

TEST REPORT

No.: 16-1-0120001T04a-C2

According to:

FCC Regulations

Part 1.1310
Part 2.1091

for

Actia Nordic AB

VCM

FCC: 2AGKKVCM

Laboratory Accreditation and Listings



Deutsche
Akkreditierungsstelle
D-PL-12047-01-01
D-PL-12047-01-03
D-PL-12047-01-04

accredited according to DIN EN ISO/IEC 17025:2018

CETECOM GmbH

Laboratory Radio Communications & Electromagnetic Compatibility
Im Teelbruch 116 • 45219 Essen • Germany

Registered in Essen, Germany, Reg. No.: HRB Essen 8984
Tel.: + 49 (0) 20 54 / 95 19-0 • Fax: + 49 (0) 20 54 / 95 19-150
E-mail: contact@cetecom.com • Internet: www.cetecom.com

Table of contents

1. SUMMARY OF TEST RESULTS.....	3
1.1 Summary of tests results.....	3
2. ADMINISTRATIVE DATA	4
2.1 Identification of the testing laboratory.....	4
2.2 Test location	4
2.3 Organizational items	4
2.4 Applicant's details	4
2.5. Manufacturer's details	4
3. EQUIPMENT UNDER TEST (EUT).....	5
3.1. Summary of product description.....	5
3.2. EUT Technologies	5
3.3. Antenna Information.....	5
3.4. EUT: Type, S/N etc. and short descriptions used in this test report	6
3.5. Auxiliary Equipment (AE): Type, S/N etc. and short descriptions.....	6
3.6. EUT set-ups	6
3.7. EUT operating modes	6
4. MEASUREMENTS	7
4.1. Radio Frequency Exposure Evaluation §2.1091.....	7
4.1.1. Test location and equipment (for reference numbers please see chapter 'List of test equipment').....	7
4.2. MPE Calculation method.....	9
4.3. Evaluation Method.....	9
4.4. Results for fixed and mobile.....	10
4.5. Conclusion	10
4.6. Measurement uncertainties	11
5. ABBREVIATIONS USED IN THIS REPORT	12
6. ACCREDITATION DETAILS OF CETECOM'S LABORATORIES AND TEST SITES	13
7. PHOTOGRAPHS OF THE EUT'S	14
8. VERSIONS OF TEST REPORTS (CHANGE HISTORY)	15

Table of annex

	Total pages
Annex 1: Separate document "Volvo_MAM_Data Sheet_2016_04_22"	14
Annex 2: Separate document "5610_40039_Antenna path loss_1.0"	01
Annex 3: Separate document "5610_40035_Technical Description of VCM_1.7"	11
Annex 4: Separate document "RE 16-1-01200 - VCM 2P91"	01

The listed attachments are an integral part of this report.

1. Summary of test results

The test results apply exclusively to the test samples as presented in this Report. The CETECOM GmbH does not assume responsibility for any conclusions and generalizations taken in conjunction with other specimens or samples of the type of the item presented to tests.

In order to verify the compliance with applicable rules, a representative configuration consisting of the main EUT and necessary representative auxiliary equipment was chosen by the applicant.

The MPE assessment report is performed for all wireless technologies usable in the EU and supported from the EUT. Following tests have been performed to show compliance with applicable FCC Part 2.1091 and FCC Part 1.1310 of the FCC CFR 47 Rules.

1.1 Summary of tests results

RF-Exposure Evaluation (separation distance user to RF-radiating element greater 20cm)						
Test cases	Port	References & Limits		EUT set-up	EUT op. mode	Result
		FCC Standard	Test Limit			
Radio frequency radiation exposure Requirements	Cabinet	§1.1310 §2.1091 §2.1093	RF-Field Strength Limits: FCC: "general population/ uncontrolled" environment	1-2	1-2	Pass

Remark: Calculations based on Test Reports mentioned in Annex 1 to 4.

The current version of the Test Report CETECOM_TR16_1_0120001T04a_C2 replaces the Test Report CETECOM_TR16_1_0120001T04a_C1 dated 2020-07-17. The replaced test report is herewith invalid.



