

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
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 3 Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Order number	PRJ0033045
Tested in period	2023-08-23 to 2023-08-29
Issue date	2023-11-20
Name and address of the testing laboratory	 Nemko Scandinavia AS Instituttveien 6 2007 Kjeller, Norway www.nemko.com CAB Number: FCC: NO0001 ISED: NO0470 ISED No: 2040D-1   An accredited technical test executed under the Norwegian accreditation scheme
	 Prepared by [Frode Sveinsen]  Approved by [Jan G Eriksen]
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Revision history

Revision	Date	Comment	Sign
A	2023-11-20	First edition	FS

GENERAL REMARKS

This report applies only to the sample(s) tested. It is the manufacturer's responsibility to ensure the additional production units of this product are manufactured with identical electrical and mechanical components. The manufacturer is solely responsible for any modifications to the product that could result in non-compliance with the relevant regulations.

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Opinions expressed within this report regarding general assessments and qualifications for PASS or FAIL to the standards limits and requirements, are not part of the current accreditation. Neither are opinions expressed regarding model variants covered by the testing of this report.

CALIBRATION

All instruments used in the tests given in this test report are calibrated and traceable to national or international standards. Between calibrations all test set-ups are controlled and verified on a regular basis by periodic checks to ensure, with 95% confidence, that the instruments remain within the calibrated levels.

MEASUREMENT UNCERTAINTY

Measurement uncertainties are calculated or considered for all instruments and instrument set-ups used during these tests. Uncertainty figures are found in a separate clause in this report.

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1 INFORMATION

1.1 Test Item

Name	Toyota
Model/version	DHUnx
FCC ID	2A226-TELETMH02
ISED ID	27732-TELETMH02
Serial number	202308REVC161150
Hardware identity and/or version	Rev. C
Software identity and/or version	1.3.0-Engdrop3-Gerrit7902_3-b253bde
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: 0.0582 W 802.11g: 0.0337 W 802.11n HT20: 0.0348 W 802.11n HT40: 0.0359 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

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	AF20	FCC ID: XMR202303AF20 IC: 10224A-202306AF20	TA R2212A1318-R2V1	BT Classic
			TA R2212A1318-R1V1	BT Low Energy
			TA R2212A1318-R1V1	WLAN
			TA R2212A1318-R3V1	UNII 2TX
			TA R2212A1318-R4V1	DFS
Quectel	AG35-NA	FCC ID: XMR201905AG35NA IC: 10224A-2019AG35NA	Sporton FG912203A Sporton FG180602A	WCDMA
			Sporton FG912203B Sporton FG180602B	LTE

GSM850/GSM1900 (2G) is disabled in this product.

1.7 Power Levels

	Bitrate	Channels	Power Setting
802.11b	1M to 11M	1 to 11	16
802.11g	6M to 54M	1 to 11	15
802.11n HT20	MCS0 to MCS7	1 to 10	15
	MCS0 to MCS7	11	14
802.11n HT40	MCS0 to MCS7	3 to 8	15
	MCS0 to 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 3 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 3, 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)	3.3 (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 3, 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	109.7	109.5	108.3	107.2	108.1	105.3		
2422 MHz							104.7	102.4
2437 MHz	111.4	111.2	109.2	108.0			108.4	106.2
2452 MHz							107.6	104.5
2462 MHz	111.7	111.6	109.9	108.7	109.7	107.4		
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	14.4	14.3	13.1	11.9	12.9	10.0		
2422 MHz							9.4	7.2
2437 MHz	16.2	16.0	14.0	12.8			13.2	11.0
2452 MHz							12.4	9.2
2462 MHz	16.4	16.3	14.7	13.5	14.5	12.2		

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

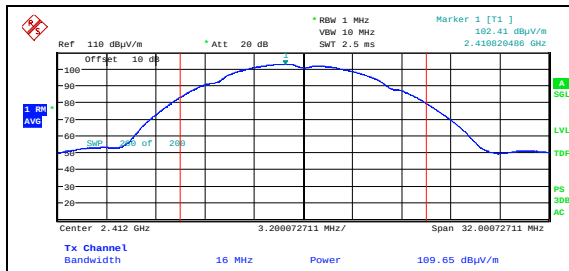
See attached plots.

Requirements:

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

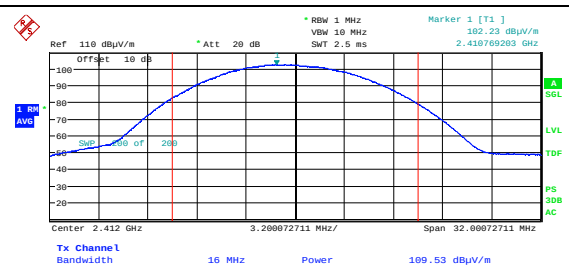
For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt (30 dBm)

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.



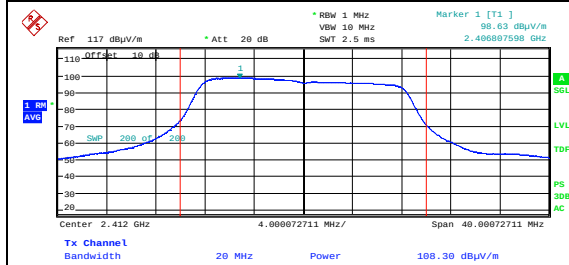
Date: 23.AUG.2023 14:58:45

Maximum Field Strength, 2412 MHz, 802.11b 1M



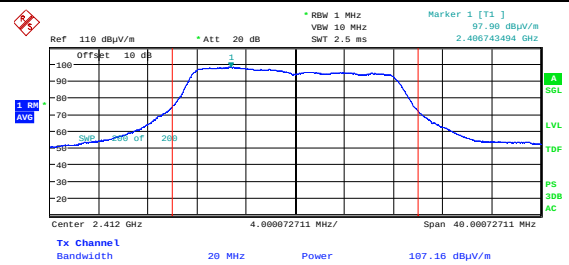
Date: 23.AUG.2023 14:53:55

Maximum Field Strength, 2412 MHz, 802.11b 11M



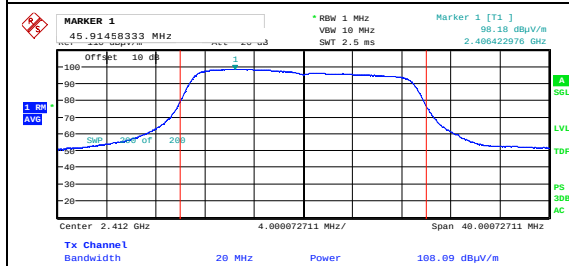
Date: 23.AUG.2023 14:09:17

Maximum Field Strength, 2412 MHz, 802.11g 6M



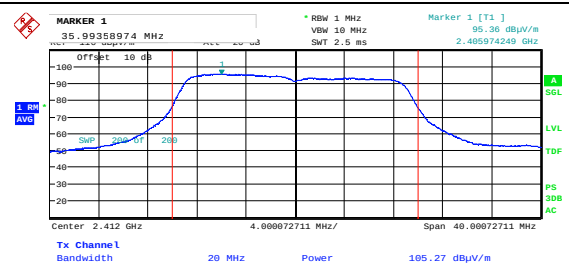
Date: 23.AUG.2023 14:27:48

Maximum Field Strength, 2412 MHz, 802.11g 54M



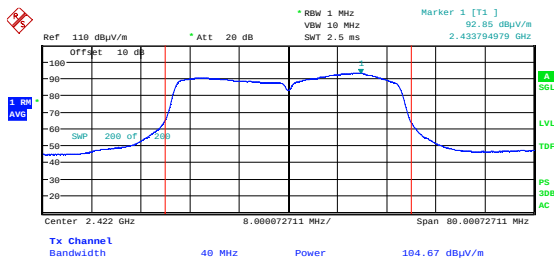
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Maximum Field Strength, 2412 MHz, 802.11n HT20 MCS0



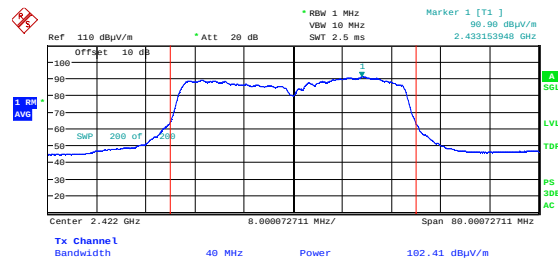
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Maximum Field Strength, 2412 MHz, 802.11n HT20 MCS7



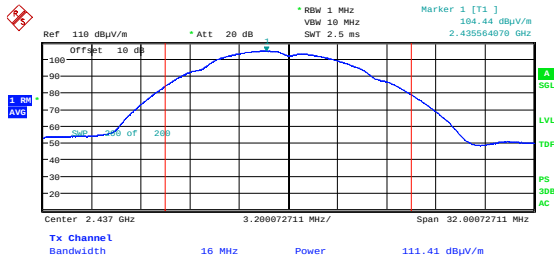
Date: 23.AUG.2023 15:58:58

Maximum Field Strength, 2422 MHz, 802.11n HT40 MCS0



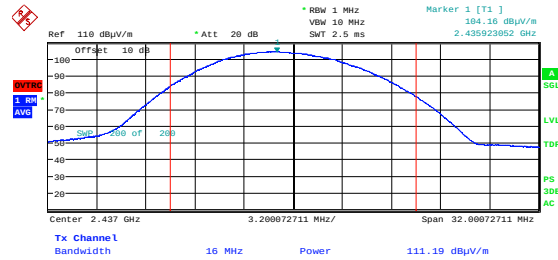
Date: 23.AUG.2023 16:01:35

Maximum Field Strength, 2422 MHz, 802.11n HT40 MCS7



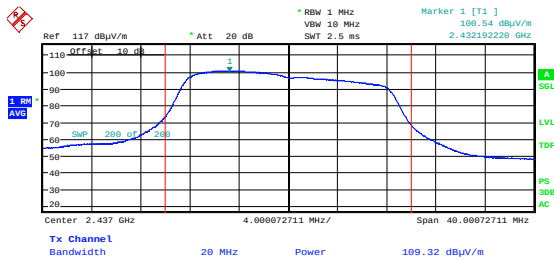
Date: 23.AUG.2023 14:34:32

Maximum Field Strength, 2437 MHz, 802.11b 1M



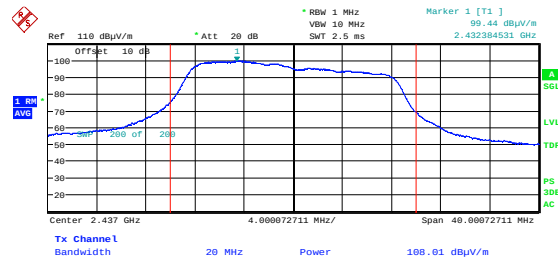
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Maximum Field Strength, 2437 MHz, 802.11b 11M



