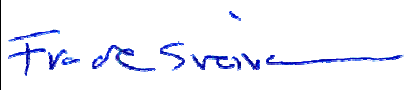


Test Report

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 Parts of FCC Parts 22 / 24 / 27 / 90 Parts of Canada RSS-247, Issue 2 Parts of Canada RSS-130 / RSS-132 / RSS-133 / RSS-139 / RSS-199
Order number	433049
Tested in period	2021-09-15 to 2021-10-26
Issue date	2022-02-24
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

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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
Number of antennas	1 for BT/BLE/WiFi 2 for WCDMA/LTE (only 1 is used for TX, both are used for RX) 1 for GPS (RX only)
Supported Radio Technologies	Bluetooth Classic Bluetooth Low energy WiFi 2.4 GHz / 5 GHz WCDMA 850 / 1900 / 2100 LTE (FDD/TDD)
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	Yes, but only for RX on LTE
Smart Antenna System	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. Both radio modules are certified radio modules. The EUT also contains a GPS receiver.

This test report only covers only interoperability tests for simultaneous operation of the two radio modules.

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 EUT Operating Modes

All tests were performed with WiFi / BT / BLE programmed from the Qualcomm Radio Control Software.

Power values for these technologies are noted in the individual test reports.

The mobile transmitter was programmed from the CMW500 for WCDMA and LTE. The mobile signal was programmed to the maximum output power supported for each technology.

1.5 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

1.6 Mobile Frequency Bands and Standards

Band	FCC	ISED Canada	Uplink Freq	Downlink Freq	Technology	Common Name
B02	Part 24E	RSS-133 Issue 6 A1	1850-1910 MHz	1930-1990 MHz	WCDMA, LTE	1900 PCS
B04	Part 27C	RSS-139 Issue 3	1710-1755 MHz	2110-2155 MHz	WCDMA, LTE	AWS-1
B05	Part 22H	RSS-132 Issue 3	824-849 MHz	869-894 MHz	WCDMA, LTE	850
B07	Part 27C	RSS-199 Issue 3	2500-2570 MHz	2620-2690 MHz	LTE	2600
B12	Part 27C	RSS-130 Issue 2	699-716 MHz	729-746 MHz	LTE	700a
B13	Part 27C	RSS-130 Issue 2	777-787 MHz	746-756 MHz	LTE	700c
B25	Part 24E	RSS-133 Issue 6 A1	1850-1915 MHz	1930-1995 MHz	LTE	1900+
B26	Part 90S Part 22H	RSS-119 Issue 12 RSS-132 Issue 3	814-824 MHz 824-849 MHz	859-869 MHz 869-894 MHz	LTE	850+
B38	Part 27C	RSS-199 Issue 3	2570-2620 (TDD)		LTE	TD 2600
B41	Part 27C	RSS-199 Issue 3	2496-2690 (TDD)		LTE	TD 2600+

1.7 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.

All results are tested to limits for FCC 15.209 since these are the strictest limits.

2 TEST REPORT SUMMARY

2.1 General

All measurements are traceable to national standards.

Tests were performed in accordance with ANSI C63.4-2014, ANSI C63.10-2013 and ANSI C63.26-2015.

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

PCB Equipment Code

☐ Family Listing



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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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
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 Radiated Emissions, Interoperability

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 below 1 GHz)

Measuring distance: 3m (1 – 18 GHz)

A 2.4 GHz Band Reject Filter was used for measurements from 1 GHz to 18 GHz

The limit for Part 15.209 was used for all tests since this is the strictest limit.

The limit for most of the tested licensed bands are -13 dBm average, which is equivalent to 82 dBµV/m @3m.

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

Results are shown below. No other emissions related to intermodulation were detected.

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	
	All Limits below 1GHz are with Quasi Peak Detector	
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
	Average Detector	Peak Detector
1 – 26 GHz	54.0 dBµV/m	74.0 dBµV/m

Band 02 + WiFi								
WiFi ch06 + LTE ch19000								
Measured Frequency (MHz)	Carrier Freq WiFi (MHz)	Carrier Freq LTE (MHz)	Measured Emissions (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
			Peak	Average	Peak	Average	Peak	Average
1343	2437	1890	< 50	/	74	54	>24	/
2984	2437	1890	< 54	< 50	74	54	>20	>4

Band 04 + WiFi								
WiFi ch06 + WCDMA1900 ch1450								
Measured Frequency (MHz)	Carrier Freq WiFi (MHz)	Carrier Freq WCDMA (MHz)	Measured Emissions (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
			Peak	Average	Peak	Average	Peak	Average
1103	2437	1770	<50	/	74	54	>24	/
3104	2437	1770	<54	/	74	54	>20	/

Band 04 + WiFi								
WiFi ch06 + LTE ch20250								
Measured Frequency (MHz)	Carrier Freq WiFi (MHz)	Carrier Freq LTE (MHz)	Measured Emissions (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
			Peak	Average	Peak	Average	Peak	Average
1043	2437	1740	<50	/	74	54	>24	/
3134	2437	1740	<56	<46	74	54	>18	>8

