XENON™ Z-1000

High-Energy Pulsed Light

Pulsed Light for Rapid Surface Sterilization

Unlike conventional methods for killing virus, bacteria and fungi, XENON's SteriPulse® Technology delivers rapid sterilization without the dangers of chemicals or mercury lamps that risk the safety of workers. This is because SteriPulse does not use toxic mercury vapor lamps. Rather, it produces germicidal UV-C by means of short duration, intense pulsed light (IPL), through an inert xenon gas flash lamp. Additional damage is caused by wavelength bands other than UV-C.[1]

Approved by the FDA[2] for microbial inactivation on the surface of food or packaging material, the broad spectrum, pulsed light can deliver microbial reduction of up to 6 log10 in 1-second.[3] Pulsed light exposure eliminates microorganisms by causing the formation of pyrimidine dimers in DNA, resulting in genetic damage to cells and their ultimate destruction. Types of damage induced by pulsed light are: photolysis; loss of colony-forming ability (death); inability to support phage growth (enzyme inactivation) and destruction of nucleic acid.

Introduction to the Z-1000 family

To support users with different requirements, XENON's Z-1000 is available with a range of user selected options that can be configured to match application-specific requirements. Examples are illustrated below.

Configuration #1	Research studies on pathogenic microorganisms
Configuration # 2	Pilot line processing for surface decontamination: packaging, food, etc.
Configuration # 3	Suitable for OEM inline process surface decontamination

Z-1000 for research studies is supported with a benchtop system configuration consisting of controller and separate sterilization chamber containing a Lamp Housing and flashlamp. The controller provides all power to the lamp as well as complete operator control of the sterilization process using front-panel controls or a user PLC. Safety interlocks are provided to protect the user from exposure from the pulse flash when the chamber door is open. An optional light intensity monitor, LiteMark-XL™, is mounted on the sterilization chamber.

Z-1000 for pilot or small production process is achieved with a system configuration that includes a benchtop controller and an air cooled standalone enclosed lamp housing with flashlamp. The controller provides all power to the lamp as well as complete operator control of the sterilization process using front-panel controls or a remote PLC. Lamp housing is easily integrated into user line. Dual lamp operation is available as an option, using InterWeave™ technology. An optional light intensity monitor, model LiteMark-XL™, is mounted on the lamp housing.

Z-1000 for OEM applications requiring integration into a large scale process can be configured with modular units that include a controller, high voltage power supply, and a standalone air cooled lamp housing with flashlamp. System control is via a remote PLC. Lamp housing is integrated on user process line. Dual lamp operation is available as an option, using InterWeave™ technology. An optional light intensity monitor, LiteMark-XL™, is mounted on the lamp housing.

[1] Bohrevora, Z., Shemer, H., Lantis, R., Impellitteri, C.A., Linden, K.G., 2008. Comparative disinfection efficiency of pulsed and continuous-wave UV irradiation technologies. Water Research 42, 2975-2982.
[2] Food and Drug Administration; 1999. Code 21CFR179.41 Pulsed Light for the treatment of food.
[3] Sonenshein, A.L., 2006. Killing of Bacillus Spores by High Intensity Ultraviolet Light. Dept. of Molecular Biology and Microbiology, Tufts University School of Medicine. Study commissioned by XENON Corporation using model Z-1000.

Specifications: Sterilization Chamber

The Z-1000 Sterilization Chamber, with removable lamp housing and sample tray, is detached from the benchtop controller. Ozone is evacuated to ensure EPA ozone level compliance in the workplace. Forced air evacuation is in the range of 1-4 volumes per minute to ensure no heat buildup within the chamber during sterilization. The chamber does not evacuate airborne pathogens nor introduce airborne pathogens into the chamber while the system is in the ON cycle. Ozone-resistant microbe filters are used at both the inlet and outlets of the ventilation path to ensure containment of airborne pathogens. The chamber has an interlocking door connected with the safety interlock switches in the controller. The chamber and insert are made of stainless steel construction for ease of sterilization and disinfection. This construction also insures the chamber is able to withstand UV light and heat conditions experienced under normal operating conditions. A total of 11 positions are available in the sterilization chamber to quickly allow the operator to position the stainless steel sample tray below the flashlamp window. This feature facilitates studies with different pulse intensities on the sample. An optional light intensity monitor, Light Mark-XL™, is mounted on the side of the sterilization chamber.

