CENTROID™

AcornCNC
Installation Manual

Centroid AcornCNC Installation Manual
CNC Software version: CNC12 V.5.0+
Models: AcornCNC

WHEN A CNC IS OPERATING, HIGH VOLTAGE LEVELS COULD BE PRESENT THAT ARE LETHAL FOR PEOPLE IF THEY COME INTO CONTACT WITH IT. It is important to always keep in mind that voltage levels present on a CNC equipped machine tool can be lethal, mistakes in wiring can be catastrophic. In addition to dangerous lethal voltages CNC machines have powerful motors and resulting dangerous unexpected forceful motion of dangerous cutters and fast moving heavy machine parts.

Installation of a CNC controller should be performed only by individuals trained and qualified to do the task. Before installation procedure and working with the equipment it is required to read and understand the user and installation manuals of all the components and equipment being used. It is necessary to be completely sure of and have full understanding possible dangers and also completely assured that installation can be performed in a safe manner. Any schematics or wiring hookup instructions presented on Centroid's website or in the online forums are incomplete educational examples for discussion only. The user, DIY'er is creating his/her own CNC device, which may include dangerous lethal voltages, powerful motors and resulting dangerous unexpected forceful motion of dangerous cutters and fast moving heavy machine parts. The information provided by CENTROID relating to wiring, installation, and operation of CNC components is intended only as a guide, and in all cases a qualified technician and all applicable local codes and laws must be consulted. CENTROID makes no claims about the completeness or accuracy of the information provided, as it may apply to an infinite number of field conditions. CNC control products from CENTROID can be installed on a wide variety of machine tools in combination with 3rd party components NOT sold or supported by CENTROID, you MUST consult and follow all safety instructions provided by your machine tool manufacturer and electrical components regarding the safe operation of your machine and unique application. If you are not qualified to accept all responsibility and/or you do not agree, DO NOT PROCEED and request a refund.

WARRANTY DOES NOT COVER DAMAGE BY FAULTY WIRING OR INSTALLATION.

Acorn Warranty details are here.
https://www.centroidcnc.com/centroid_diy/acorn_warranty.html

Basic Safety Procedures and Best Practices

Motor Safety and Handling

Be safely dressed when handling a motor. Wear safety shoes and gloves. Avoid loose clothing which can get caught on the motor. Be careful not to let hair get caught in the rotary section of the motor. Do not handle the motor with wet hands.

Shut off the power before working on a motor. Wait at least 5 minutes after the motor is shut off before touching any power terminals.

Ensure that the motor and motor related components are mounted securely. Ensure that the base or frame to which the motor is mounted to is strong enough.

Do not touch the rotary section of the motor when it is running.

When attaching a component having inertia to the motor, ensure any imbalance between the motor and component is minimized.

Be sure to use a key when the motor has a keyed shaft. Review good coupling practices as motor shaft breakage can result if over tightened or misaligned.

Use the motor in appropriate environmental conditions. Do not store flammables in close proximity to the motor. When not in use, store the motor in a dry location between 0° and 40° C.

Do not remove the nameplate from a motor.

Circuit Board Safety and Handling

Minimize handling circuit boards as much as possible. If you must hold a circuit board, grasp it by the edges as shown below. Before picking up a circuit board, always discharge any static buildup you may have by touching a grounded surface . Avoid touching any of the circuit traces, components, or component leads. Improper handling can lead to ESD (electrostatic discharge) which may damage the PCB, or shorten its lifespan.

Never work on a metal or electrically conductive surface.

Keep the work area free from static generating materials such as styrofoam, vinyl, plastic, and fabrics.

Circuit board handling procedures
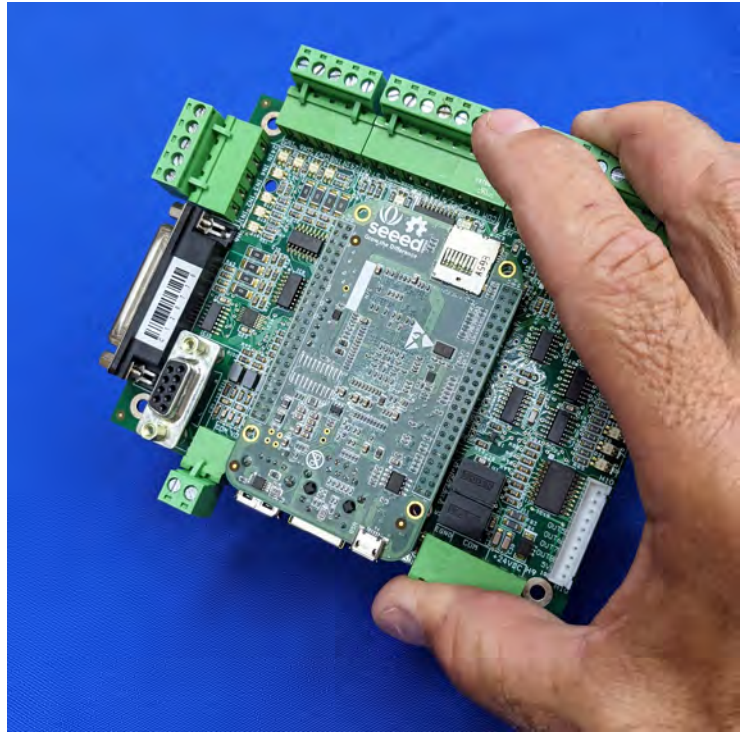
Document the CNC control system installation.

It is highly recommended that you document the components used in the CNC control system. Once parts are installed you may not be able to read the nameplates or identification markings on the part(s).

It is recommended to:

- Photograph motor nameplates
- Photograph controllers and circuit boards (especially Model, Revision and Serial)
- Download and save individual component manuals and related documentation for all parts used for future reference
- Keep a log of the various switch/jumper settings and electronic configurations
- Use a labeler to mark any relays or modules
- Create and/or update an existing schematic
- Save the CNC control configuration using the "Create Report" feature in CNC12 after every configuration change.

About This Manual

This manual describes how to install the Centroid CNC Acorn Step and Direction Motion Controller. The Acorn system provides up to four axes of step and direction interpolated motion, controlled by industry standard G and M Codes.

Acorn can be used for the CNC control of milling machines, routers, lathes, engravers, plasma cutters, laser cutters, grinders, and other specialized applications using most any step and direction axis motors and drives.

This installation manual covers the common Acorn hardware setups. For the rest of this manual, we will assume the installation is for a three-axis cnc milling machine the techniques and settings apply to Lathes, Routers and other machines as well.

Document Conventions

Please note the following conventions used in this document:

- Key Combinations: At various steps along the way you will be instructed to hold down a key (the "Alt" or "Control" key for instance) and press another key such as S or I without lifting your finger from the first key. The convention in this document to indicate this will be alt+i, ctrl+s for ctrl+alt+I for example.

Before You Begin

Before getting started, please take the time to read this document and familiarize yourself with the schematics, manuals, and all Acorn documentation which can be found here:

While doing the installation, it is very important that you follow the instructions exactly and in order. Performing the installation incrementally in order and testing as you go will allow you to immediately isolate the cause of any problems that may occur by adding one thing at a time.

Accompanying Acorn CNC Controller Requirements and Installation Videos:
https://www.centroidcnc.com/centroid_diy/acorn_quick_start_guide.html

Useful Technical Resources

All Acorn Documentation links https://centroidcncforum.com/viewtopic.php?f=60&t=3397

Acorn CNC Knowledge base Videos: http://centroidcncforum.com/viewforum.php?f=61

Acorn CNC Tech Tips Knowledge: http://centroidcncforum.com/viewforum.php?f=63

Centroid's YouTube Channel: Centroid CNC Technical Support
https://www.youtube.com/user/CentroidSupport/videos

Martyscncgarage YouTube video playlist: Centroid CNC Acorn Playlist https://tinyurl.com/ascxfev4

Free Centroid Community CNC Support Forum https://centroidcncforum.com/viewforum.php?f=20

Centroid Acorn and its CNC Accessories:
https://www.centroidcnc.com/centroid_diy/acorn_cnc_controller.html

Centroid CNC Components: http://www.centroidcnc.com/centroid_diy/cnc_components.html

DIY CNC gear https://www.centroidcnc.com/centroid_diy/diy_cnc_gear.html

Where to find support

Sign up for free tech support here: https://centroidcncforum.com/index.php

How to find answers on the Tech Support Forum and Knowledge base.

1.) Review "Acorn CNC Knowledge Base Videos" and the "Acorn CNC Tech Tips Knowledge Base" before posting questions as almost every novice question has been answered here.

2.) Use Advanced Search to look for answers to your question in the main Acorn users forum.

3.) Post a specific question in the Acorn users forum, be sure to follow the posting guidelines so your question will get answered quickly. Post your question on the forum by clicking "new topic"
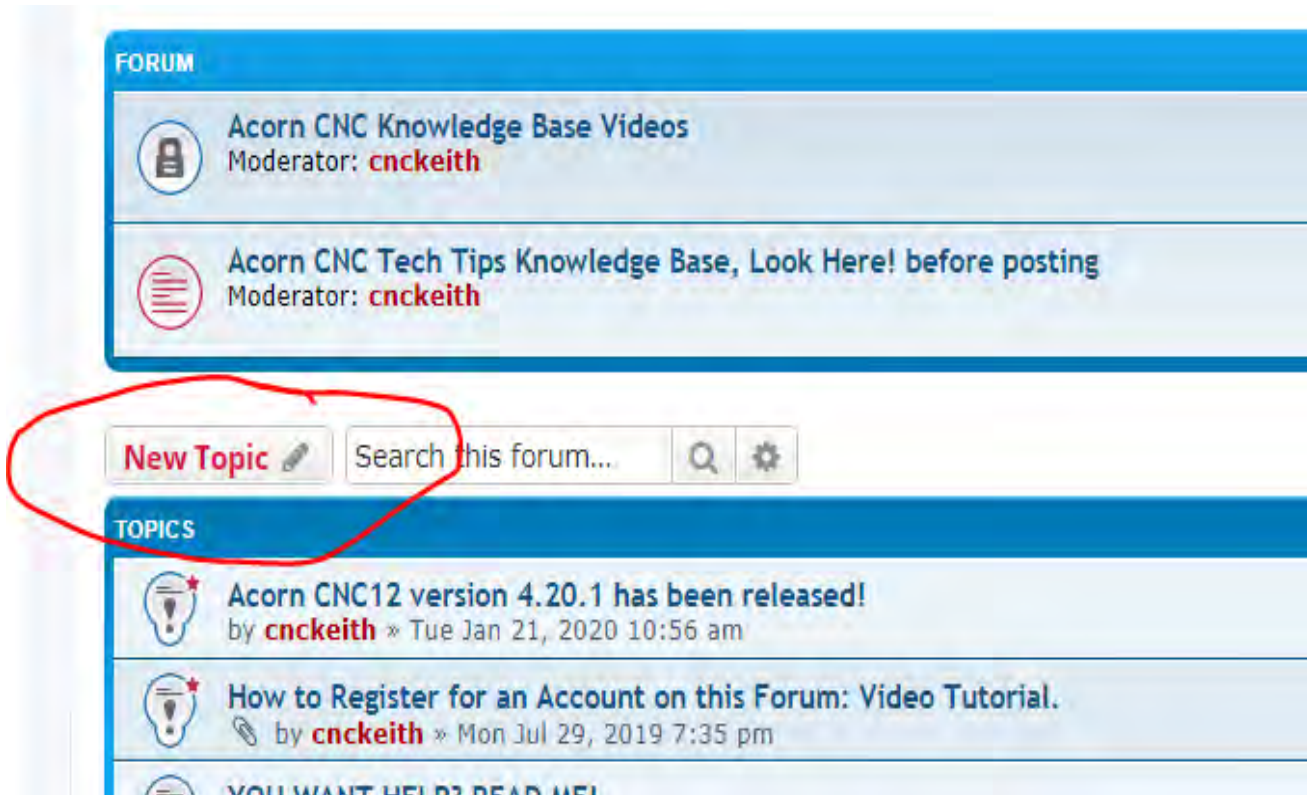

When you post to the forum, your question will be seen by many users. Possibly getting you more than one solution to your problem. Your post can be helpful others in the future.

An alternative to the free support offered on the Acorn Tech support forum is to purchase one on one Factory Direct technical support. Purchase 1 hour blocks of support time here:
https://www.centroidcnc.com/centroid_diy/purchase_tech_support.html

Chapter 1   Acorn CNC Control Kit

Congratulations on your Acorn CNC control kit purchase!

The Acorn is a step and direction motion control solution. Providing up to 4 axes of step and direction signal outputs and full Programmable Logic Controller (PLC). Make sure your kit is complete and has not been visibly damaged in shipment.
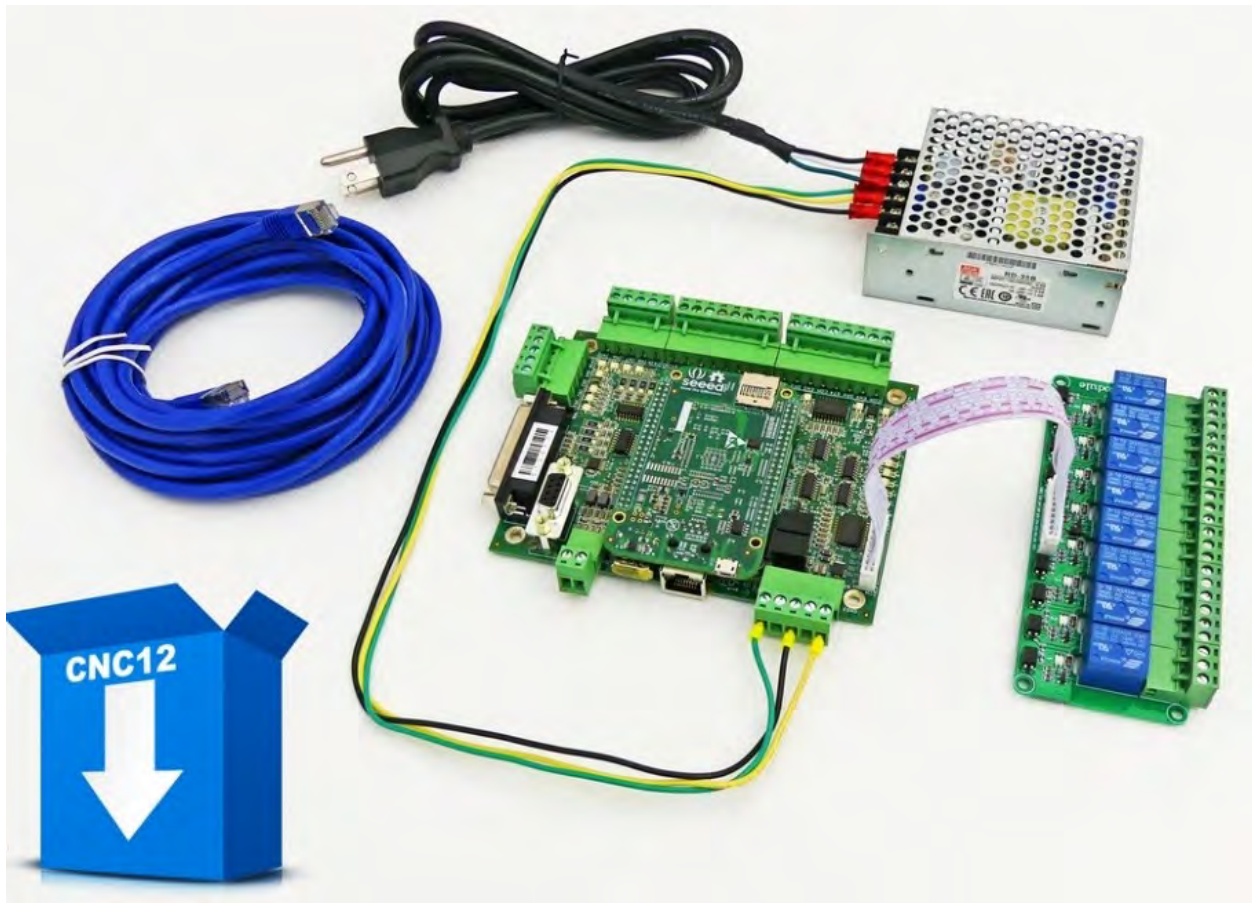
The following components are included with your Acorn CNC Controller Kit Part# 14455

- The Acorn with BeagleBone Green green installed and all terminal blocks installed.   Part#14756
- 8 output relay board with flat cable. Part #14734
- Meanwell RD-35B power supply Part #8903 with
    - 110VAC input cord Part #14459
    - 24V output to Acorn H9 header cable Part #14460
- 15ft Shielded Cat5E Ethernet cable Part #7269

Chapter 2   Bench Test Hardware Setup

2.1 Bench Testing Acorn before installation into the CNC control box.

Accompanying Bench test video for this section is on this page.

The first step in installing your new system is performing a bench test. "Bench test" means connecting all of the electronics together to test them before installing the system in a machine. This test is should be done on a work bench, hence the name.

A bench test allows you to:

- Confirm communication between the Acorn and the CNCPC a critical first step.
- Find problems before spending a lot of time wiring your machine or cabinet.
- Troubleshoot hardware and software problems early on, before they can cause permanent damage to the system.
- Identify missing or defective hardware before installing the system
- Allows for greater visibility when troubleshooting than when installed in an electrical cabinet.

Tools and Equipment Needed

• A good location – A bench test needs to be performed on a large surface with good lighting and easy access to electrical outlets. Do not use metal or plastic surfaces or surfaces that may contain metal scraps or shavings, as we will be resting powered circuit boards on the surface. Do not use fabric covered surfaces as it may cause ESD (electrostatic discharge) damage. A wooden surface is an ideal test bench location.

• A Windows 10/11 PC with an internet connection that meets the Centroid CNCPC minimum performance specifications, or a Centroid supplied CNCPC. See CNCPC minimum requirements here.
https://www.centroidcnc.com/centroid_diy/acorn_quick_start_guide.html

• A small screwdriver set, a digital multimeter

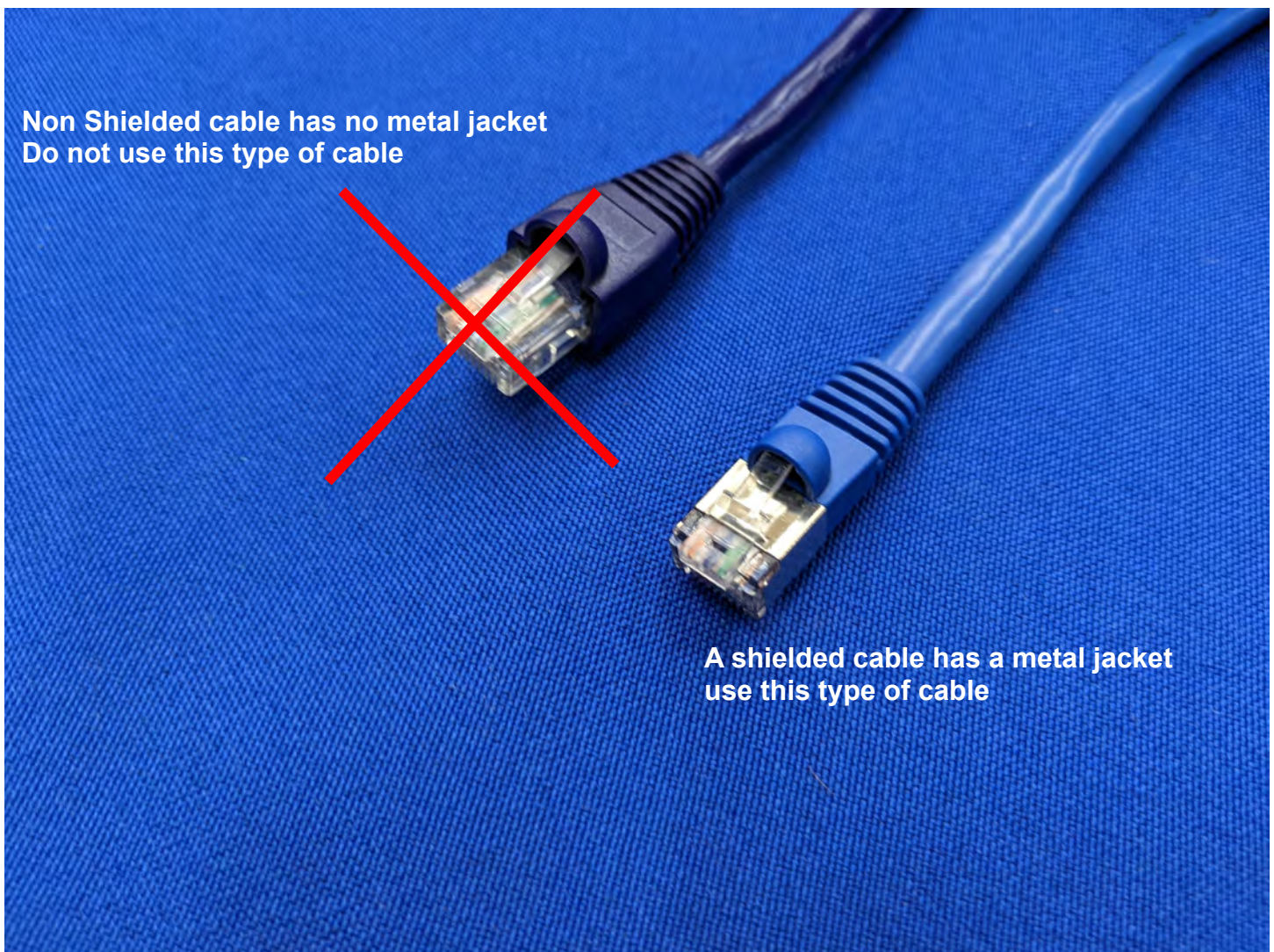Items needed to setup the Acorn controller for bench testing

2.2 Acorn Bench Test Setup

1   Connect the relay board: Use the included flat white 10 conductor cable to plug the relay board into the Acorn.
2   Connect the power supply to the Acorn: Leaving the Meanwell power supply disconnected from 110VAC, Plug the 5-pin terminal block into H9. Note: Power supply will also run on 240VAC.

3   Connect the Ethernet Cable: Connect the supplied shielded Ethernet cable to your PC's built in Ethernet port. Do not use a USB to Ethernet adapter to connect to the Acorn. Connect the other end to the Acorn. A shielded Ethernet cable will have a metal clip around the RJ-45 connector as shown on the blue cable in image below.   Use the provided 15ft Shielded Ethernet cable that is included with the Acorn kit. Note: An un-shielded cable will result in intermittent PC Data receive errors in the software due to electronic noise and interference. See TB270: https://www.centroidcnc.com/dealersupport/tech_bulletins/uploads/270.pdf

Non Shielded cable has no metal jacket Do not use this type of cable

A shielded cable has a metal jacket use this type of cable

Shielded vs non-shielded Ethernet cables

4   Plug in Meanwell power supply. The Acorn comes pre-wired to plug into 110VAC US outlet. When you are finished, the Acorn should be wired as shown in the image below.
Note: the power supply will also work with up to 240VAC supply.
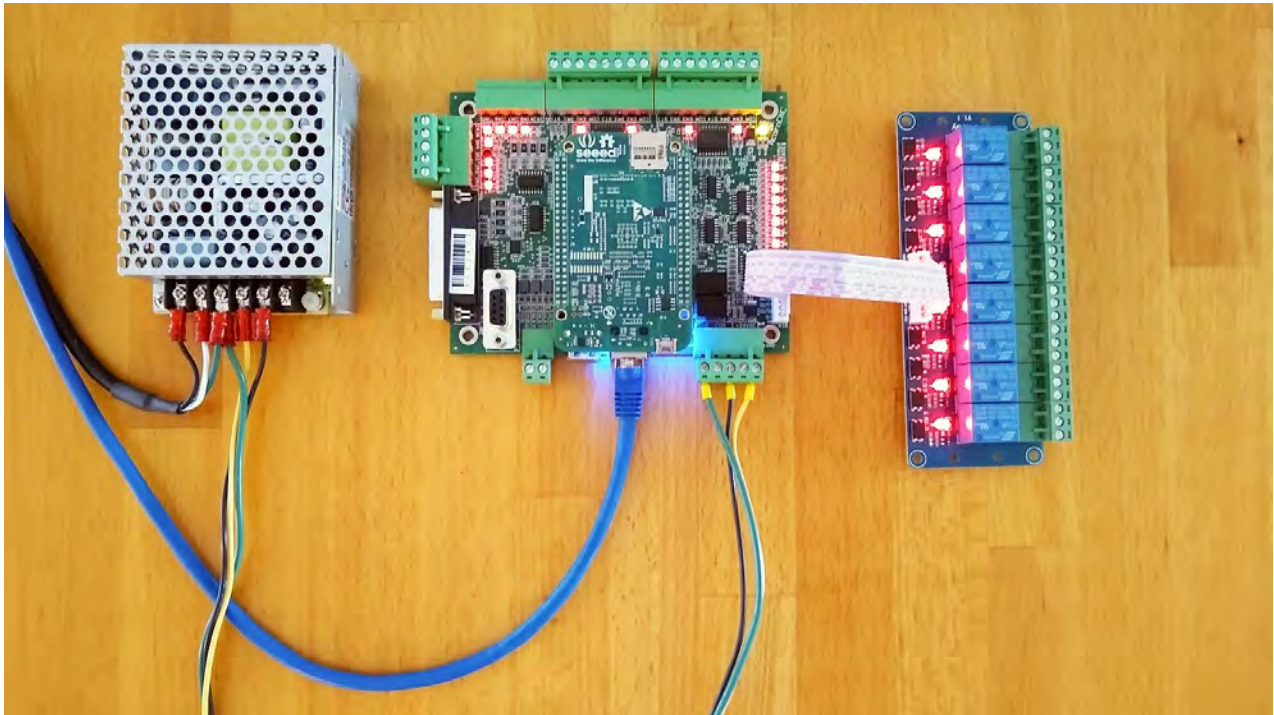
Acorn controller powered up and ready for bench testing

5   Apply power to the power supply and the Acorn will power up. The green power LED in the upper right corner on the Acorn should be lit, and the blue "Heartbeat" LED on the BBG will blink rapidly (booting) and then blink at one pulse per second (all good and running). This denotes that the Acorn is booted and ready. See Acorn LED's Explained Video.

NOTE: The Power LED also serves as an indicator for the Heartbeat of the BeagleBone Green controller. The LED will light green with 24VDC power applied to the board and will also flash if there is a good Heartbeat (firmware booted and running) from the BeagleBone Green.

All versions will have the Power LED feature as well as the Heartbeat LED found on the BeagleBone Green controller (shown below).
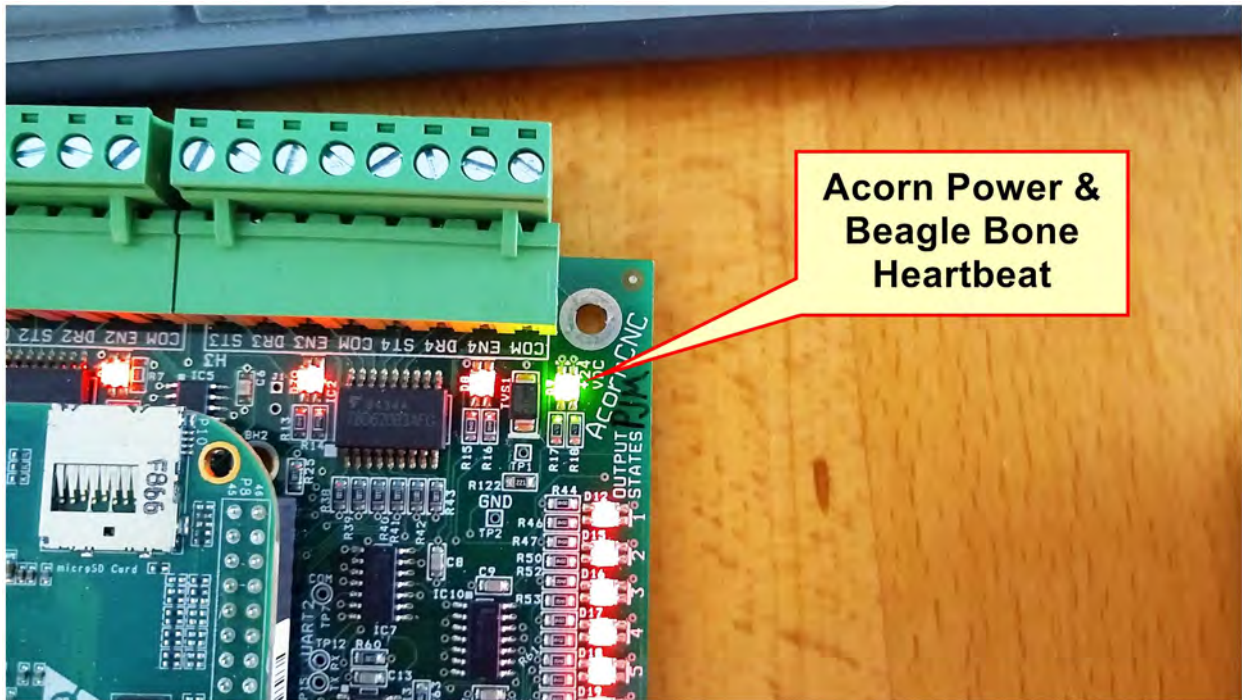
Acorn combination Power and BeagleBone Green Heartbeat LED

Beagle Bone Green (BBG) Heartbeat LED

If the Acorn Power LED is not on or Heartbeat LED is not blinking properly, see:

Centroid Community CNC Support Forum Centroid Acorn Ethernet and Firmware Heartbeat status LED lights are explained in detail:
https://centroidcncforum.com/viewtopic.php?f=61&t=1460

Note: Do not plug anything into the USB port on the BeagleBone Green board!

Chapter 3   Windows 10 configuration and CNC12 Installation

3.1 Windows 10/11 Configuration for CNC control use.

Note: Microsoft Windows 10/11 is the only supported OS with Centroid Acorn CNC12. Microsoft Windows 8.1, 7 and older versions are not supported. Mac OS and Linux operating systems are also not supported.

If you have purchased CNCPC from Centroid, it comes with Windows 10/11 properly configured for CNC control use and the CNC12 software pre-installed so you can skip this section.

If you bought or built your own computer, it must meet the prerequisites listed on the Centroid Website
https://www.centroidcnc.com/centroid_diy/acorn_quick_start_guide.html

1.) Centroid has introduced a new software App to make configuring and testing a PC for CNC use much easier, the Centroid CNC PC Tuner! Free Download here:

https://www.centroidcnc.com/centroid_diy/centroid_cnc_software_downloads.html

PC Tuner video link https://www.youtube.com/watch?v=bOZVMMdzOj8
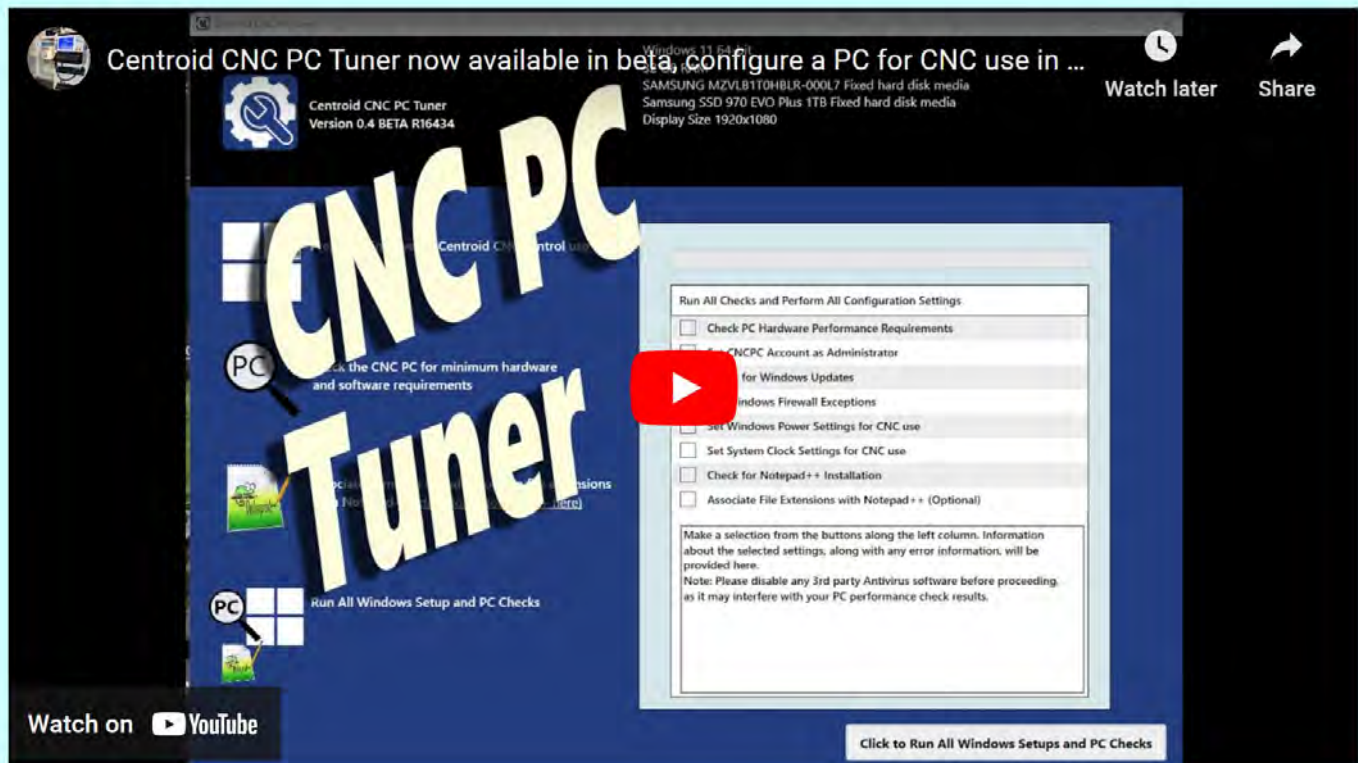
Technical bulletin 309 covers this topic as well.
h[ttps://www.centroidcnc.com/dealersupport/tech_bulletins/uploads/309.pdf](https://www.centroidcnc.com/dealersupport/tech_bulletins/uploads/309.pdf)

   3. <mark>Before installing the CNC12 software ALL anti-virus, anti-malware, and 3rd party firewall software should be uninstalled (not disabled) and your computer rebooted.</mark>

      99% of all communication problems between CNC12 and the Acorn are caused by anti-virus and 3rd party firewall software. Virus software works by stopping unusual or suspicious behavior in software, and will almost always detect the interaction between the Acorn and the PC as unusual/suspicious and interfere with the operation of CNC12. Firewalls work by blocking certain communication ports, and often these ports are needed for the operation of CNC12. The default firewall built into Microsoft Windows will work fine with CNC12 if you allow access as specified in [Appendix B](#)

      If your corporate policy requires anti-virus software, a third-party firewall, or that certain Windows security features be enabled to connect to the network, special attention will have to be made in the configuration of these tools otherwise they will interfere with control system.

3.2 CNC12 Software Installation

[Accompanying Bench test video for this section is step 3 on this webpage click to see.](#)

With the Acorn in bench configuration powered up with a heartbeat as described in [Section 2.2](#) , install the Acorn CNC12 software as follows:

   1. Click on this link to download the latest version of CNC12 software: https://www.centroidcnc.com/centroid_diy/centroid_cnc_software_downloads.html

   2. Navigate to the CNC12 installer zip file you just downloaded. Depending on your Windows settings, the file you downloaded will be displayed as "centroid_acorn_cnc12_vX.xx._installer" or similar. Right click and choose "Extract All"

   3. Copy the extracted .exe to the CNCPC's desktop. The extracted folder in this example is called "centroid_cnc12_vX.xx_installer". Your version may be newer, but the name will be the same other than the "vX.xx" which signifies the CNC12 version. Alternatively, you may extract the .zip folder to your desktop.

4. ==The CNC PC and the Acorn MUST be powered up and connected to the CNC PC's onboard Ethernet port via the provided shielded Ethernet Cable while the installation process is going on!==
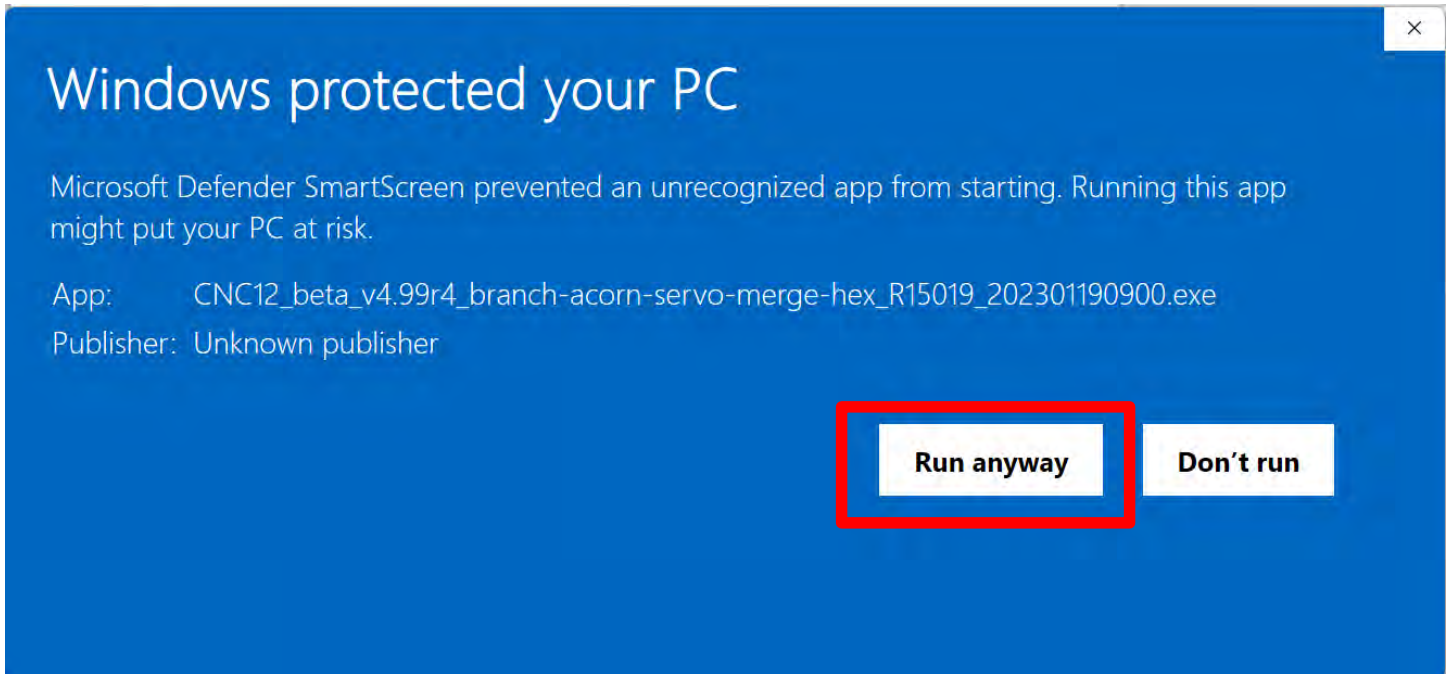
Double click "centroid_cnc12_vX.xx_installer .exe" now on desktop to start the install of CNC12.


Microsoft will issue this message.
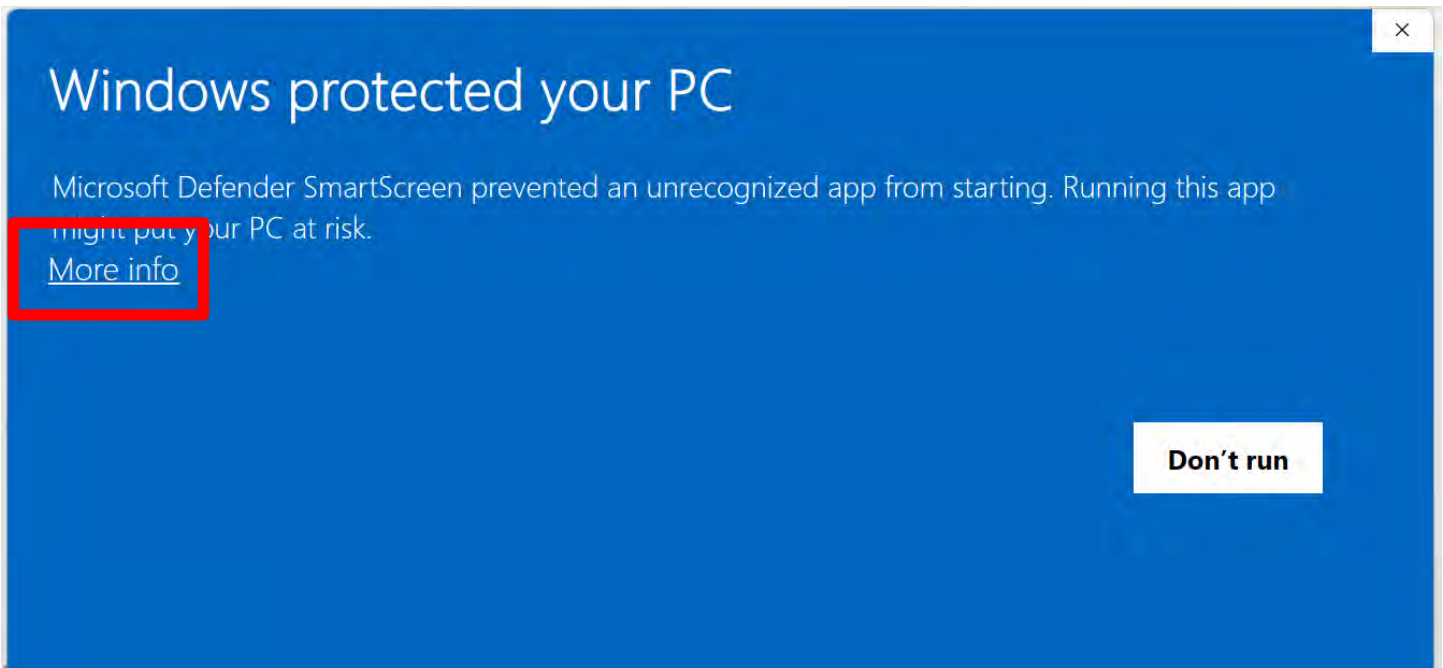
Click on "More Info"

then Click "Run anyway"

5. If "User Account Control" is enabled, Windows will ask "Do you want to allow the following program from an unknown publisher to make changes on this computer?". Click "Yes". Windows 10/11 systems may pop up a Windows Defender SmartScreen showing "Windows Defender SmartScreen prevented an unrecognized app from starting. Running this app might put your PC at risk". Click "More info", Then Click "Run anyway"

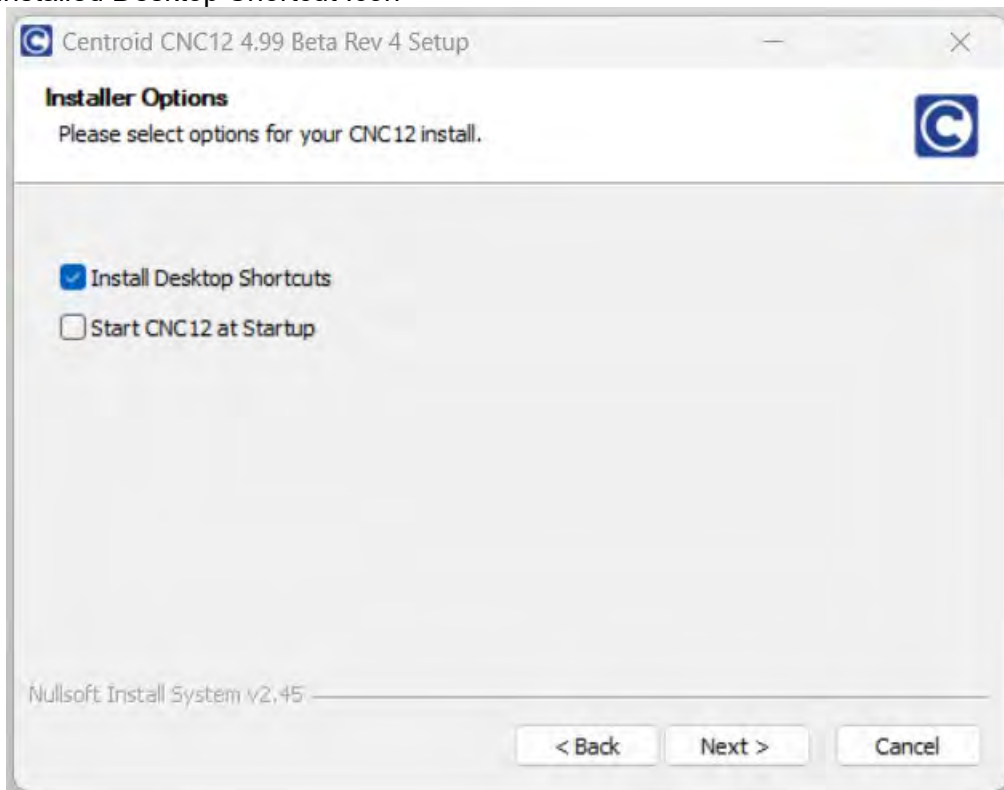Then Microsoft displays this message. Click "Yes" to continue.
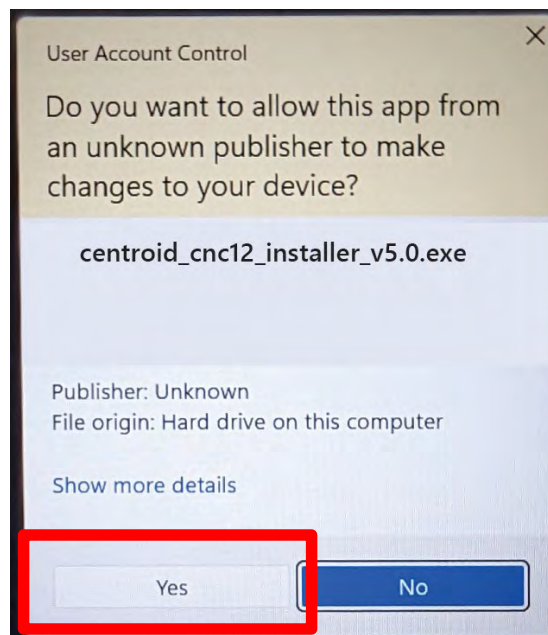
 6. Read License Agreement Read the Software license agreement for using the CNC12 Software. If you accept the terms of the agreement, click "I Agree" to continue, Otherwise, click "Cancel".
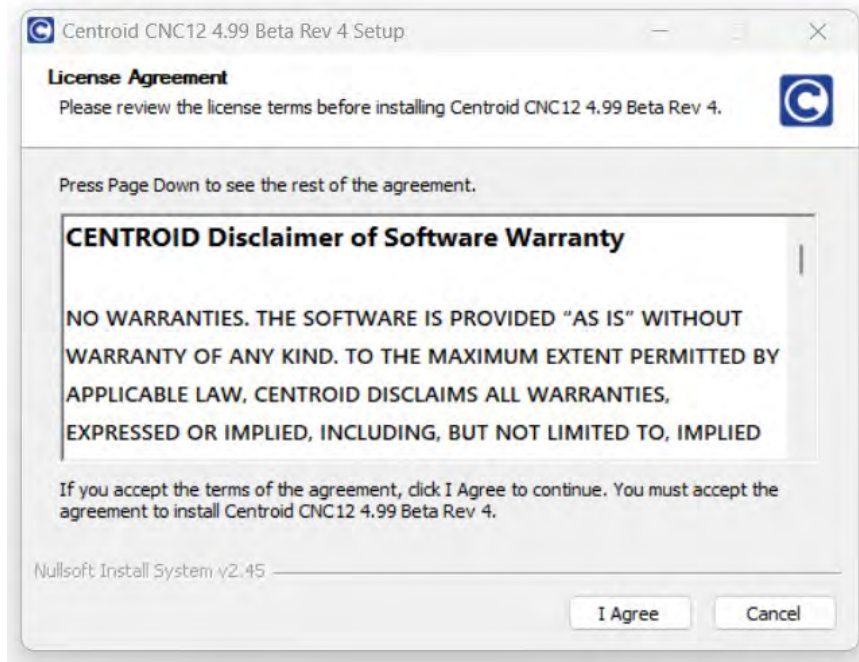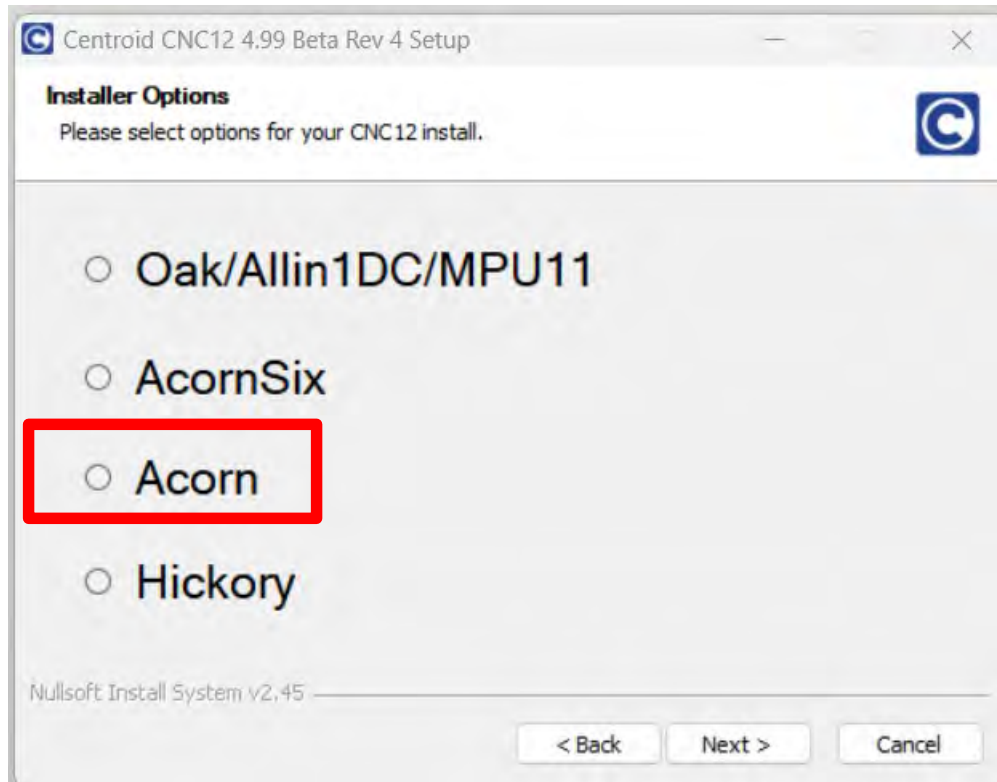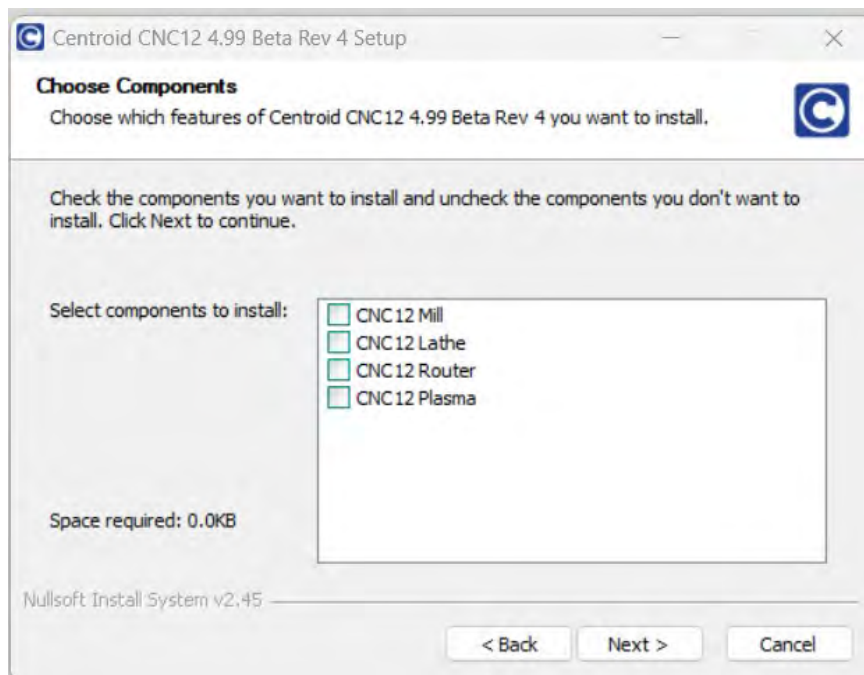
Then choose to installed Desktop Shortcut Icon

7. Select CNC12 Mill, Lathe, Router or Plasma depending on the type of installation required. For the remainder of this document, we will assume the system is being installed on a mill. Click "Next".

