SEIBERSDORF LABORATORIES

ACCREDITED TESTING LABORATORY (NR. 312)
for Laser, LED & Lamp Safety

TEST REPORT No. LE-L123/21

Scope:	Laser – and Risk group classification of a laser/LED product according to IEC 60825-1:2014, Edition 3.0. and IEC 62471:2006, respectively.
Ordered by:	Luxonis Holding Corp
Address:	Luxonis Holding Corp 1925 Harmony Park Drive Westminster, CO USA, 80234
Device under test:	IR-Illuminator and IR-projector: “OAK-D-Pro”.
Conclusions:	Under the scope of the test report the device under test was classified as LASER CLASS 1 according to IEC 60825-1:2014. Under the scope of the test report the device under test was classified as EXEMPT GROUP according to IEC 62471:2006.

This test report contains the pages 1 to 15.

Authorised person:

Marko Weber, M.Eng.

Test performed by:

Dr. Georg Vees

Date: 29.11.2021
Order Number: L-2432

Comments:
This test report refers exclusively to the device under test and to the configuration of the device under test at the date of test. Subsequent changes of the device under test are not covered by this test report.
The production or transmission of extracts of the present report is subject to authorisation by the testing laboratory.
Akkreditierung Austria is a full member of the International Laboratory Accreditation Cooperation ILAC and a signatory of the MRA for “Testing, Calibration and Inspection”.

1. Content

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2. General Information

Date of test

11th – 24th November, 2021

Place of test

Test House for Laser, LED & Lamp Safety, Seibersdorf Labor GmbH, 2444 Seibersdorf, Austria

Scope

Laser safety classification of one VCSEL-LED module according to IEC 60825-1:2014, Edition 3.0, exclusive considerations regarding single faults, temperature dependency, labelling and the manual (informational requirements), as well as according to IEC62471:2006.

Object under test

“OAK-D-Pro”
The IR-LED projects a “Flood” illumination pattern.
The IR-VCSEL projects a “Spot” pattern.

Labelling

The device under test is a prototype and has no type plate or indication.

Measurement equipment used

LAS-MM L3403	Diode array spectrometer USB 2000+
LAS-MM E0191	Oscilloscope 2 GHz RTO 1024
LAS-MM L4202	Pulse length detector UPD 200 SP
LAS-MM L1107	Aperture, 7 mm diameter
LAS-MM LE0071	Transient recorder TR 9600
LAS-MM L2204	integrating sphere (∅50mm)
LAS-MM LE0189	integrating sphere (∅150mm)
LAS-MM LE0054	Tape measure
LAS-MM L3001	Sliding calliper
LAS-MM LE0240	Diode array spectrometer Flame-S
LAS-MM LE0099	CCD–Camera
LAS-MM L4001	Room thermometer
LAS-MM L4101	Linear stage

Documentation used

[1] IEC 60825-1:2014 Edition 3.0.
[2] IEC 60825-1 (2014) Interpretation Sheet ISH 1: 2017.
[3] Internal Working Procedure Documentation LAS-AA-14.
[4] Internal Working Procedure Documentation LAS-AA-18.
[5] IEC 62471:2006: Photobiological safety of lamps and lamp systems
[6] Internal Working Procedure Documentation LE-LAS-AA 05
[7] Internal Working Procedure Documentation LE-LAS-AA-21
[8] Data sheet of the IR-LED

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General

Format of decimal figures	Congruent with ISO and IEC standard regulations, a decimal comma is used in this test report in contrast to the usual usage of a decimal point for English texts (i.e. ½ = 0,5 and not 0.5).

Acronyms

AE …	accessible emission (relevant measureable energy)
AEL …	accessible emission limit
a.u. …	arbitrary unit
FWHM …	full width half maximum
MRP …	most restrictive position
PLR …	power to limit ratio (defined as ratio AE/AEL)

Formula symbols

α …	angular subtense of apparent source
Q …	energy
P …	power
P% …	relevant partial power within α
z …	measurement distance

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3. Technical description

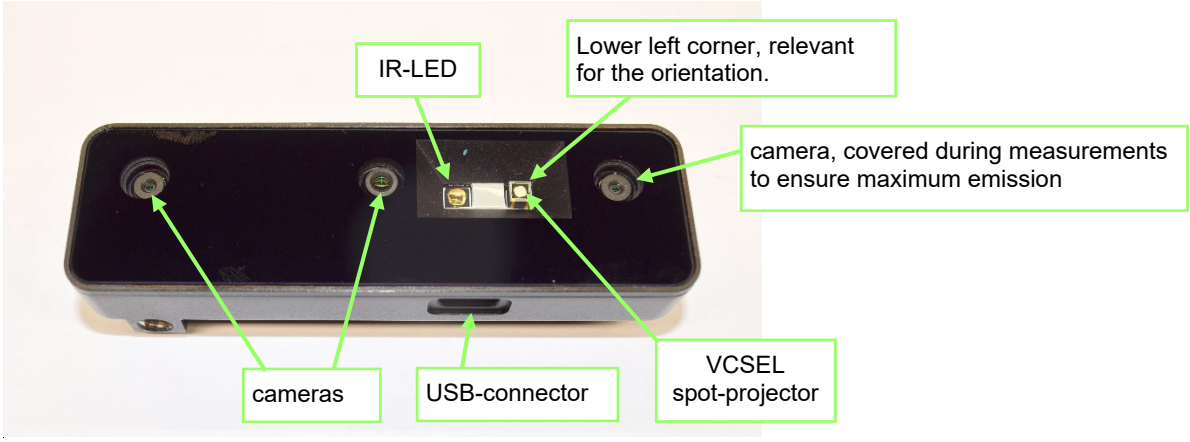

Figure 1: Front view of the module.

