Laser Safety Classification

Leica Geosystems
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CH-9435 Heerbrugg
(Switzerland)

Nr.	LSCL2012_002_Sigma1
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Revision	0
Sheet 1 of	6
Date	18.01.2012
Remark	Leica Geosystems AG internal use only

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1. Product Number — 789318, 781084

2. Product Identification — Leica EDM Sigma 1 EP
Leica EDM Sigma 1 MP

Design Status — 18.01.2012

3. Standard Applied — IEC 60825-1:Second edition 2007-03

4. Reference Documents

5. Characteristics and Description

The following data, where not otherwise stated, are worst-case design numbers. They are used for all further calculations, where not otherwise stated.

- Emission wavelength	620-690nm
- Emitting aperture (1/e)	4 x 2mm^2
- Beam divergence (1/e)	< 1.5 mrad
- Average radiant power	max. 0.95mW
- Pulse repetition frequency	320 MHz
- Burst repetition frequency	78 kHz
Pointing PRF	
- Pulse width	$0.7 \cdot 10^{-9}$ s
- Pulse suppression frequency	12.3 MHz
- Pulses per burst	650 .. 1450
- Max.emission duration	900 s
Mod. 0	
- Pulse width	$0.3 \cdot 10^{-9}$ s
- Pulse suppression frequency	no
- Pulses per burst	750.. 1760
- Max.emission duration	1.5 s (standard mode)
Mod. 1	
- Pulse width	$0.7 \cdot 10^{-9}$ s
- Pulse suppression frequency	78 MHz
- Pulses per burst	650 .. 1450
- Max.emission duration	0.5 s (standard mode), 1 s(long range mode)
Mod. 2	
- Pulse width	$0.7 \cdot 10^{-9}$ s
- Pulse suppression frequency	40 MHz
- Pulses per burst	650 .. 1450
- Max.emission duration	0.5 s (standard mode), 1 s(long range mode)
Mod. 3	
- Pulse width	$0.7 \cdot 10^{-9}$ s
- Pulse suppression frequency	17.8 MHz
- Pulses per burst	680 .. 1520
- Max.emission duration	0.5 s (standard mode), 1 s(long range mode)

Mod. 4

- Pulse width	$0.7 \cdot 10^{-9}$ s
- Pulse suppression frequency	13.9 MHz
- Pulses per burst	650 .. 1450
-	
- Max.emission duration	0.5 s (standard mode), 1 s(long range mode)

Mod. 5

- Pulse width	$0.7 \cdot 10^{-9}$ s
- Pulse suppression frequency	12.8 MHz
- Pulses per burst	680 .. 1520
- Max.emission duration	0.5 s (standard mode), 1 s(long range mode)

Mod. 6

- Pulse width	$0.7 \cdot 10^{-9}$ s
- Pulse suppression frequency	12.3 MHz
- Pulses per burst	650 .. 1450
- Max.emission duration	0.5 s (standard mode), 1 s(long range mode)

6. Accessible Emission Limits

6.1 AEL Class 2

Worst case consideration : Modulation M0

Direct ocular exposure signal evaluation mode. The AEL is determined by using the most restrictive of requirements (IEC 60825-1Second edition 2007-03 paragraph 8.3.f):

i. The exposure from any single pulse within the pulse train shall not exceed the AEL for a single pulse.

ii. The average power for a pulse train of emission duration T shall not exceed the power corresponding to the AEL for a single pulse of duration T.

iii. The average pulse energy from pulses within a pulse train shall not exceed the AEL for a single pulse multiplied by the correction factor $C_5 = N^{-0.25}$

$AEL_{train} = AEL_{single} * C_5$

6.1.1 Single Pulse (Requirement i)

T = 0.25 s (time base for class 2)

$t = 0.3 \cdot 10^{-9}$ s (pulse duration)

$C_6 = 1$ ($\alpha = \alpha_{min} = 1.5$ mrad)

$AEL = t^{0.75} \cdot C_6$ J $= \mathbf{7.2 \cdot 10^{-8}\ J}$

6.1.2 Average Power (Requirement ii)

$T \geq 0.25$ s

$C_6 = 1$ ($\alpha = \alpha_{min} = 1.5$ mrad)

N1 = 1760 Number of puses in burst (worst case)

N2 = 19500 Number of bursts in 0.25 s

$N = N1*N2 = 3.4 \cdot 10^7$ Number of pulses in 0.25 s.

