Important safety rules for operating your MillRight CNC Carve King:

Never place your hands near a spinning end mill or bit.
Unplug the router before changing cutting tools.
Always wear eye and hearing protection while operating your machine.
Always run a dust collector or wear a mask while performing a milling operation.
Do not leave the machine unattended while running a milling operation.
Do not operate your machine while under the influence of alcohol or drugs.
Secure long hair and loose clothing so it is not caught in spinning mechanisms.
Ensure work pieces are properly secured before running a milling operation.
Keep a fire extinguisher nearby.
Visually inspect wires prior to power up to prevent short circuits.
Welcome to the assembly instructions for the MillRight CNC Carve King kit. Assembly will take between six hours and a weekend depending on your experience, tools, and work pace. Don’t get in a rush. Although you are probably eager to get your machine together, it will perform better if you take your time and have fun along the way. We encourage you to read these instructions all the way through first. This will help you understand how the step you are working on ties into the next. After that, follow these instructions step by step and stay organized along the way. If you scatter components and hardware throughout your work area, assembly will take longer. If you get stuck or just have general feedback, please email us at millrightcnc@gmail.com. We strive to email back within a day. There’s also an assembly support forum at www.millrightcnc.proboards.com

The machine is comprised of the following items:

1. Frame including Front, Back, Left Bed, Right Bed, Front Bed Bottom, and Rear Bed Bottom
2. Bearing plate set including (1) X Plate, (1) Y Motor End Plate, (1) Y Idler End Plate, Z Plate, (2) Y Motor Mounts, (1) Z Motor Mount, (1) Z Stage Bottom, (4) Spacer Squares, (1) nut block spacer, and (1) UHMW Z Screw Seat
3. T-Track extrusions
4. V Slot 2040 Rails (613mm long), (2) V Slot 2040 Rails (593mm long), and (2) V Slot 2020 Rails (200mm long)
5. 600mm long lead screws and (1) approximately 178mm long lead screw
6. V wheel sets including eccentric spacers and fixed spacers
7. Motor couplers, spider style
8. NEMA 17 Stepper Motors; 2 motors will have longer cables and 2 will have shorter cables.
9. Hardware set including nuts, bolts, screws, and washers
10. Uno control board, (1) stepper driver breakout board, and (5) stepper drivers (1 extra)
11. Idler bearing pillow blocks
12. Delrin anti-backlash nuts
13. Corner brackets
14. Drag chains
15. 24V Power Supply
16. Set of laser cut acrylic parts of electronics enclosure
17. Cooling fan
Tools Required:
Screwdrivers including large, medium, and small tipped Phillips and Flat
Needle nose pliers
8mm socket
7mm socket
Ratchet or socket driver
8mm open end wrench
10mm open end wrench
Allen wrench (also known as hex keys) in metric sizes
Hammer or rubber mallet
Socket driven Phillips screwdriver bit (if you intend to install an optional corner bracket)
Basic voltage meter (needed to set stepper driver current)

Overview of Build Steps:
V Wheel Kit Assembly
Bearing Plate Assembly
Mounting Z Plate to X Plate
Gantry Assembly
Frame Assembly
Running X and Y Lead Screws
Mounting Homing Switches (If you purchased the homing kit)
Running Cable into Drag Chains and Electronics Setup

V WHEEL KIT ASSEMBLY
Locate the (22) V Wheel Kits included with the kit. Snap (1) 625 bearing into one side of the polycarbonate (NOW BLACK DELRIN) wheel body. Run an M5x30 bolt through the inside hole of that same bearing, then flip it over in your hand. Slide an M5 washer that comes in the V Wheel Kit down over the threads of the M5 Bolt. This helps properly locate the washer on the race of the bearing. DO NOT FORGET TO INSTALL THIS WASHER BETWEEN THE TWO BEARINGS, OR THE V WHEEL WILL NOT SPIN WHEN TIGHTENED AND WILL BE VERY HARD TO GET BACK APART. While leaving the bolt in, snap another 625 bearing into the wheel. It may take some effort as sometimes it is a tight fit. It goes faster if you do this assembly line style: Put in the first bearing into all the V wheel bodies, then slide in the bolt, then slide on the washer, then install the second bearing. It can also help to use a block of wood or flip it over and press it against the table to press the bearing in. Set the assembled V Wheel Kits to the side for use in the next steps.
BEARING PLATE ASSEMBLY

Begin by prepping your anti-backlash nuts. Each anti-backlash nut consists of a Delrin nut (the square black object), M5 set screw, M5 jam nut, and two M5 nylock nuts. All of this is together in one bag. Insert the set screw into the opening in the anti-backlash nut. Just thread it in to the point that it bottoms out against the inside of the nut then STOP threading. Thread an M5 jam nut onto the set screw as shown. Do not tighten the nuts down yet, we will do that later. Now press the M5 nylock nuts that came in the bag with the anti-backlash nuts into the captive nut holes. Set up all four anti-backlash nuts as shown, then set them aside.

You’ll now assemble the Y Idler End Plate. See the below pictures and take note of the side the bearings go on. Install the bottom two v wheels using the quarter inch, fixed spacers. Install these using M5x30 bolts. Put the bolt through V wheel, through the fixed spacer, through the bearing plate, and secure it to the plate using an M5 nylock nut. Don’t tighten these too much or you’ll bind the bearing. Do the same with the top two v wheels, using the eccentric spacers instead. Snug the bolt up, but don’t put a final torque on it yet. You will do that later once you preload the bearing tension to the V Slot rail. Now install the idler bearing pillow block as shown. Put an M5x16 screw through the idler block, through the plate, and secure it with an M5 nylock nut. It’s very important that the hole for the bearing be centered in the corresponding hole in the plate. If not, you run the risk of binding motion when the X axis travels close to this plate.
Now install an anti-backlash nut block. Note: It is okay if your anti-backlash nut points the opposite way of what you see in the picture. Insert an M5x16 button cap screw into the plate then into the nut block. Note that on these End Plates, the anti-backlash nuts get installed on the opposite side of the V wheels. Just snug the M5x16 button cap screws at this time, don’t tighten them all the way yet. We need to check something before we tighten them down completely. Once you have both screws in the nut block, thread a 600mm long lead screw into the nut block so that an approximately equal length is hanging out of both ends of the nut block. Stand the plate up, holding it upright with your hand. Study the screw to see if it’s angled. Rotate the nut block as necessary to make sure the screw is not canted up or down. Once each end of the screw is the same distance from the table, put a final torque on the button cap screws making sure you don’t twist the nut block when you do. Remove the lead screw and set it aside for later.