Description	
Sterilization Chamber	Chamber w/removable tray & air filters; access door on front
Sterilization Chamber	
Access door	Hinged; 45.72 x 15.24 cm (18 in x 6 in)
Chamber material	Metal grade stainless steel
Removable tray material	Metal grade stainless steel; movable to 11 positions within chamber
Air filters	Ozone resistant microbe filters (2)
Disinfecting methods, tray and chamber	Note 1
Door interlock	High Voltage disabled at controller when chamber door open
Chamber interlock cable	0.6 meters (2-ft.)
Chamber air cooling	Internal fan
Mains AC power	
Sterilization chamber mains AC power	1-phase 200-240 Vrms, 50/60 Hz, 3 amps, max (includes internal fan)
Sterilization chamber mains power cord	2.1 meters (7-ft.)
Outline Dimensions (H x W x L)	
Sterilization chamber	29.5 x 77.4 x 40.6 cm (11.6 in x 30.5 in x 16.0 in)
Removable tray	15.7 x 40.6 cm (6.2 in x 16 in)
Operating Environment	
Temperature - operating	0 - 40°C (32-104°F)
Temperature - storage	-40 to 85°C
Relative Humidity	10 - 80% (non-condensing)
Weight	25.9 kg (57 lbs.)

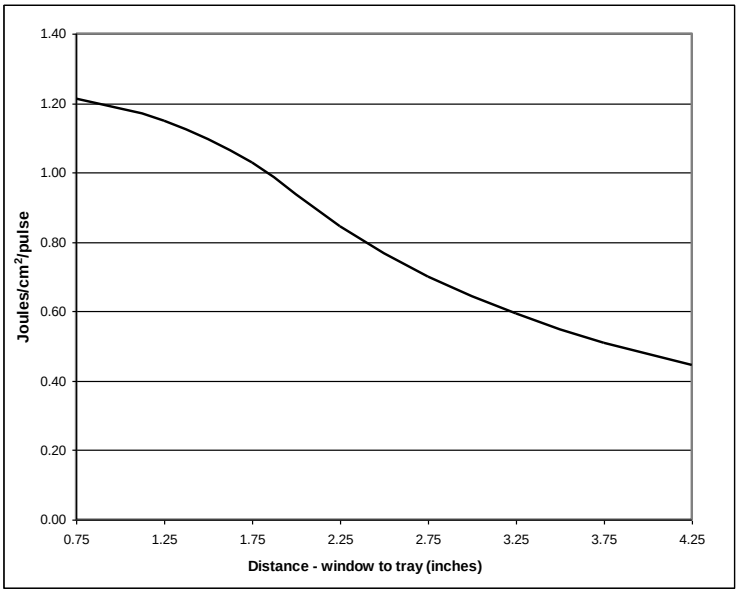
All specifications are typical unless otherwise noted (TAMBIENT @ +25°C, VINPUT = 220 Vrms).

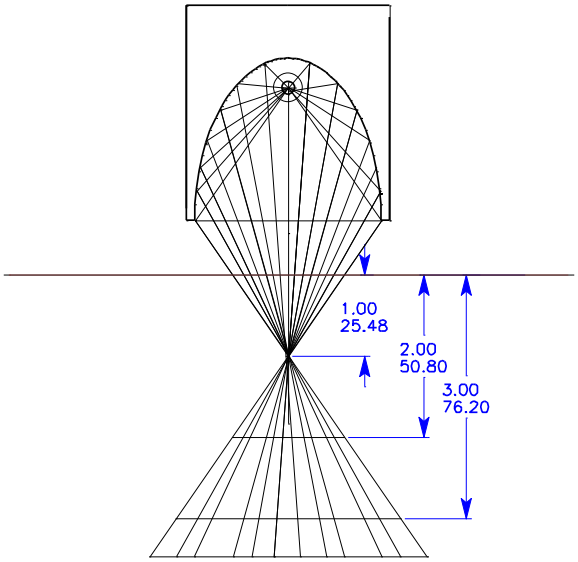
1. The sterilization chamber and tray can withstand sterilizing or disinfecting methods such as autoclaving (276°F steam at 30 psi for 30 minutes), glutaraldehyde (Cydex) and/or 7% chlorine bleach disinfectant wash

Specifications subject to change without notice.

Sterilization Chamber with enclosed air cooled lamp housing and linear flashlamp mounted on top. Sample tray is shown located in position 1 just below the chamber window. Tray may be moved to 11 unique positions to adjust pulse energy reaching sample on tray. Chamber access door is shown open. Interlocks prevent lamp flashing when access door is open.

