
The Gatalog
presents:
The SF5
3D Printable MP5

Preface

This is the Schlank Flügelmann 5 (SF5) – a 3D printable MP5 build based on the Kleiner Freund 5 (KF5). Like the KF5, it uses the core parts of the MP5 – the bolt carrier group, trunnion, barrel, and magazine/magazine catch assembly, while relying on cheaper, easier to source parts for the rest. The SF5 opts for buried/hidden fastening methods to hide the "flanges" of the KF5 – making it slimmer. Depending on where you source your parts, you can have an MP5 for under half of what factory builds cost – which is pretty slick.

This documentation will walk you through the process of building your own SF5. Because the barrel pressing/pinning process is nearly the exact same as on the Amigo Grande (the MP5 is just the smaller, Germanic cousin of the CETME C), you will need to refer to the Amigo Grande build videos to see the video of these steps. The "Pressing and Pinning the Barrel" section in this document is borrowed from the Amigo Grande tutorial for the same reason – it's a nearly identical process.

You can find the video for the Amigo Grande barrel pressing/pinning here:
https://odysee.com/@Ivan's_CAD_Streams:c/CETME-Build-Part-2:1

You can watch this assembly process on video here:
https://odysee.com/@Ivan's_CAD_Streams:c/SF5-Tutorial:c

Please note that this video shows assembly of one of the eight sub-builds this project covers, but the information within is applicable to all of the builds. The only major difference will be if you are building a 10mm or 40SW gun, in which case only the installation of the magazine catch will be different. Some of the images in this document come from the KF5 build tutorial, so don't worry if your parts look a little different from those shown – the holes will still be in the same places.

Refer to the README for basic info/print settings for this build!

I recommend you use this document in conjunction with the video, having text-based steps helps keep things organized, being able to see things in real time helps clear up confusing instructions.

Do not be intimidated by the length of the build video/tutorial. If you run into issues, the troubleshooting section at the end of this document should help you out.

If you plan on doing a 40SW or 10mm build, please note that this build does not incorporate the bolt hold open design found on the HK guns. While this may be added at a later date, I really didn't care for how it handled with the prototype designs, and in any event will make the gun less sleek. Also note that 40/10 builds tend to chew up the followers on their mags – especially without a bolt hold open mechanism. Because of this, the "Add-Ons" folder includes a printable follower so that if you are worried about damaging an original one, you can swap it out for a cheap printed one.

If you have found this tutorial useful, consider sending me Bitcoin to further development of this sort of thing – there is much more to explore in 3D printed guns, DIY guns, DIY ammo, etc.

https://ctrlpew.com/donate-to-ivanthetroll/

To all the svelte wingmen

Remember that it is our shared responsibility to be safe and smart with firearms and show the world there is a peaceful way to own guns – take the time to get training, to learn basic (and advanced) safety rules, and to share the hobby with everyone interested – those most scared of guns in the hands of the people are often the ones who have no experience with guns in the first place.

Table of Contents

Shopping List

This list will cover what supplies you will need for a SF5 build. This section is very long, but has lots of good information to help make sure you have the right supplies for your build. Read it carefully, in the order it is written. NOTE: The hardware for the Swarmtech brace add-on is in the "Add-Ons" folder.

Pre-assembled parts kits are available: https://maf-arms.com/product-category/mp5/ - buying such a parts kit would allow you to avoid having to press and pin your own barrel.

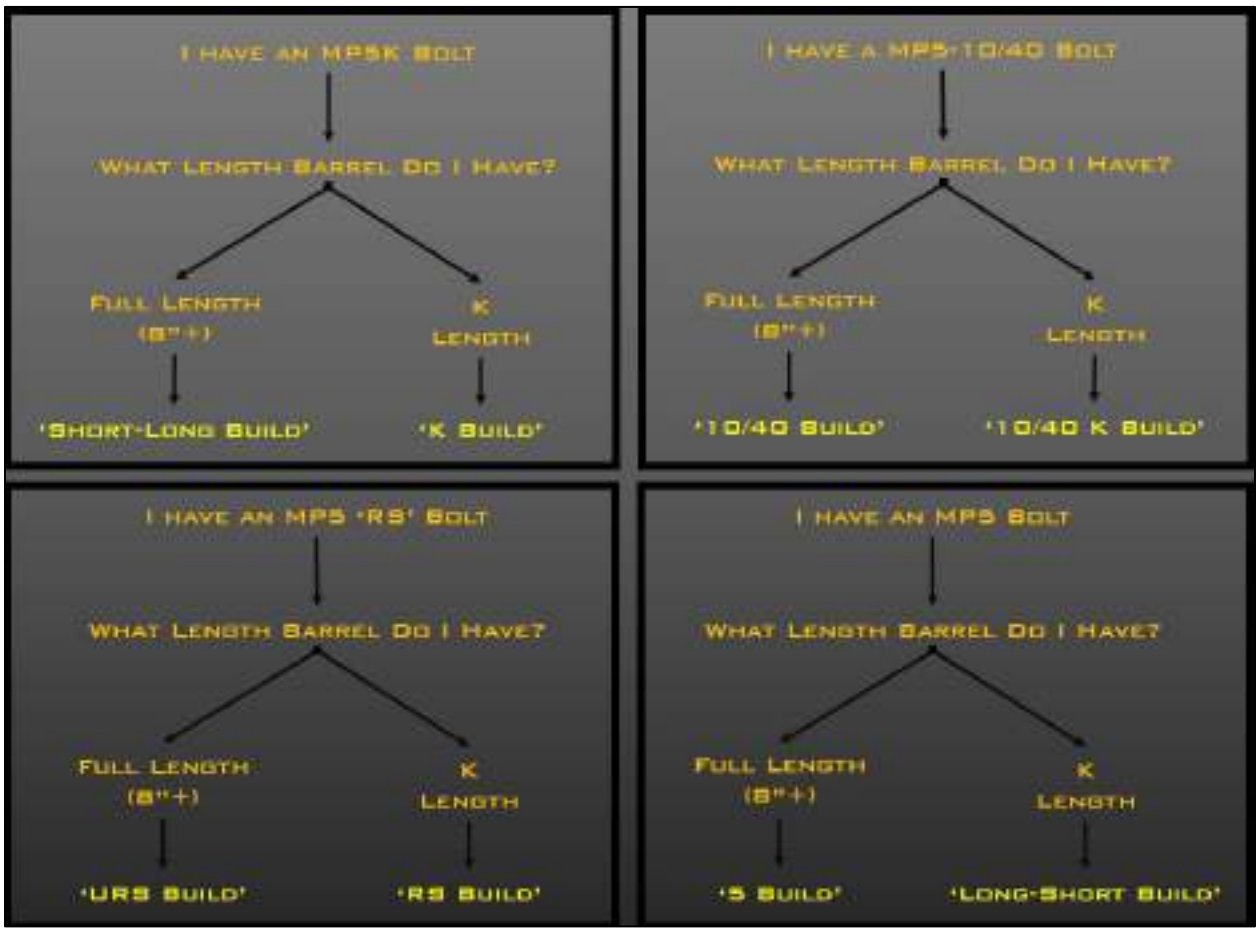
MP5 Parts

This build supports nearly every permutation of MP5 build you could dream up. However, there are some things to know about MP5 parts before you dive in. In general, so long as you have the right caliber barrel, trunnion, and bolt carrier, your parts will work. However, when it comes to barrel lengths, some attention should be paid to the bolt carrier you select. A k-length barrel will be most reliable with a k-type bolt carrier (or an RS bolt carrier). A full size barrel will be most reliable with a full size (standard) bolt carrier. 40SW and 10mm bolt carriers are interchangeable, but their barrels are not – while some handguns can safely fire 40SW from a 10mm barrel, MP5s cannot do this – a 10mm build needs a 10mm barrel, a 40SW build needs a 40SW barrel – but the bolt carriers are the same. If you do a 10mm build, see the "10mm Ammo Selection" section in the Troubleshooting section at the end of this document. The next pages will cover what sort of parts work with what particular builds – follow the flowchart image, as it will tell you what the name of your build is, which you will need to know to understand what parts to print.

- An MP5 Barrel – this build works with everything except SD barrels, which would need a different handguard design. Obviously, you will need a 9mm barrel type for 9mm builds, 40SW barrel for 40SW builds, 10mm for 10mm builds.
- An MP5 trunnion – any MP5 trunnion will work – standard and k trunnions are compatible with 9mm builds. 10 and 40 share the same trunnion, but won't work with 9mm trunnions.
- An MP5 bolt carrier group – any bolt carrier group will work – standard, K, SD, RS, 40SW and 10mm.
- MP5 Magazine – for 9mm magazines, I like KCI and Overwatch Precision mags. HK mags are the best, but are expensive. For 10/40 builds, I recommend the blue/grey HK mags – they are very expensive, but more reliable than the cheaper black mags from HK parts.
- MP5 Ejector – While this is optional for the 9mm builds (they can use a printed ejector), I recommend you use a metal ejector for the 9mm builds and you need to use one for the 10/40 builds. If doing a 9mm build, I recommend you pick up one of the Aves Rails metal ejectors – they are direct fit, work great, and need no fitting. These ejectors are included in the MAF windchime kit. If you opt for a standard 9mm ejector, you will need to do a little fitting. For 10/40 builds, you will need to do a little fitting.
- (Optional for 9mm builds) An MP5 magazine catch assembly. This is optional because a 3D printable magazine catch is possible (and works great), and the MP5 catch parts can be very expensive. You would need an MP5 magazine catch, magazine catch spring, magazine catch button, and magazine catch roll pin to do the HK based setup, while you only need the magazine catch spring for the printed catch. If you do the HK catch parts, it might be a good idea to grab 2 or 3 roll pins, since they are easy to accidentally mangle and/or lose.

- (Optional) – A steel (aka rifle) extractor spring. These are made/sold for G3s, HK33s, etc, and are a stronger, upgraded version of the MP5's standard extractor spring. The weakest part of the MP5's design (in my opinion) is the use of a copper spring for the extractor – these springs fatigue out quickly and just suck. When you're ordering your magazine and mag catch parts, be sure to pick up a couple "rifle" "steel" "G3" or "HK33" extractor springs (these springs are sold under different names). Note that 10/40 builds do not play nice with rifle extractor springs, and will need modified to work (or you can just buy new 10/40 springs).

Now – once you have your parts, you'll need to know what to do with them. This build has eight permutations, and the part you'll need to print depend on the hardware parts you buy. Use the following flowchart to find your exact build, and keep the name in mind – you'll need to print the parts from the corresponding sub-folder in the main file package.



Finally, we need to discuss locking pieces. Locking pieces are a part of the bolt carrier assembly which can be swapped out easily. They function like gas blocks on ARs – different angle locking pieces cause more or less force from firing to be diverted to cycling the bolt. Some of these builds may need different locking pieces to run perfectly – locking pieces are pretty cheap, but changing them can sometimes change your bolt gap – so if you need to change locking pieces and have a bolt carrier made by a particular company, try and make sure you get a different locking piece from the same company if at all possible.

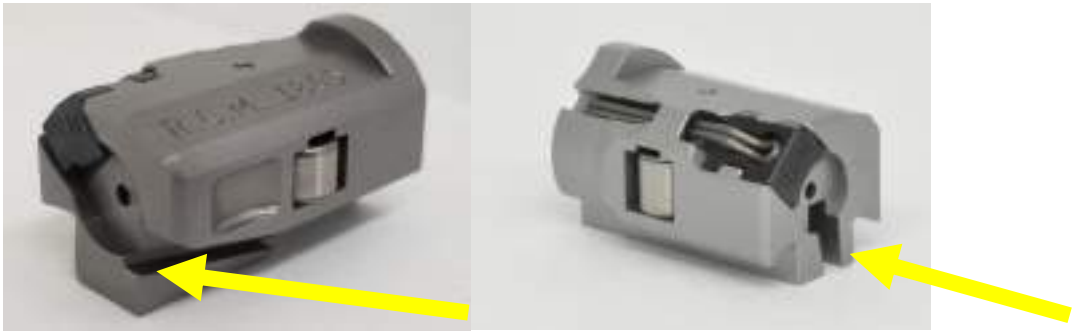
While new 9mm MP5 parts should have standard, 100 degree locking pieces, some used parts may have weirdness going on. If you have used 9mm parts, take your bolt assembly apart and check your locking piece. Try to avoid using an 80 degree locking piece in a full length barrel build, and try to avoid using a locking piece larger than 100 in a short barrel build.

For 10 and 40 MP5s, the 40SW uses what's called the Hi-Impulse locking piece, as does full power 10mm ammo. However, FBI load or other such reduced power 10mm needs a Lo-Impulse locking piece. If you plan on doing a 10mm build, check the "10mm Ammo Selection" section in the Troubleshooting section at the end of this document. I recommend you pick up the Lo-Impulse locking piece for your 10mm build even if you don't plan on shooting FBI loaded ammo, because FBI load stuff is very common and some companies try and hide the fact that their ammo is FBI load.

Bolt Carrier Assembly Identification

It can be easy to get confused about all the variations in specs for hardware parts – the image below shows a k-spec bolt carrier on top, with an MP5 spec carrier on bottom. 10/40 parts and their respective K and full size carriers also look the same (the major difference for 10/40 is in the bolt head itself – the 10/40 guns have the ejector slot in the side rather than the bottom of the bolt head).

When it comes to MP5 RS bolt carriers, they are essentially the K-spec bolt carrier assembly but with a special, longer recoil spring assembly – which makes it the same overall length as the full size assembly. However, the RS recoil spring assembly is not the same as the full size recoil spring assembly due to the difference in length of the op rods on the carriers – while some RS builds do just use the full size recoil spring, this technically isn't correct.



Left, and MP5 10/40 Bolt head. Right, a 9mm Bolt head. Note the extractor slot differences at the arrow.

When it comes to sourcing these parts, there's two important thing to know: the barrels for the MP5 are required to be pressed into the trunnion and pinned in place. This process is just like on G3s, CETME Cs, etc – it's not necessarily hard, but can be tedious. In the Preface of this document, there are links to a video showing the process/steps involved in pressing/pinning your barrel. In the next section of this document, the text instructions from the pressing/pinning steps of the barrel for the Amigo Grande are included – these steps are nearly the exact same for the MP5, and the one difference is called out at the beginning of the section. The second thing you should know is that there's this windchime company that's offering barrels pressed into trunnions and pinned into place, mated with a bolt carrier group – a drop-in unit that's ready to be assembled without you needing to do any metalworking. You can find the listing for this windchime here: https://maf-arms.com/product-category/mp5/

AR15 Parts:

- Fire control group – a complete fire control group (hammer, disconnector, trigger, safety selector, associated springs and detent). While some fancy AR15 trigger options will work here, drop-in and cassette style triggers will not – if your trigger is housed in a casing like the FRT, KE Arms SLT, CMC drop ins – it won't work on this build. Triggers such as the Geissele SSAE, LaRue MBT, and Franklin Armory BFS will all still work, however.
- Pistol Grip – you can always print the pistol grip of your liking, but remember to get the screw and lockwasher to hold it on!
- An extra AR15 fire control group pin if you plan on using the paddle-style mag release – this is optional for the 9mm builds, but required for a 10/40 build!

Hardware Parts:

Universal Hardware Parts (used in all builds)

- 2x M4x15mm Bolts – for securing handguard to receiver (M4x16mm bolts work as well)
- 1x M4x25mm Bolt – for securing endcap to receiver
- 1x M4x45mm Bolt, partially threaded ideal – for securing barrel mounts to receiver
- 4x M4 nuts – for above bolts
- 2x M5x35mm Bolts – for securing lower receiver to upper receiver (M5x30mm Bolts will also work but can't be secured with a nut)
- 2x M5 nuts – optional, for securing M5 bolts
- 1x M3x45mm Bolt – for reinforcing charging handle
- 1x M3x30mm Bolt – only needed if you use the printed magazine catch for a 9mm build - Must be fully threaded.
- 1x 4mm Ball Bearing – Used to actively retain the charging handle. Recommended, but not necessary for reliable function: https://www.amazon.com/gp/product/B09997LVKC
- 1x 0.140" OD x 0.375" spring – Used to actively retain the charging handle. Recommended, but not necessary for reliable function: https://www.mcmaster.com/9657K613/

- 1x 6mm x 8mm dowel Rod **OR** 1x 1/4” x 5/16” dowel Rod – for mounting ejector
    - Note that if you plan on using a steel ejector, you will need a 6mm dowel rod. The 1/4" diameter rods were designed around use with the printed ejectors, though the printed ejector will work with the 6mm dowel rods. Thus, 6mm rods are recommended, but if you have 1/4" rod stock handy, you can make your own pin from it for use with the printed ejector.
- (Optional) 2-6x M5x15mm Bolts – for adding pic rail/foregrip mounts to handguard.
- (Optional) 4-12 M5 Nuts – for mounting rails to the handguard.
- 1x 1/4”-20 Locking Hex Nut – for securing receiver-handguard-endcap stackup
- 2x 1/4”-20 Hex Nuts – for installing and securing threaded rod
- 1x 1/4”-20 Socket Nut (optional) – used instead of hex nuts to secure threaded rod. You will still want to get 2x hex nuts either way, but the socket nuts are great.
    - The socket nut option is simpler, stronger, and easier to deal with, but socket nuts are much more expensive than hex nuts.
    - Socket nut found here: https://www.mcmaster.com/92066A029/

K-length Specific Parts (Needed for K builds)

- 1x 1/4”-20 Threaded Rod, 12.125” Long

Standard Length Specific Parts (Needed for URS, 5 and 10/40 Builds)

- 1x 1/4”-20 Threaded Rod, 14” Long

Long-Short and RS Specific Parts

- 1x 1/4”-20 Threaded Rod, 12.625” Long

Short-Long Specific Parts

- 1x 1/4”-20 Threaded Rod, 13.5” Long

10/40 Specific Parts

- 1x 0.25”x0.75” Compression Spring

NOTE: Threaded rod lengths are significant – you might be able to get away with a 12” rod for a K build, but it won’t be as secure as having the correct 12.125” rod. You can easily buy rod that is oversized (such as an 18” rod) and cut it down to size using a Dremel tool with a metal cutoff wheel or hacksaw and file.

