



RF – TEST REPORT

- FCC Part 15.247, RSS-247 -

Type / Model Name : ZLX G2-Amplifier-Module

Product Description : Amplifier module for powered speaker

Applicant : Bosch Security Systems, LLC

Address : 130 Perinton Parkway

Fairport, NY 14450, USA

Manufacturer : Bosch Security Systems, LLC

Address : 130 Perinton Parkway

Fairport, NY 14450, USA

Test Result according to the standards
listed in clause 1 test standards:

POSITIVE

Test Report No. : **80168519-03 Rev_2**

19. December 2023

Date of issue



Deutsche
Akkreditierungsstelle
D-PL-12030-01-03
D-PL-12030-01-04

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

Contents

1	TEST STANDARDS	3
2	EQUIPMENT UNDER TEST	4
2.1	Information provided by the Client	4
2.2	Sampling	4
2.3	General Remarks	4
2.4	Photo documentation	4
2.5	Equipment type	4
2.6	Short description of the equipment under test (EUT)	4
2.7	Variants of the EUT	4
2.8	Operation frequency and channel plan	5
2.9	Transmit operating modes	5
2.10	Antenna	6
2.11	Power supply system utilised	6
2.12	Peripheral devices and interface cables	6
2.1	Determination of worst case conditions for final measurement	6
2.2	Test jig	6
2.3	Test software	6
3	TEST RESULT SUMMARY	7
3.1	Revision history of test report	7
3.2	Final assessment	8
4	TEST ENVIRONMENT	9
4.1	Address of the test laboratory	9
4.2	Environmental conditions	9
4.3	Statement of the measurement uncertainty	9
4.4	Conformity Decision Rule	10
4.5	Measurement protocol for FCC and ISED	10
5	TEST CONDITIONS AND RESULTS	13
5.2	Emission bandwidth and OBW99%	18
5.3	Maximum peak output power conducted	23
5.4	Spurious emissions radiated	25
5.5	Pseudorandom frequency hopping sequence	34
5.6	Equal hopping frequency use	35
5.7	Receiver input bandwidth	35
5.8	Dwell time	36
5.9	Carrier frequency separation	38
5.10	Number of hopping channels	40
5.11	Antenna application	42
6	USED TEST EQUIPMENT AND ACCESSORIES	43
ATTACHMENT A as separate supplement		
ATTACHMENT B as separate supplement		

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: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September 2023)

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 2023)

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 15.247	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz

ANSI C63.10: 2013 Testing Unlicensed Wireless Devices

KDB 558074 D01 v05r02 Guidance for compliance measurements on DTS; FHSS and hybrid system devices operating under Section 15.247 of the FCC rules, April 2, 2019.

ISED Canada Rules and Regulations (September 2023)

RSS-Gen, Issue 5 + Amendment 1 + 2	General Requirements for Compliance of Radio Apparatus
RSS-247, Issue 3	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
ANSI C63.10: 2013	Testing Unlicensed Wireless Devices

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

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 to his/her instructions.

2.3 General Remarks

2.4 Photo documentation

Detailed photos of EUT see ATTACHMENT A.
Detailed photos of Test Setup see ATTACHMENT B.

2.5 Equipment type

Bluetooth device

2.6 Short description of the equipment under test (EUT)

The EUT is an amplifier module for powered speaker that outputs the amplified feeded audio signal on the built in loudspeaker.

The speaker can be operated on a pole or standing on the ground.

Number of tested samples: 1
Serial number: D-Sample #1
Firmware version: Host: V.1.0.0 BT:V1.0.1

2.7 Variants of the EUT

The ZLX-G2-Amplifier-Module is used in the ZLX G2: ZLX-8P-G2, ZLX-8P-G2-EU, ZLX-8P-G2-US, ZLX-12P-G2, ZLX-12P-G2-EU, ZLX-12P-G2-US, ZLX-15P-G2, ZLX-15P-G2-EU, ZLX-15P-G2-US powered speakers.

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

2.8 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel plan:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	27	2429	54	2456
1	2403	28	2430	55	2457
2	2404	29	2431	56	2458
3	2405	30	2432	57	2459
4	2406	31	2433	58	2460
5	2407	32	2434	59	2461
6	2408	33	2435	60	2462
7	2409	34	2436	61	2463
8	2410	35	2437	62	2464
9	2411	36	2438	63	2465
10	2412	37	2439	64	2466
11	2413	38	2440	65	2467
12	2414	39	2441	66	2468
13	2415	40	2442	67	2469
14	2416	41	2443	68	2470
15	2417	42	2444	69	2471
16	2418	43	2445	70	2472
17	2419	44	2446	71	2473
18	2420	45	2447	72	2474
19	2421	46	2448	73	2475
20	2422	47	2449	74	2476
21	2423	48	2450	75	2477
22	2424	49	2451	76	2478
23	2425	50	2452	77	2479
24	2426	51	2453	78	2480
25	2427	52	2454		
26	2428	53	2455		

2.9 Transmit operating modes

The EUT allows the user to select the following modes:

- TX modulated
- RX

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

2.10 Antenna

The EUT has only an internal antenna, no temporary connector and no external antenna to be connected.

Type	Model	Frequency Range	Gain
Internal FPC antenna	PulseLARSEN W3921	2400-2500 MHz	+1 dBi

2.11 Power supply system utilised

Power supply voltage, V_{nom} : 120 V, 60 Hz

2.12 Peripheral devices and interface cables

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

- UART Cable: to interface the BT-Module Model : _____
- Laptop: to set BT-Module in test modes Model : _____
- _____ Model : _____

2.1 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 final test the following channels and test modes are selected:

BT	Available channel	Tested channels	Modulation type	Packet Type	Data rate
802.15.1	0 to 78	0, 38, 78	GFSK	DH5	1 Mbps
802.15.1	0 to 78	0, 38, 78	$\pi/4$ -DQPSK	2-DH5	2 Mbps
802.15.1	0 to 78	0, 38, 78	8-DPSK	3-DH5	3 Mbps

2.2 Test jig

No test jig is used.

2.3 Test software

The special test software Qualcomm "BlueTest 3"

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

3 TEST RESULT SUMMARY

FCC Rule Part	RSS Rule Part	Description	Result
15.207(a)	RSS-Gen, 8.8	AC power line conducted emissions	passed
15.247(a)(1)	RSS-247, 5.1(a)	20 dB EBW	passed
15.247(a)(1)	RSS-247, 5.1(b)	Channel separation	passed
15.247(a)(1)	RSS-247, 5.1(d)	Dwell time	passed
15.247(b)(1)	RSS-247, 5.4(b)	Peak power	passed
15.247(d)	RSS-247, 5.5	Spurious emissions	passed
15.247(d)	RSS-247, 5.5	Out-of-band emission, radiated	passed
15.247(d)	RSS-Gen, 8.10	Emissions in restricted bands	passed
15.247(e)	RSS-247, 5.1(d)	Hopping sequence	passed
15.247(a)	RSS-247, 5.1(a)	Receiver input bandwidth	passed
15.247(a)	RSS-247, 5.4(b)	Number of hopping channels	passed
15.247(a)	-	Equal hopping frequency use	passed
15.35(c)	RSS-Gen, 6.10	Pulsed operation	passed
15.203	RSS-247, 5.4(b)	Antenna requirement	passed

The mentioned RSS Rule Parts in the above table are related to:
RSS-Gen, Issue 5 + Amendment 1 + Amendment 2, March 2019
RSS-247, Issue 2, February 2017

3.1 Revision history of test report

Test report No	Rev.	Issue Date	Changes
80168519-03	0	06 November 2023	Initial test report
80168519-03	1	28 November 2023	Updated 5.2, 5.3 & 5.8
80168519-03	2	19 December 2023	Updated 5.2, measurement of EDR BWs 2 Mbps & 3 Mbps

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

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

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 : 07 August 2023

Testing concluded on : 19 December 2023

Checked by:

Tested by:

Klaus Gegenfurtner
Teamleader Radio

Lukas Scheuermann
Radio Team

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

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%	$\pm 3.29 \text{ dB}$
EBW and OBW	2400 MHz to 3000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Maximum peak conducted output power	2400 MHz to 3000 MHz	95%	$\pm 0.62 \text{ dB}$
Power spectral density	2400 MHz to 3000 MHz	95%	$\pm 0.62 \text{ dB}$
Conducted Spurious Emissions	9 kHz to 10000 MHz	95%	$\pm 2.15 \text{ dB}$
Conducted Spurious Emissions	10000 MHz to 40000 MHz	95%	$\pm 3.47 \text{ dB}$
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	$\pm 3.53 \text{ dB}$
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	$\pm 3.71 \text{ dB}$
Radiated Spurious Emissions	1000 MHz to 10000 MHz	95%	$\pm 2.34 \text{ dB}$
Field strength of the fundamental	100 kHz to 100 MHz	95%	$\pm 3.53 \text{ dB}$

FCC-ID: ESV-ZLXG2 **IC-ID:** 1249A-ZLXG2

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".

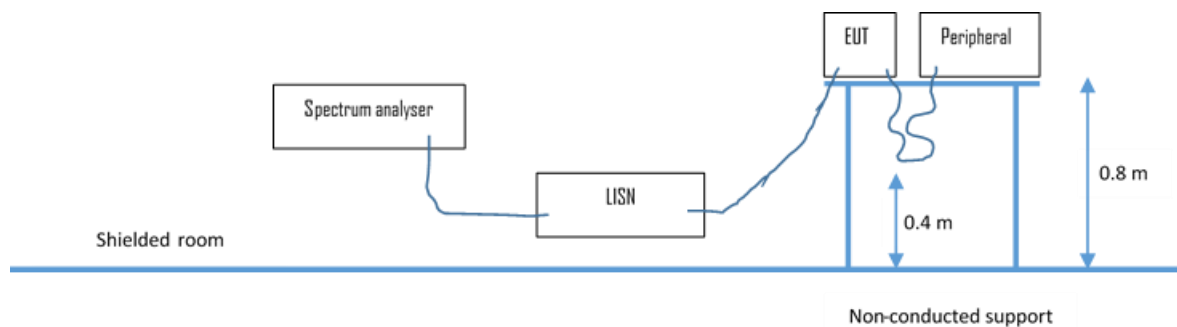
4.5.2.1 Justification

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:

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

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

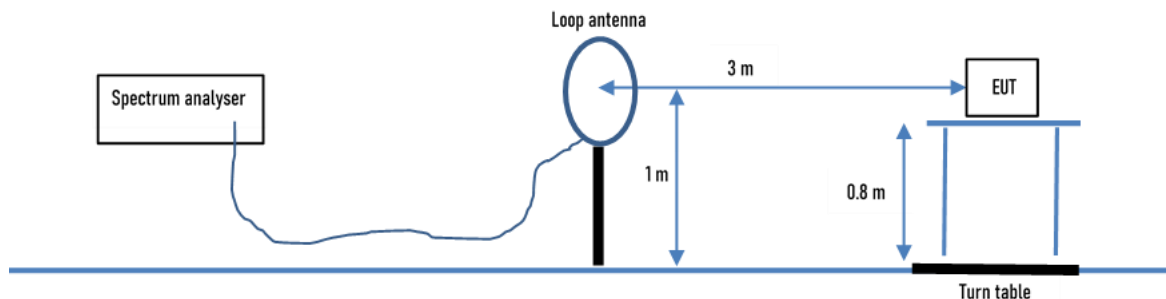
Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with $50 \Omega / 50 \mu\text{H}$ (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.