Flood-projector

- Field of illumination: 80° x 80°
- Optical peak power:

Spot-projector

- Field of illumination: 61° x 78°
- Optical peak power: about
- Number of spots: about 4700

LED as well as the VCSEL emit pulsed IR-radiation. For each source two configuration were considered. They differ in pulse frequency and –interval as well as in the operating current:

Parameter	Parameter, default values	Comment
Case #1, VCSEL	pulse duration = 6 ms pulse interval = 100 ms I_pulse = 1200 mA	1) Regarding current: the current was determined by a sliding controller in pre-defined steps. For this reason, the actual current – according to the display (note the current was not measured) - was set to: 1206 mA instead of 1200 mA 761 mA instead of 765 mA 2) Regarding pulse duration: the pulse duration can be changed by pressing the keys “I” and “O” in steps of 500 µs. Therefore, 33,0 ms were used instead of 33,3 ms to switch from 6 ms to 33 ms and back.
Case #2, VCSEL	pulse duration = 33,3 ms pulse interval = 100 ms I_pulse = 765 mA	
Case #1, LED	pulse duration = 33 ms pulse interval = 33,3 ms I_pulse = 1500 mA	
Case #2, LED	pulse duration = 33,3 ms pulse interval = 100 ms I_pulse = 1500 mA	

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Operation

Both sources (VCSEL and IR-LED) were operated via a Software (Depthai version: 2.10.0.0.dev+f70ea7fac8cd722b62f7d4628099ef828b3ca5ba) installed on a NUC (both provided by the client).

