frequency (MHz)	Modulation	Measured Emission (dBμV/m)	Limit (dBμV/m)	Margin (dB)
30 – 88	2440	Any	< 25	40.0	> 15
88 – 216	2440	Any	< 20	43.5	> 23.5
216 – 960	2440	Any	< 25	46.0	> 21
960 – 1000	2440	Any	< 30	54.0	> 24
150	Any	Any	26.0	43.5	17.5

See attached plots.

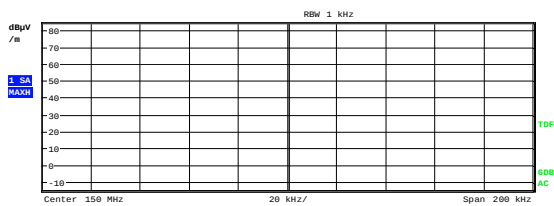
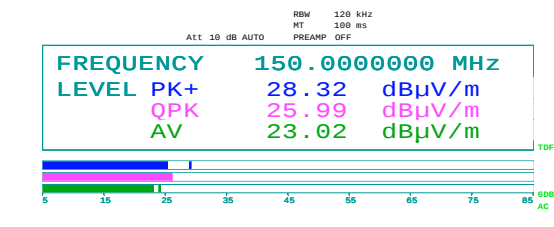
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, Clause 8.9 @ frequencies defined in clause 8.10	
Frequency	Radiated emission limit @3 meters	
30 – 88 MHz	100 μV/m	40.0 dBμV/m
88 – 216 MHz	150 μV/m	43.5 dBμV/m
216 – 960 MHz	200 μV/m	46.0 dBμV/m
960 – 1000 MHz	500 μV/m	54.0 dBμV/m
Limits above are with Quasi Peak Detector		



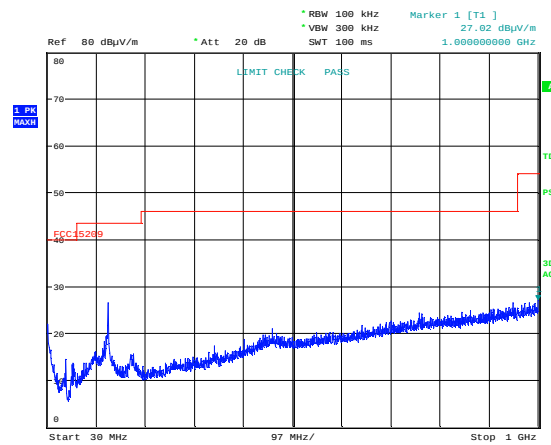
Date: 25.OCT.2021 19:23:57

Radiated Emissions 30 - 1000 MHz, 802.11g, VP



Date: 25.OCT.2021 19:14:34

Radiated Emissions 150 MHz, 802.11g, VP



Date: 25.OCT.2021 19:25:55

Radiated Emissions 30 - 1000 MHz, 802.11g, HP

3.5 Radiated Emissions, 1 -26 GHz

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Measuring distance: 3m (1 – 18 GHz)
1m (18 – 26 GHz)

RBW/VBW = 1MHz/3MHz

Carrier Frequency (MHz)	Measured Frequency (GHz)	Modulation and Bitrate	Measured Emissions (dBμV/m)		Limit (dBμV/m)		Margin (dB)	
			Peak	Average	Peak	Average	Peak	Average
Any	Any	Any	<58	<46	74	54	>18	>8

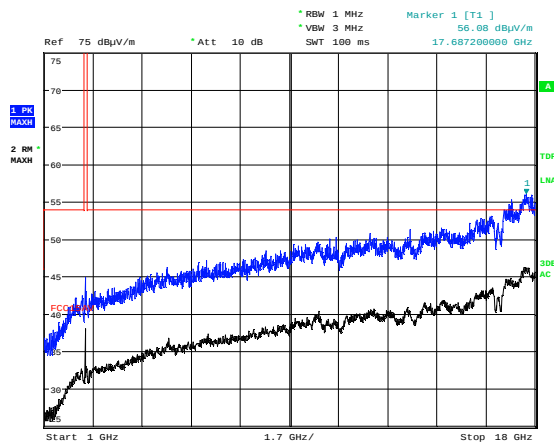
A Band Reject Filter was used for measurements from 1 GHz to 18 GHz.

