FORMLABS APPLICATION GUIDE:

3D Printing Surgical Guides with the Form 2

Formlabs Dental SG Resin is a Class 1 biocompatible material formulated for manufacturing precise surgical guides, pilot drill guides, and drilling templates. This application guide demonstrates each step for making 3D printed surgical guides on the Form 2 3D printer. Use the following workflow to ensure precise results.

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Essentials

Made by Formlabs

Form 2 (SLA) 3D Printer

Dental SG Resin

PreForm Software (free)

Finish Kit or Form Wash

Form Cure

Made by 3rd Parties

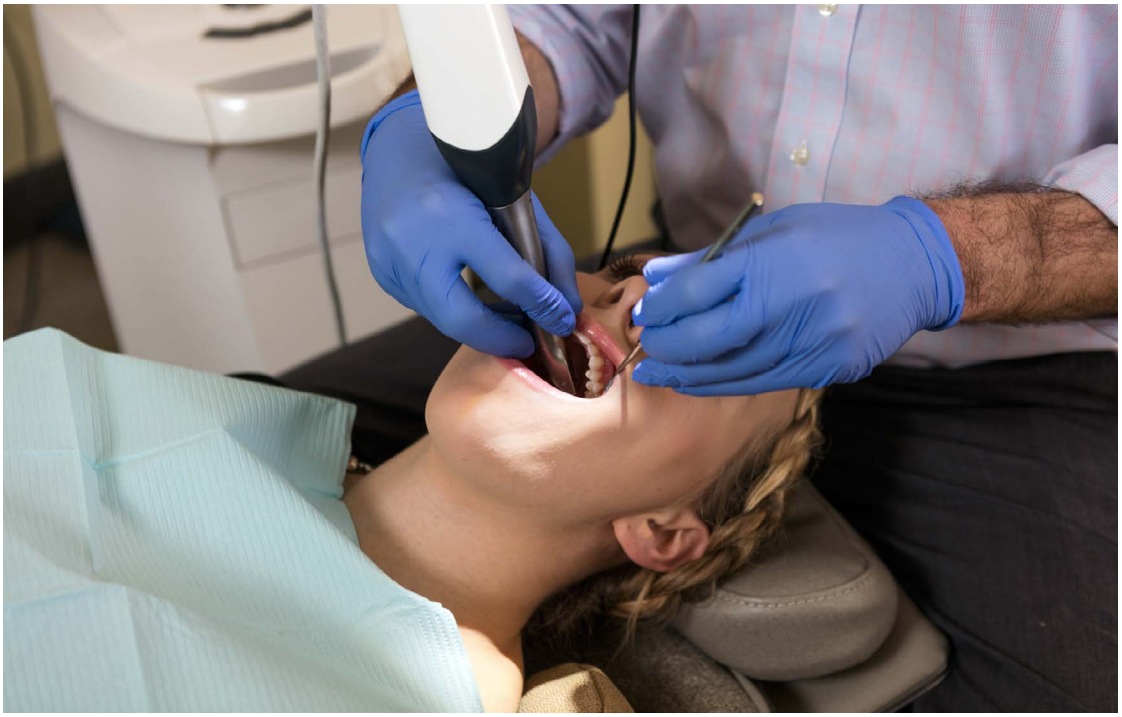
Surgical guide treatment planning and design software (CAD)

Intraoral or Desktop Optical Scanner

CBCT scanner

Metal guide tube

1. Scan



In order to plan the treatment and design a surgical guide, collect anatomical data of the patient's dentition using an optical scanner. Either scan the patient directly with an intraoral scanner, or use a desktop optical scanner to scan a polyvinyl siloxane (PVS) impression or model.

To make a fully limited surgical guide, also capture the anatomy of the patient osteotomy with a cone-beam computed tomography (CBCT) scanner.

2. Design

To begin, design the surgical guide in dental CAD software. Make sure to select software that offers open STL file export to ensure compatibility with PreForm.

Adjust design settings carefully for each guide to ensure safety, precision, and comfort. Design surgical guides following the guidelines below to ensure strong, durable results.

