

COMMISSIONING AND CALIBRATION GUIDE

LEVELING AND SQUARING A MILL

TECHNICAL DOCUMENT

? LOOKING FOR A VIDEO?

Before you begin, select the image below to watch a walk-through video of this entire procedure.



1.1 PURPOSE

This document gives instructions on leveling the mill to account for the influence of its environment.

1.1.1 Why Should I Level the Mill?

You must level the mill for it to perform to its fullest potential. At the factory, the mill is assembled, calibrated, and inspected on a leveled stand. For your mill to perform to this standard, you must level it in your shop. Leveling the machine accounts for variations in its installation, like an uneven shop floor.

Some applications may not require the level of precision afforded by leveling the machine.

1.1.2 When Should I Level the Mill?

We recommend that you level your mill when you:

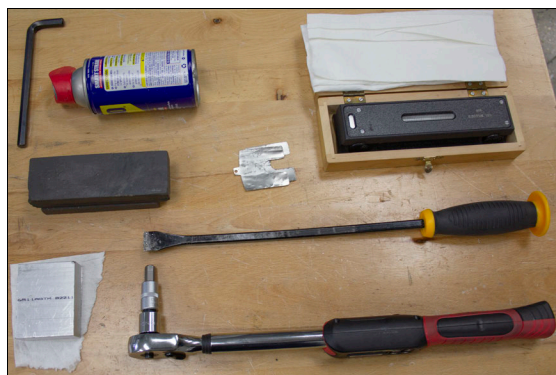
- Initially install the mill, after you've installed all major accessories (enclosure, Automatic Tool Changer)
- Move the mill

Additionally, we recommend that you verify the level of your mill:

- Annually, as part of your shop's preventative maintenance program
- Whenever a major accessory is installed

1.2 REQUIRED TOOLS

This procedure requires the following tools. Collect them before you begin.



- 10 mm hex wrench
- 10 mm or 3/8 in. diameter bar
- Block:
 - **1100M, 1100MX** 1 in. thick block that's large enough to safely support your pry bar
 - **770M, 770MX** 3 in. thick block that's large enough to safely support your pry bar
- Clean, lint-free cloth
- Machinist stone
- Mill Stand Leveling Shim Kit (PN 39565) (provided in the machine's tool bag, or shim stock of assorted thickness)
- Precision machinist's level (0.0005/10 in. graduations or better)
- Pry bar
- Torque wrench and 10 mm hex wrench socket adapter
- WD-40® (or similar water displacement oil)

1.3 BEFORE YOU BEGIN

- The machine stand must be roughly leveled front-to-back and left-to-right (use a 4-ft carpenter's level), and the machine stand must be sitting on all four feet.
- The machine must be secured to the machine stand, and the screws must be tightened to 10ft-lb (13.5 Nm) torque.
- All major accessories must be installed.
- The machine must be in its final installed location (which must be a flat, stable surface suitable for the machine's weight).
- The machine and the PathPilot controller must be powered on.

2.1 LEVEL THE MILL

Complete the following steps in the order listed:

2.1.1 Prepare the Machine.....

2.1.2 Verify the Level's Calibration.....

2.1.3 Level the Stand.....

2.1.4 Square the Machine.....

3

3

4

4

2.1.1 Prepare the Machine

1. Remove any vises, rotary tables, or fixtures from the machine table.

2. Remove any tools from the spindle or (optional) Automatic Tool Changer (ATC).

3. Remove any accumulated chips from the way covers.

NOTICE! This procedure involves jogging the machine to its extents of travel. If you leave chips on the way covers, it could damage them.

4. Remove any burrs from the machine table with a machinist stone and WD-40® (or similar water displacement oil).



Figure 2-1: Removing burrs from the machine table.

5. Wipe the surface of the machine table with a clean, lint-free cloth and, if needed, your palm.

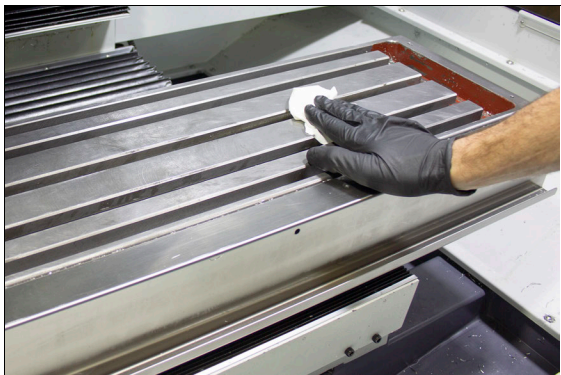


Figure 2-2: Wiping the surface of the machine table.