Install V wheels on the Y Motor End Plate. Take note of which side the V wheels are on: it’s opposite of the side they are installed on the Y Idler End Plate. Now get a NEMA 17 stepper motor. Note: Use one of the two motors with a short cable. Install a coupler onto the shaft. Slide the coupler all the way down onto the shaft until it stops, then tighten the set screw using an Allen wrench. Now you’ll mount the motor onto the Y Motor End Plate. Slide an M3 split-lock washer AND an M3 flat washer onto an M3x20 screw (use both washers to prevent the screw from bottoming out in the motor threads!), then put the screw into a hole in the plate. Slide a skinny 8mm long spacer onto the screw, then screw into the motor. A few turns. You don’t want to tighten it down all the way yet or you’ll have trouble getting the other spacers in place. Note that the 8mm long spacers are different than spacers for the V wheels; those are 6.35mm (quarter inch) and fatter than these spacers. The motor should be installed so that the wires are pointing at the BACK of the Y Motor End Plate. See the picture. Install all four M3 screws and spacers this way and be sure that you install the motor centered in the hole or else you’ll cause binding as the X axis travels close to this. Install the anti-backlash nut block on the side opposite from the V wheels and use a lead screw to ensure it is mounted properly just as you did on the other Y plate. Remove the lead screw and set it aside for later.
Grab the X Plate. Read this entire paragraph before you start work on this piece! Install the V Wheels using M5x30 bolts and M5 locknuts. The **head of the screw should be against the plate**, so you need to slide the bolts through the plate then slide the spacer and V wheel on from the other side. Take notice of the notches at the top of the X Plate. Keep in mind that this indicates the TOP of the plate.

**NOTE:** If you have the homing switch kit, install an M5x50 bolt in the position being pointed to in the photo. That bolt is in the homing kit. **This is required to trigger the X axis homing switch.** Notice that the top and bottom X Plate holes accommodate eccentric spacers (the holes are about 9/32, or 7.3mm) while the V wheels holes closer to the middle of the plate use the fixed spacers. Tighten the wheels using fixed spacers all the way now, but leave the wheels that are on eccentric spacers snug but not all the way tight yet.
Get the two 2020 extrusions, four drop in t-nuts, four square spacers, and four M5x16 button cap screws. Notice the holes on the X plate that are between the V wheels.

NOTE THAT STARTING IN JANUARY 2020 SOME CARVE KING MACHINES SHIPPED WITH NEW GANTRY RAILS. IF YOU HAVE NEW RAILS, THE X PLATE WILL HAVE POCKETS TO RECESS THE HEADS OF THE M5X16 SCREWS ON ONE SIDE FOR CLEARANCE OF OUR NEW SLEEKER AND SLIGHTLY HEAVIER GANTRY RAILS. NOTE THE DIRECTION. NOTE THAT THE V WHEELS SHOULD BE ON THE SAME SIDE AS THE V WHEELS. THE NEW RAILS HAVE ONLY ONE SLOT ON THE 40MM TALL SIDE.

Insert an M5x16 button cap screw into the X Plate from the same side the V wheel bodies are on. If you are holding the X plate with the wheels facing away from you, the threads of this M5x16 button cap screw will be pointing towards you. Now slide a square spacer of the threads of the button cap screw and thread a T nut on just one turn (leave it loose). Do this with the other three as well. Take a 2020 V Slot extrusion and slide the tee nut into the slot. Continue to slide it and guide the second T nut into the slot. Do the same with the other 2020 V Slot piece on the other side. Now, this part is important. These rails will be what the Z axis wheels roll on, so you must be sure to run them parallel. Fix one side in place first. Use a straight edge to line the 2020 extrusion to the outer edge of the X plate and make sure the end of the rail is even with the top of the X plate before you tighten down the M5x16 button cap screws. Do the
same with the other side, using a tape measurer or calipers to make sure the distance between the rails is the same at the top and bottom. Don’t get sloppy on this part, it matters a lot. Once both rails are in place and satisfactorily parallel, install an anti-backlash nut on the same side the V wheels are on using the holes in the center of the X plate. Stand the X plate up on its end and thread in a lead screw to confirm that it is not canted. Do this just like you did when you built the Y plates. Take the time to get it right. Remove the lead screw when you are done and set it aside.

You’re making good progress. Let’s move on to the Z plate. Install the remaining six V wheels using M5x30 bolts, eccentric spacers, and M5 nylock nuts. Put the bolt through the Z plate, then slide the spacers and V wheels onto the threads. All six positions use eccentric spacers. Get these tight now, but not so tight you can’t turn the eccentrics with a 10mm wrench. Now install the remaining nut block as shown using M5x25 screws. The nut block spacer must be placed between the Z plate and the nut block. Note the part of the nut block that is closest to the top of the plate. (The top of the Z plate is where the big notch is). This orientation is important. Lay the Z plate on its side and thread in a 600mm lead screw. Even though a 600mm lead screw isn’t used here, it will help you confirm that the nut block isn’t canted.
Observe the screw and adjust the mounting position of the nut block as needed, just like you did in previous steps. Remove the lead screw when you are done.

You should install any router or spindle mount that you have now. It might be harder to install if you wait. Many router mounts should use just the **TOP** set of holes (there are two identical rows of holes and slots). The spindle mount utilizes both rows. If you are using our 52mm spindle, be sure to insert the screws M6x65 from the front of the mount, first sliding them through M6 split-lock washers. If you don’t do this, you’ll hit the Z Bottom Plate that will be installed later.

**Mounting Z Plate to X Plate**

Lay the X plate down on the table with the V wheels facing down. Take the Z Axis plate and slide it onto the X axis plate from the top. Remember, the top of the X plate is the side with the two notches. This part can be tricky, so read it two or three times! First, adjust the V wheels so that they are in their inner-most position. If you don’t understand, just take a 10mm wrench, place it on an eccentric spacer and rotate it. The eccentric spacers allow the wheels to be tensioned against the rail. Do you see that when you rotate the eccentric spacer the wheel gets closer and farther away from the wheel on the other side? Turn the bottom two eccentric spacers so the bottom two wheels are CLOSEST TO EACH OTHER. In other words, we don’t want them putting any tension on the rails when we first insert them. Now, slide the bottom side of the Z plate onto the top side of the X plate up to the **middle pair** of V wheels. Just barely slide these wheels in and use your 10mm wrench to adjust the eccentrics snugly against the rail. Keep sliding the X plate down onto the X plate up to the **top pair** of V wheels and tension them against the V slot rails.
the same way. Now slide the Z plate down until the bottom pair of V wheels are at the bottom of the rails. You may have to slide the bottom pair off the bottom of the rails to get your wrench on the eccentrics. Turn the eccentrics to tighten the bottom two wheels against the rail. The proper amount of preload on the bearing is tight enough that you can turn the wheel with your finger and drive the mechanism, but loose enough that you can hold the plate with your other hand and the wheel just “free spins” when turned.