Machine Type Selection

8. Select the default machine units, Imperial or Metric. Then click "Install"
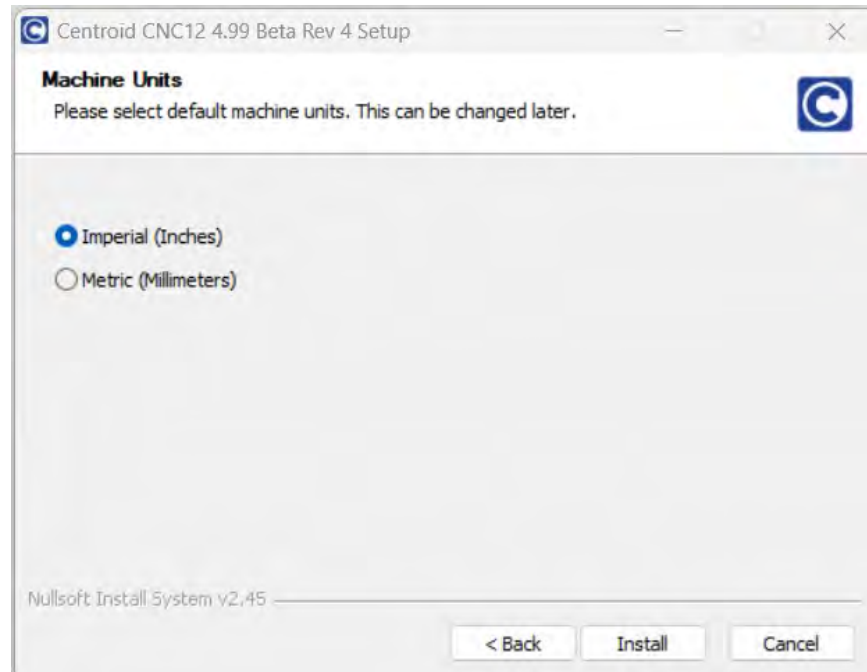
Units Selection

9. CNC12 installation will commence files are extracted and copied. Next is the Network Adapter Setup: (IMPORTANT: The PC and the Acorn MUST be powered up and connected to the CNC PC's onboard Ethernet port via the provided shielded Ethernet Cable) while the installation process is going on. Choose from the displayed network adapters that are currently installed and select the network adapter that is connected to the Acorn as shown below. Click "Next" to continue. When asked if you would like to change the IP address for the adapter selected, click "yes".
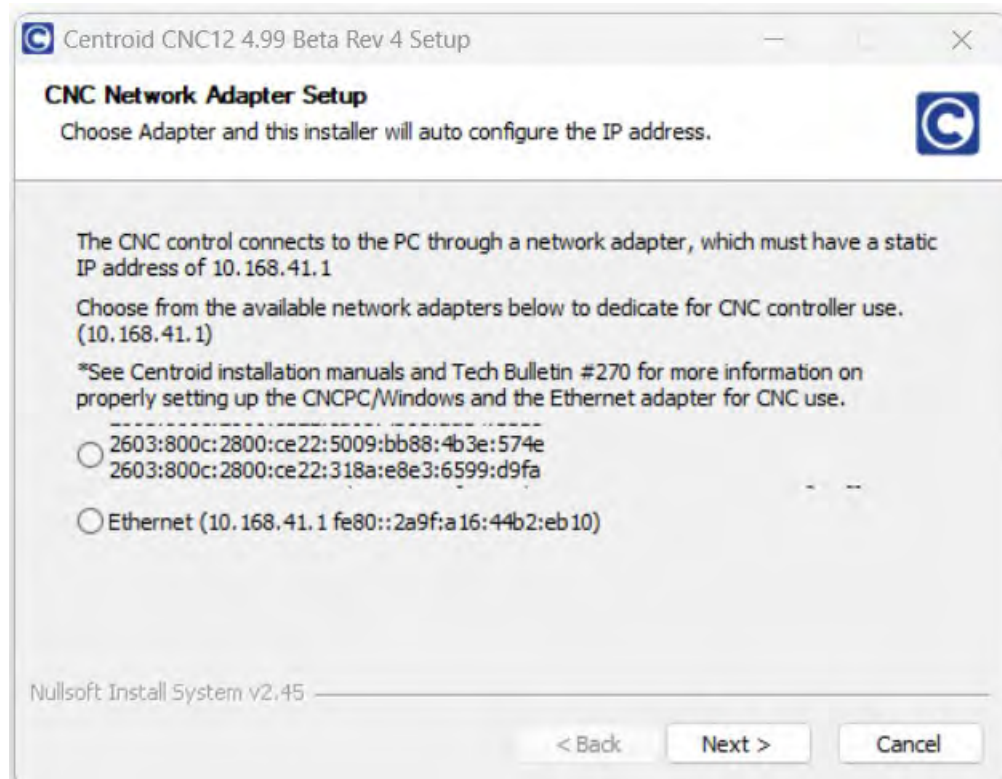
Network Adapter Selection

NOTE: Centroid recommends using a computer with two Ethernet ports. That way one Ethernet port is used for Acorn while the second is used for internet access (Windows updates, software updates, TeamViewer Remote access etc.) If you do have two built in Ethernet ports, install the CNC12 software using the Ethernet port that indicates no network access. This way the software will install to the correct Ethernet port. It is acceptable to use a USB to Ethernet adapter for Internet access if the PC is not equipped with Wi-Fi. You may also elect to purchase a USB to Wi-Fi adapter. Do not connect the Acorn to a USB Ethernet adapter. Always connect the Acorn to the PC's built in Ethernet port!

NOTE: Your IP address may differ from those shown in the screen shot above

When updating this message may appear. CNC12 recognizes that a CNC PC ethernet port has already been setup for CNC use and is asking if you want to use that one. Click Yes to use that ethernet connection, click no to select another ethernet port for Acorn use.
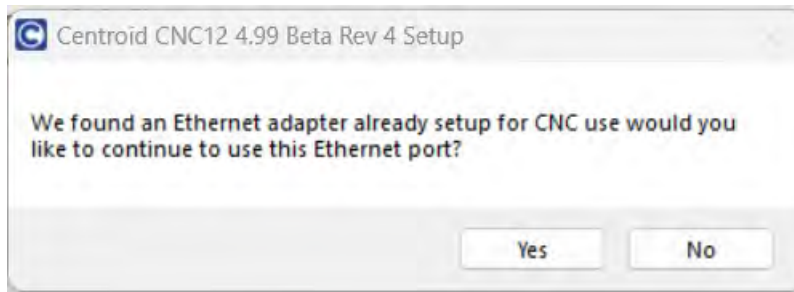
11. Click "Finish" to complete the CNC12 software installation.
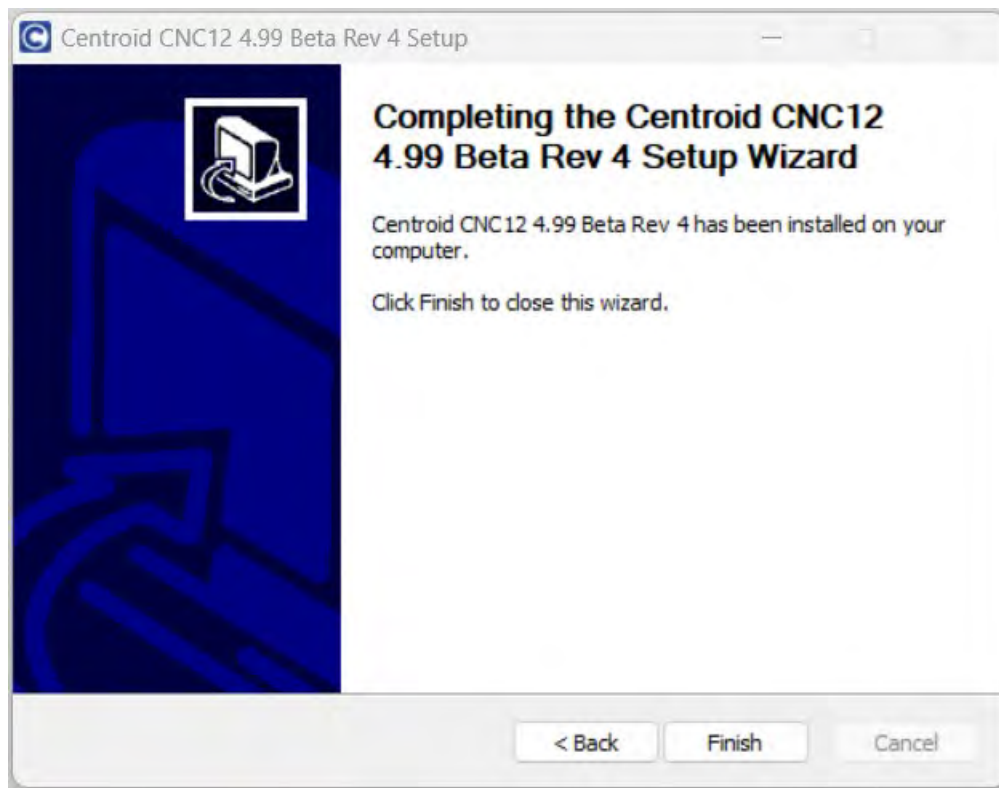
12. Start CNC12: Double Click on the CNC12 Icon that was created on your desktop during the CNC12 software installation.

CNC12 Mill
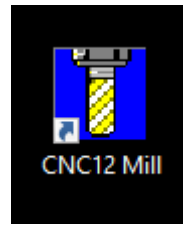
You most likely will see the following message below the first time you start CNC12. Simply wait until it completes, This message indicates that CNC12 is updating the Centroid CNC Acorn firmware located on the BBG. Every version of CNC12 has its own unique matching firmware that is installed automatically with the CNC12 installation. As the message says, do not power off the Acorn while the firmware is being updated.

Firmware being installed, MPU Rebooting, DO NOT POWER OFF Acorn

13: The "Main" CNC12 Screen will appear.
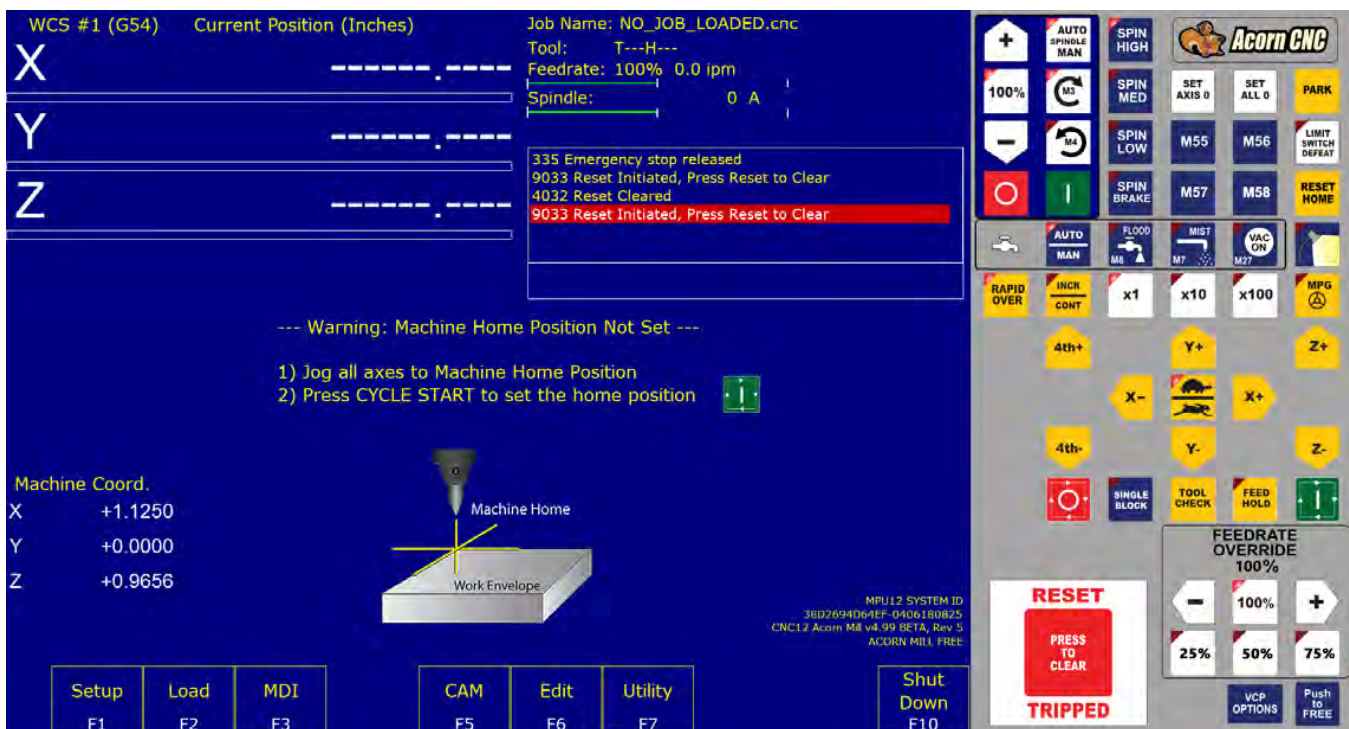
3.3 Install the Acorn License file

If you have not purchased an Acorn License upgrade, please skip to the next section.

Centroid Community CNC Support Forum: Acorn CNC12 software License ordering process explained
https://centroidcncforum.com/viewtopic.php?f=61&t=3570

Centroid Community CNC Support Forum: Video: How to install an Acorn CNC12 License
https://centroidcncforum.com/viewtopic.php?f=61&t=3345

Acorn License Installation Instructions:

1) From email save the attached license.dat file to the CNC PC desktop using a Windows PC.
(Note: Mac or any Apple computers, will corrupt the .dat file and render it useless, do not use an Apple product to download the Acorn License file)

2) With Acorn powered up and running, Start the CNC12 software.

3) Press "F7" Utility menu.

4) Choose the "F8" Option menu.

5) Choose the "F2" Import License function. This will open a file dialog. Navigate to the desktop (or the location where the license file attachment was saved) and select the license.dat file. Click "Open". CNC12 will then respond with a message stating that the license was successfully imported.
Trouble shooting License Issues:
Centroid Community CNC Support Forum: Error message: "Serial number and license file does not match this system" https://centroidcncforum.com/viewtopic.php?f=63&t=3882

3.4 Perform the Acorn to CNC12 communications stress test.

1.) Press/Click the Reset Button to cycle the reset button to clear the reset trip state.
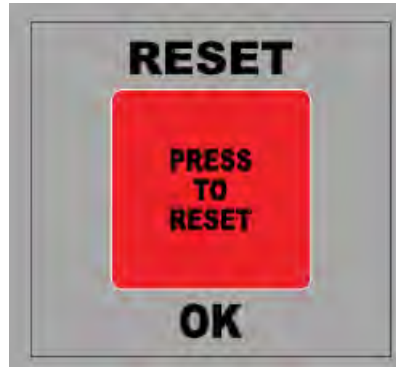
2.) Now Home CNC12. Press The Cycle Start Button.

By default CNC12 installs in "Simple Homing" mode. Simple Homing simply sets the machine home position at the current position. There is no motion with simple homing. Press Cycle Start to home CNC12 so we can load and run jobs.

Once homed, CNC12 will display the DRO (Digital Read Out) position of each axis.
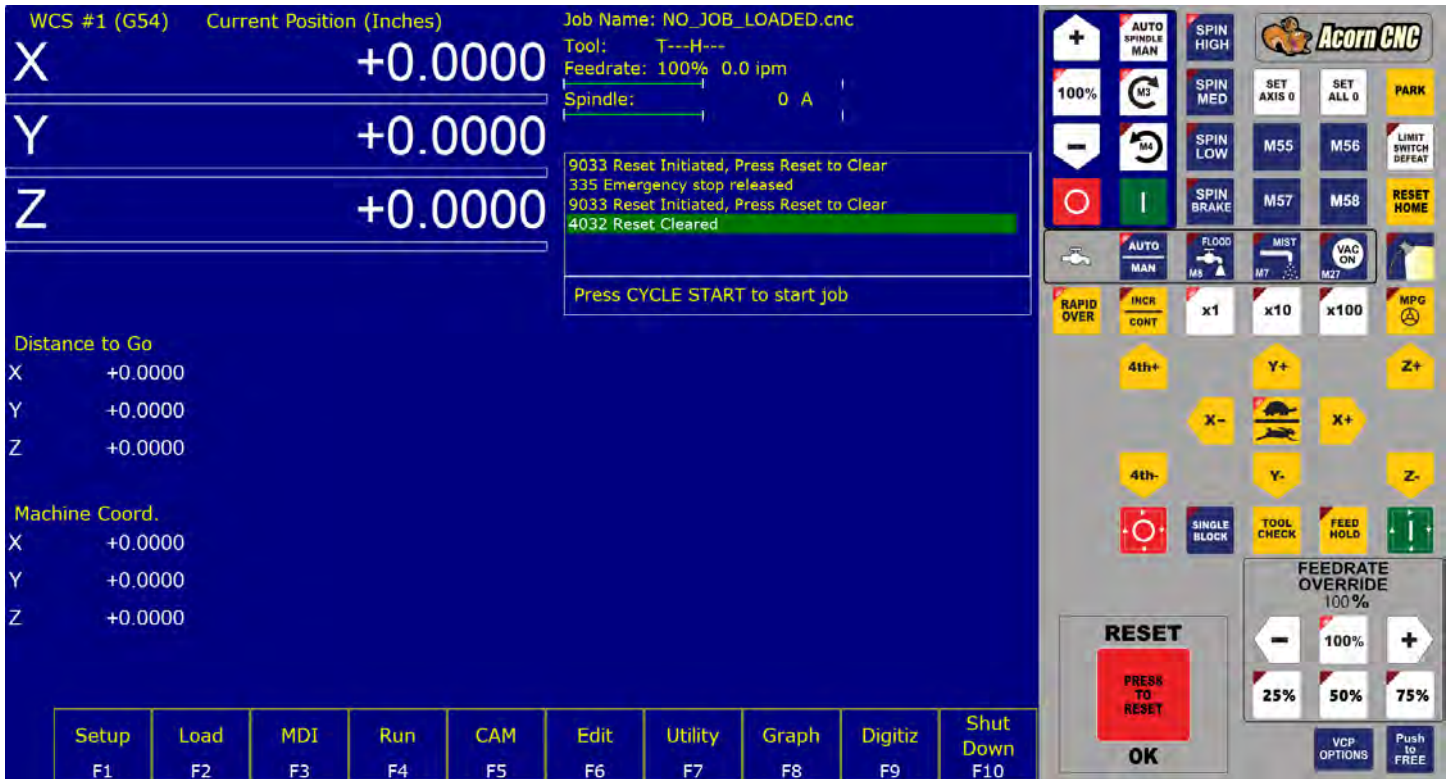
3.) Load the Stress Test CNC program. Press F2 Load, navigate to "stressTest.cnc" and click open
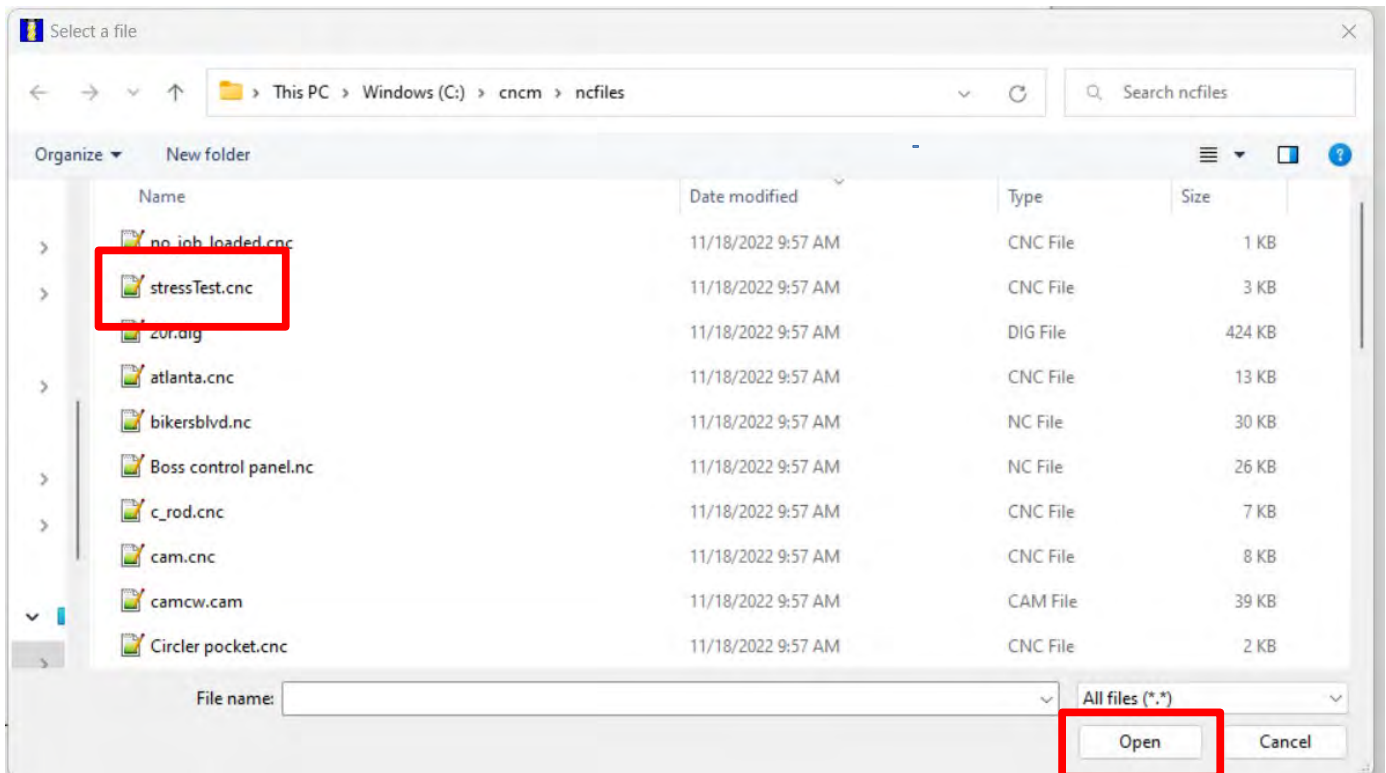
Press Cycle Start to run the Stress Test program.

Wait for the results.

If the stress test fails. Do not proceed. Solve the communication issue(s).
See this detailed post for guidance.   https://centroidcncforum.com/viewtopic.php?f=61&t=1451

Ethernet communication guidance:

Always update the Ethernet hardware driver directly from the manufacture (if possible) and update Windows to the latest release, then install CNC12 and bench test, do not use: USB Ethernet adapters, regular Ethernet cable, or any type of anti virus software (must be uninstalled not just turned off).

Things that will cause com errors

1.) using a RJ45 a bulk head connector

2.) Using a regular non-shielded Ethernet cable or the shielded cable is bad, try another shielded cable as a test.

3.) Using a USB Ethernet adapter.

4.) Ethernet adapter drivers on CNC PC haven't been updated (use manufacture drivers is possible)

5.) ANY type of anti virus software installed, you can't just simply turn it off you have to uninstall it

6.) Windows fire wall blocking cncm.exe, cncr.exe, or cnct.exe

7.) Windows or Laptop bios power saving feature turning off the Ethernet adapter, Windows resetting the ip address automatically. Un select "Obtain an IP address automatically" in Windows Ethernet adapter settings and select " Use the following IP address"

8.) Intel Ethernet drivers: Intel Ethernet driver advanced settings may need to be tweaked.
some intel Ethernet adapters need a setting changed for them to work. under the advanced tab, "speed and duplex" was set to auto negotiate. Change to 100Mbps half duplex.
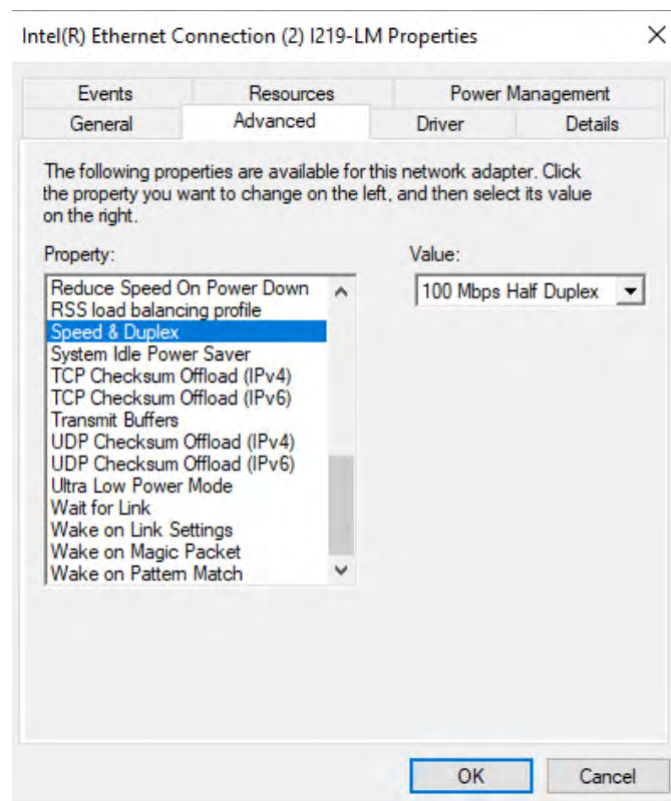
3.5 About CNC control configuration Reports

The Centroid CNC12 software contains a way to "capture" all the CNC and Machine tool specific configuration settings in one file called a "report.zip". The report.zip file will contain and can be used for:

- Records all the machine and CNC control specific parameters & settings that make the machine work.
- Contains Log files of the machine during operation.
- The report.zip can be used to quickly restore the settings after a failed HD or PC or restore an existing installation to its previously know working state.
- Users can create fresh report.zip files with the "create report" button in the utility menu. CNC12 will automatically generate a report on a weekly basis as well.
- When asking for technical support a fresh report is required as it contains critical information about your specific CNC configuration that allows the CNC technician to 'see' how your system is setup and configured.

To create a report:

1   From the main CNC12 screen press F7 Utility
2   Then F7 Create Report
3   A windows dialog will appear, select the location you want to save this file

NOTE: Once the machine is configured and running, Create a backup copy of the report.zip file on a USB memory stick (or network drive) and save it in a safe location (not on the CNCPC).

Video on Creating and Restoring a Report file:
https://centroidcncforum.com/viewtopic.php?f=61&t=3216

NOTE: It is a good idea to keep the USB memory stick in a safe location. See this post on the forums about USB backups: https://centroidcncforum.com/viewtopic.php?f=63&t=5667

Chapter 4   Bench Testing Continued

4.1 CNC12 Software Configuration

Verify that the Acorn CNC control is powered on with heartbeat and the Ethernet cable connected to the CNC PC. Double click the CNC12 Icon on the desktop.

The main screen of Acorn CNC12 will appear:
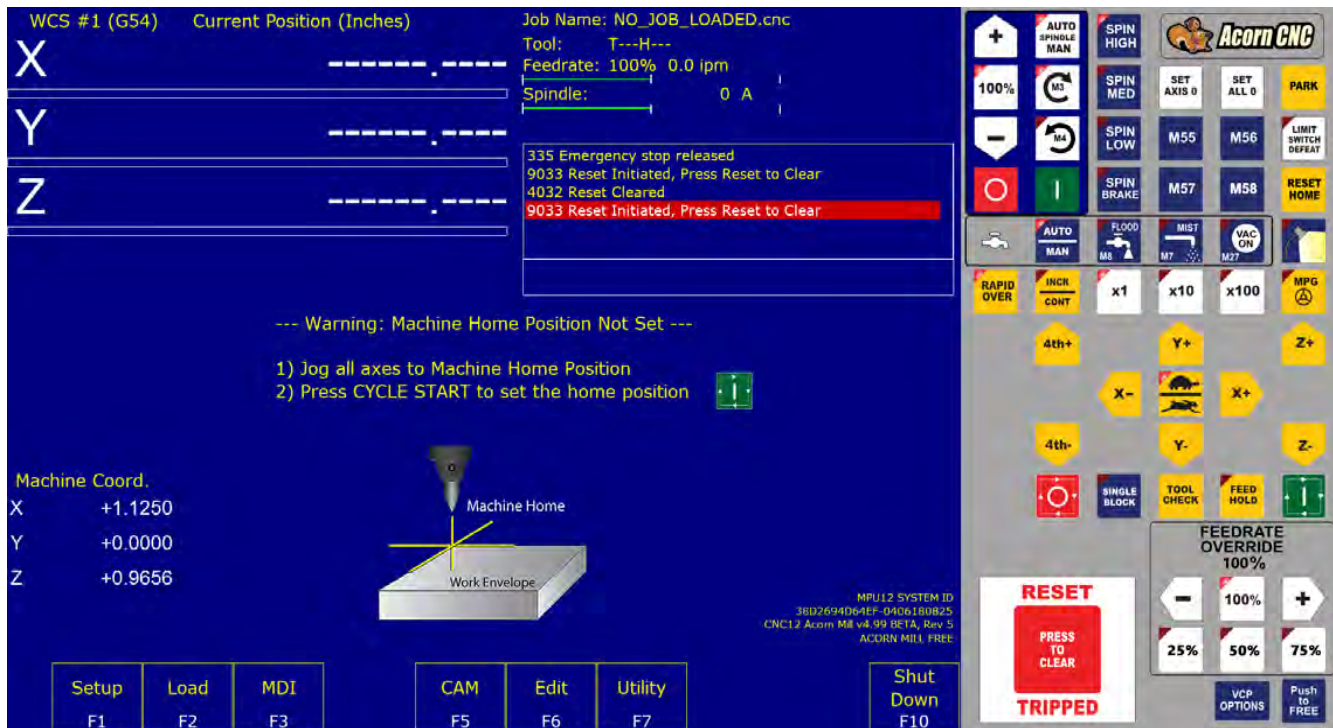
If CNC12 does not start because it timed out with the message pictured below.

Press any key to exit and try again. Some CNCPC's will do this one time the very first time CNC12 starts.

Unable to establish communication with Acorn.
If this is the first time you have seen this message, exit and restart CNC12.
Otherwise please check Window Firewall, Ethernet Cable and Acorn Heartbeat.

Press any key to exit.

Automated by Centroid technology
www.centroidcnc.com

.
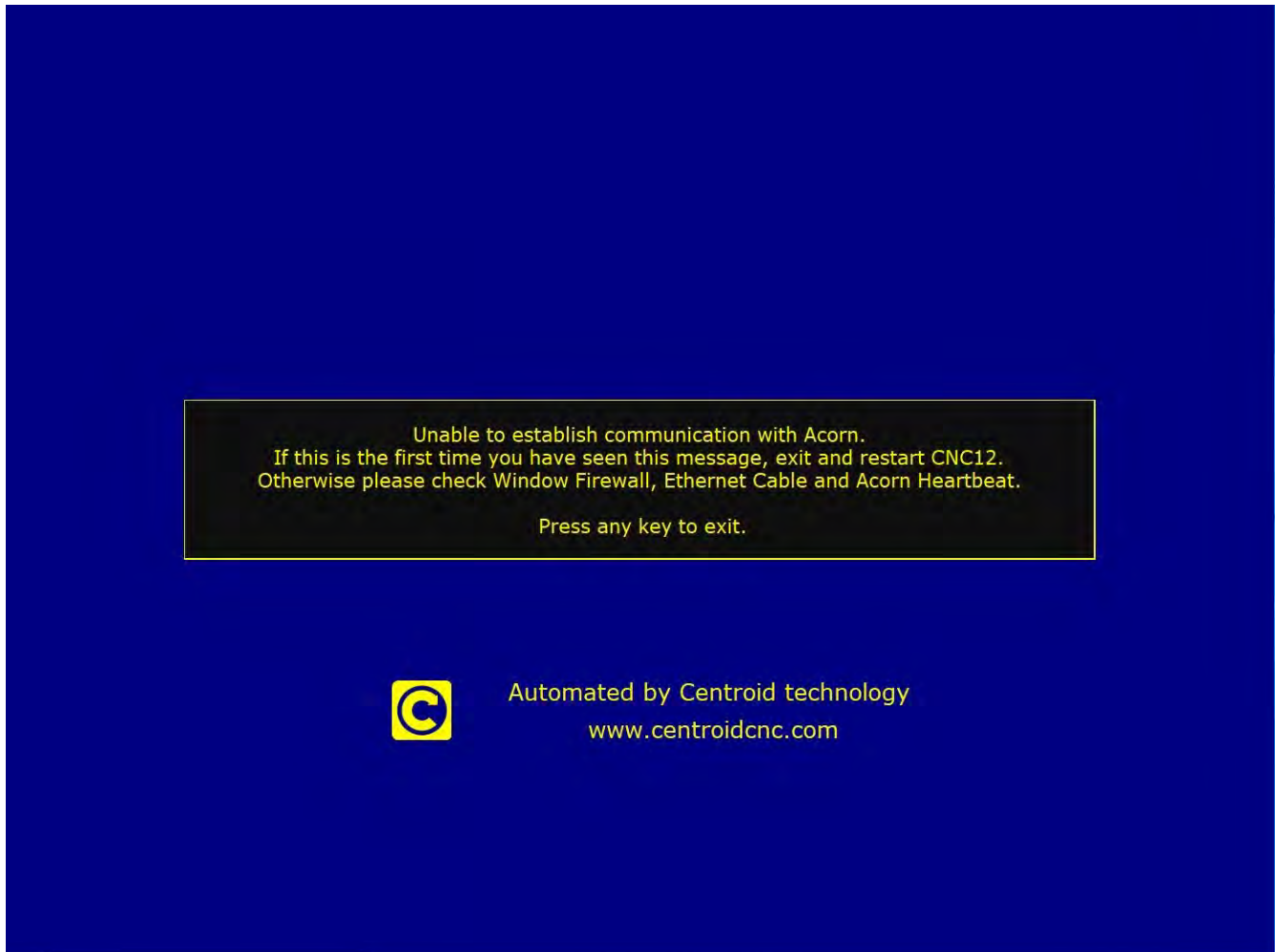
If this message appears consistently then there is a communications issue or the Acorn has no logic power.
See **3.4 Perform the Acorn to CNC12 communications stress test.** To solve communication issues.

4.2 Acorn Spindle Bench Test
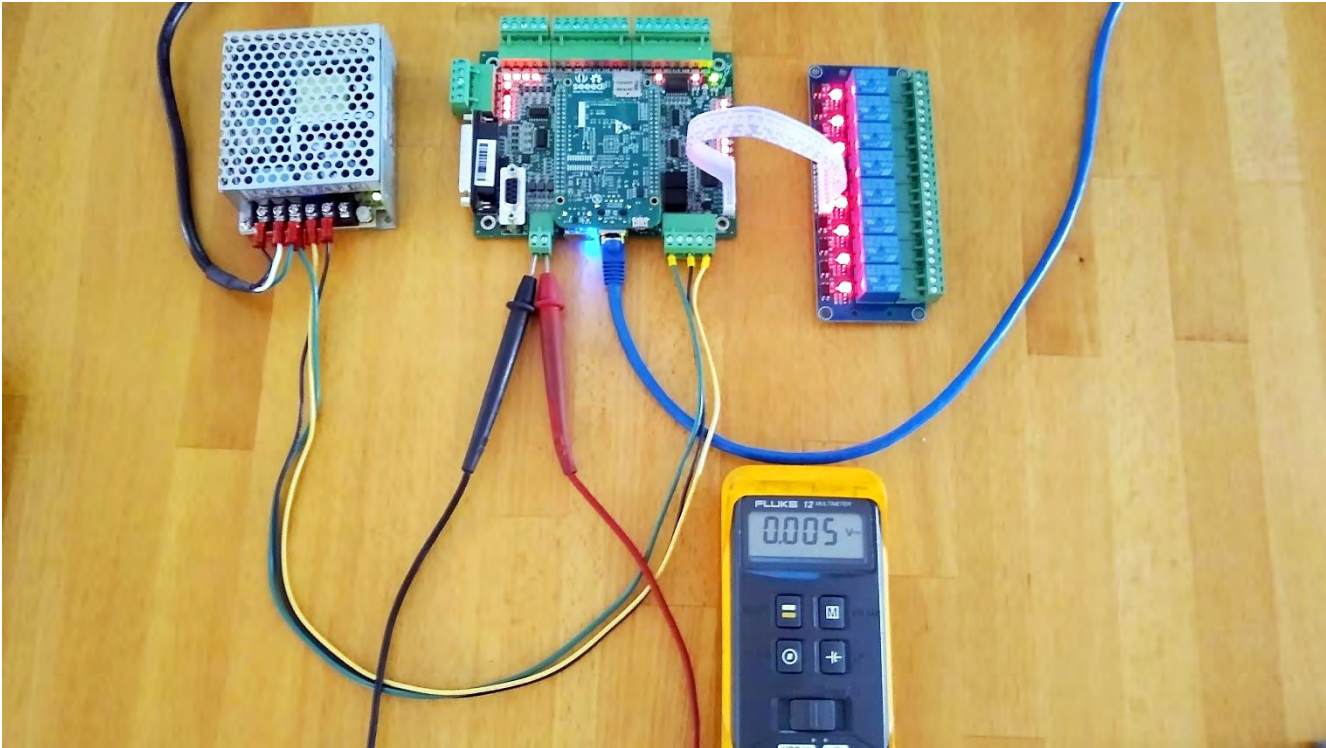
Start CNC12 with the Acorn Powered up.
Once CNC12 is running you should see this display:

Press the RESET Button on the Virtual Control Panel. The CNC12 screen should look like this:

Set Home by pressing Cycle Start.

The XYZ Digital Read Out (DRO) will now look this with 0.0000 for XYZ:

Load the G&M code program called "spindlebenchtest.cnc":

> a   Click Load (F2)
> b   A windows dialog box for C:/cncm/ncfiles will open
> c   Look for spindlebenchtest.cnc (see below)
> d   Highlight the file
> e   Click Open
> f   Spindlebenchtest.cnc should appear as the job name at the upper right corner of the CNC12 window:

Video showing the spindle analog output bench test procedure: https://centroidcncforum.com/viewtopic.php?f=61&t=2184

Testing the analog output for the spindle: Acorn provides a 0 to +10VDC analog output to provide programmable spindle speed control using a VFD (variable frequency drive). The default value for max spindle speed is 3000rpm and can be changed of course but, for this test, leave it a 3000 RPM. This test configures the control to scale the 0 to +10VDC from 0-3000rpm. With these settings a spindle speed command of S1500 will therefore output +5VDC, a command of S1000 will output close to +3.33VDC and so on.

> 1   Set a digital voltage meter to VDC
> 2   Insert the digital voltage meter leads into H8 as shown below. Tighten down the screw terminals to firmly grip the probes.
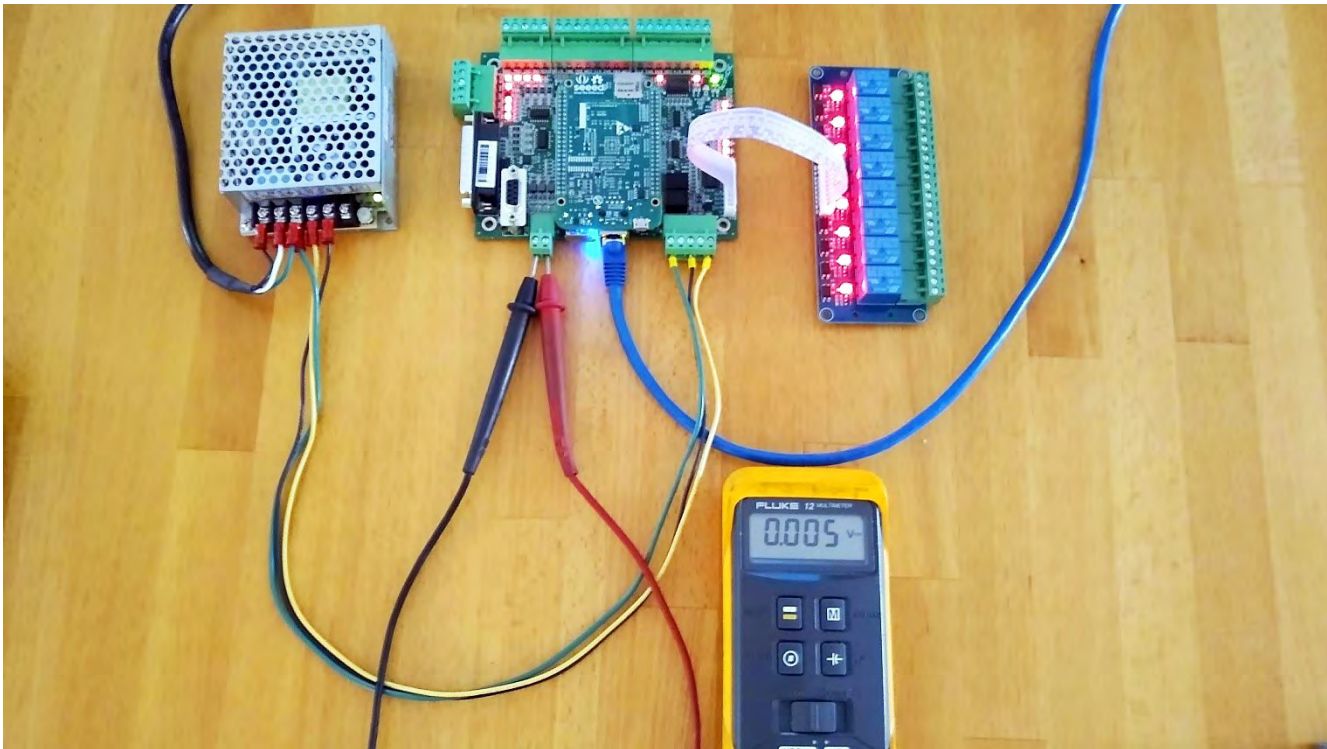
Meter connections for spindle bench testing

4. With spindlebenchtest.cnc loaded, press Cycle start to begin. The following screen will be displayed: (You may have to press Cycle start twice).

5. Enter the voltage readings when prompted in the Voltage reading box. Press Cycle Start to continue. Spindlebenchtest.cnc will display an error if the spindle does not output as expected. Continue to press cycle start as requested until the program is finished. The program will exit, and the status window will say "Job finished" after a successful completion.

5.1 Introduction to Electrical Cabinet Layout and Drive Type connections.

Now that CNCPC to Acorn communication has been confirmed it is time to think about electrical cabinet installation and basic axis motor drive type connections.

Stepper Drives connect to the DB25 port, most common method is to use a DB25 breakout connector board as seen below. These DB25 BOB's can be purchased here.
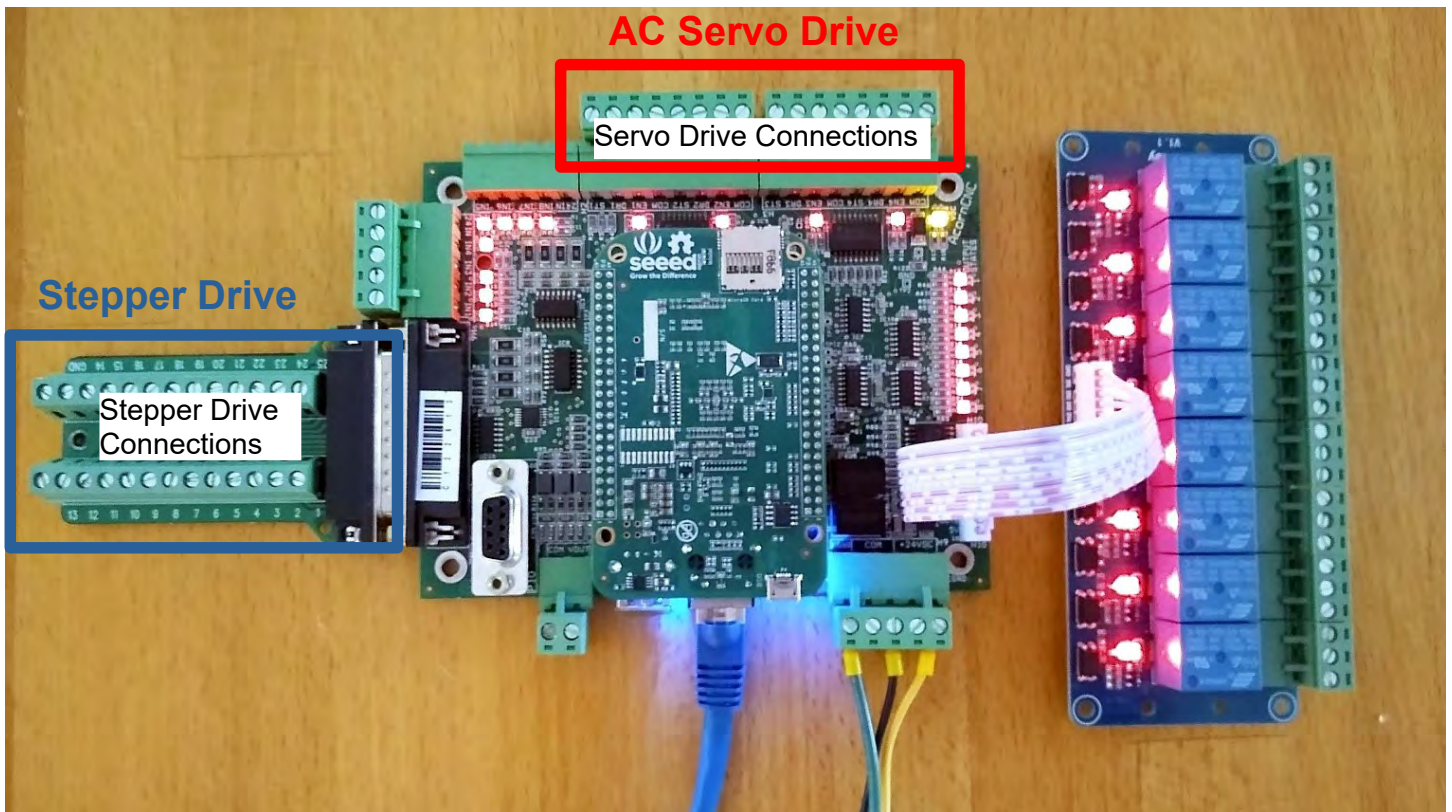
AC Servo motor drives connect to the "Screw Terminals"

There are many example axis motor drive hookup schematics available for free download on the Centroid Schematics web page. https://www.centroidcnc.com/centroid_diy/schematics/pbrowse.php

Use the search to sort the schematics. For example type in "Acorn Leadshine" to see all the Acorn to Leadshine hookup schematic examples.

