Orca

3D Printed AR-15 Rifle System

Hoffman Tactical 1/18/23 V5.3

1 Introduction

The Orca is a 3D printed AR-15 rifle. The goal of the project was to print as much of the AR-15 as possible, without compromising the performance.

The following components that would be on a factory AR-15 have been replaced by printed or non-firearm parts, or made unnecessary: Upper, lower, handguard, buffer tube, barrel nut, stock, grip, takedown pins, buffer retainer, etc.… This list is not exhaustive, but gives the reader an idea of the scope of this project.

The handguard and stock are attached to the receivers by tapered clips held in place by hose clamps. This system is strong and low profile.

The split line of the upper and lower has been fully redesigned from the simple split on a standard AR-15. This has been done to improve the strength of the upper, the upper-lower connection, and make the parts easier to print.

The barrel mount at a minimum should be printed from a high temperature filament, such as glass filled Nylon. Preferably the upper and handguard should also be printed from a high temp filament. These requirements, and the need for accurate prints that properly fit together, make this an advanced build. Precede with care.

Premade support and modifiers are included for convenience.

With most printers the Orca will require approximately 100 hours of print time.

This guide will walk you through printing and assembling the Orca.

Figure 1 Orca waiting to be assembled.

2 CREDITS

I had a lot of help with this project, and pulled a lot of ideas from elsewhere. I want to give credit where due.

@chairmanwon and *@middleton_made* both gave valuable suggestions helping with the design process and design.

I took inspiration from *@protofirearms* early work with printable AR-15 uppers, and used his method of angling the mag well to improve feeding and eliminate plastic ramps.

The clamshell barrel mount is taken from the KF-5 developed by *@IvanTheTroll (@NaviGoBoom*), originally used on his Amigo Grande, a CETME 308 rifle.

The use of the ceramic insert to support the gas tube was inspired by the steel tube used on the Bidens Bane 3D printed AR-15 upper.

The use of the fiberglass sleeve was inspired by @InvaderZip_ and his use of a PTFE gas tube sleeve on the ARK 2.0.

And special thanks goes to *@simplyhuffy, @cjs10mm, @Scsupermoto, @Nosteppyfirearms, @glowinowen, @3D_Arms,* and the rest of the Beta Testers who helped make this project possible!

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4 Resources

Parts, materials, tools, etc.…

4.1 Parts

All of the printed parts. See section five.

The following AR-15 parts are required:

- Barrel. Mid, carbine, or pistol. 5.56 has been tested. Other calibers use at your own risk.
- Gas block. Low profile. Set screw type, not clamping.
- Gas Tube. Mid, carbine, or pistol depending on barrel.
- Bolt carrier group.
- Charging Handle. Large latch recommended. Warhammer not compatible.
- Carbine buffer mass.
- Carbine buffer spring.
- Fire control group. Drop in or mil-spec.
- Selector switch, detent, and spring.
- Mag catch lever, button, and spring.
- Bolt hold open lever, pin, plunger, and spring.

The following hardware components are required:

- (3) 10-32 heat set inserts. www.mcmaster.com/97171A220/
- (2) 10-32 x 1.25” Socket Head Screws. www.mcmaster.com/91251A349/
- (1) 10-32 x 0.75” Socket Head Screw. https://www.mcmaster.com/91251A345/
- (1) 10-32 x 5/32 Set Screw. www.mcmaster.com/92311A306/
- (2) 3/32 x 1.0” Dowel Pin. www.mcmaster.com/98381A443/
- (2) #24 0.5” Wide Worm Drive Hose Camps. https://www.mcmaster.com/54155K17/
- (1) 0.375” OD 0.192 ID x 0.75” Ceramic Insert. www.mcmaster.com/96109A225/

The following parts are optional, but recommended:

- (4) Brass bushing. hoffmantactical.com/product/brass-pin-bushings/
- Muzzle device.
- Optic or sighting system.
- Magazine.
- Fiberglass sleeving for gas tube.

4.1.1 Some notes on the above parts

Two handguard files are included, a short one that will cover up to a carbine length gas system, and a longer one for a mid length system. No handguard is provided long enough to cover a rifle length system, which is why that length is not recommended. However, it would still function.

