MakerBot Stepstruder MK7

Note: these instructions are intended for users upgrading an existing bot to the MK7. See the complete build instructions if you are building a new Thing-O-Matic.

The MakerBot Stepstruder MK7 is our first dedicated 1.75 mm filament extruder. This extruder was designed from scratch, and contains a number of custom manufactured parts. We’ve learned a lot over our past extruder designs, and incorporated a lot of those lessons here: that’s why it’s smaller, lighter, and faster to build. And since it’s designed from the ground up for 1.75 mm filament, it’s light-years ahead of past designs in small-filament reliability.

Gather your tools

Provided: 1.3, 1.5 and 2 mm hex wrenches. Not Provided: Small flat head screw driver, pliers.
Gather your parts!

The main assemblies here are these four:

- Hot End: Nozzle, Heater Block, Barrel, Bar Mount, Bolt, Heater Core, Thermocouple, Ceramic Tape, Kapton Tape

- Cooling block: Fan, Heatsink, Themostat, 5/8” Spacers, Long Bolts
- Drive system: Stepper Motor, Knurled Pulley, Setscrew, Molded Drive Block, Delrin Plunger, Rubber and Metal Washers
- Extruder mount: Mounting Panel, Spacers, Thumb Screws
Assemble thumb screws

You need two M5x20 bolts and two M5 thumb screw caps.

Using pliers squeeze each bolt into a cap. Be careful not to damage the threads.

Squeeze the bolt head into the cap to ensure a secure fit.

Tip: Two pliers can be used at the same time. We recommend you use pliers with long handles, for best leverage.
You should have two M5x20 thumb screws.

Attach drive gear to motor

You need your

- stepper motor
- drive gear
- M3 set screw
- and smallest (1.3mm) hex wrench

First, disconnect the existing motor cable.
Place the drive gear over the motor shaft. Place a piece of paper between the drive gear and motor to create a small gap.

Tighten the set screw against the flat of the motor shaft. If the set screw doesn’t fit well against the flat section of the shaft, turn the pulley around 180 degrees and set the screw firmly — this should provide more than enough grip.
Then you can attach the longer cable we’ve supplied, and your motor should be ready to go.

Assemble the drive head.

You need:

- the stepper motor assembly
- drive block front
- drive block back
- Delrin plunger
- two M3x18 flat head bolt
- two plastic washers
- three metal washers
- 1.5 mm hex key

Place the plastic and metal washers on the Delrin plunger as shown.
Place the drive block back on the motor with the cable facing away from you as shown.
Place the plunger assembly in space on the right for single configuration. This is also the configuration for the left-hand side extruder in dual extruder configuration.
Place the drive block front on the assembly.

Place 2 M3x18 bolts in the holes and tighten.
Ensure that your assembly appears as shown below:

Ensure that the alignment between the filament channel and the MK7 drive gear is good.
Assemble the bar mount and thermal barrier

You need:

- the bar mount
- thermal barrier tube
- one M6 nut
- the supplied wrench

Orient the bar mount such that the **chamfered edges face you and the horizontal holes are close to the top**. Otherwise, the bar mount will not fit into the rest of the assembly. Thread the thermal barrier tube into the bar mount.

Loosely thread the M6 nut onto the thermal barrier.
Turn the thermal barrier until it is flush with the M6 nut. Finger tighten.

Grip the M6 nut with the wrench and tighten against the bar mount.

Check that your assembly looks like this. The lip of the barrel should be just barely poking up, but no threads should be showing.
As a safety check, look down the barrel, preferably towards a bright surface. You should not see any metal burrs inside the barrel. If you do, push a short length of filament all the way through, and then discard the used filament. Metal burrs left inside will cause severe jamming, and require you to take the entire hot-end apart.

**Assemble the thermal core and nozzle**

You need:

- the nozzle
- thermal core
- 2.5 mm hex key

Place the hex key through the thermal core. This will give you a good grip. Then, thread the nozzle into the side with the small M3 hole.
Grip the nozzle with an adjustable wrench or pliers. Tighten the nozzle against the thermal core.

Once the nozzle is snugly in place, continue.
Assemble the mount plate and bar mount assembly

You will need:

- the mount plate
- M6x10 bolt
- M6 nut
- bar mount assembly
- the 10mm wrench

Thread the M6 bolt onto the thermal barrier, but don’t tighten it down yet.

Thread the M6 nut into the bar mount. Leave a several millimeter gap.

Place the mount plate in front of you with the double notch on your left. Place the bar on top of the mount plate such that the thermal barrier is in the center. Ensure that your parts appear as shown.
Slip the mount plate into the gap between the bolt head and bar mount. The chamfered edges should face forwards. Ensure that your assembly appears as shown.

Use the wrench to tighten the M6 nut and bolt. You want the bolt and thermal barrier to be touching the back of their slot in the mount plate.
Mount the heater and temperature sensor

You need:

- the extruder assembly
- cartridge heater
- thermocouple
- M3x5 bolt
- M3 set screw
- M3 washer
- 2.5 mm hex key

First, you will insert the set screws for these components. Thread a socket head M3 and washer.
Next install the smaller set screw for the heater cartridge. Just turn it a few times, you do not want to obstruct the cartridge for insertion.

Place the cartridge heater in the thermal core with the wires toward the rear of the extruder. An equal length of the heater should protrude from either end.
If you received a recent MK7, you might have received a heater cartridge that looks like the one below. If so, simply insert the cartridge as fully as possible into the block. There will be enough metal contact to ensure good heat transfer.

