

TORMACH® 8L



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To the Reader

We're dedicated to continually improving our documentation and products, and welcome any clarifications, corrections, or suggestions.

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ABOUT THIS DOCUMENT

SAVE THESE INSTRUCTIONS!

This document contains important safety warnings and operating instructions for your machine. Before operating this machine in any way, you and all other operators must read and understand all instructions. If you don't, there's a risk of voided warranty, property damage, serious injury, or death. Keep these instructions with your machine so that they're readily accessible.

PURPOSE AND SCOPE

This document is intended to provide sufficient information to allow you to install, configure, and use your machine. It assumes that you have appropriate experience and/or access to training for any computer-aided design or manufacturing software for use with the machine.

GETTING HELP

We provide no-cost technical support through multiple channels. The quickest way to get the answers you need is normally in this order:

1. Read this document.
2. Read related documents at tormach.com/support.
3. If you still need answers, gather the following information so that we may help you as quickly as possible:
 - Your phone number, address, and company name (if applicable).
 - Machine model and serial number, which are located next to the Main Disconnect switch.
 - The version of PathPilot that you're running.
 - Any accessories that you have for your machine.
 - A clear and concise description of the issue.
 - Any supporting media and information that you can share with us. For example, you could:
 - Analyze what might have changed since the machine last worked correctly.
 - Record a short video.
 - Take a picture of a part.
 - For software, share log data .zip files, screen captures, or program files.
For information, see "Share Log Data .zip Files" (below).

- From the PathPilot interface, on the Status tab, record any available information.
 - Use a digital multimeter for voltage readings.
4. Once you've gathered the information in Step 3, contact us in the following ways:
 - a. Create a support ticket: Go to tormach.com/how-to-submit-a-support-ticket
 - b. Phone: (608) 849-8381 (Monday through Friday, 8 a.m. to 5 p.m. U.S. Central Standard Time)

SHARE LOG DATA .ZIP FILES

The controller keeps log data on how the machine has been working, which you can export as a .zip file. This information helps us troubleshoot software situations much faster.

To share log data .zip files:

1. Put a USB drive into the PathPilot controller.
2. From the PathPilot controller, on the **Status** tab, select **Log Data**.
PathPilot creates a file called **logdata_[TODAY'S-DATE].zip**, and saves it on your USB drive.
3. Remove the USB drive from the controller. Create a support ticket with Tormach Technical Support at tormach.com/how-to-submit-a-support-ticket for guidance on how to proceed.

ADDITIONAL INFORMATION

For additional technical information and support videos, see tormach.com/support.

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This document provides guidance on safety precautions and techniques, but because the specifics of any one workshop or other local conditions can vary greatly, we accept no responsibility for machine performance or any damage or injury caused by its use. It's your responsibility to verify that you fully understand the implications of what you're doing and comply with any legislation and codes of practice applicable to your city, state, or nation.



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SAFETY

IN THIS SECTION, YOU'LL LEARN:

- About the standards and safety precautions associated with this machine.

 Before operating the machine in any way, you must read and understand this section.

Safe operation of the machine depends on its proper use and the precautions you take. Only trained personnel — with a clear and thorough understanding of its operation and safety requirements — shall operate this machine.

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1: SAFETY

1.1 INTENDED USE

This machine is intended for general-purpose, computer numerical control (CNC) machining in the following applications:

- Educational environments
- Hobby applications
- Light production
- Prototyping
- Research and development
- Secondary operations

The intended use includes:

- Appropriate workholding, toolholding, tooling, coolant systems, and machining parameters.
- Machining of conventional, non-abrasive materials such as ferrous and non-ferrous metals below 60 HRC, woods, and plastics.

The intended use **does not** include machining materials that:

- Are abrasive, carcinogenic, explosive, flammable, radioactive, or toxic
- Produce aerosols or fine particulates when machined

The intended use **does not** include the following materials (not a full list):

- Beryllium and its alloys
- Ceramics
- Fiberglass
- G10 fiberglass laminate
- Graphite
- Magnesium and its alloys

To safely operate products, you must obey all safety precautions and warnings that are on the machines and in the documentation.

1.2 MACHINE STANDARDS

When installed and operated as intended (see "Intended Use" (above)), this machine complies with the following standards. You must follow the requirements listed in the standards so that the machine remains compliant.

1.2.1 American National Safety Institute (ANSI)

- **ANSI B11.TR3-2000** *Risk Assessment and Risk Reduction — A Guideline to Estimate, Evaluate, and Reduce Risks Associated with Machine Tools*

- **ANSI B11.5-1984 (R1994)** *Lathes*
- **ANSI B11.22-2002** *Safety Requirements for Turning Centers and Automatic Numerically Controlled Turning Machines*

1.2.2 Occupational Safety and Health Administration (OSHA)

- **OSHA 1910.212** *General Requirements for All Machines*

1.3 SAFETY OVERVIEW

Any machine tool is potentially dangerous. A CNC machine's automation presents added risk not present in a manual machine.

Before operating the machine in any way, you must read and understand this section.


- Read and understand all safety messages used in this document.
- Locate and understand all safety decals on the machine.
- Locate and become familiar with all information decals on the machine.


1.3.1 Safety Messages


The following examples show the standard safety message types used to draw your attention to important information. The standards distinguish between personal injury safety messages and property damage warning messages.

Personal Injury

Personal injury safety messages have safety alert symbols and the following hazard level labels:

 **DANGER!** Indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

 **WARNING!** Indicates a hazard with a medium level of risk which, if not avoided, can result in death or serious injury.

 **CAUTION!** Indicates a hazard with a low level of risk which, if not avoided, can result in minor or moderate injury.

Property Damage

NOTICE! Indicates a hazard which, if not avoided, can cause property damage.

1.3.2 Safety Decals

Before operating the machine in any way, you must read and understand all installed safety decals on the machine and equipment. Do not remove any safety decals. If any safety decals become worn or damaged, contact Tormach Technical Support for guidance on receiving replacement decals.

The following types of safety symbols are on the decals:

- **Warning** ⚠ This symbol indicates a hazard which, if not avoided, can result in personal injury or property damage.
- **Prohibition** 🚫 This symbol indicates an action that shall not be taken or that shall be stopped.
- **Mandatory Action** 🛑 This symbol indicates an action that you must take to avoid a hazard.

On the Electrical Cabinet Door



Figure 1-1: Example of a safety decal on the electrical cabinet door.

1. **WARNING! Electrocution Hazard.** Points in the electrical cabinet contain high voltages, which can electrocute or shock you, causing death or serious injury. Even after the machine is powered off, electronic devices in the electrical cabinet can retain dangerous electrical voltages. Use caution when servicing the machine inside the electrical cabinet.
2. **Lockout/Tagout.** Before servicing the machine, you must power off the machine and use an approved lockout/tagout device to secure the Main Disconnect switch in the **OFF** position. Points in the electrical

cabinet contain high voltages, which can electrocute or shock you, causing death or serious injury.

Next to the Main Disconnect

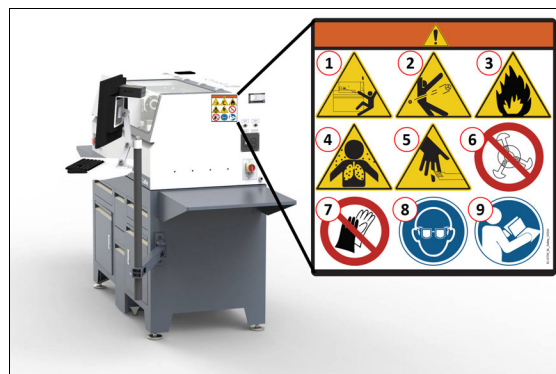


Figure 1-2: Example of a safety decal next to the Main Disconnect.

1. **WARNING! Ejection Hazard.** Fixtures, tooling, workpieces, or other loose items can become dangerous projectiles and can cause death or serious injury. Before operating this machine in any way, you must verify that you have appropriately secured all components.
2. **WARNING! Loose Workpiece or Workholding Hazard.** You must verify that the workpieces are securely clamped into the workholding device, and verify that the workholding device is securely fastened.
3. **WARNING! Fire Hazard.** The machine and its enclosure are not designed to contain fire or explosions. Only use materials and coolants that are intended for the specific machining operation. Never use flammable or explosive items. Before operating the machine in any way, you must read all Safety Data Sheets (SDSs) for any workpiece materials, coatings, coolants, lubricants, and other consumables used.
4. **WARNING! Inhalation Hazard.** The machine and its enclosure do not protect you from airborne particulates. Chips, dust, and vapors from certain materials can be toxic or otherwise harmful. Before operating the machine in any way, you must read all Safety Data Sheets (SDSs) for any workpiece materials, coatings, coolants, lubricants, and other consumables used.
5. **WARNING! Cut Hazard.** Tools and swarf can cut you. Only hold tools by the tool holder. Before inserting or removing tools from the machine, you must verify that all motion is completely stopped.

1: SAFETY

- Don't Use Extended Jaws.** You must not use jaws other than those made specifically for this machine. Extended jaw can cause the jaws to break or the chuck to fail. If you use extended jaws, there's a risk of property damage, serious injury, or death.
- Don't Wear Gloves.** You must not operate this machine while wearing gloves. If you do, the rotating components could draw you into the machine while it's powered on and operating.
- Personal Protective Equipment: Eyes.** Prevent injury by always wearing protective safety eyewear. Before operating this machine in any way, you must verify that your eyewear is impact-resistant and rated for ANSI Z87+.
- Operator Knowledge.** Before operating this machine in any way, you and all other operators must read and understand all instructions. If you don't, there's a risk of voided warranty, property damage, serious injury, or death.

On the Rear of the Headstock

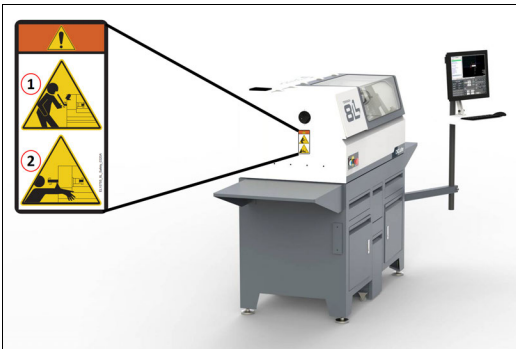


Figure 1-3: Example of safety decals on the rear of the headstock.

- WARNING! Bar Whip Hazard.** Unsupported bar stock that extends from the rear of the drawtube can bend during operation, causing it to whip unpredictably. Never extend an unsupported bar stock past the left end of the spindle bore. If you do, there's a risk of serious injury or death.
- WARNING! Entanglement / Entrapment Hazard.** The machine operates under automatic control — it can start at any time and crush, cut, entangle, or pinch body parts. Always keep clear of positions on the machine where unexpected or unintended machine motion could cause harm. Before operating this machine in any way,

you must verify that all operators know the location of the machine's Emergency Stop button.

1.3.3 Information Decals

Before operating the machine in any way, you must locate and become familiar with all installed information decals on the machine and equipment.

Serial Number Plate

The serial number plate is on the side of the electrical cabinet, near the Main Disconnect switch.



Figure 1-4: Example of the serial number plate on the side of the electrical cabinet.

1.4 MACHINE SAFETY

Before operating the machine in any way, you must read and understand this section.

Safe operation of the machine depends on its proper use and the precautions you take. Only trained personnel — with a clear and thorough understanding of its operation and safety requirements — shall operate this machine.

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1.4.1 General Shop Safety

- ✓ Verify that only qualified machinery maintenance professionals install, set up, or perform maintenance on this machine.
- ✓ Keep the work area well-lit. Use additional lighting if needed. The work area should be illuminated to a minimum of 500 lx.
- ✓ Keep the work area temperature- and humidity-controlled.
- ✓ Remove loose-fitting clothing, neckties, gloves, and jewelry.

- ✓ Tie up long hair and secure it under a hat.
 - ✓ Wear safety eye protection rated for ANSI Z87+.
 - ✓ Wear closed-toed safety shoes.
 - ✓ Wear ear protection when you expect the machine or the machining processes to exceed safe exposure limits.
 - ✓ Keep the work area clean and free of clutter. Machine motion can occur if controls are accidentally activated.
 - ✓ Immediately clean up spills after they occur.
 - ✗ Never operate the machine after consuming alcohol or taking medication that could prevent you from safely operating the machine.
 - ✗ Never operate the machine while tired or otherwise impaired.
 - ✗ Never operate the machine in an explosive (ATEX) atmosphere. Such explosive atmospheres include explosive gases, vapors, mists, powders, and dusts.
- ✓ Only use coolants designed for metal working applications such as soluble oils, semi-synthetic, or synthetic coolants.
 - ✓ Read the Safety Data Sheet (SDS) for all workpiece materials, coatings, coolants (flood or MQL), lubricants, and other consumables. Chips, dust, and vapors from certain materials can be toxic or otherwise harmful.
 - ✓ Dispose of scrap and swarf according to local regulations and guidelines.
 - ✓ Thoroughly read all safety precautions and instructions.
 - ✓ When machining an unproven program, use feed, speed, and maximum velocity overrides, Distance-to-Go (DTG) displays, single block, feed hold, and other control features.
 - ✗ Never enter the machining envelope.
 - ✗ Never reach around a guard.
 - ✗ Never allow the machine to run with the enclosure door open.
 - ✗ Never allow the machine to run unattended.
 - ✗ Never obstruct the Emergency Stop button or any other controls.
 - ✗ Never allow untrained operators to install, operate, or maintain the machine.
 - ✗ Never modify, defeat, or bypass safety devices or interlocks.
 - ✗ Never machine abrasive, carcinogenic, explosive, flammable, radioactive, or toxic materials. Such materials include, but are not limited to:
 - ✗ Beryllium and its alloys
 - ✗ Ceramic
 - ✗ Fiberglass
 - ✗ G10 fiberglass laminate
 - ✗ Graphite
 - ✗ Lead and its alloys
 - ✗ Magnesium and its alloys
 - ✗ Never allow swarf to accumulate on or within the machine.
 - ✗ Never use flammable liquids (like alcohol, diesel fuel, or kerosene) in the machine's coolant system.
 - ✗ Never use water, coolants without rust inhibitors, or straight cutting oil in the machine's coolant system.

1.4.2 Operational Safety

General

- ✓ Understand that the machine is automatically controlled and can start at any time.
- ✓ Become familiar with all physical and software controls.
- ✓ Always use a chip scraper or brush when clearing away chips, oil, or coolant.
- ✓ Examine all tools, fixtures, workpieces, and guarding for signs of damage. Replace any damaged components as soon as you find them.
The enclosure and other guards may not stop all types of projectiles, like broken tools or loose workpieces.
- ✓ Stop the machine and verify that all machine motion has completely stopped before doing any of the following:
 - ✓ Adjusting a part, fixture, or coolant nozzle.
 - ✓ Changing tools or parts.
 - ✓ Clearing away chips, oil, or coolant.
 - ✓ Reaching into any part of the machine's motion envelope.
 - ✓ Removing protective shields or safeguards.
 - ✓ Taking measurements.
 - ✓ Doing any other action inside the machine enclosure.
- ✓ Use flood or MQL (mist) coolant as required by the machining operation.

1: SAFETY


Tooling

- ✔ Use appropriate speeds, feeds, and cutting parameters for your machine, machine operation, material, and tooling.
- ✔ Use tools and tool holders that are suitable for the current operation.
- ✔ Examine tools for signs of damage. Replace any damaged tools as soon as you find them.
The enclosure and other guards may not stop all types of projectiles, like broken tooling.
- ✘ Never use unbalanced tooling or spindle fixtures.
- ✘ Never use tools that are larger or longer than necessary.
- ✘ Never use tools at speeds above their operational limits.

Workholding

- ✔ Secure workpieces with appropriate workholding devices.
- ✔ Verify that the workpiece is adequately secured.
- ✔ Position clamps and workholding devices clear of any tool paths.
- ✔ Remove cutoff workpieces and other large chips before starting the machine.
- ✘ Never extend an unsupported bar stock past the left end of the spindle bore.
- ✘ Never machine any materials without first securing them to the tailstock.
- ✘ Never operate the machine with the tailstock removed.
- ✘ Never leave tools, stock, or other loose items inside the machine.

1.4.3 Electrical Safety

 **WARNING!** Electrical Shock Hazard: You must power off the machine before making any electrical connections. If you don't, there's a risk of electrocution or shock.

- ✔ Power off the machine before servicing.
- ✔ Use an approved lockout/tagout system to secure the machine's Main Disconnect in the **OFF** position before servicing the machine.
- ✔ Understand that certain electrical components can retain dangerous electrical voltages, even after the machine is powered off and all power is removed from the system.

- ✔ Understand that certain installation, maintenance, and troubleshooting procedures — for the machine and certain accessories — require access to or modification of wiring inside of the electrical cabinet. Only qualified electrical machinery technicians shall perform these procedures.
- ✔ Confirm that the mains voltage conforms to requirements before connecting the machine.
For more information, see "Electrical and Power Requirements" (page 20).
- ✔ Confirm that the machine installation meets all codes and regulations of your locality.
- ✔ Confirm that electrical connections are performed by a certified electrician.
- ✔ Lock the electrical cabinet door and remove the keys when the machine is not being serviced to prevent unqualified or unauthorized personnel from accessing the electrical cabinet.
- ✘ Never operate the machine with the electrical cabinet door open.
- ✘ Never reach into the electrical cabinet with the machine powered on.
- ✘ Never modify the machine's electronics.
- ✘ Never drill into the electrical cabinet.

ABOUT YOUR MACHINE

IN THIS SECTION, YOU'LL LEARN:

- About this machine's specifications.

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2: ABOUT YOUR MACHINE


2.1 SPECIFICATIONS

Travels	
X-Axis	4.5" (114 mm)
Z-Axis	10" (254 mm) with tailstock
Spindle	
Spindle Speed	<ul style="list-style-type: none">• Low 180 rpm to 2500 rpm• High 350 rpm to 5000 rpm
Through Spindle Bore	1" (25 mm)
Maximum Workpiece Length	10" (254 mm) with tailstock
Maximum Feed Rate	
X- and Z-Axis	150 IPM (3.8 m/min)
Tailstock	
Taper	MT2
Diameter	0.9" (22 mm)
Travel	2.2" (55 mm)
Machine Specifications	
Table Length	7.5" (191 mm)
Table Width	4" (102 mm)
Maximum Swing Over Bed	8" (200 mm)
Maximum Swing Over Carriage	4" (100 mm)
Machine Footprint	50" × 26" (1.2 m × 0.7 m)
Overall System Height	52" (1.3 m)
Typical System Weight	838 lb (380 kg)
Power	
Primary Power Required	Single-Phase 115 Vac, 50/60 Hz
Recommended Circuit Amperage	Dedicated Dedicated 15 A breaker

SITE REQUIREMENTS

IN THIS SECTION, YOU'LL LEARN:

- About the site requirements of this machine (including electrical and power requirements).

 Before operating the machine in any way, you must read and understand this section.

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3: SITE REQUIREMENTS


3.1 GENERAL SITE AND SPACE REQUIREMENTS

When choosing a location for your machine, you must verify that it meets all requirements outlined in this section.


3.1.1 Site Requirements

You must verify that the area:

- Allows for unrestricted access to machine controls.
- Conforms to the following:
 - **Primary Power Required** Single-Phase 115 Vac, 50/60 Hz
 - **Recommended Circuit Amperage** Dedicated 15 A breaker

 **Note:** For more information, see "Electrical and Power Requirements" (below).

- Has clean, dry, compressed air.

 **Note:** Compressed air is only required for certain accessories.

- Has one continuous slab sufficient to support the weight of the machine, accessories, and any additional equipment.
- Is a dry, properly ventilated, and well-lit internal space that conforms to the following temperature and humidity requirements:
 - **Operating Temperature Range** 40°F-100°F (5°C-38°C)
 - **Humidity Range** 5%-95% (non-condensing)
- Provides for unobstructed machine motion and operation.

3.1.2 Space Requirements

The area must meet the following space requirements. Allow more space to access the rear of the machine for maintenance and repairs.

- **Machine Size** 50" × 26" (1.2 m × 0.7 m)
- **Machine Height** 52" (1.3 m)

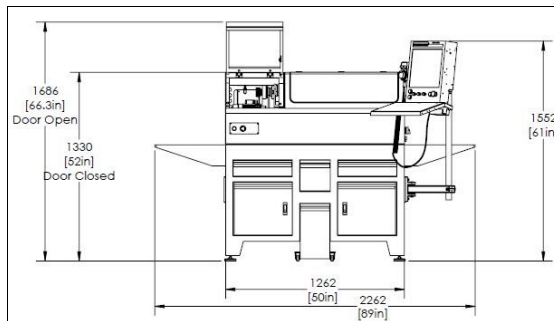


Figure 3-1: Dimensions of the machine itself, as viewed from the front.

- **Typical System Footprint** 89" × 46" (2.3 m × 1.2 m)

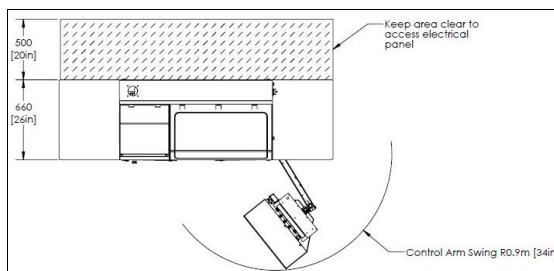


Figure 3-2: Dimensions of the machine and its required added space, as viewed from above.

3.2 ELECTRICAL AND POWER REQUIREMENTS

You must verify that the site conforms to the following electrical and power requirements. If it doesn't, you may consider other options: go to "Options for Non-Conforming Sites" (on the next page).

3.2.1 Electrical Requirements

A certified electrician must make all electrical connections, and it's your responsibility to verify that the electrical installation of the machine meets all local regulations and electrical codes.

- **Primary Power Required** Single-Phase 115 Vac, 50/60 Hz
- **Recommended Circuit Amperage** Dedicated 15 A breaker

3.2.2 Power Requirements

If the site conforms to the electrical requirements, verify that it meets the following power requirements:

- **No Electrical Noise** Primary power must be provided by a dedicated circuit, which must be isolated from electrically-noisy devices like welders or plasma torches. The machine should be isolated from inductive loads from items like vacuum cleaners or air compressors.

- **No Ground Fault Circuit Interrupter** Power for the machine must not be protected by a ground fault circuit interrupter (GFCI), as it interferes with the operation of the variable frequency drive (VFD) spindle controller.
- **Proper Grounding** You must properly ground the power input to the machine. Examine the continuity between bare metal on the machine frame and true earth ground (a water pipe or similar) to verify that it's properly grounded.
- **Correct Plug Pattern** The machine is shipped with a NEMA 5-15P plug, designed for use with a NEMA 5-15R receptacle.

3.2.3 Options for Non-Conforming Sites

For sites that don't conform to the specified "Electrical and Power Requirements" (on the previous page), you may consider the following. You must consult with an electrician to determine the suitability for your site.


- **Step-Down Transformer** Used at sites where 115 Vac service is not possible. You must make sure that the step-down transformer has sufficient capacity to supply the machine, accessories, and any 115 Vac auxiliary equipment. We recommend the [Step-Up/Step-Down Transformer \(PN 32009\)](#).



INSTALLATION

IN THIS SECTION, YOU'LL LEARN:

- About the installation process required for this machine.

 Before operating the machine in any way, you must read and understand this section.

CONTENTS

4.1 Before You Begin	24
4.2 Installation Tools and Items	24
4.3 Move the Pallet	24
4.4 Unpack the Machine Crate	24
4.5 Assemble the Machine Stand	25
4.6 Install Core Components	26
4.7 Install Accessory Components	37
4.8 Set Up the PathPilot Controller	40

4: INSTALLATION

4.1 BEFORE YOU BEGIN

1. Read the packing list to see if there are any items that have not yet been delivered. We recommend waiting until you've received all shipments to begin installing the machine. Depending on the product and options ordered, the system may arrive in one or more shipments of:
 - Accessories (if applicable)
 - Machine



Note: The machine system and large accessories are sent by freight carrier. Smaller accessories may be sent by parcel service.

2. Inspect the item(s):
 - Photograph any damage that may have occurred during shipping.
 - Note any damage on the delivery receipt before signing for the shipment.
 - Verify the received goods against the packing list. If there is any damage or shortages, you must contact Tormach within 30 days of receipt. Create a support ticket with Tormach Technical Support at tormach.com/how-to-submit-a-support-ticket for guidance on how to proceed.

4.2 INSTALLATION TOOLS AND ITEMS

Before uncrating and installing your machine, collect the following tools and items.

- 19 mm socket wrench
- Cardboard piece, large
- Carpenter's level
- Dead-blow hammer (or similar)
- 500-lb capacity engine hoist
- Lifting straps
- Metric hex wrench set
- Pallet jack
- Phillips screwdriver
- Safety eyewear that meets ANSI Z87+
- Snips
- Wood blocks
- Work gloves

4.3 MOVE THE PALLET

Tools and Items Required

- Pallet jack

Shipments arrive in crates loaded on pallets, which the freight carrier unloads onto the curb or loading dock.



WARNING! Transportation and Lift Hazard: Before moving the machine, you must confirm that all persons are clear of the area below the machine. Qualified professionals must transport, lift, and move the machine. Moving parts can entangle, pinch, or cut you, causing death or serious injury.

- Verify that the ground surface is smooth and clean of debris, and then use a pallet jack to move the pallet(s) to the desired installation location.



Note: If the ground is not smooth, you may need to use a forklift (or similar lifting equipment rated for uneven surfaces) to move the pallet(s).

4.4 UNPACK THE MACHINE CRATE

Tools and Items Required


- 19 mm socket wrench
- Phillips screwdriver
- Safety eyewear that meets ANSI Z87+
- Snips
- Wood blocks
- Work gloves



CAUTION! Sharp Objects Hazard: Before opening the shipping crate, you must put on work gloves and safety eyewear that meets ANSI Z87+. If you don't, the shipping crate and steel straps could cut you, causing serious injury.

1. Put on work gloves and eye protection.
2. Cut and remove the steel straps on the shipping crate with snips.

- Remove the screws from the bottom of the crate with a Phillips screwdriver.


 **CAUTION!** Team Lift Required: You must have the aid of more than one person to lift and move the object. The object is heavy, and lifting it by yourself can cause serious injury.

- Before you lift the top of the shipping crate off of the pallet, verify that you have assistance to help you. We recommend lifting it with at least two people.
- Remove the top of the shipping crate and set it aside.
- Remove and discard the plastic wrap from the machine.
- Inspect the item(s):
 - Photograph any damage that may have occurred during shipping.
 - Verify the received goods against the packing list. If there is any damage or shortages, you must contact Tormach within 30 days of receipt. Create a support ticket with Tormach Technical Support at tormach.com/how-to-submit-a-support-ticket for guidance on how to proceed.
- Remove the four bolts from the bottom of the pallet with a 19 mm socket wrench. Discard the bolts.


4.5 ASSEMBLE THE MACHINE STAND

Tools and Items Required


- 19 mm socket wrench
- Cardboard piece, large
- Phillips screwdriver
- Safety eyewear that meets ANSI Z87+
- Work gloves

 **CAUTION!** Sharp Objects Hazard: Before opening the shipping crate, you must put on work gloves and safety eyewear that meets ANSI Z87+. If you don't, the shipping crate and steel straps could cut you, causing serious injury.

- Put on work gloves and eye protection.
- Remove the screws from the bottom of the crate with a Phillips screwdriver.


 **CAUTION!** Team Lift Required: You must have the aid of more than one person to lift and move the object. The object is heavy, and lifting it by yourself can cause serious injury.

- Before you lift the top of the shipping crate off of the pallet, verify that you have assistance to help you. We recommend lifting it with at least two people.
- Remove the top of the shipping crate and set it aside.
- Remove the plastic wrap from the machine stand.
- Inspect the item(s):
 - Photograph any damage that may have occurred during shipping.
 - Verify the received goods against the packing list. If there is any damage or shortages, you must contact Tormach within 30 days of receipt. Create a support ticket with Tormach Technical Support at tormach.com/how-to-submit-a-support-ticket for guidance on how to proceed.
- Remove the coolant tank from the right-hand cabinet of the machine stand, and set it aside.
- The door for the right-hand cabinet is shipped inside the left-hand cabinet. Remove the plastic wrap from the door and install into the right-hand cabinet opening.
- Find the accessory box inside the machine's stand, which includes the legs for the machine's feet assembly. Set it aside for later installation.
- Find the tool box inside the machine's enclosure, which includes the machine's feet, the Ethernet cable, and four M10 lifting eyelets. Remove the machine's feet, and set the tool box aside.
- Remove the four screws securing the machine stand to the pallet with a 19 mm socket wrench.
- To install the machine stand's feet, you must first lay it on its front surface. Put a large piece of cardboard (or similar) on the floor to protect the machine stand.

 **CAUTION!** Team Lift Required: You must have the aid of more than one person to lift and move the object. The object is heavy, and lifting it by yourself can cause serious injury.

4: INSTALLATION

13. Lift the machine stand off of the pallet, and put it on the cardboard.
14. Open the accessory box that you set aside in Step 9, and identify the four legs.
15. Thread one leg into each corner of the machine stand.

 **Note:** You can insert a screwdriver into the holes on the side of the legs to tighten them.

16. Find the four feet that you set aside in Step 10.
17. Thread one foot into each leg, making sure that the leg and foot assembly is 8-1/4 in. tall.