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

4.5.3.2 Radiated emission

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

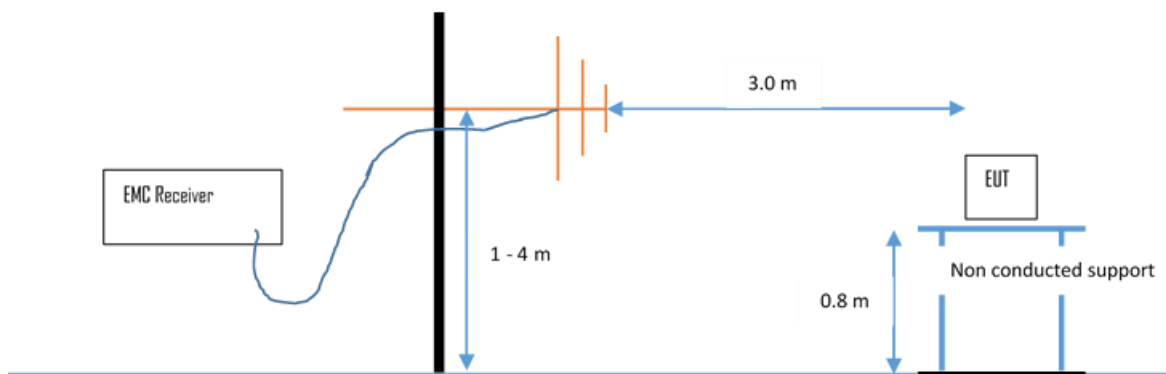
Test setup according ANSI C63.10



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 center 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 center 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

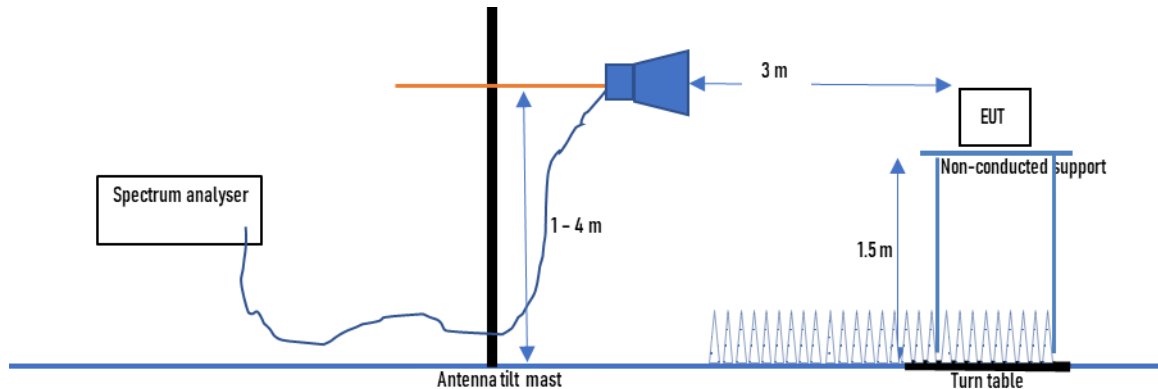
Example:

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

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

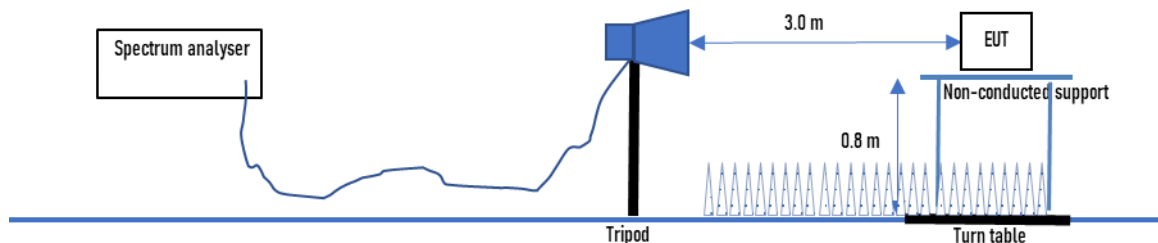
4.5.3.2.3 Anechoic chamber 1 (1000 MHz – 18000 MHz)

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 center, 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 center, 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 limits are adopted.

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

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: Anechoic chamber 2

5.1.2 Photo documentation of the test set-up

See Attachment B for detailed photo documentation of the test set-up.

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.

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: ESV-ZLXG2 **IC-ID:** 1249A-ZLXG2

5.1.5 Test result

Frequency range: 0.15 MHz - 30 MHz
Min. limit margin -7.9 dB

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

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	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

Limit according to RSS-Gen 8.8:

Frequency of Emission (MHz)	Conducted limit (dBμV)	
	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**.

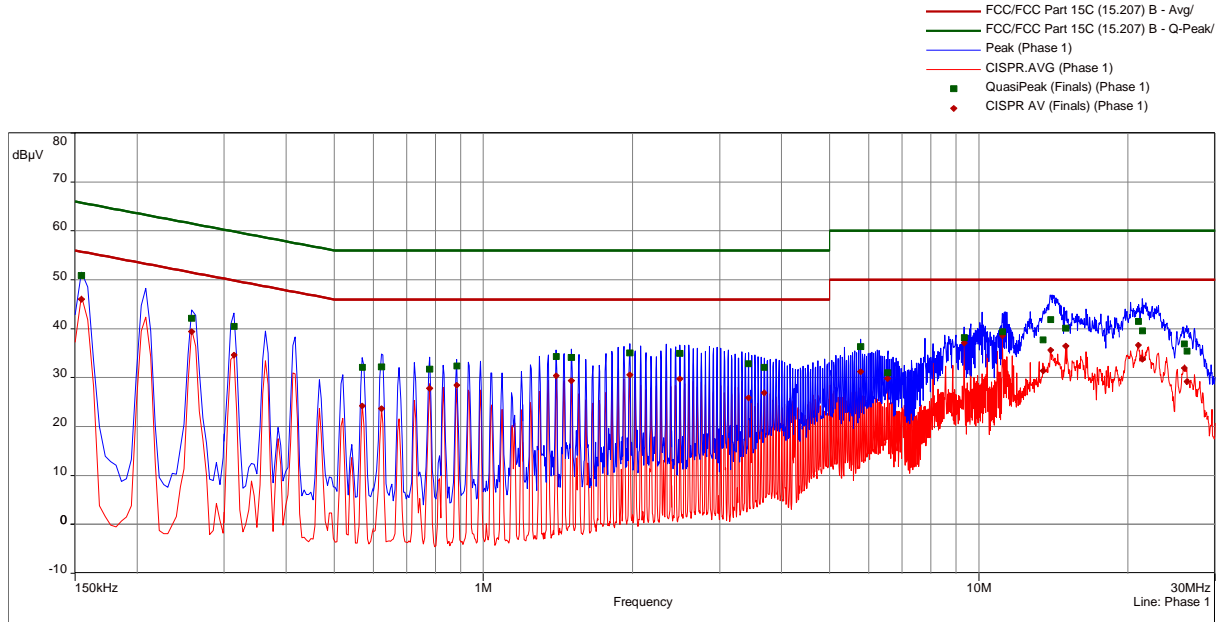
Remarks: For detailed test result please see the following test protocols

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

5.1.6 Test protocol

Test point L1
Operation mode: Transmission at 2.402 GHz
Remarks: -

Result: passed



FCC/Part 15C (15.207)B

freq MHz	QP dB(μV)	margin dB	limit dB	AV dB(μV)	margin dB	limit dB	line	corr dB
0.1545	50.97	-14.79	65.75	46.02	-9.74	55.75	Phase 1	10.08
0.258	42.20	-19.30	61.50	39.39	-12.10	51.50	Phase 1	10.10
0.3135	40.54	-19.34	59.88	34.67	-15.21	49.88	Phase 1	10.11
0.57	32.16	-23.84	56.00	24.20	-21.80	46.00	Phase 1	10.16
0.6225	32.21	-23.79	56.00	23.71	-22.29	46.00	Phase 1	10.16
0.78	31.80	-24.20	56.00	27.87	-18.13	46.00	Phase 1	10.18
0.8835	32.43	-23.57	56.00	28.47	-17.53	46.00	Phase 1	10.20
1.4025	34.40	-21.60	56.00	30.36	-15.64	46.00	Phase 1	10.26
1.506	34.18	-21.82	56.00	29.35	-16.65	46.00	Phase 1	10.27
1.974	35.09	-20.91	56.00	30.55	-15.45	46.00	Phase 1	10.27
2.4945	35.03	-20.97	56.00	29.79	-16.21	46.00	Phase 1	10.31
3.4305	32.86	-23.14	56.00	25.94	-20.06	46.00	Phase 1	10.33
3.6915	32.11	-23.89	56.00	26.95	-19.05	46.00	Phase 1	10.35
5.7765	36.37	-23.63	60.00	31.21	-18.79	50.00	Phase 1	10.50
6.5505	31.06	-28.94	60.00	29.87	-20.13	50.00	Phase 1	10.57
9.345	38.25	-21.75	60.00	37.15	-12.85	50.00	Phase 1	10.65
11.1705	39.38	-20.62	60.00	38.56	-11.44	50.00	Phase 1	10.77
13.5015	37.74	-22.26	60.00	31.39	-18.61	50.00	Phase 1	10.96
13.9605	41.87	-18.13	60.00	35.68	-14.32	50.00	Phase 1	10.99
15	40.19	-19.81	60.00	36.44	-13.56	50.00	Phase 1	11.05
21	41.50	-18.50	60.00	36.67	-13.33	50.00	Phase 1	11.30
21.3915	39.64	-20.36	60.00	33.77	-16.23	50.00	Phase 1	11.31
26.04	36.90	-23.10	60.00	32.01	-17.99	50.00	Phase 1	11.47
26.283	35.45	-24.55	60.00	29.25	-20.75	50.00	Phase 1	11.47
0.1545	51.32	-14.43	65.75	46.44	-9.32	55.75	Neutral	10.11
0.159	51.06	-14.46	65.52	46.19	-9.32	55.52	Neutral	10.11
0.2625	46.24	-15.11	61.35	41.90	-9.45	51.35	Neutral	10.14
0.3135	46.26	-13.62	59.88	38.74	-11.14	49.88	Neutral	10.15
0.417	44.53	-12.98	57.51	39.56	-7.94	47.51	Neutral	10.17