DESIGN SETTING	MINIMUM VALUE	MAXIMUM VALUE	RECOMMENDED DEFUALT VALUE
Wall Thickness Ensures structural stability, should be large enough for sufficient strength and durability.	2.0 mm	n/a	3.0 mm
Offset From Teeth Impacts how tightly the guide fits on the patient's teeth — higher values will fit more loosely, lower values will fit more tightly.	0.05 mm	0.07 mm	0.06 mm
Offset From Sleeve Ensures a tight press fit when inserting the metal guide sleeve.	0.04 mm	0.06 mm	0.05 mm
Retention Amount	0.00 mm	0.00 mm	0.00 mm

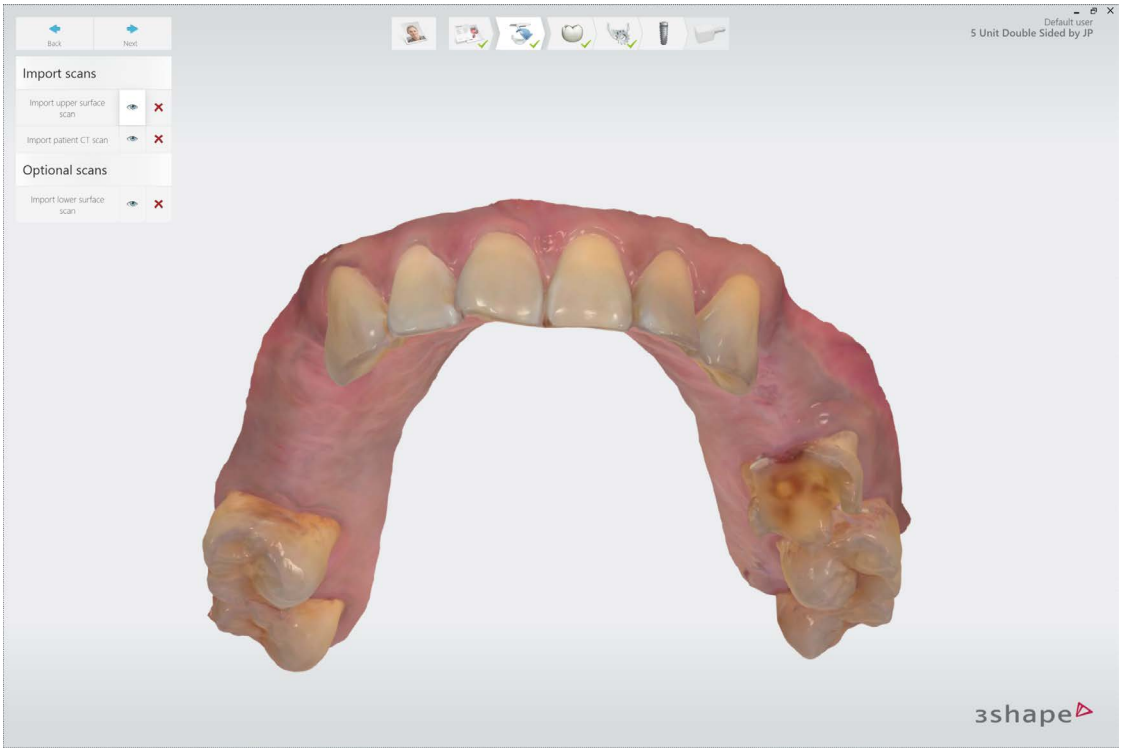
The exact step-by-step in treatment planning and surgical guide design varies by software package, but generally follow the same high level flow. For detailed advice on designing surgical guides, contact your software's manufacturer.

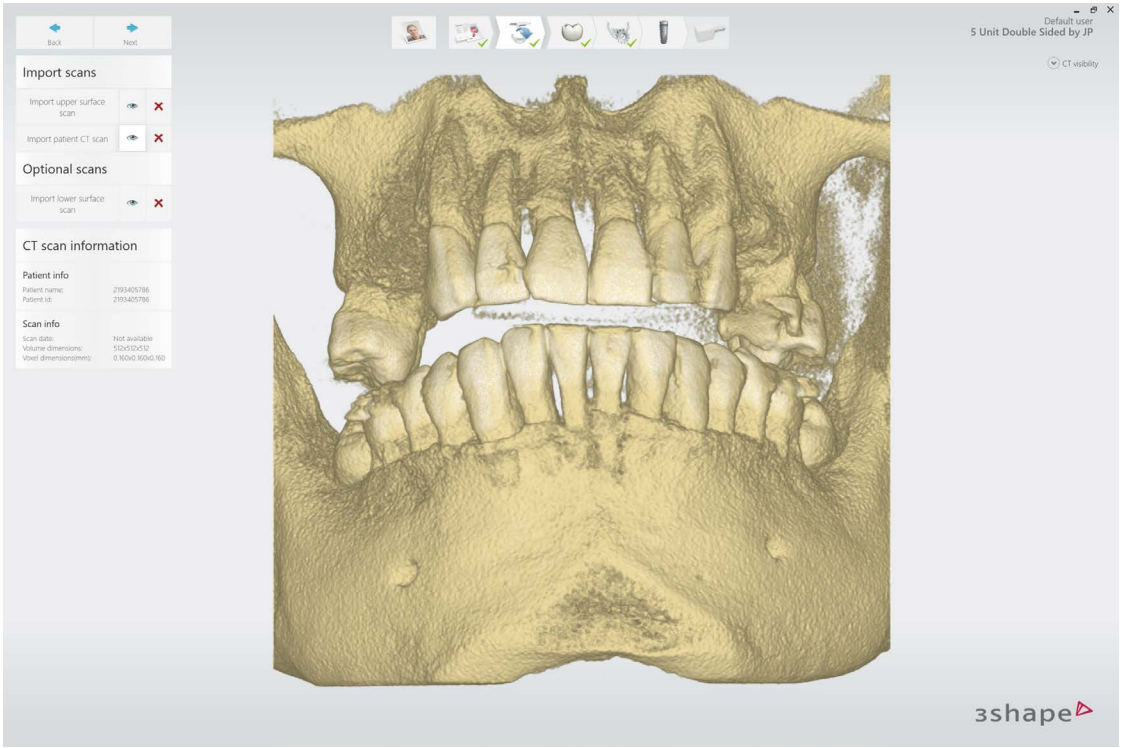
A few high level best practices and considerations for 3D printing are:

