DLS™ Design Quick Guide

V02.02
March 23, 2021

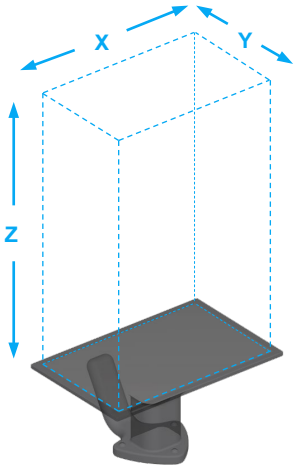
This document offers a multi-step workflow to help you design and support parts quickly. Follow the steps below to determine if the part in question is a fit for DLS™ technology and achieve first print success.

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

Build envelope: Will part(s) fit?

	M1	M2	L1
X	141 mm (5.6 in)	189 mm (7.4 in)	410 mm (16.1 in)
Y	79 mm (3.1 in)	118 mm (4.6 in)	256 mm (10.1 in)
Z	326 mm (12.8 in)	326 mm (12.8 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

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

Material properties

V04.01 | November 11, 2020

	RESIN	ULTIMATE TENSILE STRENGTH	ELONGATION AT BREAK	TENSILE MODULUS	SHORE HARDNESS	IMPACT STRENGTH *	HEAT DEFLECTION TEMP**	COMPARABLE THERMOPLASTIC	BIOCOMPATIBILITY: CYTOTOXICITY	FULL MATERIAL DATA****
2 PART	CE 221	85 MPa	3%	3900 MPa	92D	15 J/m	230° C	Glass filled nylon	✓	TDS
	EPU 40	9 MPa	300%	N/A	68A	N/A	N/A	TPU	✓	TDS
	EPU 41	15 MPa	250%	N/A	73A	N/A	N/A	TPU	✓	TDS
	EPX 82	80 MPa	5%	2800 MPa	89D	45 J/m	130° C	20% glass-filled PBT	✓	TDS
	FPU 50	25 MPa	200%	700 MPa	71D	40 J/m	70° C	Polypropylene	✓	TDS
	MPU 100	35 MPa	25%	1200 MPa	81D	30 J/m	50° C	-	✓	TDS
	RPU 70	40 MPa	100%	1700 MPa	80D	15 J/m	60° C	ABS or PC ABS	✓	TDS
	RPU 130	35 MPa	100%	900 MPa	77D	75 J/m	120° C	Nylon 6	✓	TDS
	SIL 30	3.5 MPa	350%	N/A	35A	N/A	N/A	TPE	✓	TDS
1 PART	DPR 10	45 MPa	4%	1800 MPa	N/A	20 J/m	60° C	-	✓	TDS
	Henkel IND405	42 ± 4 MPa	120 ± 8%	1500 ± 31 MPa	78D	50 J/m	53° C	Polypropylene	-	Loctite TDS
	PR 25***	29 MPa	>15%	920 MPa	N/A	18 J/m	49° C	-	✓	NA
	UMA 90	30 MPa	30%	1400 MPa	86D	30 J/m	45° C	-	✓	TDS

Indicates the highest value in its category.

* NOTCHED IZOD, ASTM D256
** 0.455 MPA, ASTM D648
*** UV-LED Cure, 30s/side
**** Refer to the TDSs for further information