Antenna factor, PreAmp Gain and Cable Loss are included in spectrum analyzer "Transducer factor".

See plots.

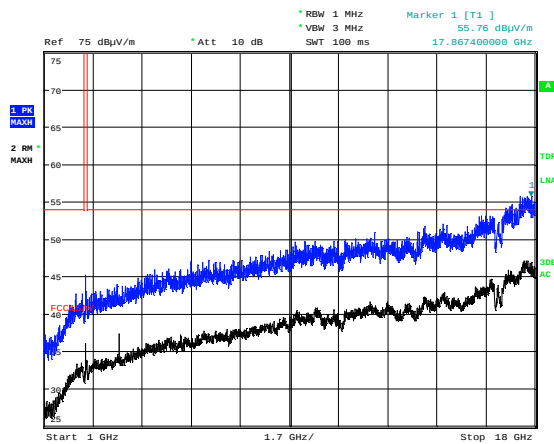
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, clause 8.9 @ frequencies defined in clause 8.10	
	Radiated emission limit @3 meters	
Frequency	Average Detector	Peak Detector
1 – 26 GHz	54.0 dBμV/m	74.0 dBμV/m



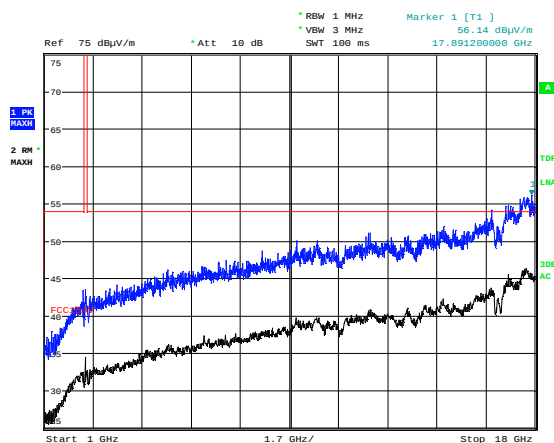
Date: 25.OCT.2021 14:56:54

Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11b 1M, HP



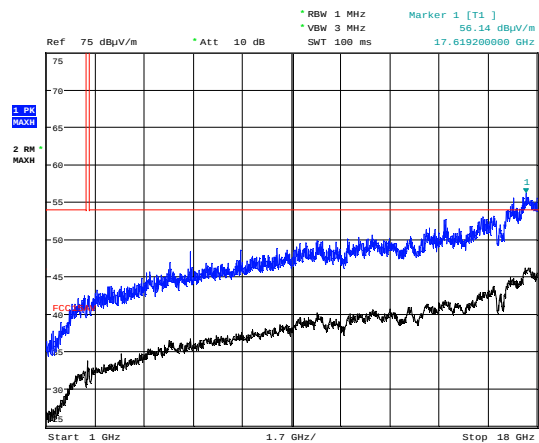
Date: 25.OCT.2021 14:46:49

Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11g 6M, HP



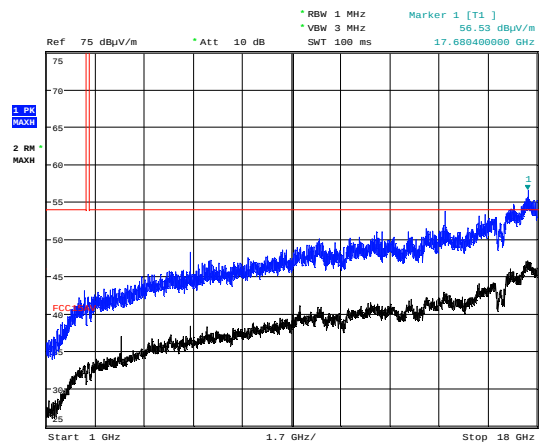
Date: 25.OCT.2021 15:02:37

Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11n HT20 MCS0, HP



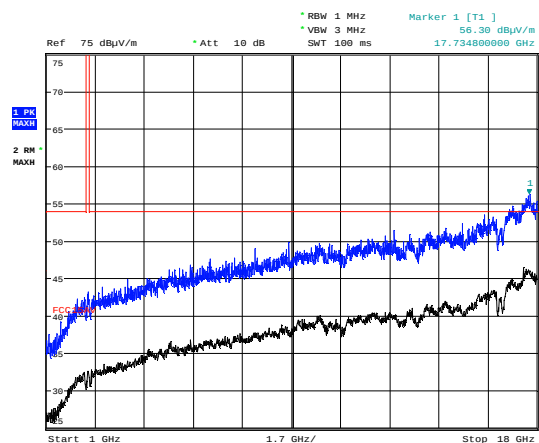
Date: 25.OCT.2021 14:54:41

Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11b 1M, VP



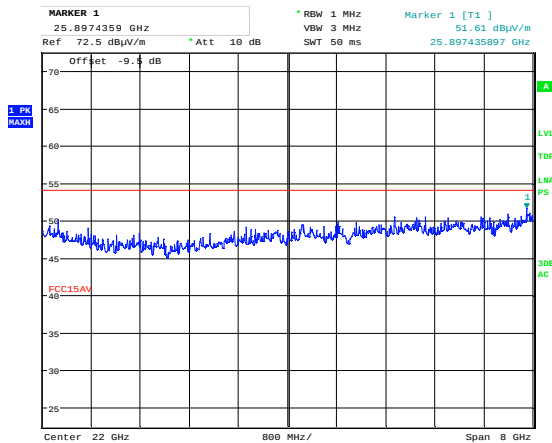
Date: 25.OCT.2021 14:44:36

Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11g 6M, VP



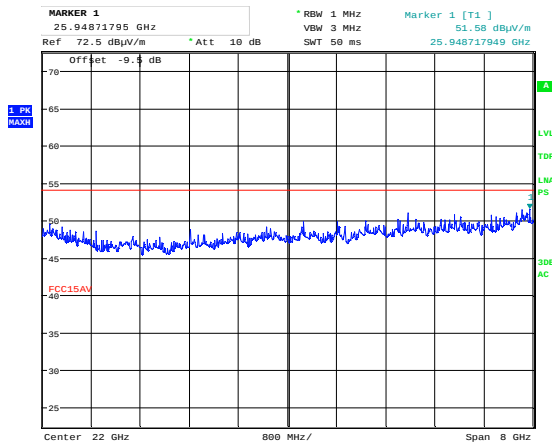
