Carbide 3D

Shapeoko
HDM

Table of Contents

Welcome and Congratulations

The Shapeoko HDM is a high-end, professional-graded CNC, the result of two years of prototyping and testing. It cuts wood and non-ferrous metals (aluminum and brass) with ease and accuracy and will run all day long without breaking a sweat. The machine comes fully-assembled, with the wiring already installed in the drag chains and plugged into the Warthog controller. The Shapeoko HDM features:

- 80mm water-cooled spindle (110 V or 220 V) with VFD control and chiller.

- Carbide 3D Warthog electronics.

- Hybrid Table with T-slot workholding.

- HG-15 linear bearings on every axis.

- Heavy-duty custom extrusions.

- 16mm ballscrews on every axis with custom ballscrew wipers on X and Y-axis.

- Optical isolation and RS-422 serial connection for reduced electrical noise and static discharge.

In this guide we'll walk you through everything you need to know to get started using your Shapeoko HDM. **If you encounter any issues setting up your machine, contact our tech support team at** support@carbide3d.com **and we'll get you up and running.**

Do Not Connect to Ethernet-Enabled Devices

While an RS-422 Ethernet cable is used to connect the electronics cabinet to the computer adapter, the Shapeoko HDM is NOT an Ethernet device. Do not use the RS-422 Ethernet cable to connect the electronics cabinet or computer adapter to any Ethernet-enabled device, such as a modem or internet router.

Software Requirements

Carbide Motion version 5 or higher required for the Warthog controller.

Warranty

The Shapeoko HDM is covered by our standard Shapeoko warranty. Visit carbide3d.com/policy/warranty for details.
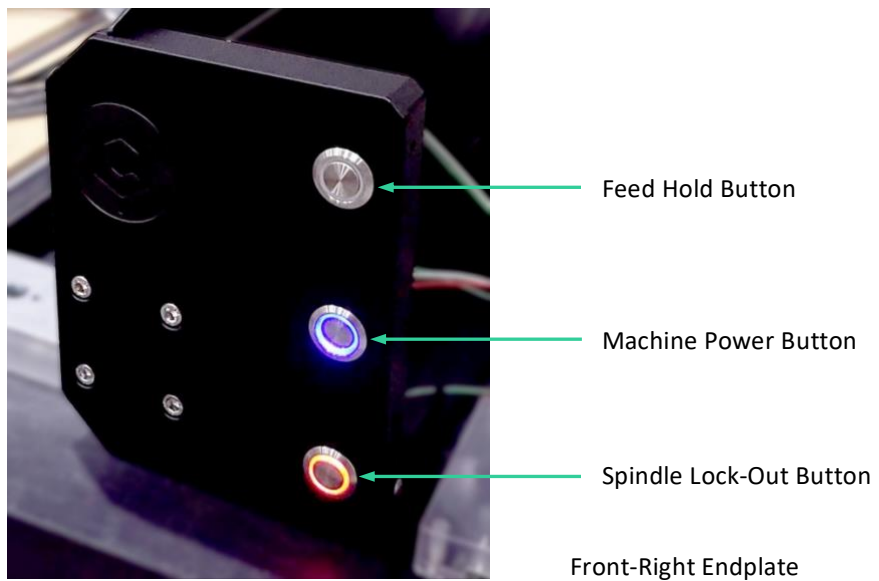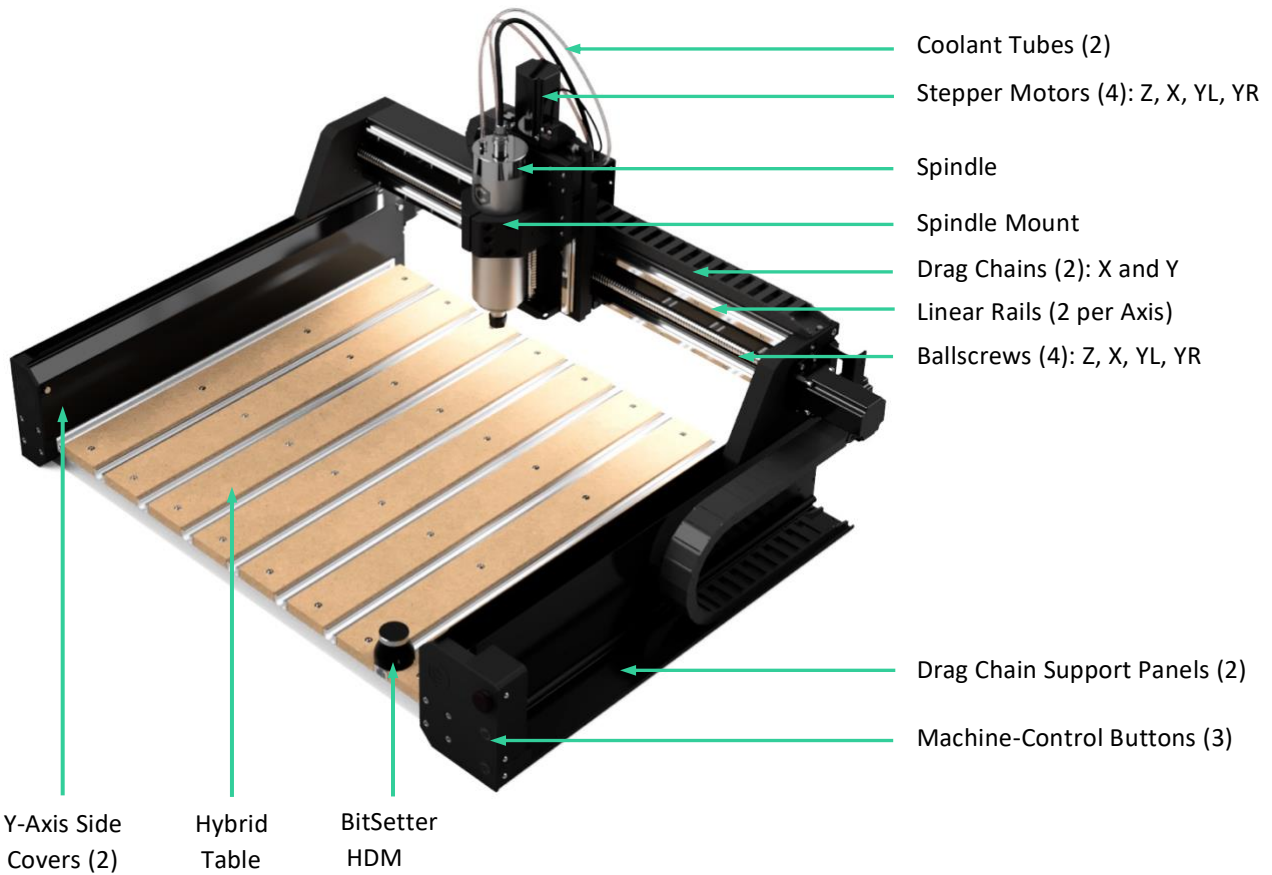
Important Call-Outs

Throughout the guide, you will find information that we've called out for you to pay particular attention to. We use three types of call-outs: Warnings, Notes, and Pro Tips.