6. Clean the base of the precision level.

2.1.2 Verify the Level's Calibration

1. Reference the machine.

2. Center the machine table: from the PathPilot interface, in the MDI Line DRO field, type the command for your machine's center position, as detailed in the following table. Then select the Enter key.

Machine	Command
1100M and 1100MX	G20 G53 G1 X9 Y-5.5 Z0 F20
770M, 770MX, and PCNC 770	G20 G53 G1 X7 Y-3.75 Z0 F20
PCNC 440	G20 G53 G1 X5 Y-3.125 Z0 F20
PCNC 1100	G20 G53 G1 X9 Y-4.75 Z0 F20

3. Put the precision level in the center of the machine table, aligned to the X-axis.

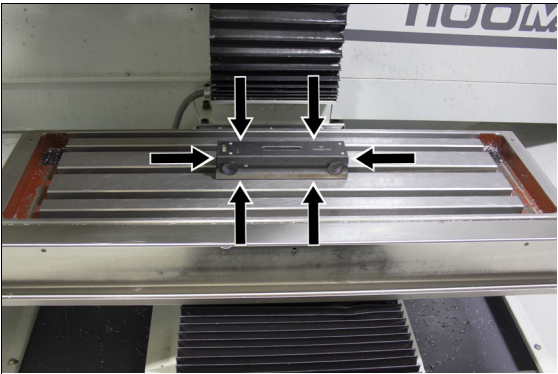


Figure 2-3: Precision level on the machine table.

4. Mark the location of the level on the machine table.



Figure 2-4: Marking the location of the precision level on the machine table.

TECHNICAL DOCUMENT

5. Make note of the bubble's position.
6. Rotate the level 180° on the machine table.
7. Make note of the bubble's new position.
 - **Bubble Hasn't Changed Positions** This indicates that the level is correctly calibrated.
 - **Bubble Changed Positions** Adjust the level's calibration according to the manufacturer's instructions. Then, repeat Step 3 through 7.

2.1.3 Level the Stand

1. Put the precision level in the center of the machine table, aligned to the X-axis.

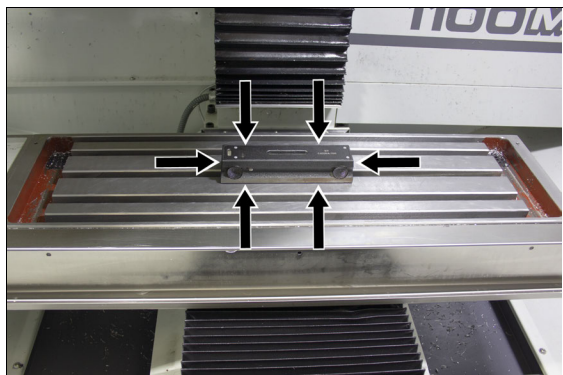


Figure 2-5: Precision level aligned to the machine table's center T-slot.

2. Read the bubble on the level, and note which side of the machine is low.
3. Raise the two feet on the low side of the machine with the 10 mm or 3/8 in. diameter bar.



Note: While you're adjusting the feet, the bottom section of the foot should remain stationary (only the foot adjuster moves).



Figure 2-6: Adjusting the machine stand's feet on a 770M.

4. Let the level's bubble settle. Then, read it again.
 - **Bubble Centered (Under $\pm 0.0015/10$ in.)** Go to Step 5.
 - **Bubble Not Centered (Over $\pm 0.0015/10$ in.)** Repeat Steps 2 through 4.
5. 5. Rotate the level on the machine table so that it's aligned to the Y-axis (the body is perpendicular to the machine table's center T-slot).