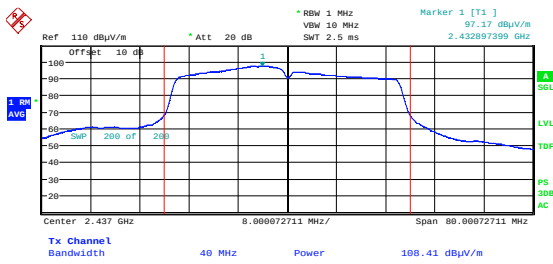
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Maximum Field Strength, 2437 MHz, 802.11g 6M



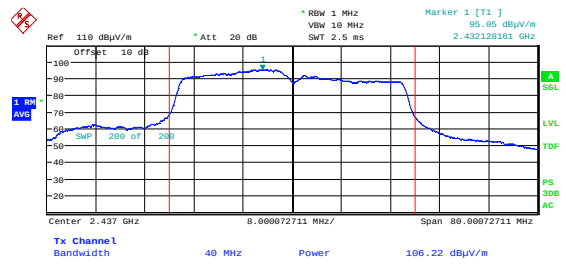
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Maximum Field Strength, 2437 MHz, 802.11g 54M



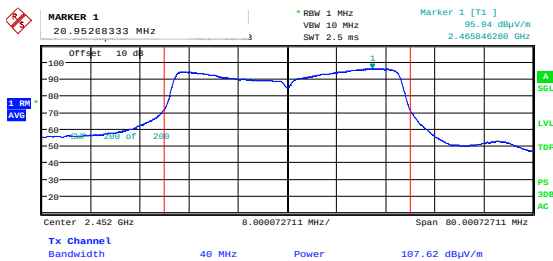
Date: 23.AUG.2023 16:14:01

Maximum Field Strength, 2437 MHz, 802.11n HT40 MCS0



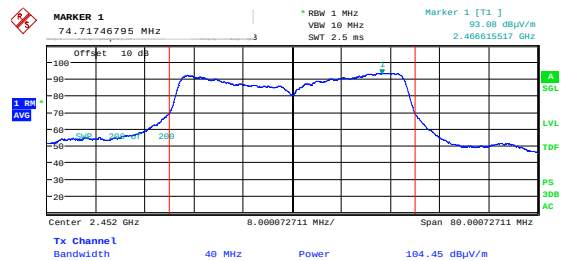
Date: 23.AUG.2023 16:06:55

Maximum Field Strength, 2437 MHz, 802.11n HT40 MCS7



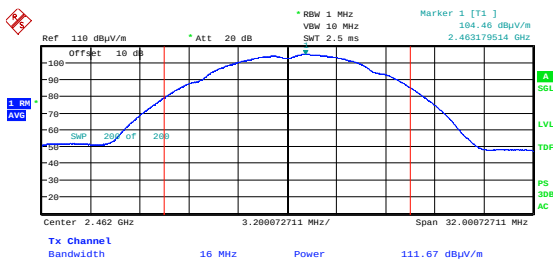
Date: 23.AUG.2023 15:58:36

Maximum Field Strength, 2452 MHz, 802.11n HT40 MCS0



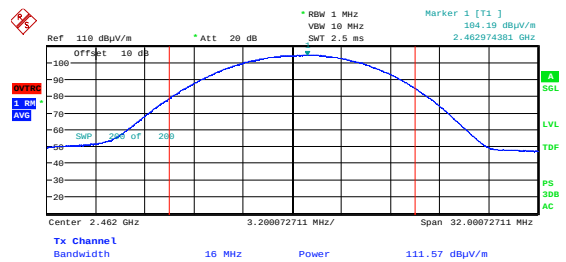
Date: 23.AUG.2023 15:44:06

Maximum Field Strength, 2452 MHz, 802.11n HT40 MCS7



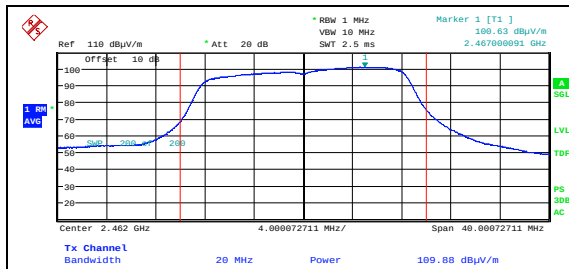
Date: 23.AUG.2023 14:45:06

Maximum Field Strength, 2462 MHz, 802.11b 1M



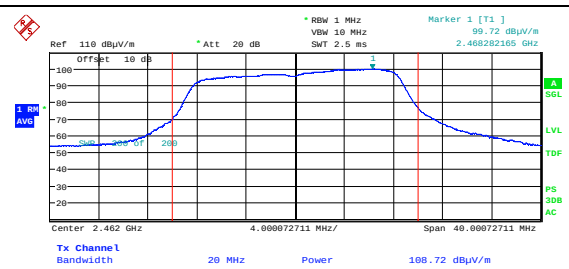
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Maximum Field Strength, 2462 MHz, 802.11b 11M



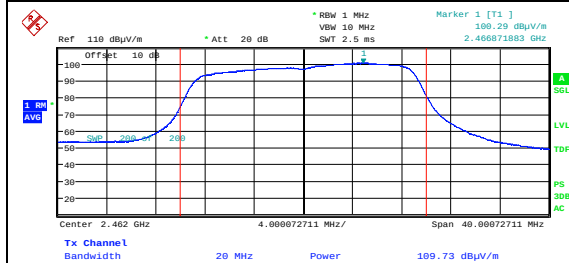
Date: 23.AUG.2023 14:20:45

Maximum Field Strength, 2462 MHz, 802.11g 6M



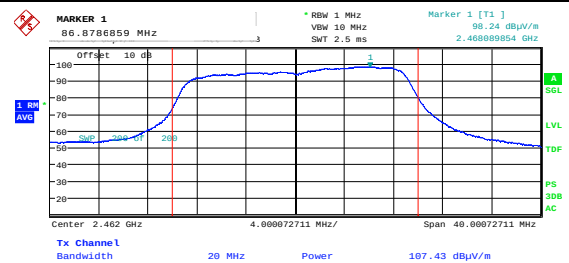
Date: 23.AUG.2023 14:23:47

Maximum Field Strength, 2462 MHz, 802.11g 54M



Date: 23.AUG.2023 15:03:56

Maximum Field Strength, 2462 MHz, 802.11n HT20 MCS0



Date: 23.AUG.2023 15:18:24

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 Canada 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)	ISSED (MHz)	FCC (GHz)	ISSED (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

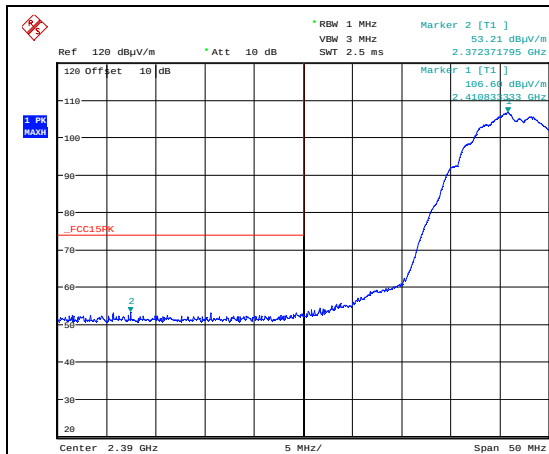
Test Results: Complies

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	53.2	41.4	74	54	20.8	12.6
	11b 11M	53.3	41.5	74	54	20.7	12.5
	11g 6M	57.5	45.3	74	54	16.5	8.7
	11g 54M	65.2	45.6	74	54	8.8	8.4
	11n HT20 MCS0	59.1	46.0	74	54	14.9	8.0
	11n HT20 MCS7	62.6	46.1	74	54	11.4	7.9
2422	11n HT40 MCS0	57.6	43.9	74	54	16.4	10.1
	11n HT40 MCS7	57.4	44.0	74	54	16.6	10.0
2452	11n HT40 MCS0	69.1	52.0	74	54	4.9	2.0
	11n HT40 MCS7	66.5	50.8	74	54	7.5	3.2
2462	11b 1M	55.5	43.3	74	54	18.5	10.7
	11b 11M	54.9	43.9	74	54	19.1	10.1
	11g 6M	59.9	46.4	74	54	14.1	7.6
	11g 54M	71.4	51.6	74	54	2.6	2.4
	11n HT20 MCS0	60.5	46.9	74	54	13.5	7.1
	11n HT20 MCS7	69.7	49.2	74	54	4.3	4.8

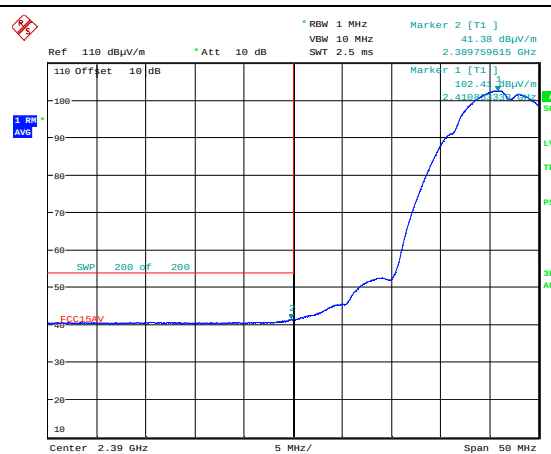
Average values were measured using trace averaging (SA1), Ref. ANSI C63.10-2013 (Duty Cycle ≈100%).

See attached plots.