Basic Tools

- Drill bits: 4mm, 5mm, 6mm, 5/32”, 3/8”
- Punches: 1/16”, 1/8”
- Metric Allen Key Set (Ideally Ball-End, but Straight End is ok)
- Imperial Allen Key Set (Ideally Ball-End, but Straight End is ok)
- Pliers

- Screwdrivers
- A boxcutter/utility knife
- ¼-28 Tap/Tap Handle
- Dremel Tool with metal cutoff wheel (if you need to cut threaded rod, add a cut to an ejector (which is required for 10 and 40 builds, as well as if you use a standard 9mm ejector and not one from Aves/MAF)
- Feeler Gauges: 0.020", 0.012", 0.015" (if you are going to press and pin your own barrel)

Printed Parts List

Hopefully you paid attention in the previous sections, and know which specific build you are going for. If not, go back and read the flowchart! In the main package directory (where you found this PDF file), there is a folder named "Build Checklists". That folder contains eight files which list the specific parts needed for the eight variations you can build – each build has a name, and the flowchart in the previous section tells you which variation you will have. All of the variations are the same basic build, but differ in key areas to allow for the use of different hardware parts, which makes this a sort of universal MP5 build. Each build will involve the following parts:

- 1x Lower Receiver – pick your desired combination of web cut, binary compatibility, and if you want a paddle release. For the 10/40 builds, your only option for the mag catch is a paddle release, but you can still choose web cut and binary compatibility. There are different lowers for 10 and 40, which optimize feeding reliability for the respective caliber.

  Note: the web cut, binary compatibility, and paddle release all do make the lower receiver a little weaker – only go with these options if you actually want them. While it does not significantly weaken the lower to have these features, the options are included so that you can optimize your build.

  Second note: If you are doing a 9mm build and desire the paddle-style mag release, you must use a 3D printed mag catch – this design has been tested extensively with every MP5 mag on the market and it functions flawlessly, even under abuse – but certainly won't be as strong as a steel mag catch

- 1x Upper Receiver
- 1x Endcap
    - Options for standard nut or socket nut – I like the socket nut option as it is easier to disassemble, but it is a little more expensive.
- 1x Handguard
- 1x End Nut Cover (Optional) – only needed if you opt for the standard nut option.
- 1x Charging Rod
- 1x Charging Handle
- 1x Ejector (only applicable for 9mm build, and only if you plan on using the printed ejector instead of the metal one)
- Printed magazine catch parts

  For 10/40 Builds (Required)

- There are mag catches specific to the two different specs for the 10mm and 40SW spec lower receivers. The 10/40 builds only have the printed paddle catch as an option.

For 9mm builds (Optional)

- This was originally designed to save the ~50 bucks that HK mag catch parts cost, but it turned out to be much easier to assemble and just as durable and reliable. I recommend the printed catch over the HK one.
- If you plan on printing the paddle mag release lower, you must print the mag catch and paddle made specifically for it.

- 1x Barrel Mount Left
- 1x Barrel Mount Right

Note: Printing the barrel mounts from a more heat resistant material, such as nylon, will greatly enhance the heat resistance of your build. If you would like to purchase high quality SLS-printed heat resistant mounts, they are available on MAF: https://maf-arms.com/product-category/mp5/ Because the mounts are the only part touching the hot parts of the gun, having them be temperature resistant is good.

Note: different manufacturers tend to have slightly different specs on their trunnions – as such, two trunnion specs are included. RCM fits RCM and HK-spec trunnions, PTR fits PTR and other US/clone brand trunnions. The assembly steps below will help you make sure you have the right trunnion mounts printed – if you have no idea where your trunnion came from or who made it, start with the RCM spec, and you can reprint if needed.

For the printed parts, if you end up with a rough finish on surfaces that touched support material, you can use a soldering iron to smooth out those areas and attain a smooth, even finish.

Pressing and Pinning the Barrel

The SF5 (like any MP5) requires the barrel to be pressed into the trunnion. You have a couple options here – you can do it yourself, find a local gunsmith and pay them to do it (it's a fairly standard operation that most gunsmiths will know how to do), or buy a barrel that's already pressed into a trunnion. This process is essentially the exact same as the other stamped roller guns – the G3, CETME C, HK33s, etc all follow the same process in this regard.

The following instructions were written for the Amigo Grande – a 3D printable CETME C receiver. While the trunnion in the pictures looks slightly different, the barrel is longer and larger, and the bolt carrier assembly is bigger, the steps themselves are the almost same - one difference between the MP5 and CETME C pressing is that when you go to measure bolt gap, the MP5 bolt carrier will not lock tight into the trunnion – since 9mm is much less powerful than 308, the carrier locking lever isn't a thing on the MP5s. As a result, you won't need to use a hammer to separate the bolt carrier from the trunnion, and when measuring bolt gap you won't be able to dangle the trunnion from the bolt carrier –

you can rest the muzzle of the barrel on a flat surface and measure bolt gap with everything vertical instead. Keep this in mind, and you'll be able to press and pin your SF5 barrel. Note that these instructions original to the Amgio documentation is left in a different font to make it easier to identify.

Prepare your trunnion and barrel for pressing. I recommend freezing your barrel prior to pressing – as metal contracts when cold, your barrel will press in a little easier if you freeze it first. This isn't necessary, but helps. To prepare your trunnion for pressing, use your finger and feel if there is any lip edge, burr, or rough spots inside of the barrel channel. If you are using a new trunnion, it's unlikely that there will be any sharp lip edge or burrs.

If you can feel any sharp edge or burr inside of the channel, take some fine grit sandpaper (I use Emery cloth) and rub out any sharp edges. Ensure that the trunnion's barrel channel is smooth along the entire journal the barrel occupies, paying special attention to the trunnion's barrel channel entrance. This shouldn't be required on brand new MP5 parts, but if you notice a ridge or burr you should sand it out.

Ensure that the barrel hole is free of burrs and sharp edges. Pay close attention to the top edge (shown by the arrows)!

Even if a spot in the hole only feels a little rough, smooth it out. I prefer to sand radially (around the hole) rather than sanding in and out of the hole.

At this point, you are ready to begin pressing the barrel into your trunnion. It is strongly recommended that you buy some moly grease or anti-seize to reduce the friction generated when pressing in the barrel. I personally prefer anti-seize, as it won't burn off like grease will – so it provides some level of rust protection should you ever have to replace your barrel in the future.

Liberally grease the barrel channel and chamber journal.

Now, take the bolt, bolt carrier assembly, trunnion, barrel, feeler gauges, grease, press, pliers, a rubber hammer, and 10-20 pennies (or similar valueless article of soft metal). Set your trunnion up on your press so that the rear end of the trunnion (the side with recess for the bolt) is facing upwards. Add a little grease to the barrel channel and evenly apply it using your finger or a brush. Take your barrel and slide it into the trunnion – the muzzle end of the barrel should go into the rear of the trunnion. After placing the barrel into the trunnion, place the trunnion and barrel onto the press.

Put two pennies on the breech face of the barrel – these will protect the barrel from getting scratched by the press ram. You can stack pennies between the press ram and barrel if your press ram needs a little more reach.

LEGAL NOTE: Many people freak out about destroying currency. It's only illegal if you do it with the express intent of removing the currency from circulation. So for a fun party trick, shout "curse the federal reserve and these specific instruments thereof!" before pressing, while actually intending to finish your build.

Position the trunnion like shown for pressing – the rear end of the trunnion should face up!

Apply a little grease to the barrel channel in the trunnion.

Place the barrel into the trunnion, muzzle first, from the rear end of the trunnion.

Place the barrel and trunnion together under the press ram.

Place two pennies on top of the barrel to protect the breech face.

NB: The 20 ton press' ram is too thicc & juicy to enter the trunnion channel from the rear. For the 20 ton, using a lawnmower spark plug socket and a useless soft metal item, such as a quarter, will work.

After getting the barrel and trunnion prepared for pressing, ensure everything is lined up – the barrel, pennies, and press ram should be lined up as close to concentric as you can get them. Start lowereing the press ram – depening on how your press works, there are different ways to do this. Most presses like the cheap one I used have a shutoff valve. The valve is closed, then a jack is pumped to lower the press ram. To raise the ram, the valve is opened. If you have never used a press before, become familiar with lowering and raising the ram before pressing your barrel in – see your press instructions.

Finally, you can begin pressing in the barrel. Press the barrel in to the point that it sits nearly flush with the seat inside the trunnion – this "seat" is where the top of the barrel hole meets with the cutout in the trunnion that the bolt fits into. HOWEVER, you SHOULD NOT just press your barrel flush to this seat and call it good – your barrel will end up needing to be close to flush, but some builds will need the barrel to be proud or flush.

IMPORTANT NOTE: Your barrel should never be pressed such that it it past flush with the seat in the trunnion. Refer to this video to see a cross-section of how these part fit together: https://www.youtube.com/watch?v=MFESb8TK7ZA

Proper Bolt Gap

Roller delayed guns have a measurement known as "bolt gap" essential to safe and reliable operation. Without going too deep into the details, "bolt gap" is a measure of exactly how much delay (in terms of time and mechanical disadvantage) the rollers will provide when the gun fires. More bolt gap equates to less delay – so bolt gap measuring 0.100" would have much less delay than a bolt gap of 0.020". 0.020" is the maximum recommended bolt gap, while 0.012" is the minimum. Less bolt gap equates to more delay, but zero bolt gap may indicate that the cartridge isn't fully chambered when the bolt is in battery. This means the cartridge is not supported—a dangerous condition. While the casing will expand *some* to seal into the chamber upon firing, if too much of the cartridge is unsupported, a catastropic failure can result. Put simply: improper bolt gap can be very dangerous.

When installing barrels on these guns, pushing the barrel in further (towards the muzzle) will decrease bolt gap. Luckily, it is very easy to measure bolt gap – simply take a feeler gauge (a flat metal bar ground to a specific width) and stick it between the bolt and bolt carrier while the bolt and bolt carrier are locked into the trunnion.

Where to measure bolt gap – between the bolt carrier body and the bolt head

This brings us to the topic of locking your bolt into the trunnion – when you get your bolt and bolt carrier from your parts kit, your bolt may be locked back against the bolt carrier. Free it by twisting the bolt, then pulling the bolt forward some, then twisting the bolt back. There are several videos online that show how to do this, I learned from this video (Note that the bolt won't get locked back to the trunnion on an MP5 (since they don't need locking claws), but the install/removal of the bolt head/locking piece is still the same process):

https://gunstreamer.com/watch/unlocking-the-rollers-on-a-g3-bolt_l2AS1wZ96d42Tu8.html

So, to lock your bolt into your trunnion, first press the barrel in far enough for the bolt to fit into the recess in the trunnion. Identify which direction is the top of your trunnion – this is the side of the trunnion that has a semi-circular cutout along its length – the operating rod (the long tube on the top of the bolt carrier) will go along the top of this cutout.

If your bolt won't fit in far enough and the rollers can't extend, press your barrel in further toward what would be the front of the gun. **IMPORTANT NOTE:** sometimes, pressing the barrel into the trunnion will shave off just a little material from the barrel. This is normal, and isn't necessarily a bad thing – these barrels are made with slightly oversized journals to ensure a good fit can be attained with the variety of CETME C/G3/PTR trunnions out there. You will have to clear out any metal chips before you lock your bolt into your trunnion. I recommend using a screwdriver to scrape out any metal chips, then use a rag to dab up any small flakes remaining – wiping with a rag can be dangerous if there are any sharp flakes, so wear gloves if you can't get all the metal out by just dabbing with a rag.

*Try pushing your bolt and carrier forward into the trunnion as shown. If your bolt isn't able to go far enough forward for the rollers to stick out (there will be an audible *click* when they snap into place), you will need to press the barrel further forward.*

Once your bolt can lock into the trunnion (snaps into place with a "click"), you can measure bolt gap. First, ensure you can't pull the bolt and trunnion apart easily—

once the rollers lock out, you should be able to pick up the trunnion and barrel assembly using the bolt carrier.

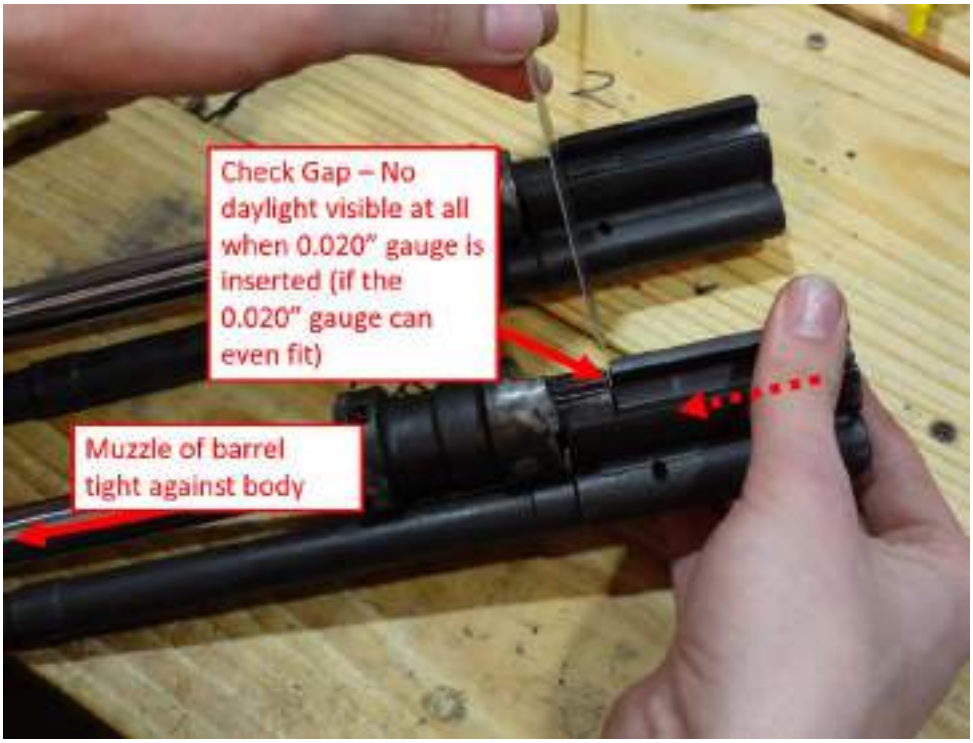
There are two schools of thought when it comes to measuring bolt gap – measuring in tension (with the weight of the barrel hanging from the bolt carrier) and in compression (with the barrel and bolt carrier being pushed towards each other). While I found measuring in tension to be more intuitive, having gone through this process 30+ times, I now prefer measuring in compression. I also believe that measuring in compression will be easier for newcomers to understand – so while instructions for both methods are present in the video and written documentation, I think measuring in compression is the best tactic.

Option 1: Measuring in Compression

After locking the bolt assembly into the trunnion, take the muzzle of the barrel and place it against your chest/abdomen. Use one hand to pull the bolt carrier towards your body – you should hold these parts fairly tight and may feel a little discomfort in your abdomen where the barrel is poking it. With your other hand, use your feeler gauges to measure the bolt gap. When measuring in compression, the 0.020" gauge should either not fit at all or fit tight enough that no light is visible between the stackup of the bolt head, 0.020" gauge, and bolt carrier. The 0.012" gauge should fit with little to no drag. Another check you can do when measuring in compression is to lock the bolt assembly into the trunnion, place your gauge between the bolt head and bolt carrier, then compress the bolt/barrel unit by pulling it into your body as described above. When you do this test, it should feel significant drag if you try to remove the 0.020" gauge (while still compressing the parts against your body), while the 0.012" gauge should be able to slip out freely or with minimal resistance.

Pull the bolt carrier tight to your body, with the muzzle of the barrel pressing against your chest.

While still pulling the parts tight to your body, use your other hand to check the bolt gap.



If, while still holding the parts tight to your body, the 0.020" gauge can fit between the bolt and bolt carrier, it should be a tight fit and no light should be able to make it through between the bolt head, feeler gauge, and bolt body. If you are able to fit the 0.020" gauge easily when holding the parts tight and there is any light visible between the bolt-gauge-carrier stackup, you need to decrease your bolt gap.

Option 2: Measuring in Tension (Note – this isn't possible with MP5s!)

Dangle the assembly straight down by holding the rear end of the bolt carrier with one hand. Because these guns are built with loose tolerances, there may be substantial wiggle between the bolt carrier, bolt, rollers, and trunnion – so when we measure bolt gap, we must make sure that everything is as close to aligned as possible.

Hold the bolt carrier and trunnion assembly straight up and down before you measure bolt gap

Now, with everything dangling, you can measure bolt gap. I recommend you get a 0.020" and 0.012" gauge (which represent the maximum and minimum bolt gaps, respectively), though you can just use a 0.015" gauge if you know what you are doing. You want the 0.020" gauge to be very tight (or not fit at all), and the 0.012" gauge to fit freely. The 0.015" gauge should have just a little bit of drag, feeling like a "perfect" fit.

A **VERY IMPORTANT** note about checking bolt gap in *tension* (parts dangling down): as I mentioned above, these guns are built to loose tolerances. There is substantial slop between how these parts fit. It is possible to fit a 0.020" gauge in a gun that has zero bolt gap if you force the bolt carrier and trunnion to rotate different directions. Just because you can force a certain size gauge into place does **not** mean that's what your bolt gap is! No forcing of gauges is acceptable when measuring in tension.

Your bolt gap should only be measured by holding the parts in alignment, and you should not have to force things to fit. If your 0.020" gauge doesn't fit, your 0.015" gauge is very tight, and your 0.012" has to be forced hard into place, you have pressed the barrel too far into the trunnion and will have to re-adjust and try again.

Measuring bolt gap in tension. Note that the parts are held straight up and down and that the gauge only takes one hand to slide between the bolt and carrier – nothing has to be forced for the 0.015" gauge to fit, but there is a little resistance.