2.1 IMPORT SCANS

Import both the intraoral or desktop optical scans of the patient dentition and the CBCT scan of the patient osteotomy into your dental CAD software.

The standard file format for optical scans is .STL, while the standard for CBCT is .DICOM. Most scanners allow open export, and most software allow open import, of these file types. Be sure to check whether software is compatible with scanners when purchasing new solutions.



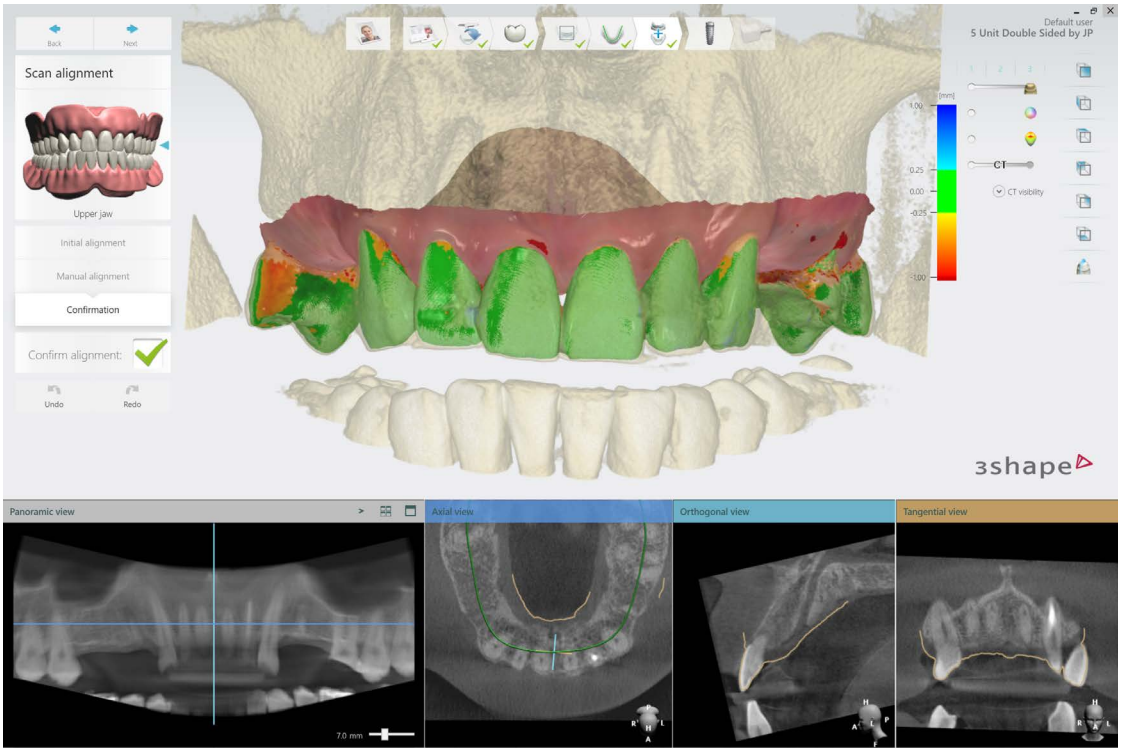


2.2 REVIEW SCANS

Review the CBCT scans, and identify the mandibular nerve if applicable.

2.3 ALIGN SCANS

Align the intraoral scan and the CBCT scan using both manual point-of-interest identification tools and automatic tools for detailed alignment. This allows both the detailed surface scan data and the CBCT bone data to be used in treatment design.

