



RF - TEST REPORT

- FCC Part 15.249, RSS210 -

Type / Model Name : ROX 12.1

Product Description : Bicycle Computer

Applicant : TQ Systems GmbH

Address : Gut Delling, Mühlstrasse 2
82229 SEEFELD, GERMANY

Manufacturer : SIGMA-ELEKTRO GmbH

Address : Dr.-Julius-Leber-Strasse 15
67433 NEUSTADT, GERMANY

Test Result according to the standards listed in clause 1 test standards:	POSITIVE
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Test Report No. : 80156936-00 Rev_0	28. February 2023 Date of issue
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Deutsche
 Akkreditierungsstelle
 D-PL-12030-01-03
 D-PL-12030-01-04



FCC ID: M5LROX-12-1

IC ID: 7580A-ROX121

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ATTACHMENT A as separate supplement



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1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September 2022)

Part 15, Subpart A, Section 15.31	Measurement standards
Part 15, Subpart A, Section 15.33	Frequency range of radiated measurements
Part 15, Subpart A, Section 15.35	Measurement detector functions and bandwidths

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (September 2022)

Part 15, Subpart C, Section 15.203	Antenna requirement
Part 15, Subpart C, Section 15.204	External radio frequency power amplifiers and antenna modifications
Part 15, Subpart C, Section 15.205	Restricted bands of operation
Part 15, Subpart C, Section 15.207	Conducted limits
Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
Part 15, Subpart C, Section 15.215	Additional provisions to the general radiated emission limitations
Part 15, Subpart C, Section 15.249	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, 5725 - 5875 MHz, and 24.0 - 24.25 GHz
ANSI C63.10: 2013	Testing Unlicensed Wireless Devices

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.



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2 EQUIPMENT UNDER TEST

2.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

2.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

2.3 General remarks

This report covers the emissions of ANT+ of the BLE-Chip "NRF52832" in combination with the host device ROX12.1.

2.4 Photo documentation of the EUT – Detailed photos see attachment A

2.5 Equipment category

ANT+ device

2.6 Short description of the equipment under test (EUT)

The EUT is a bicycle computer.
A SMD antenna is used within the system for BLE or ANT+. The EUT has only integrated antennas.

Testsystem: ROX12.1 REV0200

Number of tested samples	:	1 radiated sample DUT9	1 conducted sample DUT8
Serial number	:	38676365	38676385
Testsoftware	:	Linux Test Software	Linux Test Software
	:		

Items	Description
Technology	ANT+
Chipset type	Nordic NRF 52832
Frequency range	2457 MHz
Channel numbers	1
Data rate (kbps)	1000
Antenna type	2.4 GHz SMD Antenna

2.7 Variants of the EUT

There are no variants.



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2.8 Operation frequency and channel plan

Operation frequency: 2457 MHz

2.9 Transmit operating modes

ANT+ TX 2457 MHz

2.10 Antenna

The following antennas are used with the EUT:

Johanson Technology 2.4 GHz SMD Antenna 2450AT18D0100

2.11 Power supply system utilised

Power supply voltage, V_{nom} : 3.6V_{DC}, battery supplied

2.12 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- none Model : -

2.13 Determination of worst-case conditions for final measurement

Preliminary tests are performed in all three orthogonal axes of the EUT to locate at which position and at what setting of the EUT produce the maximum of the emissions. For the further measurement the EUT is set in Y position.

2.13.1 Test jig

No test jig is used.

2.13.2 Test software

A special test software is used for TX continuous. After connection to power supply the EUT is transmitting in continuous mode.

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3 TEST RESULT SUMMARY

FCC Rule Part	RSS Rule Part	Description	Result
15.205(a)	RSS-Gen, 8.10	Emissions in restricted bands	passed
15.207(a)	RSS-Gen, 8.8	AC power line conducted emissions ¹	passed
15.215(c)	-	EBW	passed
-	RSS-Gen, 6.7	OBW	passed
15.249(a)	RSS-210, B10(a)	Field strength of fundamental	passed
15.249(d)	RSS-210, B10(b)	Out-of-band emission, radiated	passed

The mentioned RSS Rule Parts in the above table are related to:
 RSS-Gen, Issue 5 + Amendment 1 + Amendment 2
 RSS-210, Issue 10 + Amendment

3.1 Revision history of test report

Test report No	Rev.	Issue Date	Changes
80156936-00	0	28 February 2023	Initial test report

The test report with the highest revision number replaces the previous test reports.

3.2 Final assessment

The equipment under test fulfills the requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 26 January 2023

Testing concluded on : 17 February 2023

Checked by:

Tested by:

 Jürgen Pessinger
 Radio Team

 Christopher Thaller
 Radio Team



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4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15 - 35 ° C

Humidity: 30 - 60 %

Atmospheric pressure: 86 - 106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor $k = 2$. The true value is located in the corresponding interval with a probability of 95 %. The measurement uncertainty was calculated for all measurements listed in this test report on basis of the ETSI Technical Report TR 100 028 Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1 and Part 2. The results are documented in the quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
AC power line conducted emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
EBW and OBW	2400 MHz to 30000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Output power ERP, radiated	1000 MHz to 7000 MHz	95%	± 2.71 dB
Field strength of the fundamental	1000 MHz to 7000 MHz	95%	± 2.71 dB
Power spectral density	2400 MHz to 3000 MHz	95%	± 0.62 dB
Spurious Emissions, conducted	9 kHz to 10000 MHz	95%	± 2.15 dB
Spurious Emissions, conducted	10000 MHz to 40000 MHz	95%	± 3.47 dB
Spurious Emissions, radiated	9 kHz to 30 MHz	95%	± 3.53 dB
Spurious Emissions, radiated	30 MHz to 1000 MHz	95%	± 4.44 dB
Spurious Emissions, radiated	1000 MHz to 30000 MHz	95%	± 2.34 dB
Spurious Emissions, radiated	30000 MHz to 40000 MHz	95%	± 5.13 dB

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4.4 Conformity Decision Rule

The applied conformity decision rule is based on ILAC G8:09/2019 clause 4.2.1 Binary Statement for Simple Acceptance Rule ($w = 0$).

Details can be found in the procedure CSA_B_V50_29.

4.5 Measurement protocol for FCC and ISED

4.5.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

FCC: DE 0011

ISED: DE0009

4.5.2 General Standard information

The test methods used comply with ANSI C63.10 - "Testing Unlicensed Wireless Devices".