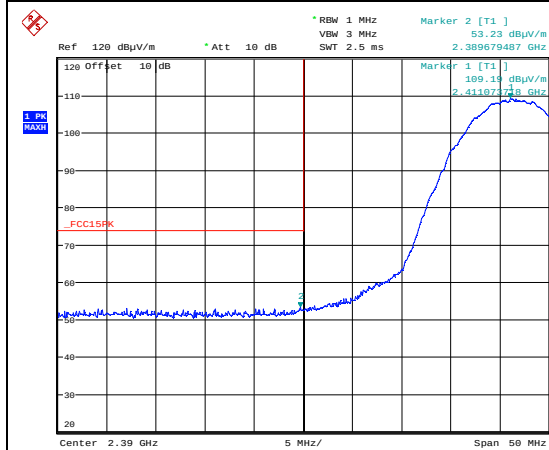
Date: 23.AUG.2023 14:59:31

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



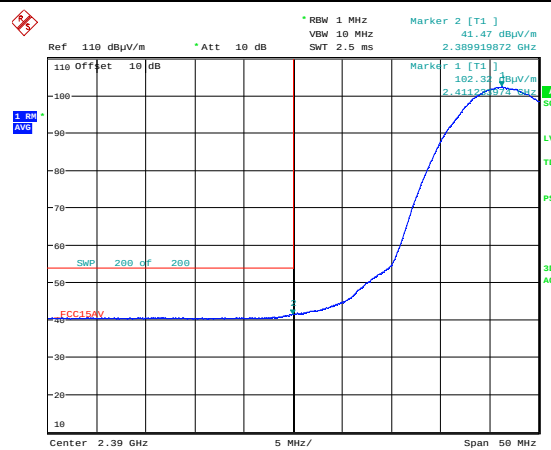
Date: 23.AUG.2023 14:59:52

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



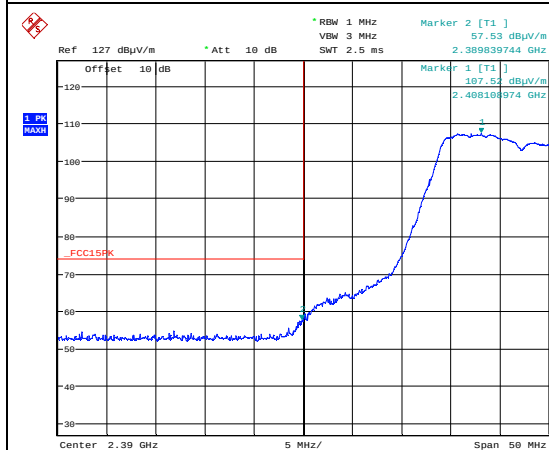
Date: 23.AUG.2023 14:54:41

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



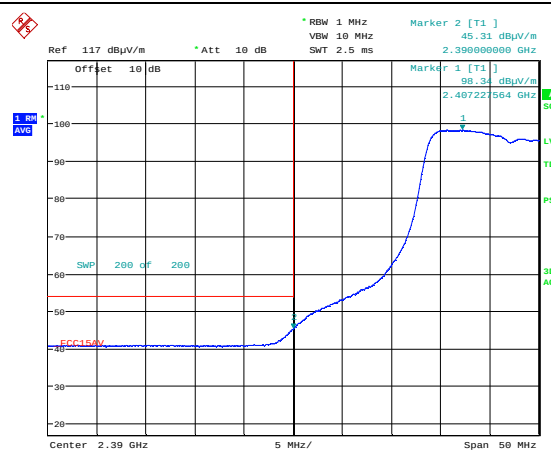
Date: 23.AUG.2023 14:55:03

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



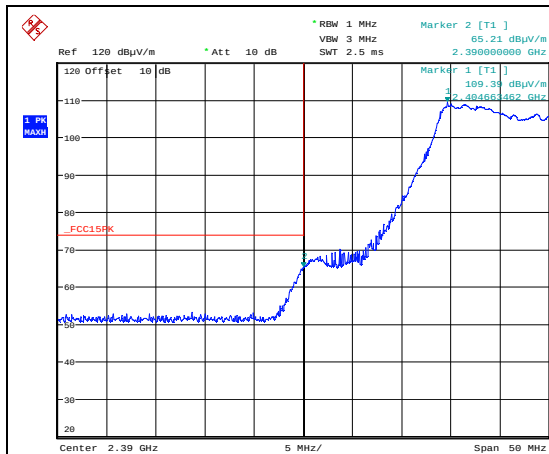
Date: 23.AUG.2023 14:12:38

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



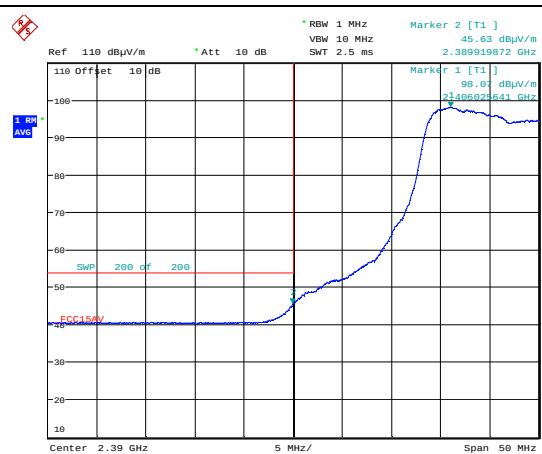
Date: 23.AUG.2023 14:13:23

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



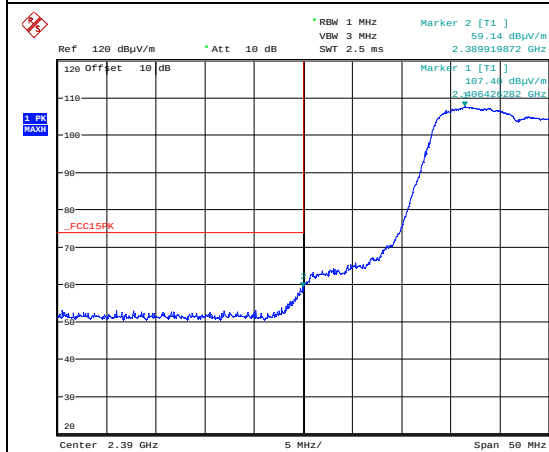
Date: 23.AUG.2023 14:29:51

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



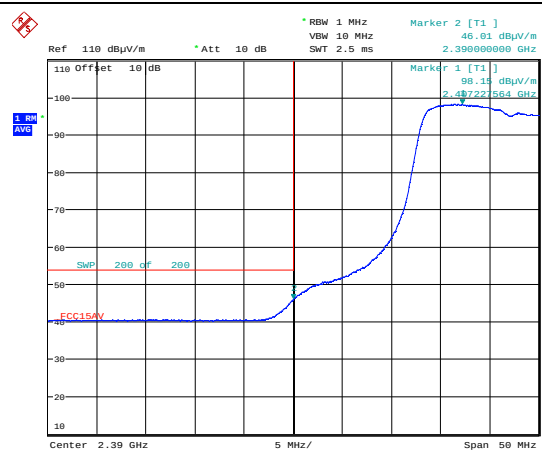
Date: 23.AUG.2023 14:30:33

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



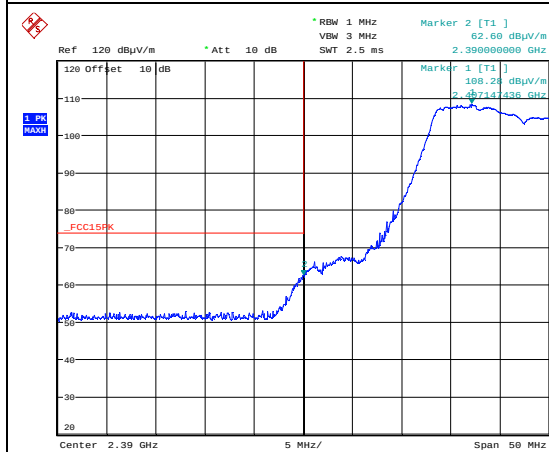
Date: 23.AUG.2023 15:30:22

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



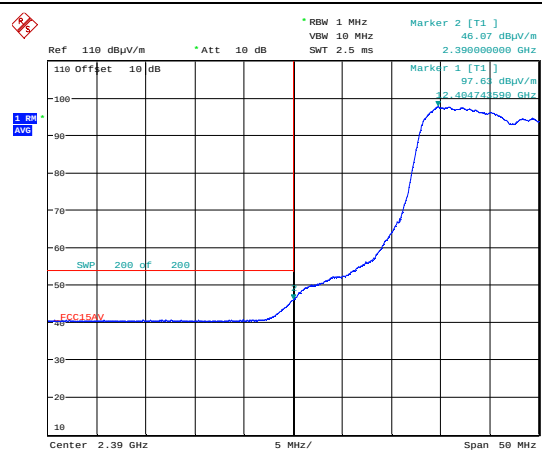
Date: 23.AUG.2023 15:30:45

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



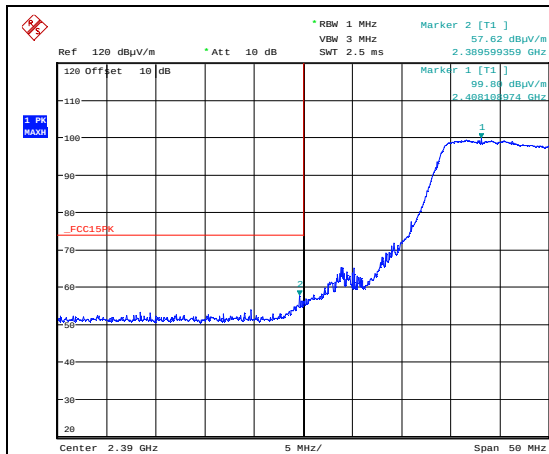
Date: 23.AUG.2023 15:26:11

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



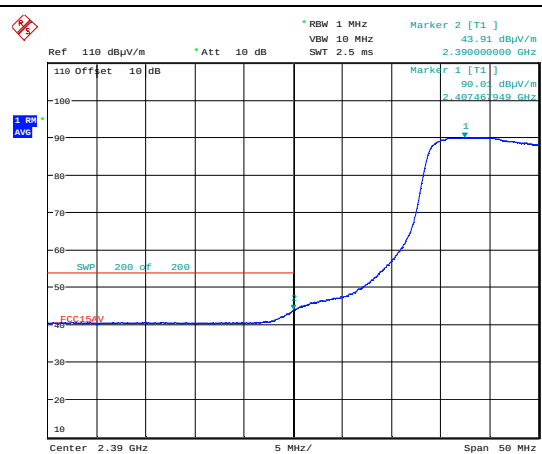
