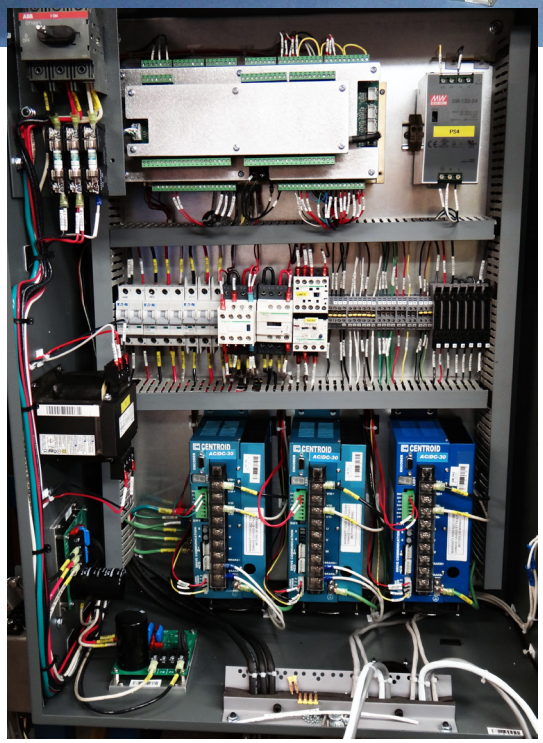
CENTROID™

MPU11-AC/DC-GPIO4D

Centroid MPU11, AC/DC, GPIO4D Install Manual

AC/DC servo drive based CNC control system step by step installation instructions



DRIVE WARRANTY DOES **NOT** COVER DAMAGE BY FAULTY MOTORS OR WIRING.

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.

As CNC control products from CENTROID can be installed on a wide variety of machine tools NOT sold or support by CENTROID, **you MUST consult and follow all safety instructions provided by your machine tool manufacture regarding the safe operation of your machine and unique application.**

Servo Motor Handling

When working with servo motors**:**

· **NEVER pick up or carry the motor by the cables or the shaft. (Always carry by the frame.) Use a crane or lift to move the motor when necessary.**

· **NEVER drop or subject the motor to impact. The servo motor is a precision device.**

· **NEVER set heavy or sharp objects on the motor or cables. Do not step or sit on the motor or cables.**

· **NEVER use a metal hammer on any part of the motor. If it is absolutely necessary to use a hammer, use a plastic hammer.**

Keep the motor properly secured and away from the edge of the work area when servicing the motor, as a dropped motor could cause personal injury or destroy the motor.

Basic Safety Procedures and Best Practices

For Motors

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 unless instructed to.

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

Be sure to attach a key to a motor with a keyed shaft.

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° to 40° C.

Do not remove the nameplate from a motor.

For Circuit Boards

Minimize handling circuit boards as much as possible. If you must hold a circuit board, grab it by the edges as shown below in figure 2. Avoid touching any of the circuits, components, or component leads. Improper handling lead to ESD (electrostatic discharge) which can damage the PCB, and shorten the operational lifespan.

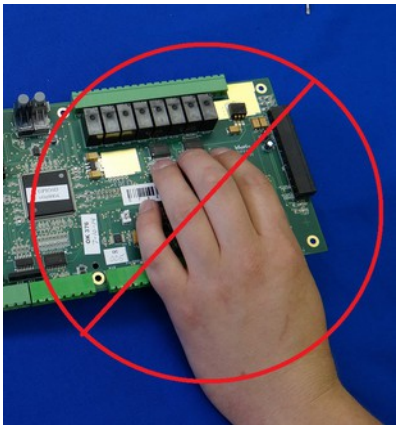


Figure 1.
Improper PCB Handling

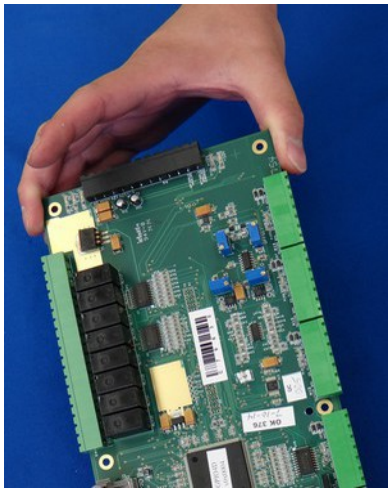


Figure 2.
Proper PCB Handling

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

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Introduction

This manual describes how to install the Centroid CNC (Computer Numerical Control) system with an AC/DC servo drive. The PC based system provides up to eight axes of closed loop servo interpolated motion, controlled by industry standard G-Codes.

Ours can be used for the CNC control of milling machines, routers, lathes, flame cutters, plasma cutters, laser cutters, water jet cutters, drill presses, grinders, and other specialized applications.

This installation manual covers the most common AC/DC hardware setups. Specifically, this manual will focus on the following equipment:

- Centroid AC/DC drive,
- Centroid GPIO4D PLC (programmable logic controller)
- Centroid MPU11 (motion processing unit)
- Installation of Centroid Software on a Computer

This manual does not cover an AC/DC drive used with a Centroid RTK4 PLC or Centroid PLCADD1616 PLC, but users of those products will benefit from the information in this manual.

Before You Begin

Before getting started, please take the time to familiarize yourself with the schematics, manuals, and installation instructions.

While doing the installation, it is ***very*** important that you follow the instructions in order and that you follow them exactly. Doing the installation incrementally and testing as you go will allow you to immediately isolate the cause of any problems that you may run into. Additional troubleshooting is included in the appendices.

If you are retrofitting Fanuc motors, it is important that perform the steps listed in the “Fanuc Retrofit Manual” before starting this manual.

Motor Compatibility

The AC/DC supports over 60 different motors. Including over 50 different Fanuc motors, 6 SEM motors, and 4 Mecapian motors. The easiest way to install an AC/DC is with motors provided by Centroid. Users should only use motors on the list of motors found in Appendix E.

What if your motor is not on the list? Most motors with a continuous stall current of above 5 amps or below 30 amps can be adapted to work with the AC/DC. *(This gives the AC/DC an approximate range of 500 watts to 6,000 watts or 0.7 hp to 7.8 hp.)* For an evaluation fee, most unsupported motors can be sent into Centroid to have the parameters needed for CNC11 software calculated. After a motor model has been evaluated once, those software parameters work on all motors of that model number. Call sales for more information.

In the future, Centroid plans on bringing an advanced set of features to the Centroid CNC11 software allowing users to calculate their own software parameters without the need to have Centroid evaluate their motors.

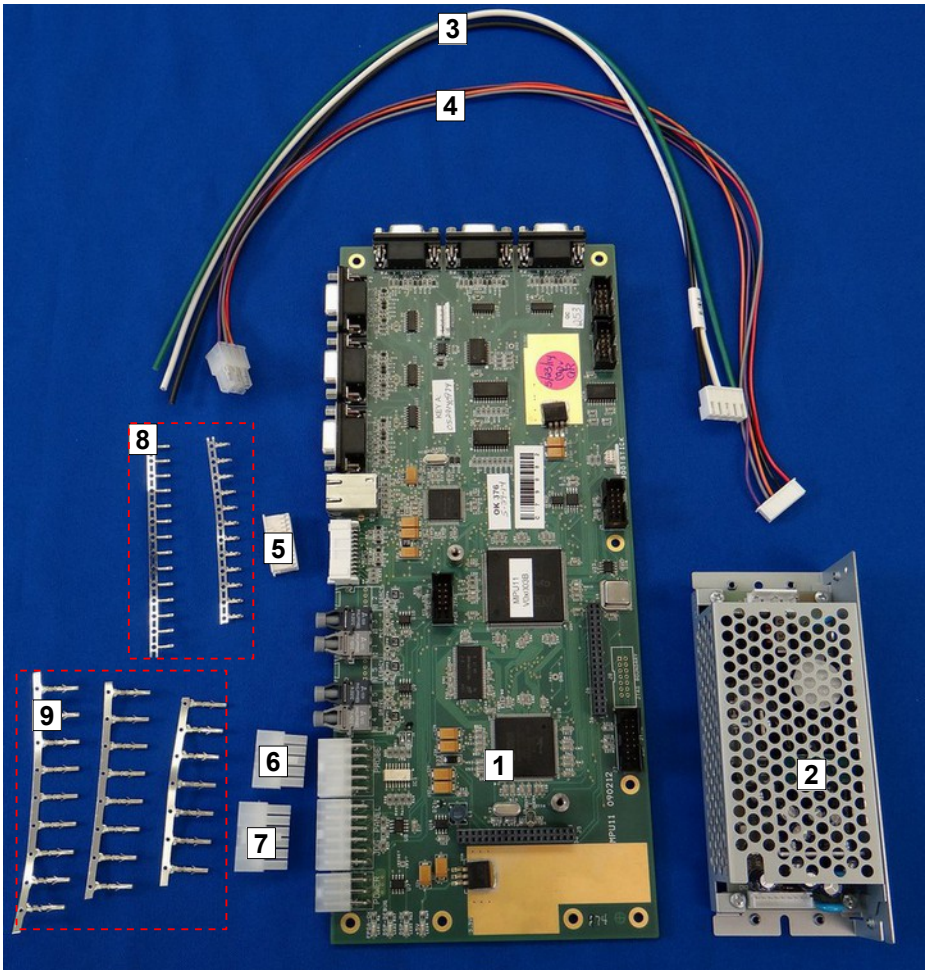
The First Steps

If you are retrofitting Fanuc motors, follow the Fanuc Retrofits Manual **BEFORE** starting on this manual. The next step is to visually inspect everything that came with your kit. Use the charts on the following pages to check for any missing parts and to familiarize yourself with the hardware.

Chapter 1
What's Included

1.1 MPU11

The MPU11 stands for “motion processing unit (version) 11”. The MPU11 is a motion control card that will act as the “brain” for your CNC system. The MPU11 provides the link connecting your computer to all of your drives, PLC, and accessories.



The following components are included with your MPU11:

1. MPU11 ..... Part Number 11012
2. Power supply..... Part Number 1331
3. Power supply AC input cable..... Part Number 3952
4. Power supply DC output cable ..... Part Number 3951
5. Twenty four pin MPG connector..... Part Number 5984
6. Ten Pin Probe connector..... Part Number 5918
7. Twelve Pin Jog panel Connector..... Part Number 5919
8. Twenty six crimp pins for MPG connector ..... Part Number 5983
9. Twenty four crimp pins for jog panel connector and probe connector ..... Part Number 5511

1.2 Crimpers

Crimp Pin Part Number 5511 (Used for making jog panel and probe cables)
The appropriate hand crimping tools are available from TE Connectivity as "*PRO-CRIMPER III Hand Tool Assembly 91387-1 with Die Assembly 91387-2 (26-22 AWG)*" or "*PRO-CRIMPER III Hand Tool Assembly 91388-1 with Die Assembly 91388-2 (22-18 AWG)*". These tools are sold separately and can be purchased from most major electronics components distributors such as Digi-Key.

Fully assembled cables for jog panels and probes can be bought through Centroid.

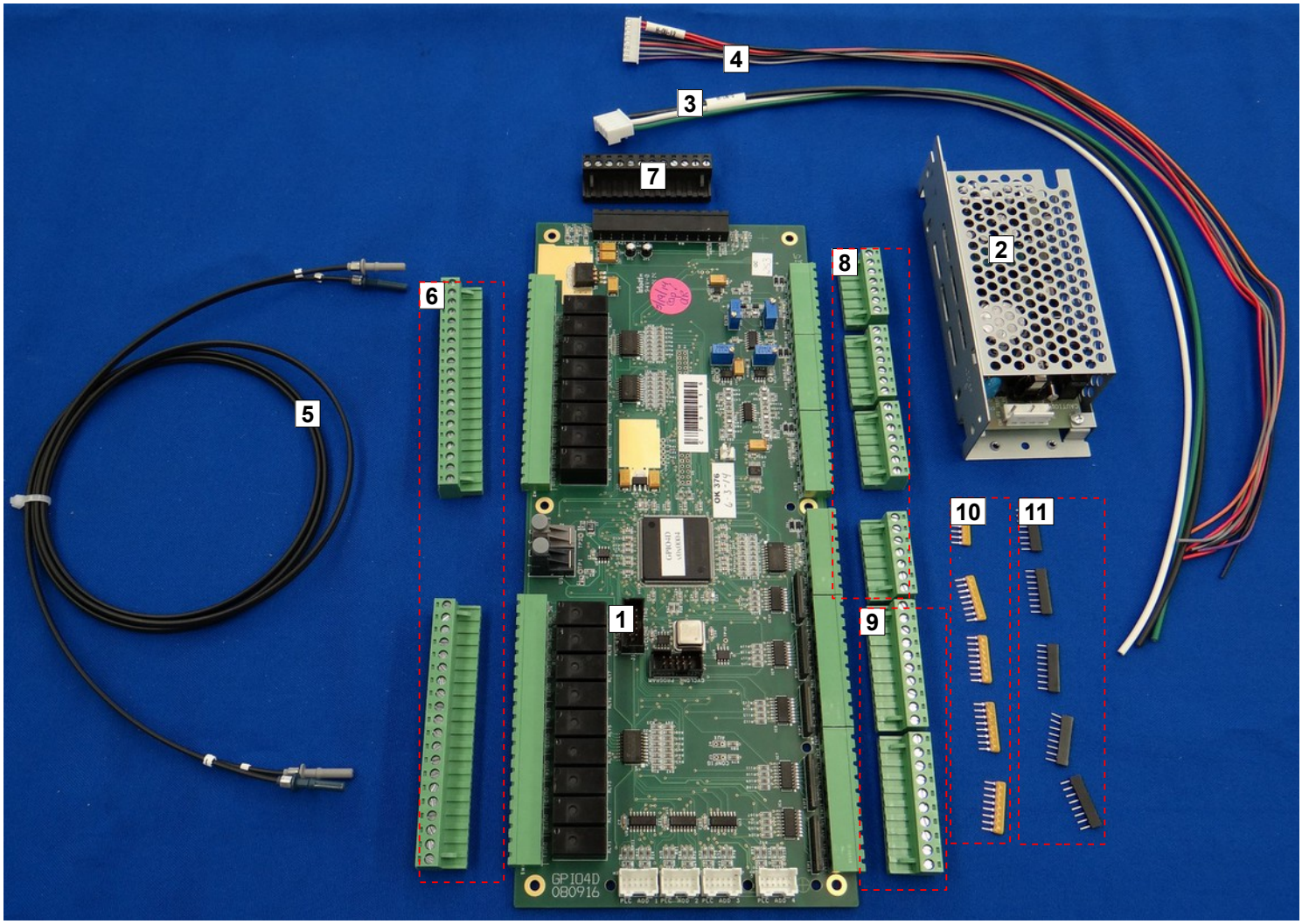
Crimp Pin Part Number 5983 (Used for making MPG cables)
The appropriate hand crimping are available from JST as "YRS-245". These tools are sold separately and can be purchased from most major electronics components distributors such as Digi-Key.

Fully assembled cables MPG cables can bought through Centroid.

1.3 GPIO4D

The GPIO4D stands for “General purpose input / output (for up to) four drives”. The GPIO4D is a PLC, meaning it is a “programmable logic controller”.

Essentially the GPIO4D is a set of computer controlled inputs and outputs. On an AC/DC system, the GPIO4D will provide I/O (“input / output”) for subsystems such as lubricant, coolant, and the spindle drive.

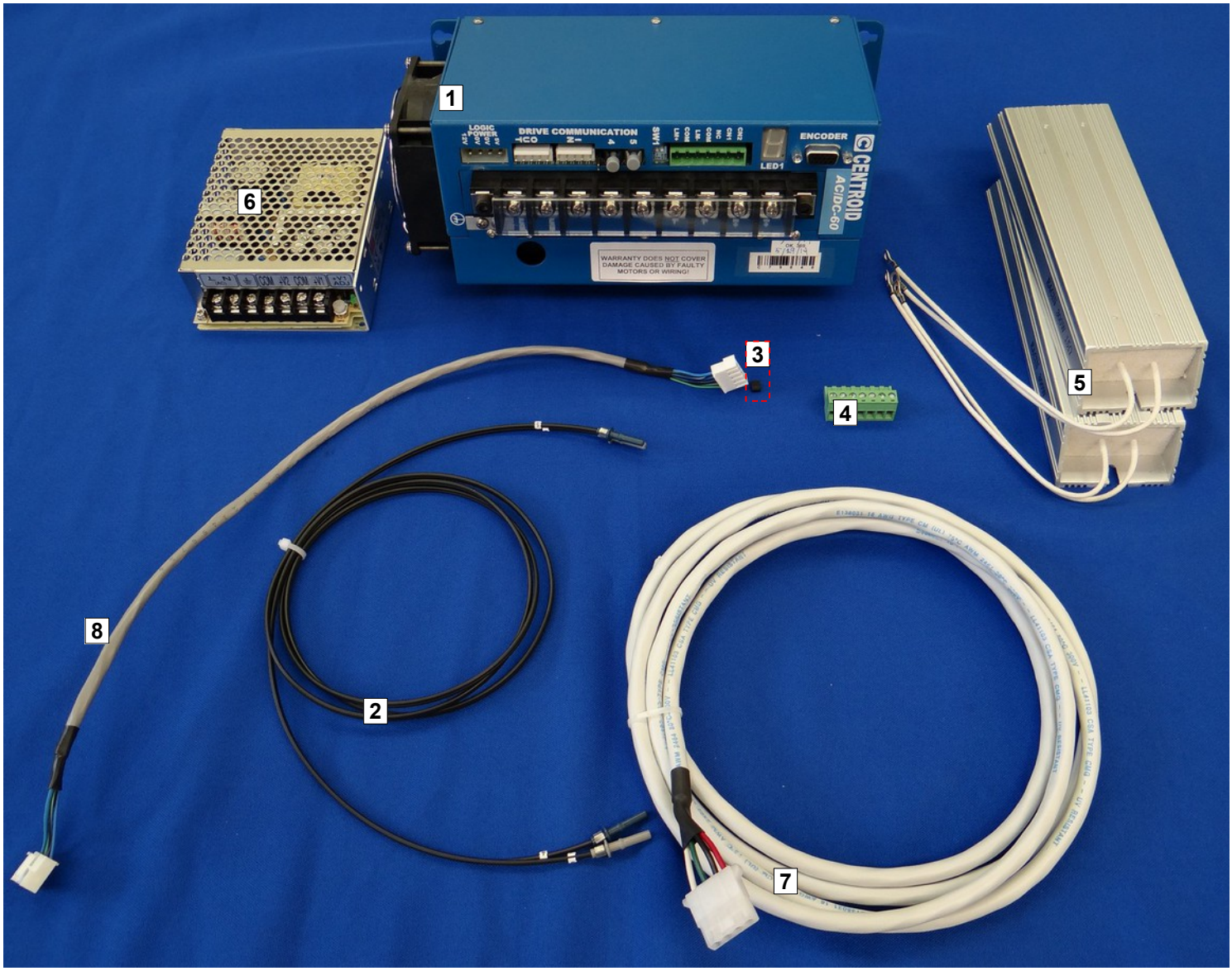


The following components are included with your GPIO4D:

1. GPIO4D..... Part Number 11018
2. Power supply..... Part Number 1331
3. Power supply AC input cable..... Part Number 3952
4. Power supply DC output cable..... Part Number 3951
5. Optic fibers labeled “1” and “3”..... Part Number 10018
6. 2 twenty position terminal blocks ..... Part Number 3450
7. Twelve position terminal block ..... Part Number 1551
8. 4 seven position terminal blocks ..... Part Number 2611
9. 2 ten position terminal blocks..... Part Number 3904
10. 5 five volt SIPS (color and appearance may vary)..... Part Number 3956
11. 5 twelve volt SIPS (color and appearance may vary)..... Part Number 4152

1.4 AC/DC

Your motors will be controlled by an AC/DC drive. AC/DC stand for “alternating current / direct current” because the drive works with both AC and DC motors.



The following components are included with your AC/DC:

1. AC/DC Drive.....Part Number 12854 (30A) or Part Number 12855 (60A)
2. Fibers labeled “4” and “5”.....Part Number 12832
3. Jumper.....Part Number 1761
4. Seven position terminal block.....Part Number 2611
5. Power Resistor(s) (2 per drive for a 60A drive, 1 per drive for a 30A drive).....Part Number 7352
6. Power Supply (1 per every 3 drives).....Part Number 7384
7. Power supply DC output cable.....Drawing Number S13352

8. Each additional AC/DC will contain the same parts except instead of having a fiber optic cable, a drive wired communication cable (Part Number 11146) will be included instead.

Chapter 2
Bench Test

2.1 Introduction

The first step in installing your new system is performing a bench test. A “bench test” is connecting all of the electronics together to test them **before** installing the system in a machine. This test is usually done on a work bench, hence the name. A bench test allows you to:

- 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 an electrical cabinet.
- Should a serious issue arise, it gives the user a knowledge base that allows Centroid Technical Support to more quickly and efficiently solve problem.

The bench test **ALWAYS** needs to be performed **BEFORE** applying **HIGH VOLTAGE** to the drive. Applying high voltage to an improperly configured system could cause permanent damage to the hardware and physical harm to the technician or operator. Figure 2.1.1 below shows an example of an AC/DC system set up for a level test. In the following pages we will guide you step-by-step through the setup and execution of a bench test.

Tools and Equipment Needed

- **Picking a good location** - A bench test needs to be performed on a large table or desk with good lighting and easy access to electrical outlets. The surface should **NOT** be made out of metal or contain metal scraps or shavings, as we will be resting powered circuit boards on the surface. Do not use fabric covered surfaces because they put the PBC high risk for ESD (electrostatic discharge) damage. Anti-static mats are normally conductive, and make a poor surface for powered boards. Plastic is acceptable, but could put the board at risk for static damage. **A wooden surface is an ideal test bench location.**
- Some method of powering multiple 120 VAC devices off and on simultaneously. An outlet strip with an “on/off” switch and some 120VAC power cords is the easiest method. For the remainder of this document, I will assume an outlet strip with power cords is being used.
- A PC with an internet connection, or a Centroid console unit (comes with CNC11 already installed). The PC must meet the specifications listed in Technical Bulletin 273, which can be found here. (http://www.centroidcnc.com/usersupport/support_files/tbs/tb273.pdf)
- Some method of splicing wires such as crimp terminals or a terminal block.
- Small screw driver set
- Wire strippers

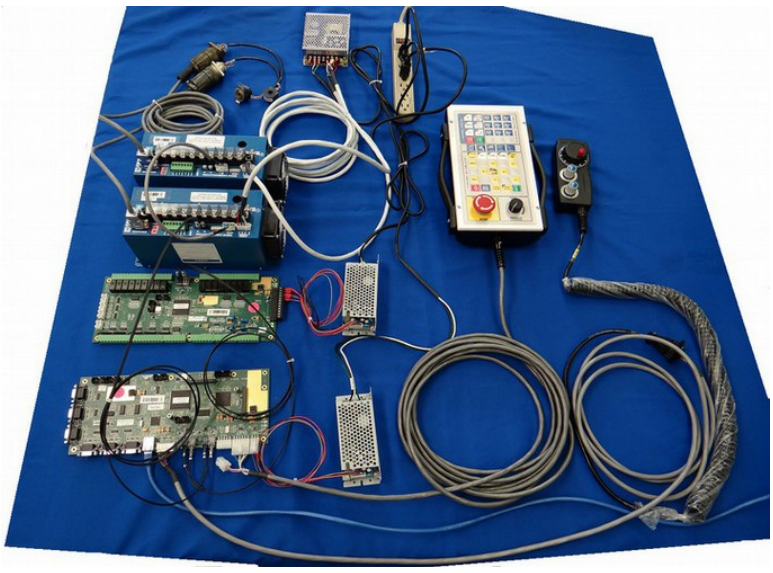


Figure 2.1.1
Example of equipment set up for a board level test.

