

User Guide

LightForge™ Custom Optic Fabrication Service



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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 below-

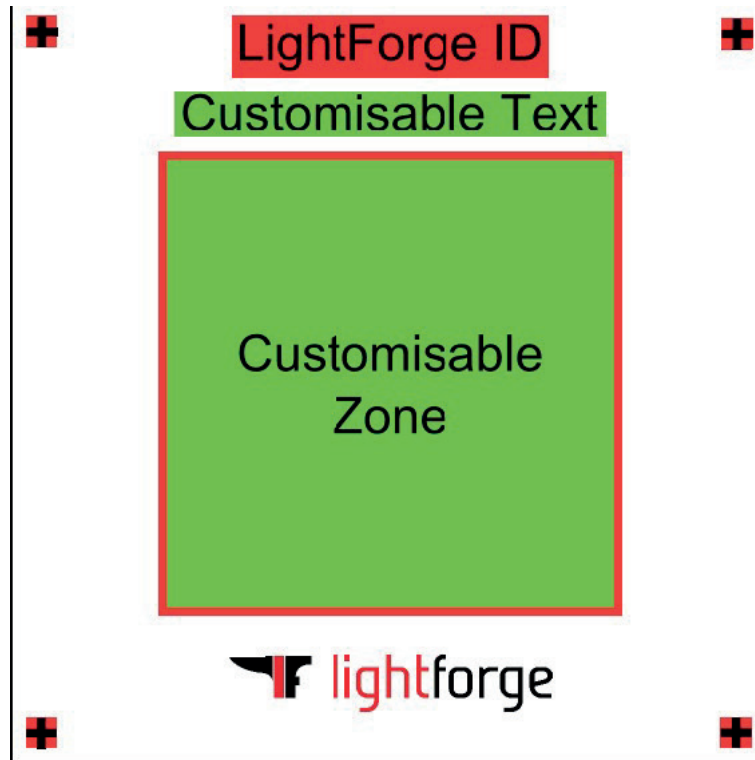


Figure 1: Schematic representation of LightForge™ part layout on square substrate

CUSTOMER-DEFINED FEATURES

- Freeform optical surface within clear aperture customizable zone
- Customer text (up to 30 characters)

PRE-DEFINED FEATURES

- 4 off alignment fiducials forming the corners of a 23.4mm square (at each corner of the part, nominally 1mm from each edge)
- A unique LightForge ID number, located near the top centre of the part
- The LightForge logo, located near the bottom centre of the part, allowing easy identification of part orientation

KEY DIMENSIONS AND SPECIFICATIONS

Square Layout:

Material	UV fused silica (Corning 7980 or equivalent)
Dimensions	25.4 × 25.4 × 1mm
Clear aperture	15 × 15 × 1mm
Customer text	Max. 30 characters