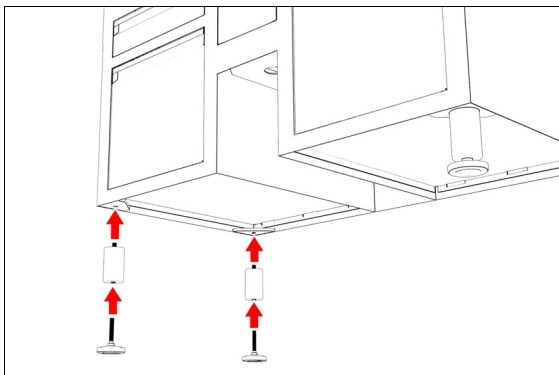



Figure 4-1: Installing the legs and feet onto the machine stand.

 **CAUTION!** Team Lift Required: You must have the aid of more than one person to lift and move the object. The object is heavy, and lifting it by yourself can cause serious injury.

18. Lift the machine stand off of the floor, and set it down onto its feet.

4.6 INSTALL CORE COMPONENTS

After moving and unpacking the machine crate, you must install the core components of the system. Complete the following steps in the order listed:

4.6.1 Lift and Move the Machine	26
4.6.2 Install the Controller Arm	28
4.6.3 Install the Controller	29
4.6.4 Verify the Installation	34

4.6.1 Lift and Move the Machine

Tools and Items Required

- 500-lb capacity engine hoist
- Lifting straps

1. Find the four M10 lifting eyelets provided in the tool box. You'll use them as lifting points to move the machine off of the pallet.
2. Install the two M10 lifting eyelets into each end of the machine by hand in the locations shown in the following image. Verify that the lifting eyelets are installed hand tight.

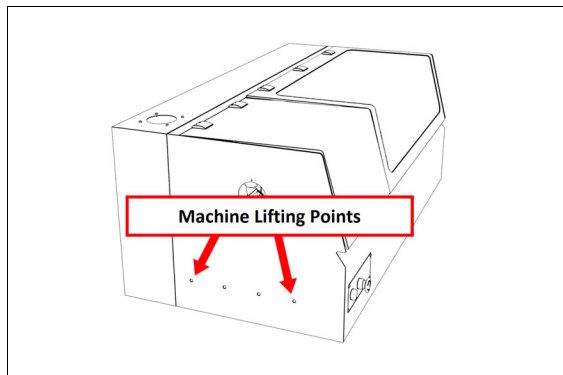



Figure 4-2: Lifting points on the left side of the machine.

 **WARNING!** Transportation and Lift Hazard: Before moving the machine, you must confirm that all persons are clear of the area below the machine. Qualified professionals must transport, lift, and move the machine. Moving parts can entangle, pinch, or cut you, causing death or serious injury.

3. Using lifting straps (not provided) on a 500-lb capacity engine hoist, lift the machine up from the pallet.
4. Depending on where you're installing the machine, do one of the following:
 - **Tormach Machine Stand** Go to "Secure the Machine to the Stand" (on the next page).
 - **500-lb Capacity Workbench** Go to "Secure the Machine to a Workbench" (on the next page).

Secure the Machine to the Stand

1. Remove the drip tray from the bottom of the machine.

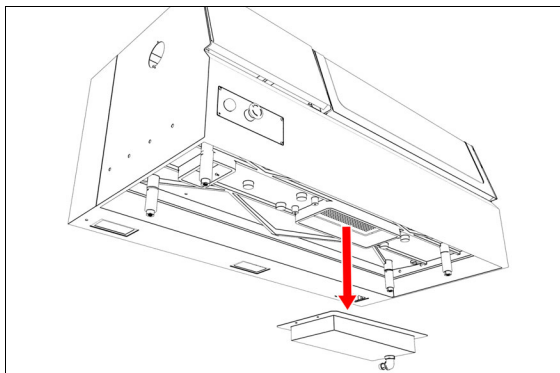


Figure 4-3: Removing the drip tray from the bottom of the machine.

2. Identify the two fixed-length standoffs on the bottom of the machine, and verify that they're tight.
3. Measure the length of the two fixed standoffs. Then, adjust the two adjustable standoffs until they're the same length as the fixed standoffs.
4. Tighten the jam nuts on the two adjustable standoffs with a 19 mm wrench.
5. Identify the four M14 set screws included in the hardware box from the stand.
6. Thread one of the set screws into each of the standoffs on the bottom of the machine. Then, tighten them using a hex key.
7. Identify the coolant tube in the chip basket. Then, attach the coolant tube onto the fitting on the bottom of the machine.

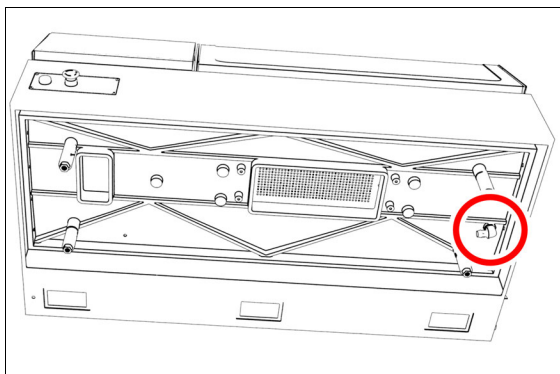


Figure 4-4: Coolant tube fitting on the bottom of the machine.

8. Carefully lower the machine onto the machine stand while routing the coolant tube through the hole in the

middle of the stand.

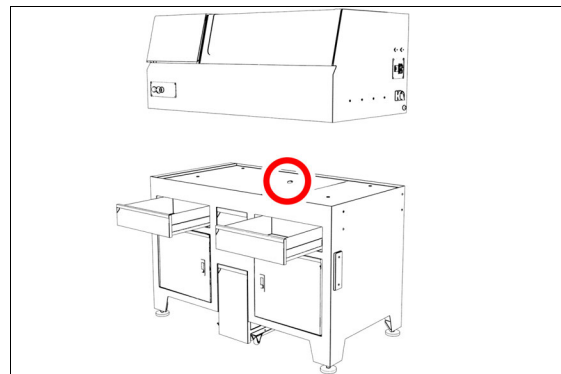



Figure 4-5: Route the coolant tube through the hole in the stand.

9. Remove the four M10 lifting eyelets from the sides of the machine.
 10. Completely open each drawer on the stand. Then, identify the plastic tabs on the drawer slides. Push the tabs up or down to remove the drawer from the drawer slide.
-  **Note:** One tab gets pushed up, and the other pushed down.
11. Install the nuts onto the bolts that secure the machine to the stand.
 12. Use an adjustable wrench to slowly lower the machine by adjusting the feet into the legs. Work your way around the machine, adjusting each foot a little at a time, being careful not to put the machine out of balance. Continue until the threaded rod on the feet is mostly inside the leg, the machine is stable, and the coolant drawer still fits under the stand.

Secure the Machine to a Workbench

1. Remove the risers from the base of the machine.
2. Install the machine feet in place of the risers that you removed in Step 1.

4: INSTALLATION

3. If you're adding flood coolant to your system, attach the coolant tube onto the fitting on the bottom of the machine.

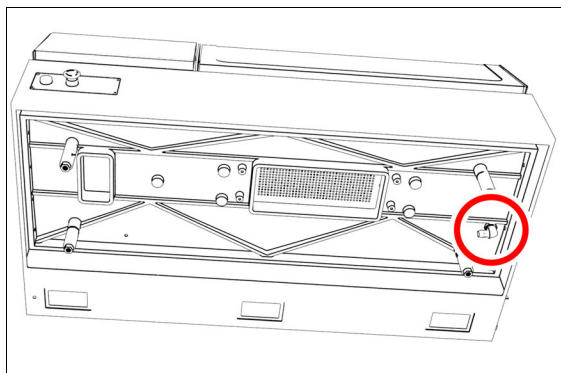


Figure 4-6: Coolant tube fitting on the bottom of the machine.

4. Carefully lower the machine onto the 500-lb capacity workbench.
5. Remove the four M10 lifting eyelets from the sides of the machine.
6. Check the machine to make sure it doesn't rock back and forth.
 - If it moves, you must level the machine on the workbench. Go to Step 7.
 - If it doesn't move, you've completed the steps to secure the machine to the workbench.
7. Identify the access panels on each end of the machine enclosure. Remove the button head cap screws with a 3 mm hex key. Then, set aside the screws and the access cover.
8. Loosen the jam butts on the leveling feet with a 19 mm wrench.
9. Use a wrench to thread the machine feet in or out to level the machine on the work bench.
10. Tighten the jam nuts on the leveling feet with a 19 mm wrench.
11. Use a 3 mm hex key to re-install the screws and access cover that you set aside earlier.

4.6.2 Install the Controller Arm

Tools and Items Required

- 4 mm hex wrench
- 6 mm hex wrench
- 8 mm hex wrench
- 17 mm hex wrench
- 17 mm socket wrench
- 21 mm wrench
- Dead-blow hammer (or similar)
- Phillips screwdriver
- Pry bar

CAUTION! Sharp Objects Hazard: Before opening the shipping crate, you must put on work gloves and safety eyewear that meets ANSI Z87+. If you don't, the shipping crate and steel straps could cut you, causing serious injury.

1. Put on work gloves and eye protection.
2. Open the Controller Arm crate with a pry bar.
3. Find the mounting pad on the machine stand.



Figure 4-7: Controller Arm mounting pad.

- Secure the square tube arm to the machine stand with two M8 socket head cap screws, two M8 flat washers, two M8 lock washers, and a 6 mm hex wrench. Verify that the white nylon washer is located toward the bottom of the mounting pad.

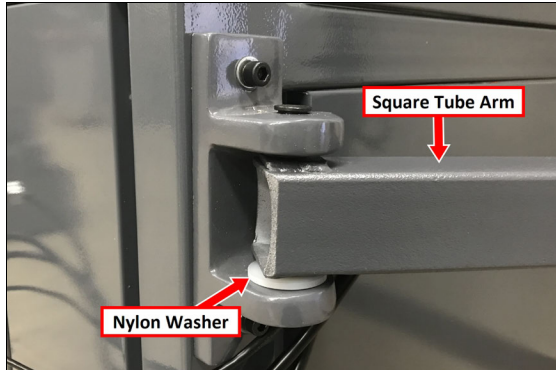


Figure 4-8: White nylon washer on the square tube arm.

- Put the monitor post into the square tube arm. Verify that the monitor bracket is toward the top, and that the threaded holes face the holes in the square tube arm.
- Tighten the cross bolt on the square tube arm with a 17 mm socket wrench and a 17 mm hex wrench.
- With a 21 mm wrench, remove the monitor bracket from the Controller Arm, and rotate it so that the largest mounting plate is facing up.

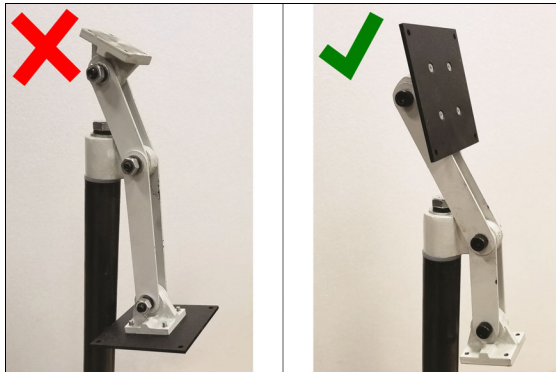


Figure 4-9: Incorrect and correct orientations of the monitor bracket on the Controller Arm.



Note: The largest mounting plate is for the monitor, and the smallest mounting plate is for the keyboard tray.

- Tighten the three pivot bolts on the monitor bracket with an 8 mm hex wrench and a 16 mm wrench.



Figure 4-10: Tightening the monitor bracket in place.



Tip! This makes it easier to install the monitor, which you'll do later in this installation procedure.

- Tap the end plug into the square tube arm with a dead-blow hammer (or similar).
- Secure the keyboard table to the monitor bracket with four M5 socket head cap screws, four M5 flat washers, four M5 split lock washers, and a 4 mm hex wrench.
- Attach four wire tie mounts to the monitor post with four 4 mm flat head machine screws and a Phillips screwdriver.

4.6.3 Install the Controller

Depending on your machine configuration, do one of the following:

- If You Have a PathPilot Controller** Go to "Install the Monitor" (page 32).
- If you have a PathPilot Operator Console** Go to "Install the PathPilot Operator Console" (on the next page).

4: INSTALLATION

Install the PathPilot Operator Console

Tools and Items Required

- 16 mm wrench
- Metric hex wrench set
- Phillips screwdriver

1. Put the operator console against the monitor mounting plate and align the holes. Attach the operator console and monitor mounting plate together with four M4 × 12 mm socket head cap screws (provided with the operator console).

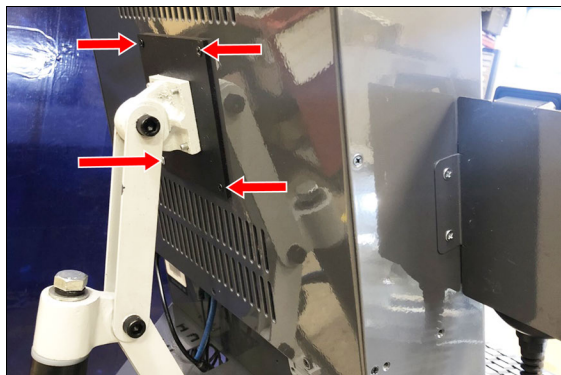


Figure 4-11: Operator console attached to the monitor mounting plate.

2. Attach the keyboard tray to the lower controller arm mount with an 8 mm hex wrench.

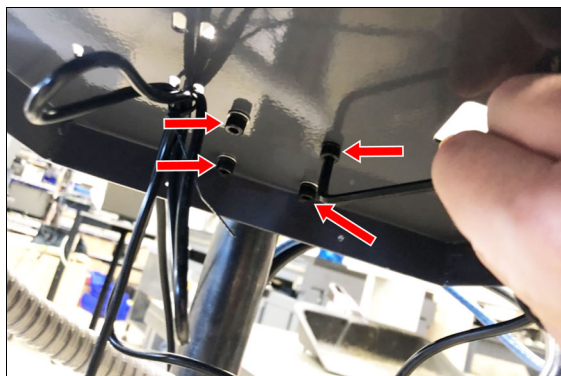


Figure 4-12: Attaching the keyboard tray to the lower controller arm mount (from below).

3. Adjust the operator console and the keyboard tray so that the two holes on the underside of the operator console line up with the holes on the keyboard tray.
4. Attach the keyboard tray to the operator console with two M3 Phillips screws (provided in the controller box) and a Phillips screwdriver.

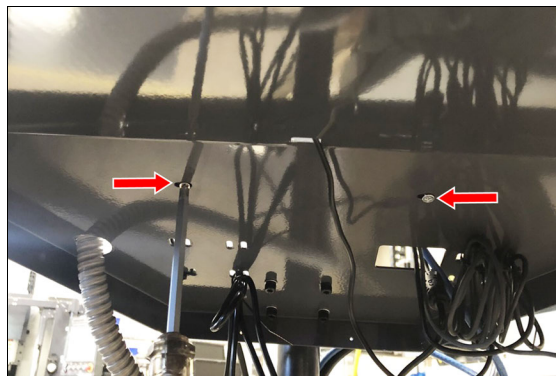


Figure 4-13: Attaching the keyboard tray to the operator console (from below).

5. Put the operator console's power supply into the power supply bracket (provided in the operator console box), and attach the assembly to the underside of the keyboard tray with M3 Phillips screws and a Phillips screwdriver.

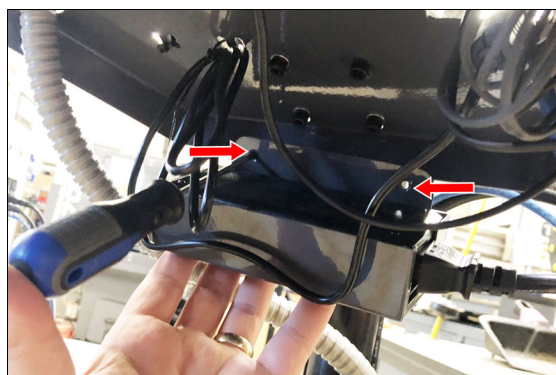


Figure 4-14: Attaching the operator console's power supply and power supply bracket to the keyboard tray (from below).

6. Connect the 12 ft power cable to the power supply.
7. Use the three pivot bolts on the controller arm monitor bracket to adjust the position of the operator console and the keyboard tray to your desired angle with a 3 mm hex wrench and 16 mm hex wrench.
8. If you have any of the following optional USB accessories, connect them to any **USB** port on the operator console:
 - Keyboard
 - Mouse
9. Connect the WiFi dongle to any **USB** port on the operator console.
10. Connect the Ethernet cable to the **Ethernet** port on the operator console.

11. Connect the barrel end of the power supply cable to the **Power Supply** port on the operator console.

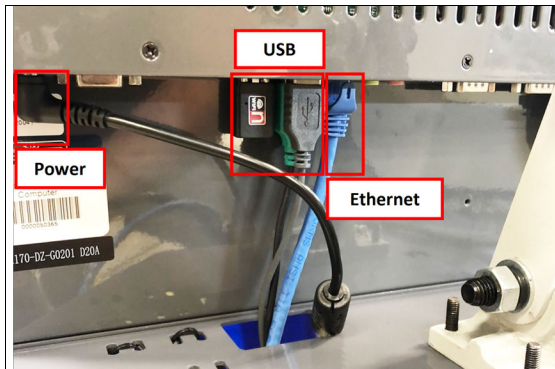


Figure 4-15: USB accessories connected.

12. Route the loose ends of the USB, Ethernet, and power supply cables through the square hole in the keyboard tray. Then, use the cable tie holes to secure the loose power supply and USB cables.

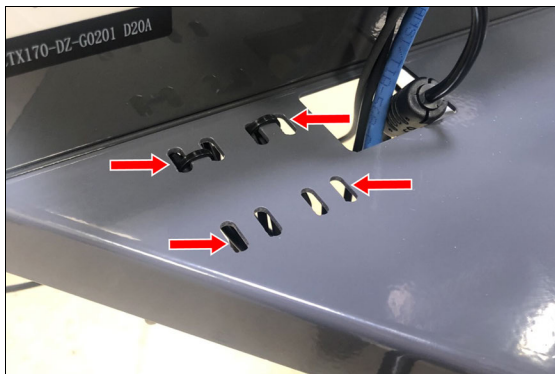


Figure 4-16: Cable tie holes.



Tip! If you're using a mouse, we recommend leaving some slack for it to move freely.

13. Connect the jog pendant cable and the Emergency Stop cable to the operator console. Route the loose end of the Emergency Stop cable through the round hole in the keyboard tray.

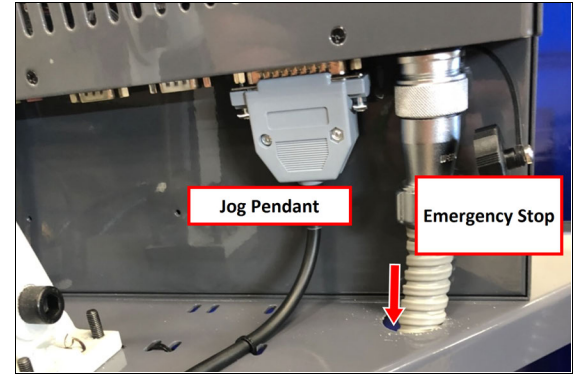


Figure 4-17: Jog pendant (left) and Emergency Stop (right) cables connected.

14. Route the loose end of the operator console's 12 ft power cable, the Emergency Stop cable, and the Ethernet cable down the controller arm. Then, route the cables through the slots in the square tube arm that's connected to the machine stand.
15. On the right side of the machine, connect the loose ends of the cables as follows:
 - a. Connect the operator console's power cable to any of the **Accessory** power outlets.
 - b. Connect the Ethernet cable to the **Controller Communications** port.
 - c. Connect the Emergency Stop cable to the **Emergency Stop** port.
16. Secure the cables to the wire tie mounts that you installed on the round monitor post with four 4 in. cable ties.



WARNING! Electrical Shock Hazard: You must power off the machine before making any electrical connections. If you don't, there's a risk of electrocution or shock.

17. Open the electrical cabinet door.

4: INSTALLATION

18. In the electrical cabinet, identify the jumper wire labeled **Remove to Install Console**, and remove it from the machine.

WARNING! You must move the jumper from the machine. If the jumper isn't removed, the console's Emergency Stop button won't function.

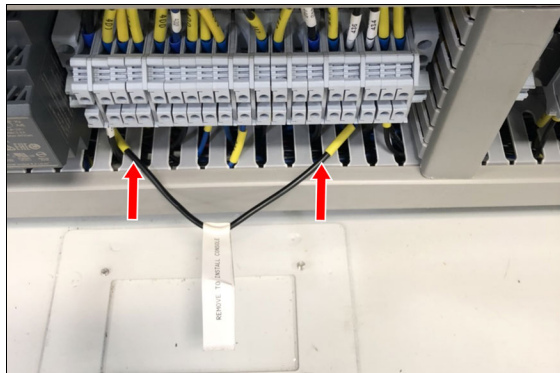


Figure 4-18: Jumper wire labeled **Remove to Install Console**.

19. Verify that the terminals are securely screwed down after removing the jumper wire.
20. Close the electrical cabinet door.

Install the Monitor

Tools and Items Required

- 3 mm hex wrench
- 8 mm hex wrench
- 16 mm wrench
- [PathPilot Controller VESA Mount \(PN 50382\)](#)

The PathPilot controller mount allows you to install the PathPilot controller behind the monitor (which is attached to the Controller Arm).



Note: If you're using a [Touch Screen Kit \(PN 35575\)](#), you must first remove the stock mounting bracket from the back of the monitor.

1. Put the [PathPilot Controller VESA Mount \(PN 50382\)](#) against the monitor mounting plate. Then, put the monitor on the other side of the PathPilot controller mount, and align the holes on the three components.
2. Attach the monitor, PathPilot Controller VESA Mount,

and monitor mounting plate together with four M4 × 12 mm socket head cap screws (provided with the PathPilot Controller VESA Mount).

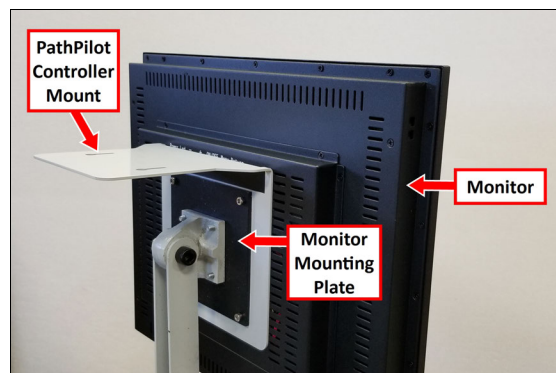


Figure 4-19: PathPilot controller mount attached to the back of the monitor.

3. Adjust the position of the monitor and the keyboard tray with an 8 mm hex wrench and a 16 mm wrench. Once complete, securely tighten the pivot screws.

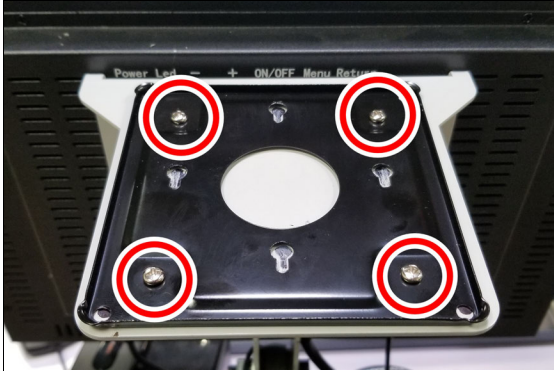
Install the PathPilot Controller

The PathPilot controller attaches to the top of the PathPilot Controller VESA Mount and behind the monitor.

1. Put four standoffs into the controller and tighten them by hand.



2. Find the four M4 screws and the VESA plate included with the controller. Then, mount the VESA plate to the PathPilot Controller VESA Mount (PN 50382). Make sure to put it flat side down with the keyholes toward the monitor.



3. Attach the controller to its mount by sliding the standoffs through the key slots.



4. Connect all USB accessories to the controller:
 - Jog Shuttle (PN 30616) (Optional)
 - Keyboard
 - Mouse
 - Monitor
5. Connect the monitor's video cable to the PathPilot controller.
6. Connect the loose end of the video cable to the monitor.
7. Connect the monitor's power cord. Depending on the type of monitor you have, do one of the following:
 - **Standard LCD Monitor (PN 30615)**
 - a. Connect two of the **Controller/Monitor** cables (provided in the machine owner's kit) together. Then, connect one end of the cable assembly into the monitor.

- b. Route the loose end of the cable assembly down the monitor post, through the square tube arm, and toward the electrical cabinet.
- c. Connect the cable assembly into one of the Accessory Power Ports.

- **Touch Screen Kit (PN 35575)**

- a. Connect the monitor's power supply into the monitor.
 - b. Route the power supply down the monitor post.
 - c. Connect one end of one **Controller/Monitor** cable (provided in the machine owner's kit) to the loose end of the monitor's power supply.
 - d. Route the loose end of the **Controller/Monitor** cable through the square tube arm and toward the electrical cabinet.
 - e. Connect the loose end of the **Controller/Monitor** cable into one of the Accessory Power Ports.
 - f. Attach the power supply to the monitor post with one cable tie (provided in the machine owner's kit).
8. Connect the PathPilot controller's power supply to the PathPilot controller.
 9. Connect the loose end of the power supply to one of the **Controller/Monitor** cables provided.
 10. Route the power cable down the monitor post, through the square tube arm, and toward the electrical cabinet.
 11. Connect the loose end of the **Controller/Monitor** cable into one of the Accessory Power Ports.
 12. Attach the PathPilot controller and monitor power supplies to the square tube arm with cable ties (provided in the machine owner's kit).

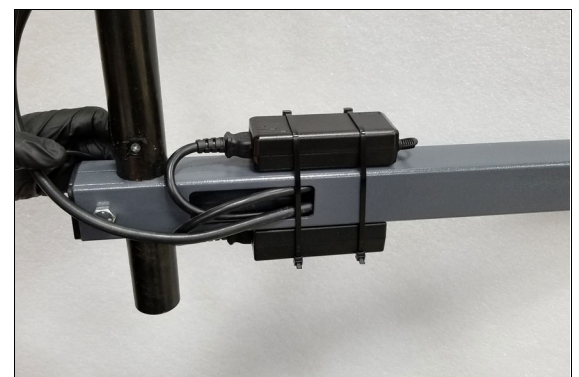


Figure 4-20: Power supply attached to the square tube arm.

4: INSTALLATION

13. Find the Ethernet cable (provided in the tool box), and then connect it to the Controller Communications outlet.
14. Route the loose end of the Ethernet cable toward the PathPilot controller, and then connect it to the PathPilot controller.
15. Secure the operator box cable, Ethernet cable, and power supply cables to the Controller Arm with four wire tie mounts and four cable ties.

4.6.4 Verify the Installation

After installing the base machine, you must verify the installation. Complete the following steps in the order listed:

Power On the Machine	34
Power Off the Machine	35
Verify Limit Switch Function	36
Verify Axes Function	36
Verify Spindle Function	36

Power On the Machine

1. Use a multimeter to verify that the electrical service in your location meets the following requirements. If your location does not meet these requirements, do not install the machine. Instead, you must consult with a local electrician about your options.
 - **Primary Power Required** Single-Phase 115 Vac, 50/60 Hz
 - **Recommended Circuit Amperage** Dedicated 15 A breaker
2. Connect the machine's mains power cable to the verified electrical service.
3. Find the Main Disconnect switch, and then remove the hang tag (if present).



Figure 4-21: The Main Disconnect switch on the side of the machine's electrical cabinet.

4. Turn the Main Disconnect switch to **ON**.

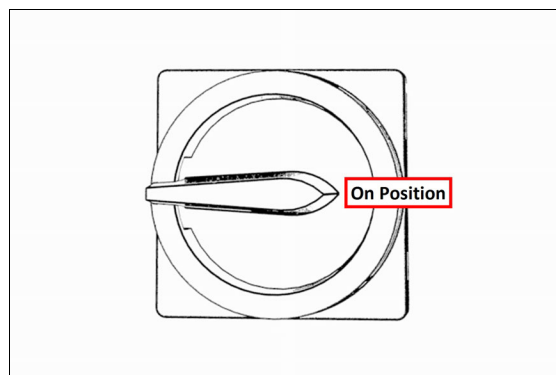


Figure 4-22: Example of the Main Disconnect switch in the On position.

Mains power is now connected to the machine.

5. Push the Power button on the PathPilot controller, if it's not already powered on.
 6. Push the Power button on the monitor, if it's not already powered on.
 7. On the **Tormach Machine Configuration** screen, verify that the version displayed in the lower right-hand corner is at least v2.7.0. If the version is older (or if no version is displayed), select **Update**.
 8. Follow the on-screen instructions to configure the PathPilot operating system and PathPilot controller. When configuration is complete, the PathPilot operating system launches.
- Note:** After you first configure PathPilot, the operating system automatically launches whenever it's powered on.
9. Depending on which monitor you have, do one of the following:
 - a. **Standard Monitor** Go to the next step.
 - b. **Touch Screen Monitor** You must first make sure that the monitor is configured and calibrated. From the PathPilot interface, in the **MDI Line DRO** field, type `ADMIN TOUCHSCREEN`. Then, select the **Enter** key, and follow the on-screen instructions.

10. Rotate the Emergency Stop button on the operator box one-quarter turn clockwise to release it.



Figure 4-23: The Emergency Stop button on the operator box.

11. Push the blue Reset button to enable the machine.



Figure 4-24: The Reset button on the operator box.

The axis drives are now powered on.

12. Verify that the blue Reset LED on the operator box comes on. From the PathPilot interface, on the **Status** tab, verify that the **Machine OK** light changes from yellow to green. Once both are on, the machine is powered on and ready to operate.

