Carbon

DLS™ Design Quick Guide

V02.42
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Overview

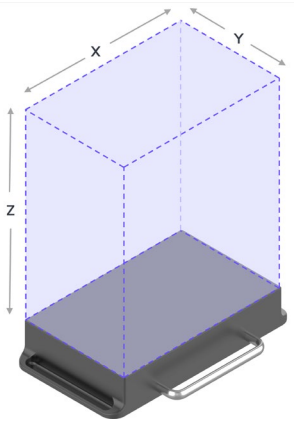
This document offers a multi-step workflow to help you design and support parts quickly. Follow the steps below to determine if the part in question is a fit for DLS™ technology and achieve first print success. This is general information that applies to all printers.

1. **Evaluate:** Determine whether DLS technology and materials are a fit for your part.
2. **Design:** Design your part using the provided guidelines.
3. **Optimize:** Modify your part as needed to improve print quality and accuracy.

Step 1: Evaluate

A. Build envelope: Will part(s) fit?

	M1	M2/M3	M3 Max	L1
X	141 mm (5.6 in)	189 mm (7.4 in)	307 mm (12.1 in)	400 mm (15.7 in)
Y	79 mm (3.1 in)	118 mm (4.6 in)	163 mm (6.4 in)	250 mm (9.8 in)
Z	326 mm (12.8 in)	326 mm (12.8 in)	305 mm (12 in)	460 mm (18.1 in)



Common uses of Carbon® materials

- Housings
- Electrical connectors
- Cushioning
- Vibration isolation
- Impact absorption
- Energy return
- Skin contact applications
- Single-use surgical instruments
- Wearable technology
- Complex water and air handling
- Fixtures for baking

B. Material properties: What properties are required for part(s)?

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	NAME	ULTIMATE TENSILE STRENGTH	ELONGATION AT BREAK	TENSILE MODULUS	SHORE HARDNESS	IMPACT STRENGTH [1]	HEAT DEFLECTION TEMP [2]	BIOCOMPATIBILITY: CYTOTOXICITY
2 PART RESINS	CE 221	85 MPa	3%	3900 MPa	92D	15 J/m	230° C	✓
	EPU 40	9 MPa	300%	N/A	68A	N/A	N/A	✓
	EPU 41	15 MPa	250%	N/A	73A	N/A	N/A	✓ [3]
	EPU 43	17 MPa	380%	10 MPa	76A	N/A	N/A	-
	EPU 44	24 MPa	275%	16 MPa	78A	N/A	N/A	-
	EPU 45	24 MPa	290%	17 MPa	77A	N/A	N/A	-
	EPU 46/Soft/Extra Soft	26/21/15 MPa	330/300/250%	15/11/4.5 MPa	78/71/56A	N/A	N/A	✓
	EPX 82	80 MPa	5%	2800 MPa	89D	45 J/m	130° C	✓
	EPX 86FR	90 MPa	5%	3300 MPa	88D	30 J/m	135° C	-
	EPX 150	76 MPa	5%	2700 MPa	87D	36 J/m	155° C [4]	✓
	FPU 50	25 MPa	200%	700 MPa	71D	40 J/m	70° C	✓
	MPU 100	35 MPa	25%	1200 MPa	81D	30 J/m	50° C	✓
	RPU 70	40 MPa	100%	1700 MPa	80D	15 J/m	60° C	✓
	RPU 130	35 MPa	100%	900 MPa	77D	75 J/m	120° C	✓
	SIL 30	3.5 MPa	350%	N/A	35A	N/A	N/A	✓
1 PART RESINS	DPR 10	45 MPa	4%	1800 MPa	N/A	20 J/m	60° C	✓
	Loctite 3843	51 MPa	43%	1800 MPa	75D	53 J/m	63° C	-
	Loctite IND147	67 MPa	2.4%	3190 MPa	94D	14.6 J/m	291° C	-
	Loctite IND405	42 MPa	120%	1500 MPa	78D	50 J/m	53° C	-
	UMA 90	30 MPa	30%	1400 MPa	86D	30 J/m	45° C	✓

Indicates the highest value in its category.

[1] NOTCHED IZOD, ASTM D256
[2] 0.455 MPA, ASTM D648
[3] Testing was done on EPU 41 Green
[4] Samples were kept in dry conditions and tested within 24 hours.