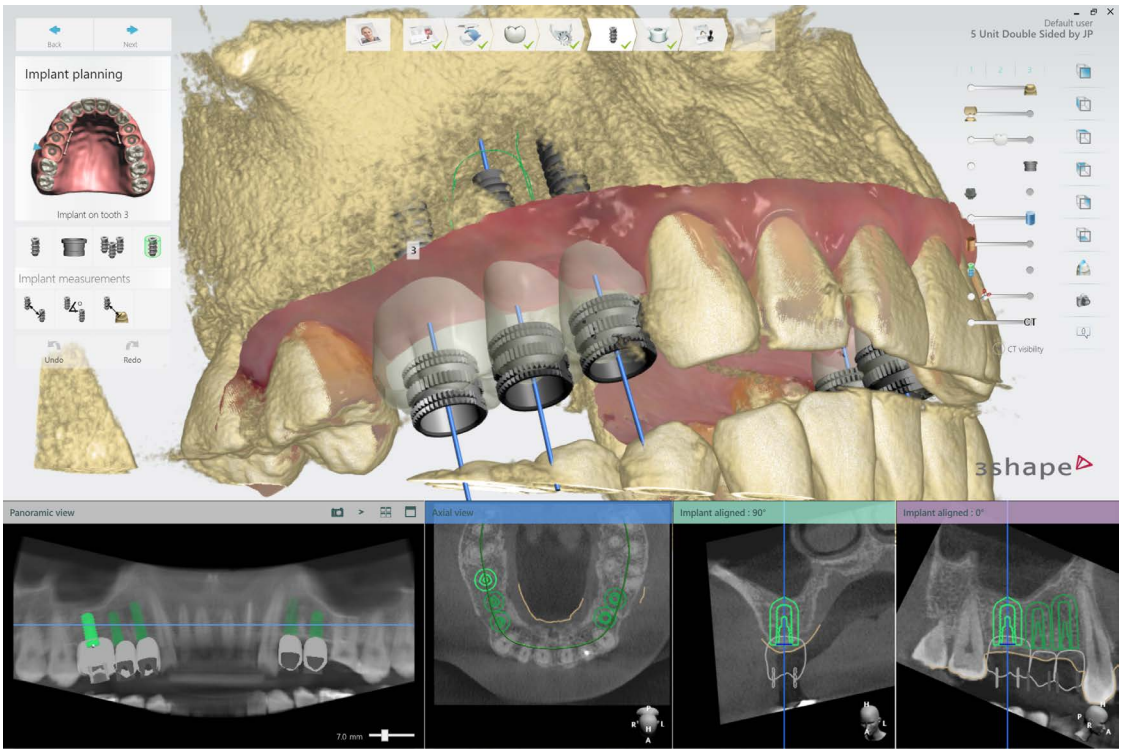


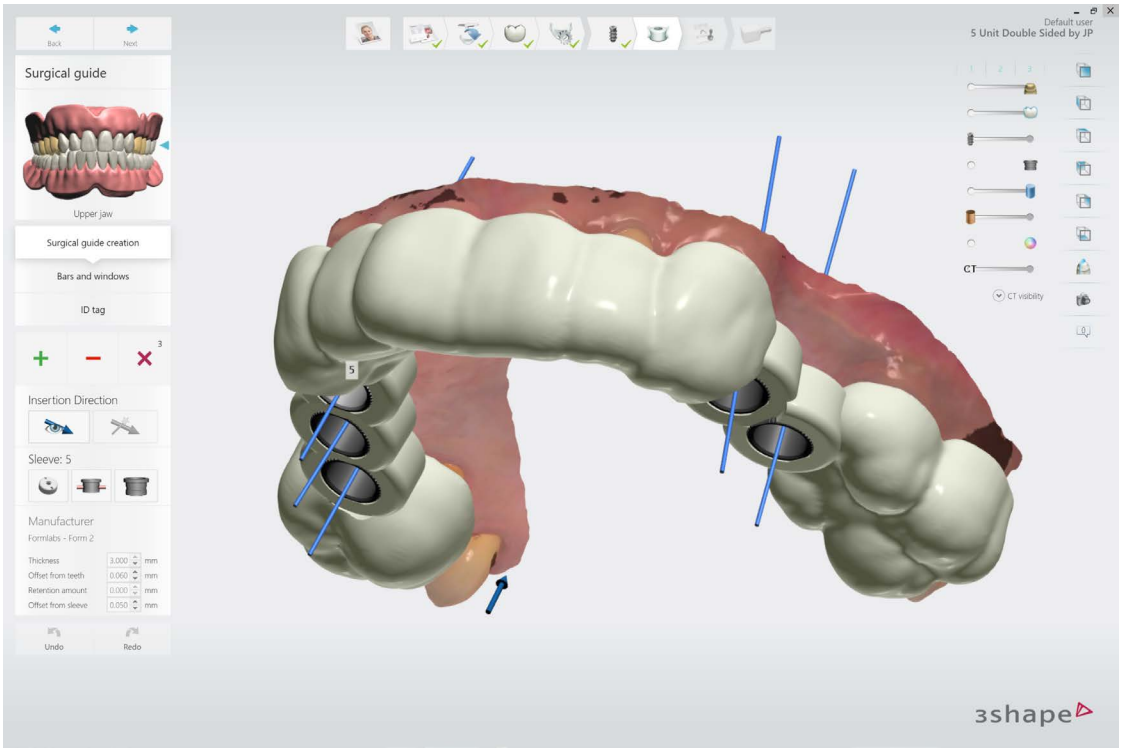
2.4 DESIGN TREATMENT

Select your desired implant and place it on the patient's anatomy. Choose the position, angulation, depth, desired clinical outcomes, and restoration design. Most dental CAD software packages offer a range of implant libraries, allowing you to design virtually with the implant system being used for the specific case.

2.5 DESIGN SURGICAL GUIDE

Design the surgical guide by drawing the desired area of the arch to cover. For the best retention and accuracy, use full arch guides. If you prefer a smaller guide, design only half or quarter-arch guides. The dental CAD software should generate a model integrating the implant system with the guide design.