The gas block must fit inside the handguard. A low profile gas block using set screws was used as the model during design. A low profile gas block using a clamping design will not work, as the clamping fingers extend down too far, and will interfere with the handguard.

While a mil-spec charging handle will work, an upgraded handle such as the Aero Precision BREACH or Radian Raptor is highly recommended, as it will make charging the weapon much easier. The Strike Industries Latchless Charging Handle may not work as internal geometry has been changed on the upper. The Breek Warhammer will also not work, as it's latch geometry is too small. However, most handles should work. Pick your favorite.

The length of the buffer tube is designed for carbine builds. Rifle springs and masses will not work.

Any fire control group should work, with the exception of Rare Breed style FRT triggers, as there locking bar geometry is too wide.

The exact specified heat set inserts should be used, as they must have the proper profile to melt into the parts.

The ceramic insert insulates the gas tube and works very well. However, they are hard to find. A metal insert of the same size with fins cut into it would also work, but would require a lathe.

The brass bushings can be eliminated by adding the bushing blocks to the lower. This is covered more in the slicing section.

The fiberglass sleeving is provided in the kits. Any high temperature fiberglass sleeving of the proper diameter should work. It covers the gas tube up to the ceramic insert, and protects the barrel mount and handguard from the extreme heat of the gas tube. I use this sleeving, after it has been coated with silicone: https://www.mcmaster.com/7324T13/

If you don't want to source all the hardware parts yourself, hardware kits are available from https://hoffmantactical.com/shop/

Figure 2 Orca hardware.

4.2 Materials

The following filaments are recommended for each part:

- Barrel Mount:
    - COEX GF Nylon.
    - Polymaker PA6-CF.
    - Any other high temp filled Nylon or Polycarbonate.
- Handguard and Upper:
    - Polymaker PA6-CF
    - COEX GF Nylon.
    - Polymaker PLA Pro.
    - Any other PLA+ or high temp filament.
- Lower and Stock:
    - Polymaker PA6-CF.
    - COEX GF Nylon.
    - Polymaker PLA Pro.
    - Any other filament with at least as much stiffness as PLA Pro.
- Clips:
    - Polymaker Polymax PC.
    - Polymaker PLA Pro.
    - Any other strong filament that will print with good detail.
- TPU Hose Clamp Covers:
    - Ninjatek Ninjaflex TPU.
    - Any other TPU that is around 85 A Shore hardness.

4.2.1 Some Notes on the Above Filament Options

COEX may have better thermal resistance then the PA6-CF, that is why it is recommended for the barrel mount. PA6-CF does have a little better surface finish, and is better for skin contact. It also may have better layer adhesion. These are the reasons that it is recommended for the other parts.

PA12-CF has been removed from the list due to concerns with creep. In testing PA12-CF had significantly higher levels of creep compared to the PA6 based Nylons. If you do use PA12-CF, be sure to anneal it first, as that does reduce the creep.

Polymax PC was recommended for the clips because it is strong, stiff, and is not fiber filled. Fibers reduce the amount of detail possible, and can result in a more rounded clip that will not hold as well. However, that is not to say that a filled Nylon is not a good option. PC does have the downside of being prone to cracking after long periods of stress.

As you can tell from the above language, these recommendations are only preliminary, and may not be best. If you have a filament you think will work, try it. Just keep the following priorities in mind for each part:

- Barrel Mount:
    - Thermal resistance.
    - Hardness.
- Handguard and Upper:

    - Layer adhesion.
    - Thermal resistance.
    - Stiffness.
- Lower and Stock:
    - Layer adhesion.
    - Stiffness.
- Clips:
    - Strength.
    - Thermal Resistance.
- TPU Hose Clamp Covers:
    - Flexible.

If this is your first upper and lower build, I would use PLA Pro for everything but the clips and barrel mount. It's easy to print, and will let you learn without spending a ton on filament.

4.2.2 Notes on Annealing

It is recommended to anneal Nylons to prevent creep. **However, Nylons will shrink when annealed and unless accounted for this will result in parts that do not function.** Before you anneal your parts fully understand how each axis will shrink. Printing a test cube with the same settings as your part, including infill type and wall count, is the best way to determine shrinkage. Measure it before and after annealing to calculate the needed scaling to account for the shrink.