.....
Dipl.-Ing. Niels Jeß
Responsible for test section



Date: 2020.08.
03 13:10:51 +
02'00'

.....
B.Eng. Martin Nunier
Responsible for test report

2. Administrative Data

2.1 Identification of the testing laboratory

Company name:	CETECOM GmbH
Address:	Im Teelbruch 116 45219 Essen - Kettwig Germany
Responsible for testing laboratory:	Niels Jeß
Deputy:	Ninovic Perez

2.2 Test location

2.2.1 Test laboratory “CTC”

Company name:	see chapter 2.1 Identification of the testing laboratory
---------------	--

2.3 Organizational items

Responsible for test report:	Martin Nunier
Receipt of EUT:	--
Date(s) of test:	--
Date of report:	2020-08-03

2.4 Applicant's details

Applicant's name:	Actia Nordic AB
Address:	Hammarbacken 4A 19149 SOLLENTUNA Sweden
Contact person:	Mr. Salah Alazawi

2.5. Manufacturer's details

Manufacturer's name:	please see applicant's details
Address:	please see applicant's details

3. Equipment under test (EUT)

3.1. Summary of product description

FCC ID:	2AGKKVCM		
Product name	VCM		
Exposure category	☒ General population/uncontrolled environment ☐ Occupational exposure/controlled environment		
Output power	☐ Conducted ☐ ERP ☒ EIRP ☐ Peak ☒ Source-based time-averaging		
Antenna gain	details refer to: "Volvo_MAM_Data Sheet_2016_04_22"		
Technology	☐ MIMO	☐ 2T2R ☐ 3T3R ☐ 4T4R	
	☒ non-MIMO	☒ 1T1R ☐ 1T2R ☐ 2T1R	
Evaluation type	☒ Standalone ☐ Simultaneous transmission		
Evaluation distance	☒ 20 cm		
	☐ XXX cm	declares by manufacturer	
EUT type	☐ Production Unit ☒ Pre-Production Unit ☐ Engineering Unit		
Device type	☐ Mobile device ☒ Fixed device		
Refer rules	☒ CFR 47 FCC Part 2.1091 ☒ CFR 47 FCC Part 1.1310 ☒ KDB 447497 D01v06 October 23, 2015 ☒ KDB 865664 D01v01r02 October 23, 2015		

3.2. EUT Technologies

Wireless Technologies	Frequency bands	Operation mode
☒ WLAN	☒ 2.4 GHz ☒ 5 GHz	normal operation mode

3.3. Antenna Information

Wireless Technologies	Frequency bands	Antenna type	Maximum antenna gain
☒ WLAN	☒ 2.4 GHz ☒ 5 GHz	☐ internal ☒ external	see Annex 1

3.4. EUT: Type, S/N etc. and short descriptions used in this test report

Short description*)	EUT	Type	S/N serial number	HW hardware status	SW software status
EUT A	VCM	Vehicle Connectivity Master	10093027	C	IP21

*) EUT short description is used to simplify the identification of the EUT in this test report.

3.5. Auxiliary Equipment (AE): Type, S/N etc. and short descriptions

AE short description *)	Auxiliary Equipment	Type	S/N serial number	HW hardware status	SW software status
AE 1	Roof mounted Antenna	Multiband Antenna Module	--	--	--

*) AE short description is used to simplify the identification of the auxiliary equipment in this test report.

3.6. EUT set-ups

EUT set-up no. *)	Combination of EUT and AE	Remarks
set. 1	EUT A	--
set. 2	EUT A + AE1	--

*) EUT set-up no. is used to simplify the identification of the EUT set-up in this test report.

3.7. EUT operating modes

EUT operating mode no. *)	Description of operating modes	Additional information
op. 1	WLAN 2.4 GHz	Only theoretical calculation
op. 2	WLAN 5 GHz	Only theoretical calculation

*) EUT operating mode no. is used to simplify the test report.

4. Measurements

4.1. Radio Frequency Exposure Evaluation §2.1091

4.1.1. Test location and equipment (for reference numbers please see chapter 'List of test equipment')

test location	☒ CETECOM Essen (Chapter. 2.2.1)	☐ Please see Chapter. 2.2.2	☐ Please see Chapter. 2.2.3
	For Evaluation instruments are not needed. Results are determined by calculation based on applicants delivered Tune-Up procedure.		