2.6 EXPORT

Once the design is created, export a digital model of the part in STL or OBJ file format.

3. Print

3.1 SELECT MATERIAL

Open PreForm. Select “Dental SG” from the Material menu.

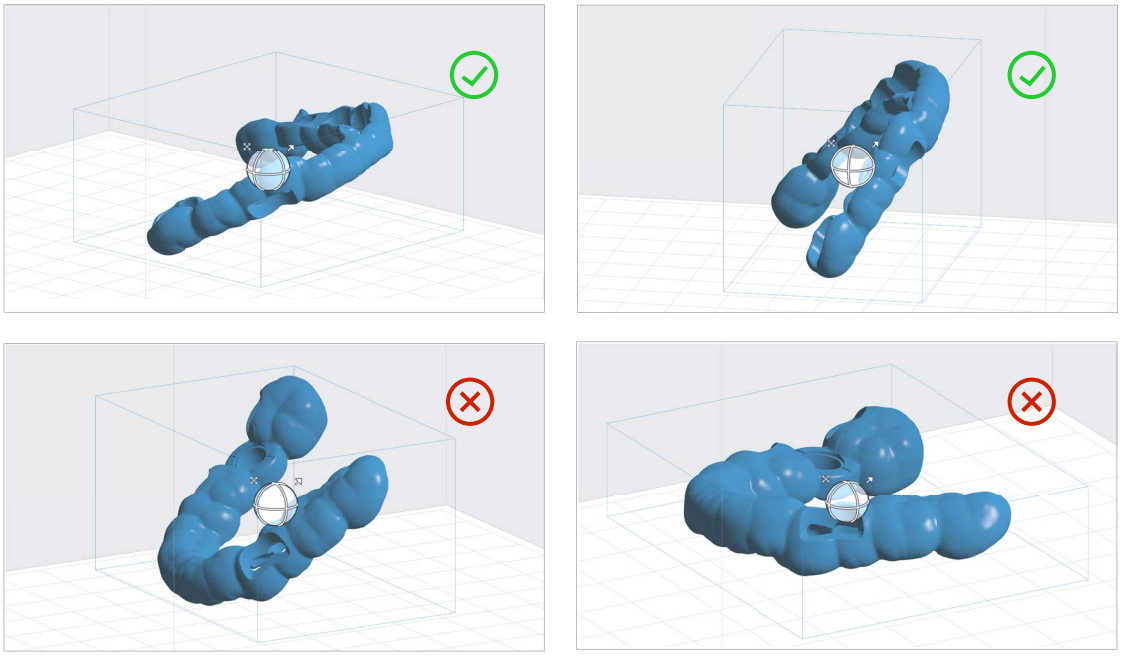
3.2 IMPORT MODEL FILES INTO PREFORM

Import the STL or OBJ file into PreForm.

> **NOTE:** If you are using 3Shape Implant Studio or other dental CAD software that integrates with PreForm, steps 3.2-3.4 are automated. The software automatically orients parts and generates supports. Your ready-to-print file will open directly in PreForm. After it loads, just click print.