Carbon Alternatives to Common Thermoplastics document can be found on carbon3d.com here.

C. Chemical Compatibility: Will part(s) be exposed to chemicals?

- For more information see the Technical data sheets (TDS) of the material in question.
- **Note:** Due to variability in part geometry and level of exposure in actual use, it is required that adequate validation is done for production applications.

		MASS GAIN* (%)												
		Rigid Resins						Elastomeric						
CLASS	CHEMICAL	CE 221	EPX 82	EPX 86FR	EPX 150	RPU 70	RPU 130	EPU 40	EPU 41	EPU 43	EPU 44	EPU 45	EPU 46	SIL 30
Household Chemicals	Bleach (NaClO, 5%)	E	E	E	E	E	-	E	E	E	E	E	E	E
	Sanitizer (NH4Cl, 10%)	E	E	E	E	E	-	E	E	E	G	G	G	G
	Distilled Water	E	E	E	E	E	-	E	E	E	G	E	G	G
	Sunscreen (Banana Boat, SPF 50)	E	E	E	E	E	G	G	P	E	G	G	G	G
	Detergent (Tide, Original)	E	E	E	E	E	-	E	G	E	G	G	G	G
	Windex Powerized Formula	E	E	E	E	E	-	G	G	E	F	G	F	G
	Hydrogen Peroxide (H2O2, 30%)	E	E	E	E	E	-	F	F	F	P	P	P	F
	Ethanol (EtOH, 95%)	E	G	E	E	F	-	P	P	P	P	P	P	P
Industrial Fluids	Engine Oil (Havoline SAE 5W-30)	E	E	E	E	E	E	E	E	-	-	-		E
	Brake Fluid (Castrol DOT-4)	E	E	E	E	E	-	F	F	-	-	-		P
	Airplane Deicing Fluid (Type I Ethylene Glycol)	E	-	-		E	-	E	-	-	-	-		E
	Airplane Deicing Fluid (Type I Propylene Glycol)	E	-	-		E	-	E	-	-	-	-		G
	Airplane Deicing Fluid (Type IV Ethylene Glycol)	E	-	-		E	-	E	-	-	-	-		E
	Airplane Deicing Fluid (Type IV Propylene Glycol)	E	-	-		E	-	E	-	-	-	-		G
	Transmission Fluid (Havoline Synthetic ATF)	E	E	E	E	E	E	E	E	-	-	-		E
	Engine Coolant (Havoline XLC, 50%/50% premixed)	E	E	E	E	E	-	E	-	-	-	-		E
	Diesel (Chevron #2)	E	E	E	E	E	F	P	P	G	E	E	E	F
	Gasoline (Chevron #91)	E	-	-		P	-	P	-	-	-	-		P
	Skydrol 500B-4	E	E	E	E	G	-	P	P	-	-	-		P
Strong Acid/ Alcohol/ Base	Sulfuric Acid (H2SO4, 30%)	E	E	E	E	E	-	P	F	G	G	P	G	P
	Sodium Hydroxide (NaOH, 10%)	E	E	E	E	E	-	E	-	E	E	E	E	E
	Sebum	-	-	-		-	-	-	-	F	-	G	G	-

Key	Rating	Gain*	Description
E	Excellent	<5%	The solvent is unlikely to degrade the material during prolonged exposure.
G	Good	5% - 15%	The solvent is unlikely to degrade the material during short-term exposure.
F	Fair	15% - 30%	The solvent will likely degrade the material during short-term exposure.
P	Poor	> 30%	The solvent will likely attack and aggressively degrade the material when exposed.

**Percentages are percent weight gain after a 1-week submersion per ASTM D543. Values do not represent changes in dimension or mechanical properties.*

Step 2: Design

Once you have determined that the part is a fit for DLS™ technology, the next step is to review the features of the part. Use the recommended feature sizes below as a guide to maximizing the printability of your part.

- Overhangs, unsupported angle, and unsupported wall thickness will inform the support strategy for your part.