CENTROID Schematics

SEARCH FILES   HELP

Search: acorn leadshine

Files	ID	R#	Date	Title
	S15147	2	08-31-2022	AcornSIX, MULTIPLE LEADSHINE CS-D1008 STEPPER DRIVES
	S15103	1	09-24-2021	ACORN_rev4, LEADSHINE ELP-D400Z SERVO DRIVE
	S15032	2	04-20-2021	ACORN_rev4, MULTIPLE LEADSHINE CS-D508 STEPPER DRIVES
	S14976	4	11-30-2021	ACORN_rev4, LEADSHINE DM 856/870/1182/2282 & MA860H
	S14975	3	04-20-2021	ACORN_rev4, LEADSHINE DM 422 & 422C
	S14974	3	04-20-2021	ACORN_rev4, MULTIPLE LEADSHINE CS-D1008 STEPPER DRIVES
	S14941	1	01-08-2019	ACORN_rev3, MULTIPLE LEADSHINE CS-D1008 STEPPER DRIVES
	S14901	3	01-07-2019	ACORN_rev3, LEADSHINE DM 856 870 1182 & 2282
	S14900	4	01-07-2019	ACORN_rev3, LEADSHINE DM 422 & 422C

How to wire the various systems in the electrical cabinet.

Related post on the Centroid Community CNC Support Forum: Control Box Building Tips

https://centroidcncforum.com/viewtopic.php?f=61&t=2443&sid=00f5418e46966cadb26ca1f3b6567b17

Centroid provided Hookup Schematic sets are provided as a guide and may be found here:
https://www.centroidcnc.com/centroid_diy/schematics/pbrowse.php
Use the Search type in search terms such as "Acorn Leadshine" to see all the Leadshine schematics etc.
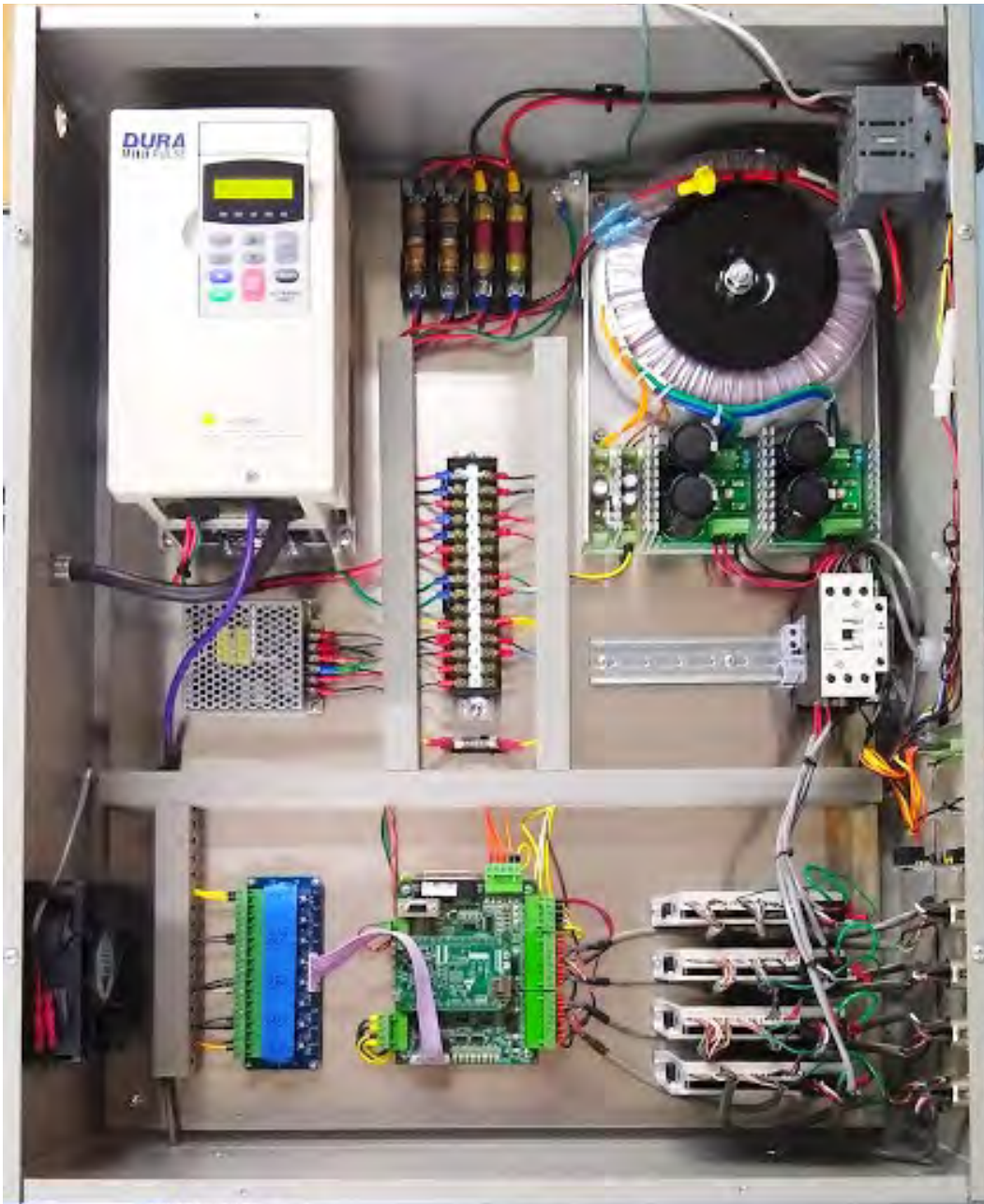
Suggested layout for the major components of the electrical panel:

- Main Power Supply – Upper Right
- Over Current Protection (fuses) Top Center
- Master ON/OFF Switch – tight in Upper Right corner
- Variable Frequency Drive – Upper Left
- E Stop Contactor – Center Right
- Axis Drives – Lower Right
- Acorn – Bottom Center
- Acorn 24VDC Logic Power Supply – Left Center
- Acorn Relay Module – Lower Left
- Cabinet Cooling Fan – Left of Acorn Relay Module
- TB1 Terminal Block - Center

Best practices for Electrical Cabinet Wiring

Minimize Noise and Interference

- Keep sensitive electronics away from noisy equipment. Install high voltage transformers, contactors, and other electrically noisy equipment as far away from low voltage circuit boards as practical. For example, it would be a bad practice mount a contactor block or large transformer directly underneath the Acorn.

- Try to keep high voltage power lines far away from low voltage signal lines. Keep the high-voltage AC power lines and motor power lines as far away from low voltage logic signal wiring as practical.

- Grounding Principle. Wire the incoming chassis (earth) ground lug directly to a single ground bus bar. Wire all cabinet doors, power supply chassis grounds, shields/drain wires and other equipment chassis ground to one single ground bus bar. What you should NOT do is have several different grounding points throughout the cabinet, as this could increase electrical noise and interference. This is very important!

- Leave plenty of space between wire ducts and components. Keep wire ducts at least 2" away from circuit boards when practical.

- Use Snubbers on Contactors and Solenoids. Contactor blocks, solenoids and relays need a snubber across the coil. Centroid recommends using Quencharc snubber networks (Centroid PART# 1819). This reduces electrical noise. If you are new to using snubbers more information can be found in Technical Bulletin #206, the latest version can be found here.

(http://www.centroidcnc.com/dealersupport/tech_bulletins/uploads/206.pdf)

- Keep wires short. Keep all cabinet wiring under 6ft.

Closed Loop Leadshine Stepper drives with Acorn, Ground lug, CNCPC, VFD, Power supplies and circuit breakers.

Link to the parts and tools used in the building of this cabinet

https://centroidcncforum.com/viewtopic.php?f=60&t=8354

Keep the cabinet maintainable and easily serviceable. Buy a larger metal enclosure than you think you need.

- Link to tools and gear that we use but don't sell.
  https://www.centroidcnc.com/centroid_diy/diy_cnc_gear.html

- Wire management: Use PVC wire ducts (such as Panduit's Panduct) to keep your wires neat and organized.

- Use DIN rails for mounting relays, contactors, terminal blocks, circuit protection blocks, disconnects, etc.

- Take all corners in the wiring ducts as wide as possible. Always leave a little bit of slack in the wires.

- Keep all the wiring in neat horizontal and vertical lines. Never run wires diagonally.

- Take detailed pictures of the cabinet.

- Label EVERYTHING. Label everything so that it matches the labels on your schematic. This includes labeling each individual wire at both ends, circuit boards, relays, contactors, etc.

- Keep the schematic attached to the cabinet somewhere so it does not get lost.

Use the correct wire gauge.

- 22 Gauge stranded is suitable for signal wires such as limit switches and VFD inputs and outputs. A twisted pair cable is ideal for devices like limit switches with one signal and one return wire.

- 18 Gauge stranded is used for 5V, 12V, 24V low current power wires. 18 gauge is used to power the Acorn and control devices connected to the outputs.

- 16, 14, 12 gauge should be used for Power wires connected to Axis drives, contactors, spindle drive, pumps and other higher current accessories. Consult the drive manual to determine current requirements. If a drive can accept 110VAC or 220VAC, wiring for 220VAC will reduce the required current.

- Stranded wire in these gauges can be purchased Automation Direct or Amazon, buy good quailty wire avoid cheap wire from China. If you are in a pinch wire from most home improvement centers carry stranded wire in the electrical section.

Special attention needs applied to any magnetic electrical coils employed in the CNC control system. Contactors, Relays and Solenoids are the three most common sources of electrical noise that can cause

reliability issues. These devices are commonly used to control M code related functions such as coolant pumps, air operated ATC's, any electrical motor, etc.   Snubbers (aka Quencharcs) are used to eliminate the electrical noise generated by the coil(s) contained in the contactors, relays and solenoids (fly back diodes can be used on solenoids as well)
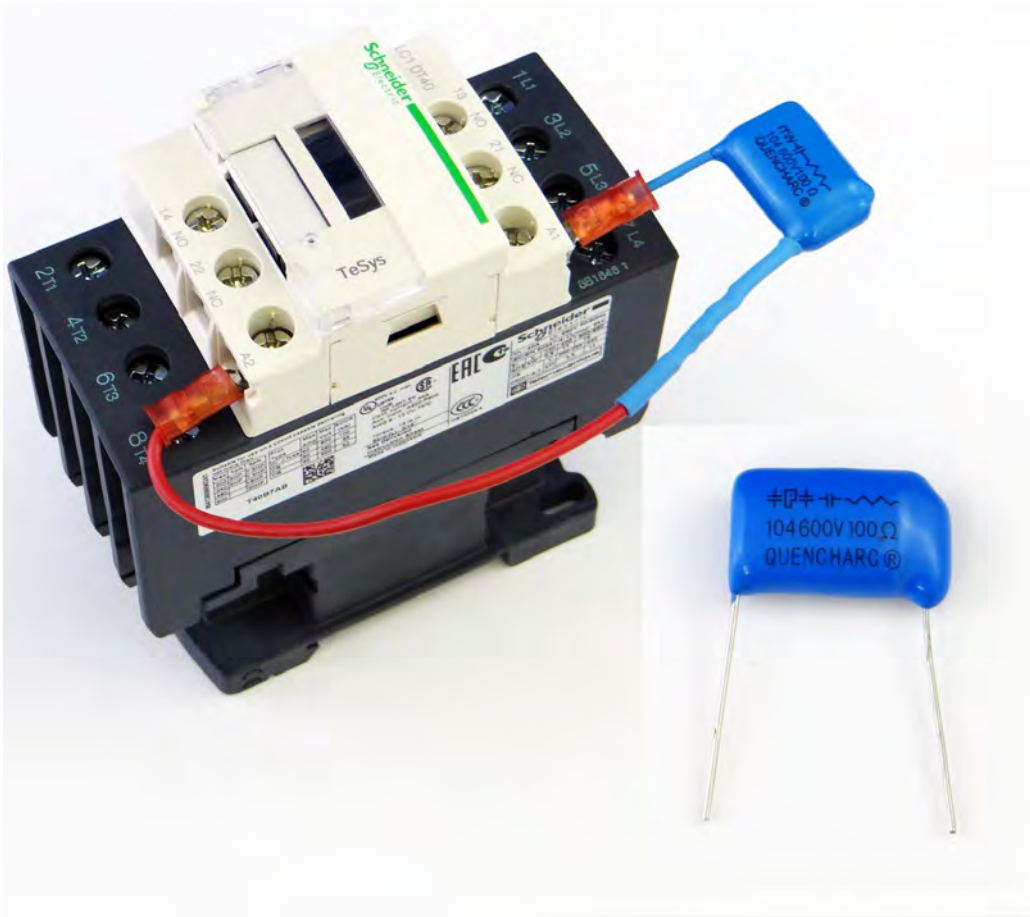
Noise suppression Snubber (aka Quencharc) installed across contactor coil

Many modern contactors have the facility to accept a plug and play quencharc that snaps onto the contactor.

Common Wiring Problems

The following information is also covered in Technical Bulletin #78 which can be found here.
(http://www.centroidcnc.com/dealersupport/tech_bulletins/uploads/78.pdf)

The wire is *too small* for the spade terminal

Red = 18-22 ga.
Blue = 14-16ga.

22 ga

Wrong Crimp Tool!

This wire is *too large* for the spade terminal

Do not cut strands away!

12 ga

Wrong Crimp Tool!

These are for *cutting* wires, not stripping!

This type of tool is used for *stripping* wires.

When cutting back the insulation on a cable, do not cut the insulation on the wires inside the cable.

There are cuts in these wires from careless stripping of cable. This is very bad.

A cutter cannot be used to strip wires!

Some strands are cut because a cutter was used to strip.

Acorn and Relay8 board size and bolt hole locations

Link to 2D CAD and 3D solid models files for the images below. Need Link to solid models.
www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/acorn_relay8_dimensions.dxf

ACORN Mounting Footprint

8 Relay Board Mounting Footprint

0.150"
(3.8mm)

Out 1 NC
Common
Out 1 NO

Out 2 NC
Common
Out 2 NO

Out 3 NC
Common
Out 3 NO

GND
Output 1
Output 2
Output 3
Output 4
Output 5
Output 6
Output 7
Output 8
5V IN

5.669"
(144mm)

Out 4 NC
Common
Out 4 NO

Out 5 NC
Common
Out 5 NO

Out 6 NC
Common
Out 6 NO

Out 7 NC
Common
Out 7 NO

5.354"
(136mm)

Out 8 NC
Common
Out 8 NO

1.890"
(48mm)

2.205"
(56mm)
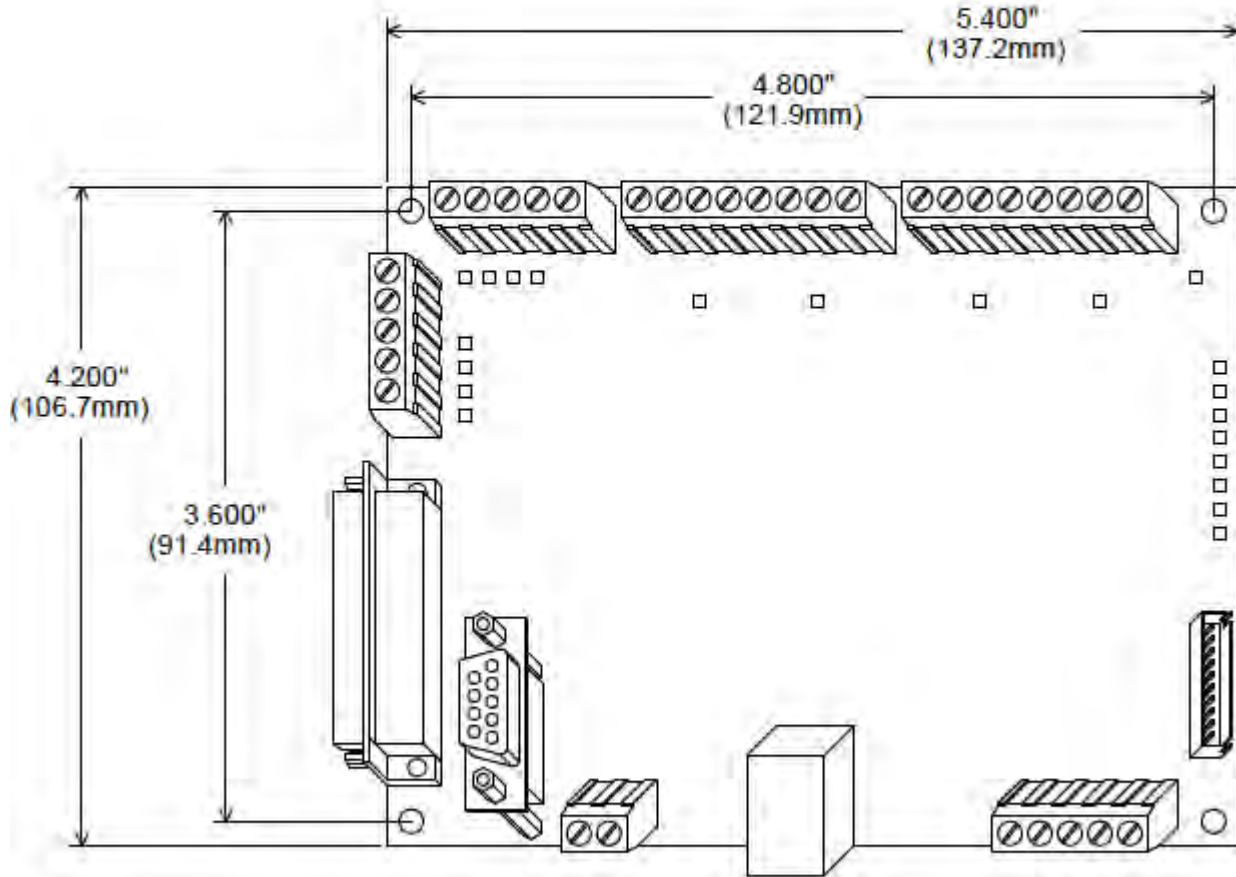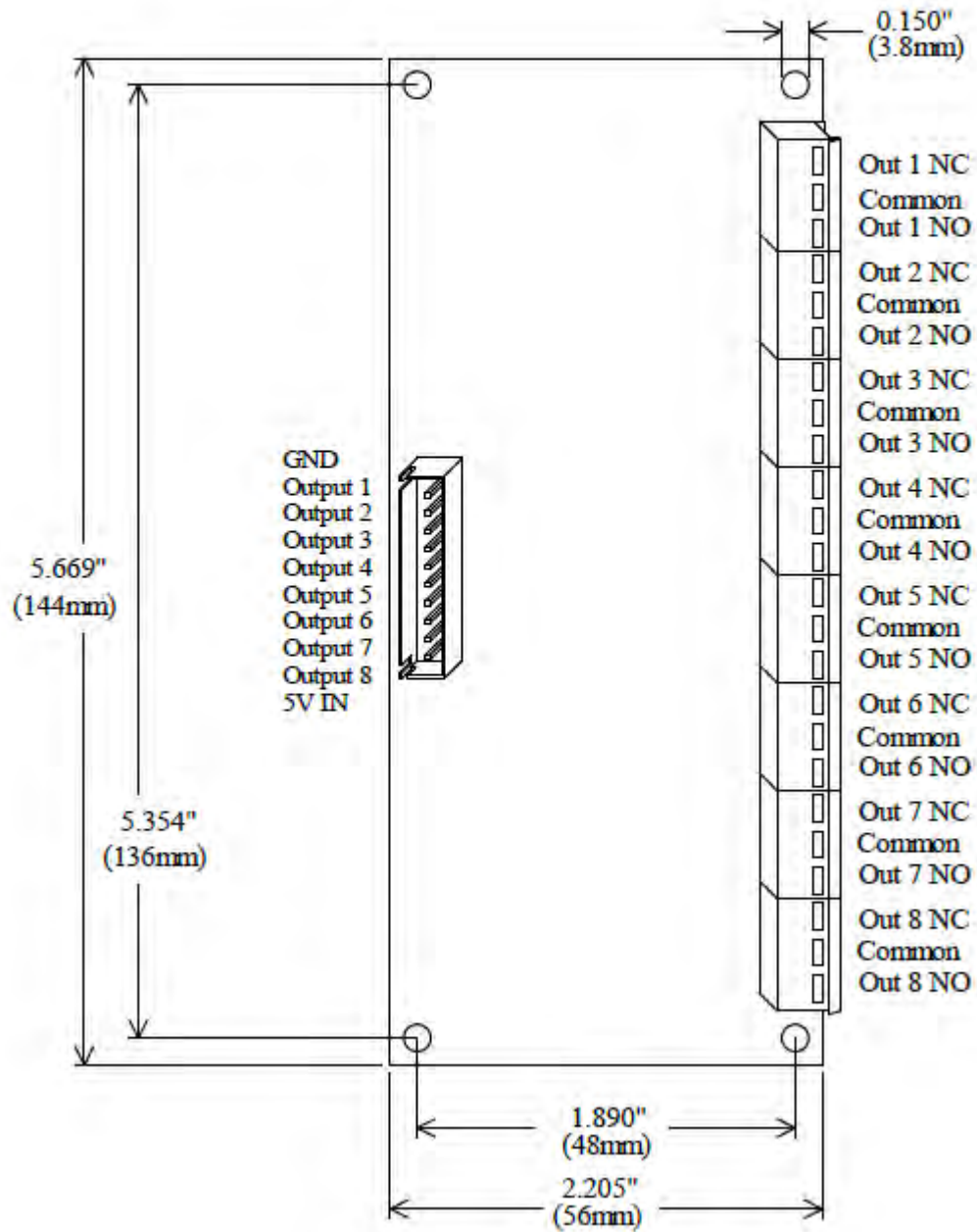
5.2 Acorn Inputs

The inputs of the Acorn are SOURCING 24VDC.

That is, the Acorn supplies 24VDC at the input and they must be "SINKed" to COMmon to activate them.

24VDC is supplied via 24IN on H4 or H5. These terminals are connected internally. Inputs 1-8 can be connected to home switches, drives, inverters, probes and other sensors and switches which sink the input to 0VDC COM.
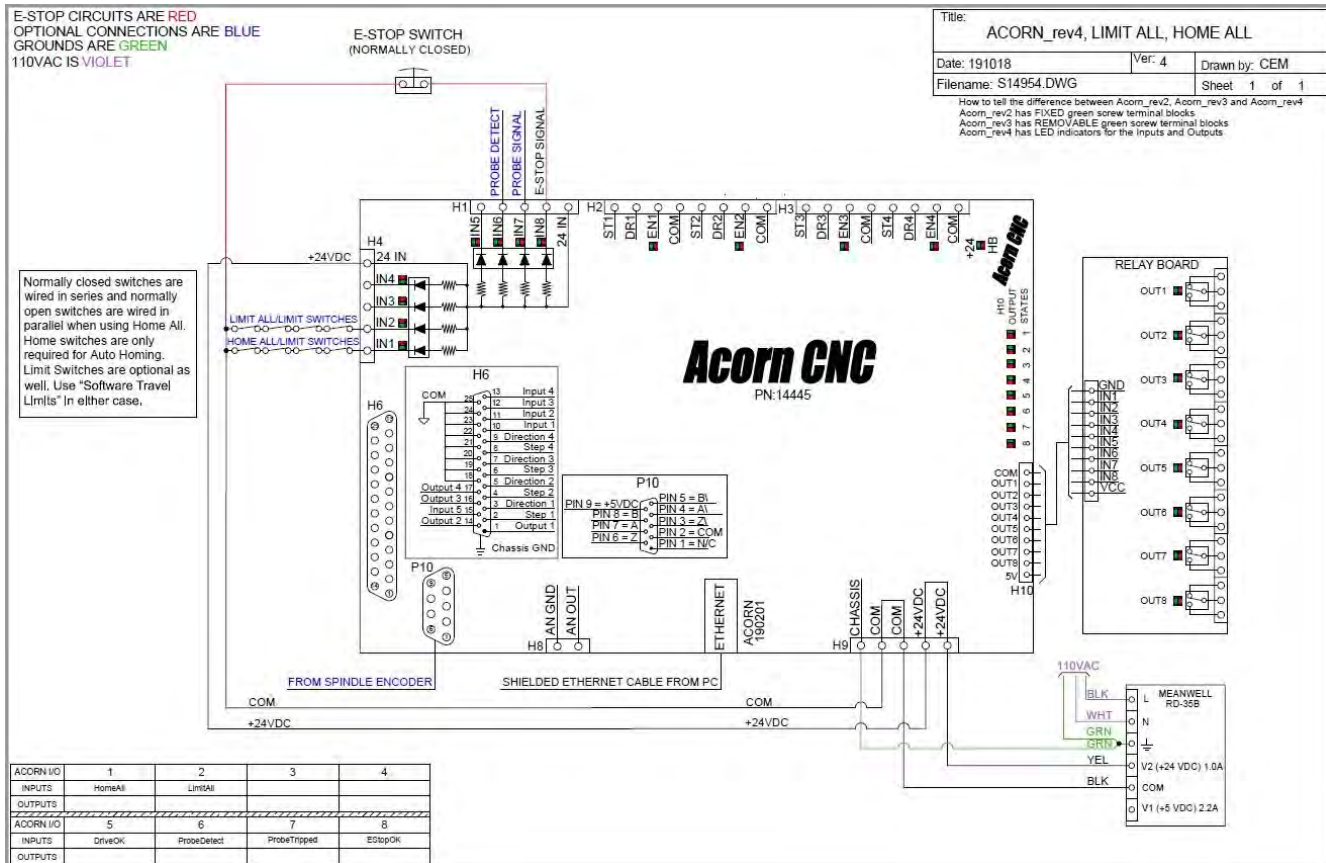
Drawing S14954 Acorn Homing, Limit and E Stop

24VDC is supplied to Limit Switches/E Stop input in the example above. The switches connected to IN1 are the Homing switches and the optional limit switches connected to IN2 are for limit switches designed to stop an accidental over travel.

When the device is active, a complete circuit is made allowing current to flow from 24VDC to 0V COM. This activates the input on the Acorn.

Acorn inputs are activated by closing simple external switches. This is known as the "contact closure to ground (COM)" method.

When using Proximity Switches, Hall Effect Sensors etc., use NPN type sensors compatible with +24VDC for use with Acorn. See Acorn schematic #S14955 for hookup of Proximity Switches.

5.3 Acorn Outputs

Centroid Acorn is equipped with 8 relay outputs. Each Acorn output toggles one SPDT relay.

Need image that shows gnd jumper
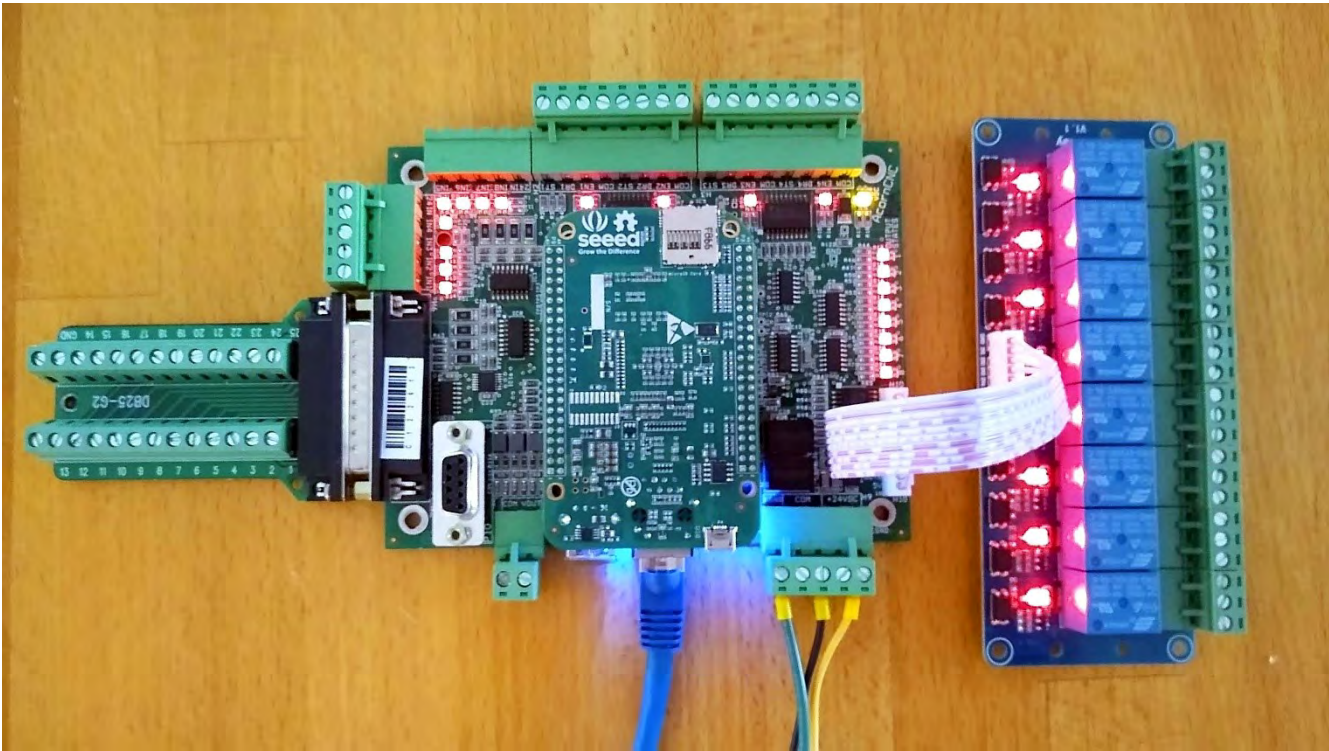
Acorn board with Output Relay Module and DB25 Breakout installed

5.4 Wiring +24VDC jumper to inputs.

Install a jumper from the spare +24VDC terminal H9 and run it to either H1 OR H4 24V IN. (they are internally tied together on the Acorn).

5.5 Wiring E-Stop Circuit

Basic Bench Test Estop Circuit wiring schematic S14954
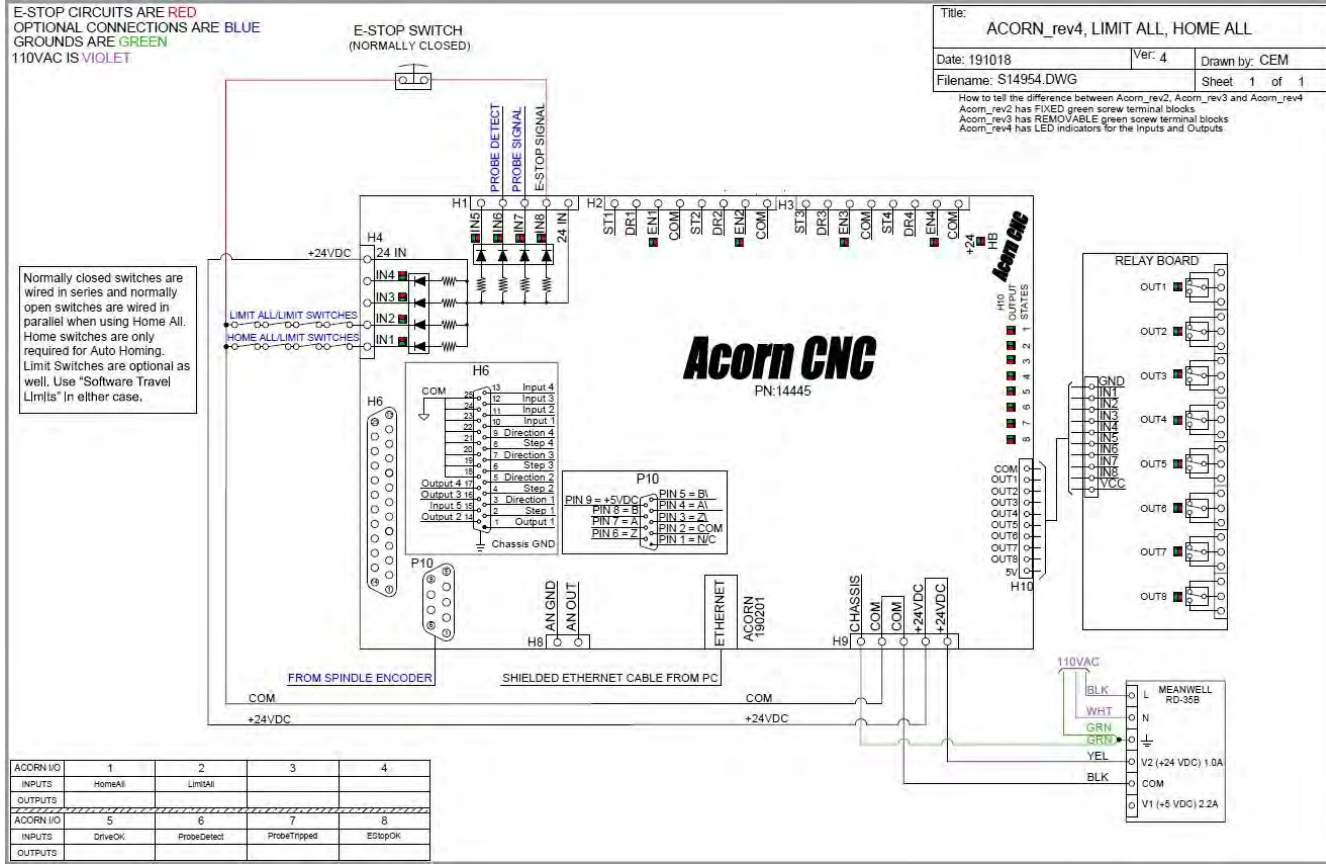
Acorn Schematic: S14954 Acorn Limit, Home and E Stop wiring example

E-Stop Basics

- The required emergency-stop (or E-stop) circuit is a safety mechanism used to shut off the machine during an emergency.

- The E-stop switch(s) is closed when the machine is in its operational state.

- A normally closed E-stop circuit prevents noise from causing spurious faults because the signal is closed when in a good state.

- For additional safety, multiple E-stops can be added to a machine and can simply be wired in series with the first estop switch.

- NOTE: Wiring E-stop in a normally open (NO) configuration is dangerous as it will not stop the machine in the event of a wire break or switch failure. Do not use a Normally Open (NO) switch for Estop.

E-Stop Switch

- Use a double pole single throw (DPST), normal closed, twist to release, emergency stop switch. Such as Centroid part number #1009 used with #5934 available on this page.

- Acorn E-Stop connections - There are two E-stop signals, one input and one output.

- Input 8 is typically assigned to the E-Stop. Input 8 on header H1 needs to be routed in series with any E-stop switches, so that if any of the E-stop switches are tripped the Acorn PLC knows that the E-stop switch is engaged.

- Any Acorn Output can be used to energize an Estop Contactor. Centroid typically uses Acorn Output 1 for Estop duty. The Acorn PLC output designation for the Estop circuit is "NoFaultOut".

- The Acorn's Output 1 relay is rated for up to 10 amps at 125 VAC or up to 5 amps at 30 VDC. Typically 24 volts DC or AC is used to energize the Estop contactor coil.

E-Stop Switch wiring:
Wire a Normally Closed Estop button (NC): Connect one wire from one NC terminal on the Estop button to Acorn power supply COM (or the spare COM Terminal on H9). Connect another wire from the other NC terminal on the Estop button to H1 IN8 (Input 8).

E-Stop Contactor

It is good practice to incorporate what is known as an "E-Stop" contactor in your build. It is powered by a separate power supply and energized with Acorn Output Relay 1 NO contacts. (Assigned in the Wizard NoFaultOut) Note: Do not use the Acorn Logic power supply to power any contactor. (Reminder, USE a snubber across the E-Stop Contactor coil)
Diagram shown above.

- A contactor is an electrically controlled switch. It can be thought of like a higher current relay. The contactor is energized by low voltage low amp power that is switched by one of the Acorn Relay Outputs, typically Output 1. The contactor allows the Acorn board to cut high power devices automatically when the Estop Button is depressed.

- Estop contactors are typically used to turn on and off high power (high voltage/high amps) to axis drives as well as to turn off the main spindle and any other high power device connected installed on the machine tool.

- If you are not using a contactor with a built in or addon snubber, a snubber needs to be placed across the contactors. Centroid recommends using Quencharc snubber networks (Centroid PART# 1819). This reduces electrical noise when the contactor is cycled on and off.

- For larger machines with AC servos, Centroid recommends using a Scheneider Electric/Telemecanique LC1DT40B7A or similar device for the E-stop contactor (Centroid PART# 14374). This Contactor assembly includes the snubber assembly and uses 24VAC to control it. Contactors must be sized appropriately to the given load, AC or DC voltage and the current requirements.
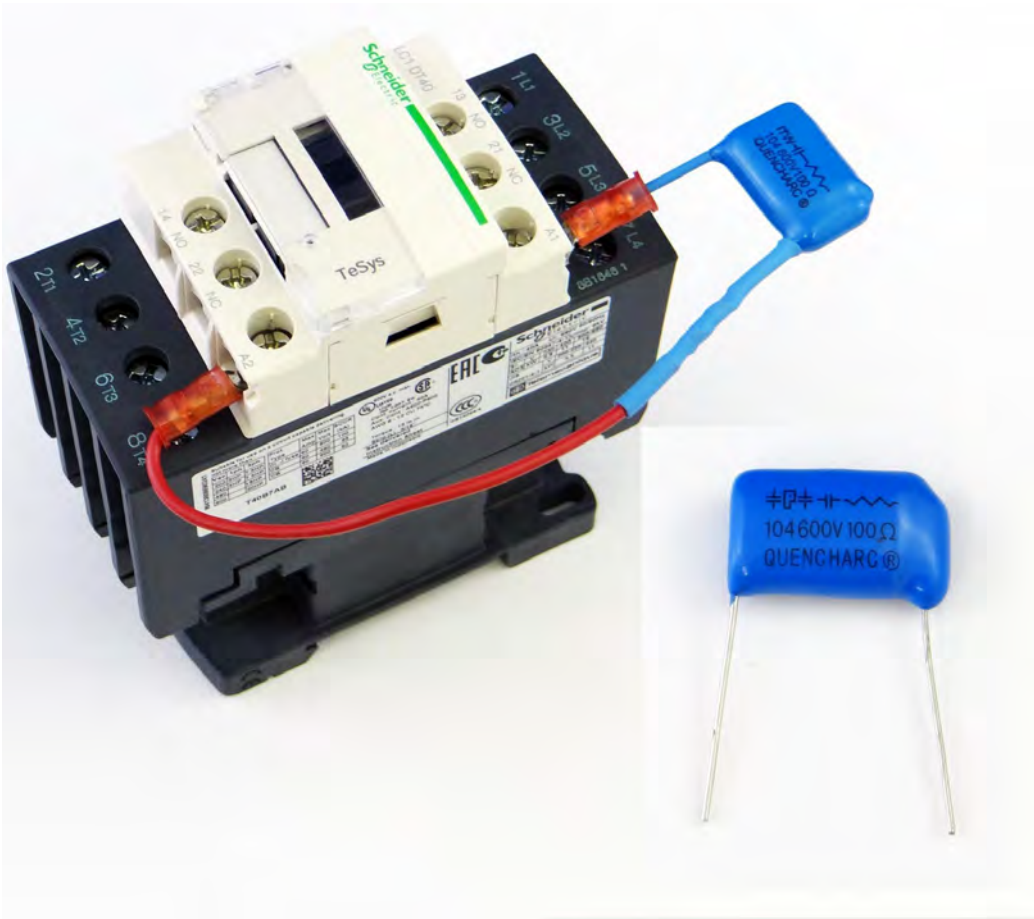
Contactor with snubber installed across the coil for contactors without a built in snubber or snap on snubber.

Testing the E-Stop Wiring

- Power up the system
- Start CNC12
- Start the Wizard, open the Input Definitions menu.
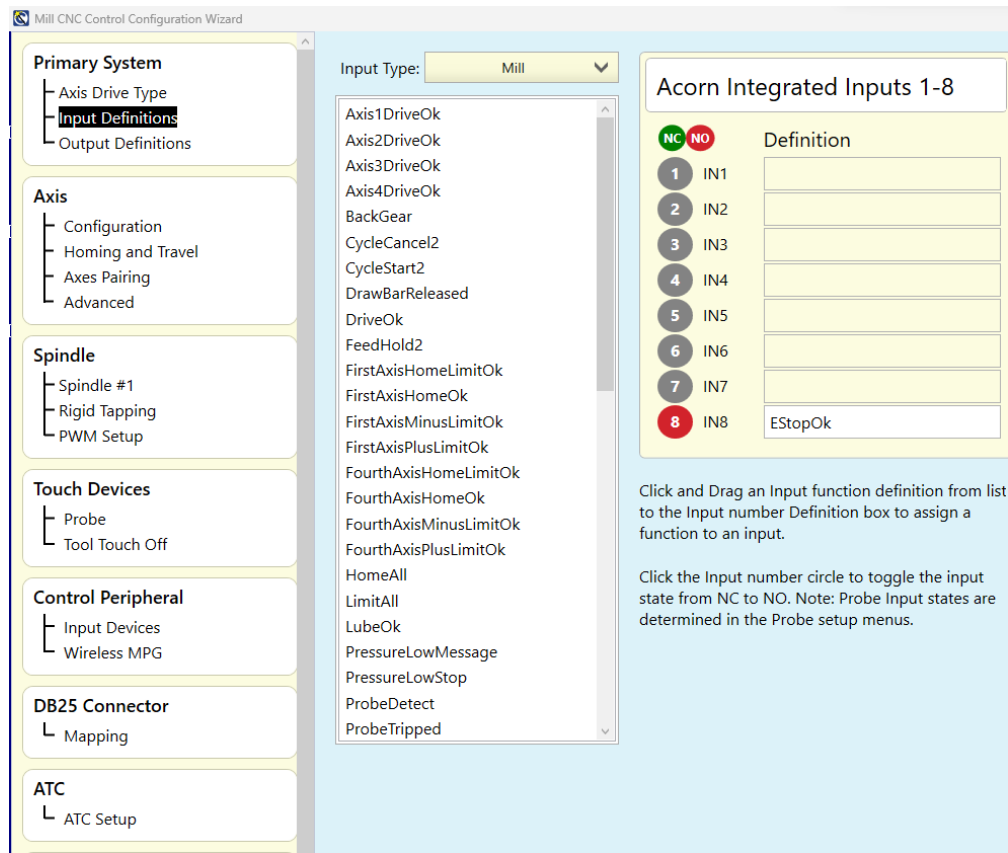
Click on the Red 8 circle beside the IN8 EstopOk input.
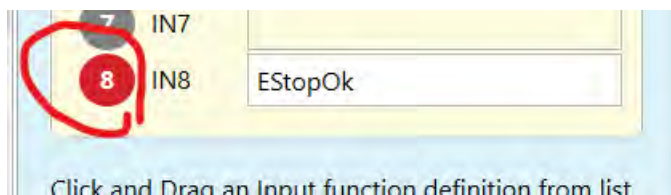
Change it to Green (Normally Closed)
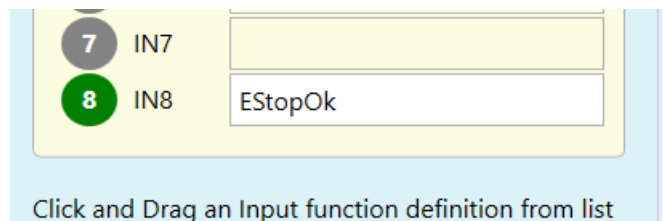
Press Write Settings to CNC control configuration and follow the instructions on the screen.

Write Settings to CNC Control Configuration
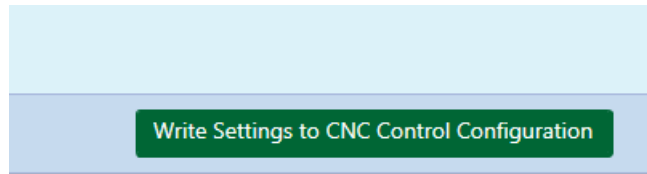
Now that we have a normally closed Estop switch wired to input 8, Test the switch by cycling it and you will see the 406 Estop detected and 335 released message in the CNC12 message dialog box change as you cycle the switch.

335 Emergency stop released
9033 Reset Initiated, Press Reset to Clear
406 Emergency stop detected
335 Emergency stop released
406 Emergency stop detected

Press CYCLE START to start job

335 Emergency stop released
9033 Reset Initiated, Press Reset to Clear
406 Emergency stop detected
335 Emergency stop released
406 Emergency stop detected
335 Emergency stop released

Press CYCLE START to start job

It is interesting to note that the Estop and all other inputs and outputs can be observed in real time using the PLC Diagnostic app. Press <Alt i> to run the PLC Diagnostic app.
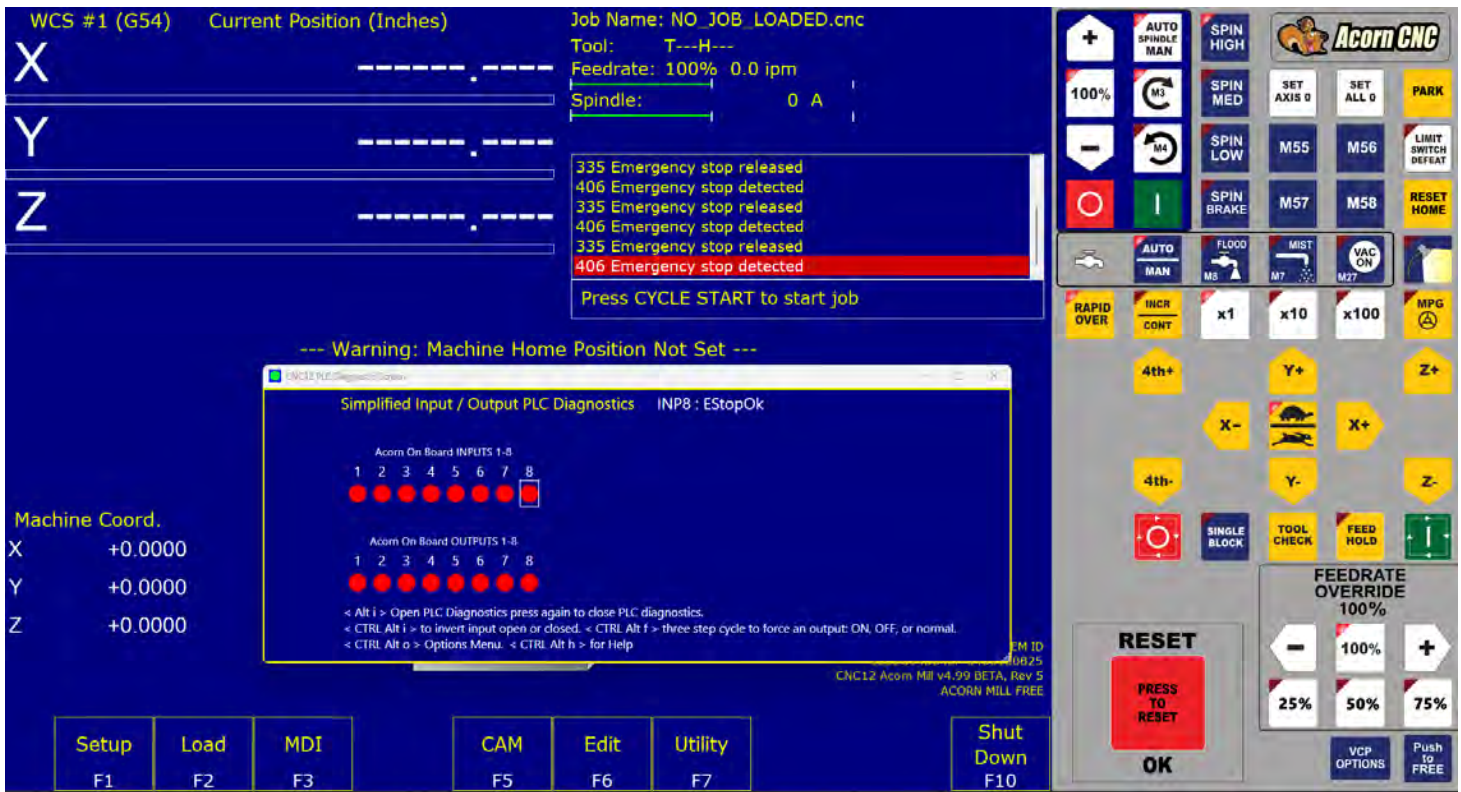
How to use the PLC Diagnostic user manual is here.
https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/cnc12_PLC_diagnostic_screen.pdf
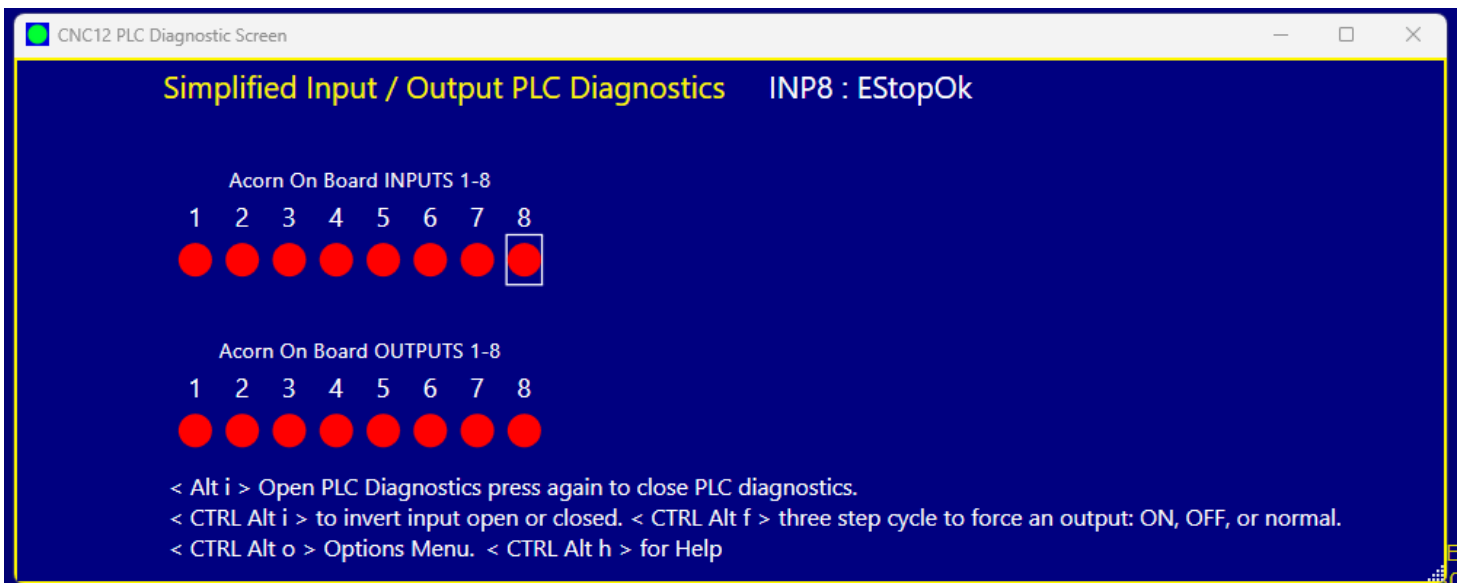
5.6 Wiring Axis Motor Drives

Each Centroid Acorn drive schematic has a corresponding "Drive Type" found in the Wizard.
Choose a schematic that matches your drive type, and select that same drive type in the Wizard and the Wizard will automatically configure CNC12 to match the schematic.