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

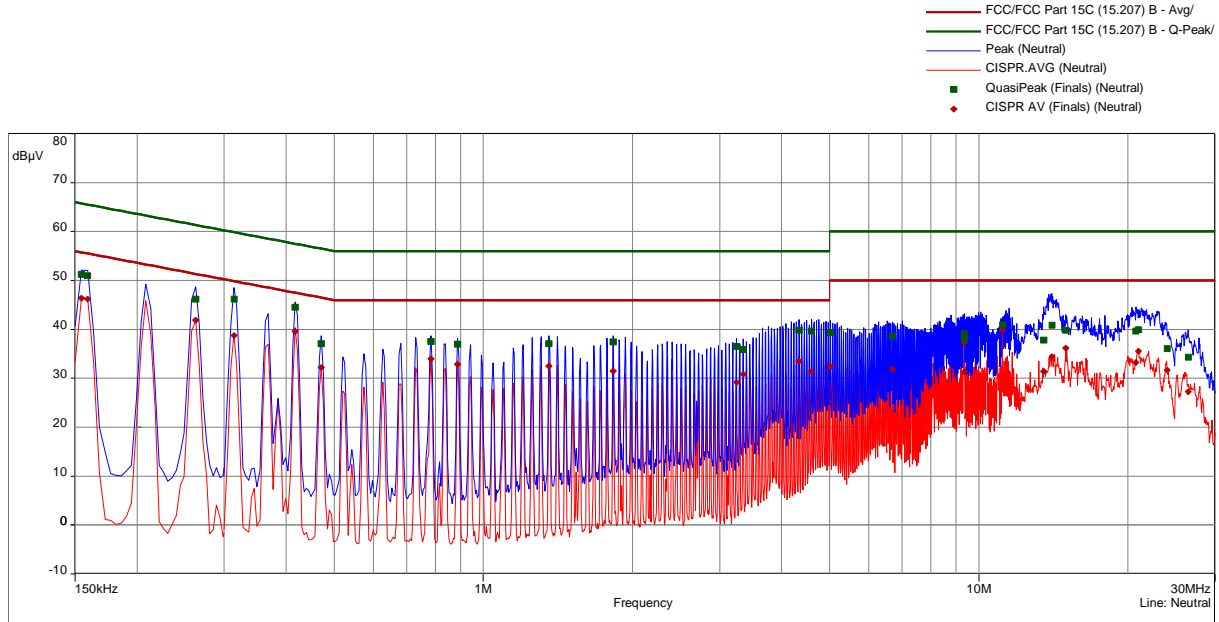
0.471	37.10	-19.39	56.50	32.22	-14.28	46.50	Neutral	10.18
0.7845	37.54	-18.46	56.00	33.95	-12.05	46.00	Neutral	10.21
0.888	37.03	-18.97	56.00	32.91	-13.09	46.00	Neutral	10.21
1.3575	37.13	-18.87	56.00	32.48	-13.52	46.00	Neutral	10.27
1.83	37.52	-18.48	56.00	31.53	-14.47	46.00	Neutral	10.30
3.2415	36.55	-19.45	56.00	29.25	-16.75	46.00	Neutral	10.38
3.345	35.95	-20.05	56.00	30.84	-15.16	46.00	Neutral	10.38
4.3395	39.91	-16.09	56.00	33.53	-12.47	46.00	Neutral	10.43
4.6005	39.70	-16.30	56.00	31.42	-14.58	46.00	Neutral	10.43
5.0205	39.46	-20.54	60.00	32.40	-17.60	50.00	Neutral	10.45
6.6945	38.68	-21.32	60.00	31.87	-18.13	50.00	Neutral	10.57
9.3405	38.05	-21.95	60.00	37.31	-12.69	50.00	Neutral	10.64
9.363	39.11	-20.89	60.00	31.34	-18.66	50.00	Neutral	10.64
11.157	40.99	-19.01	60.00	39.91	-10.09	50.00	Neutral	10.72
13.5195	37.89	-22.11	60.00	31.41	-18.59	50.00	Neutral	10.88
14.0415	40.88	-19.12	60.00	34.49	-15.51	50.00	Neutral	10.92
15	39.90	-20.10	60.00	36.20	-13.80	50.00	Neutral	10.92
20.7615	39.70	-20.30	60.00	33.22	-16.78	50.00	Neutral	11.14
21.0405	39.99	-20.01	60.00	35.58	-14.42	50.00	Neutral	11.15
24.0375	36.13	-23.87	60.00	31.70	-18.30	50.00	Neutral	11.11
26.436	34.35	-25.65	60.00	27.27	-22.73	50.00	Neutral	11.10

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: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

Test point N
Operation mode: Transmission at 2.402 GHz
Remarks: -

Result: passed



FCC/Part 15C (15.207)B

freq MHz	QP dB(μV)	margin dB	limit dB	AV dB(μV)	margin dB	limit dB	line	corr dB
0.1545	51.32	-14.43	65.75	46.44	-9.32	55.75	Neutral	10.11
0.159	51.06	-14.46	65.52	46.19	-9.32	55.52	Neutral	10.11
0.2625	46.24	-15.11	61.35	41.90	-9.45	51.35	Neutral	10.14
0.3135	46.26	-13.62	59.88	38.74	-11.14	49.88	Neutral	10.15
0.417	44.53	-12.98	57.51	39.56	-7.94	47.51	Neutral	10.17
0.471	37.10	-19.39	56.50	32.22	-14.28	46.50	Neutral	10.18
0.7845	37.54	-18.46	56.00	33.95	-12.05	46.00	Neutral	10.21
0.888	37.03	-18.97	56.00	32.91	-13.09	46.00	Neutral	10.21
1.3575	37.13	-18.87	56.00	32.48	-13.52	46.00	Neutral	10.27
1.83	37.52	-18.48	56.00	31.53	-14.47	46.00	Neutral	10.30
3.2415	36.55	-19.45	56.00	29.25	-16.75	46.00	Neutral	10.38
3.345	35.95	-20.05	56.00	30.84	-15.16	46.00	Neutral	10.38
4.3395	39.91	-16.09	56.00	33.53	-12.47	46.00	Neutral	10.43
4.6005	39.70	-16.30	56.00	31.42	-14.58	46.00	Neutral	10.43
5.0205	39.46	-20.54	60.00	32.40	-17.60	50.00	Neutral	10.45
6.6945	38.68	-21.32	60.00	31.87	-18.13	50.00	Neutral	10.57
9.3405	38.05	-21.95	60.00	37.31	-12.69	50.00	Neutral	10.64
9.363	39.11	-20.89	60.00	31.34	-18.66	50.00	Neutral	10.64
11.157	40.99	-19.01	60.00	39.91	-10.09	50.00	Neutral	10.72
13.5195	37.89	-22.11	60.00	31.41	-18.59	50.00	Neutral	10.88
14.0415	40.88	-19.12	60.00	34.49	-15.51	50.00	Neutral	10.92
15	39.90	-20.10	60.00	36.20	-13.80	50.00	Neutral	10.92
20.7615	39.70	-20.30	60.00	33.22	-16.78	50.00	Neutral	11.14
21.0405	39.99	-20.01	60.00	35.58	-14.42	50.00	Neutral	11.15
24.0375	36.13	-23.87	60.00	31.70	-18.30	50.00	Neutral	11.11
26.436	34.35	-25.65	60.00	27.27	-22.73	50.00	Neutral	11.10

FCC-ID: ESV-ZLXG2 **IC-ID:** 1249A-ZLXG2

5.2 Emission bandwidth and OBW99%

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

5.2.1 Description of the test location

Test location: Shielded Room S4

5.2.2 Photo documentation of the test set-up

See Attachment B for detailed photo documentation of the test set-up.

5.2.3 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 §§ 15.217 through 15.257 [...], must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

According to RSS-247 5.1a.:

The bandwidth of a frequency hopping channel is the 20 dB emission bandwidth, measured with the hopping stopped.

According to RSS-Gen 6.7:

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

5.2.4 Description of Measurement

The bandwidth was measured at an amplitude level reduced from the reference level of a modulated channel by a ratio of -20 dB. The reference level is the level of the highest signal amplitude observed at the transmitter at either the fundamental frequency or the first order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical. An alternative is to use the bandwidth measurement of the analyser.

Spectrum analyser settings for EBW:

RBW: 20 kHz, VBW: 100 kHz, Detector: Max peak, Span: 2 MHz;

FCC-ID: ESV-ZLXG2 **IC-ID:** 1249A-ZLXG2

5.2.5 Test result

FCC §15.215 (c) RSS-247 5.1 (a) RSS-Gen 6.7				
Modulation	Channel	Frequency	EBW	OBW99
		MHz	MHz	MHz
1 Mbps	CH0	2402	0.942	0.862
	CH38	2440	0.943	0.860
	CH78	2480	0.943	0.861
2 Mbps	CH0	2402	1.329	1.191
	CH38	2440	1.326	1.192
	CH78	2480	1.326	1.194
3 Mbps	CH0	2402	1.322	1.192
	CH38	2440	1.324	1.193
	CH78	2480	1.328	1.195

The requirements are **FULFILLED**.

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

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: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

5.2.6 Test protocols EBW & OBW

5.2.6.1 1 Mbps

Channel 0 (2402 MHz)



Channel 38 (2440 MHz)



Channel 78 (2480 MHz)



FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

5.2.6.1 2 Mbps

Channel 0 (2402 MHz)



Channel 38 (2440 MHz)



Channel 78 (2480 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: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

5.2.6.1 3 Mbps

Channel 0 (2402 MHz)



Channel 38 (2440 MHz)



Channel 78 (2480 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: ESV-ZLXG2 **IC-ID:** 1249A-ZLXG2

5.3 Maximum peak output power conducted

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

5.3.1 Description of the test location

Test location: Shielded Room S4
Test location: Anechoic chamber 1

5.3.2 Photo documentation of the test set-up

See Attachment B for detailed photo documentation of the test set-up.

5.3.3 Applicable standard

According to FCC Part 15C, Section 15.247(b)(1):

For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band: 1 watt.

According RSS-247 5.4b.:

For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; The e.i.r.p. shall not exceed 4 W.

5.3.4 Description of Measurement

A spectrum analyser is connected to the output of the transmitter via a suitable attenuator while EUT is operating in transmit mode using the assigned frequency according to ANSI C63.10, 7.8.5. The correction factor takes the cable loss into account.

Analyser settings:
RBW: 3 MHz, VBW \geq RBW, Detector: Max peak, Trace: Max hold, Sweep time: auto

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2
5.3.5 Test result

Conducted Measurement					
FCC §15.247 (b)(3) RSS-247 5.4 (d)					
Modulation	Channel	Frequency	Measured Conducted TX Power	Conducted Tx-Power Limit	Margin
		MHz	dBm	dBm	dB
1 Mbps	CH0	2402	8.0	30.0	-22.1
	CH38	2440	8.5	30.0	-21.5
	CH78	2480	8.6	30.0	-21.4
2 Mbps	CH0	2402	8.1	30.0	-22.0
	CH38	2440	8.7	30.0	-21.3
	CH78	2480	8.9	30.0	-21.1
3 Mbps	CH0	2402	7.9	30.0	-22.1
	CH38	2440	8.5	30.0	-21.5
	CH78	2480	8.6	30.0	-21.4

Peak Power Limit according to FCC Part 15C, Section 15.247(b)(1) & RSS-247 5.4b:

Frequency	Channel separation	Hop	Peak power limit	
(MHz)		Channels	(dBm)	(Watt)
2400 - 2483.5	-	≥ 75	30	1

The requirements are **FULFILLED**.

Remarks: None.

FCC-ID: ESV-ZLXG2 **IC-ID:** 1249A-ZLXG2

5.4 Spurious emissions radiated

For test instruments and accessories used see section 6 Part **SER 1, SER 2, SER 3.**

5.4.1 Description of the test location

Test location: OATS 1
 Test location: Anechoic chamber 1
 Test distance: 3 m

5.4.2 Photo documentation of the test set-up

See Attachment B for detailed photo documentation of the test set-up.

5.4.3 Applicable standard

According to FCC Part 15, Section 15.247(d):

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

5.4.4 Description of Measurement

The restricted bands are measured radiated. The span of the spectrum analyser is set wide enough to capture the restricted band and measure the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation. The restricted bands are measured falling emissions into it and the nearest restricted band are checked for emissions also the restricted band for the harmonics of the carrier.

The radiated power of the spurious emission from the EUT is measured in a test setup following the procedures set out in ANSI C63.10. If the emission level of the EUT in peak mode complies with the average limit is 20 dB lower, then testing will be stopped and peak values of the EUT will be reported, otherwise the emission will be measured in average mode again and reported.