Recommended Feature Sizes

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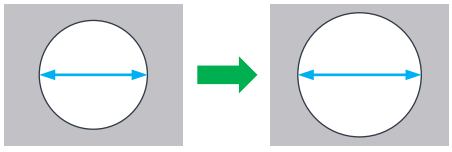
		RIGID 1-PART				RIGID 2-PART								ELASTOMER 2-PART					
FEATURE	Unit	LOCTITE 3843	LOCTITE IND147	LOCTITE IND405	UMA 90	CE 221	EPX 82	EPX 86FR	EPX 150	FPU 50	MPU 100	RPU 70	RPU 130	EPU 40	EPU 41 K	EPU 43	EPU 45	EPU 46 K	SIL 30
Wall Thickness - Unsupported	mm	1.0	1.0	1.5	2.5	2.5	2.5	2.5	1.0	2.5	2.5	2.5	2.5	2.5	2.5	1.5	1.5	1.0	2.5
Wall Thickness - Supported	mm	0.5	1.0	1.0	1.0	1.0	1.5	1.0	1.5	1.0	1.0	1.0	1.5	1.0	1.0	1.5	1.5	0.5	1.5
Maximum Overhang – M1, M2, M3, M3 Max	mm	4.0	4.0	2.0	3.0	3.0	2.0	2.0	4.0	2.0	3.0	2.0	2.0	1.0	1.0	3.0	3.0	2.5	1.0
Maximum Overhang – L1	mm	4.0	4.0	2.0	3.0	3.0	2.0	2.0	4.0	2.0	3.0	2.0	2.0	1.5	1.5	-	3.0	2.5	1.5
Maximum Bridge*	mm	8.0	8.0	4.0	6.0	6.0	4.0	4.0	8.0	4.0	6.0	4.0	4.0	2.0	2.0	6.0	6.0	5.0	2.0
Unsupported angle from horizontal	deg	15	15	40	30	40	40	40	30	35	40	30	40	40	40	30	30	30	40
Hole size – XY – M1, M2, M3, M3 Max	mm	0.5	0.3	1.0	0.9	1.0	0.6	0.6	0.4	0.5	0.9	0.5	1.0	2.0	1.5	0.75	0.75	0.7	2.0
Hole size – XY – L1	mm	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	0.75	0.6	-
Hole size – Z – M1, M2, M3, M3 Max	mm	0.5	0.4	1.5	0.8	0.7	0.9	0.5	0.4	0.5	0.8	0.6	0.8	1.0	1.0	0.75	0.75	0.8	2.0
Hole size – Z – L1	mm	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	0.75	0.8	-
Positive feature size - XY	mm	0.5	0.3	0.5	0.4	0.4	0.3	0.5	0.3	0.5	0.4	0.4	0.3	0.5	0.75	0.5	0.75	0.4	1.0
Positive feature size - Z	mm	0.4	0.6	0.2	0.2	0.2	0.2	0.5	0.3	0.2	0.2	0.2	0.3	0.2	0.3	0.6	0.75	0.3	1.0
Engraving depth/ Embossing height	mm	0.1	0.1	0.5	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.75	0.3	0.5
Text size, engraved/embossed	mm	0.8	1.0	3.0	3.0	3.0	3.0	3.0	1.0	3.0	3.0	3.0	3.0	3.0	3.0	1.3	0.75	0.3	3.0
Clearance between mating parts	mm	0.2	0.2	0.3	0.5	0.8	0.4	0.2	0.2	0.5	0.5	0.4	0.5	0.5	0.5	0.3	0.3	0.1	0.5

** Maximum bridge distance is double the overhang.*

Values are a recommended minimum unless otherwise noted.
All values pertain to both M and L printers unless otherwise noted.

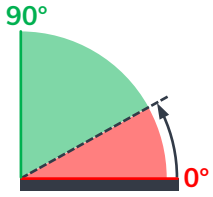
Holes

- To compensate for overcure, horizontal holes should be oversized ~**0.04 mm.**



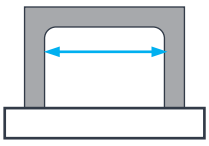
Unsupported angle

- Measured relative to the platform (XY).
- Unsupported angles over **40 degrees** are safe for all materials.



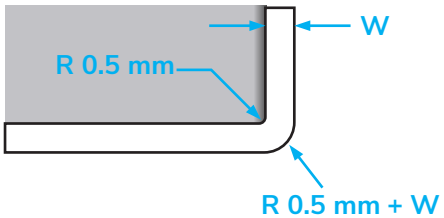
Bridges

- Bridges should span no more than twice the recommended overhang distance.