Band 07 + WiFi								
WiFi ch06 + LTE 2600 ch21175								
Measured Frequency (MHz)	Carrier Freq WiFi (MHz)	Carrier Freq LTE (MHz)	Measured Emissions (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
			Peak	Average	Peak	Average	Peak	Average
2331.5	2437	2542.5	<60	<48	74	54	>14	>6
2648	2437	2542.5	<60	<48	74	54	>14	>6

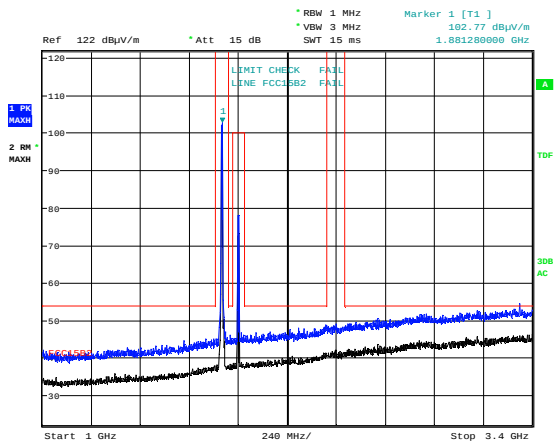
Band 12 + WiFi								
WiFi ch06 + LTE ch19000								
Measured Frequency (MHz)	Carrier Freq WiFi (MHz)	Carrier Freq LTE (MHz)	Measured Emissions (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
			Peak	Average	Peak	Average	Peak	Average
4169	2437	705	< 50	/	74	54	>24	/

Band 13 + WiFi								
WiFi ch06 + LTE ch23230								
Measured Frequency (MHz)	Carrier Freq WiFi (MHz)	Carrier Freq LTE (MHz)	Measured Emissions (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
			Peak	Average	Peak	Average	Peak	Average
4092	2437	782	< 50	/	74	54	>24	/

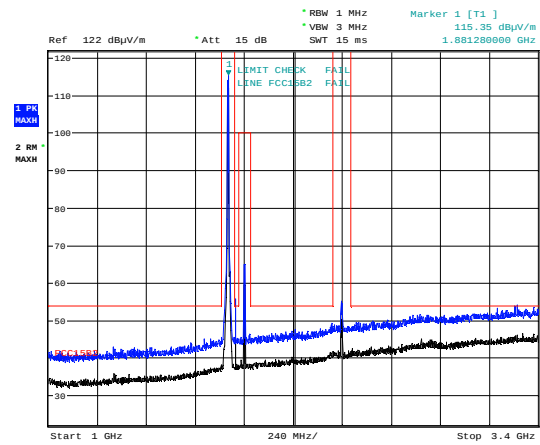
Band 25 + WiFi								
WiFi ch06 + LTE ch26365								
Measured Frequency (MHz)	Carrier Freq WiFi (MHz)	Carrier Freq LTE (MHz)	Measured Emissions (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
			Peak	Average	Peak	Average	Peak	Average
1328	2437	1882.5	< 54	/	74	54	>20	/
2991.5	2437	1882.5	<58	<48	74	54	>16	>6

Band 26 + WiFi								
WiFi ch06 + LTE ch26890								
Measured Frequency (MHz)	Carrier Freq WiFi (MHz)	Carrier Freq LTE (MHz)	Measured Emissions (dBµV/m)		Limit (dBµV/m)		Margin (dB)	
			Peak	Average	Peak	Average	Peak	Average
4040	2437	834	< 54	/	74	54	>20	/

Band 2: WCDMA1900 / LTE

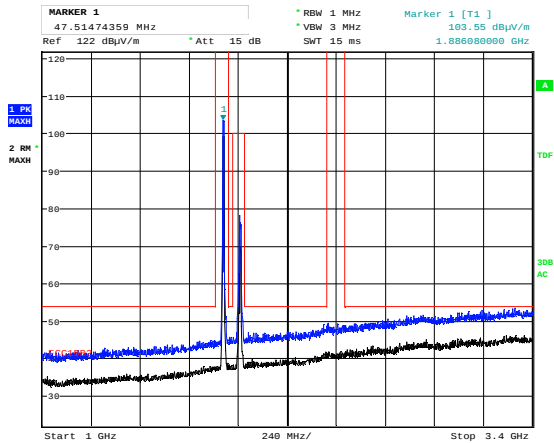


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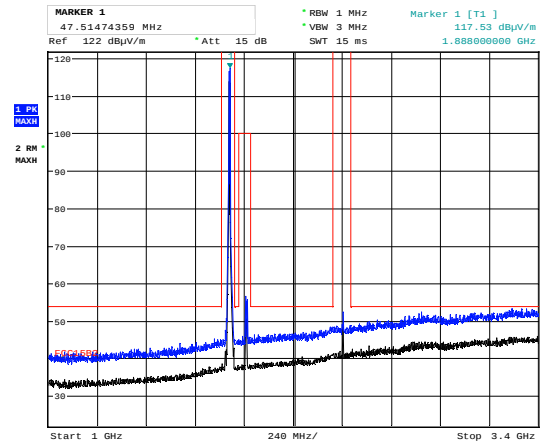
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1000-3400MHz, WiFi ch06 11B 1M + WCDMA ch9400 VP