4.3 Tools

A number of tools may be needed:

- 3D Printer capable of printing Nylons. E.g., All metal hot end.
- Slicing software with decent computer. Textured files are large.
- Soldering iron capable of installing heat set inserts. I use a 40 Watt iron.
- Drill bits for cleaning out holes.
- Punches for installing the bolt hold open roll pin and FCG pins.
- Hammer for installing the barrel mount.
- A hydraulic press is nice for installing the barrel mount. Though should not be needed.
- Allen keys.
- Socket driver or wrench for hose clamps.
- Bushing installation tool.

4.3.1 Notes on the Printer

Because the parts are large, and printed at multiple angles, it is critical that the printer is properly calibrated. Your steps per mm for all axis must be accurate. If you have not done so, you should calibrate your steps per mm before printing the Orca. Also check your skew and ensure the machine is square. If you're new to printing, definitely do a few smaller simpler builds first.

5 PRINTING

Slicing the parts should be done with care. Infill masking is used to achieve variable infill density. This is very important to a reasonably light build. Prusa Slicer is recommended due to the ease of using infill modifiers. Though other slicers will work. Bambu Lab slicers have an issue using modifiers. Hopefully this is fixed by the time you read this, but keep it in mind. If you are slicing and get weird gaps in the perimeter, you will need to try another slicer.

You will also need to import the premade supports into the slicer. If you are printing the version without bushings, you will need to also import the bushing blocks.

The STL files are broken up into categories within their own folder. All of the support and modifier files are within the same sub folder as the files for the part they go with.

There are two lengths of handguard, you will need to choose which to print based on your gas system. Carbine lengths systems use a ~7.5” long gas tube and mid length systems use a ~9.5” gas tube. The longer handguard will work with shorter gas systems.

All of these steps are covered in greater detail below.

5.1 BASIC SLICER SETTINGS

Most of the parts share the same basic slicer settings. Infill density will depend on the part, and is covered later.

- 0.4 MM nozzle.
- 0.2 MM layer height.
- 0.45 MM outer perimeter line width.
- 0.40 MM top layer line width.
- 0.50 MM line width everywhere else.
- Three walls.
- Five top and bottom layers.

Your temperatures, speeds, and cooling settings will depend on your printer and material. I recommend printing at below 50 MM/s to ensure good layer adhesion. If unsure about temps, follow the manufacturers advice.

Lots of cooling is needed when using PLA+ to ensure that the overhangs don’t curl, especially with the lower.

5.2 PRINT ORIENTATION

All parts come pre-orientated. You can double check print orientation by looking at the obvious print surfaces. Upper, Handguard, and stock print at a forty five degree angle. Lower prints at a ten degree angle.

You may rotate the parts about the Z axis to better fit on your printer’s bed, and to insure optimal cooling of the overhanging surfaces. Turning the parts so that the fan blows directly on the overhanging surfaces is best. It makes the most difference with the upper to prevent curling near the bottom.

Figure 3 Handguard printed in proper orientation.

Do not alter the print orientation other than above mentioned, the parts have been designed from the ground up with their specific orientations in mind. Both for support and structural reasons.

5.3 Using Infill Modifiers

Each file that uses a modifier includes them as additional STL files. Some parts have more than one infill modifier labeled alphabetically. They are titled “Modifiers” in the download. The modifiers have the same coordinate system as their respective parts and are ready to import into the slicer as modifiers.

In Prusa Slicer this can be done by right clicking on the part, and then selecting “Add Modifier > Load...” You can then select one or more of the needed modifiers and import them. They should be orientated and in the correct locations. You can then adjust the infill type and density for each modifier by right clicking on its name on the right hand list of objects and selecting “Infill”.

In Cura you will import the modifiers as parts, and then change the “Per Model Settings” to “Modify Settings for Overlaps.” You can then select the settings you want, in this case Infill Type, Infill Density, and Wall Count. Set the wall count to zero and the infill type and density to the required values. After this is done, you can select the modifiers and part and merge them together by right clicking and selecting “Merge Models”.

More info is in this video: https://odysee.com/@hoffmantactical:3/using-infill-masks-slicing-lighter-parts:b?r=2aDZGs7DDG2yFGLCdktcVBDPBQ6mFt73

5.4 Support Material

Custom support is provided for each part. These can be added to the part in the slicer much like you added the modifiers. In Prusa select “Add Part > Load…” rather than add modifier. In Cura simply do not change the “Per Model Settings” before merging the parts together. The support files are titled “Support” in the download.