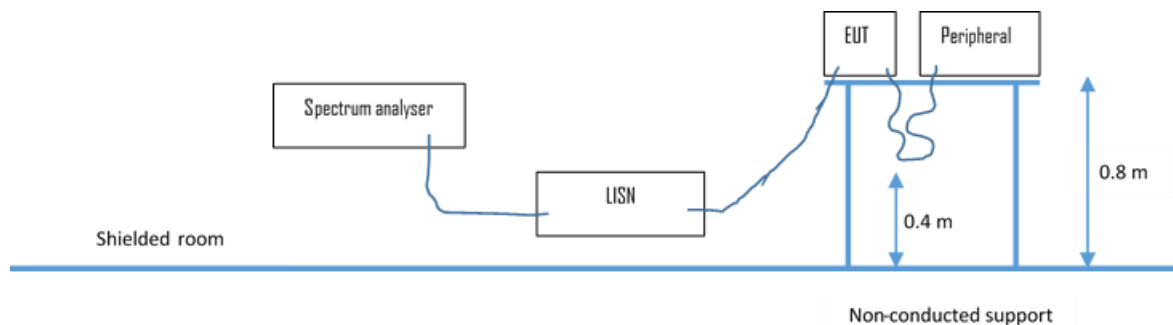
4.5.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions.

4.5.3 Details of test procedures

4.5.3.1 Conducted emission

Test setup according ANSI C63.10



The final level, expressed in $\text{dB}\mu\text{V}$, is arrived at by taking the reading directly from the Spectrum analyser. This level is compared to the limit.

To convert between $\text{dB}\mu\text{V}$ and μV , the following conversions apply:

$$\text{dB}\mu\text{V} = 20(\log \mu\text{V})$$

$$\mu\text{V} = \text{Inverse log}(\text{dB}\mu\text{V}/20)$$

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with $50 \Omega / 50 \mu\text{H}$ (CISPR 16) characteristics. The receiver is protected by means of an impedance matched pulse limiter connected directly to the RF input. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emission is re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

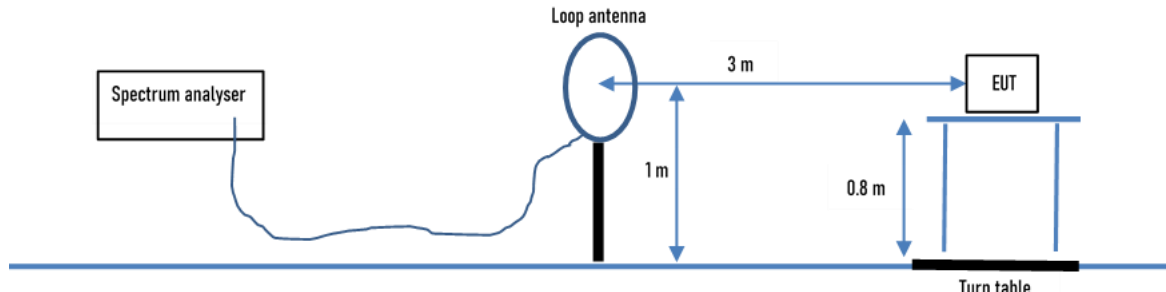
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4.5.3.2 Radiated emission

4.5.3.2.1 OATS1 test site (9 kHz - 30 MHz):

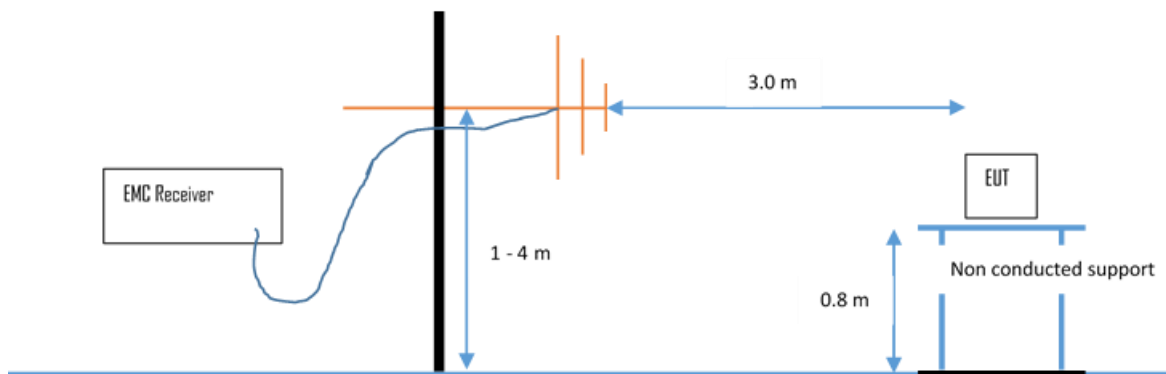
Test setup according ANSI C63.10



Emissions from the EUT are measured in the frequency range of 9 MHz to 30 MHz using a tuned receiver and a calibrated loop antenna. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Cables to simulators/testers (if used in this test) are routed through the centre of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied along the site axis and the EUT is rotated 360 degrees.

4.5.3.2.2 OATS1 test site (30 MHz - 1 GHz):

Test setup according ANSI C63.10.



Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Cables to simulators/testers (if used in this test) are routed through the centre of the table and to a screened room located outside the test area. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees. The final level in dBµV/m is calculated by taking the reading from the EMI receiver (Level dBµV) and adding the correction factors and cable loss factor (dB). The FCC limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:

30 MHz – 1000 MHz: RBW: 120 kHz

Example:

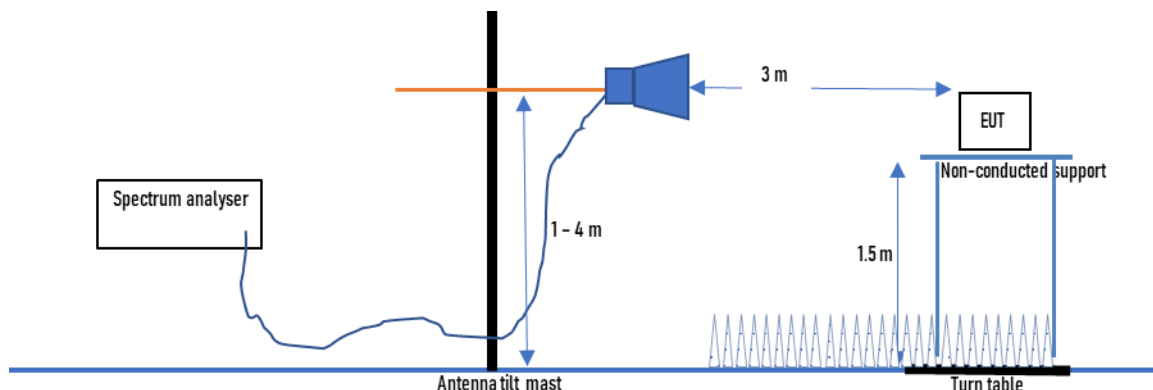
Frequency (MHz)	Level (dBµV)	+	Factor (dB)	=	Level (dBµV/m)	-	Limit (dBµV/m)	=	Delta (dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	=	-2.4

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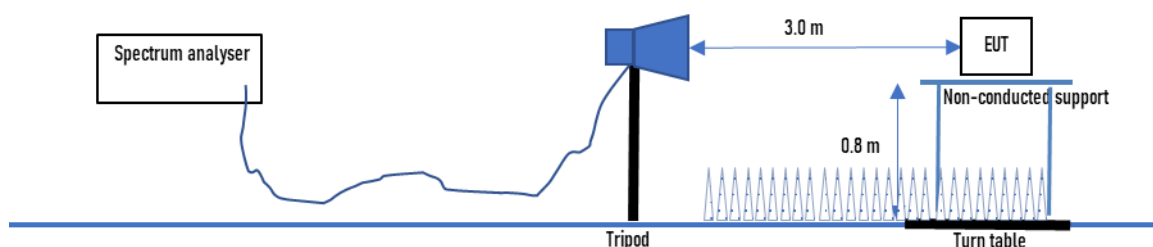
4.5.3.2.3 Anechoic chamber 1 (1000 MHz – 18000 MHz)

Test setup according ANSI C63.10.