Date: 21.SEP.2021 14:17:48

HP

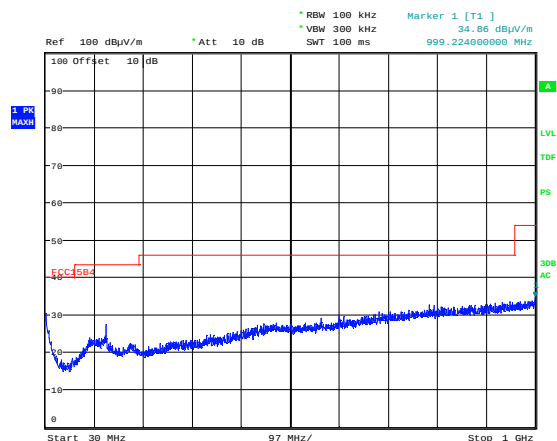


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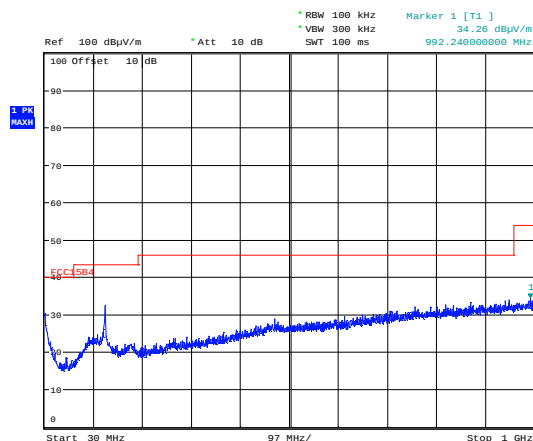
1000-3400MHz, BT GFSK ch39 + LTE ch19000 VP

HP

Band 4: WCDMA1800 / LTE

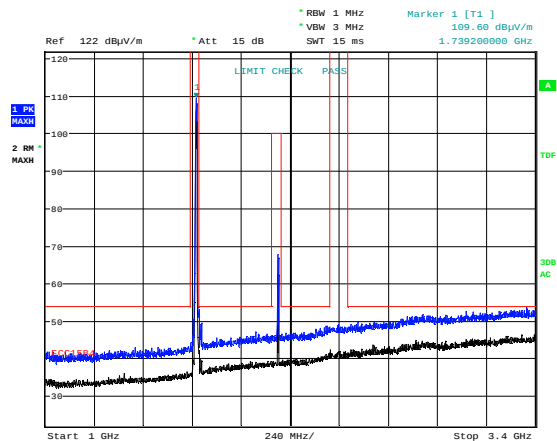


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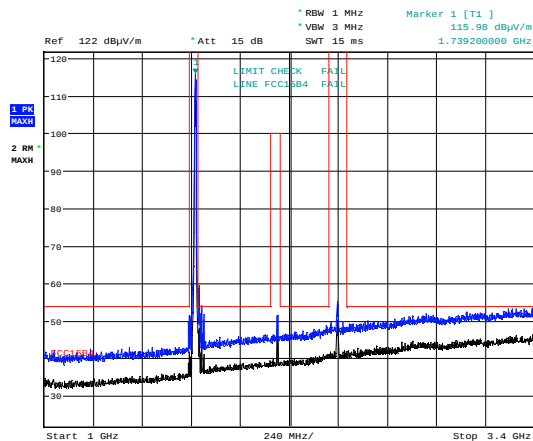
Date: 23.SEP.2021 14:06:10

30-1000MHz, WiFi ch06 11g 6M + LTE ch20175 VP



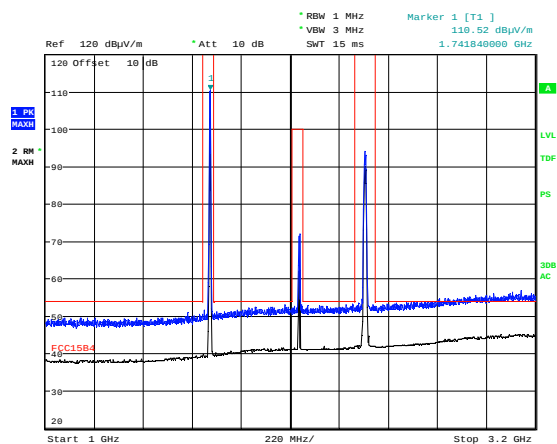
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HP