It is recommended to turn up the print speed for the support, to save time. In Prusa and Cura this is done in much the same way as changing the infill of the modifiers. I use 40-60 mm/s for the support. You only need to adjust the perimeter speeds, as the support does not contain any infill.

If you feel that your printer needs it, a brim can be used to increase bed adhesion.

The clips require a raft to prevent distortion of the lower layers, especially with PC blends. I use a 0.2 mm Z gap.

You can still use slicer generated supports if you like. I recommend paint on supports in Prusa. Look at what areas the built in support covers, and add slicer generated support to those area. This can be helpful if you are using a different nozzle size and the custom support is not compatible.

5.5 Bushing Blocks

If you don’t want to use the brass bushings, there is an option to add the bushing blocks to the lowers. These fill the bushing pockets in the slicer, and the lower prints without the pockets. The bushing blocks should be added exactly like the support material. If you have bushings, don’t add the bushings blocks. Leave the pockets open.

5.6 Specific Slicer Settings

Each part requires specific infill settings, these are listed below on a part by part basis. Your other settings not mentioned below should be the basic settings listed above.

The sub 100% infills listed below can be either gyroid or honeycomb. I like gyroid because it’s light, but honey comb can be a little stronger. It’s up to you and what your goals with the build are.

A range of infills are shown. The high end Is recommended, the low end has been tested and should be used if you want a really light build. Probably with a CF Nylon. You can always use a higher infill density if you want a really solid gun, but it’s not needed.

It may be better to use aligned rectilinear infill for all the parts, not just the lower. At this time, I am not sure, and still recommend standard rectilinear set at 45 degrees.

This is also a list of all the parts you will need to print to assemble the Orca. The barrel mount, clips, and hose clamp covers are included in the Orca kits. If you bought a kit, no need to print these.

5.6.1 Handguard

- 100% rectilinear Infill for base part.

- 15% to 25% for mask.
- Insure you have good bed adhesion. Use a brim if needed. This is a tall part.
- All other settings standard.

5.6.2 Upper

- 100% rectilinear infill for base part.
- 25% to 50% for mask.
- All other settings standard.

5.6.3 Barrel Mount

- 100% Rectilinear infill.
- All other settings standard.

5.6.4 Lower

- 100% aligned rectilinear infill for base part. Infill should run the length of the lower.
- 20% to 35% infill for mask.
- Three to six walls. Use more walls for a stronger grip. Three recommended.
- Be sure to use plenty of cooling, the lower has lots of overhangs.
- All other settings standard.

5.6.5 Stock Neck

- 100% rectilinear infill for base part.
- 25% to 50% for mask A.
- 10% to 25% for mask B.
- 25% to 50% for mask C.
- Three to six walls. Three recommended.
- All other settings standard.

5.6.6 Stock Butt

- 10% to 25% infill for base part.
- 25% to 50% for masks.
- All other settings standard.

5.6.7 Clips

- 0.40 MM outer perimeter width.
- 0.45 MM for other perimeters.
- Set seam position to random. This ensures the seam is not aligned.
- Printing on a raft is recommended to prevent slumping or distortion of the bottom layers.
- As little cooling as possible. Try and maximize layer adhesion.

5.6.8 TPU Hose Clamp Covers

- Print these slowly.

5.6.9 Assembly Block

- 100% rectilinear infill.

5.7 Printing The Parts

Once you understand the slicer settings, and have everything set up, you are ready to actually print the parts. I recommend printing one part at a time.

The most important thing to do to prevent failures, especially with taller prints like the handguard, is to have good first layer adhesion. A level bed with a thin evenly squished first layer is key. Keeping the bed clean also helps, and a little bit of adhesive never hurts.

It might take you a couple tries to get the clips perfect. I find that when printing with Polymaker Polymax PC a little bit of cooling is needed to prevent curling, and a lower bed temp is also helpful. Experiment if you don't get crisp prints the first time.

The TPU hose clamp covers are easy to print with the right set up. Printing slowly would be my biggest piece of advice when using TPU.

6 Assembly

While assembly is not difficult, care must be used when installing the clips.

Don’t drop the ceramic insert, as it is brittle.