Light Intensity verses distance
The graph shows how light intensity drops as the sterilization tray is moved farther from the widow of the chamber below the flashlamp. All measurements taken at midpoint of flashlamp and on axis. The highest pulse fluence (1.27 J/cm2) is delivered at a distance of 1.93 cm (0.76 in) from the test sample to the window of the lamp housing. The light treatment area at that location is 1.9 x 30.5 cm (0.75 in x 12 in).

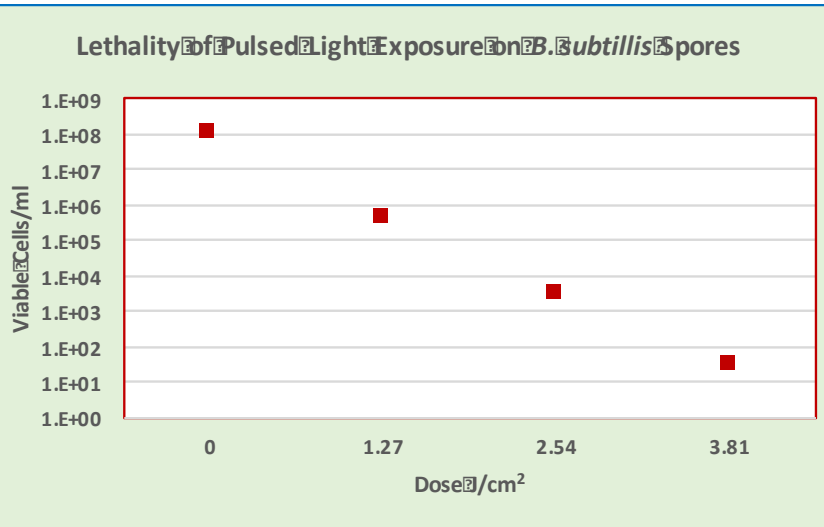




Ray trace drawing illustrating how light is distribution under the lamp from the elliptical reflector contained in the lamp housing. Dimensions are from chamber window – (inches/mm).

Example of exposing *B. subtilis* to consecutive light pulses achieving a > 6 $\log_{10}$ cfu/ml reduction after a 1-second, 3.8 J/cm^2 dose treatment (of 3 pulses). A suspension of 1.1 x 10^8 spores/ml was exposed to short, 360 µs duration pulses, each with a radiant energy of 1.27 J/cm^2/pulse, spaced 333 ms apart – 3 pulses/sec rate. XENON's model Z-1000 system was used in this study of microbial deactivation to > 99.9999%.

(Report available from XENON Corporation.)



MODEL Z-1000 LAMP HOUSING WITH FLASHLAMP

Lamp Housing Cooling

The enclosed linear flashlamp housing has been designed for continuous forced air cooling to insure the lamp temperature is maintained during operation. When the system is being shut down, air cooling should continue for a minimum of 5 minutes after lamp is flashed. Air volume of 300 cubic feet per minute is required. Light-blocking air exhaust filters are provided on the housing. A blower kit—including a blower, mains power cord, air filter, flexible aluminum ducting and hose clamps—is available for order to provide adequate cooling for the lamp housing and flashlamp.

XENON Flashlamp Design

XENON's gas lamps are by far the best light source for high peak power pulsed light delivery. XENON lamps are made of fused quartz tubing sealed at each end with an electrode assembly. There is no mercury vapor used in XENON's flashlamps. Wavelength for type C quartz lamp—the most commonly-used lamp for sanitization applications—is 200 to 1100 nm.

Lamp Housing Specifications	
Components	
Enclosed lamp housing	Lamp Housing with 40.64 cm (16 in) arc length linear flashlamp
Interconnecting cables	Two, 3 meter (9.84 ft.) lamp control cables
Pulsed Flashlamp	
Radiant energy output from flashlamp	1.27 Joules/cm^2 [1.93 cm (0.76 in) from chamber or lamp window face]
Arc length	40.64 cm (16 in) linear clear fused quartz; non-toxic; mercury free
Reflector type	Elliptical Reflector
Mounting Position	May be mounted in any position; cooling must be provided
Air Cooling	Minimum 300 cfm of filtered air at 5.08 cm (2.0 in) water gauge
Outline Dimensions (H x W x L)	
Lamp Housing for sterilization chamber	17.3 x 17.9 x 76.2 cm (6.85 in x 7.0 x 30.0 in)
Lamp Housing - model LH-840	19.1 x 17.9 x 76.2 cm (7.5 in x 7.0 x 30.0 in)
Environment	
Temperature - operating	0 - 40°C (32-104°F)
Temperature - storage	-40 to 85°C
Relative Humidity	10 - 80% (non-condensing)
Weight	16.35 kg (36 lbs.)