Join the Carbide 3D Community

Join the Carbide 3D Community. Find or start a discussion on topics such as machine troubleshooting, product announcements, software issues (Carbide Create, Carbide Motion, MeshCAM, Carbide Copper, Fusion 360), problems with tutorials, community contests, project galleries, and more.

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Parts of the Shapeoko HDM

Coolant Tubes (2)

Stepper Motors (4): Z, X, YL, YR

Spindle

Spindle Mount

Drag Chains (2): X and Y

Linear Rails (2 per Axis)

Ballscrews (4): Z, X, YL, YR

Drag Chain Support Panels (2)

Machine-Control Buttons (3)

Y-Axis Side Covers (2)

Hybrid Table

BitSetter HDM

Feed Hold Button

Machine Power Button

Spindle Lock-Out Button

Front-Right Endplate

Variable Frequency Drive (VFD)

Latches (2)

Cable Channels (3)

Power Switch

Power Cord Jack

Electronics Cabinet — Outside

Fans (2)

Variable Frequency Drive (VFD)

36V Power Supply

Warthog Controller

Electronics Cabinet — Inside

Important Safety Instructions

The Shapeoko HDM is a machine tool and requires the same caution that should be exercised with any power tool. Please keep this manual in a safe place for reference.

WARNING: To reduce risk of burns, fire, electric shock, injury, and death, or damage to equipment or property, read the following warnings carefully.

Eye Protection

Always wear safety glasses or goggles which are suitably impact-resistant.

Hearing Protection

Always wear earplugs or ear muffs. For long jobs, it may be desirable to wear both. Hearing damage is cumulative and irreversible, so one should always err on the side of caution.

Respiratory Protection

Always wear a filter or respiratory mask suitable for the type of dust generated by the material being cut. If necessary, arrange for dust collection and proper ventilation.

Clothing, Hair, and Jewelry

Always ensure that clothing, hair, and jewelry cannot become caught in the machine. Always wear appropriate clothing; long-sleeved shirts, pants, and suitable footwear are recommended. When metal-working, gloves and an apron are also recommended.

Machine Safety

Never reach into the machine's working envelope while it is running. Always engage the spindle lock-out before performing toolchanges. Always disable power to the machine and turn on the spindle lock-out (disable the spindle) before adjusting the machine or performing maintenance. Never leave the machine running unattended. Never move the machine during operation. Always inform someone before operating the machine and check in with them after successfully completing work. Never allow children to use the machine unsupervised.

Operating the Chiller

The chiller must be turned on when operating the spindle. Operating the spindle without the chiller could cause fire and/or catastrophic damage to the spindle, VFD, or machine. Always leave the chiller on for an additional 5–10 minutes after turning off the spindle to allow the it to completely cool. Never run the chiller when the coolant tank is empty. Ensure there is plenty of clear space on all sides of the chiller to allow for adequate air circulation.

Shut Off Machine When Not in Use

Always power down the machine after each use: enable the spindle lock-out, disable the power to the machine, then turn off the power switch on the electronics cabinet. Wait 5–10 minutes, then shut off the chiller.

Fire Prevention

Never run the spindle with the chiller turned off. Consider the possibility of a fire caused by friction from the spindle and take suitable fire prevention precautions (e.g. having a fire extinguisher handy and other suitable precautions).

Power Requirements

A 20A circuit is recommended to run the HDM. Two separate outlets are required: one for the electronics cabinet and one for the chiller.

End Mill Safety

Use care when handling end mills—both to avoid being cut and to avoid damaging them. Handling end mills with suitable gloves, or using a cloth to avoid contaminating them, is recommended. Inspect end mills carefully before each use, and ensure that they are securely held by the collet.

Debris Disposal

Recycle or safely dispose of milling debris and dust, keeping in mind flammability, (potential) spontaneous combustion, and chemical considerations. Even natural materials can have disposal implications. For example, walnut wood dust is allelopathic (it inhibits plant growth), an irritant to the skin and respiratory tract, and potentially poisonous to some animals. All of these possible disposal implications are in addition to the spontaneous combustion hazard posed by all types of sawdust.

Step 1: Unpack the Machine

- Use caution when lifting the machine; it weighs over 240 lbs.

- Do NOT move the machine by lifting from the ballscrews, linear rails, or drag chains.

LIFTING RECOMMENDATIONS:

- Remove the outer Hybrid Table slats and extrusions before moving.

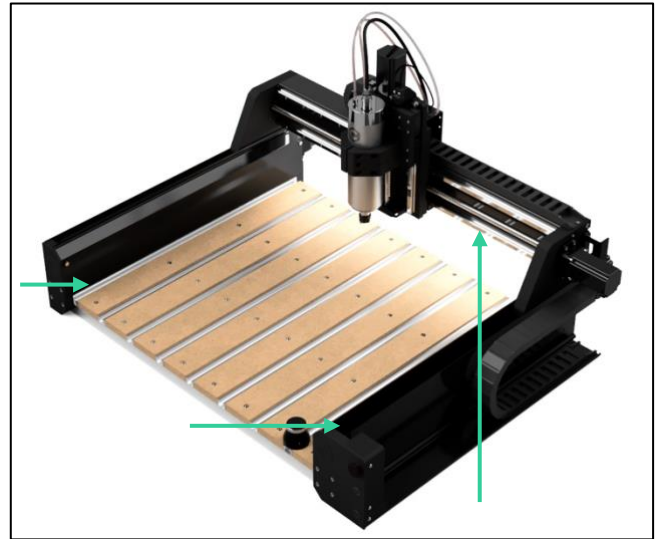- Lift from the front edge of the X-extrusion and the front end of the two Y-extrusions. See *Fig. 1*.

Figure 1

Unbox the Shapeoko HDM

To remove the machine from the packing crate:

1. Lift the sides of the packing crate to remove them.

2. Remove the two outer MDF slats and aluminum extrusions from the Hybrid Table.

   a. Remove the twenty-four (24) M6 screws (4 per MDF slat and 8 per aluminum extrusion).

Figure 2

3. Use a #2 Phillips-head screwdriver to remove the two (2) screws securing the machine to the pallet. Screw location is marked by red arrows in *Fig. 2*.

4. With the help of another person (or two), lift the machine from the pallet.

   a. Lift from the front edge of the X-extrusion and the front end of the two Y-extrusions. See *Fig. 1*.

   b. Try to keep the machine level when lifting.

5. Set the machine on a sturdy, level worksurface.

6. Re-install the two outer aluminum extrusions and MDF slats.

Unpack the Accessory Boxes

Chiller Box

Item	Description	Qty
A	CW-3000 Chiller	1
B	Power Cord	1
C	User Manual	1

Accessories Box

Item	Description	Qty
D	Electronics Cabinet Power Cord	1
E	USB C-to-A Cable	1
F	Sweepy 80mm V2 Dust Boot with Hose Adapters (3)	1
G	#201 ¼" Square End Mill	1
H	Precision Collets: ¼" and $\frac{1}{8}$" (ER-20)	2
I	Injection-Molded Clamping Kit: T-Nuts (12), M6×25mm (6) SHCS, Clamps (6)	1
J	Spindle Wrenches: 30mm and 22mm	2
K	Tool Kit: 1.5, 2, 2.5, 3, 4, 5mm Ball-Nose Hex Keys; 8, 10, 13mm Wrenches	1

Electronics Cabinet

Item	Description	Qty
L	Electronics Cabinet – Pre-Wired	1
M	Warthog Computer Adapter (Inside the Electronics Cabinet)	1

BitSetter HDM Box

Item	Description	Qty
O	BitSetter HDM	1

NOTE:

- If any items are missing or damaged in shipping, contact us at **support@carbide3d.com** and we'll ship you a replacement ASAP.