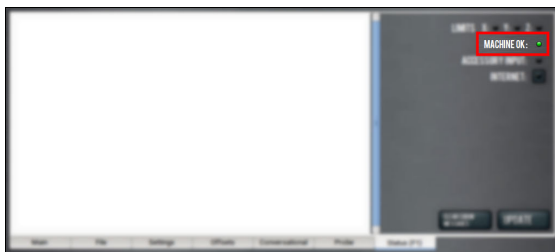


Figure 4-25: Machine OK light on the Status tab.

13. Select **Reset**.



Figure 4-26: Reset button.

Power Off the Machine

1. Push the Emergency Stop button on the operator box to lock it into the disabled position.

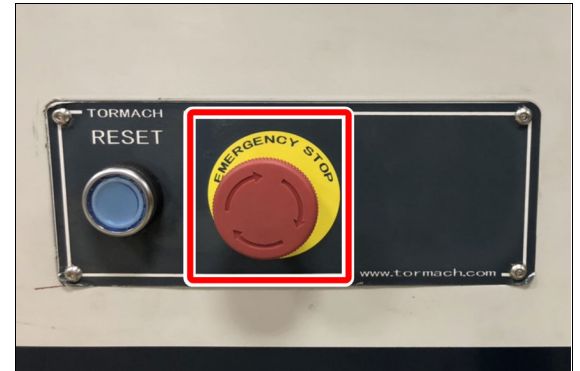


Figure 4-27: Example of the Emergency Stop button locked in the disabled position.

With the Emergency Stop button in the disabled position all motion and spindle function stops, and the Reset button is disabled. On the operator box, the blue Reset LED goes off. From the PathPilot interface, on the **Status** tab, the **Machine OK** light illuminates yellow.

2. From the PathPilot interface, select **Exit**.
3. When prompted, select **OK**.
4. Once the PathPilot interface indicates that it's safe to power off the machine, turn the Main Disconnect switch to **OFF**.

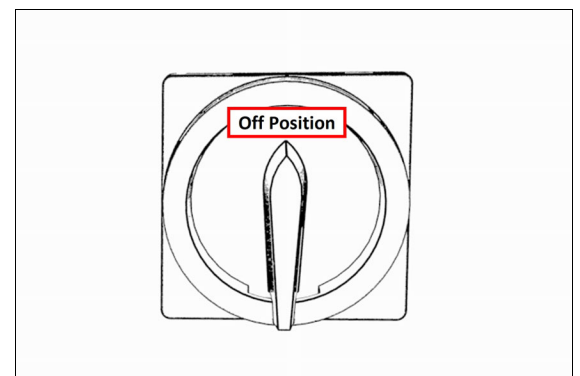


Figure 4-28: Example of the Main Disconnect switch in the Off position.

Mains power is disconnected from the machine.

4: INSTALLATION

Verify Limit Switch Function

You must confirm that the limit switches correctly operate.

1. Power on the machine and the PathPilot controller.
 - a. Turn the Main Disconnect switch to **ON** on the side of the electrical cabinet.
 - b. Twist out the machine's red Emergency Stop button, which enables movement to the machine axes and the spindle.
 - c. Press the Reset button.
2. From the PathPilot interface, on the **Status** tab, identify the **Limits** light.

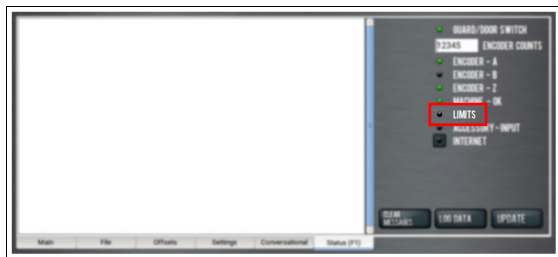


Figure 4-29: Limits light on the Status tab.

3. Hold a piece of steel (like a screwdriver or a wrench) up to each limit switch.

The red light on each limit switch is on until the steel is within sensing range, at which point the red light dims or turns off.

From the PathPilot interface, on the **Status** tab, the **Limits** light comes on.

4. From the PathPilot interface, select **Reset**.

Verify Axes Function

You must confirm that the axes correctly operate.

1. Power on the machine and bring it out of Reset.
2. Reference the axes: from the PathPilot interface, select **Ref Z**, **Ref X**.



Figure 4-30: Ref Z, Ref X, and Ref Y buttons.

The machine moves to the reference position.

3. Use the keyboard to verify axes motion:
 - Select the **Up Arrow** key and then the **Down Arrow** key.

The carriage moves away from you (X+), then toward you (X-).

- Select the **Right Arrow** key and then the **Left Arrow** key.

The carriage moves right (Z+), then left (Z-).

4. If applicable, verify the optional Jog Shuttle:

- Press any axis button on the Jog Shuttle — **X**, **Y**, **Z**, or **A** — to select an axis.

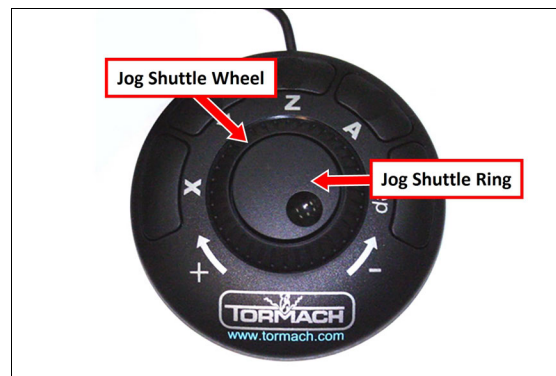


Figure 4-31: Functions on the optional Jog Shuttle.

From the PathPilot interface, on the **Main** tab, the corresponding green **Axis** light comes on.

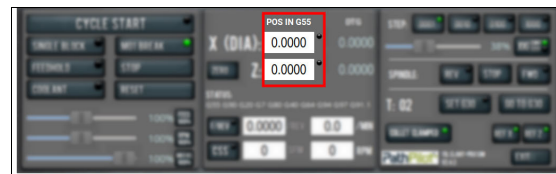


Figure 4-32: Axis lights.

- Turn the **Jog Shuttle Ring** in any direction to move the selected axis, then turn it in the opposite direction to reverse the direction.



Note: On this machine, two of the axis selection buttons — Y-axis and A-axis — won't result in any motion if selected.

Verify Spindle Function

You must confirm that the spindle correctly operates.

1. From the PathPilot interface, confirm that the **Spindle Override** slider isn't set to 0% (when it's set to 0%, the slider is yellow). To clear the override, select **RPM 100%**.



Figure 4-33: Spindle Override slider.



Note: The **Spindle Override** slider changes the programmed spindle speed by a specific percentage. If it's set to 0%, the spindle won't move during the following steps in this procedure. For information, see About Spindle Override.

- From the PathPilot interface, in the **RPM DRO** field, type 180. Then select the **Enter** key.
- Select **FWD**.

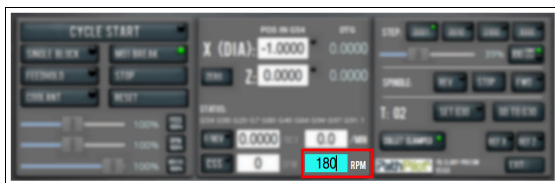


Figure 4-34: Spindle controls.

The spindle rotates clockwise at 180 rpm.

- Examine the spindle direction: verify that it's rotating counterclockwise, as shown in the following image.



Figure 4-35: Spindle rotating counterclockwise, in the correct forward direction.

- Select **STOP**.
The spindle stops rotating.
- Select **REV**.
The spindle rotates clockwise at 180 rpm.
- Examine the spindle direction: verify that it's rotating clockwise, as shown in the following image.

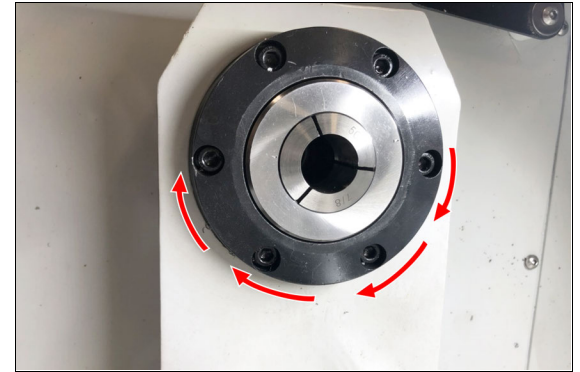


Figure 4-36: Spindle rotating clockwise, in the correct reverse direction.

- Select **Stop**.
The spindle stops rotating.

4.7 INSTALL ACCESSORY COMPONENTS

Install accessory components in the order specified, skipping any components that you don't have.

When you're finished installing accessory components, go to "Set Up the PathPilot Controller" (page 40).

4.7.1 Install the Quick Change Tool Post Kit.....	37
4.7.2 Install the Machine Stand Coolant Kit (PN 50931)....	40

4.7.1 Install the Quick Change Tool Post Kit

Complete the following steps in the order listed:

Required Tools.....	37
Install the Quick Change Tool Holder.....	37
Install the Tool into the Quick Change Tool Holder.....	38
Align the Tool.....	39

Required Tools

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

- Adjustable wrench
- Dead-blow hammer
- Magnetic dial test indicator
- Metric hex wrench set
- Rust preventative

Install the Quick Change Tool Holder



Note: If the quick-change tool post is already installed on your machine, skip this section and go to the next.

4: INSTALLATION

1. Remove the mounting block from the bottom of the tool post, and discard it.
2. Examine the surface of the machine's carriage and the mounting plate for burrs, grit, or dirt.
3. Use a machinist's stone to remove any burrs.
4. Use a rust preventative (like WD40® or similar) on the surfaces.
5. Attach the tool post with the tool post stud, and hand tighten the nut on top.



Figure 4-37: Tool post installed.

Install the Tool into the Quick Change Tool Holder

1. Find a tool and its equivalent tool holder, and put the tool into the tool holder. Lock the tool into the tool holder: with the tool pointing toward you, tighten the hex head screws.

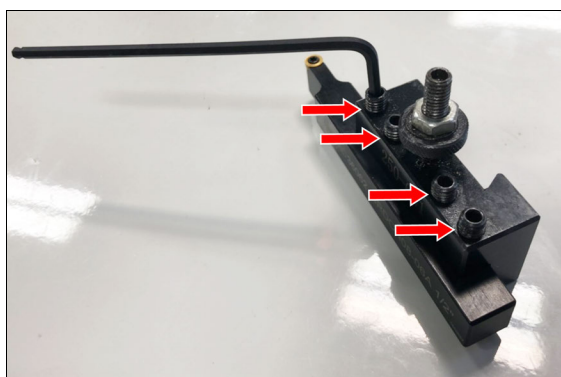


Figure 4-38: A tool with its equivalent tool holder.

2. Set the rough tool height by adjusting the thumb screw. Then, secure it in place with the stop nut. You'll make fine adjustments later in this procedure to bring the tool plane on center with the spindle.

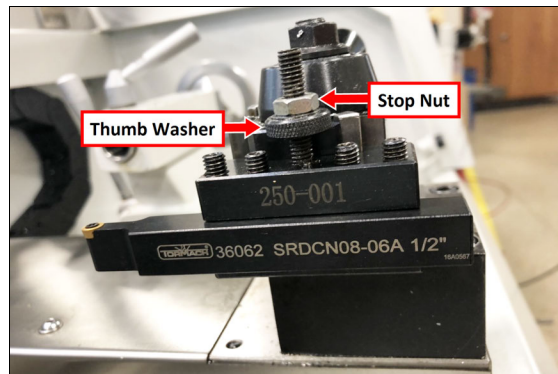


Figure 4-39: Adjustment components on the tool holder.

3. To attach the tool holder, the tool post must be in the unlocked position: move the tool post handle up.

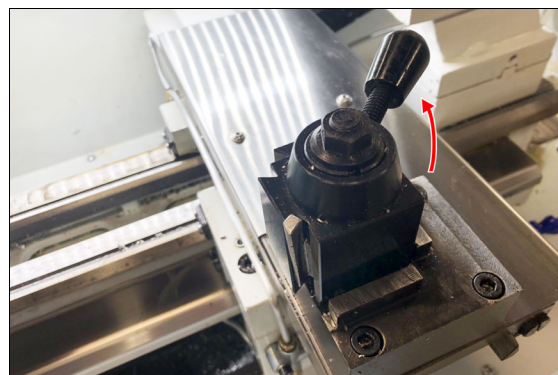


Figure 4-40: Quick change tool post positions.

4. Put the tool holder onto the tool post, and then move the tool post handle down to the locked position.
5. Before operating the machine, you must make sure that the quick change tool holder is aligned. Go to "Align the Tool" (on the next page).

To Use a Boring Bar

1. To attach the tool holder, the tool post must be in the unlocked position: move the tool post handle up.
2. Put the tool into the boring bar holder.
3. Put the tool holder onto the tool post, and then move the tool post handle down to the locked position.

4. Lock the tool into the tool holder: tighten its two hex head screws.

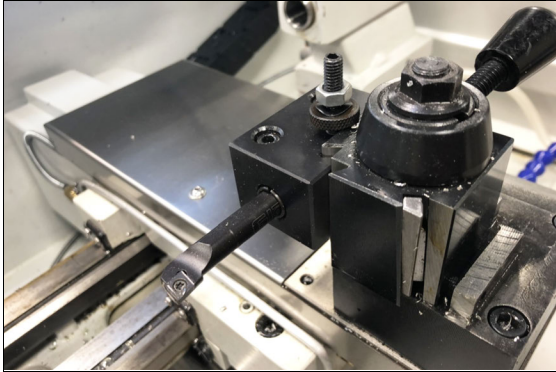


Figure 4-41: Boring bar installed in a boring bar tool holder.



Tip! When you remove the tool, loosen the hex head screws, and gently tap them with a dead-blow hammer.

Align the Tool

1. Attach a magnetic dial test indicator to the spindle.
2. Put the indicator tip on the face of the tool holder.



Figure 4-42: Magnetic dial test indicator on the face of the tool holder.

3. Power on the machine and the PathPilot controller.
 - a. Turn the Main Disconnect switch to **ON** on the side of the electrical cabinet.
 - b. Twist out the machine's red Emergency Stop button, which enables movement to the machine axes and the spindle.
 - c. Press the Reset button.
 - d. Bring the machine out of reset and reference it.

4. Slowly jog the machine along the X-axis to move the indicator tip along the face of the tool.
5. Adjust the quick change tool post alignment as necessary: use a 3 mm hex wrench to adjust the two set screws on the front and right sides of the quick change tool post risers to clock the tool post until the indicator reads zero.

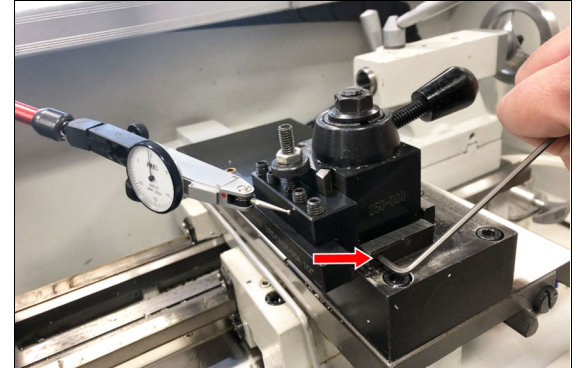


Figure 4-43: Aligning the quick change tool post.

6. Securely tighten the tool post nut with an adjustable wrench.



Figure 4-44: Tool post nut securely tightened with an adjustable wrench.

7. Repeat Steps 4 through 5 to make sure that the tool post is still correctly aligned after tightening the tool post nut.

4: INSTALLATION

4.7.2 Install the Machine Stand Coolant Kit (PN 50931)

1. Because the coolant pump is dual voltage, you must verify that the motor strapping is correct before you install it:
 - a. Remove the access cover on the coolant pump, and then identify the jumper configuration diagram.



Figure 4-45: Coolant pump motor jumper configuration diagram.

- b. Verify that the jumpers are in the correct configuration (120 Vac or low volt) for your installation. If necessary, adjust the configuration. Go to "Adjust the Coolant Pump Motor Strapping" (below).
2. Remove the four M8 socket head cap screws pre-installed on the coolant tank. Set the screws aside.
 3. Put the coolant pump into the coolant tank, and secure it with the four socket head cap screws that you set aside in Step 2.
 4. Attach the provided 90° push-to-connect fitting to the coolant pump.
 5. Find the coolant tube, which you routed through the machine stand earlier. Attach the loose end of the coolant tube to the push-to-connect fitting on the coolant pump.
 6. Route the power cord on the coolant pump to the right side of the machine, and connect it to the Coolant Pump Power outlet.
 7. Verify that the coolant setup operates properly:
 - a. From the PathPilot interface, on the **Main** tab, select **Coolant**.
The coolant pump powers on.

- b. Select **Coolant** again.
The coolant pump powers off.

Adjust the Coolant Pump Motor Strapping

Because the coolant pump is dual voltage, you may need to adjust the motor strapping.

1. Identify the jumper configuration diagram.



Figure 4-46: Coolant pump motor jumper configuration diagram.

2. Remove the access cover on the coolant pump.
3. Reference the configuration diagram and move the jumper to the 120 Vac (low volt) position. Don't change the position of any wires – just the jumper that connects the terminals.

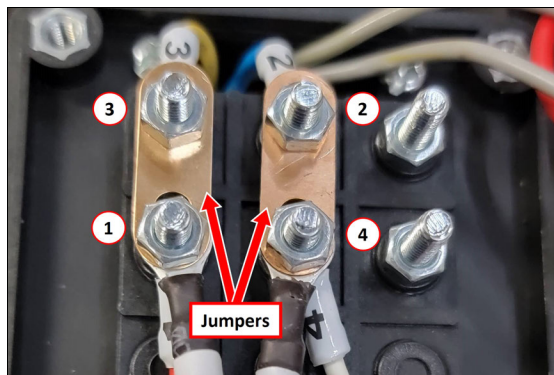


Figure 4-47: Coolant pump motor strapping adjusted for 120 Vac.

4. Reinstall the access cover on the coolant pump.

4.8 SET UP THE PATHPILOT CONTROLLER

Before operating your machine, configure in PathPilot the date, time, keyboard language, and — if applicable — the optional Touch Screen Kit (PN 35575).

4.8.1 Specify the Date and Time

1. From the PathPilot interface, on the **Main** tab, in the **MDI Line DRO** field, type `ADMIN DATE`. Then select the

Enter key.

The **Time and Date Settings** dialog box displays.

2. Complete the fields in the **Time and Date Settings** dialog box, and then select **Close**.

4.8.2 Specify the Keyboard Language

By default, the keyboard language is set to English.

To specify a different keyboard language:

1. From the PathPilot interface, on the **Main** tab, in the **MDI Line** DRO field, type `ADMIN KEYBOARD`. Then select the **Enter** key.
The **Keyboard Preferences** dialog box displays.
2. Select the **Layouts** tab and select the desired language.
If the language you want is not listed, select **Add** to specify the language. Then, select **Close**.

4.8.3 Configure the Optional Touch Screen Kit

Before using a touch screen, you must make sure that it's configured and calibrated. To calibrate it:

1. From the PathPilot interface, on the **Main** tab, in the **MDI Line** DRO field, type `ADMIN TOUCHSCREEN`. Then select the **Enter** key.
2. Follow the on-screen instructions.

4.8.4 Update PathPilot

We're constantly updating PathPilot to bring you more features. Before operating your machine, update to the latest version.


- From the **Status** tab, select **Update**.



SYSTEM BASICS

IN THIS SECTION, YOU'LL LEARN:

- About the main components of the machine and how it moves.

 Before operating the machine in any way, you must read and understand this section.

CONTENTS

5.1 System Reference.....	44
5.2 Basic Controls Reference.....	44

5: SYSTEM BASICS

5.1 SYSTEM REFERENCE

To operate your machine, you must become familiar with the components of its system.

5.1.1 Spindle

The machine uses a native 5C taper for precision turning of stock less than 1.125 in. in diameter.

- **Spindle Power** 1.5 hp (1.11 kW)
- **Spindle Speed** Two spindle ranges with speeds from 180 to 5,000 rpm

About the Spindle

The machine spindle rotates the workpiece, which is then machined upon by a cutting tool to remove material. The spindle is driven by the spindle motor.

Operate the spindle either manually or by G-code commands (entered in the MDI Line DRO field or programmed into a G-code program).

The machine's spindle rotates either clockwise (forward) or counterclockwise (reverse) at a specified spindle speed.

5.1.2 Axes

The machine has two linear axes of motion used for machining:

- The Z-axis, which is parallel to rotational axis of the spindle.
The -Z direction is toward the headstock, and the +Z direction is opposite the headstock (toward the tailstock).
- The X-axis, which is perpendicular to the Z-axis and nominally parallel to the long dimension of the carriage.
The +X direction is toward the front, and -X direction is toward the rear.
- **X-Axis** 4.5" (114 mm)
- **Z-Axis** 10" (254 mm) with tailstock

5.2 BASIC CONTROLS REFERENCE

To safely and effectively operate your machine, you must become familiar with how it moves. The machine has two forms of basic controls: machine controls and the PathPilot interface.

5.2.1 Machine Controls

The following controls energize the machine's control electronics:

- The Main Disconnect switch, located on the right side of the electrical cabinet.
The Main Disconnect switch has two positions: **OFF** and **ON**. When it's in the **OFF** position, it separates the other machine control electronics from the mains electrical supply. When it's in the **ON** position, the other machine control electronics are able to receive power.



WARNING! Before opening the electrical cabinet for maintenance or troubleshooting, you must lockout the mains power: Turn the Main Disconnect switch to the **OFF** position, and secure an approved lockout device through the lockout rings at the bottom of the switch.

- The operator panel — which contains the Reset button and the Emergency Stop button — located on the front left side of the base of the machine.
When pushed in, the Emergency Stop button interrupts power to the spindle and axis drives, and stops the machine's motion. When the Emergency Stop button is twisted out, press the blue Reset button to enable the machine, allowing spindle and axis motion. The Reset button's LED turns on when the machine is enabled and the spindle and axis drives receive power.

5.2.2 PathPilot Interface

PathPilot is the primary means by which you interact with your machine. PathPilot controls all of the automatic motion of the machine axes and spindle, as well as some accessories. The PathPilot control system consists of one of the following:

- Controller Arm
 - Controller
 - *(Optional)* Jog Shuttle
 - Keyboard
 - Monitor or *(Optional)* Touch Screen Kit
 - Mouse
- Operator Console
 - Console (with integrated touch screen)
 - *(Optional)* Keyboard
 - *(Optional)* Mouse
 - Jog pendant

BASIC OPERATIONS

IN THIS SECTION, YOU'LL LEARN:

- About the basic operations required for most projects, organized as a suggested project workflow.

CONTENTS

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6.9 Set Tool Geometry Offsets.....	52
6.10 Operate the Coolant Pump.....	54

6: BASIC OPERATIONS

6.1 START THE MACHINE

Power on the machine and the PathPilot controller.

1. Turn the Main Disconnect switch to **ON** on the side of the electrical cabinet.
2. Twist out the machine's red Emergency Stop button, which enables movement to the machine axes and the spindle.
3. Press the Reset button.

6.2 BRING THE MACHINE OUT OF RESET

- Select **Reset**.



Figure 6-1: Reset button.

For more information on reset mode, see "About Reset Mode" (below).

6.2.1 About Reset Mode

When the machine is first powered on, or after an emergency stop, the Reset button flashes. When you select the flashing Reset button, PathPilot verifies communication to the machine and does the following activities:

- Brings the machine out of an emergency stop condition
- Clears alarms
- Clears the tool path backplot
- Resets all modal G-codes to their normal state
- Rewinds the currently loaded G-code program
- Stops machine motion, but is **not** a replacement for the Emergency Stop button

You can select the Reset button any time while the machine is on.

6.3 REFERENCE THE MACHINE

1. Verify that the machine can freely move to its reference position (at the ends of travel).
2. To verify that the tooling is clear of any possible obstructions, reference the Z-axis before referencing the other axes: from the PathPilot interface, select **Ref Z**.



Figure 6-2: Reference buttons.

3. Once the spindle is clear of any possible obstructions, continue referencing all axes.



Note: You can select the buttons one after another. Once the machine references one axis, it'll move on to the next.

After each axis is referenced, its button light comes on.

For more information on referencing the machine, see "About Referencing" (below).

6.3.1 About Referencing

You must reference the machine to establish a known position for PathPilot. The position that's set while referencing the machine is the origin of the machine coordinate system. Without referencing the machine, PathPilot won't know the current position of the machine axes.

You must reference the machine at the following times:

- After you power on the machine
- After you push in the Emergency Stop button
- Before running a G-code program
- Before using MDI commands
- Before setting work or tool offsets
- After a collision or an axis stall/fault

When referencing, the machine moves each axis to the end of its travel. The machine stops at the limit switch, which sets the axis' reference position.

6.4 JOG THE MACHINE

To switch between jogging modes:

- From the **Manual Control** area, in the **Jog** group, select **Jog**.

PathPilot toggles between continuous velocity mode and step mode.

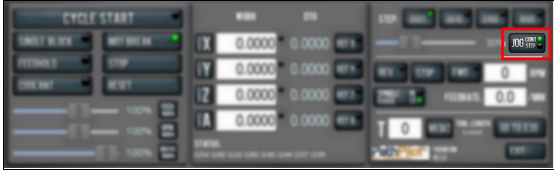


Figure 6-3: Jog button.

When the **Cont** green light is on, continuous velocity mode is selected.

When the **Step** green light is on, step mode is selected.

To use continuous velocity mode:

- Set the velocity: drag the **Jog Speed** slider.



Figure 6-4: Jog Speed slider.

For more information on continuous velocity mode, see "About Continuous Velocity Jogging" (below).

To use step mode, select the step size. Do one of the following, depending on your accessories:

- In the **Manual Control Area**, in the **Jog** group, select the step size.
The **Step** button's light comes on, indicating which step size is active.



Figure 6-5: Step buttons (in G20 mode).

- On the (optional) Jog Shuttle, press the Step button to toggle the currently selected step size.
In the PathPilot interface, the **Step** button's light comes on, indicating which step size is active.

For more information on step mode, see "About Step Jogging" (below).

6.4.1 About Jogging

Jogging is the operation of manually moving an axis in various directions (like to set up and indicate fixtures or workpieces). You can't manually jog the machine while it's performing automatic operations (like running a G-code program or an MDI command).

Jog the machine using the keyboard or the optional Jog Shuttle. Whether you're jogging with the keyboard or with the Jog Shuttle, you can either:

- Jog the machine at a consistent velocity (for information, see "About Continuous Velocity Jogging" (below)).
- Jog the machine in steps (for information, see "About Step Jogging" (below)).

For more information, see "Jog Controls Reference" (below).

About Continuous Velocity Jogging

While jogging in continuous velocity mode, the machine moves at a constant speed for as long as:

- A keyboard key is pressed
- The Jog Shuttle outer ring is twisted away from the neutral position

This is useful when you're doing things like:

- Roughly positioning the machine (for example, to move the spindle head away from the workpiece).
- Moving the machine a certain distance at a constant speed.

About Step Jogging

While jogging in step mode, the machine moves one step each time you either press a jog key on the keyboard or click the inner wheel of the Jog Shuttle. The jog step sizes range depending on the programming mode you are using:

- **Imperial (G20) Mode** 0.0001 in. to 0.1000 in.
- **Metric (G21) Mode** 0.01 mm to 10 mm

Step jogging mode is useful to finely move the machine, like when you're indicating a workpiece or manually setting tool lengths.

The jog keys on the keyboard only move the machine in steps when step mode is indicated in PathPilot. The inner wheel on the jog shuttle always moves the machine in steps, regardless of which mode is indicated in PathPilot.

6.4.2 Jog Controls Reference

The machine's jogging functions are controlled by the following:

- The Jog group of the Manual Control area in the PathPilot interface
- The keyboard
- The (optional) Jog Shuttle

6: BASIC OPERATIONS

Axis	Direction	Keyboard Key	Jog Shuttle
X-Axis	Positive	Up Arrow	Clockwise
	Negative	Down Arrow	Counterclockwise
Z-Axis	Positive	Right Arrow	Clockwise
	Negative	Left Arrow	Counterclockwise

Jogging in PathPilot

From the PathPilot interface, in the Manual Control area, the Jog group has the following functions:

- The Jog button, which toggles between continuous velocity mode and step mode.
- The Jog Speed slider, which controls the machine's jog rate (whether in continuous velocity mode or in step mode).

The jog rate is measured as a percentage of the machine's maximum jog rate.

Jogging with the Keyboard

Pressing the keys results in the following actions:

- **[KEY]** jogs the axis at the current jog rate.
- **[KEY]+Shift** jogs the axis at the maximum jog rate.

Jogging with the (Optional) Jog Shuttle

The optional Jog Shuttle has the following functions:

- An inner wheel and outer ring that jog the currently selected axis.
Rotating either clockwise jogs the axis in the positive direction.
Rotating either counterclockwise jogs the axis in the negative direction.
- Four axis selection buttons, which toggle the currently selected axis. On this machine, two of the axis selection buttons – Y-axis and A-axis – won't result in any motion if selected.

Note: The currently selected axis displays in PathPilot: in the Position Status group, there's a green light to the left of the Axis DRO field. When it's on, it indicates the active axis.

- A step button, which toggles the selected jog step size.

6.5 CHANGE THE SPINDLE SPEED RANGE

This machine has two spindle speed ranges:

- **High** 350 rpm to 5000 rpm
- **Low** 180 rpm to 2500 rpm

⚠ WARNING! Entanglement / Entrapment Hazard. The machine operates under automatic control — it can start at any time and crush, cut, entangle, or pinch body parts. Always keep clear of positions on the machine where unexpected or unintended machine motion could cause harm. Before operating this machine in any way, you must verify that all operators know the location of the machine's Emergency Stop button.