Date: 23.AUG.2023 15:27:07

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



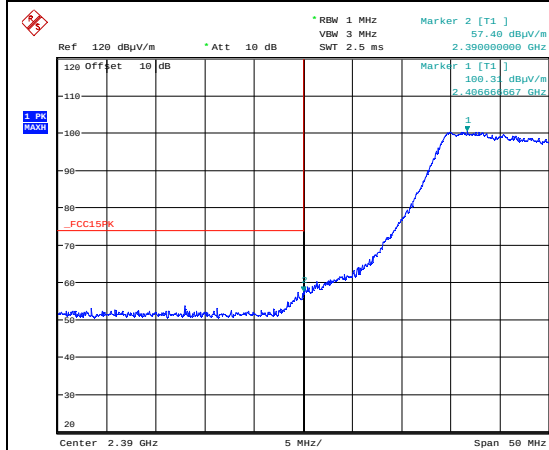
Date: 23.AUG.2023 15:59:47

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



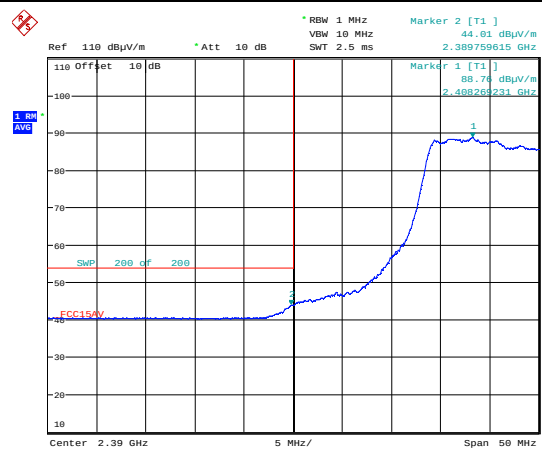
Date: 23.AUG.2023 16:00:09

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



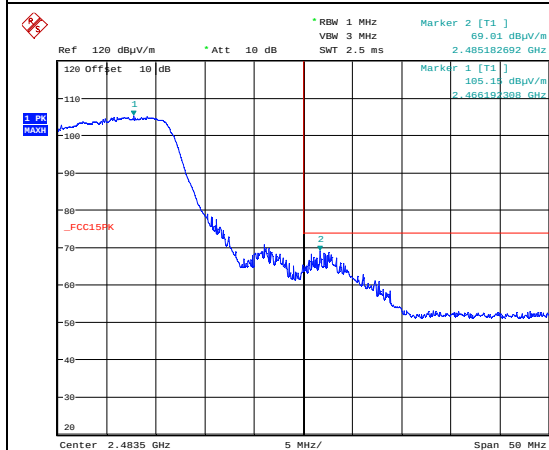
Date: 23.AUG.2023 16:02:21

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



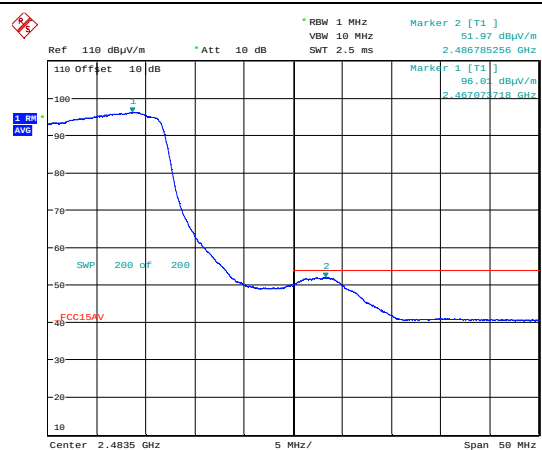
Date: 23.AUG.2023 16:02:43

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



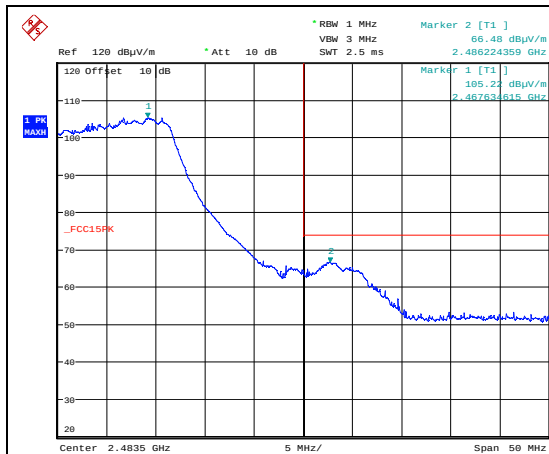
Date: 23.AUG.2023 15:49:37

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS0, Peak PL12



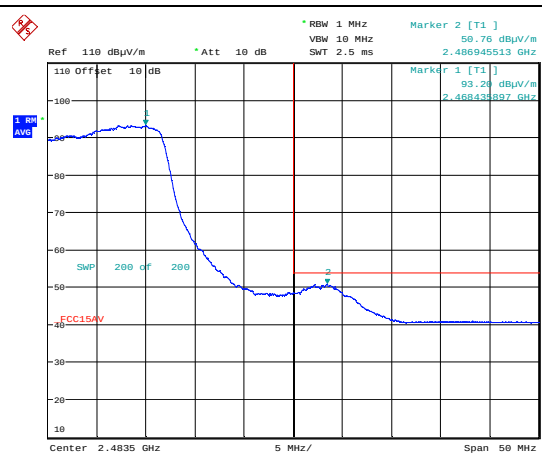
Date: 23.AUG.2023 15:46:59

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS0, Average PL12



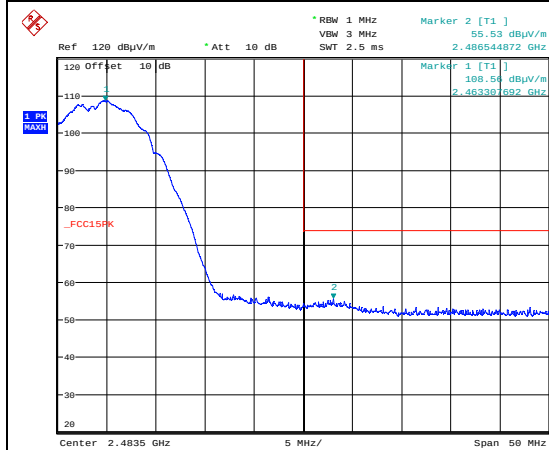
Date: 23.AUG.2023 15:43:05

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS7, Peak PL11



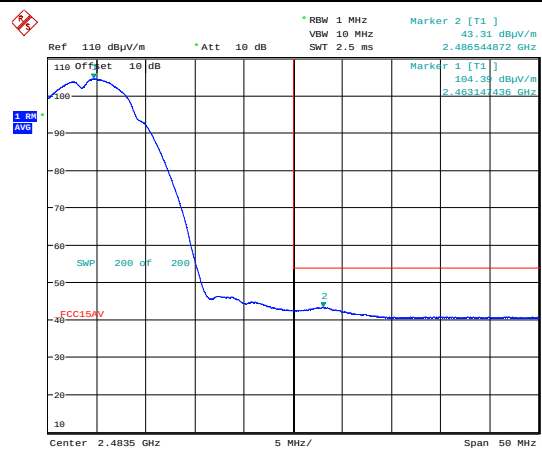
Date: 23.AUG.2023 15:42:15

Upper Band Edge, 2452 MHz, 802.11n HT40 MCS7, Average PL11



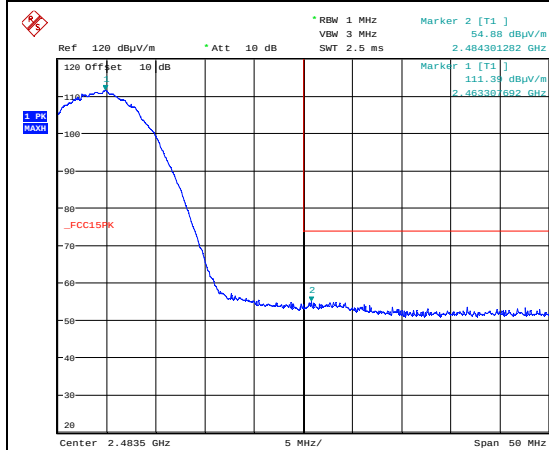
Date: 23.AUG.2023 14:46:33

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



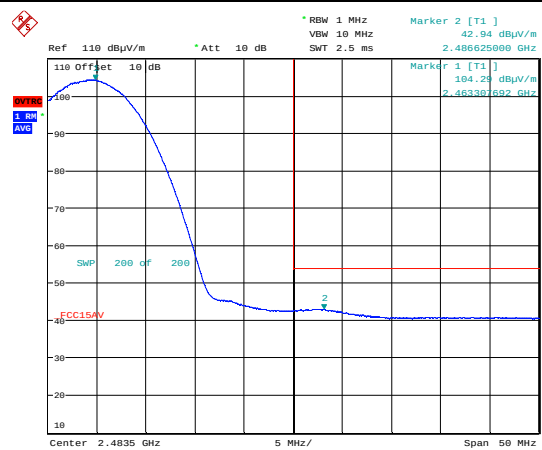
Date: 23.AUG.2023 14:48:15

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



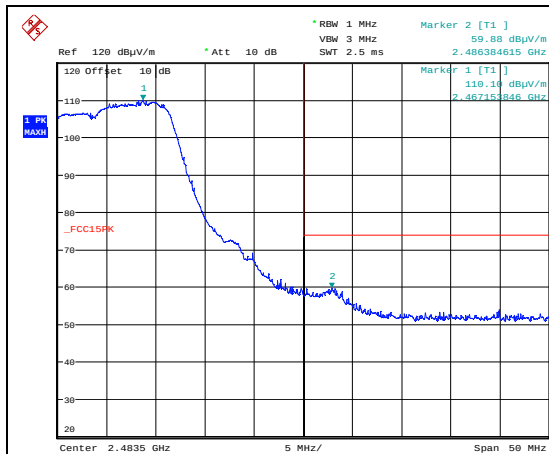