$AELav = 1 \cdot 10^{-3} \cdot C_6$ W $= \mathbf{2.5 \cdot 10^{-4}\ J}$

$= \mathbf{1.0 \cdot 10^{-3}\ W}$

$$AELav(pulse) = \frac{AELav}{N} = \frac{2.5 \cdot 10^{-4}}{3.4 \cdot 10^{7}} = 7.2 \cdot 10^{-12}\ J$$

6.1.3 Single Pulse within a Pulse Train (Requirement iii)
Worst case : Modulation M0

T = 0.25 s (time base for class 3R)
$t = 0.3 \cdot 10^{-9}$ s (pulse duration)
$C_6 = 1$ ($\alpha = \alpha_{min} = 1.5$ mrad)
PRF = 320 MHz pulse repetition frequency
N1 =1760 (max number of pulses in a burst)
Burst repetition frequency = 78 kHz
N2 = 19500 (number of bursts in time base 0.25 s)
$N = N1 * N2 = 3.4 \cdot 10^{7}$
$C_5 = N1^{-0.25} = 0.013$
AEL(single pulse) = $7.2 \cdot 10^{-8} \cdot C_6 \cdot C_5$ J = **$9.4 \cdot 10^{-10}$ J**

The average power requirement is the most restrictive one.

7. Measurement

7.1. Date and Place of Measurements / Measurement Engineer

Date	16.01.2012
Place	CRI - Technology Services, Heerbrugg
Measurement Engineer	Magdalena Dagorov

7.2. Measurement Equipment

Types and S/N or Ident.Nr.	
Ammeter	Keithley Electrometer 617 Ident-Nr.
Detector	Si-Diode Gamma Scientific DR-2550-2B+FF+UK1

7.3. Measurement Geometry

Aperture	D_M = 50 mm
Measurement Distance	R_M = 2000 mm

7.4. Measurement Uncertainties

± 5%

7.5. Measurement Results

S/N of measured unit : 0814040198

Emission duration	*AEL Class 2*	*Measured values*
0.25 s	1.0 mW	0.87 mW

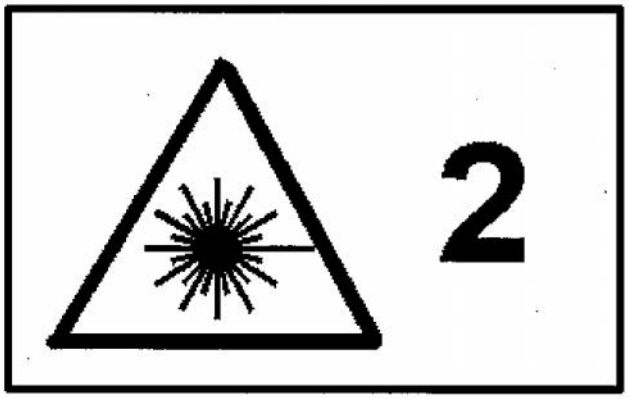
8. Additional Examinations
NA

9. Classification

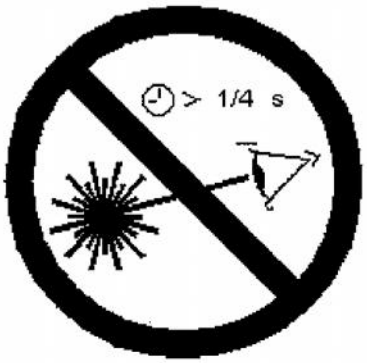
Leica EDM Sigma 1 is a class 2 product according to IEC 60825-1: Second edition 2007-03