All specifications are typical unless otherwise noted ($T_{AMBIENT}$ @ +25°C).

Specifications subject to change without notice.

Specifications:
Model RC-847 Controller

Z-1000 BENCHTOP CONTROLLER

XENON's benchtop controller provides all pulse power and operator control to deliver high energy pulses to the flashlamp. The system offers single, cycled or continuous pulse flashing operation, using either the timer on the front panel or by a user supplied interface such as a PLC.

The continuous mode provides a sequential train of light pulses at a 3-pulse/sec rate. In the single mode, the operator can manually flash the lamp each time a front-panel switch is operated. Pulse duration (360 µs) and max pulse rate (3 pulses/sec) are factory set. Front panel status indicator lights provide status of AC power, High Voltage and lamp flash.

Controller - Benchtop	
Description	
Controller	Lamp power, PFN[1], PLC & front panel operator controls
Operator Controls	
AC Power	ON/OFF
High Voltage	ON/OFF
Lamp Select	None, Lamp A or Lamp B
Pulse Mode Select	Manual, Single Pulse, Continuous
Programmable Timer	1 to 999 seconds in 1 sec intervals
Trigger Select	Start/Stop
PLC Control	
Optically isolated user interface	37-pin I/O connector
Electrical output to lamp	
Pulse Width	360 µs (factory set)
Pulse Rate	3 pulses/sec, max (factory set)
Electrical Energy	505 Joules/pulse; 1,516 Joules/sec (factory set)
Mains AC power	
AC Input	1-phase 200-240 Vrms, 50/60 Hz, 20 amps max
Warm-up time	1-minute
Mains line power	2500 W, maximum
Mains power cord	2.4 meters (8 ft.)
Outline Dimensions (H x W x L)	
Controller	22.6 x 48.0 x 70.6 cm (8.8 in x 18.9 in x 27.8 in)
Environment	
Temperature - operating	0 - 40°C (32-104°F)
Temperature - storage	-40 to 85°C
Relative Humidity	10 - 80% (non-condensing)
Weight	39 kg (87 lbs.)

All specifications are typical unless otherwise noted (TAMBIENT @ +25°C, VINPUT = 220 Vrms).
1- PFN = Pulse Forming Network
Specifications subject to change without notice.

Z-1000 MODULAR CONTROLLER FOR OEM APPLICATIONS

The ability to implement remote Programmable Logic Control (PLC) for timed sterilization permits ease of integration into small and large scale manufacturing systems. XENON's compact, modular controller provides a pulse forming network (PFN) and pulse flashing control via a user supplied interface such as a PLC. All I/O is optically isolated to minimize interference from noise signals. High voltage and +24 VDC power is supplied from the modular high voltage power supply. Lamp housing control is provided using high voltage and analog control cables connected to the controller. An optional dual lamp capability, incorporating InterWeave™ technology, is available. Internal fan provides cooling. Max lamp pulse rate, 3 pulses/sec, and pulse electrical energy, 505 J/pulse, are factory set.

Controller - modular	
Description	
Controller	Lamp power, Pulse Forming Network, PLC I/O
PLC I/O Interface	
Optically isolated user interface	37-pin I/O connector
Pulse trigger	ON/OFF
HV monitor	Overload, over voltage, over temperature
HVPS +15 VDC & +24 VDC	Monitor
Lamp Housing	Trigger enable and interlock monitor (cover in place)
Lamp flash	Confirm
HVPS Input	
Voltage	High Voltage and +24 VDC
HVPS control	15-pin connector
Electrical output to lamp	
Pulse Width	360 µs (factory set)
Pulse Rate	3 pulses/sec, max (factory set)
Electrical Energy	505 Joules/pulse; 1,516 Joules/sec (factory set)
Mains Power	
AC Input	1-phase 200-240 Vrms, 50/60 Hz, 30 amps max
Warm-up time	1-minute
Outline Dimensions (H x W x L)	
Controller	16.8 x 30.5 x 48.2 cm (6.63 in x 12.0 in x 19.0 in)
Environment	
Temperature - operating	0°C - 40°C (32°F-104°F)
Temperature - storage	-40 to 85°C
Relative Humidity	10% - 80% (non-condensing)
Weight	12.8 kg (28 lbs.)

All specifications are typical unless otherwise noted ($T_{AMBIENT}$ @ +25°C, V_{INPUT} = 220 Vrms).

Specifications subject to change without notice.

