LightForge™ User Guide

Custom Freeform Optic Fabrication Service for Rapid Prototyping

CONTENTS

PRODUCT DESCRIPTION

LightForge is a custom optical component that provides a freeform refractive surface within a 15 × 15mm clear aperture. This clear aperture area can contain any desired surface shape, within the design guidelines described in Appendix 1.
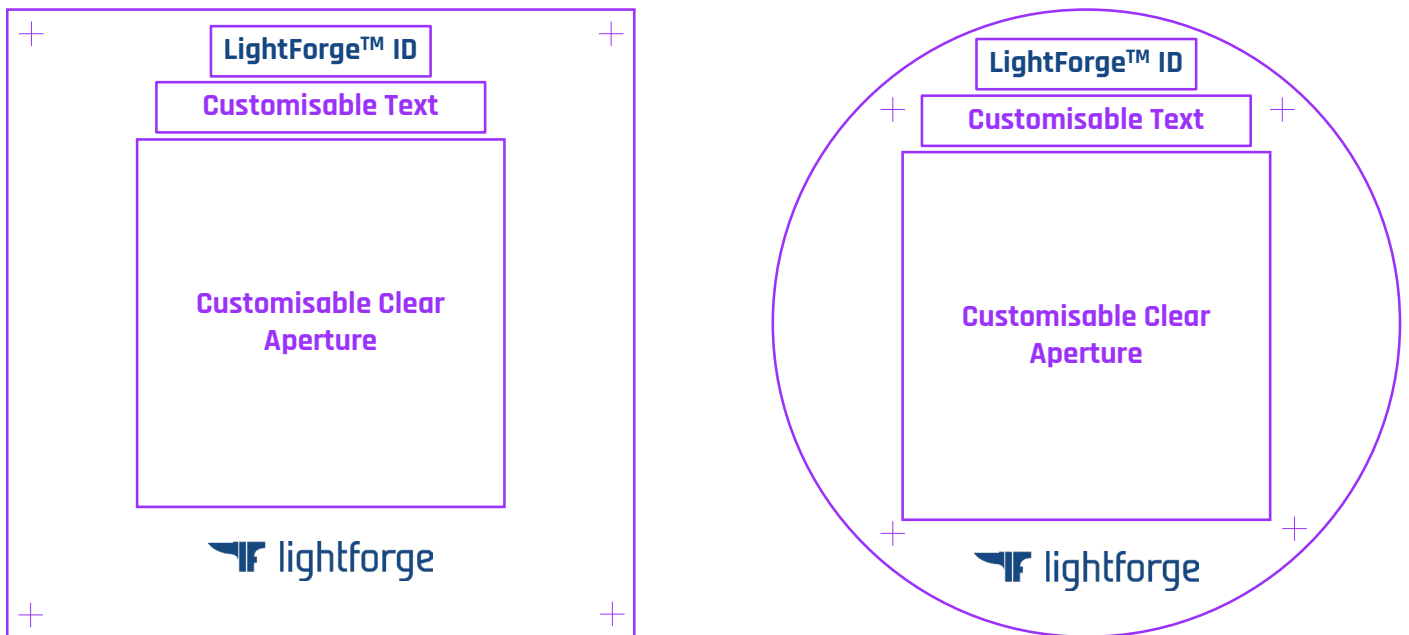

Figure 1: Substrate layout for square and circle LightForge™, showing customer customisable areas.