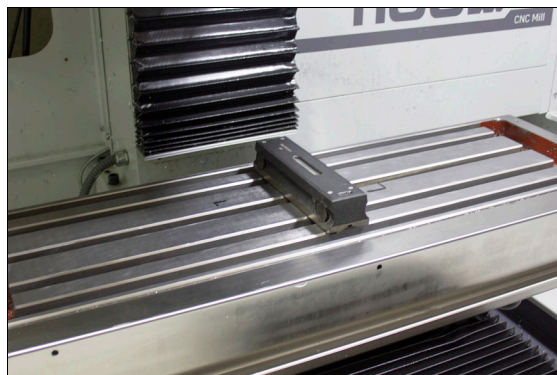


Figure 2-7: Precision level perpendicular to the machine table's center T-slot.

6. Read the bubble on the level, and note which side of the machine is low.
7. Raise the two feet on the low side of the machine with the 10 mm or 3/8 in. diameter bar.
8. Let the level's bubble settle. Then, read it again.
 - **Bubble Centered (Under $\pm 0.0015/10$ in.)** This indicates that the machine stand is level in both the X and Y directions.
 - **Bubble Not Centered (Over $\pm 0.0015/10$ in.)** Repeat Step 6 through 8.
9. Verify that the stand is still level in the X direction.

2.1.4 Square the Machine

1. Put the precision level in the center of the machine table, aligned to the X-axis.

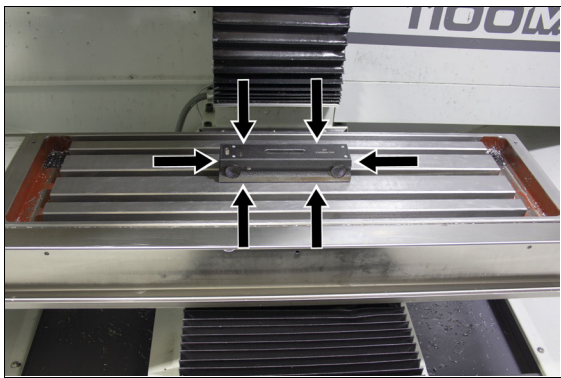


Figure 2-8: Precision level on the machine table.

2. Move the machine to the Y- limit: from the PathPilot interface, in the **MDI Line** DRO field, type the command for your machine's Y- limit, as detailed in the following table. Then select the **Enter** key.

Machine	Command
1100M and 1100MX	G20 G53 G1 X9 Y-11 Z0 F20
770M, 770MX, and PCNC 770	G20 G53 G1 X7 Y-7.5 Z0 F20
PCNC 440	G20 G53 G1 X5 Y-6.25 Z0 F20
PCNC 1100	G20 G53 G1 X9 Y-9.5 Z0 F20



Figure 2-9: Machine table moved to the Y- limit.

3. Read the bubble on the level, and note its position.

4. Move the machine to the Y+ limit: in the **MDI Line** DRO field, type the command for your machine's Y+ limit, as detailed in the following table. Then select the **Enter** key.

Machine	Command
1100M and 1100MX	G20 G53 G1 X9 Y0 Z0 F20
770M, 770MX, and PCNC 770	G20 G53 G1 X7 Y0 Z0 F20
PCNC 440	G20 G53 G1 X5 Y0 Z0 F20
PCNC 1100	G20 G53 G1 X9 Y0 Z0 F20

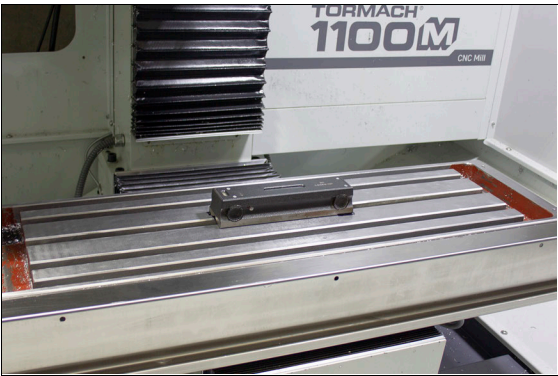


Figure 2-10: Machine table moved to the Y+ limit.

5. Read the bubble on the level. Depending on its position, do one of the following:
- **Moved Less Than $\pm 0.0005/10$ in.** This indicates that there's no twist in your base casting. You've completed the leveling and squaring procedure.
 - **Moved More Than $\pm 0.0005/10$ in.** You must use shims to remove the twist in the base casting: go to Step 6.
6. Depending on your machine, use one of the equations below to calculate the required shim thickness.