LITEMARK-XL LIGHT MONITOR

A useful accessory item that can be supplied with the Z-1000 systems is the LiteMark-XL Light Monitor. The LiteMark-XL Monitoring System is a photo-electric detector module that is factory supplied mounted on a lamp housing or sterilization chamber to enable the operator to monitor, on a real-time basis, the performance of a flashlamp system. This capability allows the flashlamp to be changed before the output falls below a predetermined minimum. It does this by sensing the light intensity from each flash which is scattered sideways in the Lamp Housing window and relating it to the side-scattered intensity produced by the same flashlamp when new. The side-scattered intensity produced by the new flashlamp is designated as the “100% level”, and the intensity at any later time is compared to that 100% level to produce a percentage value slowly declining from 100% as the lamp continues in use, indicative of the status of the flashlamp at any given time. A correlation chart must be used in conjunction with the LiteMark-XL data to obtain the reduced exposure percentage.

MEASUREMENT OF INTENSITY

Since the LiteMark-XL detector does not look directly at the flashlamp and is not located at the actual target surface, it does not provide an absolute calibration in Joules/cm² of the energy striking that target surface. It does, however, provide an indirect and real-time means of tracking the target surface exposure at any time if the new-lamp exposure value (the “100% level”) has been measured at the target. The correspondence between the actual target surface exposure at any time and the reduced value derived from the LiteMark-XL relative value will remain in close agreement during the entire effective operating life of the flashlamp.

The starting exposure (the 100% level) at the target surface must be measured with an exposure (Joules/cm^2) measuring instrument having a current calibration certification. The instrument calibration certification should cover the spectral range from 200 nm to 3 microns, the nominal transmittance range of the quartz components in the light path, except in cases where narrow-band exposure data is needed. It should be noted that this real time monitoring procedure has taken place without having to interrupt operation.

LiteMark-XL Specifications	
Accuracy [1]	±10%
Linearity	±2%
Linear Output Range	0 - 2 VDC
Over Range	1% (+2.2 VDC)
Output Load [2]	10K Ω, max
Relative Light Intensity Signal [3]	+2 VDC nominal output @ 10KΩ Load
Decay Time	600 milliseconds
I/O Interface Connector	DB9F, 9-Pin Sub D socket
Warm-up Time [4]	1 minute
Power Input [5]	+5 VDC ± 5% @ 50 milliamps
Operating Temperature	0 - 40º C (32 -104ºF)
Relative Humidity	10 - 80% (non-condensing)
Outline Dimensions (H x W x L)	3.58 x 15.5 x 3.8 cm (1.5 in x 6.12 in x 1.41 in)
Weight	7 oz. (198 g)

All specifications are typical unless otherwise noted (TAMBIENT @ +25□C, VINPUT = +5 VDC)
[1] Tolerance of output voltage relative to light input
[2] Protected for shorts to signal ground
[3] Factory calibrated setting
[4] Initial flashlamp operating time to achieve peak flash output level
[5] Not protected for reverse polarity
Specifications subject to change without notification

DATA LOGGER SYSTEM

The incorporation of the Data Logger System into the LiteMark-XL Light Monitoring System enables the evaluation process to be carried on continuously without the need for operator calculations. The Data Logger is a computerized data collection and analysis system which captures, records, processes, stores and prints radiant energy information from any Xenon Corporation Lamp Housing or Sanitization Chamber fitted with a LiteMark-XL Light Monitoring system. The Data Logger interfaces to a personal computer through an Analog-to-Digital Converter (ADC) which is built into the output connector of the Data Logger cable and plugs directly into the computer printer port. The system operator can observe the flashlamp intensity display on his computer monitor as either tabulated data or as a graph. Additionally, the operator can input the data into a spreadsheet for further processing off-line.

SYSTEM CONFIGURATION EXAMPLES

For help configuring a Z-1000 system that best matches your application, please contact your XENON sales representative. Responding to your needs is what XENON does well. If our standard equipment is not sufficient, we will work closely with you on a more application-specific system design. With over 50 years of experience working with pulsed light technology, XENON is ready to respond to your needs.

System Configuration Examples	Research	Pilot	OEM
Enclosed, air cooled lamp housing with linear flashlamp	✔	✔	✔
Sterilization Chamber with sample tray and air filters	✔		
Benchtop controller with PFN & high voltage power supply	✔	✔	
Modular controller with PFN and PLC user control			✔
Modular High Voltage Power Supply			✔

Options	Research	Pilot	OEM
InterWeave™ controller for 2-lamp operation		✔	✔
LiteMark-XL™ Light Intensity Monitor	✔	✔	✔
Data Logger	✔	✔	✔
Blower for lamp housing, model TB-100-1	✔	✔	✔

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XENON The Pulsed Light Experts

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