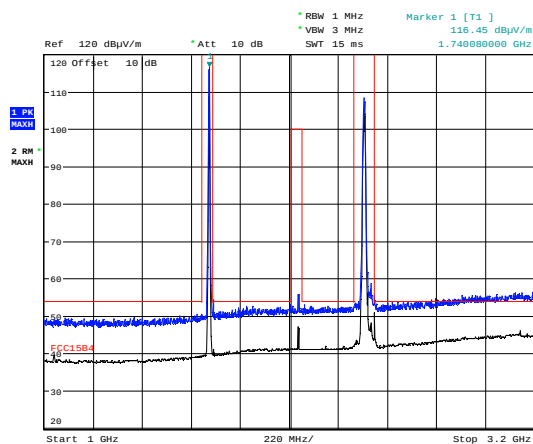
Date: 21.SEP.2021 12:31:59

1000-3400MHz, WiFi ch06 11b 1M + WCDMA ch1450 VP



Date: 21.SEP.2021 10:51:43

HP

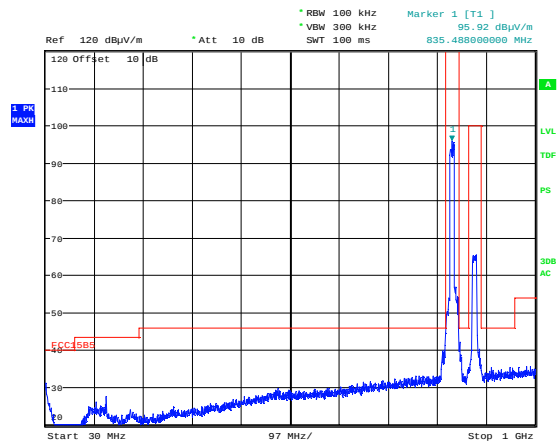


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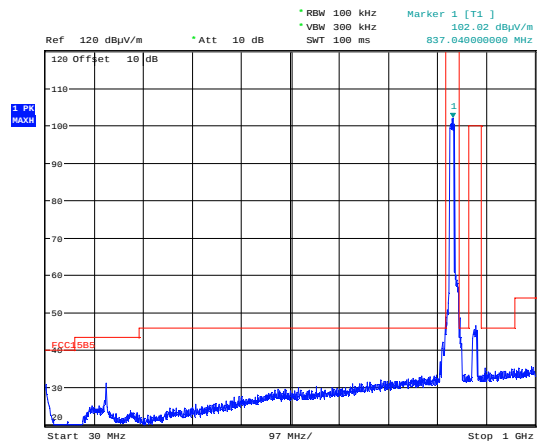
1000-3200MHz, WiFi ch06 11b 1M + LTE ch20250 VP

HP

Band 5: WCDMA850 / LTE

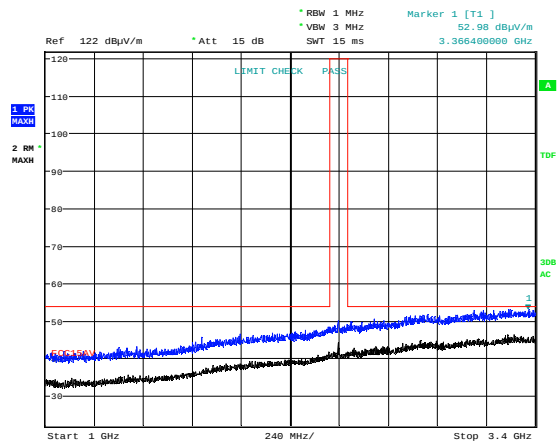


Date: 23.SEP.2021 14:58:43



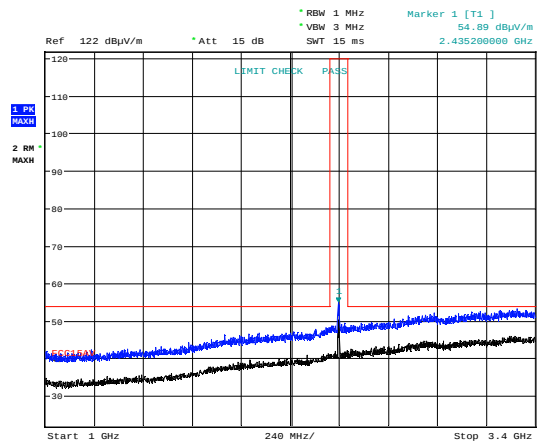
Date: 23.SEP.2021 14:52:31

30-1000MHz, WiFi ch06 11g 6M + LTE ch20510 VP



Date: 21.SEP.2021 12:55:17

HP

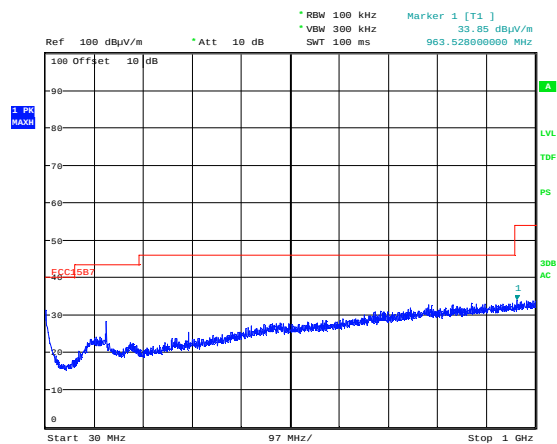


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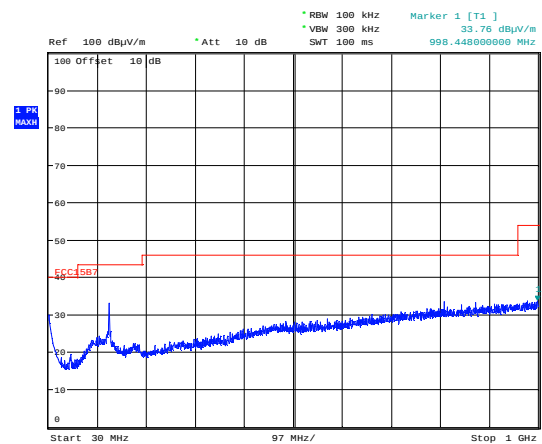
1000-3400MHz, WiFi ch06 11b 1M + WCDMA ch4180 VP