To change the spindle speed range:

1. Power off the machine and the PathPilot controller.
 - a. Push in the machine's red Emergency Stop button, which removes power to motion control.
 - b. From the PathPilot interface, select **Exit**.
 - c. Turn the Main Disconnect switch to **OFF** on the side of the electrical cabinet.
 - d. Follow correct lockout/tagout procedures.
2. Open the spindle cabinet door.
3. Loosen the 8 mm socket head cap screw on the far side of the motor mount with a 6 mm hex wrench.
4. Lift the spindle motor up (it tilts toward you, pivoting about the remaining screw). The spindle belt slackens, which allows you to move the belt from one pulley to the other.

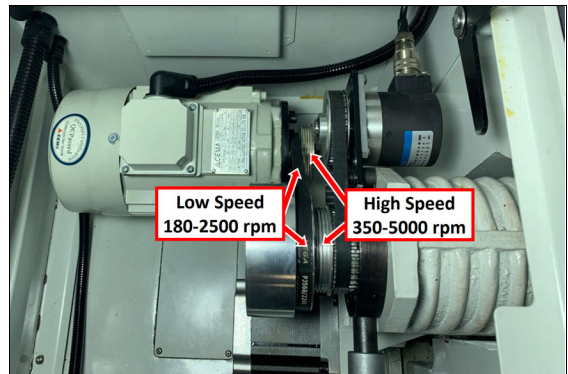


Figure 6-6: Example of the spindle belt in the low position.

5. With the spindle belt in its new position, retighten the 8 mm socket head cap screw that you loosened in Step 3.

6. Rotate the spindle by hand to visually confirm that the spindle belt is fully seated in the pulley.
7. Close the spindle cabinet door.
8. From the PathPilot interface, on the **Settings** tab, select the appropriate spindle pulley ratio option.

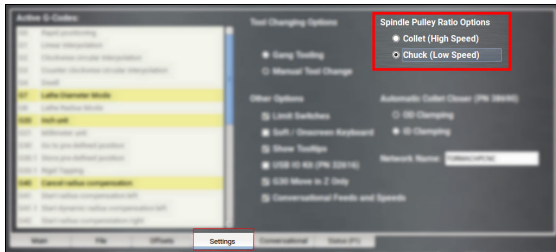


Figure 6-7: Spindle Pulley Ratio Option selections.

6.6 LOAD MATERIAL INTO THE SPINDLE

1. Open the enclosure door and the spindle door. Verify that the latch on both doors is seated to prevent the doors from unexpectedly falling.
2. Install the draw tube through the spindle.

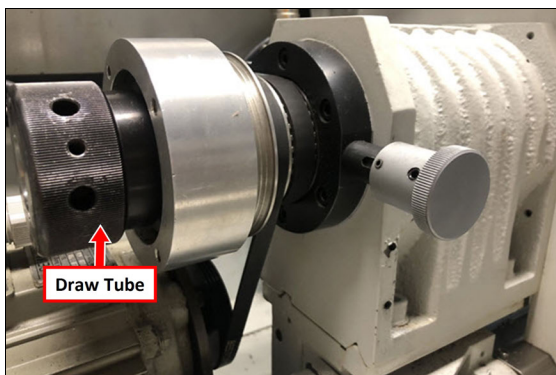


Figure 6-8: Draw tube installed into the spindle.

3. Install a 5C collet or chuck into the headstock.

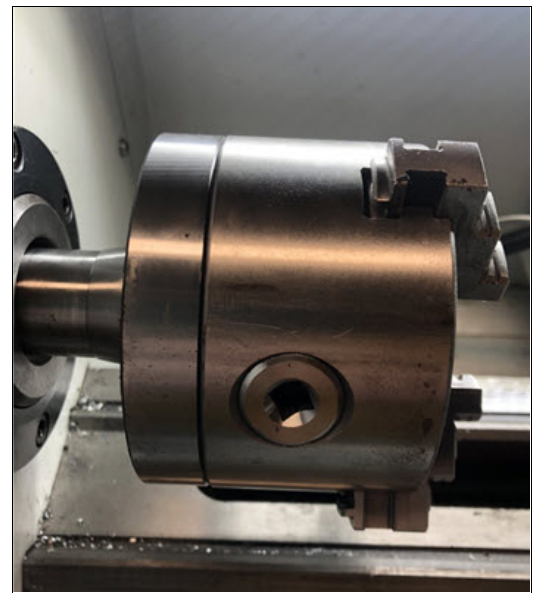


Figure 6-9: Workholding option installed.

6: BASIC OPERATIONS

- Depending on which workholding option you're using, do one of the following:

- **5C Collet** Put a piece of stock into the collet, and adjust the length of the stock in the cutting area.

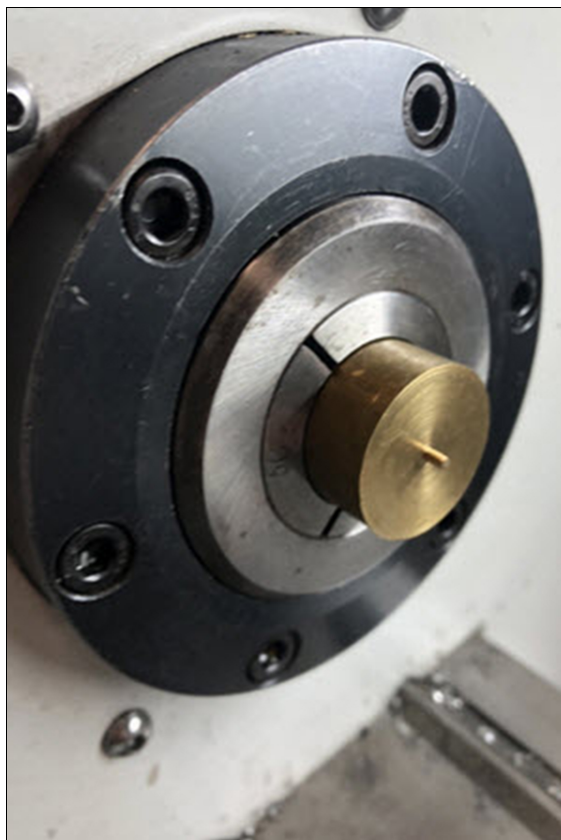


Figure 6-10: Material installed into the collet.

- **Chuck** You'll install the stock after the drawtube and the chuck are securely tightened.
- Gently push on the spindle lock and rotate the spindle with your hand. Stop rotating the spindle once you feel the lock engage.

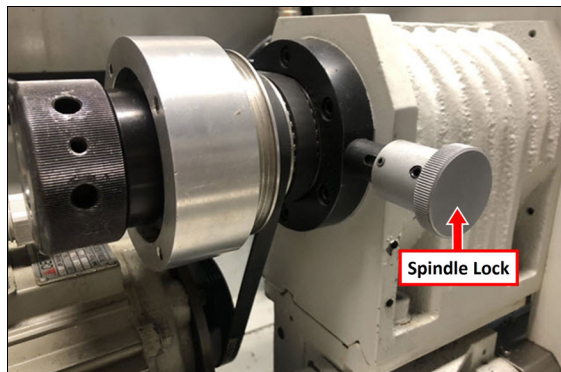


Figure 6-11: Spindle lock.

- Hold the spindle lock with one hand and, using the other hand, tighten the draw tube with the (provided) spanner wrench until the draw tube is tight.

6.7 LOAD G-CODE

To run a G-code program on a PathPilot controller, you must first verify that the file is on the controller. For more information on transferring and moving files, see "Transfer Files to and From the Controller" (below).

To load G-code:

- From the **File** tab, in the **Controller Files** window, select the desired .nc file.
- Select **Load G-Code**.

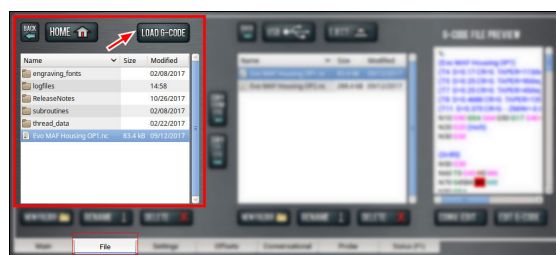


Figure 6-12: Controller Files window on the File tab.



Note: This function is only available for files stored on the PathPilot controller.

PathPilot loads the G-code file and opens the **Main** tab.

6.7.1 Transfer Files to and From the Controller

To run a G-code program, you must transfer the files to the PathPilot controller. For information, see About System Files.

To transfer files to and from the controller:

- Insert a USB drive into any open USB port.
- From the **File** tab, select the file to transfer (either in the **USB Files** window or the **Controller Files** window).



Note: Select **Back** to move backward and either **Home** or **USB** to move to the highest level.

- Select the location to which you want to copy the transferred file.

4. Select either **Copy From USB** or **Copy to USB**.

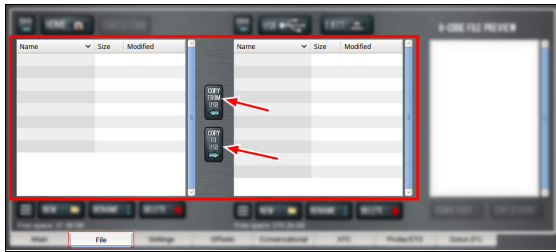


Figure 6-13: File tab.



Note: The file must have a unique name. If it doesn't, you must either overwrite the file, rename the file, or cancel the file transfer.

5. Select **Eject**.

It's safe to remove the USB drive from the controller.

6.8 SET WORK OFFSETS

In the the **X (Dia)** DRO field, all values are expressed in terms of the diameter of the workpiece, not the radius.



EXAMPLE

If the active tool is 2 in. away from the spindle centerline, **4.000** displays in the **X** DRO field.

To set the current axis location to zero in the active work coordinate system:

- Select **Zero**.

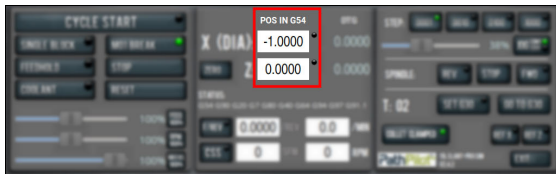


Figure 6-14: Work Offset DRO fields.

To change work offsets:

1. On the **Main** tab, in the **MDI Line** DRO field, type the new work offset to activate (for example, G55). Then select the **Enter** key.
2. The new work offset displays in the following locations in the PathPilot interface:
 - The **Status** read-only DRO field.
 - Above the **Work Offset** DRO fields.

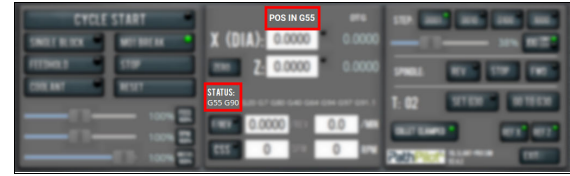


Figure 6-15: Work offset indicated in the PathPilot interface.



Note: The values in the **Work Offset** DRO fields update to indicate the new location of each axis in the new work offset.

For more information on using work offsets, see "About Work Offsets" (below).

6.8.1 About Work Offsets

Work offsets allow you to think in terms of X and Z coordinates with respect to the part, rather than thinking of them with respect to the machine position. This means that you can jog the machine to an arbitrary location (like the end of a workpiece) and call that location zero.

You can save up to 500 work offsets in PathPilot. The naming structure varies based on the offset number, as detailed in the following table.

Work Offset Naming		
Offsets 1-9 (Use either name)		
Offset	Extended Name	Name
1	G54.1 P1	G54
2	G54.1 P2	G55
3	G54.1 P3	G56
4	G54.1 P4	G57
5	G54.1 P5	G58
6	G54.1 P6	G59
7	G54.1 P7	G59.1
8	G54.1 P8	G59.2
9	G54.1 P9	G59.3
Offsets 10-500 (Use extended name)		
Offset	Extended Name	Name

6: BASIC OPERATIONS

Work Offset Naming		
10	G54.1 P10	Not used
11	G54.1 P11	Not used
...		
499	G54.1 P499	Not used
500	G54.1 P500	Not used

6.9 SET TOOL GEOMETRY OFFSETS

Before running a G-code program, PathPilot must know the geometry of the tools that are required for the program. For more information on using tool length offsets, see "About Tool Offsets" (on the next page).

Note: You can import a .csv file with tool geometry offset data. For information, see "Import and Export the Tool Table" (on the next page).

To set tool geometry offsets:

1. Verify that the machine is powered on, out of reset, and the axes have been referenced.
2. From the PathPilot controller, on the **Offsets** tab, select the **Offsets Table** tab.
3. Find the **Tool Table** window.

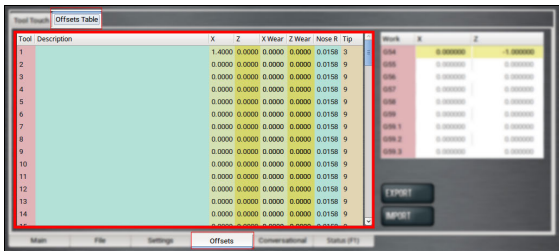


Figure 6-16: Tool Table window on the Offsets tab.

4. Touch off the tool geometry offsets. For information, see "Touch Off the Tool Geometry Offsets" (below).
5. (Optional) Select a field to edit. When finished, select the **Enter** key.

6.9.1 Touch Off the Tool Geometry Offsets

On the Offsets tab, you can use the Tool Touch tab to graphically select a tool, and then touch off the tool to set the geometry offsets.

Tip! When using this method to measure your tool geometry, remember that the X zero location never changes (the spindle centerline is always X = 0), but the Z zero location may change depending on the length of the workpiece that is chucked into the spindle. As long as each tool is measured to a face that has been zeroed, only measure these tools one time or until you replace an insert.

To touch off the tool geometry offsets:

- From the **Offsets** tab, on the **Tool Touch** tab, select a tool. The tools along the bottom of the screen are front tool post tools (used by machines with a quick-change tool post setup).

Note: Gang tooling setups typically use both front and rear tool post tools.

After you select the tool, PathPilot:

- Sets the tip orientation for the tool, used (along with tip radius) in cutter compensation.
- Sets the tool type (front tool post or rear tool post), used by the conversational routines to double check the user entry fields in an attempt to try to detect and prevent crashes.
- Displays the tool touch off dialog.

Touch X

1. Take a skim cut off of the diameter of the workpiece — just long enough to measure the cut surface with a micrometer.
2. Jog the tool away from workpiece in Z, but don't jog the machine in X.
3. Measure the diameter of the skim-cut workpiece with a micrometer.
4. In the **Touch X** DRO field, type the value that you measured in Step 3.

Note: If you're touching off a front tool post tool, verify that the value you enter is positive.

5. Select **Touch X**. The LED comes on.

Touch Z

1. Jog the machine toward the part zero (usually the face of the workpiece) in the Z direction.
2. Move the tool so that its cutting edge is just touching the surface of the material and define this as Z = 0. Use a sheet of paper to indicate when the tool is touching the material.
3. Slowly jog the Z-axis until it's approximately 1/4 in. away from part zero on the workpiece.
4. With the paper between the tool and the workpiece, slowly jog the machine until you feel a light pull on the paper.
5. In the Touch Z DRO field, type the thickness of the piece of paper. Then select **Touch Z**.

6.9.2 About Tool Offsets

Tool offsets allow you to use various tools while still programming with respect to the workpiece. Tools can have different lengths (and, while using gang tooling, different X/Z positions on the carriage).

Tool offsets are broken down into two components:

- **Geometry Offsets** Represents the distance from the work offset zero location to the tool's control point.



Note: Unlike on a mill (where G43 must be called out to apply an offset), tool geometry offsets are automatically applied with the `Txx` tool change command.

- **Wear Offsets**

The sign convention for the machine are as follows:

- Z negative is toward the spindle.
- X positive is toward the operator.

Sign convention is important when you choose the manual tool change option or the gang tooling option.

All tools mounted for use on the operator side of the workpiece are touched off using positive X (diameter) values, and most X words in part programming for these tools have positive values.

6.9.3 Import and Export the Tool Table

You can manage the tool table using an external .csv file.

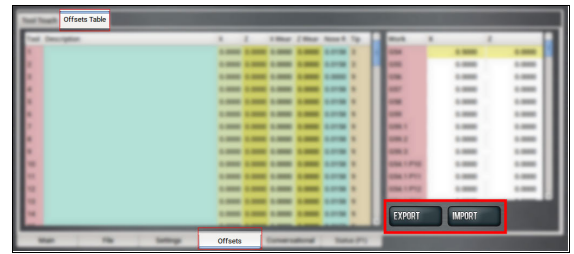


Figure 6-17: Export and Import buttons on the Offsets tab.

Import a .csv File

1. Transfer the .csv file to a USB drive.
2. Insert the USB drive into the PathPilot controller.
3. Confirm that the PathPilot controller is on.
4. From the **Offsets** tab, on the **Offsets Table** tab, select **Import**.

The **Import** dialog box displays.



Figure 6-18: Import dialog box.

5. Navigate to the .csv file on the USB drive. Then, select **OK**.

The .csv file updates the tool table.

Export the Tool Table as a .csv File

1. From the **Offsets** tab, on the **Offsets Table** tab, select **Export**.

PathPilot generates the .csv file, and the **Export** dialog box displays.

6: BASIC OPERATIONS

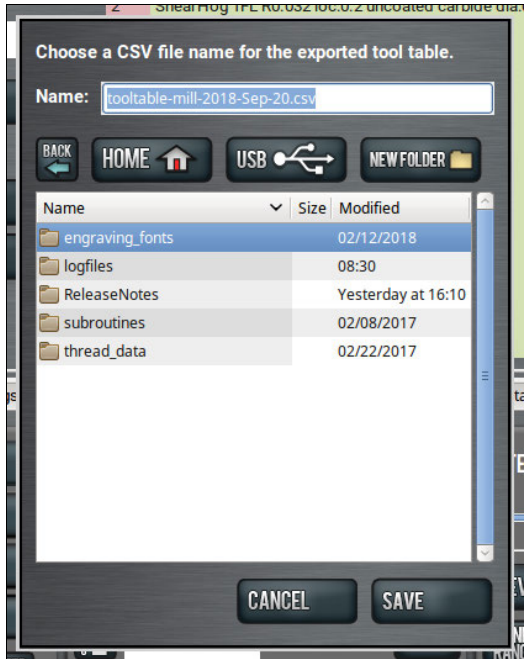


Figure 6-19: Export dialog box.

2. In the **Name** DRO field, type the name for the .csv file.
3. Select **Save**.
The .csv file is saved in the **File** tab.
4. From the **File** tab, select the newly created .csv file, and then select **Copy to USB**.
5. Select **Eject**.
It's safe to remove the USB drive from the controller.

6.10 OPERATE THE COOLANT PUMP

To turn coolant on or off:

- Select **Coolant**.

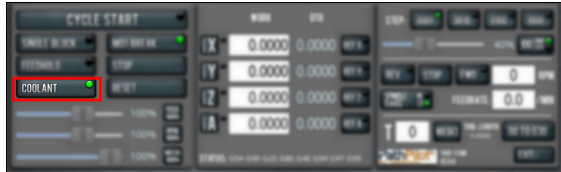


Figure 6-20: Coolant button.

For more information on turning on and off coolant, see "About Coolant" (below).

6.10.1 About Coolant

In the PathPilot interface, the Coolant button controls the machine's coolant pump power outlet. The Coolant button's light shows the current state of the outlet: the light is on when the outlet has power; the light is off when the outlet does not have power.


Note: The Coolant button is equivalent to using an M08 (coolant on) or M09 (coolant off) command in the G-code program.

Use the Coolant button before or after a program is running, while a program is running, or while you are using manual data input (MDI) commands.

MACHINE MAINTENANCE

IN THIS SECTION, YOU'LL LEARN:

- About the required maintenance procedures that you must do so that this machine operates as designed.

 Before operating the machine in any way, you must read and understand this section.

CONTENTS

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7.5 Examine the Spindle Belt	57
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7: MACHINE MAINTENANCE

7.1 MAINTENANCE SAFETY

Read and understand the following safety messages before beginning any maintenance procedures.

7.1.1 All Maintenance Procedures

- ✓ Understand that the machine is automatically controlled and can start at any time.
- ✓ Power off the machine and disconnect the pneumatic supply before doing any maintenance procedures.
- ✓ When appropriate, lockout/tagout the Main Disconnect switch and the pneumatic supply line before doing any maintenance procedures.
- ✓ Wear safety eye protection rated for ANSI Z87+.

7.1.2 Swarf Maintenance Procedures

- ✓ Wear work gloves.

7.1.3 Coolant Maintenance Procedures

- ✓ Wear rubber gloves.

7.2 MAINTENANCE SCHEDULES

To keep your machine running as smoothly as possible, you must regularly do the following maintenance procedures.



Note: Before you begin any maintenance procedures, read and understand "Maintenance Safety" (above).

If you disassemble any components, refer to the machine's reference drawings when you've completed the maintenance procedure. For information, see "Diagrams and Parts Lists" (page 81). For any additional support, we can help. Create a support ticket with Tormach Technical Support at tormach.com/how-to-submit-a-support-ticket for guidance on how to proceed.

7.2.1 Daily

- Clean the ways and carriage of chips and other swarf with a chip brush.
- Clean the chip basket on the coolant tank.
- Examine the coolant level and condition and refill as necessary.
- Examine the way oil level and refill as necessary.
- Retract the plunger on the manual oiler, hold it in the retracted position for two seconds, and then release it.



Note: The plunger should move slowly from the retracted position. If it doesn't, it could indicate a malfunctioning oiler.

- Use a rust inhibitor on all exposed, non-lubricated, non-painted metal surfaces.



Note: Don't use rust inhibitor on the ball screws or the slideways.

- If you have any accessories that require compressed air, verify that the FRL Filter-Regulator-Lubricator has at least 90 psi compressed air, and that the lubricator has air tool oil above the bottom of the plastic tube.

7.2.2 Weekly

- Clean all exterior surfaces with a clean rag.
- Verify that the machine's lubrication points (sliding surfaces and ball screw nuts) are receiving way oil.
- Examine the enclosure and other guards for damage.
- Examine and, if necessary, adjust the draw tube tension when using the 5C automatic collet closer.

7.2.3 Monthly

- Clean the electrical cabinet vents of dust with a clean cloth or compressed air.
- Remove the coolant tank pump to remove any sediment buildup in the coolant tank.
- Dispose of oil in the drain bucket.

7.2.4 Semi-Annually

- Examine the way covers for wear.
- Examine the oil system for blockages.
- Examine lubrication hoses for wear.

7.2.5 Annually

- Verify that the limit switches are properly functioning.


7.3 CLEAN THE COOLANT SYSTEM

To extend the service life of the coolant and the coolant pump, you must make sure that both are free of contaminants.

Regularly do the following:

- Use a chip brush to clean the machine, chip trays, and enclosure of chips and other swarf.

- Empty the chip strainer on the coolant tank.
- Measure the coolant concentration, pH, and volume, and then compare your findings to the material's safety data sheet (SDS).
 - **Coolant Level Too Low** Fill the coolant tank with fresh coolant, making sure that it is the appropriate concentration.
 - **Coolant pH Outside of Manufacturer's Recommended Coolant Limits** Adjust the pH according to the manufacturer's recommendation.

 **Note:** You must only use coolant that is recommended for machining. See "Cutting Fluid Reference" (below).

- Examine the coolant pump's impeller for blockages.
- Use a Floating Tramp Oil Collection Pillow (PN 31925) or an oil skimmer to remove tramp way oil from the coolant tank.

Periodically do the following:

- Remove the coolant tank covers and the chip strainer, and then clean the fine swarf from the coolant tank.
- If you're using a filter to prevent small particles from entering the coolant tank, replace it when it's saturated with chips, swarf, or tramp oil.
- Examine the coolant for contamination, and determine if the coolant's oil-water emulsion has broken.
- Drain and thoroughly clean the coolant tank, and then replace with fresh coolant.

NOTICE! Hazardous Waste: Only dispose of coolant as advised by local environmental protection authorities. You must not dispose of coolant in a septic system or a sewer.

7.3.1 About Cutting Fluid

Clean and well maintained coolant has increased performance, prevents rust, and smells better than contaminated coolant.

Coolant becomes contaminated when:

- Swarf accumulates in the chip pans, the chip strainer, or the coolant tank.
- Tramp oil isn't regularly removed from the coolant tank.

- The concentration or pH aren't maintained to the manufacture's specifications.

7.3.2 Cutting Fluid Reference

Using flood coolant provides the following benefits:


- Cools the cutting zone
- Flushes away swarf
- Lubricates the cutting tool
- Provides some degree of rust inhibition

You must only use flood coolant that is recommended for CNC machining applications, like:

- Soluble oils
- Semi-synthetic coolants
- Synthetic coolants

You must never use:

- Coolant without rust inhibitors
- Flammable coolants such as alcohols, diesel fuel, or kerosene

 **WARNING!** Fire Hazard: The machine and its enclosure are not designed to contain fire or explosions. Only use materials and coolants that are intended for the specific machining operation. Never use flammable or explosive items.

- Straight cutting oil
- Water

If you use a coolant concentrate, you must mix it with water to the dilution ratio recommended by the coolant manufacturer.

Use an optical refractometer to measure coolant concentration.

7.4 EXAMINE THE ENCLOSURE WINDOWS

Regularly examine the enclosure windows, and all other guarding, for signs of wear or damage.

When required, replace the windows with: Window, 8L, Enclosure Door (PN 50513)

7.5 EXAMINE THE SPINDLE BELT

To extend the service life of the spindle belt, you must regularly examine it for signs of damage or wear.

If the spindle belt is damaged, you must replace it with Spindle Belt, 8L (PN 37832).

7: MACHINE MAINTENANCE

7.6 LUBRICATE THE MACHINE

To keep the machine operating properly, and to extend the service life of the machine, you must verify that the slideway surfaces and ball screws are receiving lubrication.

Regularly do the following:

- Clean the oil reservoir's cover and all exposed surfaces surrounding the oil reservoir. Swarf or debris that enters the oil reservoir can plug the small, internal passages of the lubrication system.



Note: The strainer at the top of the oil reservoir isn't a filter, and can't remove all types of debris that may cause blockages.

- Examine all axes' slideway surfaces and ball screws to determine if an oil film is present. If there's not an oil film, examine the lubrication system for blockages, broken fittings, or pinched oil lines.
- Examine the amount of available oil and, if necessary, refill with new, high-quality ISO VG 68 grade Machine Oil (PN 31386).

7.6.1 About the Manual Oiler

The manual oiler operates with a plunger:

- **On the Pull Stroke** The oiler pulls machine oil from the oil reservoir.
- **On the Retract Stroke** The oiler pushes machine oil through the lubrication system.

The plunger is spring-loaded, and creates a light hydraulic pressure sufficient to distribute the oil through the machine.

Do not push the plunger after you retract it.

When the machine is first powered on (and then after every four hours of operation), retract the oiler's plunger and hold it in the retracted position for two seconds. Then, release the oiler's plunger.



Note: The plunger should move slowly from the retracted position. If it doesn't, it could indicate a malfunctioning oiler.

7.6.2 Lubrication System Reference

The machine's lubrication system distributes oil to the following 10 points:

- Eight sliding surfaces
 - Four on the X-axis
 - Four on the Z-axis
- Two ball nuts

7.7 PREVENT RUST

Take proper care to protect all exposed iron and steel surfaces on your machine. To reduce the possibility of rust, you must regularly do the following:

- Clean all exterior surfaces with a mild cleaner.
- Only use flood coolant that is recommended for machining (see "Cutting Fluid Reference" (on the previous page)).
- Periodically test the coolant concentration, and adjust (if necessary) to meet coolant manufacturer's recommended concentration.
- Put LPS 3® (or similar rust inhibitor) on the machine before installing any workholding or accessories.
- Only operate the machine in a temperature- and humidity-controlled environment. Extreme changes in temperature or humidity can create condensation on the machine.
- Put LPS 3® (or similar rust inhibitor) on all exposed, non-painted metal surfaces before leaving the machine unused.
- Remove all workholding and accessories, and then check for rust.
- If needed, reapply rust inhibitor before reinstalling workholding or accessories.

TROUBLESHOOTING

IN THIS SECTION, YOU'LL LEARN:

- About common causes of failure in this machine, and our recommendations for diagnosing and correcting them.



WARNING! Electrocution Hazard - Electrical Cabinet: Do not make or disconnect connections under power.



Before operating the machine in any way, you must read and understand this section.

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7: TROUBLESHOOTING

7.8 TROUBLESHOOTING SAFETY

Read and understand the following safety messages before beginning any troubleshooting procedures.

- ✔ Take things slow and be extra cautious. During troubleshooting, you're exposed to more hazards than during normal operation. For example, you may have to do an electrical test on a live circuit, remove guards, or override a safety switch to make an observation.
- ✔ Power off the machine and disconnect the pneumatic supply before doing any troubleshooting procedures.
- ✔ When appropriate, lockout/tagout the Main Disconnect switch and the pneumatic supply line before doing any troubleshooting procedures.

7.9 GETTING HELP

We provide no-cost technical support through multiple channels. The quickest way to get the answers you need is normally in this order:

1. Read this document.
2. Read related documents at tormach.com/support.
3. If you still need answers, gather the following information so that we may help you as quickly as possible:
 - Your phone number, address, and company name (if applicable).
 - Machine model and serial number, which are located next to the Main Disconnect switch.
 - The version of PathPilot that you're running.
 - Any accessories that you have for your machine.
 - A clear and concise description of the issue.
 - Any supporting media and information that you can share with us. For example, you could:
 - Analyze what might have changed since the machine last worked correctly.
 - Record a short video.
 - Take a picture of a part.
 - For software, share log data .zip files, screen captures, or program files. For information, see "Share Log Data .zip Files" (below).
 - From the PathPilot interface, on the Status tab, record any available information.
 - Use a digital multimeter for voltage readings.
4. Once you've gathered the information in Step 3, contact us in the following ways:
 - a. Create a support ticket: Go to tormach.com/how-to-submit-a-support-ticket
 - b. Phone: (608) 849-8381 (Monday through Friday, 8 a.m. to 5 p.m. U.S. Central Standard Time)

Share Log Data .zip Files

The controller keeps log data on how the machine has been working, which you can export as a .zip file. This information helps us troubleshoot software situations much faster.