Date: 23.AUG.2023 14:42:12

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



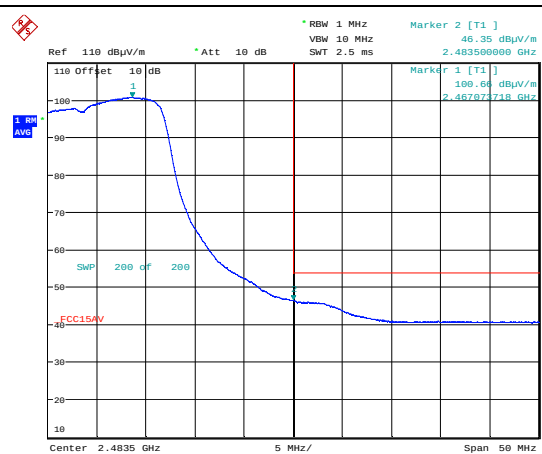
Date: 23.AUG.2023 14:42:44

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



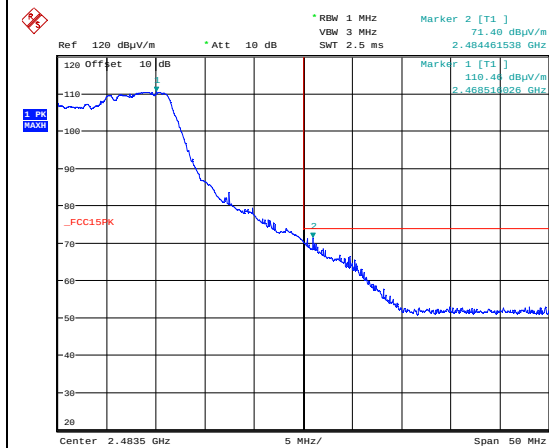
Date: 23.AUG.2023 14:19:52

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



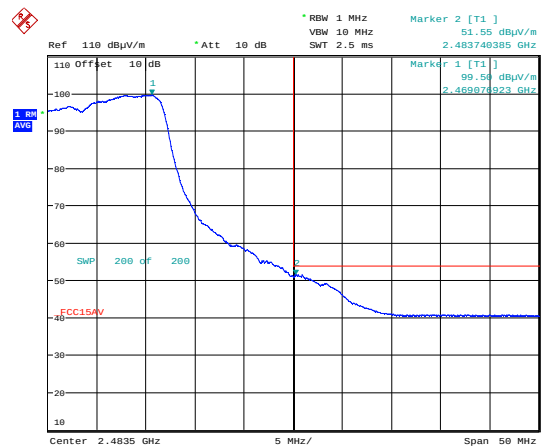
Date: 23.AUG.2023 14:19:04

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



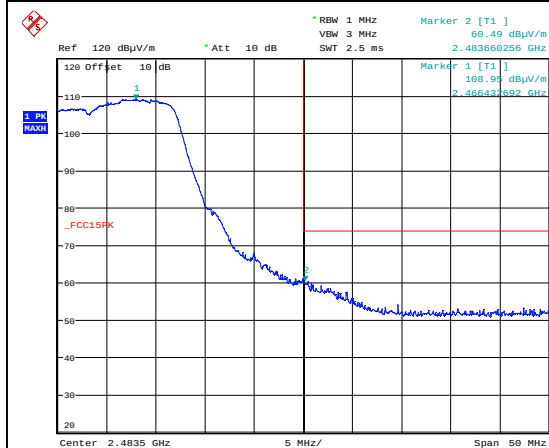
Date: 23.AUG.2023 14:22:50

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



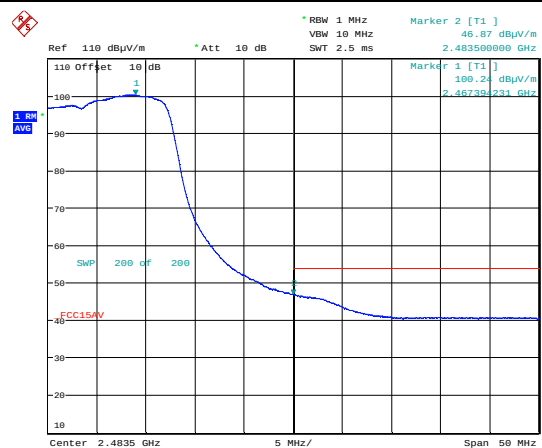
Date: 23.AUG.2023 14:22:00

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



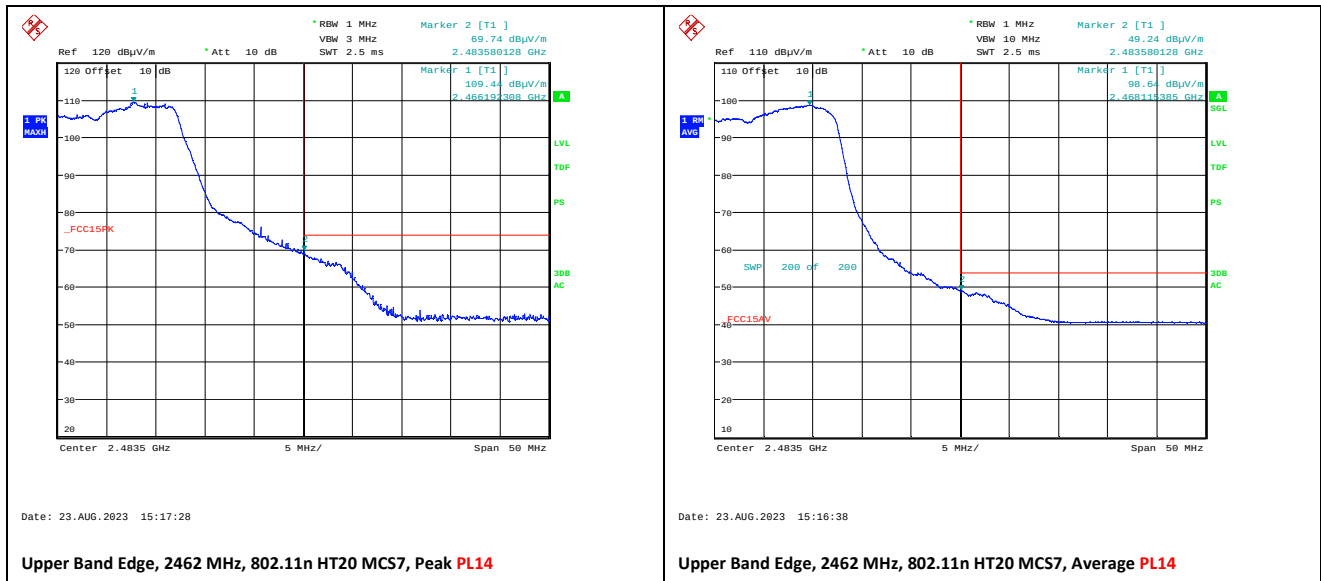
Date: 23.AUG.2023 15:04:42

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



Date: 23.AUG.2023 15:05:02

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

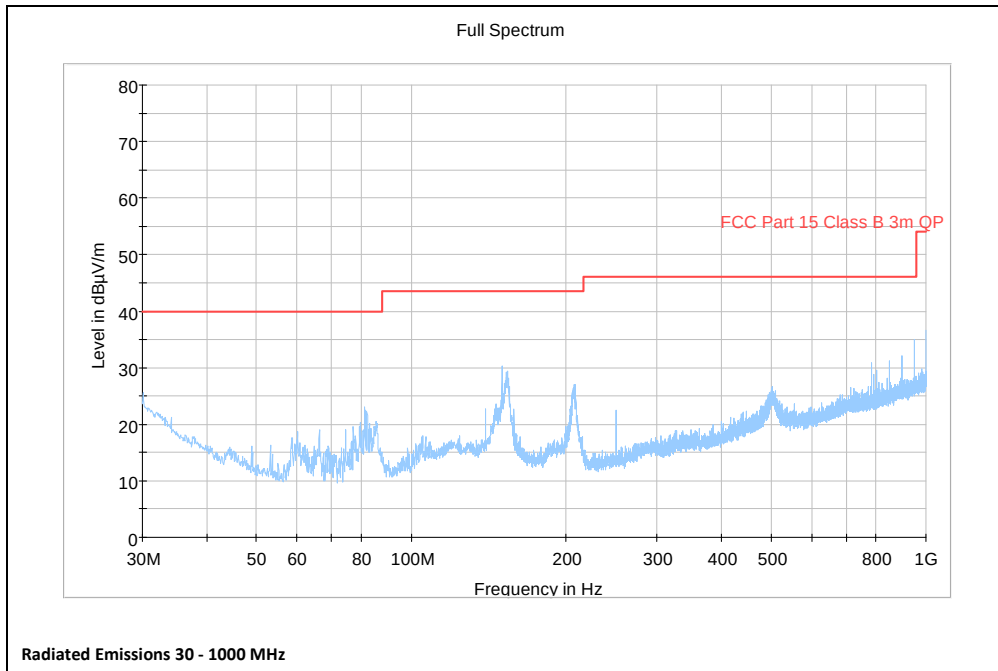
Measuring distance 3m

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
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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	



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	< 56	< 46	74	54	>18	>8

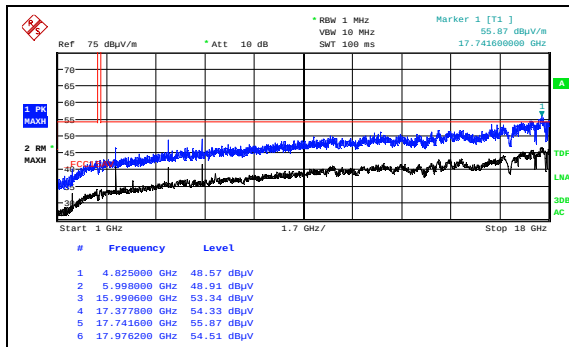
A Band Reject Filter was used for measurements from 1 GHz to 18 GHz.

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

See plots.