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Step 2: Install the Software

Carbide Motion

Carbide Motion is the machine-control software for the Shapeoko HDM CNC machine. Carbide Motion lets you control your machine by jogging it around, setting zeroes, and loading and running G-code. You'll need to install this software in order to operate the machine. Download and install the latest version of Carbide Motion:

1. Download Carbide Motion: carbide3d.com/carbidemotion/download (Windows and Mac OS X available).

2. Once the download completes, double-click the file and follow the instructions to install the software to your computer.

3. After Carbide Motion installs, it is a good idea to drag the icon onto your Windows Taskbar (or Dock on a Mac) for easy access to the program.

Check out the Carbide Motion User Guide: docs.carbide3d.com/assembly/carbidemotion/userguide.

Carbide Create

Carbide Create is a cross-platform 2D CAD/CAM software package made by Carbide 3D. This software is ideal for designing 2D and 2.5D parts, has built in 3D previews and works flawlessly with your machine. You'll use Carbide Create to create 2D and 2.5D designs, generate toolpaths, and export G-code which you will run in Carbide Motion to machine the part. Download and install the latest version of Carbide Create:

1. Download Carbide Create: carbide3d.com/carbidecreate/download (Windows and Mac OS X available).

2. Once the download completes, double-click the file and follow the instructions to install the software.

3. After Carbide Create installs, drag the icon onto your Windows Taskbar (or Dock on a Mac).

Check out the Carbide Create Video Tutorial Series: docs.carbide3d.com/assembly/carbidecreate/video-tutorials.

Step 3: Install the BitSetter HDM

The BitSetter HDM is an automatic tool offset probe. It tracks the length of every tool installed in the spindle and updates the Z-zero position based on changes to the length of the tool. The BitSetter HDM will automatically measure the tool length in three circumstances:

- When you press the **Initialize button** in Carbide Motion.

- When you press the **Load New Tool button** in Carbide Motion.

- When your G-code program requests a toolchange (Carbide Motion will prompt you to change the tool).

If you change the tool any other time, the BitSetter HDM will not re-measure the tool length, so it will not update the Z-height.

IMPORTANT NOTES ABOUT CHANGING TOOLS:

- When running a job, do NOT perform toolchanges without first being prompted by Carbide Motion.

- When no project is in progress, ALWAYS press the Load New Tool button in Carbide Motion and follow all onscreen prompts to change the tool.

- If you accidentally change the tool unprompted, click the Load New Tool button to tell the BitSetter to measure the tool length, then go check or reset your Z-zero value.

Installing the BitSetter HDM

The BitSetter HDM is designed to be installed almost anywhere on the Hybrid Table, but we recommend installing it the far-right T-track slot. The BitSetter HDM is anchored to the Hybrid Table via a T-nut and M6 screw.

1. Remove the three (3) M3 screws from the BitSetter HDM body, and then remove the body from the thin baseplate.
2. Loosen, but do not remove, the M6 screw in the center of the baseplate.
3. Slide the T-nut into the desired T-track slot in the Hybrid Table.
4. Tighten the M6 screw to secure the baseplate.
5. Re-insert and fully tighten the M3 screws secure the BitSetter HDM to its baseplate.
6. Locate the 3-pin BitSetter cable exiting the rear cable channel of the electronics cabinet.
7. Plug the cable into the 3-pin pigtail exiting the base of the BitSetter HDM.
8. Route the BitSetter cable down the slot in the Hybrid Table and out the back of the machine.

NOTE: Instructions for enabling the BitSetter HDM in Carbide Motion are located in Step 7 on page 14.

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Step 4: Set Up the Chiller

Chiller Overview

The CW-3000 chiller is a non-refrigerated, industrial chiller. It continually routes coolant (distilled water, windshield wiper fluid, or antifreeze) through the spindle to prevent overheating and to maintain consistent, high-quality cutting.

In the event of a malfunction, the chiller will display an error code on the LED screen. Error codes are listed in the included chiller manual. Contact the Carbide 3D tech support team at support@carbide3d.com for assistance troubleshooting error codes.

WARNINGS:

- The chiller **MUST** be turned on when operating the spindle. Operating the spindle without the chiller could cause fire and/or catastrophic damage to the spindle, VFD, or machine.

- Always leave the chiller on for an additional 5–10 minutes **AFTER** turning off the spindle/VFD to allow the spindle to completely cool.

- Never run the chiller when the coolant tank is empty.

- Ensure there is plenty of clear space on all sides of the chiller to allow for adequate air circulation.

NOTES:

- Always use distilled water, windshield wiper fluid, or antifreeze in the chiller. Using tap or other non-distilled water will lead to bacteria growth inside the tank.

- Antifreeze is recommended when operating in a cold environment.

Setting Up the Chiller

1. Place the chiller on the base of the workbench or on the floor beneath it.

    a. Each side of the chiller must be clear so air can circulate freely around the device. This will keep the coolant at ambient air temperature.

2. Open the water-supply inlet on the top of the chiller and fill the reservoir tank with distilled water, windshield wiper fluid, or antifreeze. Do not overfill.

3. Locate the two 8mm clear coolant tubes exiting the Y-Axis drag chain (at back-right corner).

4. Push the tubes into the two 8mm push-fittings on the back of the chiller. The tubes are interchangeable.

5. Plug the power cord into the jack on the back of the chiller and into a power outlet.

Step 5: Set Up the Spindle

The 80mm spindle has an 8–24k RPM water-cooled motor. The spindle is controlled by the variable-frequency drive (VFD) and cooled by the closed-loop chiller. The VFD's custom-interface board turns the spindle on and off and sets the RPM based on the project G-code.

The display screen on the VFD will show the spindle RPM during operation and error codes in the event of a malfunction. Contact the Carbide 3D tech support team at support@carbide3d.com for assistance troubleshooting error codes. Download the VFD manual for error code and safety information: docs.carbide3d.com/assembly/HDM/VFDmanual.pdf.

WARNINGS:

- The chiller **MUST** be turned on when operating the spindle. Operating the spindle without the chiller could cause fire and/or catastrophic damage to the spindle, VFD, or machine.

- Always engage the spindle lock-out before performing toolchanges.

- Do not attempt to operate the VFD via its control panel; Carbide Motion and the G-code control the spindle via the VFD.

Adjusting the Height of the Spindle (Optional)

To move the spindle up or down in the spindle mount:

1. Loosen the top and bottom M6×30mm screws on the right side of spindle mount.

2. Insert an M6 screw in the middle hole in the mount and slowly tighten.

    a. Tighten until the mount opening is just wide enough to slide the spindle up or down.

