

Test Report

Report Number:

F231783E7

Equipment under Test (EUT):

VISCM4

Applicant:

Wöhler Technik GmbH

Manufacturer:

Wöhler Technik GmbH



Deutsche
Akkreditierungsstelle
D-PL-17186-01-00

References

- [1] **CFR 47 Rule part 1** Practice and Procedure
- [2] **CFR 47 Rule part 2** Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
- [3] **KDB 447498 D04 Interim General RF Exposure Guidance v01**

Test Result

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test. The complete test results are presented in the following.

“Passed” indicates that the equipment under test conforms with the relevant limits of the testing standard without taking any measurement uncertainty into account. However, the measurement uncertainty is calculated and shown in this test report.

Tested and written
by:

Signature

Reviewed and
approved by:

Signature

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The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

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1 Identification

1.1 Applicant

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Country:	Germany
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eMail address:	t.wulf@woehler.de
Applicant represented during the test by the following person:	Mr. Thomas WULF

1.2 Manufacturer

Name:	Wöhler Technik GmbH
Address:	Wöhler-Platz 1, 33181 Bad Wünnenberg
Country:	Germany
Name for contact purposes:	Mr. Thomas WULF
Phone:	+49 2953-73-100
eMail address:	t.wulf@woehler.de
Applicant represented during the test by the following person:	Mr. Thomas WULF

1.3 Test Laboratory

The tests were carried out by: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) according to DIN EN ISO/IEC 17025:2018. The accreditation is only valid for the scope of accreditation listed in the annex of the certificate D-PL-17186-01-00. FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment under Test)

Test object: *	Radio module VISCM4
Model name: *	VISCM4
Model number: *	NA
Order number: *	NA
FCC ID: *	2ANWR-VISCM4
IC certification number: *	23256-VISCM4
PMN: *	VISCM4
HVIN: *	VISCM4
HMN: *	Wöhler VIS 7 HD Video-Inspection System
FVIN: *	NA

Host information:

Test object: *	Inspection camera for exhaust (et al.) pipes
Model name: *	Wöhler VIS 7 HD Video-Inspection System
Model number: *	NA
Order number: *	NA
FCC ID:	2ANWR-VIS7HD
IC certification number:	-
PMN: *	-
HVIN: *	-
FVIN: *	-

	EUT number		
	1	2	3
Serial number: *	-	-	-
Host serial number: *	5136	-	-
Host PCB identifier: *	VIS700-MB-B	-	-
Host Hardware version: *	v2.0	-	-
Host software version: *	v4.1.3	-	-

* Declared by the applicant

One EUT was used for all tests.

Note: PHOENIX TESTLAB GmbH does not take samples. The samples used for tests are provided exclusively by the applicant.

1.5 Technical Data of Equipment

General EUT data			
Power supply EUT: *	DC battery powered; AC with AC/DC converter		
Supply voltage EUT battery powered: *	$U_{nom} = 3.7 \text{ V}_{DC}$	$U_{min} = 3 \text{ V}_{DC}$	$U_{max} = 4.2 \text{ V}_{DC}$
Supply voltage EUT AC/DC converter powered: *	$U_{nom} = 5 \text{ V}_{DC}$	$U_{min} = 4.75 \text{ V}_{DC}$	$U_{max} = 5.25 \text{ V}_{DC}$
Temperature range: *	0°C to +40°C		
Lowest / highest internal clock frequency: *	8.9 kHz / 2462 MHz		

IEEE 802.11 frequencies			
20 MHz		40 MHz	
Channel 1	2412 MHz	-	-
Channel 2	2417 MHz	-	-
Channel 3	2422 MHz	Channel 3	2422 MHz
Channel 4	2427 MHz	Channel 4	2427 MHz
Channel 5	2432 MHz	Channel 5	2432 MHz
Channel 6	2437 MHz	Channel 6	2437 MHz
Channel 7	2442 MHz	Channel 7	2442 MHz
Channel 8	2447 MHz	Channel 8	2447 MHz
Channel 9	2452 MHz	Channel 9	2452 MHz
Channel 10	2457 MHz	-	-
Channel 11	2462 MHz	-	-