2.2 Power Supply Configuration

1. Connect AC/DC to the power supply

    1. Connect AC/DC logic power cable (Dwg No. S13352) to the power supply (PN 7384) as shown in below Figure 2.2.1. Up to **three** AC/DC's can be powered with a PN 7384 supply.

        1. Connect the shield (bare metal), 5V ground (black), and the 12V ground (green) to the common terminal as shown in Figure 2.2.1.

        2. Connect +5V to +V1 and +12V to +V2.

        3. Connect your 120VAC line cord to the corresponding live, neutral, and chassis ground screw. Connect the other end to your outlet strip *(keep your outlet strip turned **off** until instructed to turn it on)*.

    2. Plug the connector on the other end of the power cable to the “Logic Power” input of the AC/DC as shown in figure 2.2.2.

        1. **NOTICE:** Do **NOT** construct a longer or lighter gauge cable. Do **NOT** daisy chain logic supply connections. This can produce a voltage drop which can cause the AC/DC to operate incorrectly.

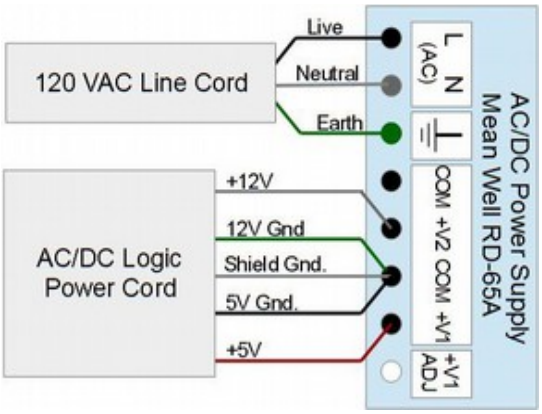


Figure 2.2.1
Power Supply Wiring Diagram For AC/DC

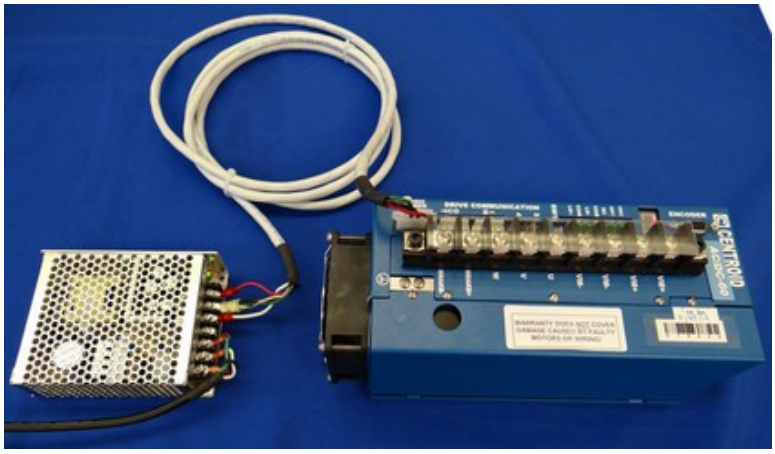


Figure 2.2.2
Power Supply Connected to AC/DC

2. Connect MPU11 to the power supply

    1. Plug the power supply AC input cable (PN 3952) and DC output cable (PN 3951) to the power supply (PN 1331).

    2. Splice your power cord to the power supply AC input cable. Connect the power cord to the outlet strip.

    3. Connect the power supply input cable to rectangular plug labeled “power” in the MPU11 as shown in figure 2.2.3

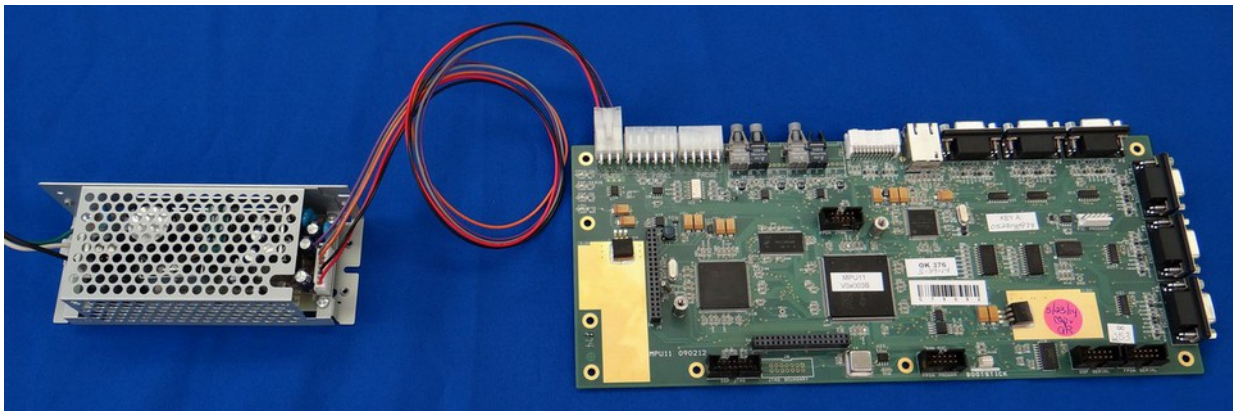


Figure 2.2.3
Power Supply Connect to MPU11

3. Connect GPIO4D to the power supply

    1. Plug the power supply AC input cable (PN 3952) and DC output cable (PN 3951) to the power supply (PN 1331).

    2. Splice your power cord to the power supply AC input cable. Connect the power cord to the outlet strip.

    3. Connect the other end of the power supply DC output cable to the twelve pin terminal block connecting to header H6 as shown below in Figure 2.2.4. and in Figure 2.2.5

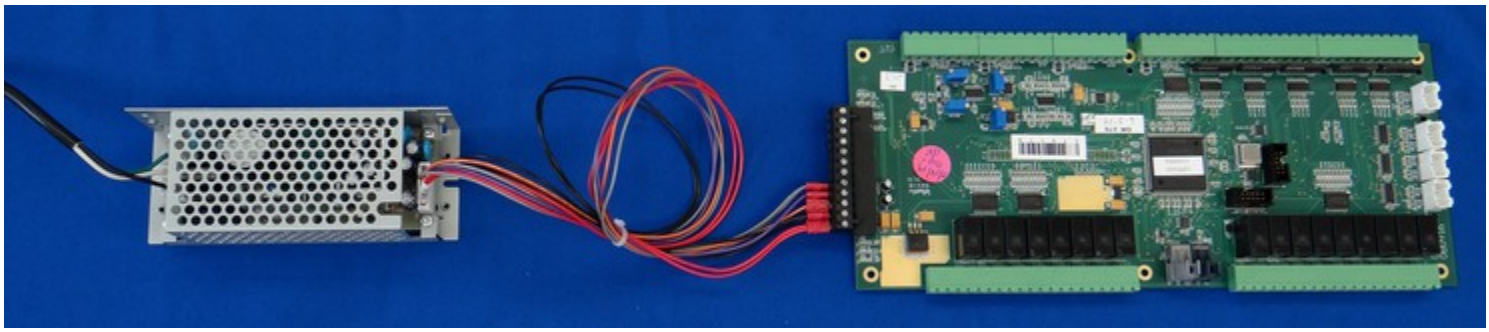


Figure 2.2.4
Power Supply Connected to GPIO4D

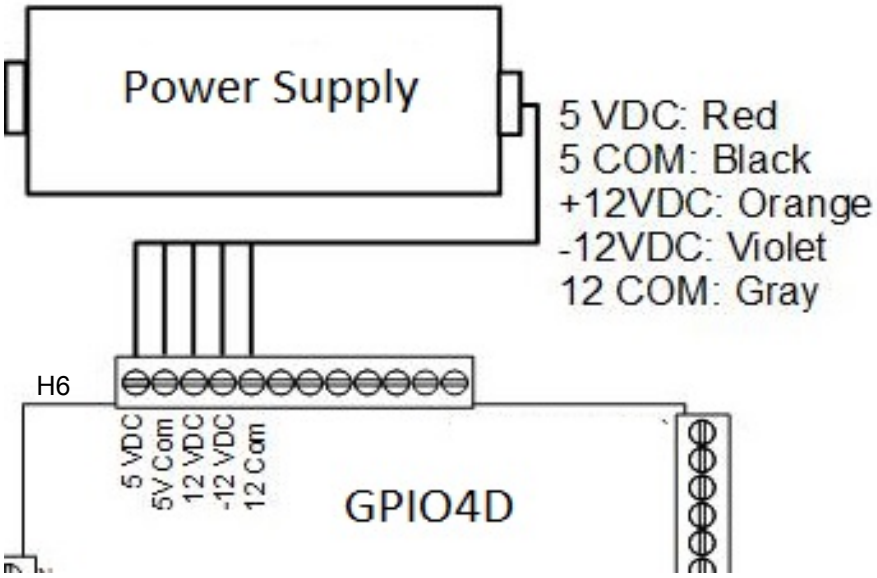


Figure 2.2.5
Power Supply Wiring Diagram For GPIO4D

2.3 Communication Configuration

4. Configure AC/DC communication

    1. AC/DCs need to be chained together with wire or fiber optic cables to allow them to communicate. The AC/DC that is **furthest** away from the MPU11 in the communication chain will be the **first axis**. The drive closest to the MPU11 will be your **last axis**. An example set up is shown in Figure 2.3.8.

    2. On the **last axis**, connect fibers 5 and 4 (PN 12832) from AC/DC to the MPU11. When connecting fibers match the colors and numbers. *(Ex. gray connector to gray socket, fiber 5 to socket 5)* as shown below in Figures 2.3.6 and Figure 2.3.7.

    3. On the **last axis** remove or offset the wired input jumper (PN 1761) so that it does not connect both pins as shown in Figure 2.3.8. The wired input jumper will not disable the wired output, only the wired input.

    4. Connect the drive communication cable (PN 11146) from the "**drive communication out**" last axis to the "**drive communication in**" of the next drive in the communication chain as shown in 2.3.8

Figure 2.3.6
Connect drive communication
fibers 4 and 5 to the AC/DC.

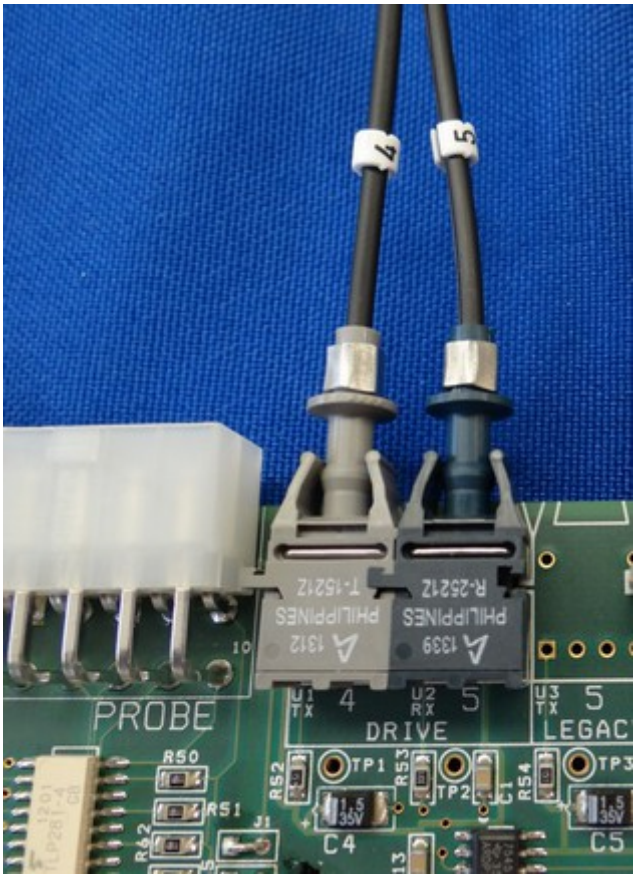


Figure 2.3.7
Connect drive communication
fibers 4 and 5 to the MPU11

5. For rest of the drives in the communication chain, the wired input jumper needs to be connected to both pins as shown. Connect the drive communication cable (PN 11146) from the output of one drive to the input of the next drive as shown below.

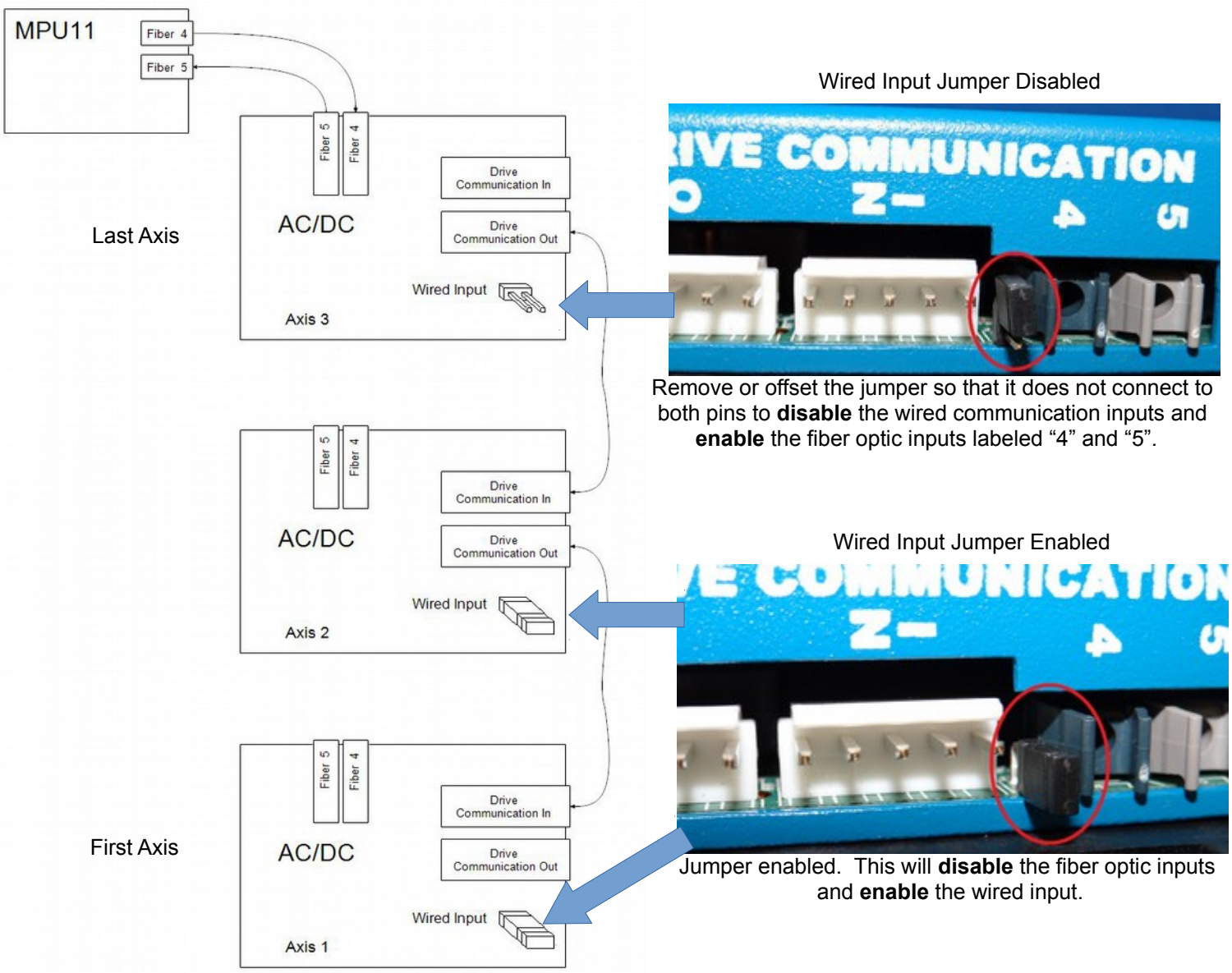


Figure 2.3.8
AC/DC Communication diagram

5. Configure MPU11 Communication

    1. Connect a shielded Ethernet cable from your MPU11 device to the PC. A shielded Ethernet cable will have a metal clip around the RJ-45 connector it as shown by the blue cable in Figure 2.3.9 Centroid recommends using snagless patch cables from StarTech. **StarTech ID# S45PATCH25BL.** This information is outlined in Technical Bulletin #251, the latest version can be found here. (http://www.centroidcnc.com/usersupport/support_files/tbs/tb251.pdf)

        1. **NOTICE**: An unshielded cable can cause intermittent PC Data receive errors in the software due to electronic noise and interference.

Figure 2.3.9
Unshielded Ethernet cable (gray) compared to Shielded Ethernet cable (blue)

6. GPIO4D Communication and setup

    1. Connect PLC communication fibers labeled “3” and “1” (PN 10018) from the GPIO4D to the MPU11 as shown in Figures 2.3.10 and 2.3.11.

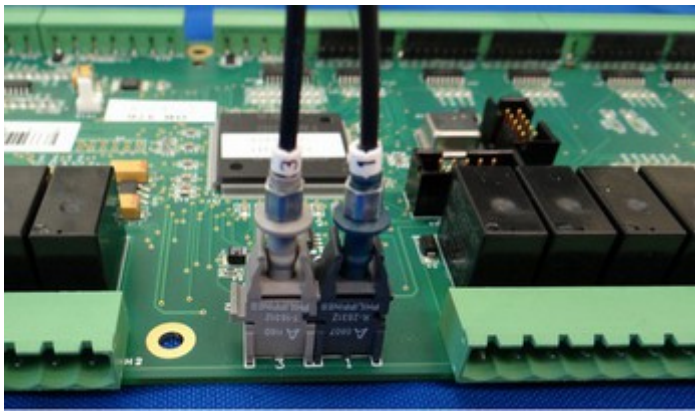


Figure 2.3.10
Connect PLC communication fibers to the GPIO4D.

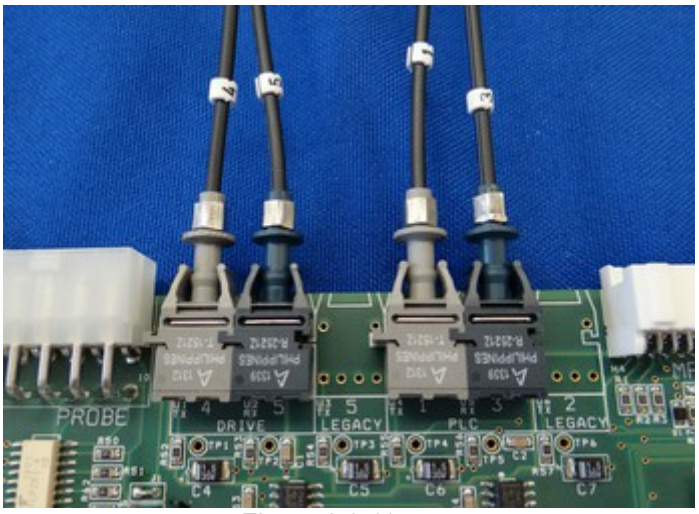


Figure 2.3.11
Connect PLC communication fibers to the MPU11.

2.4 Encoder Set-up

7. Connect the motor encoders. A table of supported Centroid encoders with part numbers is provided in **Appendix C, Stock Centroid Encoders**.

    1. The encoder cables **MUST** be shielded cables. The shield wire of the encoder cable needs to be grounded to the metal shield of the DB-15 connector as seen in figure 2.4.1. Centriod recommends using a twisted pair cable.

        1. **NOTE:** Failure to do so can cause encoder differential errors in the software.

    2. Connect the motor encoders to the AC/DC. Do **not** use the encoder connectors on the MPU11 (encoders 1-6) when connecting a motor to a AC/DC. Use the encoder connection on the front of the AC/DC as shown in Figures 2.4.2 and 2.4.3.

    3. AC/DC accepts incremental quadrature encoders and BiSS serial protocol encoders. The type of encoder will be automatically detected when logic power is applied. The encoder must be connected **before** applying power, or the AC/DC will report an encoder type of "none" and be unable to control a motor. Wiring diagrams for supported encoders are shown below in 2.4.4

        1. **Incremental quadrature encoders** Encoders must have RS422 type differential outputs to work with AC/DC. The outputs have additional voltage level requirements described in the table below:

Characteristic	Min.	Typ.	Max.	Unit
Encoder channel low level	0.0	0.3	0.5	V
Encoder channel high level	3.0	3.5	5.0	V

            1. **AC Incremental Quadrature Encoders** Commutation encoders for use with AC brushless (PMSM) motors have commutation channels (U, V, W) in addition to the position channels (A, B, Z) as shown on the next page. These additional channels are used to indicate rotor position for smooth initial start up. Commutation channels must be aligned using the "move sync" functions in CNC11 when mounting a new encoder. This is detailed later in this document in section "6.4 AC Encoder Alignment".

            2. **DC Incremental Quadrature Encoders** These encoders for DC brush motors require only A, B, and Z position channels as shown on the next page. Notice that the A and B channels are swapped for DC encoders to reverse the count direction and maintain backward compatibility with older Centroid DC systems.

            3. **BiSS protocol encoders:** These encoders communicate all needed information over only two differential pairs. This type of encoder is available in single and multi-turn absolute versions. The more advanced protocol allows for a very high number of counts per revolution, which enables very smooth motion and high accuracy. For the purpose of a bench test, the encoders do not need to be connected to a motor. If you did not purchase an encoder cable, wire the DB15 connector that connects your encoders to the AC/DC as shown on the next page.

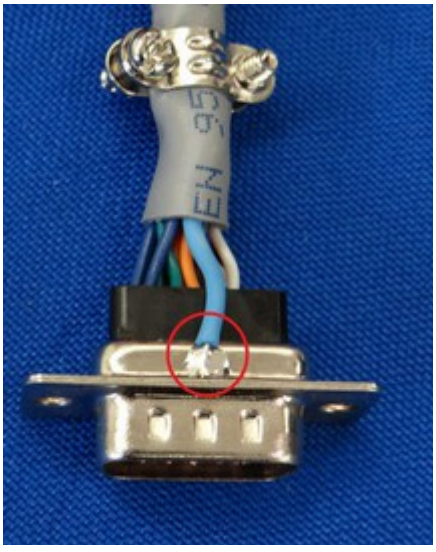


Figure 2.4.1
Cable shield grounded to the metal shield of the D-sub connector.