To share log data .zip files:

1. Put a USB drive into the PathPilot controller.
2. From the PathPilot controller, on the **Status** tab, select **Log Data**. PathPilot creates a file called **logdata_[TODAY'S-DATE].zip**, and saves it on your USB drive.
3. Remove the USB drive from the controller. Create a support ticket with Tormach Technical Support at tormach.com/how-to-submit-a-support-ticket for guidance on how to proceed.

7.10 REQUIRED TOOLS

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

- #2 Phillips screwdriver
- #3 Phillips screwdriver

- 1/8 in. flat-blade screwdriver
- 3/16 in. flat-blade screwdriver
- Digital multimeter that can test for:
 - Vac volts (up to 300 Vac)
 - Vdc volts (up to 100 Vdc)
 - Resistance (from 0 to 1M ohms)
 - Hz (frequency)
- Electrical safety gloves
- Measuring tools (like a tape measure, calipers, or dial indicator with magnetic base)
- Needle nose pliers
- Trouble light, headlamp, or flashlight
- Wire stripper

7.11 FREQUENTLY FOUND PROBLEMS

There are several frequently found problems with all electromechanical machinery. Among the problems that have occurred, we've found that the following are more frequent than others:

- **Loose Wires**



Note: Before you begin the two-finger pull test, we recommend taking photos of the inside of the electrical cabinet to serve as a visual reference while reconnecting any loose wires.

To determine if a wire is loose, use the two-finger pull test:

1. Power off the machine and the PathPilot controller.
 - a. Push in the machine's red Emergency Stop button, which removes power to motion control.
 - b. From the PathPilot interface, select **Exit**.
 - c. Turn the Main Disconnect switch to **OFF** on the side of the electrical cabinet.
 - d. Follow correct lockout/tagout procedures.
2. With your thumb and index finger, hold the wire close to its termination point, and gently tug each wire.
3. If the wire comes loose, re-terminate and reconnect it before moving on to other wires.

- **Poor Cable Connections**

An improperly seated cable may allow some functions to work but cause others not to. We have found that the ribbon cables' plug connections can become loose during the shipping process.

1. Power off the machine and the PathPilot controller.
 - a. Push in the machine's red Emergency Stop button, which removes power to motion control.
 - b. From the PathPilot interface, select **Exit**.
 - c. Turn the Main Disconnect switch to **OFF** on the side of the electrical cabinet.
 - d. Follow correct lockout/tagout procedures.
2. Unplug and firmly reseal connectors.

7.12 POWER DISTRIBUTION SUBSYSTEM

Electrical power is run through a single power cord to the Main Disconnect switch. This switch controls all power to the machine, the coolant pump, and the PathPilot controller.

To troubleshoot the power distribution subsystem, read the following:

7.12.1 The Controller Won't Power On 62

7: TROUBLESHOOTING

7.12.2 The Coolant Pump Won't Run 62

7.12.1 The Controller Won't Power On

Cause: The PathPilot controller isn't plugged in to an outlet.

Probability	How-To Steps	Need More?
High	➤ Reseat the power cord connection at both the outlet and the controller.	It's possible that the power cord could become loose from movement.

Cause: The CB3 circuit breaker tripped.

Probability	How-To Steps	Need More?
Medium	➤ If the monitor and the controller both don't have power, examine the power cords for damage or exposed wires, and then reset the CB3 circuit breaker.	CB3 affects the monitor and the controller.

Cause: The video cable is disconnected from the PathPilot controller.

Probability	How-To Steps	Need More?
Low	➤ Reseat the video cable connection at both the monitor and the PathPilot controller.	If the monitor is disconnected, it could seem like a controller power issue.

7.12.2 The Coolant Pump Won't Run


Cause: Fuse F1 on the machine control board is blown.

Probability	How-To Steps	Need More?
Medium	<ol style="list-style-type: none"> 1. Unplug the coolant pump power cord and examine it for damage. 2. Use a digital multimeter to verify the motor's winding-to-winding and winding-to-ground resistances. If any winding-to-winding resistance measurement is a short (near zero resistance) or an open circuit or if the winding-to-ground resistance is a short, the coolant pump must be replaced. 3. Replace the fuse with a 3A slow-blow fuse, power on and reset the machine, and select the Coolant button in PathPilot. Use a digital multimeter to test the power at the XS2 receptacle. If the fuse blows again with the pump plugged in, replace the pump. 	If the coolant pump shorts, the 3 A, slow-blow, F1 flood coolant fuse on the ECM1 control board blows before CB3 trips.

Cause: The coolant pump isn't plugged in to an outlet.

Probability	How-To Steps	Need More?
Low	➤ Examine the connection at the outlet.	It's possible that the power cord could become loose from movement.

Cause: The coolant control relay on the machine control board failed.

Probability	How-To Steps	Need More?
Low	<ol style="list-style-type: none"> 1. From the PathPilot interface, toggle the Coolant button to On. 2. Examine the coolant receptacle for power. If there's no power, and fuse F1 has continuity, it's likely that the K3 relay failed. 3. Power off the machine (see "Power Off the Machine" (page 35)). Then, install a short jumper between wires J5-1 and J5-2. 4. Power on the machine (see "Power On the Machine" (page 34)). If the pump runs when the machine is powered on, replace the machine control board. 	<ol style="list-style-type: none"> 1. Power off the machine (see "Power Off the Machine" (page 35)). Then, install a short jumper between wires 109 and 125 on the machine control board. 2. Power on the machine (see "Power On the Machine" (page 34)). If the pump runs when machine is powered on, it's likely that the problem is the K3 relay. <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p>Note: This relay will fail if too high of a current draw passes through it. This is common  when electrical loads much larger than the coolant pump are plugged into the coolant outlet.</p> </div>

7.13 CONTROL POWER SUBSYSTEM

To troubleshoot the control power subsystem, read the following:

7.13.1 The Machine Won't Power On 63

7.13.1 The Machine Won't Power On

Cause: The Emergency Stop button is pushed in.

Probability	How-To Steps	Need More?
High	<ul style="list-style-type: none"> ➤ Twist out the Emergency Stop button and press the Reset button. 	<p>The Reset button doesn't illuminate until after you:</p> <ol style="list-style-type: none"> 1. Twist out the Emergency Stop button. 2. Press the Reset button.

Cause: The DC power supply PS1 is defective.

Probability	How-To Steps	Need More?
Medium	<ul style="list-style-type: none"> ➤ Measure for 24 Vdc nominal between wires 401 and 400. 	<p>Before you replace the DC power supply, power off the machine (see "Power Off the Machine" (page 35)).</p>

7: TROUBLESHOOTING

Cause: The Main Disconnect switch is in the Off position.

Probability	How-To Steps	Need More?
Low	<ul style="list-style-type: none"> ➤ Examine the Main Disconnect switch. If it's not already in the On position, turn it on. 	If needed, measure for 115 Vac nominal between wires 101 and 100/N.

Cause: The mains breaker is turned off.

Probability	How-To Steps	Need More?
Low	<ul style="list-style-type: none"> ➤ Examine the breaker. If it's not already on, turn it on. 	

Cause: The CB1 and/or CB2 circuit breaker tripped.

Probability	How-To Steps	Need More?
Low	<ol style="list-style-type: none"> 1. Measure for 115 Vac nominal between wires 105 and 100/N. 2. Measure for 115 Vac nominal between wires 107 and 100/N. 	Before you reset the tripped breaker, power off the machine (see "Power Off the Machine" (page 35)).

Cause: The contactor K1 is defective.

Probability	How-To Steps	Need More?
Low	<ul style="list-style-type: none"> • If the contactor's red LED is on, the contactor is latched. Use a digital multimeter to examine the power at K1-1 and wire 115. • If the contactor's LED is not on, press and hold the Reset button and observe the LED on K1: <ul style="list-style-type: none"> ◦ If it's on, K1 has a latching circuit issue. ◦ If it's not on, K1 may have a coil issue. 	Contactor K1 energizes the DC-BUS board, which provides 65 Vdc to the machine. K1 can fail by not energizing the coil, or the contacts could fail.

7.14 AXES DRIVE SUBSYSTEM

The axis motors are used to move the X- and Z-axis. The motors are powered by electronic driver modules (also referred to as axis drivers) which receive control signals from the control board. The electronic driver modules are powered by the DC-BUS board. Travel limits are established by limit switches when the machine is referenced.

To troubleshoot the axes drive subsystem, read the following:

7.14.1 All Axes Won't Move When Commanded	65
7.14.2 One Axis Won't Move (or Only Moves in One Direction), and Other Axes Move	65
7.14.3 Axis Movement is Noisy	68
7.14.4 Can't Reference All Axes	69
7.14.5 Lost Motion on Axis Travel	70

7.14.1 All Axes Won't Move When Commanded

Cause: Control signals aren't reaching the electronic driver modules.

Probability	How-To Steps	Need More?
High	<ol style="list-style-type: none"> 1. Power off the machine (see "Power Off the Machine" (page 35)). 2. Examine the connectors at the J6 connection at the machine control board, and the ribbon cables at the axes drivers: <ol style="list-style-type: none"> a. Remove the connectors, and inspect them for any bent pins or discoloration. b. Firmly reseal the connectors. 	Examine the ribbon cable 423 from the control board (J6) to the axes motors.

Cause: The DC-BUS board is malfunctioning.

Probability	How-To Steps	Need More?
Medium	<p>The loss of DC-BUS board power to one or more axes is likely if the axes driver LEDs are not on, if they're dim, or if they're a color other than green.</p> <ul style="list-style-type: none"> ➤ Examine the axis status LEDs on the axis drivers. 	For information, see "There's a blown fuse on the DC-BUS board" in "One Axis Won't Move (or Only Moves in One Direction), and Other Axes Move" (below).

Cause: PathPilot isn't commanding the move, or there's a controller problem.

Probability	How-To Steps
Low	<ol style="list-style-type: none"> 1. Jog the axes and, from the PathPilot interface, examine the value displayed in their DRO fields. If the position doesn't change while you're jogging, there's a problem with the controller. 2. Select the Main tab, then, on the keyboard, select the Esc key. 3. Try to jog the axes again, and examine the value displayed in their DRO fields. 4. If the problem persists, restart the controller.


7.14.2 One Axis Won't Move (or Only Moves in One Direction), and Other Axes Move

Cause: There are loose wires or ribbon cables.

Probability	How-To Steps
High	<ol style="list-style-type: none"> 1. Power off the machine (see "Power Off the Machine" (page 35)). 2. Examine the connection of the J6 ribbon cable and the power wires from the DC-BUS board to the affected driver. 3. Power on the machine (see "Power On the Machine" (page 34)) and test for operation.

7: TROUBLESHOOTING

Cause: There's a defective or malfunctioning axis driver.

Probability	How-To Steps	Need More?
Medium	<ol style="list-style-type: none"> 1. Power off the machine (see "Power Off the Machine" (page 35)). 4. On the malfunctioning axis driver, replace the ribbon cable connector for the control signals and the motor/DC supply connector with those from a functioning axis driver. 6. Power on the machine (see "Power On the Machine" (page 34)). 7. Jog the malfunctioning axis in both directions. If the malfunctioning axis now moves properly, then it's likely that the malfunctioning axis driver is defective. 8. Jog the functioning axis in both directions. A defective malfunctioning axis driver is confirmed if the previously functioning axis has the same problem. 	<p>Swapping control signals between axis drivers is very helpful during troubleshooting (there are at least three identical axis drivers in this subsystem).</p> <div style="border: 1px solid black; padding: 5px;"> <p>Note: If control signals are switched from the driver on the non-functioning axis to a driver on a functioning axis,  the end of travel limit switch on the non-functioning axis won't work. Take care to avoid reaching the end of travel when moving an axis.</p> </div>

Cause: There's a blown fuse on the DC-BUS board.

Probability	How-To Steps	Need More?
Medium	<ol style="list-style-type: none"> 1. Power off the machine (see "Power Off the Machine" (page 35)). 2. Remove the cover from the DC-BUS board. 3. Measure the continuity on each fuse with a multimeter. Then, visually inspect each fuse. If a fuse is blown, replace it with an equivalent fuse. 	<p>A blown fuse usually is the result of a defective drive or wiring. Inspect the axis' wiring carefully and repair any damage observed. If you replace a fuse and it immediately blows, it's likely a defective axis drive or its wiring.</p>

Cause: There's a loose axis motor coupling.

Probability	How-To Steps
Low	<ul style="list-style-type: none"> • Jog the axis and listen to determine if you can hear the motor run. • Remove the cover plate over the coupling and make witness marks to determine if the motor's turning but the screw isn't.

Cause: There's a defective motor or motor connection.

Probability	How-To Steps	Need More?
Low	<ol style="list-style-type: none"> 1. Power off the machine (see "Power Off the Machine" (page 35)). 4. Remove the motor leads from the axis driver, and examine the motor for signs of coolant contamination. 5. Measure the resistance of windings at the green connector on the axis driver (see Motor Resistance Reference). 6. If the resistance is out of range, carefully check the wiring: <ol style="list-style-type: none"> a. Locate the axis motor connector near the motor and repeat the resistance test. b. If the resistance is out of spec again, then the motor is defective. c. If the resistance is within spec, then inspect the cable and connectors between the axis motor and axis driver. 	When making resistance measurements on motors and other devices with low resistance, always take a tare reading on the meter before doing the resistance measurement on the motor or device.

Cause: The gibs are too tight or too loose.

Probability	How-To Steps	Need More?
Low	<ul style="list-style-type: none"> ➤ Adjust the gibs. 	Gibs that are too tight result in too much friction in the ways. Gibs that are too loose can cause binding.

Cause: Oil isn't getting to the ways and ball screw.

Probability	How-To Steps
Low	<ol style="list-style-type: none"> 1. Examine the oil level in the oiler. 2. Investigate the oiling system for lack of oil and/or plugged lines (See Tormach service bulletin SB0031).

Cause: There's oil residue from long-term storage.

Probability	How-To Steps
Low	<ul style="list-style-type: none"> ➤ Repeatedly pump oil and slowly jog the axis.

Cause: There's debris on the ball screw.

Probability	How-To Steps	Need More?
Low	<ul style="list-style-type: none"> ➤ Clean the ball screw. 	Debris on the ball screws can rapidly accelerate wear and reduce the lifespan of your machine. Evaluate if additional measures are required to protect your machine's ball screws and ways (like supplemental dust collection).

7: TROUBLESHOOTING

Cause: There's a thermal trip or an electrical short on an axis driver.

Probability	How-To Steps
Low	<ol style="list-style-type: none"> 1. Examine the LEDs on the axis drivers. If there's a red LED on the driver, that means it's tripped. 2. Power the machine on and off, and the trip should reset. 3. If the problem continues, examine the wiring for shorts and test the motor resistance. (For more information, see "There's a defective motor or motor connection." earlier in this section.) 4. If the problem continues, replace the axis driver.

7.14.3 Axis Movement is Noisy

Before You Begin

⚠ WARNING! Electrocutation Hazard: When servicing the machine from inside the electrical cabinet, always use caution. Points in the electrical cabinet have high voltages that can electrocute or shock you. Even after you've powered off the machine, electronic devices in the electrical cabinet may retain dangerous electrical voltages. Only qualified electrical machinery technicians should perform maintenance or troubleshooting procedures inside the electrical cabinet while power is still on.

Some procedures in this section require servicing the machine from inside the electrical cabinet. Before you begin, you must identify a qualified electrical machinery technician to perform the procedures.

Cause: There's a loose wire connection or failed connector.

Probability	How-To Steps	Need More?
High / Low	<ul style="list-style-type: none"> ➤ Power off the machine (see "Power Off the Machine" (page 35)). Then, tighten all screw connections. 	Examine the green power connector for signs of overheating.

Cause: There's a defective axis driver module.

Probability	How-To Steps	Need More?
Medium	<ul style="list-style-type: none"> ➤ See "One Axis Won't Move (or Only Moves in One Direction), and Other Axes Move" (page 65). 	There have been cases of a noisy axis relating to a defective axis driver. This may be temperature-dependent.

Cause: There's loose sheet metal.

Probability	How-To Steps	Need More?
High	<ul style="list-style-type: none"> ➤ Feel for vibrating sheet metal. 	Loose sheet metal is mistakenly diagnosed as a noisy axis motor. On some systems, certain axis motor speeds can cause audible vibration.

Cause: The C1 (DC-BUS) capacitor is defective.

Probability	How-To Steps
Low	<ol style="list-style-type: none"> 1. Power off the machine (see "Power Off the Machine" (page 35)). Then, unplug the green power connectors on all of the axis drivers (X, Y, Z, and A). 2. With the electrical cabinet door open, power on the machine (see "Power On the Machine" (page 34)). 3. Examine the green LED on the DC-BUS board, and then twist out the Emergency Stop button and press the Reset button. The green LED should come on. 4. Push in the Emergency Stop button. If the LED goes out in two seconds or less, the capacitor is defective and must be replaced. If the LED takes five seconds or more to go out, the capacitor is OK. 5. If the results are not conclusive, power off the machine (see "Power Off the Machine" (page 35)). Then, unplug the green power connectors from the axis drivers (if they're not already unplugged). 6. Power on the machine (see "Power On the Machine" (page 34)). Then, carefully measure DC voltage on wires 202 (common) and 203 on the DC-BUS board. If there's a DC voltage of a nominal 65 Vdc (55-75), this indicates the capacitor is OK. If there's a DC voltage of a nominal 40 Vdc (35-45), this indicates the capacitor is defective.

7.14.4 Can't Reference All Axes

Cause: The machine must be reset.

Probability	How-To Steps	Need More?
High	<ul style="list-style-type: none"> ➤ From the PathPilot interface, select Reset. 	For information, see "Bring the Machine Out of Reset" (page 46) and "About Reset Mode" (page 46).

Cause: The machine is stuck on a limit switch.

Probability	How-To Steps	Need More?
High	<ul style="list-style-type: none"> ➤ From the PathPilot interface, on the Status tab, examine the axes' Limits LEDs. If one or more LEDs are on, do the following: <ol style="list-style-type: none"> 1. Identify which axis is stuck on a limit switch. 2. From the PathPilot interface, on the Settings tab, clear the Limit Switches checkbox. Then, on the dialog box, select OK. 3. Jog the axis away from the limit switch that it's on. 4. From the PathPilot interface, on the Settings tab, select the Limit Switches checkbox to re-enable the limit switches. 	If an axis is moved before referencing the machine, it can trigger a limit switch and become stuck. When you disable the limit switches, the machine completes a unique referencing procedure after selecting the axis reference buttons: rather than moving each axis to the end of its travel, the reference position is set as the machine's current position.

7: TROUBLESHOOTING

Cause: A limit switch is defective.

Probability	How-To Steps	Need More?
Low	<ol style="list-style-type: none"> Go to "The machine is stuck on a limit switch." earlier in this section. Examine each limit switch for its red LED. If any of the limit switch's red LEDs is off, go to "A limit switch's cable or connector is defective." later in this section. 	Each limit switch has a red LED that illuminates whenever the machine is powered on.

Cause: A limit switch's cable or connector is defective.

Probability	How-To Steps	Need More?
Low	<ol style="list-style-type: none"> Power off the machine (see "Power Off the Machine" (page 35)). Inspect and reseat the limit switch's connectors on both ends of the cable. Inspect the limit switch's cable for wear or damage. 	Each limit switch's cable is routed from the machine control board to the limit switch, and it has a connector on each end.

Cause: A limit switch flag is improperly adjusted.

Probability	How-To Steps	Need More?
Low	<p>If the machine crashes into the hard stop during the referencing procedure:</p> <ol style="list-style-type: none"> Jog the machine to its reference position. From the PathPilot interface, on the Settings tab, clear the Limit Switches checkbox. Then, on the dialog box, select OK. Push in the Emergency Stop button on the operator box. Adjust the limit switch flag so that the limit switch's red LED is off. Jog the machine off of the limit switch. From the PathPilot interface, on the Settings tab, select the Limit Switches checkbox to re-enable the limit switches. <p>For information, see "The machine is stuck on a limit switch." earlier in this section.</p>	If the limit switch flags are improperly adjusted, the limit switch won't trigger when the machine is referenced. Instead, the axis will crash into the hard stop.

Cause: The control board is defective.

Probability	How-To Steps	Need More?
Low	<ul style="list-style-type: none"> ➤ Go to Limit Switch Function Reference. 	A defective control board will report no change in the state of the limit switch, even though the switch and wiring are functioning properly.

7.14.5 Lost Motion on Axis Travel

The machine uses stepper motors — open-loop control motors that are accurate and reliable — to control axis motion. With stepper motors, however, there's a chance of losing steps in axis motion. This is because lost steps occur when the commanded number of steps and the actual number of steps don't match (a risk with open-loop control). A step mismatch results in a loss of motion on the axis. In most cases, when a machine loses steps, it loses many steps all at once — resulting in a visible stutter or a stall in axis motion, and/or an audible noise. Lost steps often occur when a stepper motor is pushed too hard or too fast, and it exceeds its limits.

Although this machine uses stepper motors to control axis motion, the entire system is designed to reduce the likelihood of losing steps. In most cases, the machine breaks smaller cutting tools or stalls the spindle with bigger cutting tools before losing steps. Outside variables, like programming, tooling, workholding, and operator error, are sometimes misinterpreted as lost steps.

Cause: Improper use of tool offset, work offset, or cutter compensation.

Probability	How-To Steps	Need More?
High	<ul style="list-style-type: none"> ➤ Examine the G-code programs. You must fully understand tool offsets, work offsets, and cutter compensation. 	The most common cause of a perceived loss of position or lost steps is operator error.

Cause: The spindle tooling isn't properly clamped (Z-axis only).

Probability	How-To Steps	Need More?
High	<ul style="list-style-type: none"> ➤ Examine the cutter to verify that it's not slipping in the holder, or that the tool holder isn't pulling out of the spindle collet. 	

Cause: The motor coupling is loose or cracked.

Probability	How-To Steps	Need More?
Low	<ul style="list-style-type: none"> ➤ Examine the motor coupling. 	You may find it useful to carefully run the axis with the cover removed. Make a paint line from the shaft through the coupling to the screw to examine if there's any movement over time.

Cause: Controller or PathPilot problem.

Probability	How-To Steps	Need More?
Low	<ul style="list-style-type: none"> ➤ Restart the controller and send the log file (from the logfiles directory) to Tormach Technical Support. Create a support ticket with Tormach Technical Support at tormach.com/how-to-submit-a-support-ticket for guidance on how to proceed. 	For information, see "Getting Help" (page 60).

7: TROUBLESHOOTING

Cause: There's an obstruction or excessive friction (the gibs aren't adjusted properly, or poor lubrication), or there's high load in the mechanical system.

Probability	How-To Steps	Need More?
Low	<ul style="list-style-type: none"> ➤ Jog the axis and carefully observe the motion. 	<p>If you lose steps, it's normally many steps. You should be able to hear the motor. Mechanical issues most often result in losing a large number of steps or stalling. Typical mechanical issues include: an increase in friction due to lack of oil at the way surfaces or ball screw and/or improperly adjusted gibs. They also come from excessive load on the system due to chips or debris on the way surfaces or ball screw, a sticking Z-axis brake or an end-of-travel bumper wedged against the motor mount casting. This occurs sometimes after a limit switch failure and is more common on the Z-axis.</p>

Cause: The axes drivers have the wrong DIP switch settings.

Probability	How-To Steps	Need More?
Low	<ul style="list-style-type: none"> ➤ See the machine's electrical schematic. 	<p>New axis drivers require you to set the DIP switches at installation.</p>

7.15 SPINDLE DRIVE SUBSYSTEM

The machine's spindle is driven by an AC motor whose speed is controlled by a variable frequency drive (VFD).

The spindle is in a ready-to-run condition when:

1. The control power is on.
2. The machine is reset.
3. The spindle brake resistor thermal switch isn't tripped.

To troubleshoot the spindle drive subsystem, read the following:

7.15.1 Spindle Turns in Reverse	72
7.15.2 The Spindle Won't Turn	73

7.15.1 Spindle Turns in Reverse

Cause: The tooling is incorrectly installed.

Probability	How-To Steps
Medium	<ul style="list-style-type: none"> ➤ Check the direction in which the tooling is installed. Inserts should face away from you when installed on the reverse-action quick-change tool post.

Cause: There's no power to the VFD.

Probability	How-To Steps
Low	<ol style="list-style-type: none"> 1. Power off the machine and the PathPilot controller. <ol style="list-style-type: none"> a. Push in the machine's red Emergency Stop button, which removes power to motion control. b. From the PathPilot interface, select Exit. c. Turn the Main Disconnect switch to OFF on the side of the electrical cabinet. d. Follow correct lockout/tagout procedures. 2. Remove the VFD's cover with a Phillips screwdriver. 3. Identify motor wires #401 and #402 (on the bottom of the VFD). Loosen the set screws above wires #401 and #402 and swap the wire connections. Then, retighten the set screws. 4. Put the VFD cover back, and close the electrical cabinet door. 5. Power on the machine and the PathPilot controller. <ol style="list-style-type: none"> a. Turn the Main Disconnect switch to ON on the side of the electrical cabinet. b. Twist out the machine's red Emergency Stop button, which enables movement to the machine axes and the spindle. c. Press the Reset button. d. Bring the machine out of reset and reference it. 6. From the PathPilot interface, on the Main tab, select Spindle Fwd. 7. Confirm the spindle is rotating in the correct forward direction.

7.15.2 The Spindle Won't Turn

Cause: The motor runs, but the spindle doesn't turn.

Probability	How-To Steps	Need More?
Low	<ul style="list-style-type: none"> ➤ Examine the spindle belt for wear or damage. 	If the display on the VFD is on, the belt may be loose or broken. You'll hear the spindle motor running.

Cause: There's no power to the VFD.

Probability	How-To Steps	Need More?
—	<ul style="list-style-type: none"> ➤ Examine the VFD display: it has power if its digital lights are on. 	When power is removed, the VFD display remains active until the internal capacitors dissipate their energy. That usually takes about five seconds.

7: TROUBLESHOOTING

Cause: There's no power to the VFD because contactor K2 is not energizing. (Examine the voltage across 112/N and 117 at the VFD, which should be 115 Vac nominal.)

Probability	How-To Steps
High	<p>There are loose power or control wires in the VFD circuit.</p> <ol style="list-style-type: none"> 1. Power off the machine (see "Power Off the Machine" (page 35)). 2. Examine the circuit for loose wires. 3. Power on the machine (see "Power On the Machine" (page 34)) and test operation.
Probability	How-To Steps
Medium	<ol style="list-style-type: none"> 1. Examine the spindle cover door to verify that it's being held closed. 2. Verify that there's 24 Vdc measured from wire 400 to wire 436.
Probability	How-To Steps
Low	<p>Thermal switch (TS1) tripped, preventing K2 from latching.</p> <ol style="list-style-type: none"> 1. Power off the machine (see "Power Off the Machine" (page 35)). 2. Allow the brake resistor to cool, and reset thermal switch by pressing reset button (between its two terminals).
Probability	How-To Steps
Low	<p>The control board isn't providing a run command or holding the K2 contactor on.</p> <ol style="list-style-type: none"> 1. Examine wires 434 and 436 for 24 Vdc on wires J10.1 and J10.3, respectively. 2. Start the spindle and listen for a soft, audible click on the control board. If you hear this click (from a relay contact on the board), the machine control board is functioning properly. If you don't hear the click: <ul style="list-style-type: none"> • Verify that there's 24 Vdc measured from wire 400 to wire 434. Make a jumper wire and, carefully, momentarily jumper wires 434 and 436. <ul style="list-style-type: none"> ◦ If contactor K2 pulls in (you will hear an audible clunk) while you have the jumper on but drops out as soon as you remove the jumper, the holding contact on K2 is defective. ◦ If K2 stays powered on, the control board is not passing the run signal to the circuit. The control board passes 24 Vdc from wire 434 to 436 via a relay to create the start pulse. Measure wire 434 for 24 Vdc power. If present, the control board or wire 436 connected to J10.3 is defective. Power off the machine (see "Power Off the Machine" (page 35)), and jumper J10.1 to J10.3 Power on the machine (see "Power On the Machine" (page 34)) and check the VFD for a display. If the VFD reads rdy, the control board is defective. If not, wire 436 may be broken. Lift the connections of wire 436 at the control board and K2 and measure continuity.

Cause: The VFD tripped.

Probability	How-To Steps	Need More?
Low	<p>➤ If the VFD tripped, an error code displays. Read the error code and go to "Spindle VFD Trip Reference" (page 76).</p>	<p>You can clear a VFD trip by either:</p> <ul style="list-style-type: none"> • Removing power from the VFD for 30 seconds. • Pressing the red Reset button on the front of the VFD .

Cause: The VFD is defective.

Probability	How-To Steps
Low	<p>The VFD may be defective if:</p> <ul style="list-style-type: none"> The display isn't on and there is nominal 115 Vac between wires 117 and 112/N at the VFD. The VFD displays a trip condition that does not clear when power is removed, the VFD may be defective.

Cause: The VFD is not programmed, or it's programmed incorrectly.