CUSTOMER DEFINED FEATURES

The following features can be defined by the customer:
- Customised Freeform Surface within the optic clear aperture
- Customer Text (up to 30 Characters)

PRE-DEFINED FEATURES

The following features are pre-defined by PowerPhotonic:
- 4 Alignment Fiducials
- 1 Unique LightForge™ ID Number
- LightForge™ Logo

KEY DIMENSIONS AND SPECIFICATIONS

SQUARE LAYOUT:

Parameter	Value
Material	UV Fused Silica (Corning 7980)
Dimensions, L x W x T (mm)	25.4 x 25.4 x 1
Clear Aperture, L x W (mm)	15 x 15
Customer Text	Maximum of 30 Characters

ROUND LAYOUT:

Parameter	Value
Material	UV Fused Silica (Corning 7980)
Dimensions, Diameter x T (mm)	25.4 x 1
Clear Aperture, L x W (mm)	15 x 15
Customer Text	Maximum of 30 Characters

DESIGN DATA

The optical surface of the LightForge™ part is defined as a set of surface height values z sampled on a 10µm × 10µm grid. The z values define surface height relative to a reference plane that is parallel to the entrance surface. Before manufacture, a constant value ('piston' term) is added to the surface height data so that the highest point on the surface is slightly lower (~5µm) than the unetched region.

DESIGN REQUIREMENTS:

Parameter	Value
Minimum Feature Size	UV Fused Silica (Corning 7980)
Surface Sagitta, Maximum	25.4 x 25.4 x 1
Sampling Grid	15 x 15
Surface Slope, Maximum	Maximum of 30 Characters

Step features (>45° slopes) in the design will be fabricated as a smooth transition over approximately 150µm. As a consequence, sharp angular features are rounded off into a concave or convex feature, over a length scale of approximately 40µm.

The origin of the submitted design can be located anywhere, as the design will be centered on the substrate.

TYPICAL PERFORMANCE

Parameter	Value
Scaling Accuracy	±3%
Form Error, Maximum (over surface area ≤8°)	0.5µm
Form Error, Maximum (over surface area >8°)	Not Specified

The LightForge™ fabrication service is optimised for highly smooth surfaces with extremely low roughness.

SUBMISSION FILE FORMAT

Data is submitted to LightForge™ in a GridXYZ format, which specifies surface height data, z on a rectangular x-y grid.

The x, y, and z values are given in microns, where:-
- XYZ forms a right-handed co-ordinate system
- The Z values represent surface height at points (X, Y) relative to a reference plane

Data should be provided in a '.dat' extension, arranged as a rectangular matrix, where:-
- The first row comprises a zero followed by the X values, in ascending order, running left to right
- The first column comprises a zero followed by the Y values, in descending order, running top to bottom
- The remaining matrix elements comprise the Z values
- The data are in decimal notation to 3 decimal places (i.e. a height resolution of 1nm) with a decimal point used as the separator

