

RADIO REPORT FCC 47 CFR Part 15C Digital transmission systems operating within the 2400.0 MHz - 2483.5 MHz band	
Report Reference No	G0M-2205-1460-TFC247WF-V01
Testing Laboratory	Eurofins Product Service GmbH
Address	Storkower Str. 38c 15526 Reichenwalde Germany
Accreditation	 DAkkS - Registration number : D-PL-12092-01-04 (FCC) FCC Filed Test Laboratory, Reg.-No.: 96970
Applicant	REMS GmbH & Co KG
Address	Stuttgarter Strasse 83 71332 Waiblingen Germany
Test Specification	47 CFR Part 15C
Non-Standard Test Method	None
Equipment under Test (EUT):	
Product Description	576003
Model(s)	Akku-Press 22V ACC CONNECTED
Additional Model(s)	None
Brand Name(s)	None
Hardware Version(s)	V7
Software Version(s)	V7.0.4
FCC ID	2BAPC-576003
Test Result	PASSED

Possible test case verdicts:		
Required by standard but not tested	N/T	
Not required by standard	N/R	
Not applicable to EUT	N/A	
Test object does meet the requirement	P(PASS)	
Test object does not meet the requirement	F(FAIL)	
Testing:		
Test Lab Temperature	20 °C - 30 °C	
Test Lab Humidity	25 % - 55 %	
Date of receipt of test item	2023-03-06	
Report:		
Compiled by	Odai Qawasmeh	
Tested by (+ signature) (Responsible for Test)	Radwan Jaafar	
Approved by (+ signature) (Test Lab Engineer)	Wilfried Treffke	
Date of Issue	2024-02-16	
Total number of pages	39	
General Remarks:		
The test results presented in this report relate only to the object tested. The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report. This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.		
Additional Comments:		
None		

VERSION HISTORY

Version History			
Version	Issue Date	Remarks	Revised By
01	2024-02-16	Initial Release	--

ABBREVIATIONS AND ACRONYMS

Acronyms	
Acronym	Description
BPSK	Binary Phase Shift Keying
DSSS	Direct Sequence Spread Spectrum
EUT	Equipment Under Test
FCC	Federal Communications Commission
HT	High Throughput
IEEE 802.11	MAC and PHY Layer for WiFi
ISED	Innovation, Science and Economic Development Canada
OFDM	Orthogonal Frequency Division Multiplexing
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RBW	Resolution bandwidth
RMS	Root mean square
VBW	Video bandwidth
V _{NOM}	Nominal supply voltage

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1 Equipment (Test Item) Under Test

Description	576003	
Model	Akku-Press 22V ACC CONNECTED	
Additional Model(s)	None	
Brand Name(s)	None	
Serial Number(s)	Prototype	
Test Sample Id(s)	43278	
Hardware Version(s)	V7	
Software Version(s)	V7.0.4	
FCC ID	2BAPC-576003	
Equipment type	End Product	
Radio type	Transceiver	
Assigned frequency bands	2400.0 MHz - 2483.5 MHz	
Radio technology	IEEE 802.11 b/g/n (HT20 + HT40)	
Modulation	BPSK, QPSK, 16-QAM, 64-QAM	
Number of antenna ports	1	
Radio Module	Type	WiFi module
	Model	ESP32-S2 WROVER
	Manufacturer	Espressif
	HW Version	A
	SW Version	v7.0
	FCC-ID	2AC7Z-ESP32S2WROVER
Antenna	Type	Integrated
	Model	ESP32-S2 WROVER
	Manufacturer	Espressif
	Gain	3.40 dBi
Supply Voltage	V _{NOM}	21.6 VDC
Operating Temperature	T _{NOM}	20°C
AC/DC-Adaptor	Model	571587
	Vendor	REMS GmbH & Co KG
	Input	100-240 VAC
	Output	max. 25.2 VDC
Manufacturer	REMS GmbH & Co KG Stuttgarter Strasse 83 71332 Waiblingen Germany	

1.1 Photos – Equipment External



EUT Top View



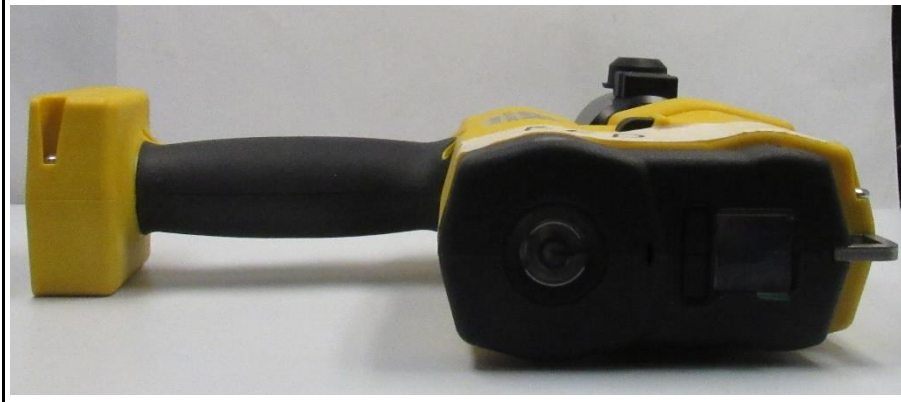
EUT Bottom View



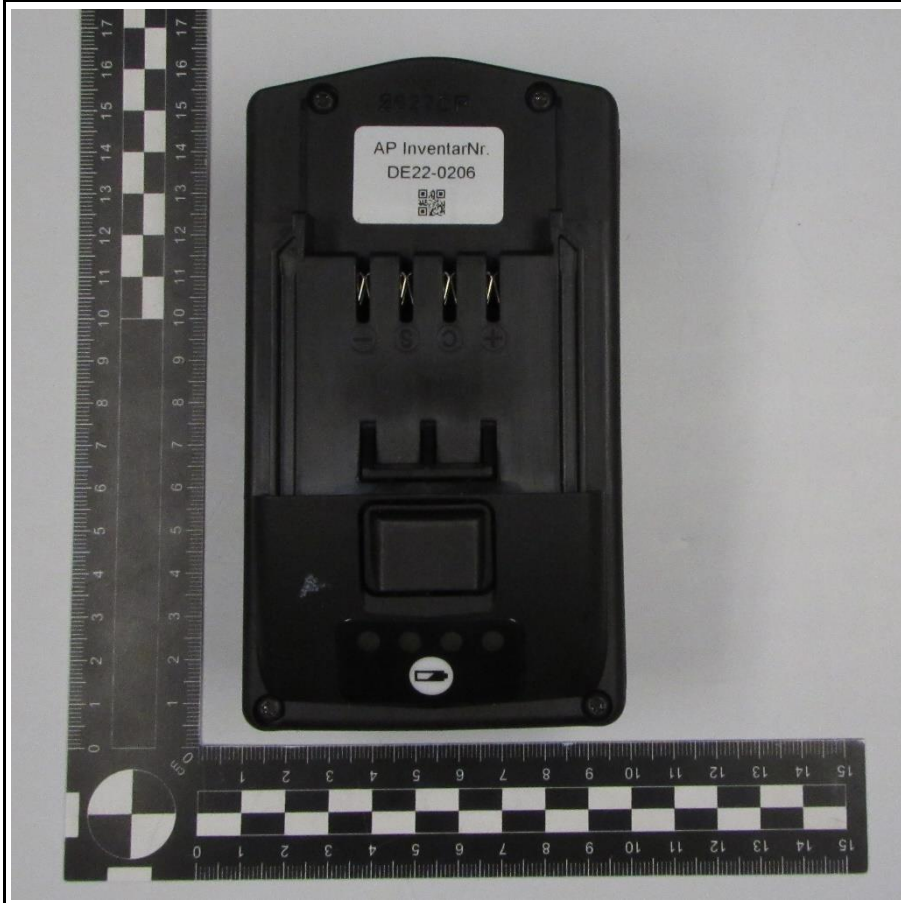
EUT Side View (left)



EUT Side View (right)



EUT Battery Front View



EUT Battery Rear View



EUT Battery Top View



EUT Battery Bottom View



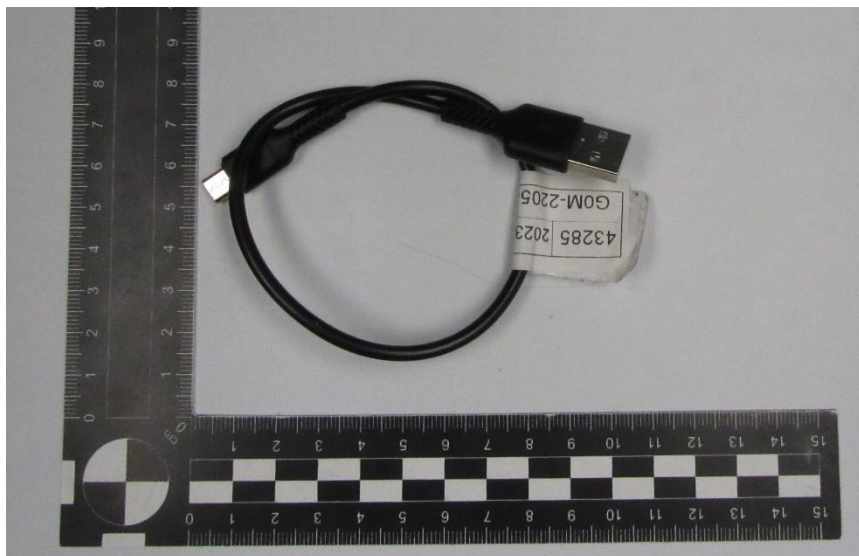
EUT Battery Side View (left)



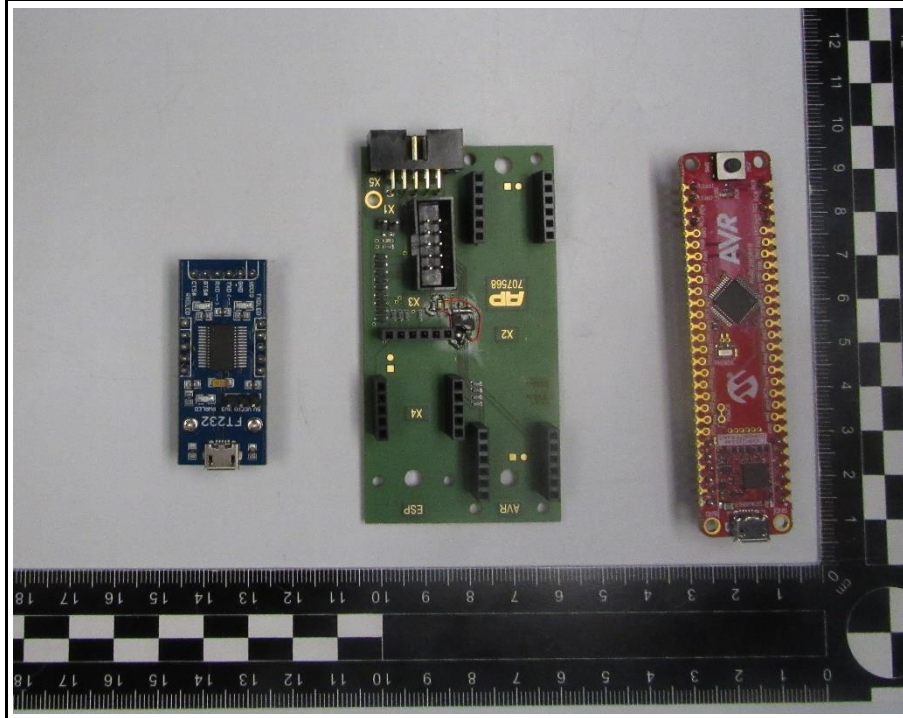
EUT Battery Side View (right)