Put an 8mm wrench onto the nylock nuts to hold them and put a final torque on the V wheel bolts. Make sure as you do this you don’t turn the v wheel away from the rail and lose your tension. You’ll probably have to hold the head of the bolt with a socket or wrench to keep it from spinning.

Set the X/Z assembly aside for a moment and grab the Z motor mount, a NEMA 17 stepper motor with a long cable, one motor coupler, four M3x10 button cap screws, and four M3 split-lock washers. Look at the picture to see which side the wires should be on. Slide an M3 split-lock washer onto an M3x10 button cap screw, put the screw through the plate, and fasten the motor to the plate. Do this with all four screws. Now slide a motor coupler down onto the shaft until it stops, then tighten the set screw to secure it to the motor shaft. Get the X/Z assembly you just put together and thread the 178mm lead screw into the Z axis anti-backlash block half way down. You will now join the Z axis motor plate to the X/Z assembly.
using two 1” long, #10 self-drilling screws. Put the Z motor mount onto the top of the plate so that the back flushes up to the back of the X plate. Do not tighten the set screw that clamps the coupler to the lead screw yet. Secure the motor mount with the screws. Note: if you find that the Z screw is pushing the Z Motor Mount left or right so it doesn’t line up with the tap holes in the rail, just loosen the screws on the anti-backlash nut mounting screws, secure the motor mount, then tighten the anti-backlash nut mounting screws again.

Get the Z base plate and affix the UHMW (an extremely wear resistant engineering plastic) Z Screw Seat to the center holes using M5x12 machine screws and an M5 nylock nuts. Insert the M5x12 machine screws through the bottom of the Z base plate, through the Z screw seat piece, and secure it with an M5 nylock nut. Put the Z base plate up to the bottom of the X/Z assembly and secure it using #10 x 1” self-drilling screws into the tap holes of the V Slot. Once the Z Base Plate is secured, make sure the Z screw is seated against the UHMW Screw Seat by pulled downward on the Z plate. Once it’s seated against the Z Screw Seat, tighten the set screw that clamps the coupler to the Z screw.

Now, turn the coupler on the motor with your hands to drive the Z towards the bottom of travel. Using an Allen wrench, come in from the opening notch at the top of the Z plate and spin the jam nut that is on the anti-backlash nut screw clockwise with your finger until the nut is seated against the body of the nut. Now apply just a little preload to the nut against the lead screw by turning the set screw on the anti-backlash nut clockwise. Now turn the coupler with your thumb to drive the Z plate back towards the motor. If it’s really hard to turn, there is too much preload on the anti-backlash nut and you will stall the motor or loose steps when you get running. Once the bottom of the thread of the M5 grub screw is against the body of the anti-backlash nut (which you did when you first built the anti-backlash nuts), you only need about 1/3 of a turn to get adequate preload. Turn the lead screw throughout its range using your thumb.
and make sure you can turn it freely. If the coupler gets hard to turn at the top of its range, there could be some slight misalignment between the motor shaft, lead screw, and nut block. If you feel that it binds towards the top of the range, you can loosen the two tapping screws on the Z motor mount that screw into the Z Axis V Slot a few turns. If there is misalignment in the system, doing this with the Z at the top of its range will help “float” the motor into alignment. Continue to move the Z up and down with your thumb and get confident that you have good motion before moving onto the next step.

Congrats! You just built your plates!

**Gantry Assembly**

Grab your Y Idler End Plate, Y Motor End Plate, the two 613mm long 2040 V Slot extrusions, and eight #10 x 1” self-drilling screws. Take note that you have two pairs of 2040 V Slot extrusions. This is the longer (613mm) pair. NOTE THAT IN JANUARY 2020 SOME MACHINES STARTED SHIPPING WITH OUR NEW, SLEeker, 2040 EXTRUSION FOR THE GANTRY RAIL (613MM RAIL). UNLIKE THE OLDER RAIL, THIS RAIL ONLY HAS ONE SLOT ON THE 40MM FACE. YOU MUST INSTALL THOSE RAILS EXACTLY AS YOU ARE SHOWN BELOW OR YOU WILL NOT BE ABLE TO MOUNT OTHER ITEMS INTO THE SLOTS IN THE LATER STEPS. NOTICE THAT THE SLOTS IN THE RAILS ARE FACING AWAY FROM THE PLATE AND ARE BOTH CLOSEST TO THE MIDDLE.
Use a 5/16 or 8mm socket to drive the self-drilling screws in, starting with the top extrusion on the Y Motor End Plate. The extrusion should butt up to the Y Motor Plate on the same side that the motor shaft is sticking out of. These plates are designed so that the top flushes up exactly with the top of the extrusion. Make sure you don’t mount it twisted, high, or low. Put a final torque on these two screws. Now attach the bottom extrusion using two more #10 x 1” self-drilling screws. Get these two snug, but not completely tight yet.

Notice that the V wheels with the eccentric spacers are at the top and bottom of the X Plate. You’ll need to adjust those to the loose position so you can slide the wheels on the extrusions. Slide the X/Z assembly onto the open end. The Z Plate should be facing towards the FRONT! Study the below pictures to makes sure you orient this correctly. Now fasten the two extrusions to the Y Idler End Plate with #10 x 1” self-drilling screws, flushing the top of the extrusion to the top of the plate, just like you did on the opposite side. **Be sure to alternate tightening between the four screws or you will cant the plate, bind it, and break a screw in the tap hole.** Slide the X/Z assembly towards the Y Idler End Plate and fasten the bottom extrusion to a final torque with #10 x 1” self-drilling screws. Now slide the X/Z assembly towards the Y
Motor End Plate. Loosen the two screws that go into the tap holes for the bottom extrusion a few turns, then tighten them to a final torque. This procedure will help “float” the rail into alignment.

Turn the eccentric spacers to preload the bearings against the rail with your 10mm wrench. You want the V wheel to be firmly against the rail, but still loose enough that you can hold the plate with your other hand and the wheel just “free spins” when turned.