PowerPhotonic also provides a Zemax macro, which will translate a Zemax optic surface file into the GridXYZ format.
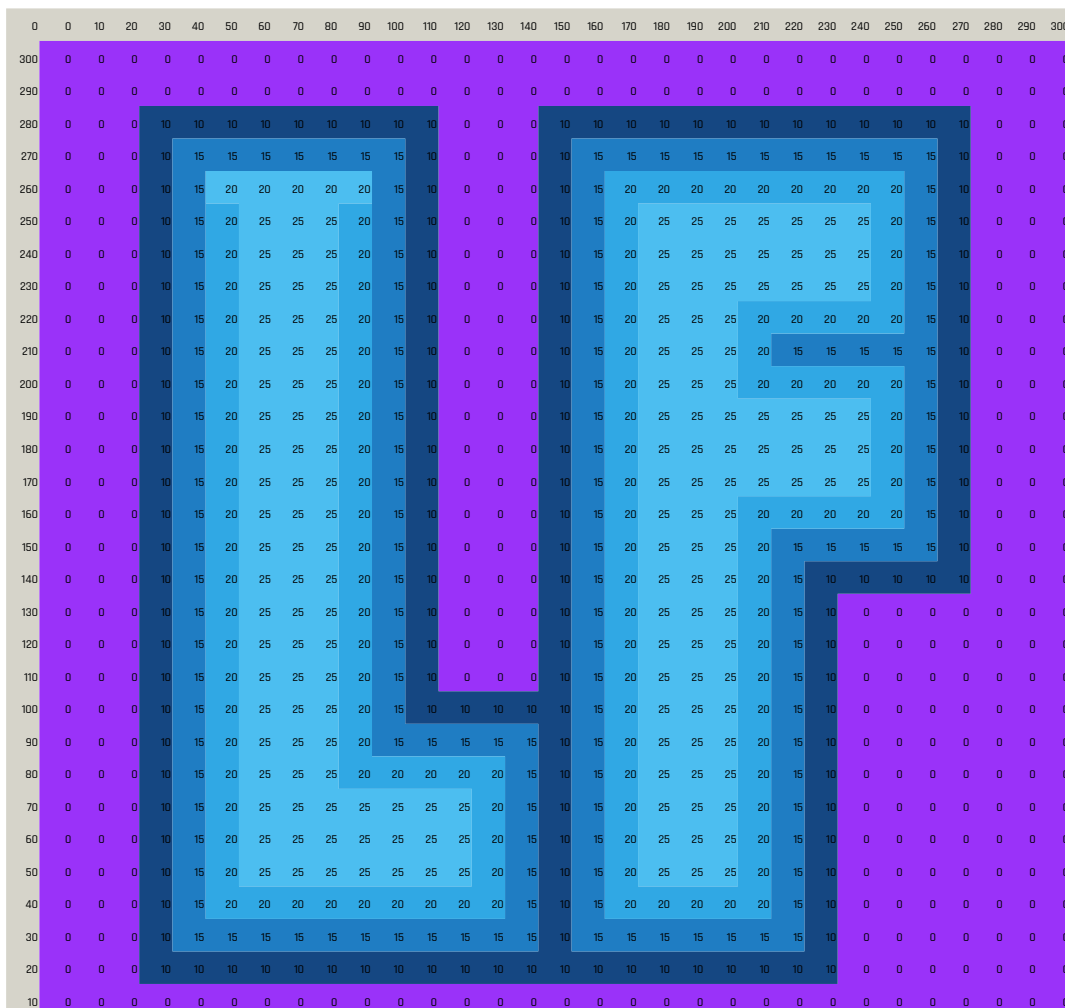

Figure: 2 GridXYZ Co-ordinate Map for an 'LF' surface

DESIGN EXAMPLE - 'L F'

The following surface profile and mesh profile represents the design surface for the raised letters 'LF' from the precious page. Using an L or an F is a useful tool to ensure orientation of the surface.
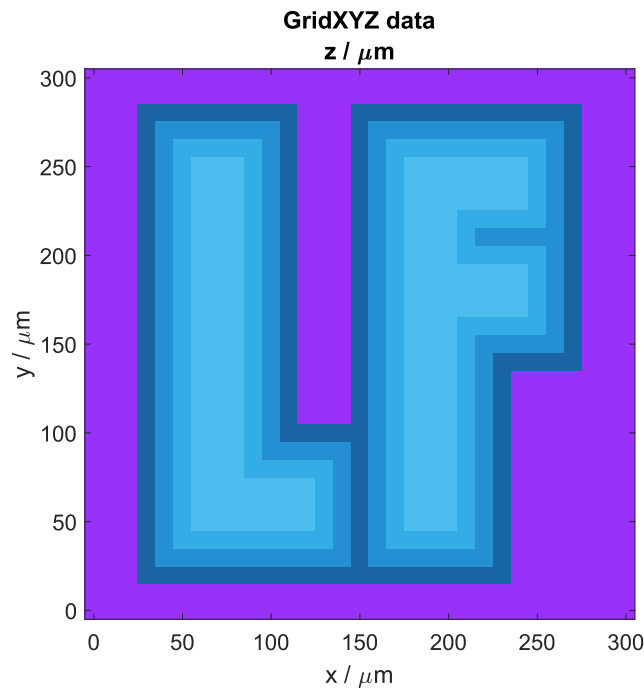