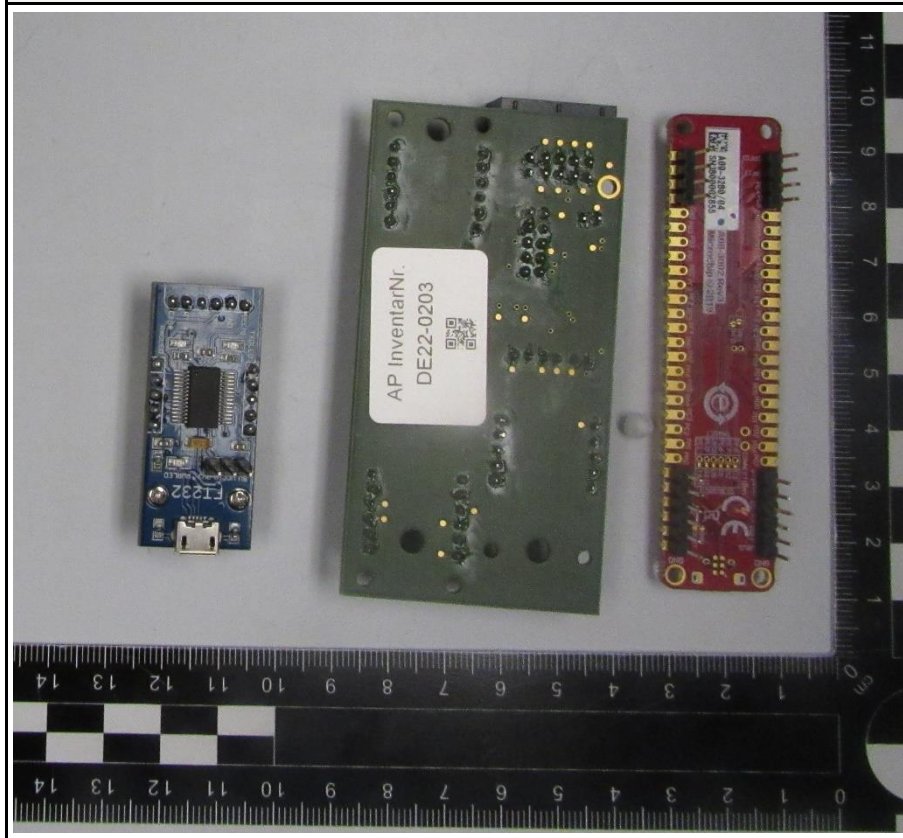
Micro to USB A cable



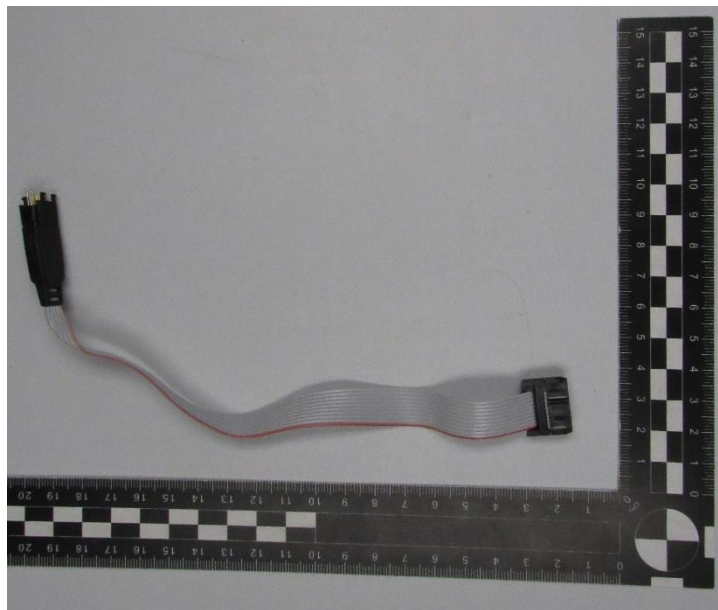
Adapter PCBs Top View



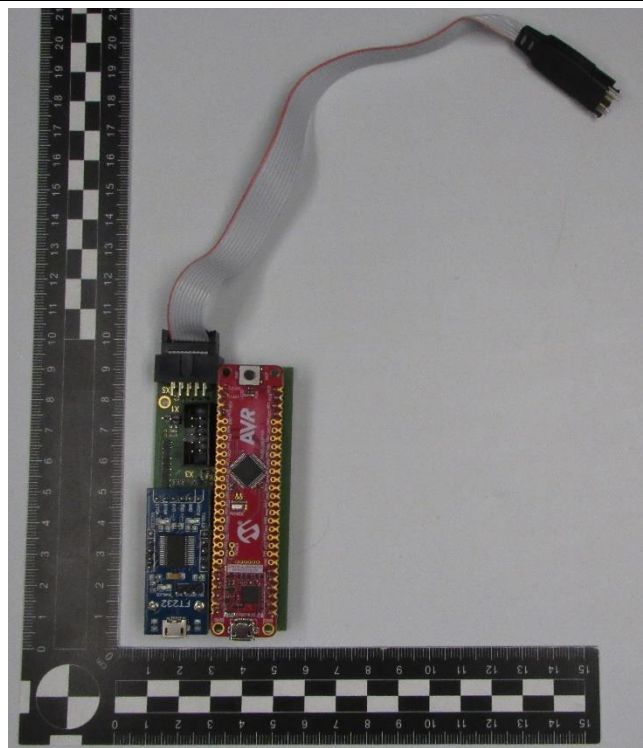
Adapter PCBs Bottom View



Ribbon cable for PCB Adapter



PCB Adapter assembled with ribbon cable



1.2 Photos – Equipment Internal

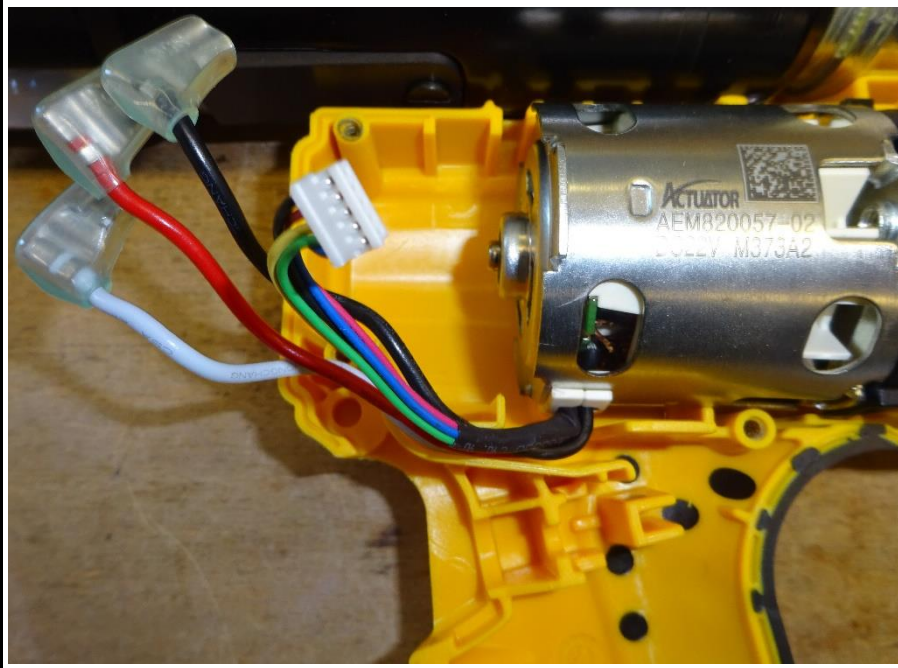
EUT opened



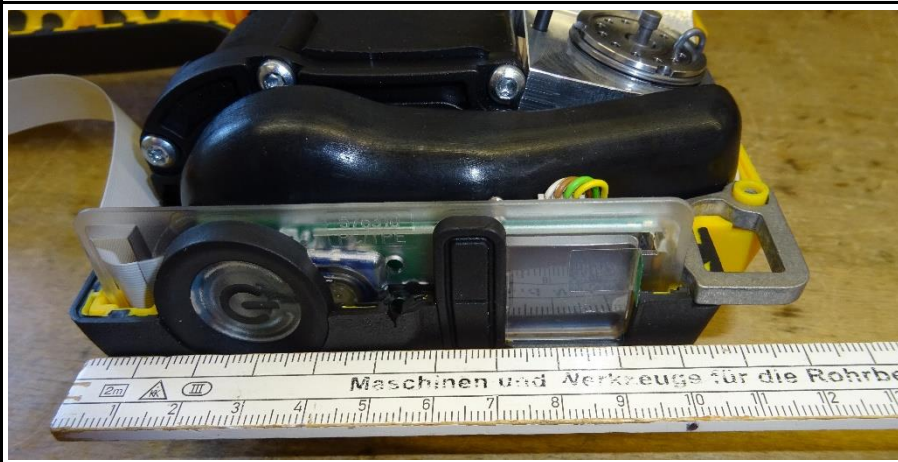
EUT opened



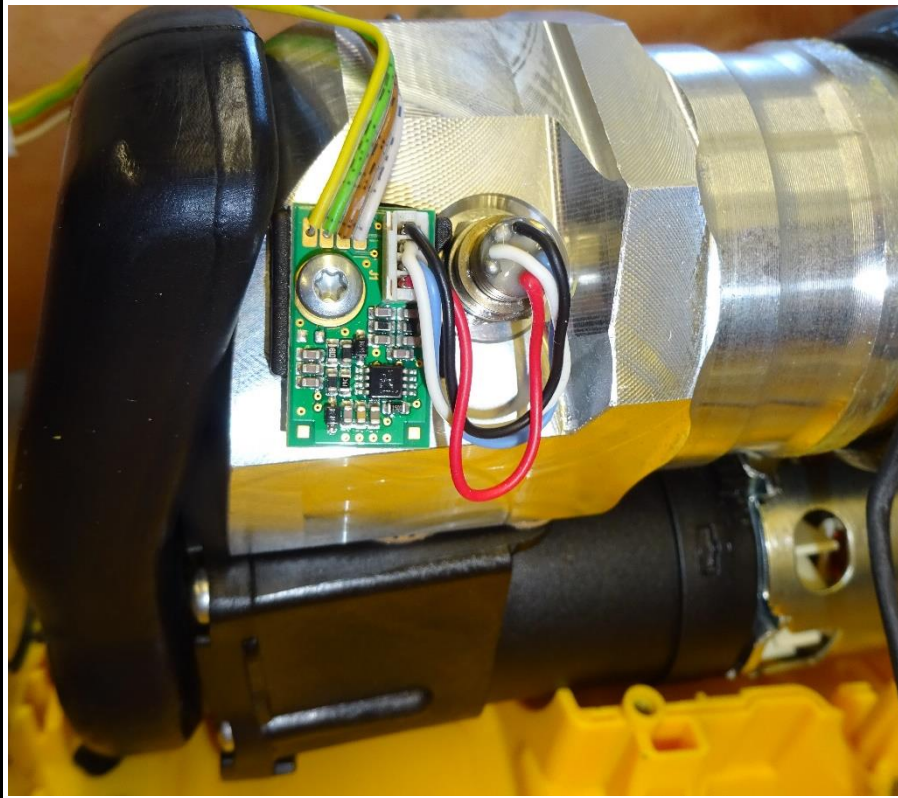
EUT internal wires



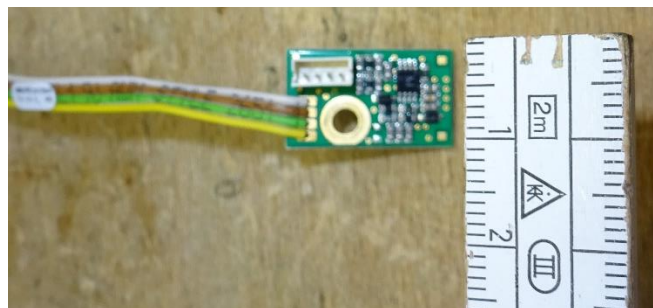
EUT Display



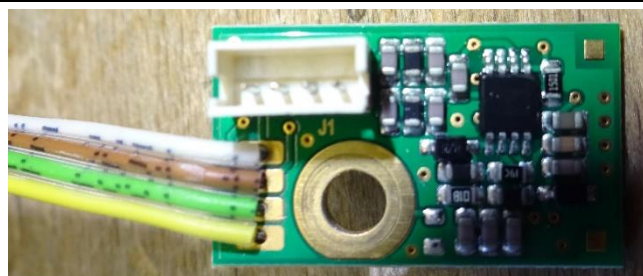
EUT amplifier PCB



EUT amplifier PCB



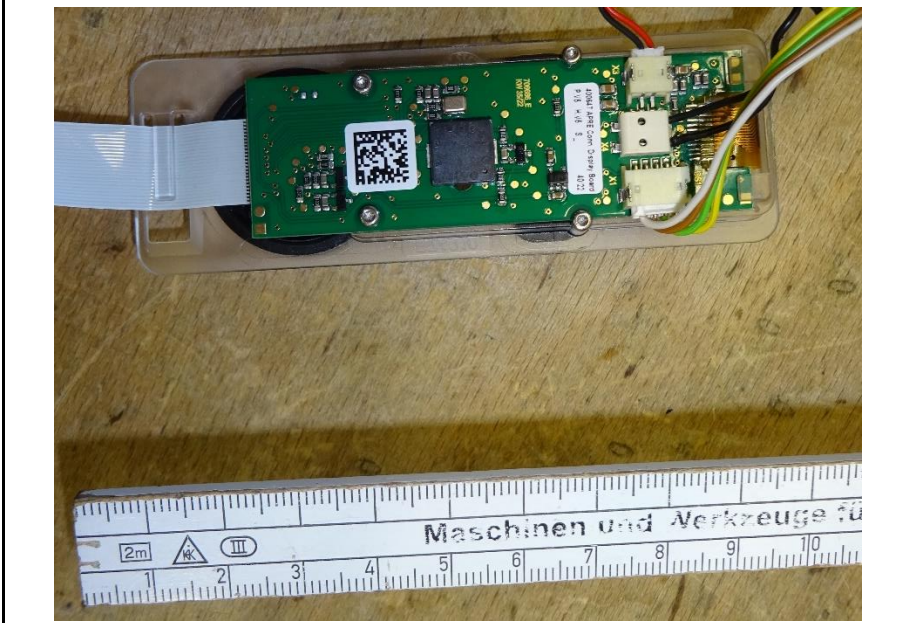
EUT amplifier PCB zoomed



EUT Display PCB



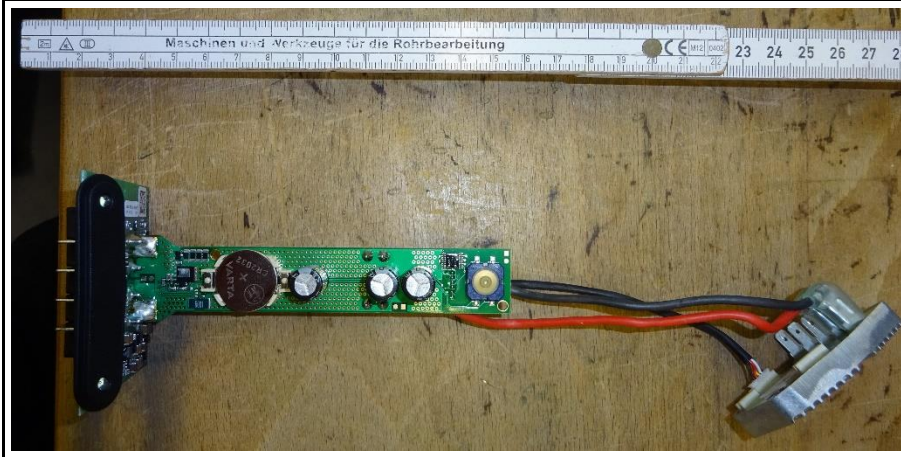
EUT display PCB zoomed



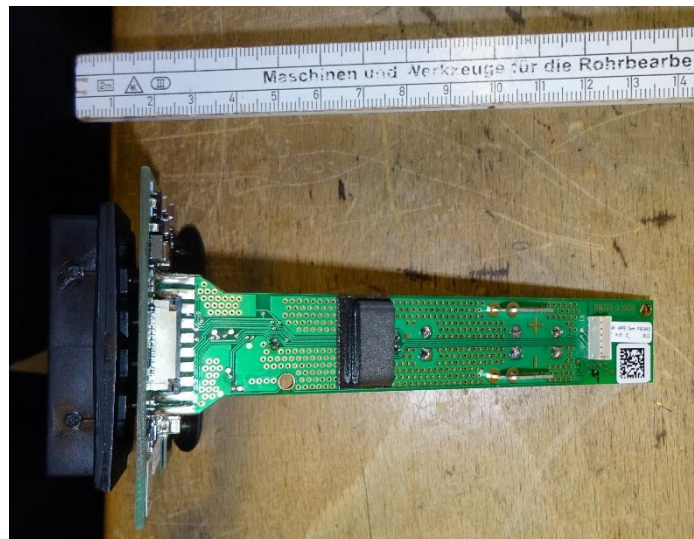
EUT display



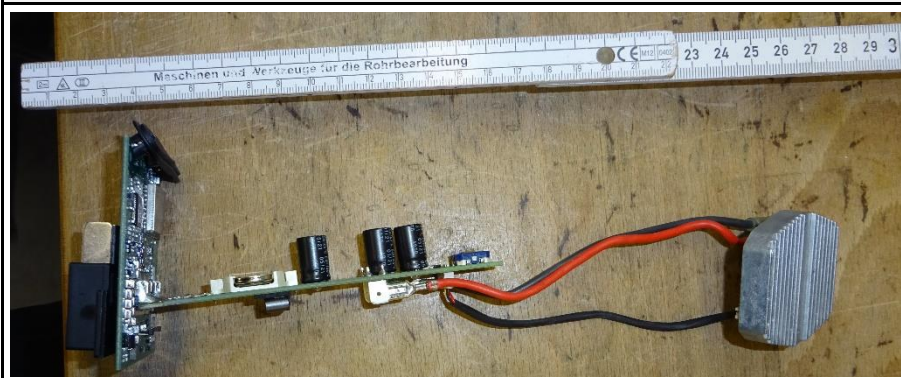
EUT main PCB top view



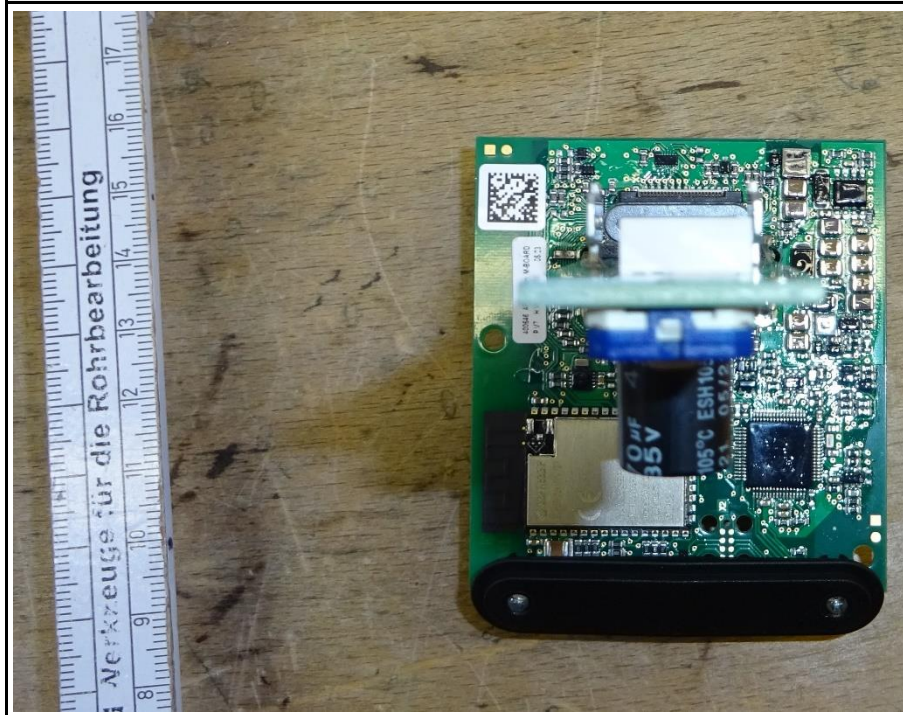
EUT main pcb bottom view



EUT main PCB side View



EUT main PCB Front View



1.3 Support Equipment

Product Type	Device	Manufacturer	Model	Comment
AE	Notebook	Lenovo	T450	For test mode configuration
AE	Adapter	REMS GmbH & Co KG	---	
CBL	USB (Micro to Type A)	---	---	
SFT	EspRFTTestTool	Espressif Systems	---	
Description:				
AE	Auxiliary Equipment			
SIM	Simulator			
CBL	Connecting Cable			
SFT	Software			
Comment:				

1.4 Test Modes

Mode	Description
HT20 (IEEE 802.11n)	Mode = Transmit Modulation = OFDM Bandwidth = 20 MHz Duty cycle = 100% Power setting (1 Simultaneous Tx) = 8 Data rate (1 Simultaneous Tx) = 6.5 Mbps MCS (1 Simultaneous Tx) = 0
Receive	Mode = Receive
Comment: The above settings are found as worst case during evaluation of the original modular test report RSHD190920001-00A, issued on 2019-10-18 by Bay Area Compliance Labs Corp. Conducted peak/average output power was evaluated to determine the worst case settings.	