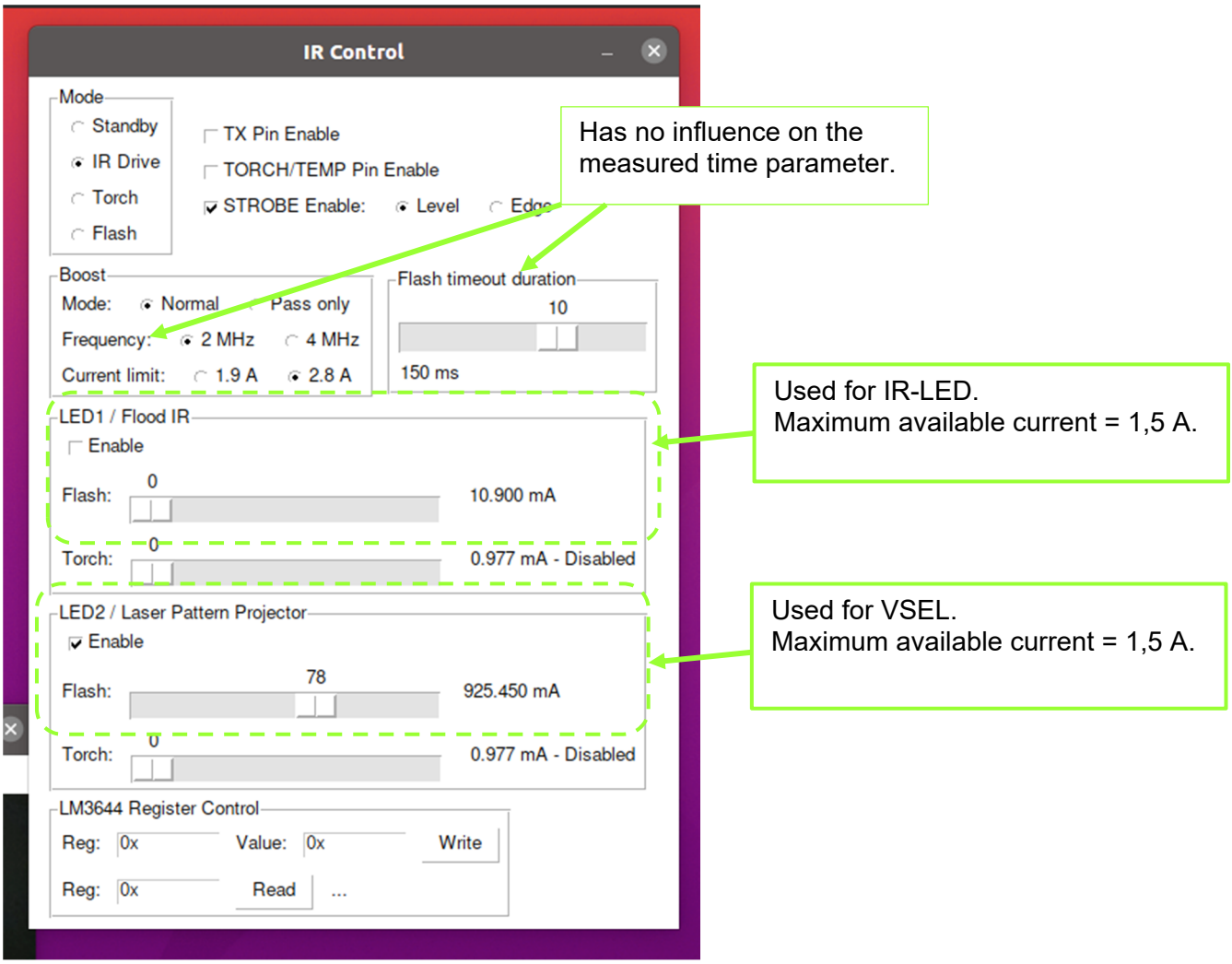

Figure 2: Screen shot of user surface.

The IR-LED and the VCSEL can be operated separately or simultaneously. As their wavelength show an additive effect on the retina, also their combination should be considered:

Due to the geometrical distance between the IR-LED and the VCSEL (about 10 mm) they can be evaluated and classified separately, the simultaneous emission is not relevant for the classification in this case.

4. Basic measurements for the VCSEL

All measurements were carried out at an ambient temperature of about +24°C to 26°C (room temperature) in a darkened laboratory.

Measurement distance: all distances refer to the point of origin, which is not identical with the "reference point" according to the standard. The reference point would be the surface of the DOE, which is about 4,8 mm behind the front of the cover window. However, for practical reason the front of the front side of the protective window was used as point of origin for all distance measurements.
Therefore, in the sense of worst-case, 95 mm correspond to 100 mm minimum standardized measurement distance.

Note: all values regarding the current through the VCSEL were taken from the display of the operating SW provided by the client.

4.1. Peak wavelength

The peak wavelength of the emitted laser radiation was measured with the diode array spectrometer USB 2000+.

Result: peak wavelength: 942,7 nm @360mA

Bandwidth (FWHM): 1,72 nm @360mA

Note: the peak wavelength shifts to higher values, if the current is increased, e.g. λ = 946 nm @1500mA

4.2. Pulse pattern

All relevant time durations were measured with the help of a 6 GHz- oscilloscope and a Transient recorder TR 9600.

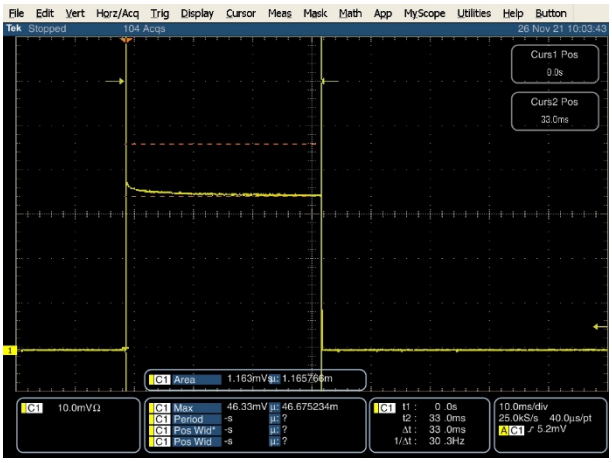

Figure 3: VCSEL, typical pulse shape for 33,0 ms.

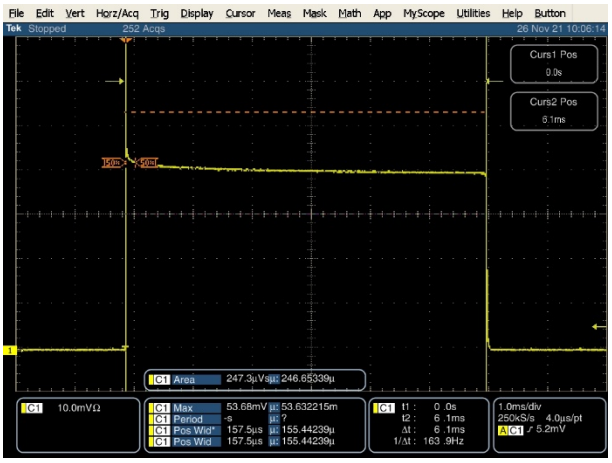

Figure 4: VCSEL, typical pulse shape for 6,0 ms

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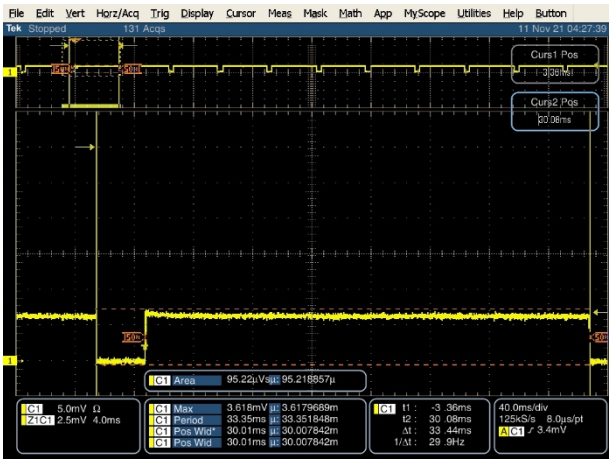

Figure 5: IR-LED: pulse interval (33,35 ms).