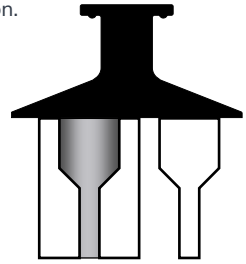
Fillets

- Interior corners ~ **0.5 mm** minimum
- Exterior corners ~ **0.5 mm** + wall thickness



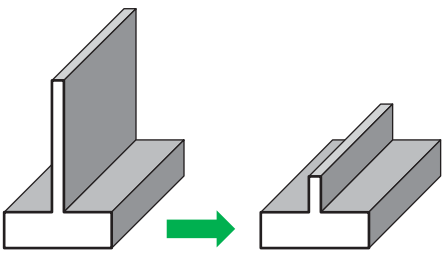
Mating parts

- Print mating parts in the same orientation.



Wall thickness

- For walls at minimum thickness, keep the walls short.



Step 3: Optimize

Now that the part features have been sized according to Carbon's recommendations, the next step is to optimize the design for supporting and printing.

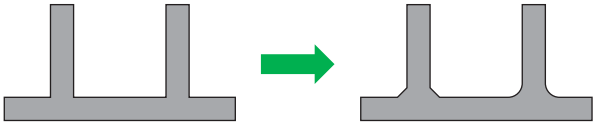
A. Issues to address before supporting

Low resolution model

- Adjust export settings to make a smooth model.

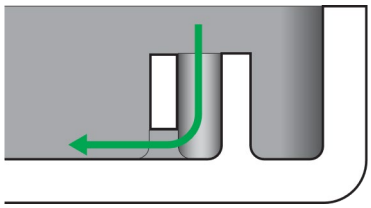
Sharp corners

- Add fillets or chamfers



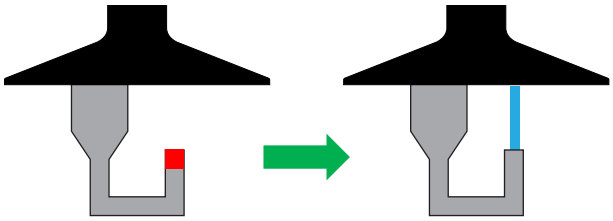
Unvented volumes and blind holes

- Add **2-3 mm** vents or re-orient part



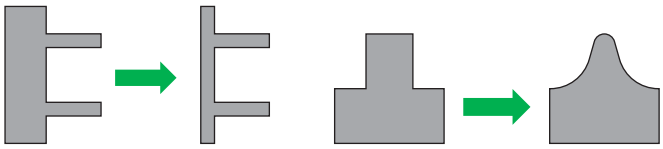
Slice islands

- These are unstable features that suddenly appear in the slice video. Islands must be supported or connected to part to prevent defects.



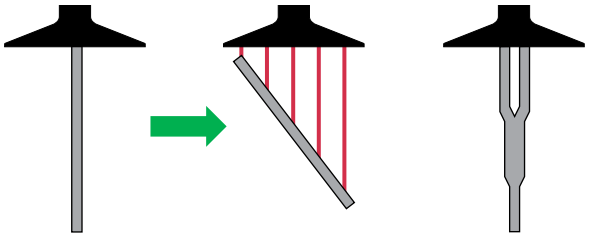
Non-uniform, rapidly changing or stepped wall thickness

- Make wall thickness uniform or as gradual as possible to minimize printing defects and prevent warp during baking.



Tall, thin parts

- Change orientation or redesign to reduce part height or create stability.



B. Supporting

- Check overhangs
- Check unsupported angles
  - Use **Overhang Detection**
- Place supports no closer than the recommended overhang distances from:
  - Part walls
  - Other supports
- Support any slice islands
- **Advanced supports** provide 1st print success.
- Reinforce supports taller than **76 mm**
  - Fence supports can use bar supports in the fence as reinforcement

C. 1st Print Accuracy

- Accuracy is dependent on many factors including:
  - Part geometry
  - Resin
  - Baking method
- For 1st print assume **±70 µm + 1µm per mm dimension size**
- **Iterate on design, orientation, and/or supports as needed to improve accuracy**