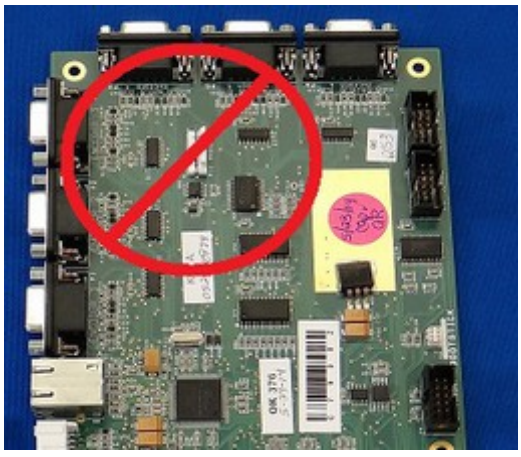
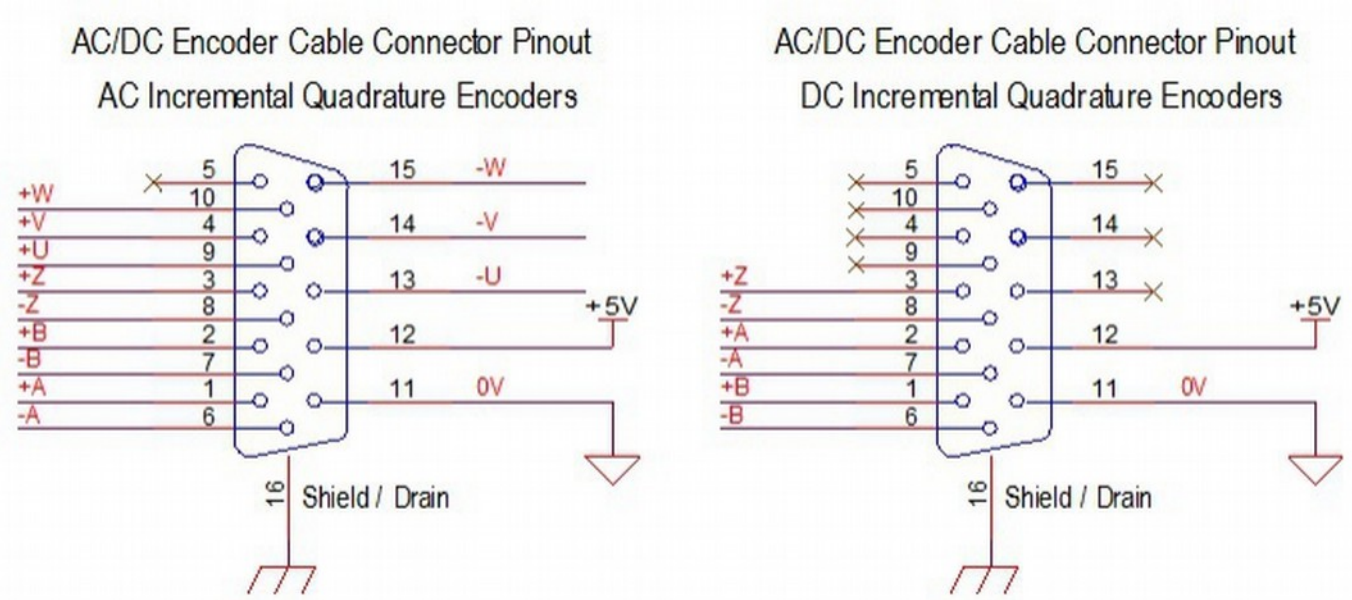


Figure 2.4.2
Do **not** use the encoders on the MPU11 when connecting motors to the AC/DC!

Figure 2.4.3
Use the encoders connection on the front of the AC/DC.



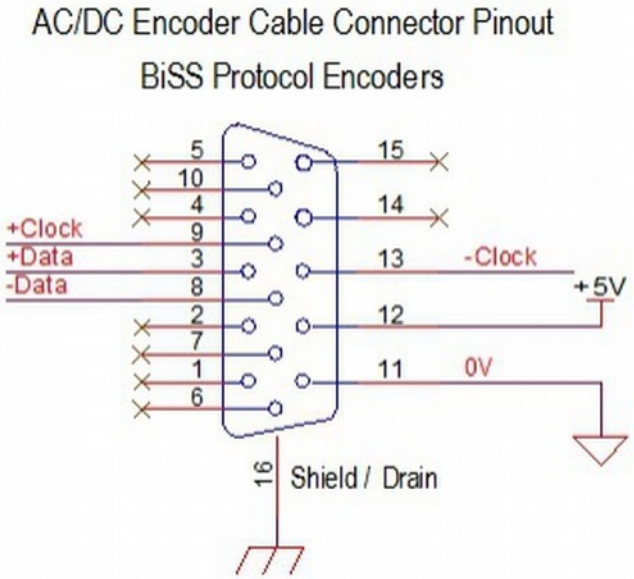


Figure 2.4.4
All drawings are shown from the perspective of the mating end of the encoder cable

(As opposed to the end containing the soldered or crimped connections.)

Pin	Quadrature	Quadrature	Protocol
1	+A	+B	-
2	+B	+A	-
3	+Z	+Z	+Data
4	+V	-	-
5	-	-	-
6	-A	-B	-
7	-B	-A	-
8	-Z	-Z	-Data
9	+U	-	+Clock
10	+W	-	-
11	0V	0V	0V
12	+5V	+5V	+5V
13	-U	-	-Clock
14	-V	-	-
15	-W	-	-
Case	Shield / Drain	Shield / Drain	Shield / Drain

Count Directions	
Motor	**Encoder Count Direction (while turning shaft clockwise, looking at mounting flange)**
Brushless	PID screen Abs Pos increases
Brush	PID screen Abs Pos decreases

2.5 MPU11 Accessories

8. Connect additional accessories

1. If a jog panel/pendant or MPG was ordered, please connect it to the MPU11 as seen in Figures 2.5.1 and 2.5.2.

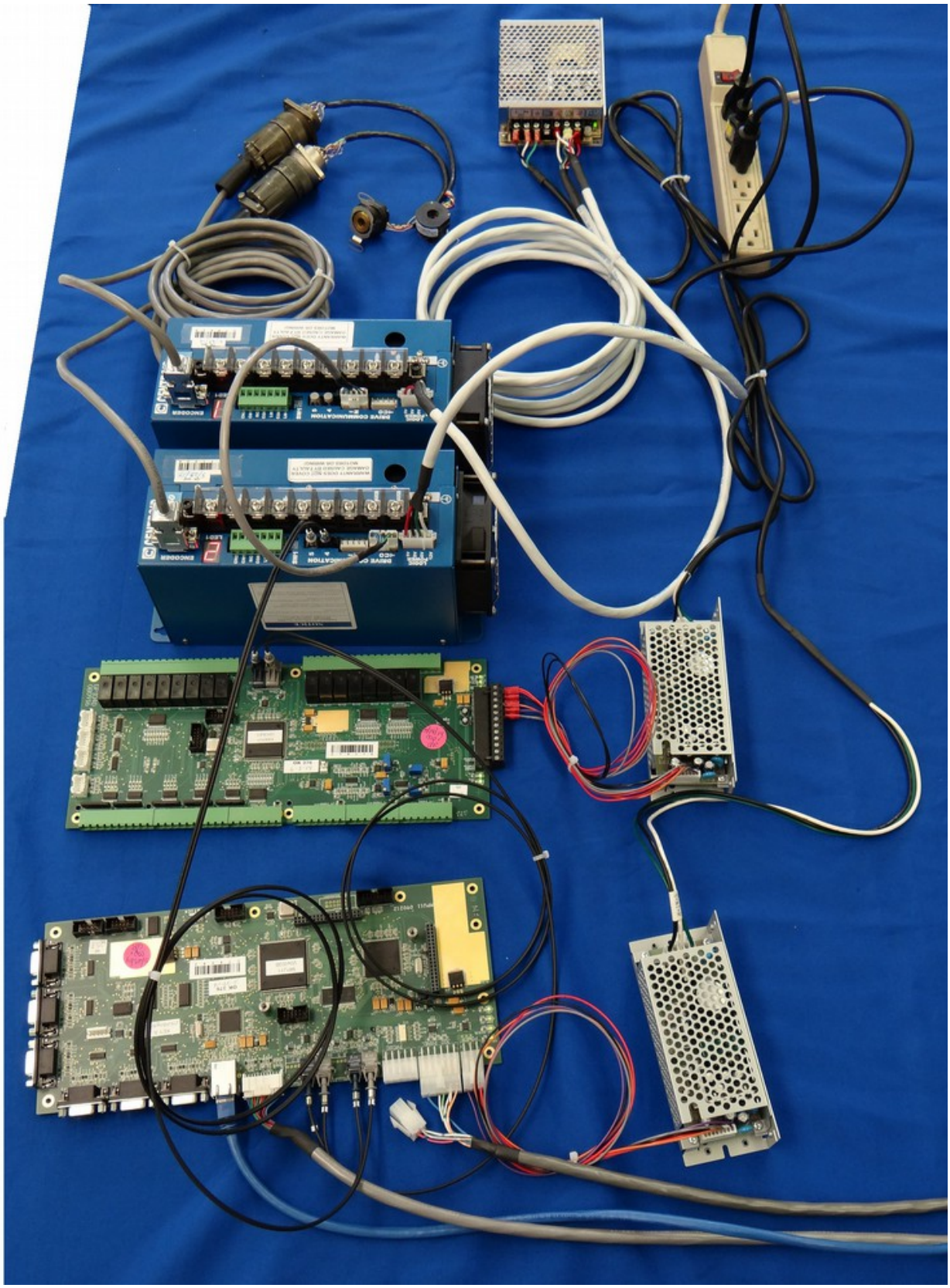
Figure 2.5.1
Jog Pendant

Figure 2.5.2
MPG

9. Connect any additional PLC I/O.

1. The use and operation of additional PLC I/O (Such as PLCADD1616) is beyond the scope if this document and will not be covered in detail. If you have any additional PLC I/O, you should consult the appropriate documentation and hook it up accordingly for the bench test.

Depending on the number drives and accessories, each customers bench test setup will look a little different. When you are finished, it should look somewhat similar to the picture shown below.



Figures 2.5.3
AC/DC, MPU11, GPIO4D connect for a bench test.

2.6 Powering On & Verifying LED States

Before powering on, perform a visual inspection of what you have set up so far. Check to make sure no metal object can short against the circuit boards. Check to make sure all wiring is firmly in place.

Switch the outlet strip on, powering on the AC/DCs, MPU11, GPIO4D, and any accessories if applicable.

GPIO4D LED States: Just like the MPU11, the LED's are next to the power connector as shown in Figure 2.6.1. After 15 to 30 seconds all LEDs should initialize to solid green. Make sure that all light are on, indicating the GIO4D has proper power and is communicating with the MPU11.

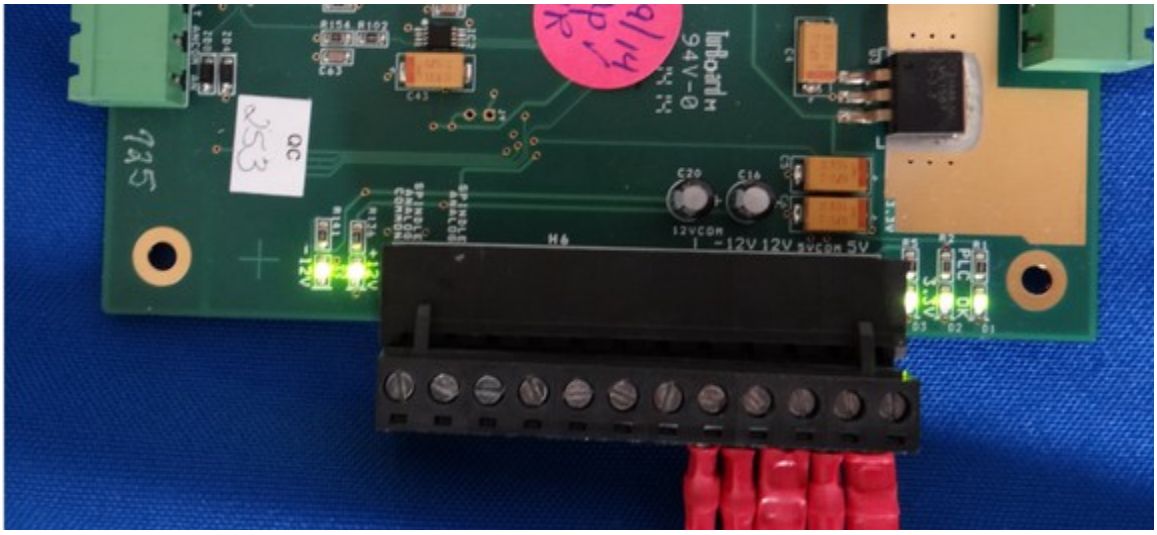


Figure 2.6.1
LEDs on the GPIO4D

GPIO4D LED States		
LED Name	**LED Function**	**Nominal State**
PLC OK	Indicates that the PLC is communicating with the MPU11	Solid Green
3.3V	The PLC has 3.3 volt power.	Solid Green
5V	The PLC has 5 volt power.	Solid Green
+12V	The PLC has +12 volt power.	Solid Green
-12V	The PLC has -12 volt power.	Solid Green

MPU11 LED states: While powering up, there are 4 LED's next to the power connector on the MPU11 that flicker while the MPU11 is initializing as shown in Figure 2.6.2. After 15-30 seconds the LED's should initialize to the state shown in the table below.

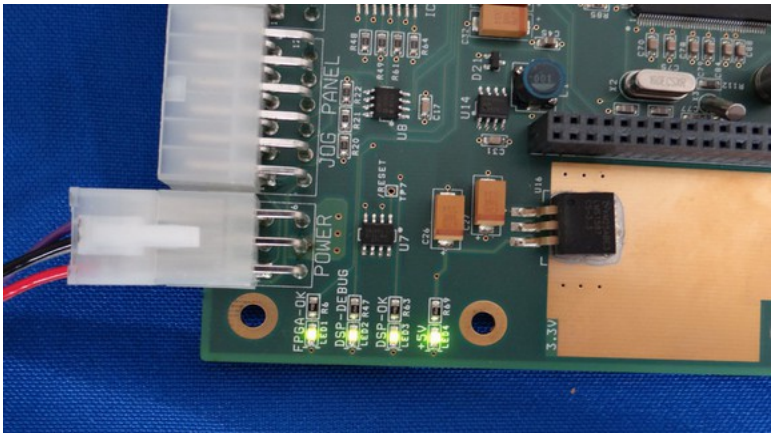


Figure 2.6.2
LEDs on the MPU11

MPU11 LED Nominal LED States		
LED Name	**LED Function**	**Nominal State**
FPGA-OK	The FPGA is working correctly	Solid green
DSP-DEBUG	Flashing indicates drive detected.	Flashing ~1 per second
DSP-OK	The DSP is working correctly	Solid Green
+5V	The board has 5 volt power.	Solid Green

MPU11 LED LED Troubleshooting		
LED Symptiom	**Possible Cause**	**Corrective Action**
FPGA-OK not lit	MPU11 Not Ready	Wait for the MPU11 to start and enter run mode
	Internal hardware Fault	Return for repair
DSP-OK not lit	MPU11 is booting up	Wait for the MPU11 to start and enter run mode
DSP-DEBUG LED flashing twenty times per second	MPU11 is detecting hardware	Wait for MPU11 to detect hardware and start run mode
DSP-DEBUG and DSP-OK LED flashing alternately eight times per second	FPGA memory test failed	Return for repair
DSP-DEBUG and DSP-OK LED both on continuous	DSP Failed to initialize	Return for repair

1. **AC/DC LED States:** The AC/DC is different from the MPU11 and GPIO4D in the fact that it uses both a seven segment display and LEDs to provide the user with information. Always wait 15 to 30 seconds for the drive to initialize for checking the LED states.

   The LEDs on the AC/DC are hidden on the side of the drive opposite of the fan as seen in Figure 2.6.3. You do not need to remove the cover to view the LED's, but for your reference a picture of the logic board with the cover removed is provided in Figure 2.6.4. Make sure the FPGA OK, +5V, and +12V LEDs are solid green. The DSP OK light should flash.

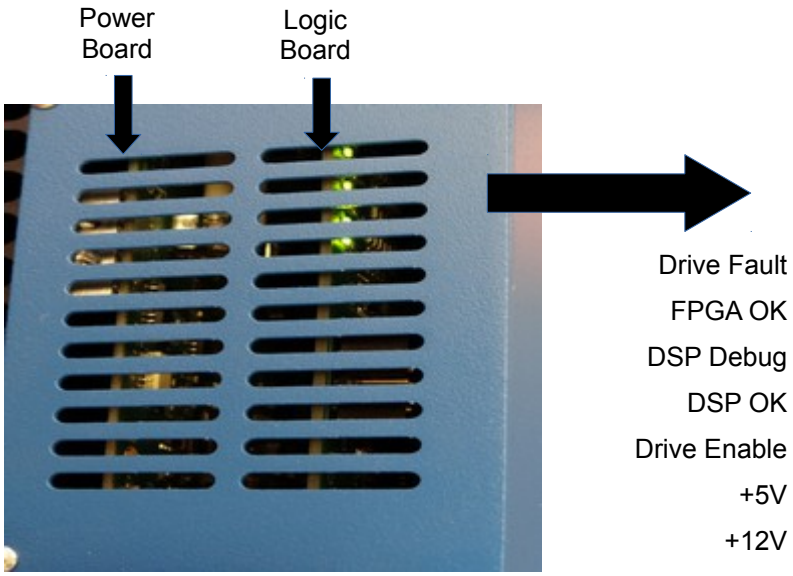


Figure 2.6.3
LEDs on the side of the drive.

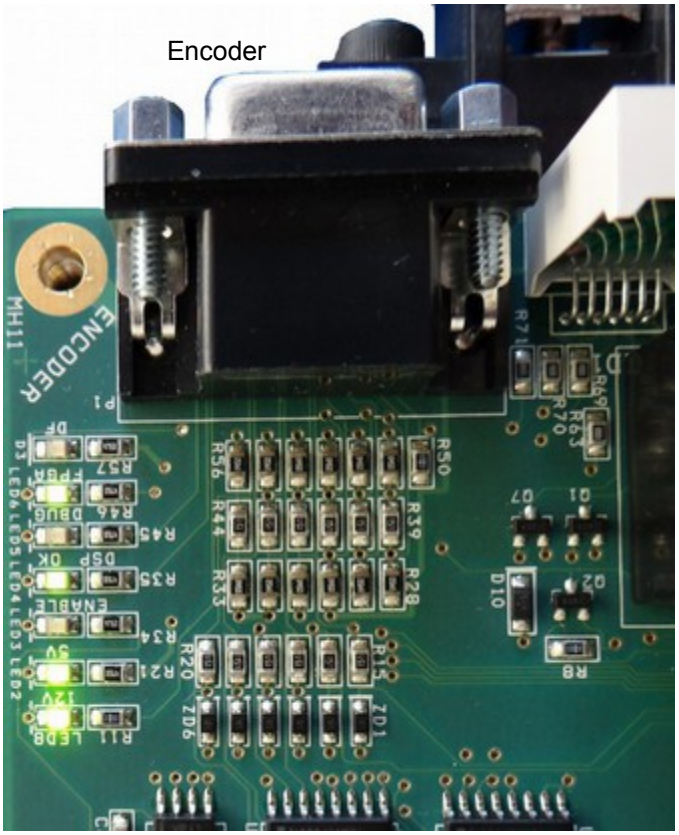


Figure 2.6.4
LEDs on the Logic board

ACDC Logic LED States		
LED Name	**LED Function**	**Nominal State**
Drive Fault	Status of the drive fault relay.	Turns on when communication is established with the software and all drive faults are cleared.
FPGA OK	The FPGA is working correctly. If this light is off, it indicates a possible hardware failure.	Solid Green
DSP Debug	Should never be on, not used.	Off
DSP OK	The flashing once per seconds means the DSP is working correctly. If this light is off, it indicates a possible hardware failure.	Flashing ~1 per second
Enable Axis	Indicated when the drive is enabled by the software.	Turns on when the drive is enabled by the software.
+5V	The drive has 5 volt power.	Solid Green
+12V	The drive has 12 volt power.	Solid Green

2. **AC/DC LED1 (Seven Segment Display) States:** Approximately 15-30 seconds after starting LED1 will display a number. If the seven segment display is displaying a solid number without a decimal point it indicates the drive axis number as seen in Figure 2.6.5. If LED1 is flashing with a decimal point it indicates an error as shown in Figure 2.6.6.

   If you have a blinking 4, that means the AC/DC is not seeing the limit switches. Since we have not hooked up limit switches, you can disable them by switch SW1 to the down position as shown in Figure 4.2.7. If done correctly, the drives will all be displaying their drive axis number. A table of other drive errors and their definitions is provided below.

Figure 2.6.5
Drive Number

Figure 2.6.6
Drive Error
(Please note the decimal point)

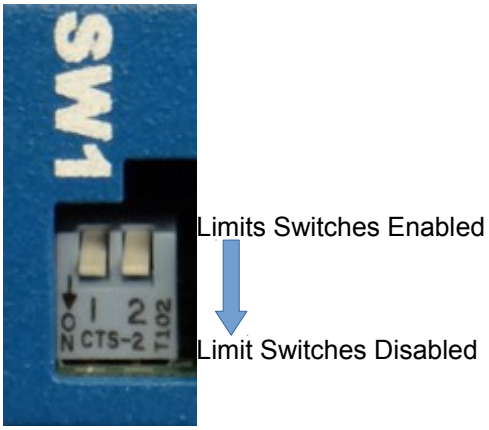


Figure 2.6.7
Switch SW1

ACDC Seven Segment States			
Error Number	**Meaning**	**Cause**	**Corrective Action**
1	Communication Error	"Wired Input" Jumper set incorrectly or fiber 4 or cable connection not working properly	Set jumper properly and check communication cables.
4	Limit Tripped	any limit switch is tripped	Use the limit defeat switches to disable hardware limits
5	Drive Error	A serious fault has caused the drive to shut down	Check HSC Screen for error cause <F7>, <F9>, <F5>

CHAPTER 3
SOFTWARE INSTALLATION

3.1 Preinstallation

1. If you have purchased a console unit or computer from Centriod, it already comes with Windows properly configured and the CNC11 software already installed. Please skip to section "**3.3 AC/DC Setup Wizard"**.

2. If you have a computer with the Microsoft Windows 8 operating system, please skip to **Appendix A, Windows 8 preinstallation.**

3. If you have a computer with the Microsoft Windows 7 operating system, please skip to **Appendix B, Windows 7 preinstallation.**

4. Microsoft Windows Xp, Vista, and older versions of Windows are not supported. Mac OS and Linuix are also not supported.

5. **Before installing CNC11, all anti-virus and 3rd party firewall software should be uninstalled (not disabled) and your computer rebooted.**

    1. **Nearly 100% of all communication problems between CNC11 and the MPU11 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 MPU11 and the PC as unusual/suspicious and interfere with operation of CNC11. Firewalls work by blocking certain communication ports, and often these ports are needed for operation of CNC11. The default firewall built into Microsoft Windows will work fine with CNC11 if you allow access as specified in this manual.

    2. 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, then Centroid recommends that you keep any computers with CNC11 installed disconnected from the network.

3.2 CNC11 and PLC Installation

With your bench configuration completely connected and your PC running and powered up as described in section 3, install the CNC11 Software as follows:

1. **Download the latest CNC11 Software version.** It is important that you download the latest version of the Centroid CNC11 software before continuing. Click on the link below to download the latest version of CNC11 software: CNC11 Software download (http://www.centroidcnc.com/usersupport/support_files/latest_release/cnc11_latest.zip)

2. **Copy the downloaded file to your desktop.** Depending on your Windows 7 settings, the file you downloaded will be displayed as either cnc11_win7_current.zip or cnc11_win7_current. Copy this file to your desktop and then double click on the file from your desktop.