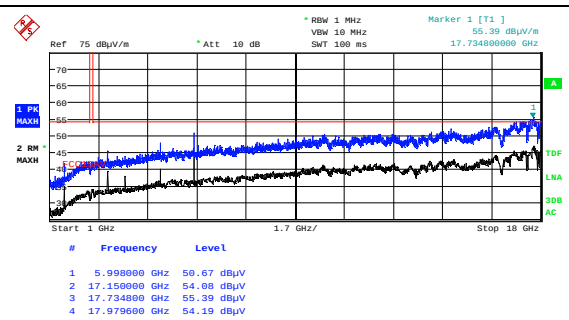
Requirements/Limit

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



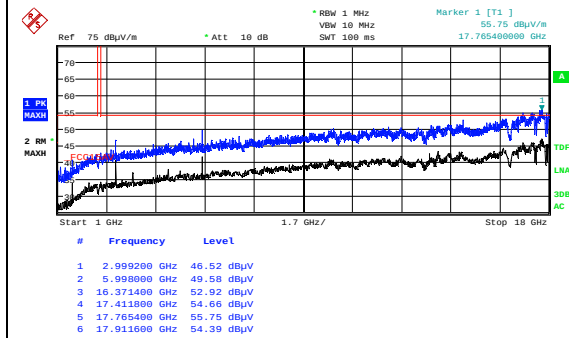
Date: 25.AUG.2023 14:45:25

Radiated Emissions 1 - 18 GHz, 2412 MHz, 802.11b 11M, VP



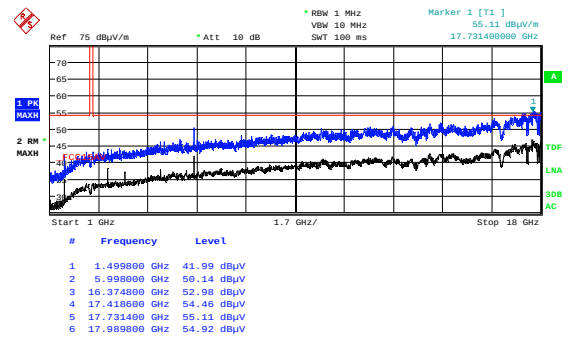
Date: 25.AUG.2023 14:47:22

HP



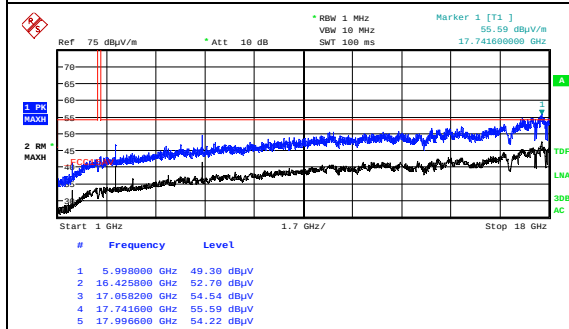
Date: 25.AUG.2023 14:20:02

Radiated Emissions 1 - 18 GHz, 2412 MHz, 802.11g 54M, VP



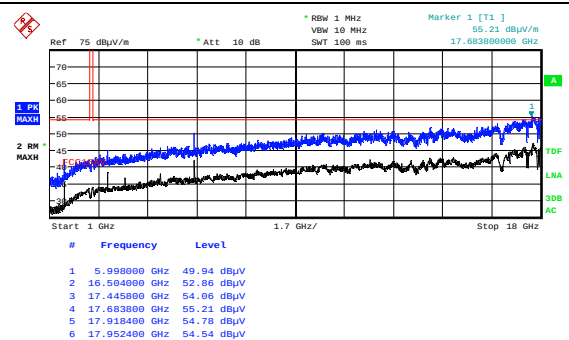
Date: 25.AUG.2023 14:21:59

HP



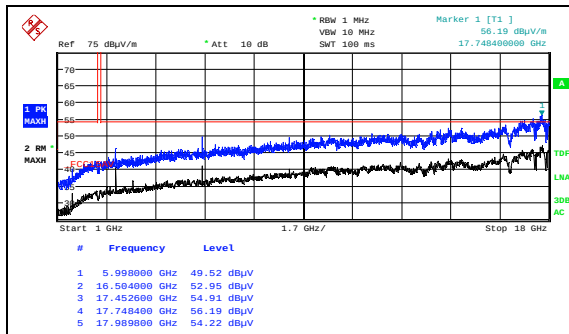
Date: 25.AUG.2023 15:05:45

Radiated Emissions 1 - 18 GHz, 2412 MHz, 802.11n HT20 MCS7, VP



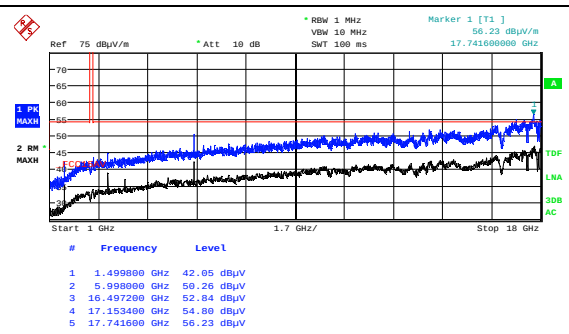
Date: 25.AUG.2023 15:07:42

HP



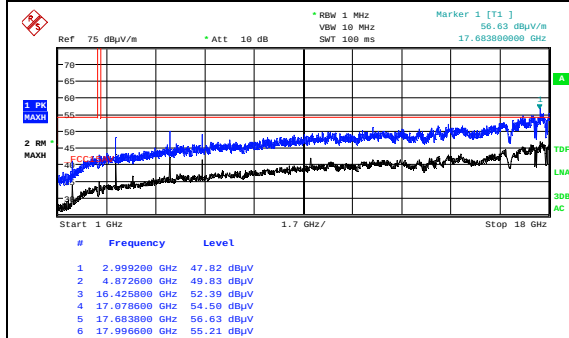
Date: 25.AUG.2023 15:28:24

Radiated Emissions 1 - 18 GHz, 2422 MHz, 802.11n HT40 MCS7, VP



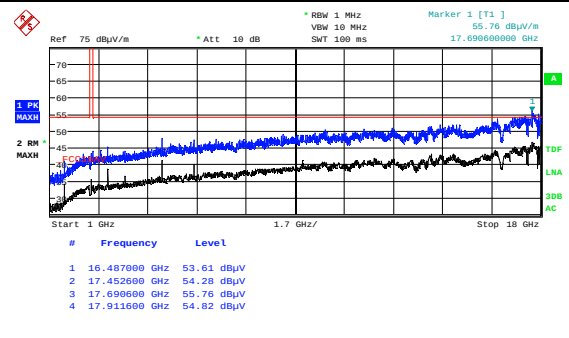
Date: 25.AUG.2023 15:30:21

HP



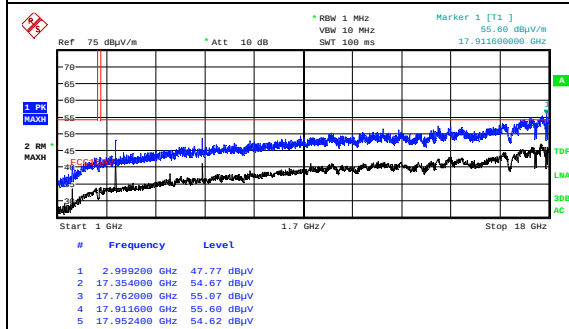
Date: 25.AUG.2023 14:38:54

Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11b 11M, VP



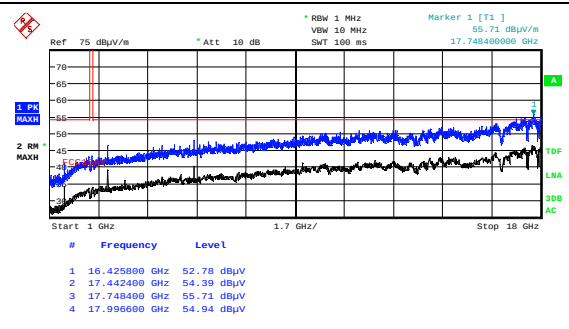
Date: 25.AUG.2023 14:41:07

HP



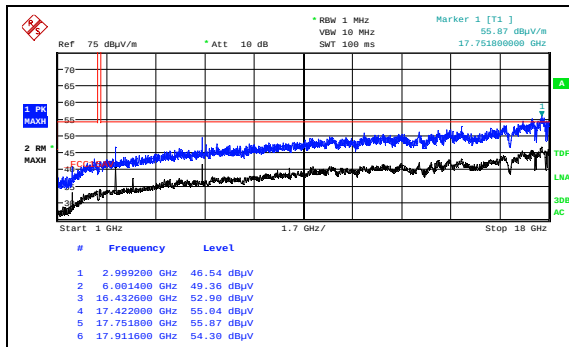
Date: 25.AUG.2023 14:06:42

Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11g 54M, VP



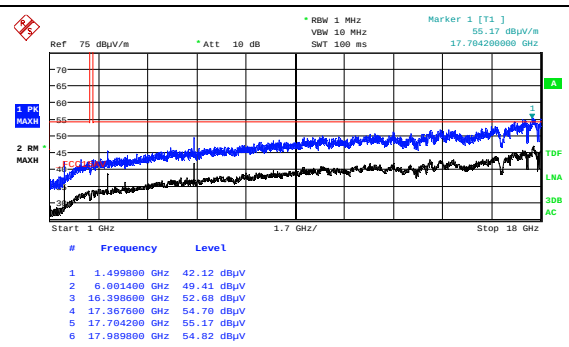
Date: 25.AUG.2023 14:12:36

HP



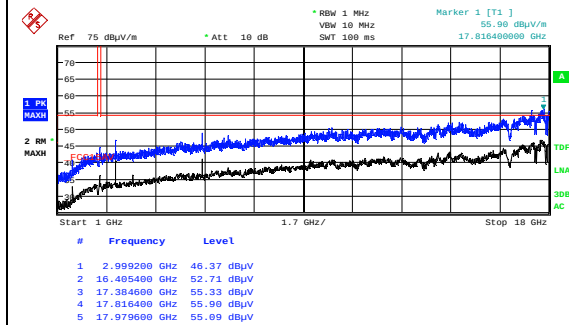
Date: 25.AUG.2023 14:58:19

Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11n HT20 MCS7, VP