Have all of your parts ready. Read the section fully, then begin assembly.

It is highly recommended to watch the assembly video:
https://odysee.com/@hoffmantactical:3/Orca-V5.3-Detailed-Assembly-Video:1

6.1 Preparing the Printed Parts

Once printed, the parts will need to be cleaned up. Having clean parts without surface anomalies or adhered support is important to ensure smooth assembly. Start by removing all support from the parts.

6.1.1 Handguard

Very little cleanup is needed for this part. Make sure there is no stringing or blobs in the area that interfaces with the barrel mount.

Use a 0.375” drill to clean out the QD points.

6.1.2 Upper

Ensure that the underside of the upper that will interface with the lower is smooth and free of support. Some filing may be needed to clean up the supported area.

Check inside the barrel mount area. It need to be clean, Same with the inside of the rest of the upper.

Use a 3/16” drill to clean out the take down screw hole on the front of the upper.

6.1.3 Lower

The top surface of the magazine catch slot and the underside of the rear lugs must be free of support and may need to be filed smooth.

Use a mag catch lever to test fit the slot. It should slid freely in the slot.

Use the upper to test the lugs by sliding the upper onto the lower from the front. It should be tight, but fully seat when forced. If the upper will not seat then use a knife or file to remove a little material from the underside of the support lugs. This fitting should be done until the upper can be pressed into place.

To remove the upper, tap the rearward tang on the edge of a table while holding the lower. This will work the upper loose.

Use a 3/8” drill to clean out the selector switch hole.

Use a 5/32” drill to clean out the bolt hold open lever spring hole.

Use a 3/32” drill to clean out the dowel pin hole on the rear of the buffer tower. It should be 0.5” deep.

Use a 3/16” drill to clean out the take down screw hole on the front of the upper.

Use a 1/8” bit to clean out the selector switch detent hole. You need to do this by hand as a drill cannot access the hole because it is blocked by the grip.

It’s a good idea to check the lower for fit. Try a magazine and see how it fits. If it’s tight, you might need to take a closer look at your printer.

Compare the upper and lower as well. Upper should fit onto the lower with a few taps, and fully seat. Be fully aligned.

6.1.4 Stock Neck

Check the bore to ensure that the buffer will slide freely. A bit of sandpaper on a stick can help remove anomalies, but this is where a good printer really pays off.

Use a 3/32” drill to clean out the dowel pin hole on the front of the part. It should be 0.5” deep.

Use a 3/32” drill to clean out the dowel pin hole at the rear of the part. It should be 0.5” deep.

Use a 3/8” drill to clean out the QD points.

Removing any flashing from the edge that was against the bed can make the finished build a bit cleaner, but don’t over do it.

6.1.5 Stock Butt

Use a 3/16” drill to clean out the two screw holes, if needed.

Use a 3/32” drill to clean out the dowel pin hole. It should be 0.5” deep.

As with the butt, you can removing any flashing from the edge that was against the bed.

6.1.6 Barrel Mount

Ensure all traces of the support have been removed. If the part slumped or suffered from elephants’ foot, carefully cut or file it away. It is always recommended to run a knife or deburring tool around the print surface of the part to remove any edge that may interfere.

Remove all stringing from the inside of the parts. The grooves should be clean and free of debris.

Lightly sand the top surface of each mount to remove any blobs or lines. You don’t want anything to hold the mounts apart.

Test the barrel mount for fit is important to prevent a jammed mount. The two halves of the mount should slide together into the front of the upper. They should fall in with gravity until about 0.1” from fully seated. A small amount of force should fully seat them. They should stay in place when you invert the upper, but be loose enough where you can pull them out again with your fingers. If they are too tight, a little bit of sanding on the outside surfaces should help.

Another test can be done while you install the barrel. With the barrel and mounts together, press them into the upper by hand. There should be some friction between the outside surfaces of the mount, and you should be able to press the mount in until it is within about 0.3” Inches of fully seating. If you can’t get it this close, then do not proceed, you risk jamming the mount before it

is fully seated. If you don't have a press, this is difficult to fix. Instead, remove the mount and sand the outside of it down a little. It normally does not take much.

6.1.7 Clips

The raft should be peeled off the bottom of the parts, and any stringing or blobs should be carefully removed. The clips are fragile, so handle them with care.