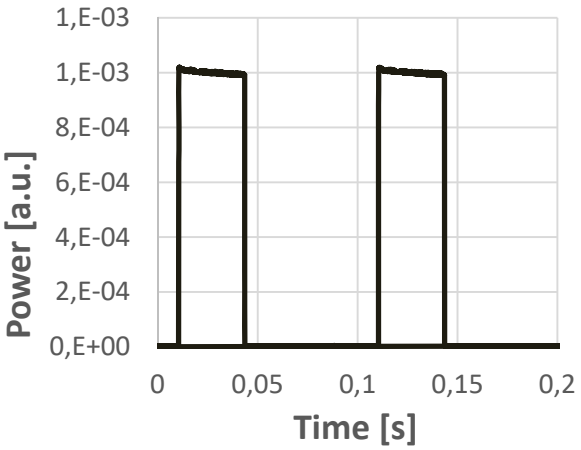

Figure 6: IR-LED: pulse interval (100,03 ms).

Table 1: Summary of time parameters

	VCEL		IR-LED	
Time parameter	1206 mA	761 mA	1500 mA	1500 mA
Pulse duration (typ.) [s]	6,1 ms	33,0 ms	33,0	33,0
Pulse interval [s]	100,0 ms	100,0 ms	33,4	100,0

Observations:

Although the time duration can be determined via SW in steps of 0,5 ms sometimes the measured value diverges from the predetermined value.

4.3. Energy

4.3.1. Total energy

The energy was measured with the transient recorder TR 9600 and an integrating sphere that has a measurement aperture of 25 mm diameter. This integrating sphere was positioned as close as possible to the DUT: the distance was less than 2 mm.

Table 2: Total pulse energy for pulse duration = 20 ms.

I [mA]	Qmax [J]
198,5	1,77E-03
397,825	4,540E-03
761,3	9,09E-03
995,8	1,20E-02
1206,25	1,350E-02

Note: This measurement was performed just to show the relationship between pulse energy and current.

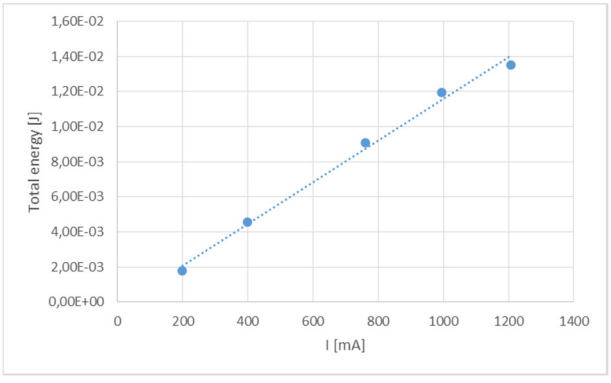

Figure 7: Total pulse energy vs VCSEL-current for 20 ms pulse duration.

Result: within the considered current range the emission increases more or less linearly with the current through the VCSEL.

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4.3.2. Energy vs pulse duration

Table 3: Pulse energy for 761 mA at 95 mm distance.

t [µs]	Qmax [J]
1000	1,63E-06
2000	3,25E-06
4000	6,50E-06
6000	9,72E-06
12000	1,93E-05
20000	3,19E-05
33000	5,15E-05

Note: not optimized for maximum energy. This measurement was performed just to show the linear relationship between energy and pulse duration.

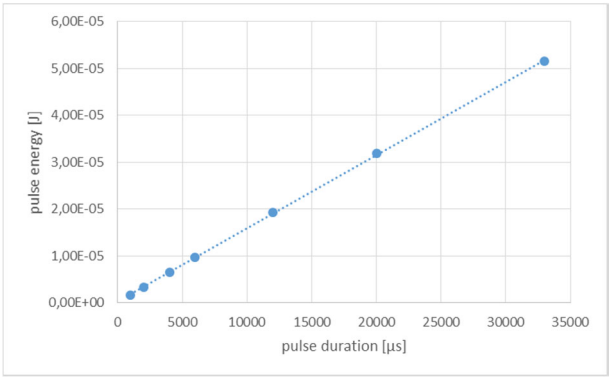

Figure 8: Pulse energy vs pulse duration for 761 mA.

Result: within the considered time duration range the emission increases linearly with the pulse duration.

Combining the last two results give the maximum total pulse energy that is used for worst-case skin safety considerations:

Q_total for 761 mA = 14,99 mJ
Q_total for 1206mA = 4,05 mJ

4.3.3. Energy vs distance

The energy was measured with the transient recorder TR 9600 (with integrating sphere). The measurement aperture with 7 mm diameter was directly mounted on the integrating sphere. Measurements were carried out under normal operating conditions.