Probability	How-To Steps	Need More?
Low	<ol style="list-style-type: none"> Push Enter on the front panel of the VFD twice. The display changes to 00.000, with the .000 blinking. Repeatedly push the Up Arrow until .000 changes to .011. Push Enter again. The display shows the model of the machine or accessory (for example, 1100 for an 1100M, or RT11 for a RapidTurn on an 1100M). Push the Up Arrow once more, and the VFD displays parameter .012, which is the software version number (for example, version 2.01). Push Back to exit this mode. 	<p>Create a support ticket with Tormach Technical Support at tormach.com/how-to-submit-a-support-ticket for guidance on how to proceed.</p>

Cause: The machine control board is defective, or there are defective cables between the machine control board and the spindle VFD.

Probability	How-To Steps
Low	<p>➤ Examine all cables to verify that they're properly seated in their connectors on the machine control board.</p>

Cause: The motor is defective.

Probability	How-To Steps	Need More?
Low	<ol style="list-style-type: none"> Power off the machine (see "Power Off the Machine" (page 35)). Wait 30 seconds, and then remove wires 118, 119, and 120 from the VFD terminals. Measure the resistance between: <ul style="list-style-type: none"> Wires 118 and 119 Wires 119 and 120 Wires 120 and 118 Resistance should be in the range of approximately 2-4 Ω. 	<ul style="list-style-type: none"> 0 Ω indicates that the winding is shorted. >1M Ω indicates that the winding is open. <p>Both cases indicate a defective motor or compromised wiring to the motor from the VFD.</p>

Run and Direction Commands Reference

Command From Card	Monitoring Points One Probe on Each		Voltage Measured	
	Common wire number	Wire number	Voltage when control board command is on	Voltage when control board command is not on
Run (FWD)	403	404	14-20 Vdc	0 Vdc
Reverse	403	406	14-20 Vdc	0 Vdc

7: TROUBLESHOOTING

The display on the VFD provides valuable information for troubleshooting. The display diagnostics include:

- Frequency output (proportional to speed. Range is ~7 Hz to 142 Hz).
- Status (rd for ready, inh for inhibit which will occur when there is no jumper between terminals B2 and B4 on the drive).
- Fault information (Er for trip) and a code for the fault.

Spindle VFD Trip Reference

Trip Code	Condition	Likely Cause
UU	DC-BUS under-voltage.	This happens when the VFD is powered down.
OU	DC-BUS over-voltage.	Braking resistor failed open or wiring connection open between the VFD and the resistor. Resistance to measure 70 ohms.
OI.AC	VFD output instantaneous over current.	Phase to phase or phase to ground short on output of VFD to motor. This trip code cannot be reset until 10 seconds after the trip was initiated.
OI.br	Braking resistor instantaneous over current.	Braking resistor shorted or partially shorted out or short in wiring between the VFD and the resistor. Resistance to measure 70 ohms. Check brake resistor wiring.
It.br	I^2t (power) on braking resistor.	Excessive braking resistor energy caused by too frequent and too severe deceleration cycles or AC supply voltage too high.
It.AC	I^2t (power) on VFD output current (used to protect motor).	You are working the spindle motor too hard. Ensure that the spindle is not jammed or sticking. Consider running the spindle motor at half speed for 10 minutes with no load to cool the motor down.
Oht.C	VFD is working too hard and stops to cool power electronics down to prevent failure.	Spindle motor working too hard. Stop running the spindle but leave the VFD power on and let the power electronics cool down.
Oht.I	Heat sink temperature is too high because the VFD is working too hard and stops to cool power electronics down to prevent failure. Cabinet may also be too hot.	Spindle motor working too hard or it is too hot in work location. Stop running the spindle but leave the VFD power on and let the power electronics cool down. Check to see if the fan on the VFD is running and check filters on the cabinet. Cool work location down if required.
HF01 through HF23	Cooling fan is not cooling.	Failed drive.

7.16 OPERATOR CONSOLE TROUBLESHOOTING

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7.16.1 The Screen Doesn't Respond to Touch Inputs

Problem

The touch screen does not respond to touch inputs on all or part of the screen's surface.

Cause

The sensitivity setting for the touch controller is too low.

Solutions

You Might Need To...	Probability	How-To Steps	Need More?
Adjust touchscreen sensitivity.	High	<ol style="list-style-type: none"> 1. Verify that you have PathPilot v2.4.4 or higher installed on your controller. 2. From the PathPilot interface, in the MDI Line DRO field, type <code>ADMIN TOUCHSCREEN SENSITIVITY</code> <code>1000</code> and press Enter. You can use a value between 1 and 2047, but 1000 is generally sufficient for most shop spaces. 3. Verify that the touch screen responds to touch inputs. If it doesn't, go to the next step. 4. From the PathPilot interface, on the File tab, find the <code>pointercal.xinput</code> file and delete it. 5. Restart the PathPilot controller. The calibration utility displays. For now, skip this procedure. 6. From the PathPilot interface, in the MDI Line DRO field, type <code>ADMIN TOUCHSCREEN SENSITIVITY</code> <code>1000</code> and press Enter. 7. From the PathPilot interface, in the MDI Line DRO field, type <code>ADMIN TOUCHSCREEN</code> and press Enter. The calibration utility displays. Use your finger (not a mouse) to touch all four points that display on the screen. 	The touchscreen is a resistive type to prevent accidental triggering from drops of coolant on the screen. The resistive touchscreen may need its sensitivity adjusted when used in a shop space with very high or low humidity.

7: TROUBLESHOOTING

7.16.2 The Screen Doesn't Display an Image or Respond to Power Button

Problem

The console screen doesn't display an image or respond to the power button.

Cause

The console isn't receiving power.

Solutions

You Might Need To...	Probability	How-To Steps	Need More?
Examine power input to the console.	High	➤ Examine the green LED on the power brick for the console. If it's not lit, examine the power cords to the power brick.	If your console receives power from the Accessory Input ports on the machine, look for tripped breakers inside your machine's electrical cabinet.
Test the power button functionality.	Low	➤ Examine the green ring around the power button. It should light up when you press the power button.	

7.16.3 The Screen is Scrambled or Illegible

Problem

The console screen turns on, but is scrambled or illegible.

Cause

The BIOS isn't configured for the correct screen output.

Solutions

You Might Need To...	Probability	How-To Steps	Need More?
Configure the display output settings in BIOS.	High	<ol style="list-style-type: none"> 1. Connect a VGA monitor to the console. 2. Power the console on and select the Delete key to enter the BIOS. 3. From the Advanced tab, select Display Configuration. 4. Configure the display as follows: <ul style="list-style-type: none"> • Primary IGFX Boot Display: Auto • LCD Panel Type: 1280x1024 LVDS • Panel Channel: Dual Channel • Panel Color Depth: 24 Bit 5. Select the Esc key, go to Save and Exit, and select Save Changes and Reset. 	This configuration problem can occur if your console has a CMOS battery failure. Replace the battery if it reoccurs.

7.16.4 The Knobs Don't Respond

Problem

The RPM, Feed Override, or Max Velocity knobs don't respond or aren't smooth.

Cause

The ribbon cable connecting the knobs is disconnected or the circuit board is damaged.

Solutions

You Might Need To...	Probability	How-To Steps	Need More?
Examine the connectors on the ribbon cable.	High	<ol style="list-style-type: none"> 1. Remove the rear panel of the console. 2. Examine the connectors on both ends of the cable going from J4 on the control board to the potentiometer board. 	Shipping can sometime cause connectors to become loose. Re-seating the connectors will usually fix non-responsive override knobs.

7: TROUBLESHOOTING

You Might Need To...	Probability	How-To Steps	Need More?
Examine the USB connection to the control board.	High	<ol style="list-style-type: none"> 1. Remove the rear panel of the console. 2. Examine the USB cable going from the header on the computer motherboard to connector J12 on the control board. 	Verify that the power LED on the console control board lights up when the console is turned on. If it doesn't light up, and you have confirmed the USB connection, replace the control board (PN 39146).

7.16.5 The Buttons Don't Respond

Problem

The Cycle Start or Feed Hold buttons don't respond.

Cause

The control board is disconnected or the wires to the buttons are loose.

Solutions

You Might Need To...	Probability	How-To Steps	Need More?
Examine the wiring to the buttons.	High	<ol style="list-style-type: none"> 1. Remove the rear panel of the console. 2. Examine the wire inputs to connector J13 on the control board. If any wires are loose, tighten the screw terminals. 3. Using a continuity tester, measure the resistance between terminals 1 and 2 when Feed Hold is pressed and 3 and 4 when Cycle Start is pressed. <ul style="list-style-type: none"> • If there's continuity at the terminals on the control board and the buttons still don't work, examine the USB cable to the control board. • If there's not continuity at the terminals when the buttons are pressed, remove the lower rear panel of the console and examine the screw terminals on the rear of the buttons themselves. 	Shipping can sometime cause wire terminals to become loose. Re-seating the wires will usually fix non-responsive buttons. If you have tested all terminals and the buttons still don't have continuity when pressed, replace the buttons: <ul style="list-style-type: none"> • Feed Hold Button (PN 37363) • Cycle Start Button (PN 37362)
Examine the USB connection to the control board.	High	<ol style="list-style-type: none"> 1. Remove the rear panel of the console. 2. Examine the USB cable going from the header on the computer motherboard to connector J12 on the control board. 	Verify that the power LED on the console control board lights up when the console is turned on. If it doesn't light up and you have confirmed the USB connection, replace the control board (PN 39146).

DIAGRAMS AND PARTS LISTS

IN THIS SECTION, YOU'LL LEARN:

- About this machine's components.

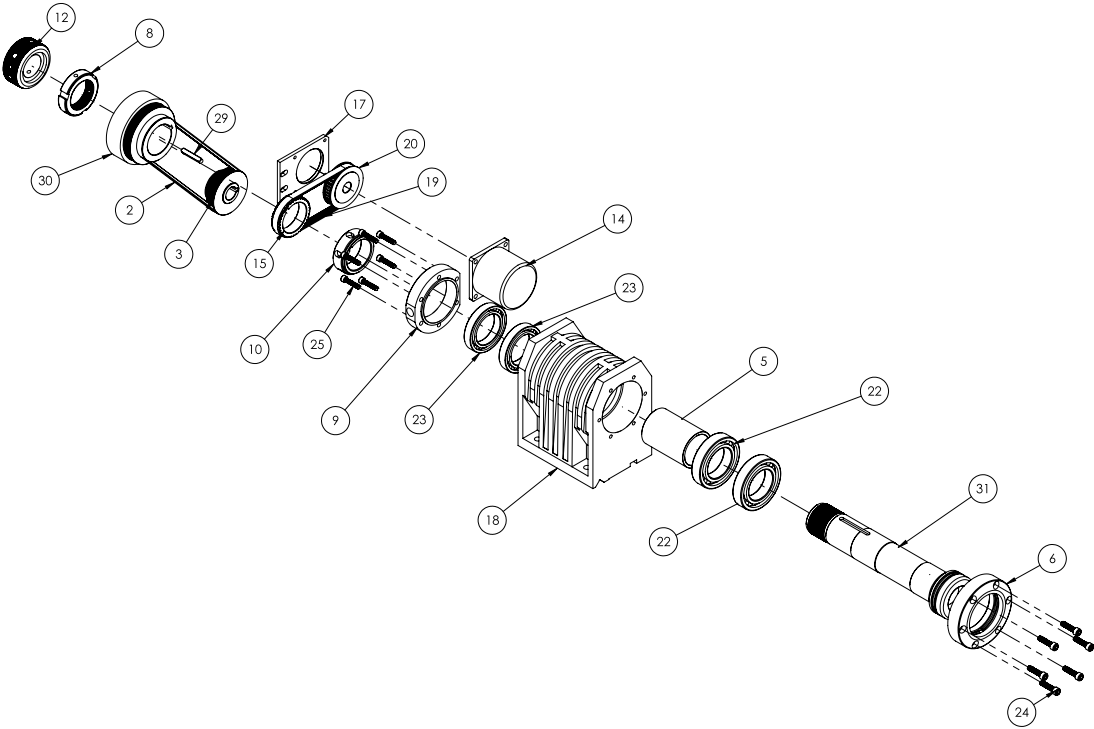
NOTICE! Only use Tormach-approved parts when making replacements. If you don't replace parts with those listed in this section, you may void your warranty.

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7: DIAGRAMS AND PARTS LISTS

7.17 HEADSTOCK EXPLODED VIEW

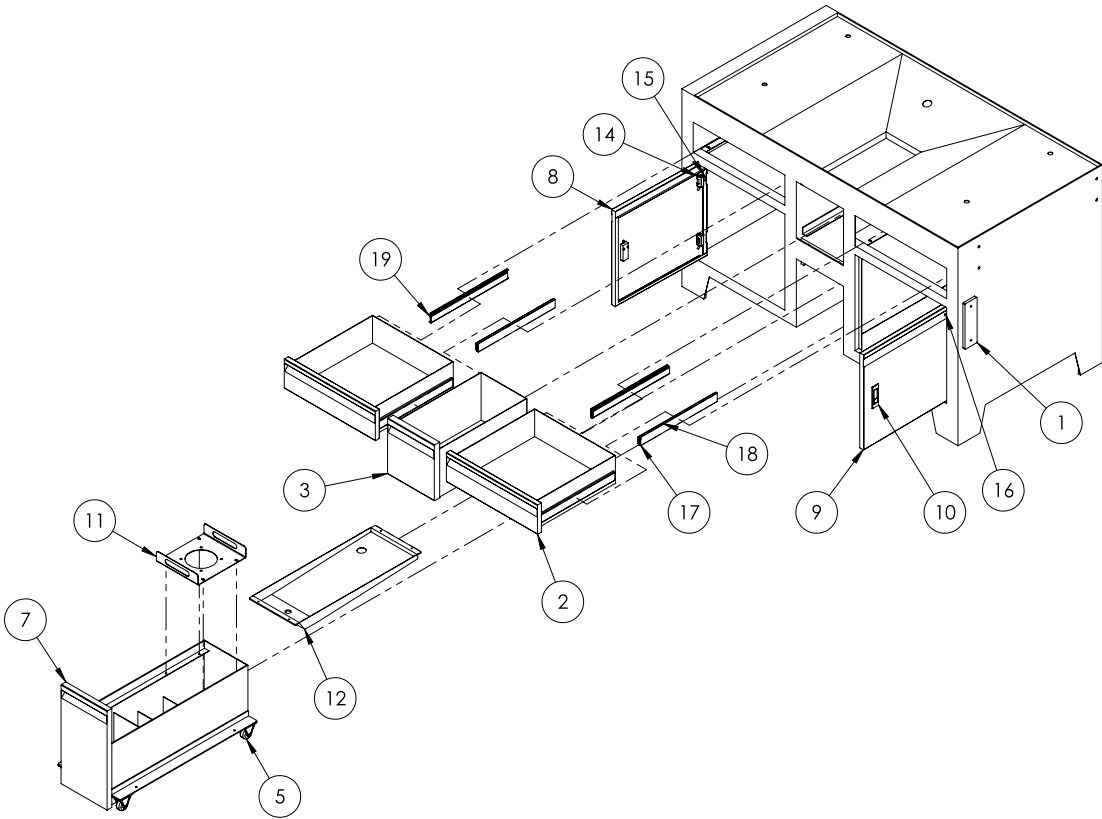


7.18 HEADSTOCK PARTS LIST

ID	Description	Quantity
2	Spindle Belt, 8L (PN 37832)	1
3	Spindle Motor Pulley (PN 37830)	1
4	Spindle (PN 37837)	1
5	Spacer (PN 37838)	1
6	Spindle Front Retainer (PN 37835)	1
7	Spacer (PN 37843)	1
8	Spindle Retainer (PN 37844)	1
9	Spindle Rear Retainer (PN 37836)	1
10	Spindle Lock Ring (PN 37845)	1
11	Spacer (PN 37842)	1
12	Draw Tube Knob (PN 37841)	1
13	Collet Draw Tube (PN 37839)	1
14	Spindle Encoder (PN 37826)	1
15	Encoder Spindle Shaft Pulley (PN 37840)	1
16	Spindle Pulley (PN 37831)	1
17	Spindle Encoder Mounting Plate (PN 37829)	1
18	Headstock Frame (PN 37824)	1
19	Spindle Encoder Belt (PN 37833)	1
20	Encoder Pulley (PN 37834)	1
21	8L Drawtube Assembly (PN 51892)	1
22	Rolling Bearings 6009 (PN 51043)	2
23	Rolling Bearings 61909 (PN 51044)	2
24	M6 × 25 Screw (PN 51039)	6
25	M5 × 25 Screw (PN 51045)	6
26	M5 × 5 Screw (PN 51046)	2
27	M6 × 8 Screw (PN 51047)	3
28	M6 × 6 Screw (PN 51048)	3
29	6 × 36 Key (PN 51049)	1
30	Spindle Pulley (PN 37853)	1
31	Spindle (PN 37852)	1

7: DIAGRAMS AND PARTS LISTS

7.19 STAND EXPLODED VIEW

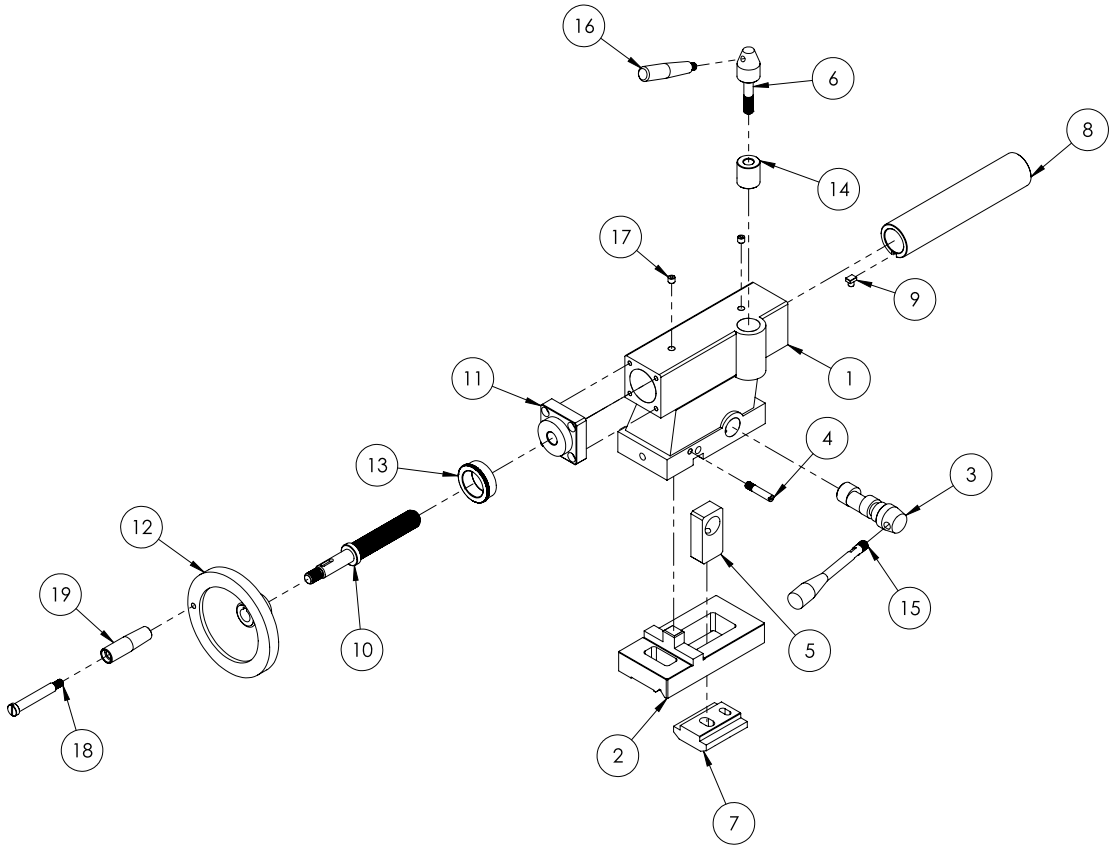


7.20 STAND PARTS LIST

ID	Description	Quantity
1	Machine Stand Frame (PN 50553)	1
2	Machine Stand Drawer (PN 50554)	2
3	Machine Stand Chip Drawer (PN 50555)	1
4	Coolant Tank Plug Bung (PN 50566)	1
5	Coolant Tank Caster (PN 50567)	4
6	Coolant Tank Plug (PN 50565)	1
7	Coolant Tank (PN 50563)	1
8	Left Stand Door (PN 50557)	1
9	Right Stand Door (PN 50558)	1
10	Door Latch (PN 50561)	2
11	Coolant Pump Flange (PN 50564)	1
12	Coolant Funnel in Stand (PN 50559)	1
13	Stand Shelf (PN 50556)	2
14	Door Hinge (PN 505601)	4
15	Stand Hinge (PN 505602)	4
16	Hinge Pin (PN 505603)	4
17	Drawer Slide Out (PN 505621)	4
18	Drawer Slide Inner (PN 505622)	4
19	Drawer Slide Bearing (PN 505623)	4

7: DIAGRAMS AND PARTS LISTS

7.21 TAILSTOCK EXPLODED VIEW

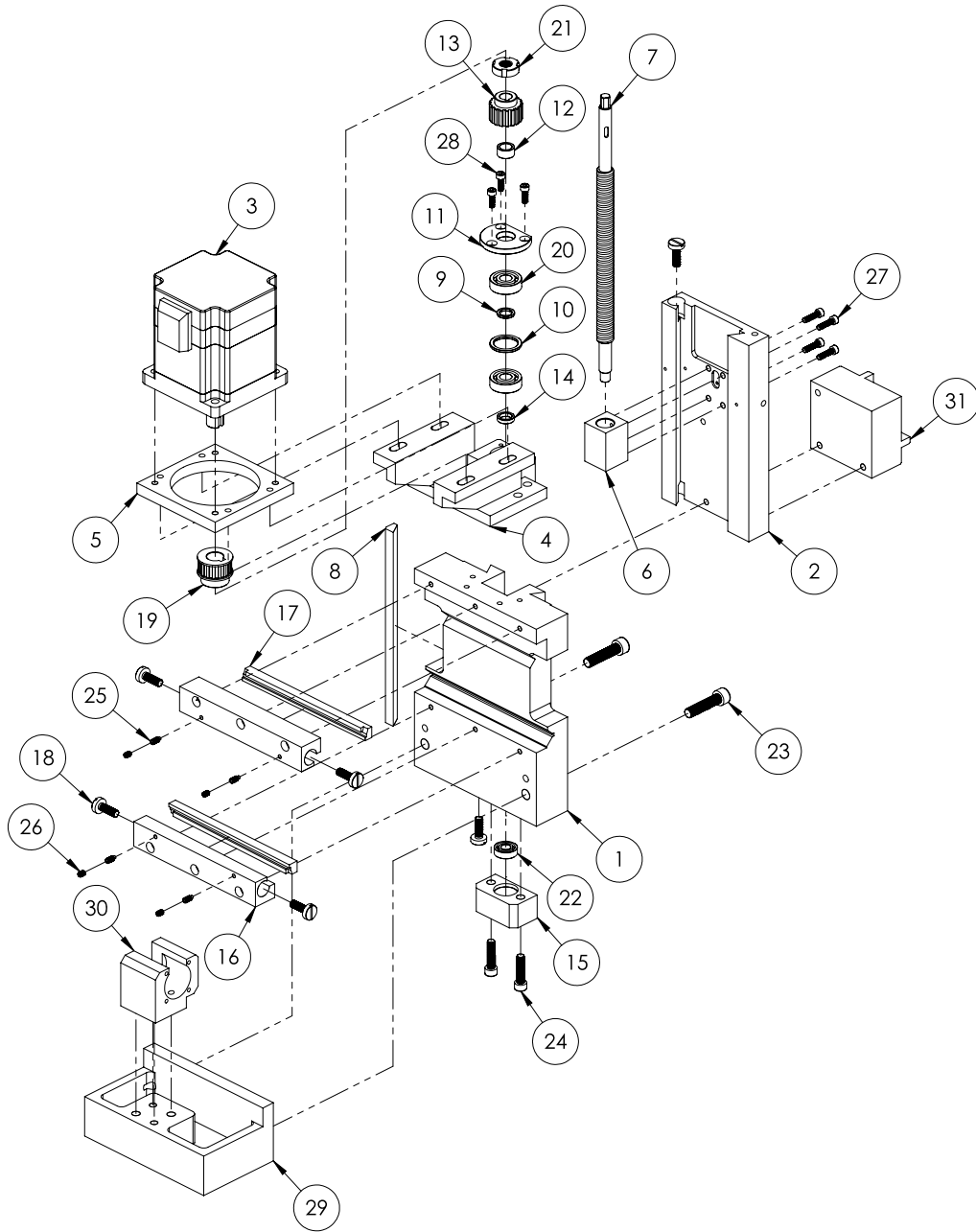


7.22 TAILSTOCK PARTS LIST

ID	Description	Quantity
1	Tailstock Frame (PN 37805)	1
2	Tailstock Base (PN 37806)	1
3	Tailstock Location Cam (PN 37821)	1
4	Fastner (PN 37823)	1
5	Tailstock Lock (PN 37822)	1
6	Tailstock Slide Lock (PN 37816)	1
7	Tailstock Location Lock Block (PN 37819)	1
8	MT2 Adapter (PN 37807)	1
9	Slide Guide (PN 37818)	1
10	Tailstock Slide Screw (PN 37811)	1
11	Tailstock Slide Screw Nut (PN 37808)	1
12	Hand Wheel (PN 37809)	1
13	Graduation Wheel (PN 37810)	1
14	Slide Lock Mount (PN 37817)	1
15	Tailstock Location Lock Handle (PN 37820)	1
16	Tailstock Handle (PN 37815)	1
17	Spring Plunger (PN 37814)	2
18	Shoulder Screw (PN 37813)	1
19	Tailstock Wheel Handle (PN 37812)	1

7: DIAGRAMS AND PARTS LISTS

7.23 X-AXIS EXPLODED VIEW

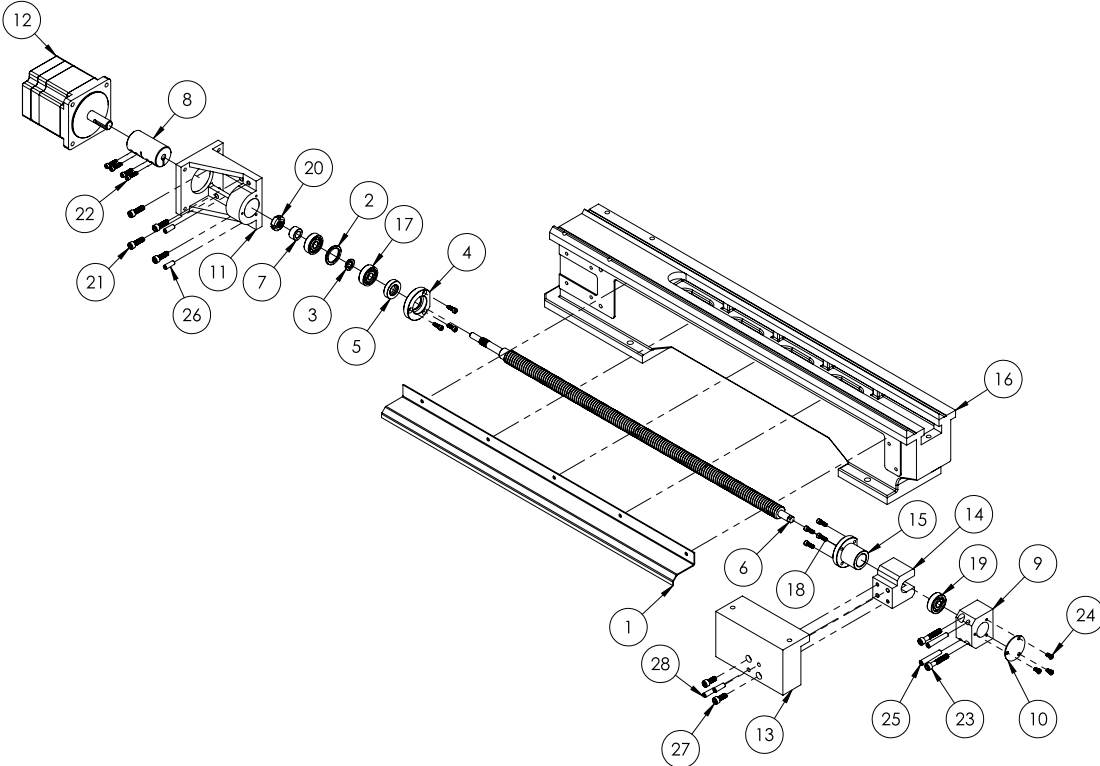


7.24 X-AXIS PARTS LIST

ID	Description	Quantity
1	X-Axis Base (PN 37780)	1
2	X-Axis Slide (PN 37781)	1
3	Stepper Motor (PN 39533)	1
4	X-Axis Motor Mount (PN 37782)	1
5	X-Axis Motor Adjustment Plate (PN 37784)	1
6	X-Axis Ball Screw Nut (PN 37793)	1
7	X-Axis Ball Screw, 160 mm Long (PN 37792)	1
8	X-Axis Gib (PN 37787)	1
9	Spacer, 2 THK, 10 ID × 14.5 OD (PN 37796)	1
10	X-Axis Ball Screw Bearing Spacer (PN 37789)	1
11	X-Axis Ball Screw Retainer (PN 37788)	1
12	Spacer, 7.5 THK, 10 ID × 14.5 OD (PN 37797)	1
13	X-Axis Ball Screw Pulley (PN 37790)	1
14	Spacer, 3.5 THK, 10 ID × 14 OD (PN 37795)	1
15	X-Axis Ball Screw Support (PN 37794)	1
16	Gib Retainer, Z-Axis, 8L Lathe (PN 37785)	2
17	Gib, Z-Axis, 8L Lathe (PN 37786)	2
18	Gib Adjustment Screw, Z-Axis, 8L Lathe (PN 37799)	6
19	X-Axis Motor Pulley (PN 37849)	1
20	Rolling Bearing S7200 (PN 51026)	2
21	M10 × 1 Lock Nut (PN 51027)	1
22	Rolling Bearings 619-8 GB 276-94 (PN 51037)	1
23	M8 × 35 Socket Head Cap Screw (PN 51038)	2
24	M6 × 25 Screw (PN 51039)	2
25	M4 × 8 Set Screw (PN 51040)	4
26	M4 × 6 Set Screw (PN 51041)	4
27	M4 × 16 Socket Head Cap Screw (PN 51042)	4
28	M4 × 12 Screw (PN 51025)	3
29	Z-Axis Carriage Mount (PN 37769)	1
30	Z-Axis Ball Screw Block (PN 37768)	1
31	Quick Change Tool Post Mount (PN 50603)	1

7: DIAGRAMS AND PARTS LISTS

7.25 Z-AXIS EXPLODED VIEW



7.26 Z-AXIS PARTS LIST

ID	Description	Quantity
1	Ball Screw Shield (PN 37851)	1
2	Z-Axis Ball Screw Spacer (PN 37776)	1
3	Z-Axis Spacer (PN 37850)	1
4	Ball Screw Plate (PN 37775)	1
5	Z-Axis Ball Screw Seal (PN 37772)	1
6	Z-Axis Ball Screw, 555 mm (PN 37771)	1
7	Z-Axis Spacer (PN 37779)	1
8	Ball Screw Coupler (PN 37773)	1
9	Z-Axis Ball Screw Support (PN 37765)	1
10	Ball Screw Cover (PN 37766)	1
11	Z-Axis Motor Mount (PN 37764)	1
12	Stepper Motor (PN 39533)	1
13	Z-Axis Carriage Mount (PN 37769)	1
14	Z-Axis Ball Screw Block (PN 37768)	1
15	Z-Axis Ball Screw Nut (PN 37770)	1
16	Z-Axis Way (PN 37763)	1
17	Rolling Bearing S7200 (PN 51024)	2
18	M4 × 12 Screw (PN 51025)	7
19	Rolling Bearings Ball Screw (PN 51026)	1
20	M10 × 1 Lock Nut (PN 51027)	1
21	M6 × 20 Screw (PN 51028)	4
22	M4 × 16 Screw (PN 51029)	4
23	M6 × 35 Screw (PN 51030)	2
24	M4 × 8 Phillips head screw (PN 51031)	3
25	6 × 40 Taper Pin (PN 51032)	2
26	6 × 18 Taper Pin (PN 51033)	2
27	M6 × 16 Screw (PN 51034)	2
28	6 × 20 Taper Pin (PN 51035)	2



ELECTRICAL SCHEMATICS

IN THIS SECTION, YOU'LL LEARN:

- About the electrical schematics for this machine's electronics.