6.1.8 Support Block

Make sure it's clean and it should be ready to use. The support block is very important, don't try and skip it ;).

6.1.9 TPU Hose Clamp Covers

Removing the support and any stringing is all you need to do with these.

6.2 Installing Heat Set Inserts

Ensure your soldering iron has a tip that will fit inside the brass inserts. You can get special tips for this, but they are not required.

The Stock Neck requires two inserts on the side facing the print bed. The Lower requires one insert on the inside of the mag well at the top of the front surface.

Press the insert in by hand to get it started, then use the iron to melt it in. I like to push it in most of the way with the iron, and then quickly thread a screw into the insert and use that to fully seat the insert and hold it in place until the plastic cools. On the lower you can install the screw from the outside before even using the iron, you can then use the screw to pull the insert in as you heat it.

Alignment is critical. If you have trouble installing the screws later, it's probably the alignment of the brass inserts being off. Reheating them and using a screw to carefully pull them into alignment is the solution.

Be very careful not to overheat the insert and melt out the hole, this can destroy the part.

Figure 4 Installing brass insert into lower.

6.3 Using the Clip Mounting System

The two parts to be joined, the Upper and Handguard or the Lower and Stock, are fastened together using the clips and a hose clamp. The two parts should be pressed together and held vertically, so that the clips do not fall out of their pockets when they are installed.

The clips are not universal, you will notice that each clip has two letters and an arrow on the outside face. The first letter is ‘F’ front or ‘B’ back. The second letter is ‘T’ top or ‘B’ bottom. The front clips hold the Upper to the Handguard and the back clips hold the Stock to the Lower. Bottom clips go on the bottom side of the firearm, top clips on the top side. Arrows should face up.

The handguard will be held in place by the barrel mount while you install the clips. The stock is held in place by the dowel pin.

With the two parts held together, and a hose clamp preinstalled on the neck of the stock or on the base of the handguard, pop the clips into place. Being careful to not dislodge them, slide the hose clamp into place and tighten it down.

The key is to be careful and not dislodge the clips until the hose clamp is holding them in place. The clips have small dimples on each side that will snap into divots on the larger parts. This will help retain the clips, as long as the two larger parts are held firmly together.

Figure 5 Clips in place.

6.4 Assembling the Upper

You should install the gas block and gas tube assembly onto the barrel along with the muzzle device before assembling the upper. *Ensure the gas block is properly aligned.*

It's recommended to install the muzzle device first, so that you don't try and torque it against the printed barrel mount after assembly, which will create problems. Using an aluminum upper, or dedicated barrel clamp is the best way to hold the barrel while torquing the muzzle device.

Also, it's important to assemble the upper before assembling the stock onto the lower. This was you can use the support block and lower to properly support the upper during assembly.

Slide the fiberglass sleeve over the gas tube, being careful not to fray it.

Place the barrel mount around the barrel extension, one half on each side. The position of the alignment pin hole on the mount halves must align with the alignment pin on the barrel. The gas tube hole on the barrel mount halves is a good indicator of orientation. The larger side of this hole that is sized to fit the ceramic insert faces backward, away from the muzzle.

Work the fiberglass sleeve into each side of the barrel mount as you fit them together, be sure that the sleeve is not pinched by the mount. It should be fully retained within its channels. The end of the sleeve should be even with the end of the ceramic inserts pocket. See Fig 4.

Slide the ceramic insert onto the gas tube and into the barrel mount. It should fully seat in its chamber. Keep holding the barrel mount halves in place to prevent them from falling off.

Slide the barrel assembly into the upper, the barrel mount is tapered and should become tight before fully seating.

Be sure to read the section 6.1.6 before proceeding.