4.1.2. Requirements

FCC: §1.1310	<i>The criteria used for the evaluation of human exposure to radio frequency radiation is table 1 according FCC §1.1310 and table chapter 4.2 of RSS-102 standard and it is subject for evaluation of the RF exposure prior to equipment authorization. As the mobile equipment is authorized under Part 22 (Subpart H) and Part 24 of the FCC Rules, it is subject for evaluation of the RF exposure prior to equipment authorization.</i>
FCC § 2.1091	<i>Further information on evaluating compliance with these limits can be found in the FCC's OST/OET Bulletin Number 65, "Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation." For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits given in Table 1 of Appendix A.</i>

4.1.2.1. Valid for FCC

Table 1: LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)				
Frequency range [MHz]	Electric field strength [V/m]	Magnetic field strength [A/m]	Power density [mW/cm ²]	Averaging time [minutes]
30 - 300	61.4	0.163	1.0	6
300 - 1500	-	-	f/300	6
1500 - 100,000	-	-	5	6
(B) Limits for General Population / Uncontrolled Exposure				
0.3 - 1.34	614	1.63	*(100)	30
1.34 - 30	824/f	2.19/f	*(180/f ²)	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	-	-	f/1500	30
1500 - 100,0	-	-	1.0	30

f=frequency in MHz

*Plane-wave equivalent power density

NOTE1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure. These limits apply to amateur station licensees and members of their immediate household as discussed in the text.

NOTE2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure. As discussed in the text, these limits apply to neighbours living near amateur radio stations.

4.1.3 General Limits:

FCC: §1.1307	Cellular Radiotelephone Service (subpart H of part 22) Non-building-mounted antennas: height above ground level to lowest point of antenna < 10 m and total power of all channels > 1000 W ERP (1640 W EIRP)
FCC §1.1307	Personal Communications Services (part 24) Broadband PCS (subpart E): non-building-mounted antennas: height above ground level to lowest point of antenna < 10 m and total power of all channels > 2000 W ERP (3280 W EIRP)
FCC §1.1310	LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE) Table 1(B) Limits for General Population/Uncontrolled Exposure 300–1500 MHz: $f/1500 \text{ mW/cm}^2$ 1500–100,000 MHz: 1.0 mW/cm^2
FCC §2.1091	Subject to routine evaluation is required when the device operate at frequencies of 1.5 GHz or below and their effective radiated power (ERP) is 1.5 watts or more, or if they operate at frequencies above 1.5 GHz and their ERP is 3 watts or more.
FCC §24.232	(a) Base stations are limited to 1640 watts peak equivalent isotropically radiated power (e.i.r.p.) with an antenna height up to 300 meters HAAT. b) Mobile/portable stations are limited to 2 watts e.i.r.p. peak power, ...
FCC §22.913	(a) Maximum ERP. The effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 Watts. The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.
FCC §27.50 (C)(10)	(10) Portable stations (hand-held devices) are limited to 3 watts ERP; and
FCC §27.50(d)	(4) Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band are limited to 1 watt EIRP.
KDBs	No. 447498 D01 v06

4.2. MPE Calculation method

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{EIRP}{4\pi R^2} = \frac{P * G}{4\pi R^2}$$

$$G_{NUMERIC} = \frac{S * 4\pi R^2}{P}$$

Where: S=power density

P=power input to antenna

G=power gain of the antenna in the direction of interest relative to an isotropic radiator

R=distance to the centre of radiation of the antenna

4.3. Evaluation Method

4.3.1. Standalone

Valid for WLAN 2.4GHz:

- The peak power was checked on 3 frequencies (lowest/middle/highest) within the 2.4 GHz band
- Only worst case 2.4 GHz W-LAN mode considered
- Only worst case antenna gain considered

Valid for WLAN 5GHz Mode:

- The peak power was checked on 4 frequencies (U-NII-1/2A/2C/3) within the 5 GHz band (see Annex 4).
- Only worst case 5 GHz W-LAN mode considered
- Only worst case antenna gain considered

Please find in the following tables the calculations based on Annex 1 to 4.