IEEE 802.11 radio mode			
Fulfil radio specification: *1	IEEE 802.11 b IEEE 802.11 g IEEE 802.11 n (20 MHz) IEEE 802.11 n (40 MHz)		
Radio chip: *1	Raspberry Pi RM0		
Antenna type: *1	Wi-Fi PCB antenna		
Antenna name: *1	W2.4-5P-U / Inventek Systems		
Antenna gain: *1	2.6 dBi		
Antenna connector: *1	-		
Type of modulation: *1	IEEE 802.11b	DSSS (1 Mbps DSSS (2 Mbps DSSS (5.5/11 Mbps	DBPSK) DQPSK) CCK)
	IEEE 802.11g	OFDM (6/9 Mbps OFDM (12 / 18 Mbps OFDM (24/36 Mbps OFDM (48/54 Mbps	BPSK) QPSK) 16-QAM) 64-QAM)
	IEEE 802.11n 20 MHz (SISO 1x1:1)	MCS0 MCS1/2 MCS3/4 MCS5/6/7	OFDM (7 Mbps OFDM (14 – 22 Mbps OFDM (28 – 43 Mbps OFDM (58 - 72 Mbps
	IEEE 802.11n 40 MHz (SISO 1x1:1)	MCS0 MCS1/2 MCS3/4 MCS5/6/7	OFDM (15 Mbps OFDM (30 / 45 Mbps OFDM (60 – 90 Mbps OFDM (120 - 150Mbps
			BPSK) QPSK) 16-QAM) 64-QAM)
Operating frequency range: *1	IEEE 802.11b	2412 – 2462 MHz	
	IEEE 802.11g	2412 – 2462 MHz	
	IEEE 802.11n 20 MHz	2412 – 2462 MHz	
	IEEE 802.11n 40 MHz	2422 – 2452 MHz	
Number of channels: *1	IEEE 802.11b	11 (5 MHz channel spacing)	
	IEEE 802.11g	11 (5 MHz channel spacing)	
	IEEE 802.11n 20 MHz	11 (5 MHz channel spacing)	
	IEEE 802.11n 40 MHz	9 (5 MHz channel spacing)	

*1 declared by the applicant

1.6 Dates

Date of receipt of test sample:	21.08.2024
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2 Evaluation Method

2.1 RF exposure test exemptions for single sources

2.1.1 General Exemption CFR 47 §1.1307(b)(3)(i)(A)

The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in [paragraph \(b\)\(3\)\(ii\)\(A\)](#) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

2.1.2 SAR Based Exemption CFR 47 §1.1307(b)(3)(i)(B)

The available maximum time-averaged power of effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz inclusive.

For the following separation distances [d] and frequency ranges P_{th} is given by the following formulas

	0.5 cm ≤ d ≤ 20cm	20 cm < d ≤ 40 cm
0.2 GHz ≤ f < 1.5 GHz	$P_{th}(mW) = ERP_{20cm} \left(\frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 2040f$ $x = -\log_{10} \left(\frac{60}{ERP_{20cm} \sqrt{f}} \right)$	$P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 2040f$
1.5 GHz ≤ f ≤ 6 GHz	$P_{th}(mW) = ERP_{20cm} \left(\frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 3060$ $x = -\log_{10} \left(\frac{60}{ERP_{20cm} \sqrt{f}} \right)$	$P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 3060$

2.1.3 MPE Based Exemption CFR 47 §1.1307(b)(3)(i)(C)

By using Table 1 and the minimum separation distance (d in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, d must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

RF Source frequency [MHz]	Threshold ERP [W]
0.3 - 1.34	1920 d ²
1.34 – 30	3450 d ² /f ²
30 – 300	3.83 d ²
300 – 1500	0.0128 d ² /f
1500 - 100000	19.2 d ²

d: Minimal separation distance from antenna to the user

2.1.4 Stand alone MPE evaluation limits

The human exposure to RF emissions from such devices could be evaluated based on the MPE limits adopted by the FCC for electric and magnetic field strength and / or power density. The limits for General Population / Uncontrolled Exposure are given in the following table from CFR 47 §1.1310(e)1:

Frequency range [MHz]	Electric field strength (E) [V/m]	Magnetic field strength (H) [A/m]	Power density (S) [mW/cm ²]	Averaging time [min]
(i)Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	*(100)	≤6
3.0 – 30	1842/f	4.89/f	*(900/f ²)	<6
30 – 300	61.4	0.163	1.0	<6
300 – 1,500			f/300	<6
1,500 – 100,000			5	<6
(ii)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 – 100,000			1.0	< 30

Note: f = frequency in MHz; * Plane – wave equivalent power density

The power density is calculated as follows:

$$S = \frac{P \cdot G \cdot D}{4 \cdot \pi \cdot d^2}$$

Where:

P: conducted power

G: Antenna gain (linear)

D: Duty Cycle

d: Minimal separation distance from antenna to the user

2.2 RF exposure test exemptions for simultaneous transmission sources

2.2.1 1 mW Test Exemption for simultaneous transmission sources

As discussed in CFR 47 §1.1307(b)(3)(ii)(A) [1] the 1 mW exemption intended for single transmitters may be also applied to simultaneous transmission conditions, within the same host device, according one of the following criteria:

- a. When the maximum available power each individual transmitting antenna with the same time averaging period is ≤ 1 mW, and the nearest parts of the antenna structures of the simultaneously operating transmitters are separated by at least 2 cm
- b. When the aggregate maximum available power of all transmitting antennas is ≤ 1 mW in the same time-averaging period

This exemption may not be combined with any other exemption.