Frame Assembly

We’ll start by building the bed. There are a lot of fasteners on the bed, so let’s get to work. The bed consists of four pieces: Front Bottom, Rear Bottom, Left Bed, and Right Bed. The “Bottom” pieces have eighteen circular pockets each, while the “Left and Right” have long rectangular pockets in them. These pieces look very similar, but we drilled some indicator holes to help you identify which is which. Look at the “Left and Right” pieces and observe the holes that are in the long rectangular pockets. All the holes are equally spaced, except for one hole that is the indicator. This is the Left Bed and that indicator hole is closest to the FRONT of that piece. Now look at the “Bottom” pieces. Notice that they have the same hole spacing and there is one drill hole that is spaced closer than the others. This is the Front Bottom.
Lay the Left Bed on your work table, then place the Right Bed next to it. The rectangular pockets should align. Now take T track and place it into the long rectangular pockets. Notice that the holes that are punched in the T track will align with the holes in the long rectangular pockets. Most T tracks will fit freely and can just be laid into the pockets in the bed. You might need to use a rubber mallet or a hammer and a small block of wood to lightly tap the T Track into the rectangular pocket.

Now flip the Left and Right bed over so the T Tracks are face down, against your work table. Lay the Front Bottom and Rear Bottom onto the other bed pieces with the circular pockets FACE UP. The indicator holes in the Front Bottom and the Left Bed will line up if placed properly. **Note:** You just flipped the Left Bed and Right Bed upside down, so the indicator hole is now on the right side when you are looking down at it. Insert an M4x25 machine screw through the T track, through the Right Bed piece, through the Bottom, and secure it with an M4 washer and M4 Nylock nut. Secure the fasteners by sliding the bed assembly over the edge of your work table. Rotate different portions of the bed off your work table as you secure these fasteners. Use a small screwdriver to fish out washers or Nylock nuts from the circular pocket holes if you drop them in crooked. **Start from one end and put a fastener in each hole as you go. Make sure that**
the bed stays square and flush as you do this. The Front Bottom and Rear Bottom should stay flush to the Left Bed and Right Bed.

Get the Rear Frame and observe that it has thin rectangular pockets cut into one side, but not the other. The Rear Frame must be installed with the thin rectangular pockets facing TOWARDS the bed. Get two 5/16” washers, two 5/16 x 1.5” machine screws, and two 5/16” square nuts. Place the machine screws through the washers, and into the holes in the bottom of the Rear Frame from the side that does NOT have the thin rectangular pockets. Thread the 5/16” square nuts onto the end of these screws just one full turn. These square nuts will get installed in the corresponding notches in the rear of the bed. (Note, if you don’t remember which side is the rear of the bed, pick it up and look at the bottom of the bed for your indicator hole. The indicator hole is closest to the FRONT.) These are a tight fit in this notch. Place it from above, first with your hand, then use the open end of a wrench to push the square nut all the way down until it hits the bottom bed piece. Now begin to tighten the Rear Frame against the bed by turning the machine screws with a big Phillips screwdriver. You want the bottom edge of the frame to be flat against the table. Slide this entire assembly off the edge of your table once secured and confirm that the bottom edge of the Rear Frame is lined up with the bottom of the Rear Bed. Take the time to get this pretty close, or the machine will never run with anything close to a constant Z height. Once confirmed that it’s straight, put a final torque on the 5/16 machine screws.
Now grab two corner brackets, two M6x40 machine screws, two M5x30 machine screws, as well as a flat washer, split-lock washer, and nut for each. Slide the entire frame assembly so the rear over hangs your work table a few inches. Place the first corner bracket on the bed as shown. Slide an M6 flat washer onto the M6x40 machine screw, and place the screw up through the bed, from the bottom. Slide and M6 split-lock washer over the threads, then put an M6 nut onto the threads. You may have to hold the nut in place with your finger and turn the screw as you probably won’t have enough room to spin the nut. You want to tighten this down such that the vertical face of the corner bracket is about 1/64” (0.4 mm) from the edge of the bed. This will leave enough room to “pull in” the rear frame. Get this M6x40 screw and nut tight now. Slide an M5 washer onto an M5x30 machine screw, then place the screw through the rear frame. Put an M5 split-lock washer onto the threads that are sticking out, then thread on an M5 hex nut. Again, you may have to hold this nut with your finger and turn the head of the screw to start getting it threaded. The M5 nut will be hard to get a wrench or socket on. Try grabbing the nut with a needle nose pliers as your turn the screw. Tighten this down now. Install the other corner bracket the same way you did this one.
Now we’re about to install these 593mm long V Slots that make up the Y rails onto the Rear Frame. First, find a couple objects that are about 3 to 3.5 inches tall that you’ll use to support the free end as you fasten one end. A motor with a coupler on it works nicely. Now collect your two 593mm long V Slots, two Y motor mounts, and four #10x1.5” self-drilling screws. We’ll be working from the Rear Frame. Put two self-drilling screws about 1” deep into the mounting holes of a Y motor mount. These may be snug and require them to be turning in with a 5/16” or 8mm socket. Place the screw threads into the two corresponding holes on the rear frame. Turn the screws so that the threads are sticking out from the other side about a quarter inch (6mm). Grab one of the 593mm long V Slots and slide the tap holes over the drill points on these self-drilling screws. Support the free end of the V Slot with that 3 to 3.5” tall object you found earlier. Begin to drive the self-drilling screws into the holes, while firmly holding the extrusion in place as you turn the screws and alternating between tightening the top and bottom screw. Stop before you get them all the way tight. The top of the V Slot extrusion should flush up to the top of the Rear Frame and the top section of the Y motor mount should be close to flush with the top of the Rear Frame. When you feel like you’ve got good alignment, tighten them down. If you tighten these too much, you WILL break the screw off in the extrusion. Install the other Y rail the same way, leaving the free end of both still supported.
Gather two corner brackets, two drop in T nuts, two M5x10 machine screws, four M5 split-lock washers, two M5x30 machine screws, two M5 flat washers, and two M5 nuts. Place the corner bracket into the corner where the V Slot and rear frame meet. Take note of about where you need to drop the T nut, and install it into the V Slot there. Secure the corner bracket to the V Slot by sliding an M5 split-lock washer onto an M5x10 machine screw and threading into the T nut. Now slide an M5 flat washer onto an M5x30 machine screw and insert the screw into the corresponding hole in the Rear Frame from the outside. Slide an M5 split-lock washer onto the threads, then secure it with an M5 nut. Install the other corner bracket on the other Y rail the same way.