Once the spindle is at the desired height:

1. Remove the M6 screw from the middle hole.

2. Fully tighten the top and bottom M6×30mm screws to secure the spindle.

Step 6: Set Up the Electronics

The electronics cabinet contains the Warthog controller, power supply, and variable-frequency drive (VFD), which controls the water-cooled spindle. The Warthog controller uses the 36-volt power supply to power the motors and gantry. Warthog uses a combination of optical isolation and an RS-422 serial connection to the computer for increased immunity from electrical noise and static discharge.

Included with the electronics cabinet is a separate Warthog Computer Adapter that will be the connection point between the electronics cabinet and your machine-control computer. An RS-422 Ethernet cable is used to connect the electronics cabinet to the Warthog Computer Adapter; however, the machine and its components are not Ethernet devices.

WARNINGS:

- Always turn off the power switch on the electronics cabinet after using the machine.

- Before opening the electronics cabinet, always turn off the power switch AND unplug the power cable from the outlet.

- Do not use the RS-422 Ethernet cable to connect the electronics cabinet or computer adapter to any Ethernet-enabled device, such as a modem or internet router.

- Always ensure the two fans on the side of the electronics cabinet are completely clear to ensure they receive plenty of airflow.

Connecting the Electronics Cabinet

1. Place the electronics cabinet on the base of the workbench or on the floor beneath it.

2. Locate the RS-422 Ethernet cable exiting the rear cable channel of the electronics cabinet.

3. Plug the RS-422 cable into the Ethernet port on the Warthog Computer Adapter.

4. Plug the USB C-to-A cable into the USB-C port on the computer adapter.

5. Place the computer adapter on top of the electronics cabinet lid or affix it to the side of the workbench.

6. Insert the power cable into the jack on the side of the electronics cabinet.

7. Plug the power cable into an outlet.

Step 7: Enable & Configure the BitSetter HDM

Setting Up the BitSetter HDM

Home the Machine

First, connect to and home the machine:

1. Power up your computer.

2. Connect the USB cable to the computer.

3. Start Carbide Motion.

4. Turn on the electronics cabinet power switch.

5. Press the **Machine Power button** on the front-right endplate to enable power to the machine.

6. In Carbide Motion, click the **Connect to Cutter button**.

7. Click the **Initialize Machine button**.

PRO TIP: The machine can be re-homed later on in a project (see *Fig. 3*). To do so:

1. Click **MDI** in the top menu bar.

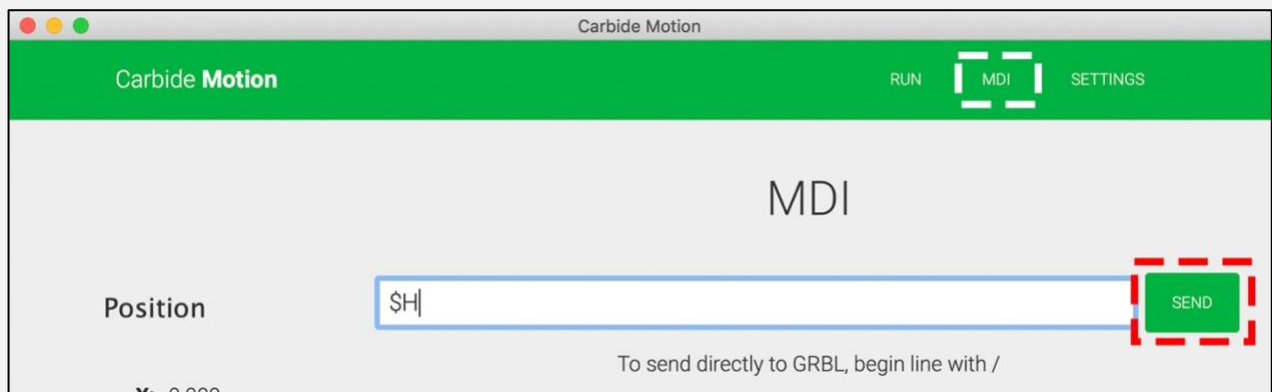2. Enter **$H** in the command line and click the **Send button**.

Figure 3

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Position the Spindle

Position the spindle directly above the BitSetter HDM:

1. In Carbide Motion, click **Jog** in the menu bar at the top of the screen.

2. On the *Jog screen*, click the **Set Zero button**.

3. Click the **Clear All Offsets button** and then click **Done**.

4. Jog the machine so that the spindle is directly above the BitSetter HDM.

Enable the BitSetter HDM in Carbide Motion

Enable the BitSetter HDM and save the spindle position in the settings menu:

1. In Carbide Motion, click **Settings** in the menu bar.

2. Click the **Options tab** in the Settings menu.

3. In the *BitSetter section*, select the **Enabled check box**.

4. Click the **Use Current Location button** to save the current X/Y location of the spindle.

5. Click **Ok** to save and close.

Set the Post Processor in Carbide Create

In order for the BitSetter HDM to work, the post processor in Carbide Create must be correctly set:

1. In Carbide Create, go to **Edit > Select Post Processor** in the menu bar.

2. Select **Carbide 3D Shapeoko**.

3. In the *Output Units dropdown list*, select **Metric** or **Inch**.

4. Click **Ok** to save and close.

Step 8: Control the Shapeoko HDM

Machine-Control Buttons

There are three machine-control buttons on the front-right endplate (see *Fig. 4*):

1. **Feed Hold Button:** Press and hold the button for momentary feed hold. Release the button to return to normal operation. When the button is pressed, Carbide Motion will open a dialog box letting you know that feed hold is activated. When the button is released, a dialog box will open letting you that feed hold has been deactivated.

2. **Machine Power Button:** Press to enable/disable power to the machine. When the blue LED is lit, power to the machine is enabled.

3. **Spindle Lock-Out Button:** Press to enable/disable the spindle lock-out. When the red LED is lit, the spindle is enabled. When the button LED is off, spindle is disabled.
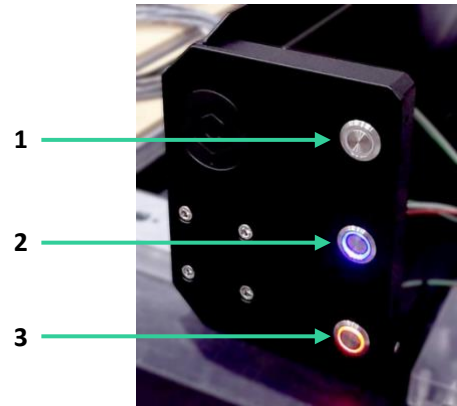

Figure 4

WARNINGS:

- Always turn off the power switch on the electronics cabinet after using the machine.

- Before opening the electronics cabinet, always turn off the power switch and unplug the power cable from the outlet.

IMPORTANT NOTES ABOUT CHANGING TOOLS:

- When running a project, do NOT perform toolchanges without first being prompted by Carbide Motion.

- When no project is in progress, ALWAYS press the Load New Tool button in Carbide Motion and follow all onscreen prompts to change the tool.

Controlling the Shapeoko HDM

To run a project:

1. Turn on the electronics cabinet power switch.

2. Press the **Machine Power button** to turn on the machine.

3. Connect to and home the machine.

4. Load the G-code and the first tool, and set job zero. Ensure the spindle lock-out is engaged (the button LED will be off) before loading the first tool.