HP

Band 7: LTE 2600

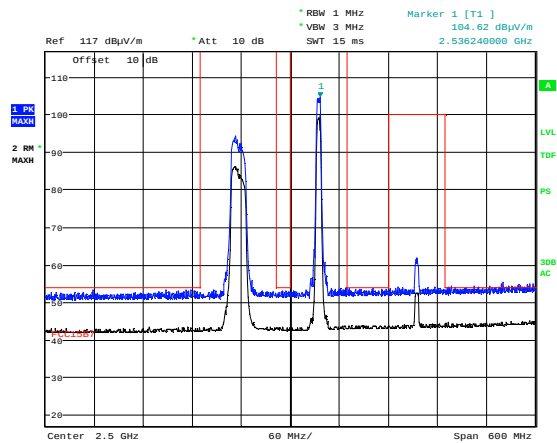


Date: 23.SEP.2021 14:19:06



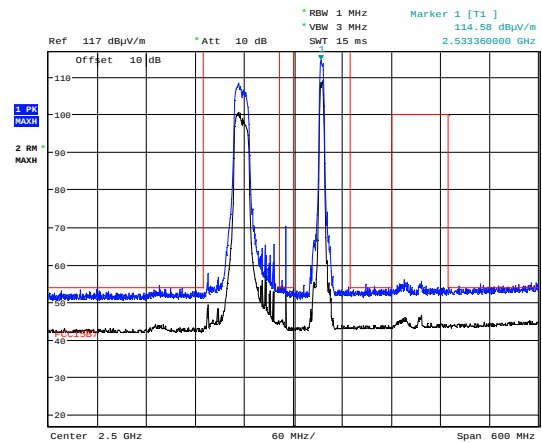
Date: 23.SEP.2021 14:20:54

30-1000MHz, WiFi ch06 11g 6M + LTE ch21100 VP



Date: 21.SEP.2021 09:58:52

HP

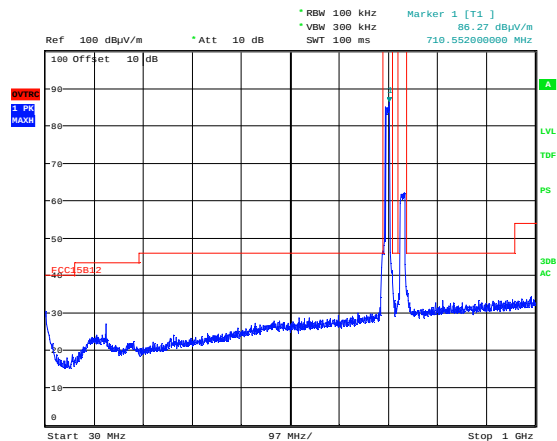


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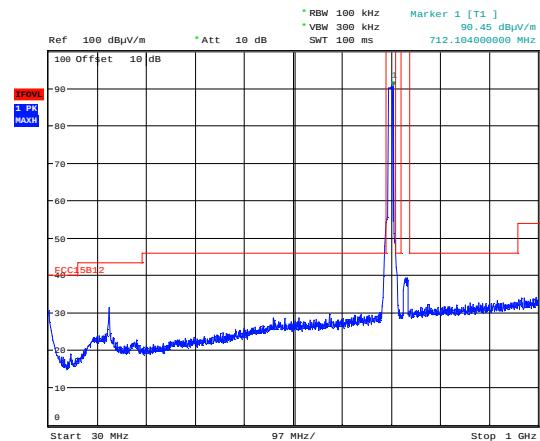
2200-2800MHz, WiFi ch06 11g 6M + LTE ch21175 VP