3. **Drag the installation folder from the compressed file to your desktop.** The folder in this example is called centroid-cnc11-v312-D, your version maybe newer but the name will be the same other than the "v312" which signifies the CNC11 version number as shown below in Figure 3.2.1.

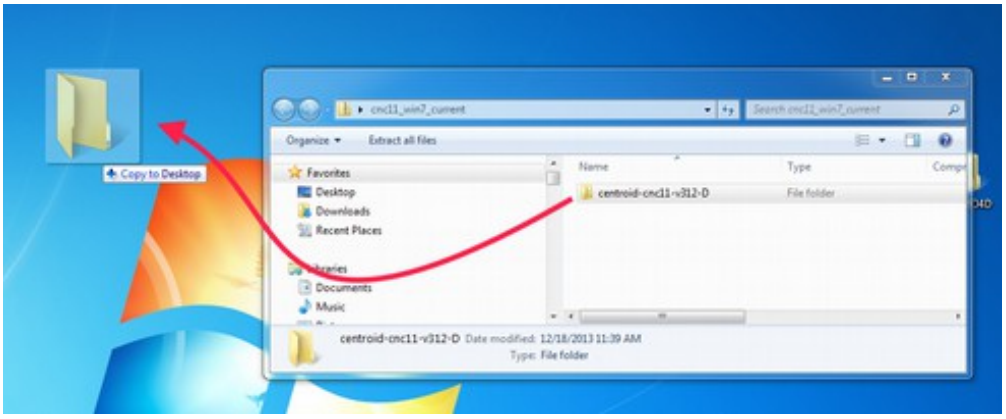


Figure 3.2.1
Copy to desktop

4. **Double click the install folder and double click setup to begin CNC11 install as seen in Figure 3.2.2**

mpuplcprograms	File folder		5/15/2014 6:46 PM
autorun	Setup Information	1 KB	5/15/2014 6:35 PM
cnc	Icon	1 KB	5/15/2014 6:35 PM
plcinstaller	Application	1,570 KB	5/15/2014 6:39 PM
Sentinel Protection Installer 7.6.6	Application	8,214 KB	5/15/2014 6:35 PM
setup	Application	20,203 KB	5/15/2014 6:47 PM
version	Text Document	1 KB	5/15/2014 6:45 PM
WinPcap_4_1_3	Application	894 KB	5/15/2014 6:35 PM
WinPcap-license	Text Document	13 KB	5/15/2014 6:35 PM

Figure 3.2.2
Double click "Setup"

5. On a Windows 7 or 8 computer 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**".

6. Select CNC11 Mill and WinPcap for a Mill installation as shown in Figure 3.2.3. Select CNC11 Lathe and WinPcap for a Lathe installation. For the remainder of this document we will assume the system is being installed on a mill. Click "**Next**", accept default installation drive and directory (c:\) and click "**Install**" as seen in Figure 3.2.4. The software will extract as shown in Figure 3.2.5.

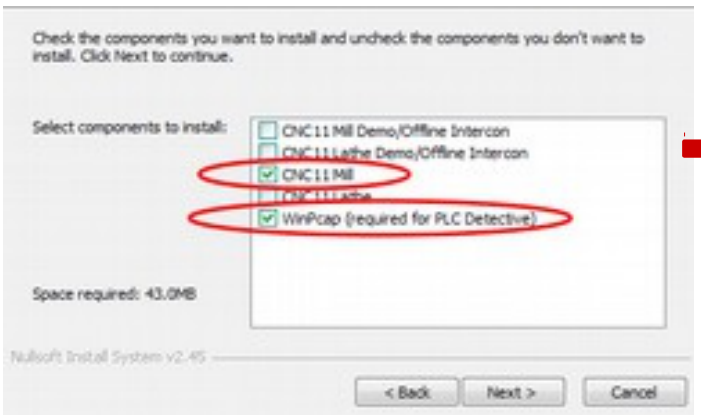


Figure 3.2.3
Selecting CNC11 and WinPcap

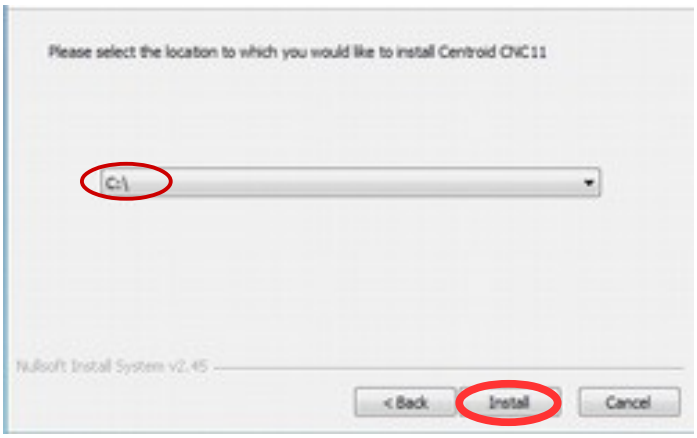


Figure 3.2.4
Select the C drive

7. **Install WinPcap** Click "**Next**" in the WinPcap Setup Wizard window as circled in Figure 3.2.6. Check the "**Automatically start the WinPcap at boot**" box when prompted.

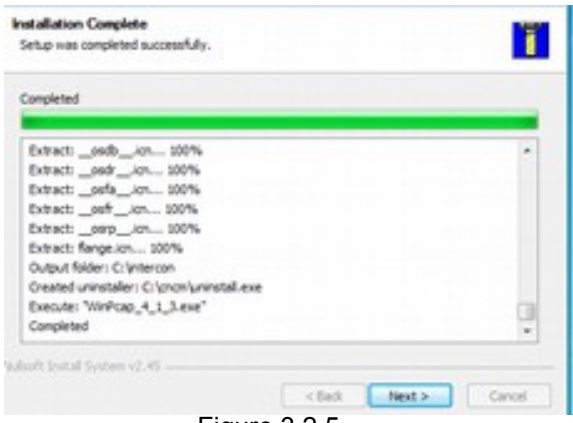


Figure 3.2.5
Software installation

Figure 3.2.6
Installation complete

8. **Click "Next" to continue.** After the WinPcap installation has finished, click "**Next**" in the "Installation Complete" window to continue.

9. **Network Adapter Setup:** Click the down arrow to display the network adapters that are currently installed and select the network adapter that is connected to the MPU11 as circled in Figure 3.2.7. Click "**Next**" to continue. When asked if you would like to change the IP address for the adapter selected, click "**yes**".

    1. **NOTE**: Centroid recommends using a computer with two Ethernet ports. That way one Ethernet port is used for the MPU11, and the second Ethernet port can be used to access the internet.

    2. **NOTE**: Your IP address will differ from those shown in the picture. If you only have the MPU11 hooked up (and are disconnect the internet/network), only the MPU11 will be detected.

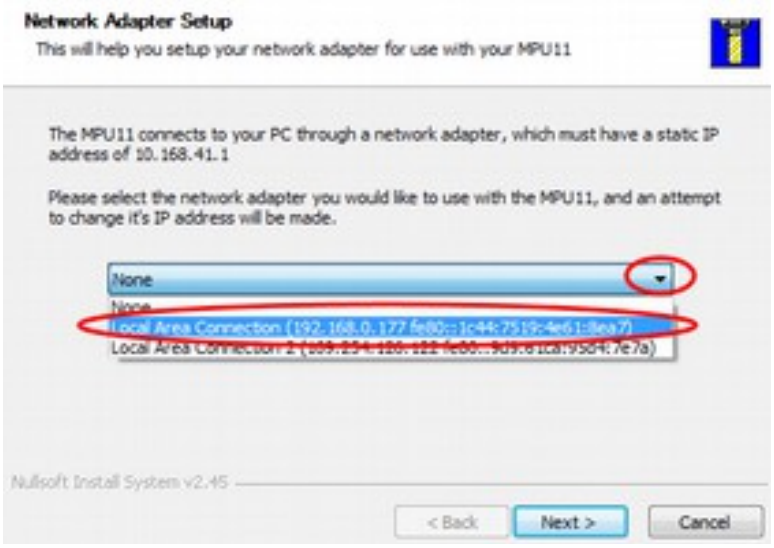


Figure 3.2.6
Select the network adapter that is connected to the MPU11

10. **Installing a PLC program:** After the CNC11 software has been installed, the installer will prompt you to install a PLC program, select "**Yes**". Click on the "+" signs next to Mill and GPIO4D. Click on "**acdc-basic**", then click "**Install**" as shown in Figure 3.2.7.

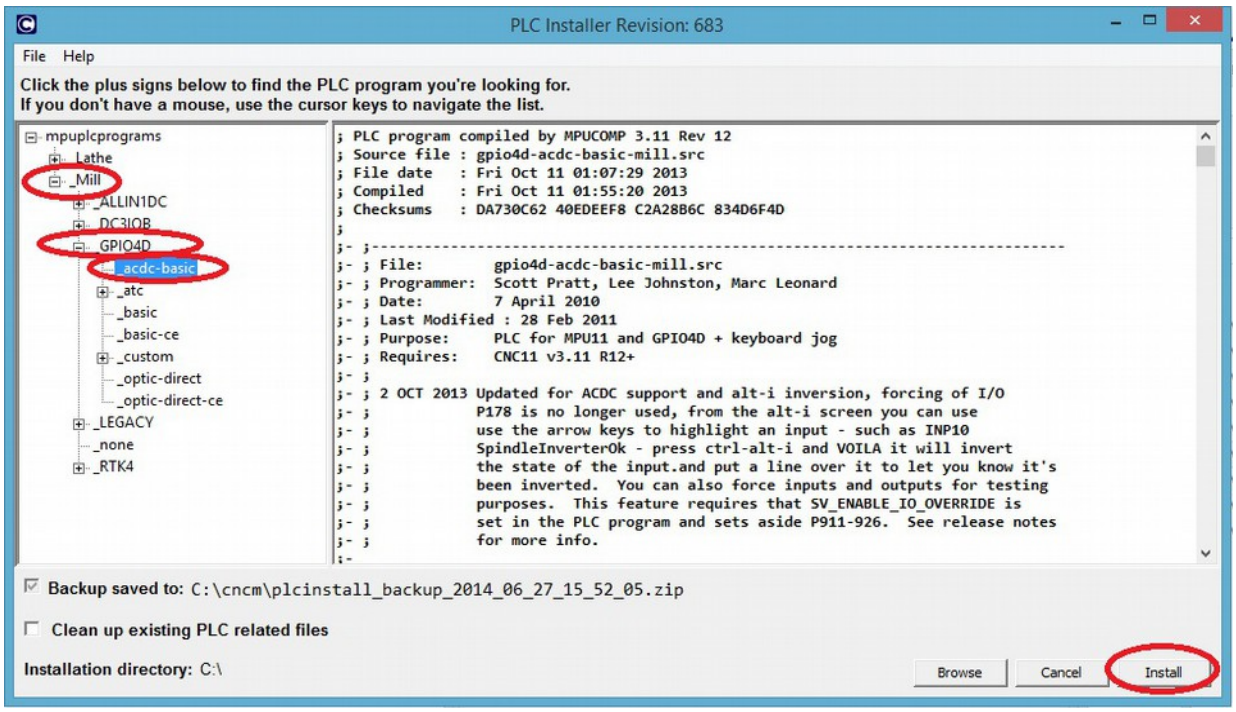


Figure 3.2.7
Install the PLC program

11. **Click "Finish" to complete CNC11 software installation**. After the PLC program installation has completed, click "Finish" to complete the installation.

12. **Power off the computer, MPU11 and GPIO4D and restart.**

13. **Configuring Windows Firewall To Allow CNC11 to Communicate with The MPU11:** The first time you run CNC11 under Windows 7, you will see a pop up window asking you if you wish to allow CNC11 to communicate with the MPU11. Check both the "**Private**" and "**Public**" check boxes, in the "Allow cncm to communicate on these networks" section and then click "Allow **access**" to continue. If CNC11 timed out while trying to initialize the MPU11, see Appendix A for troubleshooting.

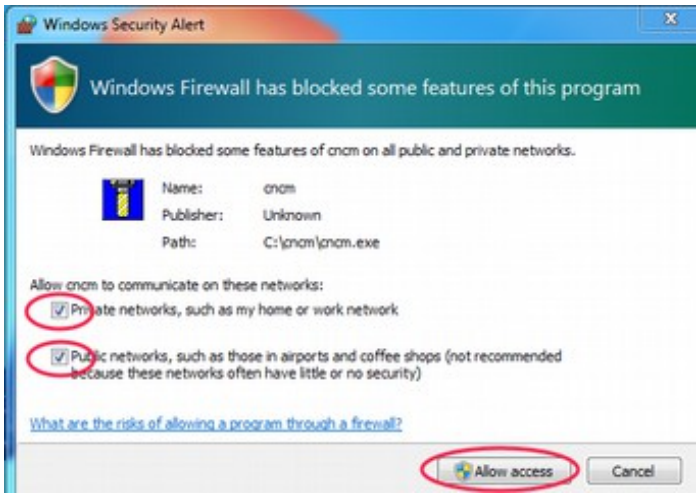


Figure 3.2.8
Make a firewall exception

14. Confirm that CNC11 start up correctly. Close CNC11 and continue on to the next step.

    1. **NOTE** On wide screen monitors, CNC11 will only take up 2/3rds of the monitor screen while running in "full screen".

3.3 AC/DC Setup Wizard

Centroid has a motor configuration tool to simplify setting up an AC/DC. This same information is found in Technical Bulletin TB277. The latest version can be found here. (http://www.centroidcnc.com/usersupport/support_files/tbs/tb277.pdf)

The Centroid AC/DC Setup Wizard simplifies setting up an AC/DC. Alternatively, an AC/DC can be setup without using the tool by referring to the tables listed in Appendix B

1. **Download the latest version of the AC/DC Motor Setup Wizard.** Click on the link below to download the latest version of CNC11 software: AC/DC Motor Configuration Tool (www.centroidcnc.com/usersupport/support_files/acdc/acdc_setup_wizard.zip).

2. **Extract/Decompress the downloaded file**. Double click on the downloaded file. Extract the compressed file. On Windows 8 extraction is done by clicking on the "Extract all" button as shown below in Figure 3.3.1.

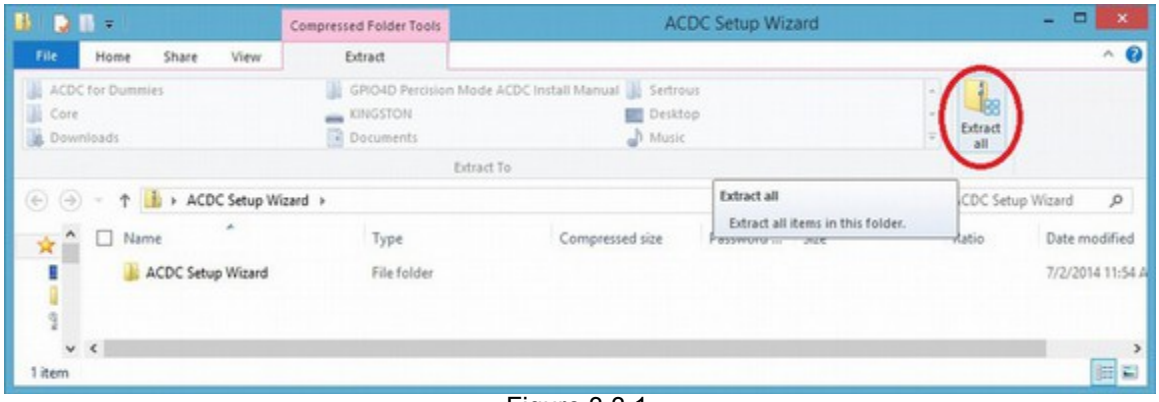


Figure 3.3.1
Extracting the AC/DC setup wizard

3. **Copy and Paste into the CNCM / CNCT directory.**
   1. Select the extracted files "***ACDC Setup Wizard (.exe)***" and "***pwm_parameters (.xml)***"
   2. Copy both files as demonstrated in Figure 3.3.2.
   3. **Right click** on your **CNC11** desktop shortcut.
   4. Select **properties** as seen in Figure 3.3.3
   5. In the shortcut tab, click on "**Open File Location**" as shown in Figure 3.3.4.
   6. Windows explorer will open up in a new window showing the contents of your CNC11 directory *(The directory will be called "CNCM" or "CNCT" depending on weather you have a mill or a lathe)*. Paste both files into your CNC11 directory.

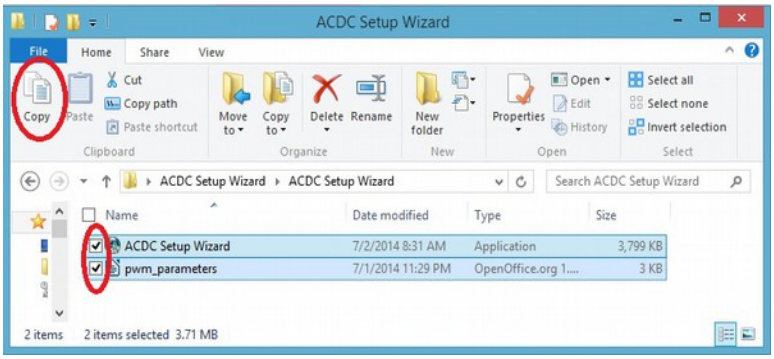


Figure 3.3.2
Steps 1 & 2. Select and copy the extracted files.

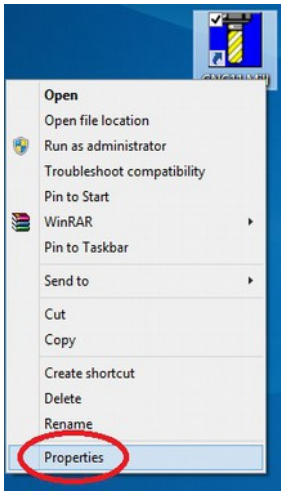


Figure 3.3.3
Step 3 & 4. Right click on your CNC11 software selecting properties

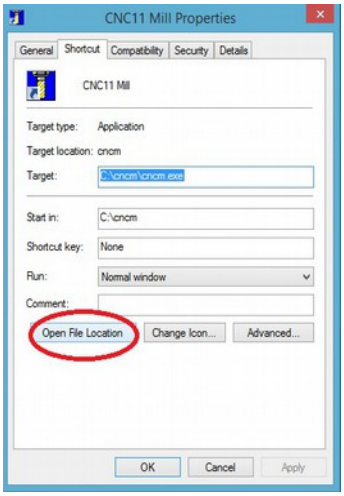


Figure 3.3.4
Step 5. Click "open file location"

4. **Create a desktop shortcut.**
    1. Highlight just the ***ACDC Setup Wizard (.exe)*** inside your CNC11 directory.
    2. Right click on the application. A drop down menu will come up.
    3. Select "**Send To**" on the drop down menu
    4. Select "**Desktop (Create Shortcut)**" as shown in Figure 3.3.5
    5. Exit Windows File Explorer. On your desktop you should now have a shortcut to CNC11 and to the ACDC Setup Wizard.

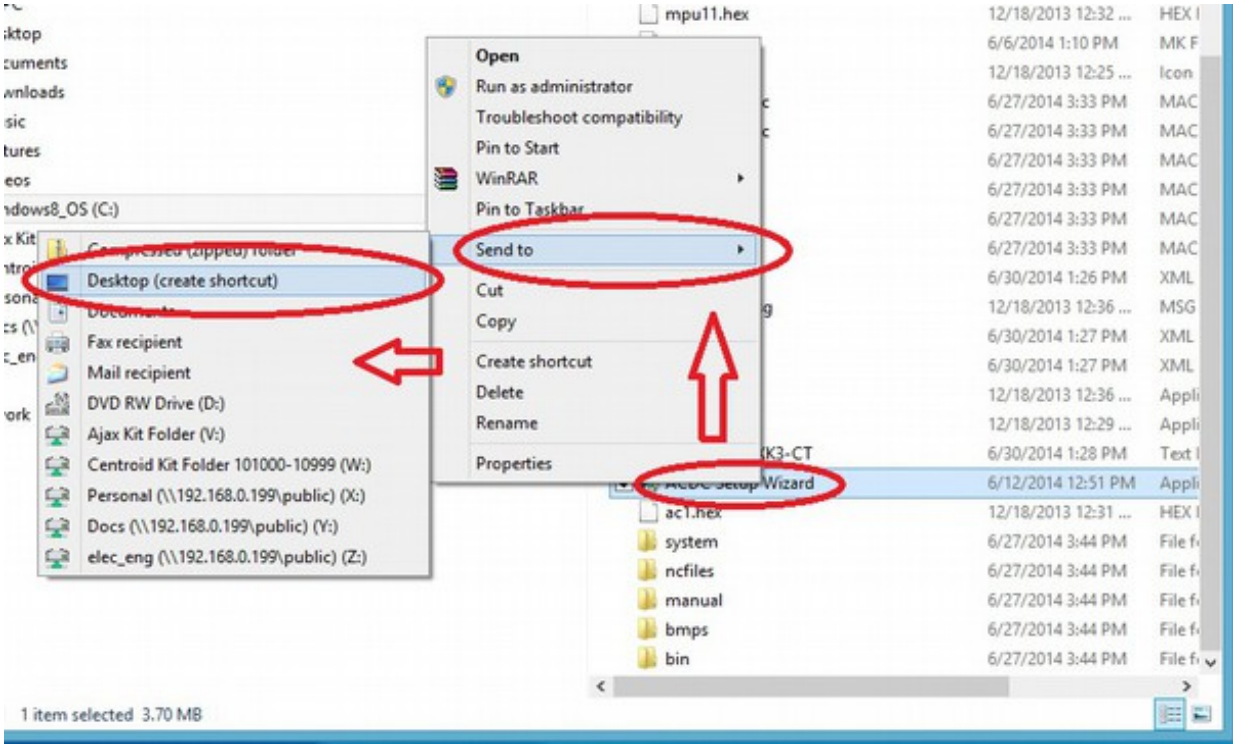


Figure 3.3.5
Creating a desktop shortcut for an application

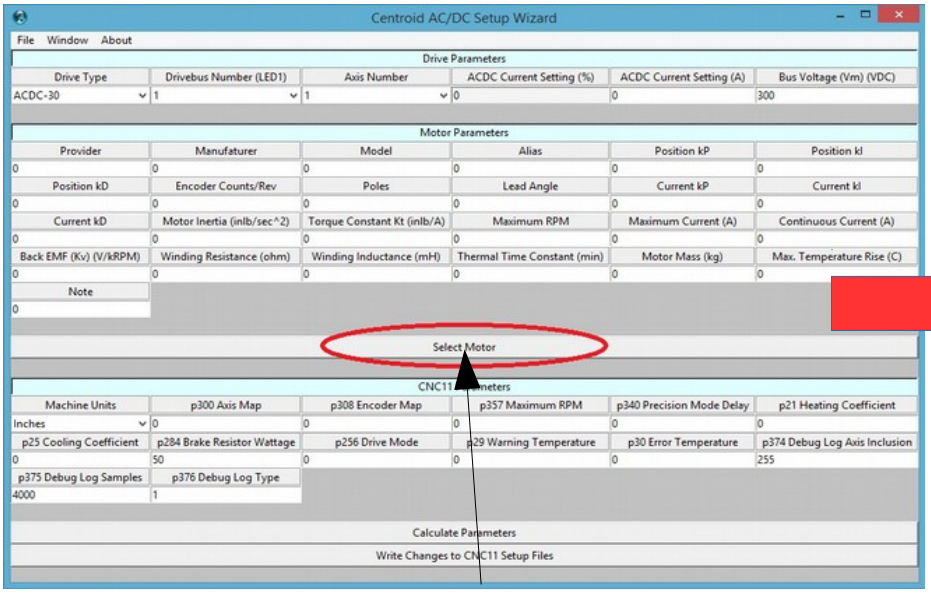
5. Using the Centroid AC/DC Setup Wizard

1. On your desktop, double click on the ACDC Setup Wizard. The tool should looks like the figure 3.3.6 shown below. If **Windows Smart Screen** tries to block this program, click "*more info*", then "*run anyways*".