5. Turn on the chiller.

6. Press the **Spindle Lock-Out button** to enable the spindle (the red LED will turn on).

7. Start the project in Carbide Motion. Carbide Motion, via the VFD, will automatically turn the spindle on/off and control the RPM.

8. When prompted by Carbide Motion to perform a toolchange:

    a. Press the **Spindle Lock-Out button** to disable the spindle (the button LED will turn off).

    b. Load the new tool.

    c. Press the **Spindle Lock-Out button** again to enable the spindle (the red LED will turn on).

    d. Press the **Resume button** in Carbide Motion. The BitSetter HDM will automatically measure the length of the new tool and update the Z-height.

WARNING: **Do NOT perform a toolchange without first being prompted by Carbide Motion**. When you change the tool unprompted, the machine does not know to measure the length of the new tool with the BitSetter HDM and to re-zero your Z-Axis; this can result in the Z-Axis plunging too deeply into your stock.

9. Press and hold the **Feed Hold button** any time you wish to momentarily pause the feed. Release the button to resume normal operation.

10. To pause the project and the machine during operation, press the **Pause button** in Carbide Motion. Press the **Start button** to resume the project.

11. Once the project is complete, disable the spindle and disable the power to the machine. Then, turn off the electronics cabinet power switch.

12. Leave the chiller on for an additional 5–10 minutes to allow the spindle to completely cool.

Shapeoko HDM Maintenance

Recommended Oil

We only recommend using Mobile Vactra No 2 oil on linear rails, ball bearing carriages (AKA guides or carriages), and ball screws. It should NOT be used on any other parts of the machine.

Follow the safety guidelines provided with the oil. Wear gloves and safety glasses.

Linear Rail and Ball Bearing Carriage Maintenance

Our linear rails and guides are rated for tens of thousands of hours of use. To keep them in optimal condition, we recommend the following:

General Maintenance

- We recommend vacuuming or brushing out the Y-axes daily.

- After every use, wipe down the linear rails and guides with a clean, dry, lint-free cloth to remove any dust or debris.

- We do not recommend using compressed air on the linear rails and guides.

- Never use water-based products on the linear rails and guides.

- Rub a small amount of the recommended oil on the linear rails using a lint-free cloth. Be sure to clean off any excess.

Lubricating the Axes

Maintenance intervals will vary according to use, but we recommend every 3–6 months (or more frequently depending on use) lubricating the linear rails, carriages and ball screws. Everything is rubber sealed with dust wipers but additional oiling will keep the linear rails in top condition.

To lubricate an axis:

1. Remove the two Y-Axis inside covers.

2. Move the axis to be lubricated to one end of its travel, e.g. all the way to the top (Z-Axis), back (Y-Axis), or left (X-Axis).

3. Fill a large-bore plastic syringe with Mobile Vactra No. 2 oil.

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4. Remove the small M4 grub screw in the center of each carriage. See *Fig. 5*. *
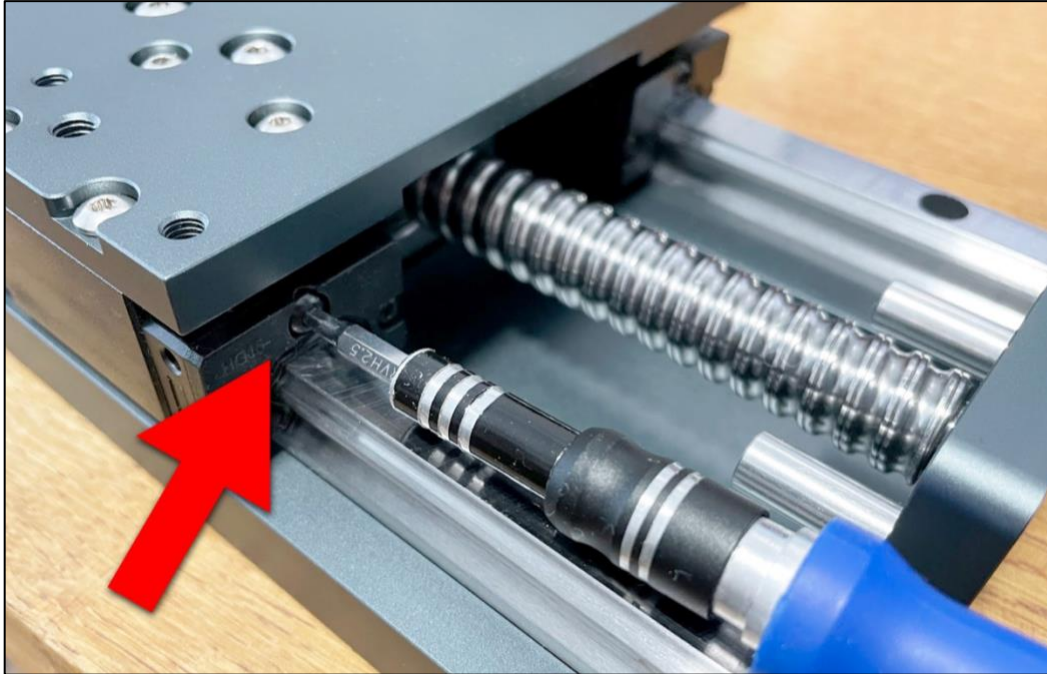

Figure 5

5. Press the tip firmly into the screw hole and gently squeeze about 1ml of oil into each linear guide. See *Fig. 6*. *
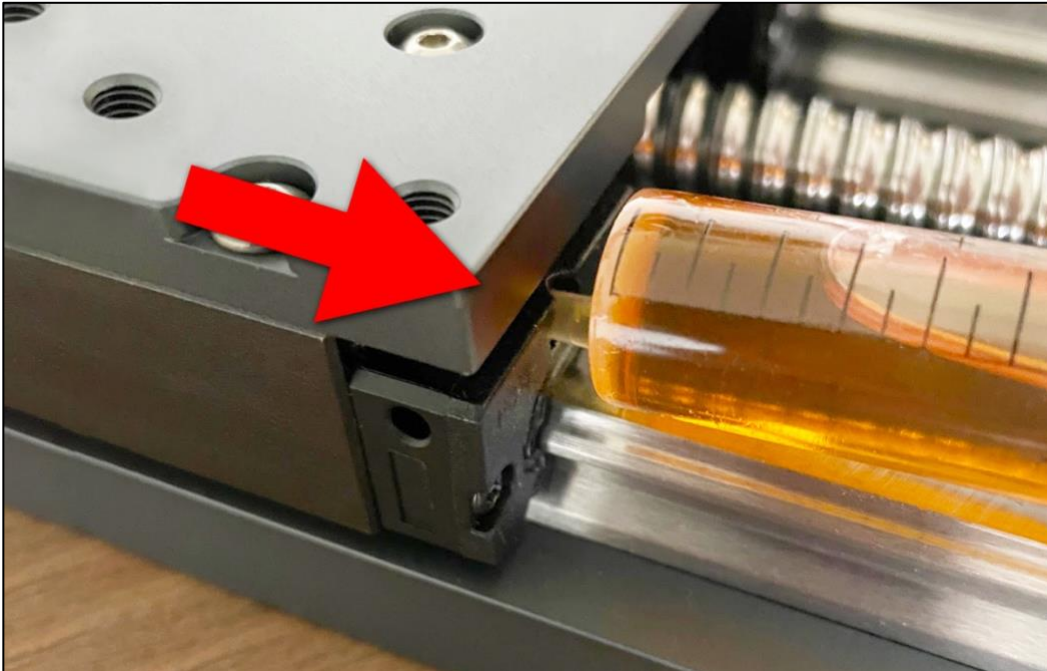

Figure 6

* The axis pictured is a Shapeoko HDZ.