Table 4: Maximum pulse energy vs distance.

z [mm]	Q_max for 761mA	Q_max for 1206mA
95	6,26E-05	1,70E-05
97	5,94E-05	1,62E-05
99	5,84E-05	1,59E-05
101	5,66E-05	1,56E-05
103	5,54E-05	1,51E-05
105	5,41E-05	1,47E-05
107	5,20E-05	1,42E-05
110	4,88E-05	1,36E-05
113	4,72E-05	1,26E-05
117	4,25E-05	1,16E-05

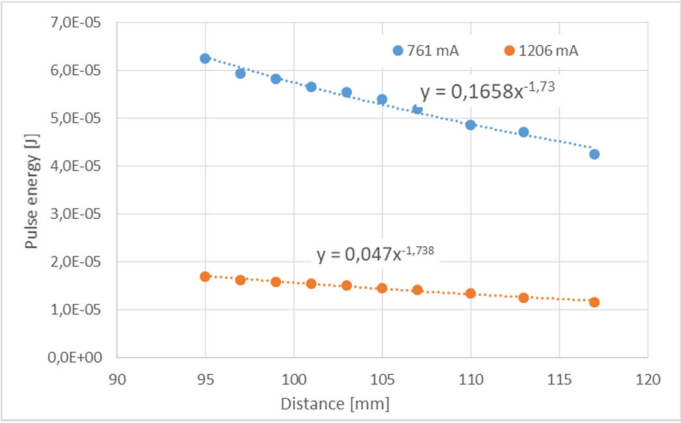

Figure 9: Q_pulse vs distance.

The maximum emitted energy was found at the “corners” of the projected pattern. The results listed above are valid for the lower left corner (see Figure 2). To compare all four corners to each other, additional measurement at all four corners were carried out. It turned out that the left corners emit more or less the same whereas the right corners emit about 10-15% less the right corners.

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Due to self-heating the emission decreases with time. The emission is about 11% higher after starting the emission. For this reason the accessible emission was increased by this factor.

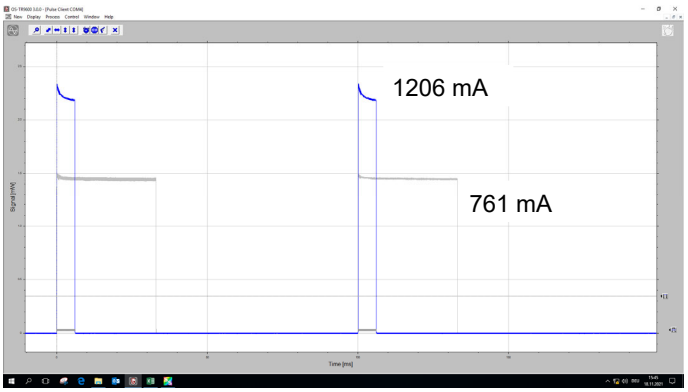

Figure 10: Pulse shape at z = 101 mm (for 10 Hz).

4.4. Determination of the angular subtense of the apparent source

Determination of the time depending α_{max} for image analysis:

Table 5: α_{max} [mrad] and T2 used for image analysis.

Time duration	761 mA	1206 mA
pulse duration	36,33	15,62
2 pulse duration	72,94	65,15
T2	100	100

First, measurements were performed to show the difference between 761 mA and 1206 mA operating current. It turned out, that running the VCSEL with 761 mA is more restrictive than an operation with 1206 mA. For this reason and in the sense of worst-case, for all measurements 761 mA were used.

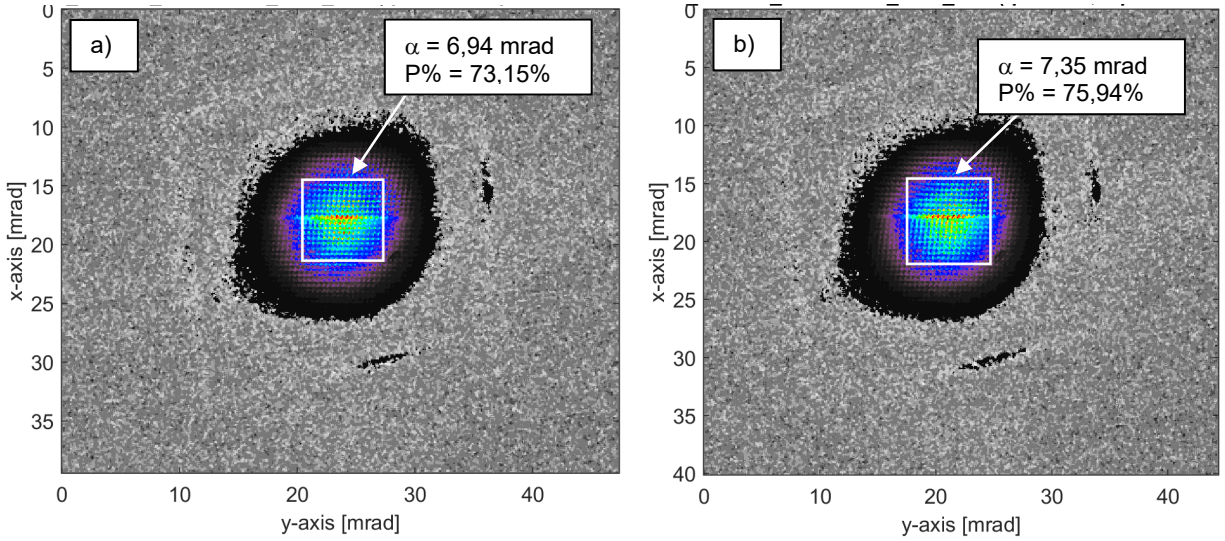

Figure 11: a) Result of the image analysis that is most restrictive at 103 mm regarding pulse duration for the “761mA-evaluation”.
b) Result of the image analysis that is most restrictive at 101 mm regarding pulse duration for the “1206mA-evaluation”.