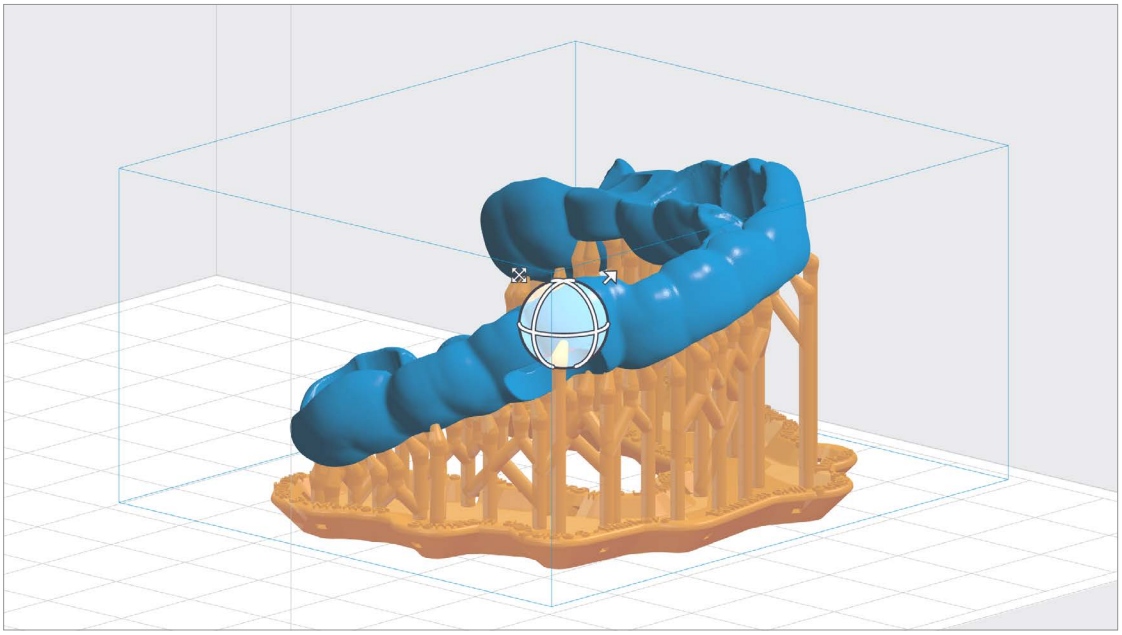
3.3 ORIENT MODELS

Orient parts with the intaglio surfaces facing away from the build platform to ensure that supports will not be generated on these surfaces. If printing more than one surgical guide in a single print, manipulate the placement of each model on the build platform for the best fit.



3.4 GENERATE SUPPORTS

Generate supports using PreForm's auto-generation feature. To allow for simple and precise assembly, ensure that there are no supports near the guide tube holes or on the intaglio surfaces. Use the manual support editing feature to closely inspect support locations and add or remove supports as needed.



3.4 UPLOAD THE PRINT

3.5 PREPARE THE PRINTER AND RESIN

Thoroughly agitate the resin cartridge by shaking and rotating it several times. Insert a resin tank, the resin cartridge, and a build platform into the printer.

> **WARNING:** For full compliance and biocompatibility, Dental SG requires a dedicated Resin Tank, Build Platform, and Finish Kit, which should only be used with other Formlabs biocompatible resins, such as Dental LT Clear.

USING STANDARD RESIN TANKS VS. RESIN TANK LT

For the highest accuracy and precision, Resin Tank LT is recommended for printing with Dental SG. Tests using Dental SG on Resin Tank LT revealed no degradation of accuracy or precision over the lifetime of the tank.

If printing with a standard resin tank, laser exposure forms white, clouded marks on the surface of the resin tank's silicone layer. This clouding eventually becomes extreme enough to affect accuracy. Testing revealed that surgical guide accuracy began decreasing after 2,000 layers were printed in a given position on the tank. In testing a worst-case scenario of printing an identical surgical guide in the same position in a standard resin tank multiple times, surgical guides still fit accurately after 25 consecutive prints.

To avoid fit issues due to tank clouding, switch to a new standard resin tank after 25 consecutive prints, or with every new cartridge of resin, whichever comes earlier.

3.6 PRINT

4. Post-process

Thoroughly agitate the resin cartridge by shaking and rotating it several times. Insert a resin tank, the resin cartridge, and a build platform into the printer.

PRINTED POST-CURED FINISHED ASSEMBLED STERILIZED

4.1A WASH PARTS WITH FORM WASH

If you do not own a Form Wash, skip to 4.1b.

Place the build platform, with surgical guides still attached, in a Form Wash filled with isopropyl alcohol (IPA), 96% or higher. Set to wash for 5 minutes to clean the parts and remove liquid resin before post-curing.

Leave parts to air dry completely, or use a compressed air hose to blow IPA away from surfaces. Inspect parts closely to ensure all uncured resin has been removed. Repeat wash if necessary, but do not leave parts in IPA for more than 20 minutes, as this may reduce mechanical performance and cause defects in the printed parts.

Remove parts from the build platform with the part removal tool.

4.1B WASH PARTS WITH THE FINISH KIT

If you do own a Form Wash, skip 4.1b.

Remove parts from the build platform with the part removal tool.

Rinse the parts in two buckets of isopropyl alcohol (IPA), 96% or higher, for 5 minutes each to clean parts and remove liquid resin before post-curing.