6. Replace the M4 screws.

7. Apply a small amount of Vactra No 2 along the ball screw and linear rail (approximately 1–2ml).

8. Jog the axis the full length of travel a number of times at approximately 1000mm a min.

9. Use a clean, lint-free cloth to wipe off any excess oil.

10. Repeat steps 2–9 to lubricate each axis.

11. Re-attach the two protective covers.

Replacing the Fuse

If the machine stops working suddenly, the fuse in the electronics cabinet may have blown. Contact the tech support team at support@carbide3d.com for instructions for replacing the fuse.

Tramming the HDM

What is Tramming and Why Is it Important?

Have you ever seen small tool marks on your projects or found that the audible pitch of the router/spindle changes significantly when cutting in a certain direction? If you are nodding to either of these, then you may need to tram your machine.

As the end mill travels along the X/Y axis, the actual tip of the end mill should be parallel to the machine bed. When the bottom of the end mill is not parallel, the lowest edge of the end mill becomes the deepest part of the cut (*Fig. 7* shows an exaggerated view of this). When this happens, you get the issues described above.

These tool marks are-more prevalent in harder materials like metals or composites than in wood because wood is softer. They will also be more prominent when using a larger stepover or a larger end mill.

Tramming isn't a new 'thing', every single CNC machine—even a $150,000 VMC—will have been trammed upon setup and regularly thereafter as part of its maintenance cycle.
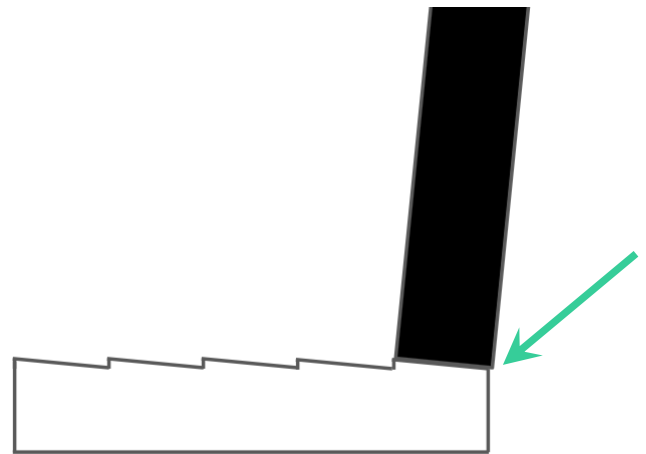
Figure 7

Identifying and Defining Tram

Below we will define the two types of tram and look at how you can correct them. To help visualize this, imagine the end mill is your head.

- **Nod:** Nod is where the spindle tram is out front-to-back. The spindle is nodding forwards or backwards.

- **Yaw:** This is where the tram is tilted from side-to-side. The spindle is tilted in a clockwise or counterclockwise direction.

On the next page is a quick guide to help you identify in which direction the tram is out. The guide shows a birds-eye view of the surface finish. The red line indicates where the cutter is cutting deepest.
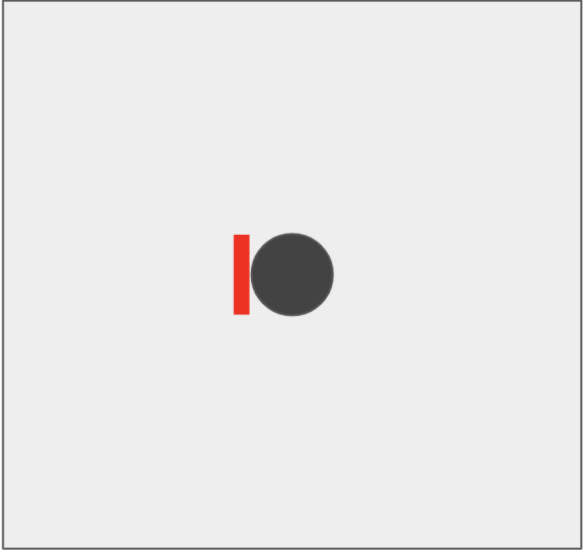
Spindle is nodding backward.
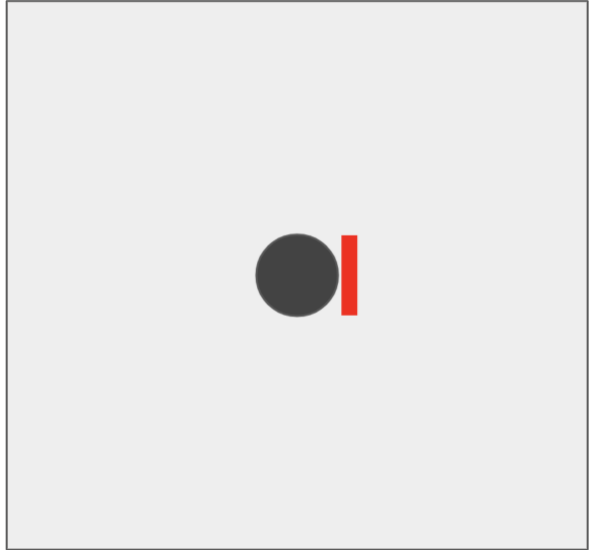**The rear edge is cutting deepest.**
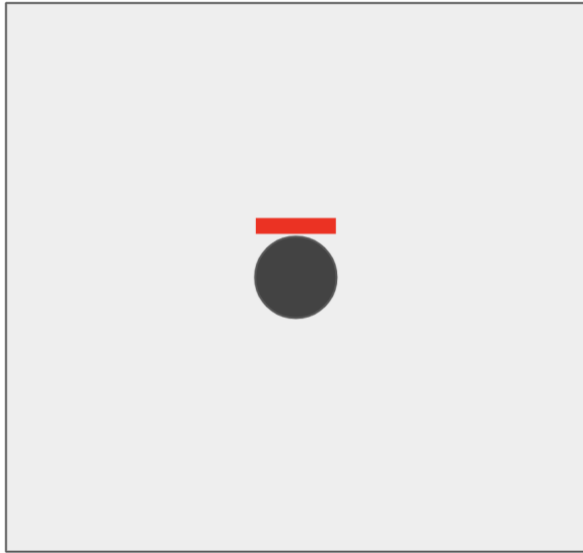
Spindle is nodding forward.
The front edge is cutting deepest.
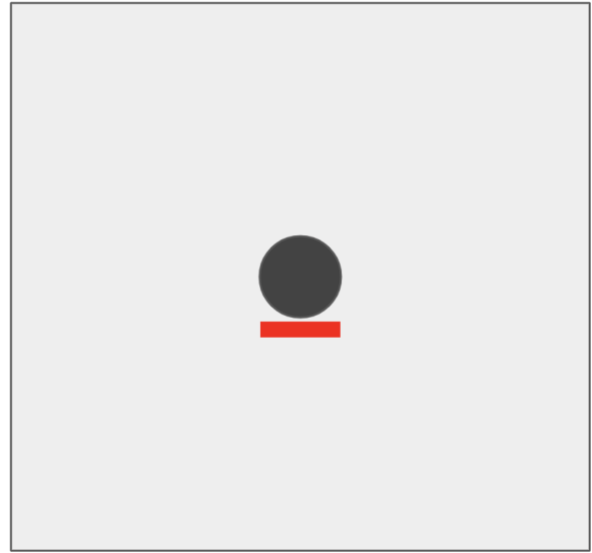
Spindle yaw is counterclockwise.
The left edge is cutting deepest.