Secure with the M3 set screw. Tighten only until you cannot push it out from the metal end by hand. Any tighter and you run the risk of stripping the threads.
Secure the thermocouple against the thermal core with the M3x5 bolt and M3 washer as shown. It is advisable to put a single layer of kapton tape over the head, to electrically insulate it from the extruder. This is required for all Dual-Extruder configurations, as two uninsulated thermocouples will interfere with each other.

Cover both sides of the thermocouple in Kapton tape.

Now, bend the tip of the thermocouple 90 degrees.
Place the thermocouple under the set screw washer and tighten it down. Tip: It is easier to tighten in place if the hook points clockwise.

Once the thermocouple is securely bolted you’re ready for the next step.
**Insulate the Heater**

From a length of ceramic tape, measure and cut a 3-inch segment. Then, cover the ceramic tape with a layer of Kapton tape. You can use any width of kapton tape for the covering. This makes the insulation easier to work with and also helps thermally insulate the head.

Starting at one end, cut a 1cm long 5mm wide slot toward the center of the segment, skip along 1cm, and cut another 1cm slot. The center slot allows the nozzle and cartridge heater set screw to be accessed.
Place the insulation on the heater, so that the nozzle pokes up through the center slot. The “legs” of the insulation should be facing away from the cartridge heater.
Wrap the uncut insulation around the bottom, tape it down to the heater core, and tape the legs back to the body when they pass the barrel.
Next, add an extra 1/4″ piece of ceramic insulating tape to the side where you’ll mount the thermostat. Cut a 1/4″ piece of ceramic tape and install it like this, on the thermocouple side of the block:
Now tape thermostat to side of heater core that does **NOT** have the heater in it; you want it on the nozzle side so it doesn’t trip at normal operating temperatures.

**Secure the thermal core assembly**

You need:

- the mount plate assembly
- the thermal core assembly

Thread the thermal core onto the thermal barrier.
Tighten the heater core down as tightly as you can with your fingers. The core might not line up perfectly with the slots as the illustration shows, but a solid connection is more important than the orientation.

Ensure that your assembly appears similar to what is shown. And again, your thermal core may not be in the same orientation as pictured.

**Putting it all together**

Place 2 M3x45 bolts in the fan as shown.
Place the spacers on the bolts. Note the orientation of the wires and label.

Place the fan assembly onto the heatsink.
Take the fan assembly and put the bolts through the mount bar and into the motor as shown.

Tighten the bolts down.
Your fully assembled MK7 should look like this:

Build the safety cutoff

Build and install the safety cutoff board. The MK7 also contains a cartridge heater that can reach temperatures in excess of 500 C and should not be run without a thermal cutoff board.

Install the safety cutoff board.

You need:

- a completed safety cutoff board
- two M3x16 bolt
- two M3 nut
- two 1/8” spacer

The safety cutoff can be installed in a few different places, but our default suggestion for single-extruder
setups is on the right-hand side of the Z-stage. You’ll need to carefully drill some mounting holes.

Bolt it in place with two 1/8” spacers and two M3x16mm bolts and nuts.

**Install the extruder**

You need:

- a completed extruder
- two M5x22 thumb screw bolts
- two M5 nuts
- two 1/4” spacers
Lower the extruder mounting plate onto the two bolts, and finger tighten the nuts.

Ensure that your assembly appears as shown.

**Connect to the safety cutoff board**

Connect the extruder thermostat to the “sensor” port of the safety cutoff board as shown. There is no polarity on these leads.
Connect the cartridge heater leads to the “HTR” port of the safety cutoff boards output as shown. There is no polarity.

Connect 24 inches of black/red cable to the input of the safety cutoff board as shown. This is polarity sensitive, the black wire connects to the “FET” port and the red connects to the 12v port. Secure these wires tightly.
Connect the other end to extruder controller “heater” port as shown.

Connect the endstop cable to the safety cutoff board as shown.
Connect the other end of the endstop cable to the E-Stop port on the motherboard as shown. Be careful not to confuse this port with the Z-Max port.

Connect the thermocouple leads to the T+ and T- terminals on the Extruder Controller. The yellow lead goes into the T+ port and the red lead goes into the T- port.
Do not hook this up backwards: If you do, the temperature will read zero regardless of actual temperature. This will continually run the heater coil, and will damage your extruder controller and/or Stepstruder’s hot end.

**Connect the fan**

Solder 24 inches of black/red cable to the fan leads as shown, and insulate with heat-shrink tubing or kapton tape.
Connect the cable to 1A/1B of the extruder controller as shown. The red lead connects to Port 1A, and black connects to port 1B. This is polarity sensitive.

Calibration

If you haven’t already, set the potentiometer values on your stepper driver board as shown [here](#). Keep in mind that the MK7 ships with a Moons Stepper, and the REF voltage should be between 1.675 and 1.680 volts.

You’ll also need to recalibrate the Thing-O-Matic height as described [here](#). This video has step-by-step
Software configuration

Please note: MK7 profiles will be released shortly with a new version of ReplicatorG. For now, use the Print-O-Matic settings below with a standard MK6 profile.

When it is time to render an STL into gcode for printing, you must choose one of the MK7 specific profiles. Replicator G contains a separate profile for ABS and the experimental PLA and PVA plastics.

<table>
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<th>Select a Skeinforge profile:</th>
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<tr>
<td>1.75mm ABS - No supports</td>
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<td>1.75mm ABS - Support</td>
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<td><strong>1.75mm ABS MK7</strong></td>
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<td>1.75mm PLA MK7</td>
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<td>1.75mm PVA MK7</td>
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Next, under Print-o-Matic, we will enter reasonable settings for the MK7.

Layer heights of between 0.32 and 0.27 should be possible right out of the box; make sure that your filament diameter is set correctly for your 1.75mm stock. Configure infill and shells as you see fit. The nozzle and drive gear diameter should be set as shown.