HP

Band 12: LTE

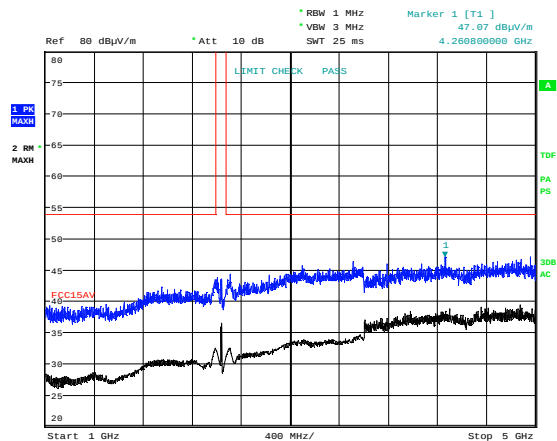


Date: 23.SEP.2021 14:25:54



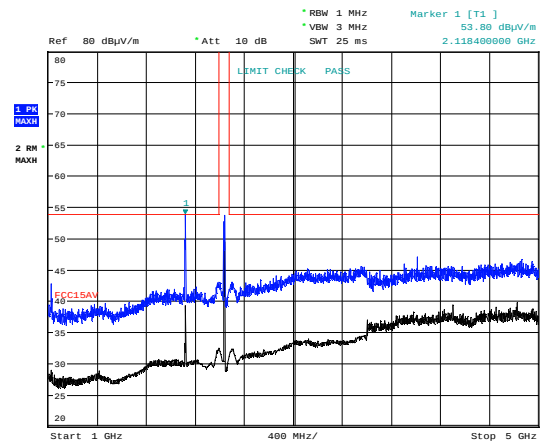
Date: 23.SEP.2021 14:27:43

30-1000MHz, WiFi ch06 11b 1M + LTE ch23095 VP



Date: 21.SEP.2021 12:02:20

HP

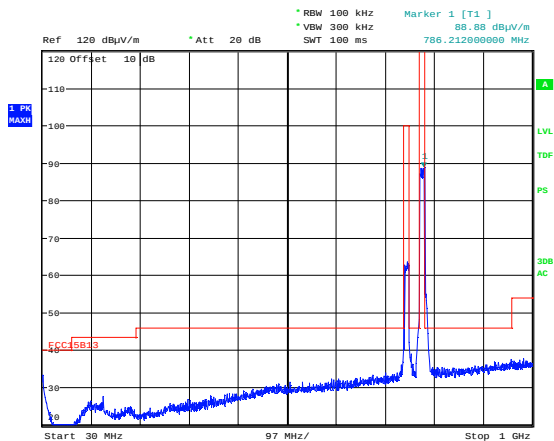


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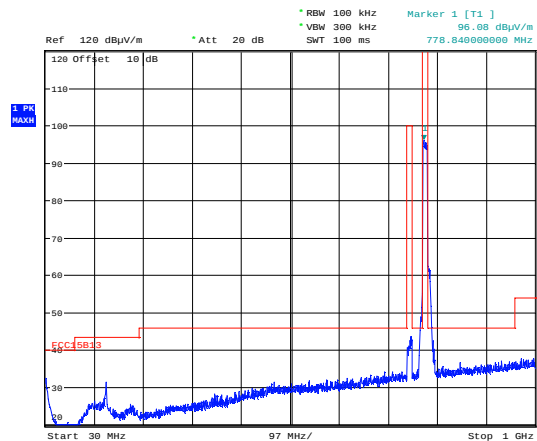
1000-5000MHz, WiFi ch06 11b 1M + LTE ch23070 VP

HP

Band 13: LTE

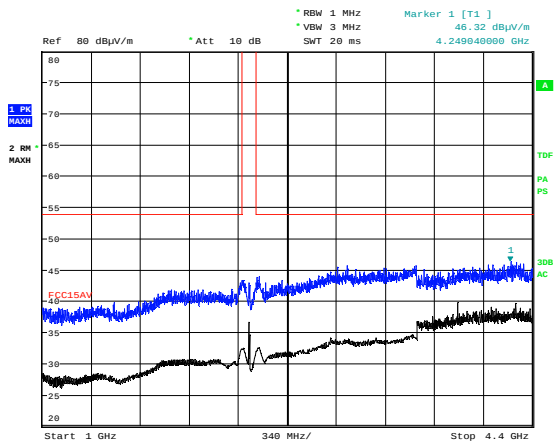


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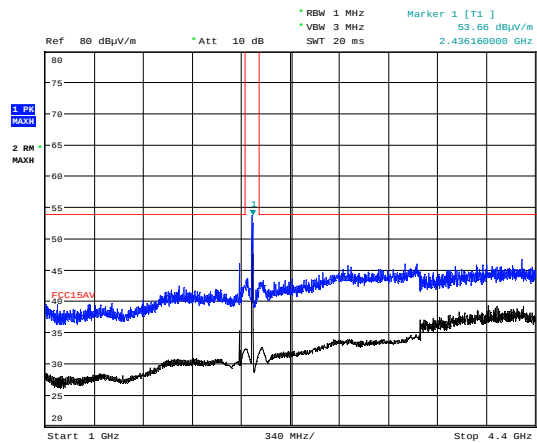
Date: 23.SEP.2021 13:53:17