Date: 25.OCT.2021 15:00:25

Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11n HT20 MCS0, VP



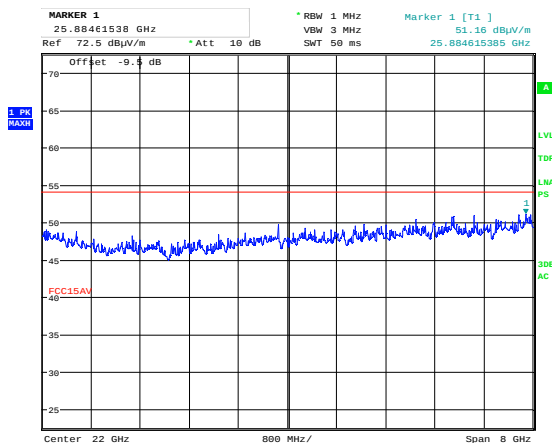
Date: 12.OCT.2021 15:15:03

Radiated Emissions 18 - 26 GHz, 2437 MHz, 802.11b 1M, HP



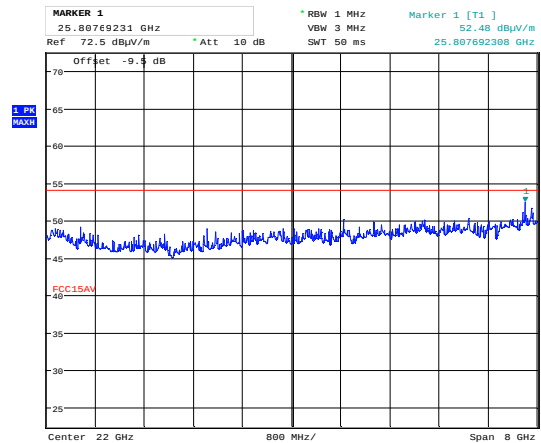
Date: 12.OCT.2021 15:19:19

Radiated Emissions 18 - 26 GHz, 2437 MHz, 802.11g 6M, HP



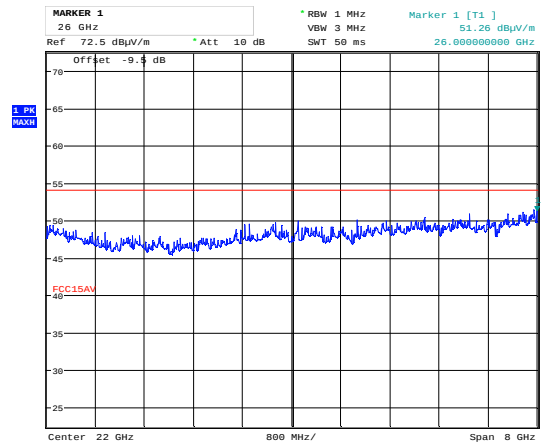
Date: 12.OCT.2021 15:29:31

Radiated Emissions 18 - 26 GHz, 2437 MHz, 802.11n HT20 MCS0, HP



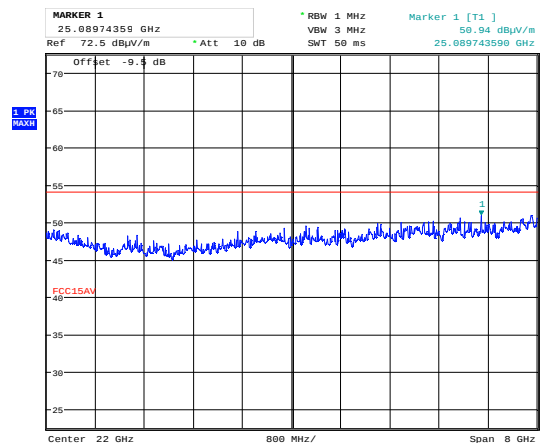
Date: 12.OCT.2021 15:15:53

Radiated Emissions 18 - 26 GHz, 2437 MHz, 802.11b 1M, VP



Date: 12.OCT.2021 15:18:33

Radiated Emissions 18 - 26 GHz, 2437 MHz, 802.11g 6M, VP



Date: 12.OCT.2021 15:30:05

Radiated Emissions 18 - 26 GHz, 2437 MHz, 802.11n HT20 MCS0, VP

4 Measurement Uncertainty

Measurement Uncertainty Values		
Test Item		Uncertainty
Output Power		±0.5 dB
Power Spectral Density		±0.5 dB
Out of Band Emissions, Conducted	< 3.6 GHz	±0.6 dB
	> 3.6 GHz	±0.9 dB
Spurious Emissions, Radiated	< 1 GHz	±2.5 dB
	> 1 GHz	±2.2 dB