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Chemical Compatibility

Will part(s) be exposed to chemicals? For more information see the Technical datasheets 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**	**RPU 70**	**RPU 130**	**EPU 40**	**EPU 41**	**SIL 30**
Household Chemicals	Bleach (NaClO, 5%)	<5%	<5%	<5%	-	<5%	<5%	<5%
	Sanitizer (NH4Cl, 10%)	<5%	<5%	<5%	-	<5%	<5%	5 – 15%
	Distilled Water	<5%	<5%	<5%	-	<5%	<5%	5 -15%
	Sunscreen (Banana Boat, SPF 50)	<5%	<5%	<5%	5 -15%	5 -15%	>30%	5 -15%
	Detergent (Tide, Original)	<5%	<5%	<5%	-	<5%	5 -15%	5 -15%
	Windex Powerized Formula	<5%	<5%	<5%	-	5 -15%	5 -15%	5 -15%
	Hydrogen Peroxide (H2O2, 30%)	<5%	<5%	<5%	-	15 -30%	15 -30%	15 -30%
	Ethanol (EtOH, 95%)	<5%	5 -15%	15 -30%	-	>30%	>30%	>30%
Industrial Fluids	Engine Oil (Havoline SAE 5W-30)	<5%	<5%	<5%	<5%	<5%	<5%	<5%
	Brake Fluid (Castrol DOT-4)	<5%	<5%	<5%	-	15 -30%	15 -30%	
	Airplane Deicing Fluid (Type I Ethylene Glycol)	<5%	-	<5%	-	<5%	-	<5%
	Airplane Deicing Fluid (Type I Propylene Glycol)	<5%	-	<5%	-	<5%	-	5 -15%
	Airplane Deicing Fluid (Type IV Ethylene Glycol)	<5%	-	<5%	-	<5%	-	<5%
	Airplane Deicing Fluid (Type IV Propylene Glycol)	<5%	-	<5%	-	<5%	-	5 -15%
	Transmission Fluid (Havoline Synthetic ATF)	<5%	<5%	<5%	<5%	<5%	<5%	<5%
	Engine Coolant (Havoline XLC, 50%/50% premixed)	<5%	<5%	<5%	-	<5%	-	<5%
	Diesel (Chevron #2)	<5%	<5%	<5%	15 -30%	>30%	>30%	15 -30%
	Gasoline (Chevron #91)	<5%	-	>30%	-	>30%	-	>30%
	Skydrol 500B-4	<5%	<5%	5 -15%	-	>30%	>30%	>30%
Strong Acid/Alcohol/Base	Sulfuric Acid (H2SO4, 30%)	<5%	<5%	<5%	-	>30%	15 -30%	>30%
	Sodium Hydroxide (NaOH, 10%)	<5%	<5%	<5%	-	<5%	-	<5%

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

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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 maximize the printability of your part.

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

Recommended feature sizes

V05.05
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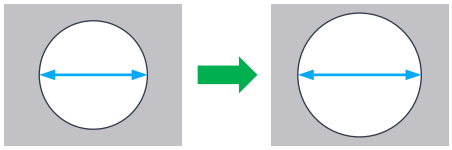
FEATURE	RIGID 2-PART						RIGID 1-PART			ELASTOMER		
	CE 221	EPX 82	FPU 50	MPU 100	RPU 70	RPU 130	LOCTITE IND405 Clear	PR 25	UMA 90	EPU 40	EPU 41	SIL 30
Wall Thickness - Unsupported (mm)	2.5	2.5	2.5	2.5	2.5	2.5	1.5	2.5	2.5	2.5	2.5	2.5
Wall Thickness - Supported (mm)	1.0	1.5	1.0	1.0	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.5
Maximum Overhangs (mm) M1/M2	3.0	2.0	2.0	3.0	2.0	2.0	2.0	3.0	3.0	1.0	1.0	1.0
L1	3.0	2.0	2.0	3.0	2.0	2.0	2.0	3.0	3.0	1.5	1.5	1.5
Maximum Bridges (2x overhang) (mm)	6.0	4.0	4.0	6.0	4.0	4.0	4.0	6.0	6.0	2.0	2.0	2.0
Unsupported angle (deg) - from horizontal	40	40	35	40	30	40	40	30	30	40	40	40
Hole size XY (mm)	1.0	0.6	0.5	0.9	0.5	1.0	1.0	0.9	0.9	1.0	1.5	2.0
Hole size Z (mm)	0.7	0.9	0.5	0.8	0.6	0.8	1.5	0.6	0.8	0.8	1.0	2.0
Positive feature size XY (mm)	0.4	0.3	0.5	0.4	0.4	0.3	0.5	0.6	0.4	0.5	0.75	1.0
Positive feature size Z (mm)	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.3	1.0
Engraving depth/Embossing height (mm)	0.4	0.3	0.3	0.3	0.3	0.3	0.5	0.3	0.3	0.3	0.3	0.5
Text size, engraved/embossed (mm)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Clearance between mating parts (mm)	0.8	0.4	0.5	0.5	0.4	0.5	0.3	0.5	0.5	0.5	0.5	0.5