If you get your bolt gap set correctly on your first attempt, you can move on to the next section, and should probably buy a lottery ticket on your way there. However,

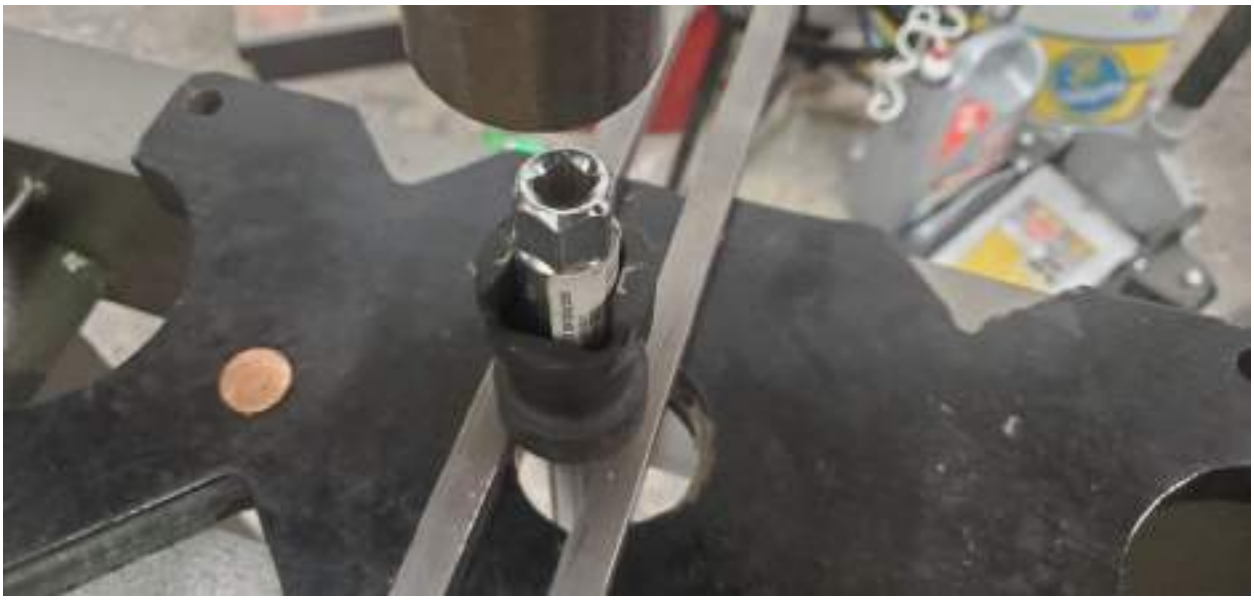
it's pretty common that you overshoot (press the barrel in too far) on your first attempt. This is ok!

It can be stressful messing with this stuff for the first time, but the CETME (or MP5 😊) is forgiving if you miss the sweet spot the first time around. There are two ways to correct a barrel that's been pressed too far: attempting to re-adjust the barrel or pushing the barrel all the way out and trying again.

Option 1: Re-Adjusting the Barrel

Now that you know what your bolt gap is, you know which direction the barrel needs to be nudged. If your bolt gap is too large, the barrel needs to go towards what would be the front of the gun, and if the gap is too small, the barrel needs to go towards what would be the buttstock.

An option should you need more bolt gap.



An option should you need less bolt gap.

When pressing your barrel in, you may have experienced the barrel "jumping," making clicking noises as it jumped a millimeter or so each time. Oftentimes simply running the press gingerly will do the job, but when fine-tuning for bolt-gap, we sometimes need a way to move the barrel only so much.

One method for fine tuning is by "pre-loading" the barrel in the direction you need it to go, pumping down with light pressure against the part, then striking the press' cross-beam with a hammer. This often sees the barrel move in smaller increments than simply pumping up the jack.

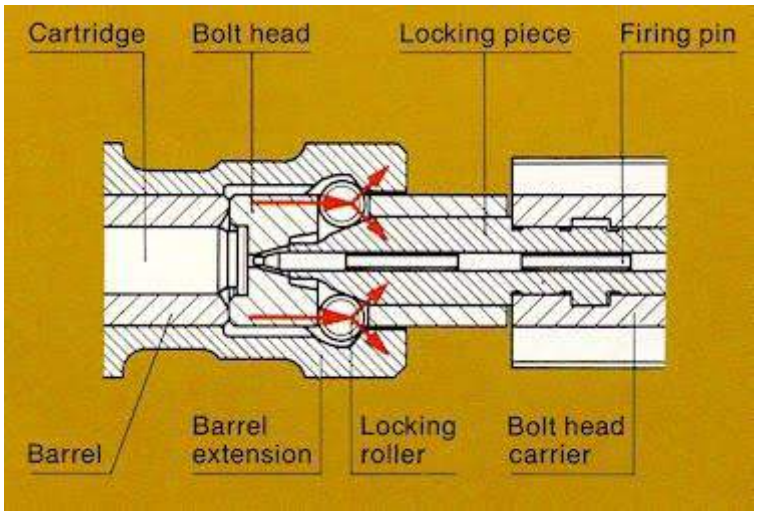
Option 2: Trying Again

Some prefer to simply push the barrel all the way out and try again. For this. take the barrel back to your press, stack up some pennies, and press the barrel down until it pops out of the bottom of the trunnion – be sure and keep a hand on the barrel so that it doesn't shoot out and hit the floor as you're pressing it out. After the barrel is out, thoroughly clean the barrel and trunnion again. Finally, check again for sharp edges or burrs in the barrel channel, and smooth them out should they exist. Apply fresh grease to the inside of the barrel channel on the trunnion, put the barrel back in the trunnion, stack up the pennies, and press the barrel back in. Don't get frustrated and remember to take breaks if you start getting annoyed – my first build took me *eight* tries to get the barrel pressed in just right.

The best strategy I have found is pressing the barrel in until it feels like you are getting close, then measuring the gap, then pressing just a tiny amount, then measuring, and repeating until the barrel is right where it needs to be.

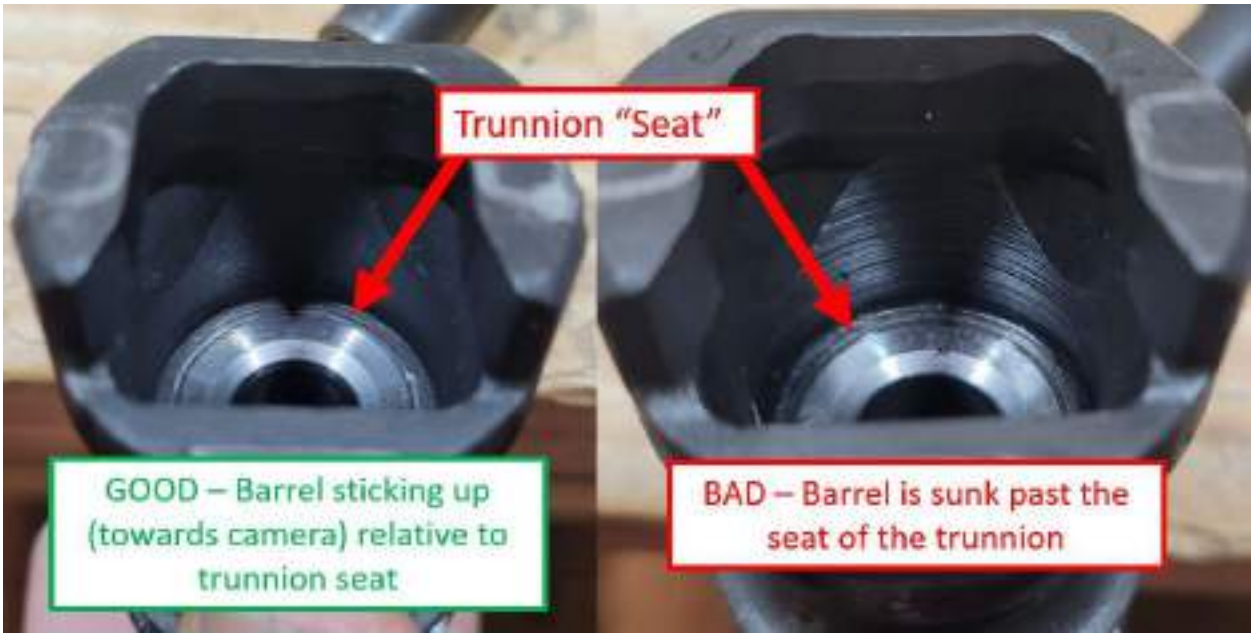
If you do have to take a lot of attempts to get things lined up, you may have to use a little emery cloth to polish the part of the barrel that gets pressed into the trunnion – sharp edges can form on the barrel after a couple attempts, these must be smoothed out before another attempt.

An important final check before you move on to the next step is visually verifying that your barrel isn't pressed too deep into the trunnion. When you look at the barrel/trunnion assembly from the *rear* (the side that you've been putting the bolt head into to check the bolt gap), you should notice that the bolt head itself cannot fit into the hole that the barrel is pressed into. As such, the barrel *should not* be pressed such that the barrel sits below the face of that hole in the rear of the trunnion.



Correct positioning of the barrel relative to the inside of the trunnion (cutaway view). The breech end of the barrel should be flush with or sticking slightly into the rear cavity on the trunnion. The barrel should NOT be pushed so deep into the trunnion that the bolt head cannot touch the breech end of the barrel.

An easy way to check to make sure that your barrel's breech face isn't pressed past the seat in the trunnion is to use a screwdriver to feel for the seat in the trunnion. Take a large flathead screwdriver and try to place the screwdriver on the seat of the trunnion (as show in the picture below). Glide the screwdriver towards the middle of the barrel. If you feel the screwdriver "click" down onto the breech face of the barrel, then your barrel is pressed too far and your barrel needs to be pressed into the proper position.



After you have things pressed in just right, proceed to the pinning section below

Pinning the Barrel

The barrel is right where you want it. Now you need to make sure it stays that way. If you skip this step, firing your gun will move the barrel out, which will cause the gun to become unsafe to shoot. You **MUST** pin your barrel after pressing it in, the press fit is not tight enough to trust.

To pin these barrels, you must drill a hole that lines up with the existing hole in the trunnion. If you have a brand new trunnion, it might not have a hole drilled all the way through it – this is ok. If your trunnion doesn't have a hole through the barrel pin flat already (or if it just has a hole barely started), you can just use a 5mm drill bit to drill your barrel pin hole.

Using a Virgin Trunnion

If you are using a virgin trunnion, you will want to use the 5mm drill bit *with the drilling point down* in the chuck – line the drill bit up with the predrill hole on your trunnion (if you have a pre-drilled spot, otherwise just line up with the middle of the flat spot on the trunnion where the barrel pin goes). Once everything is lined up, drill straight down and use plenty of cutting fluid – these trunnions are hard steel, and you'll have to use a good quality, sharp 5mm drill bit. After drilling all the way through with the 5mm drill bit, you are ready to stick a pin into the hole.

Using a Pre-Drilled or Used Trunnion

If your trunnion has a hole drilled all the way through it already, you'll need to use an endmill to make a pilot hole in your barrel.

An endmill, for those that don't know, is similar to a drill bit, but is more rigid and has a flat bottom. For my builds, I used a 3/16" carbide endmill that I got from Travers Tool – endmills can be hard to find in person, you usually have to get them online.

If you aren't familiar with setting up a drilling operation, refer to the video tutorial. In general: clamp the trunnion in a vise so that the pin hole in the trunnion is facing upwards. Take a 5mm drill bit, clamp it in your drill press/mill's chuck *upside down*, use the upside-down drill bit to line up the drill chuck perfectly with the hole.

Next, swap the drill bit for your 3/16" endmill. Using plenty of cutting fluid, use the endmill to cut through the round part of your barrel obscuring the pin hole. This will leave a clean pilot hole for the drill bit to follow. After drilling with the endmill, switch back to the 5mm drill bit and drill the hole again – remember that too much cutting fluid isn't a real thing, and that too much is always better than not enough. It's not expensive and it won't ruin anything but your shoes. After drilling with the 5mm drill bit, you are ready to stick a pin into the hole.

Drilling out the pin hole – refer to the video to see how to set this up if the instructions are unclear!

When it comes to installing the barrel pin, some kits do not have their original 5mm pin – for these kits, you will have to make or buy a new pin. Don't worry, as this is actually very easy. I opted to use 0.197" steel rod to make the new pins, so that they are snug but not extremely tight. If you want to use a press-fit pin, you can order 0.199 or 0.200" rod to make a pin out of.

I got my rod stock from McMaster (https://www.mcmaster.com/8893K183/) and cut it to length with a hacksaw. I then beveled the ends of the pin using a Dremel tool and hammered the pin into place. I then used the Dremel tool to cut away any pin sticking out past the body of the trunnion.

Cut your drill rod to length – these pins should be about 1” long.

Adding a chamfer to the ends of the pin is a good idea.

Install the pin into the trunnion. If you use 0.197" rod, you will need a punch and hammer to seat the pin. If you use larger rod, you will need a press or to squeeze the pin using a vise to seat it.

If any of the pin sticks out past the body of the trunnion, grind it down.

Congrats! You have finished the hard part of this build: your barrel and bolt should be properly set up to chew through 9mm!

Build Tutorial

I recommend you read this section in its entirety, then watch the build video while you go about building your SF5. It's a fairly easy process but following the video should save you from wasting any time due to silly mistakes.

Before we start off, if you aren't familiar with how roller delayed guns and would like to learn more, this video highlights the technical details in an easy to see manner:
https://www.youtube.com/watch?v=MFESb8TK7ZA

REFER TO THE README FOR BASIC PRINT INFORMATION

Step 1: Lay Out Your Parts/Prep Work

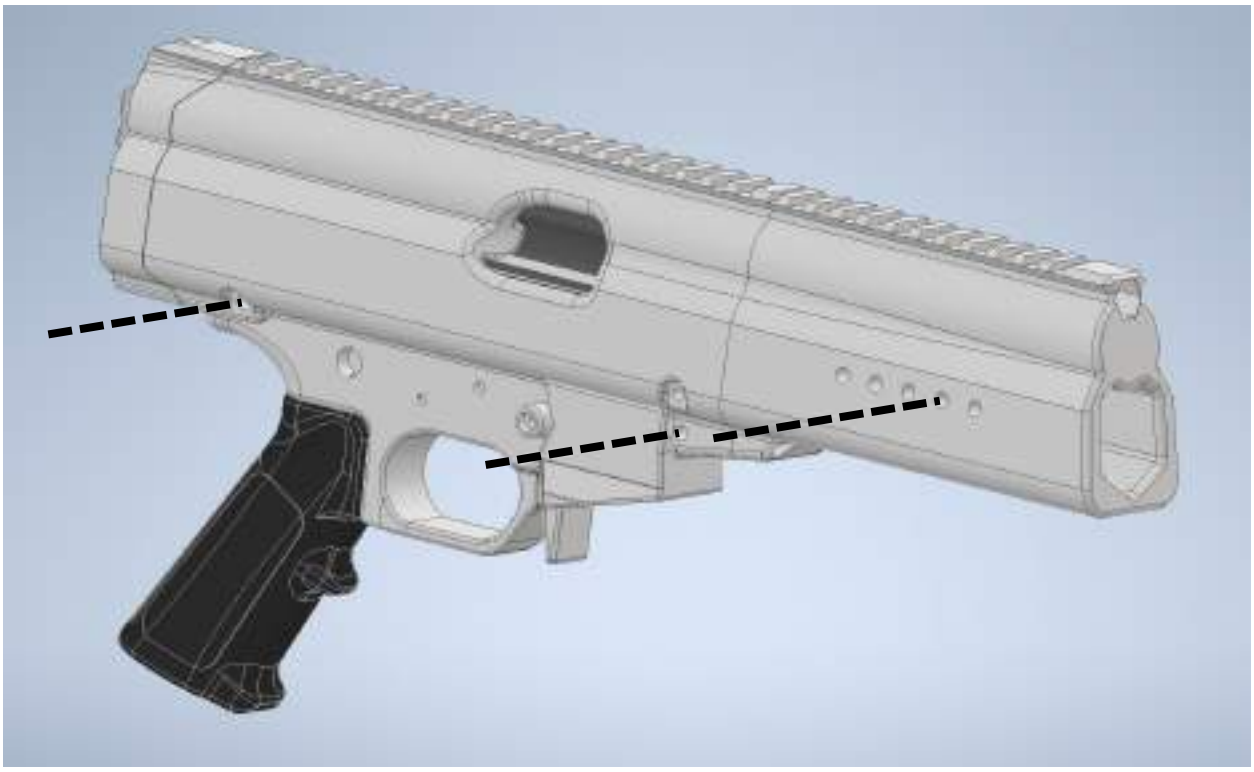
Spread of tools and parts used in a KF5 Build.

Begin by organizing all your parts, as laid out in the shopping list – there's quite a few tools, hardware parts, and printed parts involved.

As usual, begin by removing all support material from printed parts.

You can knock out some prep work now – there are many holes on the printed parts that will need cleaned up using a drill bit. Use a 5mm drill bit to clean up the two lugs on the lower receiver and the corresponding lugs on the upper receiver.

If you plan on using the add-on pic rails, you should use the 5mm drill bit to clean out the mounting holes on the add-on adapter and the handguard.



5mm Drill Locations – Note that holes on flanges are mirrored, and that all holes in the handguard can be cleaned with the 5mm Drill.