1.5 Test Frequencies

Designator	Mode	Channel	Frequency [MHz]
F1	Tx	1	2412
F2	Tx	11	2462

1.6 Sample emission level calculation

The following is a description of terms and a sample calculation, as appears in the radiated emissions data table. The numbers used in the calculation are for example only. There is no direct correlation to the specific data taken for the product described in this document:

Reading:

This is the reading obtained on the spectrum analyzer in dB μ V. Any external preamplifiers used are taken into account through internal analyzer settings.

A.F.:

This is the antenna factor for the receiving antenna. It is a conversion factor, which converts electric fields strengths to voltages, which can be measured directly on the spectrum analyzer. It is treated as a loss in dB. Cable losses have been included with the A.F. to simplify the calculations. The antenna factor is used in calculations as follows:

$$\text{Reading on Analyzer (dB}\mu\text{V)} + \text{A.F. (dB/m)} = \text{Net field strength (dB}\mu\text{V/m)}$$

Net:

This is the net field strength measurement (as shown above).

Margin:

This is the margin of compliance below the FCC limit. The units are given in dB. A negative margin indicates the emission was below the limit. A positive margin indicates that the emission exceeds the limit.

Field strength limit:

This is the FCC Class B radiated emission limit (in units of dB μ V/m). The FCC limits are given in units of μ V/m. The following formula is used to convert the units of μ V/m to dB μ V/m:

$$\text{Field strength limit (dB}\mu\text{V/m)} = 20 \cdot \log (\mu\text{V/m})$$

Example only for radiated field strength:

Reading + AF	= Net Reading	:	Net reading	- Field strength limit	= Margin
+21.5 dB μ V	+ 26 dB/m	:	47.5 dB μ V/m	- 57.0 dB μ V/m	= -9.5

2 Result Summary

FCC 47 CFR Part 15C				
Product Standard Reference	Requirement	Reference Method	Result	Remarks
ISED RSS-Gen, Issue 5 A2 (section 6.7)	Occupied Bandwidth	ANSI C63.10-2013	N/R	Informational only
FCC § 15.247(a)(2)	6 dB Bandwidth	ANSI C63.10-2013	N/T	
FCC § 15.247(b)	Maximum peak conducted power	ANSI C63.10-2013	N/T	
FCC § 15.247(e)	Power spectral density	ANSI C63.10-2013	N/T	
FCC § 15.207	AC power line conducted emissions	ANSI C63.10-2013	N/T	No direct or indirect connection to AC mains
FCC § 15.247(d)	Band edge compliance	ANSI C63.10-2013	N/T	
FCC § 15.247(d)	Conducted spurious emissions	ANSI C63.10-2013	N/T	
FCC § 15.247(d) FCC § 15.209	Transmitter radiated spurious emissions	ANSI C63.10-2013	PASS	
Comment: The Decision Rule is applied on the basis of ETSI TR 102 273 and ETSI TR 100 028. These standards provide guidance on how to calculate and apply measurement uncertainty whilst providing maximum uncertainties allowance. In all cases due consideration will be given to ILAC-G8:09/2019. Where a result is considered conditional in respect of its proximity to the limit line, the customer would be made aware of situation so that they can make an informed decision on how to proceed.				

Possible Test Case Verdicts	
PASS	Test object does meet the requirements
FAIL	Test object does not meet the requirements
N/T	Required by standard but not tested
N/R	Not required by standard for the test object

3 Test Conditions and Results

3.1 Test Conditions and Results - Transmitter radiated emissions

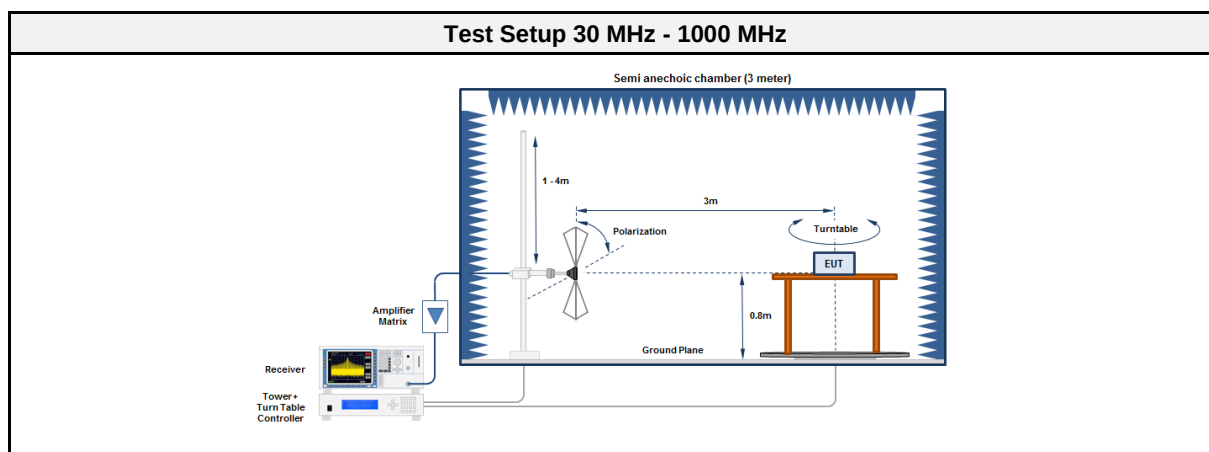
3.1.1 Information

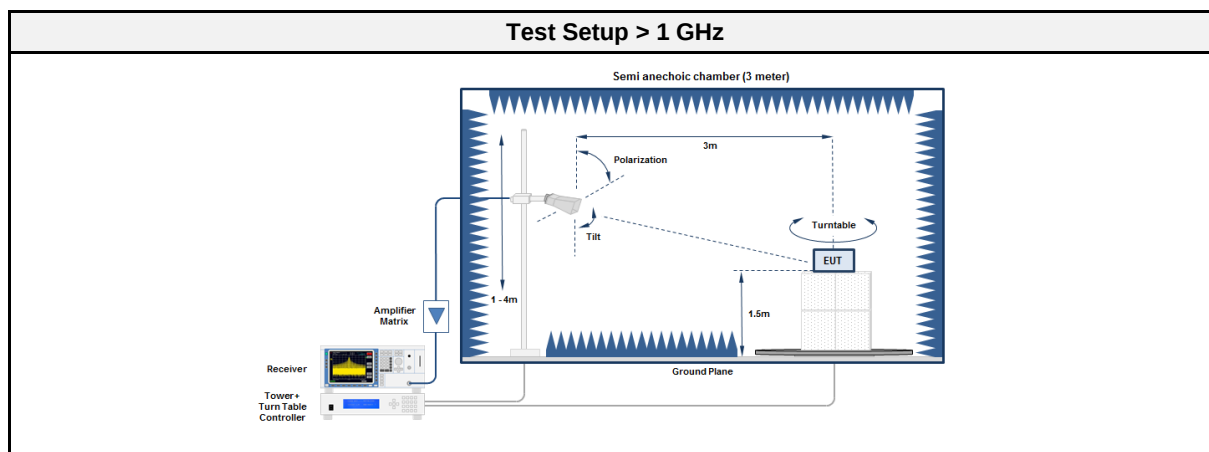
Test Information	
Reference	FCC § 15.247(d); FCC § 15.209
Measurement Uncertainty	± 5.95 dB
Measurement Method	ANSI C63.10 6.4, 6.5, 6.6, 11.12
Operator	Odai Qawasmeh
Date	2023-03-07 + 2023-03-08

3.1.2 Limits

Limits			
Frequency range [MHz]	Detector	Field strength [µV/m]	Measurement distance [m]
0.009 - 0.09	Average	2400/F[kHz]	300
0.09 - 0.110	Quasi-Peak	2400/F[kHz]	300
0.110 - 0.490	Average	2400/F[kHz]	300
0.490 - 1.705	Quasi-Peak	24000/F[kHz]	30
1.705 - 30.0	Quasi-Peak	30	30
30 - 88	Quasi-Peak	100	3
88 - 216	Quasi-Peak	150	3
216 - 960	Quasi-Peak	200	3
960 - 1000	Quasi-Peak	500	3
>1000	Average	500	3

3.1.3 Setup





3.1.4 Equipment

Test Software			
Description	Manufacturer	Name	Version
EMC Software	DARE Instruments	RadiMation	2020.1.8

Test Equipment 30 MHz - 1000 MHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF00062	2022-11	2025-11
Measurement Receiver	Agilent	N9038A-526/WXP	EF01070	2023-02	2024-02
Antenna	Schwarzbeck	VULB 9168	EF01824	2022-10	2023-10

Test Equipment > 1 GHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC2	EF01616	2022-10	2023-10
Spectrum analyzer	R&S	FSW43	EF00896	2022-08	2023-08
Antenna	Schwarzbeck	BBHA 9120B	EF01678	2021-03	2024-03
Antenna	Schwarzbeck	HWRD 650	EF01679	2021-03	2024-03
Antenna	Amplifier Research	AT4560	EF00302	2021-06	2023-06