For instance:

IMPORTANT: While on the bench, take the time to wire ONE axis drive and one Axis Drive and Motor. Configure and test it. Once you have one drive and motor successfully configured and turning, then replicate the steps to attach and configure the remaining drives and motors on the bench. Verify all are working by jogging each axis using the Virtual Control panel before proceeding.

top

The Acorn supports a wide variety of Axis drives that take standard step and direction input. There are two ways to connect AXIS motor drives to the Acorn. The Axis drive headers (H2 and H3) are generally reserved for AC servo motor drives. These are open collector outputs used to signal step, direction and enable to a connected axis drive. Below is an example of Acorn to Estun AC servo drive wiring using the Acorn open collector step and direction outputs. Schematic S14965.

The DB25 connector is also provided for drives that use a +5VDC Logic input. This is the recommended method of connecting most Stepper Motor drives such as Leadshine and other similar drives using +5VDC logic.

More information on DB25 vs Drive headers can be found here:

Centroid Community CNC Support Forum: DB25 or Header? for drive connections...
https://centroidcncforum.com/viewtopic.php?f=63&t=2227

A DB25 male breakout board is recommended for easy stepper motor to Acorn DB25 connection.
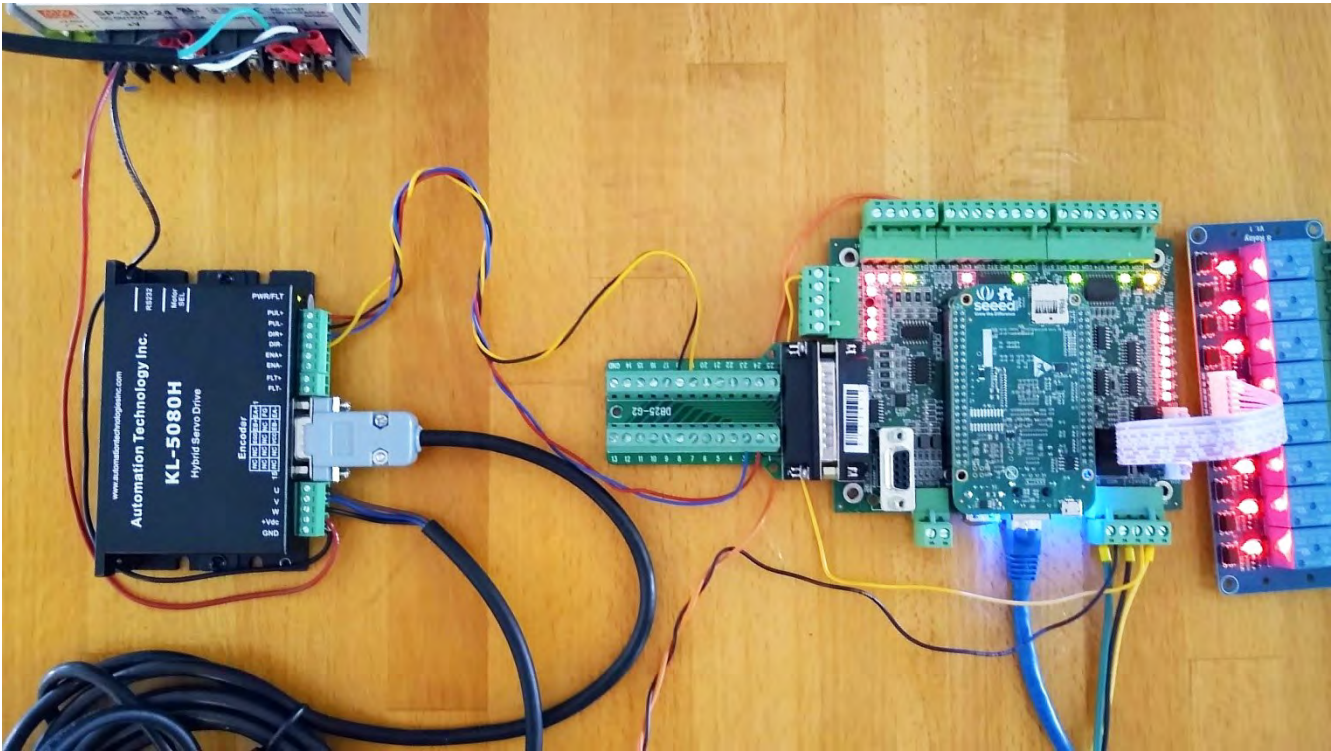
Typical Stepper motor driver wiring to Acorn using the DB25 connector.
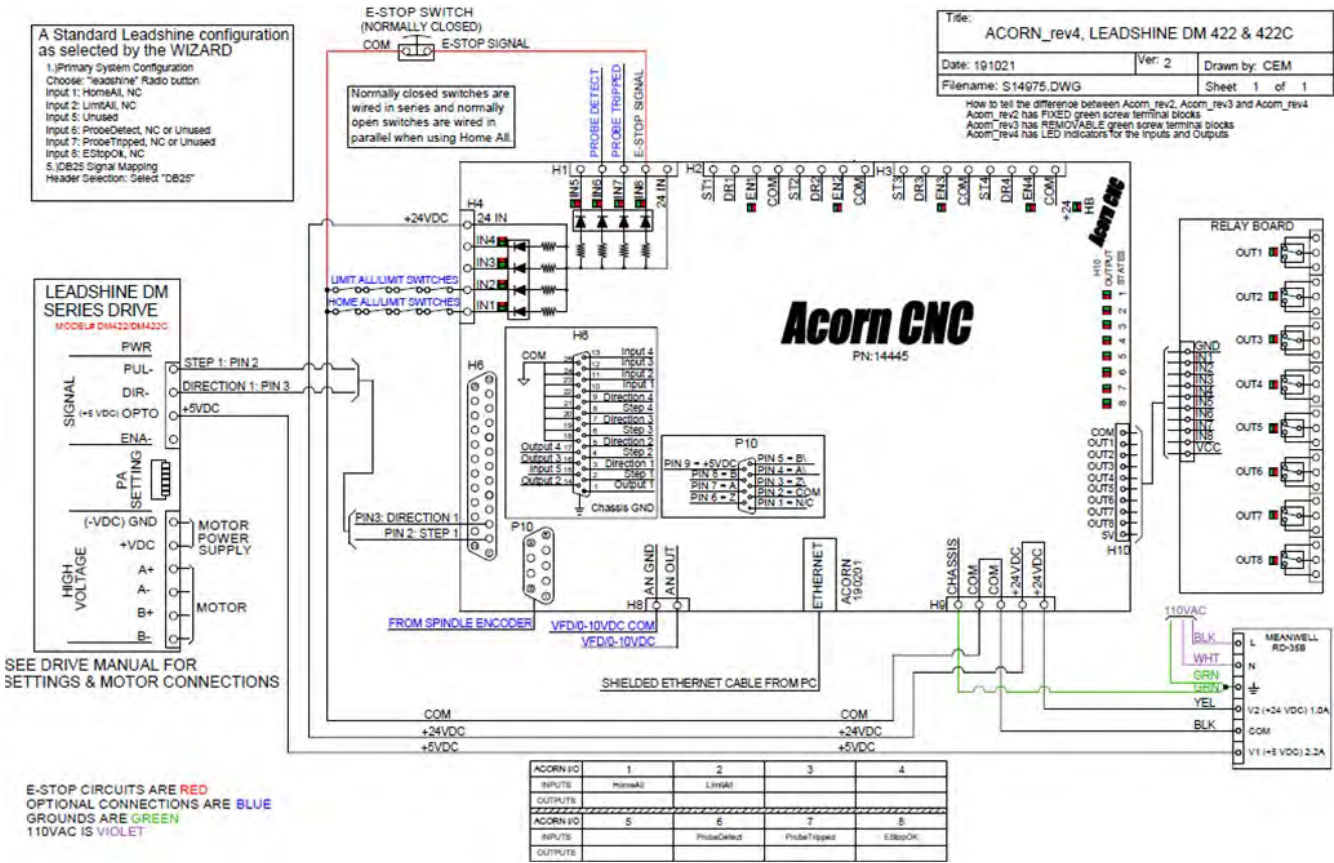
Schematic S14975 of a typical Leadshine stepper drive wiring

Legacy Parallel Port support

The DB25 can also be used to connect directly using a straight through parallel cable to legacy control systems that previously used a PC compatible parallel port.
This style connection is found in some import tabletop routers and the Gecko G540 is also cable compatible.
Note: For non standard DB25 pin configurations, the Acorn DB25 pin functions can be rearranged and reassigned in the CNC12 wizard that saves creating a custom cable or connection.
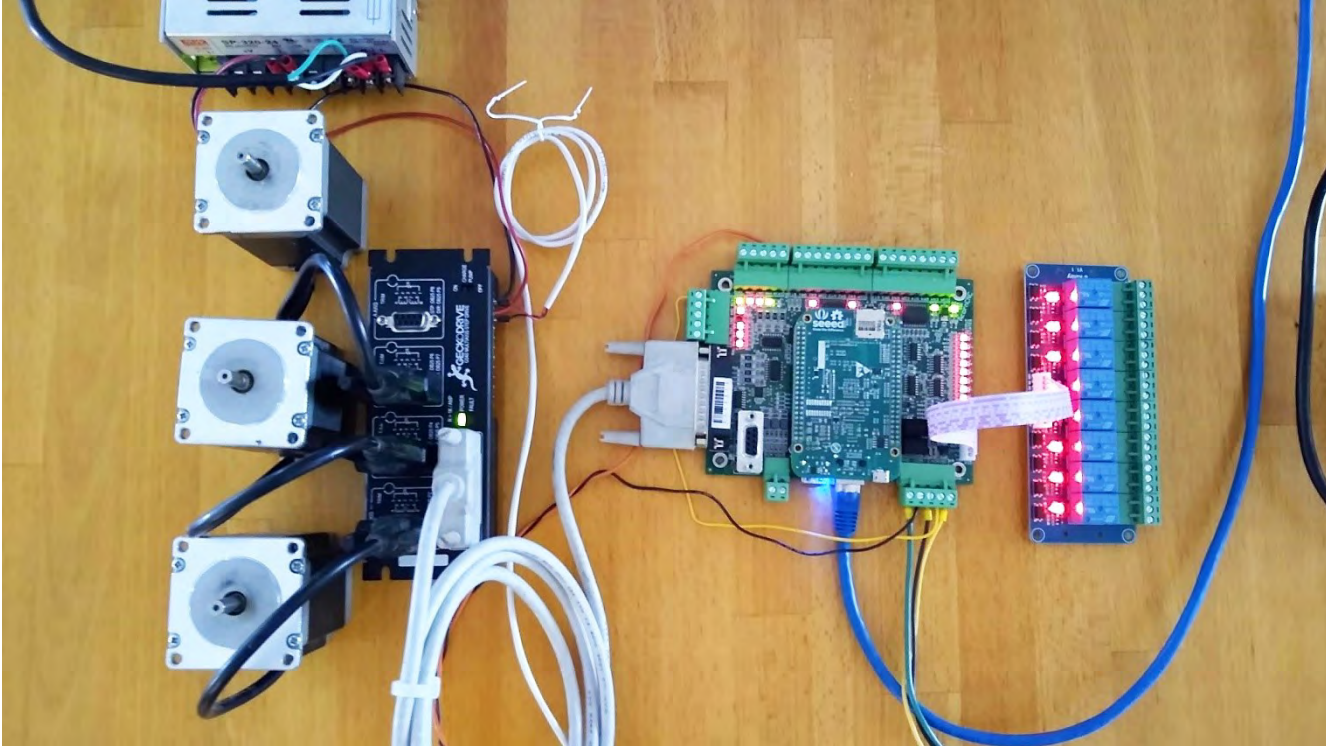
Teknic Clearpath

Acorn systems with multiple Clearpath servos require a unique setup so that the servo fault signals reliably trigger one Acorn input. There are currently two approved methods for connecting Clearpath SDSK/SDHP motors to Acorn.

That information can be found here:
https://centroidcncforum.com/viewtopic.php?f=60&t=5531

Centroid has created example schematics for many popular axis motor drives. Search "Acorn" on the Centroid schematic page to see all Acorn schematic. As of this writing Acorn to: Yaskawa, Estun, Delta, Clearpath, Leadshine, Stepper Online, GeckoDrive, Centroid Micro 1, DMM. Links to all Acorn schematics are here along with All Acorn documentation.

5.7 Wiring Home and Limit Switches

All inputs used for Limit and Home switches should be of the normally closed type switch. The switch should be closed when the machine is in its operational state.

Note: Using Normally Open switches for Limit or Home switches is dangerous as the machine will not stop in the event of a wire break or switch failure. Using NO switches also introduces more sustainability of electrical noise causing an erroneous input trigger.

The I/O configuration on every machine is different. While the examples below assume dry contact type switches utilizing 24VDC, your machine may utilize different voltage levels and different type devices such NPN or PNP proximity sensors. If your devices are proximity sensors, they MUST be 3-wire sensors, 2-wire sensors will not work reliably and should be avoided.

Connect the Home and the OPTIONAL limit switches as shown below in schematic S14954.When Input 1 is configured as HomeAll, the normally closed switch from each axis will all be wired in series conserving 2 inputs, while this is not the only way to wire and configure home switches this is the preferred Acorn Home switch wiring technique.
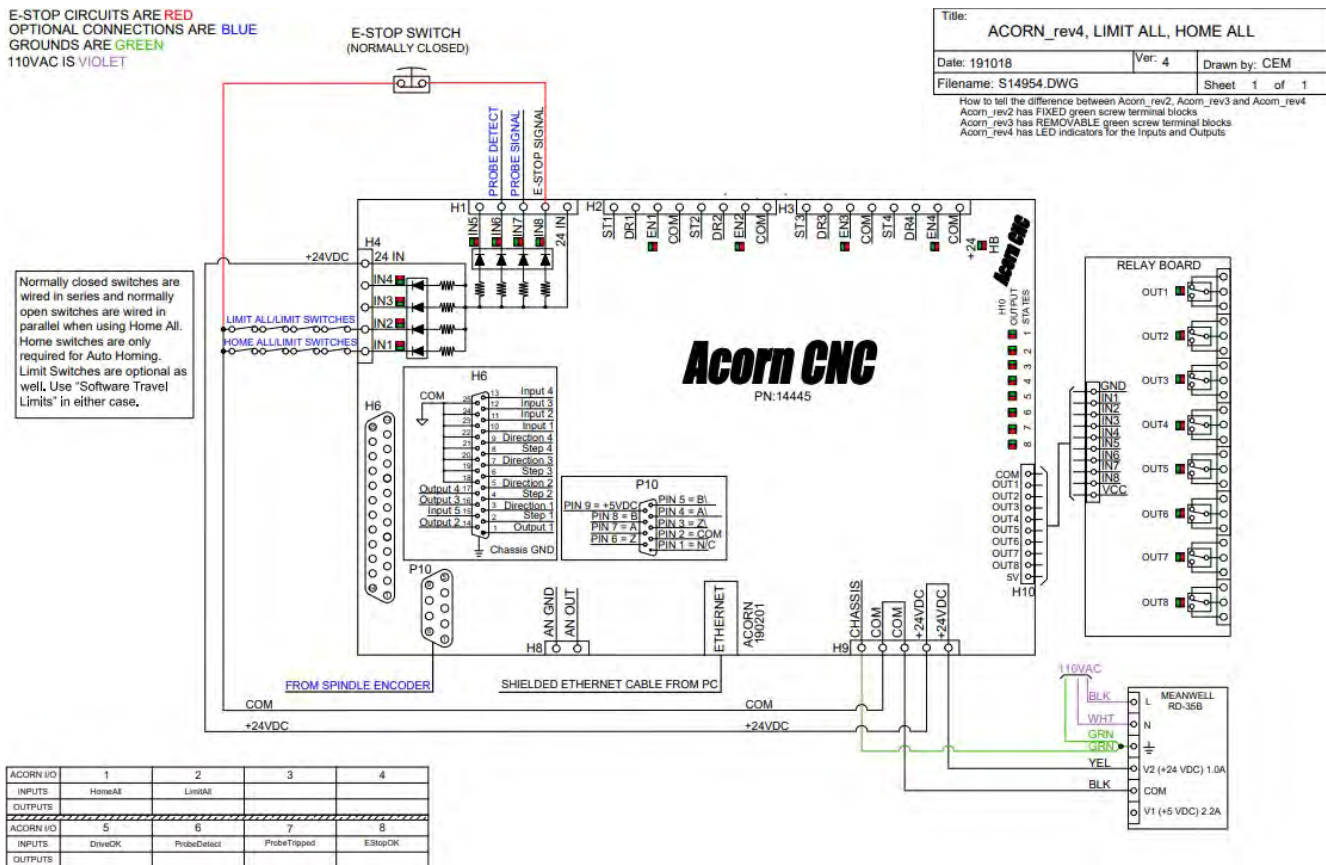
Schematic S14954
If using proximity sensors (THEY MUST BE NPN type) as home switches follow this example:
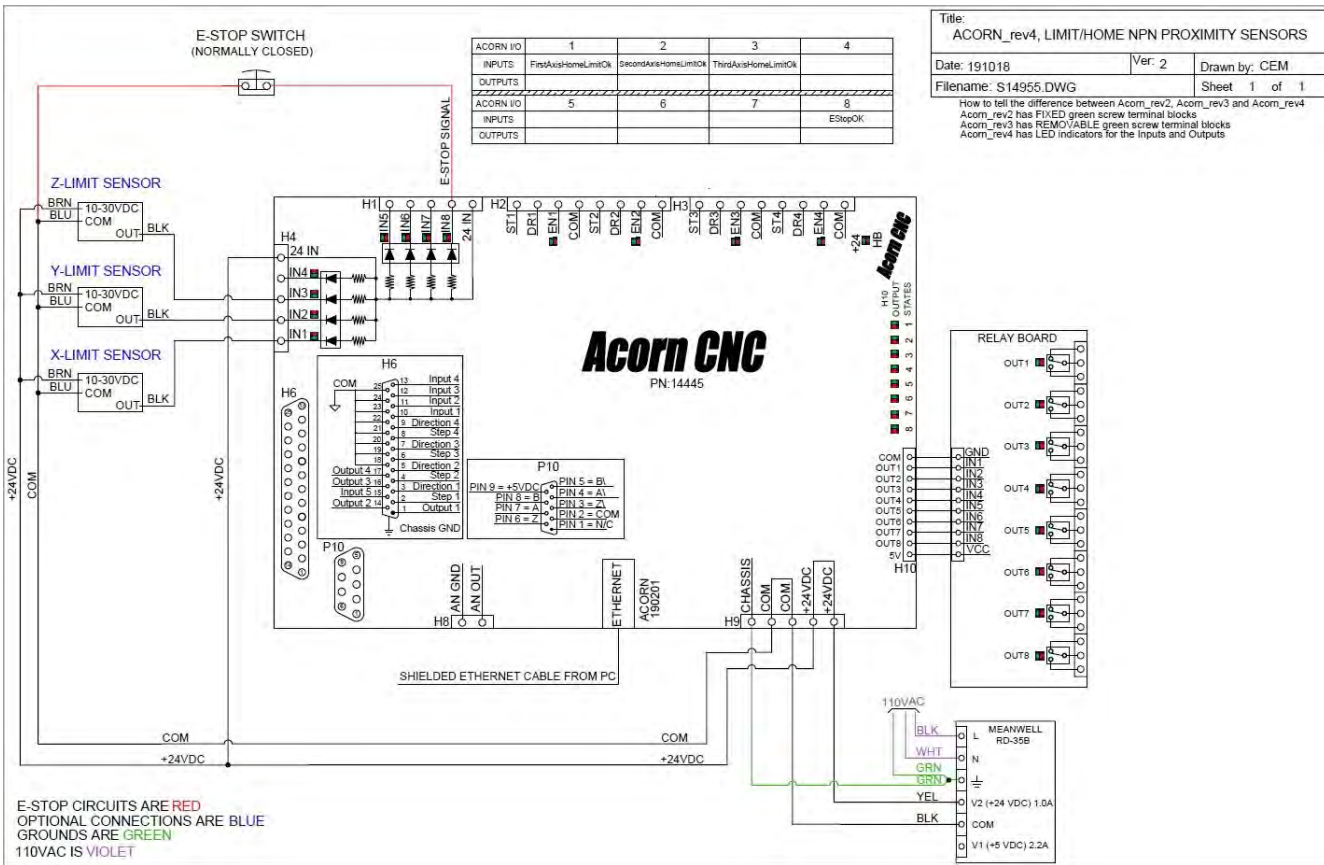
Schematic S14955 Proximity sensor wiring

Testing Limit Switch Wiring

1. Power up your system.
2. Start CNC12.
3. From the main menu press alt+i to bring up the real time I/O display.
4. Top line of virtual LED's are the inputs. Input 1 starts at the far left.
5. Confirm that all limit switches are green when nothing is tripped.
6. Confirm that the correct input turns red when each switch is manually tripped.
7. To toggle the diagnostic screen, press alt+i to return to the main CNC12 screen.
   See the PLC Diagnostic Menu Users guide for more info located in All Acorn Documentation page here.

REFERENCE:
Martyscncgarage: Centroid Acorn CNC Basics - N.O. vs. N.C. Switches & E-stop Contacts
https://www.youtube.com/watch?v=j3VPnozuuug

Special cases such as axis pairing and auto squaring refer to the Centroid Acorn CNC12 Axis Pairing and Squaring Manul which has detailed home switch wiring examples.

https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/paired_axes_acorn_user_guide.pdf

Centroid CNC12 software supports a wide variety of Home and Limit input combinations and configuration. Centroid has provided the tools so that the integrator can configure and use the machine's home and limit switches any way he likes. These tools are: The CNC12 PLC program, CNC12 Macro programming, CNC12 configuration menus.

The Acorn and AcornSix Wizard provides the user with home and limit switch configuration with auto home program generation so the user does not need to learn how to Edit a PLC program, program a custom CNC Macro or use the CNC12 configuration menus.

The Wizard provides easy drag and drop and click method to configure a wide variety of Home and Limit combinations for a given machine tool.

Centroid's #1 recommended home switch configuration is to use one home switch per each axis of the machine tool. Wire all Home switches into one input defined as "HomeAll" and use Software Travel Limits to control the travel limits of the machine tool on both the plus and minus side of each axis. Follow schematic #14954 and just omit the LimitAll connection.

Centroid's #2 recommended home switch configuration is to use one home switch per each axis of the machine tool. Wire all Home switches into one input defined as "HomeAll" and use Software Travel Limits to control the travel limits of the machine tool on both the plus and minus side of each axis. And use Limit switches on each side of each axis of the machine tool, wire them all into one input "LimitAll" as seen in schematic #14954
https://www.centroidcnc.com/dealersupport/schematics/uploads/S14954.r5.pdf

Let's define what a Home Switch is and what it does and what a Limit Switch is and what it does.

Home Switch:

- A switch used to automatically define the location of the machine home position.
- Home switches are used to 'remember' the machine home position, machine work envelope and part zero position after a machine tool power cycle.
- Home switches are only active during the home program (cncm.hom, cnct.hom).
- Home switches are not limit switches.
- Home switches are ignored during regular CNC control operation
- The more accurate the home switches the more accurate the remembering of the part zero position location(s) after a power cycle.
- Home switches should be "Normally Closed". "Normally Closed" = Closed when NOT tripped.
- Home switches can be wired to individual inputs or all home switches wired into one input called "HomeAll" (to save on inputs)
- Home switches should be mounted so that an axis over travel will not crush the switch.
- Home switches should be of the type designed for CNC use. Do not use long throw general automation / farm equipment limit switches.
- When ever possible mount switch so that the switch does not move with the machine so the cable going to the switch doesn't get fatigued over time. When not possible pay attention to cable wire routing and strain relief to minimize fatigued and use good quality cable designed for movement.

Home Program: A G&M code program (aka macro) that commands the machine tool axes to move and seek the home switch trigger event, stop, back off to clear the switch and set machine home at that location. A mill, router and plasma home program is named "cncm.hom" a Lathe home program is named "cnct.hom"

All inputs used for Limit and Home switches should be wired in a normally closed configuration. Normally Closed (NC) means that the switch should be **closed** when the machine is in its **normal** operational state. This is the CNC industry standard way of doing things.

While there are situations when a Normally Open configuration would be used, in general a Normally Open (NO) setup is dangerous as the machine will not stop in the event that a wire breaks or switch failure/damage etc. Using Normally Closed switches (and other devices) also prevents noise from causing spurious faults because the signal is being electrically held at the operational level.

"Regular" switches (aka dry contact) can be utilized as well as 3 wire NPN proximity switches.

Avoid long throw limit switches commonly used on conveyor belts and heavy equipment.
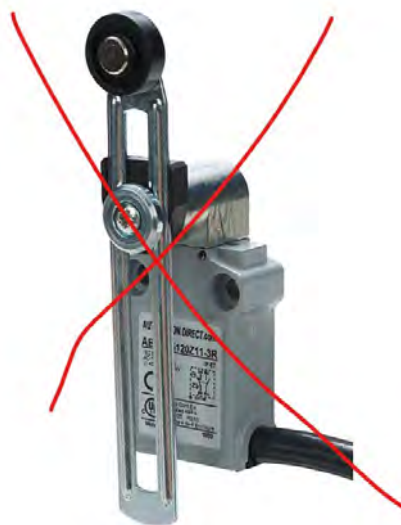
Limit Switch:

- A switch use to indicate to CNC12 that an over travel event has occurred.
- A limit switch trigger causes a CNC12 Emergency Stop event.
- Typically used as last resort machine tool axis over travel crash protection
- Limit switches should be "Normally Closed". "Normally Closed" = Closed when NOT tripped.
- Limit switches can be wired to individual inputs or all switches wired into one input called "LimitAll" (to save on inputs)
- Limit switches should be mounted so that an axis over travel will not crush the switch.
- Limit switches should be of the type designed for CNC use. Do not use long throw general automation / farm equipment limit switches.
- Limit switches are active all the time but can be ignored by CNC12 when commanded to.
- CNC12 can be commanded to ignore a limit switch, this is used to allow jogging if a limit has been tripped (or other special cases where it is necessary to ignore a limit for a short period of time)
- Typically mounted so the Limit switch triggers some distance before the actual end of travel of the axis and used in conjunction with a polyurethane bumper to adsorb the axis coasting to a stop after the limit event has been triggered.
- When ever possible mount switch so that the switch does not move with the machine so the cable going to the switch doesn't get fatigued over time. When not possible pay attention to limit cable wire routing and strain relief to minimize fatigued and use good quality cable designed for movement.

Cons of using limit switches.
- Expense in the components and labor to wire
- Issues cause by durability especially in large format machine tools. Such as false limit trip message due to improper grounding, power supply issues, limit wire breakage due to fatigue in track ways etc.
- For open loop/hybrid systems like Acorn and AcornSix after a limit switch trigger event re-homing the machine may be necessary and is advised. (in fact there is an option in the Wizard to force a re home message after any Estop (limit switch) condition.) Note: With fully closed loop systems like Oak, Allin1DC and Hickory re homing after a limit switch trigger is not pessary as CNC12 is always reading the axis motor encoder and knows where it is at.

Pros of installing Limit Switches
- Insurance to prevent unexpected damage to the machine tool. A good idea for machine tools that can not withstand an axis over travel event.

Limit Switch Discussion:

CNC12 Software Travel Limits works so well that it has largely eliminated the need for axis limit switches on many machine tools. Software Travel Limits work in the case where either the G code part program or the user commands the machine to move beyond its useful working envelope. It is however, up to the integrator to decide whether or not to use limit switches and how to best configure them for his particular application.
A case where the Software Travel feature will fail is when there is a catastrophic axis motor drive failure and the drive failed in the full power mode (aka axis motor runaway). In this case, a proper Limit Switch (and cnc control estop contactor wiring and a bump stop) would protect the machine tool from axis over travel crashing. Luckily at this day and age axis motor drive runaway is quite rare on modern drives. But, for the best machine tool damage protection use Limit Switches on all axes on both plus and minus ends of the axes and use an Estop contactor so the Axis motor drive power is disconnected from the axis motor automatically when a limit switch is tripped.

Acorn and AcornSix Wizard

The Wizard Input Definitions menu is categorized, use the drop down box to see the choices for each category.

Input Type: Limit ⌄

FirstAxisMinusLimitOk
FirstAxisPlusLimitOk
FourthAxisMinusLimitOk
FourthAxisPlusLimitOk
LimitAll
SecondAxisMinusLimitOk
SecondAxisPlusLimitOk
ThirdAxisMinusLimitOk
ThirdAxisPlusLimitOk

Acorn Integrated Inputs 1-8

NC **NO**   **Definition**

1 IN1
2 IN2
3 IN3
4 IN4
5 IN5
6 IN6
7 IN7
8 IN8   EStopOk

Click and Drag an Input function definition from list to the Input number Definition box to assign a function to an input.

Click the Input number circle to toggle the input state from NC to NO. Note: Probe Input states are determined in the Probe setup menus.

Input Type: HomeLimit ⌄

FirstAxisHomeLimitOk
FourthAxisHomeLimitOk
SecondAxisHomeLimitOk
ThirdAxisHomeLimitOk

Acorn Integrated Inputs 1-8

NC **NO**   **Definition**

1 IN1
2 IN2
3 IN3
4 IN4
5 IN5
6 IN6
7 IN7
8 IN8   EStopOk

Click and Drag an Input function definition from list to the Input number Definition box to assign a function to an input.

Click the Input number circle to toggle the input state from NC to NO. Note: Probe Input states are determined in the Probe setup menus.

Wizard Home Input Name	Description
HomeAll	One input for all Home Switches.
FirstAxishomeOk	Used for individual inputs for each home switch. One input for Axis #1 home switch
SecondAxishomeOk	Used for individual inputs for each home switch. One input for Axis #2 home switch
ThirdAxishomeOk	Used for individual inputs for each home switch. One input for Axis #3 home switch
FourthAxishomeOk	Used for individual inputs for each home switch. One input for Axis #4 home switch
SlavedHomeInput	Used with the Centroid supplied canned autosquaring paired axis routine. See Paired Axis installation manual.
ZriHomingAll	Input for axis motor encoder index pulse (aka marker pulse) homing
Wizard Limit Input Name	**Description**
LimitAll	One input for all Limit Switches.
FirstAxisMinusLimitOk	Used for individual inputs for each limit switch. One input for Axis #1 minus direction limit switch
FirstAxisPlusLimitOk	Used for individual inputs for each limit switch. One input for Axis #1 plus direction limit switch
SecondAxisMinusLimitOk	Used for individual inputs for each limit switch. One input for Axis #2 minus direction limit switch
SecondAxisPlusLimitOk	Used for individual inputs for each limit switch. One input for Axis #2 plus direction limit switch
ThirdAxisMinusLimitOk	Used for individual inputs for each limit switch. One input for Axis #3 minus direction limit switch
ThirdAxisPlusLimitOk	Used for individual inputs for each limit switch. One input for Axis #3 plus direction limit switch
FourthAxisMinusLimitOk	Used for individual inputs for each limit switch. One input for Axis #4 minus direction limit switch
FourthAxisPlusLimitOk	Used for individual inputs for each limit switch. One input for Axis #4 plus direction limit switch
Wizard Home/Limit Input Name	**Description**
FirstAxisHomeLimitOk	One switch used as both a home switch and a limit switch for Axis #1 using one input per switch
SecondAxisHomeLimitOk	One switch used as both a home switch and a limit switch for Axis #2 using one input per switch
ThirdAxisHomeLimitOk	One switch used as both a home switch and a limit switch for Axis #3 using one input per switch
FourthAxisHomeLimitOk	One switch used as both a home switch and a limit switch for Axis #4 using one input per switch

Centroid's Recommended Home and Limit Switch Input definition.
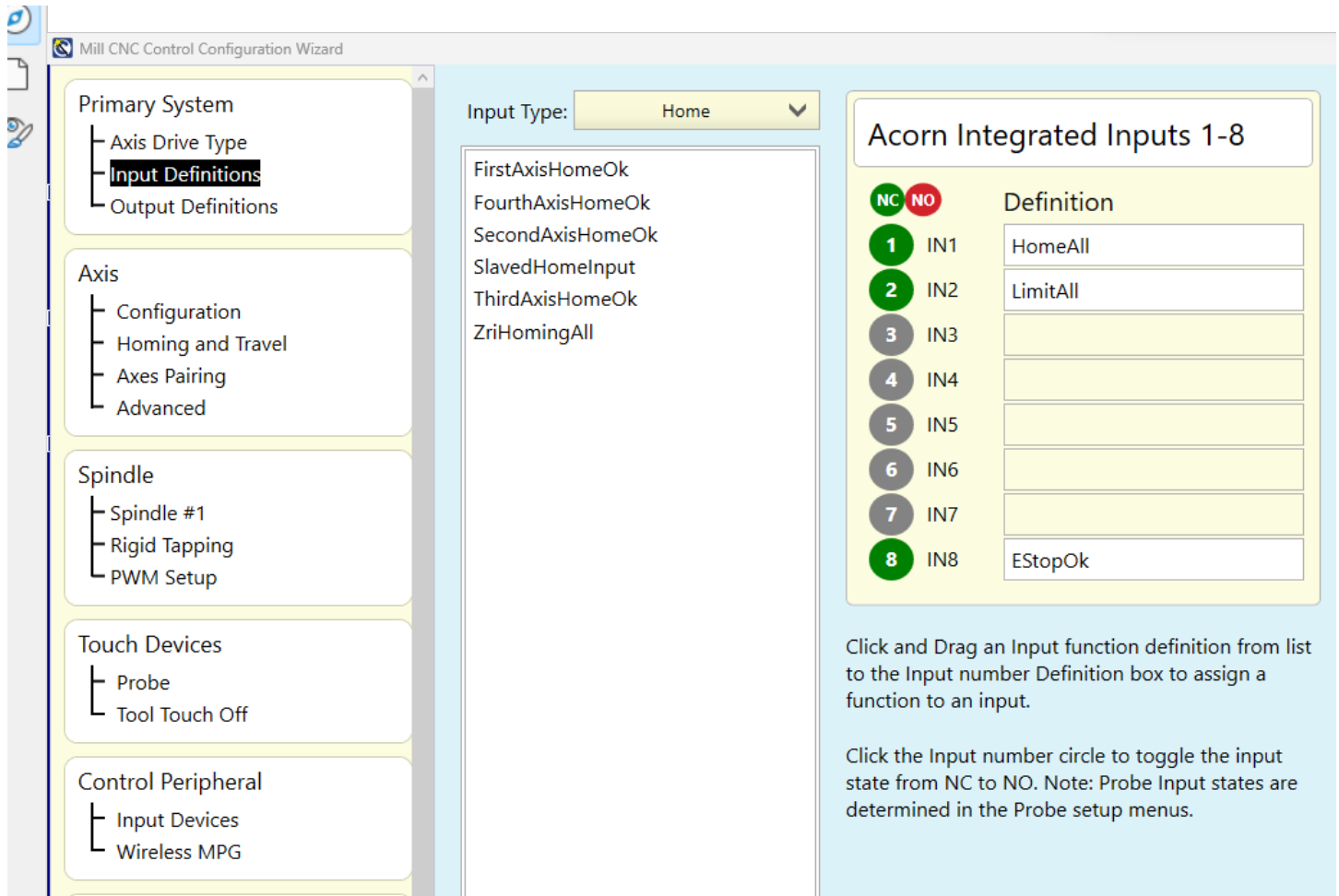
See schematic #14954 for HomeAll and LimitAll hookup wiring.

https://www.centroidcnc.com/dealersupport/schematics/uploads/S14954.r5.pdf

Zri homing: Zri homing is a very accurate method of being able to repeat to the same home position after a power cycle. The Zri method requires a closed loop axis motor drive that has the capability to close an Acorn input when the axis drive 'sees' the axis motor encoder marker pulse (aka Index Pulse, once per revolution of the motor).   The Zri input is used in conjunction with the Home switch input. The home switch is used to 'get in the ballpark' and then the Zri is used to set the home position very accurately from that point by seeking the marker pulse and setting the home position when the Zri input closes.

See Macro programming guide page

Example schematic using Zri homing.
https://www.centroidcnc.com/dealersupport/schematics/uploads/S14966.r4.pdf

Also there are good Zri homing discussions on the Centroid Tech Support Forum. Search "Zri"

Testing of Limit and Home Switches.

From the main screen of CNC12 press the keys <ALT> and <i> at the same time.

<Alt i> will launch the CNC12 PLC Diagnostic menu.
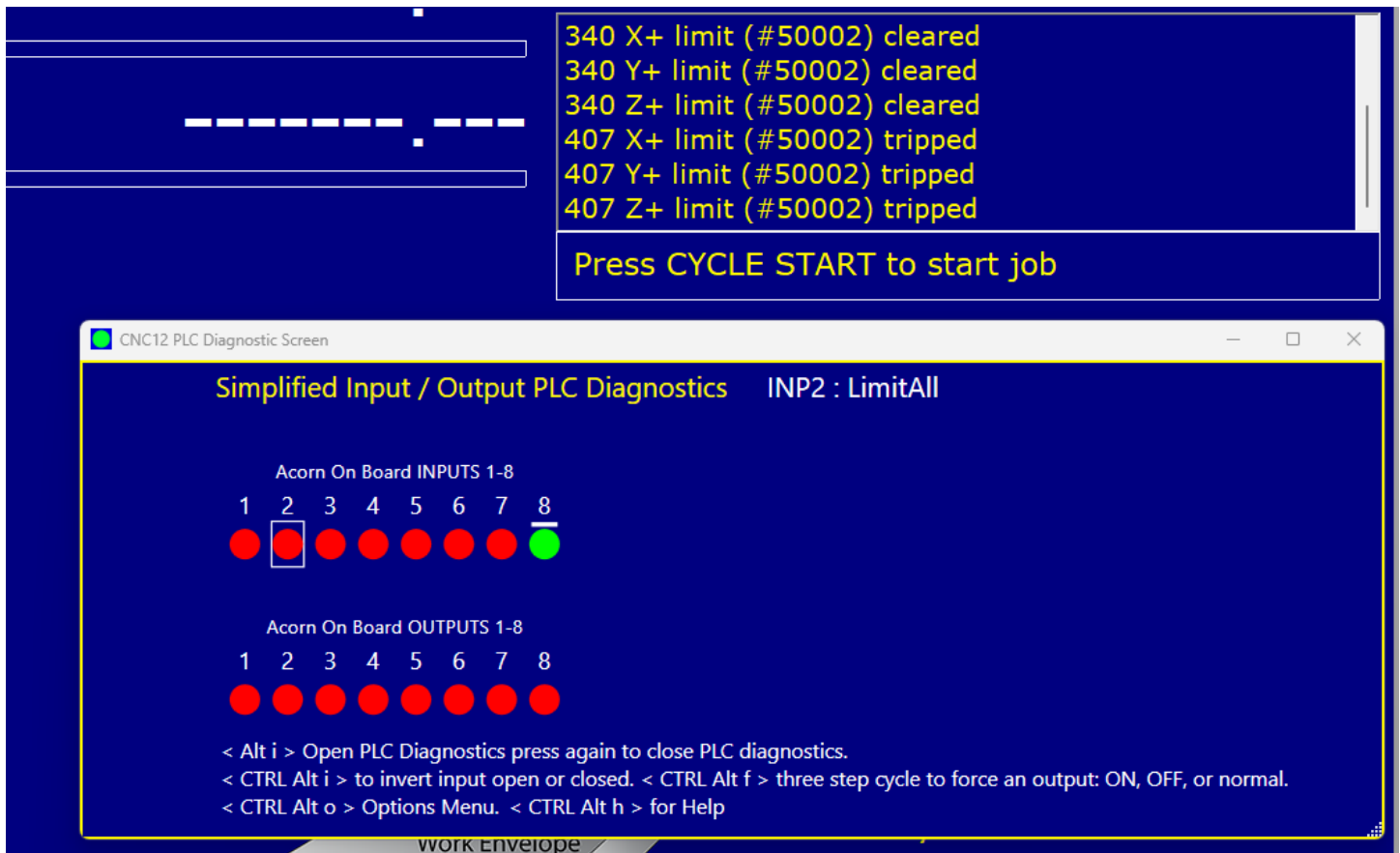
Trigger the switches by hand and observe the assigned input Virtual LED change from Green to Red.

5.8 Wiring the Spindle Motor

STOP! Before wiring the spindle make sure that you have already bench tested the spindle analog output as previously directed during the board level tests.

There are two methods of wiring a spindle motor:

1   Connect three phase directly to an induction spindle motor using contactor(s) as shown in this example:

INCOMING 3 PHASE
FROM MAIN DISCONNECT
BREAKER OR FUSES

GND

REVERSING
CONTACTOR
W/ SNUBBERS
PN:14375
SEE NOTE 2

L1 L2 L3 13NO 21NC A1   L1 L2 L3 13NO 21NC A1
COIL   COIL
T1 T2 T3 14NO 22NC A2   T1 T2 T3 14NO 22NC A2

220-208 BLK
220-209 BLK
220-210 BLK

24H-544 RED

24H-545 RED

(24VACH)
18 AWG

(24VACN)
18 AWG

L1 L2 L3
OVERLAND
RELAY
PN:692
T1 T2 T3 97NO 98NO 95NC 96NC

24N-512 BRN

+24-803 RED

(24VACN)
18 AWG

WIRES MUST
BE SIZED
FOR SPINDLE
MOTOR HP

220-211 BLK
220-212 RED
220-213 WHT

24N-511 BRN

24VDC
FOR INPUTS

(+24VDC)
18 AWG

(+24VDC)
18 AWG

24C-946 BLK

(24VDC COM)
18 AWG

GND

FG T3 T2 T1

SPINDLE
MOTOR

(24VDC COM)
18 AWG

24C-947 RED

+24VDC CONNECTED TO THE
INPUT COMMONS WITH THE
INPUTS PULLED DOWN TO
24VDC COMMON IS STANDARD

Hooking the three phases directly saves costs, but prevents the Centroid CNC software from being able to control the speed of the spindle. The spindle speed will have to be controlled by mechanical methods such as pulleys.

A contactor can be used to turn the spindle on and off with the software. A reversing contactor with snubber #14375 from Centroid can be used to change direction.

2   Preferred method: Use a spindle controller. Variable Frequency Drive for example:

ACORN I/O	1	2	3	4
INPUTS				
OUTPUTS				SpinFWD
ACORN I/O	5	6	7	8
INPUTS	SpindleOk			
OUTPUTS	SpinREV	VFDResetOut		

Title: ACORN_rev4, GENERIC VFD
Date: 191022   Ver: 2   Drawn by: CEM
Filename: S14983.DWG   Sheet 1 of 1

How to tell the difference between Acorn_rev2, Acorn_rev3 and Acorn_rev4
Acorn_rev2 has FIXED green screw terminal blocks
Acorn_rev3 has REMOVABLE green screw terminal blocks
Acorn_rev4 has LED indicators for the Inputs and Outputs

Acorn CNC PN:14445

GENERIC VFD
- INPUT COMMON
- SPIN FORWARD
- SPIN REVERSE
- FAULT RESET
- 0-10VDC
- 0-10VDC COM
- FAULT COM
- FAULT NC
- GROUND
- L1/R
- L2/S   POWER IN
- L3/T
- GROUND
- BRAKING RESISTOR
- BRAKING RESISTOR
- T1/U
- T2/V   3 PHASE
- T3/W   POWER OUT
- GROUND

SEE VFD MANUAL FOR POWER AND MOTOR CONNECTIONS

MEANWELL RD-35B
L, N, V2 (+24 VDC) 1.6A, COM, V1 (+5 VDC) 2.2A

SHIELDED ETHERNET CABLE FROM PC

OPTIONAL CONNECTIONS ARE BLUE
GROUNDS ARE GREEN
110VAC IS VIOLET

Spindle VFD Controller example

Note: "Inverter", "AC Drive", and "VFD" (Variable Frequency Drive) are terms that are used interchangeably and refer to the spindle controller.

Centroid does not provide spindle controllers and recommends:

- Delta Products VFDs
- Automation Direct GS2 and GS3 AC drives
- Yaskawa VS (Varispeed) Inverters

It is the responsibility of the installing technician to consult their spindle controller manufacturer for support.

The Acorn Wizard can configure the I/O for use with a spindle. For example:

- Input 6 could be used for the Spindle Fault input
- Output 4 is SpinFwd
- Output 5 is SpinRev
- Output 6 is the inverter fault reset
- An input needs to be assigned to the spindle fault output SpinOk (Input 5 in the diagram above)
- Always refer to your schematic

Other spindle drives may be used. (DC Spindle Drive) HOWEVER, it is important to verify that the Analog inputs are isolated. If they are not, or it is not known and you connect them to the Acorn's 0-10V analog output, you may severely damage the Acorn and possibly your spindle drive. If they are not isolated, you will need to source a signal isolator such as the KB Electronics KBSI-240D or replace your drive with one that has a Signal Isolator on it.

Centroid Community CNC Support Forum: Video: Installing a KB Electronics KBIC-120 & SI5
https://centroidcncforum.com/viewtopic.php?f=61&t=2027

Centroid Community CNC Support Forum: Setting up and Benchtesting an Automation Direct GS1 VFD:
https://centroidcncforum.com/viewtopic.php?f=61&t=2446

REMINDER! All contactors need snubbers! Centroid recommends using the Quencharc snubber network
(Centroid PART# 1819) on the coil of the contactor. This reduces electrical noise when the spindle is turned off
and on.

Contactor with snubber installed across the coil

5.9 Spindle Encoder Wiring and Configuration

For spindle slaved movements such as rigid tapping and threading (lathe), the spindle encoder needs to be connected to the Acorn. The spindle encoder must meet the prerequisites listed in section 5.9.

Additional Encoder basics information is located in the Acorn Knowledge Base forum here.

Video covering Acorn Encoder basics with Rigid Tapping parameter sheet is here.