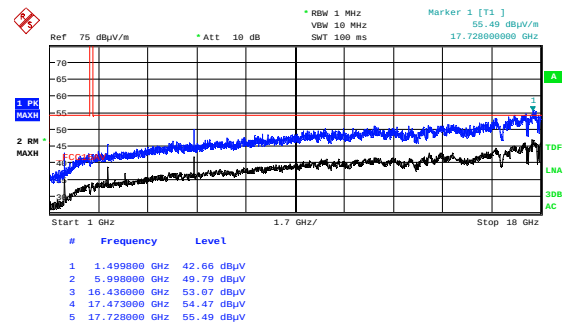
Date: 25.AUG.2023 15:00:16

HP



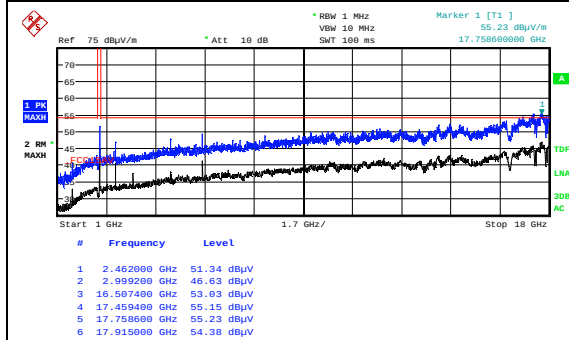
Date: 25.AUG.2023 15:20:53

Radiated Emissions 1 - 18 GHz, 2437 MHz, 802.11n HT40 MCS7, VP



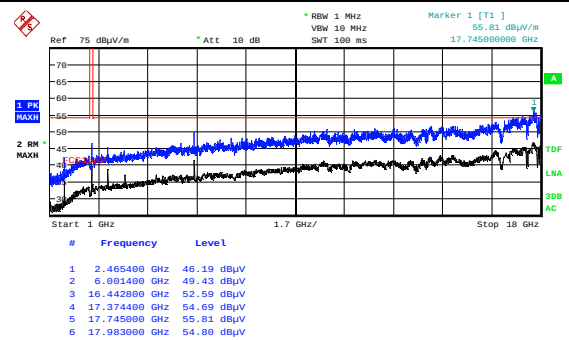
Date: 25.AUG.2023 15:22:49

HP



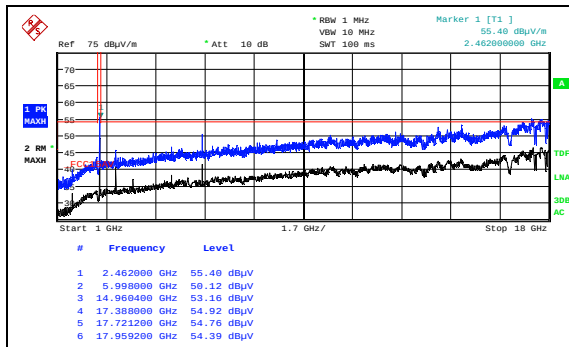
Date: 25.AUG.2023 15:33:42

Radiated Emissions 1 - 18 GHz, 2452 MHz, 802.11n HT40 MCS7, VP



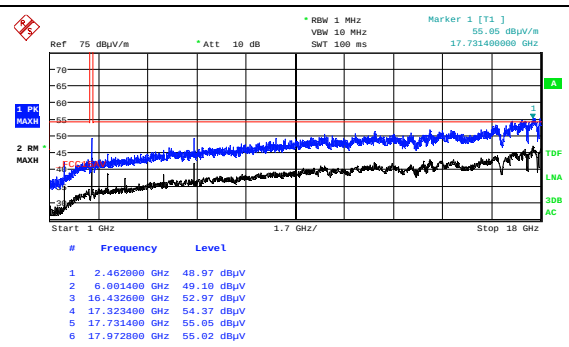
Date: 25.AUG.2023 15:35:39

HP



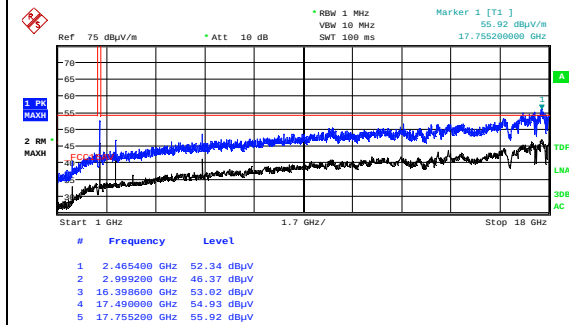
Date: 25.AUG.2023 14:52:41

Radiated Emissions 1 - 18 GHz, 2462 MHz, 802.11b 11M, VP



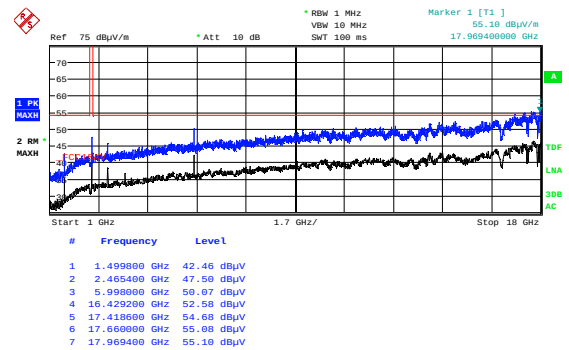
Date: 25.AUG.2023 14:54:38

HP



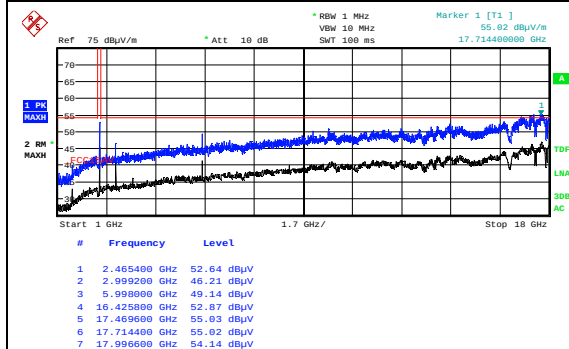
Date: 25.AUG.2023 14:25:45

Radiated Emissions 1 - 18 GHz, 2462 MHz, 802.11g 54M, VP



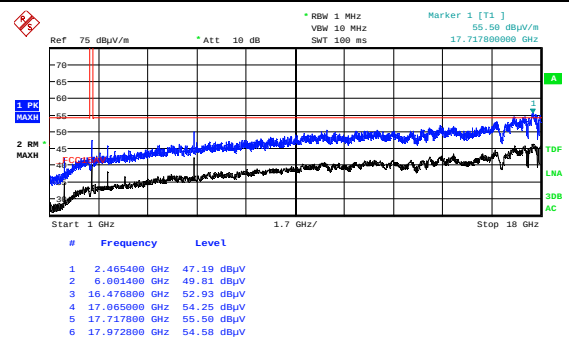
Date: 25.AUG.2023 14:27:41

HP



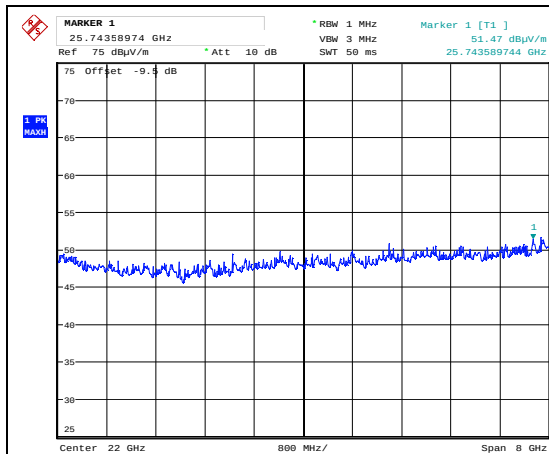
Date: 25.AUG.2023 15:11:37

Radiated Emissions 1 - 18 GHz, 2462 MHz, 802.11n HT20 MCS7, VP



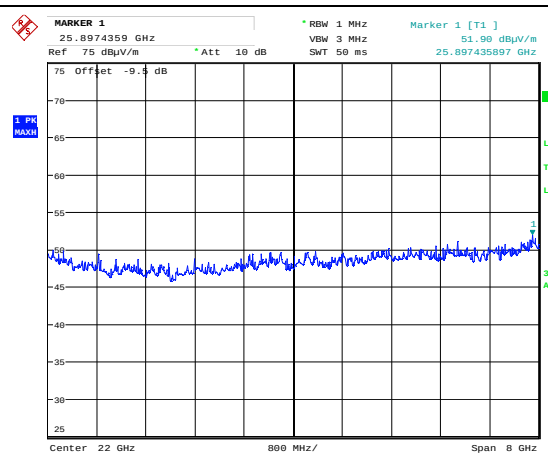
Date: 25.AUG.2023 15:13:34

HP



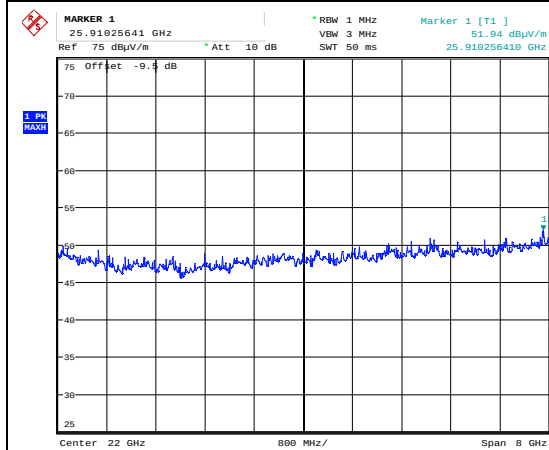
Date: 28.AUG.2023 15:43:29

Emissions 18 - 26 GHz, 2412 MHz, 802.11g 54M, VP, @1m



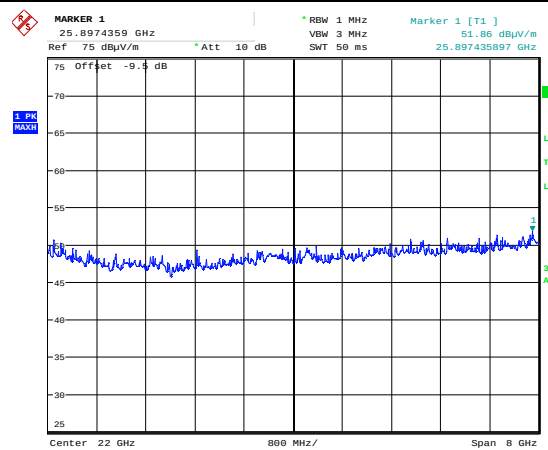
Date: 28.AUG.2023 15:41:15

HP



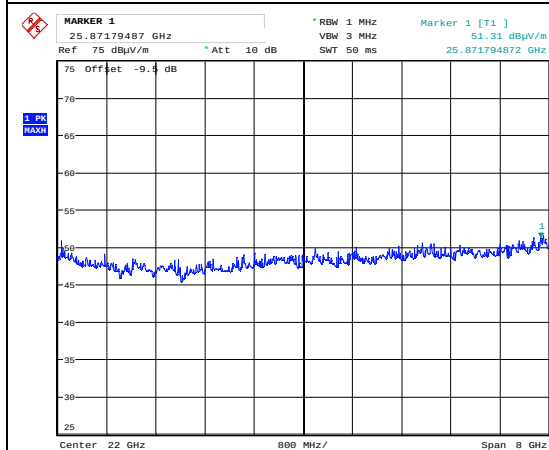
Date: 28.AUG.2023 15:19:49

Emissions 18 - 26 GHz, 2437 MHz, 802.11b 11M, VP, @1m