The restricted bands are measured radiated. The span of the spectrum analyser is set wide enough to capture the restricted band and measure the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation. The restricted bands are measured falling emissions into it and the nearest restricted band are checked for emissions also the restricted band for the harmonics of the carrier.

Measurements are performed in following order:

1) Measurement of emissions according to General Limit specified in section 15.209(a):

Test receiver settings for SER1, SER2:

9kHz-150kHz	RBW: 200 Hz	Detector: Quasi peak*	Meas. Time: 1 s,
150kHz-30MHz	RBW: 9 kHz	Detector: Quasi peak*	Meas. Time: 1 s,
30MHz-1GHz	RBW: 120 MHz	Detector: Quasi peak	Meas. Time: 1 s,

*AV Detector in the ranges 9-90kHz and 110-490kHz

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

Spectrum analyser settings for SER3:

1GHz-26GHz RBW: 1 MHz Detector: Max. peak Trace: Max. hold Sweep: Auto

2) If emissions outside the Restricted Bands are above General Limit additional measurements of emissions according to Spurious Emissions Limit specified in section 15.247(d) are performed:

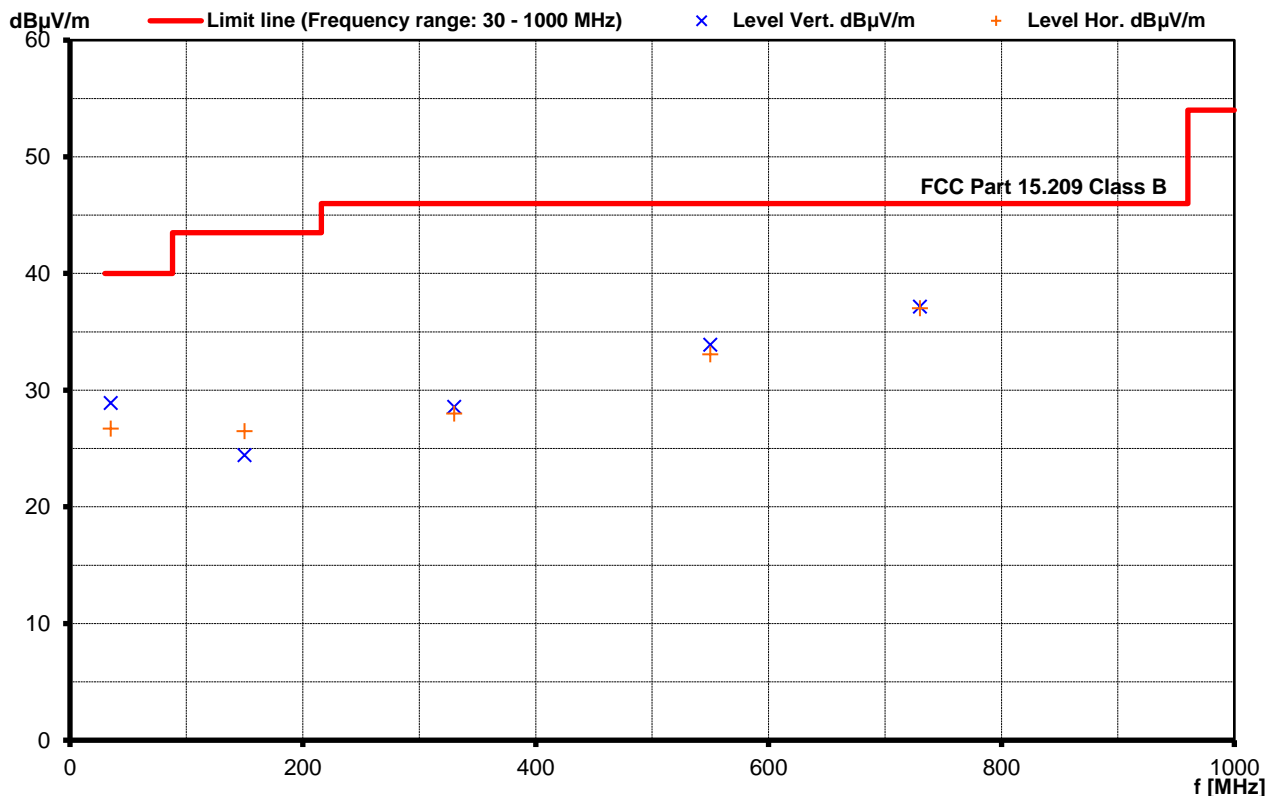
Spectrum analyser settings:

RBW: 100 kHz VBW: 300 kHz Detector: Max. peak Trace: Max. hold Sweep: Auto

5.4.5 Test result

f < 1000 MHz:

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)
35.00	15.0	14.0	13.9	12.7	28.9	26.7	40.0	-11.1
150.00	10.5	11.7	13.9	14.8	24.4	26.5	43.5	-17.0
330.00	10.8	10.6	17.8	17.4	28.6	28.0	46.0	-17.4
550.00	9.9	9.3	24.0	23.8	33.9	33.1	46.0	-12.1
730.00	9.4	9.8	27.8	27.2	37.2	37.0	46.0	-8.8

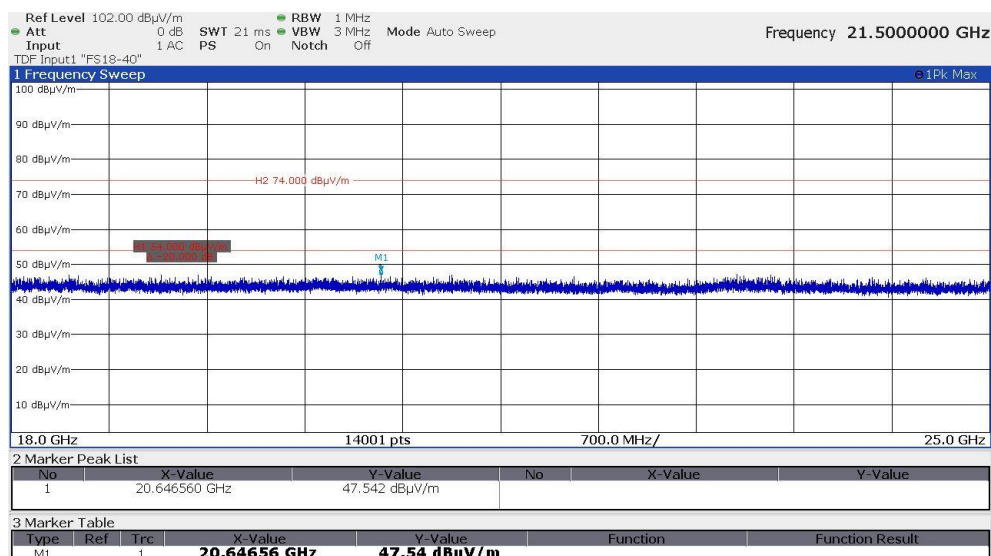
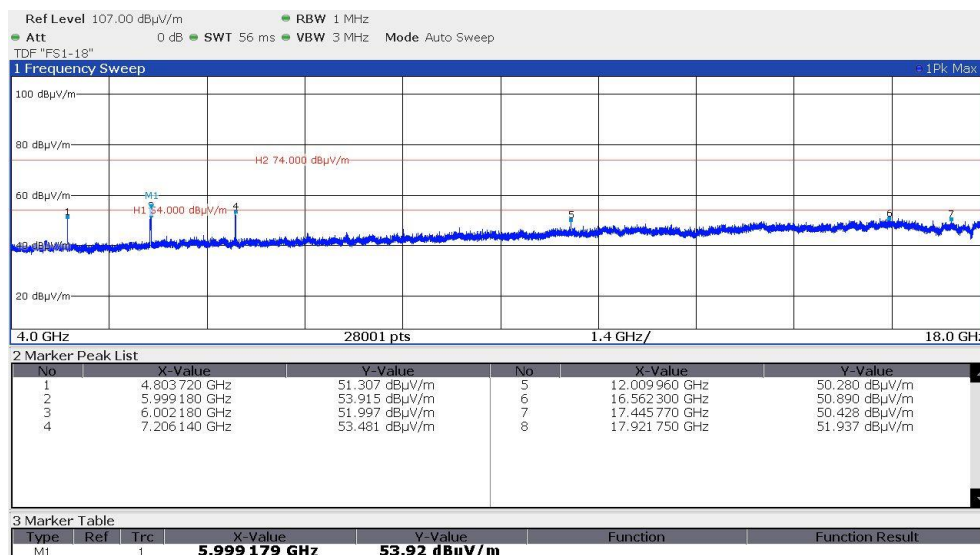
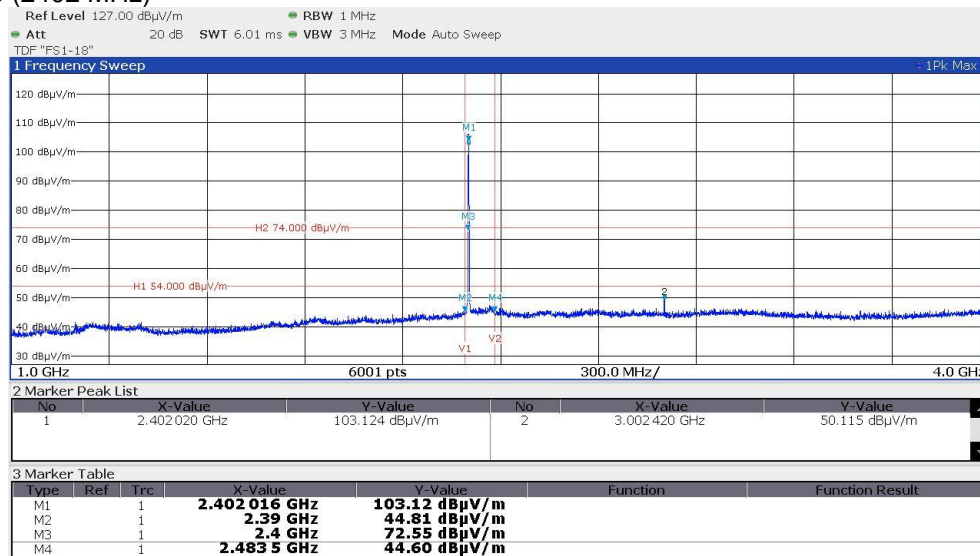


Note: No emissions detected in the frequency range below 1 GHz. The recorded values are solely noise values of the OATS.