Rigid tapping should be enabled last, after the spindle is functioning and the machine is successfully wired and configured.

A multitude of software parameters need to be set up for rigid tapping, which is beyond the scope of this document. More information on how to set up rigid tapping is contained in your CNC12 operator's manual and the Acorn Rigid Tapping parameters cheat sheet both are found in the All Acorn Documentation thread here.

If you are making your own cables or using your own encoders, make sure they adhere to the guidelines listed below:

1.1 Encoder Cables: The encoder cables MUST be twisted pair shielded cables. The shield wire of the encoder cable needs to be grounded to the metal shield of the DB-9 connector as seen in figure 2.3.1. If the D-sub connector does not provide a method of attaching the shield wire, the shield wire should to be soldered to the metal shield DB-9 connector.

NOTE: Failure to ground the cable shield may cause encoder errors in the software.
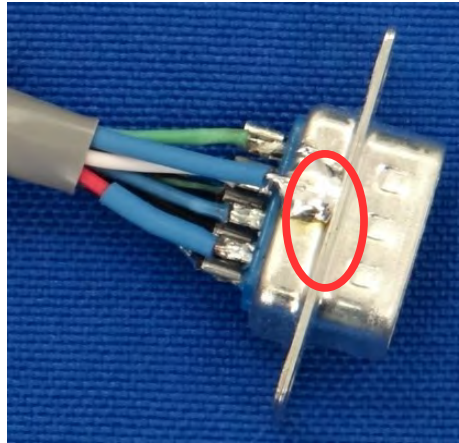
Cable shield ground attached using solder to the metal shield of the D-sub connector.

1.2 Encoder Output: Encoders must have RS422 type (differential) quadrature outputs with A, B, and Z channels to work with the Acorn. A 1000-line encoder count is suitable for a spindle. Be sure to check the specifications of the encoder to ensure it will operate at the highest spindle RPM.

The following link lists encoders and premade encoder cables available through Centroid.
http://www.centroidcnc.com/centroid_diy/cnc_components.html

1.3 The outputs have additional voltage level requirements described in the table below:

Characteristic	Minimum	Typical	Maximum	Unit
Encoder channel low level	0.0	0.3	0.5	V
Encoder channel high level	3.0	3.5	5.0	V

1.4 Wiring Code: Wire the encoder according to the diagram and the table shown below. Refer to the encoder manufacturer's data sheet for the wiring color code.

4.1 Note: The +5V is an output provided by the ALLIN1DC.

Pin	Quadrature
1	Not used
2	Common (ground)
3	Z-
4	A-
5	B-
6	Z+
7	A+
8	B+
9	+5V
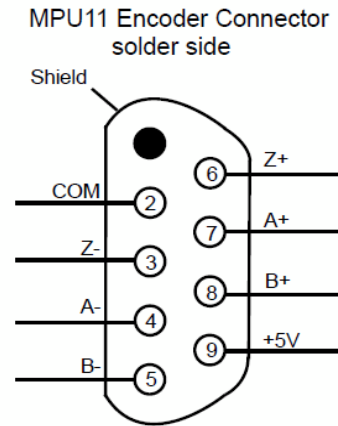
If you have a spindle encoder, ensure it was connected to the Acorn spindle encoder port prior to powering up the Acorn. If not, stop, power down the Acorn, the CNC PC, connect the encoder, and power the Acorn and the CNC PC up and start CNC12.

1. From the main menu press F7-Utility → F10 Acorn Wizard. Then go to SPINDLE and under it, SETUP. Make sure the proper Spindle Encoder Counts value is entered. (Encoder counts per revolution X 4. For example, if you have a 1000-line encoder, enter 4000 in the Spindle Encoder Counts field).
2. From the main menu press F1-Setup → F3-Config. The password is 137. Press F4- PID.
3. Manually rotate the encoder one full revolution. Record how much the motor has counted. (This value should be close to equal to the WIZARD Spindle Encoder count field).

Chapter 6   CNC 12 Software Configuration Using the Wizard

6.1 Introduction to Software Configuration

This chapter assumes that you have completed the board level test above, do not proceed to this section until the bench test above have been completed..

Acorn CNC12 provides a "WIZARD" for setting the parameters needed for proper CNC Control of the machine. It allows the user the ability to select, adjust, and assign:

- AXIS motor Drive Type
- Inputs and Outputs
- Machine Overall Turns Ratio
- Axis direction reversal
- Motor/Drive steps per revolution
- Machine Travel Limits
- Homing routines
- Axis Pairing
- Step Rate
- Spindle configuration
- Touch Device (Tool Touch off Probes and Probes)
- Input Devices such as Wireless Manual Pulse Generator (MPG), Keyboard Emulators
- DB25 Signal Mapping
- CNC Control and Wizard Preferences.

Lets start at the top of the Navigation tree and work our way down through it. To access the Wizard Screen, from Main Screen F7 Utility:

CNC12 Main Screen
Then select F10 Wizard:

CNC12 Utility Menu

6.2 Primary System Axis Drive Type
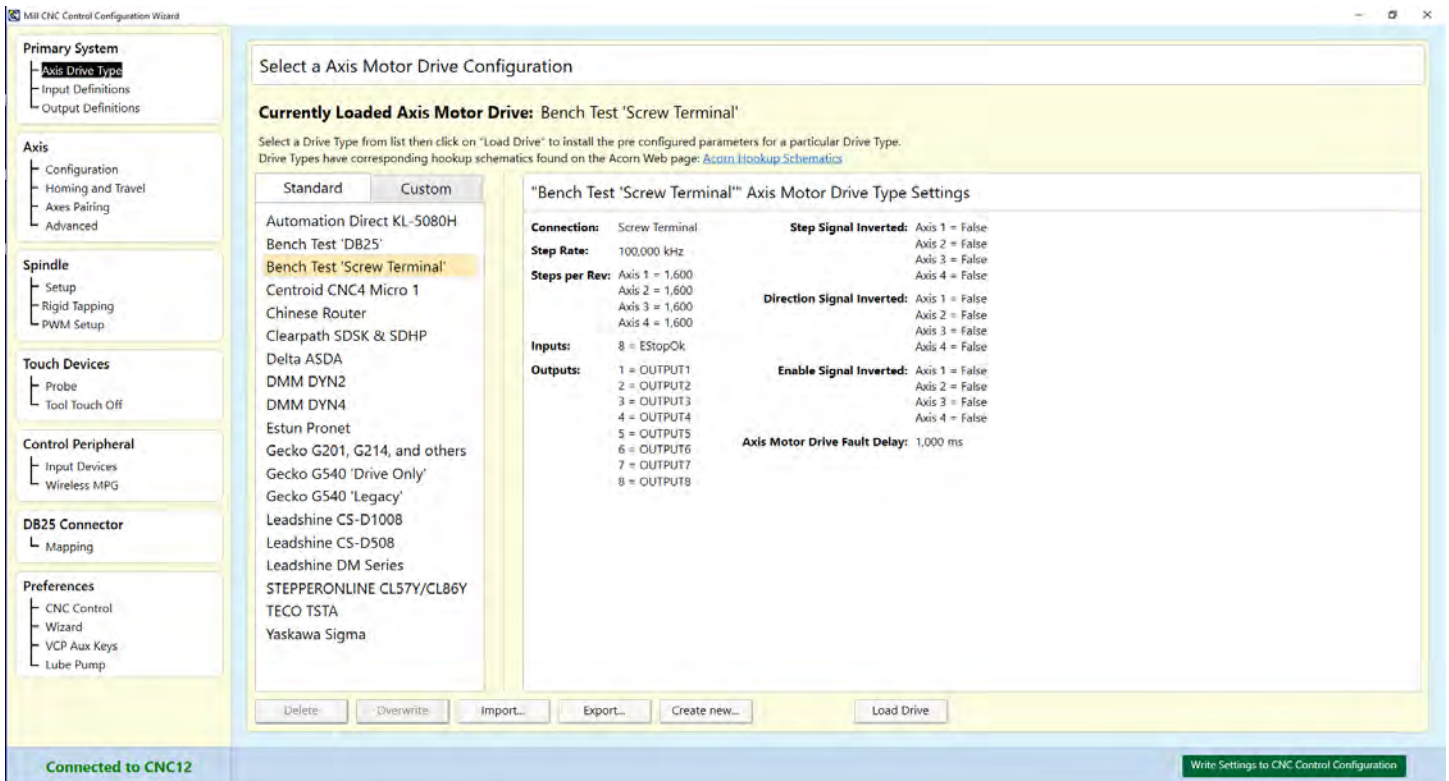
Wizard Axis Motor Drive Type Menu

This screen allows you to manage and select and even create "drive types" A "drive type" is a pre set configuration for a given make and model of axis motor drive. The drive type was create to make configuration of the Acorn system easy with its matching schematic. Select the drive type and wire the system according to the match schematics. By default a new installation of CNC12 will default to "Bench Test 'Screw Terminal' as the drive type. This is fine for communication bench testing the Acorn with no axis drives connected. After passing that test, choose the drive type that matches the axis motor drives that are being employed, click on a drive type and click "Load Drive".

As a convenience, this will pre-populate the IO map and some other screens of the Wizard that match the corresponding Acorn to axis drive schematic. The matching schematics are here, use when wiring the control for the particular drive type being used.

[The Acorn Schematics are found in the All Acorn Documentation thread found here.](#)

Note: While we have tested and provided many different proven Acorn to axis drive schematics and Wizard drive types to make hookup simple and easy, when using an axis drive that is not on the list pick one that is close and use that and/or even modify the drive type and save it as a custom. You can even export the custom drive type and import it on another system or share it on the forum.

The "Create new…" button will allow you to create a "Custom" Drive type with currently selected settings in the wizard. These Drive Types can be Exported and Imported using the available buttons on screen. Step and direction signals will be present on the Acorn regardless of the drive type selected. However, it is best if you start with a drive type that closely matches the drives you are using. You can then work your way down through the Wizard tree to tailor the control to your application.

IMPORTANT: When you have completed any or ALL changes done in the Wizard pages, you must click "Write Settings to CNC Control Configuration" for the changes to take effect.

Follow any on screen prompts to complete the changes.

6.3 Primary Input Definitions
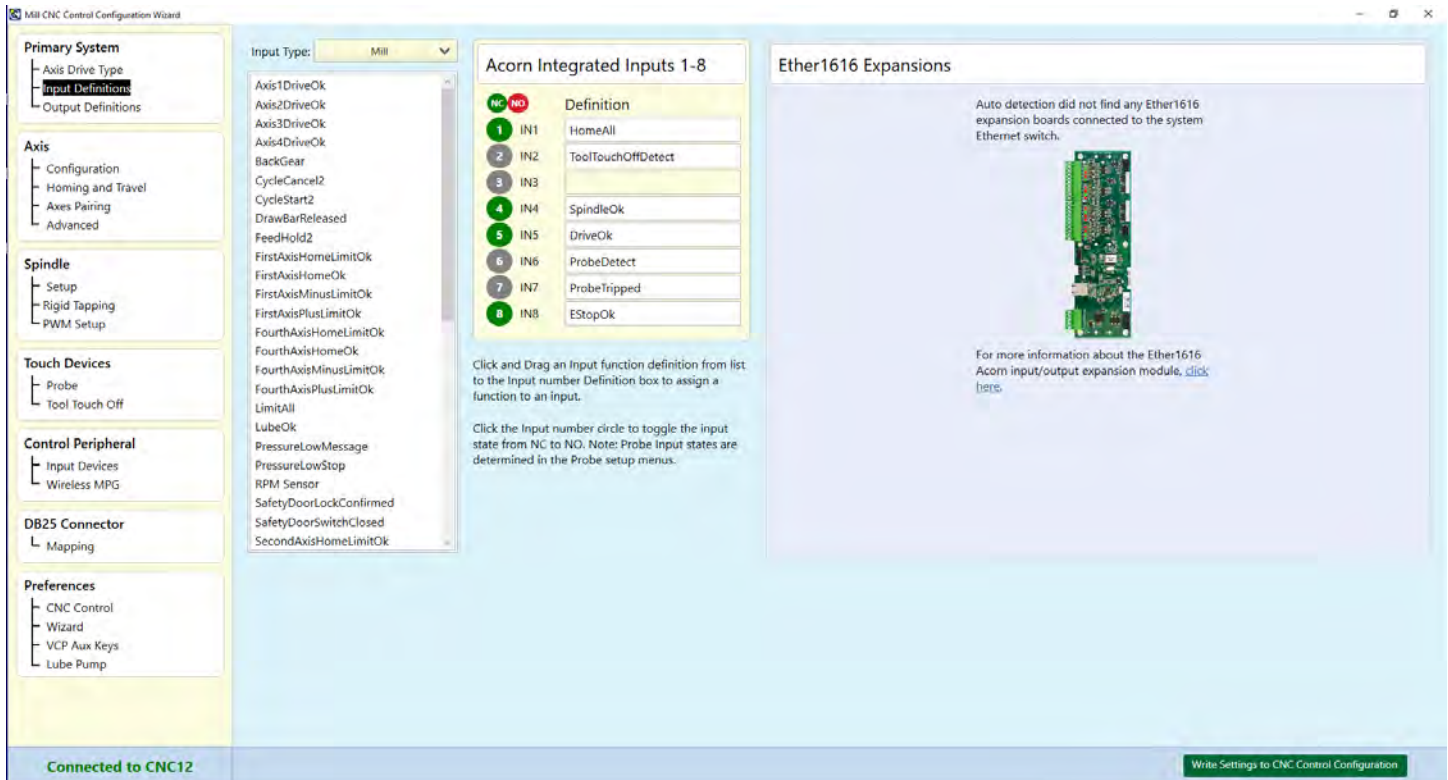
Wizard Inputs Dialog: Mill example (yours will be different)

- Use the sort drop down list to select the machine type on the Input Type Drop down box shown above. (Alternatively, select ALL to see ALL the inputs
- For a list and definition of all available inputs click here: https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/ acorn_wizard_input_output_plc_functions.pdf
- To select an Input, from the drop down, click on the desired Input, hold and drag it over to the appropriate input number and drop it
- Click on the input number to change the input state from Normally Open (Red) to Normally Closed (Green)
- Remove an input definition by clicking on it and dragging it back to the Input box

The Input number corresponds to the input terminal number on the Acorn.

Inputs are found on H1 and H4

6.4 Primary System Output Definitions
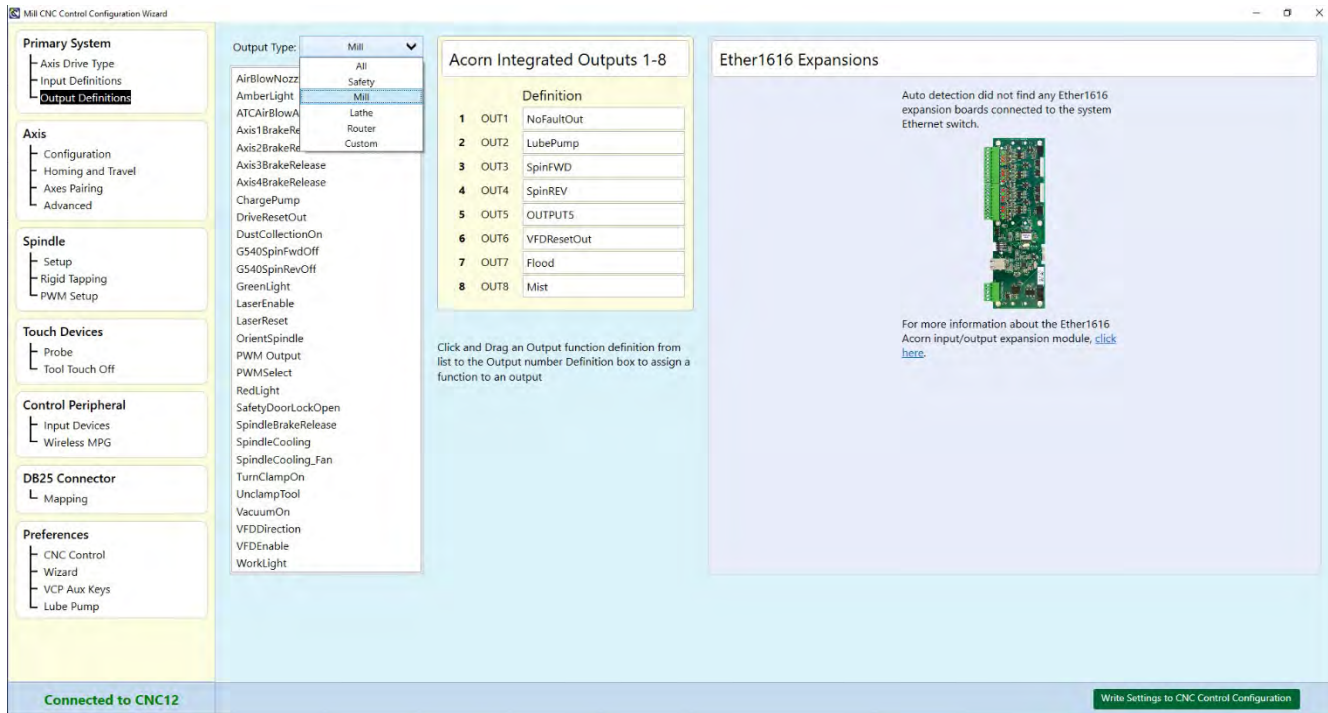
Wizard Outputs dialog Mill example (yours will be different)

- Use the sort drop down list to select the machine type on the Output Type Drop down box shown above. (Alternatively, select ALL to see ALL the Outputs. Example shown above of a currently configured milling machine, yours will be different.

- For a list and definition of all available inputs click here:
  https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/acorn_wizard_input_output_plc_functions.pdf

- To select an Output, from the drop down, click on the desired Output, hold and drag it over to the appropriate Ouput number and drop it.

- Remove an Output definition by clicking on it and dragging it back to the Output box

The Output number corresponds to a Relay on the Acorn relay board.
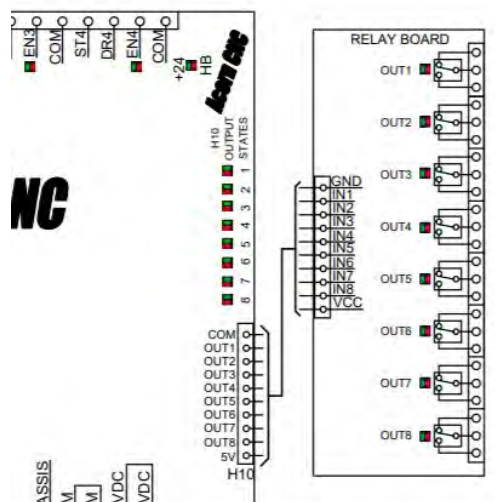
6.5 Axis Configuration
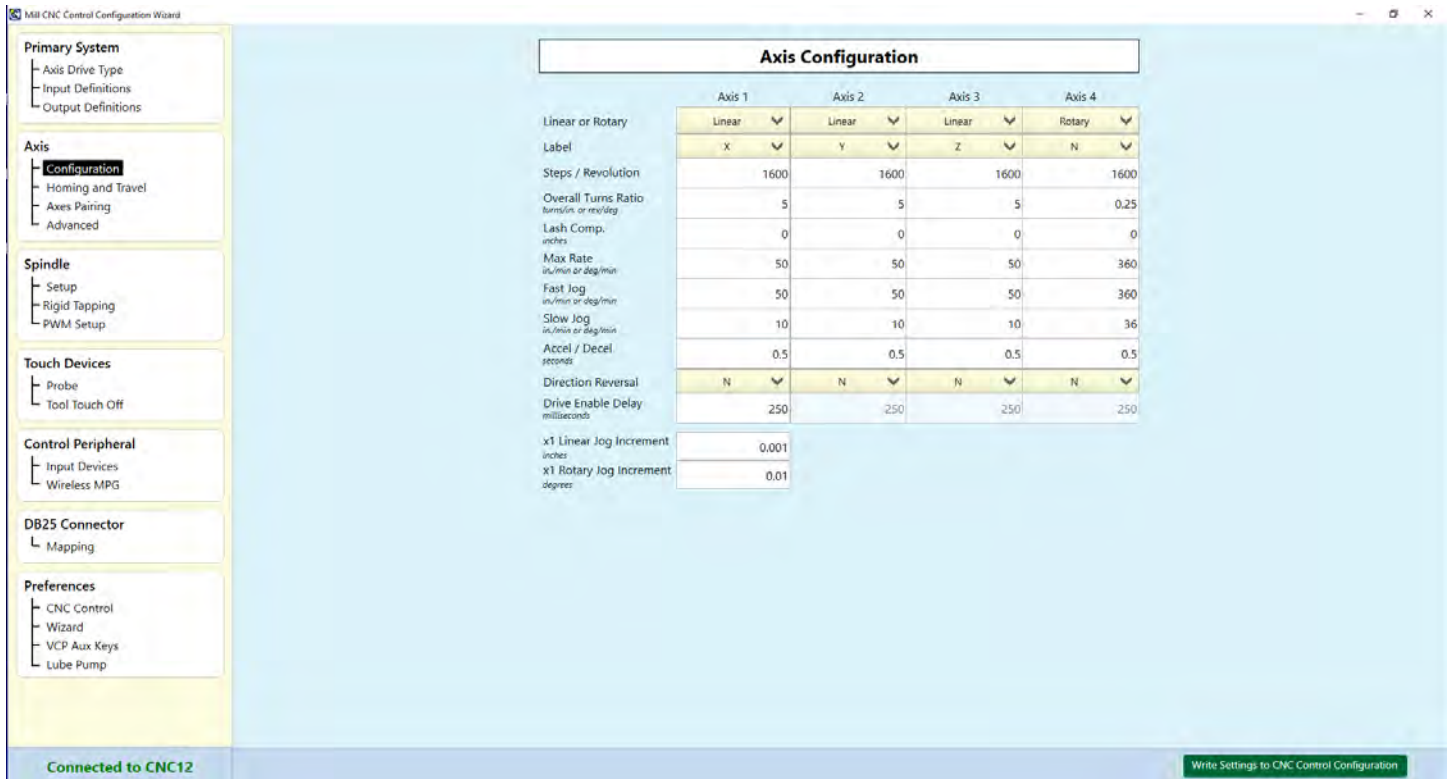
Wizard Axis Configuration menu

Note: 4th axis simultaneous motion is not included in the free version of CNC12, a Pro license is required for four axis interpolated simultaneous movement. CNC12 "Free" is limited to 3 axis simultaneous moves with single axis 4th axis moves.

- LINEAR defines that an axis moves in a linear fashion (left/right or up/down etc)

- ROTARY select rotary if the axis in not linear and rotates. (such as a rotary table)

- LABEL definitions allow you to choose the axis labels that will appear on the main screen Digital Read Out (aka DRO) see machine tool axis labeling industry standards for proper axis labeling.

- STEPS/REVOLUTION: Defines the number of steps it takes for the axis motor shaft to rotate ONE revolution.

Most stepper motors turn 1.8 degrees per step. It takes 200 FULL steps to turn the motor 360 degrees but in modern times now many stepper drives have a feature called microstepping. Most drives are equipped with the microstepping feature, follow the drive instructions and enter the number of MICROSTEPS it takes to turn the motor one full revolution. For example, if a drive can microstep 10X, then you would enter a value of 2000 (200 steps per revolution X 10) in the Steps/Revolution field.

When using closed loop drives (highly recommened as they prevent the dreaded lost steps of open loop stepper systems) closed loop drive use an Encoder, typically would usually enter the encoder value X 4 in the Step/Revolution field. For example, if you have a 1000-line encoder, in quadrature (X 4) you would enter 4000 in the Steps/Revolution field. Consult your drive manufacturer's manual.

It is important to note, ONLY the number of steps it takes to turn the motor ONE full revolution goes in the Steps/Revolution Field! This field must MATCH the settings on the drive, do not adjust this field to adjust the commanded distance. Please read this post for more infor machine on how NOT to do it like Mach3 does it.

- OVERALL TURNS RATIO: The Overall Turns Ratio is a physical constant there is only one number possible for the overall turns ratio of a particular axis. The overall turns ratio is define by the machine's ballscrew (or rack) pitch and the motor to ballscrew (or rack) pulley reduction ratio (Number of teeth on the axis drive motor pulley and number of teeth on the axis ballscrew pulley x the pitch of the ballscrew)

For example, a ballscrew that requires 5 turns of the screw to move the axis 1 inch of linear travel, connected to an axis motor via belt and pulleys with 10 teeth on the axis drive motor pulley and 20 teeth on the ballscrew pulley would would result in an overall turns ratio of 10. Said another way it takes exactly 10 turns of the axis motor to product one inch of linear travel on the axis. The axis pulley reduction is 20/10=2 times the ballscrew pitch of 5 so 2 X 5=10. Mechanical system are often not perfect so some fine tuning of this calculated number can be done with physical measurements see fine tuning of the overall turns ratio in section 7.11.

- LASH COMP: Axis machine backlash compensation is the LAST thing you should setup once the machine is fully configured and operational.

Software backlash compensation is effective but limited in its scope. For backlash compensation to work well the free play aka lash of an axis should be mechanically minimize. Lash Comp will not compensate for large and inconsistent backlash in a mechanical system. That being said it work quite well when the mechanical system has a repeatable and small lash amount that can be accurately measured. Then and only then can CNC12 "compensate" for mechanical backlash by adding movement to that axis motor. If you have a very accurate system with measured lash under .0002" (2 tenths) often it is best to leave the lash comp set at zero. Typical lash numbers for good milling machines are zero to .0015"   for routers zero to .005"
Lash comp cannot cure mechanical play so ut is very important that every effort is made to remove mechanical backlash from all axes before setting this value.
See section 7.4 for detailed instructions on how to properly measure and correct for backlash.

- MAX RATE: This is the maximum rapid rate(a G0 Move) that an axis is allowed to travel at. This number is heavily dependent on many factors.

Correctly sizing the axis motors and drives to the machine is important, as well as the voltage supplied which relates to the power and speed of a given axis motor.

As a general starting point on an open loop stepper machine start this number low and work your way higher until you see or hear the stepper stall and then reduce that number by 30-40% to create a safe operating zone that will be free of lost steps due to the motor and drive not being able to perform the commanded accelerations and velocities. .

You can also use the following equation to get an rough max rate estimation: (maximum motor rpm / overall turns ratio) * 0.85 = maximum feed rate

- FAST JOG: This is the fastest the axis will move when in the RAPID (Hare) Continuous Jog mode on the VCP.

- SLOW JOG: This is the slowest the axis will move when in the SLOW (Tortoise) Continuous Jog mode on the VCP. It is also the speed that the machine will home at.

- ACCEL/DECEL: Acceleration is the time for the axis to reach maximum velocity.
An acceleration rate of 0.1 second is very fast, where an acceleration rate of 1.0 is considered very slow.

CNC12 defaults to an acceleration of 0.5 this number is used for both acceleration and deceleration.

Acceleration tuning is a fairly subjective process. What might be acceptable for one person or machine might be unacceptable for another person or machine.

Often the limiting factors are the amount of mechanical stress that the machine can handle and the amount of current that can be provided to the motors. Quick acceleration numbers can lead to jerking of the machine and lost steps if motor is undersized/under powered.

- DIRECTION REVERSAL: Change this from No to Yes if you need to reverse the direction of the axis motor in order to move the machine in the PROPER direction. See axis conventions for definition of industry standard tool motion directions in Chapter 7.

- DRIVE ENABLE DELAY: This is the amount of time the control allows your drive to "come online" and ignores the DRIVE FAULT input (If used in the I/O map). Generally, this can be left at the default value.

6.6 AXIS (Homing and Travel)
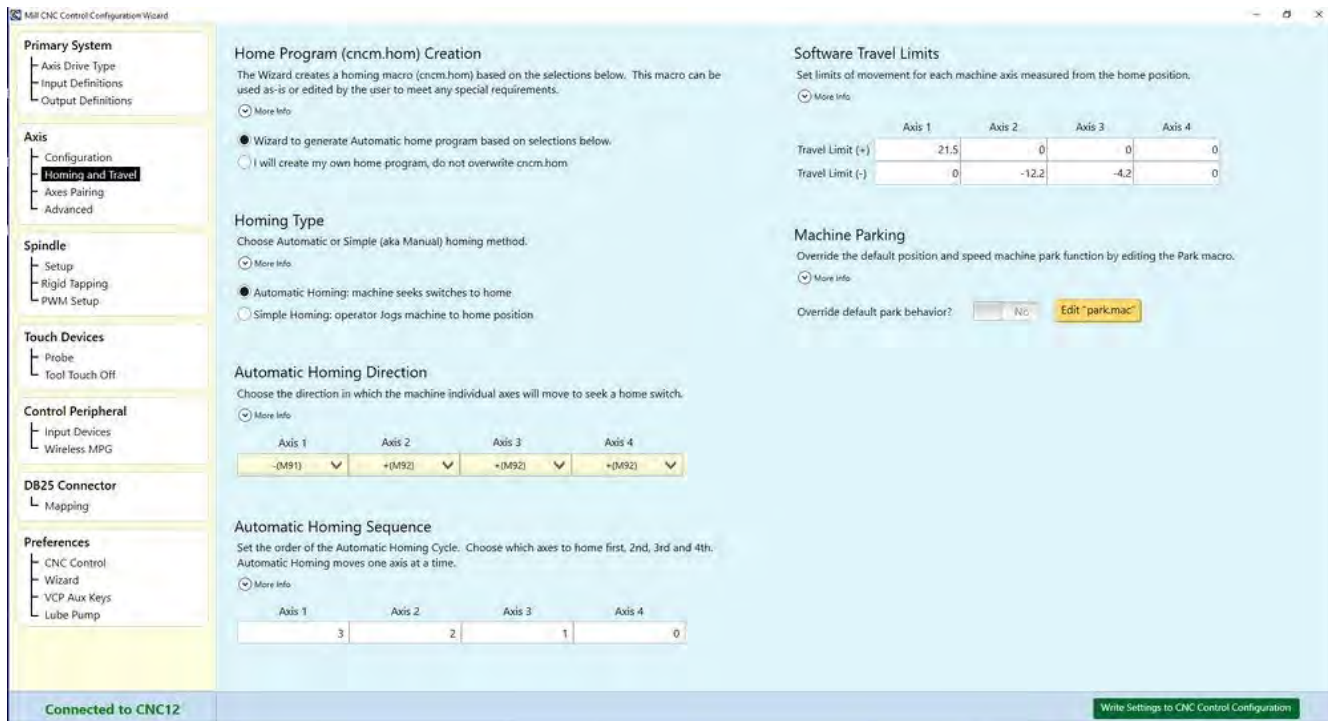
Wizard Homing and Travel dialog

In this screen, we will setup how the machine will:

- Home
- The directions in which it will Home
- Software Travel Limits
- Machine Parking.

HOME PROGRAM:

> CNC12 Generates a .HOM file automatically. IF you have a custom .HOM file, then change Home file to: "Custom User Defined". Otherwise leave it to the default of Wizard Generated. A ".hom" file is simply a G code program that defines how the machine will "home out" based on the selections made in this menu.

HOMING TYPE:

- Select "Simple Homing" if the machine uses no home switches. Simple Home means that the operator will simply jog the machine to the desired home position and then press cycle start to set home at that position.
- Select "Home to Switch" if the machine is equipped with home switches.
- Selecting "Automatic Homing" will display additional homing options for Automatic Homing.

Homing Direction:

- If the machine axis must move in the positive direction to seek the home switch, then use +(M92).
- If it must move in the negative direction to seek the home switch, then use –(M91).
- Set Homing Direction for each axis.

Homing Sequence:

- Sets the order in which the axis is homed.
- By default, the order is 3rd axis, 2nd axis, 1st axis, and 4th axis in sequence. This is important, generally you want to move the cutter away from the table first. So typically the Z axis is first, followed by the Y axis and then the X axis last. IF the machine is equipped with a rotary axis, and it has a home switch, that will be last to home.

SOFTWARE TRAVEL LIMITS:

Travel limits are used so that CNC12 knows the usable work envelope of the machine tool use of software travel limits is strongly suggested in all cases (whether you are using home switches and or limit switches in any combination)

- Travel Limit (+) is used if the home switch is on the NEGATIVE end of the axis. The value entered here would be a positive number. This number is the distance between the home switch and the other end of the axis travel, typically just shy of hitting a hard stop.

- Travel Limit (-) is used if the home switch is on the POSITIVE end of the axis. The value here would be a negative number. This number is the distance between the home switch and the other end of the axis travel, typically just shy of hitting a hard stop.

For example, the home switch is on the Y Positive end of the travel and there is 12.2" of travel on Y. The value entered would be -12.2.

For more information, see

MACHINE PARKING:

Parking the machine before shut down is not necessary but is useful. When parking before "Shut Down" of the machine, all axes will travel to a predetermined position

- By default, "PARKing" the machine will send all axis near, but not tripping, the home switch so that the next time the machine is powered up, it will not take so long for the machine to find its home position

- For a milling machine for example, you can send Z up near its +Z axis Home switch, and you can send the Y axis near its Home switch. But you could center the X axis so the table isn't hanging off to one side

- The feature's intent is twofold. To speed up the Homing routine the next time the machine is started by not having to travel so far at a slow rate to reach the home switch and/or to put the machine into a convenient position when shutting down

- Find the PARK feature by pressing F10 SHUTDOWN and F1 PARK or by selecting PARK on the Virtual Control Panel

- To EDIT the default park.mac click on the EDIT button

6.7 Axis Pairing.
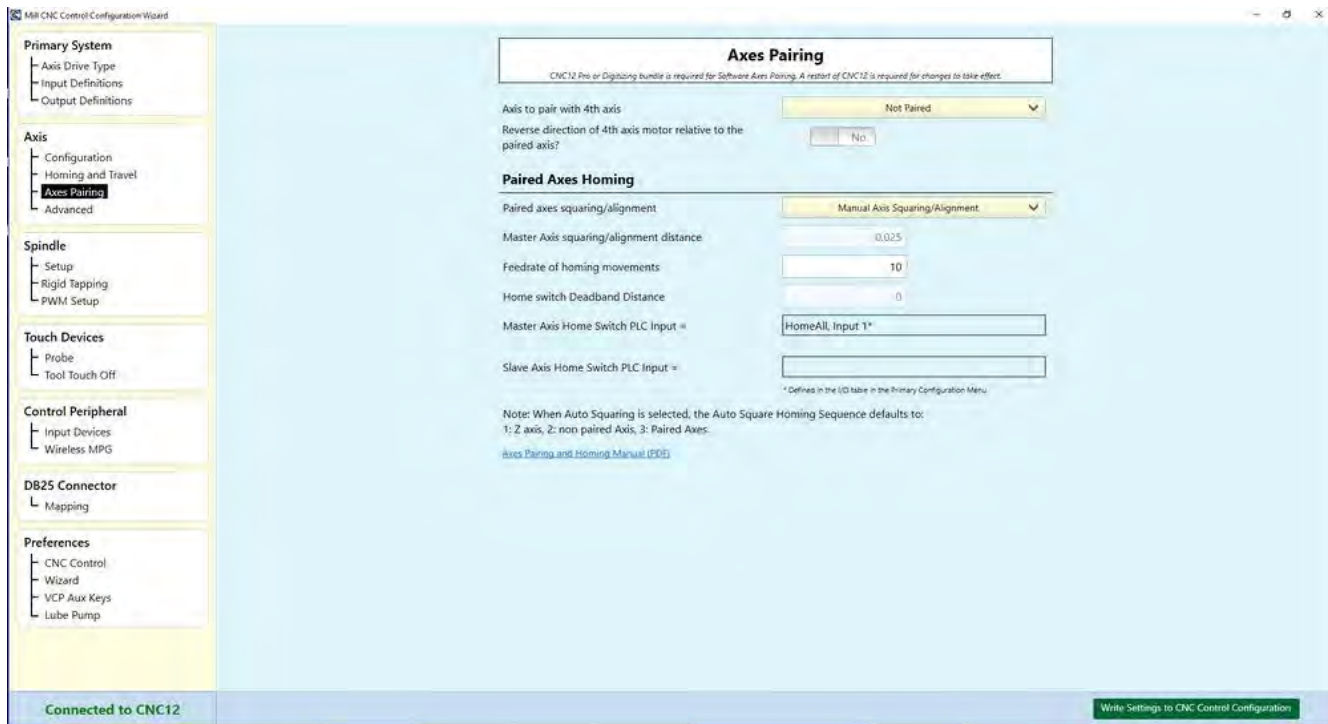
Wizard Axis Pairing dialog. Note: Software Axis Pairing feature is not included in the Free version of Acorn CNC12 software. A Pro license is required to enable this feature.

Axis to pair with 4th Axis

- Select axis for Software Pairing.

Reverse direction of 4th axis motor

- Setting this to "Yes" will reverse the direction of the 4th axis motor relative the master axis. For when the two paired motors are mounted in such a way that they have to spin in opposite directions to produce the same axis movement.

Paired axes squaring/alignment

- Select between Manual and Automatic Squaring/Alignment.

Master Axis squaring/alignment distance

- Maximum independent movement distance of the master axis during home program. This is always away from the master home switch and typically close to the value of the slave switch offset from square.

Feedrate of Homing Movements

- The speed in which the home program will move the axis to seek home switches.

Home Switch Deadband Distance

- The amount of travel the home program will move into the home switch once the home switch has been triggered to eliminate switch flicker (deadband).
- Note: Typically, cheaper switches have more deadband.

Master Axis Home Switch PLC Input

- Shows the input for the Master Home switch as set in Input Definitions.

Slave Axis Home Switch PLC Input

- Shows the input for the SlavedHomeInput as set in the Input Definitions.

For more information on proper pairing techniques, check out the Axis Paring and Squaring Acorn Guide. (https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/paired_axes_acorn_user_guide.pdf)

6.8 Advanced Axis Configuration

In general changes to settings in this section are usually not required. Only make changes when advised to do.

Wizard Advanced Axis Configuration dialog

Axis Signal Inversion

- Invert the Step, Direction, or Enable signal for each individual axis. Sometimes required depending on type of drives used. DO NOT USE the "Direction" on this menu to change the Axis movement direction! See Axis Configuration to change the Axis movement direction.

Step Rate

- Maximum steps rate in steps per second that Acorn will feed to the drive. (be sure to check the maximum rating of the drive step Frequency value in the drive manual) If a value HIGHER than your drive can tolerate, you may have unpredictable movement. Start with 100,000 if you are not sure as that is typically the fastest a stepper motor driver can handle, AC drives typically can handle faster step rates.

Axis Motor Drive Fault

- Fault Delay for when the DriveOK input is not active. Used to give some time to the drive to send the DriveOK signal to Acorn so Acorn knows that it is good to go.

Charge Pump:

This is a legacy drive support function for older drives that require a charge pump signal.

6.9 SPINDLE (Setup Mill)
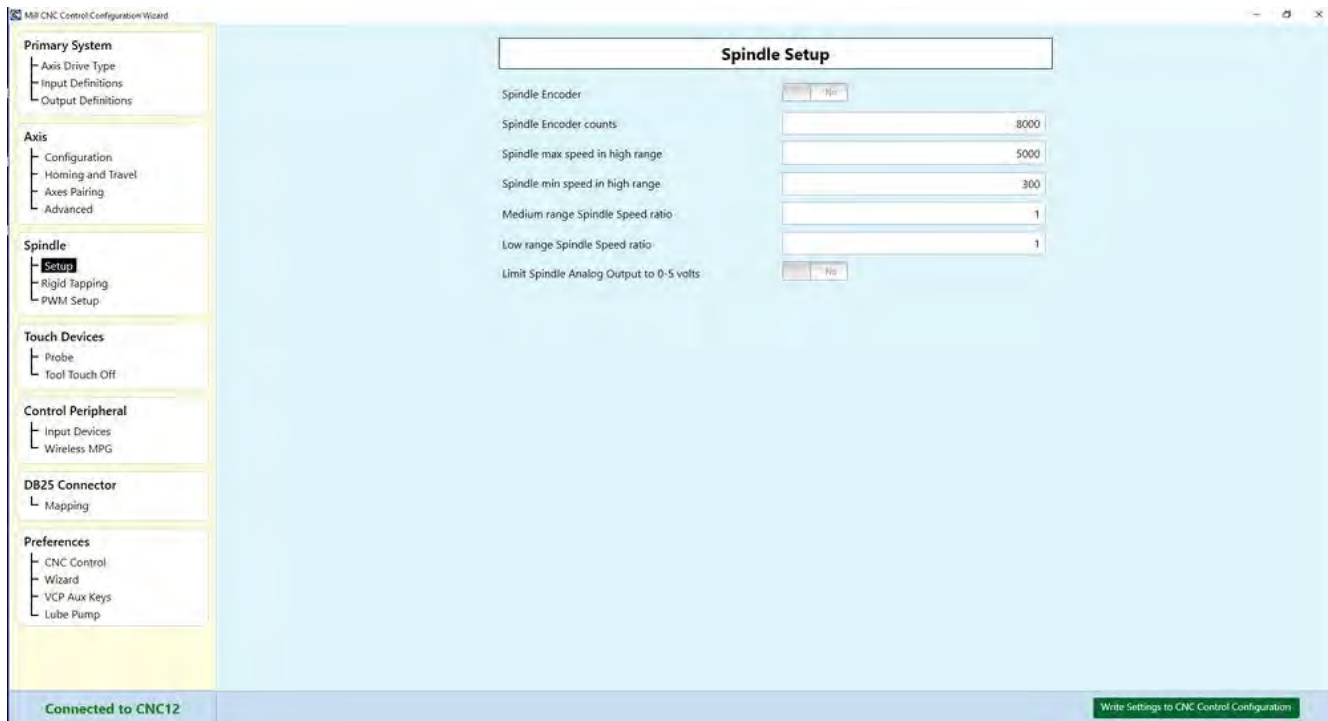
Wizard Spindle Setup menu - Mill example

Mill:

Spindle Encoder

- Is there a Spindle Encoder connected to the Acorn? If Yes, click on the button to move it to YES.

Spindle Encoder Counts

- Encoder Counts per Revolution of the spindle. This value will be the line number on the encoder multiplied by 4. For example, for a 1000 line encoder, enter a value of 4000.

Spindle max speed in high range

- Maximum speed in rpm for spindle in high range gear.

Spindle min speed in high range

- Minimum speed in rpm for spindle in high range gear.

Medium range spindle speed ratio

- Medium gear ratio (Medium max RPM divided by High max RPM). Used for spindles that employ step pulleys or transmissions. For example if the spindle MAX RPM is 3000 and the Medium range is 1500, enter .5 (1500/3000) =.5   For cases when the gear range reverses spindle direction set the ratio as a negative value. For our example if the gear range mechanically reverses direction of the spindle enter -.5

Low range spindle speed ratio

- Low gear ratio (Low max rpm divided by high max rpm). For example, if the Max RPM is 3000 and them Max RPM in Low range Low range is 500, then enter .166. If the gear reverses spindle direction then make ratio a negative value. (-.166)

6.10 Spindle (Setup Lathe)
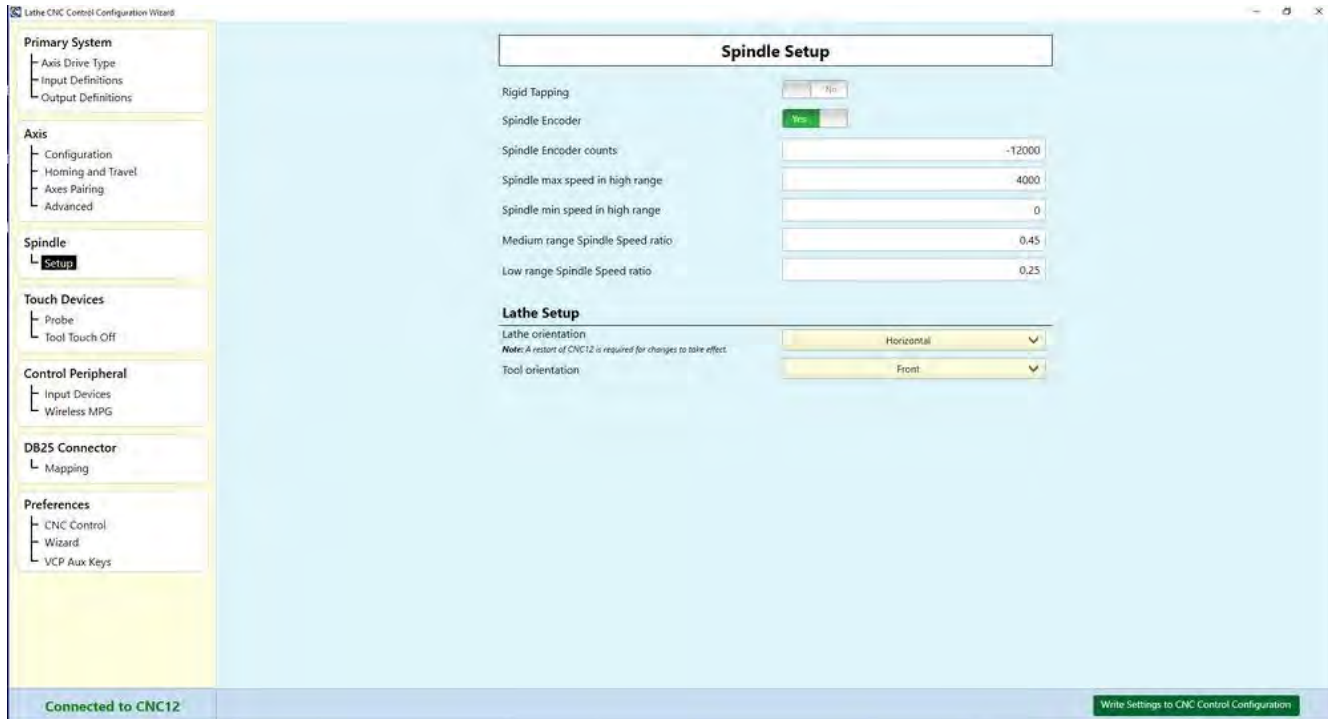
Wizard Spindle Setup dialog - Lathe example

Lathe Orientation

- Designate lathe as horizontal or vertical. (Most lathes are Horizontal)
- Note: After "write settings to CNC control" follow the instructions, a CNC12 reboot is required after a change is made.

Tool orientation

- Front or Rear. This will reverse the X axis direction. If the tool is presented to the work piece from the front, then it is a Front Tool Orientation. If the tool is presented to the work-piece from the rear, then it is a Rear Tool Orientation.

Spindle Encoder

- Is there a Spindle Encoder connected to the Acorn? If Yes, click on the button to move it to YES.

Spindle Encoder Counts

- Encoder Counts per Revolution of the spindle. This value will be the line number of the encoder multiplied by 4. For example, for a "1000-line" encoder, enter a value of 4000 counts per revolution.

Spindle max speed in high range

- Maximum speed in rpm for spindle in high range gear. T

Spindle min speed in high range

- Minimum speed in rpm for spindle in high range gear.

Medium range spindle speed ratio

- Medium gear ratio (Medium max RPM divided by High max RPM). Used for spindles that employ step pulleys or transmissions. For example if the spindle MAX RPM is 3000 and the Medium range is 1500, enter .5 (1500/3000) =.5   For cases when the gear range reverses spindle direction set the ratio as a negative value. For our example if the gear range mechanically reverses direction of the spindle enter -.5

Low range spindle speed ratio

- Low gear ratio (Low max rpm divided by high max rpm). For example, if the Max RPM is 3000 and them Max RPM in Low range Low range is 500, then enter .166. If the gear reverses spindle direction then make ratio a negative value. (-.166)

6.11 Spindle (Rigid Tapping)
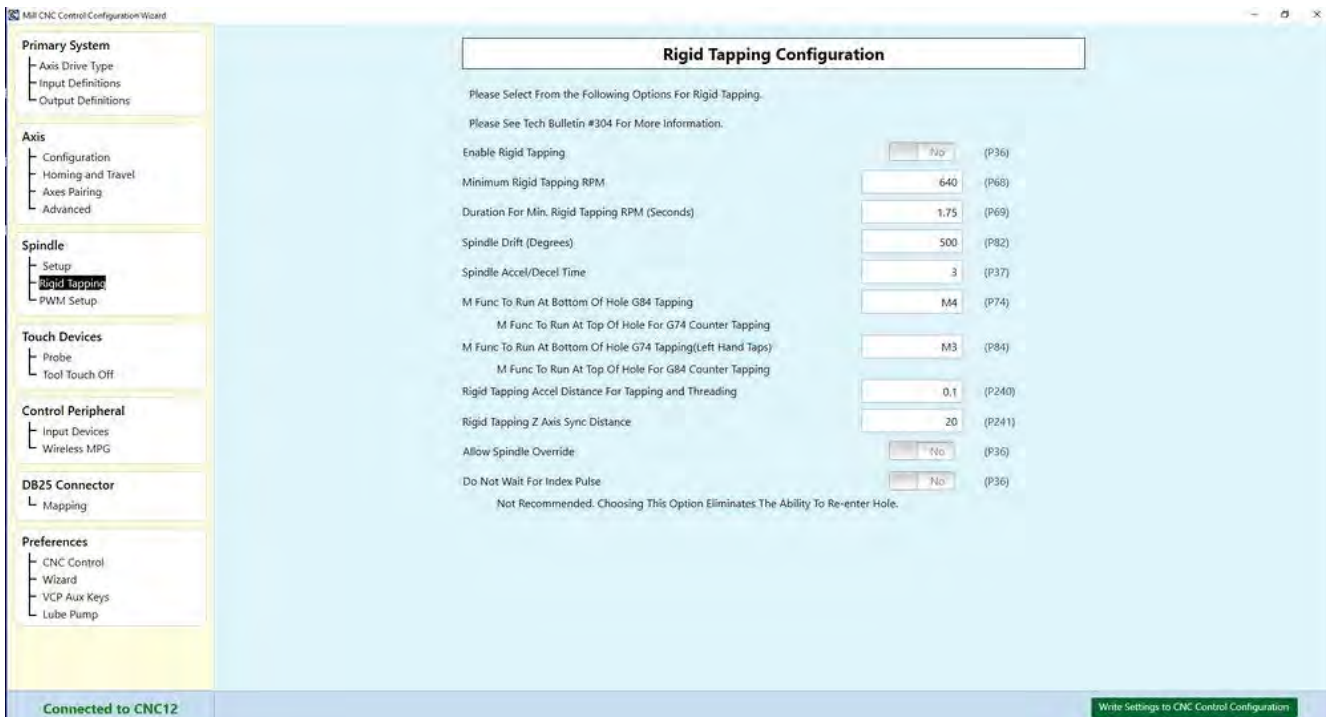
Wizard Rigid Tapping Menu

- Centroid Technical Support Bulletin: Acorn CNC Spindle Speed Calibration with VFD Hz Adjustment & Rigid Tapping setup must be done before proceeding with the section. See https://www.centroidcnc.com/dealersupport/tech_bulletins/uploads/304.pdf

- See Section 5.9 for wiring the encoder
- Rigid tapping also requires PRO License. Do not enable and test Rigid Tapping until have completely configured, setup and tested your machine!