Radiated emissions from the EUT are measured in the frequency range 1 GHz up to 18 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 1.5 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the centre, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements.

4.5.3.2.4 Anechoic chamber 1 (18 GHz – 40 GHz)



Emissions from the EUT are measured in the frequency range 18 GHz up to 40 GHz as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a non-conducting table, 0.8 metre above the ground plane. The turntable is fully covered with the appropriate absorber (Type VHP-12). Any controlling device is positioned such that it does not significantly influence the measurement results. Interconnecting cables that hang closer than 40 cm to the ground plane are folded back and forth in the centre, forming a bundle 30 cm to 40 cm long. Measurements are made in three orientations of the EUT and the horizontal and vertical polarization planes of measurement antenna in a fully anechoic room. The measurement antenna is adjusted and the EUT orientated to permit the measurement of the maximum emission from the EUT. The conditions determined as worst-case will then be used for the final measurements. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty. The limit is adopted.

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5 TEST CONDITIONS AND RESULTS

5.1 AC power line conducted emissions

For test instruments and accessories used see section 6 Part A 4.

5.1.1 Description of the test location

Test location: Shielded Room S2

5.1.2 Photo documentation of the test set-up – see Attachment B Part A4

5.1.3 Applicable standard

According to FCC Part 15, Section 15.207(a):

Except as shown in paragraphs (b) and (c) of this Section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the given limits.

5.1.4 Description of Measurement

The measurements are performed following the procedures set out in ANSI C63.10 described under item 4.4.3. If the minimum limit margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz

Min. limit margin -9.5 dB at 0.475 MHz

Limit according to FCC Part 15, Section 15.207(a):

Frequency of Emission (MHz)	Conducted Limit (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency

The requirements are **FULFILLED**.

Remarks: For detailed test result please see the following test protocols.

Travel adapter Panasonic Model-No. VSK0772, hp notebook charger: CT:WDWRT0BAR9N3HX



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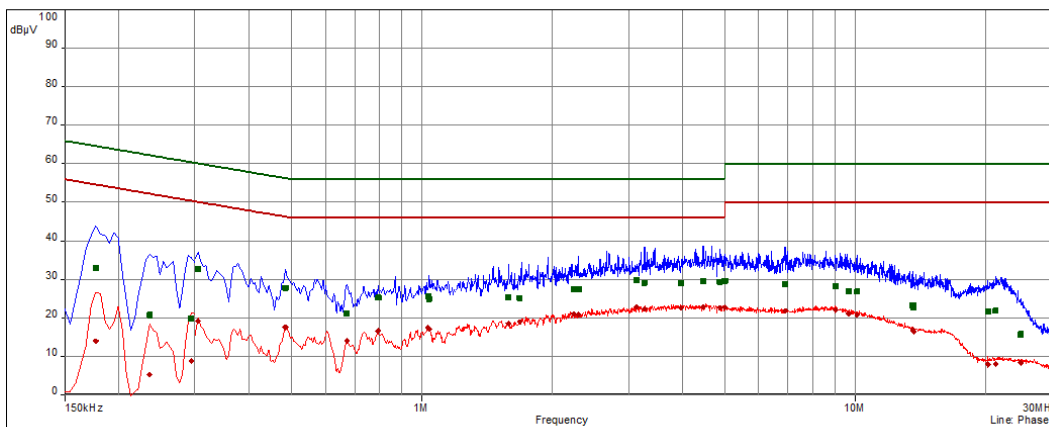
5.1.6 Test protocol

Test point
Operation mode:

L1
Transmission at 2.4 GHz, JBP – EUT connected to PC over USB

Result: passed

- FCC/FCC Part 15C (15.207)B - Avg/
- FCC/FCC Part 15C (15.207)B - Q-Peak/
- Peak (Phase 1)
- CISPR_AVG (Phase 1)
- QuasiPeak (Finals) (Phase 1)
- ◆ CISPR_AV (Finals) (Phase 1)



FCC/FCC Part 15C (15.207)B

freq	SR	QP	margin	limit	AV	margin	limit	line	corr
MHz		dBµV	dB	dBµV	dBµV	dB	dBµV		dB
0.18	1	33.0	-31.6	64.6	14.0	-40.6	54.6	Phase 1	10.1
0.24	1	20.8	-41.4	62.3	5.2	-47.1	52.3	Phase 1	10.1
0.29	1	19.9	-40.5	60.4	8.8	-41.6	50.4	Phase 1	10.1
0.30	2	32.8	-27.4	60.1	19.1	-31.0	50.1	Phase 1	10.1
0.48	2	27.8	-28.5	56.3	17.6	-28.7	46.3	Phase 1	10.2
0.67	3	21.2	-34.8	56.0	14.0	-32.0	46.0	Phase 1	10.2
0.79	3	25.2	-30.8	56.0	16.6	-29.4	46.0	Phase 1	10.2
1.04	3	25.7	-30.3	56.0	17.5	-28.5	46.0	Phase 1	10.2
1.04	3	25.0	-31.0	56.0	17.1	-28.9	46.0	Phase 1	10.2
1.59	4	25.5	-30.6	56.0	18.5	-27.5	46.0	Phase 1	10.3
1.69	4	25.1	-30.9	56.0	18.9	-27.1	46.0	Phase 1	10.3
2.24	4	27.5	-28.5	56.0	21.1	-25.0	46.0	Phase 1	10.3
2.30	4	27.5	-28.6	56.0	20.8	-25.2	46.0	Phase 1	10.3
3.13	5	29.9	-26.1	56.0	22.9	-23.1	46.0	Phase 1	10.3
3.27	5	29.2	-26.8	56.0	22.3	-23.7	46.0	Phase 1	10.3
3.97	5	29.1	-26.9	56.0	22.6	-23.4	46.0	Phase 1	10.4
4.47	5	29.6	-26.4	56.0	22.8	-23.2	46.0	Phase 1	10.4
4.88	6	29.3	-26.7	56.0	22.7	-23.4	46.0	Phase 1	10.4
5.01	6	29.7	-30.3	60.0	22.7	-27.3	50.0	Phase 1	10.4
6.89	6	28.9	-31.1	60.0	21.9	-28.1	50.0	Phase 1	10.6
9.02	6	28.2	-31.8	60.0	22.0	-28.0	50.0	Phase 1	10.6
9.68	7	27.0	-33.0	60.0	21.1	-28.9	50.0	Phase 1	10.6
10.12	7	26.9	-33.1	60.0	20.8	-29.2	50.0	Phase 1	10.7
13.60	7	23.2	-36.8	60.0	16.9	-33.1	50.0	Phase 1	11.0
13.67	7	22.6	-37.4	60.0	16.5	-33.5	50.0	Phase 1	11.0
20.25	8	21.7	-38.3	60.0	7.9	-42.1	50.0	Phase 1	11.3
21.14	8	21.9	-38.1	60.0	8.1	-41.9	50.0	Phase 1	11.3
24.16	8	15.8	-44.2	60.0	8.4	-41.6	50.0	Phase 1	11.5
24.18	8	15.5	-44.5	60.0	8.3	-41.7	50.0	Phase 1	11.5