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

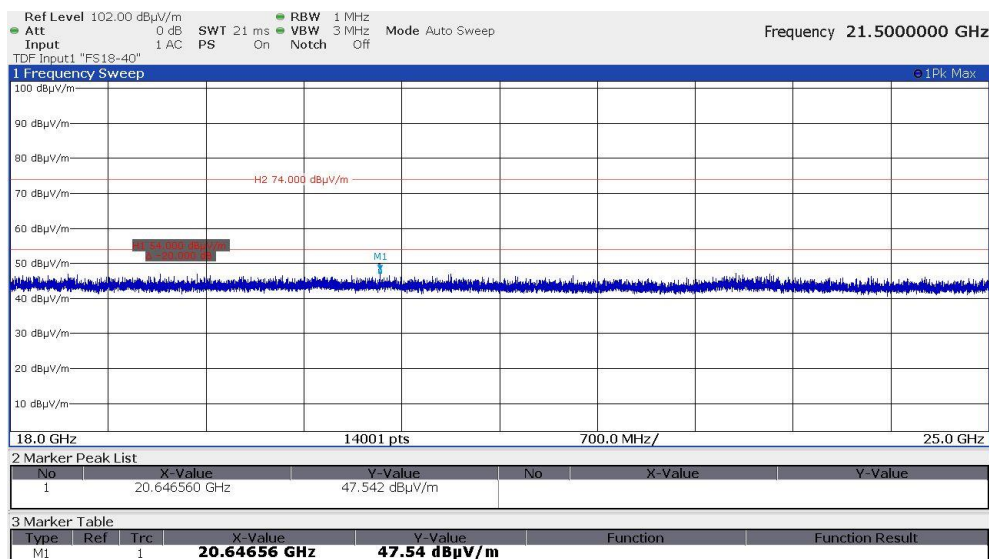
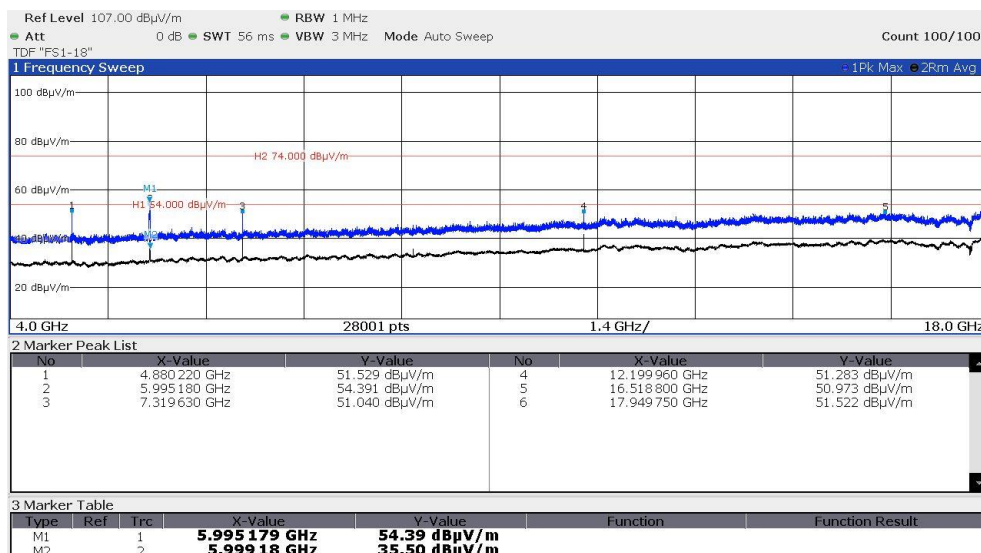
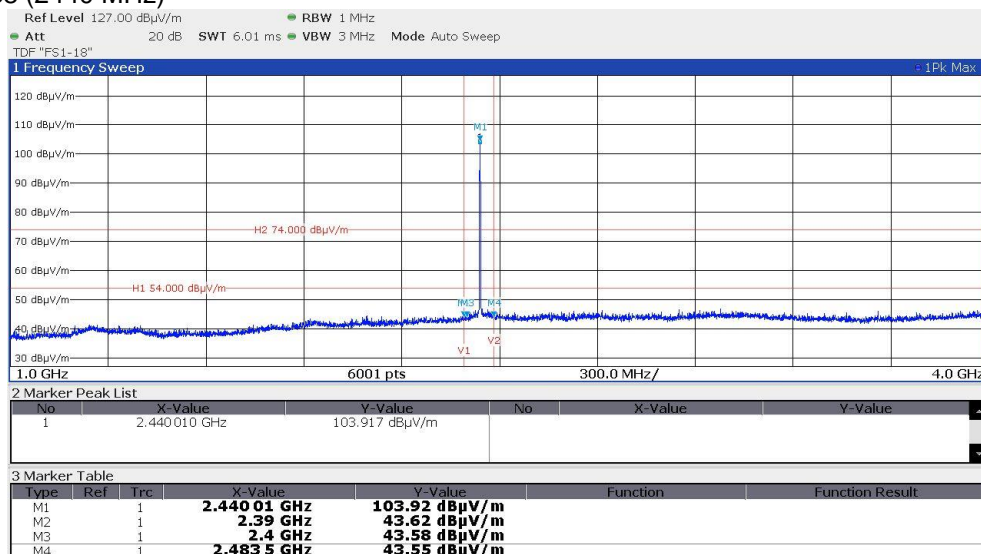
f > 1000 MHz

1) Measurement of emissions according to General Limit specified in section 15.209(a) / RSS-Gen 8.9:
BT 1 Mbps CH0 (2402 MHz)



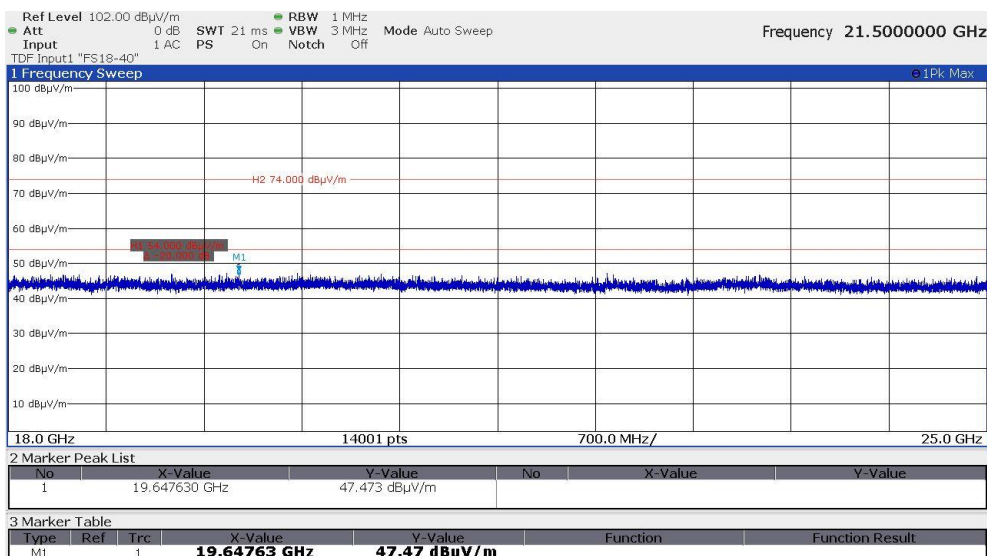
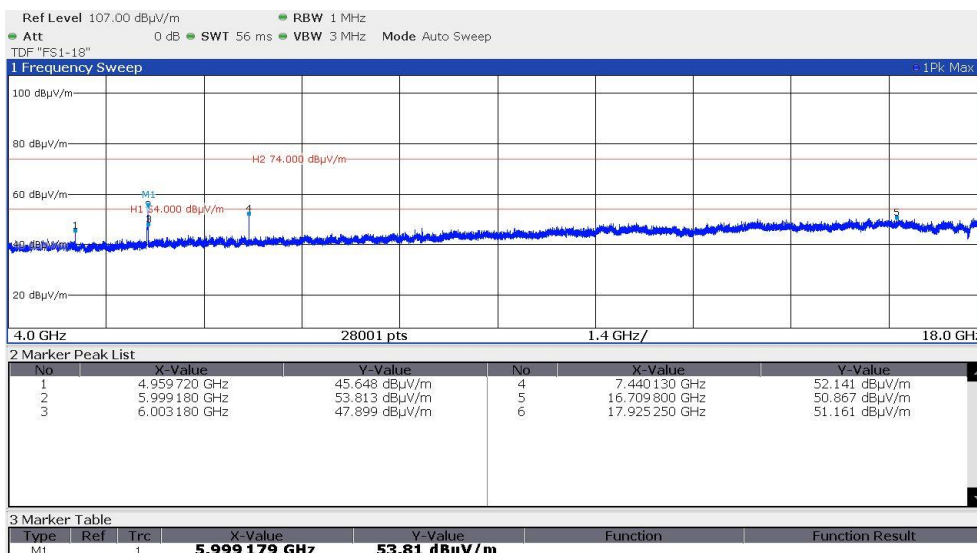
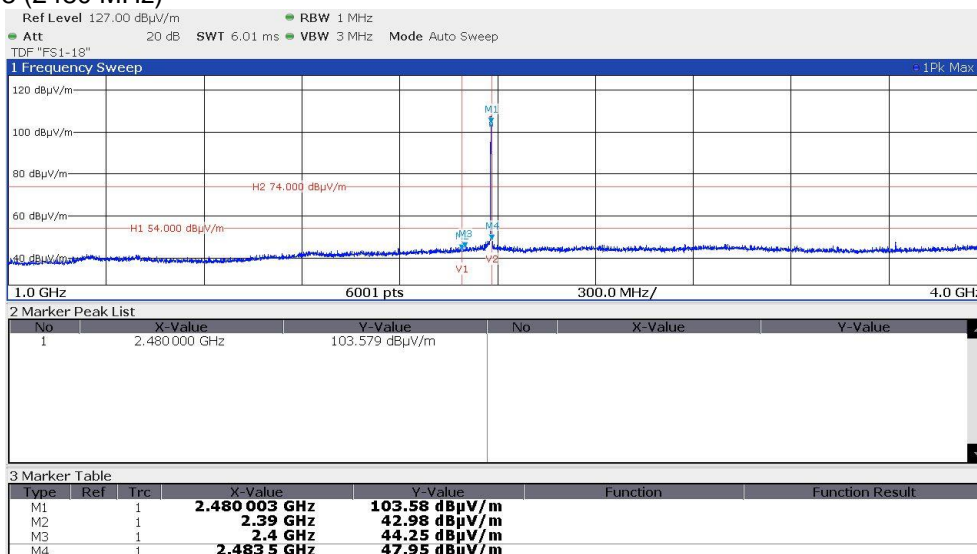
FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

BT 1 Mbps CH38 (2440 MHz)