Emission Bandwidth		±4 %
Power Line Conducted Emissions		+2.9 / -4.1 dB
Spectrum Mask Measurements	Frequency	±5 %
	Amplitude	±1.0 dB
Frequency Error		±0.6 ppm
Temperature Uncertainty		±1 °C

All uncertainty values are expanded standard uncertainty to give a confidence level of 95%, based on coverage factor k=2

5 LIST OF TEST EQUIPMENT

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the Test Laboratory.

No.	Model number	Description	Manufacturer	Ref. no.	Cal. date	Cal. Due
1	ESU40	Measuring Receiver	Rohde & Schwarz	LR 1639	2021-02 2022-01	2022-02 2023-01
2	6810-17B	Attenuator	Suhner	LR 1669	2021-08	2022-08
3	N0324415	BandStop Filter (2.4 GHz)	Microwave Circuits	LR 1760	COU	
4	WLK5-1100-1485-7000-40SS	Low Pass Filter (1.0 GHz)	Wainwright Inst.	LR 1761	COU	
5	317	Preamplifier	Sonoma Inst.	LR 1687	2021-08	2022-08
6	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2021-08	2022-08
7	3115	Horn Antenna	EMCO	LR 1330	N/A	
8	3117-PA	Horn Antenna +PreAmp	EMCO	LR 1717	2021-08	2022-08
9	Model 638	Antenna Horn	Narda	LR 1480	N/A	
10	ST18/SMA/N/36	RF Cable	Suhner	LR 1627	COU	