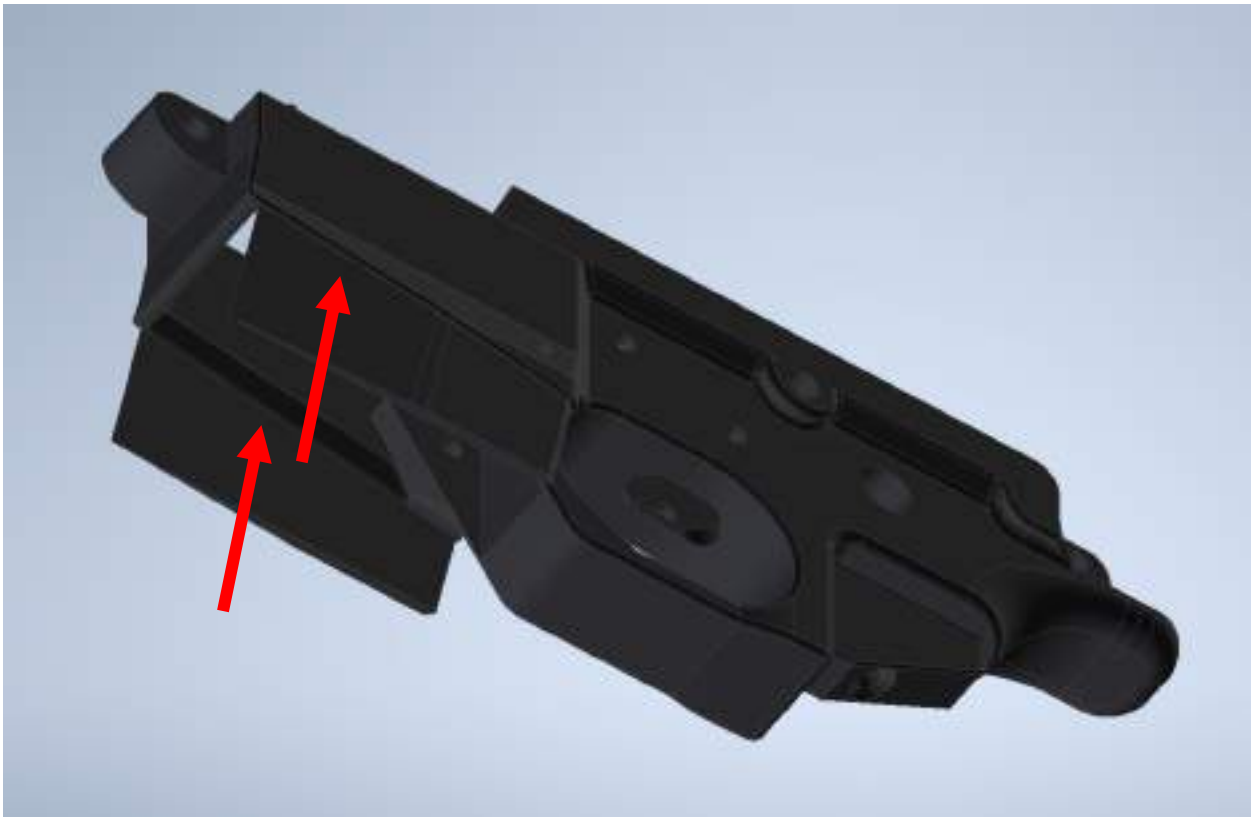
The rest of the holes will be cleaned out later – but doing the 5mm holes first is a good plan since there are a lot of them.

Step 2: Assembling your Lower Receiver

Take your Lower Receiver, magazine catch parts (the catch, spring, button, and pin), AR15 fire control group, ejector, and ejector pin. These steps make up most of the complexity of this build, but with a little patience you'll get through them.

Begin with checking the fit on your magazine catch. Note that three options exist – for a printed magazine catch, a printed catch with a paddle release, and for the standard HK-style catch. All options work well, but HK catch assemblies can go for well over 50 bucks, so having a printed option is a great price saver. If using the printed mag catch, print the catch body and cap. If you plan on using the paddle mag release lower, you will need to print a lower from the "Paddle Lower" folder, the mag catch body from that folder, as well as the paddle itself.

NOTE: if you build a 10 or 40 lower, a paddle mag release is the only option, and a printed paddle is the only solution – real paddle setups are very expensive and won't work well with a printed lower. Note that the bottom of the magwell is actually critical geometry on the 10 and 40 guns – magazine wiggle and overinsertion is handled by the base of the magwell (which means the magwell can't have as much flare as the 9mm lower, unfortunately). Because of this, integral support ears are added to the lower receiver to ensure that the bottom of the magwell prints without much sagging. After printing, you can remove these ears by bending them until they snap off, then using a box cutter to carefully scrape the remaining material off until the stub of the ear is flush with the bottom of the magwell. If you have trouble with magazines locking in, make sure that you trimmed all/enough of the ear material away!



Trim the two support ears on the bottom of the magwell away after printing.

For 9mm builds - insert your magazine catch backwards into the rectangle-shaped cutout on the left side of the lower. The rectangular end of the catch should fit with minimal drag – if it feels tight, you will need to make sure that all support material is scraped clean from the rectangular hole in the lower.

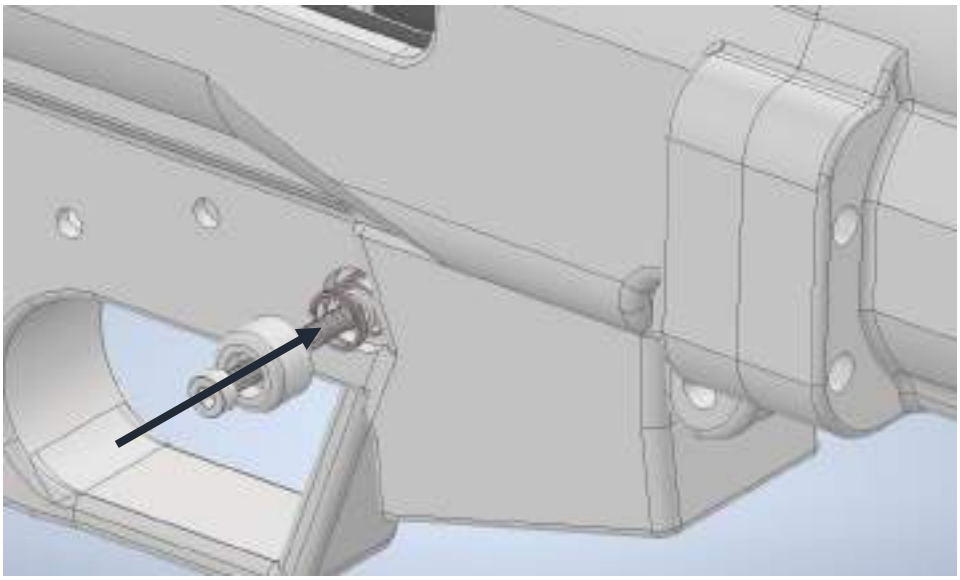
Once the square parts fit together, you can try inserting the magazine catch normally. The round leg on the magazine catch will likely be too tight to fit in the hole – if this is the case, get your 6mm drill bit and *gently* drill out the hole. If you drill this hole out crooked or unevenly, magazines may have excessive wobble when inserted and feeding issues may result. If using the printed magazine catch, you can lightly sand the round leg on the mag catch body to ensure a smooth fit.

Drill out magazine catch hole carefully with a 6mm drill bit.

After drilling, test fit the magazine catch again – it should move freely but shouldn't have much free play. If it still feels tight, repeat the above steps until a better fit on the magazine catch is achieved.

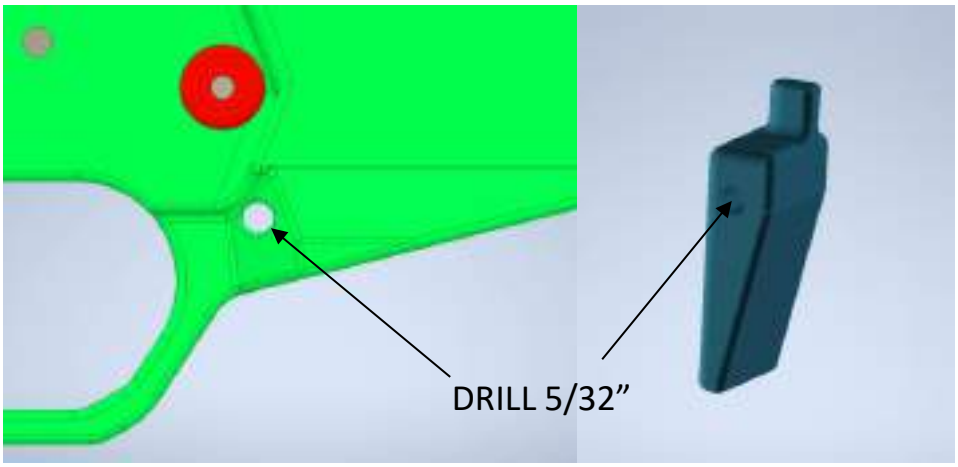
With the magazine catch fitting completed, it's now time to install it. This is much easier to do with the printed magazine catch. If using the HK parts and you have trouble, refer to the build video – seeing it in real-time can help a lot.

For the printed magazine catch, insert the catch from the left side of the lower. You may need to lightly sand the outside of the round section of the mag catch shaft – this fit should have as little wobble as possible while not being so tight that the parts bind up. Insert the magazine catch spring into the right side of the lower. Take your M3x30mm bolt and the printed magazine catch button. Put a couple drops of oil on the M3x30mm bolt, stick the bolt through the hole in the magazine catch button, and screw the bolt into the printed magazine catch body.

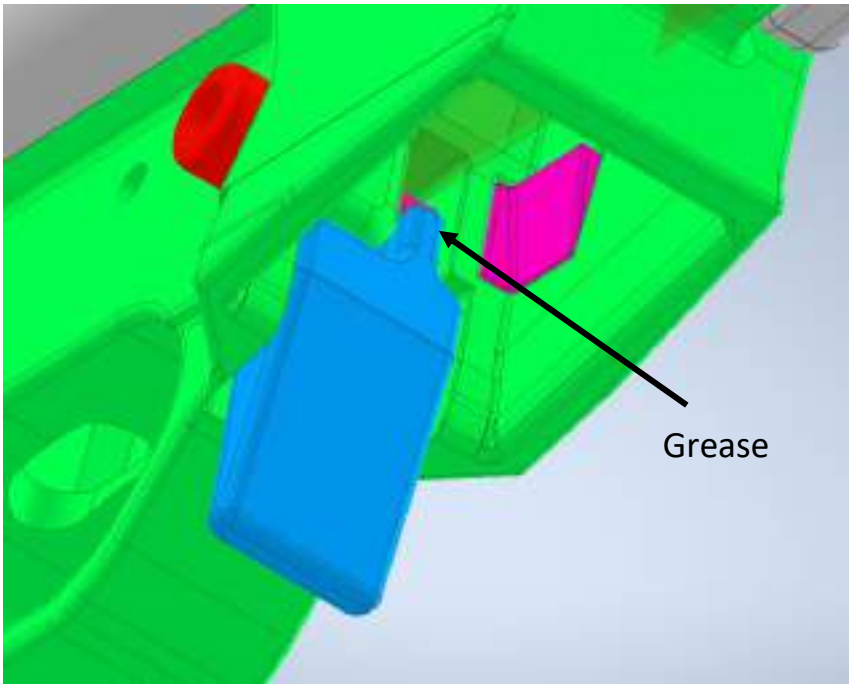


Assembly of the printed magazine catch parts. M3x30mm bolt will fasten the catch button to the magazine catch body.

If you plan on using the paddle mag release as well, you will need to have printed the paddle-compatible lower receiver. Install the paddle-compatible mag catch as instructed above. Use a 5/32” drill bit to drill out the hole for the pin in the lower and the hole in the paddle release itself.

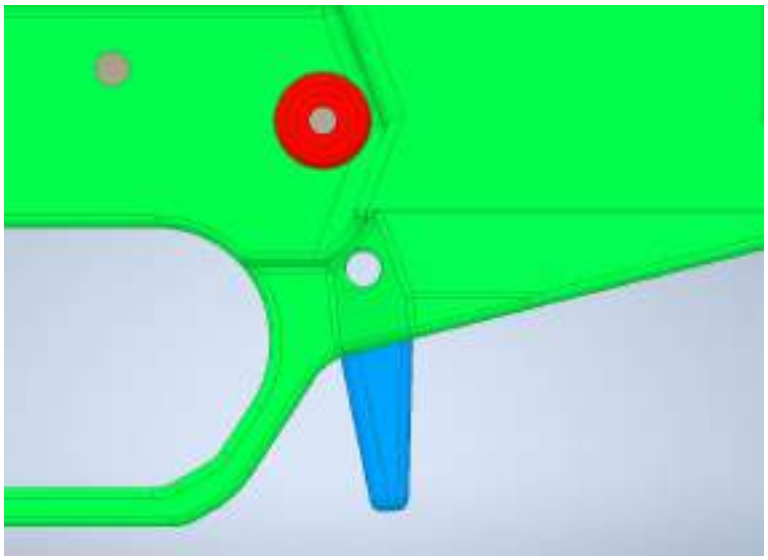


Apply a liberal amount of grease to the top of the top nub on the paddle. Next, take your paddle itself and place it into the lower – it will line up with the cutout in the lower itself.

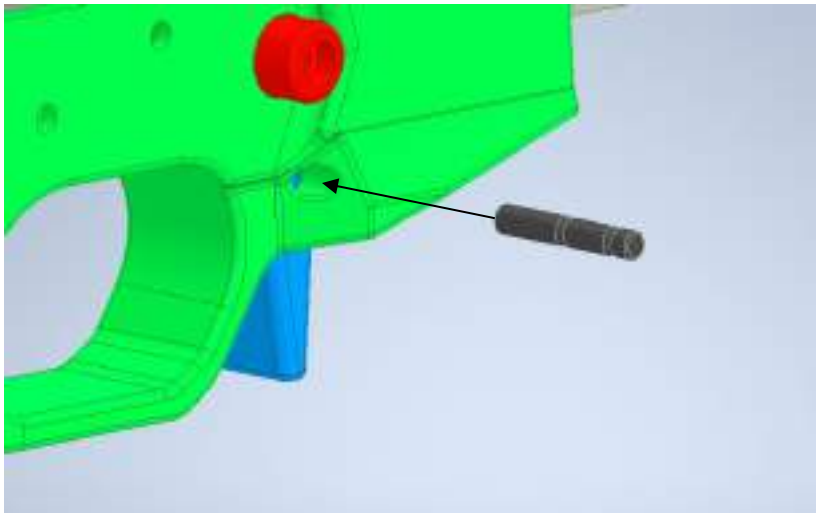


Place the paddle in the lower after applying grease to the top nub.

Line up the pin hole and stick an AR15 fire control group pin through. The pin will be recessed on either side, so get it close to centered. The pin shouldn't be at risk of walking out, but if you are worried about that or have issues with pin walking, you can use a soldering iron to melt excess plastic into the hole to secure the pin.



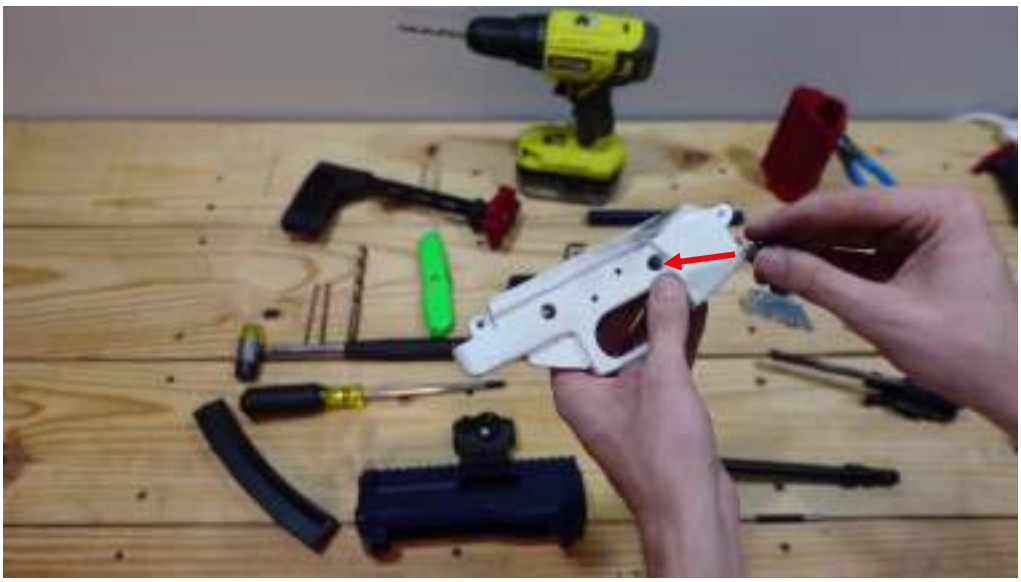
Line up the pin holes…



…and insert and center an AR15 fire control group pin.

After the pin is in place, the paddle may initially be very stiff – play with it a little and it should break in nicely. Note that some drum magazines may interfere with the function of the paddle, but all stick-style magazines available work fine with it.

If using the HK magazine catch, begin by inserting the catch from the left side of the lower. Flip the lower over, then place the magazine catch spring down into the hole on the right side of the lower. Take the magazine catch button, and identify the flat side of the magazine catch button – this side of the button will face forwards, towards the magwell. Take the magazine catch button pin and stick it partway into the *bottom side* of the magazine catch button. Finally, identify the hole in the magazine catch itself – you will have to place the magazine catch button down onto the magazine catch, align the pin with the hole in the catch, then push it into place.