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Test point

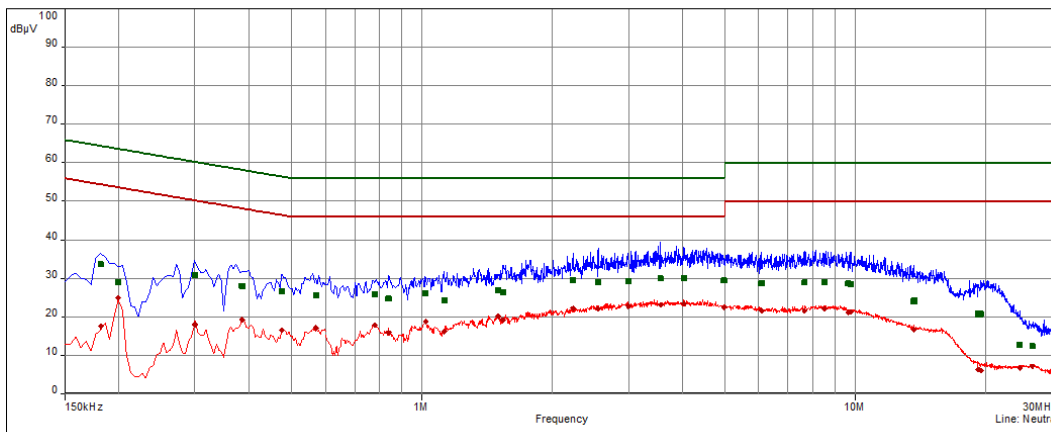
N

Result: passed

Operation mode:

Transmission at 2.4 GHz, JBP – EUT connected to PC over USB

- FCC/FCC Part 15C (15.207) B - Avg/
- FCC/FCC Part 15C (15.207) B - Q-Peak/
- Peak (Neutral)
- CISPR AVG (Neutral)
- QuasPeak (Finals) (Neutral)
- ◆ CISPR AV (Finals) (Neutral)



FCC/FCC Part 15C (15.207)B

freq	SR	QP	margin	limit	AV	margin	limit	line	corr
MHz		dBµV	dB	dBµV	dBµV	dB	dBµV		dB
0.18	9	33.6	-30.8	64.4	17.6	-36.8	54.4	Neutral	10.1
0.20	9	29.2	-34.4	63.6	25.0	-28.7	53.6	Neutral	10.1
0.30	9	30.9	-29.4	60.2	18.1	-32.2	50.2	Neutral	10.2
0.30	10	30.8	-29.5	60.2	18.1	-32.2	50.2	Neutral	10.2
0.39	10	28.0	-30.2	58.2	19.2	-29.0	48.2	Neutral	10.2
0.48	10	26.5	-29.9	56.4	16.5	-29.9	46.4	Neutral	10.2
0.57	10	25.7	-30.3	56.0	17.1	-28.9	46.0	Neutral	10.2
0.78	11	25.9	-30.2	56.0	17.8	-28.2	46.0	Neutral	10.2
0.84	11	24.8	-31.2	56.0	16.0	-30.0	46.0	Neutral	10.2
1.02	11	26.2	-29.8	56.0	18.8	-27.2	46.0	Neutral	10.2
1.13	11	24.4	-31.6	56.0	16.3	-29.8	46.0	Neutral	10.2
1.50	12	27.0	-29.0	56.0	20.1	-25.9	46.0	Neutral	10.3
1.54	12	26.5	-29.5	56.0	19.3	-26.7	46.0	Neutral	10.3
2.24	12	29.5	-26.5	56.0	22.2	-23.8	46.0	Neutral	10.3
2.56	13	29.1	-26.9	56.0	22.0	-24.0	46.0	Neutral	10.4
2.99	13	29.4	-26.7	56.0	22.8	-23.2	46.0	Neutral	10.4
3.56	13	30.0	-26.0	56.0	23.1	-22.9	46.0	Neutral	10.4
4.03	13	29.9	-26.1	56.0	23.4	-22.6	46.0	Neutral	10.4
4.99	14	29.5	-26.5	56.0	22.5	-23.5	46.0	Neutral	10.5
6.08	14	28.7	-31.3	60.0	21.6	-28.4	50.0	Neutral	10.5
7.64	14	28.9	-31.1	60.0	21.6	-28.4	50.0	Neutral	10.6
8.49	14	29.0	-31.0	60.0	22.1	-27.9	50.0	Neutral	10.6
9.63	15	28.7	-31.3	60.0	21.2	-28.8	50.0	Neutral	10.6
9.78	15	28.5	-31.5	60.0	21.2	-28.8	50.0	Neutral	10.6
13.69	15	23.9	-36.1	60.0	16.7	-33.3	50.0	Neutral	10.9
13.71	15	24.3	-35.7	60.0	16.7	-33.3	50.0	Neutral	10.9
19.24	16	20.7	-39.3	60.0	6.4	-43.6	50.0	Neutral	11.1
19.54	16	20.7	-39.3	60.0	6.1	-43.9	50.0	Neutral	11.1
24.05	16	12.8	-47.3	60.0	6.7	-43.3	50.0	Neutral	11.1
25.70	16	12.4	-47.6	60.0	7.2	-42.8	50.0	Neutral	11.1

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.



FCC ID: M5LROX-12-1

IC ID: 7580A-ROX121

5.2 Field strength of fundamental

For test instruments and accessories used see section 6 Part CPR 3.

5.2.1 Description of the test location

Test location: Anechoic chamber 1
 Test distance: 3 m

5.2.2 Photo documentation of the test set-up – see Attachment B

5.2.3 Applicable standard

According to FCC Part 15C, Section 15.249(a):

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the effective limits.