Now get your gantry assembly that you built previously. Make sure the eccentric spacers on the V wheels are turned to their loosest positions. Slide the objects you are using to support the free end of the Y rails about 8 inches (200mm) back from the free end. Pick up your gantry assembly and slide the gantry onto the V Slot with the Z Axis Plate facing the same direction as the free end is pointing. It can be a little tricky to get both rails fed between the wheels at the same
time, so take your time and bring in an extra hand if you can. Slide the gantry further onto the rail and, while still supporting the weight of the gantry, move your support pieces to the very end of the free end and push the gantry all the way back to the Rear Frame.

Gather the front frame piece, two 5/16” washers, two 5/16x1.5” machine screws, and two 5/16” square nuts. Observe the Front Frame and notice that one side has thin rectangular pockets while the other does not. The rectangular pockets will be installed facing the bed. Place the machine screws through the washers, and into the holes in the bottom of the Front Frame from the side that does NOT have the thin rectangular pockets. Thread the 5/16” square nuts onto the end of these screws just one or two turns. These square nuts will get installed in the corresponding notches in the front of the bed. Push them in from above, first with your hand, then use the open end of a wrench to push the square nut all the way down until it hits the bottom bed piece. Now begin to tighten the Front Frame against the bed by turning the 5/16” machine screws with a big screwdriver. You want the top edge of the front frame to flush up to the top of the bed. Once confirmed that it’s straight, put a final torque on the 5/16 machine screws.

Get four #10x1.5” self-drilling screws. Place them through the holes in the front frame and drive them into the tap holes of the V slot extrusion. Be sure that the top of extrusion flushes with the top and side of the frame piece.

Now grab two each of the following: Corner bracket, M6x40 machine screw, M5x30 machine screw, M6 split-lock washer, M6 Flat washer, M5 split-lock washer, M5 flat washer. Slide the entire frame so the front over hangs your work table slightly. Place the first corner bracket on the bed and against the front frame. Slide an M6 flat washer onto the M6x40 machine screw, and place the screw up through the bed, from the bottom. Slide and M6 split-lock washer over the threads, then put an M6 nut onto the threads. You may have to hold the nut in place with your finger and turn the screw as you probably won’t have enough room to spin the nut. You want to tighten this down such that the vertical face of the corner bracket is about 1/64” (0.4 mm) from the edge of the bed. This will leave enough room to “pull in” the front frame. Get this M6x40 screw and nut tight now. Slide an M5 washer onto an M5x30 machine screw, then place the screw through the rear frame. Put an M5 split-lock washer onto the threads that are sticking out, then thread on an M5 hex nut. Again, you may have to hold this nut with your finger and turn the head of the
screw to start getting it threaded. Tighten this down now. Install the other corner bracket the same way you did this one.

You have a choice to make now. We’re about to install a corner bracket on the edge of the V Slot that will join to the front frame. You can choose to install these and you will have a stiffer connection to the front frame, or leave them off and gain about a 5/8” (16mm) of Y axis travel. It’s not dramatically stiffer if you install these, but it helps. If you decided to install these, gather two corner brackets, two drop in T nuts, two M5x10 machine screws, two M5x30 machine screws, two M5 flat washers, and four M5 split-lock washers. Install the drop in T nut on the underside of the rail, close to where it meets the Front Frame. Slide an M5 split-lock washer onto the thread of an M5x10 screw and put the screw into one of the slots of the corner bracket. With the threads through the corner bracket, catch the thread of the T nut you just installed. You’ll need to come at the screw from underneath with a ratchet and a screw-driver bit, as shown in the picture. You won’t be able to get a regular screwdriver on it. Install the other corner bracket on the OTHER 593mm V Slot Extrusion, NOT on the opposite side of the same extrusion. Secure both corner brackets with an M5x30 machine screw, M5 flat washer, M5 split-lock washer, and M5 nut.

Now tighten the eccentric spacers on the v wheels against the Y rail using a 10mm wrench. Remember to get them snug, but not too tight that you deform the wheel. If you find that the heads of the button cap screws that are in the anti-backlash nuts drag along the slot of the rail, tighten the V wheels the opposite way, or take some tension off. Sometimes, certain “clock directions” of the eccentric spacers can cause the heads of those button-cap screws to drag against the rail slightly. Spend a couple minutes adjusting this out if necessary. You can spin the X and Y couplers by hand to confirm there is not scraping.

Congrats, you just finished the frame assembly!
Running X and Y Lead Screws

Grab the remaining two NEMA 17 stepper motors and motor couplers. Install the couplers onto the motor shaft, pushing them down until they seat, then tighten the set screw that clamps the coupler to the motor shaft. Do this for both motors, then set them aside.

Get a 600mm long lead screw, a pillow block bearing, two M5x30 machine screws, two M5 flat washers, and two M5 nylock nuts. Use a metric Allen wrench (hex key) to loosen the set screws on the pillow block bearing. Be careful not to thread these all the way out and lose them. They are tiny. Move the gantry so the front of the Y plate 3 inches (75mm) from the front frame. Keep threading it through until the end of the screw is past the front of the Y plate. Slide the pillow block bearing onto the end of the lead screw so that about 5/8” (15mm) is sticking out of the back of the pillow block bearing. Now move the gantry so the pillow block is against the front frame.

Install the pillow block bearing on the front frame piece, being careful not to pull the screw up or down from its natural position as it exits the anti-backlash nut. Slide an M5 washer onto an M5x30 machine screw, put the machine screw through the top hole in the front frame from the front, Install an M5 nylock nut onto the threads. Confirm that it’s still well aligned by viewing it from the sides and the top. You should not see it bend from the pillow block bearing to the anti-backlash nut. Mount the other pillow block bearing on the other side the exact same way. This time you need to spin the screw and slide the pillow-block bearing by hand to get it to the front frame since one side of the gantry already has a lead screw installed.

You’ll now install the motor onto the screw. The back right Y motor should use the remaining long cable motor. For each side, get one motor, three 8mm long spacers, three M3x20 screws, three M3 flat washers, and three M3 split-lock washers. Bring the lead screws back so about the amount shown is sticking out past where the extrusion meets the rear frame. Put the shaft of the Y motor through the Y
motor mount and slide the motor coupler over the lead screw. (Note: The Y motors should be mounted so that the wires are inboard, facing down). Now slide a flat washer then a split-lock washer onto the M3x20 screw (Note: really use both washers, we’re trying to make the screw doesn’t bottom out in the motor threads!) Slide the M3 screw through the Y motor mount from the front, then place an 8mm spacer over the threads. Insert the threads into the Y motor. Don’t tighten them up until you get all three screws in. It helps to hold the spacers with needle nose pliers, already lined up with the hole.