30-1000MHz, WiFi ch06 11g 6M + LTE ch23230 VP



Date: 21.SEP.2021 11:12:56

HP

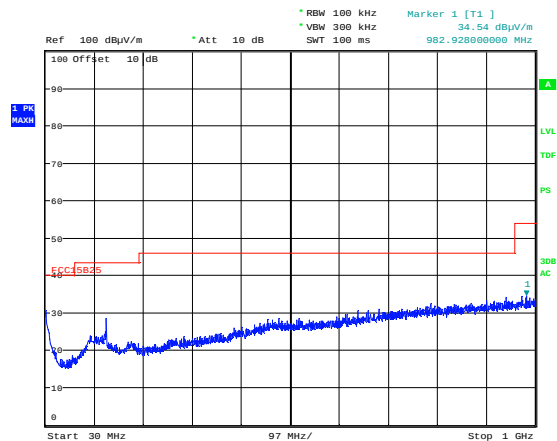


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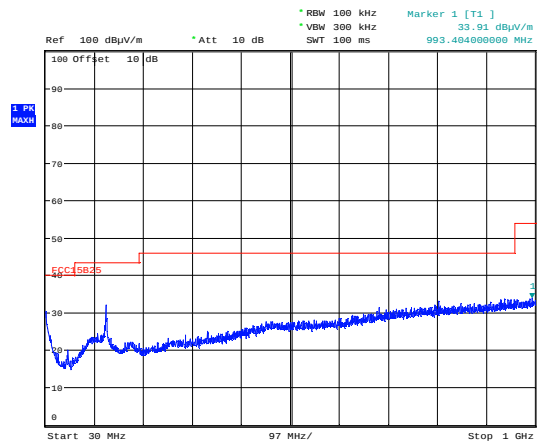
1000-4400MHz, WiFi ch06 11b 1M + LTE ch23230 VP

HP

Band 25: LTE

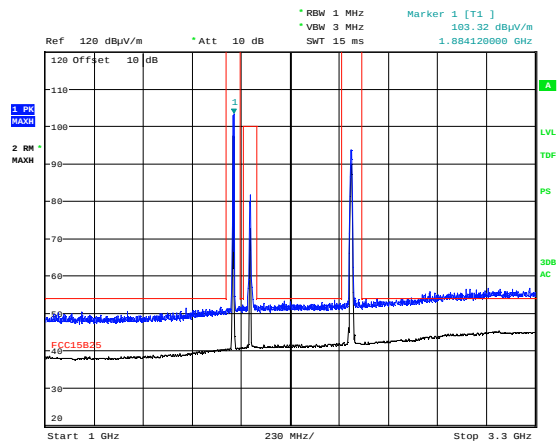


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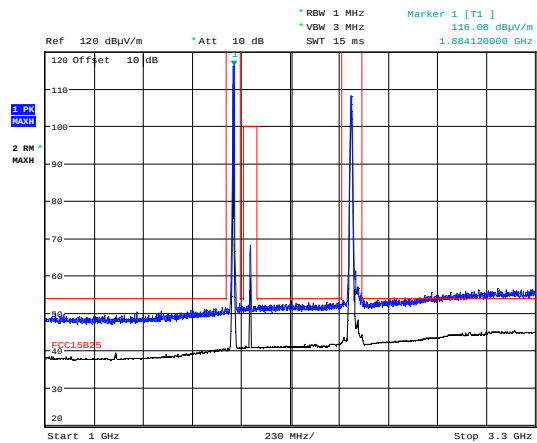
Date: 23.SEP.2021 14:11:35

30-1000MHz, WiFi ch06 11g 6M + LTE ch26390 VP



Date: 21.SEP.2021 10:29:20

HP

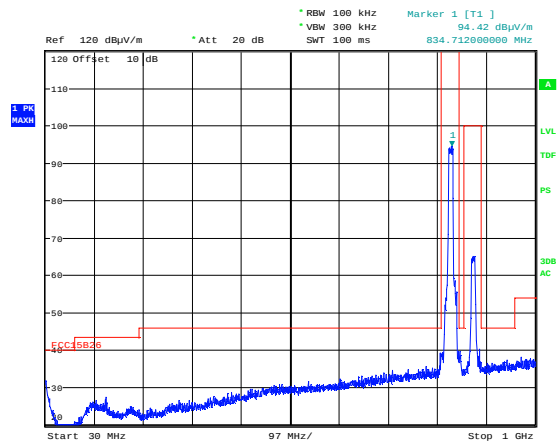


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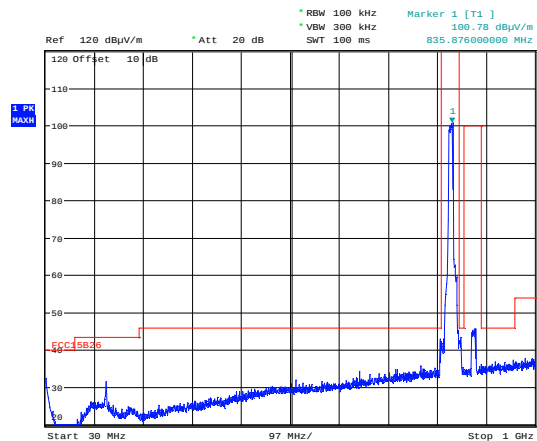
1000-3300MHz, WiFi ch06 11b 1M + LTE ch26365 VP