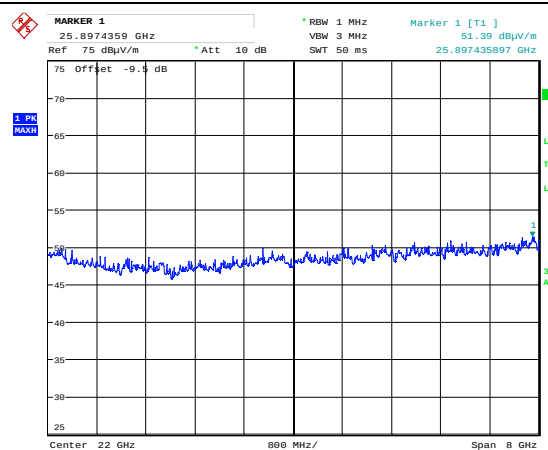
Date: 28.AUG.2023 15:17:44

HP



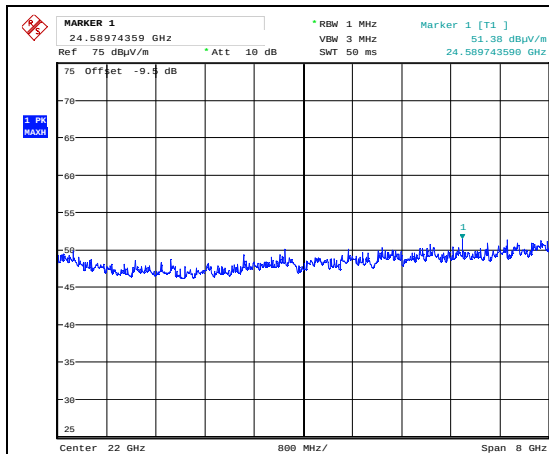
Date: 28.AUG.2023 15:23:05

Emissions 18 - 26 GHz, 2437 MHz, 802.11g 54M, VP, @1m



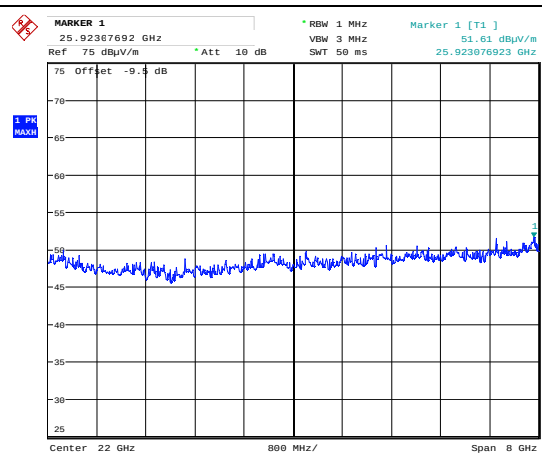
Date: 28.AUG.2023 15:26:26

HP



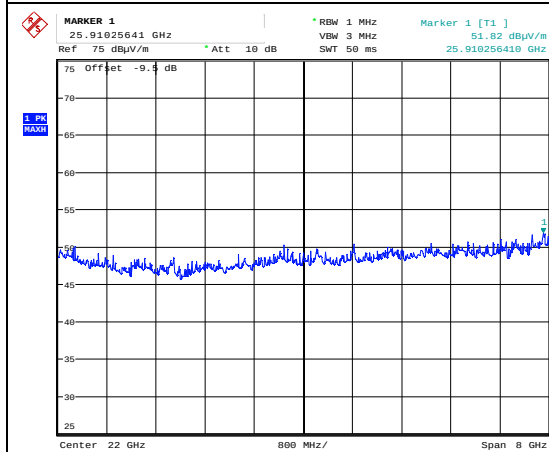
Date: 28.AUG.2023 15:31:19

Emissions 18 - 26 GHz, 2437 MHz, 802.11n HT20 MCS0, VP, @1m



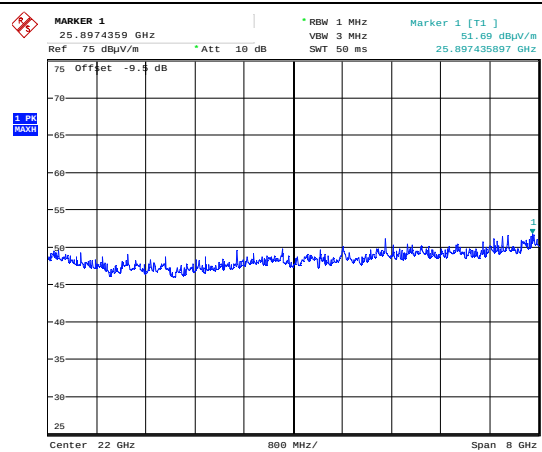
Date: 28.AUG.2023 15:29:15

HP



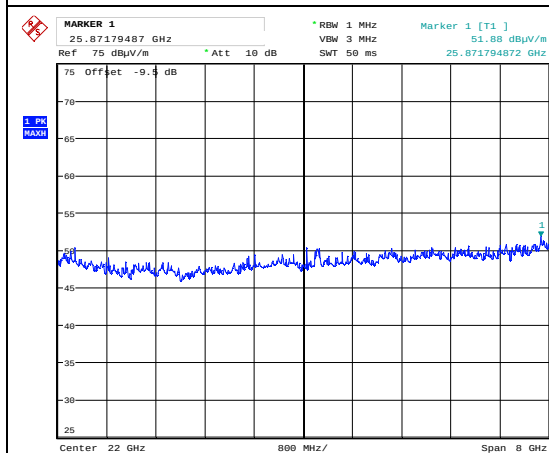
Date: 28.AUG.2023 15:34:40

Emissions 18 - 26 GHz, 2437 MHz, 802.11n HT40 MCS0, VP, @1m



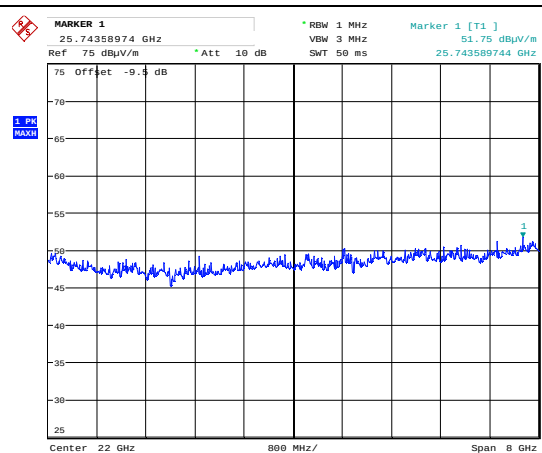
Date: 28.AUG.2023 15:36:55

HP



Date: 28.AUG.2023 15:47:02

Emissions 18 - 26 GHz, 2462 MHz, 802.11g 54M, VP, @1m



Date: 28.AUG.2023 15:49:18

HP

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	2023-01	2024-01
2	N0324415	BandStop Filter (2.4GHz)	Microwave Circuits	LR 1760	COU	
3	WLK5-1100-1485-7000-40SS	Low Pass Filter (1.0 GHz)	Wainwright Inst.	LR 1761	COU	
4	310	Preamplifier	Sonoma Inst.	LR 1686	2023-08	2024-08
5	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2023-08	2024-08
6	3115	Horn Antenna	EMCO	LR 1330	2022-12	2027-12
7	3117-PA	Horn Antenna +PreAmp	EMCO	LR 1717	2023-08	2024-08
8	JB3	BiLog Antenna	Sunol	N-4525	2023-04	2026-04
9	Model 638	Antenna Horn	Narda	LR 1480	N/A	

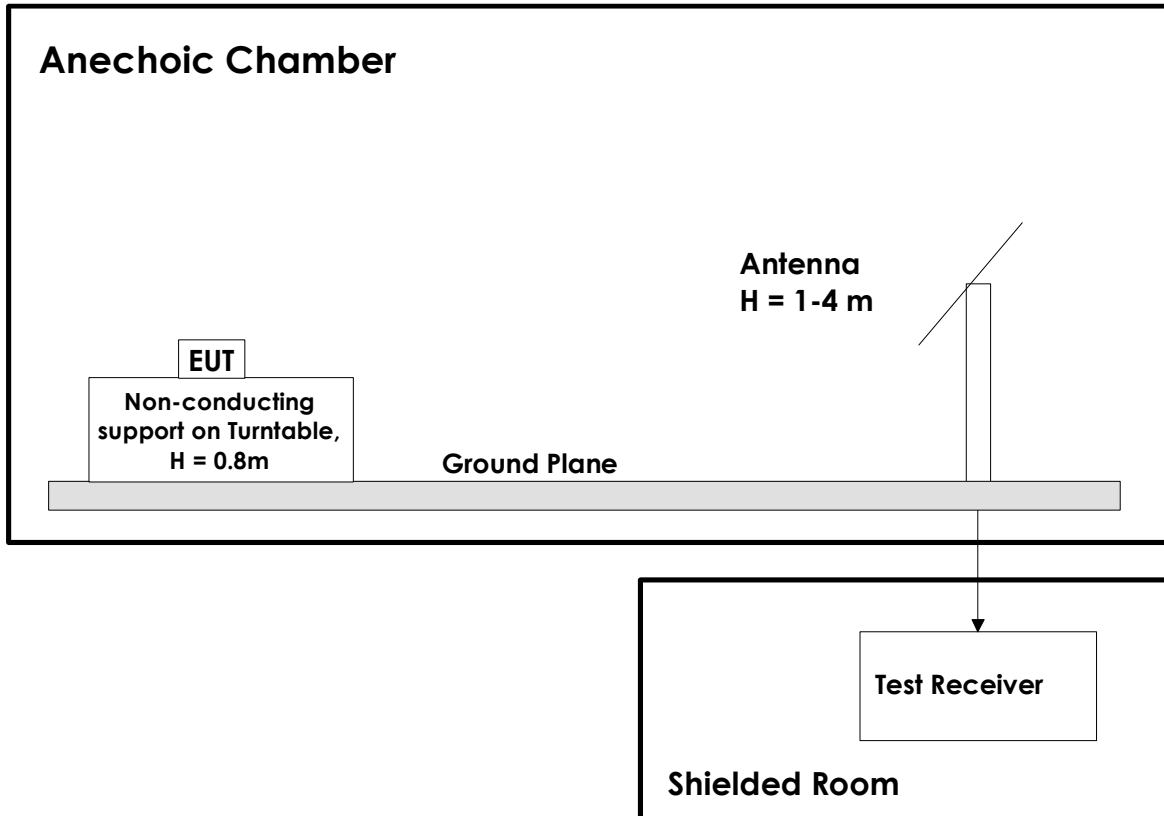
Note: COU – calibrate on use; N/A – Not Applicable

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.