3.1.5 Procedure

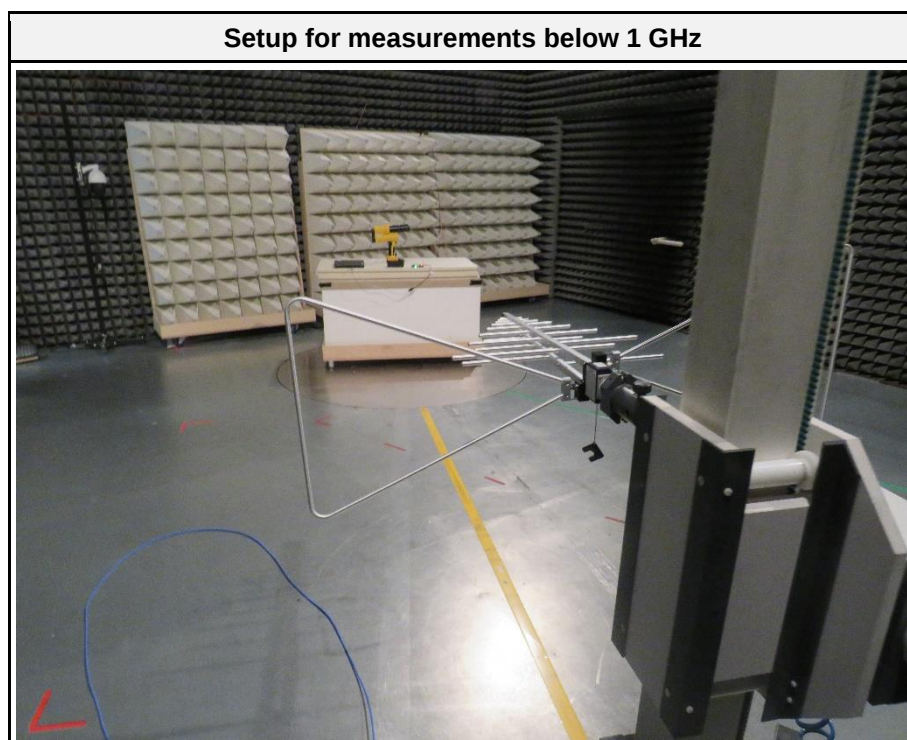
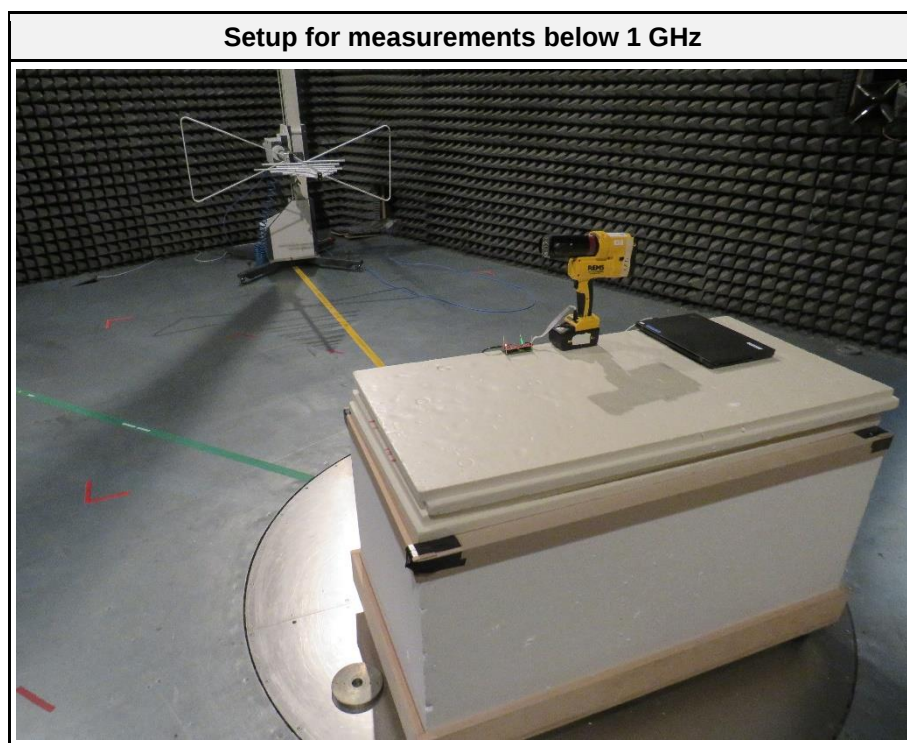
Test Procedure 30 MHz - 1000 MHz	
1. EUT is placed on a non conducting support at the center of a turn table 0.8 m above the ground 2. EUT set to test mode 3. The receiver is set to peak detection with max hold 4. The EUT is rotated through 360° and the height of the antenna is varied from 1 m to 4 m 5. All significant emissions are measured again using the corresponding final detector	

Test Procedure > 1 GHz	
1. EUT is placed on a non conducting support at the center of a turn table 1.5 m above the ground 2. EUT set to test mode 3. The receiver is set to peak detection with max hold 4. The EUT is rotated through 360° and the height of the antenna is varied from 1 m to 4 m 5. All significant emissions are measured again using the corresponding final detector	

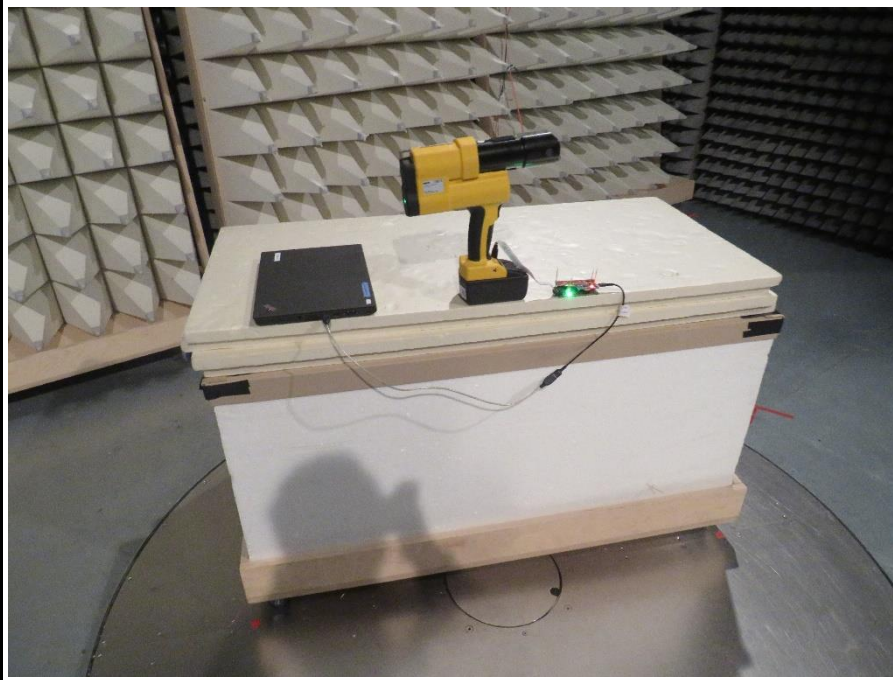
3.1.6 Results

Test Results - HT20						
Channel [MHz]	Emission [MHz]	Level [dBμV/m]	Det.	Pol.	Limit [dBμV/m]	Margin [dB]
2462	122.7562	28.10	pk	ver	43.50	-15.40
2462	156.8517	29.80	pk	hor	43.50	-13.69
2462	156.876	26.20	pk	ver	43.50	-17.34
2462	257.7928	34.20	qpk	hor	46.00	-11.82
2462	258.4022	32.90	qpk	hor	46.00	-13.15
2462	2490.6	64.18	pk	hor	74.00	-09.82
2462	2490.6	43.28	avg	hor	54.00	-10.72
2462	4924	51.28	pk	ver	74.00	-22.72
2462	4924	42.98	avg	ver	54.00	-11.02
2462	7394	46.33	pk	ver	74.00	-27.67
2462	7394	37.16	avg	ver	54.00	-16.84
2462	18387	46.27	pk	ver	74.00	-27.73
2462	18387	38.12	avg	ver	54.00	-15.88

3.1.7 Setup Photos



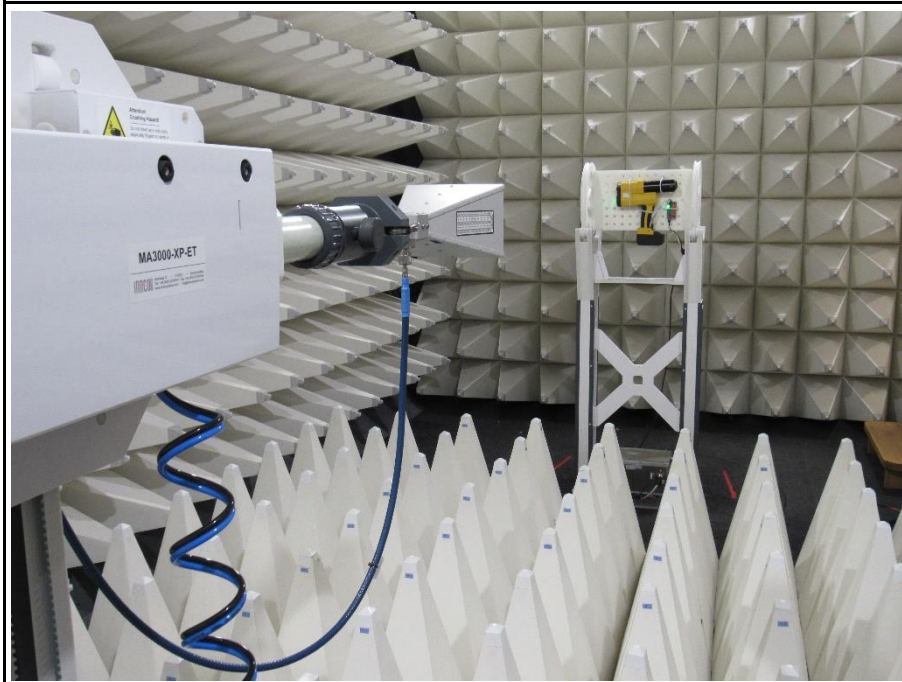
EUT Test Setup (vertical)



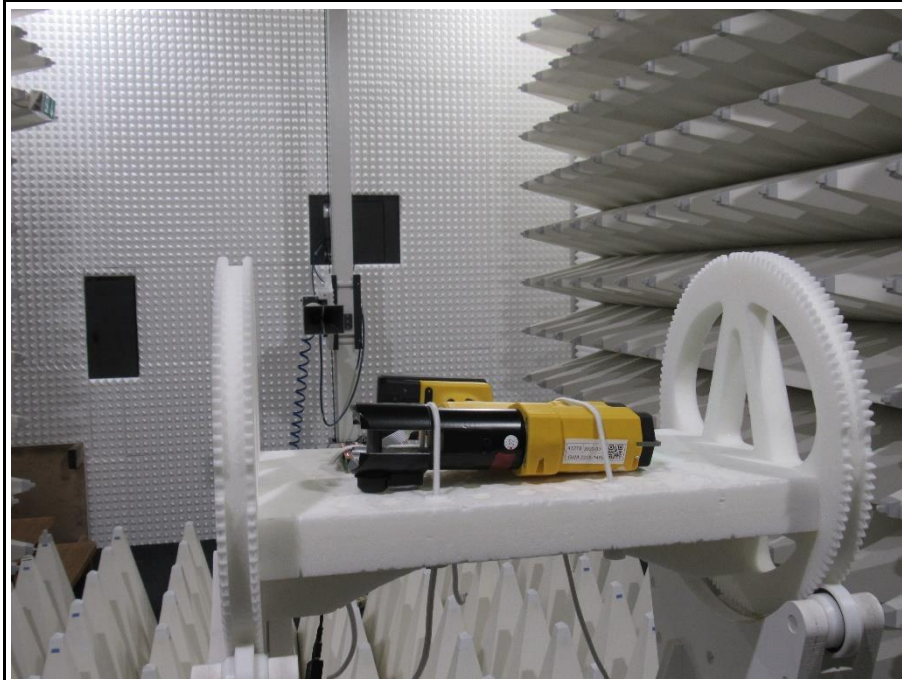
EUT Test Setup (horizontal)