4.4. Results for fixed and mobile

4.4.1. Results for FCC Standard

4.4.1.1. MPE results for 2.4 GHz

Operation Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Max. positive tolerance according manufacturer (dB)	Antenna Gain (dBi)	Path Loss to ext. antenna connector according manufacturer (dB)	Declared maximum ERP (Measured+ Tune-up) (dBm)	Duty cycle (%)	Declared Maximum conducted output power (W)	Equivalent conducted output power (output power x duty cycle) (mW)	MPE Limit accord. Table 1 (mW/cm ²)	MPE-Value (mW/cm ²)	Margin to Limit:	Fraction for Co-location calculations	Max. Fraction-Value within Frequency-Band
W-LAN 802.11b 2.4GHz	2412.0	18.0	1.0	6.0	5.6	19.4	100%	0.0871	87.1	1.0000	0.0173	0.9827	0.017327	0.0173273
	2437.0	18.0	1.0	6.0	5.6	19.4		0.0871	87.1	1.0000	0.0173	0.9827	0.017327	
	2462.0	18.0	1.0	6.0	5.6	19.4		0.0871	87.1	1.0000	0.0173	0.9827	0.017327	

Maximum calculated MPE value:		
Lowest MPE-Limit:	1.0000	[mW/cm ²]
Highest MPE value:	0.0173	[mW/cm ²]
Lowest Margin to limit:	0.9827	[mW/cm ²]

4.4.1.2. MPE results for 5 GHz

Operation Mode	Frequency on channel (MHz)	Measured maximum conducted output power (dBm)	Max. positive tolerance according manufacturer's tune-up info (dB)	Declared Antenna Gain (dBi)	Path Loss to ext. antenna connector according manufacturer (dB)	ERP (dBm)	Duty cycle (%)	Maximum ERP (W)	Equivalent ERP (ERP x duty cycle) (mW)	MPE-Value (mW/cm ²)	MPE-Value (mW/cm ²)	Margin (mW/cm ²)	Fraction for Co-location calculations	Maximum Fraction Value within Frequency band
WLAN 802.11 a	U-NII-1 (5150 MHz to 5250 MHz)	13.0	2.0	8.2	7.4	15.8	100%	0.038	38.02	1.0000	0.00756	0.9924	0.0076	0.0076
	U-NII-2A (5250 MHz to 5350 MHz)	13.0	2.0	8.2	7.4	15.8	100%	0.038	38.02	1.0000	0.00756	0.9924	0.0076	
	U-NII-2C (5470 MHz to 5725 MHz)	13.0	2.0	8.2	7.4	15.8	100%	0.038	38.02	1.0000	0.00756	0.9924	0.0076	
	U-NII-3 (5725 MHz to 5850 MHz)	11.0	2.0	8.2	7.4	13.8	100%	0.024	23.99	1.0000	0.00477	0.9952	0.0048	

Maximum calculated MPE value:		
5GHz		
Lowest MPE-Limit:	1.0000	[W/m ²]
Highest MPE value:	0.0076	[W/m ²]
Margin to limit	0.9924	[W/m ²]

4.4.1.3. Co-location assessment (scenario)

No Multiple band or Dual Band Mode on radio equipment -> no assessment

4.5. Conclusion

The measurement results comply with the FCC Limit per 47 CFR 2.1091 for the uncontrolled RF Exposure of mobile device.

4.6. Measurement uncertainties

The reported uncertainties are calculated based on the standard uncertainty multiplied with the appropriate coverage factor **k**, such that a confidence level of approximately 95% is achieved.

For uncertainty determination, each component used in the concrete measurement set-up was taken in account and it's contribution to the overall uncertainty according to its statistical distribution calculated.

Following table shows expectable uncertainties for each measurement type performed.

RF-Measurement	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%							Remarks
Conducted emissions (U _{CISPR})	CISPR 16-2-1	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB							-
Radiated emissions Enclosure	CISPR 16-2-3	30 MHz - 1 GHz 1 GHz - 18 GHz	4.2 dB 5.1 dB							E-Field
Disturbance power	CISPR 16-2-2	30 MHz - 300 MHz	-							-
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB							Substitution method
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2			
		9 kHz - 12.75 GHz	N/A	0.60	--	--	--		-	
		12.75 - 26.5GHz	N/A	0.82	--	--	--			
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	--	--	--		N/A - not applicable	
		2.8 GHz - 12.75 GHz	1.48	N/A	--	--	--			
		12.75 GHz – 18 GHz	1.81	N/A	--	--	--			
		18 GHz - 26.5 GHz	1.83	N/A	--	--	--			
Occupied bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)							Frequency error
			1.0 dB							Power
Emission bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)							Frequency error
	-		See above: 0.70 dB							Power
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm							-
Radiated emissions Enclosure	-	150 kHz - 30 MHz	5.0 dB							Magnetic field E-field Substitution
		30 MHz - 1 GHz	4.2 dB							
		1 GHz - 20 GHz	3.17 dB							