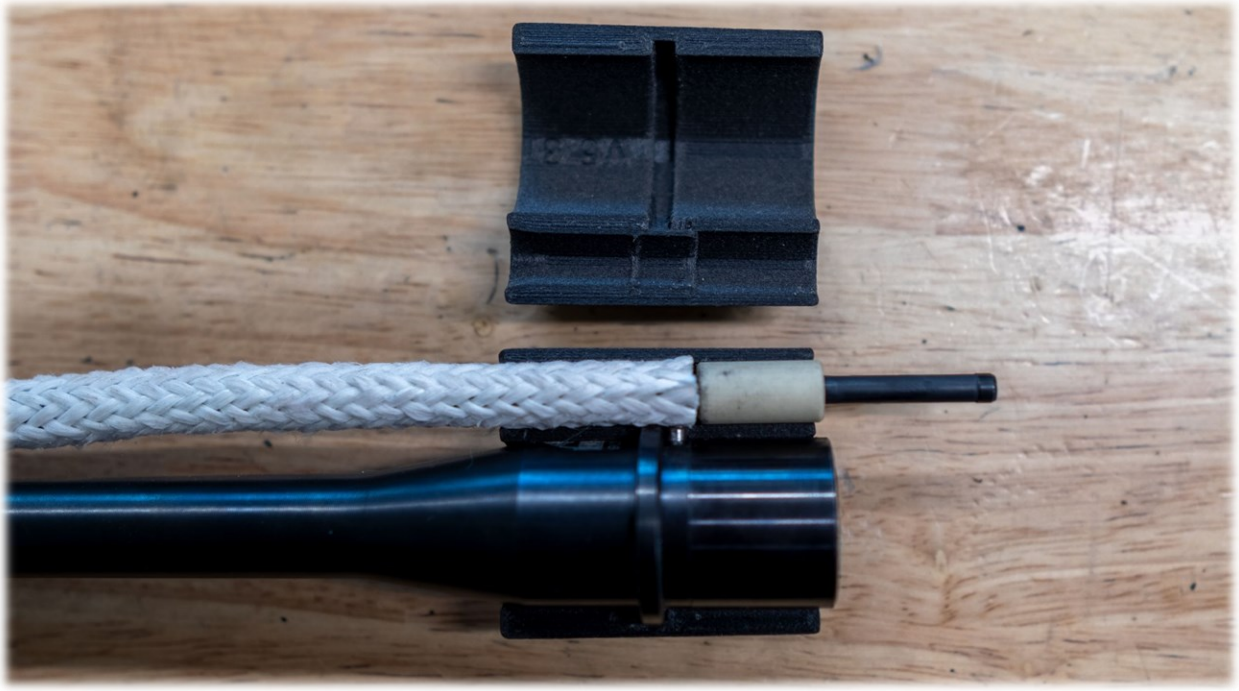

Figure 6 Installing the sleeve.

You will need to use a press, or hammer, to fully seat the barrel mount. Use a plastic, wood, or soft metal spacer to protect the end of your barrel when doing this. You will also need to protect the bottom of the upper. Install the lower onto the upper and use the provided assembly block to support the lower against a table or floor. If you attempt to pound or press the mount in without supporting the upper, you will damage it.

The barrel mount should protrude from the front of the upper by 0.253” to 0.265” If it protrudes more it is not fully seated. Also, there is a reference line inside the upper. The barrel extension should meet this line when fully installed.

Figure 7 Pounding in barrel.

Once fully seated you can install the handguard.

Slide a loose hose clamp over the base of the handguard. The screw on the clamp should be on the left side, facing down.

Slide the handguard over the barrel and press it onto the barrel mount. There should be a gap between 0.003” and 0.018” between the upper and handguard.

Once the handguard is in place, carefully press each clip into its slot on the assembly. Be sure to use the proper clip for each slot. Once all the clips are in, slide the clamp down over them. You can now carefully tighten the clamp while ensuring that no clip is out of place or being pinched.

The clamp should be torqued to 35 to 40 in*Lb.

6.5 Assembling the Lower

The heat set inserts should be installed as the first step. One in the lower and two in the stock neck.

Use the bushing installation tool to pull the bushings into their pockets inside of the fire control group well. This only applies to the version with bushings.

Figure 8 Installing the bushings.

The mag catch, bolt hold open, and fire control group are then installed as they would on any other AR-15 lower. It is recommended to install the roll pin for the bolt hold open from the front to ensure proper tool clearance.

The detent and spring for the selector switch are not installed in the same way as other lowers. Because the grip is integrated, the spring and detent are held in by a set screw from the underside. After installing the selector switch, slide the detent and spring in through the detent hole, and hold them in place by threading the set screw in after them. The threads are printed into the lower. Pressing in firmly while threading in the set screw will help it engage with the printed threads. Don't over torque the set screw, turn it until you feel it fully seat, and no more.