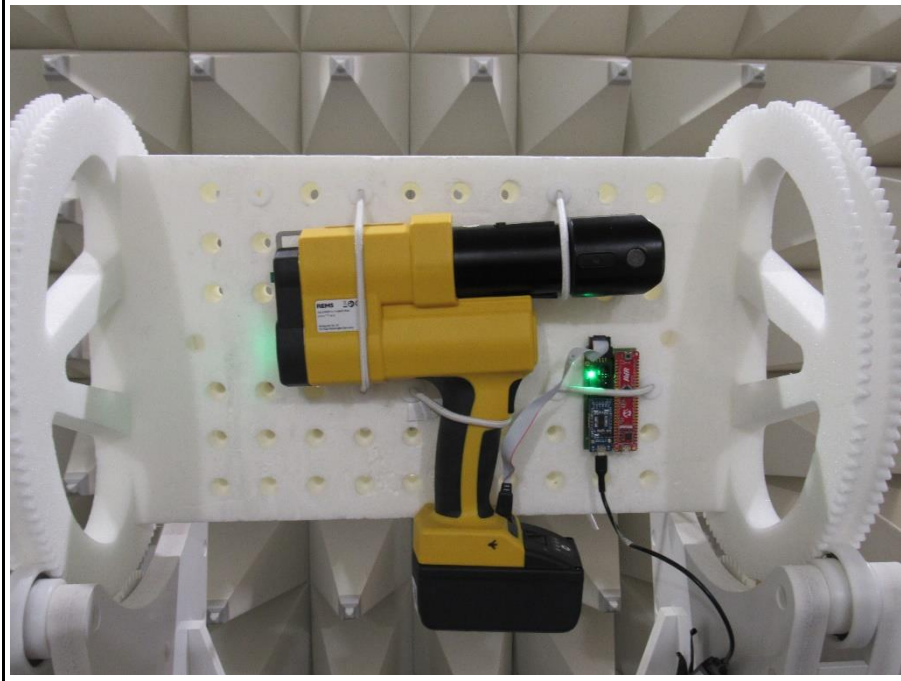
Setup for measurements above 1 GHz



Setup for measurements above 1 GHz



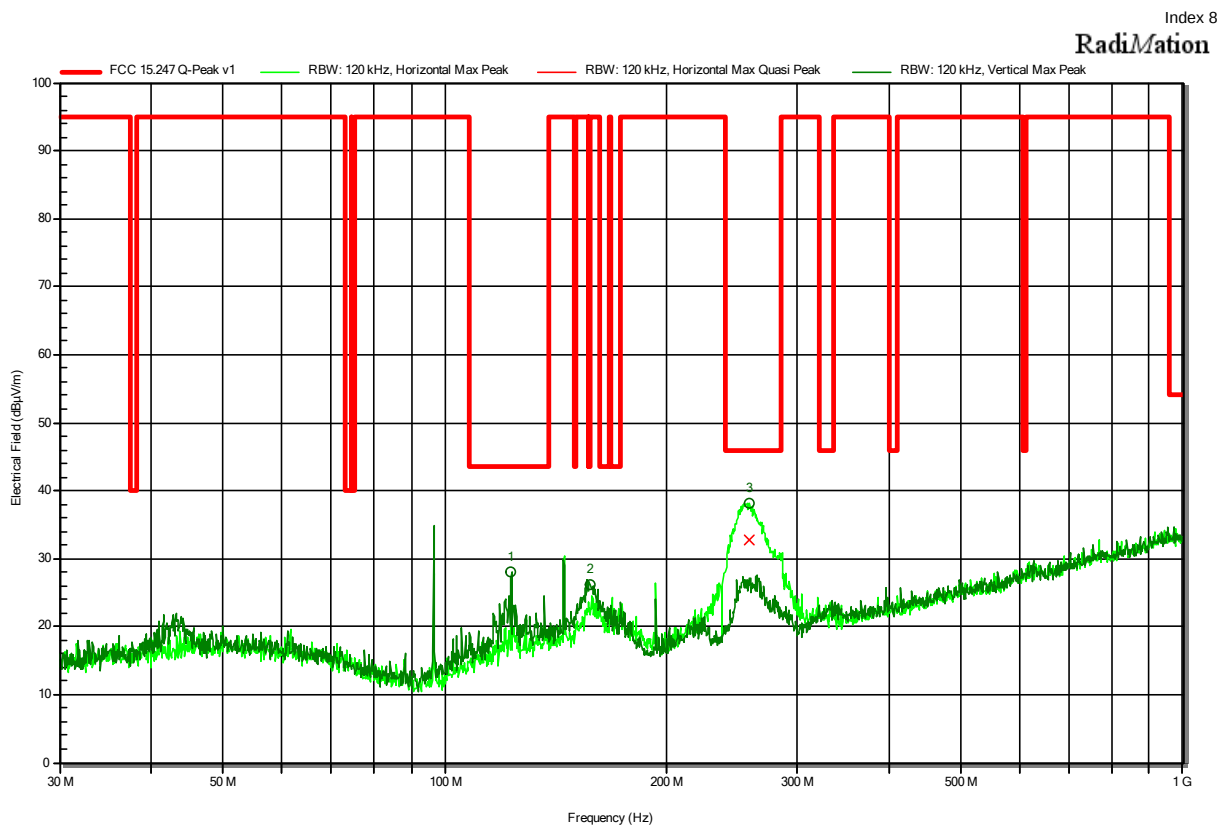
EUT Test Setup



ANNEX A Transmitter spurious emissions

Radiated Spurious Emissions according to 47 CFR Part 15.247

Project Number: G0M-2205-1460
 Applicant: Eurofins Electric & Electronic Products Testing AG
 Model Description: Akku-Press 22V ACC CONNECTED
 Model: 576003
 Test Sample ID: 43278
 Test Site: Eurofins Product Service GmbH
 Operator: Mr. Qawasmeh
 Measurement software: RadiMation, version 2020.1.8
 Test Conditions: Tnom: 21 °Celsius, Vnom: 21.6 VDC
 Antenna: Schwarzbeck VULB 9168
 Measurement distance: 3 m
 Mode: Tx; IEEE802.11n, 2462 MHz, 20 MHz, MCS0
 Test Date: 2023-03-08
 Note: EUT vertical



Frequency	Peak	Peak Limit	Peak Difference	Peak Status	Polarization
122.7562 MHz	28.1 dBµV/m	43.5 dBµV/m	-15.4 dB	Pass	Vertical
156.876 MHz	26.2 dBµV/m	43.5 dBµV/m	-17.34 dB	Pass	Vertical

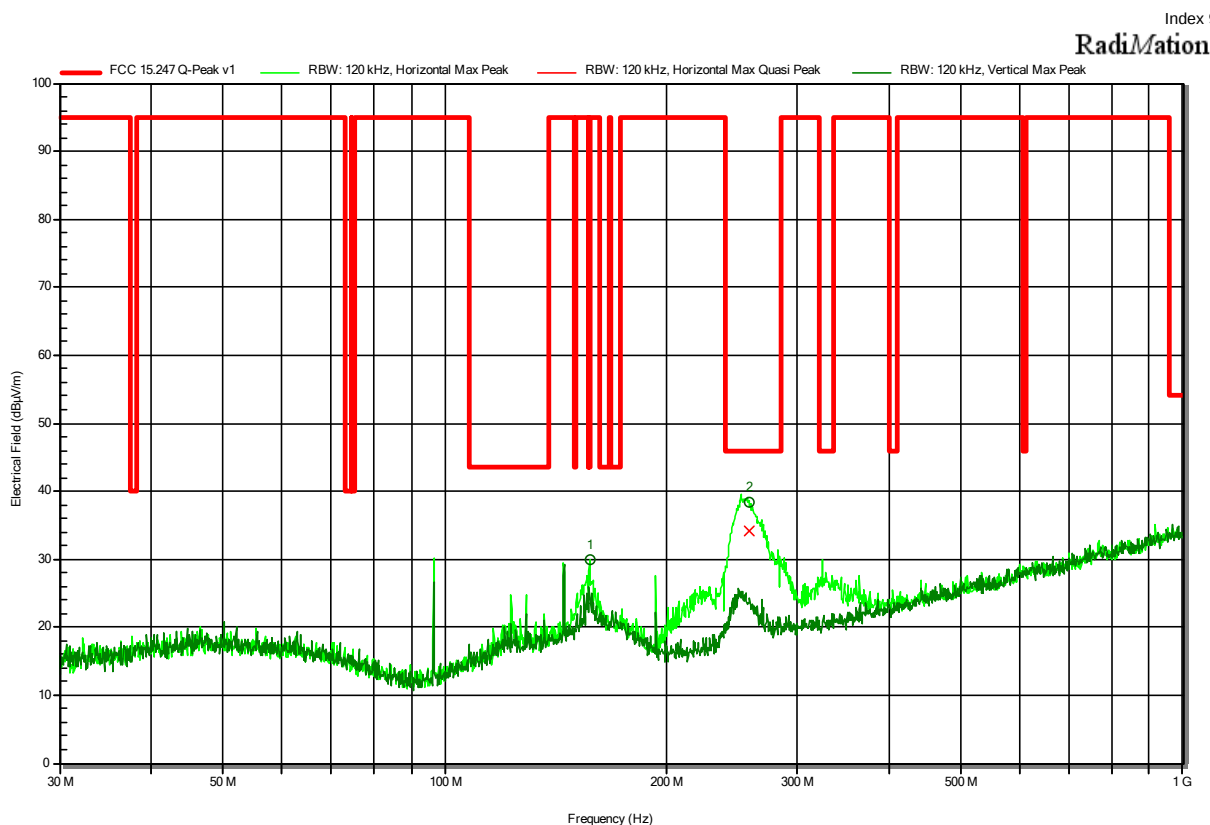
Frequency	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Polarization
258.4022 MHz	32.9 dBµV/m	46 dBµV/m	-13.15 dB	Pass	Horizontal

