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Report Date: 2nd October 2020
Test Date: 1st October 2020
Report Number: 2388

Laser Classification Report to BS EN 60825-1:2014

Product Name: AD-96TOF1-EBZ
Product Serial Number: 01102020a

SUMMARY

The product is a time-of-flight sensor, using four near-IR VCSELs in an array. The radiation is pulsed, with the pulses grouped in bursts. Radiation is directly accessible and widely divergent.

This product meets the power requirements for a Class 1 Laser product to BS EN 60825-1:2014 under normal operating conditions and those of single fault failure.

Client
Analog Devices International
Raheen Business Park,
Sluggary,
Limerick,
V94 RT99,
Ireland

Manufacture/Supplier
Analog Devices International
Raheen Business Park,
Sluggary,
Limerick,
V94 RT99,
Ireland

1) Optical sources

a) Manufacturer(s) and type details

I940-G2332-NBC VCSEL manufactured by Finisar.

b) Wavelength(s)

944 nm to 951 nm with a peak at 950 nm

Measured on Spectrometer LM-SPC-001; see Annex A for spectrum.

c) Pulsed or continuous

Pulsed

If pulsed:

i) Manufacturers stated data:

None given.

ii) Measured data:

Pulse Repetition Frequency: 5.4 MHz
Pulse Duration: 50 ns
Burst duration = 750 µs
Burst frequency = 860 Hz

d) Other relevant data

Beam is widely divergent.

e) Accessibility of Radiation

Radiation is directly accessible.

2) Apparent Source size/angular subtense.

a) Manufacturer's data.

None given.

b) Measured.

The sources are the same as used in Report 2132; therefore the apparent source size can be carried forward.

The apparent source size was measured to be 0.883 mm, equating to an angular subtense (α) of 8.83 mrads at 100 mm.

Source size measurements were taken in accordance with Research Report 345 'Investigation of a measurement technique to determine the apparent source size for light emitting diodes, prepared by National Physical Laboratory and Europtics Ltd for the Health & Safety Executive 2005.

3) Measurement Conditions:

a) Control Settings

Unit operated according to manufacturer's instructions.

b) Location of test:

Lasermet, Bournemouth.

c) AELs

i) Correction Factors

C_4 = 3.16
C_5 = 0.4
C_6 = 3.33, 3.65 and 5.89 for T_i, burst, and average power respectively
C_7 = 1

ii) Time Bases:

T = 100 s
T_2 = 11.9 s
T_i = 5.0 µs

iii) Equations:

Class 1 $AEL_T = 7 \times 10^{-4} \times C_4 \times C_6 \times T_2^{-0.25} = 7.01$ mW

Class 1 $AEL_{Ti} = 7 \times 10^{-4} \times C_4 \times C_6 \times t^{0.75} = 779$ nJ
Class 1 $AEL_{s\ p\ train}$ = Class 1 $AEL_{Ti} \times C_5 = 312$ nJ
Class 1 $AEL_{single} = 7 \times 10^{-4} \times C_4 \times C_6 \times t^{0.75} = 36.6$ µJ

d) Measurement Apertures and distances.

All measurements were taken at 100 mm from the apparent source using a 7 mm aperture in accordance with Condition 3. Condition 1 is not required as the sources are divergent. The sources were treated separately.

4) Measurements.

a) Meter(s) used for measurement:

The optical output was measured with Lasermet's calibrated Ophir Nova II power meter LM-PM-003.

Lasermet's power meters are regularly cross-checked for calibration against a power meter calibrated by the UK National Physical Laboratory.

b) Maximum Readings

Top:	
Average power = 0.831 mW	EHV = 11.9% PASS Class 1
Energy per pulse = 0.239 nJ	
Energy per T_i = 6.45 nJ	EHV = 2.07% PASS Class 1
Energy per burst = 966 nJ	EHV = 2.64% PASS Class 1
Bottom:	
Average power = 0.843 mW	EHV = 12.0% PASS Class 1
Energy per pulse = 0.242 nJ	
Energy per T_i = 6.53 nJ	EHV = 2.09% PASS Class 1
Energy per burst = 980 nJ	EHV = 2.68% PASS Class 1
Left:	
Average power = 0.812 mW	EHV = 11.6% PASS Class 1
Energy per pulse = 0.233 nJ	
Energy per T_i = 6.29 nJ	EHV = 2.02% PASS Class 1
Energy per burst = 945 nJ	EHV = 2.58% PASS Class 1
Right:	
Average power = 0.824 mW	EHV = 11.8% PASS Class 1
Energy per pulse = 0.237 nJ	
Energy per T_i = 6.40 nJ	EHV = 2.05% PASS Class 1
Energy per burst = 958 nJ	EHV = 2.62% PASS Class 1

c) Corrections, if any.