The next step is to assemble the stock. The butt is fastened to the stock neck by the two 10-32 x 1.25" screws. The 3/32" dowel pin is used to align them. Press the pin into one side, and then press the two parts together. Install the screws and evenly tighten them to 5 in*Lb. If you have trouble starting the screws, or they feal like they are cross threading, you should reheat and realign the threaded inserts.

The final step is to fasten the stock assembly to the lower.

A dowel pin is again used to align the parts and hold them in place while assembling the clips. Assembly is done in the same way as the upper. Be sure to slide the hose clamp onto the stock neck before assembling. The clamps screw should be on the left side with the head facing down. Work should be done with the stock vertical and the butt against a table. Be careful to hold the parts together so as not to pop the clips out before the hose clamp is installed.

The clamp should be torqued to 35 to 40 in*Lb.

6.6 Final Assembly

Once the upper and lower have been assembled, they can be fastened together to form the completed firearm.

First, you can install the TPU hose clamp covers onto both hose clamps. A small flat head screw driver can help pop them over the clamps.

Ensure that the hammer is cocked back and the safety is on.

Slide the buffer spring and buffer mass into the buffer tube. There is no detent, instead the hammer holds the buffer mass in place until the upper is installed.

Install the charging handle and bolt carrier group into the upper.

Slide the upper onto the lower from the front. The tapered dovetail on the front of the lower will engage with the front of the upper. The rear lugs will engage with the rear of the upper.

The Bolt carrier will force the buffer mass and spring into the buffer tube. After the upper is fully seated, install the 10-32 x 0.75” screw through the front of the upper and into the lower. Continue to hold the upper onto the lower until the screw is engaged, as the buffer spring will attempt to jettison the upper from the lower.

The take down screw should be torqued to 15 to 20 in*Lb.

Figure 9 Complete Orca, after painting.

7 Testing

A complete function check should be conducted prior to live fire testing.

The bolt carrier group should cycle relatively smoothly without binding. If the upper or lower was printed too narrow, it can result in the bolt carrier being too tight. Sanding the inside of the upper where the bolt carrier interferes can be a quick fix.

If the bolt carrier binds in the buffer tube, it could indicate that the stock or the buffer tower warped during annealing, or that the joint between the two is not collinear. Adding thin shims between the stock and lower can fix this issue, though should not be needed.

Ensure that the bolt is fully locking and that the bolt carrier is moving fully forward.

If you have head space gauges it is a good idea to use them.

Check the function of the safety and fire control group. The trigger should release the hammer, and the reset should function as it would in other firearms.

An empty magazine should latch into the mag well with the bolt closed. When you pull the bolt back it should lock open on the empty mag.

If everything checks out you are ready for live fire testing.

Because a factory barrel, barrel extension, and bolt are used, the possibility for a catastrophic failure is very low. However, it is recommended to test the firearm for the first shots in a sled away from your face or body.

7.1 Troubleshooting

7.1.1 Failures to feed and failures to eject

These are the most common issues. They are normally caused by the bolt not cycling fully to the rear. Try firing with an empty magazine. The bolt should lock open every time. If not, you are short stroking.

Opening up the gas block or removing weights from the buffer are the two of the most common fixes. Check to make sure the gas block is properly aligned.

Excessive friction between upper and bolt carrier can also be a cause.

7.1.2 Upper Does Not Align with Lower

If there is a gap between the rear of the upper and the buffer tower, or the upper is longer then the lower and the front surfaces are not flush, then you have a scaling issue. Minor errors are not an issue, but if it’s enough to cause the upper to be loose, or the magazine to not fit, then you need to reprint after calibrating your printer. Conduction a steps/mm calibration on all axis of your printer is the best way to do this.

7.1.3 Bolt Is Hard to Cycle

Excessive friction will cause lots of issues. The bolt carrier should move freely inside the upper and buffer tube. Over extrusion or scaling issues can cause the inside of these parts to be too tight. Sanding can fix the problem, but it's best to have a properly tuned printer.

Another cause is if the lower is too narrow. Even if the upper is perfect, the lower will pull the bottom edges of the upper together making it tighter.

In an extreme case, the stock neck may be misaligned. Check that the mating surfaces of the lower and neck are flat and free of defects.