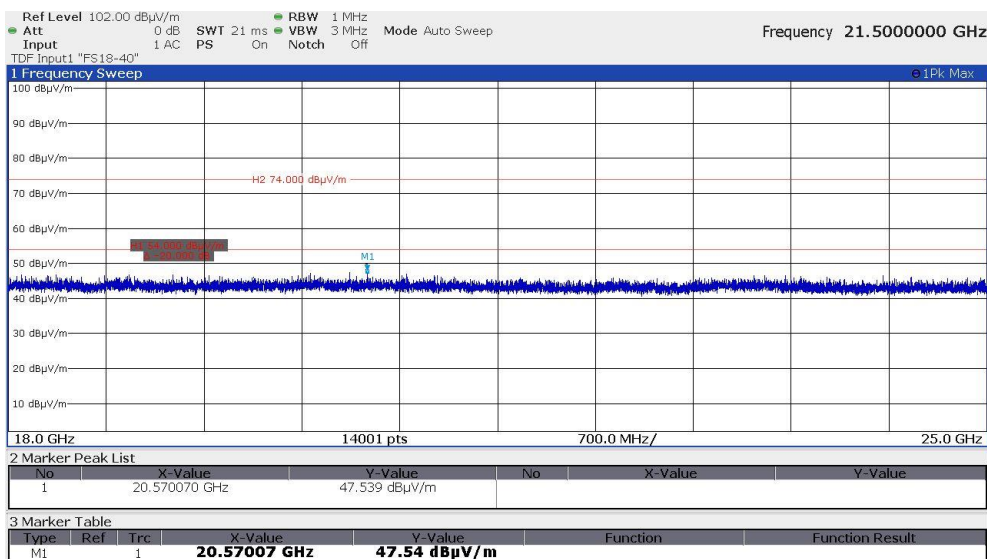
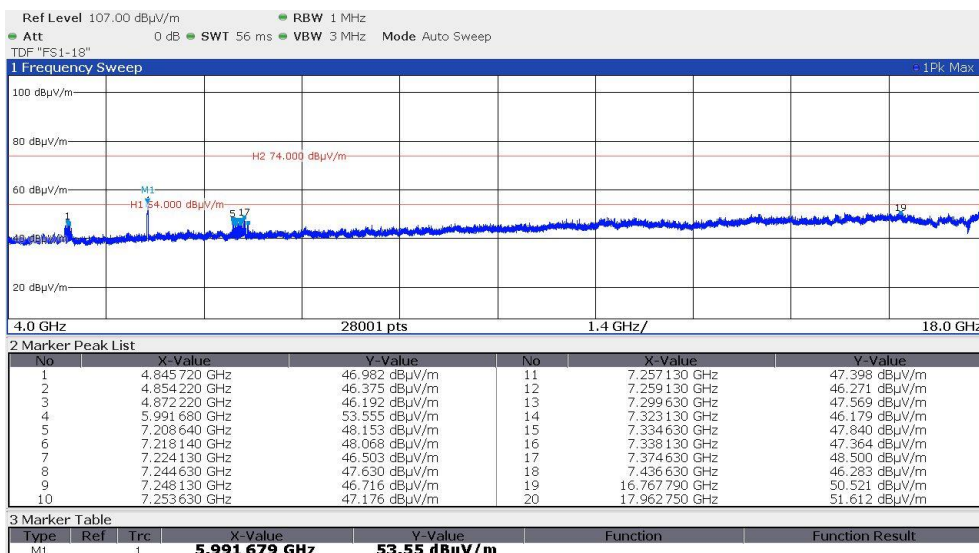
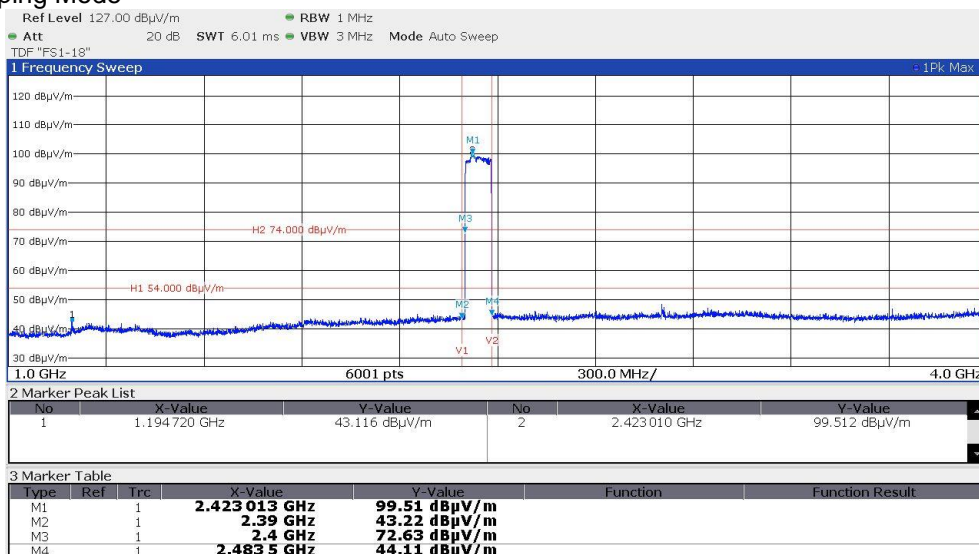
FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

BT 1 Mbps CH78 (2480 MHz)



FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

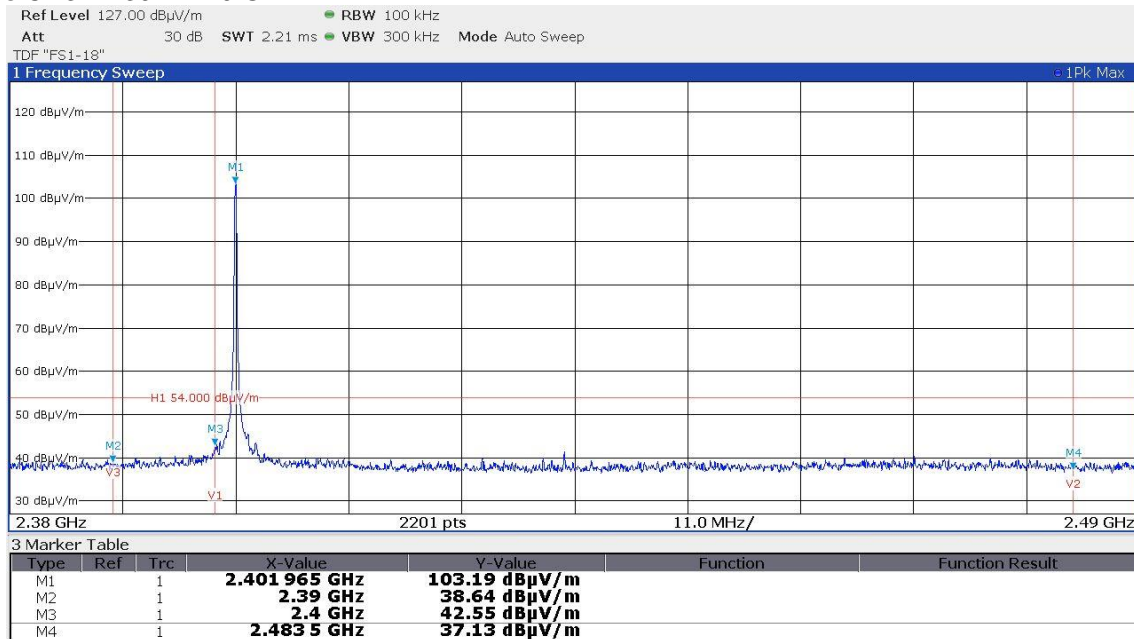
BT 1 Mbps Hopping Mode



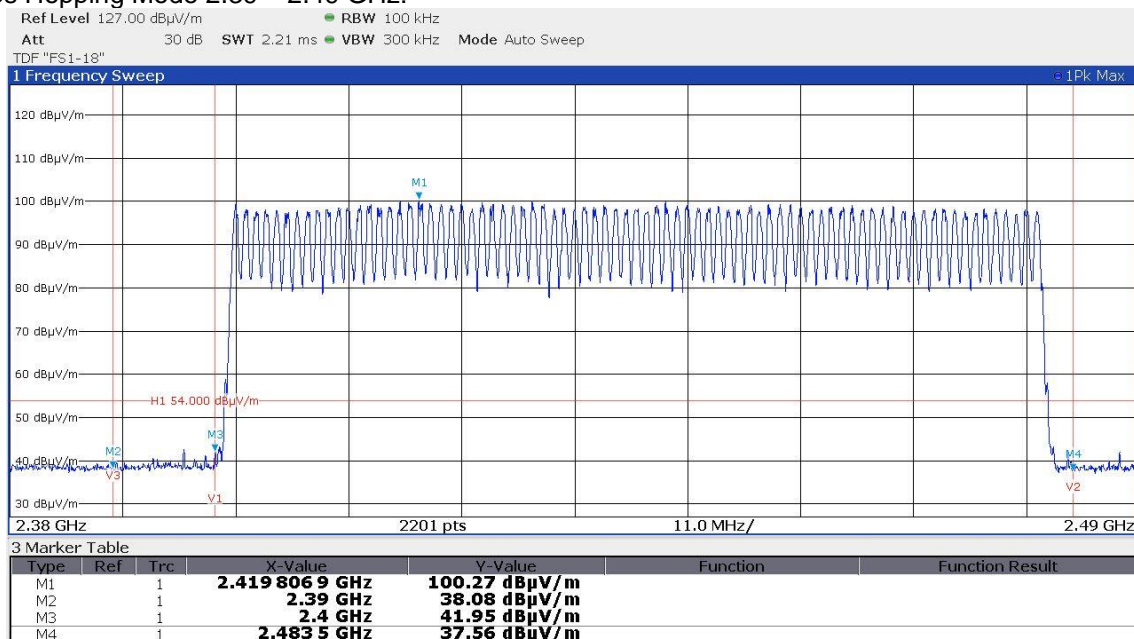
FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

2) Measurements of emissions according to spurious emissions limit specified in section 15.247(d) / RSS-247 5.5:

BT 1 Mbps CH37 2.39 – 2.49 GHz:



BT 1 Mbps Hopping Mode 2.39 – 2.49 GHz:



FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

Radiated limits according to FCC Part 15, Section 15.209 for spurious emissions which fall in restricted bands:

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

Radiated limits according to RSS-Gen, 8.9 for spurious emissions which fall in restricted bands:

Frequency (MHz)	RSS-Gen Limits (μA/m)	Measurement distance (m)
0.009 - -0.49	63.7/f(kHz)	300
0.49 – 1.705	63.7/f(kHz)	30
1.705 – 30.0	0.08	30

Frequency (MHz)	RSS-Gen Limits (μV/m)	Measurement distance (m)
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Limit according to FCC Part 15, Section 15.247(d) for emissions falling not in restricted bands:

Frequency (MHz)	Spurious emission limit
Below 1000	20 dB below the highest level of the desired power
Above 1000	20 dB below the highest level of the desired power

Attenuation below the general limits specified in Section 15.209(a) is not required.

Limit according to RSS-247, 5.5 for emissions falling not in restricted bands:

Frequency (MHz)	Spurious emission limit
Below 1000	20 dB below the highest level of the desired power
Above 1000	20 dB below the highest level of the desired power

Attenuation below the general limits specified in RSS-Gen is not required.

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2
Restricted bands of operation:

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	399.9 – 410	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	608 – 614	5.35 – 5.46
2.1735 – 2.1905	16.80425 – 16.80475	960 – 1240	7.25 – 7.75
4.125 – 4.128	25.5 – 25.67	1300 – 1427	8.025 – 8.5
4.17725 – 4.17775	37.5 – 38.25	1435 – 1626.5	9.0 – 9.2
4.20725 – 4.20775	73 – 74.6	1645.5 – 1646.5	9.3 – 9.5
6.215 – 6.218	74.8 – 75.2	1660 – 1710	10.6 – 12.7
6.26775 – 6.26825	108 – 121.94	1718.8 – 1722.2	13.25 – 13.4
6.31175 – 6.31225	123 – 138	2200 – 2300	14.47 – 14.5
8.291 – 8.294	149.9 – 150.05	2310 – 2390	15.35 – 16.2
8.362 – 8.366	156.52475 – 156.52525	2483.5 – 2500	17.7 – 21.4
8.37625 – 8.38675	156.7 – 156.9	2690 – 2900	22.01 – 23.12
8.41425 – 8.41475	162.0125 – 167.17	3260 – 3267	23.6 – 24.0
12.29 – 12.293	167.72 – 173.2	3332 – 3339	31.2 – 31.8
12.51975 – 12.52025	240 – 285	3345.8 – 3358	36.43 – 36.5
12.57675 – 12.57725	322 – 335.4	3600 – 4400	Above 38.6

RSS-Gen, Table 6 – Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090 - 0.110	12.57675 - 12.57725	399.9 - 410	7.250 - 7.750
0.495 - 0.505	13.36 - 13.41	608 - 614	8.025 – 8.500
2.1735 - 2.1905	16.42 - 16.423	960 - 1427	9.0 - 9.2
3.020 - 3.026	16.69475 - 16.69525	1435 - 1626.5	9.3 - 9.5
4.125 - 4.128	16.80425 - 16.80475	1645.5 - 1646.5	10.6 - 12.7
4.17725 - 4.17775	25.5 - 25.67	1660 - 1710	13.25 - 13.4
4.20725 - 4.20775	37.5 - 38.25	1718.8 - 1722.2	14.47 - 14.5
5.677 - 5.683	73 - 74.6	2200 - 2300	15.35 - 16.2
6.215 - 6.218	74.8 - 75.2	2310 - 2390	17.7 - 21.4
6.26775 - 6.26825	108 – 138	2483.5 - 2500	22.01 - 23.12
6.31175 - 6.31225	149.9 - 150.05	2655 - 2900	23.6 - 24.0
8.291 - 8.294	156.52475 - 156.52525	3260 – 3267	31.2 - 31.8
8.362 - 8.366	156.7 - 156.9	3332 - 3339	36.43 - 36.5
8.37625 - 8.38675	162.0125 - 167.17	3345.8 - 3358	Above 38.6
8.41425 - 8.41475	167.72 - 173.2	3500 - 4400	
12.29 - 12.293	240 – 285	4500 - 5150	
12.51975 - 12.52025	322 - 335.4	5350 - 5460	

The requirements are **FULFILLED**.