    1. **NOTE:** Some of the information provided in the wizard is used for calculating values for unknown/unapproved motors. In this manual we will **not** be covering these advanced uses of the tool and can ignore the extra information.

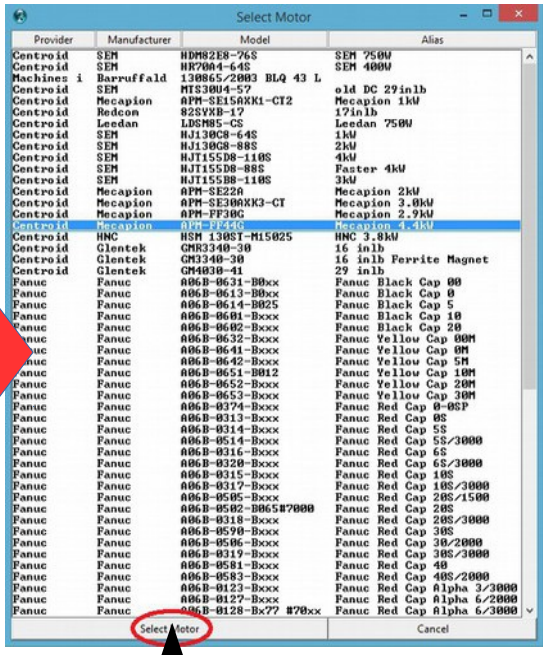
2. Motor Configuration
    1. Click the large "**select motor**" button in the center of the screen circled in Figure 3.3.6
    2. A new window will pop up. Click on the motor you are using for this axis.
    3. With your motor highlighted, click "**select motor**" at the bottom of the screen to finalize your selection as shown in Figure 3.3.7.

Figure 3.3.6
Selecting a motor



Step 1

Figure 3.3.7
Motor selection menu



Step 2

3. Drive parameters
    1. Under “**Drive Parameters**” use the “**Drive Type**” dropdown box to select your model of AC/DC as circled below in Figure 3.3.8.
    2. Under “**Drive Parameters**” set the “**Drivebus Number (LED1)**” and the “**Axis Number**” as circled below. For the first axis, set the Drivebus Number to 1 and the Axis Number to 1. If you have multiple AC/DCs connected together, the first axis is defined as the AC/DC that is farthest away from the MPU11. For most applications you want the drive bus number to be the same as the axis number.
    3. Under “**Drive Parameters**” enter the motor voltage supply value in the “**Bus Voltage (Vm) (VDC)**” field as circled below. This is set by the output of your DC rectifier.
    4. Under “**CNC11 Parameters**” enter your brake resistor wattage into “**p284 Brake Resistor Wattage**” as circled below. In most systems an AC/DC 30 will use 300 watts, and an AC/DC 60 will use 600 watts. The brake wattage is usually printed directly on the resistor.

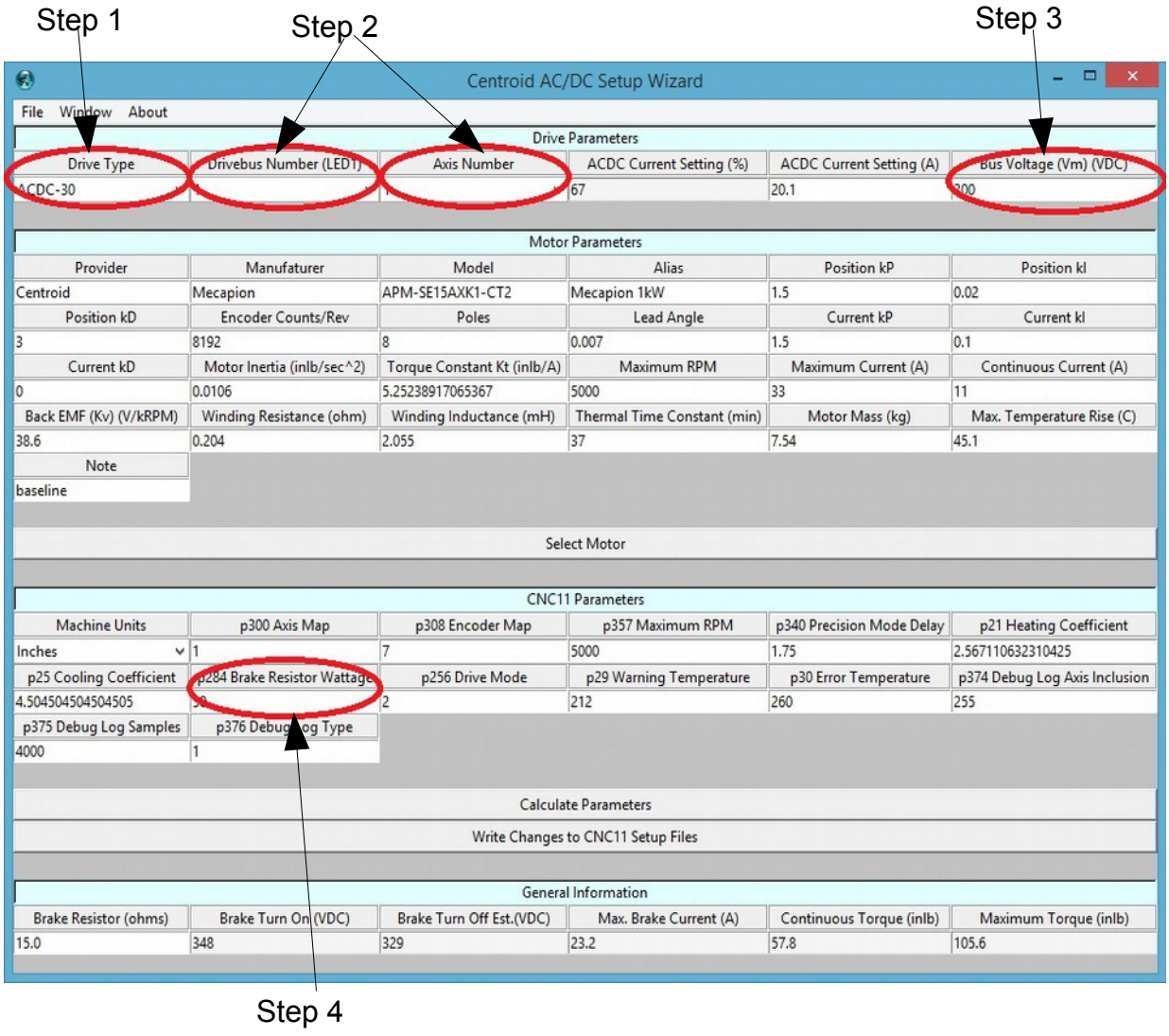


Figure 3.3.8
Entering the parameters into the AC/DC Wizard

4. Motor Parameters and General Information
   1. Under "**Motor Parameters**" enter your encoder counts in the "**Encoder Counts/Rev**" box as circled in Figure 3.3.9.
   2. Under "**General Information**" enter your brake resistor resistance in "**Brake Resistor (ohms)**" as circled below.. For most systems an AC/DC 30 is 15 Ω and an AC/DC60 is 7.5 Ω.
   3. Click "**Calculate Parameters**" as circled below.

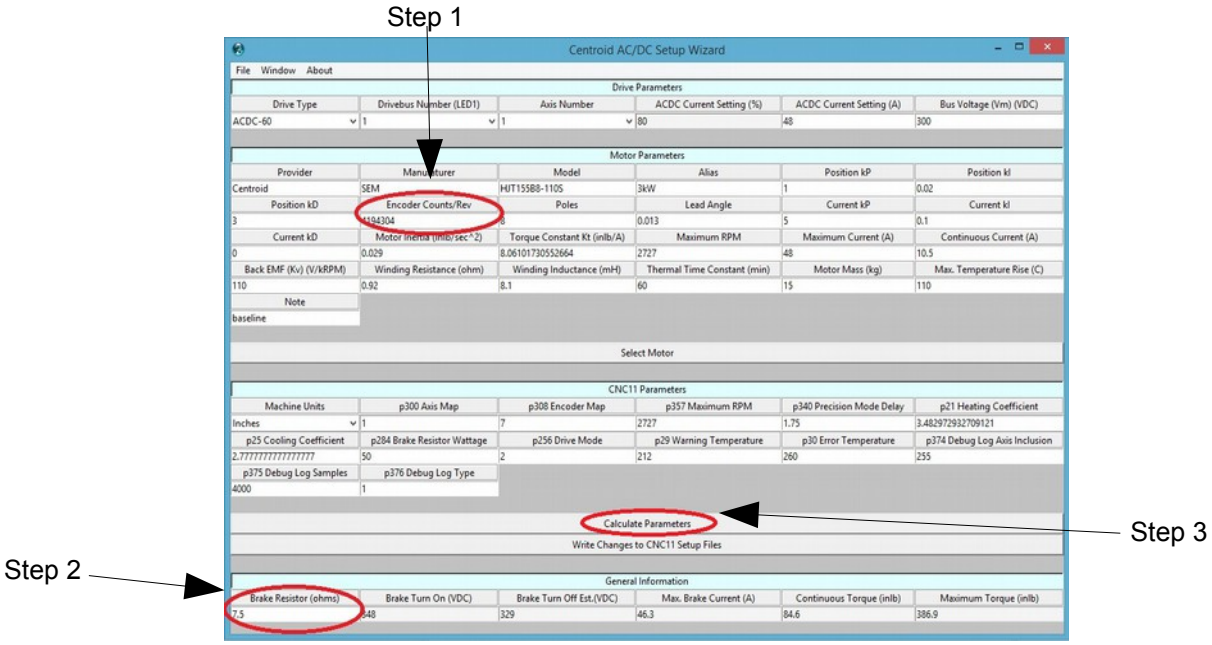


Figure 3.3.9
Final parameters

5. **<u>Take a few seconds to review what the tool calculated.</u>** Look over all the boxes to make sure all values seem reasonable. Check for errors in any of the boxes.

   1. **Troubleshooting and Tips**

      1. If the box labeled "**ACDC Current Setting (%)**" says "**Over 100%**" the drive will still work with the AC/DC. Your motor will not run at maximum performance due to the AC/DC not being able to provide maximum power to the drive.

      2. In the unlikely event that the Wizard does encounters a "**Data Missing**" error, there is a box with missing information. If you get this error, contact technical support.

      3. If you click on the "**Window**" button on the top left of the screen a menu will come up with some additional motor related tools. These tools are provided by Centroid for your convenience and are intended for advanced users.

         1. "**Estimate Motor Performance**" will graph your motor's estimated performance using the data provided. The tool will create a graph of motor power and torque. This estimate may not be accurate on all motor types.

         2. "**Conversions**" will convert from one unit to another

6. With **CNC11 closed**, click "**Write change to CNC11 Setup Files**" and as shown circled below in Figure 3.3.10.

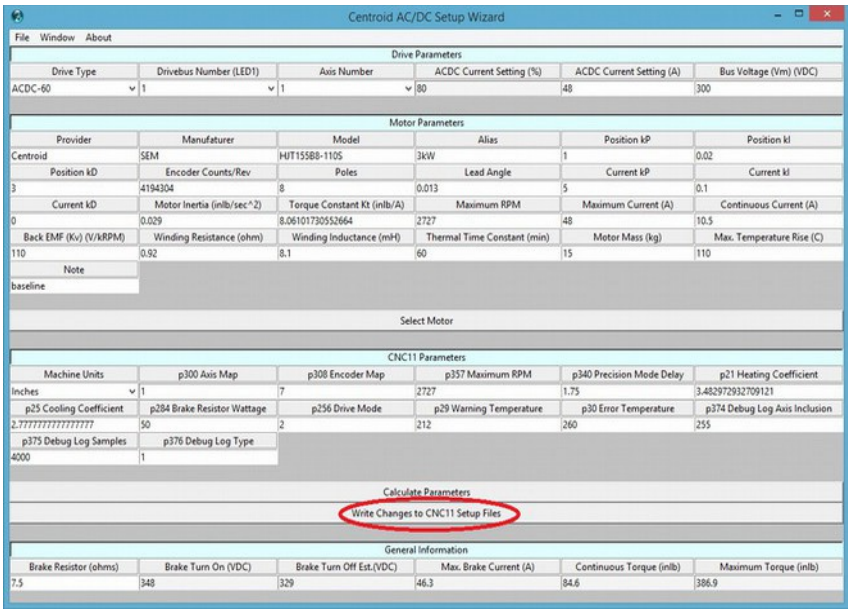


Figure 3.3.10
Writing parameters to CNC11

7. If multiple drives are being used, repeat this procedure.
   1. For the second drive, select 2 for the Drivebus number and axis number. For the third drive, use 3 and so forth.
   2. If all the axes are the same drive model / motor model keep the other parameters the same and continue to the next step. Otherwise, update any other parameters that need changing (such as a different motor for the second axis.)
   3. Recalculate parameters again.
   4. Write changes again to CNC11 setup files.
   5. **Repeat until all drives axes have been set up.**

8. After all drives have been setup close the AC/DC setup wizard.

Congratulations! Your AC/DC(s) have been configured to work with your motors.

Chapter 4
Bench Test

4.1 Software Configuration

Start the CNC11 Software

Troubleshooting

If you clicked on the CNC11 icon to start the software and you are getting "**Timeout: MPU11 not responding**" errors, you most likely didn't have the MPU11 connected to the PC when you installed the software. Check your Ethernet card to make sure it is configured properly.

Go to "**Control Panel**", select "**Network and Internet**", and then "**Network and Sharing Center**". Click on "**change adapter settings**" on the upper left corner of the window, right click on the network icon, select "**Properties**". Highlight "**Internet Protocol Version 4 (TCP/IPv4)**", then click "**Properties**" again.

Select "**Use the following IP address**" then set the IP address and Subnet mask to:

IP address: 10.168. 41.1
Subnet mask: 255.255.255.0

Click **Ok** and then try to start the CNC11 software again.

For more in troubleshooting see Appendices C and D.

If your software has been configured correctly, you should see the screen below. Press **F10** to continue to the main screen. If CNC11 does not start because it timed out waiting for the MPU11, see **Appendix A – Troubleshooting Communication Errors**".

1. **Enter your Software Unlock Demo Code** To enter a software unlock press **F1-Unlock Option**. In "Enter Unlock #:" enter **297** for demos or 298 for permanent unlocks as shown on your unlock sheet**.** This will display the Unlock Value window as shown in Figure 4.1.1. Look at the value in the "Software Unlocks" sheet that shipped with control. Enter the value next to the unlock number.
2. Repeat the process to unlock other options, such as Intercon or DXF import. To get back to the **Software Add-Ons** menu screen from the main menu press **F7 – Utility → F8-Option → F1-Unlock Option**.

Figure 4.1.1
Unlocking Options

From now on when using CNC11, you can always go up one menu level by pressing the escape key (**ESC**). Tapping escape multiple times from any menu will eventually take you back to the main menu.

To do the bench testing temporarily disable the fault protection logic built into CNC11 and the PLC program as specified in the following pages. CNC11 monitors the signal levels of hardware as jog panels and encoder inputs, and will generate a fault if any hardware does not respond as expected. In addition, the ACDC-basic PLC program contains default logic that monitors the inputs for Limit Switches (inputs 1-8), Lube Fault (input 9), Spindle Fault (input 10), Estop (input 11), and Axis Drive Faults (inputs 17-20). If ANY of these inputs are open a fault will be issued.

3. **Change Machine Home Type** To navigate to the "**Control Configuration**" screen. From the main screen press press **F1-Setup → F3 -Config.** The password is **137**. Then press **F1 Contrl.** Using the keyboard spacebar change "**Machine home at power up**" to "**Jog**".
   1. **TIP** If you can not save any of your changes in CNC11, close CNC11. Right click on CNC11 desktop shortcut. Select **properties.** Click on the **Compatibility** tab. Check the box labeled "**Run this program as an administrator**". Click "**Apply**". Click "**OK**". Start CNC11 again.

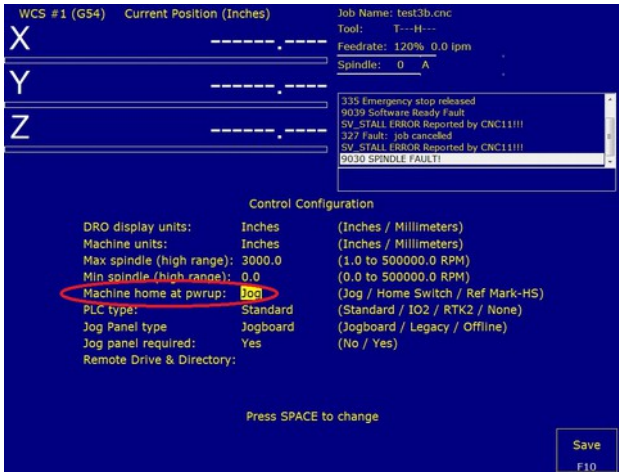


Figure 4.2.2
Changing machine home at powerup to disable limit switches

4. **Disable Jog Panel Communication Faults** *(If you have a jog panel or pendant connected, skip this step.)* If the optional Jog Pendant is not connected for bench testing, disable Jog Panel communication faults. Use the arrow keys to select "Jog Panel Required" in the Control Configuration and press the space bar to toggle to "**No**".

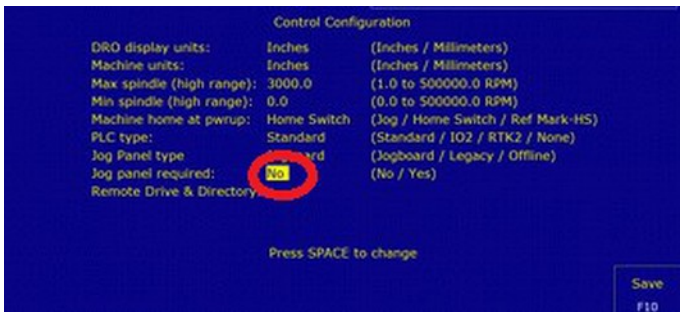


Figure 4.1.3
Disabling jog panel

Press **F10-SAVE** to save. After Saving, Press **escape** to go back to the Main Screen. Press **F10-Shutdown**, → **F2 Power Off**, and then power off the MPU11 and GPIO4D via switching of your outlet strip. Wait 30 seconds and power everything back up.

5. **Disable PLC faults for Limit Switches, Lube, Spindle, Estop and Axis Faults.** At the main screen press the **alt** and **i** keys to bring up the real-time I/O display as shown in Figure 4.1.4. Using the arrow keys, move the selection box to the top left of the inputs. The screen should read "INP1 *Ax1_MinusLimitOk*" as circled below. Press the **ctrl alt** and **i** keys simultaneously to invert this input.

   You will notice that the LED will turn from red to green and a line will be drawn over the top to indicate that it the state of the input has been programmatically inverted. Repeat the process until inputs 1-11 and inputs 17-20 are green as shown below.

   1. **NOTE**: Using alt + I to disable I/O only works for those using the default Centroid provided PLC programs. On a custom PLC program, this feature may need to be added to the PLC code.

Figure 4.1.4
Disabling inputs using alt + i

6. **Label the Axes:** From the main menu, press **F1-Setup → F3 -Config.** The password is **137**. Press **F2 Mach**. → **F2 Motor**. Under "**Label**" configure the software for the correct number of axes and label them appropriately. Any unused axes should be set to "**N**" to disable the axis as seen in Figure 4.1.5.

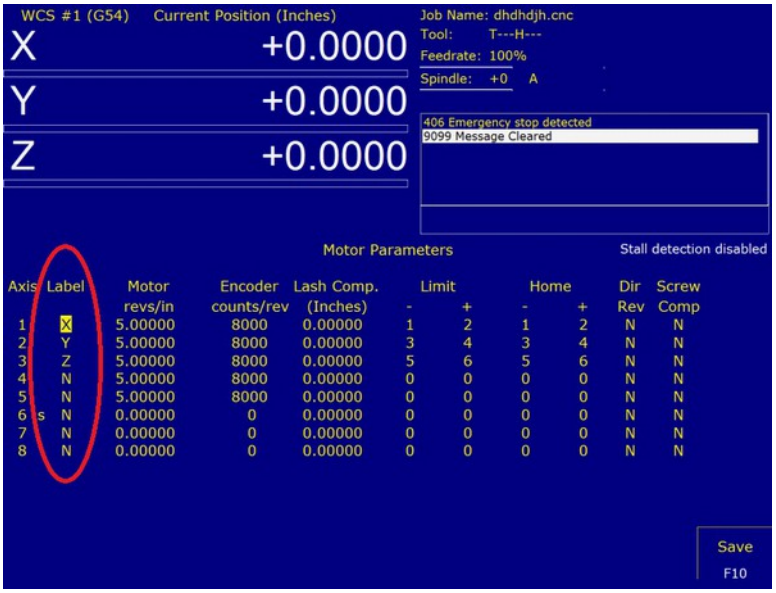


Figure 4.1.5
Labeling the axses and verifying the spindle axis.

7. **Verify Spindle Axis:** Your spindle axis will have an “S” next to it in the motor parameters as shown in Figure 4.1.5. The default is axis 6.

    1. **Reassigning Spindle Axis:** If the spindle axis is set incorrectly, it will have to be fixed by changing parameter 35 in the machine parameters menu as shown in Figure 4.1.6. The machine parameter menu can be reached by pressing **F1-Setup → F3 -Config** from the main menu**.** The password is **137**. Press **F3-Parms**. Use the arrow keys to navigate to the field labeled “35”. Click enter to edit the field. Type in a whole number for the axis that corresponds to yours spindle. Typing in a zero will disable the spindle. Press **enter**, then **F-10 save**. Verify the spindle is set up by going back into the Motor Parameter menu and looking for the S as shown in Figure 4.1.5.

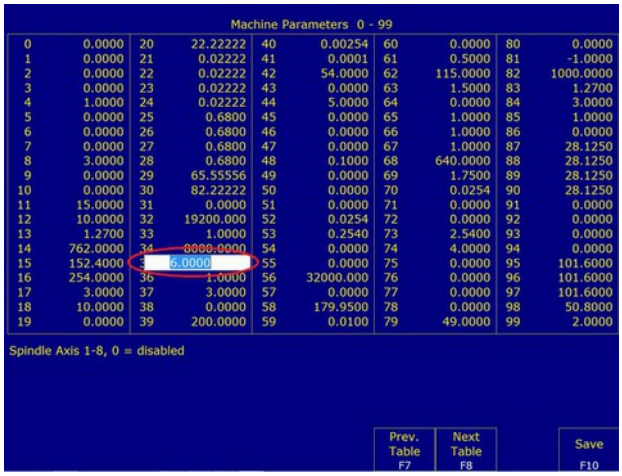


Figure 4.1.6
Setting the spindle axis

8. **Zero out any unused axes** Axis can be turned off in the motor menu, but still be assigned axis numbers in the parameters menu. Go into the parameters menu. The machine parameter menu can be reached by pressing **F1-Setup → F3 -Config** from the main menu**.** The password is **137**. Press **F3-Parms**. Pres F8-Next Table repeatedly until parameters 300-307 are displayed. Set any unused axes to zero. If you need to zero out any axis, the machine will need to be restarted before you can continue.