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Table 6: Angular subtense α of apparent source as well as partial power P% vs distance z.

z [mm]:	95	97	99	101	103	105	107	110	113	117
α_s.p. [mrad]:	7,84	7,60	7,43	7,35	6,94	6,84	6,82	6,72	6,44	6,27
α_2-pulse [mrad]:	7,84	7,60	7,43	7,35	6,94	6,84	6,82	6,72	6,44	6,27
α_T2 [mrad]:	8,17	7,76	7,52	7,35	7,27	7,17	6,82	6,97	6,70	6,45
P%_s.p. [%]:	71,41%	73,04%	74,24%	75,94%	73,15%	73,27%	73,69%	74,46%	73,37%	73,80%
P%_2-pulse [%]:	71,41%	73,04%	74,24%	75,94%	73,15%	73,27%	73,69%	74,46%	73,37%	73,80%
P%_T2 [%]:	74,37%	74,58%	75,05%	75,94%	76,56%	76,76%	73,69%	77,22%	76,24%	75,82

Note: because the α-results are smaller than the corresponding α_max, the unlimited alpha is identical with α_s.p. or α_2-pulse.

5. Classification of the VCSEL according to IEC 60825-1, Ed.3.0

Due to the high divergence of the laser beams Condition 1 was not evaluated.

The comparison of accessible emission (AE) with accessible emission limit (AEL) of a given class is to be carried out at the most restrictive position, which is that position along the beam axis where the maximum ratio of AE to AEL occurs.
For Condition 3 the evaluation condition for extended sources was applied (see Clause 5.4.3 of IEC 60825-1)..

- A time base of 100 s was applied (time base for Class 1 laser products).
- The AEL was calculated for correction factor C_4 :

λ [nm]	943
C_4:	3,06

→ Ti = 5 µs

- All pulse intervals > 5 µs (Ti) → no pulses within Ti.
- T2 results from α_T2:

Table 7: T2 [s] vs distance for all three configurations.

z [mm]:	95	97	99	101	103	105	107	110	113
T2 [s:]	11,69	11,58	11,51	11,47	11,44	11,42	11,32	11,36	11,29

5.1. AE - Accessible Emission

The AE includes the corresponding P%, the “corner-correction-factor”, and the self-heating effect.

Table 8: AE - “Single pulse criterion”.

z [mm]	95	97	99	101	103	105	107	110	113	117
Case #1, 761 mA										
Q_s.p. [J]	49,58E-6	48,17E-6	48,10E-6	47,68E-6	45,01E-6	43,96E-6	42,56E-6	40,30E-6	38,46E-6	34,82E-6
Q_2-pulse [J]	99,17E-6	96,34E-6	96,20E-6	95,35E-6	90,03E-6	87,92E-6	85,12E-6	80,60E-6	76,93E-6	69,63E-6

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Case #2, 1206 mA										
Q_s.p. [J]	13,48E-6	13,17E-6	13,08E-6	13,15E-6	12,27E-6	11,92E-6	11,62E-6	11,22E-6	10,27E-6	9,53E-6
Q_2-pulse [J]	26,97E-6	26,33E-6	26,16E-6	26,30E-6	24,54E-6	23,85E-6	23,25E-6	22,43E-6	20,54E-6	19,05E-6

Table 9: AE - “Average pulse criterion”.

z [mm]	95	97	99	101	103	105	107	110	113	117
Case #1, 761 mA										
P 2_pulses [W]:	745,6E-6	724,3E-6	723,3E-6	716,9E-6	676,9E-6	661,1E-6	640,0E-6	606,0E-6	578,4E-6	523,5E-6
P_T2 [W]:	516,4E-6	491,8E-6	486,3E-6	476,8E-6	471,1E-6	460,5E-6	425,6E-6	417,9E-6	399,7E-6	357,7E-6
Case #2, 1206 mA										
P 2_pulses [W]:	254,4E-6	248,4E-6	246,7E-6	248,1E-6	231,5E-6	225,0E-6	219,3E-6	211,6E-6	193,8E-6	179,8E-6
P_T2 [W]:	140,4E-6	134,4E-6	132,2E-6	131,5E-6	128,4E-6	124,9E-6	116,2E-6	116,3E-6	106,7E-6	97,9E-6

5.2. AEL – Accessible Emission Limits

The reduced pulse criterion should be applied to single pulses and pulse groups.