5.2.4 Description of Measurement

The radiated emission of the fundamental wave from the EUT is measured using a spectrum analyser and appropriate linear polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.10, Item 6.6. The EUT is measured in TX continuous mode unmodulated under normal conditions.

Analyser settings:

Peak measurement:	RBW: 2 MHz	VBW: 5 MHz	Detector: Max peak
AV measurement:	RBW: 2 MHz	VBW: 5 MHz	Detector: Max peak

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

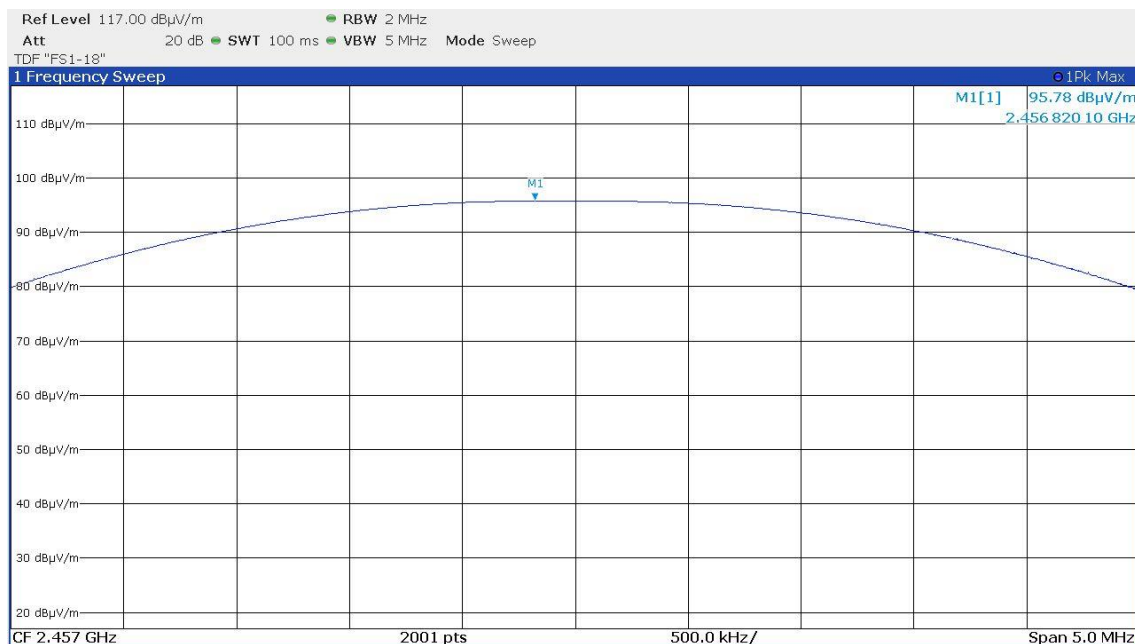


FCC ID: M5LROX-12-1

IC ID: 7580A-ROX121

5.2.5 Test result

Peak measurement:



Average with Duty Cycle Correction:

$$KE = 20 \log (t_B/T_B) = -27.9 \text{ dB}$$

Average Power: **67.9 dBµV/m**

Average-Limit according to FCC Part 15C, Section 15.249(a):

Frequency (MHz)	Field strength of fundamental	
	(mV/m)	dB(µV/m)
902 - 928	50	94
2400 - 2483.5	50	94
5725-5875	50	94
24000 - 24250	250	108

Peak-Limit according to FCC Part 15C, Section 15.249(e):

However, the peak fieldstrength shall not exceed the maximum permitted average limit by more than 20 dB.

The requirements are **FULFILLED**.

Remarks: none

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.



FCC ID: M5LROX-12-1

IC ID: 7580A-ROX121

5.3 Out-of-band emission, radiated

For test instruments and accessories used see section 6 Part **SER1, SER 2, SER 3.**

5.3.1 Description of the test location

Test location: OATS 1
 Test location: Anechoic chamber 1

Test distance: 3 m

5.3.2 Photo documentation of the test set-up – see Attachment B

5.3.3 Applicable standard

According to FCC Part 15C, Section 15.249 (d):

Emission radiated outside of the specified frequency bands, except harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated limit in FCC Part 15C, Section 15.209, whichever is the lesser attenuation.

5.3.4 Description of Measurement

The radiated emissions from the EUT are measured in the frequency range of 9 kHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.10, Item 6.3. In the frequency range above 1 GHz a spectrum analyser is used with appropriate linear polarized antennas. If the emission level in peak mode complies with the average limit testing is stopped and peak values will be reported, otherwise, the emission is measured in average mode again and reported. The EUT is measured in TX continuous mode unmodulated under normal conditions.

Instrument settings:

9 kHz – 150 kHz RBW: 200 Hz
 150 kHz - 30 MHz RBW: 9 kHz
 30 MHz – 1000 MHz: RBW: 120 kHz
 1000 MHz – 25 GHz RBW: 1 MHz

5.3.1 Test result f < 30 MHz

Note: In the frequency range 9 kHz to 30 MHz no emission could be detected. The frequencies mention the noise level. The measurement results from distance 3 m are extrapolated (D factor) to the specified distance.

FCC Part 15.209 Radiated emission limits; general requirements (< 30 MHz)									
Frequency (kHz)	PK reading (dBµV)	QP reading (dBµV)	Duty cycle corr. (dB)	Ant. factor (dB)	Distance corr. (dB)	corr. AV level (dBµV/m)	QP level (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
32.768	6.2	-3.0	0.0	20.0	-80.0	-53.8	-63.0	37.3	-91.1
200.000	42.8	42.3	0.0	20.0	-80.0	-17.2	-17.7	21.6	-38.8
5000.000	26.0	23.5	0.0	20.0	-40.0	6.0	3.5	29.5	-26.0
24000.000	26.5	15.3	0.0	20.0	-40.0	6.5	-4.7	29.5	-34.2