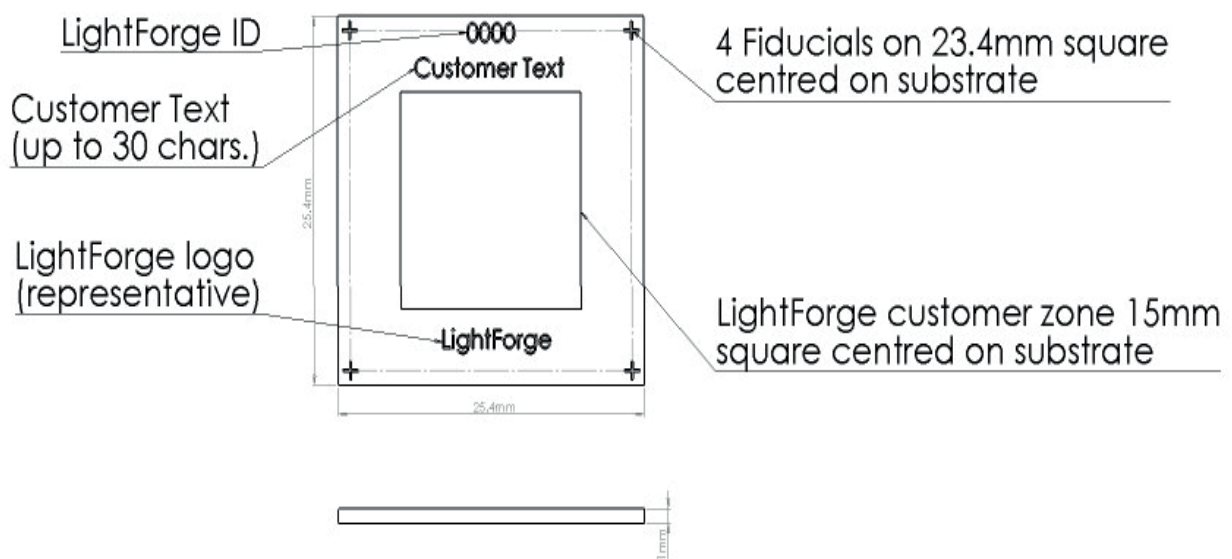
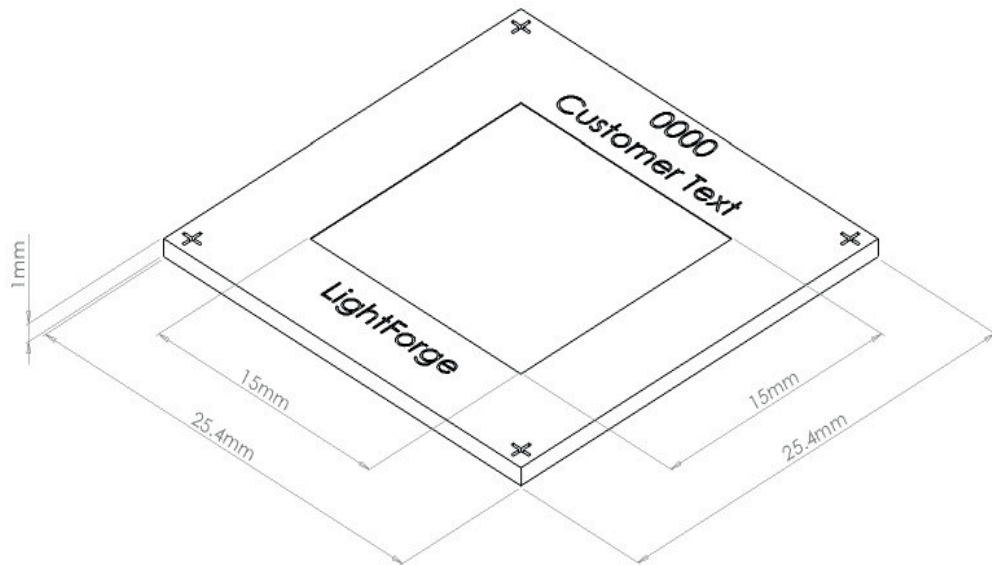


Figure 2: LightForge™ Mechanical Diagram

ROUND LAYOUT:

Material	UV fused silica (Corning 7980 or equivalent)
Dimensions	25.4µm x 1mm
Clear aperture	15 × 15 × 1mm
Customer text	Max. 30 characters

DESIGN DATA

The optical surface of the LightForge™ part is defined as a set of surface height values z sampled on a $10\mu\text{m} \times 10\mu\text{m}$ 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 ($\sim 5\mu\text{m}$) than the unetched region.

DESIGN REQUIREMENTS

Minimum Feature Size	250µm Recommended
Surface sag, maximum	65µm Enforced
Sampling grid	10µm × 10µm Enforced
Surface slope, maximum 45°	Recommended

Step features ($>45^\circ$ slopes) in the design will be fabricated as a smooth transition over approximately $150\mu\text{m}$. As a consequence, sharp angular features are rounded off into a concave or convex feature, over a length scale of approximately $40\mu\text{m}$.

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

TYPICAL PERFORMANCE

Scaling accuracy	±3%
Form error, max. slope $\leq 8^\circ$	0.5µm peak to valley
Form error, max. slope $> 8^\circ$	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 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 is provided in a tab-delimited ASCII file, 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 ascending 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.

DESIGN EXAMPLE - 'LetterF'

The following dataset represents a raised letter 'F', described by surface height, and is useful for verifying axis orientation.