6.12 Spindle (PWM Setup)

Wizard Spindle PWM Setup menu

The Acorn PWM can be used to command a Laser and/or a PWM Spindle Drive and use the Gcode "S function" (Note: PWM output is not to be confused with 0-10 s command analog output which is used with VFD's to control 3 phase spindle motors which has its own dedicated output on H8.)

PWM Setup
- PWM enable
- Base Frequency (HZ)
- PWM Command Range 0-100 or 0-1000   this divides up the laser power or spindle RPM by 100 or 1000 increments. For example: A S command of S1000 would result in max laser power or max spindle RPM when 0-1000 range is selected.
- PWM Minimum S command power level to start Laser
- Inverse Output
- Jtech Laser Presets with matching Acorn Schematics

Laser specific setup documentation.
https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/acorn-CNC12_v4.60_laser.pdf

Search "Acorn Laser" on this page to see all the Acorn to Laser hook up schematics.
https://www.centroidcnc.com/centroid_diy/schematics/pbrowse.php

Note: PWM output is located on DB25 connector, Output #2, Pin 14.
When PWM is employed it 'takes over' output #2 which can not be used for any other purpose.
The output ribbon cable to the relay board must be modified to cut the output #2 signal to the relay when PWM is used.
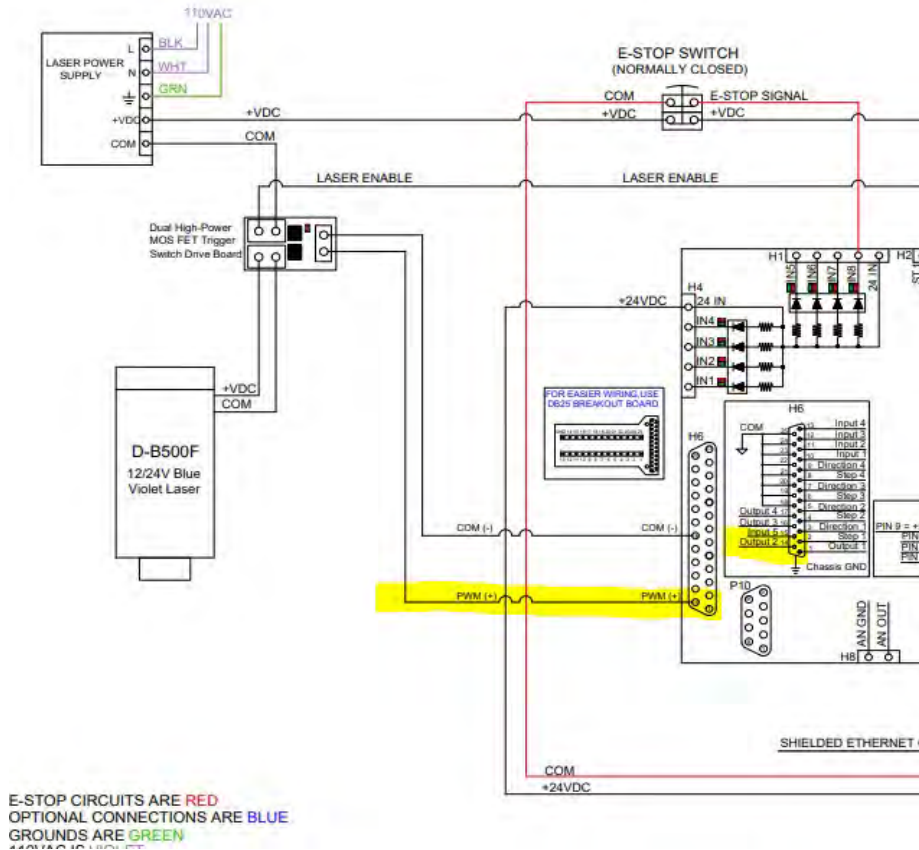
Cutting of Output #2 wire in ribbon cable when PWM feature is being used.
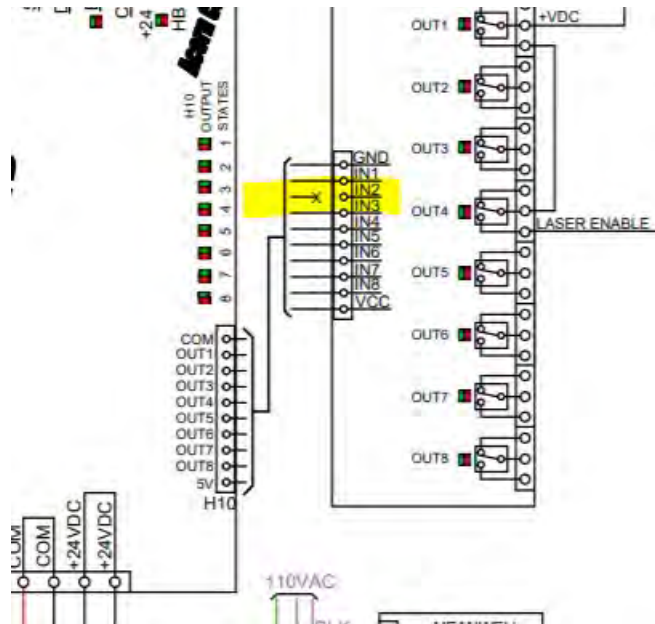
6.13 Touch Devices Probe Configuration
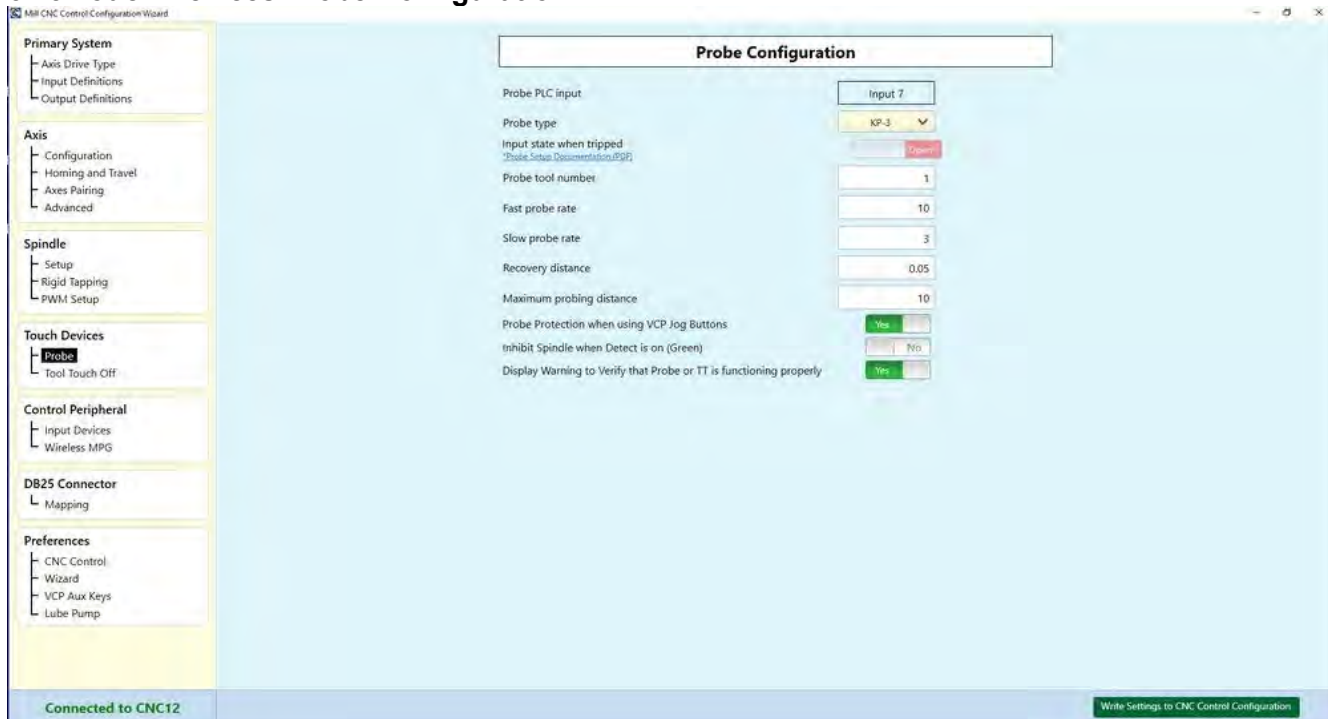
Wizard Probe Configuration menu

Probe PLC Input

- The Acorn input number used as the ProbeTripped input, as set in the Input Definitions.

Probe type

- Choose the type of probe being used. Centroid DP-4, Centroid KP-3, or 3rd party Mechanical/Conductive.

Input state when tripped

- The state of the input when the probe is tripped. Refer to the Acorn Probe Setup Guide for more info located in the All Acorn Documentation thread here.

Probe tool number

- The tool number assigned to the probe, used to look up the length offset and tip diameter of the probe from the CN12 tool library.

Fast probe rate

- Used for positioning moves and initial surface detection, this parameter is determined by machine response and permitted probe deflection as well as desired accuracy tolerance.
- Default value is 10 ipm (30 to 10 inches per minute is typical for milling machines and 20 to 40 inches per minute for most CNC routers, adjust as needed)

Slow Probe rate

- Used for final measuring moves for maximum accuracy, this parameter value is determined by speed/accuracy trade off.
- Default value is 3 inches per minute which is a typical rate for milling machines and routers.
- Adjust this value as needed for accuracy required.
- Warning: setting this parameter to very slow rates will often cause issues with "double triggers.

Recovery Distance

- The additional distance the probe moves off of a surface after contact is broken, before attempting to traverse parallel to the surface.

Maximum Probing Distance

- The Maximum distance that a probing cycle "searches" for a surface in a given direction

.

Probe Protection when using VCP Jog Buttons

- This feature 'protects' the probe by immediately stopping all motion of the machine tool when an "unexpected probe contact" has been made. For instance when an operator is using the VCP axis jog buttons to move an axis with the probe connected, if the probe is tripped all motion is stopped and CNC12 waits for the operator to clear the probe by slow jogging it off the contacted surface.
Set to YES then moves from the VCP are probe protected. If set to No, VCP Jogging is no longer protected and the machine will continue to move even when probe is tripped therefore crashing the probe due to operator error.

Inhibit the Spindle from moving when probing

- Determines if spindle is allowed to spin while the probe is detected.
- This feature requires that the probe to has a detect signal and the input Probe Detect assigned in Input Definitions. All Centroid supplied probes have a detect signal so CNC12 knows when a probe is in use.
- By default it is set to "Yes" for Mills and "No" for Lathes.

Display Warning to Verify that the Probe or TT is functioning properly
CNC12 will ask to you verify that the probe is working properly before each probing cycle to prevent user error such as, not plugging in a probe or not testing it by hand before running a probing cycle. This section allows the user to turn off this warning/help message if they do not want this message to display each time a probing cycle is run.

For more information on setting up your probe, check out the Probe Setup Guide.
(https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/acorn_probe_setup.pdf)

6.14 Touch Devices Tool Touch Off, (aka Touch Plates) Configuration

Wizard Tool Touch Off Configuration dialog

Tool Touch Off PLC Input

- The Acorn input number used as the ToolTouchOffTriggered input, as set in the Input Definitions.

Tool Touch Off Type

- Choose the type of TT being used. Centroid's TT-1, TT-2 or 3rd party Mechanical/Conductive.

Input state when triggered

- The state of the input when the tool touch off device is triggered
- Refer to Probe Setup Guide for more info.
- Centroid's tool touch offs are closed when tripped

Subtract height of tool touch off device

- When using Auto Part Z zero probing cycle with TT device, subtract the height of the TT device when setting Z part zero.
- Used when TT is sitting on top of the material you wish to set zero for.

Tool Touch off device height

- Value is taken into account when the TT device is being utilized with auto part Z zero location probing cycle.
- This height value is typically the distance from the top to the bottom of the TT device.

Use Tool Touch Off device to set Z reference

- Use the top of the TT device as the Tool Height measurement reference location when measuring tool heights automatically.
- Typically used when top of TT is a fixed Z position to measure all tool heights from. Commonly found on routers and bed mills. Is not used for Knee Mill Applications.

Inhibit the Spindle from moving when probing with ToolTouch

- Determines if spindle is allowed to spin while TT is detected.
- This requires the TT to have a detect signal and the input ToolTouchOffDetect assigned in Input Definitions.
- By default, this is set to "No" on Mills and "Yes" on Lathes.

For more information on setting up your Tool Touch Device, check out the Probe Setup Guide. (https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/acorn_probe_setup.pdf)

6.15 Control Peripheral Input Devices Setup
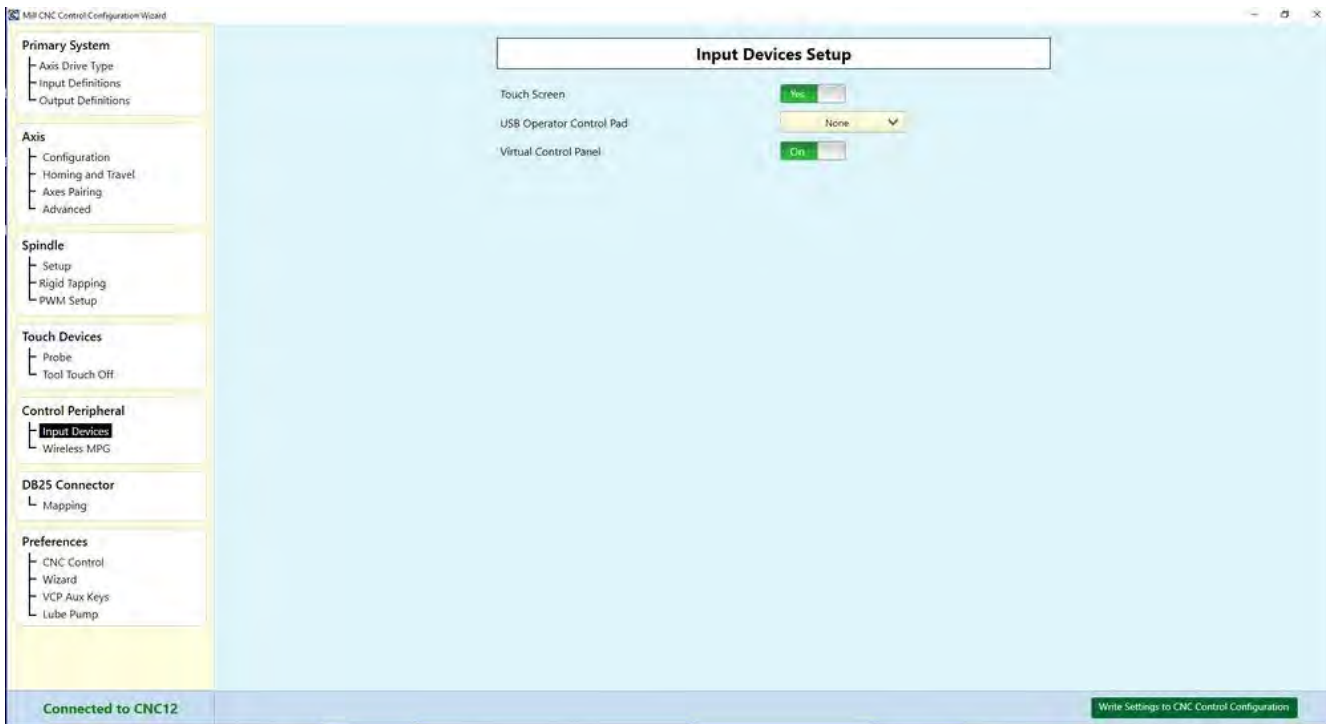
Wizard Input Devices menu

Input Devices Setup
- Touchscreen Yes/No
- USB Operator Control Pad (if you are using a keyboard emulator such as X-Keys)
- Virtual Control Panel. On if you want the VCP on the display.

6.16 Control Peripheral Wireless MPG Configuration
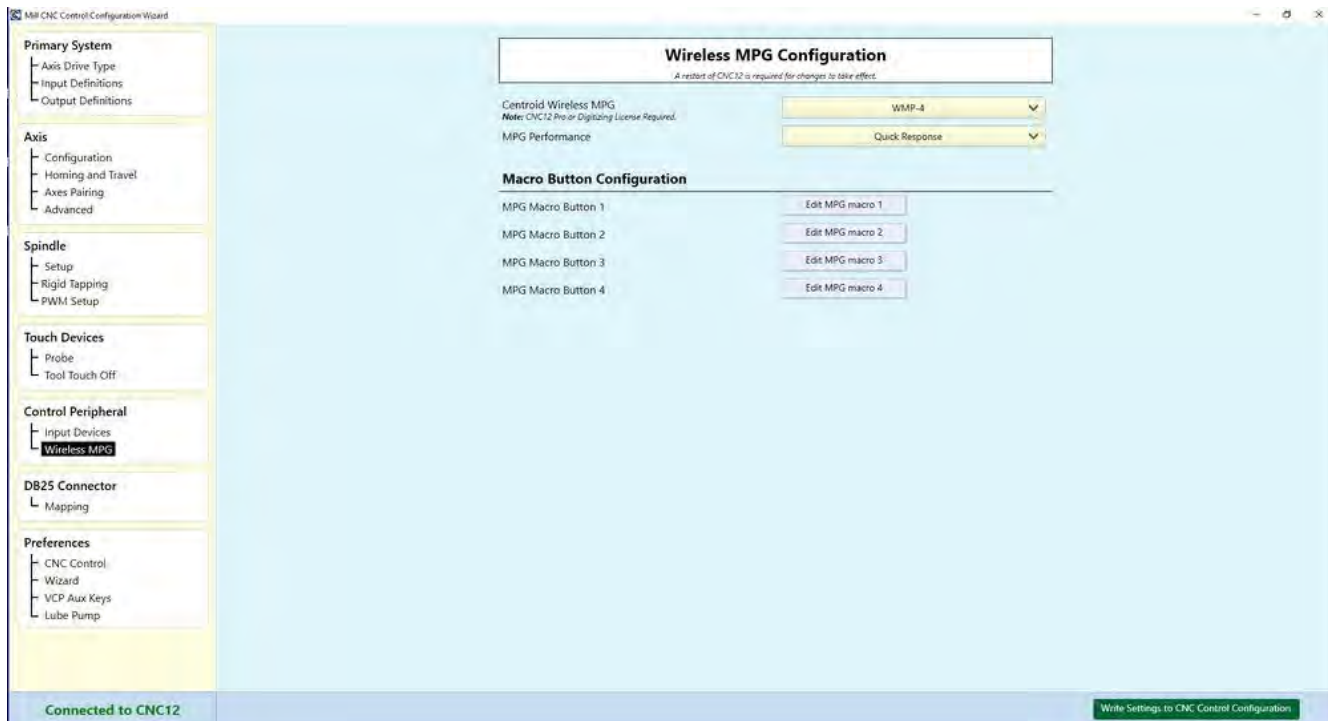
Wizard Wireless MPG Configuration Menu

Wireless MPG Configuration.
- • Centroid Wireless MPG. Select the correct MPG model
- • MPG Performance allows user to change the reaction speed of the MPG.
- • Macro Button Configuration. User defined Macros used on the WMPG. Click on buttons 1-4 to Edit each Button Macro and program them for a custom use.

6.17 DB25 Connector selection and optional Mapping

Step and direction output

- Selection between "Screw Terminal" OR DB25 Port.
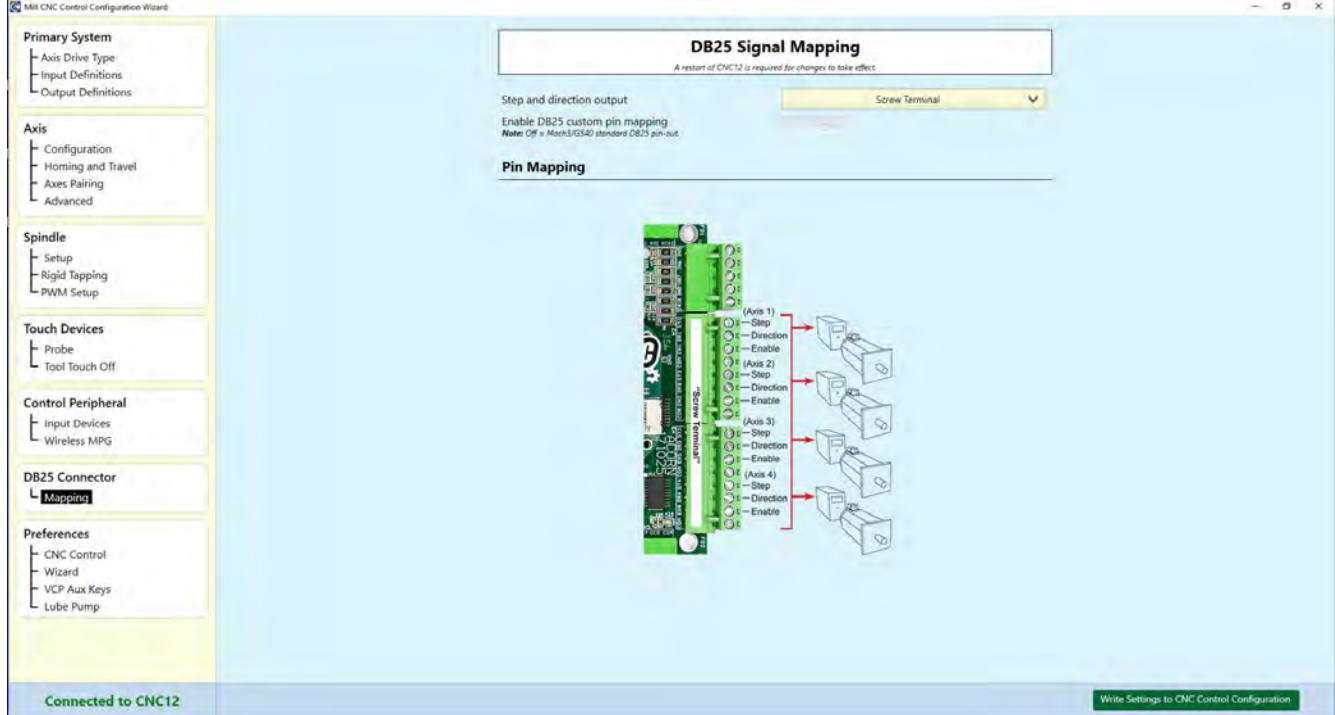
Wizard DB25 setlection and optional Signal Mapping Menu

Screw Terminal step and direction output

Screw Terminal Step and Direction outputs are designed for AC servo motor drives that accept 24 volt open collector signals.

- "screw terminal' is the Default setting
- Screw Terminal Pins cannot be re-mapped, follow provided Acorn schematics.

DB25 connector step and direction output

The DB25 connector is designed for stepper motor drives that use 5 volt step and direction signals. In most every case use the DB25 connector step and direction output for use with stepper motor drives.

Enable DB25 use default pin mapping OR create a custom DB25 pin map

- The default DB25 pin configuration uses the long time Gecko G540/Mach3 standard This is what most users will use. The Acorn Wizard allows the user to change the pin out (which pins do what) of the DB25 connector via software therefore saving on custom cable or adapter creation for connection to non standard pin out drives and breakout boards.

Wizard DB25 Signal Mapping dialog
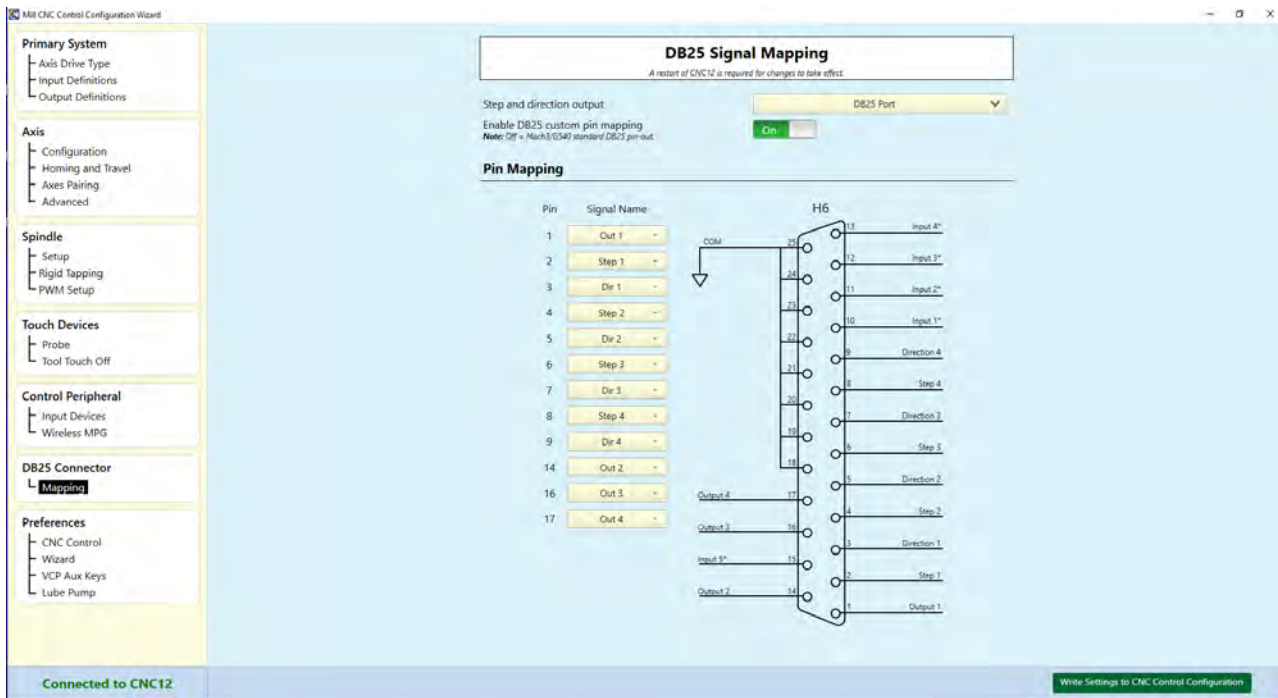
DB25 port

- Enabled
- Use default Pin assignments or re-map them to match your application.
- Note: Charge Pump cannot be re-mapped from pin 16 Output 3. It is only physically available on that pin.

6.18 CNC Control Preferences
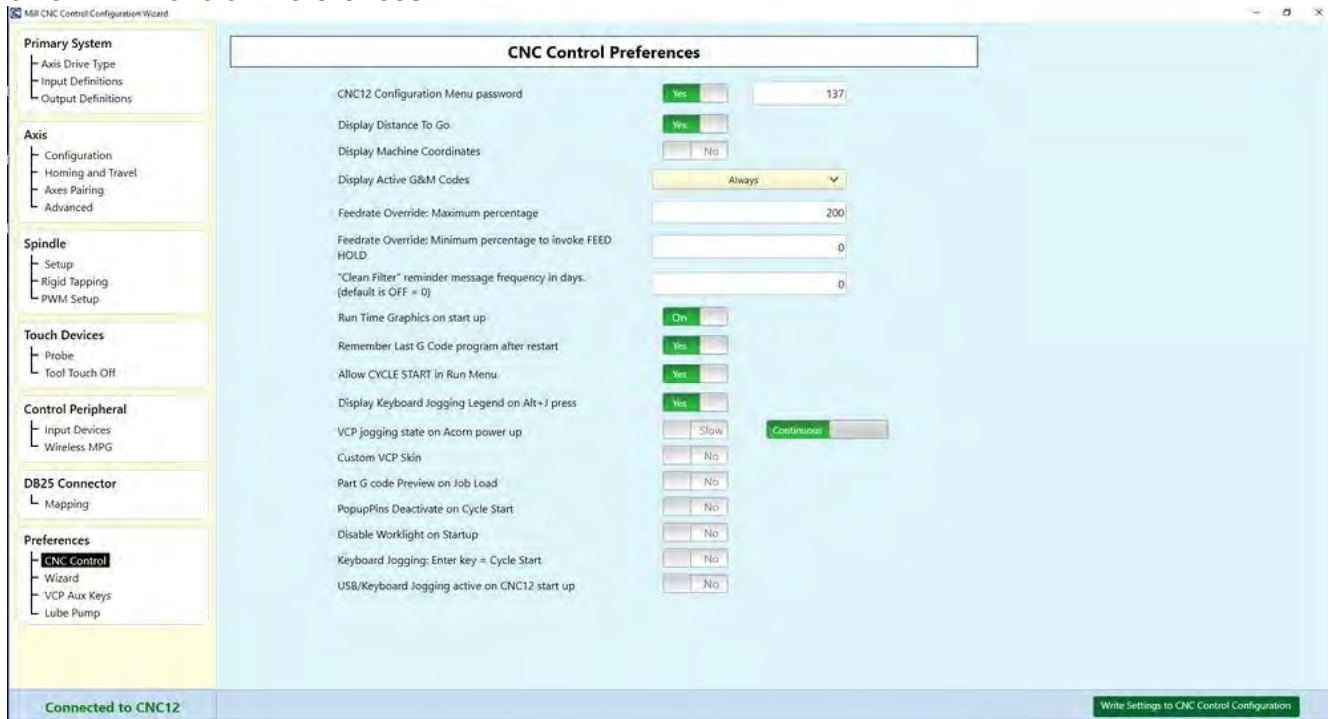
Wizard CNC Control Preferences menu

CNC12 Configuration Menu password

- Set Password to access CNC12 Configuration menus. Prevents accidental editing of the CNC12 configuration menu by operators.
- Default password is 137, you can change it or eliminate it
- The Wizard automatically sets many of the parameters in the CNC12 configuration menu for you. Sometimes during special applications it is necessary to edit a parameter in the CNC12 configuration menu directly (one that the wizard doesn't edit)

Display Distance To Go

- Choose to display "Distance to Go" readout on the main CNC12 screen.

Display Machine Coordinates

- Choose to display Machine Coordinates readout on the main CNC12 screen.

Display Active G&M Codes

- Choose to display currently active G&M codes when while in MDI or Always.

Feedrate Override

- Maximum percentage: Allows to override maximum feedrate to a maximum of 200%, for most open loop systems is it advised to set this value to 100%

Minimum percentage to invoke Feed Hold

- Feed hold will be active when Feedrate override is below this value. This is a nice feature when used in conjunction with the Wireless MPG as turning the MPG knob will down to slow down the machine will put the machine into feed hold mode automatically once the feedrate override goes below this threshold. Nice threshold values are typically 1-2% and 2-3 percent for routers.
  Set to zero if you do not want feed hold to be invoked with the Feedrate override controls.

Clean Filter Reminder Message
- 0=Do Not Display. Otherwise enter the days between the clean filter message.

Run Time Graphics on Start Up

- Set to have CNC12 always start run time graphics while running job. (Requires CNC12 restart for changes to take effect) If you select NO you can still always use CNC12 to select run time graphics on a per job basis. This selection simply forces RTG to start with every job automatically.

Remember Last G Code Program after restart

- If set, CNC12 will load last G Code Program set on start up. Otherwise upon restart of CNC12 the operator would have to reload the last job run.

Allow CYCLE START in Run Menu

- When set, allows operator to start a G Code Program from the Run Menu.
- Disables the forced return to CNC12 main menu to run a G Code Program saving keystrokes after using the Run menu.

Display Keyboard Jogging Legend on Alt+J press

- Displays Keyboard shortcut legend when using Keyboard Jogging (Alt+J). Or don't display it. Its best to print out a copy of the keyboard jogging short cuts and not display the legend but this is user preference.

VCP jogging state on Acorn power up

- Sets when on startup the VCP defaults for Fast/Slow and Continuous/Incremental. Typical setting for a Mill or Lathe are Slow Incremental or Slow Continuous
  Typical settings for router are Slow Continuous or Fast Continuous

Custom VCP Skin
- When a custom VCP is in use this selection stops the Wizard from overwriting the custom VCP. See VCP manual for more info on customizing the VCP found the All Acorn Documentation thread here.

Part G Code Preview on Job Load
- Displays the beginning of the G code program when the G code file is loaded. This allows operator to see the beginning of the G code program before pressing cycle start without having to open it in an editor to see it.

Pop Up Pins Deactivate on Cycle Start
- Automatically retracts the pop up pins when cycle start is pressed. This prevents tools from crashing into the pop up pins if the operator/programmer forgot to retract the pins in the G code program.

Disable Worklight on Startup

- Most machines are setup so that the worklight is ON when the machine is on by default. This selection allows user to choose to NOT have the worklight come on when the machine is on. The work light is still always activated by the VCP worklight button in either case.

Keyboard Jogging: Enter Key = Cycle Start
- Many router customers are familiar with other cnc controls that use the Enter key on a PC keyboard to act as cycle start button. This selection allows this functionality.

USB/Keyboard Jogging active on CNC12 Startup
- Normally as a safety feature CNC12 USB and keyboard jogging is not active on boot up, the user has to enter into that mode (alt j) after boot up. This selection forces CNC12 to activate Keyboard and USB device jogging upon boot up.

6.19 Wizard Preferences
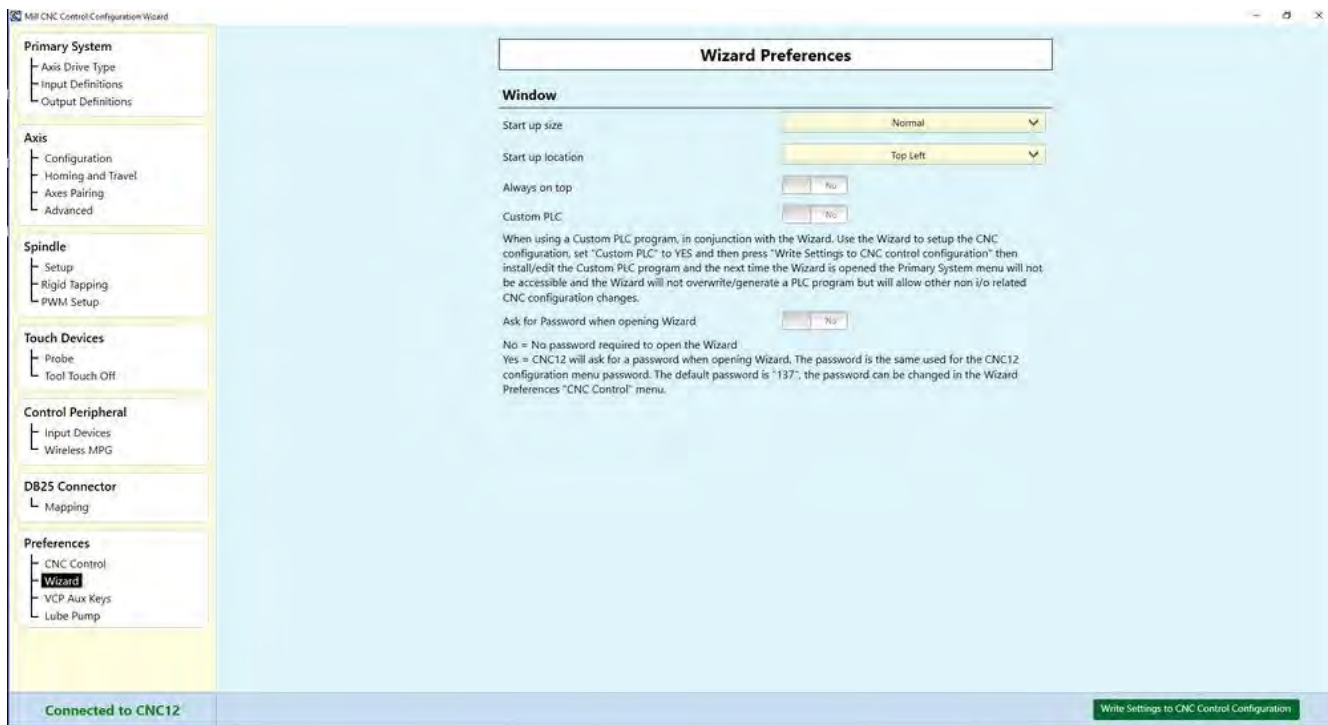
Wizard Preferences dialog

Start Up Size
- Window size of the Wizard dialog
- Default is Normal

Start Up Location
- Where on the Windows desktop the Wizard is located
- Default is Top Left

Always on Top
- Keeps the wizard on top of all other screens
- Yes/No

Custom PLC
- If a custom PLC program is in use, use this selection to let the Wizard know not to overwrite the custom PLC program.

Ask for password when opening Wizard

- Locks user out of Wizard unless password is entered
- If enabled, uses the same as the Configuration Menu Password

6.20 Preferences VCP Aux Keys Macro Assignments
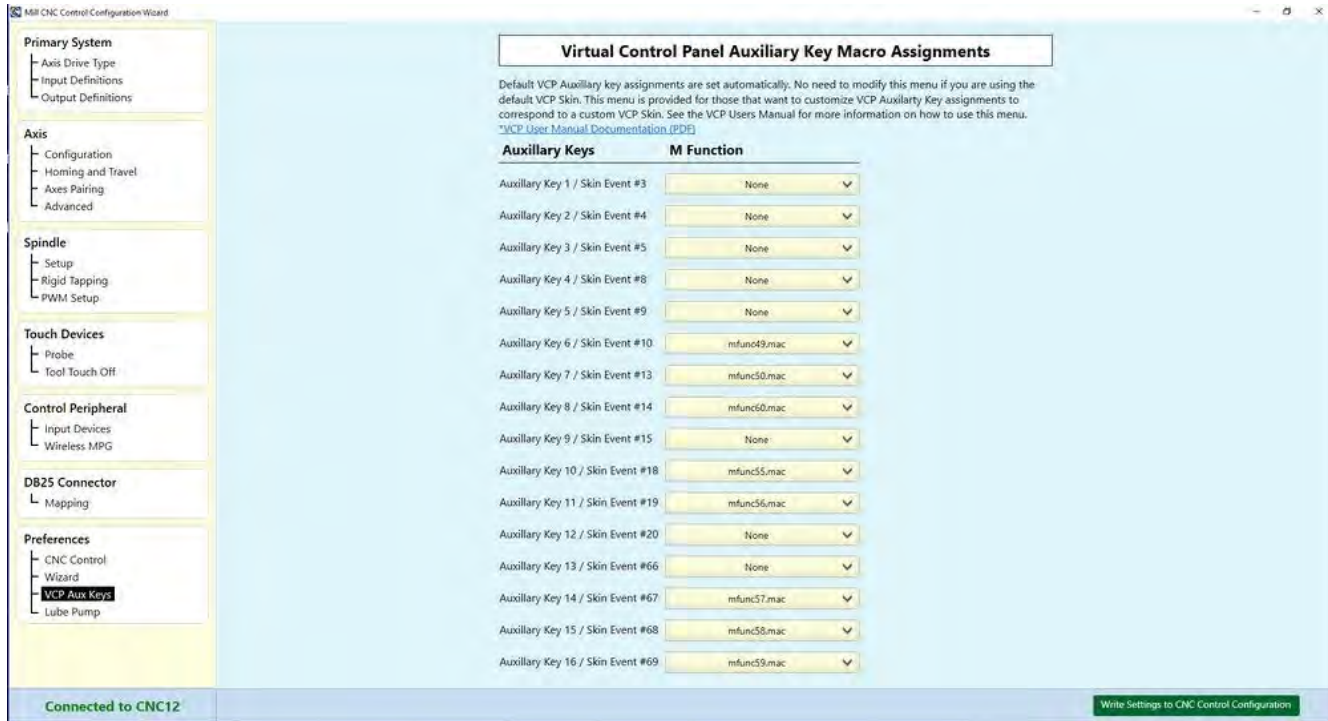
Wizard VCP Auxiliary Key Macro Assignments menu

Virtual Control Panel Macro Assignments

- Lists the macros that are pre assigned to the VCP buttons.
- Defaults shown
- See the VCP Users manual for details:
  https://www.centroidcnc.com/centroid_diy/downloads/centroid_vcp_users_manual.pdf

6.21 Lube Pump Preferences
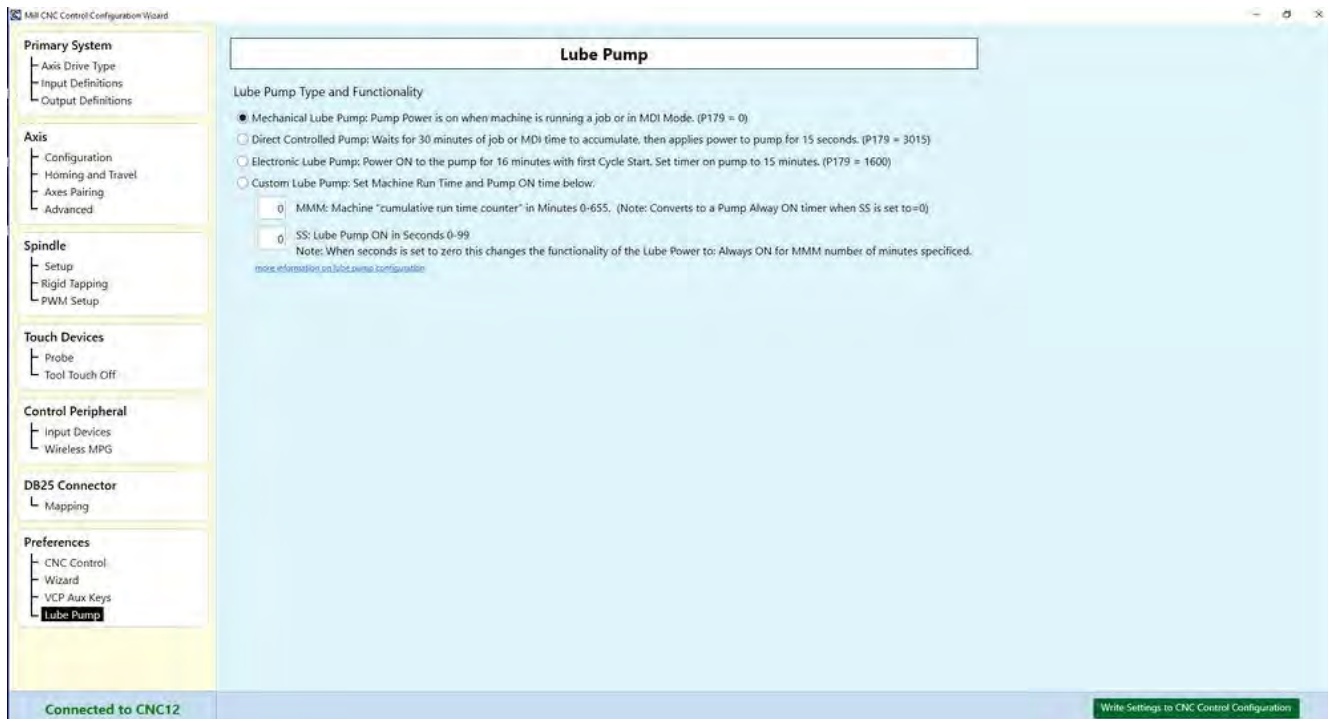
Wizard Lube Pump Menu

Lube Pump Type and Functionality

Define Lube Pump type, Mechanical, Direct Controlled, Electronic, or Custom.

- Mechanical: The Lube Pump Output is on at all times when CNC12 is running job or in MDI mode. This is used for Lube   Pumps with their own timer.

- Direct Controlled: After 30 minutes of MDI or Job Running, the Lube Pump Output is turned on for 15 seconds applying power to the lube pump which in turns pumps oil into the lube system. Used with Lube Pumps that pump when power is applied to them.

- Electronic: for "Lube First" or "Lube Last" pumps

- Custom: User defined timer for Lube Pump Output.

See Lube Pump Techbulletin #171 for more info.

Chapter 7   Machine Motion Tuning

7.1 Axis Motor Testing & Configuration Setup

DANGER: MECHANICALLY DISCONNECT THE AXIS MOTORS FROM THE MACHINE TOOL before proceeding.

The first time jogging of an axis motor, the best practice is to have it disconnected from the machine. (Either by physically removing the motor from the machine or removing a gear or drive belt.) This way if something goes wrong, there is a minimal risk of mechanical damage to the machine. If one of the parameters or settings was entered incorrectly during the setup, the motor may oscillate violently or move out of control.

The axis motors need be able to move freely. Failure to disconnect the motors from the machine could result in personal injury or damage to the machine.

1   Release E-stop to clear all errors and provide VM power to the axis motors.

2   Set the feedrate to around 10%

3   Jog each axis motor while it is disconnected from the machine (or on the bench) if you have not already done so. Use the arrow keys on the Virtual Control Panel (VCP) to confirm that the motors are moving correctly.

4   While jogging, disable increment mode by making sure the button on the VCP labeled 'Incr Cont" is not lit up.

5   TROUBLESHOOTING TIP #1: If movement does not occur, some things to check:
     5.a Make sure you are using the DB25 for +5VDC logic drives (most all stepper drives)
     5.b Make sure you are using a schematic that closely matches your drives
     5.c Make sure you have wired the drive per the manufacturer's manual
     5.d Make sure E-Stop button is OUT, and you have no "406 Emergency Stop Detected" in the dialog box
     5.e Make sure VCP RESET button does not show "Tripped"
     5.f Make sure you have motor power to your axis drive
     5.g Make sure your axis motor is properly wired to your drive, including encoder if applicable.
     5.h Try NOT using the enable signal connection during testing, as this could inadvertently DISABLE the drive under Acorn control. This can be setup later after motor is moving under CNC12 control

(If these tips do not resolve the issue, visit the Centroid Acorn User Forums:

and be sure to follow this post explicitly about how to request support:

The more information you can provide, the better suggestion we can make. This includes a FRESH REPORT (F7 Utility, F7 Create Report) Links to axis drive manuals, Spindle drives, pictures of your setup and machine etc.

6   After successful axis motor movement, power down the system.

7   Manually move all axes to the center of their travel to provide safe clearance when the motors are connected to the machine.

8   Mechanically connect the axis motors to the machine, allowing the motors to control the movement of the machine.

9   Power up the machine. Release E-stop to provide power to the axis motors

10 Check home configuration: Make sure in the Wizard (F7 Utility, F10 Wizard), you have SIMPLE HOME selected next to Homing Type.

DANGER: Since the home switches have not been configured correctly yet, homing to switches right now could cause physical damage to your machine.

11 Make sure the feedrate is turned down to around 10%

12 Press the Start button ![button] on the Virtual Control Panel, or press alt+s key from the keyboard. This will set home right where it is. DRO's should now show Zeros.

13 Slow jog each of the axis motors, checking that each axis of the machine can move by pressing the axis jog keys on the VCP.