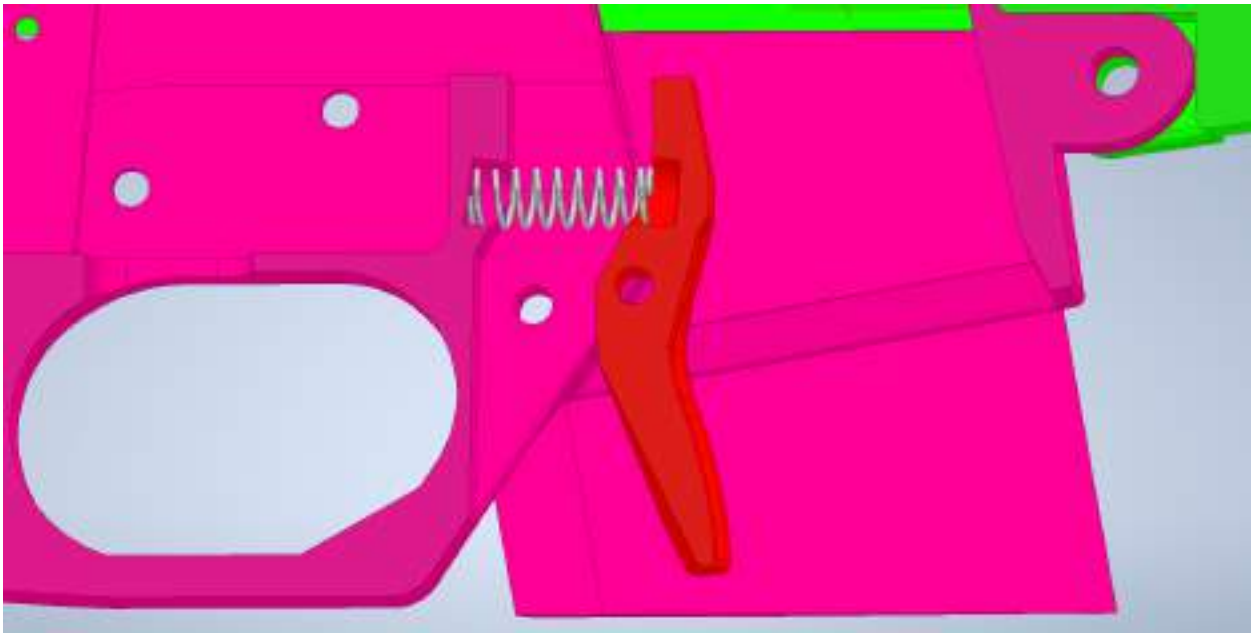


Insert the magazine catch from this side of the lower

With the hollow side of the magazine catch button facing up, and the flat side facing you (like in this picture), insert the roll pin into the right side of the button. Only insert the pin enough so that it holds itself in the button, it should not stick through into the side hollow cavity on the button.

I recommend using a pair of pliers to place the button down onto the magazine catch, and while compressing the spring, pushing the roll pin in using the pliers. This can be a tricky technique to get a hold of, but makes installation of the magazine catch very easy in my opinion.

For 10/40 builds - you will need a 5/32” pin or AR-15 fire control group pin, as well as a 0.25”x0.75” spring. Install the paddle by placing the spring onto the recess in the lower and placing the recess on the paddle over it. Compress the spring and get the pin holes in the paddle and lower to line up. Insert your pin. Note that you may need to trim the spring down a few coils – you want this spring to have sufficient tension, but too long of a spring won’t compress enough to let a mag insert and release. A weak spring can let the magazine fall out of the gun under recoil.



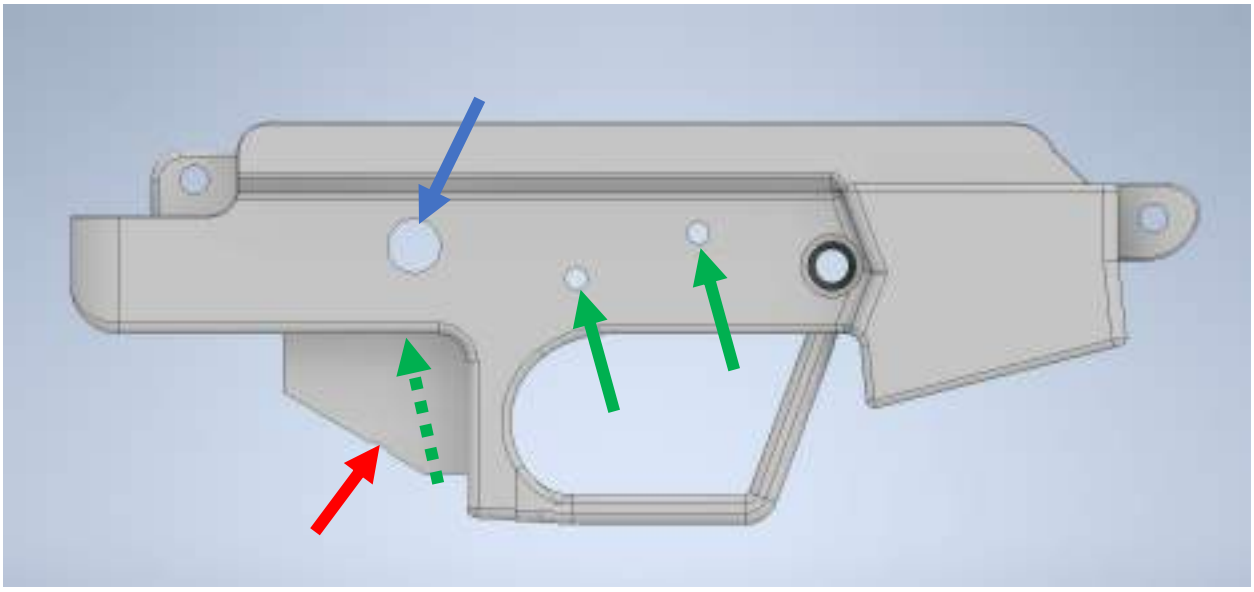
Cross-section of the magwell showing alignment of the spring, lower, and paddle. It can be a little tricky to get the spring compressed just right, so be patient. If you have trouble with the spring wanting to fall out of the hole in the lower, you can wrap a little painters tape around the end in the lower so that it is a snug fit. Finally, align the hole in the paddle and lower and stick the pin in!

Finally, with the magazine catch installed, you can test fit magazines. On a freshly printed lower, some magazines may fit tight, but the magwell will wear in slightly to allow magazines to fit correctly. Note that polymer MP5 magazines – such as ETS or ACUnity magazines – will fit very tight, even after a magwell is “broken in”. Also note that the magazine over-insertion stop for the MP5 is on the trunnion – so when you fit magazines on a lower (without the upper installed), magazines can easily insert too far.

If your magazine catch does not move freely when assembled, it is likely that you didn’t properly ensure its fit before assembling it. You will need to drive the roll pin back out of the button, disassemble the catch, and make sure everything fits correctly.

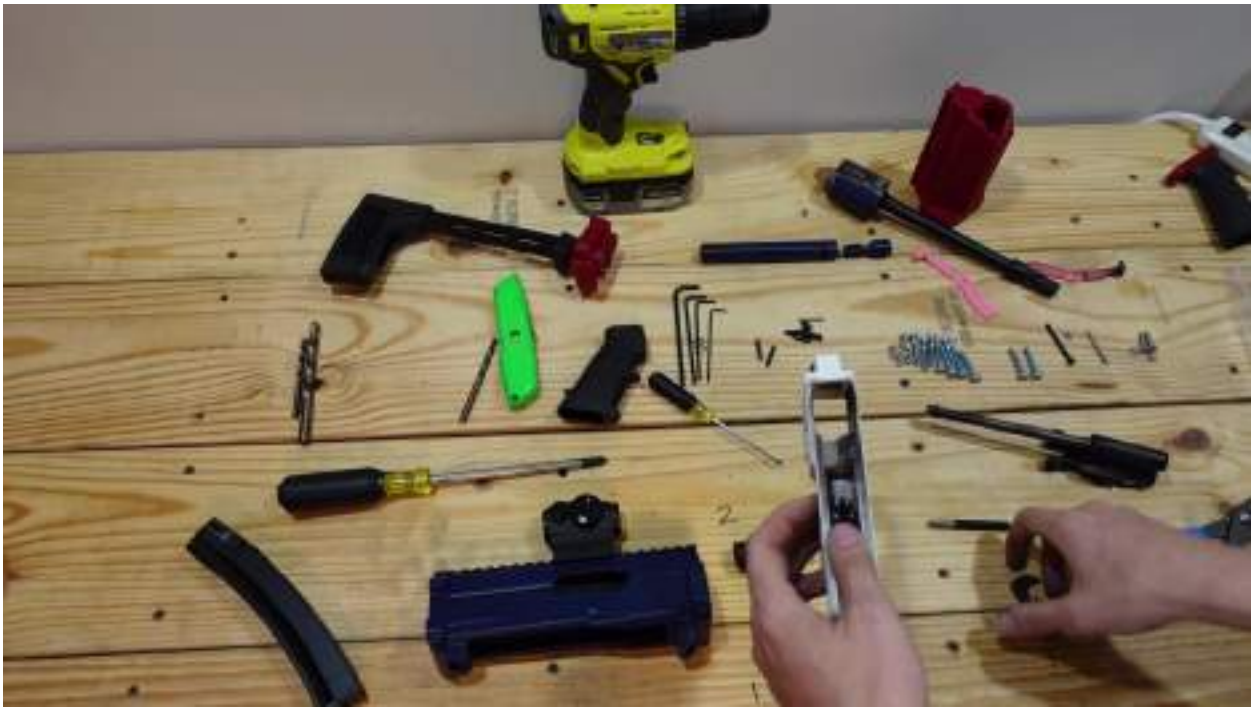
Now – with the magazine catch install, it is time to install the fire control group and ejector. As a side note, be aware that the fire control group cannot be removed once the ejector is installed – unless you remove the ejector first, which can be a little tricky. Take your lower and install the AR15 fire control group – this goes exactly like installing an AR15 fire control group on any build.

Starting off, use a 5/32” drill bit to drill out the trigger and hammer pin holes, as well as the selector detent hole. Use a 3/8” drill bit to drill out the safety selector hole. Use a 1/4-28” tap to cut threads into the pistol grip screw hole.



Drill diagram – 5/32” Drill is in GREEN, 3/8” Drill is in BLUE. 1/4-28” Tap is in RED.

With the holes prepared, take your trigger, disconnector, and their associated springs – install them in the lower receiver.

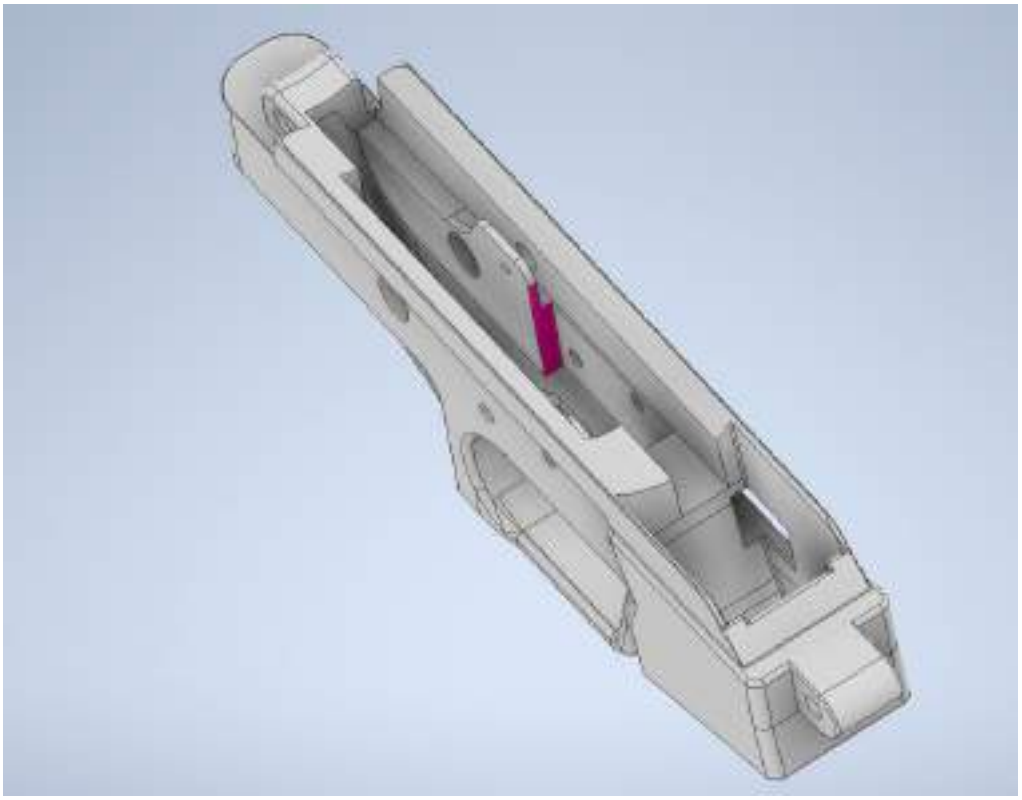


Install the trigger and disconnector in the lower – just like a standard AR15

You will need to cut the left side leg on your hammer spring a little short – this is so it can fit around the tower that mounts the ejector. You should only have to remove about 0.250” of length. When installing the hammer, ensure that the left side leg does not bind up against this tower.

Note that the left side hammer leg is cut a littler short – you can use a Dremel tool, hacksaw, or side-cutter pliers to do this.

Insert the hammer – if you have removed enough length from the hammer spring leg, it should still rest on top of the trigger, but won’t interfere with the wall in the lower.

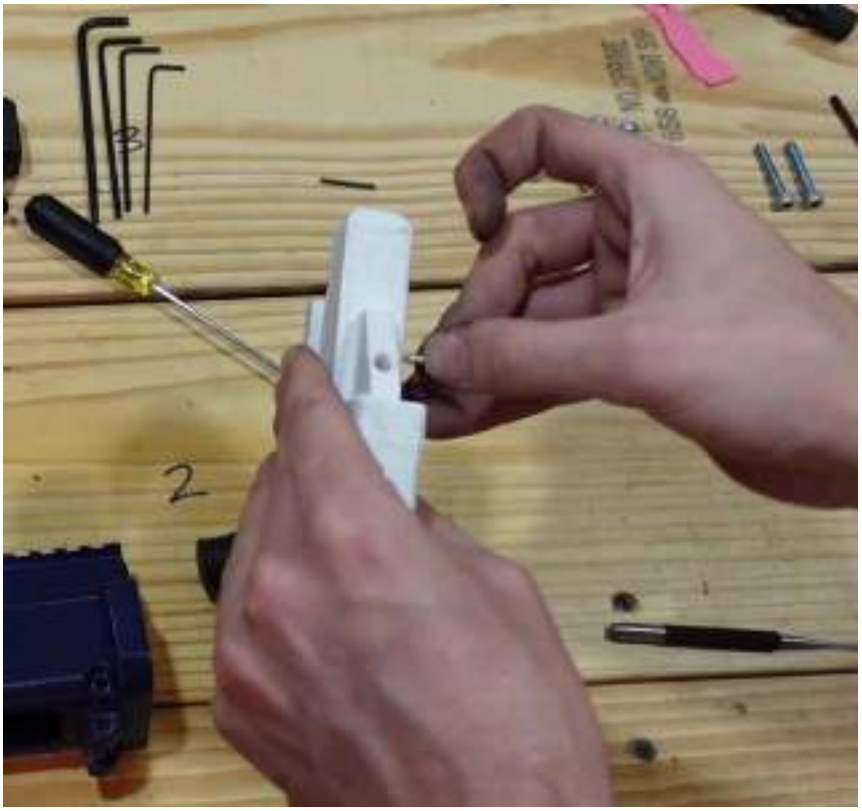


Make sure that the leg on the hammer does not interfere with the pink face shown.

A view of the installed fire control group.

Next, the safety selector and pistol grip will be installed. These steps are also identical to an AR15 – cock the hammer, insert the safety selector drum, insert the safety detent, then install the grip and safety detent spring.

Insert the safety selector – note that the hammer will need to be cocked back for the selector to be inserted.

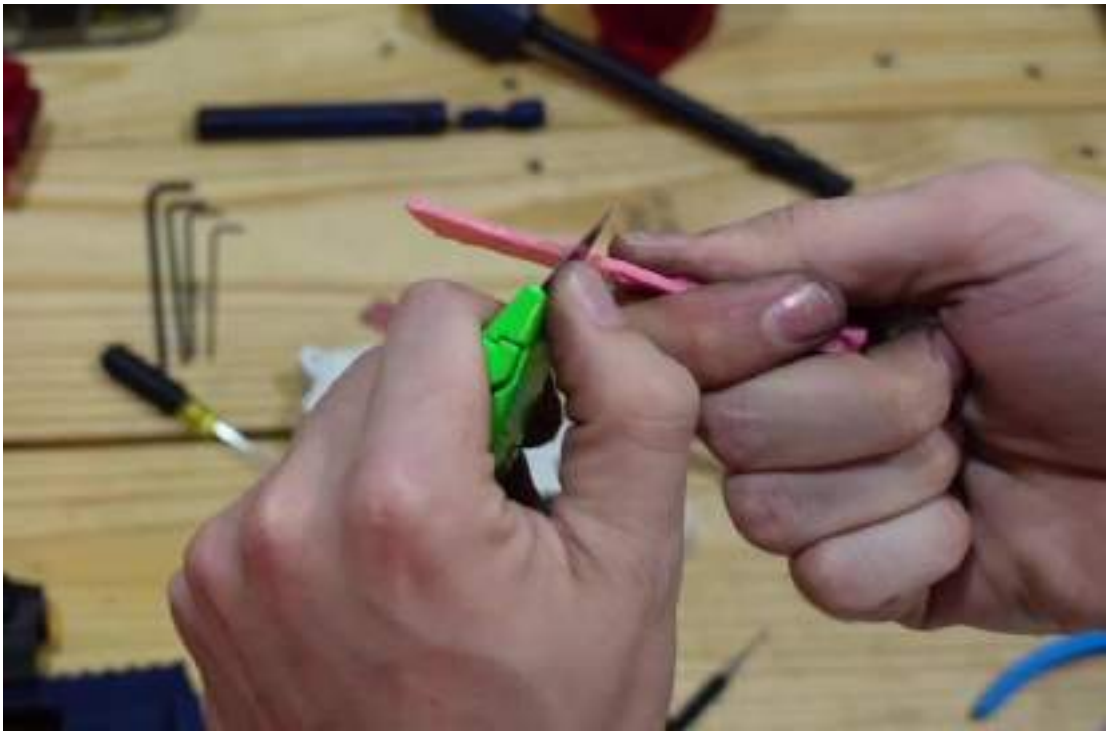


Insert the selector detent

Install the pistol grip and detent spring

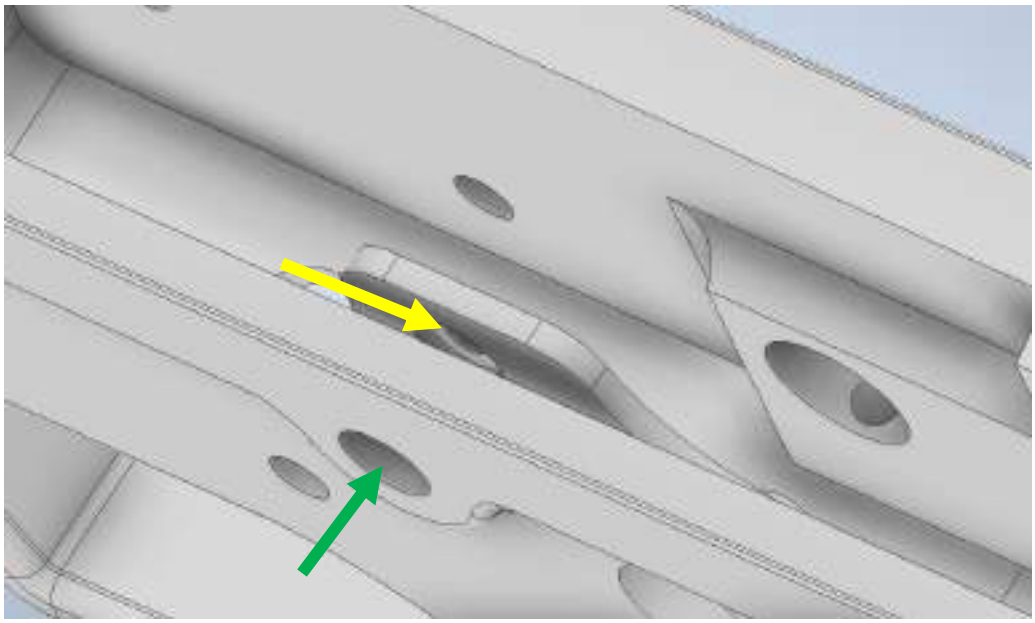
Go ahead and give the fire control group a function check – but be careful not to let the hammer slam forwards against the lower – this will damage the lower.