HP

Band 26: LTE

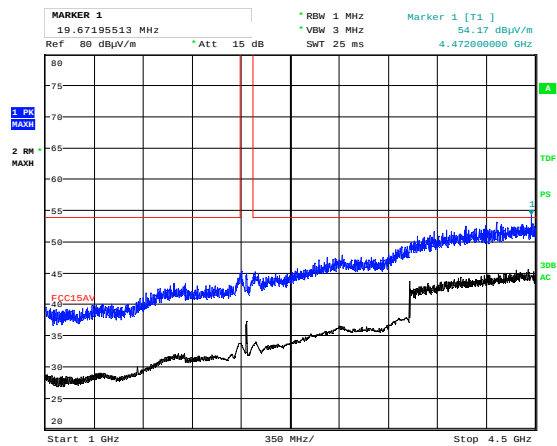


Date: 23.SEP.2021 13:57:02



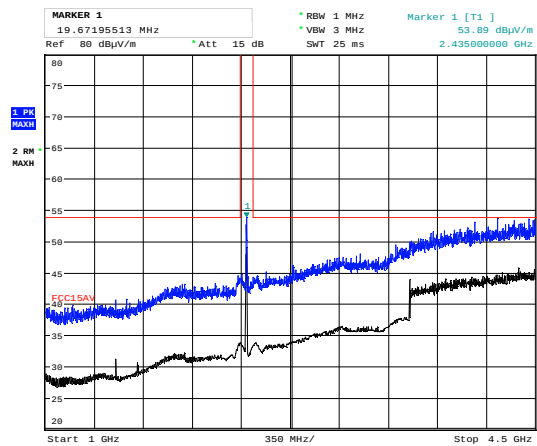
Date: 23.SEP.2021 13:58:50

30-1000MHz, WiFi ch06 11g 6M + LTE ch26875 VP



Date: 21.SEP.2021 15:05:27

HP



Date: 21.SEP.2021 15:07:40

1000-3400MHz, WiFi ch06 11b 1M + LTE ch26890 VP

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	2021-02	2022-02
2	6810-17B	Attenuator	Suhner	LR 1669	2021-08	2022-08
3	N0324415	BandStop Filter (2.4GHz)	Microwave Circuits	LR 1760	COU	
4	WLK5-1100-1485-7000-40SS	Low Pass Filter (1GHz)	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	

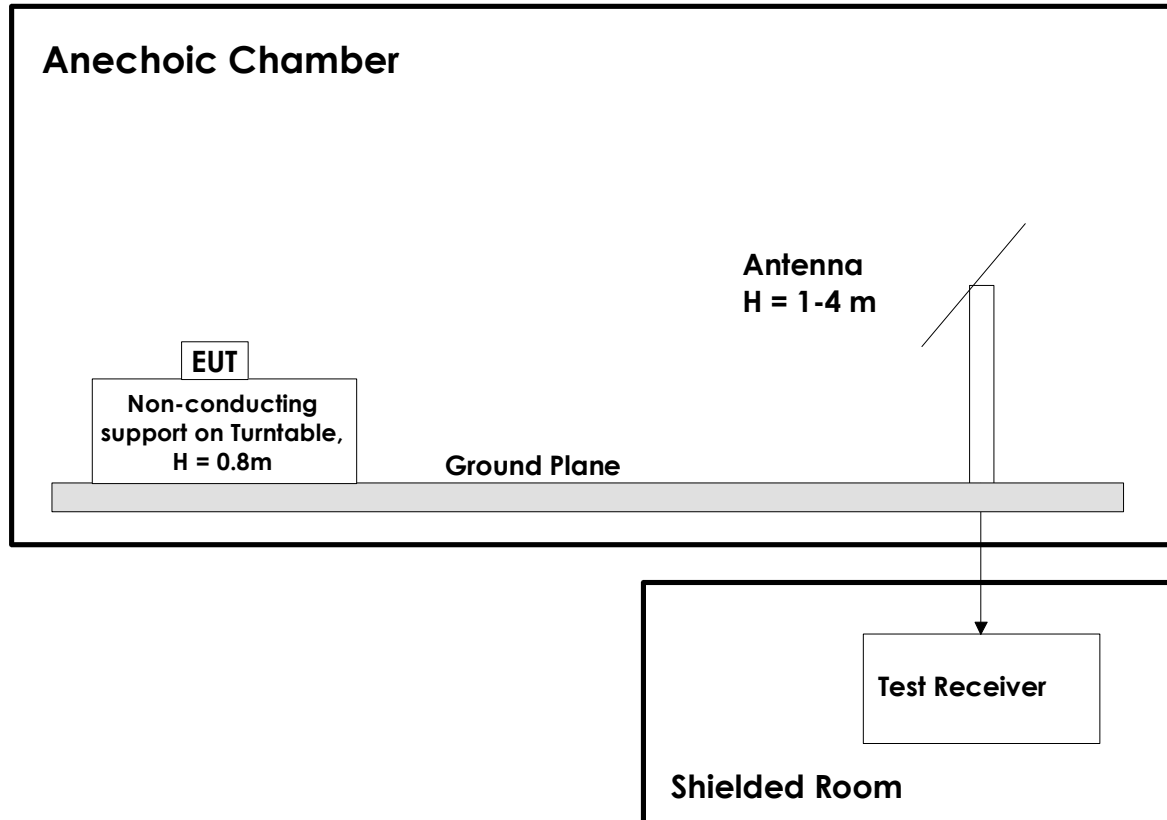
Note: COU – calibrate on use; N/A – Not Applicable

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.