Table: measurement uncertainties, valid for conducted/radiated measurements

5. Abbreviations used in this report

The abbreviations	
ANSI	American National Standards Institute
AV , AVG, CAV	Average detector
EIRP	Equivalent isotropically radiated power, determined within a separate measurement
EGPRS	Enhanced General Packet Radio Service
EUT	Equipment Under Test
FCC	Federal Communications Commission, USA
IC	Industry Canada
n.a.	not applicable
Op-Mode	Operating mode of the equipment
PK	Peak
RBW	resolution bandwidth
RF	Radio frequency
RSS	Radio Standards Specification, Documents from Industry Canada
Rx	Receiver
TCH	Traffic channel
Tx	Transmitter
QP	Quasi peak detector
VBW	Video bandwidth
ERP	Effective radiated power

6. Accreditation details of CETECOM's laboratories and test sites

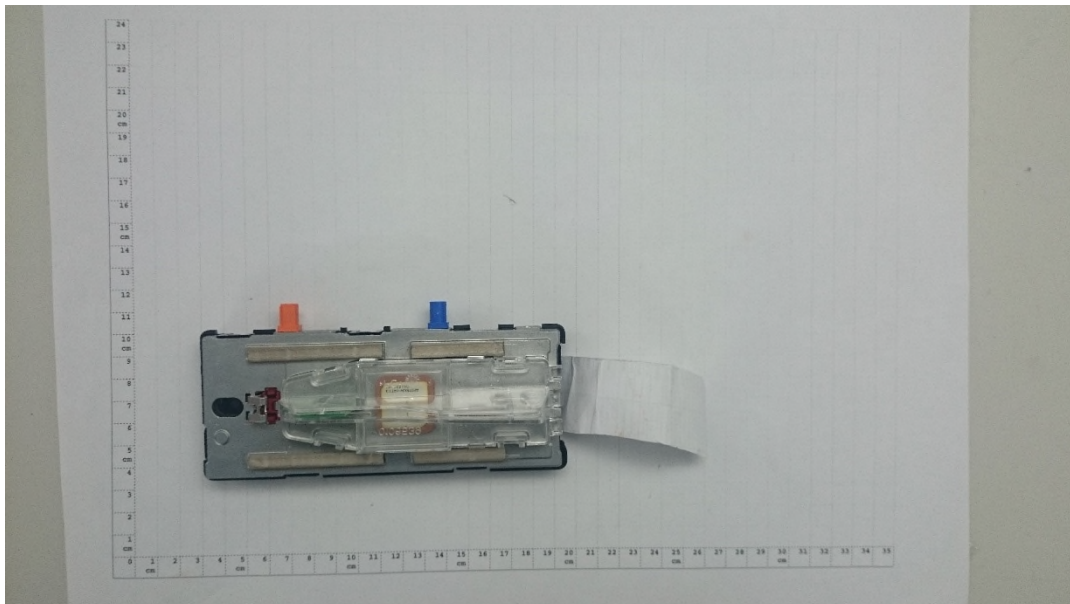
Ref.- No.	Accreditation Certificate	Valid for laboratory area or test site	Accreditation Body
-	D-PL- 12047-01-01	All laboratories and test sites of CETECOM GmbH, Essen	DAkkS, Deutsche Akkreditierungsstelle GmbH
337 487 558 348 348	MRA US-EU 0003	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	FCC, Federal Communications Commission Laboratory Division, USA
337 487 550 558	3462D-1 3462D-2 3462D-2 3462D-3	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR)	IC, Industry Canada Certification and Engineering Bureau
487 550 348 348	R-2666 G-301 C-2914 T-1967	Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	VCCI, Voluntary Control Council for Interference by Information Technology Equipment, Japan
OATS = Open Area Test Site, SAR = Semi Anechoic Room, FAR = Fully Anechoic Room			

7. Photographs of the EUT's

Photograph 1: EUT A Top side



Photograph 2: AE1 Roof mounted Antenna top side



8. Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2019-07-09
C1	Tune-up information changed for 5GHz WLAN	2020-07-14
C2	New Technical Description of VCM	2020-08-03

END OF TEST REPORT