With the fire control group installed, it's finally time to install your ejector. Depending on which size dowel pin you are using – 1/4" or 6mm – you will need to use either a 1/4" drill bit or a 6mm drill bit to clean out the hole in the lower that the ejector pin will go through. Also note that if you use a printed ejector, you will need to use the same drill bit to clean out the hole in the ejector. If you are using a steel ejector, you should not have to drill it out, and should use a 6mm drill bit and pin in conjunction with it.



If you use a printed ejector, be sure and remove ALL the brim/bulge from the side of the ejector that was on the print bed!

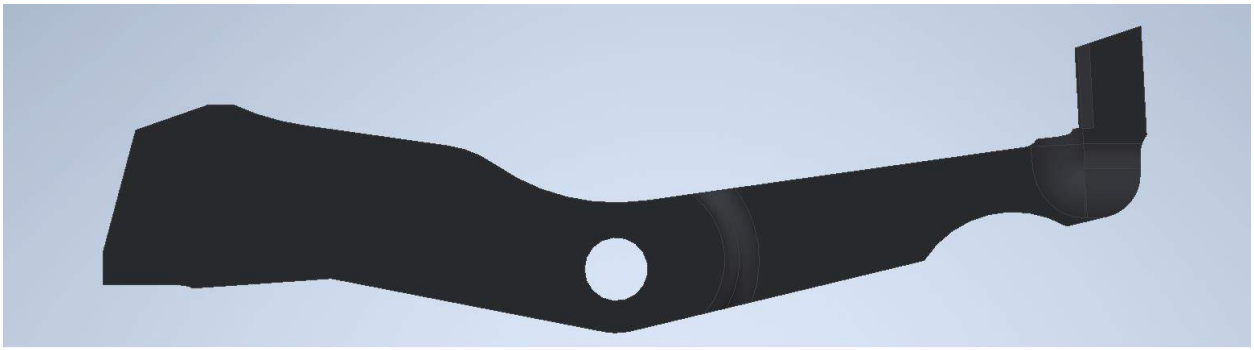
Take your ejector, correct size drill bit, ejector pin, and your lower. *VERY GENTLY* use your drill bit to clean out the ejector pin hole in the lower. You SHOULD drill all the way through the outside wall of the lower, but you SHOULD NOT drill on the inside "hump" – this hump will support the end of the pin, but should not be drilled out.



Drill through GREEN, but do NOT drill through YELLOW – stop drilling when the tip of your drill bit touches YELLOW

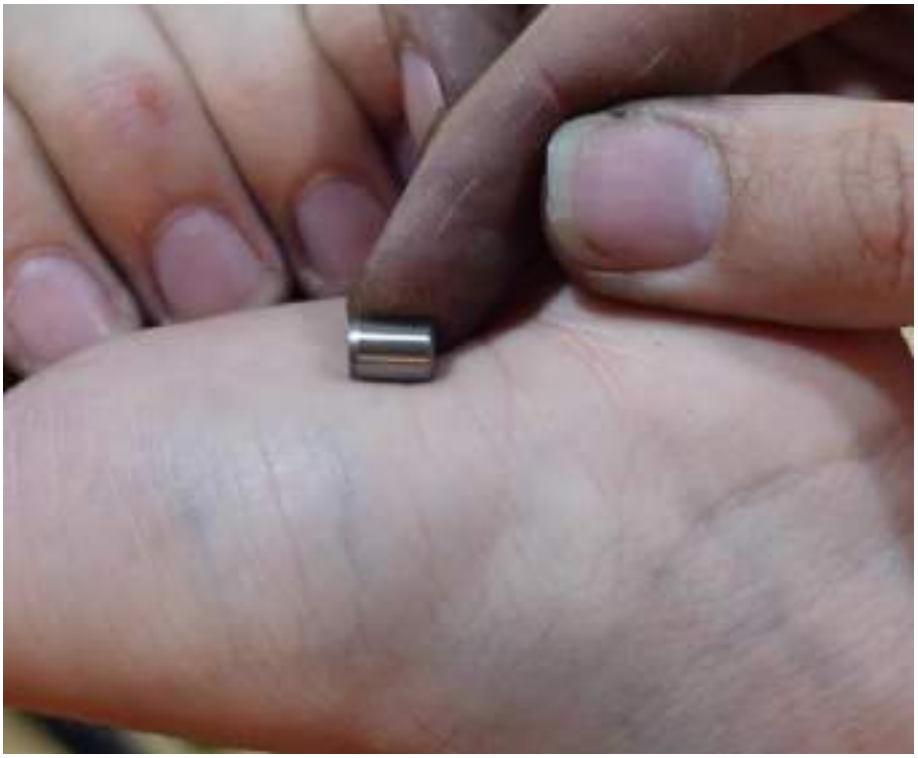
Be very careful and drill slowly – don't drill too far!

At this point, you will need to make sure that your ejector has a cutout to give it clearance over the hammer spring. If you are doing a 10/40 build, you will need to use a Dremel tool to make this cutout yourself. If you buy an ejector from Aves/MAF, it will have the cutout. If you buy a standard 9mm ejector, you will need to add the cutout yourself.



The cutout is easy to make – a rough round shape where the ejector will hit the hammer spring. You can place the ejector into the lower and mark the area where the ejector will interfere with the spring. Use a Dremel tool or hand file to add a little clearance.

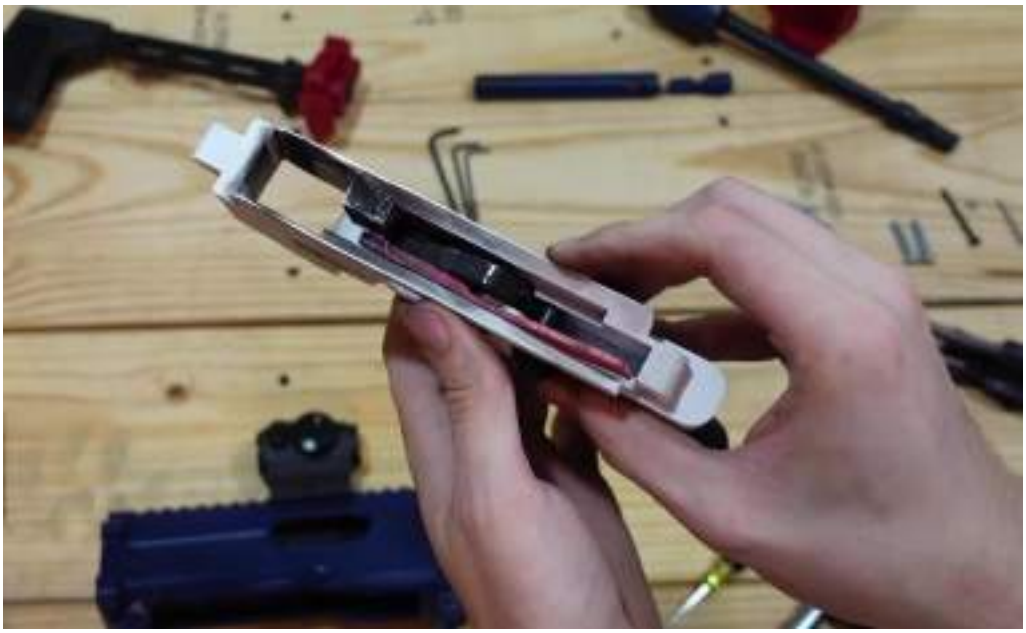
Next, identify the chamfered edge of your ejector pin. The chamfered edge will need to be inserted first.



Identify which side of your ejector pin has a chamfered edge (it may be both ends, but it is important that you stick a chamfered end into the hole!)

With the hammer cocked, insert the ejector into the lower, lining the hole in the lower and ejector up. Stick your ejector pin through – it may be stiff, but be careful not to push it too far into the lower – if you just try hammering it in as hard as you can, you will break the "hump"

When the pin is fully seated, it will be just slightly recessed past the outer wall of the lower receiver. It may help to hold your thumb on the opposite side of the hump as you push the pin in, so that you can feel when the pin starts pushing on the hump. Once the pin is slightly recess past the out wall of the lower receiver, it is installed. However, I recommend that you take a soldering iron and melt some of your support material over the head of the pin to help retain it – I have had ejectors try and walk out after a couple hundred rounds, which a little bit of melted plastic to cover the pin resolved.



Ejector installed in the lower

Important Note – with the ejector installed, you should not let the hammer snap forwards for any reason (as it will damage or break the ejector). I recommend that you keep your hammer cocked back any time the lower receiver is taken off the upper receiver for this reason.

Finally, your lower is fully assembled. Make sure that you ejector can rock up and down – it doesn't have to move freely, but it shouldn't be hard to rock it up and down. If you ever need to remove your ejector, you can work the pin out by pushing through the little hole in the hump – I recommend using a small screwdriver or an Allen wrench to do this. Generally speaking, you should treat the ejector pin as a permanent install, as it is easy to damage the hump while removing the ejector pin – but if you are careful, it can be done.

Some fitting may be required on your ejector, but we'll cover that later – usually, this just involved a little filing to ensure a consistent engagement between the bolt carrier and the ejector itself.

Step 3: Assembling Upper Receiver

Begin by locating your upper receiver and barrel assembly, as well as your left and right hand barrel mounts. I also recommend you take some RTV (or other silicone gasket maker material), as you can use it to create a heat resistant barrier between the barrel assembly and barrel mount.

First – the uppers have integral support legs to help ensure the lugs on the upper print properly. While ideal cooling fan and support settings make these legs unnecessary, the inclusion of the legs ensures you don't need a well-tuned printer to get good results – and nothing sucks more than waiting to the end of a 2-day print to find out you needed a little more cooling fan or a little closer support interface! After printing, carefully use a boxcutter, Dremel tool, soldering iron, or other tool of your choice to remove the support legs flush with the round profile of the lug.

Trim the legs off flush with the profile of the lugs.

Then, use your 4mm drill bit to clean out the mounting holes on the upper:

Drill the two front-facing holes out with a 4mm drill bit…

…and the one rear-facing hole with a 4mm drill bit.

To begin assembly, smear a coat of RTV on the inside of both barrel mounts. Use your finger to evenly distribute the RTV. Take the two barrel mounts and sandwich them onto the trunnion – make sure that the bottom of the trunnion is aligned with the split between the two mounts.

Applying RTV to the inside of the barrel mounts is recommended – any type/color of RTV works fine. Smear a thin coat onto the mounts using your finger or an application tool.

Smush the mounts onto the trunnion – make sure that you don't install the mounts backwards, they should look like in the above picture!

Make sure that the trunnion is aligned with the mounts properly – the seam at the bottom of the mounts should be directly under the centerline of the trunnion.

After pinching the mounts tight to the trunnion, you can shove the barrel mount/trunnion assembly into the pocket in the front of the receiver. It may be a little tight at first, so inserting the mounts at an angle and wiggling them to get things started can help. Remember to keep pinching the mounts while you begin pushing the mounts into the upper.

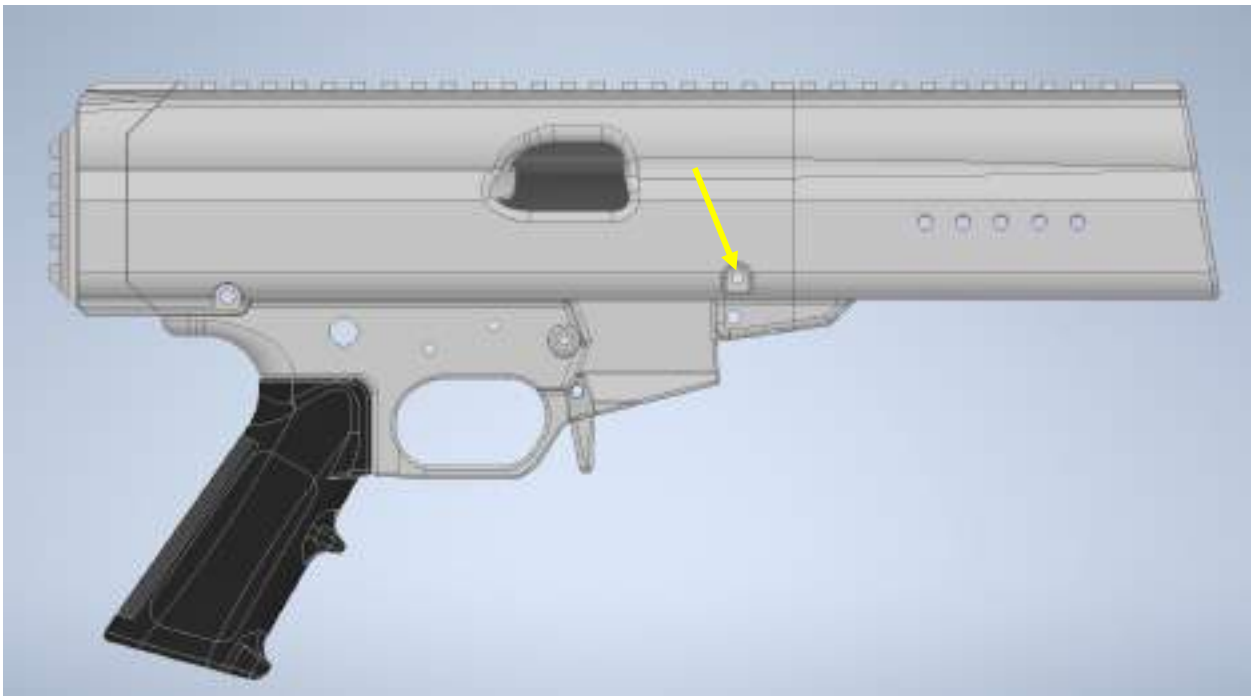
Install the mounts/trunnion assembly in the front of the upper receiver – make sure you get the mounts going in straight.

Push the mounts in until the front of the mounts is flush with the front of the upper receiver. You may need to use a hammer to tap the back of the receiver while the barrel is pressed against a table.

The barrel mounts and trunnion should be flush with the front of the receiver when you are done. Wipe away any excess RTV!

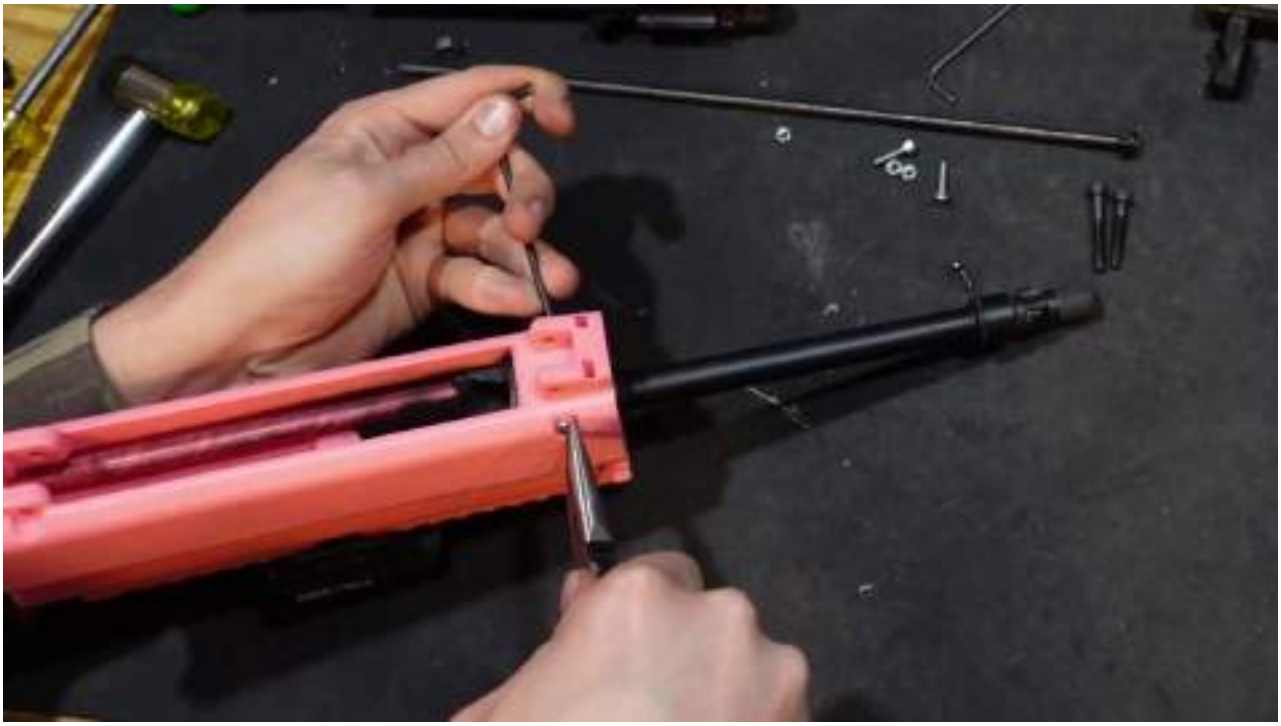
If your barrel mounts are extremely tight, you can use a box cutter or similar tool to shave a little material off of them before insertion. If your barrel mounts are very loose (drop right in to the upper and the barrel is loose/wiggly), you will need to reprint your barrel mounts – movement is likely a sign of a calibration issue with your printer, but if you don't want to mess with your calibration, you can scale the X and Z of your barrel mounts (make them taller and wider with respect to their installed location, but don't make them longer) by 100.2% and step up in 0.2% increments until you have a good, tight fit.