9. **Clear Software Ready Faults** Anytime the CNC11 software has been exited and restarted without the hardware also being powered off and restarted, the CNC11 software will report a “Software Ready Fault” as demonstrated below in Figure 4.1.7. A “Software Ready Fault”, like spindle, lube, encoder and position fault is a “stop fault”. A “stop fault” removes power from all motors, prevents program or MDI operation, turns off all drive and spindle enables and requires that the Estop input MUST be cycled in order to clear the fault. During the bench test we will trick the software into thinking we cycled the E-stop (not connected yet), by toggling the input 11 using alt + I.

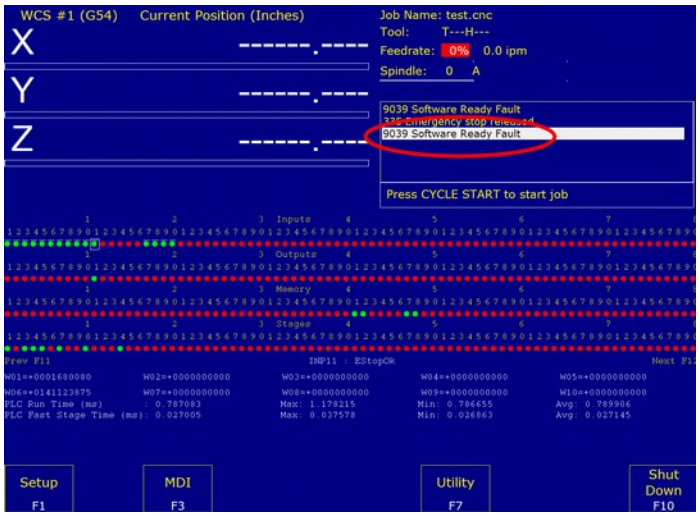


Figure 4.1.7
Software Ready Fault

To clear a stop fault, press the alt-i keys to bring up the real-time I/O screen, use the arrow keys to select the "*EstopOk input(11)*" as shown below in Figure 4.1.8. Press the ctrl-alt-i keys simultaneously to toggle the EstopOK input to red, and press the crtl-alt-i keys again to toggle it back to green.

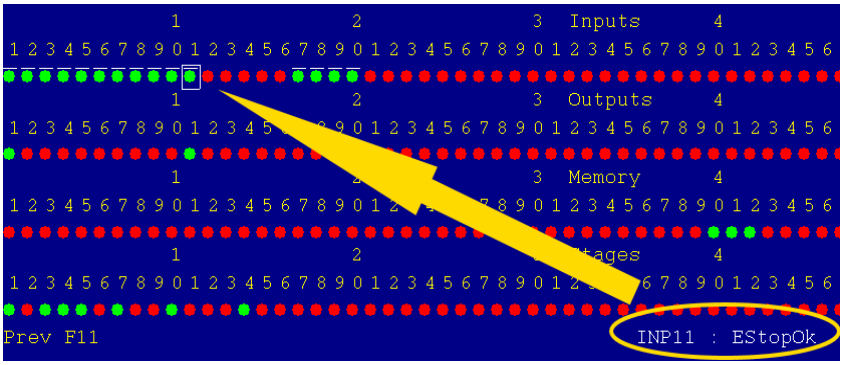


Figure 4.1.8
Toggling E-stop

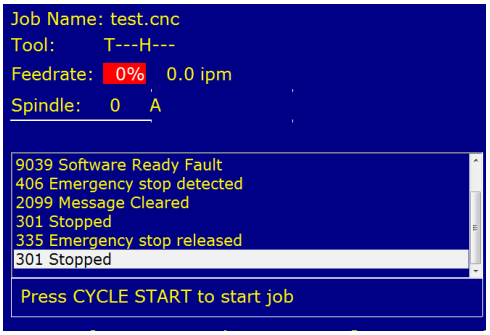


Figure 4.1.9
Status window showing the emergency stop clearing faults.

Notice that as you toggle the EstopOk input to red "*406 Emergency Stop Detected*" is displayed in the status window as shown above in Figure 4.1.9. When the emergency stop is pressed notice how "*2099 Message Cleared*" is displayed, referring to clearing the "*9039 stop fault*". Toggling *EStopOK* back to green displays "*335 Emergency Stop Released*".

10. **Clear Any Existing Faults Before Beginning Bench Testing.** To confirm that all faults have been cleared before continuing, press **F3 MDI** from the main menu. If all faults have been cleared correctly, the screen should look like Figure 4.1.10.

    If the screen shown in Figure 4.1.10 is not displayed, there is an existing fault. Please check the status window to determine the cause of the fault and then clear it as shown in Figure 4.1.8. Confirm that all parameters are set as required and that all inputs (1-11 & 17-20 green) are in the correct state.

    All faults shown in Figure 4.1.11 (as well as other faults) are "Stop Faults". Stop faults cancel existing jobs, prevent new jobs from being started, stop the spindle, prevent motion, and require that the E stop PLC input be cycled (opened and closed) in order to clear the fault before continuing.

    If you have any stop faults, they will have to be removed then E-stop will have to be toggled as shown in the previous step.

Figure 4.1.10
MDI Command Mode

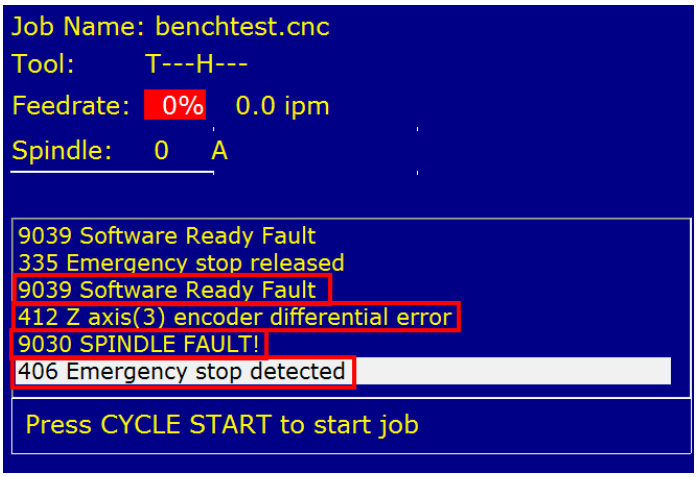


Figure 4.1.11
Faults detected

4.2 Bench Testing the AC/DC

Since the AC/DC is a drive, there is not a lot of I/O testing we can do. Primarily we want to test drive communication with the MPU11 and encoder communication with the drive.

1. From the main menu press **F7 Utility → F9 Logs → F5 HSC.** The HSC menu is the most powerful software tool for troubleshooting an AC/DC. More details about how to use this menu and what each box means is contained in Appendix B. This screen is organized by DriveBus channels, therefore the channel number at the top of a column matches LED1 on the AC/DC. The columns are **not** reorganized by axis according to the drive mapping done in the parameters.

   If everything is connected correctly:

   1. the "**Debug counter**" should be counting in hexadecimal for each drive connected to the system as circled below in Figure 4.2.1. This indicates that the drive is talking to the MPU11.

   2. Make sure the "**Encoder OK**" as circled below is set to a **one** as shown below.

   3. **T**urn each of the motor shafts clockwise by hand. If using an AC motor, **ErrorUVWInvalid**, **ErrorUVWBadTransition**, and **ErrorUVWBadSize** should all be **zero**. **CommutationZone** should count **1-6.** If not using a BiSS encoder, ignore **BissRecptionErrors.** If using a DC motor, **ErrorUVWInvalid**, **ErrorUVWBadTransition**, **ErrorUVWBadSize,** and **CommutationZone** have no meaning and should be ignored.

      1. **NOTE**: A value of "0" for the debug counter means communication was not correctly established between the MPU11 and the AC/DC. Go back and double check your wiring and jumper settings. Give the system a reboot and see if the problems still occurs. If it still is not communicating, consult Appendix A and B for troubleshooting.
      2. **NOTE**: The menu is labeled "AC1 Status" on the top left. AC1 was the original code name of the AC/DC drive. AC/DC and AC1 are the same thing.

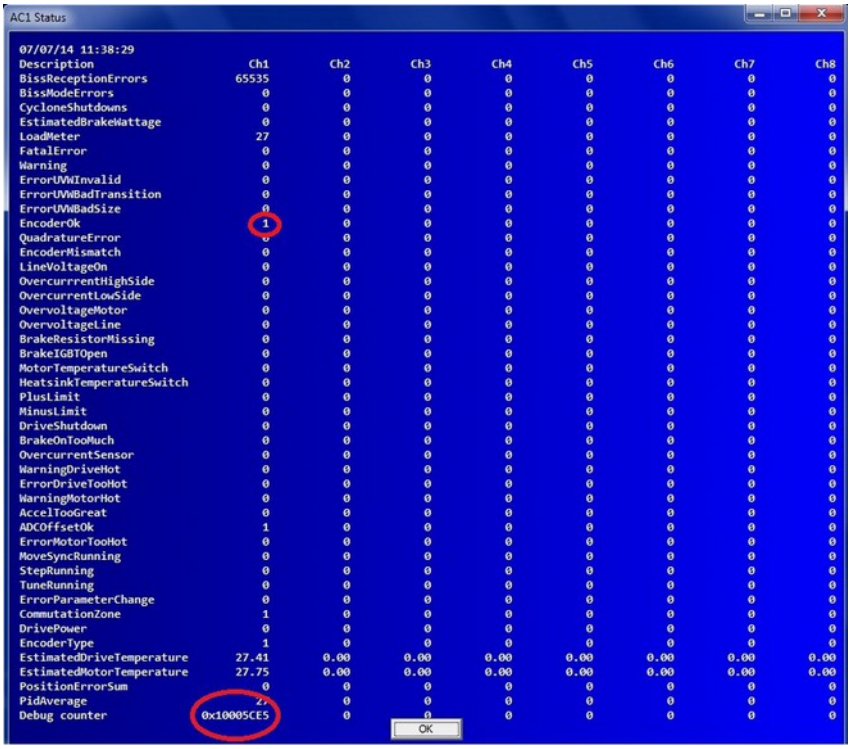


Figure 4.2.1
The HSC screen

2. Press the Estop button in keep it depressed. Go back to the main menu. From the main menu press **F1 -Setup → F3 Config**. The password is **137**. Press **enter → F4 PID**. This will display the PID menu screen below and allow you to monitor the encoder counts by watching the values in "Abs Pos" field (circled below in Figure 4.2.2) for each axis.

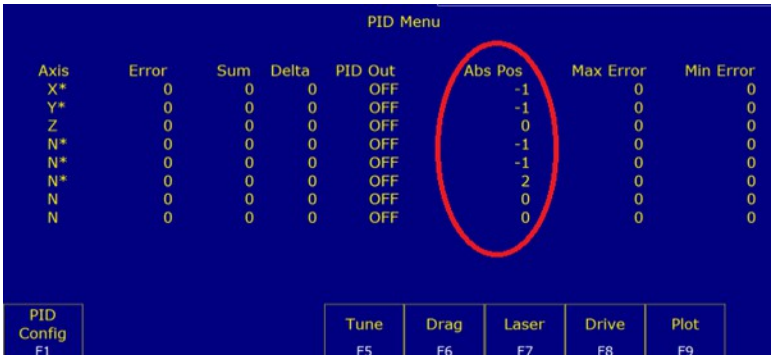


Figure 4.2.2
Watching absolute position of the PID menu

7.5 To confirm that each encoder is wired correctly, rotate the motor shaft Clockwise (as seen while looking at the face of the motor as shown below) and confirm that the counts displayed in the ABS Pos column of the PID menu change. For a DC brushed motor the absolute position value should decrease. For a brushless motor the absolute position should increase.

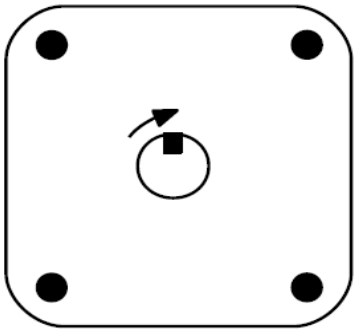
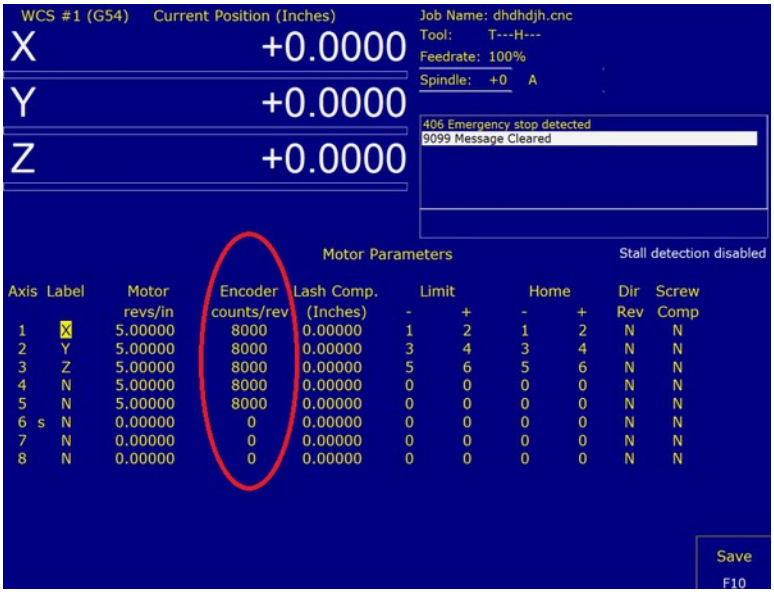


Figure 4.2.3
Rotate the motor clockwise

Record how much the motor counts during one revolution. Go into the motor parameters menu. From the main menu, press **F1-Setup → F3 -Config.** The password is **137**. Press **F2 Mach**. → **F2 Motor**. The **encoder counts/rev** field (circled below in Figure 4.2.4) should approximately match how much the encoder counted when it was turned one revolution.

Figure 4.2.4
Encoder counts per revolution



4.3 Bench Testing the MPU11 and GPIO4D

Bench testing the MPU11 and GPIO4D will confirm that the MPU11 and GPIO4D are operational and that the software has been properly configured to begin the installation process. Bench Testing is **required** as it provides a known base configuration that our support engineers can refer to when trying to diagnose any issues that may have arisen. To complete Bench Testing, a USB thumb drive and DVM (Digital Volt Meter) is required.

1. **Set Home and load spindlebenchtest.cnc:** From the main menu press **F2-Load.** Use the arrow keys to select the file **spindlebenchtest.cnc**

    1. **If spindlebenchtest.cnc is not present in the c:\cncm\ncfiles directory it can be downloaded here: spindlebenchtest.cnc** (http://centroidcnc.com/usersupport/support_files/benchtest/spindlebenchtest.cnc)
    2. Download spindlebenchtest.cnc. If your web browser does not provide an option to download spindlebenchtest.cnc and instead displays a bunch of code, copy the code from your web browser into your default text editor (such as notepad++). Save the file as spindlebenchtest.cnc.
    3. Copy spindlebenchtest.cnc to your CNC11 root directory.
        1. Right click on your CNC11 shortcut
        2. Click **properties** as shown in figure 4.3.1.
        3. A window will pop up, go to the “shortcut” tab and click “**open file location**” as shown in Figure 4.3.2.
        4. Open the folder labeled “ncfiles”. Paste spindlebenchtest.cnc into the ncfiles directoy.
        5. In the load menu of CNC11 press **F8-refresh**.
2. With spindlebenchtest.cnc highlighted, press **F10 Accept**. If the DRO does not display when you press alt-s, you likely encountered a fault. See clearing faults is covered in section 4.3.3

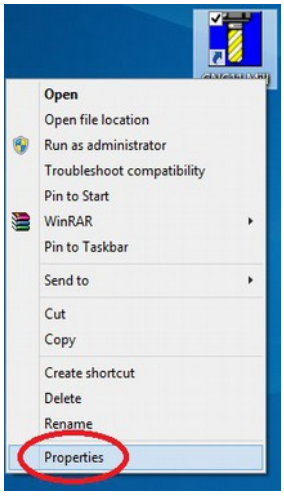


Figure 4.3.1
Right click on CNC11 and click “properties”

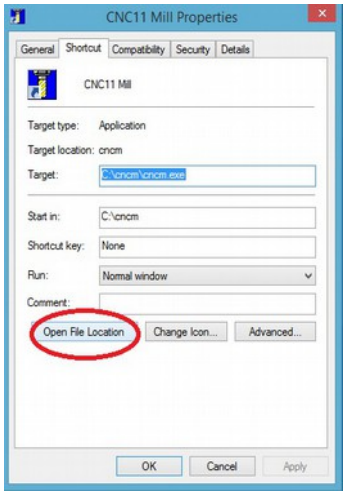


Figure 4.3.2
Select the “shortcut” tab and click “Open File Location”

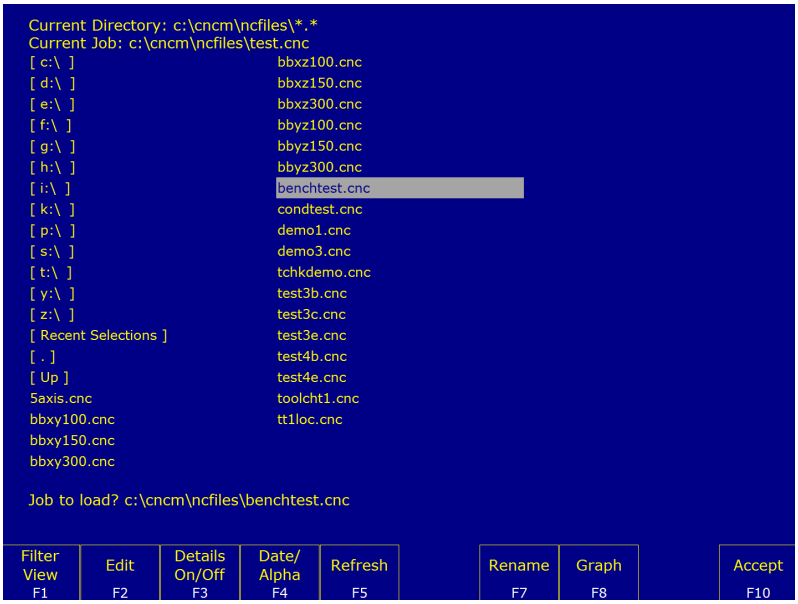


Figure 4.3.3
Selecting Benchtest.cnc

Testing the analog output for the spindle: The GPIO4D provides a 0 to +10VDC analog output to provide programmable spindle speed control using a VFD (variable frequency drive). The default maximum spindle speed specified in the Control Configuration is 3000rpm. This configures the control to scale the 0 to +10VDC from 0-3000rpm. A spindle speed command of S1500 will therefore output +5VDC, a command of S1000 will output +3.33VDC and so on.

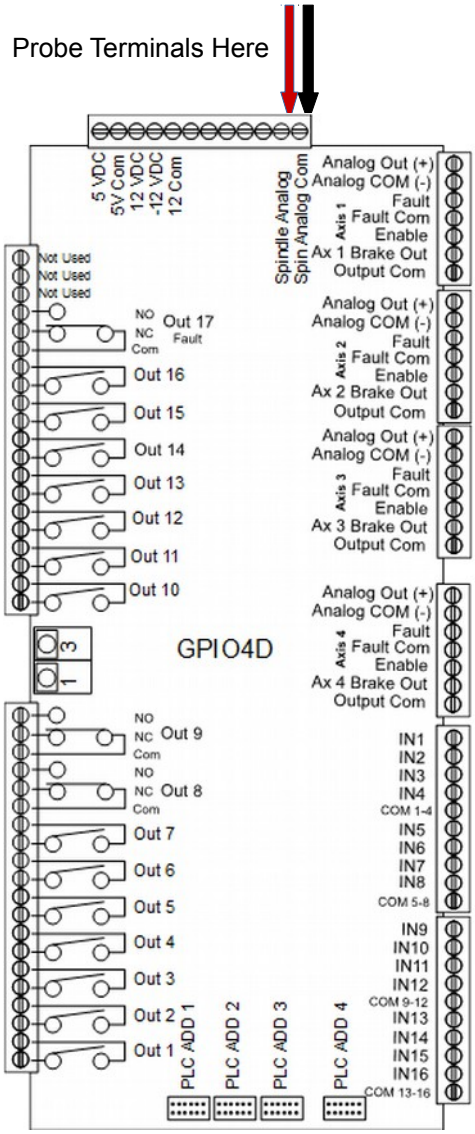


Figure 4.3.4
Selecting
Benchtest.cnc

1. Set a digital voltage meter to VDC as shown in Figure 4.4.4.

2. Insert the digital voltage meter leads into H6 as shown in Figure 3.9.4. Tighten **down the screw terminals to firmly grip the probes.**

3. With benchtest.cnc loaded, press Cycle start (alt-s) to begin. The following screen will be displayed: (You may have to press Cycle start twice)

```
Welcome to the Bench Testing Utility.
Please make sure you have a DVM and a copy of the Installation Manual on hand.
Press Cycle start (alt-s) to continue
```

4. Enter the voltage readings as pictured, and press Cycle start to continue.

```
Voltage Reading #1 - S500
Enter the voltage (VDC) read between Spindle Analog and Spindle Analog Com
Press Cycle start (alt-s) to continue
.612
```

Chapter 5
Electrical Cabinet Installation

5.1 Introduction to Electrical Cabinet Layout

Now that you are finished with the board level test it is time to think about electrical cabinet installation. In this chapter of the manual we will go into detail about how to wire the various systems into your cabinet. Below is a sample AC/DC electrical cabinet from Centroid in the final stages of wiring. *(Note: some of the wiring in the picture below is in the process of being added).* During cabinet wiring it is important that you follow the schematic provided by Centroid. The following page and the picture below outline some basic best practices.