None

d) Reasonably foreseeable failures

No single potential faults were identified.

e) CONCLUSION (tentative classification)

The accessible power does not exceed the Class 1 limits under any hazard condition.

5) Required Accuracy of Measurements, Uncertainties.

The peak output was less than 15% of the Class 1 limit under Condition 3. The total estimated measurement uncertainty was ±6.86% at 95% confidence.

6) Engineering Controls:

- The laser product shall have a protective housing that when in place prevents access to laser radiation in excess of the Class 1 AELs except where necessary for the functioning of the product. (Present)

7) Labelling:

The labelling required for a Class 1 product is shown below. All labels shall be legible, durable and permanently attached.

(Present)

8) User Information:

- Adequate instructions for proper assembly, maintenance and safe use, including clear warnings concerning precautions to avoid possible exposure to hazardous laser radiation. (Present)
- A description of the radiation emitted from the product, including wavelength, divergence, and maximum average power. (Present)
- Legible reproductions of all required labels and hazard warnings to be affixed to the laser product. The corresponding position of each label shall be indicated. (Present)

- List of controls, adjustments and procedures for operation and maintenance, including the warning “Caution – Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure”. (Present)

9) Class Awarded:

Class 1

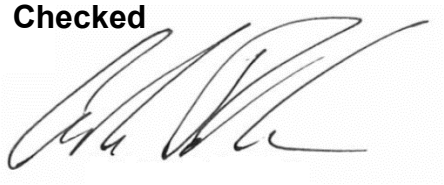
Conditions (state changes required for full conformity)

This classification is based on the performance of the lasers supplied to us for testing and is only valid for the products listed in this report. The manufacturer is responsible for ensuring that sufficient quality control during manufacturing is in place.

Signature

Fiona Robertson

Checked



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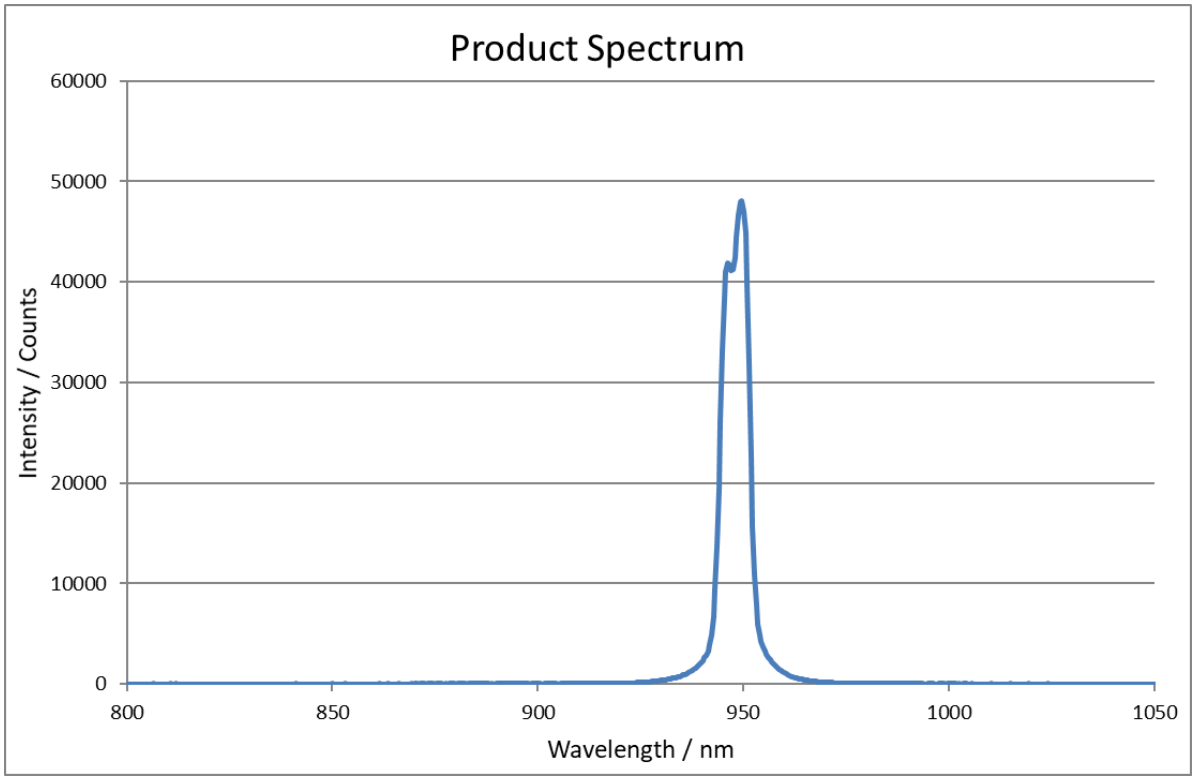
Annex A