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 Operator: Mr. Qawasmeh
 Measurement software: RadiMation, version 2020.1.8
 Test Conditions: Tnom: 21 °Celsius, Vnom: 21.6 VDC
 Antenna: Schwarzbeck VULB 9168
 Measurement distance: 3 m
 Mode: Tx; IEEE802.11n, 2462 MHz, 20 MHz, MCS0
 Test Date: 2023-03-08
 Note: EUT horizontal



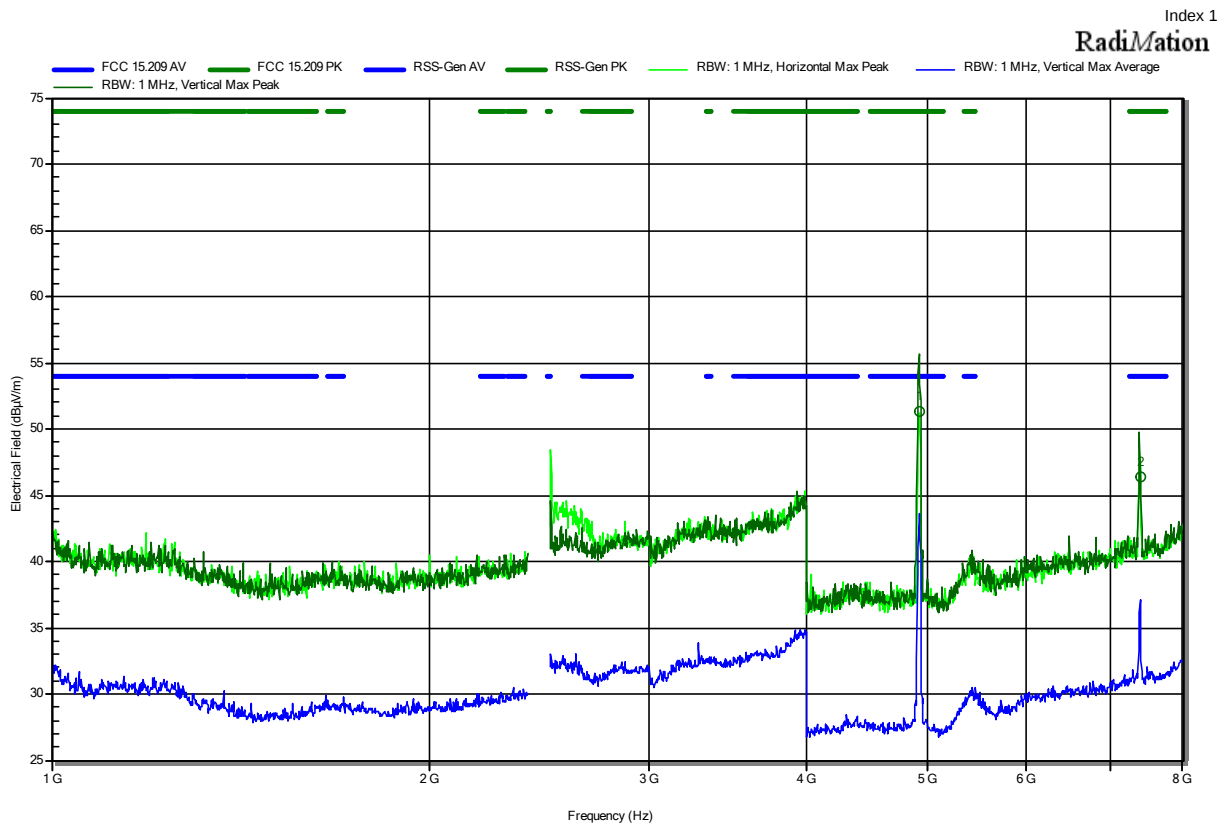
Frequency	Peak	Peak Limit	Peak Difference	Peak Status	Polarization
156.8517 MHz	29.8 dBμV/m	43.5 dBμV/m	-13.69 dB	Pass	Horizontal
Frequency	Quasi-Peak	Quasi-Peak Limit	Quasi-Peak Difference	Quasi-Peak Status	Polarization
257.7928 MHz	34.2 dBμV/m	46 dBμV/m	-11.82 dB	Pass	Horizontal

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Radiated Spurious Emissions according to 47 CFR Part 15.247

Project Number: G0M-2205-1460
 Applicant: Eurofins Electric & Electronic Products Testing AG
 Model Description: Akku-Press 22V ACC CONNECTED
 Model: 576003
 Test Sample ID: 43278
 Test Site: Eurofins Product Service GmbH
 Operator: Mr. Qawasmeh
 Measurement software: RadiMation, version 2020.1.8
 Test Conditions: Tnom: 23 °Celsius, Vnom: 21.6 VDC
 Antenna: Schwarzbeck BBHA 9120B
 Measurement distance: 3 m
 Mode: Tx; IEEE802.11n, 2462 MHz, 20 MHz, MCS0
 Test Date: 2023-03-07
 Note:

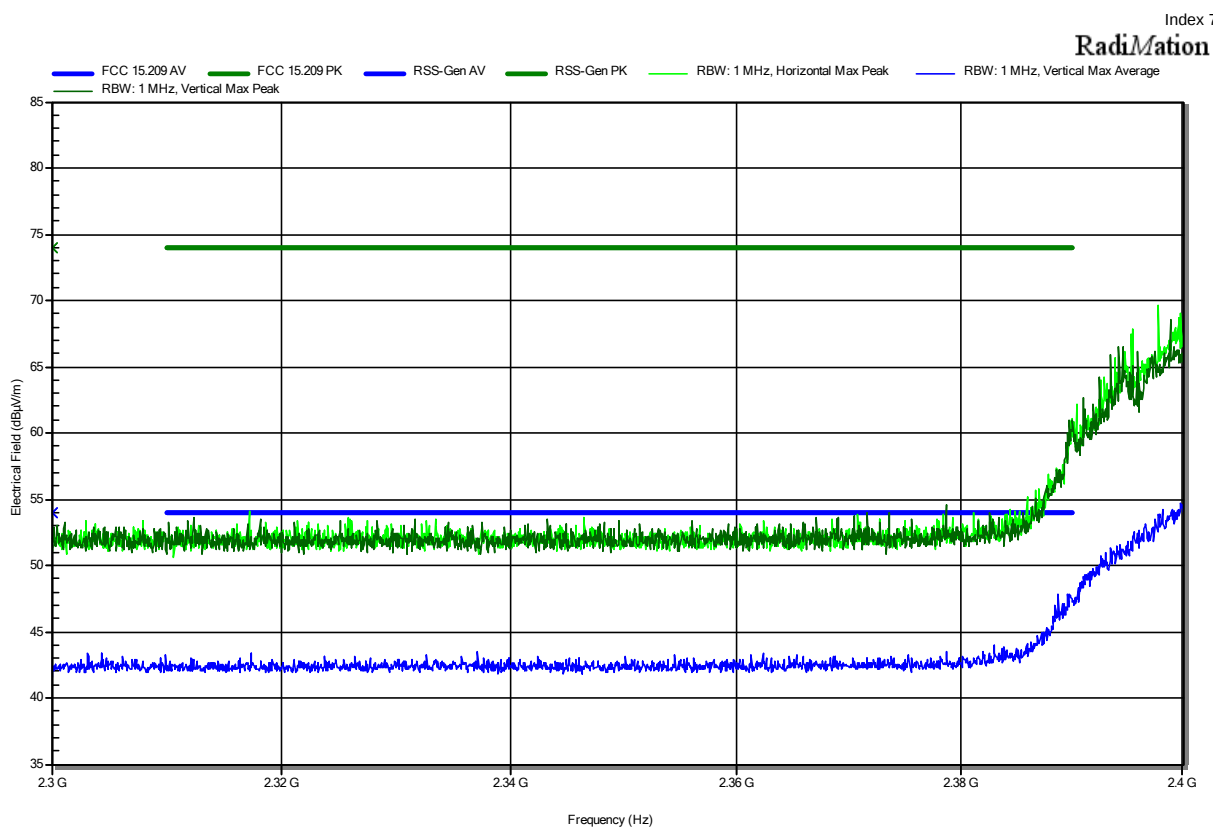


Frequency	Peak	Peak Limit	Peak Difference	Peak Status	Polarization
4.924 GHz	51.28 dBμV/m	74 dBμV/m	-22.72 dB	Pass	Vertical
7.394 GHz	46.33 dBμV/m	74 dBμV/m	-27.67 dB	Pass	Vertical

Frequency	Average	Average Limit	Average Difference	Average Status	Polarization
4.924 GHz	42.98 dBμV/m	54 dBμV/m	-11.02 dB	Pass	Vertical
7.394 GHz	37.16 dBμV/m	54 dBμV/m	-16.84 dB	Pass	Vertical

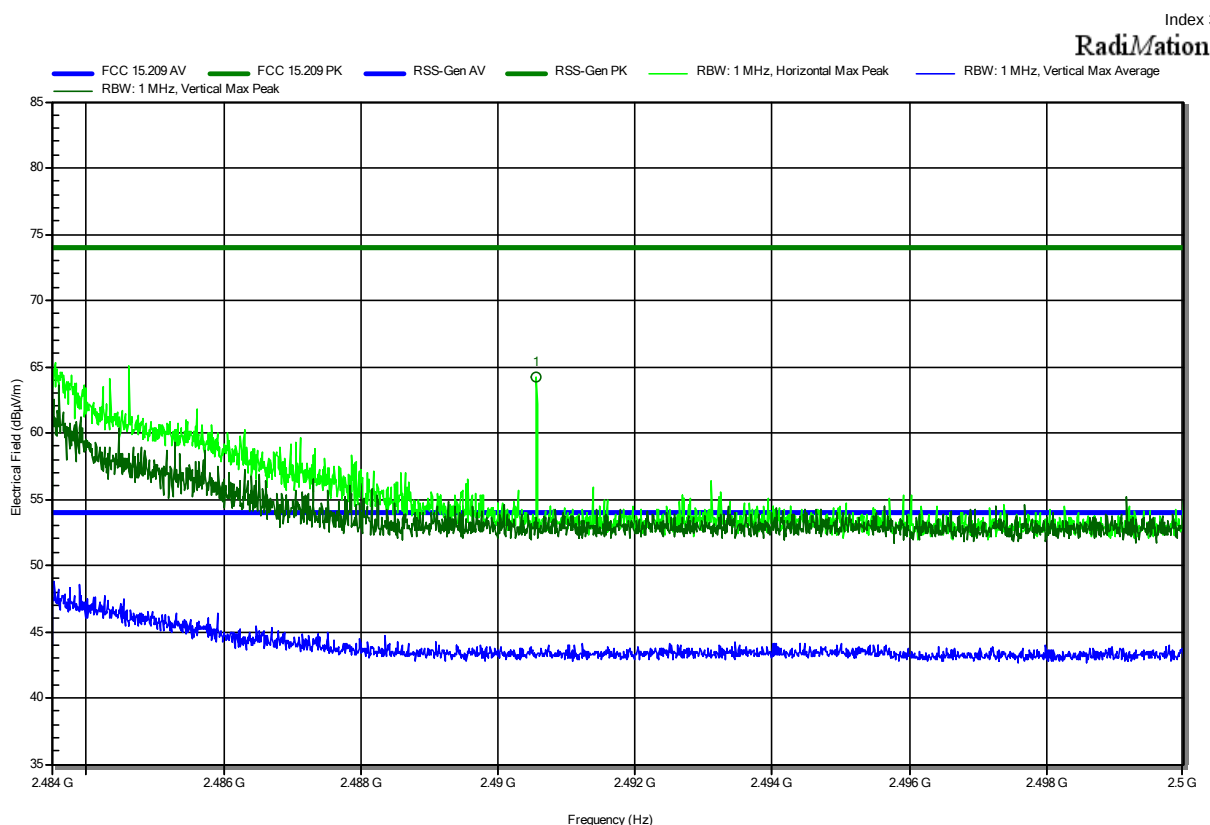
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 Operator: Mr. Qawasmeh
 Measurement software: RadiMation, version 2020.1.8
 Test Conditions: Tnom: 23 °Celsius, Vnom: 21.6 VDC
 Antenna: Schwarzbeck BBHA 9120B
 Measurement distance: 3 m
 Mode: Tx; IEEE802.11n, 2412 MHz, 20 MHz, MCS0
 Test Date: 2023-03-07
 Note: lower bandedge