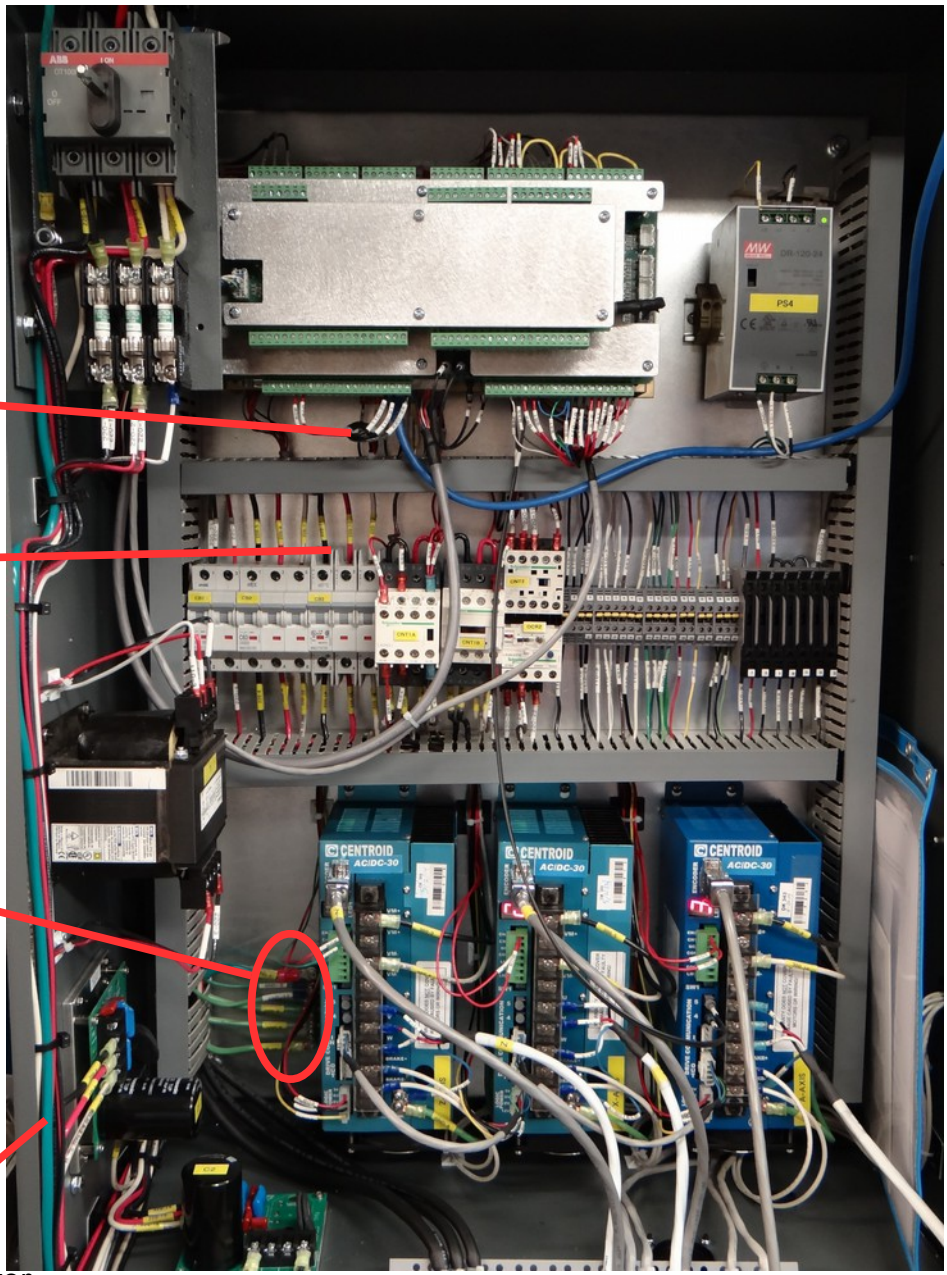


Figure 5.1.1
Sample Electrical Cabinet

- **Minimize Noise and Interference**
  - **Keep sensitive electronics away from noisy equipment.** Install high voltage drives, rectifiers, transformers, contactors, and other electrically noisy equipment as far away from low voltage circuit boards (such as the MPU11 or GPIO4D) as practical.
  - **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 signals as practical.
  - **Grounding Principle**. Wire the incoming chassis ground lug directly to a single ground bus bar as shown in the picture on the previous page. Wire all cabinet doors, AC/DC chassis grounds, power supply chassis ground, 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.
  - **Leave plenty of space between wire ducts and components.** Keep wire ducts at least 2" away from components when practical.
  - **Use Snubbers on Contactors.** Contactor blocks 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/usersupport/support_files/tbs/tb206.pdf)
- **Keep the cabinet maintainable and easily serviceable.** Centriod can provide electrical cabinet materials such as contactors blocks, time delay contactor blocks, relays, fuse blocks, din rails, overload relay with fuses, din rail end stops, terminal blocks, etc. Call Centroid for details.
  - **Wire management** Use PVC wire ducts (such as Panduit Panduct) to keep your wires neat and organized.
  - **Use DIN Rails** Use DIN rails for mounting relays, contactors, terminal blocks, circuit protection blocks, disconnects, etc.
  - **Leave a little bit of slack in the wire**. 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.**
  - **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.
  - **Don't lose the schematic.** Keep the schematic attached to the cabinet somewhere so it doesn't get lost.
- **Use the correct AWG** Below is the **minimum** AWG for the AC/DC.

Minimum Wire Gauge (AWG)[1]

	Motor Power Cable	Vm+, Vm-	Brake+, Brake-	Logic Power
AC/DC-30	16	14	16	16
AC/DC-60	12	10	12	16

1. Recommendations for typical applications – cable lengths, drive current setting, and motor loads may change requirements. Always follow the electrical code.

Common Wiring Problems

The following information is also covered in Technical Bulletin #78 which can be found here.
(http://www.centroidcnc.com/usersupport/support_files/tbs/tb078.pdf)

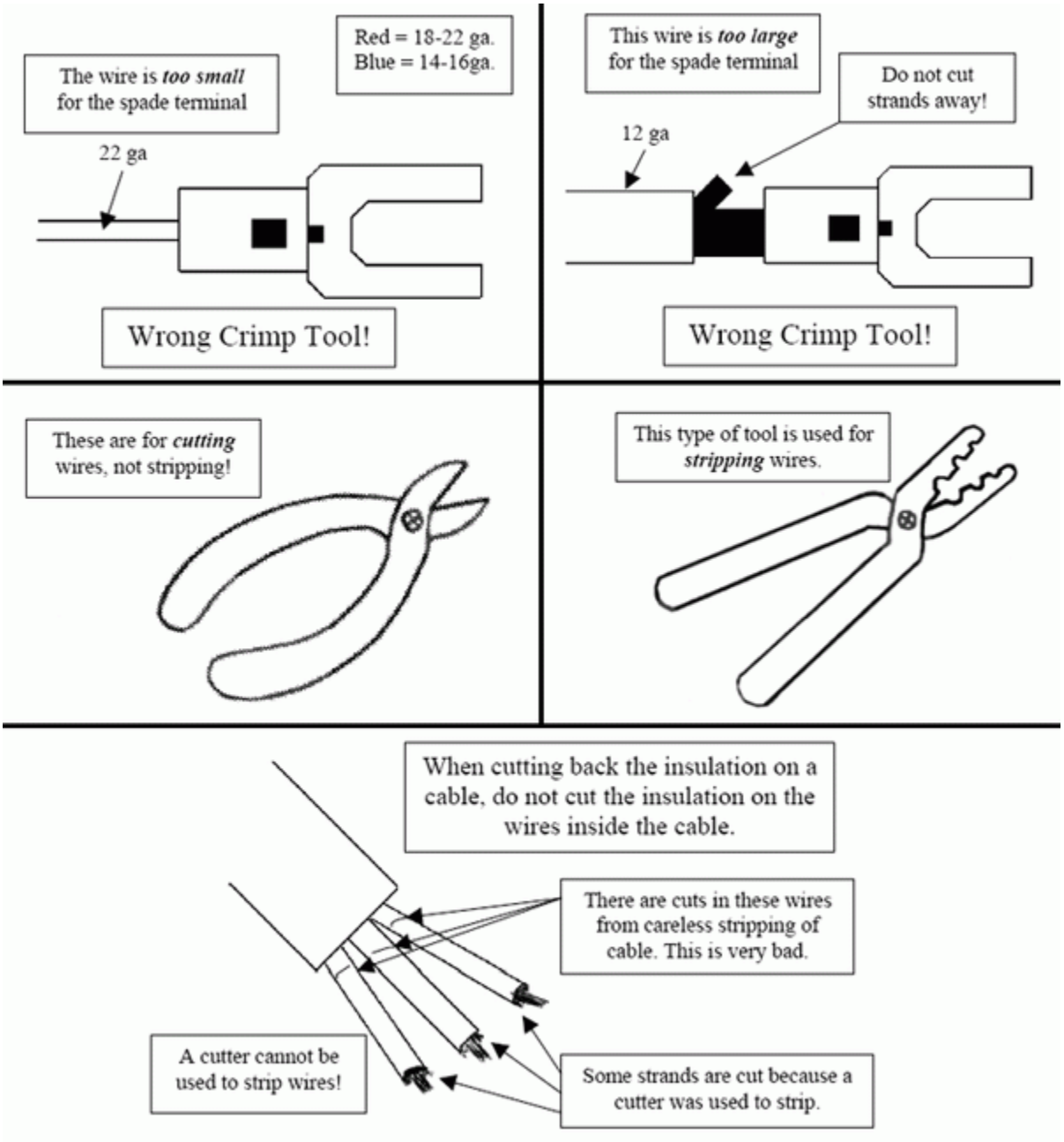


Figure 5.1.2
Common Wiring Problems

5.2 Electrically Configuring Inputs on the GPIO4D

The inputs of the GPIO4D can be configured for either 5, 12, or 24 volts DC. The input voltage is changed by changing the resistance of the SIP (single inline package) resistor. By default the GIO4Ds come with SIPs for 24VDC installed. If you are using a voltage other than 24VDC, the SIPs need to be changed.

The SIP resistance is the defined by the last three numbers of the manufacturers part number as shown in Figure 5.2.1. Of the last three numbers, the first two digits signify the value of the resistance. The last digit signifies the number of zeros after the value. For example if the manufacturers part number is “4308R-102 LF – 222”, the values 222 define the resistance. The resistance is 22 plus two zeros, so the final value is 2200 Ohms. The chart next to Figure 5.2.1 defines which resistors are needed for which voltages.

Voltage Level	Centriond SIP Part #	SIP Value
5VDC	3950	470 Ohm(471)
12VDC	4152	1K Ohm(102)
24VDC (default)	1548	2.2K Ohm(222)

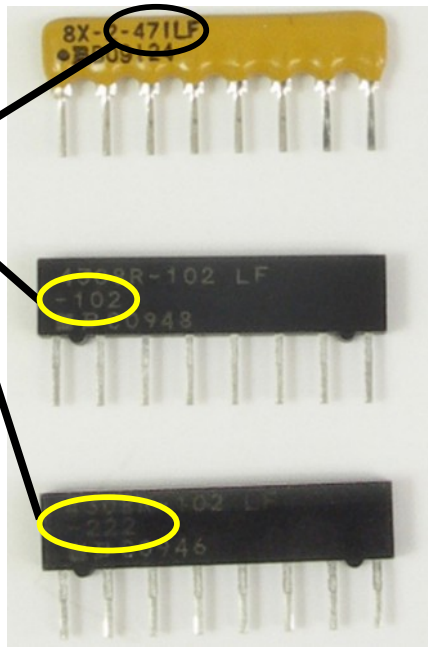


Figure 5.2.1
Reading SIPs

Looking closely at the GPIO4D, the silkscreen is labeled “SIP1, SIP2, SIP3, and SIP4” as shown in Figure 5.2.2. Each SIP controls a group of I/O as demonstrated by the table below.

Input Group	SIP Number
Inputs 1-4	4
Inputs 5-8	3
Inputs 9-12	2
Inputs 13-16	1

Figure 5.2.2
Location of SIPs

All inputs on the GPIO4D can be configured for sourcing or sinking operation using either 5VDC, 12 or 24 VDC. The inputs are arranged in groups of four with a common shared by each input in a group.

There are two ways to wire I/O on the GPIO4D:

- **Sourcing** Connecting the inputs to power is sourcing. The netagive lead of the power supply must be connected to common. This is demonstrated on inputs 1-4 in Figure 5.2.3.

- **Sinking** By connecting the inputs to ground is sinking. The positive lead of the power supply must be connected to common. This is demonstrated on inputs 5-8 in Figure 5.2.3

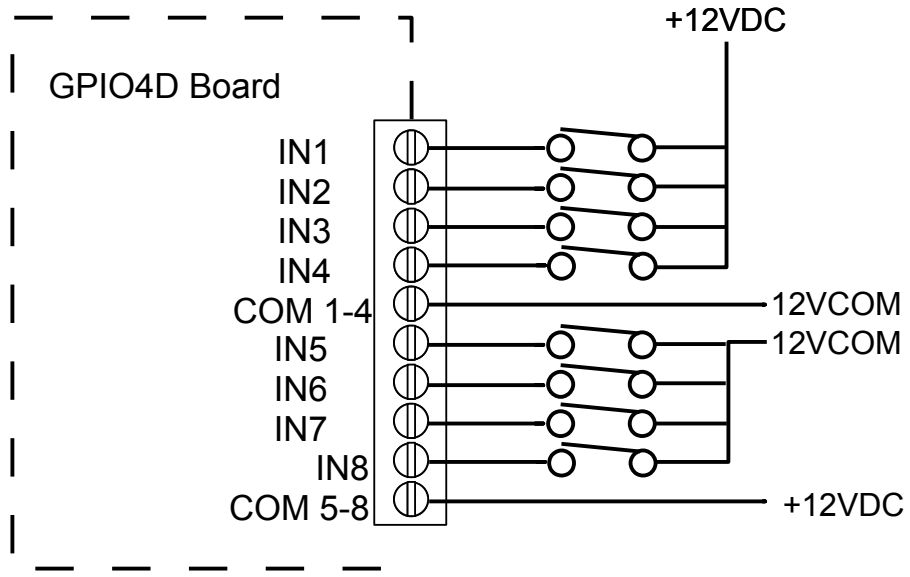


Figure 5.2.3
Wiring Limit
Switches

5.3 Wiring Motors

The AC/DC supports over 60 different motors. Including over 50 different Fanuc motors, 6 SEM motors, and 4 Mecapian motors. The easiest way to install an AC/DC is with motors provided by Centroid. Users should only use motors on the list of motors found in Appendix G. What if your motors not on the list? For an evaluation fee, Centroid can evaluate your motor and provide you with the correct software parameters.

In the future, Centroid plans on bringing an advanced set of features to the Centroid CNC11 software, allowing users to calculate their own software parameters without the need to have Centroid evaluate their motors.

Motor Installation Procedure

1. On the motor, check for >100 MΩ between the motor chassis, and the motor power terminals.
2. On the AC/DC drive, check for >100 MΩ between the motor chassis and the power terminals.
3. Wire the motors to the drive.
    1. 16 AWG minimum is required for the AC/DC 30. 12 AWG minimum is required for the AC/DC 60.
    2. For AC motors connect the U, V, and W to the corresponding terminals of the AC/DC. For DC motors connect the negative wire to the V terminal and the positive wire to the W terminal as shown below in Figure 5.3.1.
    3. Ground the motor power cable to the AC/DC Chassis as shown below in Figure 5.3.1.

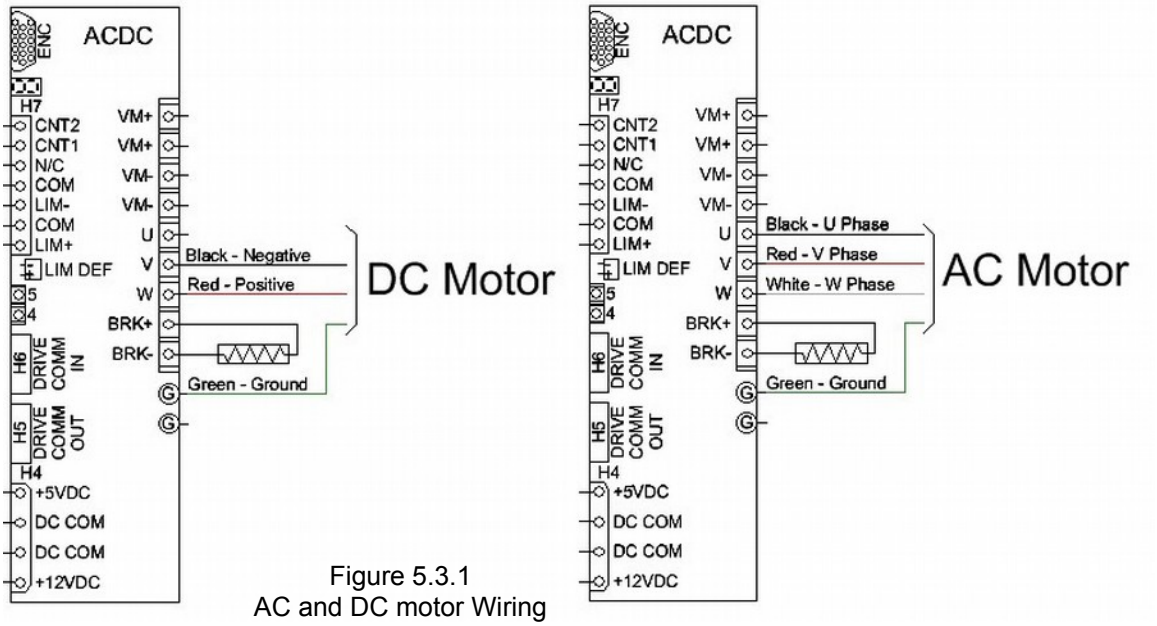


Figure 5.3.1
AC and DC motor Wiring

4. With the motors connected, confirm continuity between motor chassis and the AC/DC chassis using a DVM/multimeter.
    1. **DANGER** An ungrounded motor is an electrocution hazard. Always confirm continuity with a multimeter!

5.4 Wiring AC/DC Brake Resistor

A motor acts like a generator when it is trying to slow down. The AC/DC slows the motor by converting unwanted electricity into heat using a brake resistor. Therefore, the brake resistor gets **extremely hot** and can run over 65C or 150F.

Centroid recommends installing the brake resistor outside the electrical cabinet, but always consult with your local electrical code first and be sure to follow any safety requirements. Care must be taken to ensure that the brake resistor gets adequate air flow, and does not overheat the electrical cabinet or pose a burn hazard. Always keep the electrical cabinet below 40°C (104°F). A guard can be fabricated around the brake resistor if needed to prevent accidental burns.

Brake resistors are **NOT** polarity sensitive.

Centroid recommends using two 300 watt 15 ohm brake resistors *(Part Number 7352)* in parallel for an AC/DC60, and one 300 watt 15 ohm brake resistor *(Part Number 7352)* for an AC/DC 30. 12 AWG minimum is required for an AC/DC60, and 16 AWG minimum is required for an AC/DC-30.

5.5 Wiring E-Stop

(refer to the picture on the next page)

1. **E-Stop Wiring** The E-stop is a safety mechanism used to shut off the machine during an emergency. The switch should be closed when the machine is in it's operational state. Wiring E-stop in a normally open configuration is dangerous as it will not stop the machine in the event that a wire breaks. It also prevents noise from causing spurious faults because the signal is being electrically held at the operational level.

    1. **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.

    2. **GPIO4D E-Stop** - Input 11 needs to be routed through your E-stop switch so the PLC knows if the E-stop is engaged. The coil voltage that controls the Estop contactor is routed through <u>two</u> sets of fault relays on the GPIO4D. The Estop switch and fault relays are wired in series so that, if any of the circuits is opened the Estop contactor is dropped out.

        1. The first relay, Output1, is controlled by the PLC program. It can be used to drop the Estop contractor based on any PLC event.

        2. The second relay, Output17, is used to drop the Estop contractor in the event that a fault occurs that the PLC is not be able to recognize – such as a hardware communication error between the GPIO4D and the MPU11.

    3. **AC/DC E-Stop** - Wire the AC/DC E-stop relay in series with the GPIO4D E-stop relay as shown on the next page. Treat CN1 (pin 2) as your E-Stop input for the AC/DC, and CN2 (pin1) as your E-stop output for the AC/DC. This allows the AC/DC to cut the power to the motors in the event of a fault, even if they have lost communication with the MPU11 and GPIO4D.

    4. **Contactor –** A snubber needs to be placed across the contactor(s). Centroid recommends using Quencharc snubber networks (Centroid PART# 1819). This reduces electrical noise when the motor power is cycled on and off.

    5. **Voltages**

        1. **GPIO4D Inputs –** The example on the next page uses +12VDC for input 9. This voltage can be 5 to 24 VDC depending on the SIPs used in the GPIO4D as demonstrated in section 4.2

        2. **GPIO4D and AC/DC Relay Outputs** – In the example on the next page 24VAC is used for the relays. The relay outputs on the AC/DC and GPIO4D are rated for up to 30 VDC @ 5 amps OR up to 125 VAC @ 10 Amps. It is best practice to use lowest practical voltage with your relays, as higher voltages create more electrical noise and interference.

2. **Testing E-Stop Wiring**

    1. Power up your system.
    2. Start CNC11 and press F10 to continue to the main screen
    3. Enable the E-stop (which was inverted during board level testing). In the main menu press alt + I to bring up the real time I/O display.
    4. Click on input 11.
    5. Press the ctrl-alt-i keys simultaneously to remove the bar over the input in the display, enabling your E-stop.
    6. Toggle the E-stop. Confirm that input 11 is green when the E-stop is released (not tripped).

Example E-Stop Wiring

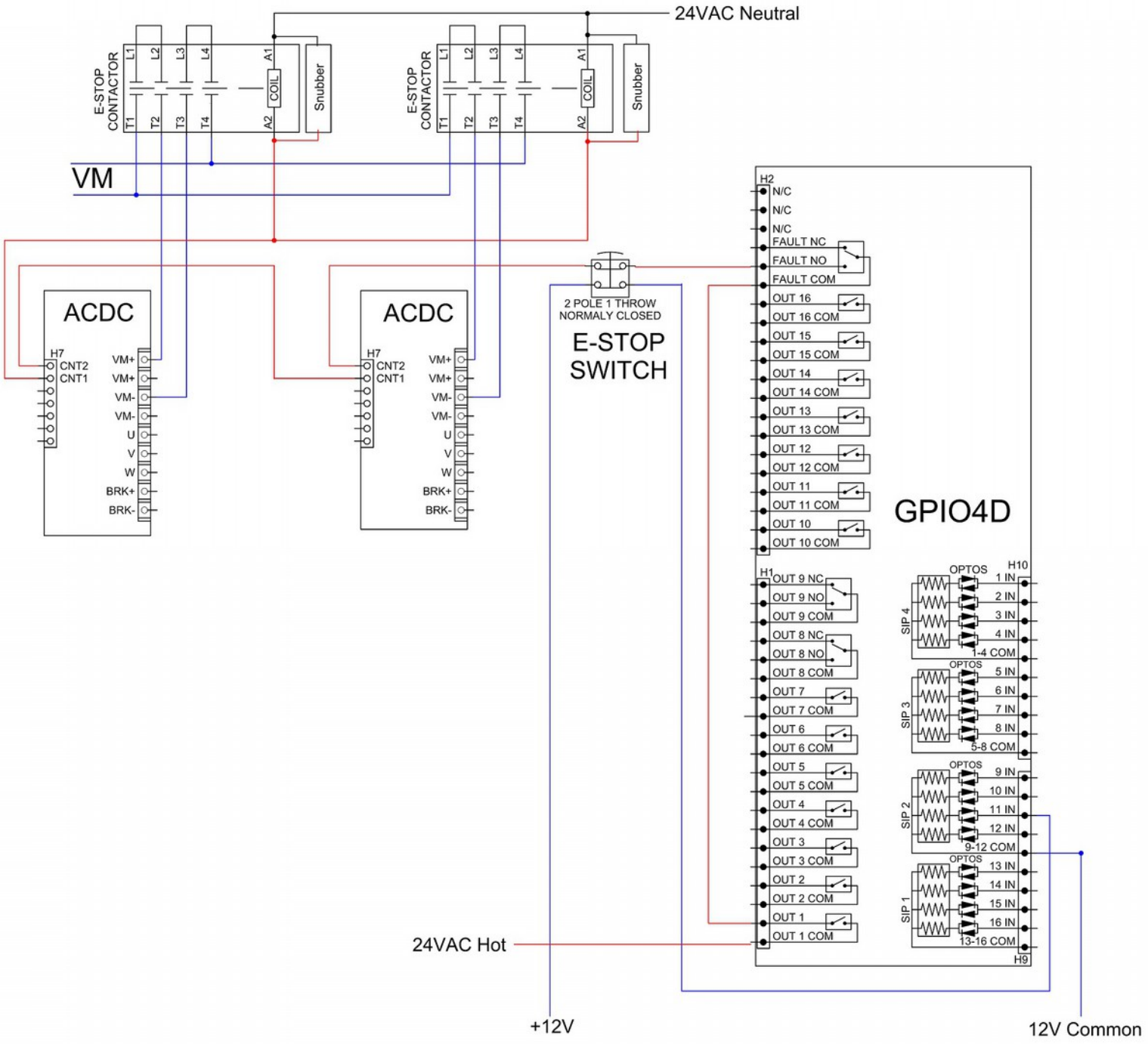


Figure 5.5.1
E-Stop Wiring

5.6 Wiring Limit Switches

All inputs used for Limit switches must be wired in normally closed configuration. The switch should be closed when the machine is in its operational state. Wiring any of these inputs in a Normally Open configuration is dangerous as the machine will not stop in the event that a wire breaks. It also prevents noise from causing spurious faults because the signal is being electrically held at the operational level.