Spindle yaw is clockwise.
The right edge is cutting deepest.

Tramming

Once identified, it is easy enough to correct the tramming. Our entire Shapeoko range can be adjusted as needed. We recommend designing a basic square pocket surfacing toolpath for a small 2" × 2" square of stock and surface it using a ¼ end mill, with a depth of cut of 0.1mm (0.0039"), and a 6.35mm (¼") step over.

Adjusting Nod

Nod should always be adjusted first. To adjust nod, we recommend using metal shims. You can use standard kitchen foil which is usually 0.024mm (0.00094") thick. You may use specialist shims, if desired. These can be purchased from most machinist stores.

The shim should be the width of the spindle mount and one piece of foil can be folded over multiple times to build thickness, as needed.

1. Loosen the four (4) spindle mount bolts.
2. Place the shim between the Z-Axis carriage and the spindle mount, at either the top edge or the bottom edge of the spindle mount, depending on which way it needs to be adjusted.
3. Re-tighten the spindle mount bolts.
4. Check the tram.
5. Repeat steps 1–4, introducing more shim thickness, if necessary.

Adjusting Yaw

Yaw is a little simpler, it's just a matter twisting the spindle mount:

1. Loosen the four (4) spindle mount bolts half a turn so the mount is loose but still firmly on the machine.
2. With the palm of your hand or a soft rubber mallet, very gently tap the edge of the main body of the spindle/router in the correct direction.
3. Re-tighten the bolts.
4. Check the tram
5. Repeat steps 1–4 to re-adjust, if necessary.

Tools to Help You Tram

There are a number of gauges out there that can help you tram to a very high level of precision.

If you want to calibrate your spindle head to a high precision, we recommend the Edge Technology Mini Pro Tram System (with ¼ shank). Other brands are available but we have found this one to be a high-quality, accurate tool, well suited to the machine size.

For instructions on how to use the tool, please consult the manufacturer manual.

Extras

Troubleshooting Guide

PROBLEM	POSSIBLE REASON	HOW TO RESOLVE
Machine will not turn on.	Power switch on the control cabinet is not turned on.	Power on the control cabinet.
	Power to the machine is disabled.	Press the Machine Power button on the front-right endplate (the blue button LED will turn on).
	Cables are not correctly plugged in.	Ensure all cables are correctly connected.
Spindle will not turn on.	Power switch on the control cabinet is not turned on.	Power on the control cabinet.
	The spindle lock-out is enabled (spindle is disabled).	Press the Spindle Lock-Out button on the front-right endplate to enable the spindle (the red button LED will turn on).
	G-code not loaded or project not started.	Load the project and tool in Carbide Motion, then start the project.
Machine stopped working suddenly.	The fuse in the electronics cabinet may have blown if the machine stops suddenly and the buttons on the front-right endplate do not light up.	Contact the tech support team at support@carbide3d.com for instructions for replacing the fuse.

Carbide 3D

Machine Operating Checklist

1. Practice Safe Machining

Always follow the safety guidelines listed at the beginning of this document. Always wear appropriate safety equipment, especially safety glasses/goggles and hearing protection.

2. Check the Machine Condition

Check that all screws are tight; ballscrews, linear rails and guides, spindle, VFD, chiller, and extrusions are in good condition with no nicks or other damage; wiring and coolant tubing is in good condition with continuity and securely fastened; and nothing is frayed or broken and everything is clear and safe.

3. Examine the End Mill(s)

Ensure each end mill to be used is sharp, in good condition, and not chipped.

4. Secure the Workpiece

Secure the workpiece right-side up and in the desired orientation to the worksurface using a technique appropriate to the material.

5. Clear the Work Area

Ensure the work area is clear and the spindle can move without interference.

6. Power on the Machine and Connect to the Machine-Control Computer

1. Power up the computer.

2. Connect the USB-C-to-A cable to the computer.

3. Start Carbide Motion.

4. Turn on the power switch on the electronics cabinet.

5. Press the Machine Power button on the front-right endplate to enable power to the machine.

6. In Carbide Motion, connect to and home the machine.

7. Load the First Tool

After homing the machine, Carbide Motion will prompt you to load the first tool:

1. Ensure the spindle lock-out feature is engaged and the spindle is OFF—the Spindle Lock-Out button LED will be off.

2. Load the tool, ensuring that the collet is tight enough that the end mill will not work loose during operation.

3. Click the **Resume button** in Carbide Motion. The BitSetter HDM will automatically measure the tool length.

If, after loading the first tool, you decide to change it:

1. Click the **Load New Tool button** in Carbide Motion.

2. Load the new tool.

3. Click the **Resume button** in Carbide Motion. The BitSetter HDM will automatically measure the length of the new tool.

8. Set Job Zero

Set job zero manually, or by using the probing sequence if you have a BitZero V1 or V2.

If you wish to change the tool after setting job zero:

1. Go to **Run**, then click the **Load New Tool button** in Carbide Motion.

2. Load the new tool.

3. Click the **Resume button** in Carbide Motion. The BitSetter HDM will automatically measure the length of the new tool and update the Z-height.

9. Remove the BitZero (If Applicable)

Remove the grounding clip and place the BitZero outside of the work envelope.

10. Load the G-code File

Press the **Load New File button** in Carbide Motion to load the .nc file.

11. Power on the Chiller

Turn on the power switch on the front of the chiller.

12. Enable the Spindle

Press the Spindle Lock-Out button on the front-right endplate to disable the spindle lock-out function and enable the spindle (the red LED will turn on).

13. Start the Project

Start the project in Carbide Motion.

14. Perform Toolchanges—ONLY When Prompted by Carbide Motion

Follow all prompts in Carbide Motion for toolchanges. When prompted to change the tool:

1. Press the Spindle Lock-Out button to disable the spindle (the button LED will turn off).

2. Load the new tool.

3. Press the Spindle Lock-Out button again to re-enable the spindle (the red LED will turn on).

4. Press the **Resume button** in Carbide Motion. The BitSetter HDM will automatically measure the length of the new tool and update the Z-height. **NOTE: If you disable the BitSetter HDM, you MUST manually re-zero your Z-Axis.**

Do NOT perform a toolchange without first being prompted by Carbide Motion. When you change the tool unprompted, the machine doesn't know to measure the length of the new tool with the BitSetter HDM and to re-zero your Z-Axis; this can result in the Z-Axis plunging too deeply into your stock.