10. Labeling
The instrument shall have affixed labels as follows:

10.1. Warning Label and Prohibition Label

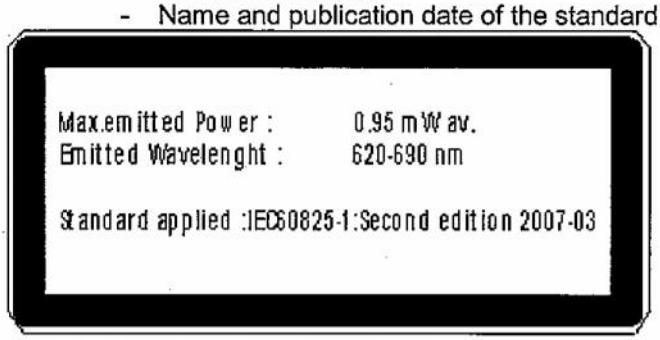


Text, borders and symbols:
black on yellow background



Black pictogram on white background,
red border and red diagonal line

10.2. Explanatory Label
- Maximum output of laser radiation with the magnitudes of the cumulative measurement uncertainty and any expected increase at any time after manufacture added to that value
- Emitted wavelength
- Name and publication date of the standard to which the product was classified



If the size or design of the product makes labeling impractical, the label should be included with the user information or on the package.

10.3. Identification and Certification Label

1. The full name and address of the manufacturer of the product 2. The place, month and year of manufacture
Complies with FDA performance standards for laser products Except for deviations pursuant to Laser Notice N0.50 June 24,2007

10.4. Aperture Label
N/A

11. Information to be Provided
11.1. User Information (Manual)

11.1.1. A statement of beam divergence, pulse duration and maximum output, with any expected increase in the measured quantities at any time after manufacture added and the magnitudes of the cumulative measurement uncertainty:

- Maximum average radiant power 0.95 mW ± 5%
- Pulse duration 300 ps
- Pulse repetition frequency, PRF 320 MHz
- Beam divergence < 1.5 mrad

11.1.2. Adequate instructions for proper assembly, maintenance, and safe use.

11.1.3. Legible reproduction of all required labels and warnings and the corresponding position of each label affixed to the product.

11.1.4. A clear indication of all location of laser apertures.

11.1.5. A listing of controls, adjustments and procedures for operation and maintenance including the warning: "Caution - Use of controls or adjustments or performance of procedures other then those specified herein may result in hazardous radiation exposure" must be included as well.

11.2. Purchasing Information
In all catalogues, specification sheets and descriptive brochures, the safety classification of the laser product and any warnings shall be stated.

11.3. Servicing Information

11.3.1. Instructions for service adjustments and service procedures, which include clear warnings and precautions to be taken to avoid possible exposure to radiation.

11.3.2. Schedule of maintenance necessary to keep the product in compliance with the standard.

11.3.3. Listing of those controls and procedures which could be utilized by persons other than the manufacturer or his agents to increase accessible emission levels of radiation.

11.3.4. Clear description of the location of displaceable portions of the protective housing which could allow access to laser radiation in excess of the accessible limits.

11.3.5. Protective procedures for service personnel to avoid exposure to levels of laser radiation known to be hazardous for each procedure to be accomplished.

11.3.6. Legible reproduction (color optional) of required labels and hazard warnings.

12. Safety Requirements

Precautions are only required to prevent continuous viewing of the direct beam. A momentary (0.25s) exposure as would occur in accidental viewing situation is not considerd hazardous.

13. Place and Date CH-9435 Heerbrugg, 18.01.2012

14. Signatures

Name	Dagorov Magdalena	Ramseier Ernst
Title	Laser Classification Responsible	Laser Safety Responsible
Signature	.....	.....