Next, take your 4mm drill bit and drill through the barrel mount retention hole – this hole is located above the front lugs on the upper receiver. After you have drilled this hole with your 4mm drill bit, take your M4x45mm bolt and nut and secure the barrel mounts using the screw. The bolt and nut do not need to be very tight but should be snug enough that the nut will not come loose.



Drill out the barrel mount hole with a 4mm drill bit – be sure and drill straight and carefully!

Stick your M4x45mm bolt through the hole…



Stick your M4x45mm bolt through the hole and secure it using an M4 nut.

With the barrel installed, the upper receiver is assembled.

Step 4: Assembling and Installing Charging Handle/Handguard

If you plan on using the active charging handle retention detent (recommended, but optional), you will need your 4mm ball bearing and 0.140" OD spring. If you don't plan on installing the detent, you can ignore the parts of this step that discuss using the bearing and spring and just assemble without them.

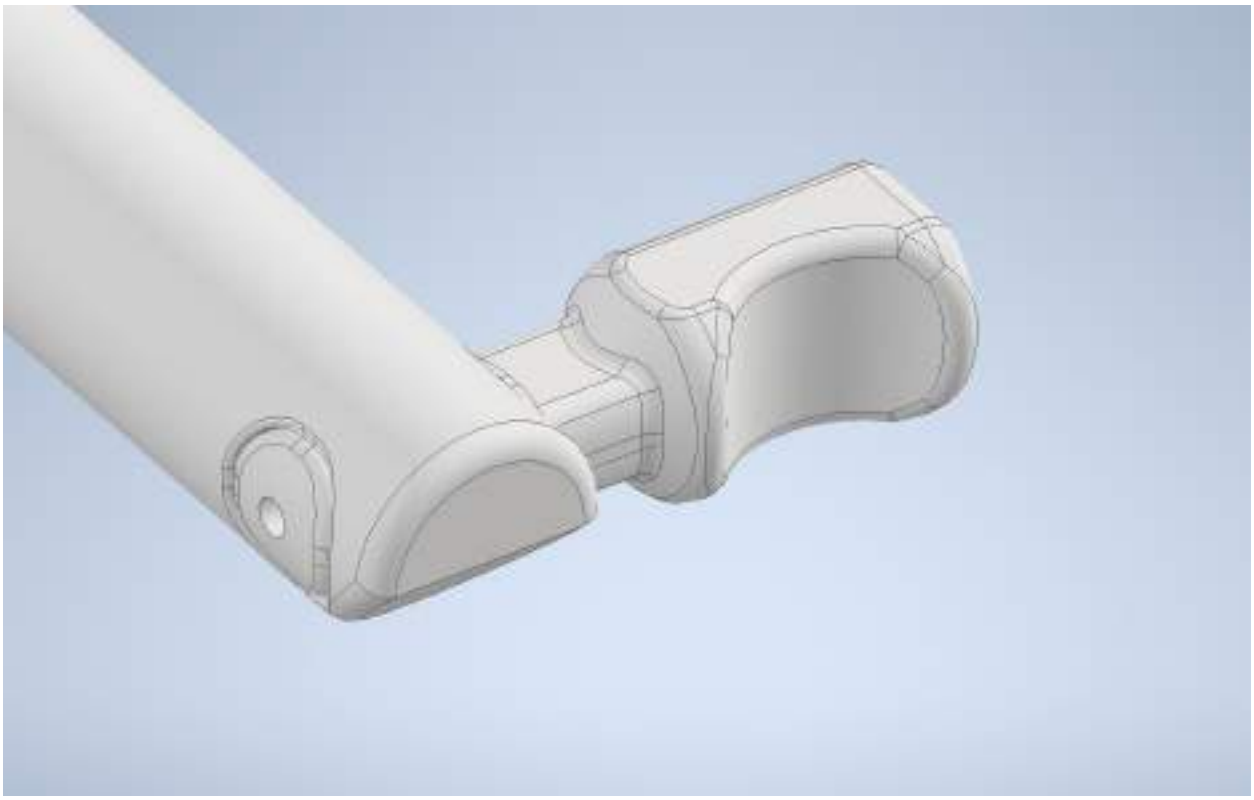
Note: While the charging handle detent is optional, if you don't use it, your charging handle may "float" during recoil – moving a little bit, which can be annoying.

Take your M3x45mm bolt, charging handle, charging rod, and handguard. Screw the M3 bolt into the center recess on the charging handle

Screw the M3 bolt into the center recess on the charging handle.

If your charging rod has a rough outer surface or any print defects on its outside face, use a boxcutter or razor to smooth out the outside – the rod should be smooth and slide freely inside the large, round hole in the handguard/cocking tube.

Take note of the curvature on the end of your charging handle – observe how if the charging handle is installed incorrectly into the charging rod, it will not conform to the curvature of the charging rod. Be sure that when you insert your charging handle into the charging rod, that the curvature on these parts line up.



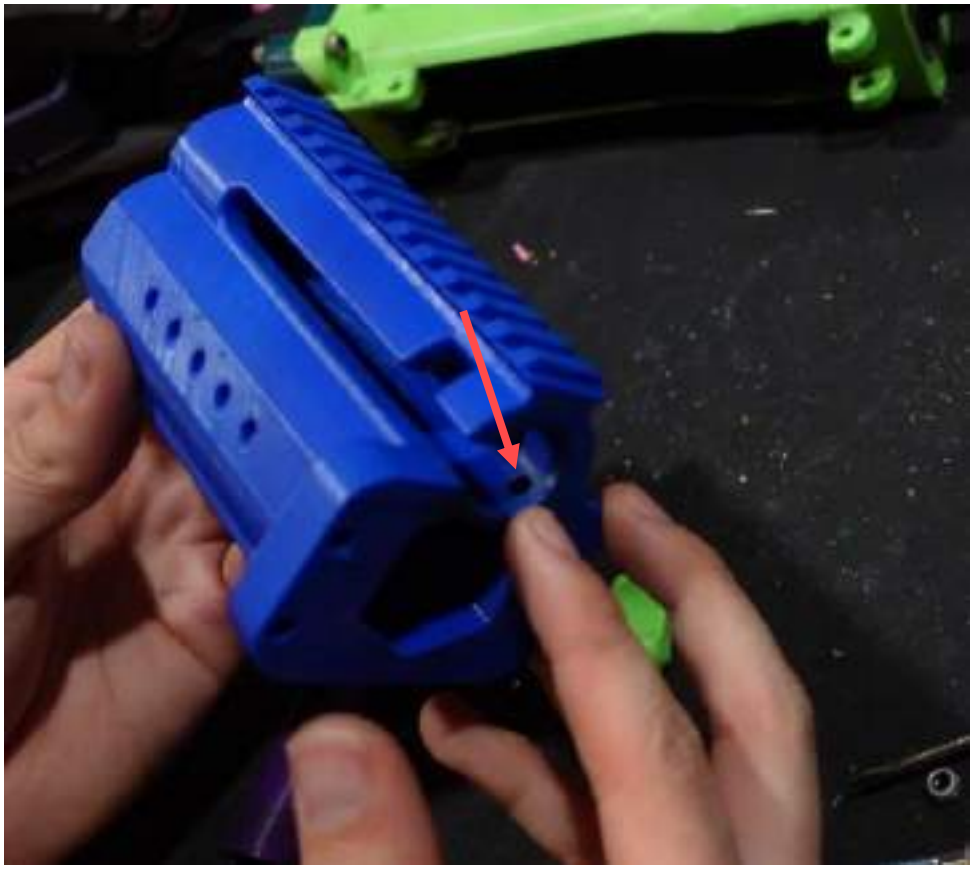
Correct orientation of charging handle

If your charging handle feels excessively loose in the charging rod, you can use a piece of tape or similar to create a shim to get a tighter fit – a single ply of duct tape wrapped around the charging handle shank that inserts into the rod should fix it. These parts are designed to have a loose fit, as tight fitment here can weaken the charging rod itself – but tape or RTV creates a compressible medium that avoids too tight of a fit while removing slop.

With the orientation of the charging handle understood, you are ready to install your charging handle assembly. Take your ball bearing and spring. Place the spring into the small hole in the handguard – it should seat fully, sitting close to flush with the mouth of the hole. Take your ball bearing and place it on top of the spring. You should be able to compress the spring using the ball bearing. Next, take your charging handle rod and observe the spherical feature which the ball bearing will lock into. Also note the location of the beveled face of the changing handle rod. You will use this beveled face to help push the ball bearing down, compressing the spring, and retaining the ball bearing under the rod.

With the ball bearing retained under the rod, rotate and insert the charging rod far enough so that the square cutout in the rod lines up with the notch in the handguard. Again, note the location of the spherical features on the charging rod, and make sure it is lined up with the location of the ball bearing.

Stick the charging handle into the charging rod in the correct orientation. Guide the charging handle forward. You should feel it click into place as it comes all the way forward. There should be a little for-aft play in the charging handle, but it should make a tangible “click” as it moves to its forward position and as you pull it back.



Locate the hole in the handguard. Make sure it is free of support material!

Locate the spherical feature in the charging rod.

Insert the spring into the hole in the handguard. It should be close to flush. If too much is sticking out and you have trouble assembling, you can trim one or two coils off of the spring.

Place the ball bearing on top of the spring in the hole.

Insert the charging handle rod, using the beveled face to push the ball bearing down into the hole.

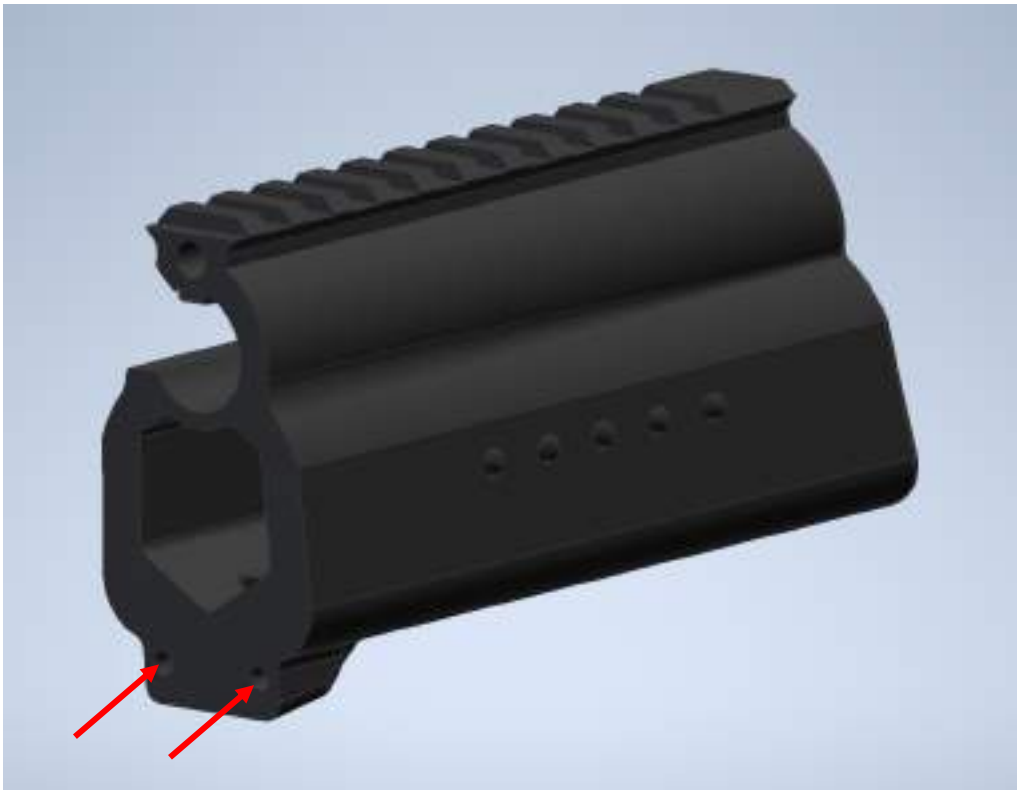
Once the bearing pushed down into the hole and the charging rod is retaining it, you can proceed. It may take you a couple tries to get the bearing retained.

Rotate the charging rod so that the spherical feature will line up with the ball bearing once the charging rod is pushed fully forwards.

Take the charging handle and rotate the charging rod so that the hole is aligned with the assembly/bolt hold open notch. Insert the charging handle.

With the assembly installed correctly, the charging handle will be retained by the detent system and will not fall downwards when you point the handguard upwards. You should feel a tangible click when the bearing engages the charging handle rod. If you don't feel the charging handle snap when it engages or disengages the detent, you may have incorrectly installed something – double check it!

Next, use a 4mm drill bit to clean out the two holes on the bottom of the handguard:



The two bottom holes

Next, we need to talk about what we'll refer to as the union rod – it's a length of threaded rod that holds the handguard, upper receiver, and endcap together. The parts list tells you the exact length of rod you need, so refer to that if you skipped it earlier. In order to disassemble this build as easily as possible, we will want to turn one end of this threaded rod into a bolt head – while you could just use a bolt, 1ft+ 1/4"-20 bolts can be very expensive – so instead, what we'll do is install a locking 1/4"-20 nut on one end of the rod to act as a bolt head. In order to do this, we will need two standard 1/4"-20 nuts and will utilize the cross-tightening method. If you know what this is, use it to thread the locking nut on till it is flush with the end of the rod. If you don't, here's the rundown:

Thread the locking nut on until the locking feature engages and it becomes hard to turn by hand. Take your two standard nuts and thread them on about an inch along the other end of the rod. Then use two pliers or wrench or whatever else to tighten the two standard nuts towards each other so that they get tight against one another, Finally, while using a wrench or pliers to hold the two standard nuts, spin the locking nut with another wrench or pair of pliers until the end of the rod is flush with the end of the locking nuts. Remove the two standard nuts by loosening them with the wrench/pliers.

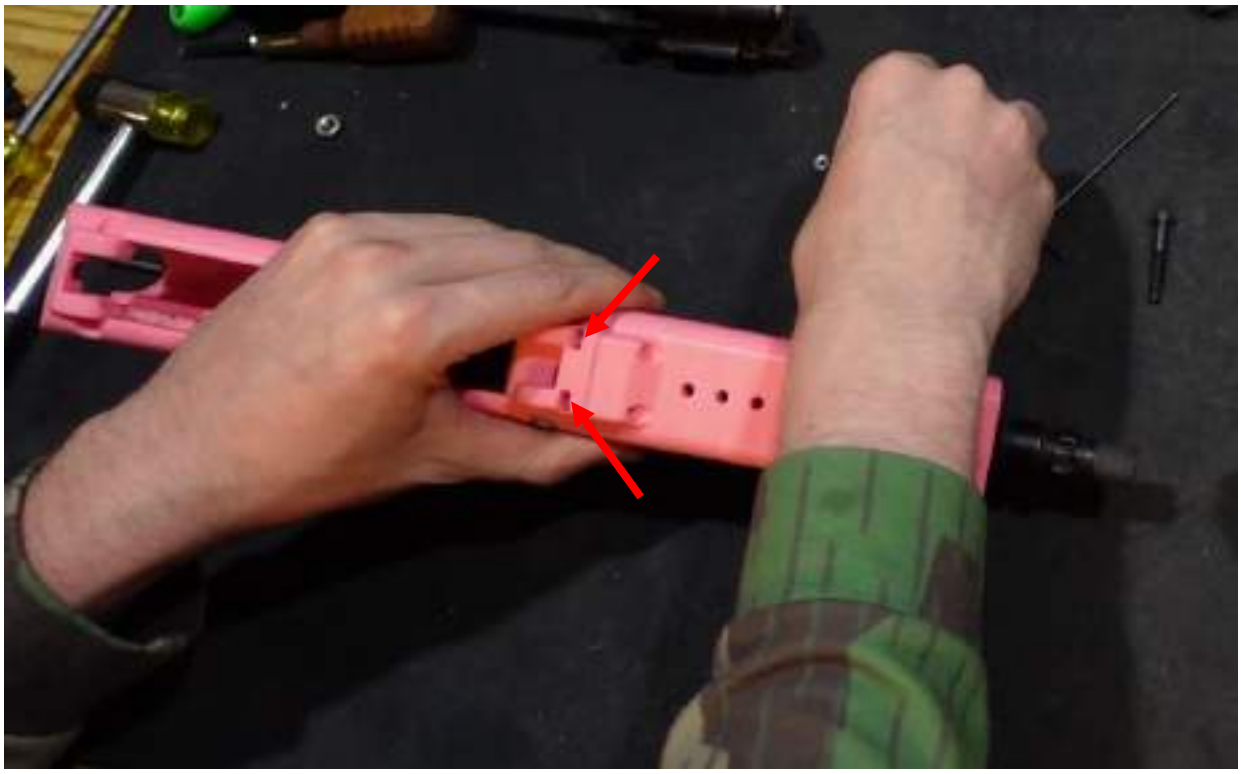
Thread the locking nut on until it is flush with the end of the rod.