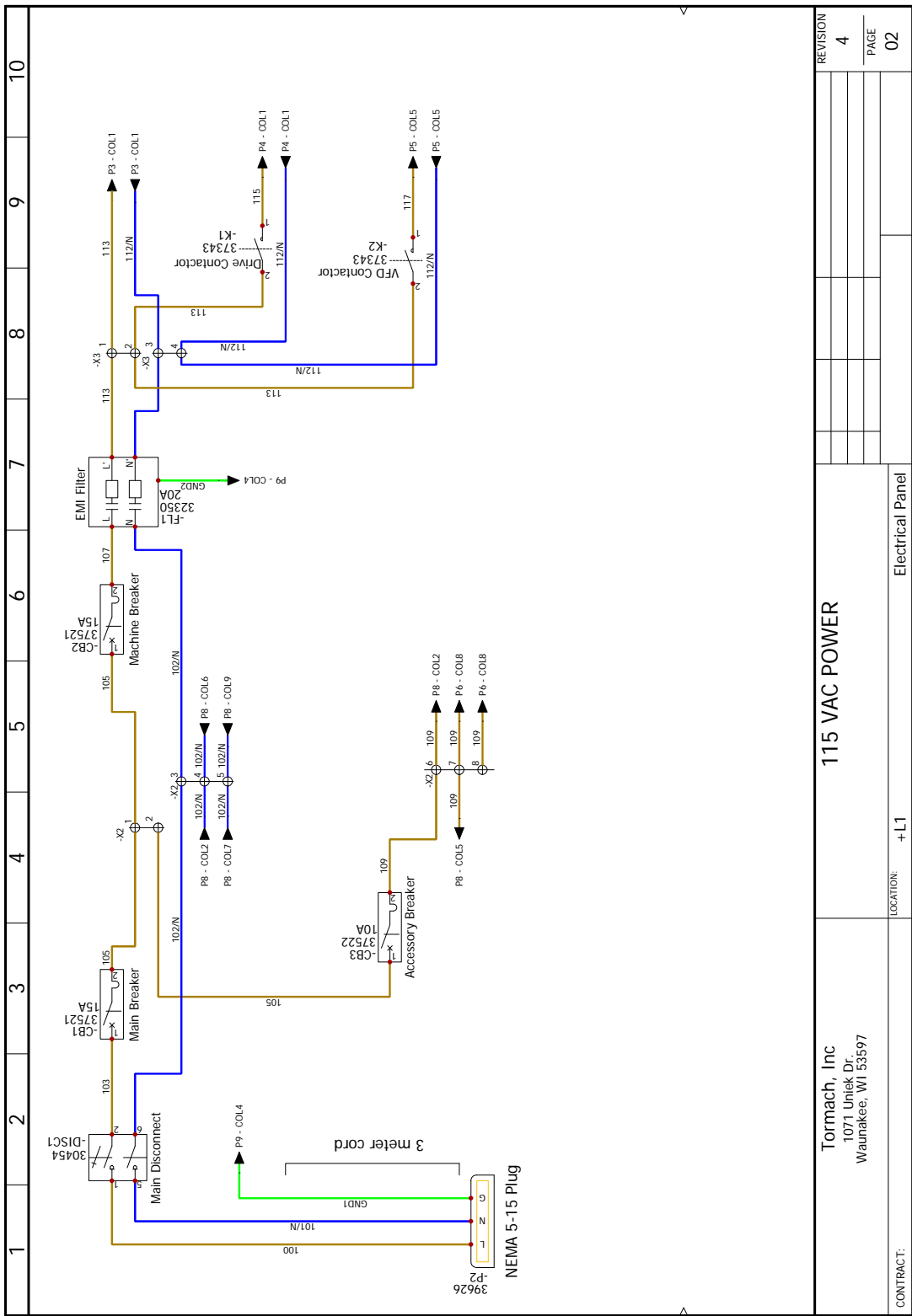
The electrical schematic varies by serial number. Identify your machine's serial number (on the right-hand side of the machine, near the Main Disconnect switch). If the serial number is **10506 or higher**, refer to the electrical schematics in this manual. If the serial number is **10505 or lower**, refer to [Tormach document TD10829](#).

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7: ELECTRICAL SCHEMATICS

7.27 115 VAC POWER (SHEET 2)



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115 VAC POWER

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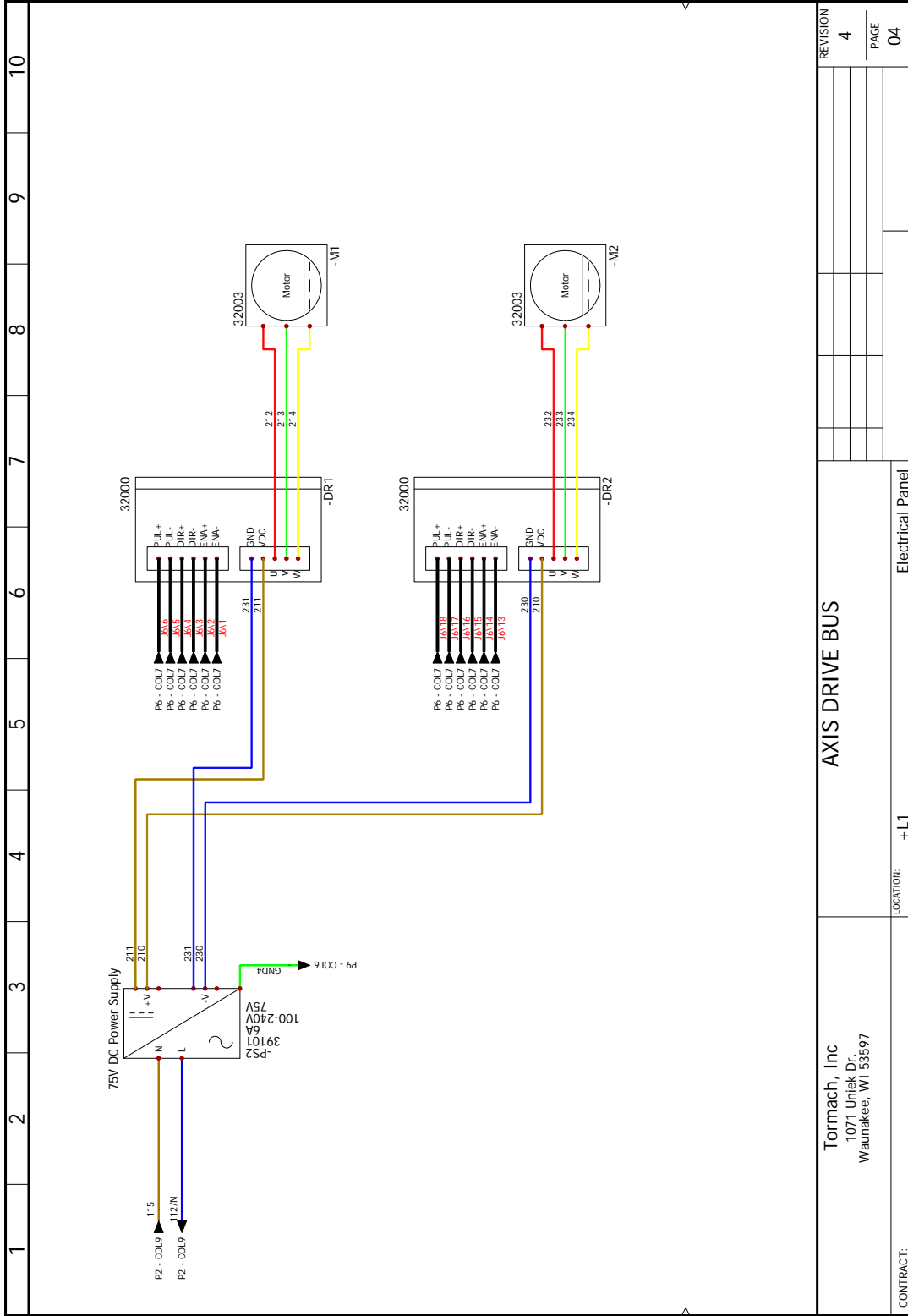
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7.29 AXIS DRIVE BUS (SHEET 4)



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AXIS DRIVE BUS

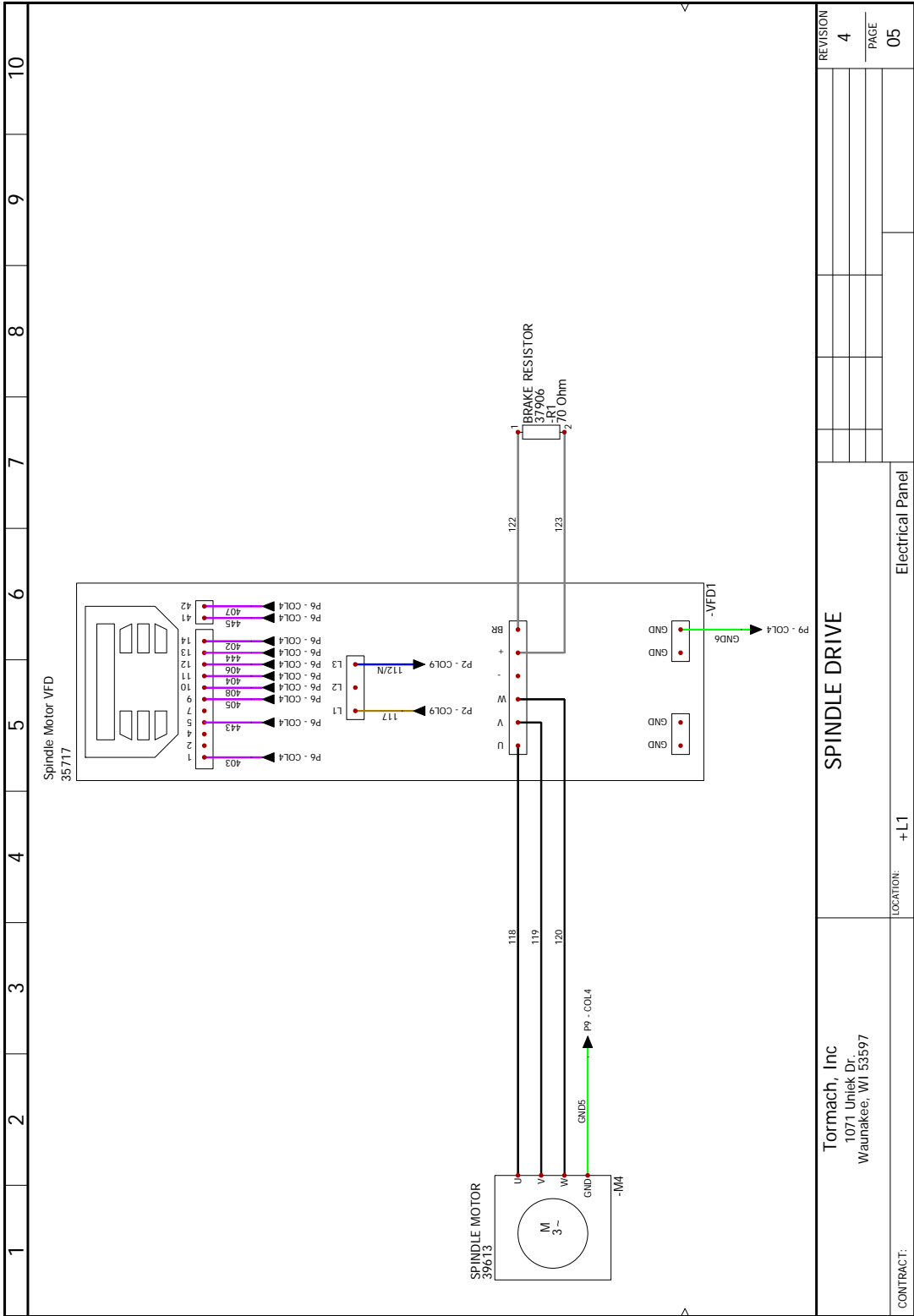
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7.30 SPINDLE DRIVE (SHEET 5)

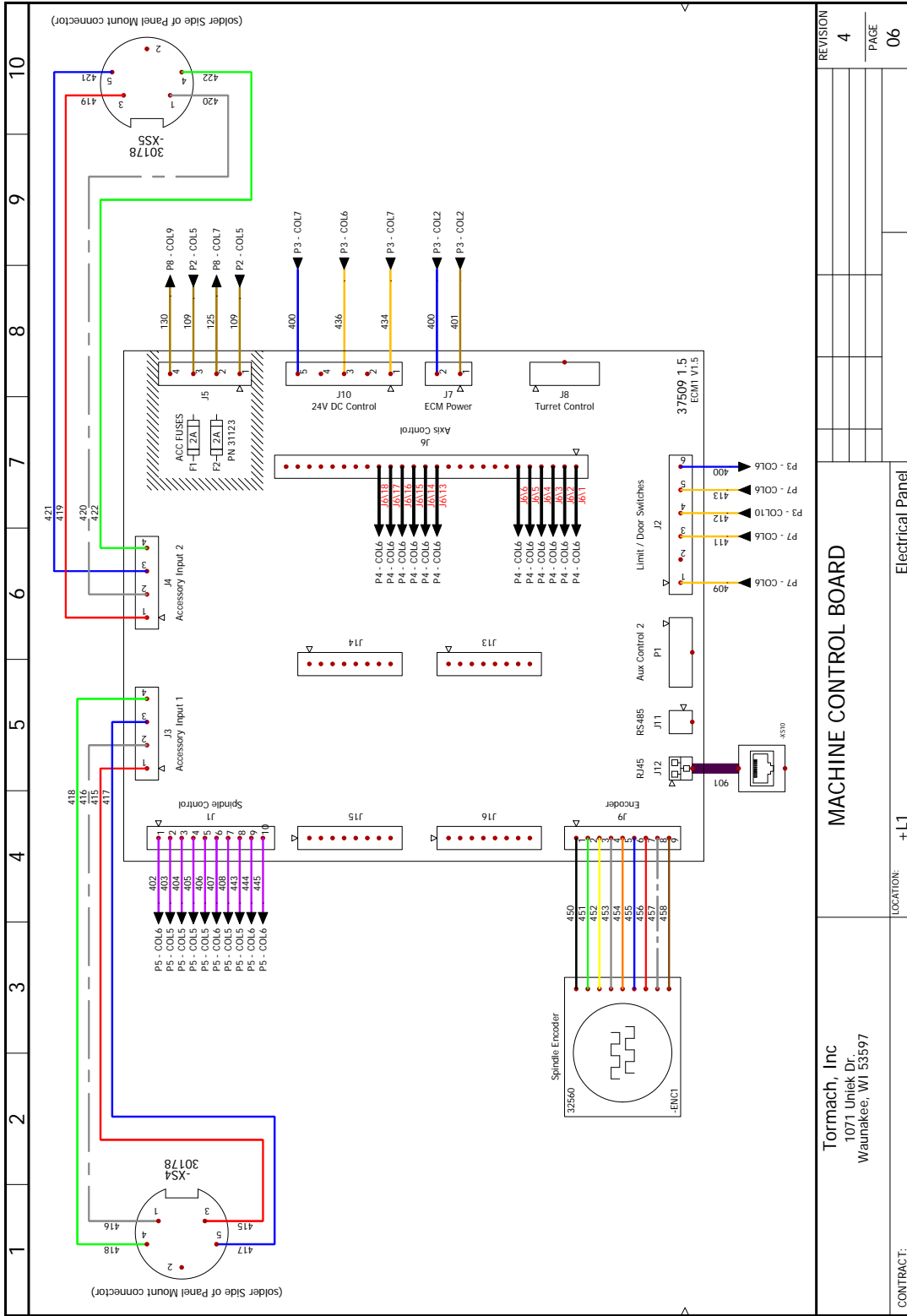


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SPINDLE DRIVE	
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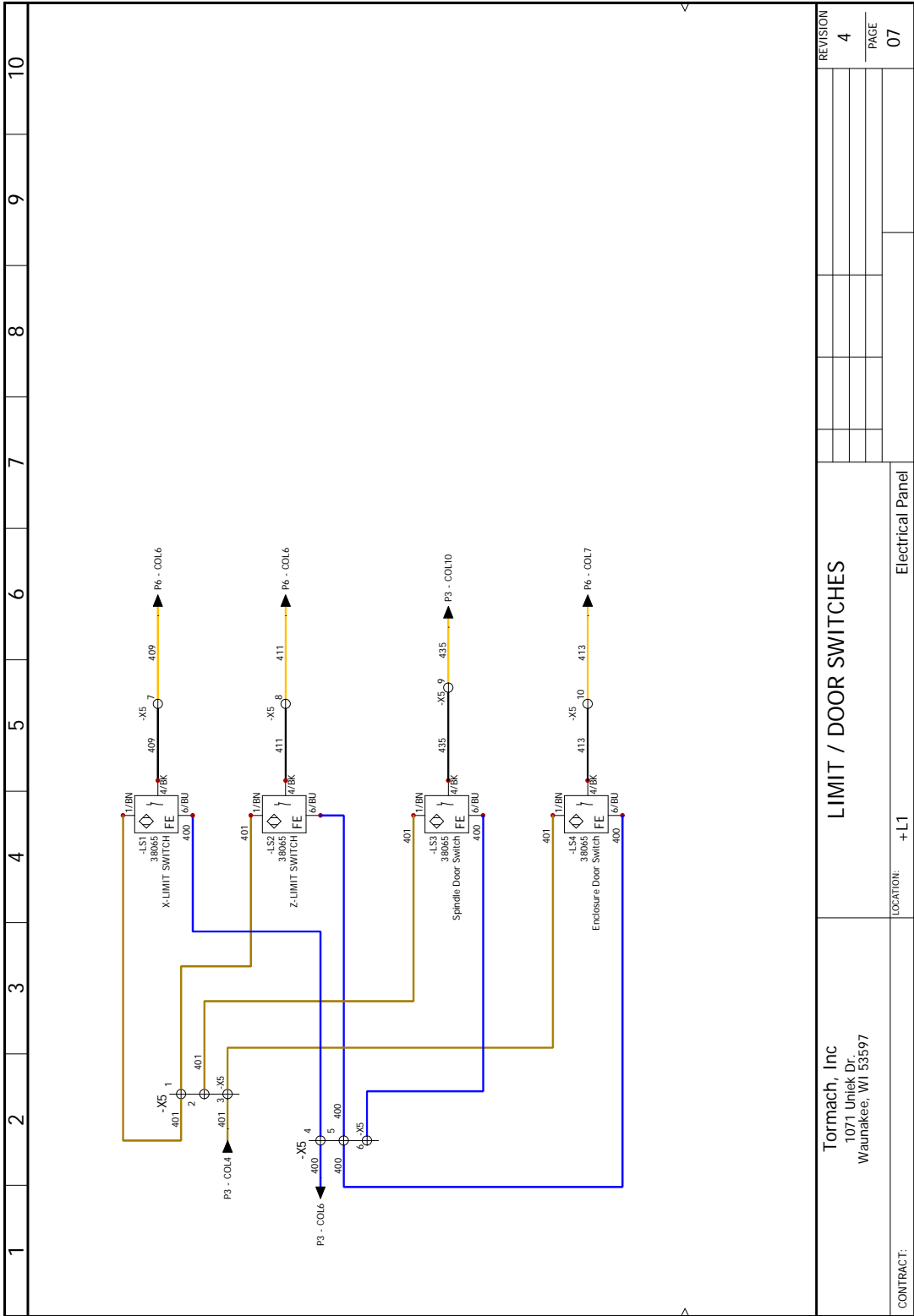
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7.31 MACHINE CONTROL BOARD (SHEET 6)



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7.32 LIMIT/DOOR SWITCHES (SHEET 7)

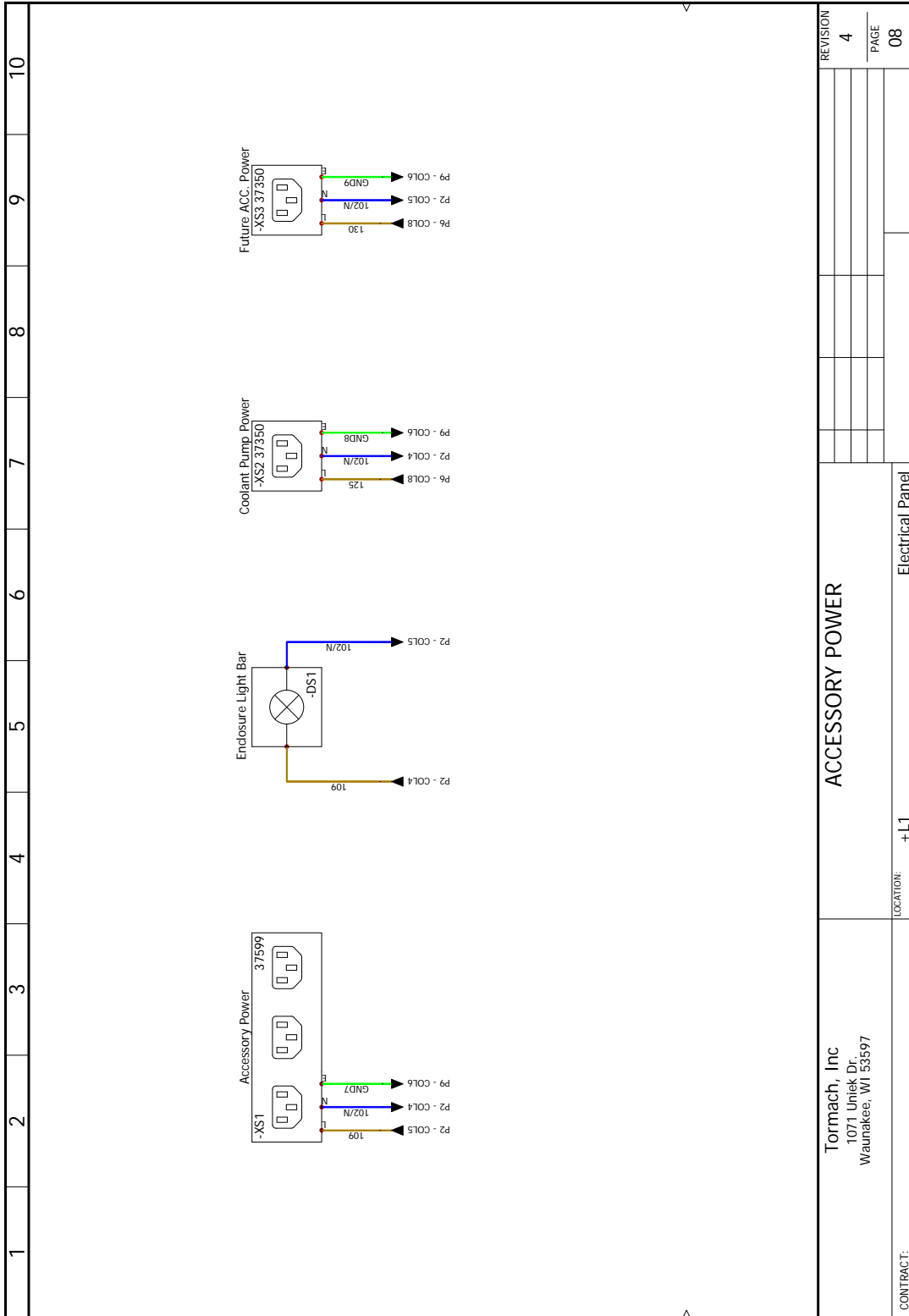


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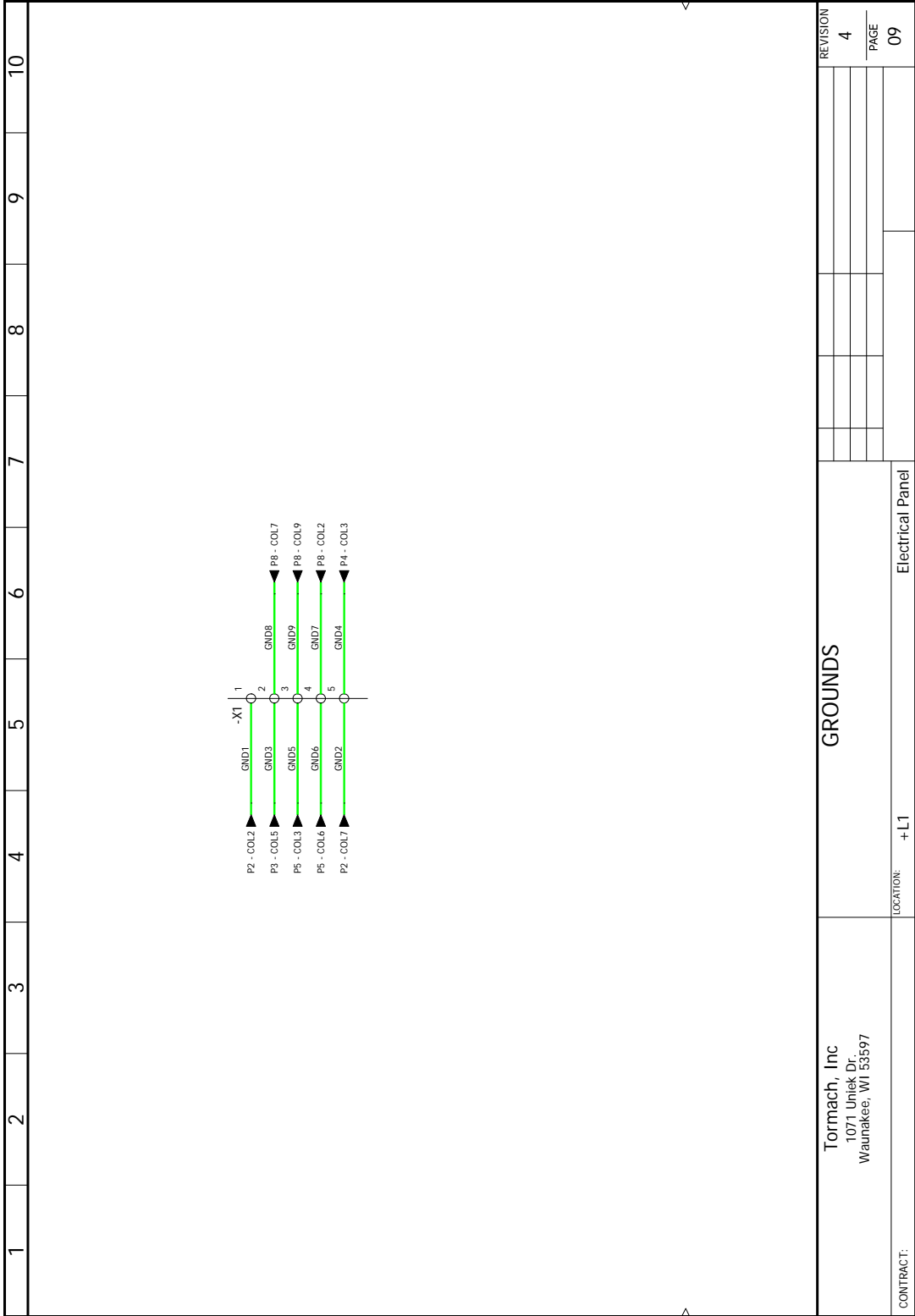
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7.33 ACCESSORY POWER (SHEET 8)