Remarks: The measurement was performed up to the 10th harmonic. Only the worst-case plots are listed.

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: ESV-ZLXG2 **IC-ID:** 1249A-ZLXG2

5.5 Pseudorandom frequency hopping sequence

Requirement according to FCC Part 15C, Section 15.247(a):

The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies.

Co-ordination of the hopping sequence in data mode to avoid simultaneous occupancy by multiple transmitters: Bluetooth units which want to communicate with other units must be organized in a structure called pico net. This consists of maximum 8 Bluetooth units. One unit is the master the other seven are the slaves. The master co-ordinates frequency occupation in this for all units. As the master hop sequence is derived from its BD address which is unique for each Bluetooth device, additional masters intending to establish new Pico nets will always use different hop sequences.

Example of a 79 hopping sequence in data mode:

40, 21, 44, 23, 42, 53, 46, 55, 48, 33, 52, 35, 50, 65, 54, 67, 56, 37, 60, 39, 58, 69, 62, 71, 64, 25, 68, 27, 66, 57, 70, 59, 72, 29, 76, 31, 74, 61, 78, 63, 01, 41, 05, 43, 03, 73, 07, 75, 09, 45, 13, 47, 11, 77, 15, 00, 64, 49, 66, 53, 68, 02, 70, 06, 01, 51, 03, 55, 05, 04

Derivation and examples for a hopping sequence in hybrid mode

For the generation of the inquiry and page hop sequences the same procedures as described for the data mode are used (see chapter 5), but this time with different input vectors:

- For the inquiry hop sequence, a predefined fixed address is always used. This results in the same 32 frequencies used by all devices doing an inquiry but every time with a different start frequency and phase in this sequence.
- For the page hop sequence, the device address of the paged unit is used as input vector. This results in the use of a subset of 32 frequencies which is specific for that initial state of the connection establishment between the two units. A page to different devices would result in a different subset of 32 frequencies.

So it is ensured that also in hybrid mode the frequency use equally averaged.

Example of a hopping sequence in inquiry mode:

48, 50, 09, 13, 52, 54, 41, 45, 56, 58, 11, 15, 60, 62, 43, 47, 00, 02, 64, 68, 04, 06, 17, 21, 08, 10, 66, 70, 12, 14, 19, 23

Example of a hopping sequence in paging mode:

08, 57, 68, 70, 51, 02, 42, 40, 04, 61, 44, 46, 63, 14, 50, 48, 16, 65, 52, 54, 67, 18, 58, 56, 20, 53, 60, 62, 55, 06, 66, 64

Remarks: This item is part of the Bluetooth Core Specifications V2.1+EDR compliance and approved.

FCC-ID: ESV-ZLXG2 **IC-ID:** 1249A-ZLXG2

5.6 Equal hopping frequency use

Requirement according to FCC Part 15C, Section 15.247(a):

Each frequency must be used equally on the average by each transmitter.

The generation of the hopping sequence in connection mode depends essentially on two input values:

1. LAP/UAP of the master of the connection.
2. Internal master clock.

The LAP (lower address part) is the 24 LSB's of the 48 BD_ADDRESS. The BD_ADDRESS is an unambiguous number of every Bluetooth unit. The UAP (upper address part) are the 24 MSB's of the 48 BD_ADDRESS. The internal clock of a Bluetooth unit is derived from a free running clock which is never adjusted and is never turned off. For synchronization with other units only offset are used. It has no relation to the time of the day. Its resolution is at least half the Rx/Tx slot length of 312.5 µs. The clock has a cycle of about one day (23hr30min). In most case, it is implemented as 28 bit counter. For the deriving of the hopping sequence the entire LAP (24 bits), 4 LSB's (4 bits) (Input 1) and the 27 MSB's of the clock (Input 2) are used. With this input values different mathematical procedures (permutations, additions, XOR-operations) are performed to generate the sequence. This will be done at the beginning of every new transmission.

Regarding short transmissions the Bluetooth system has the following behaviour: The first connection between the two devices is established, a hopping sequence was generated. For transmitting the wanted data the complete hopping sequence was not used. The connection ended. The second connection will be established. A new hopping sequence is generated. Due to the fact that the Bluetooth clock has a different value the hopping sequence will always differ from the first one, because the period between the two transmissions is longer and it cannot be shorter than the minimum resolution of the clock is 312.5 µs. This circumstance is always the same therefore the average of the frequency use is the same on all transmitters.

Remarks: This item is part of the Bluetooth Core Specifications V2.1+EDR compliance and approved.

5.7 Receiver input bandwidth

Requirement according to FCC Part 15C, Section 15.247(a):

The system receivers shall have input bandwidth that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signal.

Receiver input bandwidth and behaviours for repeated single or multiple packets:

The input bandwidth of the receiver is 1 MHz. In every connection one Bluetooth device is the master and the other one is the slave. The master determines the hopping sequence (see chapter 5). The slave follows this sequence. Both devices shift between Rx and Tx time slot according to the clock of the master. Additionally the type of connection (e.g. single or multi-slot packet) is set up at the beginning of the connection. The master adapts its hopping frequency and its Tx/Rx timing according to the packet type of the connection. Also the slave of the connection will use these settings. Repeating of a packet has no influence on the hopping sequence. The hopping sequence generated by the master of the connection will be followed in any case. That means, a repeated packet will not be send on the same frequency, it is send on the next frequency of the hopping sequence.

Remarks: This item is part of the Bluetooth Core Specifications V2.1+EDR compliance and approved.

FCC-ID: ESV-ZLXG2 **IC-ID:** 1249A-ZLXG2

5.8 Dwell time

5.8.1 Applicable standard

According to FCC Part 15, Section 15.247(a)(1)(iii):

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

5.8.2 Test Result

Mode	Number of transmissions in 31.6 s (= 79 CH * 0.4 s)	Length of a single transmission (µs)	Dwell Time (ms)	Limit (ms)
1 Mbps	319	399.309	127.38	400
2 Mbps	319	294.500	93.95	400
3 Mbps	319	252.610	80.58	400

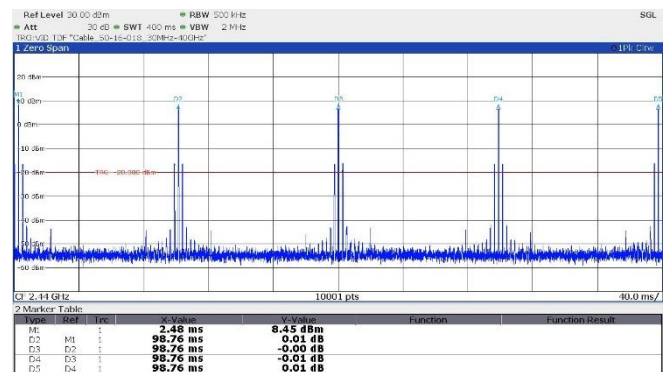
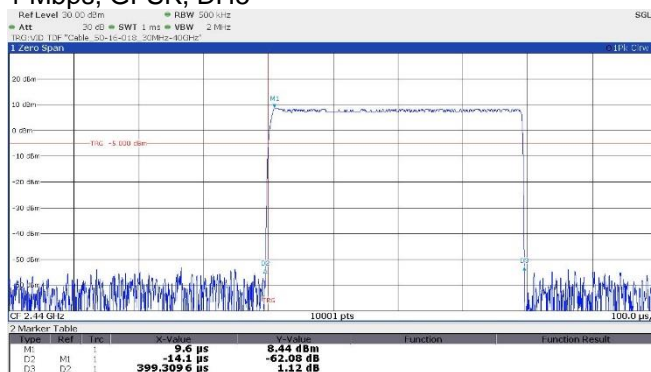
Remarks: For detailed test result please see the following test protocols.

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.

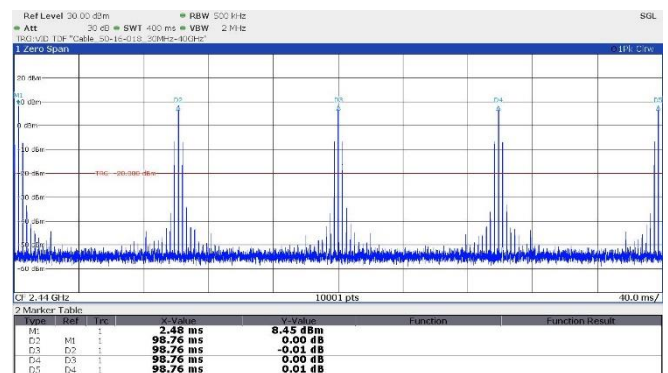
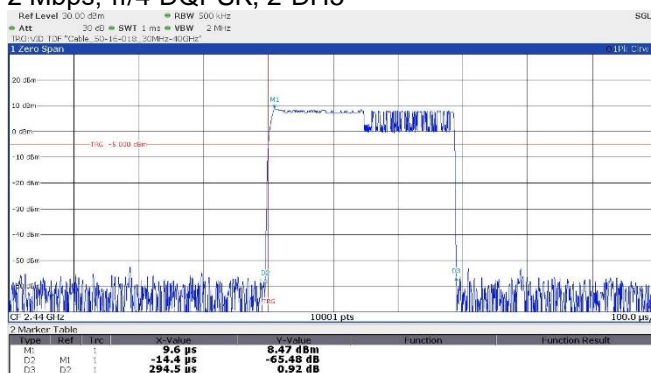
FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

5.8.3 Test protocols

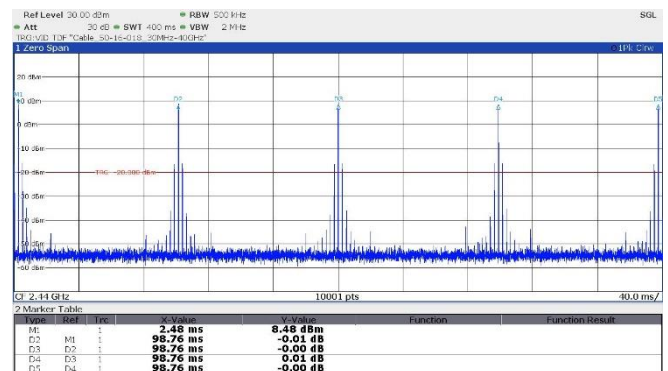
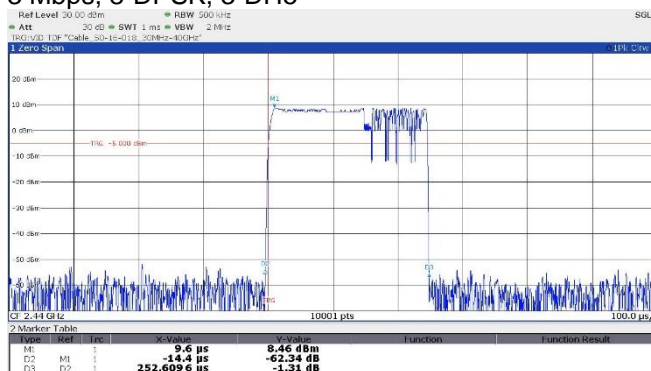
1 Mbps, GFSK, DH5



2 Mbps, $\pi/4$ -DQPSK, 2-DH5



3 Mbps, 8-DPSK, 3-DH5



Signal occurs on selected channel every 98.76 ms. This results in 319 transmissions in 31.6 s.