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

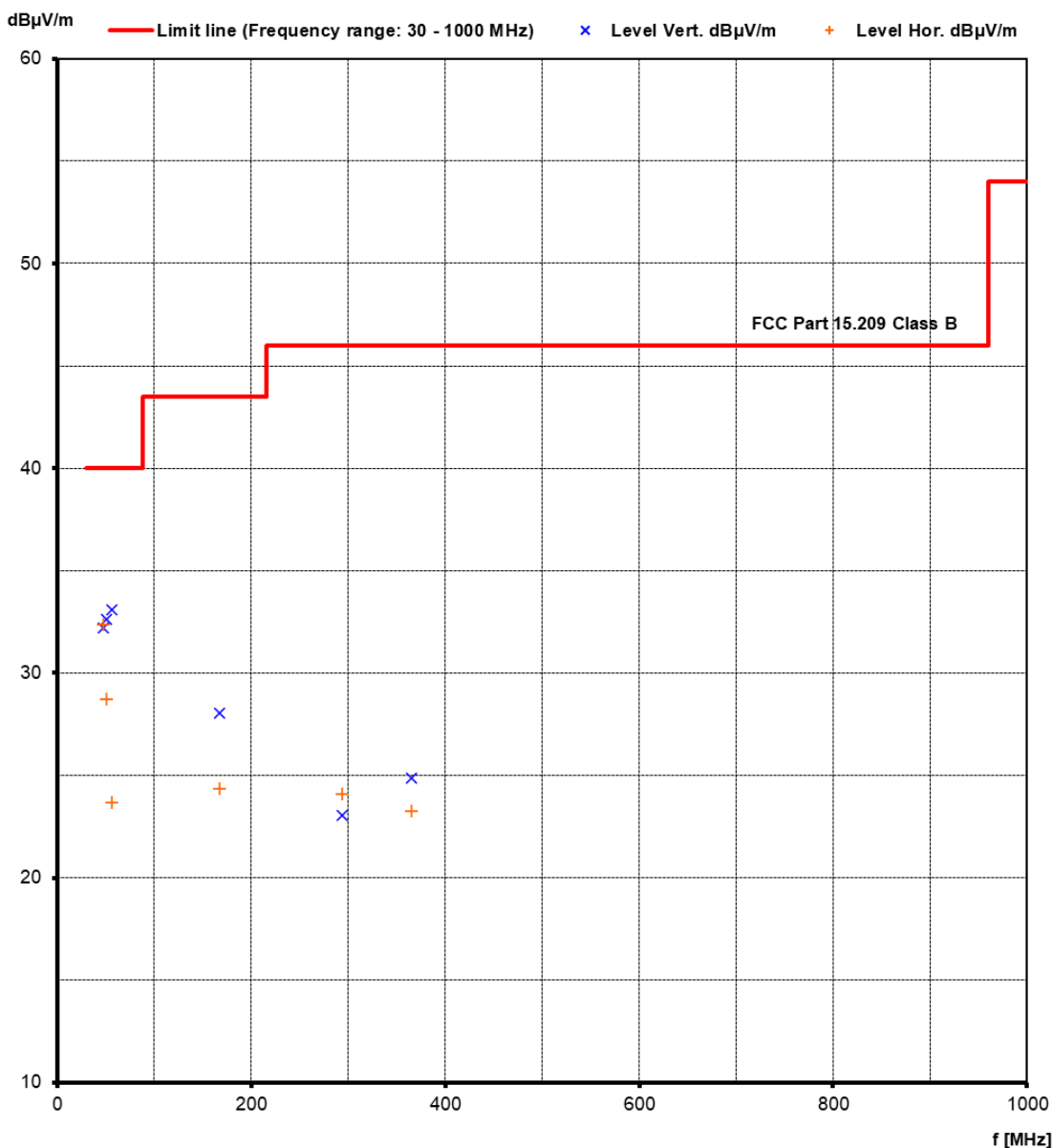


FCC ID: M5LROX-12-1

IC ID: 7580A-ROX121

5.3.2 Test result f < 1 GHz

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
47.80	14.6	13.7	17.6	18.7	32.2	32.4	40.0	-7.6
50.40	15.2	9.9	17.5	18.8	32.6	28.7	40.0	-7.4
56.50	15.9	5.3	17.2	18.3	33.1	23.6	40.0	-6.9
167.70	8.8	5.7	19.2	18.6	28.1	24.3	43.5	-15.4
293.30	3.1	3.7	20.0	20.4	23.1	24.1	46.0	-21.9
365.40	2.8	0.7	22.1	22.5	24.9	23.2	46.0	-21.1



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

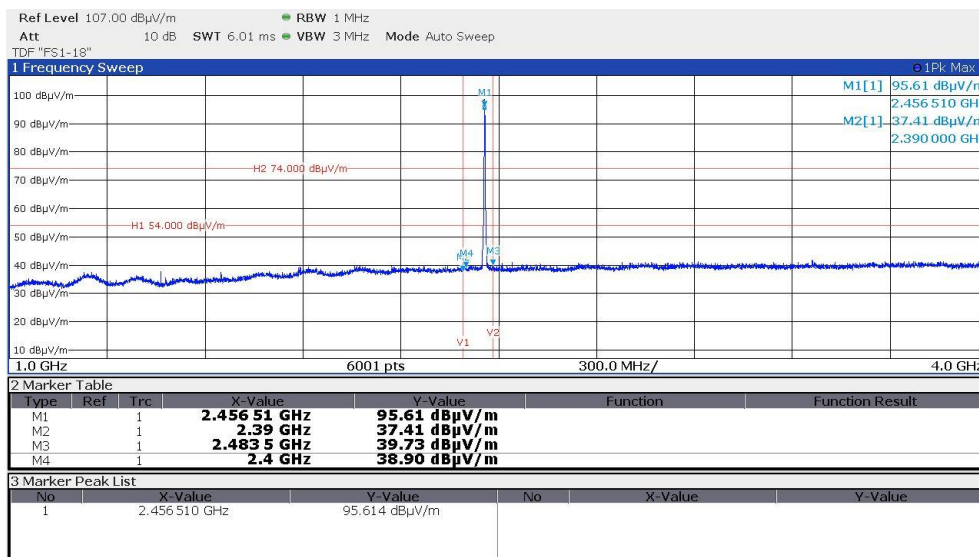


FCC ID: M5LROX-12-1

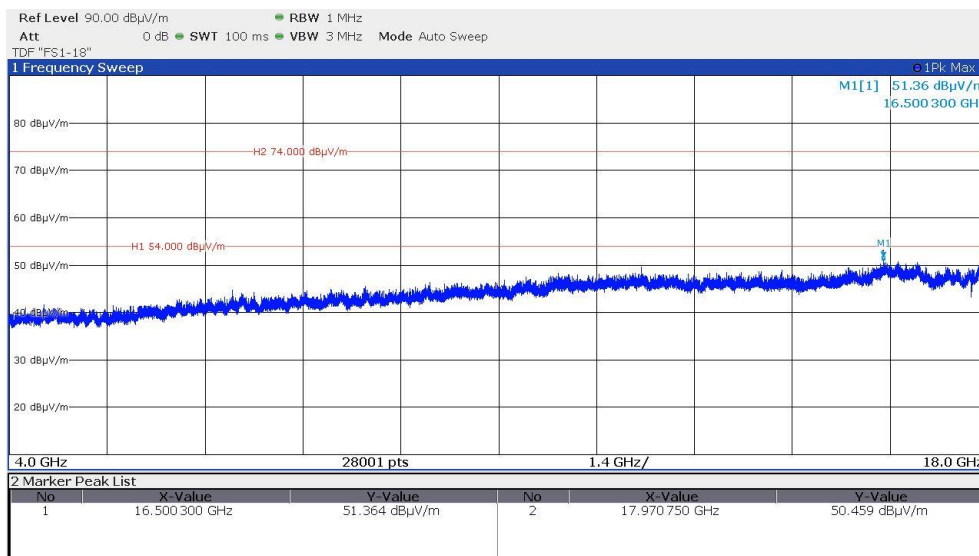
IC ID: 7580A-ROX121

5.3.3 Test result f > 1 GHz

Spurious emissions from 1 to 4 GHz
(incl. Fundamental carrier)