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

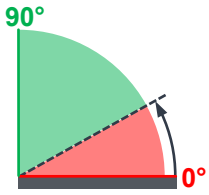
Holes

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



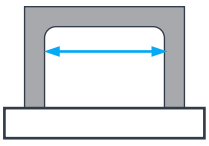
Unsupported angle

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



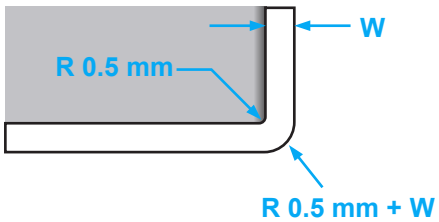
Bridges

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



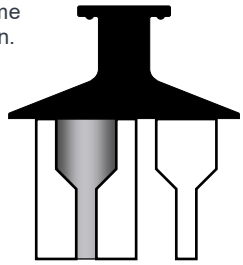
Fillets

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



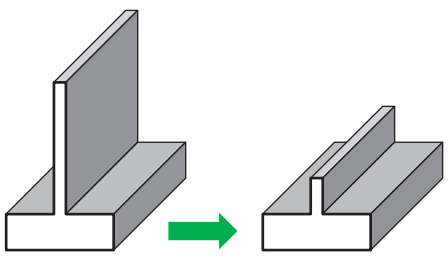
Mating parts

- Print mating parts in the same orientation.



Wall thickness

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



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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.

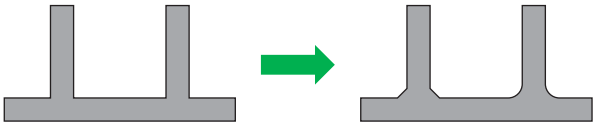
Issues to address before supporting

Low resolution model

- Adjust export settings to make a smooth model.

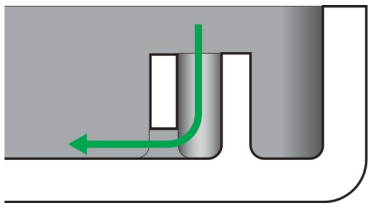
Sharp corners

- Add fillets or chamfers



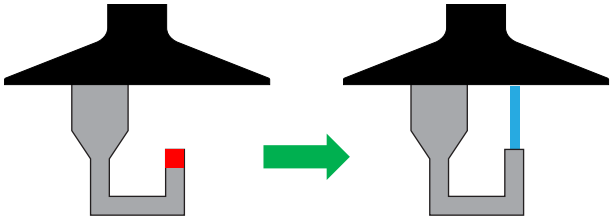
Unvented volumes and blind holes

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



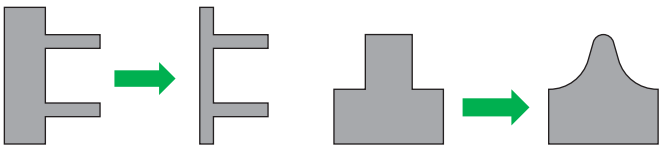
Slice islands

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



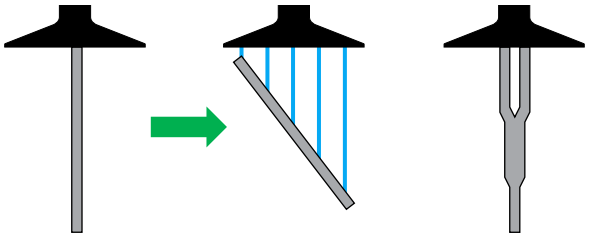
Non-uniform, rapidly changing or stepped wall thickness

- 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.



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

1st Print Accuracy

- Accuracy is dependent on many factors including:
  - Part geometry
  - Resin
  - Baking method
- For 1st print assume **±0.200 mm** as a general guide
- **Iterate on design, orientation, and/or supports as needed to improve accuracy**