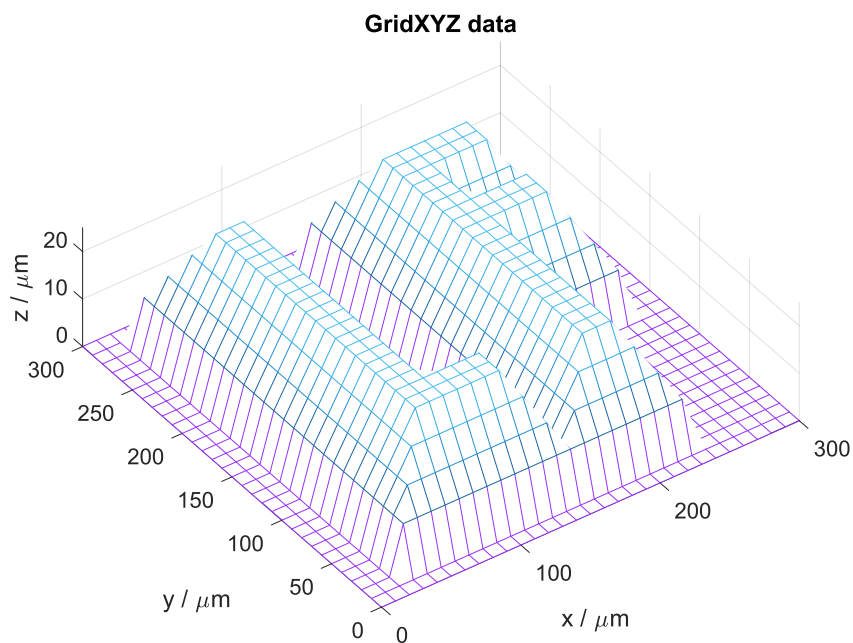Figure 3: Surface Layout from imported .dat file

Figure 4: Surface Mesh Layout from imported .dat file

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HANDLING AND CLEANLINESS

Each LightForge part is packaged and sealed in a cleanroom environment. To maintain its cleanliness:

- Use clean, laboratory grade latex or nitrile gloves when handling the LightForge™ optic
- When unpacking the LightForge™ optic for the first time, retain the packaging for re-use if storage is required
- Remove any dust with either oil-free compressed dry air (CDA) or high-purity dry nitrogen to blow off the dust
- Should the surface become contaminated with material that cannot be removed by the above method, it is recommended to follow standard lens-cleaning techniques using either optical-grade methanol, isopropyl alcohol, or acetone as the solvent
- When using solvents, wear gloves that are resistant to the specific solvent used
- LightForge™ optics can also be rinsed in de-ionised water and dried with CDA or nitrogen

WORKING WITH LASERS

When using LightForge parts with laser light, be aware of the presence of back-reflections, particularly with uncoated parts. For complex surfaces, reflections may occur over a wide range of angles. Only suitably-qualified personnel should use these parts with laser beams.

APPENDIX 1: DESIGN RULE SUMMARY

Material Properties	Nominal Specification	
Material	UV fused silica	
Specific Type	Corning 7980	
Transmission	≈ 92% uncoated, >99% coated	
Refractive Index	1.453 @ 808nm	

Mechanical Characteristics	Dimensions and Tolerance	Units
Length (L) or Diameter (D)	25.4 +0/-0.1	mm
Width (W)	25.4 +0/-0.1	mm
Thickness	1.0 +/- 0.05	mm

Optical Characteristics	Dimension	Units
Clear Aperture (X)	15.0	mm
Clear Aperture (Y)	15.0	mm

Process Parameters	Range	Units
Sag	0 - 65	µm
Slope (form error PV < 500nm)	0 - 8	degrees
Slope	0 - 45	degrees
Feature Size	200 - 15000	µm
Steps & Discontinuities	smoothed over 150µm	

Custom Options Available	Notes
AR Coating	Choice of none; AR-GREEN 532 ± 30nm AR-IR Broad 780-1020nm; AR-IR-V 1064 nm; AR-TELECOM 1260 - 1620nm;
Customer Marking	0 - 30 characters, centered above clear aperture
Mounting Options	2" round interface plate for square substrate

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