2.2.2 Simultaneous transmission SAR based and MPE based test exemptions

Although this is not a module integration in the sense of product approval, the procedure for simultaneous transmission specified in KDB 447498 D04 Interim General RF Exposure Guidance v01 [3] in chapter 2.2 was taken into account:

According to the RF exposure KDB 447498 D04 General RF Exposure Guidance v01 [3] in chapter 2.2.2: This case is described in detail in CFR 47 §1.1307(b)(3)(ii)(B) and covers the situations where both SAR-based and MPE-based exemption may be considered for test exemption in fixed, mobile, or portable device exposure conditions. For these cases, a device with multiple RF sources transmitting simultaneously will be considered an RF exempt device if the condition of the following formula is satisfied.

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$$

For these test exemptions to apply, the maximum output power, duty factor, and other applicable parameters used in the standalone ERP determination tests, must be the same, or corresponding to a more conservative choice, than those required for simultaneous transmission.

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0 , according to calculated/estimated, numerically modelled, or measured field strengths or power density. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to the MPE limit at the test frequency.

2.2.3 Test exemption based on the SAR to Peak Location Separation Ratio

When the ERP-based condition in the previous section does not apply, a test exemption may be still applicable based on the SAR to peak location separation ratio (SPLSR) procedure.

In this case, the simultaneously transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SPLSR that qualifies for the additional test exemption.

This ratio is defined as:

$$SPLSR = (SAR_1 + SAR_2)^{\frac{1.5}{R_i}}$$

Where: SAR_1 and SAR_2 = highest reported SAR or estimated SAR values for the two sources in the pair i , and R_i is their distance in mm.

When $SPLSR \leq 0.0.4$ (rounded to two decimal digits), for all antenna pairs in the configuration, then the device qualifies for 1 g SAR test exemption.

When 10 g SAR applies (e.g. for extremities) the corresponding test exemption condition is $SPLSR \leq 0.10$.

If any antenna pair does not qualify for simultaneous transmission SAR test exemption, then the device must be tested for SAR compliance, according to the enlarged zoom scan and volume scan post-processing procedures in KDB Pub. 865664 D01.

3 Results of evaluation

3.1 Used evaluation methods

RF Exposure test exemptions for single sources			
Used	Method	See sub-clause	Comment
☐	General Exemption acc. CFR 47 §1.1307(b)(3)(i)(A)	2.1.1	-
☒	SAR Based Exemption acc. CFR 47 §1.1307(b)(3)(i)(B)	2.1.2	-
☐	MPE Based Exemption acc. CFR 47 §1.1307(b)(3)(i)(C)	2.1.3	-
☐	MPE Calculation	2.1.4	-

RF Exposure test exemptions for simultaneous transmission sources			
Used	Method	See sub-clause	Comment
☒	Not applicable		No simultaneous possible
☐	1 mW test Exemption acc. 2.2.1 [3]	2.2.1	-
☐	SAR Based Exemption acc. 2.2.2 [3]	2.2.2	
☐	MPE Based Exemption acc. 2.2.2 [3]	2.2.2	
☐	SAR to Peak location separation ratio acc. 2.2.3 [3]	2.2.3	

3.2 Evaluation Distance

According to the CFR47 §2.1091 the device as declared by the applicant is a mobile device which is used at least with the following separation distances between the device and the users.

A minimum distance of 1.8749 cm from the antenna to the user was declared by the applicant. For reference see the image below.



This image was provided by the applicant.

Antenna	Min separation distance as declared by the applicant
Antenna 0	1.8749 cm

3.3 WLAN 2.4 GHz Emissions

The following information are based on the test report F231783E2 issued by PHOENIX TESTLAB GmbH.

Antenna 1 SAR Based Exemption CFR 47 §1.1307(b)(3)(i)(B)

b)

P _{con} [dBm] incl. Tuneup*	P _{con} [mW] incl. Tuneup	Ant. Gain [dBi]	Cable Antenuation [dB]	P _{e.i.r.p} [dBm]	P _{e.i.r.p} [mW]	P _{e.r.p} [dBm]	P _{e.r.p} [mW]
4.46	2.79	2.6	1.84	5.22	3.33	3.07	2.03
Frequency [GHz]	d [cm]	ERP _{20cm}	x	P _{th} [mW]	P _{e.r.p.} [mW]	Result	
2.437	1.8749	3060	1.901	33.99	2.03	exempted	
for 0.5 cm ≤ d ≤ 20 cm and 1.5 GHz ≤ f ≤ 6 GHz							

*: As declared by the applicant, the tune up range is 0.5 dB.

4 Conclusion

The EUT complies in all operational modes to the limits given in CFR 47 §1.1310(e)1 in a separation distance of 1.8749 cm for antenna 0.

5 Report History

Report Number	Date	Comment
F231783E7	14.04.2025	Initial Test Report
-	-	-
-	-	-

----- end of test report -----