Product Spectrum
60000
50000
40000
30000
20000
10000
0
Intensity / Counts
800
850
900
950
1000
1050
Wavelength / nm

Annex B

Source of uncertainty	value (±)	prob distribution	diviso	c_i	u_i	$(u_i)^2$	v_i
power meter calibration	3.00%	normal	2	1	1.50%	0.02%	∞
Experimental set up	2.00%	Normal	2	1	1.00%	0.01%	∞
Continuous Power Laser	No						
CW Laser power resolution, power meter reading	0.53%	rectangular	1.732	1	0.31%	0.00%	∞
Pulse Laser by Peak Power	No						
Pulse Laser Peak power resolution	0.53%	rectangular	1.732	1	0.31%	0.00%	∞
oscilloscope resolution, (voltage representing current, 70 is the voltage reading)	0.19%	rectangular	1.732	1	0.11%	0.00%	∞
oscilloscope resolution, (sig-gen peak power)	0.19%	rectangular	1.732	1	0.11%	0.00%	∞
Oscilloscope resolution, (photodiode peak power)	0.19%	rectangular	1.732	1	0.11%	0.00%	∞
Oscilloscope voltage uncertainty, (quoted)	0.50%	normal	2	1	0.25%	0.00%	∞
Pulse laser by Average Power	Yes						
Pulse Laser Average power resolution	0.53%	rectangular	1.732	1	0.31%	0.00%	∞
oscilloscope resolution, (voltage representing current, 70 is the voltage reading)	0.19%	rectangular	1.732	1	0.11%	0.00%	∞
oscilloscope resolution, (sig-gen peak power)	0.19%	rectangular	1.732	1	0.11%	0.00%	∞
Oscilloscope resolution, (photodiode peak power)	0.19%	rectangular	1.732	1	0.11%	0.00%	∞
Oscilloscope voltage uncertainty, (quoted)	0.50%	normal	2	1	0.25%	0.00%	∞
osc pulse length resolution (quoted)	5.00%	rectangular	1.732		2.89%	0.08%	∞
Source Size Measurement	No						
Measuring Element	0.85%	rectangular	1.732	1	0.49%	0.00%	∞
Voltage Cal: Oscilloscope	0.50%	normal	2	1	0.25%	0.00%	∞
Time Cal: Oscilloscope	0.50%	normal	2	1	0.25%	0.00%	∞
Trigger jitter	0.79%	rectangular	1.732	1	0.46%	0.00%	∞
Repeatability	2.00%	normal	2	1	1.00%	0.00%	∞
Optical attenuator	2.00%	rectangular	1.732	1	1.15%	0.00%	∞
Measuring distance	2.00%	rectangular	1.732	2	1.15%	0.00%	∞
For 62471 - Spectrometrer Uncertainty	No						
Is the most limiting EHV Blue Light?	No						
Spectrometer Uncertainty	0.00%	rectangular	1.732	1	0.00%	0.00%	∞
Standard deviation of the mean	0.05%	normal	2	1	0.03%	0.00%	9
combined standard uncertainty		normal			3.43%	0.12%	>500
expanded uncertainty		normal (k=2)			6.86%		>500