1100M, 1100MX, AND PCNC 1100 MILLS

$\times 4 =$

Measured Twist (From Step 5)Shim Thickness

770M, 770MX, AND PCNC 770 MILLS

$\times 2 =$

Measured Twist (From Step 5)Shim Thickness

TECHNICAL DOCUMENT

- Convert the value from Step 6 into millimeters, and then determine which shim stock to use from the provided shim kit (in the machine's tool bag).



Tip! 1 in. = 25.4 mm.

- Move the machine to the Y- limit: in the **MDI Line** DRO field, type the command for your machine's Y- limit, as detailed in the following table. Then select the **Enter** key.

Machine	Command
1100M and 1100MX	G20 G53 G1 X9 Y-11 Z0 F20
770M, 770MX, and PCNC 770	G20 G53 G1 X7 Y-7.5 Z0 F20
PCNC 440	G20 G53 G1 X5 Y-6.25 Z0 F20
PCNC 1100	G20 G53 G1 X9 Y-9.5 Z0 F20

- Find the appropriate shim thickness as you determined in Step 7. If needed, remove any burrs from it with a machinist stone and WD-40® (or similar water displacement oil), and set the shim aside.



Figure 2-11: Shim stock between two machinist stones.

- Loosen the front two bolts securing the mill base to the machine stand with a 10 mm hex wrench.



Figure 2-12: Loosening the front bolt on the base.

NOTICE! Don't use excessive force while lifting the base. For thick shims, you may need to loosen all four base bolts to create enough clearance to insert the shim. If you don't, you could damage the machine.

TECHNICAL DOCUMENT

11. Lift the front low corner of the mill with a pry bar and block. If you have a 770M or 770MX, put the pry bar into the lifting holes.

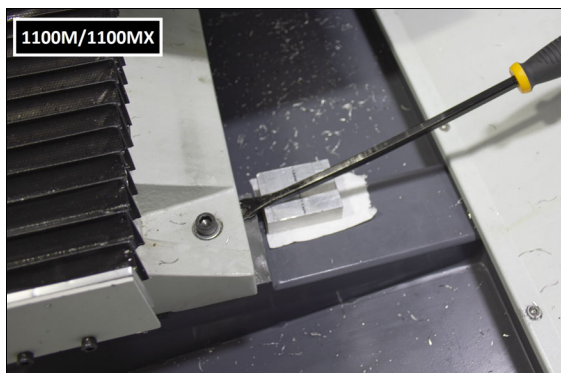


Figure 2-13: Lifting the lowest corner of the base on an 1100M.

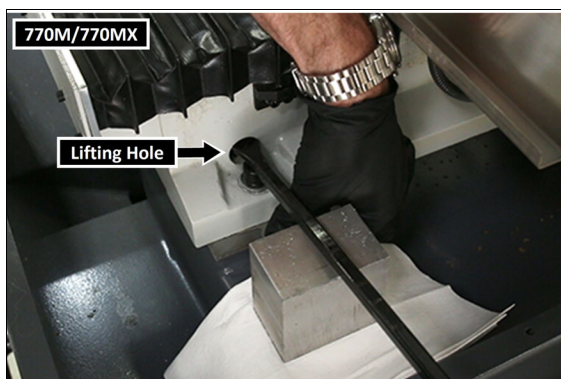


Figure 2-14: Lifting the lowest corner of the base on a 770M.



Tip! If the material slides on the stand, use a paper towel to keep it in position.

12. With the front of the mill lifted, put the shim stock (that you calculated in Step 6) around the bolt and between the base and the stand.



Figure 2-15: Putting a shim stock piece between the base and the stand.

13. Remove the pry bar and block.
14. Tighten the machine stand screws to a torque of 10ft-lb (13.5 Nm) with the torque wrench and 10 mm hex wrench adapter.



Figure 2-16: Tightening the front bolt on the base.



Note: Using a torque wrench is critical to successfully level the machine. Inconsistently torquing the stand screws adversely affects the level and performance of your machine.

15. Repeat Step 1 through 5 to verify that you eliminated any twist. Adjust shim thickness as needed to minimize twist.



Note: Adding a shim may max out your level. If it does, go to "Level the Stand" (page 4), and repeat the procedure. Once you're done, repeat Steps 1 through 5 in this section.

You've completed the leveling and squaring procedure.