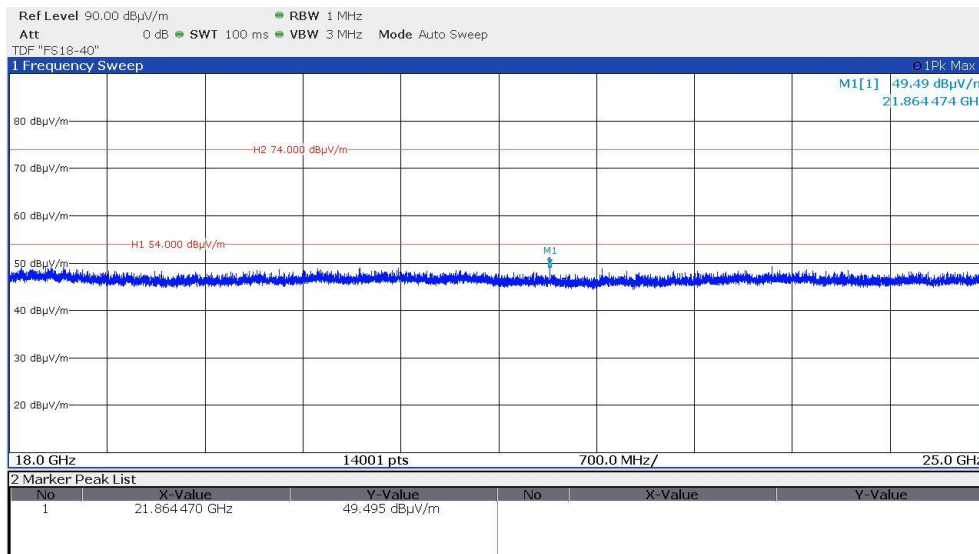
Spurious emissions from 4 to 18 GHz



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.



FCC ID: M5LROX-12-1 IC ID: 7580A-ROX121
 Spurious emissions from 18 to 25 GHz



Limit according to FCC Part 15C, Section 15.209:

Frequency (MHz)	15.209 Limits (μV/m)	Measurement distance (m)
0.009 - -0.49	2400/f(kHz)	300
0.49 – 1.705	24000/f(kHz)	30
1.705 – 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Average limit according to FCC Part 15C, Section 15.249(a):

Fundamental frequency (MHz)	Field strength of harmonics	
	(μV/m)	dB(μV/m)
902 - 928	500	54
2400 - 2483.5	500	54
5725 - 5875	500	54
24000 - 24250	2500	68

The requirements are **FULFILLED**.

Remarks: The measurement was performed up to the 10th harmonic (25000 MHz).

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.



FCC ID: M5LROX-12-1

IC ID: 7580A-ROX121

5.4 EBW and OBW

For test instruments and accessories used see section 6 Part MB.

5.4.1 Description of the test location

Test location: Shielded Room S6

5.4.2 Photo documentation of the test set-up – see Attachment B

5.4.3 Applicable standard

According to FCC Part 15, Section 15.215(c):

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in Section 15.217 through Section 15.257, must be designed to ensure that the 20 dB bandwidth of the emission is contained within the frequency band designated in the rule section under which the equipment is operated.

5.4.4 Description of Measurement

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio of -20 dB (99%). The x-dB-down (OBW) function of the analyser is used. The measurement is performed with normal modulation in TX continuous mode.

Spectrum analyser settings:

RBW: 10 kHz, VBW: 30 kHz, Span: 2 MHz, Trace mode: max. hold, Detector: max. peak;

5.4.5 Test result

Operating frequency band (MHz)	20 dB Bandwidth (MHz)
$f_{low} > 2400$	$f_{low} = 2456.64$ MHz
$f_{high} < 2483.5$	$f_{high} = 2457.31$ MHz

80% bandwidth of the permitted band: 66.8 MHz

Limit according to FCC Part 15C, Section 15.215(c):

If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within the central 80% of the permitted band in order to minimize the possibility of out-of-band operation. The stability of the EUT will be shown staying within the central 80% of the operating channel.

The requirements are **FULFILLED**.

Remarks: For detailed test result please refer to following test protocols.

The OBW99 is measured for RSS only.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