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7.34 GROUNDS (SHEET 9)



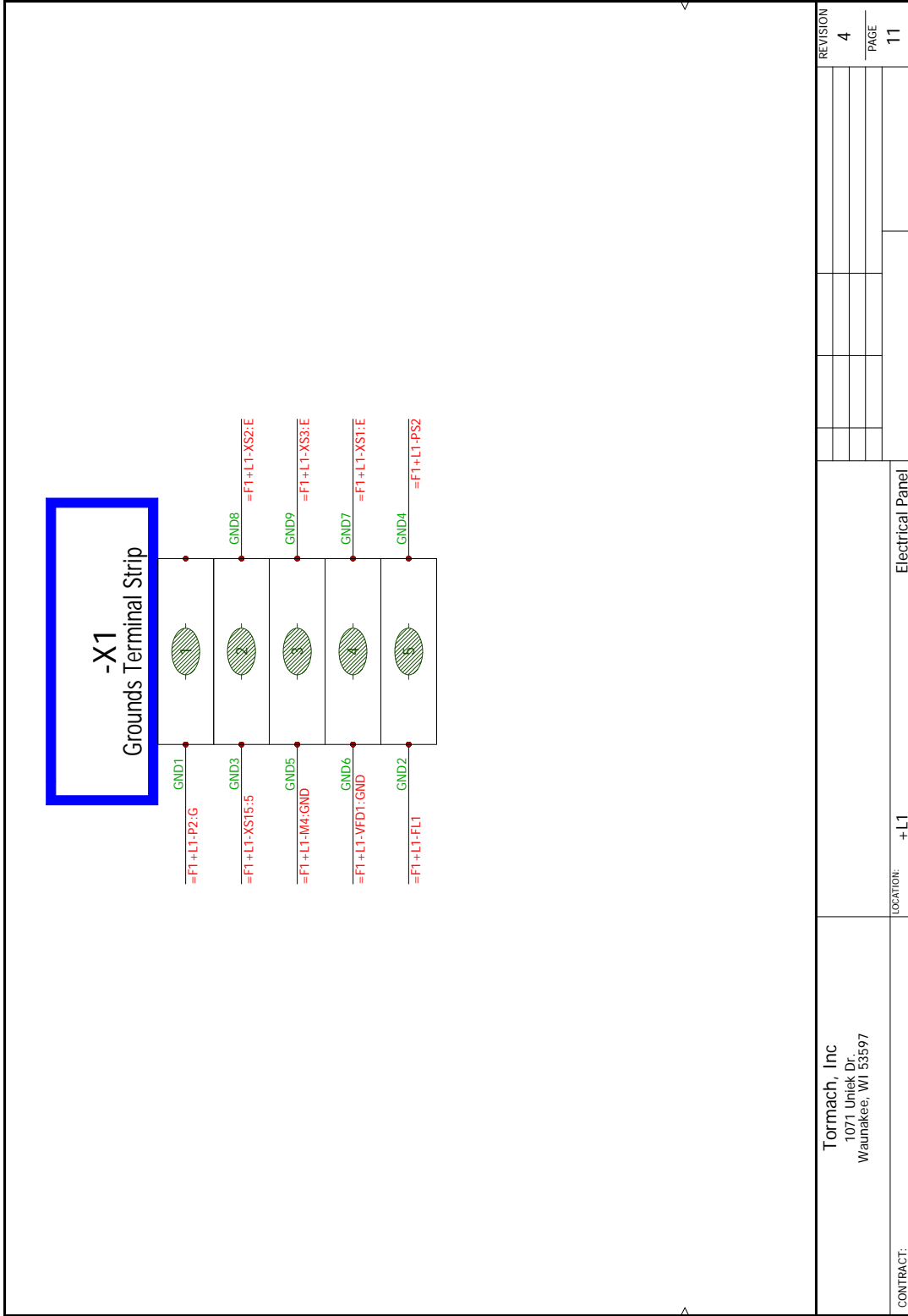
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7: ELECTRICAL SCHEMATICS

7.35 GROUNDS TERMINAL STRIP (SHEET 11)



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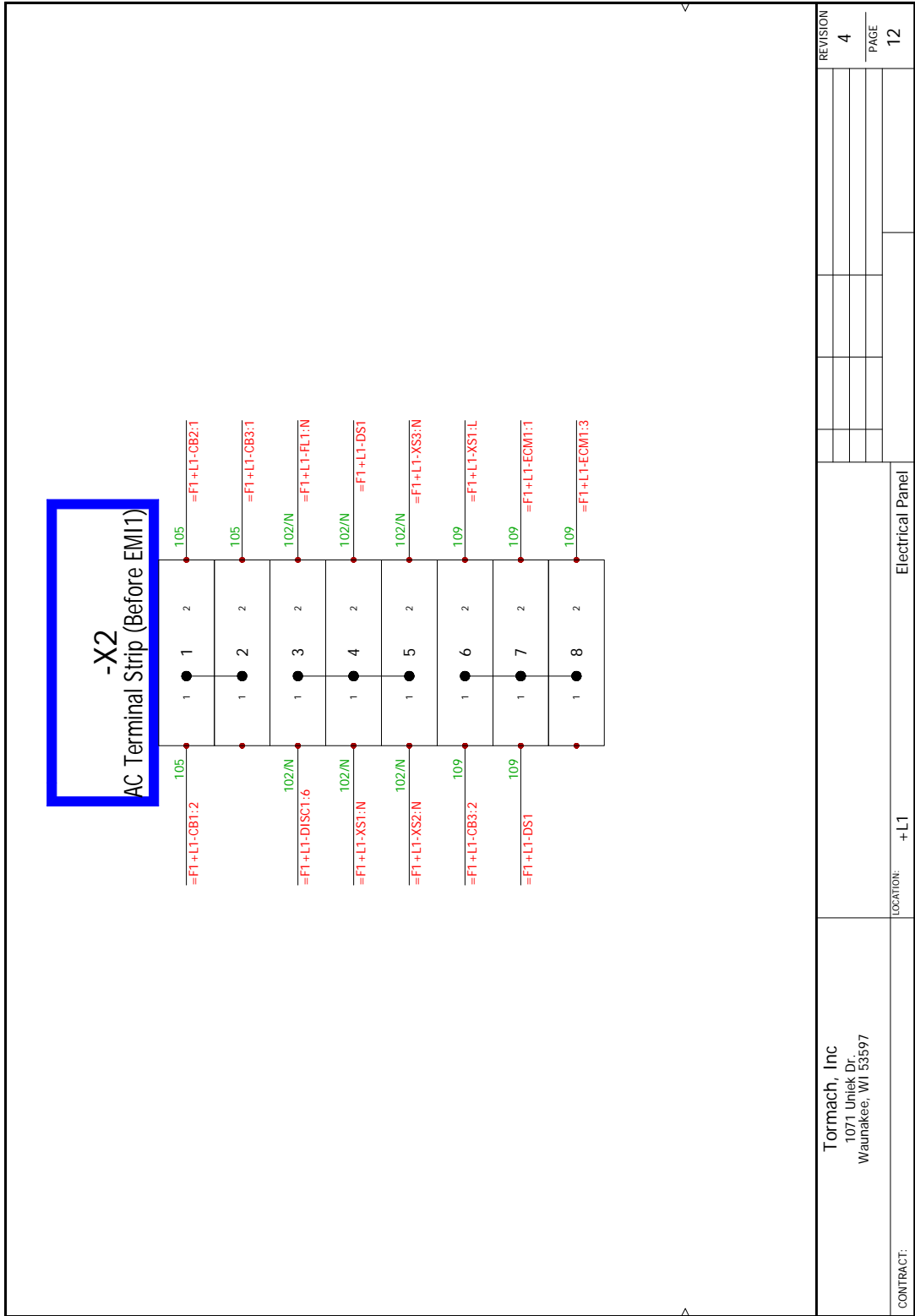
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7.36 AC TERMINAL STRIP (BEFORE EMI1) (SHEET 12)



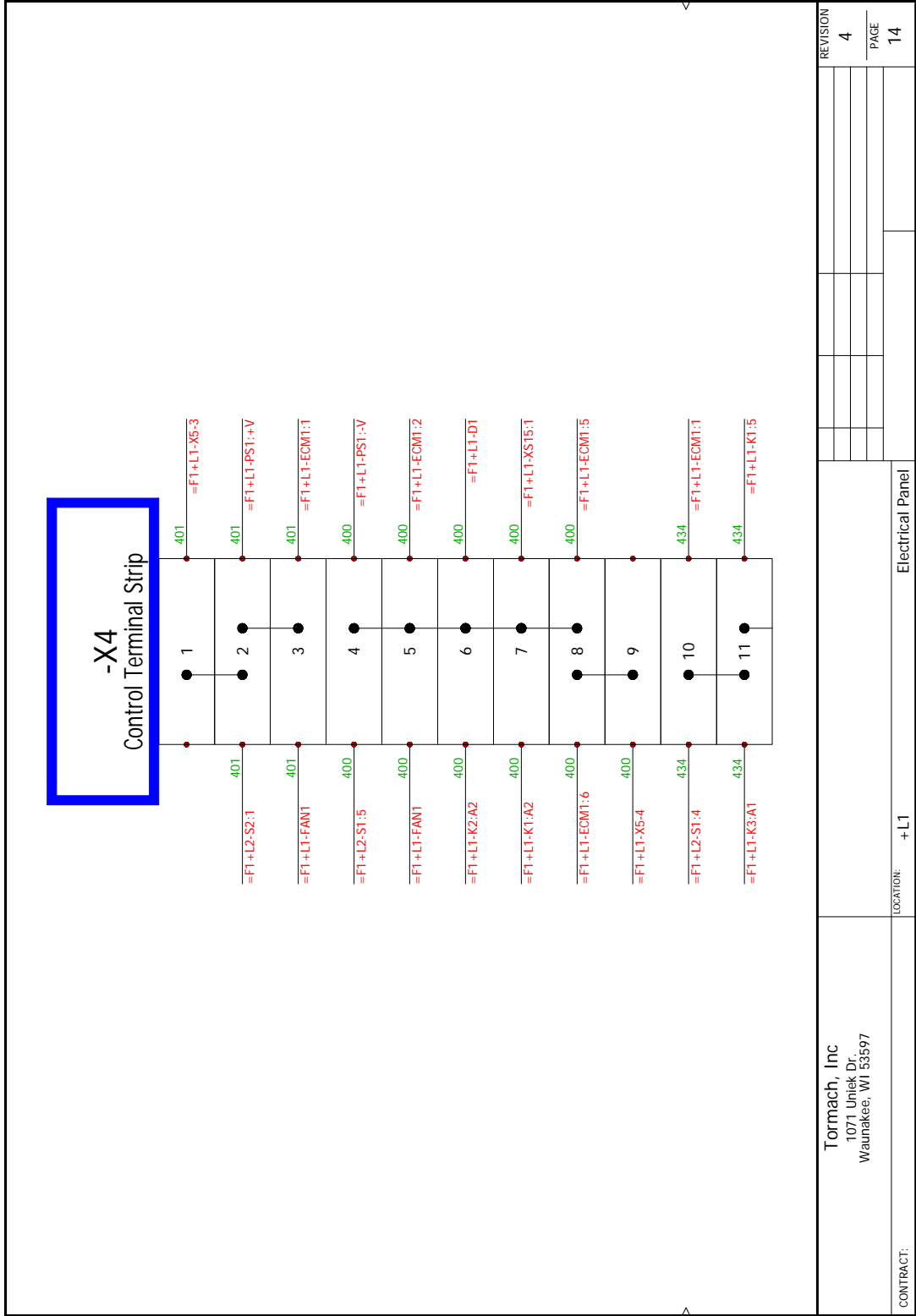
-X2
AC Terminal Strip (Before EMI1)

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7.38 CONTROL TERMINAL STRIP (SHEETS 14-16)

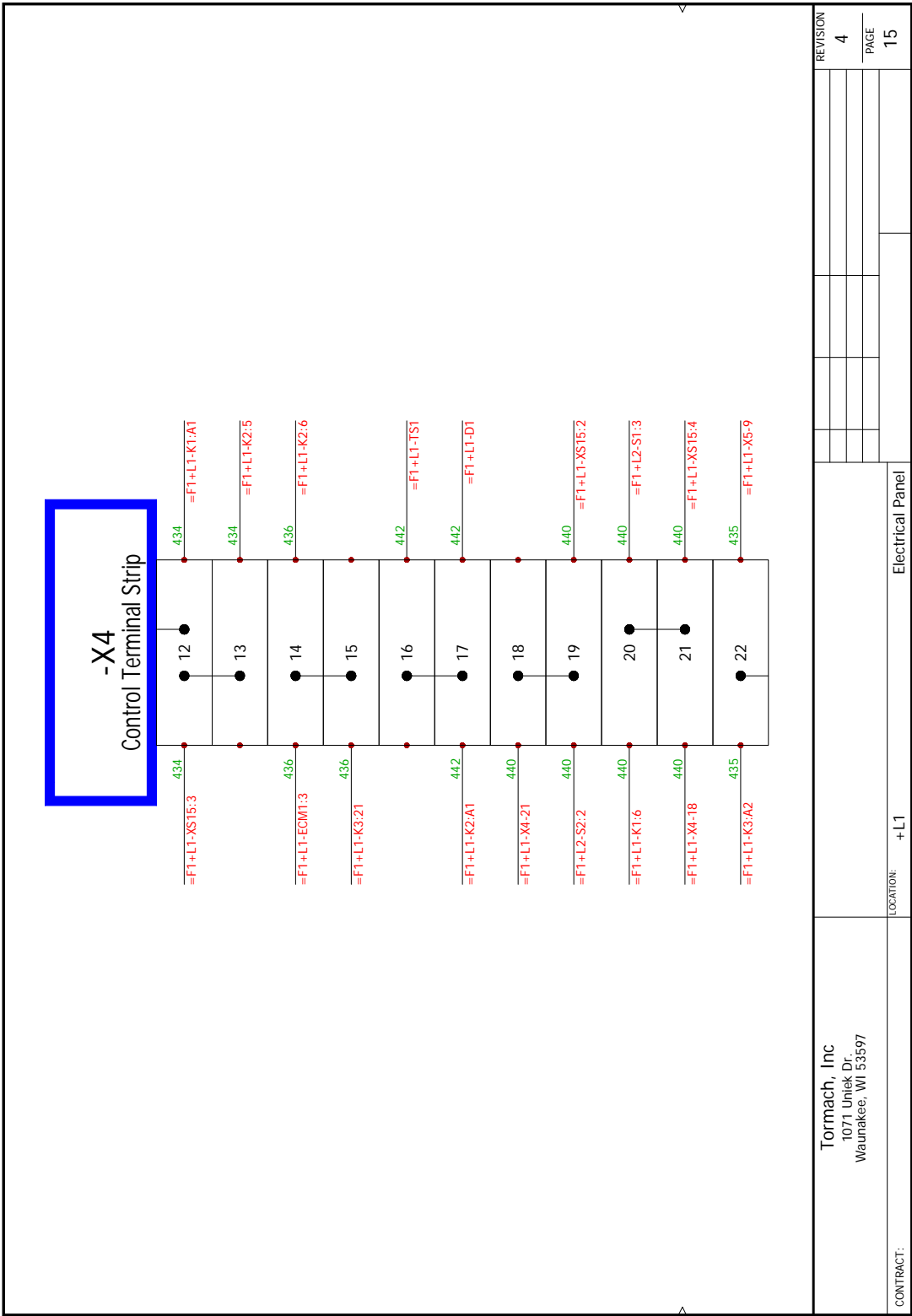


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7: ELECTRICAL SCHEMATICS



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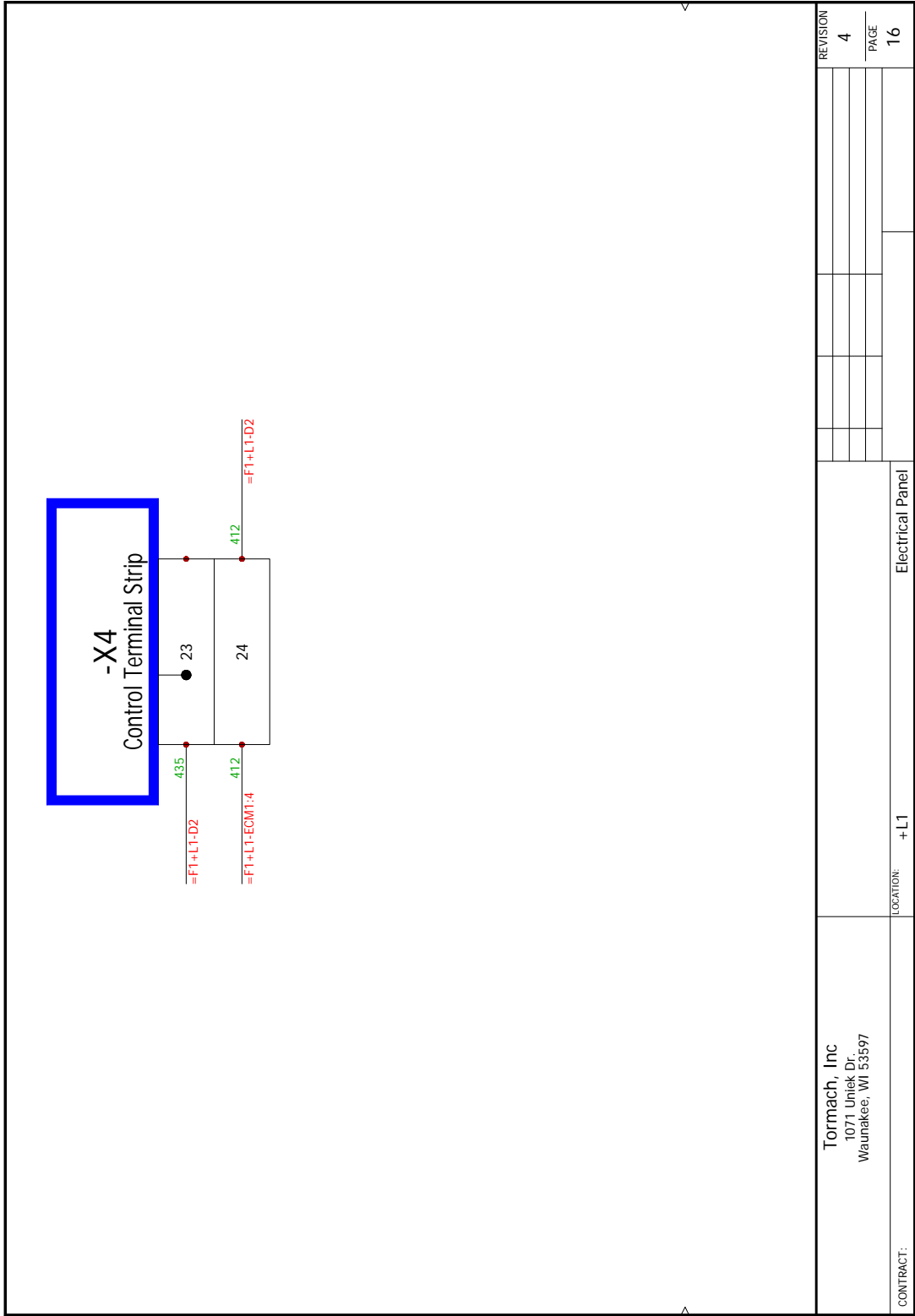
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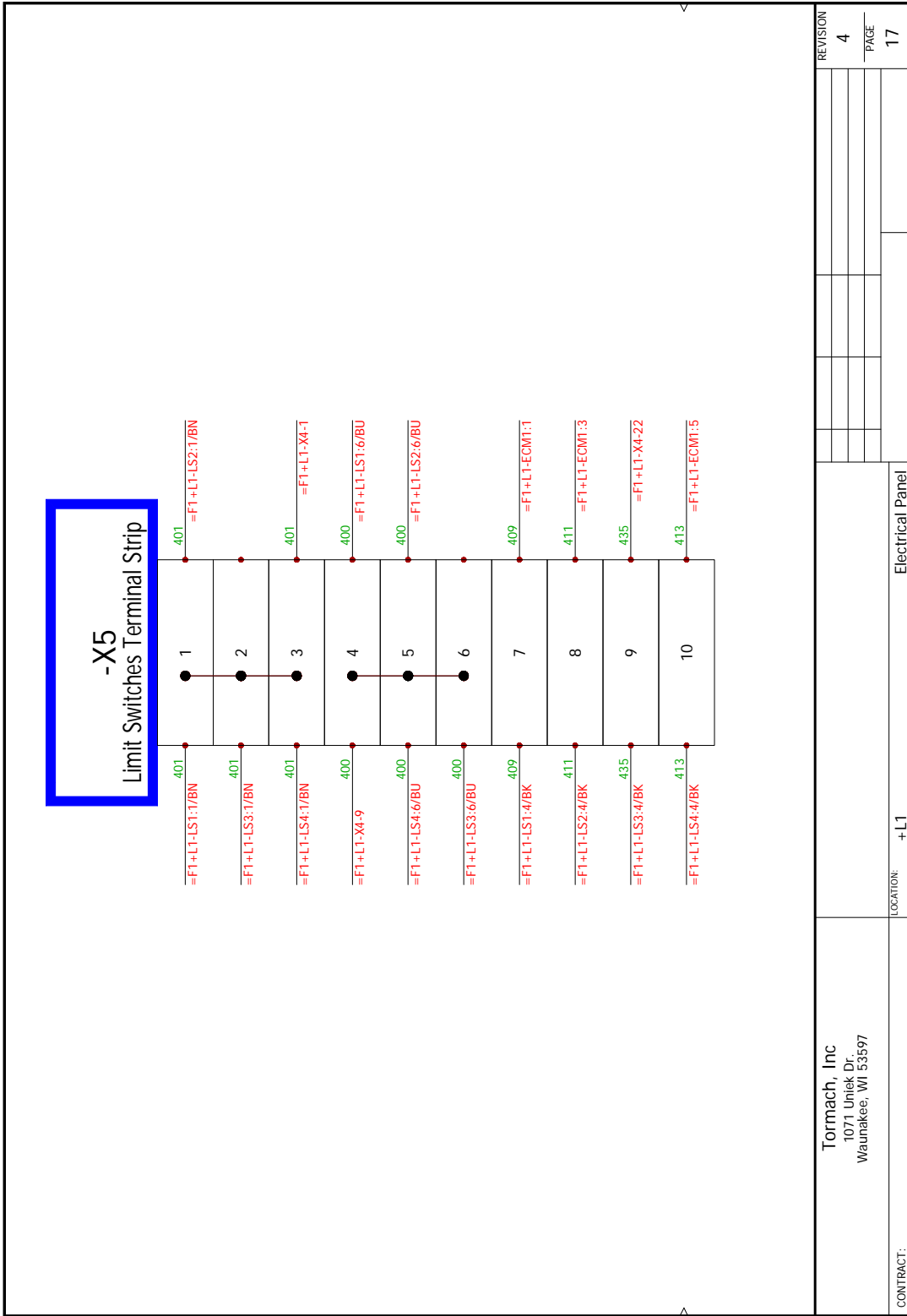


Tormach, Inc 1071 Uniek Dr Waunakee, WI 53597		Electrical Panel	
CONTRACT:		LOCATION: +L1	
<small>Document created with version: 2022-03-16</small>			
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7: ELECTRICAL SCHEMATICS

7.39 LIMIT SWITCHES TERMINAL STRIP (SHEET 17)



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LOCATION:

+ L1

Electrical Panel

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7: ELECTRICAL SCHEMATICS

Wire number	Section	Length (mm)	Color code
434	.75 (mm²)	0	OG
435	.75 (mm²)	0	OG
435	.75 (mm²)	0	BK
435	.75 (mm²)	0	OG
435	.75 (mm²)	0	BK
436	.75 (mm²)	0	OG
436	.75 (mm²)	0	OG
436	.75 (mm²)	0	OG
438	.75 (mm²)	0	OG
440	.75 (mm²)	0	OG
440	.75 (mm²)	0	OG
440	.75 (mm²)	0	OG
440	.75 (mm²)	0	OG
440	.75 (mm²)	0	OG
440	.75 (mm²)	0	OG
442	.75 (mm²)	0	OG
442	.75 (mm²)	0	BK
442	.75 (mm²)	0	OG
443	.75 (mm²)	0	VT
444	.75 (mm²)	0	VT
445	.75 (mm²)	0	VT
450	.75 (mm²)	0	BK
451	.75 (mm²)	0	GN
452	.75 (mm²)	0	YE
453	.75 (mm²)	0	GY
454	.75 (mm²)	0	OG
455	.75 (mm²)	0	BU
456	.75 (mm²)	0	RD
457	.75 (mm²)	0	WH
458	.75 (mm²)	0	BN
901	-1	0	
GND1	2.5 (mm²)	0	GNVE
GND2	2.5 (mm²)	0	GNVE

Wire number	Section	Length (mm)	Color code
GND3	2.5 (mm²)	0	GNVE
GND4	2.5 (mm²)	0	GNVE
GND4	2.5 (mm²)	0	GNVE
GND5	2.5 (mm²)	0	GNVE
GND6	2.5 (mm²)	0	GNVE
GND15	2.5 (mm²)	0	GNVE
GND16	2.5 (mm²)	0	GNVE

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WIRING TABLE

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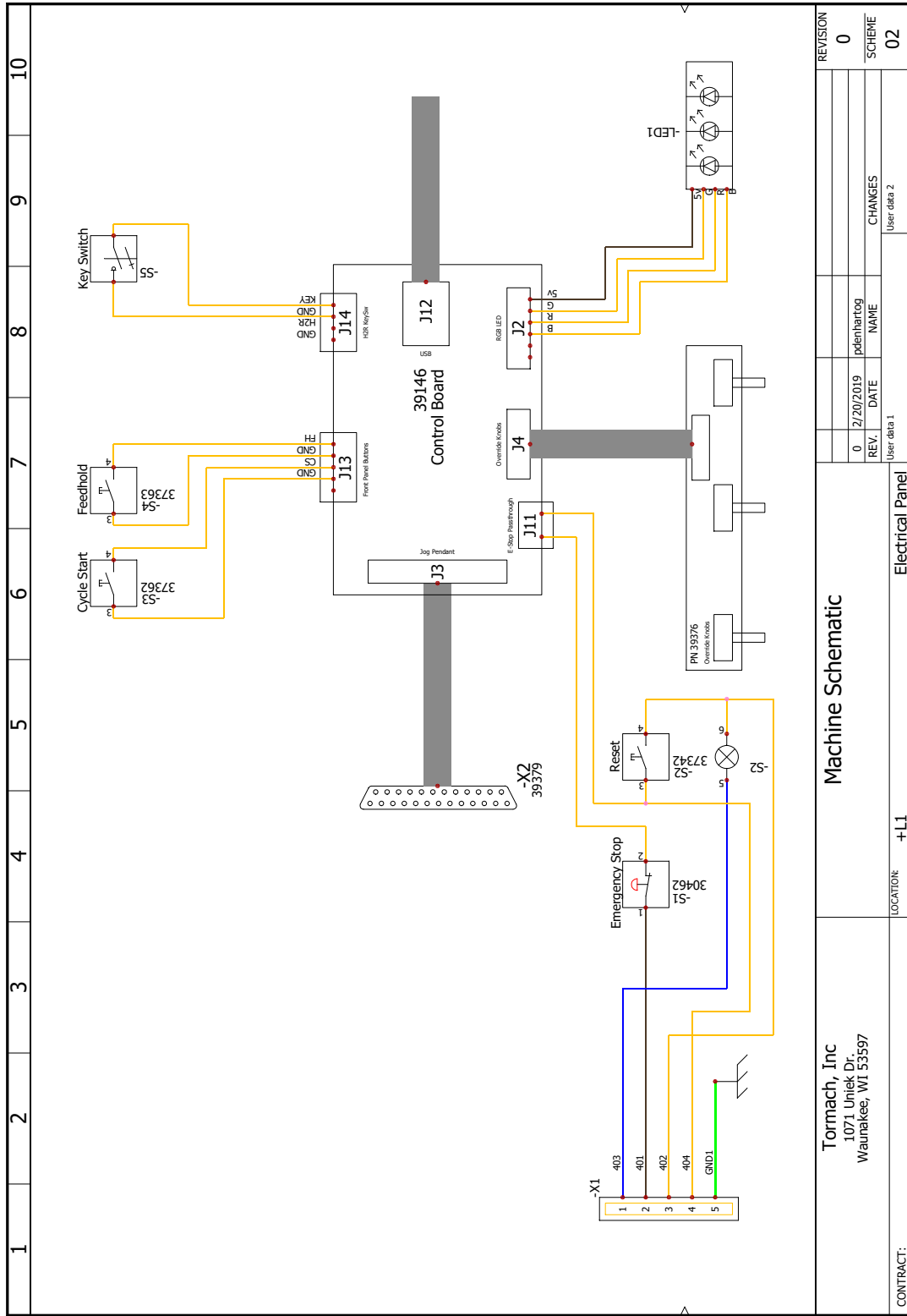
+ L1

Electrical Panel

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Document finalized with version: 2023.02.01.06

7.41 OPERATOR CONSOLE SCHEMATIC



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Machine Schematic

LOCATION: +L1

Electrical Panel

REV.	DATE	NAME	CHANGES
0	2/20/2019	pdenhartog	User data 1
02			User data 2

REVISION

0

SCHEME

02

CONTRACT:

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