Leave parts to air dry completely, or use a compressed air hose to blow IPA away from surfaces. Inspect parts closely to ensure all uncured resin has been removed. Repeat wash if necessary, but do not leave parts in IPA for more than 20 minutes, as this may reduce mechanical performance and cause defects in the printed parts.

4.2A POST-CURE PARTS WITH FORM CURE

If you do not own a Form Cure, skip to 4.2B.

Printed surgical guides must be exposed to light and heat to achieve biocompatibility and optimal mechanical properties. Place the printed guides inside Form Cure. Post-cure for 30 minutes at 60 °C.

During post-curing, a color change from translucent yellow to translucent orange will occur.

4.2B POST-CURE PARTS WITH AN ALTERNATIVE POST-CURE CHAMBER

If you do own a Form Cure, skip 4.2B.

Printed surgical guides must be exposed to light and heat to achieve biocompatibility and optimal mechanical properties. Cure time depends on the light intensity and the internal temperature of the curing device. One acceptable method for post-curing is exposure for 10 minutes to 108 watts each of Blue UV-A (315 – 400 nm) and UV-Blue (400 – 550 nm) light, in a heated environment at 60 °C (140 °F). One acceptable lighting setup is six (6) 18W/71 lamps (Dulux L Blue) and six (6) 18W/78 lamps (Dulux blue UV-A). Ensure that the target temperature is reached before beginning the timer.

WARNING: Post-curing outside of the recommended settings can lead to suboptimal mechanical and biocompatibility properties. Post-cure only in accordance with official recommendations from Formlabs for the best possible results.

4.3 REMOVE SUPPORTS

Use the flush cutters included in the Formlabs Finish Kit to carefully cut the supports at the points where they attach to the part. Use caution when cutting the supports, as the post-cured material may be brittle. Supports can also be removed using other specialized appliances, such as cutting disks or round cutting instruments like carbide burs.

WARNING: Remove supports only after post-curing to ensure that parts do not warp.

4.4 POLISH PARTS

Polish parts using high grit sandpaper to smooth support marks. For higher levels of part translucency, polish guides using pumice and a rag wheel or other specialized appliances.

4.5 ASSEMBLE THE SURGICAL GUIDE

Metal guide tubes are required to ensure that drill bits do not cut into the printed guide itself. To ensure proper safety and use, assemble printed guides with metal guide sleeve tubes.

When using the recommended design parameters, metal tubes can be press fit into the guide. Friction holds the metal tube in place.

5. Use

5.1 STERILIZATION, CLEANING, AND DISINFECTING

Dental SG printed guides can be sterilized in industry-standard steam autoclaves, either with or without sterilization pouches. Sterilize according to one of the approved cycles below.

	TEMPERATURE	TIME
Schedule 1	121 °C	15 minutes
Schedule 2	134 °C	6 minutes
Schedule 3	138 °C	3 minutes

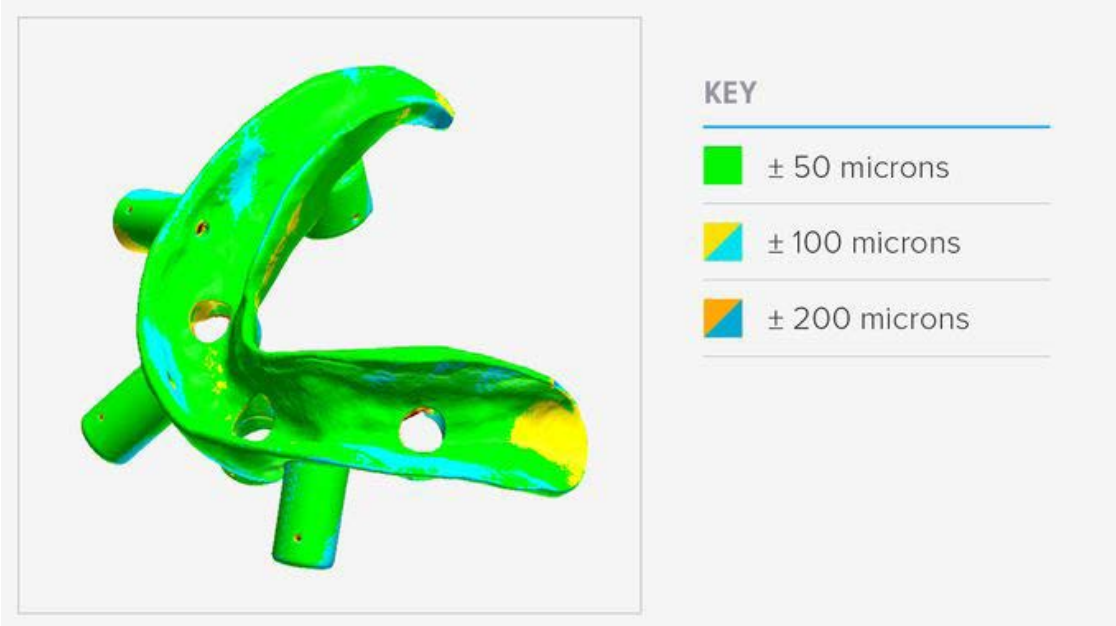
After autoclaving, parts will lighten in color.