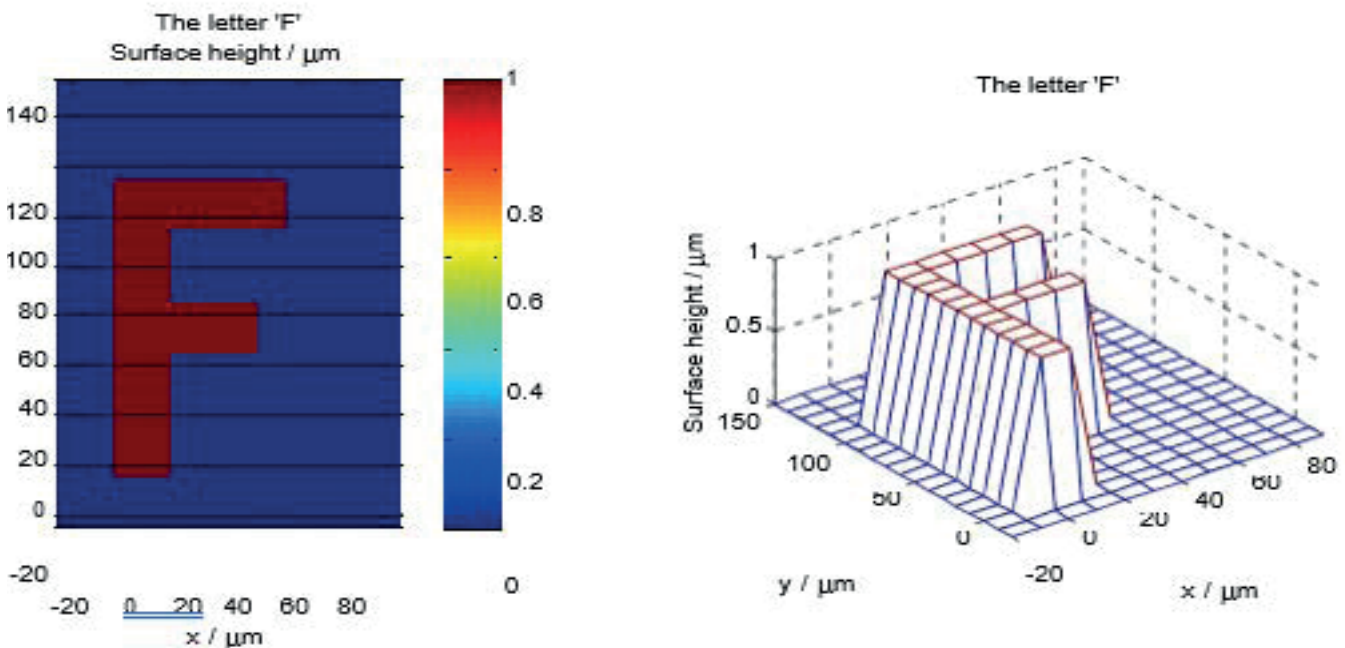


Figure 3: Plan and isometric view of surface described by sample dataset 'LetterF'

0.0	-20.0	-10.0	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	x-values
-20.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
-10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
0.0	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
10.0	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
20.0	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
30.0	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
40.0	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
50.0	0.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	
60.0	0.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	
70.0	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
80.0	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
90.0	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
100.0	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	
110.0	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	
120.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
130.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
140.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
150.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
y-values													z-values

Table 1: GridXYZ data representing the letter “F” shown in MS-Excel Note: The “F” appears upside down since the y-values increase top to bottom

The file should be saved with a .dat extension and then zipped using Windows zipping tool (right- click, select “Send to” then select “Compressed (zipped) folder”) or the compression software of your choice to produce a .zip file.

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 recommend 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	UV-fused silica	
Specific Type	Corning 7980, Spectrasil 2000 or similar	
Transmission	>96% transmission uncoated, >99% coated	
Refractive index	1.4532 @ 808nm	
Mechanical Characteristics	Description and Notes	Units
Height (H)	25.4 ± 0.05	mm
Width (W)	25.4 ± 0.05	mm
Thickness (T)	1.0 ± 0.05	mm
Mechanical Characteristics	Description and Notes	Units
Diameter (Φ)	25.4 ± 0.05	mm
Thickness	1.0 ± 0.05	mm
Process Parameters	Description and Notes	Units
Sag	0-65	micron
Slope	0-45	degree
Feature Size	250-15000	micron
Optical Performance Characteristics	Description and Notes	Units
Clear Aperture (x)	15.0	mm
Clear Aperture (y)	15.0	mm
Customisations Available	Notes	
AR Coating	See AR Coating specification document for details	
Customer Marking	0-30 Characters, centered above optic	