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 Test Conditions: Tnom: 23 °Celsius, Vnom: 21.6 VDC
 Antenna: Schwarzbeck BBHA 9120B
 Measurement distance: 3 m
 Mode: Tx; IEEE802.11n, 2462 MHz, 20 MHz, MCS0
 Test Date: 2023-03-07
 Note: upper bandedge



Frequency 2.4906 GHz	Peak 64.18 dBµV/m	Peak Limit 74 dBµV/m	Peak Difference -9.82 dB	Peak Status Pass	Polarization Horizontal
Frequency 2.4906 GHz	Average 43.28 dBµV/m	Average Limit 54 dBµV/m	Average Difference -10.72 dB	Average Status Pass	Polarization Horizontal

Test Report No.: G0M-2205-1460-TFC247WF-V01

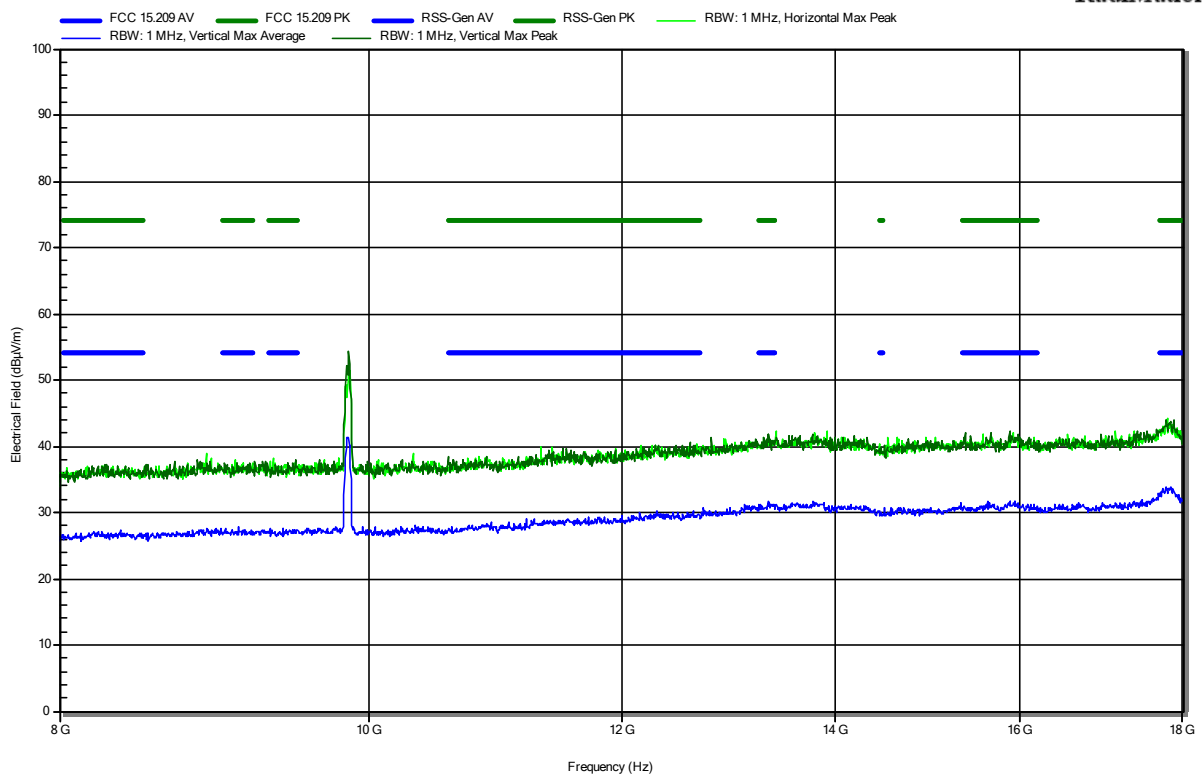
Eurofins Product Service GmbH
 Storkower Str. 38c, D-15526 Reichenwalde, Germany

Radiated Spurious Emissions according to 47 CFR Part 15.247

Project Number: G0M-2205-1460
 Applicant: Eurofins Electric & Electronic Products Testing AG
 Model Description: Akku-Press 22V ACC CONNECTED
 Model: 576003
 Test Sample ID: 43278
 Test Site: Eurofins Product Service GmbH
 Operator: Mr. Qawasmeh
 Measurement software: RadiMation, version 2020.1.8
 Test Conditions: Tnom: 23 °Celsius, Vnom: 21.6 VDC
 Antenna: Schwarzbeck HWRD 650
 Measurement distance: 3 m
 Mode: Tx; IEEE802.11n, 2462 MHz, 20 MHz, MCS0
 Test Date: 2023-03-07
 Note:

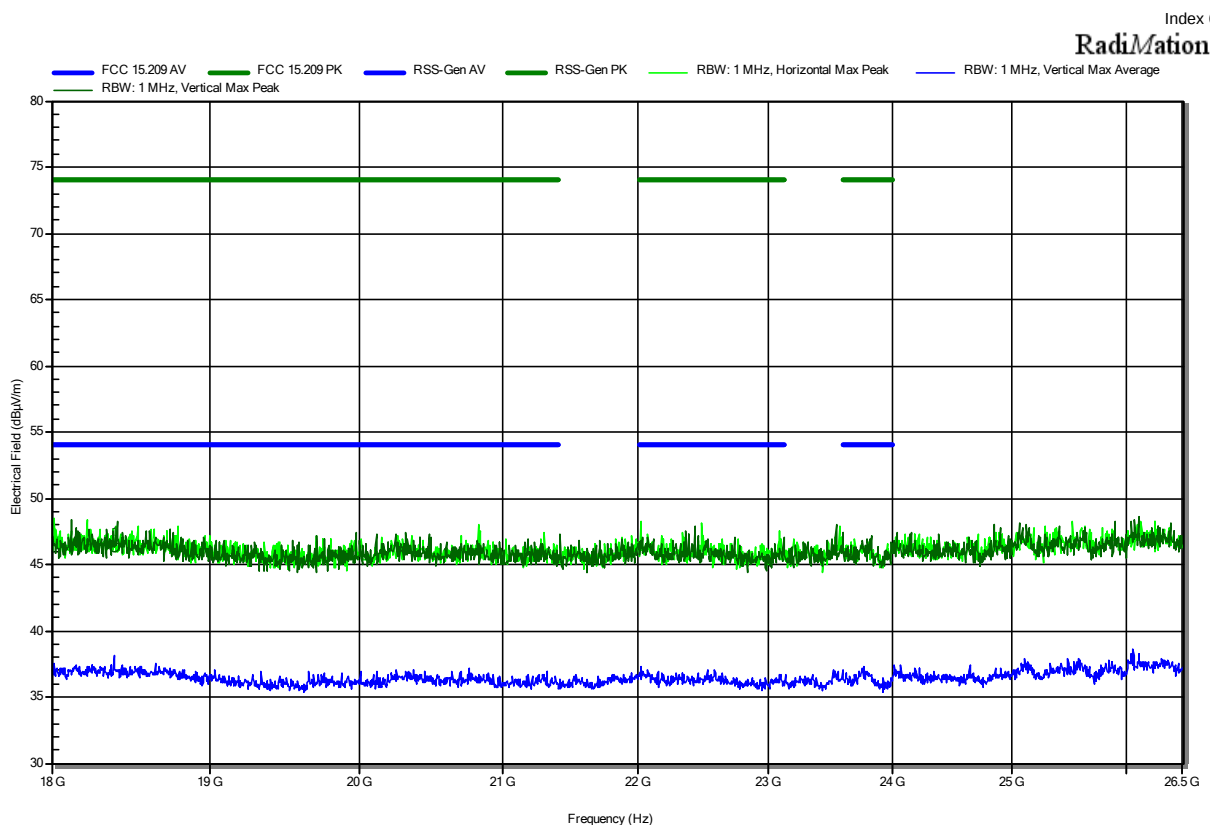
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RadiMation



Radiated Spurious Emissions according to 47 CFR Part 15.247

Project Number: G0M-2205-1460
 Applicant: Eurofins Electric & Electronic Products Testing AG
 Model Description: Akku-Press 22V ACC CONNECTED
 Model: 576003
 Test Sample ID: 43278
 Test Site: Eurofins Product Service GmbH
 Operator: Mr. Qawasmeh
 Measurement software: RadiMation, version 2020.1.8
 Test Conditions: Tnom: 23 °Celsius, Vnom: 21.6 VDC
 Antenna: Amplifier Research AT4560
 Measurement distance: 3 m
 Mode: Tx; IEEE802.11n, 2462 MHz, 20 MHz, MCS0
 Test Date: 2023-03-07
 Note:



Frequency 18.387 GHz	Peak 46.27 dBμV/m	Peak Limit 74 dBμV/m	Peak Difference -27.73 dB	Peak Status Pass	Polarization Vertical
Frequency 18.387 GHz	Average 38.12 dBμV/m	Average Limit 54 dBμV/m	Average Difference -15.88 dB	Average Status Pass	Polarization Vertical

== = END OF TEST REPORT == =

Test Report No.: G0M-2205-1460-TFC247WF-V01

Eurofins Product Service GmbH
 Storkower Str. 38c, D-15526 Reichenwalde, Germany