If cleaning or disinfection methods are preferred or required, use non-chemical products or an ethanol solution.

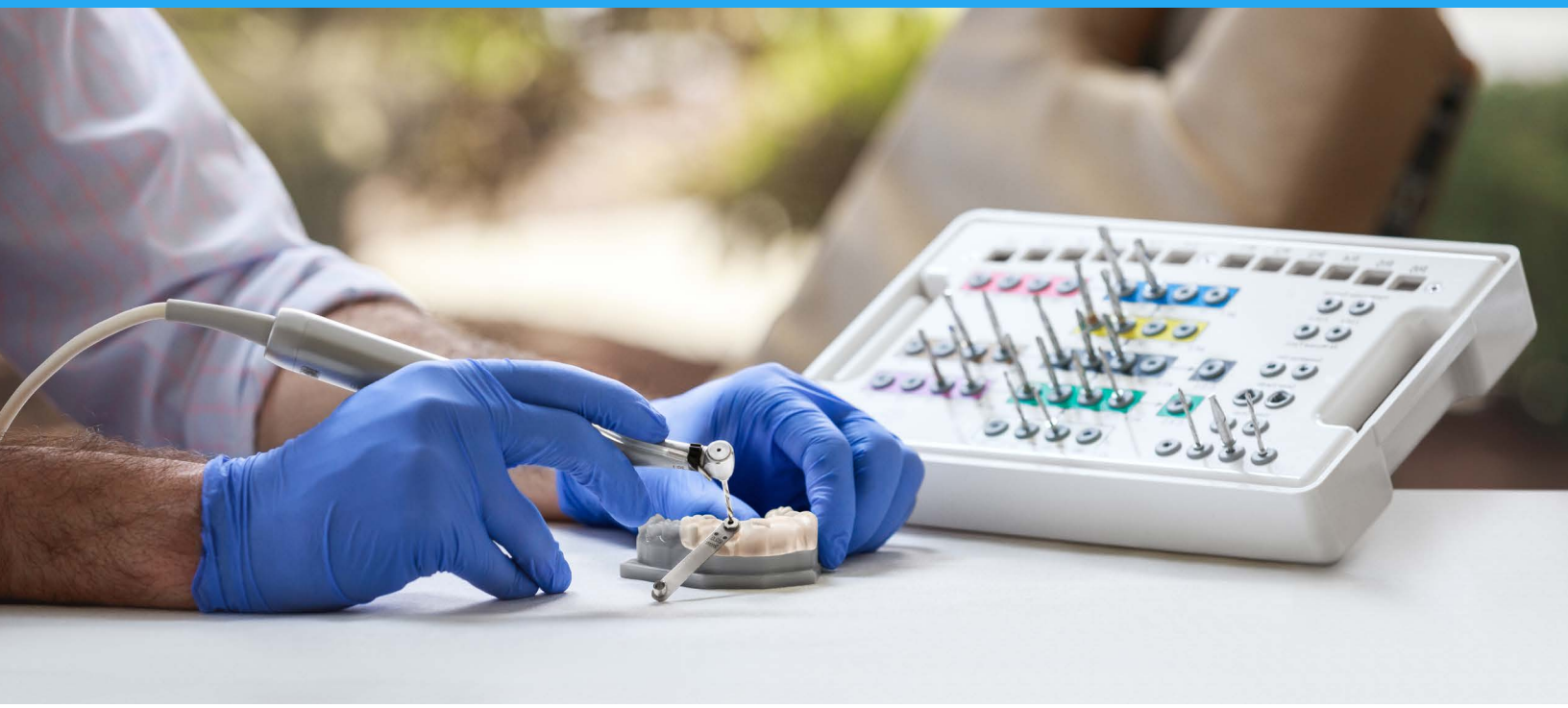
5.2 PERFORM PROCEDURE

Carry out the procedure with precision using the surgical guide.

Accuracy Study



An in-depth accuracy study of 84 Dental SG printed surgical guides showed that intaglio surfaces of Form 2 printed surgical guides were dimensionally accurate within ±100 microns over 93 percent of the surface area. This was found to provide a precise fit on both models and patients.



Biocompatibility

Dental SG adheres to the following ISO standards:

EN-ISO 10993-1:2009/AC:2010
EN-ISO 20795-1:2013
EN-ISO 7405:2009/A1:201

EC Declaration of Conformity