Once both motors are mounted, tighten the set screw to clamp the motor coupler to the lead screw, then go back to the side with the pillow block bearings and tighten the set screws against the lead screw. Stand behind the machine and use your hands to turn the motor couplers the same direction to bring the gantry to the back of the machine. Look at the screws from the side and from the top to ensure that they aren’t binding. The screw should not be angled from where it leaves the anti-backlash nut to where it enters the motor coupler. If it is, loosen the screws that fix the motor to the motor mount and adjust its position. This will “float” the motor into place.

Now use an Allen wrench to preload the anti-backlash nut against the screw. Since the set screw should already be resting against the inside body of the nut block, use about 1/3” turn of the set screw as your baseline. Turn the jam nut on the anti-backlash nut to lock the set screw in place. Do this on both sides of the Y. Turn both motor couplers at the same time and assess how well it turns. Just like on the Z, it should not be very hard to turn or else the motors will stall out as it travels. You want some tension, but don’t come close to locking down. Grab each end plate and push and pull it in the direction of the screw. You should not hear or feel any knocking as you do this. If you do, there is still backlash. Those with dial indicators may choose to make more refined measurements later.

Now loosen the set screws on the pillow block bearing on the Y Idler End Plate. Slide the remaining lead screw from the outside, through the plate, through the pillow block bearing, to the anti-
backlash nut, then thread the screw into the nut. Push the plate towards the motor and observe how well the lead screw aligns with the X axis motor coupler. The pillow block may catch or “grab” at the screw as you try to insert it. First, make sure the pillow block’s set screws aren’t catching the screw, then rock the screw very slightly while applying light forward pressure. When you get it to the other end, where the motor coupler is and you confirm that it is properly aligned, insert the screw into the coupler and tighten the set screw on the coupler to clamp the coupler to the screw. Spin the coupler to drive gantry back to the idler side and confirm the screw is reasonably straight as it leaves the anti-backlash nut and enters the pillow block bearing. Adjust the mounted position of the pillow block bearing as necessary, then tighten the pillow block’s set screws to the lead screw. Now take the backlash out of the system by preloading the anti-backlash nut against the lead screw, just as you did previously.

Here is what your machine should look like now:

Mounting Homing Switches

This section only applies if you purchased the homing kit. If you did not purchase the homing kit, please proceed to the next step.

First, we will affix all the switches to their brackets. Each switch attaches to its bracket using two M3x20 machine screws, two M3 split-lock washers, two M3 flat washers, and two M3 nuts. Start with the Z. The Z switch has a long metal paddle and has the noise filtering capacitor on the black side of the switch. Slide an M3 split-lock washer on the M3 screw, put the screw through the switch, through the bracket, then secure it with a flat washer and M3 nut. See the picture for the correct orientation.
Now get the X switch, which has the noise filtering capacitor resting on the red side of the switch. Mount it as shown in the picture.

The remaining switch, for the Y, has a roller wheel on the end and the noise filtering capacitor is on the red side of the switch. Mount it as shown, noting the direction of the “L”.

From your homing kit, gather one drop in T nut, an M5x16 machine screw, and an M5 flat washer. Insert a drop in T nut into the top of the Z slot that is facing the Y Idler End Plate. Slide the M5 washer onto the M5x16 screw, put the screw through the bracket, and affix the bracket as shown. Before you get this completely tight, stop and check the paddle. You want to mount this so that the end of the paddle is about 10mm from the bottom of the Z motor mount when it is not engaged (IE: when nothing is
touching it). Once you get it in a good position, gently tighten the screw for the bracket. This is a plastic bracket. If you over tighten it, YOU WILL BREAK IT.

Now get the X switch and bracket, a 6.35mm spacer, an M5x16 machine screw, and M5 flat washer, and a drop in T nut. Insert the T nut into the top slot of the bottom gantry extrusion. Slide an M5 washer onto the M5x16 screw then insert screw through the L bracket, and slide the 6.35mm spacer onto the threads. Thread the screw into the drop in T nut and get it just snug for now. Spin the coupler on the X motor in order to get the X switch engagement stud (the M5x50 bolt you installed into the X plate when you built it) close to the switch. Move and rotate the switch as needed so that it “snaps” when the wheels on the X plate are just a couple mm (about 1/16”) from hitting the Y extrusion. Once this is in place, tighten it all the way down being careful not the rotate the switch out of position as you do.

Get the Y switch and bracket, an M5 washer, and a #10x5/8” wood screw. There is a 1/8” hole in the top of the rear frame (the back left as you stand in front of the machine). Slide the M5 washer onto the wood screw then insert the wood screw into this hole and gently tighten it. You’ll need to turn both Y motor couplers at the same time to bring the gantry to the rear of the frame. Angle the switch bracket forward, as shown, so the roller can contact the bottom X axis extrusion. Just like with the X switch, this switch should snap when the wheels get within a couple mm of the rear frame. Once you’ve found the correct angle for the switch bracket, tighten down the wood screw. If you over tighten this screw, you will pull out the hole or split the frame! Not much torque is needed because these switches trigger with little force.
Now let’s get the wires ready. You have three red and black wire pairs. The longest cable is for the Z, the second longest is for the X, and the short one is for the Y. Each pair has an end with a 2-pin female connector on it and another with an open end. Strip about 5mm of wire from the open end and slide on a piece of heat shrink tubing. Put a female quick disconnect on, crimping it firmly. It’s important that you get a good crimp here. If not, you’ll have homing problems. Do this for all the open ends now. Don’t forget to slide on your heat shrink tubing beforehand. Once crimped, slide the heat shrink tubing over the connector and shrink it with a lighter. Don’t put the flame directly onto the wire or you’ll melt the insulation. Note: The picture here does not show it with the heat shrink over the connector base. Make sure the heat shrink is over your connector base before you heat it.

Starting with the Z switch, slide the connector attached to the black wire onto the switch terminal labelled “COM”. This is the one on the switch that sticks out from the side. The red wire goes to the switch terminal labelled “NO”. This is the one closest to the “COM” terminal. Put a one loop knot around the Z motor wire as shown with the wires.

Now connect the X switch wires just as you did with the Z. Black to “COM” and red to “NO”. Run the wires towards the Y Motor End Plate in the top slot of the bottom X axis rail. Use the two fatter pieces of heat shrink from the homing kit to hold the wire in the slot. You can stuff these into the slot over the wire using a flathead screwdriver. Put one piece right near the end plate.