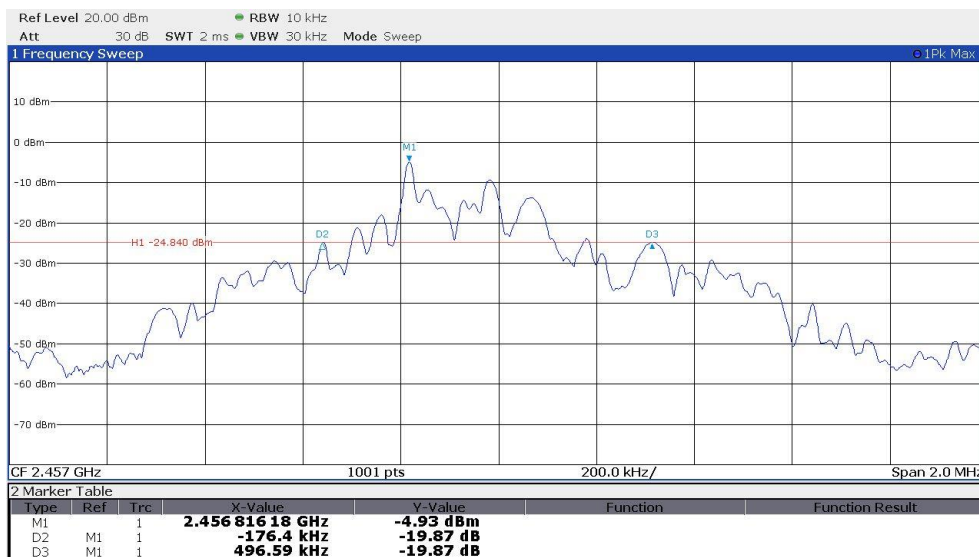


FCC ID: M5LROX-12-1

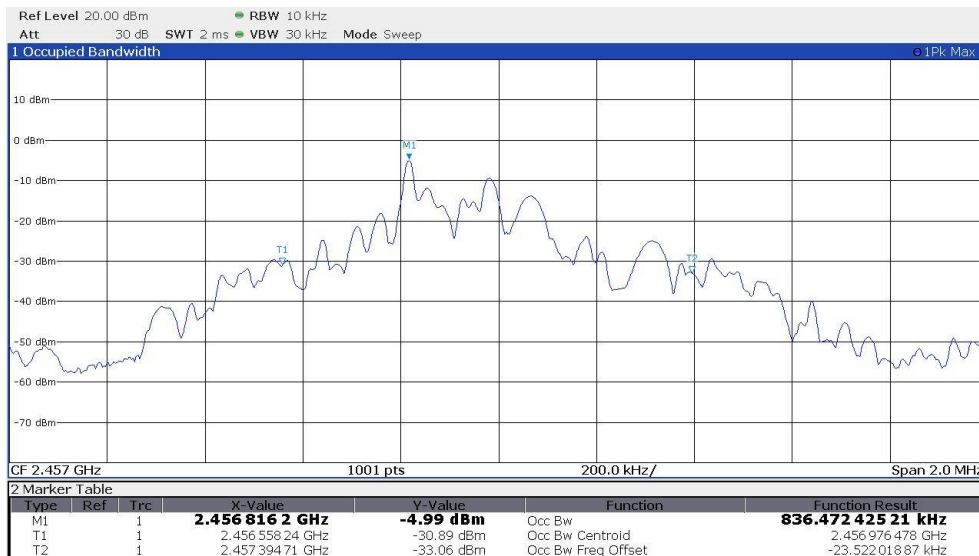
IC ID: 7580A-ROX121

5.4.6 Test protocols

20 dB bandwidth



OBW 99%



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.



FCC ID: M5LROX-12-1 IC ID: 7580A-ROX121

5.5 Correction for pulse operation (duty cycle)

For test instruments and accessories used see section 6 Part DC.

5.5.1 Description of the test location

Test location: Shielded Room S6

5.5.2 Photo documentation of the test set-up – see Attachment B

5.5.3 Applicable standard

According to FCC Part 15A, Section 15.35(c):

When the radiated emission limits are expressed in terms of average value and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete puls train, including blanking intervals, as long as the pulse train does not exceed 0.1s. In cases where the puls train exceeds 0.1s, the measured field strength shall be determined from the average absolute voltage during a 0.1s interval during which the field strength is at its maximum. The exact method of calculating the average field strength shall be submitted.

5.5.4 Description of Measurement

The duty cycle factor (dB) is calculated applying the following formula:

$$KE = 20 \log (t_B/T_B)$$

- KE*: pulse operation correction factor
- t_B* pulse duration for one pulse
- T_B* a period of one pulse

5.5.5 Test result

<i>t_B</i> (μs)	<i>T_B</i> (μs)	<i>KE</i> (dB)
157.8	3903.3	-27.9

Remarks: For detailed results, please see the test protocol below.

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

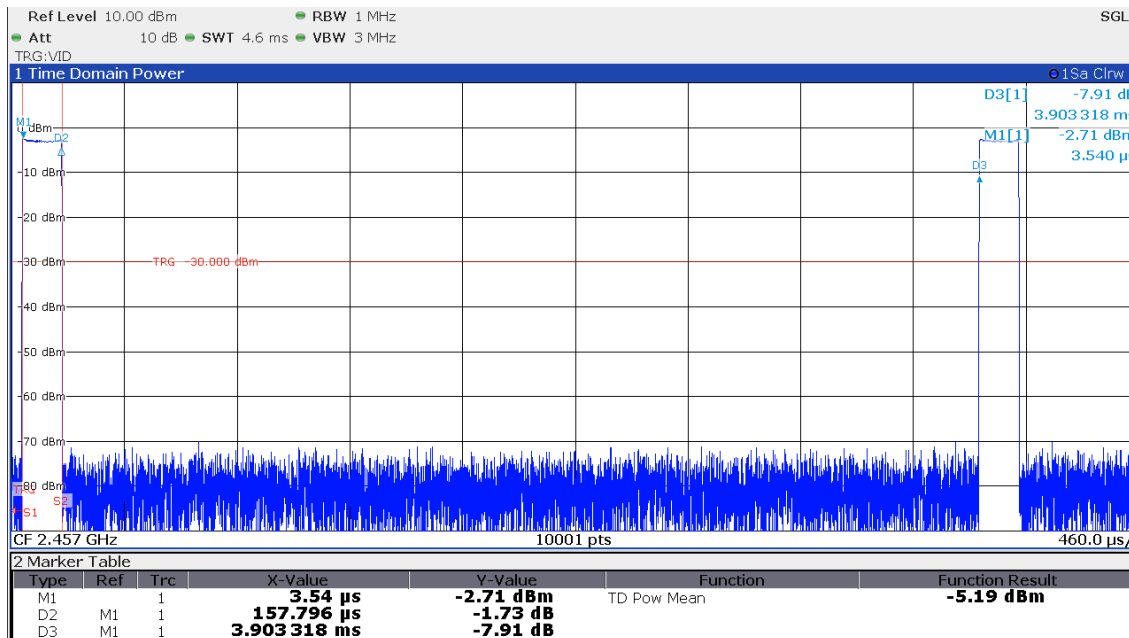


FCC ID: M5LROX-12-1

IC ID: 7580A-ROX121

5.5.6 Test protocol

Correction for Pulse Operation (Duty Cycle)
FCC Part 15A, Section 15.35(c)



The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

FCC ID: M5LROX-12-1

IC ID: 7580A-ROX121

5.6 Antenna application

5.6.1 Applicable standard

According to FCC Part 15C, Section 15.203(a):

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section.

5.6.2 Result

The EUT use an integrated PCB antenna. No other antenna than that furnished by the responsible party or external power amplifier can be applied by a customer.

The antenna of the EUT meets the requirement of FCC Part 15C, Section 15.203 and 15.204.

The requirements are **FULFILLED**.

Remarks: none

FCC ID: M5LROX-12-1 IC ID: 7580A-ROX121

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
CPC 3	FSW43	02-02/11-21-001	16/05/2023	16/05/2022		
MB	FSW43	02-02/11-21-001	16/05/2023	16/05/2022		
SER 2	VULB 9168	01-02/24-14-007	04/04/2023	04/04/2022		
	ESR 7	02-02/03-13-001	11/03/2023	11/03/2022		
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N20 m	02-02/50-12-018				
	KK-SD_7/8-2X21N-33,0M	02-02/50-15-028				
SER 3	50F-003 N 3 dB	02-02/50-21-010				
	FSW43	02-02/11-21-001	16/05/2023	16/05/2022		
	AMF-6D-01002000-22-10P	02-02/17-15-004				
	LNA-40-18004000-33-5P	02-02/17-20-002				
	3117	02-02/24-05-009	23/06/2023	23/06/2022		
	BBHA 9170	02-02/24-05-013	19/05/2023	19/05/2020	10/03/2023	10/03/2022
	WHK 3.0/18G-10EF	02-02/50-05-180				
	BAM 4.5-P	02-02/50-17-024				
	NCD	02-02/50-17-025				
	KK-SF106-2X11N-6,5M	02-02/50-18-016				
KMS116-GL140SE-KMS116-	02-02/50-20-026					
BAT-EMC 2022.0.23.0	02-02/68-13-001					