Next, we have another fork in the rod – you can use either a standard 1/4"-20 nut or a socket nut to secure the threaded rod. Both work the same, but the socket nut makes for a little easier assembly and disassembly. The only real difference is the tool you use to install the nut option you choose and if you will install an end nut cover (which hides the standard nut since it's a little ugly otherwise).

Anyway – what you'll do first is stick the threaded rod through the handguard, bare end first – we want the locking nut to end up in the hex recess in the handguard. If you haven't installed your charging handle assembly yet, do so now. Stick the bare end of the threaded rod into the front of the upper receiver, and mate the handguard to the upper receiver. At this point, you will fasten the bottom of the handguard to the upper. To do this, take your two M4x15 or M4x16mm bolts and two M4 nuts. Place

the nuts in the recesses in the upper and install the bolts in the handguard. Just get these bolts slightly snug for now, we will tighten them later. You may need to wiggle the handguard around a little to get the bolts to start threading into these nuts.

Stick the threaded rod all the way through the handguard and upper – note that the locking nut is retained in the hex-recess in the handguard.



Install your nuts in the recesses…

…and tighten your M4x15 (or M4x16mm, which also work here) bolts until they are just barely snug – we will tighten them all the way later.

Step 5: Installing the Endcap

Next, we will install the bolt carrier assembly and then the endcap. The bolt carrier assembly slides in from the rear – it should guide in easily, if it feels like it is stuck, make sure that your bolt head is pulled forward relative to the bolt carrier.

Install your bolt carrier assembly

To secure the endcap to the receiver, we will need to compress the recoil spring with the endcap then secure an m4 bolt/nut combo and then your 1/4"-20 threaded rod. The nut will sit in a recess inside the upper. For k-length upper receivers, this nut isn't fully retained – so you will have to hold it in place with a finger until the bolt starts to thread into it. I like to get the M4 bolt and nut started first, then to do the 1/4"-20 setup next. This can be a little tricky since you are fighting the spring pressure from the recoil spring while you do it, but with a little patience it isn't hard to do. Don't tighten the M4 bolt much, just get it snug at this point.

The recess for the nut in a k-length upper. For the full-size uppers, this recess will contain the nut, but for the short uppers, you will have to hold it in place.

Push the endcap onto the threaded rod.

While holding the endcap against the upper receiver, take your M4x25mm bolt and thread it into the M4 nut inside the upper receiver. For full size uppers the nut will be retained so you can leave the upper upright and secure the endcap. For k-length uppers, I recommend the above technique – hold the nut with one hand which is also used to pinch the endcap against the upper while the other hand tightens the bolt.

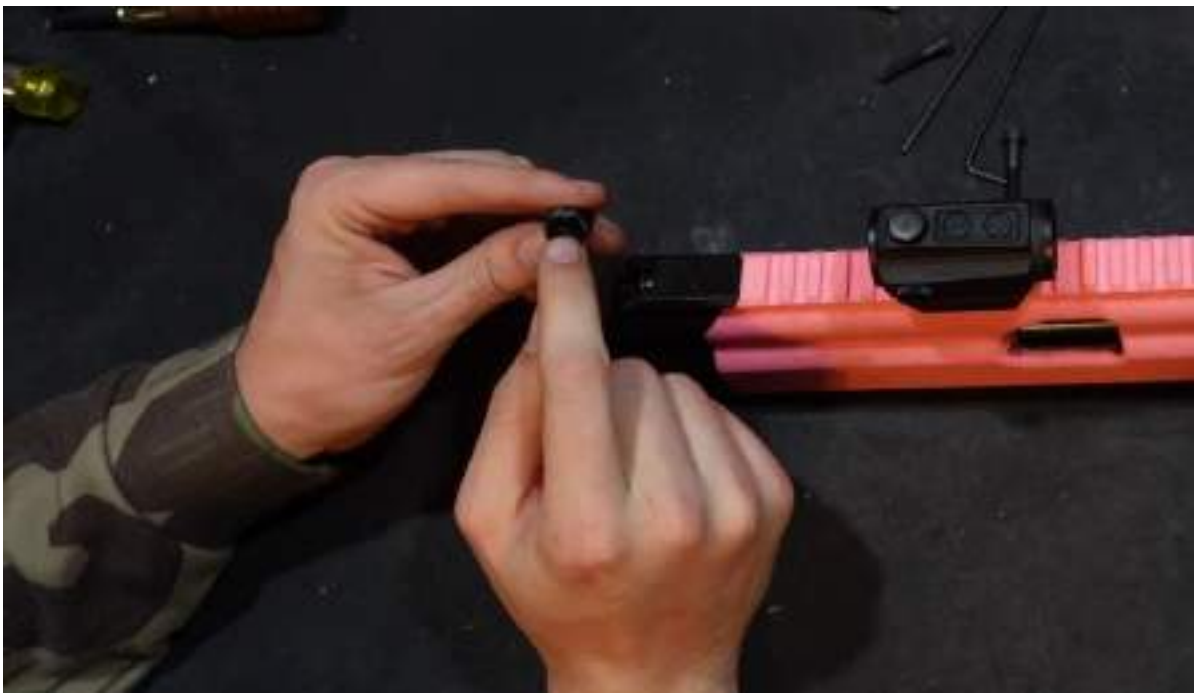
Finally, we can secure the threaded rod using whatever nut option you chose – with the 1/4"-20 option, you will need to use a pair of needle-nosed pliers to tighten the nut. This can be tricky if you have bad hand strength – the socket nut option will be much better for you in this case. The socket nuts installs using an Allen wrench. However, the socket nut option requires that your threaded rod be cut to a precise length – you may need to trim the threaded rod if you can't get your socket nut tight.

Example of tightening the standard nut

Whereas the socket nut will install using an Allen wrench.

With all the fasteners in place, tighten them to a good snug fit in this order – first, the top 1/4"-20 rod. Next, the endcap's single M4 bolt. Finally, the two M4 bolts in the handguard. You do not need to get the M4 bolts extremely tight – because the nuts are held by plastic, if you overtighten them, they can strip out the plastic and you'll have to drill or Dremel the bolts out, which isn't fun.

If you opt to use the standard nut, you can print the end nut cover part to hide the nut. This part is held in place by friction, and can come loose over time – I recommend installing this part with a dab of RTV, which will hold it in place under recoil and use, but still allow it to be removed – but you will need to reapply RTV when you reinstall the cover.



A dab of RTV inside the nut cover will retain it to the upper without fear of it coming off under recoil.

The nut cover is installed by simply pushing it onto the endcap.

Step 6: Mating the Receivers

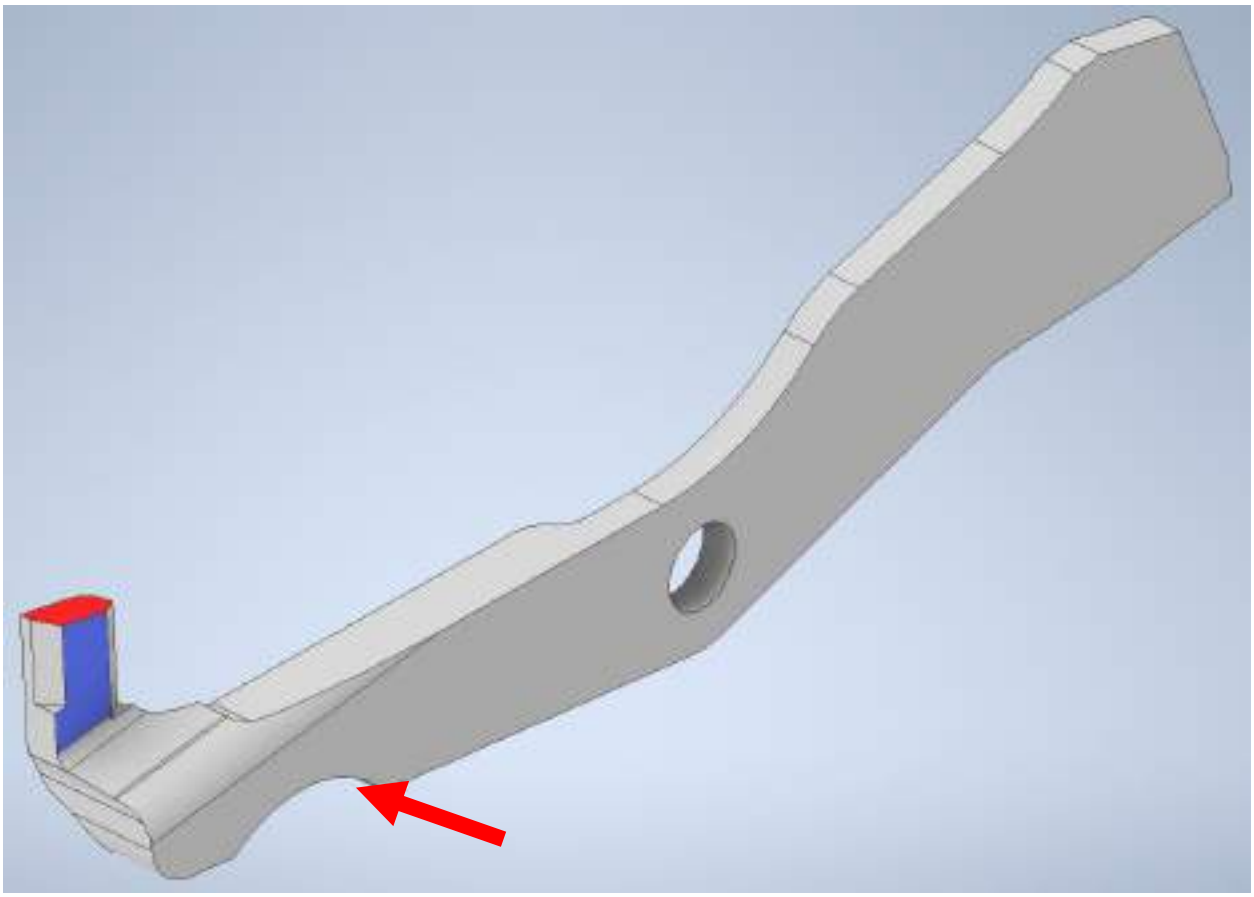
Take your lower and mate it up with the upper. Use your M5 bolts to attach them. The bolts should insert without much resistance – if they feel very tight, you can use a 5mm drill bit to mate-drill the holes. However, be careful when you do this – hold the lower as tight against the upper as you can to avoid drilling the holes crooked, as this can ruin an upper and a lower!

Finally, take your lower receiver and mate it up with the upper receiver. You will use two M5x35 or M5x30 bolts to secure the lower to the upper. The M5x35mm option allows you to put a nut on the end of the bolt to retain it in a more secure manner to the upper. These bolts should have a little resistance when installing them, but shouldn't take hard hits.

After installing these two bolts, you are ready for function testing.

After the receivers are mated, attempt to rack the bolt by pulling back the charging handle. Do this gently, as there is a chance your ejector will bind up against the bolt group and forcing it can cause parts to break. If you can pull your bolt all the way back without heavy resistance, you are ready to proceed to the next step. If it feels like your bolt gets stuck as you pull it back, remove your lower receiver and attempt to pull back on the charging handle. If your bolt group moves freely again with the lower removed, then you will need to do a little fitting on the ejector. Generally speaking, the place that needs fitting is on the top of the fin on the ejector – as shown in the picture below. Sometimes, the sides of the fin may also need a little material removed, but this is uncommon.

You can do any fitting your ejector may require without removing the ejector from the lower receiver – just be sure and support the ejector with your hand to keep it from bending and use a Dremel tool or a file to shave small amounts of material off. If you are working on a steel ejector, take care not to get the ejector so hot that it can melt any plastic – keep your cuts light and allow time for the ejector to cool.



Areas on the ejector where fitting may be required – should fitting be necessary, the red face is the one the most common face that needs a little material removed, while the blue face only needs material removed sometimes. Make sure that your ejector has a cutout hump for the hammer spring as shown at the arrow above – if it doesn't, your bolt will bind up!

After removing a little material from your ejector, mate the upper and lower receiver again and check fitment. Once the gun has the same resistance when charging with the lower installed as it does when it is removed, your ejector is properly fit. If you look in through the ejector port when racking your gun, you can see the tip of the ejector pop up as the bolt comes back – the top peak of the ejector should be very close to the cutout in the bolt head but shouldn't be dragging on it.

Step 7: Final Checks and Considerations

Before you go to fire your build, I recommend that you do a final check of your bolt gap. To do this easily, you can remove the lower from the upper, lock the bolt back, slap the charging handle so that the bolt slams shut, then attempt to insert a 0.015" feeler gauge between the bolt carrier and bolt head. The 0.015" feeler gauge should be able to fit between the bolt head and bolt body without having to be forced. After you have fired your first hundred shots or so, check your bolt gap again – it can change some as the barrel bears up against the barrel pin. If you ever go to measure bolt gap and find that there is zero bolt gap (you can't fit a 0.010" feel gauge between the bolt head and bolt carrier without forcing it) or you go to measure gap and find that a 0.020" feeler can fit with no resistance at all, you should consider changing out your rollers to shim the bolt gap back to spec.

This video covers how to remove and replace the rollers in your bolt, as well as how to measure your rollers and how to make sense of the sizing (and how it effects bolt gap): https://odysee.com/@Ivan's_CAD_Streams:c/Roller-Video:2.

Note that when compared to the bolt gap as measured with +0 (standard) rollers, BIGGER rollers (+2, +4, +6, +8, etc) will result in BIGGER bolt gap, while SMALLER rollers (-2, -4, -6, -8) will result in SMALLER bolt gap. Note that while a CETME bolt is being demonstrated in the video, the process and technique is the same for the MP5. You can purchase new rollers from HKParts or RTG.

You can perform feeding/ejection testing prior to your range trip using dummy rounds (or live ammo if you are careful and have a designated safe area to do it in). You can also put a little oil in the upper receiver (lock the bolt back and drop some oil on the two rails in the receiver), and I recommend that you insert and remove your magazines to ensure that your magwell works correctly and that the overtravel stops in the upper receiver correctly allow you to seat magazines.

FAQ/Troubleshooting

Q: What sort of round counts should I expect? What ends up breaking?

A: Easily a thousand, so long as everything is printed and assembled correctly, and that you don't overheat your gun. So long as you keep magdumps to under 150 rounds without a cooling break, your SF5 should be sturdy enough to last a long time.

Q: How long can the barrel mounts last?

A: It depends on what material you print your mounts out of, as well as if you use RTV to create a heat barrier between the trunnion and barrel mounts. Based on my testing, PLA barrel mounts with the RTV heat barrier can withstand 10+ 150 rounds dumps (so long as things are allowed to cool between dumps) without any sort of zero shift or loss of accuracy. Note that this value will vary greatly based on environmental heat and other factors, and is given here for reference only – but in general, this is a heat resistance design in PLA, and in better materials, it will hold up extremely well.

Q: What sort of reliability should I expect?

A: When using good quality magazines (such as KCI or HK OEM), reliability is extremely good – I was able to get to 1000 rounds without a single issue on one build. Using the metal ejectors in place of the printed ones will tend to help reliability.

Q: Why do I keep getting failures to eject?

A: Most likely this is due to your extractor spring being worn out, but it could also be an issue with a poorly fit or misshapen ejector – double check your extractor to make sure it fits snug, but not too tight against the bolt as you cycle the action on your gun. Assuming this checks out, remove your bolt carrier assembly from the gun and check the extractor spring – if you are using one of the awful copper extractor springs, I recommend you replace it with a steel extractor spring (sold as rifle/G3/HK33 extractor springs). A quick check you can do it to take your bolt carrier and a 9mm round. Snap a round onto the bolt face of your bolt. If you venously shake the bolt carrier up and down, the round should not fall off the bolt face – if it falls off, your extractor spring needs replaced.

Q: What can I do about the rough finish where supports were touching the parts?

A: If the few places this happens bothers you, you can use a soldering iron to melt these areas smooth.

Q: Why do I keep getting hammer follows/dead triggers/double fires?

A: Weak disconnector springs or out of spec disconnectors can cause this. Many disconnector springs sold are weak, and might work well with AR15s, but will have trouble in other guns.

Q: Why isn't by bolt going into battery?

A: Make sure that you are using the correct length charging rod for the bolt carrier that you are using. The "k" charging rod is to be used with MP5k carriers, and the standard charging rod is to be used with MP5 carriers.

Q: Why can't I lock by bolt back and do the HK slap?

A: Make sure that you printed the correct receiver, charging rod, and endcap for the parts that you are using. Using the wrong combination of parts can prevent the action from being cycled far enough to lock the bolt back.

Q: What parts work?

A: Refer to the parts list section for a detailed breakdown.

Q: What mags work?

A: For the 9mm guns, I recommend you opt for KCI mags or HK OEM magazines. KCI magazines are about half the price of HK mags and I've yet to run into feeding issues with them, so they are my recommendation. If you don't want to swing the cash for the KCI mags, the ETS mags do feed well, but fit very tight in the magwell. AC Unity magazines sometimes have feeding issues when fully loaded, but don't need to fit as tight as the ETS magazines in order to run reliably.

For the 10/40 guns, I recommend the HK mags – but they are extremely expensive. The HKParts black polymer mags do work well, but aren't as reliable as the HK mags.

Q: 10mm Ammo Selection – What's Up?

10mm as a cartridge has essentially two main loadings – full power 10 and FBI load 10 (which is identical to 40SW ballistics). The trouble with 10mm is that full power 10 is too hot for many guns available in 10mm, so some ammo makers sell "full power" 10mm which is actually halfway between full power and FBI load. This is relevant to 10mm MP5 builds because FBI load 10 does not have enough pressure to cycle the Hi-Impulse locking piece (while full power 10 and 40SW do). As a result, you will need to be careful when picking ammo for your 10mm build. Always start with the Hi-Impulse locking piece in the gun when evaluating a new loading of ammo – if it cycles, great – stick with the Hi-Impulse locking piece. If it doesn't cycle (fails to eject or extract), you will want to switch to the Lo-Impulse locking piece and will need to use that locking piece any time you use that ammo.

This build has been tested with actual full power 10mm and it holds up fine – but for the reasons above, reliability issues can arise from using the wrong locking piece.