

SteriPulse® Technology

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 FDA² 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-second³. 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

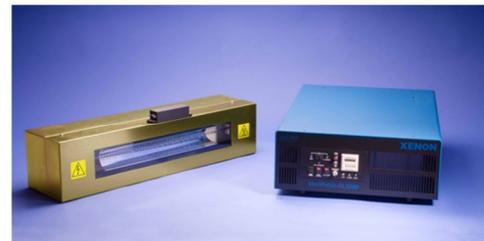
To support users with different requirements, XENON's Z-1000 is available with a range of user selected options that can be configured to match application-specific requirements. Examples are illustrated below.

| | |
|-------------------------|--|
| 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

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, LightMark-XL™, is mounted on the side of the sterilization chamber.

| 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) |
| 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 ($T_{\text{AMBIENT}} @ +25^{\circ}\text{C}$, $V_{\text{INPUT}} = 220 \text{ Vrms}$).

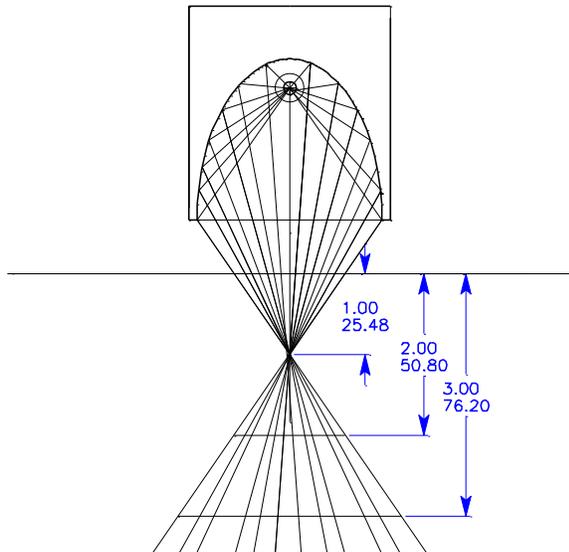
1. The sterilization chamber and tray can withstand sterilizing or disinfecting methods such as autoclaving (276°F steam at 30 psi for 30 minutes), glutaraldehyde (Cydex) and/or 7% chlorine bleach disinfectant wash

Specifications subject to change without notice.

Specifications – Sterilization Chamber, continued



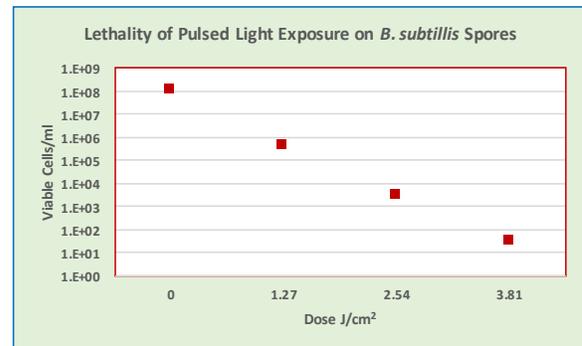
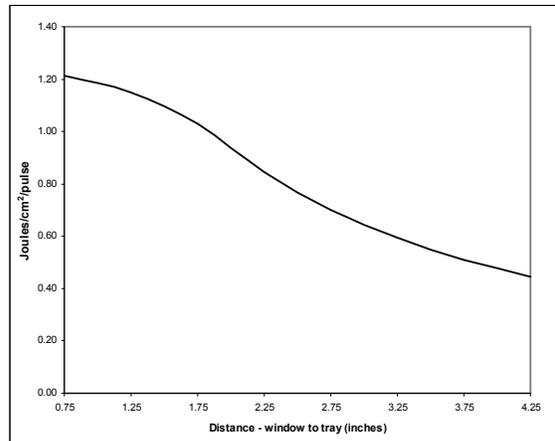
Sterilization Chamber with enclosed air cooled lamp housing and linear flashlamp mounted on top. Sample tray is shown located in position 1 just below the chamber window. Tray may be moved to 11 unique positions to adjust pulse energy reaching sample on tray. Chamber access door is shown open. Interlocks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



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).

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/cm^2) 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).



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 1.1×10^8 spores/ml was exposed to short, 360 μs duration pulses, each with a radiant energy of $1.27 \text{ J/cm}^2/\text{pulse}$, 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.)

Specifications – Lamp Housing and Flashlamp

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. An optional 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 μ s) 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 μ s (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 ($T_{\text{AMBIENT}} @ +25^{\circ}\text{C}$, $V_{\text{INPUT}} = 220 \text{ Vrms}$).

1- PFN = Pulse Forming Network

Specifications subject to change without notice.

Specifications: Model CRT-810 Controller

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 μ s (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.

Specifications – LiteMark-XL Light Monitor

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/cm²) 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 - 40° C (32 -104°F) |
| 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 (T_{AMBIENT} @ +25°C, V_{INPUT} = +5 VDC)

1 Tolerance of output voltage relative to light input

4 Initial flashlamp operating time to achieve peak flash output level

2 Protected for shorts to signal ground

5 Not protected for reverse polarity

3 Factory calibrated setting

Specifications subject to change without notification

Specifications – Data Logger and System Configuration Examples

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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