Put the short wires on the Y axis switch in the same way: Black to COM, red to NO.

Running Cable into Drag Chains and Electronics Setup

Start by affixing your 12” (300mm) long aluminum angle to the backside of the upper gantry rail. Insert two drop in T nuts into the lower slot of the top extrusion in positions that roughly correspond to the two holes in the angle. The aluminum angle will get mounted so that the drag chain can run on top of the outside of one of the angle’s legs. Run an M5x10 screw through the aluminum angle and into the thread of the T nut, applying good forward pressure to catch the thread. This isn’t a precision piece, but you should generally align it with the bottom of the extrusion. Now get one drag chain, one M3x10 button cap screw, one M3 split-lock washer, and one M3 nut. Affix the drag chain into the hole in the top of the angle, as shown.
Feed your Z motor cable, and Z homing switch cable if you have the homing kit, into the end of the drag chain. Push the cable as far as you can, then use some needle nose pliers or a screwdriver to reach into openings in the drag chain and nudge the connectors along to the other end.

Now devise some system to mark which motor and switch connectors are the X and which is the Z. Use a piece of tape, a dot of ink, or whatever you think will help. Once you insert them into the other drag chain, you won’t easily be able to tell the X from the Z if you don’t mark one axis. Run them through this drag chain, just as before.
For your convenience, the blue Uno board, red breakout board, and stepper drivers have already been set up for you. You just have to install the fan and power connections into the screw terminals. This applies to all orders shipped after December 1, 2019. Please do NOT adjust the purple driver boards.

Insert the Red wire coming from the plug socket and the red lead from the fan into the screw terminal marked “+” on the red CNC Shield. Insert the black wires into the “-” terminal. WARNING: DO NOT PLUG THE POWER SUPPLY INTO THE FEMALE SOCKET ON THE BLUE UNO BOARD OR YOU WILL DESTROY IT! FOLLOW THESE INSTRUCTIONS CAREFULLY.

Tip: With this system, it’s always best to plug in the 24V power before the USB cable.

First plug in the 24V power adapter into the female socket, then plug the USB cable in from the Uno board to your computer. Leave the motors unplugged at this time. Give it a moment and the drivers for this board should auto-load in the background. If you are running Windows 7, there is a good chance the drivers will not autoload for you. If, in a later step, you can’t connect to the COM port for this board, follow the procedures in this forum thread: http://millrightcnc.proboards.com/thread/118/windows-7-sp1-uno-driver

Now, power things back completely off by unplugging your power supply from the wall and the USB cable from your computer and wait 60 seconds. Plug in your motors into the corresponding ports on the CNC shield. First, let’s get oriented on the CNC Shield. The screw
terminal where the power wires are is the bottom of the board. The stepper motors have four wires in this order: Blue, Red, Green, Black. Look at the picture and plug them in to match that. All the motors, except the X axis, have the BLUE wire pointed down.

If you have homing switches, also plug them in now. The right side of the CNC shield has a section labelled “End Stops” with pins Z+, Y+, and X+. Plug the switches into the corresponding axis with the red wire to the LEFT. Don’t plug them in up and down. The two pin connector for the Z switch should be on the two Z+ pins with the red wire on the left and the black wire on the right.

Now manually spin the couplers so each axis is about midway in its travel. Once you have your motors and homing switches plugged in, plug your power supply back up. The socket can be a tight fit. Plug the USB cable into the Uno board and then into your computer.

Take note at power-up which direction the fan blows. Usually the fan has an arrow on the side of it to indicate which direction it blows, but if you can’t find this just observe which way it blows and mark it accordingly. In a later step, you’ll install the fan so it blows down on the stepper drivers, so you need to know which way it blows.

Open Universal G Code Sender, Grbl Panel, or your G Code Sender of choice. We are documenting this with Universal G Code Sender Platform. You can download Universal G Code Sender Platform from this link: https://winder.github.io/ugs_website/download/. Scroll down and get “UGS Platform” from the bottom, nightly build session. In Windows, unzip the download then run ugsplatform.exe or ugsplatform64.exe from the “bin” folder. (whether you use the “64” version” depends on your system).
Make sure that the firmware in the dropdown is “Grbl” and the baud is 115200. Hit the refresh button next to the word “Port” then click the drop down to look for your COM port. There will probably only be one port shown. Mac users will see “dev\....” instead of “COM”.

Click the socket icon that is to the right of the baud rate. It will turn from red to green, indicating that a connection has been made. We will now make some jogs on the machine. Set your steps/mm settings to what you see in the picture below. It’s very important that we start with just 1 millimeter steps at first. We’ll use these small steps to see if something is backwards or crossed up. Press the Z+ button in the job screen shown below. We are expecting the Z axis to move up 1mm. If it moves the opposite direction, make a note of it. Once power is turned off (and only when power is off and has been off for 60 seconds) you’ll need to flip the Z axis motor plug 180 degrees if it moves backwards. Now press X+. We are expecting the X axis to move to the right when viewed from the front of the machine. If not, make a note so the X plug can be flipped around. Now press Y+. We want to see the gantry move towards the back frame on both sides. Pay special attention to whether one motor is turning opposite the other. If one or both Y motors is driving its side towards the front frame when you press the Y+ button, make a note so you can flip the plug on that particular motor. If necessary, remove the power plug from the wall and the USB cable from your computer, wait 60 seconds, and flip relevant motor plugs if any motor was travelling opposite the intended direction.
Now get your electronics enclosure kit. Pull the CNC Shield (the red board) off the Uno board and attach just the Uno board (the blue board only) to the acrylic base using three M3x10 button cap screws. See the picture and take note that only three of the four mounting holes have screws in them. The forth one is a little close to the header, so just leave that empty. **DO NOT OVERTIGHTEN ANY OF THESE SCREWS OR YOU WILL BREAK THE ACRYLIC!** Use M4x10 screws to come from under the base and secure the yellow corner pieces as shown. Now you’ll use M3x10 button cap screws to attach the sides of the enclosure. Use the pictures as a guide. **Install all the enclosure side pieces, except the enclosure side piece that the USB port fits through.**
Remove the red and black wires from the + and – terminals on the CNC Shield. We just installed them earlier for testing purposes. Pull the nut off the female plug adapter. Slide it down the wires to remove it. Slide the wires through that acrylic side piece that you haven’t installed yet. Secure the female plug adapter to this acrylic piece with the nut you just took off. Side Note: There’s a place for a circular rocker switch on the acrylic side pieces if you choose to install and wire one in, but generally speaking the machine is turned on and off by applying power to this port. Since the enclosure is made of delicate acrylic, it’s best to leave the power supply plugged in here and just plug and unplug it from the wall when you wish to apply or remove power.