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

5.9 Carrier frequency separation

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

5.9.1 Description of the test location

Test location: Shielded Room S6

5.9.2 Photo documentation of the test set-up

See Attachment B for detailed photo documentation of the test set-up.

5.9.3 Applicable standard

According to FCC Part 15C, Section 15.247(a) and RSS-247 5.1b:
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

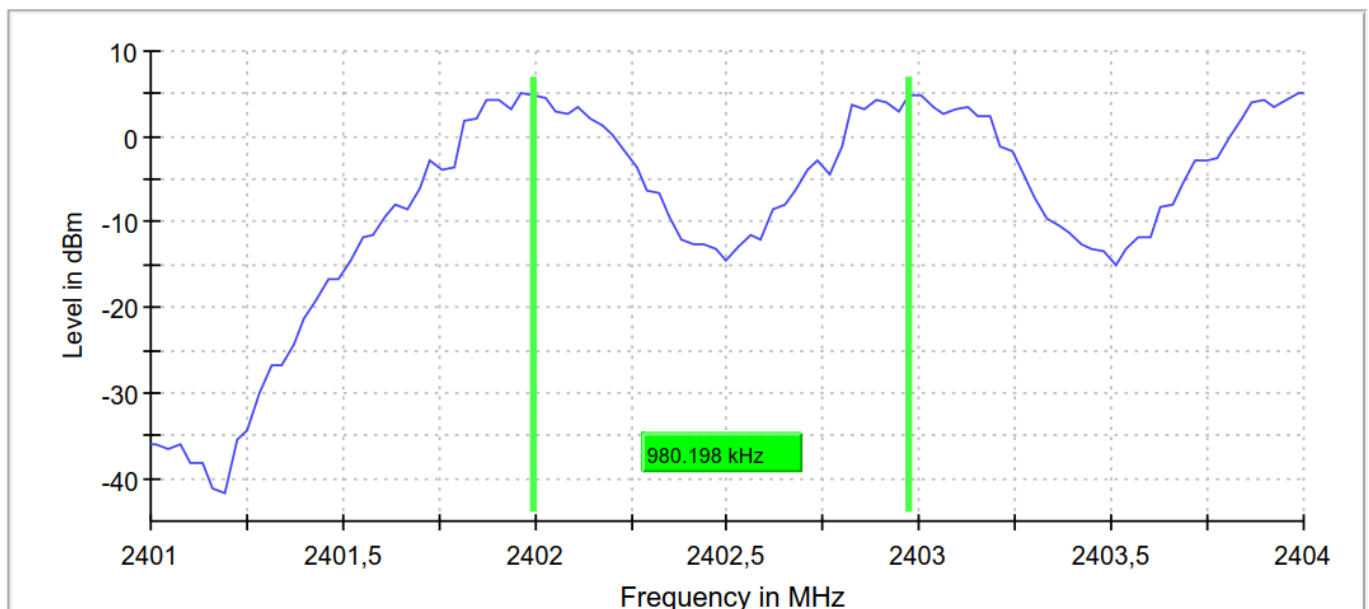
5.9.4 Description of Measurement

The method of measurement is used set out in ANSI C63.10, 7.8.2.

Analyser settings:

RBW: 30 kHz, VBW: 100 kHz, Sweep time: auto, Detector: Peak, Trace mode: Max hold

5.9.5 Test result



FCC-ID: ESV-ZLXG2 **IC-ID:** 1249A-ZLXG2

Limit according to FCC Part 15C, Section 15.247(a):

Frequency (MHz)	Hopping channels	Limit channel separation
All systems		> 25 kHz or 20 dB bandwidth, whichever is greater
2400 - 2483.5	≥ 15	> 25 kHz or 2/3 of 20 dB bandwidth, whichever is greater

The requirements are **FULFILLED**.

Remarks: Δf shall be minimum 744 kHz (= 2/3 * 1.11 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: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

5.10 Number of hopping channels

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

5.10.1 Description of the test location

Test location: Shielded Room S6

5.10.2 Applicable standard

According to FCC Part 15, Section 15.247(a)(1)(iii):
Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

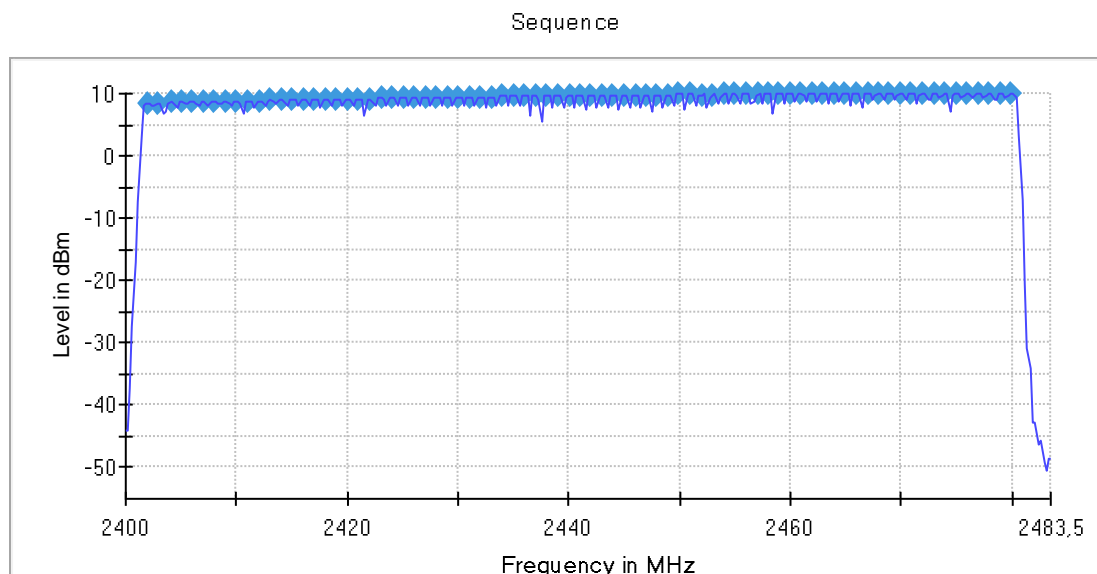
5.10.3 Description of Measurement

The method of measurement is used set out in ANSI C63.10, 7.8.3.

5.10.4 Photo documentation of the test set-up

See Attachment B for detailed photo documentation of the test set-up.

5.10.5 Test result



Hopping channel frequency range	Number of all available hopping channels
2402 - 2480	79

FCC-ID: ESV-ZLXG2 **IC-ID:** 1249A-ZLXG2

Limit according to FCC Part 15C, Section 15.247(1):

Frequency range (MHz)	LIMIT (Number of Hopping Channels)			
	20dB Bandwidth < 250kHz	20dB Bandwidth > 250kHz	20dB Bandwidth < 1 MHz	20dB Bandwidth > 1MHz
2400 – 2483,5	15	15	15	15

The requirements are **FULFILLED**.

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

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: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

5.11 Antenna application

5.11.1 Applicable standard

According to FCC Part 15C, Section 15.203:

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. The manufacturer may design the unit that broken antennas can be replaced by the user, but the use of a standard antenna jack is prohibited.

The EUT has an integrated chip antenna; special tools are needed for replacing the antenna that prevents manipulation by a user. No external power amplifier can be connected. The requirements of part 15.203 and 15.204 are met.

5.11.2 Antenna requirements

According to FCC Part 15C, Section 15.247 (b)(4):

The conducted output power limit specified in paragraph (b) of 15.247 is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2) and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Remarks: No power reduction results from the defacto limit.

FCC-ID: ESV-ZLXG2 IC-ID: 1249A-ZLXG2

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.
All used instruments were within calibration and verification interval to the time of measurement.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
A 4	BAT-EMC 2022.0.23.0	01-02/68-13-001				
	ESCI	02-02/03-15-001	03/07/2024	03/07/2023		
	ESH 2 - Z 5	02-02/20-05-004	13/10/2025	13/10/2022	17/10/2023	17/04/2023
	N-4000-BNC	02-02/50-05-138				
	ESH 3 - Z 2	02-02/50-05-155	09/11/2025	09/11/2022	25/01/2024	25/07/2023
	SP 103 /3.5-60	02-02/50-05-182				
CPC 3	FSW43	02-02/11-15-001	04/05/2024	04/05/2023		
	minibend KR-16	02-02/50-16-017				
CPR 3	FSW43	02-02/11-15-001	04/05/2024	04/05/2023		
	AFS5-12001800-18-10P-6	02-02/17-06-002				
	AFS4-01000400-10-10P-4	02-02/17-13-002				
	AMF-4F-04001200-15-10P	02-02/17-13-003				
	3117	02-02/24-05-009	12/07/2024	12/07/2023		
	Sucoflex N-2000-SMA	02-02/50-05-075				
MB	SMBV100A	02-02/05-09-001	24/03/2024	24/03/2021	21/02/2024	21/02/2023
	SMB100A	02-02/05-14-001	22/05/2024	22/05/2023		
	FSW43	02-02/11-15-001	04/05/2024	04/05/2023		
	OSP-B157W8 with OSP120	02-02/30-13-002	10/07/2024	10/07/2023		
	OSP-B157WX with OSP120	02-02/30-18-007	12/07/2024	12/07/2023		
	Sucoflex N-1000-SMA	02-02/50-05-072				
	KMS116-GL140SE-KMS116-	02-02/50-16-010				
	minibend KR-16	02-02/50-16-017				
	2.4/5.2/5.8GHz Antenna + S	02-02/50-17-027				
	Semflex K-400-K	02-02/50-19-013				
	SMB-K27 PULSETRAIN	02-02/68-19-001				
SER 1	ESVS 30	02-02/03-05-006	27/07/2024	27/07/2023		
	HFH 2 - Z 2	02-02/24-05-020	01/06/2025	01/06/2022	05/09/2024	05/09/2023
	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				
	50F-003 N 3 dB	02-02/50-21-010				
SER 2	ESVS 30	02-02/03-05-006	27/07/2024	27/07/2023		
	VULB 9168	02-02/24-05-005	20/04/2024	20/04/2023	03/05/2024	03/05/2023
	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				
	50F-003 N 3 dB	02-02/50-21-010				
SER 3	FSW43	02-02/11-15-001	04/05/2024	04/05/2023		
	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	12/07/2024	12/07/2023		
	BBHA 9170	02-02/24-05-013	21/03/2026	21/03/2023	21/03/2024	21/03/2023
	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				