Table 10: AEL – “Single pulse criterion”.

z [mm]	95	97	99	101	103	105	107	110	113	117
Case #1, 761 mA										
Q_s.p. [J]	867,6E-6	840,5E-6	822,4E-6	813,4E-6	767,9E-6	756,7E-6	754,6E-6	743,1E-6	712,4E-6	694,0E-6
Q_2-pulse [J]	2,5E-3	2,4E-3	2,3E-3	2,3E-3	2,2E-3	2,2E-3	2,1E-3	2,1E-3	2,0E-3	2,0E-3
Case #2, 1206 mA										
Q_s.p. [J]	241,6E-6	234,0E-6	229,0E-6	226,5E-6	213,8E-6	210,7E-6	210,1E-6	206,9E-6	198,3E-6	193,2E-6
Q_2-pulse [J]	2,1E-3	2,0E-3	2,0E-3	2,0E-3	1,8E-3	1,8E-3	1,8E-3	1,8E-3	1,7E-3	1,7E-3

Table 11: AEL – “Average power criterion”.

z [mm]	95	97	99	101	103	105	107	110	113	117
Case #1, 761 mA										
P 2-pulse [W]:	18,56E-3	17,98E-3	17,59E-3	17,40E-3	16,42E-3	16,18E-3	16,14E-3	15,89E-3	15,24E-3	14,84E-3
P_T2 [W]:	6,31E-3	6,01E-3	6,02E-3	6,03E-3	6,03E-3	6,03E-3	6,04E-3	6,04E-3	6,05E-3	6,06E-3
Case #2, 1206 mA										
P 2-pulse [W]:	19,64E-3	19,03E-3	18,62E-3	18,41E-3	17,38E-3	17,13E-3	17,08E-3	16,82E-3	16,12E-3	15,71E-3
P_T2 [W]:	6,31E-3	6,01E-3	6,02E-3	6,03E-3	6,03E-3	6,03E-3	6,04E-3	6,04E-3	6,05E-3	6,06E-3

Table 12: AEL - “Reduced pulse criterion”.

z [mm]	95	97	99	101	103	105	107	110	113	117
Case #1, 761 mA										
N_s.p. in T2[-]	117	116	115	115	114	114	113	114	113	112
C5_s.p. [-]	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40
red AEL_s.p. [J]	347,0E-6	336,2E-6	329,0E-6	325,4E-6	307,2E-6	302,7E-6	301,8E-6	297,2E-6	284,9E-6	277,6E-6
N_2-pulse in T_2[-]	58	58	58	57	57	57	57	57	56	56
C5_2-pulse [-]	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40
red AEL_2-pulse [J]	987,2E-6	956,3E-6	935,8E-6	925,5E-6	873,7E-6	861,0E-6	858,6E-6	845,5E-6	810,5E-6	789,7E-6

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Case #2, 1206 mA										
N_s.p. in T2[-]	117	116	115	115	114	114	113	114	113	112
C5_s.p. [-]	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40
red AEL_s.p. [J]	96,63E-6	93,61E-6	91,60E-6	90,59E-6	85,52E-6	84,28E-6	84,05E-6	82,76E-6	79,34E-6	77,30E-6
N_2-pulse in T_2[-]	58	58	58	57	57	57	57	57	56	56
C5_2-pulse [-]	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40
red AEL_2-pulse [J]	832,7E-6	806,7E-6	789,3E-6	780,7E-6	737,0E-6	726,2E-6	724,2E-6	713,2E-6	683,7E-6	666,1E-6

5.3. PLR - comparison of AE to AEL

Table 13: PLR =AE/AEL vs distance.

z [mm]	95	97	99	101	103	105	107	110	113	117
Case #1, 761 mA										
Q_s.p. [J]	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,05	0,05	0,05
Q_2-pulse [J]	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04
P 2-pulse [W]	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,03
P_T2 [W]	0,08	0,08	0,08	0,08	0,08	0,08	0,07	0,07	0,07	0,06
red AEL_s.p. [J]	0,14	0,1433	0,1462	0,1465	**0,1465**	0,145	0,14	0,14	0,13	0,13
red AEL_2-pulse [J]	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,09	0,09
Case #2, 1206 mA										
Q_s.p. [J]	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,05	0,05	0,05
Q_2-pulse [J]	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
P 2-pulse [W]	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
P_T2 [W]	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
red AEL_s.p. [J]	0,14	0,14	0,143	**0,145**	0,143	0,14	0,14	0,14	0,13	0,12
red AEL_2-pulse [J]	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,03

Summary:

Condition 1: not relevant in this case, therefore not evaluated.

Condition 3: The highest ratio AE/AEL equals about 0,15 for both cases (the difference is within the measurement uncertainty) regarding the multiple pulse criterion for single pulses.

The MRP is about 100-104 mm in front of the cover glass.

Note: the results presented in the tables above do not include any environment temperature dependency and no single-fault considerations.

5.4. Skin Considerations

The maximum PLRs regarding skin limits equals 0,31 for Case #1 for worst-case assumptions.

As all PLRs are less than 1, no additional warning regarding skin burn is required.