14 Configure axis motors to move in the correct direction: It is important to understand that correct axis motor direction is determined by the motion of the tool relative to the part.
    14.a   Lathe with Front Mount Tool Post:
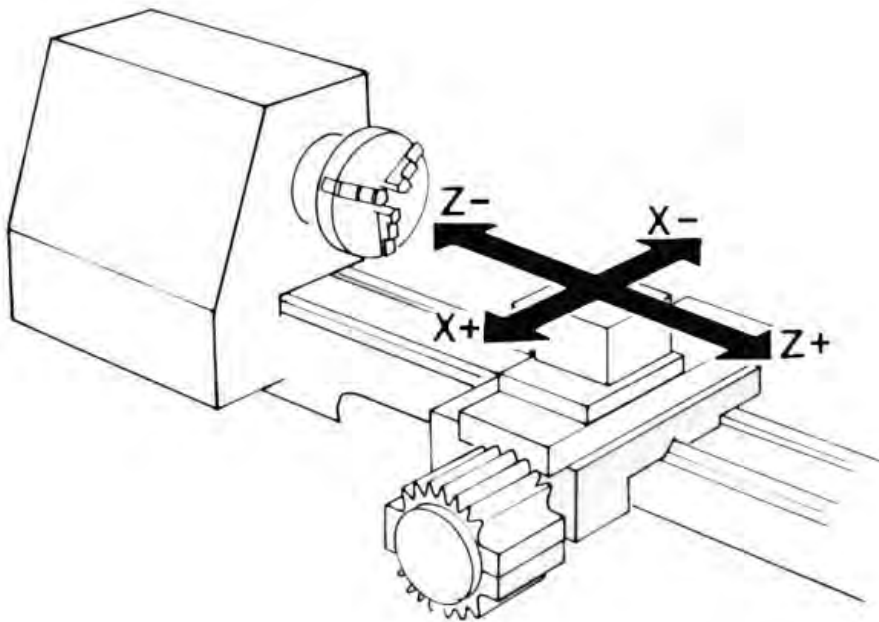
Lathe note: On a rear mounted tool post, the X axis would be reversed compared to a front mounted tool post.

    14.b   Milling Machine axis movement conventions is based on TOOL movement.

Column (Z-Axis)
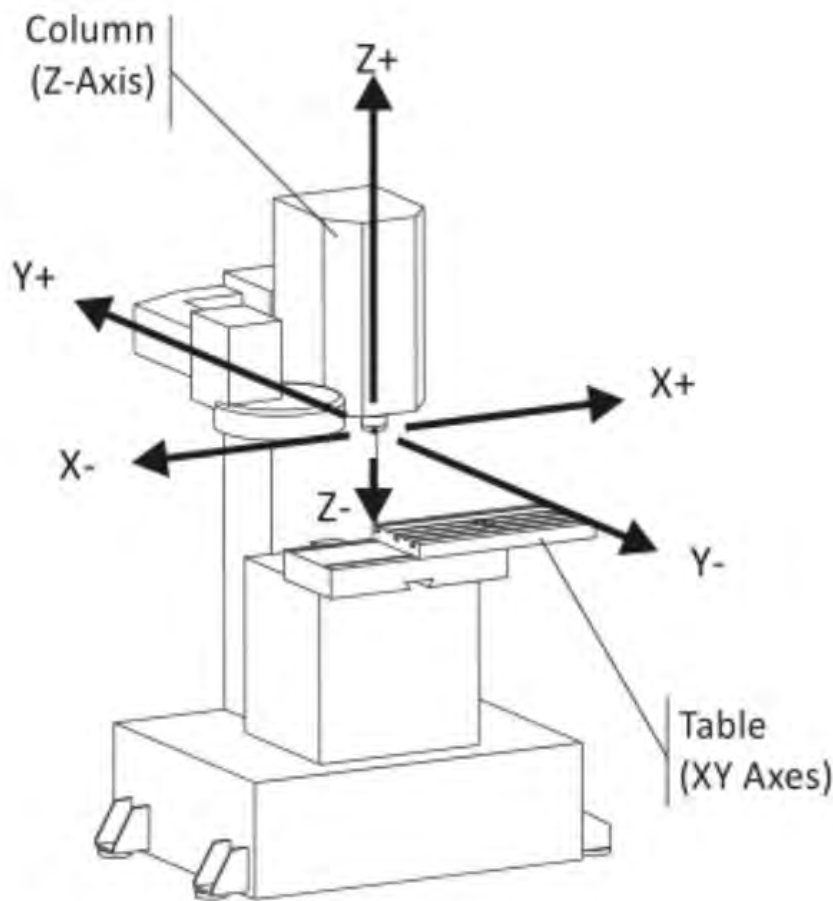
Table (XY Axes)

NOTE: For machines that move the table while the tool remains stationary such as the X & Y axes on a typical Bridgeport type knee mill, the table motion is the opposite of the "tool motion". For machines that move the tool, such as the quill on a knee mill, axis motion is the same as the tool motion. .

15 Use the axis jog buttons on VCP to move each axis, observe and determine if the axis is moving in the correct industry standard direction. See this related post for more information.

Jog the axis and observe that the DRO position moves more positive while moving an axis in the positive direction and that it counts more negative while moving in the negative direction.

To correct for an axis that is moving in the wrong direction, if necessary, reverse the axis motor direction from within the Acorn Wizard, F7-Utility → F10 Acorn Wizard Under Axis, select Configuration. Then in the appropriate Axis Column, in Direction Reversal, select Y to reverse the direction. Review Section 6.5 Axis Configuration
Once axis direction is confirmed, then you may move on to the next section.

7.2 Coarse configuration of commanded movement vs actual/DRO display.

For imperial machine configurations the "Overall Turns Ratio" is the number of motor revolutions required to move an axis 1"

For metric machine configurations the "Overall Turns Ratio" is the number of mm's traveled during one revolution of the motor.

NOTE: The best way to determine the "Overall Turns Ratio" for a machine tool axis is to use simple math calculations to get a good starting value that we will fine tune later. This is described in the first part of Technical Bulletin #36, which can be found here.
And read Related detailed information on overall turns ratio is here

While it is always best to use the method in TB36 to set the Overall Turns Ratio, An alternative trail and error method can be used in situations where it is very difficult to determine the # of teeth on a pulleys or gearbox etc. This method simply compares the commanded movement with the actual movement of the axis using a scale or tape measure to observe and measure the movement. Before we can fine tune the DRO to an exact number, this trail and error method will get in the ballpark so we can move forward with the rest of the machine tool configuration. Later in this chapter, we will perform a fine adjustment on the overall turns ratio to calculate an exact value.

1   Jog the machine so that the spindle is in the center of the table.

2   Zero the DRO position for the axis being tested: From the main menu, press F1 – Setup → F1 Part → F10 Set Zero as shown below in Figure 7.12.1.

3   Set Up a Tape Measure or machinist scale on the table so that 0" is lined up under the center of the spindle/tool/pointer.

4   Command the machine to move. The longer the move the more accurate the measurement will be. It is recommended that you move the machine at least 1 foot. To move a specified amount MDI (Manual Data Input) screen. From the main menu, press F3 MDI. If we were testing the X axis for example, type "G1 X12 F10". Which commands the control to "move in straight line (G1) the X axis in the positive direction(X12) at 10 inches per minute (F10)" , they press cycle start to execute the entered command.

WARNING: It is a good idea to use slow feedrate and be prepared to hit E-stop to prevent and accidental crash if the machine moves too far or too fast unexpectedly. If it does either then it is likely that either the Steps per Rev or Overall turns ratio is not configured properly. Related: Often it is a good idea to have some sort of 'soft' mechanical bumper on the axis so if an overtravel occurs the axis simply 'bumps' into the bumper and stalls the motor not damaging anything. Polyurethane bumpers are often employed for this use.

5   Measure the amount of travel moved and adjust the Overall Turns Ratio Value if necessary. Obviously if the measured movement equals the commanded movement we are done.   If not perform the calculation below to determine a new overall turns ratio.

Using Imperial Units When command to move 10 inches via MDI and the machine moves 10 inches you have the correct overall turns ratio and you can stop here.   If the machine moves a different amount than commanded calculate a new value to be entered in the revs/inch field, Divide the distance moved (Digital Read Out value) by the distance that the axis actually moved (measuring tape). Multiply this result by the current value in the Overall Turns Ratio field for the axis you are working on. This the new value that you will enter in the Overall Turns Ratio field. For example If the axis traveled 6", but the commanded move entered into MDI was 7.5", then: 7.5/6 = 1.25, if the current Overall Turns Ratio is 5.000 * 1.25 = 6.25 is the new value to enter in the Overall Turns Ratio field.

Using Metric Units To calculate the value to be entered in the overall turns ratio, when using metric the units are mm/revolution of the motor. This distance that the machine moves in mm for one revolution of the axis motor. When command to move 2500 mm and the machine moves 2500 mm you have the correct overall turns ratio and you can stop.   If the machine moves a different amount than commanded, calculate a new value for the overall turns ratio, Divide the distance that the axis actually moved (measuring tape) by the distance commanded in MDI (DRO value). Multiply this result by the current value in the Overall Turns Ration field. This the new value that you will enter in the Overall Turns Ratio field. If the axis traveled 150mm", but the commanded move entered into MDI was 175mm, then:150/175 = .85714, if the current Overall Turns Ratio is 5.08 * .85714 = 4.35428 is the new value to enter in the Overall Turns Ratio Field.

 Enter this new Overall Turn Ratio value: Axis Configuration section of the Wizard. From the main menu press F7 Utility → F10 Acorn Wizard. Click on Axis Configuration, adjust value, press "Write Settings to CNC Control" follow the instructions.

6   Repeat the test as needed until the commanded movement/DRO matches the measuring tape movement.

7   Repeat the test for each axis.

7.3 Fine Adjustment of overall turns ratio.

For imperial machine configurations the overall turns ratio is the number of motor revolutions required to move an axis 1"

For metric machine configurations the overall turns ratio is the number of mm's traveled during one revolution of the motor.

The method to fine tune the overall turns ratio is based on measuring an accurate gauge block of known dimensions. There are two typical measurement tools employed to do this measurement, a Dial Indicator and a Touch Probe. This document covers how to fine tune the overall turns ratio using a Dial Indicator.

1   Attach a dial test indicator (also known as a lever arm test indicator or a finger indicator) to the spindle.

Create a Test Fixture: Create a fixture that is "L" shaped using a standard to act as a reference for measurement. Precision ground 'standards' are available at the typical machine shop supply websites. The exact length of the "long" part of the "L" is the precision ground standard of known dimensions.. An example of a typical test fixture is shown below.

The long part of the "L" is a gauge block measuring 12.000"

Test Fixture

The gage block should be appropriately 6 inches to 12 inches in length. A longer standard will give you better accuracy. (alternatively several 1-2-3 blocks can be measured and used in place of the gauge block shown. It is important the exact dimensions are known of the gauge block being used.)

2. Secure the test fixture so that it runs parallel to the axis being tested.

3. Move the dial indicator into position: Start from away from the standard block and slow jog towards standard. (open end of the "L" see below). Set VCP jog buttons to incremental x100 when close and continue to move the spindle/indicator so that it touches the standard block. Now switch to x10 and increment a few more times into the standard to take up an spring or play in the system, stop and observe the dial position on the indicator, do not touch the indicator.

NOTE: Only jog towards the block. If you jog too close and have to back up slightly, backlash will be introduced into your measurement. In that case you will have to start the test again. Move away and the move back towards the gauge block so that you are only moving in one direction during the measurement process.

Dial Test Indicator

Spindle

Set point as X0, y0, Z0 in software

Direction of movement
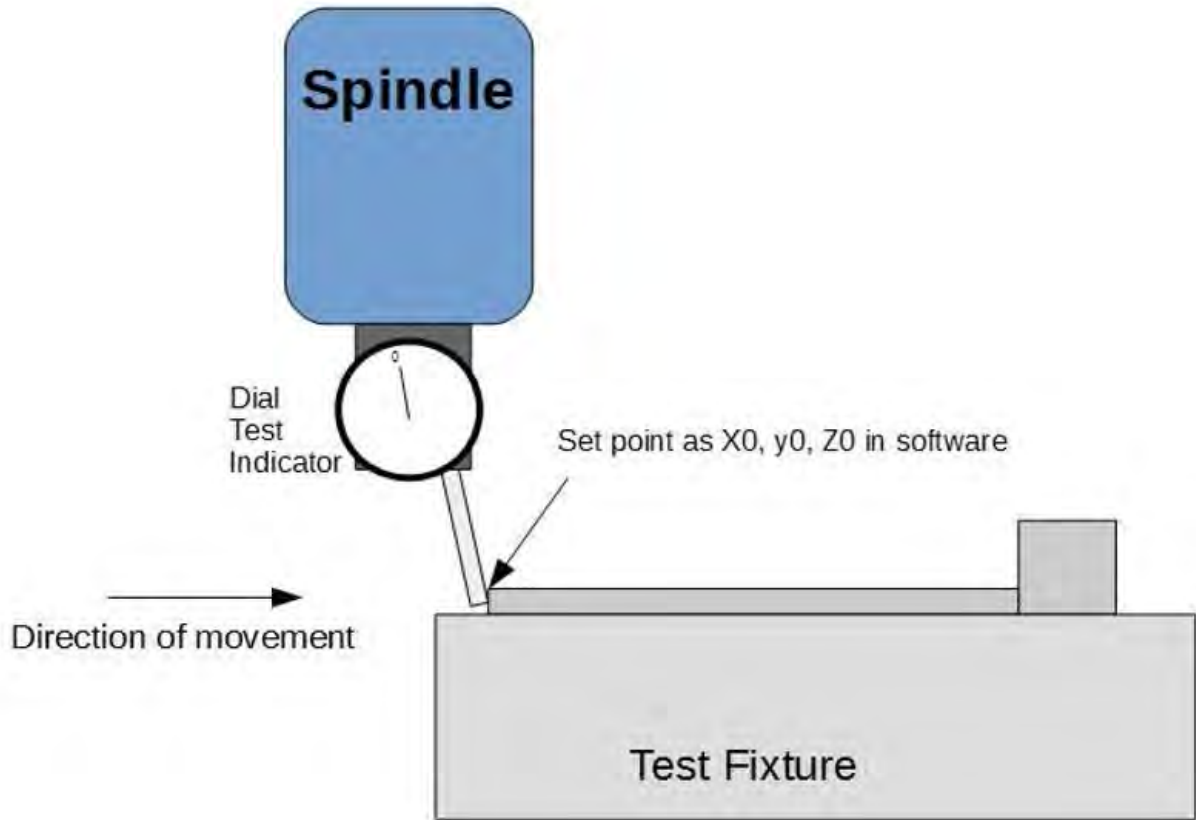
Test Fixture

4   Zero the DRO position in CNC12. From the main menu, press F1 – Setup → F1 Part → F10 Set Zero for the given axis you are working on:

5   Raise the spindle axis: Move the axis that the indicator is on so that it is away from the test fixture. If we are configuring the X or Y axis we need to the raise the Z-axis and jog the indicator towards the base of the "L" of the test fixture. Set jog panel mode to incremental when you get close, x100 then x10, then x1 until the indicator just touches the end block.

NOTE: Only jog towards the block. If you jog too close and have to back up slightly, backlash will be introduced into your measurement. In that case you will have to start the test again.

6   Observe the distance moved on the DRO. For our example the observed distance moved on the DRO is 12.005. What this means is we moved exactly 12 inches by using the standard and the indicator but the control thinks we moved more than that. These kind of results are typical and are due to ballscrew pitch not being perfect. High quality ball screw typically will not have this issue.

7   Calculate new Overall Turns ratio values:

Imperial Units: To calculate the new overall turns ratio for inch units, divide the distance moved (Digital Read Out value) by the distance that the axis actually moved (the dimension of the standard). Multiply this result by the current value in the Overall Turns Ratio field for the axis you are working on. This the new value to be entered in the Overall Turns Ratio field. In our example the standard is exactly 12" but the DRO shows a distance moved of 12.005. 12.005 / 12 = 1.000416   Now, if the current Overall Turns Ratio is 5.000 multiply by 1..000416 = 5.00208 this is the new value to enter in the Overall Turns Ratio field. Save it and run the measurement test again until the actual distance moved and the DRO match.

Metric Units To calculate the new overall turns ratio. Divide the distance that the axis actually moved (gage block length) by the distance observed on the DRO. Multiply this result by the current value in the Overall Turns Ratio field. In our example the axis traveled is 300 mm (gage block length) but, the DRO displays 304.927. Divide 300 by 304.927 = .98384, Multiply .98384 by the the current Overall Turns Ratio for example if the axis has a 20 mm pitch ballscrew belted 1:1 with the axis motor the "rough" overall turns ratio is 20.   20 x .98384 = 19.6768 is the new value to enter in the Overall Turns Ratio Field. Save it and run the measurement test again until the actual distance moved and the DRO match.

8   Repeat the test as needed until the DRO measures the same as the gauge block.

9   Repeat the test for each axis.

7.4 Machine Axis Backlash Compensation

 Axis machine backlash compensation is the LAST thing to setup once the machine is fully configured and operational.

1. Software backlash compensation is effective but limited in its scope. For backlash compensation to work well the free play aka 'lash' or 'backlash' of an axis should be mechanically minimize. Lash Comp will not compensate for large and inconsistent backlash in a mechanical system. That being said it works quite well when the mechanical system has a repeatable small lash amounts that can be accurately measured. Then and only then can CNC12 "compensate" for mechanical backlash by adding movement to that axis motor on turn arounds. Typical lash numbers for good milling machines are zero to .002", and for routers zero to .005"
   Lash comp cannot cure mechanical play so it is very important that every effort is made to remove mechanical backlash from all axes before setting this value. (Note: More advanced techniques of axis position compensation are available with CNC12 and can be employed with Ballscrew Mapping techniques using either a Laser or digital scale to generate commanded position vs actual position correction tables. Also if the system is very accurate with measured lash under .0002" (2 tenths) often it is best to leave the lash comp set at zero.)

1   Always manually measure and adjust Mechanical Lash Before configuring the "electronic" backlash compensation in the control, every effort should be made to reduce the mechanical lash in the machine to less than 0.002". (Use the test below to verify the backlash is less than 0.002).

2   Attach a plunge type dial indicator, roughly align it parallel to the axis being measured and perpendicular to the touch surface

3   In the Acorn Wizard axis configuration menu make sure to Zero any Previous Backlash Values: Do not attempt to measure the backlash with the CNC control while the CNC control is

compensating for backlash! Enter the Wizard. F7 Utility, F10 Wizard. Proceed to the Axis Configuration Screen. Zero out any backlash values that was previously entered into the Lash Comp fields save the zero settings with "write settings to cnc control" and confirm changes were made.

4   Move the dial indicator into position: Start from away from the touch point and SLOW jog towards it then once touching it, Set VCP jog mode to "incremental" (INC) and set to .010" (X10) then continue to jog incrementally in the same direction pressing the axis jog button until the dial indicator lands on a position that is easy to remember. Any position will work, just so its easy to remember. (doesn't have to be zero) DO NOT TOUCH THE DIAL INDICATOR. For this example the dial indicator needle has 'landed' very close to 21, remember this position.
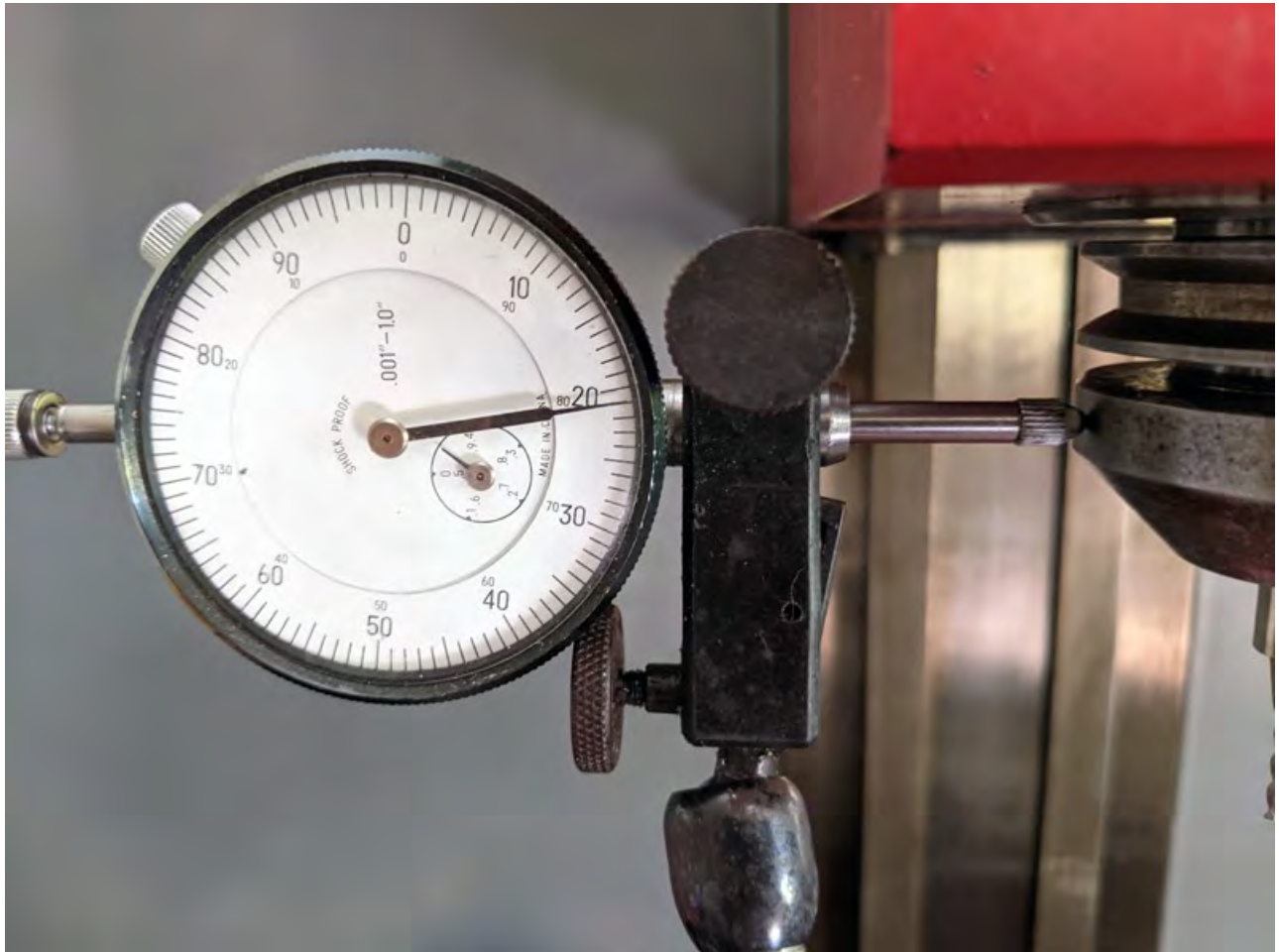
5   Now press the incremental jog button 10 times moving in the same direction and do not worry about the indicator value at this point it is irrelevant.

Now press the incremental jog button 10 times in the opposite direction.

The dial indicator will do one of two things, it will return to the observed and remembered starting location (in this case "21") or it will 'fall short' of the observed position of 21, the amount that it falls short is the mechanical backlash of the axis. In our example the indicator fell short of the starting position of 21 and landed on 22. this means that this axis has .001" of back lash.
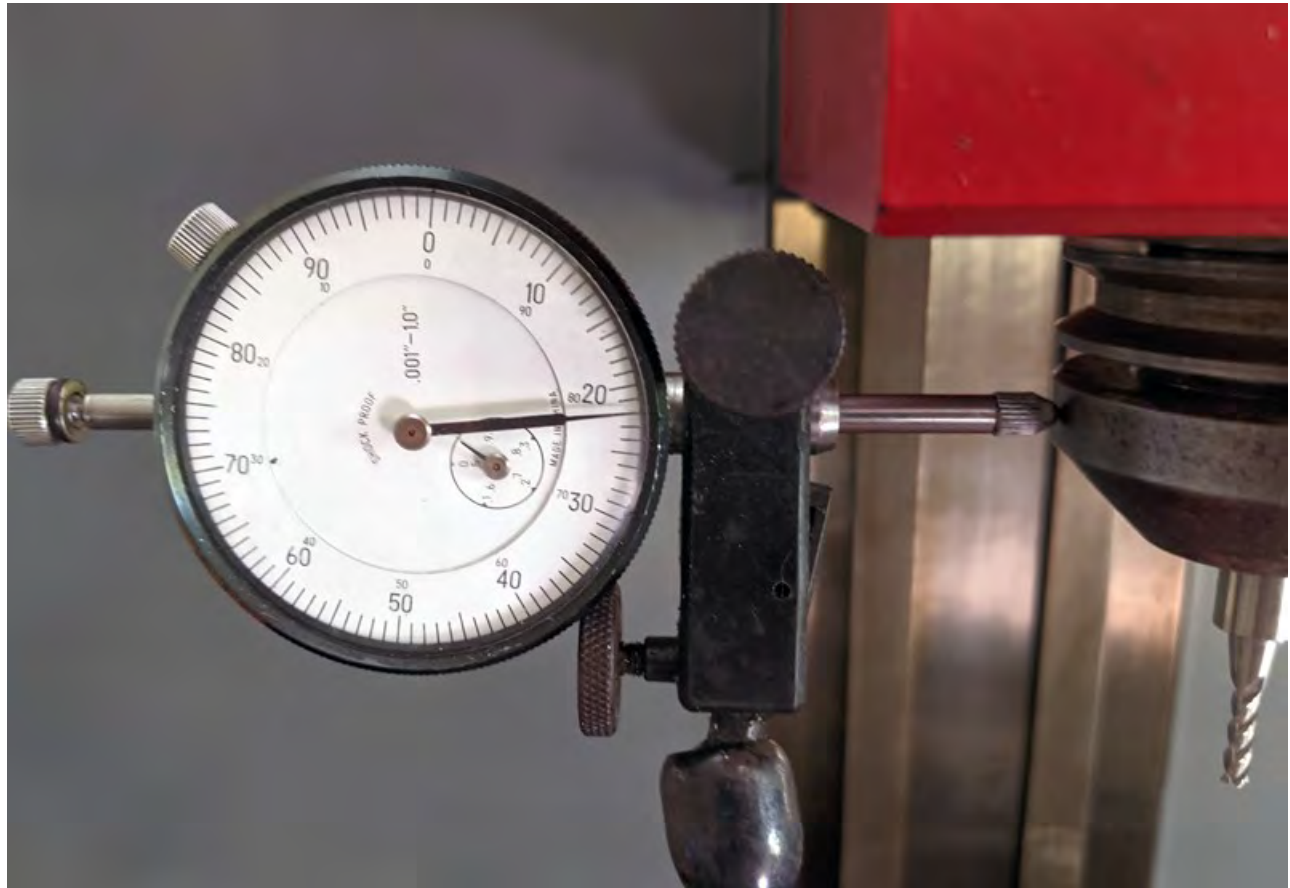
6   Enter the measured backlash value in the Acorn Wizard for the axis being measured and re run this test. If the backlash compensation value is accurate the dial indicator will return to the remembered position.

Follow backlash Technical Bulletin #37:
https://www.centroidcnc.com/dealersupport/tech_bulletins/uploads/37.pdf

more info on how to accurately measure backlash is here.
https://centroidcncforum.com/viewtopic.php?p=46199#p46199

7.5 Software Travel Limits

Relevant Video: Setting Software Travel Limits https://youtu.be/X7i4bKGLwVQ

NOTICE: Without software travel limits the machine can go maximum speed until a limit switch is tripped as shown below. Sometimes there is not enough time to decelerate the axis after the limit switch is tripped causing the machine to crash into the hard stop. This collision may cause serious damage to both the mechanical and electrical system.
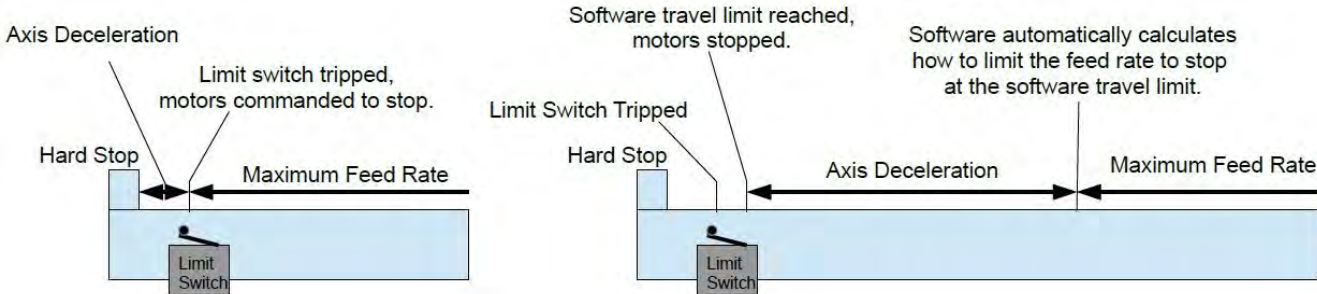
Machine without software travel limits.   Machine with software travel limits

Setting up software travel limits will let CNC12 know the machine work envelope and automatically decelerate the axis right before it reaches the limit switch preventing possible damage to the machine as shown above. Additionally, CNC12 will stop the machine if a G code has commanded the machine to move past the software travel limit and produce an error message letting the operator know that the travel of the machine has been exceeded.

Prerequisites: Before starting, the steps per rev and overall turns ratio is required to be configured correctly and the maximum feed rate and acceleration should be correctly set up. Restart the machine and home it before continuing with this procedure.

1   Set the DRO to display the Machine Coordinate System. Press the "alt" key and "D" key simultaneously until "machine" is displayed in the top left corner of the DRO as shown below: When at the "home" position the Machine Coordinates will read zero.

Machine Coordinates DRO

2   From the home position Jog an axis to the opposite end of travel. Stop just short of the hard stop at the end of travel an amount that is 'safe' this is machine dependent typical values are .1" to .37" . Now note the distance displayed on the DRO for the axis being set. This DRO position

will be the software travel limit for that axis. (Note: Some values may be a negative number, (it all depends on where you decided to set the home position) record the negative number) Repeat and write down the values for each individual axis.

3   From the CNC12 main screen, enter the Wizard by pressing F7 Utility, F10 Wizard. Enter the Homing and Travel Screen:
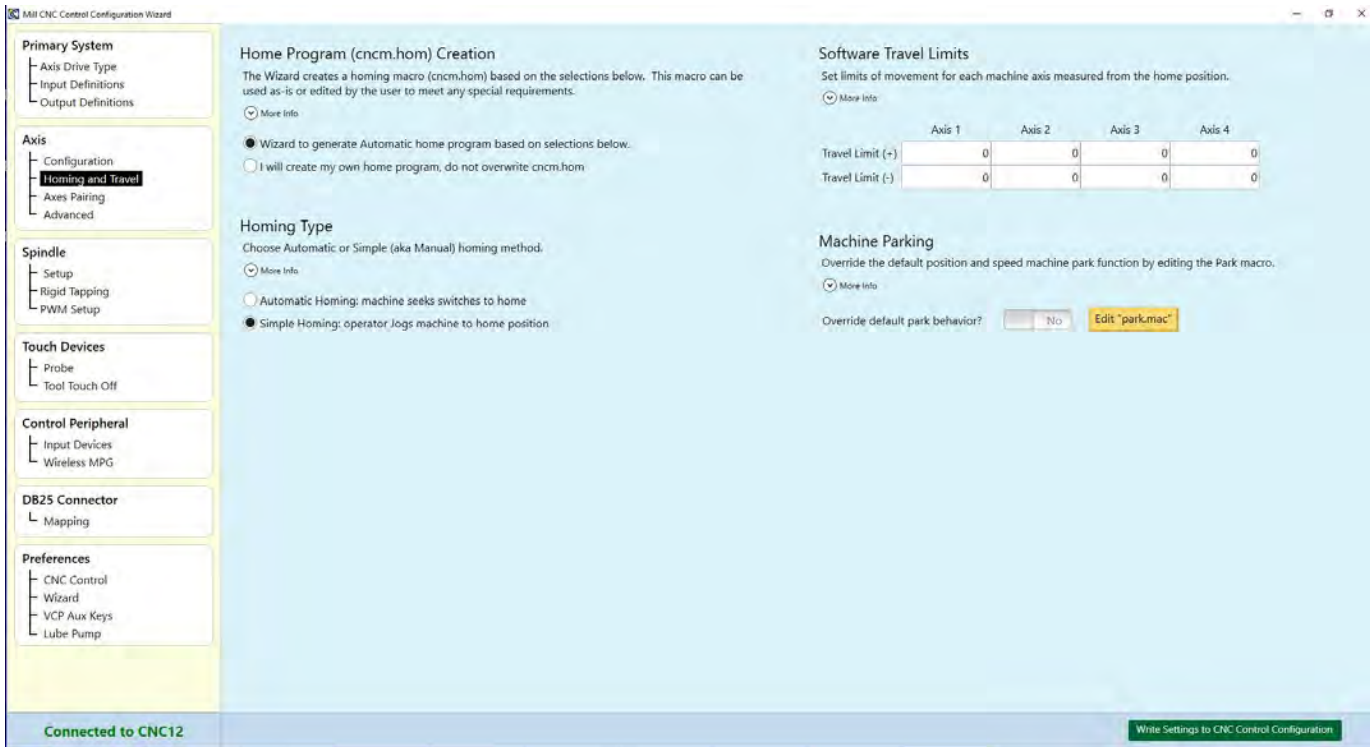
Wizard Homing and Travel dialog

Enter the position for the software travel limit into the appropriate "Travel (-)" or "Travel (+)" box.

NOTE: When both the Travel(-) limit and the Travel(+) limit are set to zero, software travel limits are disabled for that axis. As soon as either one of the two values (plus or minus) change to a non-zero value, that axis movement will be limited on both ends using the values you entered based in the machine coordinate system. (distance from the Home position)

4   Repeat for each axis.

5   Test by manually jogging each axis toward the limit/home switch in CONTinuous Slow mode via the VCP. Watch that the axis automatically stops at the software travel limit position set before the limit/home switch is tripped. As another confirmation test use the F3 – MDI menu and issue G-code that asks the CNC12 to move just beyond the software travel limit, if travel limits are set up correctly the CNC12 will not move the axis and the status window will produce an error such as "907 # axis travel exceeded, 325 Limit: job canceled"

Appendix A   Windows 10 Configuration

Windows 10 configuration for use with Centroid CNC software and hardware.
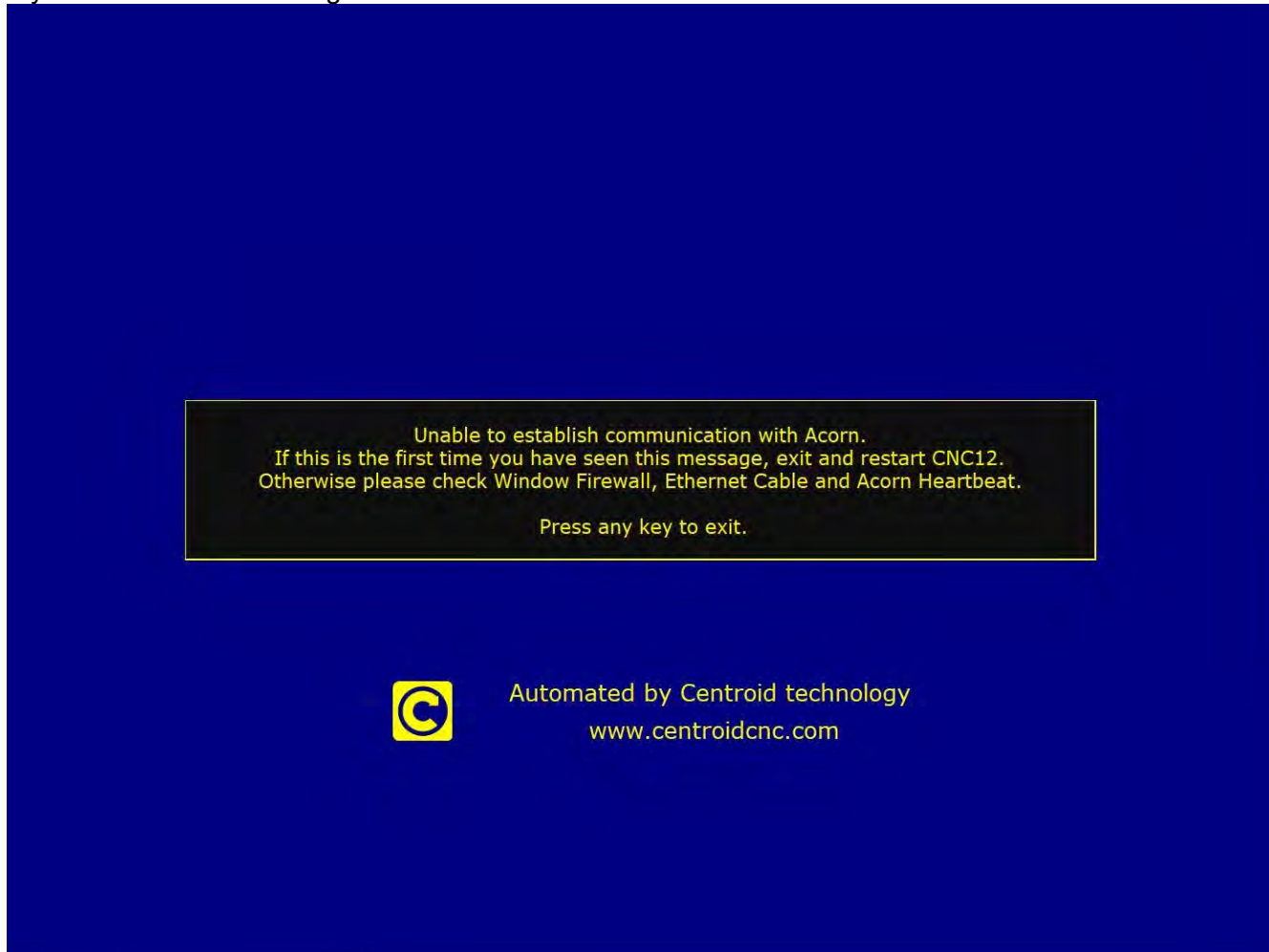
This procedure is outlined here on this
page.https://www.centroidcnc.com/centroid_diy/acorn_quick_start_guide.html

and in TB#309 https://www.centroidcnc.com/dealersupport/tech_bulletins/uploads/309.pdf

Appendix B   Troubleshooting

CNC12 Acorn Communication Time Out

If you received the message in the screen below:

Unable to establish communication with Acorn.
If this is the first time you have seen this message, exit and restart CNC12.
Otherwise please check Window Firewall, Ethernet Cable and Acorn Heartbeat.

Press any key to exit.

Automated by Centroid technology
www.centroidcnc.com

1   Manually check the Ipv4 Settings for the Ethernet adapter being used with Acorn.

Ethernet adapter used with Acorn should have IPv4 manually configured:
- Ip Address 10.168.41.1
- Subnet mask 255.255.255.0

Visit the Community CNC Support Forum: Quick Tip: Checking Network IP Address Settings (solving communication errors) https://centroidcncforum.com/viewtopic.php?f=61&t=1451

2   Ensure that Windows defender firewall is turned off OR CNCM.EXE or CNCT.EXE are allowed through the Windows Defender Firewall. (Choose to allow them in both Public and Private Networks when prompted when CNC12 starts for the first time)

3   In the Windows Search Box, type Windows Defender Firewall

4   On the left side of the screen, select "Turn Windows Defender Firewall On or Off"

5   Click "Turn Windows Defender Firewall off" for both Public and Private networks
6   Windows defender is now off.
7   Now check the CNCPC for Antivirus or Antispyware software. These software programs will block CNC12. Sometimes these programs will allow CNC12 to run however, the program will slow communication between CNC12 and the Acorn causing inconsistent performance. These types of program must be uninstalled and not simply disabled.
8   Reboot the CNCPC and power the Acorn down and back up for good measure and then try and restart CNC12. If it starts, allow it to do any firmware updates and then continue with the installation
9   If CNC12 again does not start:
    9.a Make sure the CNCPC's Ethernet port drivers are the latest.
    9.b Try another shielded cable

PLC Diagnostic Screen

From the main program window press alt+i, to bring up the real time I/O (input output) display.

- Using the four arrow keys on the keyboard, you can move your cursor from row to row and within the row to select the item you want to use.
- The rows are:
    - Inputs
    - Outputs
    - Memory
    - Stages
- Most users will be primarily interested in Inputs and Outputs
- When an item is highlighted with the cursor the definition of the item is shown below the last row of LED indicators.
- Active items are Green, inactive are Red
- To exit the PLC Diagnostic Screen use alt+i

For details on the PLC diagnostic screen see:
https://www.centroidcnc.com/centroid_diy/downloads/acorn_documentation/cnc12_PLC_diagnostic_screen.pdf

Appendix C   Free CNC Tech Support Forum and Knowledge Base

Review the information in the Acorn knowledge base: https://centroidcncforum.com/viewforum.php?f=63

Review the Acorn Knowledge base Video Library: https://centroidcncforum.com/viewforum.php?f=61

Please Read this post before posting questions on the forum (Fresh Reports are always required. F7 Utility, F7 Create Report): https://centroidcncforum.com/viewtopic.php?f=60&t=1043
When you post to the forum, then your question will be seen by many, possibly get more than one solution, and be there to be found by others and potentially help many more. Go here

All Acorn Documentation link
https://centroidcncforum.com/viewtopic.php?f=60&t=3397

Alternatively, Factory Direct Technical Support is available. Purchase here.
https://shopcentroidcnc.com/centroid-factory-direct-11-technical-support/

Centroid Community CNC Support Forum: Quick Tip: Setting up TeamViewer for remote technical support
https://centroidcncforum.com/viewtopic.php?f=61&t=1448

Centroid Community CNC Support Forum: Quick Tip: Creating and Restoring from a Report file
https://centroidcncforum.com/viewtopic.php?f=61&t=3216

About Touch Screens

A touch screen is not required to run Centroid CNC software (a mouse works just fine) but, a touch screen does work with Centroid CNC software.   If you want to use a touch screen the best ones to use in a CNC environment are resistive touch screens.

Resistive Touch Screens are preferred for CNC control console use since they don't false trigger like capacitive touch screens with dust and dirt on them.

Resistive Touch Screens are harder to find as the home/office market for touch screens has gone to multipoint capacitive technology which is less than ideal for a dusty dirty machine shop.

You have to look hard to find a good resistive touch screen, we recently bought this one 1920x1080 unit which is available in 21 and 24" sizes and it works well so i wanted to share this link. We do not make any money off of this link. Just posting as a courtesy to Centroid CNC control users who might be looking for a good touch screen to use on their CNC project.

Good resistive touch screen unit for CNC use.

https://centroidcncforum.com/viewtopic.php?p=70990#p70990

Centroid CNC Tool Height Offset Methods: There are three main ways to setup and define tool lengths.

Method 1.) Measure Tool Lengths from the Z machine Home position.
Method 2.) Use a reference tool to measure tool lengths relative to the reference tool length.
Method 3.) Always re-measure every tool before use (don't use a reference tool or reference position, don't use tool offsets at all)

Which Method you choose hinges on:

- If the machine has a reliable Z home position or not
- If you want to retain tool heights from day to day, maintain a tool library with many tool holders setup with commonly used tools or do you have one tool holder and you are constantly changing out bits and there for changing the lengths of those tool each time you take then in and out of the spindle/tool holder (think collet type spindles on inexpensive routers)

Once you have decide which Method you want to use. Then you can use a wide variety of work flows used to actually measure the tool lengths to suit your application or personal preference.
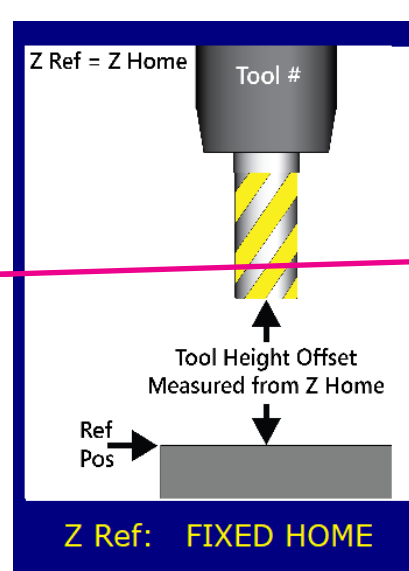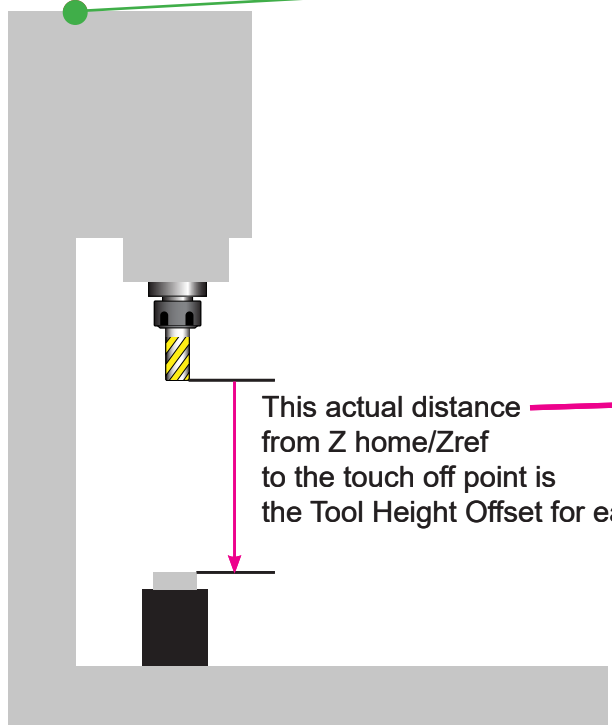
If the machine does have a reliable repeatable Z home position then I suggest Method 1. Method 2 will work on a machine tool that has a reliable machine home position as well. So, in the case of a machine with a reliable Z home position it is user preference which method to use.

If the machine DOES NOT have a reliable Z home position then Method 2 or 3 will be employed.

Machine has reliable Z home position. Method 1:

Z home = Z reference = Machine Coordinate Z0.0000

Z reference is the point in which the tool lenght is measured from.

Method 1 example above in inches, note the tool height offsets are all negative values. These values are simply the distance the machine had to move in Z from Z home to the tool touch off for each tool. Set CNC12 parameter #4 = 6 to let CNC12 that you want to use this method and CNC12 will automatically set the Z referecnce position to equal Z home after the daily machine homing has been completed. Tool heights will automatically be retained day to day and only one tool is required to set a part Z zero position and all the tools setup in the tool library will automatically be set that same Z part zero. (no need to remeasure any tools unless they break or are changed, even then only that tool needs to be reset)

Machine does not have a reliable Z home position. Method 2: Use a refernce tool to set a reference position to measure tools against the lenght of the reference tool itself.
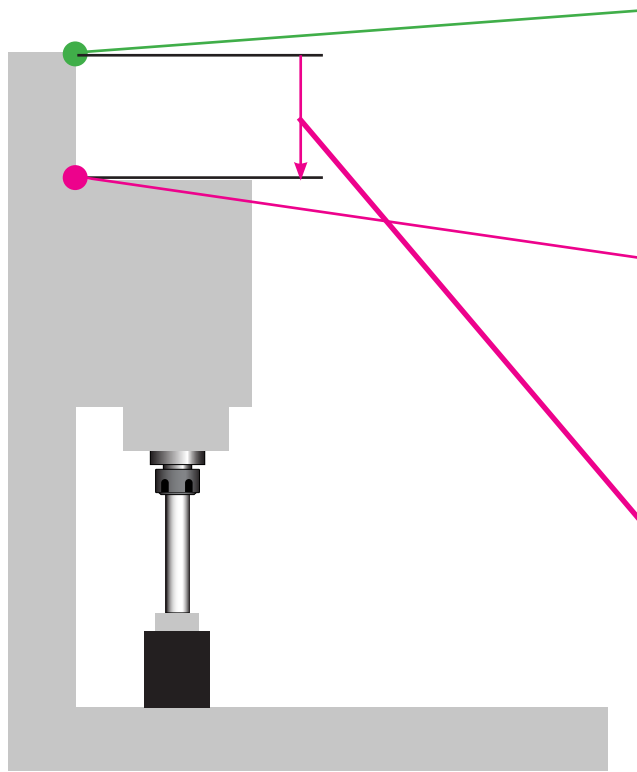
Z home = Machine Coordinate Z0.0000

Z reference = point in which tool heights will be measured from

Z reference is set each day by the user before measuing any tools

Set up a reference position with a referecne tool.
1.) Home the machine
2.) Touch refercne tool manually or automatically to the tool touch off point press F1 Z ref and follow the intstructions.

Tool #		Ref Tool	H001
			H002
			H003
			H004
			H005
			H006
			H007
Height			H008
Offset			H009
Ref			H010
Pos			H011
			H012

Z Ref: -6.0000

X Esc	Z Ref F1	Manual Measure F2	Auto Measure F3
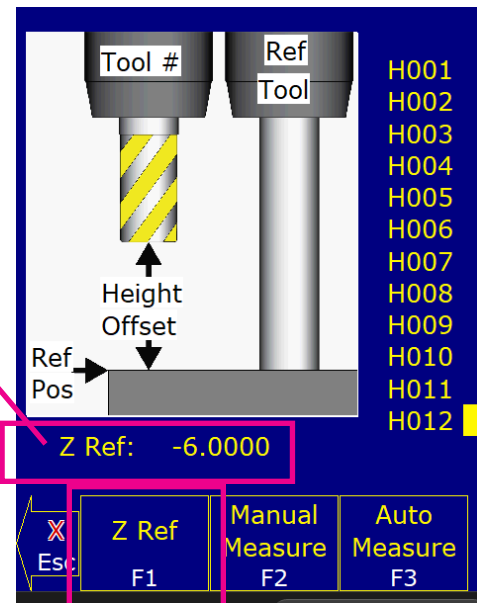
The Z reference point value is the distance CNC12 moved the Z axis from the Z Machine Home (machine coordinate z 0.000) to touch the reference tool to the tool touch off point.