Reconnect the fan leads and the red and black wires from the female plug adapter to the + and – (red to +, black to -) screw adapter on the CNC Shield. Gently mount the CNC Shield back on top of the Uno board. Be careful not to tug the wires out or bend the prongs on the shield when you remount the shield to the Uno board. Now screw the last acrylic side piece on. Don’t tug the wires loose!
Now mount the enclosure to the wooden anchor piece using #6x3/8” wood screws and an M4 washer. Note the orientation of the piece. Now mount the end of the drag chain to the piece that joins the electronics enclosure to the drag chain using #6x3/8” wood screws and M4 washers. Note in the pictures where this is located. This location is within range of all the wires. If you move it too far from this location, some cables won’t reach.

Run the wires through the slots and circular openings in the acrylic side pieces and plug them into the appropriate locations, just as you did when you were testing the electronics. Very gently pack the wires down so that the fan blades won’t hit them as they turn. You may have to gently pull some extra wire out of the enclosure. Put the fan onto the enclosure, but don’t screw it down yet. If the fan won’t lay on top of the enclosure’s corner brackets, then the wires are in the way. Plug up your power supply to see if wires are being hit by the fan blade. If they are, unplug the power from the wall and pack the wires down some more. Place the fan back on and check for interference. Once this is ok, put the acrylic fan guard over the fan (the piece with the MillRight CNC logo laser etched into it) and secure it down using #8x1.5” machine screws.
You can use the zip ties that came in the bag labelled “wire management” to bundle up extra wires, such as the extra length of wire on the Y motor nearest the electronics enclosure. You can also use the spiral wrap to and zip ties wrap up extra wire for a cleaner look.

Before your first cuts, you’ll want to be sure that the gantry sits square to the Y rails. If it does not, power down and manually turn coupler to bring the machine to square.

Congrats on the build! Feel free to contact us at support@millrightcnc.com if you have any problems. We welcome comments as well as we want to continually improve these instructions.

Take a look at the resources page of www.millrightcnc.com to check out tutorials and the quick start guide. Although the tutorials and quick start guide are written directly for the MillRight CNC M3, these will almost directly apply to your operation of the Carve King. Also check out YouTube for tutorials for software such as Autodesk Fusion 360 or MakerCAM.

Finally, you will gain a lot of knowledge by joining the MillRight CNC forum at www.millrightcnc.proboards.com

Happy Machining!
Troubleshooting Addendum

Problem: Universal G Code Sender gives an error when trying to open a connection, or the machine has stopped responding.
Solution: Close UGS, remove USB cable from USB port, wait five seconds, plug back in, open UGS, and attempt to open a connection.

Problem: The motors make a noise that sounds like radio static.
Solution: This is normal when the machine is first booted up and no motion commands have been issued.

Problem: The machine isn’t moving to the commanded position.
Solution: Most often this happens when incremental positioning is set (G91) but the user thinks the machine is in absolute positioning (G90). Set the appropriate mode.

Problem: The machine appears to be missing steps or not moving the full distance commanded on one axis in particular.
Solution: The set screws should be checked on the motor couplers to be sure that they are grasping the motor shaft and lead screw. Pre-load on the anti-backlash nuts should be checked to make sure that there isn’t too much pre-load. Also, the voltage should be checked on the stepper motor driver to ensure that it is around 0.65 volts. Also, it’s not uncommon for customers who have used the software “Easel” to have their firmware re-flashed to other settings. First, confirm the settings that you have in place match what you see in the appendix below. If they are different, manually correct them then view this forum post to learn how to prevent Easel from overwriting your settings: http://millrightcnc.proboards.com/post/2599

Problem: Files are running erratically or commands are being skipped with a warning that the command length is too long.
Solution: Confirm that the line length maximum is set to 70 in UGS. Also confirm that your CAM software is not using more than four decimal places for a position command. Review your G code to see if the header is selecting different work
coordinate systems than you are initially starting in (such as G54, G55, G56) or if it is issuing a G28 command. If it’s issuing a G28 command, either set your G28 position with G28.1 or delete the G28 line.

Problem: The motor stalls or the machine jumps off the planned path when cutting.
Solution: Slow down the feed rate and/or shallow up the cut. Confirm that the anti-backlash nut doesn’t have excessive pre-load and that the lead screw is not misaligned.

Problem: The machine stops during homing before it hits the homing switch.
Solution: 99.9% of the time initiating another homing cycle will fix this. It just picked up noise prior to hitting a switch. You can also twist the red and black wires from a homing switch together all along the way from the switch to the controller to help protect it from electrical noise.

Grbl Settings Appendix:

These are the default Grbl settings for the MillRight CNC Carve King. Please do not modify these settings unless directed to do so by MillRight CNC staff or you feel qualified to do so.

Here are a few notes for the advanced user:
We’ve configured Grbl so that it does not open into “Alarm Lock” even when homing is enabled. Soft limits can be enabled if you have homing switches but you need to configure the soft limit distances in settings 130-132 and run a homing cycle first. Hard limits are not recommended unless you take some additional electrical noise precautions. The capacitors soldered to the homing switches and the internal pull-up resistors on the homing switch pins form a low-pass filter that helps filter noise, but this is not robust enough to prevent false triggers. If you wish to enable hard limits you should consider replacing homing switch wires with ground shielded cables. Properly configured soft limits and homing before operating will prevent most possibilities of a crash, however. There is a little conservatism built into the velocity and acceleration settings. The machine could be pushed a little harder, but our default settings are really where they need to be. The motors can’t reach much higher RPM than is currently set by the max velocity parameters without stalling or leadscrew whip occurring. The max velocity settings are quite adequate for most any hobby CNC operation.

$0 = 10$ (Step pulse time, microseconds)
$1 = 255$ (Step idle delay, milliseconds)
$2 = 0$ (Step pulse invert, mask)
$3 = 0$ (Step direction invert, mask)
$4 = 0$ (Invert step enable pin, boolean)
$5 = 0$ (Invert limit pins, boolean)
$6 = 0$ (Invert probe pin, boolean)
$10 = 1$ (Status report options, mask)
$11 = 0.010$ (Junction deviation, millimeters)
$12 = 0.002$ (Arc tolerance, millimeters)
$13 = 0$ (Report in inches, boolean)
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