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6. Conclusions

The DUT was classified as LASER CLASS 1 according to IEC 60825-1, Edition 3.0 (2014) under the scope of this test report, i.e. exclusive considerations regarding single faults, temperature dependency, labelling and the manual (informational requirements), as the accessible emission (AE) is below the AEL for Class 1 for all measurement conditions, although worst-case assumptions were made.

7. Measurements for the IR-LED

Measurement distance

The physical position of the IR LED was used as reference plane. According to the information provided by the manufacturer the IR LED is located about 5,66 mm behind the front of the cover window. Therefore, the risk group classification according to IEC 62471:2006 was made at a distance of 194 mm in front of the cover window.

Average spectral irradiance

Irradiance measurements were performed by means of a spectrometer, where the input optics consists of a diffusor with 3,9 mm in diameter (worst-case). The measured average spectral irradiances are shown in Figure 12 and Table 14. The measurements were made with open FOV.

Analysis of the measured pulse pattern (see section 3 and 4) and average spectral irradiance showed that the peak radiated power is less than ten times higher as the average radiated power. Consequently the DUT can be classified using the “averaged power” – criterion, i.e. as quasi - continuous wave emission (see sub-clause 3.30 in IEC 62471:2006).

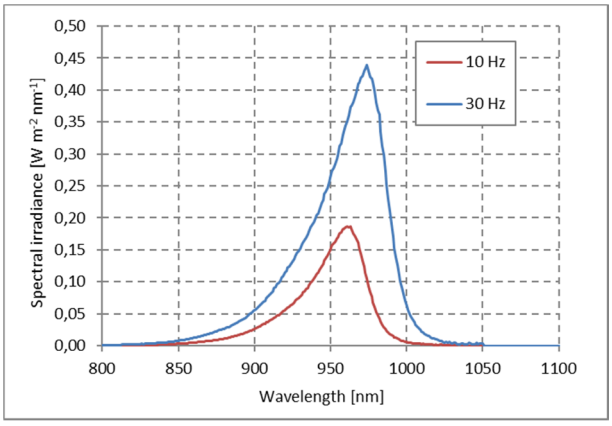

Figure 12: Average spectral irradiance measured for both cases with open FOV.

Table 14: Measured average irradiances of the IR LED as shown in Figure 12.

Mode	Average irradiance
10 Hz (Case #2, LED)	9,14 W m^{-2}
30 Hz (Case #1, LED)	24,21 W m^{-2}

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8. Risk group classification according to IEC 62471:2006

The DUT was classified using the “averaged power” – criterion. Only the hazards “infrared radiation eye”, “retinal thermal” and “skin thermal” are relevant for the tested IR LED. All other hazards are not relevant due to the spectral characteristics of the emission. As the luminance is less than 10 cd m^{-2} the hazard “retinal thermal, weak visual stimulus” was applied for the continuous wave criterion (average power) for all operating modes. The hazard “skin thermal” is not relevant for risk group classification.

Table 15. Comparison of the measurement results with the emission limits given for continuous wave lamps according to IEC 62471:2006 – 10 Hz (Case #2, LED).

Photobiological hazard	Wavelength range [nm]	Unit	AEL Exempt Group	AE
Retinal thermal, weak visual stimulus	780 - 1400	W m^{-2} sr^{-1}	$1{,}2 \cdot 10^{6}$ *)	$3{,}12 \cdot 10^{4}$
Infrared radiation eye	780 - 3000	W m^{-2}	100	9,14

*) α = 0,005 rad (Dimensions of the active chip area according to datasheet (SFH 4725AS A01))

For the 10 Hz mode an effective irradiance of 9,14 W m^{-2} was measured for the hazard “skin thermal”. The limit for “skin thermal” of 3557 W m^{-2} (for t = 10 s) is not exceeded.
No Exempt Group limit was exceeded when the IR-LED of the DUT was operated in 10 Hz mode.

Table 16. Comparison of the measurement results with the emission limits given for continuous wave lamps according to IEC 62471:2006 – 30 Hz (Case #1, LED).

Photobiological hazard	Wavelength range [nm]	Unit	AEL Exempt Group	AE
Retinal thermal, weak visual stimulus	780 - 1400	W m^{-2} sr^{-1}	$1{,}2 \cdot 10^{6*)}$	$7{,}93 \cdot 10^{4}$
Infrared radiation eye	780 - 3000	W m^{-2}	100	24,21

*) α = 0,005 rad (Dimensions of the active chip area according to datasheet (SFH 4725AS A01))

For the 30 Hz mode an effective irradiance of 24,21 W m^{-2} was measured for the hazard “skin thermal”. The limit for “skin thermal” of 3557 W m^{-2} (for t = 10 s) is not exceeded.
No Exempt Group limit was exceeded when the IR-LED of the DUT was operated in 30 Hz mode.

9. Conclusions

The IR-LED of the DUT, when operated with the settings described in section 3 and 4, do not exceed any Exempt Group (Risk Group 0) limit of IEC 62471:2006.
The device under test was therefore classified as an Exempt Group (RG0) product according to IEC 62471:2006.

End of test report.

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