If the machine does not have a reliable Z home position this Z reference point value will often CHANGE each time you set the Z reference position with the referecne tool   But that is ok, since Method 2 uses a measured DIFFERENCE in lenght of the actual tools to a standard (the referecne tool) the position of the Z reference point itself is of little consequence as it is just a temporary point in which to COMPARE tool lenghts of actual tools to the reference tool itself.

The reference tool can be an actual tool number if you like. In our example Tool #12 is the reference tool. If you measure the Reference tool against itself the Height Offset value for the reference tool is 0.0000 since it is not longer or shorting than itself.

Z reference = point in which tool heights will be measured from

Difference in lenght between the reference tool and the tools is the tool height offset value

Tool #   Ref
          Tool

Height
Offset

Ref
Pos

Z Ref: -6.0000

Tool Geometr
Height Offset
H001	-3.6464
H002	-0.5636
H003	1.4523
H004	3.8516
H005	4.5175
H006	-1.5040
H007	3.4341
H008	1.1349
H009	0.2686
H010	-1.4139
H011	0.0000
H012	0.0000

Method 2 example above in inches, note the tool height offsets can have positive or negative values. These values are simply the distance the machine had to move from Z reference to touch the tools to the same tool touch off point that the referece tool has used to set the reference position. These values are simply the difference in Lenght between the referecne tool and the actaul tool itself. Positive numbers means the tool is longer than the reference tool. Negative numbers means the tool is shorter than the referecne tool.

In this example these are the same tools used in the Method 1 example. Note the height offset values are different eventhough they are the same tools. The reference tool in this example is 6" long. Set CNC12 parameter #4 = 0 to let CNC12 that you want to use the reference tool Method 2.

Ref Tool   Tool #1

Difference in lenght between the reference tool and tool #1

Tool #   Ref
          Tool

Height
Offset

Ref
Pos

Z Ref: -6.0000

Tool Geometr
Height Offset
H001	-3.6464
H002	-0.5636
H003	1.4523
H004	3.8516
H005	4.5175
H006	-1.5040
H007	3.4341
H008	1.1349
H009	0.2686
H010	-1.4139
H011	0.0000
H012	0.0000

Once you have determined which main method to employ each method support a wide variety of work flows to accommodate specific machine applications and personal preferences. For example, below is list of common tool height setup work flows, note this is a incomplete list and Centroid CNC12 is not limited to any of these work flows

1.) Method 1: Measure from Z home
       a.) with a fixed position TT, with a movable TT
       b.) with a 123 block manual touch
       c.) with an ATC auto touch with TT fixed or movable, or with a 123 block and manual touch
       d.) with a laser fork TT, with or without and ATC

2.) Use a reference tool to measure from
       a.) with a reference tool
       b.) with a probe as a reference tool
       c.) with a fixed position tt, with a movable TT
       d.) with an ATC auto touch with TT fixed or movable, or with a 123 block and manual touch
       e.) with a laser fork TT, with or without and ATC

3.) Always reset part Z zero with each tool that is about to be used before use (don't use a reference tool or reference position, don't use tool offsets at all)
       a.) do this manually
       b.) do this automatically with a custom M6 with a TT (fixed or floating) so for each tool change CNC12 will proper the operator to use a TT or 123 block or paper to touch off the tool within any G code job.

What ever main method you choose the variation are the exact same process just using different devices.

Pitfalls.
- Don't mix up setting part zeros with setting tool heights
- Don't mix up using a reference tool with measuring tool height from z home (don't try and use both methods at the same time)

Appendix D: ACORN CNC controller _rev4 Specifications Manual

For Revision 190201
Updated 9/16/19

Overview

ACORN is technically a breakout board for the BeagleBone Green or BeagleBone Black embedded computer. The remainder of this document will refer to the breakout board with BeagleBone installed as ACORN. It is a low cost motion control processor, PLC, and drive interface board. It is intended to operate entry level machining equipment with up to four axes.

Features

Function:	Motion Control Processor, PLC, and Drive Interface
Maximum number of Axes:	4
Maximum pulse rate:	400kHz
Control Interface:	100 Mb/s Ethernet to PC
Drive Application:	Drives with step and direction inputs
Digital PLC Inputs:	8
Digital PLC Outputs:	8
Analog Output resolution:	12 bits
Dimensions (W*D*H):	5.4 * 4.2 * 0.7 inches
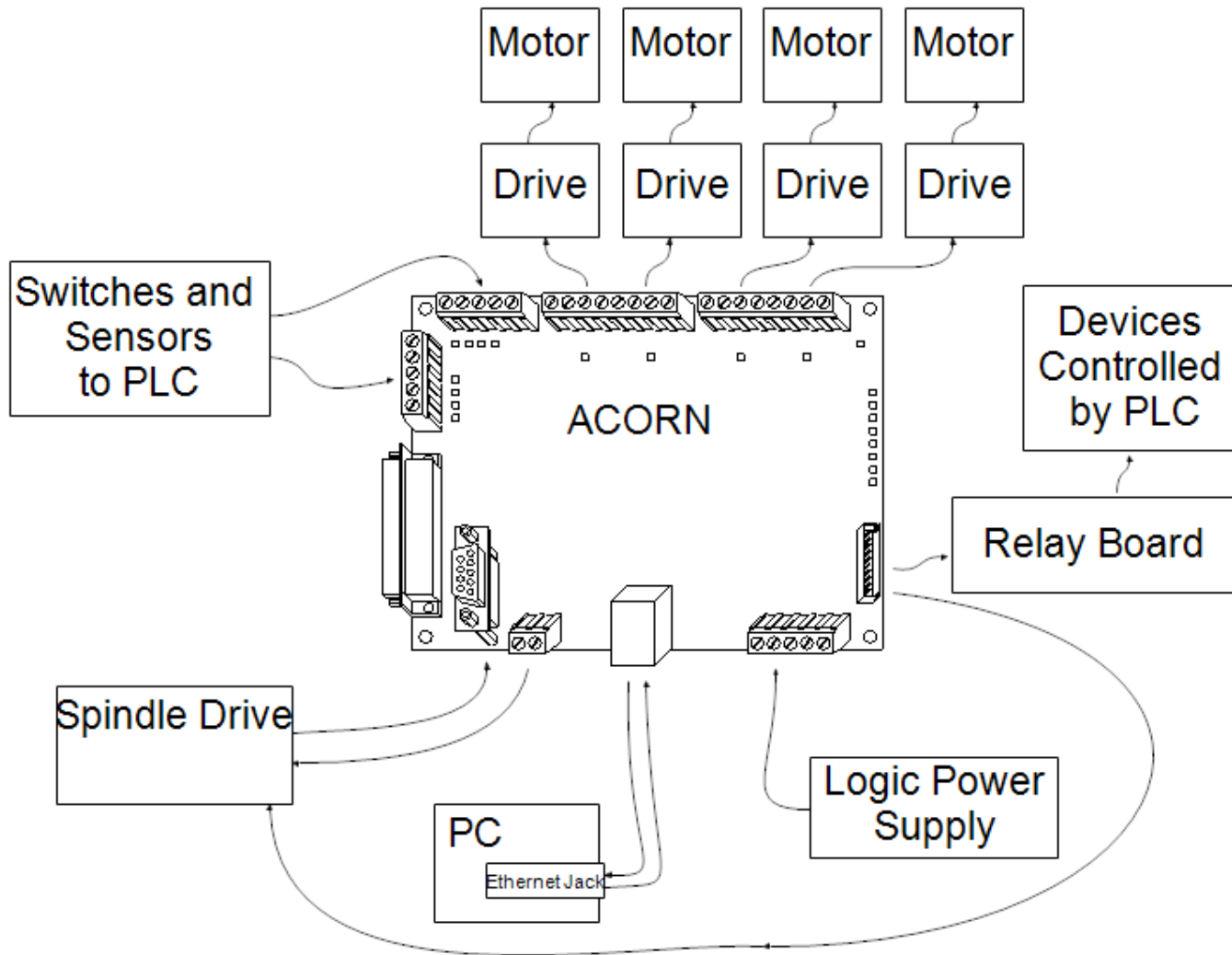
Connections

Two connection methods are available. A female DB25 connector is available that can mate with many stepper control units with a straight through cable. The inputs and outputs are 5V compatible. Check the DB25 pinout and circuit descriptions to determine if it is compatible with a particular control unit. The DB25 provides the simplest and quickest connection method if it is compatible.

Screw terminals are available for custom configurations. This allows for additional I/O and the most connection versatility. All input and output signals on the DB25 connector are available on the screw terminals except with 24V levels.

Inputs may only be used on the DB25 or screw terminal, not both. For example, only screw terminal input 1 or DB25 input 1 may be connected at the same time. However, screw terminal input 1 may be used at the same time as DB25 input 2.

DB25 (H6) Signals

Pin	Signal		Pin	Signal
1	Output 1		14	Output 2
2	Step 1		15	Input 5
3	Direction 1		16	Output 3
4	Step 2		17	Output 4
5	Direction 2		18	
6	Step 3		19	
7	Direction 3		20	
8	Step 4		21	
9	Direction 4		22	
10	Input 1		23	
11	Input 2		24	
12	Input 3		25	
13	Input 4			

24V COM

Chassis GND
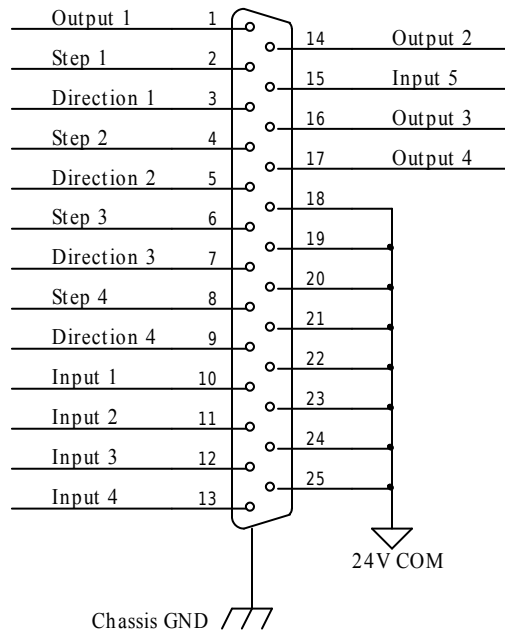
Drive Interface Section

Four sets of step, direction, and enable outputs are provided to control motor drives. The outputs are open collector type and can provide up to 400kHz step frequency.

ACORN Drive Outputs

Motor Drive Connection Example

External Power Supply

+24 VDC

24 COM

Stepper Drive

Enable
Direction
Step

4 COM
3 EN
2 DR
1 ST

+24 VDC

H2 or H3
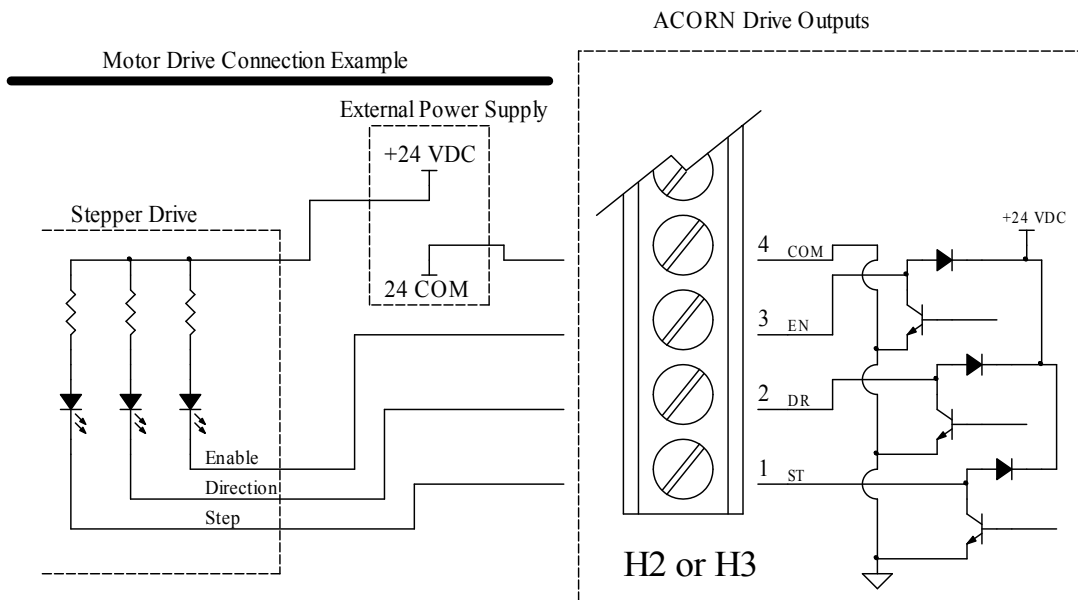
PLC Section

The ACORN has 8 digital inputs, 8 digital outputs, and one analog output. Check the "ACORN I/O Map" and "ACORN Specifications" sections to determine I/O type and capability.

Outputs

5V logic level relay outputs are available on the DB25 connector. 8 open collector outputs are normally wired with a ribbon cable to an external 8 relay board.

Internal Circuitry
DB25 Connector Outputs

+5 VDC

OUTPUT

Internal Circuitry
Screw Terminal Outputs

+24 VDC

Output

Common

Inputs

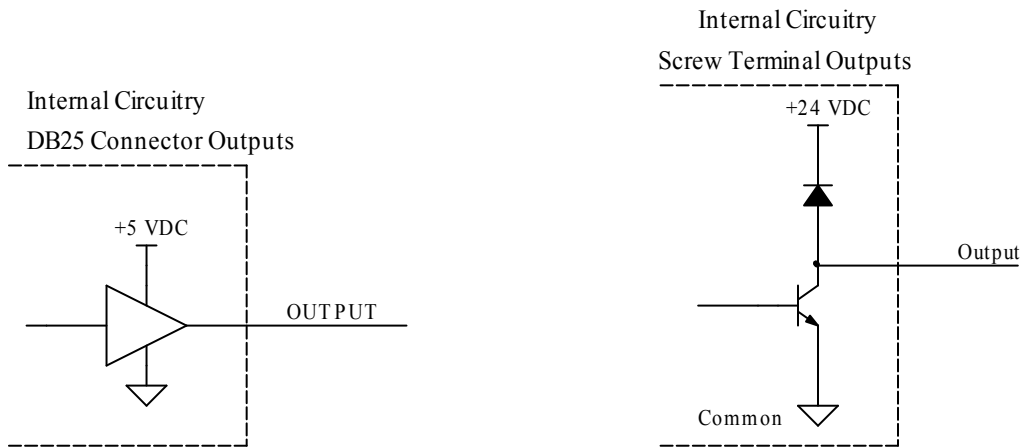ACORN uses optically isolated inputs for screw terminal inputs. These inputs can be used with 24 VDC sensors or switches. The 24 VDC for inputs may be supplied from the ACORN logic supply. For improved isolation and noise immunity, a separate 24 VDC may be used to power the inputs. Compare the specifications of sensors to the "ACORN Specifications" chart to ensure reliable operation.

DB25 inputs are only compatible with 5V logic levels. These inputs are not isolated.

Internal Circuitry
DB25 Connector Inputs

+5 VDC

INPUT

Internal Circuitry
Screw Terminal Inputs

+24 VDC

1.2k

220
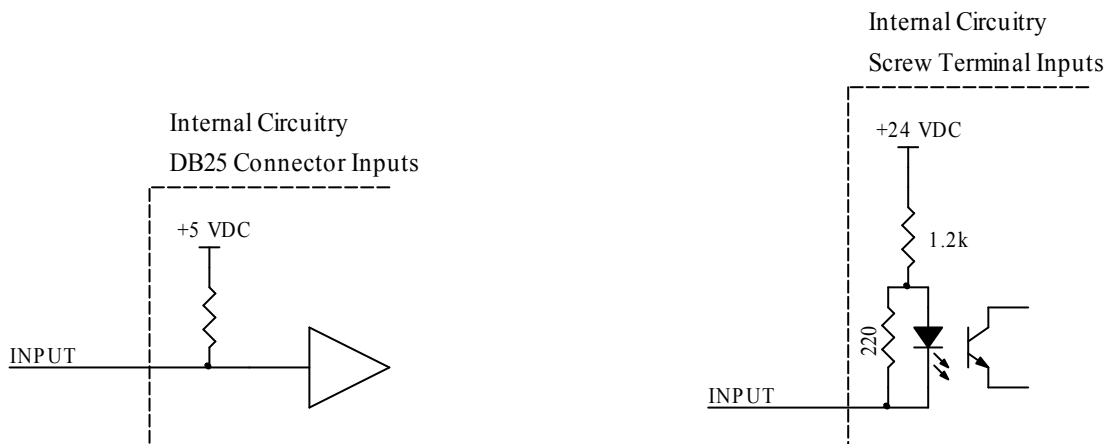
INPUT

Input Connection Examples

Switch Wiring Example

ACORN Inputs

External Power Supply

+24 VDC

24 COM

1
2
3
4
5

H1 or H4

Sinking (NPN) Sensor Wiring Example

ACORN Inputs

External Power Supply

+24 VDC

24 COM

+24 VDC

Sensor

24 COM

1
2
3
4
5

H1 or H4

Notice: Do not use 2 wire sensors. The voltage drop across 2 wire sensors usually causes unreliable operation. If a 2 wire sensor works when connected, it still may be unreliable for long term use.

Analog Output

An analog output is provided for controlling spindle speed. The output voltage range is 0 to 10 VDC.

Internal Circuitry
Analog Output

+24 VDC ANALOG

Analog Output

Analog Common

24 COM

Analog Output Calculations

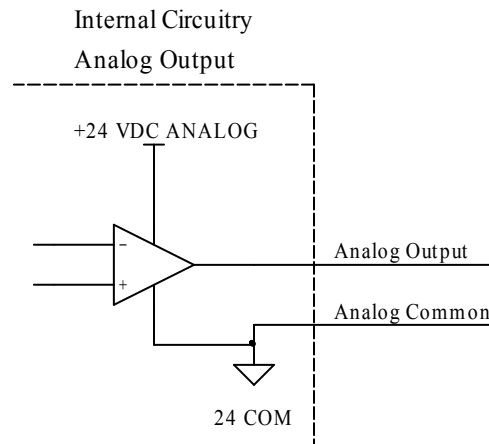The analog output uses a 12 bit digital to analog converter (DAC) to generate analog from the DAC request sent from the PLC program. The 12 bit value allows a DAC request of 0 to 4095, which corresponds to 0 to 9.998 volts in the 0 to 10V range.

$$\text{output voltage} = \frac{\text{DAC Request}}{4096} * 10$$

Analog Output Wiring

The analog output should be wired using a shielded twisted pair for best results. The analog output terminal is paired with a common terminal for direct wiring of the signal, common, and shield. In most cases, it is best to connect the shield to the common only at the ACORN. Routing analog cables away from power wires and other noise sources is also critical for good performance. See "ACORN Connections" section for terminal locations.
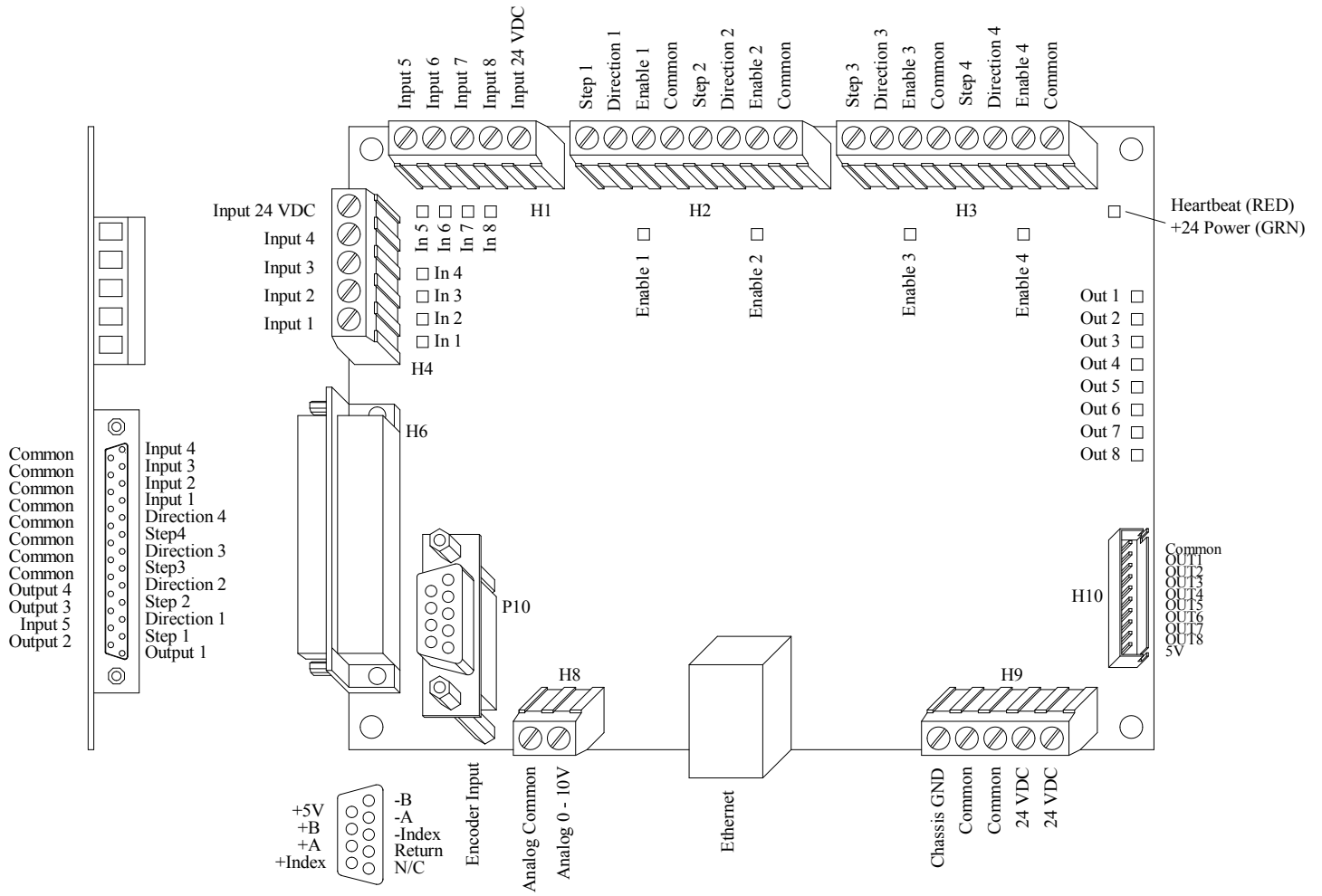
ACORN I/O Map

Input Specification		Input Location 1			Input Location 2		
Number	Function	Type	Connector	Pin	Type	Connector	Pin
1	General Purpose	Sourcing	H4	5	Logic w/ 5V Pullup	H6	10
2	General Purpose	Sourcing	H4	4	Logic w/ 5V Pullup	H6	11
3	General Purpose	Sourcing	H4	3	Logic w/ 5V Pullup	H6	12
4	General Purpose	Sourcing	H4	2	Logic w/ 5V Pullup	H6	13
5	General Purpose	Sourcing	H1	5	Logic w/ 5V Pullup	H6	15
6	General Purpose	Sourcing	H1	4	-	-	-
7	General Purpose	Sourcing	H1	3	-	-	-
8	General Purpose	Sourcing	H1	2	-	-	-

Output Specification		Output Location 1			Output Location 2		
Number	Function	Type	Connector	Pin	Type	Connector	Pin
1	General Purpose	Open Collector	H10	2	5V Logic	H6	1
2	General Purpose	Open Collector	H10	3	5V Logic	H6	14
3	General Purpose	Open Collector	H10	4	5V Logic	H6	16
4	General Purpose	Open Collector	H10	5	5V Logic	H6	17
5	General Purpose	Open Collector	H10	6	-	-	-
6	General Purpose	Open Collector	H10	7	-	-	-
7	General Purpose	Open Collector	H10	8	-	-	-
8	General Purpose	Open Collector	H10	9	-	-	-
17-28	Analog out	12 bit DAC	H8	1	-	-	-

ACORN Specifications

Characteristic	Min.	Typ.	Max.	Unit
24 Volt Supply Current (Vsupply)	0.5	-	-	A
24V Input Pullup Voltage (Vinp)	22	-	26	VDC
24V Input Off Voltage	19.1	-	26	VDC
24V Input On Voltage	0	-	5.9	VDC
24V Input Operating current	9	11	15	mA
Open Collector Output Current	0	10	50	mA
Open Collector Output Voltage	0	24	Vsupply	VDC
DB25 Input Pullup Voltage (internal) (VCC)	3.8	4.4	5.5	VDC
DB25 Input On Voltage	VCC x 0.7	-	-	VDC
DB25 Input Off Voltage	-	-	VCC x 0.3	VDC
DB25 Output High Voltage	3.66	4.4	VCC	VDC
DB25 Output Low Voltage	0	0.1	0.44	VDC
DB25 Low Level Output Current	0	3	20	mA
DB25 High Level Output Current	0	3	20	mA
Analog Output Current	0	1	10	mA
Analog Output Voltage	0	-	10	V
Analog Output Resolution	-	12	-	bits
Relay Output Current (relay board)	0.01	-	10	A @ 125VAC
Relay Output Current (relay board)	0.01	-	10	A @ 28VDC
5 Volt Supply Current (relay board)	0.3	-	-	A
Size: 5.4 * 4.2 * 0.7 (W*D*H)				Inches

ACORN Connections

ACORN Mounting Footprint

8 Relay Board Mounting Footprint

0.150"
(3.8mm)

Out 1 NC
Common
Out 1 NO

Out 2 NC
Common
Out 2 NO

Out 3 NC
Common
Out 3 NO

Out 4 NC
Common
Out 4 NO

GND
Output 1
Output 2
Output 3
Output 4
Output 5
Output 6
Output 7
Output 8
5V IN

Out 5 NC
Common
Out 5 NO

Out 6 NC
Common
Out 6 NO

Out 7 NC
Common
Out 7 NO

Out 8 NC
Common
Out 8 NO

5.669"
(144mm)

5.354"
(136mm)

1.890"
(48mm)

2.205"
(56mm)
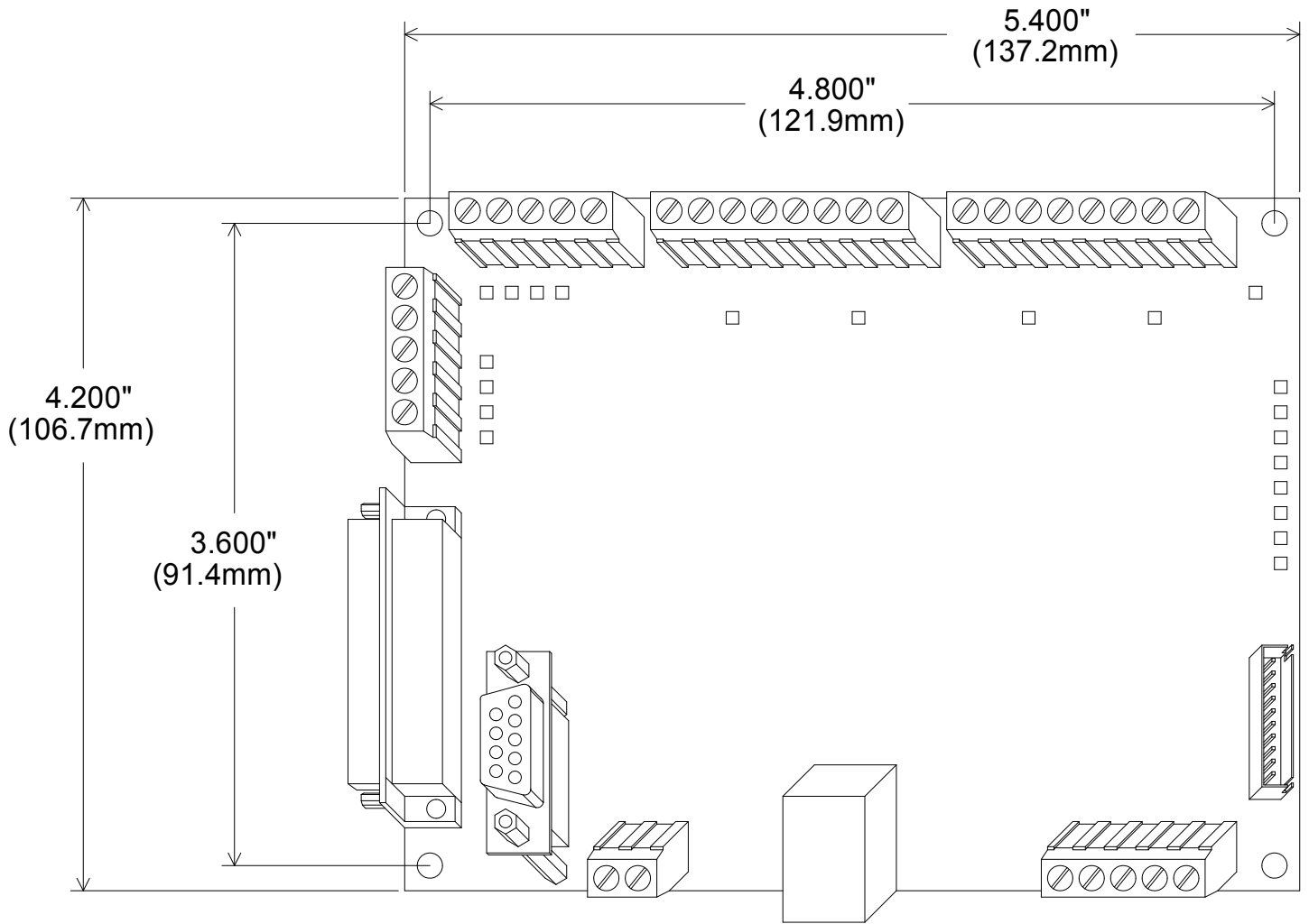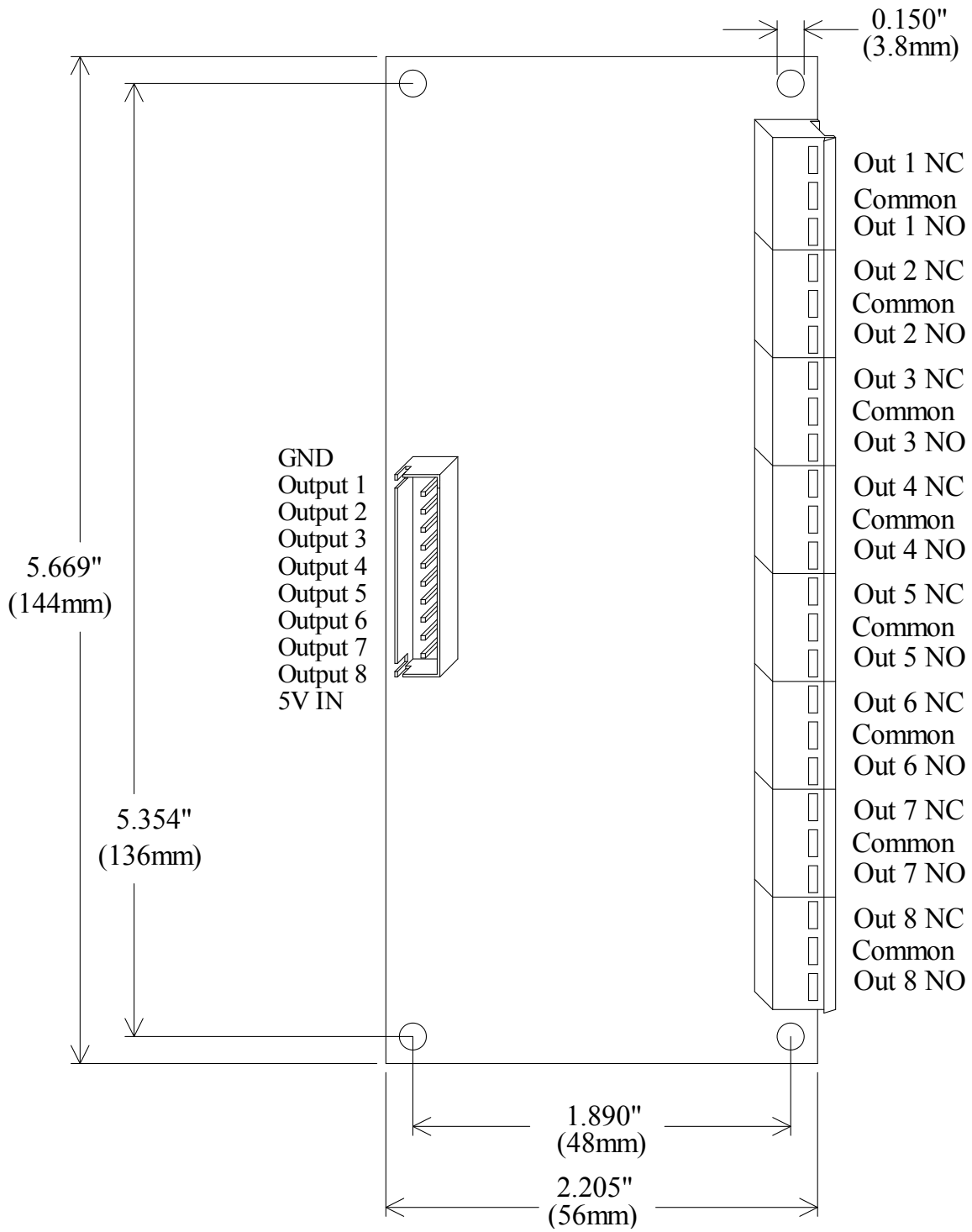
SONGLE RELAY

	RELAY ISO9002	**SRD**

1. MAIN FEATURES

• Switching capacity available by 10A in spite of
  small size design for highdensity P.C. board
  mounting technique.

• UL,CUL,TUV recognized.

• Selection of plastic material for high temperature and
  better chemical solution performance.

• Sealed types available.

• Simple relay magnetic circuit to meet low cost of
  mass production.

2. APPLICATIONS

• Domestic appliance, office machine, audio, equipment, automobile, etc.

  (Remote control TV receiver, monitor display, audio equipment high rushing current use application.)

3. ORDERING INFORMATION

SRD	XX VDC	S	L	C
Model of relay	Nominal coil voltage	Structure	Coil sensitivity	Contact form
SRD	03、05、06、09、12、24、48VDC	S:Sealed type	L:0.36W	A:1 form A
				B:1 form B
		F:Flux free type	D:0.45W	C:1 form C

4. RATING

    CCC   FILE NUMBER:CH0052885-2000   7A/240VDC
    CCC   FILE NUMBER:CH0036746-99   10A/250VDC
    UL /CUL   FILE NUMBER: E167996   10A/125VAC 28VDC
    TUV   FILE NUMBER: R9933789   10A/240VAC 28VDC

5. DIMENSION(unit:mm)   DRILLING(unit:mm)   WIRING DIAGRAM
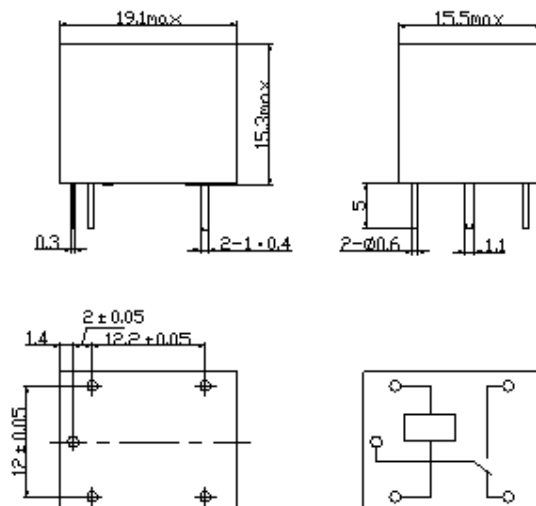
6. COIL DATA CHART (AT20°C)

Coil Sensitivity	Coil Voltage Code	Nominal Voltage (VDC)	Nominal Current (mA)	Coil Resistance (Ω) ±10%	Power Consumption (W)	Pull-In Voltage (VDC)	Drop-Out Voltage (VDC)	Max-Allowable Voltage (VDC)
SRD (High Sensitivity)	03	03	120	25	abt. 0.36W	75%Max.	10% Min.	120%
	05	05	71.4	70				
	06	06	60	100				
	09	09	40	225				
	12	12	30	400				
	24	24	15	1600				
	48	48	7.5	6400				
SRD (Standard)	03	03	150	20	abt. 0.45W	75% Max.	10% Min.	110%
	05	05	89.3	55				
	06	06	75	80				
	09	09	50	180				
	12	12	37.5	320				
	24	24	18.7	1280				
	48	48	10	4500	abt. 0.51W			

7. CONTACT RATING

| Item \ Type	SRD FORM C	SRD FORM A
Contact Capacity Resistive Load (cosΦ=1)	7A 28VDC 10A 125VAC 7A 240VAC	10A 28VDC 10A 240VAC
Inductive Load (cosΦ=0.4 L/R=7msec)	3A 120VAC 3A 28VDC	5A 120VAC 5A 28VDC
Max. Allowable Voltage	250VAC/110VDC	250VAC/110VDC
Max. Allowable Power Force	800VAC/240W	1200VA/300W
Contact Material	AgCdO	AgCdO

8. PERFORMANCE (at initial value)

| Item \ Type	SRD
Contact Resistance	100mΩ Max.
Operation Time	10msec Max.
Release Time	5msec Max.

Dielectric Strength
  Between coil & contact
  Between contacts
	1500VAC 50/60HZ (1 minute)
	1000VAC 50/60HZ (1 minute)

Insulation Resistance	100 MΩ Min. (500VDC)
Max. ON/OFF Switching Mechanically Electrically	300 operation/min 30 operation/min
Ambient Temperature	-25°C to +70°C
Operating Humidity	45 to 85% RH
Vibration Endurance Error Operation	10 to 55Hz Double Amplitude 1.5mm 10 to 55Hz Double Amplitude 1.5mm
Shock Endurance Error Operation	100G Min. 10G Min.
Life Expectancy Mechanically Electrically	10^7 operations. Min. (no load) 10^5 operations. Min. (at rated coil voltage)
Weight	abt. 10grs.

9. REFERENCE DATA

Coil Temperature Rise
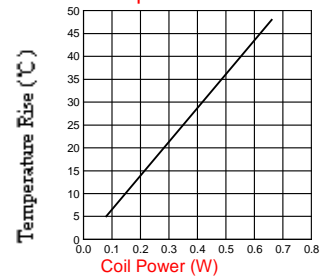
Operation Time
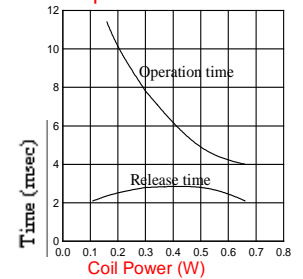
Life Expectancy
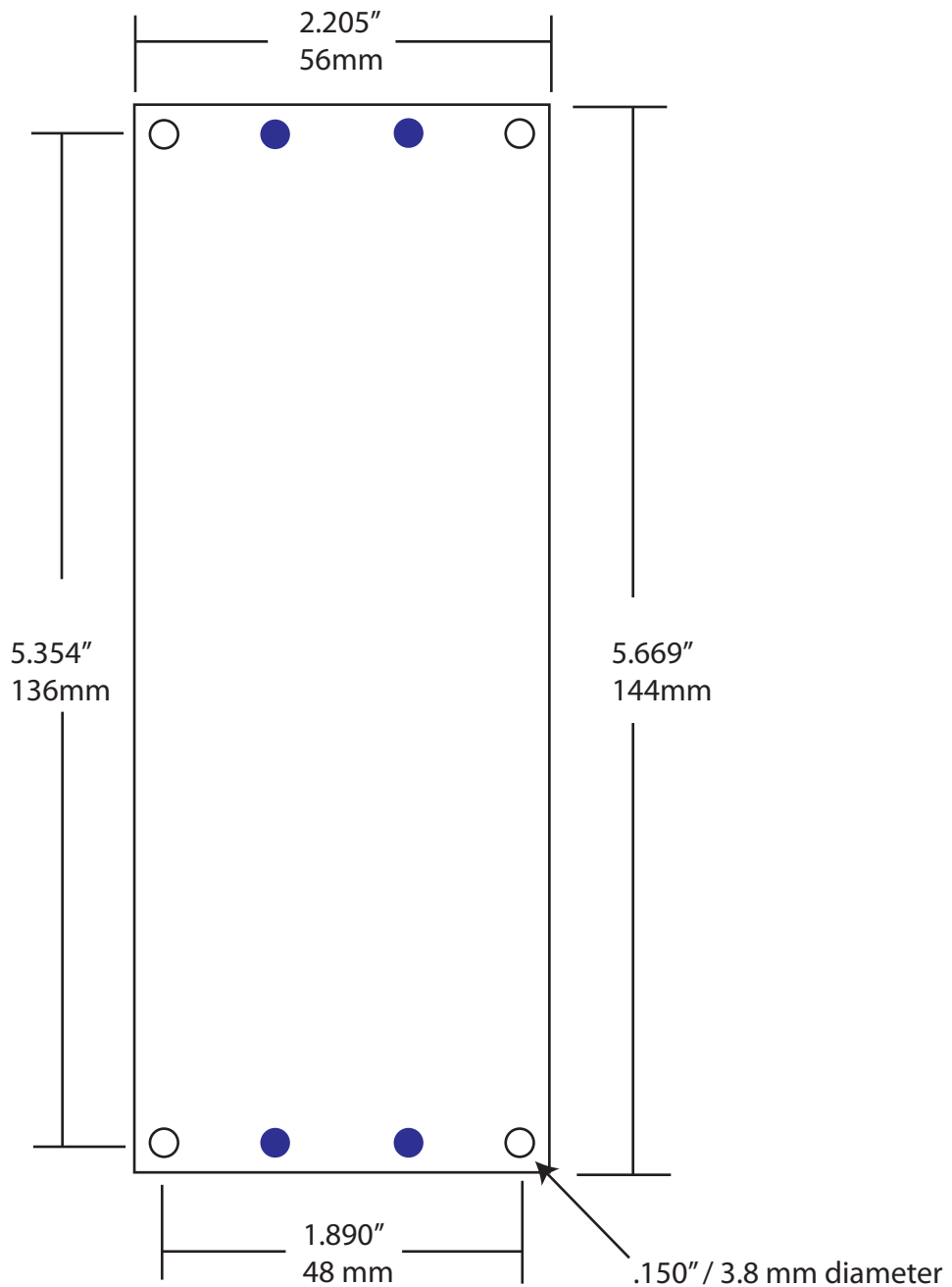AC120V/DC24V cosΦ=1
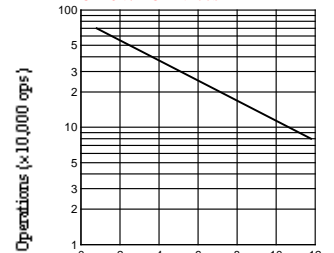
Life Expectancy
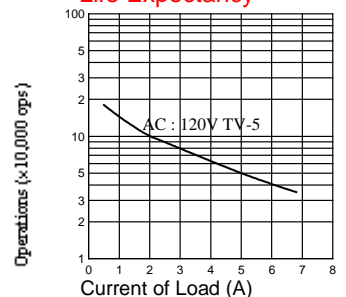
Acorn CNC control board Mounting Footprint.
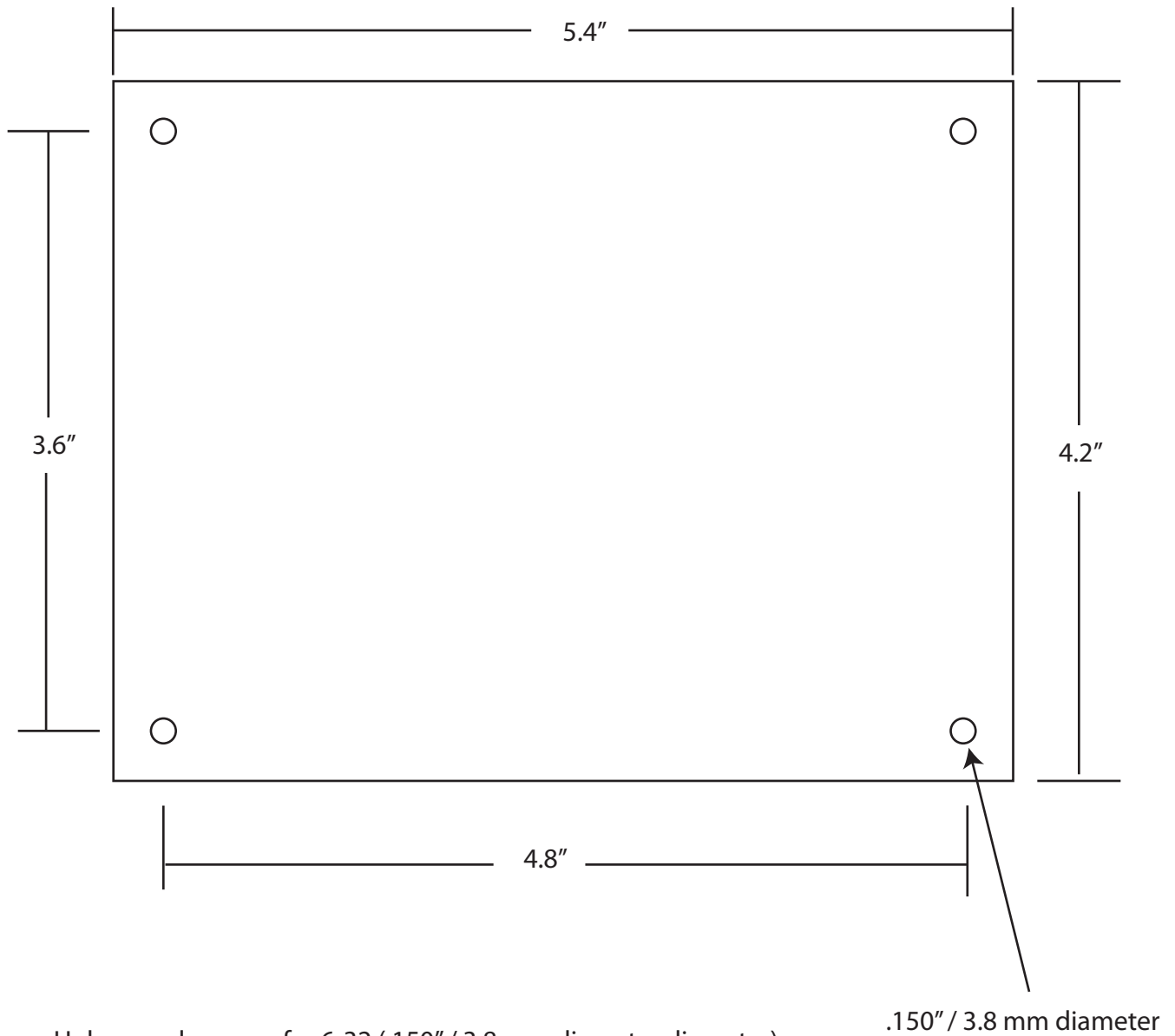
- Holes are clearence for 6-32 (.150″ / 3.8 mm diameter diameter)
- 6-32 metal standoffs are recommended

Acorn CNC 8 Relay Module Mounting Footprint.

2.205"
56mm

5.354"
136mm

5.669"
144mm

1.890"
48 mm

.150" / 3.8 mm diameter

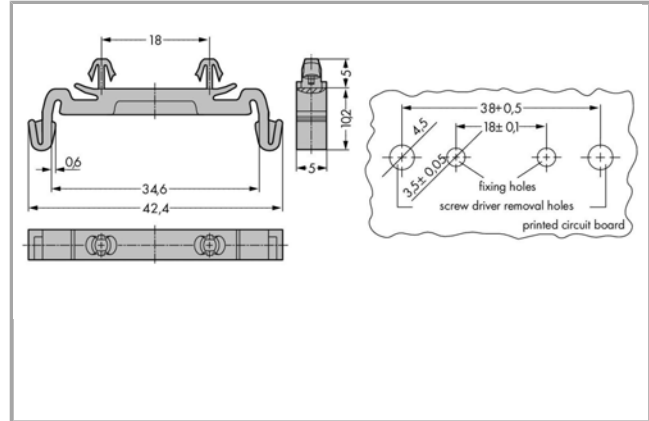- Holes are clearence for 6-32 (.150" / 3.8 mm diameter)
- 6-32 metal standoffs are recommended

The 8 Realy Module Din Rail Mounting holes accept Din Rail standard clips such as the Wago 209188 clip and alternatives. https://www.wago.com/us/rail-chassis-terminal-blocks/mounting-foot/p/209-188

Data
Geometrical Data

Width	5 mm / 0.197 inch
Height from upper-edge of DIN-35 rail	5.1 mm / 0.201 inch
Depth	42.4 mm / 1.669 inch

Material Data

Weight	0.96 g

Commercial data

Product Group	2 (Terminal Block Accessories)
Country of origin	DE
GTIN	4017332200998

Downloads
CAD/CAE-Data

CAD data

3D Download 209-188	URL	Download

EPLAN

EPLAN Data Portal 209-188	Download