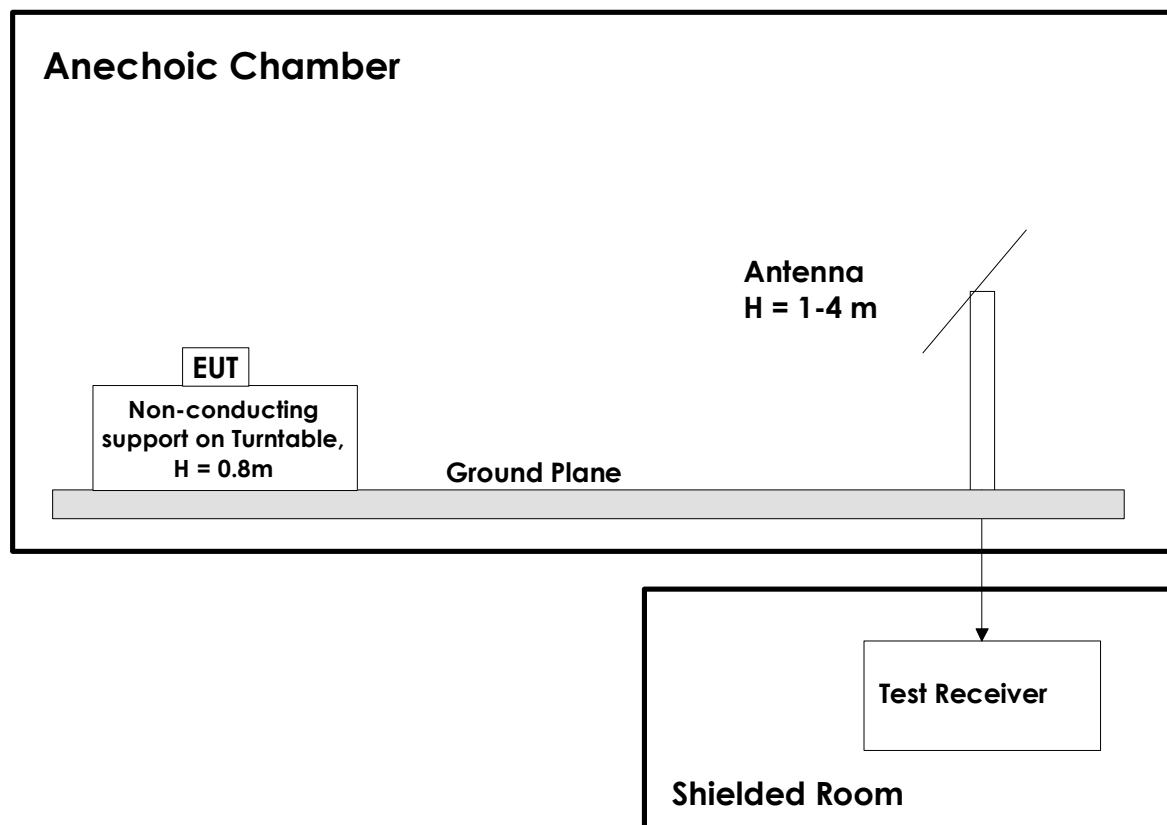
Note: COU – calibrate on use; N/A – Not Applicable

The software listed below has been used for one or more tests.

No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	EMC32	10.50.10	EMC test software
2	Nemko AS	RSPlot	1.0.8.0	Screenshots from R&S Spectrum Analyzers

6 BLOCK DIAGRAM

6.1 Test Site Radiated Emission



This test setup is used for all radiated emissions tests. For frequencies below 30 MHz the measuring distance is 10m, for all other frequencies it is 3m or 1m. Emissions above 1 GHz are measured with a Spectrum Analyzer and Horn Antenna. For measurements above 18 GHz the test receiver is moved inside the anechoic chamber and located next to the antenna to minimize the cable loss. All measurements at 1GHz and above were performed with turntable height 1.5m and with the ground plane covered by absorbers. A pre-amplifier is used for all measurements above 30 MHz, and High-Pass or Band-Pass filter is used for all harmonics.