15. Monitor the Machine During Operation

Ensure there is no build-up of dust, debris, or fumes, and that nothing works loose. Do not reach into the machine work envelope or insert any object into it while the machine is operating.

16. Shut Down Machine and Components

Once the job is complete, the spindle will automatically pause and move up to its parked position. Disable the spindle and the power to the machine. Turn the power off to the electronics cabinet. Wait 5 minutes before turning off the chiller to allow the spindle to completely cool down.

17. Clean Up

Remove the finished workpiece and any waste. Store end mills carefully when not in use to protect the cutting edges. Collets and end mills should be cleaned when they accumulate milling debris. The easiest way to clean end mills and collets is by dipping them into a suitable solvent such as isopropyl alcohol. Make sure to let the alcohol complete evaporate before using again.

Glossary

BitSetter: BitSetter is an automatic tool offset probe that makes it easy to run jobs using multiple tools without the need to stop and re-zero manually. BitSetter measures the length of the cutter in the spindle and, combined with Carbide Motion, automatically resets the Z-axis zero point to reflect the new length.

CAD (Computer Aided Design): CAD is where you turn your idea into a digital design. CAD is software that allows you to draw on your computer. This can be anything from a full-blown parametric 3D modeling package like Solidworks, to something as simple as Carbide Create. Don't let the word CAD scare you. All it means is 'a program to draw in'.

CAM (Computer Aided Manufacturing): CAM is where you turn your CAD design into something your CNC machine can understand. CAM is software that lets you specify HOW your design is going to be made on your CNC machine. Your CAM program will output G-Code. Like most terminology around CNC, CAM sounds scarier than it really is.

Chiller: The closed-loop chiller constantly circulates coolant (distilled water, antifreeze, or windshield wiper fluid) through the water-cooled spindle during operation.

Collet: A collet is a cone-shaped sleeve that holds an end mill in place in the spindle.

End Mill / Cutter / Tool: End mills are the cutting tools used by the Shapeoko HDM. They come in several varieties, such as square, ball nose, and V-bit, and many sizes.

G-code: G-code (general, or geometric, code) is a CNC programming language that controls when, where, and how the machine moves across the workpiece (for example, when to turn on or off, how fast to travel to a particular location, what paths to take, etc.).

Home: Homing the machine is the process of sending it to a known, fixed, repeatable location. This means that every time you home, the machine will move to exactly the same position allowing you to move the machine to positions relative to the home position, with great precision. On the Shapeoko HDM, home is position is the back-right corner.

Hybrid Table: The Hybrid Table has slabs of MDF nestled within aluminum T-track extrusions. The Hybrid Table makes the machine base square, extremely rigid, and provides multiple workholding options.

Job Zero / Job Origin / Toolpath Zero / Program Zero: It may have many names, but job zero basically tells the machine where to begin running the job. Job zero is a point in your design where all of the toolpaths will be based from (the X, Y, and Z coordinates). Job zero is most commonly set in the lower-left corner of your stock.

Jog: Move the spindle to a specific position (a set of X, Y, Z coordinates) in the work area.

Spindle: The spindle is the part of the Shapeoko HDM that turns the end mills. The 80mm water-cooled spindle has an 8–24k RPM motor. It is controlled by the variable-frequency drive (VFD) and cooled by the closed-loop chiller.

Stock / Workpiece / Material: The sheet of material (wood, plastic, composite/synthetic, metal) being machined.

Toolpath: A toolpath is the "route" the cutting tool will follow as it shapes the workpiece. We use Carbide Create or MeshCAM to define the toolpaths for a project.

Toolchange: When running a job that require multiple tools, Carbide Motion will prompt you each time you need to change tools. After each toolchange, the machine will use the BitSetter HDM to measure the length of the new tool.

Variable Frequency Drive (VFD): The VFD controls the spindle. The custom VFD interface board turns the spindle on and off and automatically sets the RPM based on the project G-code. It also filters the AC power lines to reduce the electrical noise that can leave the VFD and spindle and get into the AC supply lines.

Warthog: Warthog is the fourth major version of our GRBL-based motion control. It uses a 36-volt power supply for better performance with the bigger motors used in the HDM. Warthog also uses a combination of optical isolation and an RS-422 serial connection to the computer for additional immunity from electrical noise and static discharge.

Work Envelope: A working envelope is the CNC machine's range of movement across its three axes: X, Y, Z.

Machine-Use and Maintenance Log

Track project specs, maintenance timeline, and cutter, project, and machine hours with the Machine-Use and Maintenance Log on the next page.

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Date _____

Project Name _____

Material 1 _____

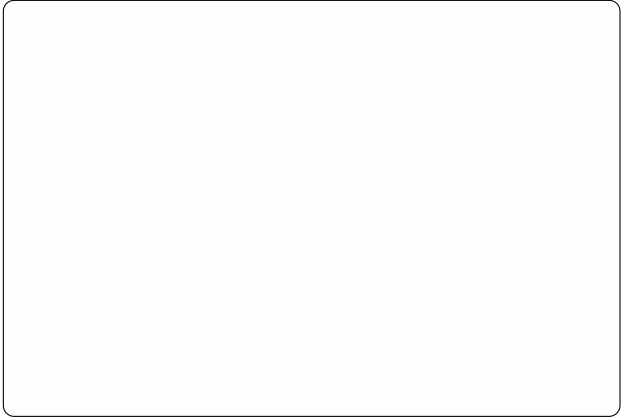Dimensions _____

Material 2 _____

Dimensions _____

Fixture(s) _____

Origin(s) _____

Setup Notes _____

Image

Shapeoko HDM Operation and Maintenance Checklist

<table>
<tr><td rowspan="4">BEFORE EACH USE</td><td colspan="2">SAFETY</td><td colspan="4">CHECK CONDITION</td></tr>
<tr><td>☐ Workpiece Secure</td><td>☐ PPE</td><td>☐ Collet & Cutter</td><td>☐ Spindle</td><td>☐ HDM BitSetter</td></tr>
<tr><td>☐ Work Area Clear</td><td>☐ Dust Extraction</td><td>☐ Ballscrews</td><td>☐ VFD</td><td>☐ Electronics & Wiring</td></tr>
<tr><td>☐ End Mill Secure</td><td>☐ Emergency Stop</td><td>☐ Linear Rails & Guides</td><td>☐ Chiller</td><td></td></tr>
<tr><td>☐ BitZero Removed</td><td>☐ Fire Prevention</td><td>☐ Extrusions</td><td>☐ Coolant Tubing</td><td></td></tr>
</table>

MAINTENANCE
☐ Lubricate Axes

Tool Chain

	End Mill	RPM	Feed Rate	Time (hr/min)
1.	_____	_____	_____	_____ / _____
2.	_____	_____	_____	_____ / _____
3.	_____	_____	_____	_____ / _____
4.	_____	_____	_____	_____ / _____
5.	_____	_____	_____	_____ / _____
6.	_____	_____	_____	_____ / _____
			Total Cutter Time	_____ / _____

Total Project Time

Estimated (hr/min) _____ / _____   Start Time _____

Actual (hr/min) _____ / _____   End Time _____

Total Machine Hours

_____

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