The I/O configuration on every machine is different. While the examples below assume dry contact type switches and utilize 12VDC, your machine may utilize different voltage levels and different type devices 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. Make sure the SIPS you installed in section 4.2 match the voltage levels for your devices.

Failure to install the proper SIPS to match the voltage levels being used will damage the GPIO4D.
Do not use the limit switch I/O on the AC/DC. At the time of this writing, they are not supported.

Connect your limit switches as shown below in Figure 5.6.2.

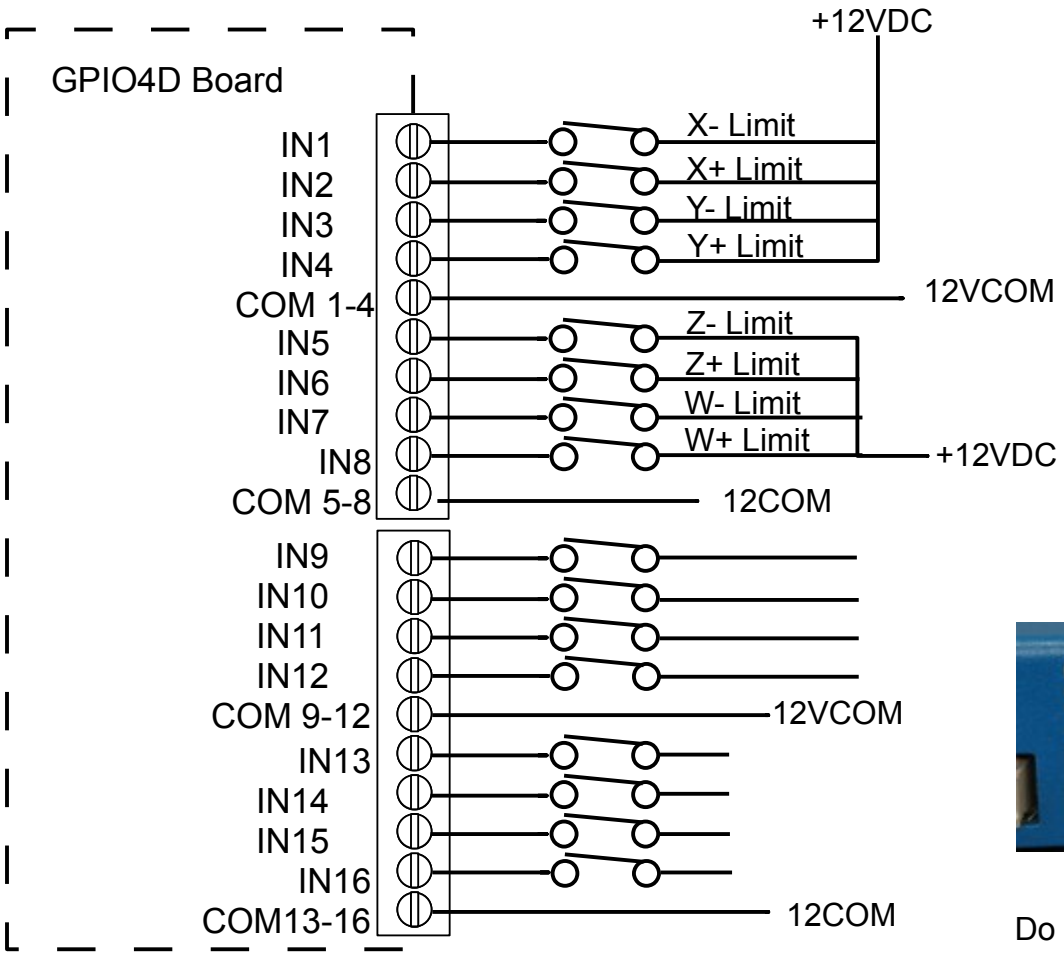


Figure 5.6.2
AC/DC limit switches.

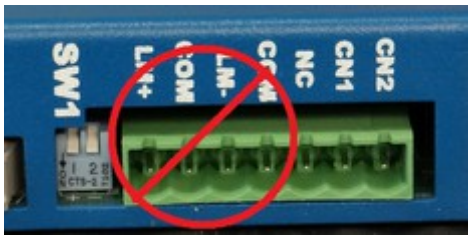


Figure 5.6.1
Do **not** use AC/DC limit switches.

Testing Limit Switch Wiring

1. Power up your system.
2. Start CNC11 and press F10 to continue to the main screen
3. Invert the limit switches (which were inverted during board level testing). In the main menu press alt + I to bring up the real time I/O display.
4. Click on limit switch inputs (input 1 - 8), and press the ctrl-alt-i keys simultaneously to remove the bar over the input in the display. This will enable your limit switches.
5. Confirm that all limit switches are are green when nothing is tripped. Confirm that the correct input turns red when the switch is tripped.

5.7 Wiring Lube Pump

(refer to the picture on the next page)

The typical lube pump circuit consists of two parts: The first part is the control of the lube pump itself which is controlled by **output 2** sending 110VAC to the lube pump. The second part is the low lube alarm signal which gets wired to **input 9**. The low lube signal tells the control to produce a "**405 Low lube**" alarm which inhibits the control from starting a new job until the lube pump is refilled and the alarm is cleared.

Keep in mind that the GPIO4D output relay is rated for up to 5 amps DC or 10 Amps AC. If your lube pump draws more current you will need to install a contactor.

When wiring your lube pump it is important to know which type of lube pump you have so that you configure it correctly. Typically lube pumps come in one of 3 types:

- **Mechanical Cam Actuated Lube Pump:** This pump is based on a simple mechanical plunger riding on a clock motor driven cam. The advantage of this type of lube pump is that it is reliable and it remembers where it was and how much run time has been accumulated even between power cycles. So that you actually get lube every 10 minutes for 5 seconds of machine use.

- **Electronic Lube Pumps:** These pumps try to imitate the mechanical cam pumps but often forget where in sequence they were when powered off. There are two types of Electronic lube pumps, "lube first" which pumps lube immediately after power on. Which typically results in too much lube. The second type is "lube last", this type waits a set amount of time before lubing the machine. The problem with this type is on small jobs your machine may never get any lube, therefore possibly damaging the machine. To avoid this some people wire the lube last type to get power all the time which then results in too much lube.

- **Direct controlled lube pumps:** These pumps are controlled by the control via the PLC program and the software. With this type the lube pump is not responsible for the timing of the pump actuation. This method is the best for reliable, even lubing of your machine. Centroid Users see Tech Bulletin #171 and Parameter 179 in the operators manual for further explanation.

Enabling Lube Inputs

1. Power up your system.
2. Start CNC11 and press F10 to continue to the main screen
3. Invert the lube fault input (which was inverted during board level testing). In the main menu press alt + I to bring up the real time I/O display.
4. Click on input 9, and press the ctrl-alt-i keys simultaneously to remove the bar over the input in the display. This will enable your lube fault input.
5. Confirm that lube fault is green when nothing is tripped. Confirm that the correct input turns red when the switch is tripped.

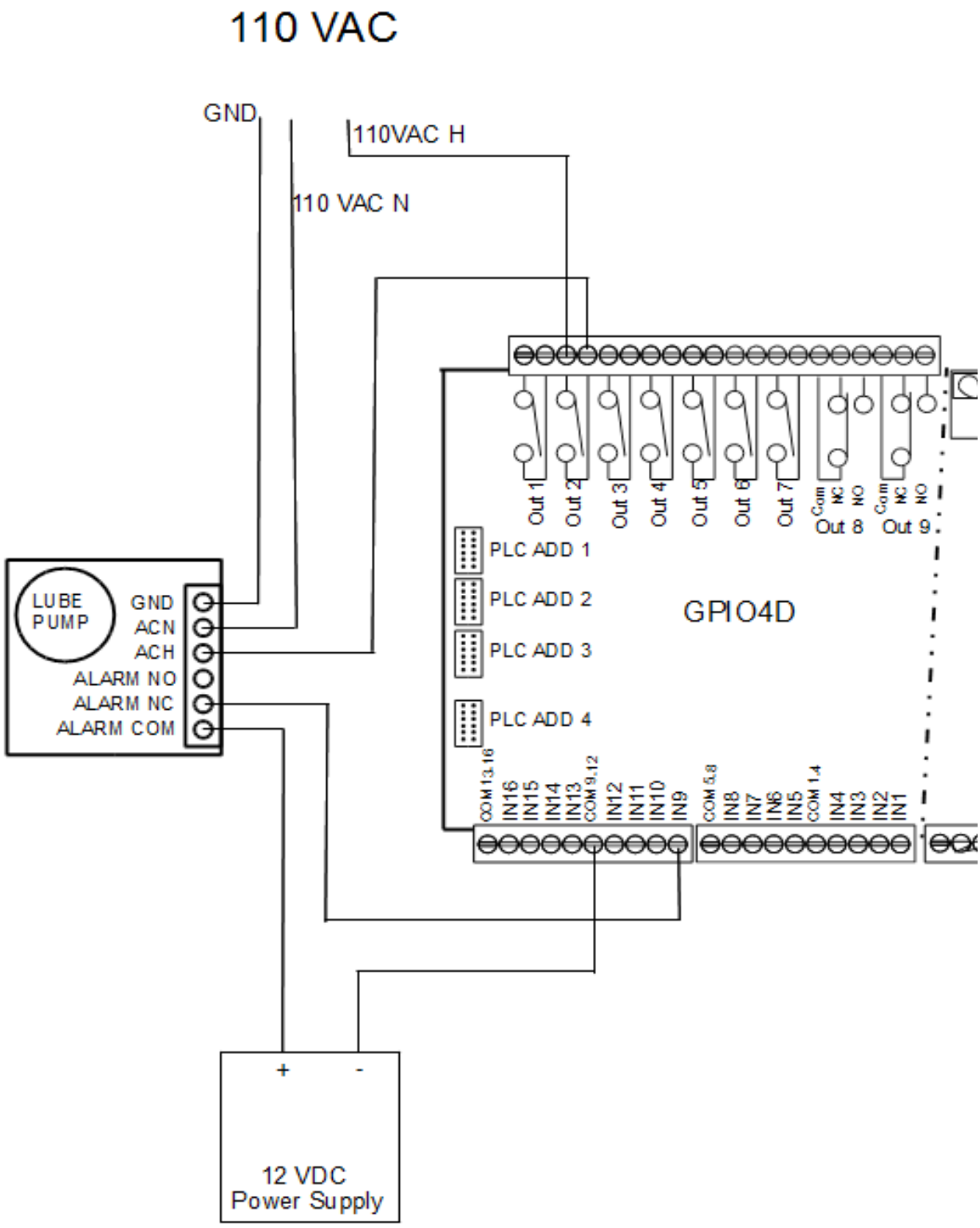


Figure 5.7.1
Sample Lube Pump Circuit

5.8 Wiring Coolant Pump

By default GPIO4D **output 3** is the coolant flood pump output and **output 4** is the default output for a coolant mist pump. If you have a custom PLC program your I/O may be different.

This sub-circuit shows how to hook up a 3 phase Flood Pump. Because the pump in this example draws more power than the GPIO4D is rated for, a Flood Contactor (Centroid PART# 3959) is needed.

All contactors need a snubbers. Centriod recommends using the Quencharc snubber network (Centroid PART# 1819) on the coil of the contactor. This reduces electrical noise when flood coolant is cycled on and off. A thermal overload is also shown, this part protects the motor by opening the circuit if it stalls for any reason, such as metal chips in the pump.

Centroid recommends a thermal overload protector. The example below diagram depicts the 24VAC wired through the NC contacts on the overload section of the contactor. The overload protection circuit on your existing contactor may be labeled differently or there may be no overload protection.

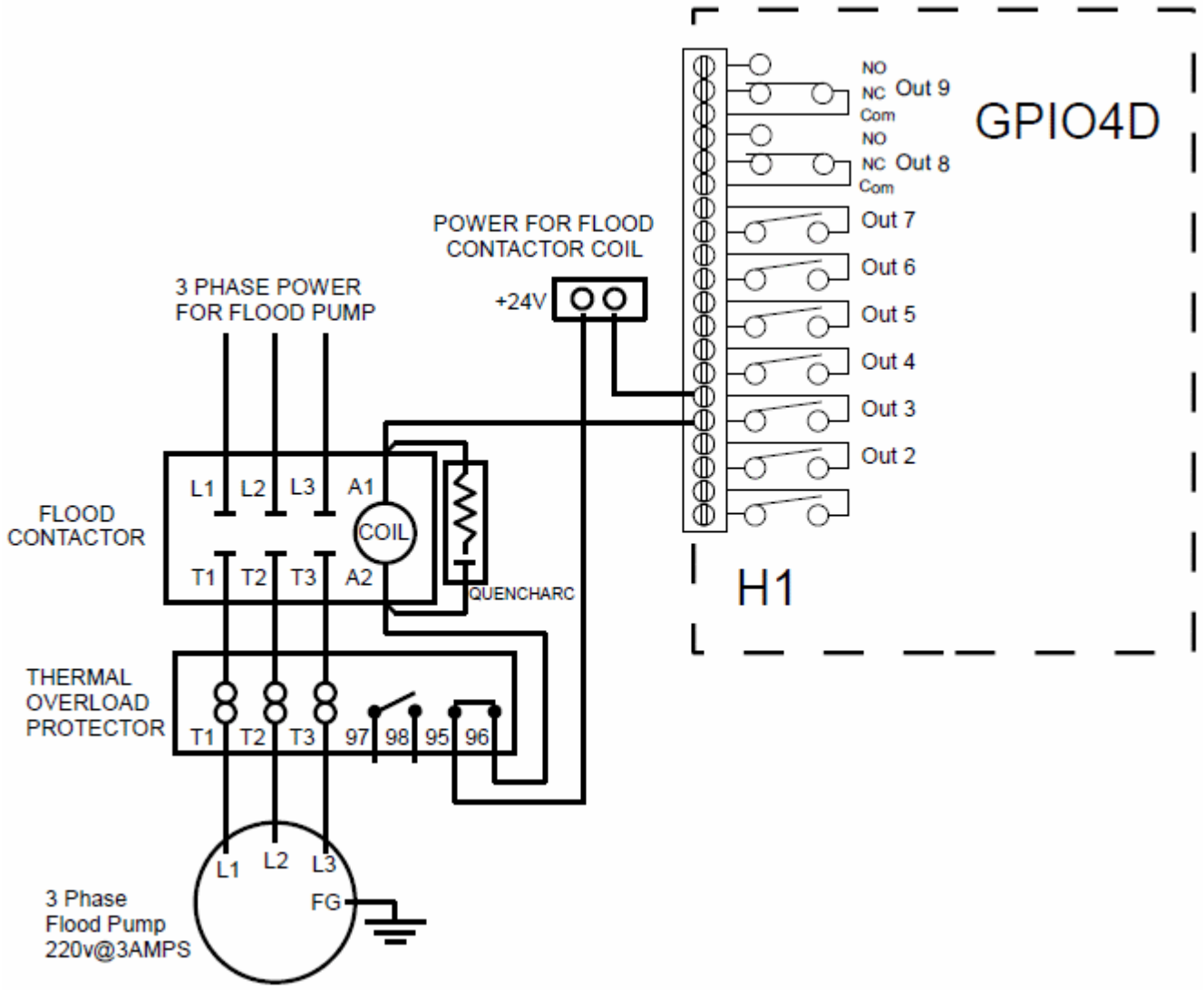


Figure 5.8.1
Sample Coolant Pump Circuit

5.9 Wiring Spindle

More information on spindle can be found in Technical Bulletin #152, which can be found here.
(http://www.centroidcnc.com/usersupport/support_files/tbs/tb152.pdf)

STOP: Before wiring up the spindle make sure that you already tested the spindle as directed during the board level tests.

There are two methods of wiring a spindle:

1. Connect three phase directly to an induction motor (shown on the next page). Hooking the three phase directly saves costs, but prevents the Centriod 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.

2. Use a spindle controller (not shown). The terms “inverter” (short for power inverter), “AC Drive”, and “VFD” (Variable Frequency Drive) can all refer to the spindle controller. Centroid does **not** provide spindle controllers and recommends using Delta Products VFDs, Automation Direct GS2 and GS3 AC drives, as well as Yaskawa VS (Varispeed) Inverters. It is the responsibility technician installing to consult their spindle controller manufacturer for support. However, Centroid does provide Technical Bulletins with detailed installation instructions and troubleshooting for a few select models of spindle controllers.

With the default PLC program, several of the I/O are decided for use with a spindle. **Input 10** is the spindle fault input. **Output 7** is the spindle fault output. **Output 5** is the inverter fault reset. **Output 8** is the inverter direction. **Output 10** is for a spindle cooling fan. Always refer to your schematic.

In the example below the thermal overload protector is wired directly to the spindle fault. If your spindle controller has a fault condition it should be wired in series with the thermal overload protector.

All contactors need snubbers. Centriod 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.

Enabling Spindle Fault Inputs

1. Power up your system.
2. Start CNC11 and press F10 to continue to the main screen
3. Invert the spindle fault input (which was inverted during board level testing). In the main menu press alt + I to bring up the real time I/O display.
4. Press the ctrl-alt-i keys simultaneously to remove any bars over the input in the display. This will enable the spindle inputs.

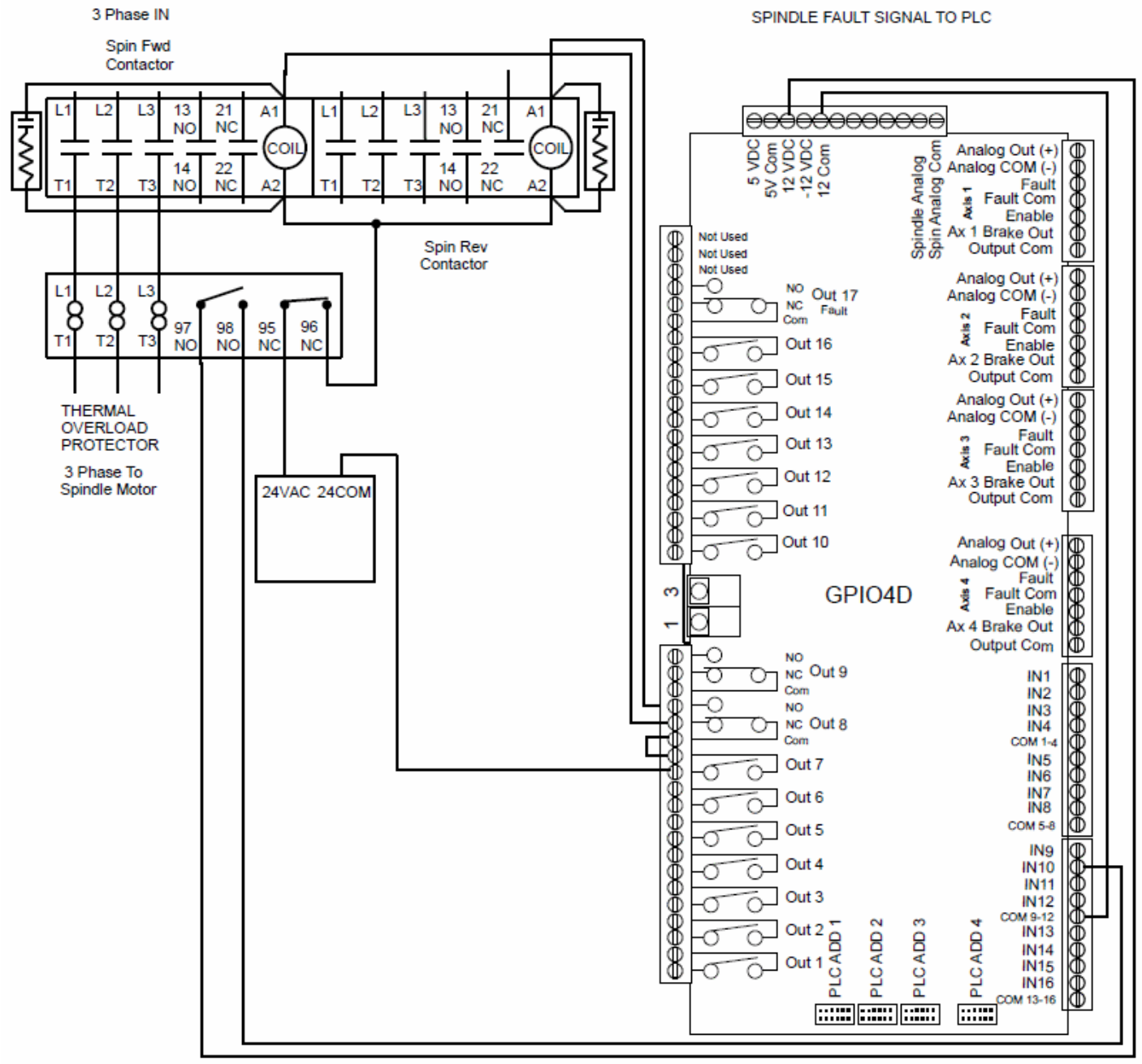


Figure 5.9.1
Sample Spindle Wiring

CHAPTER 6
FINAL SOFTWARE CONFIGURATION

6.1 Introduction

This chapter assumes that you have completed the board level test, and have built up a level of confidence with the hardware and software. PID settings and parameters for the AC/DC need to be entered into the software as described during the board level test before continuing with chapter 6.

6.2 Confirm AC/DC Communication

The very first time the AC/DC is switched on after being wired up, check to see if the AC/DC is detecting any errors or problems with your system.

Use the HSC screen to check for any AC/DC communication problems exactly as you did during the board level test. From the main menu press **F7 Utility → F9 Logs → F5 HSC.** More details about how to use this menu is contained in Appendix B.

If everything is connected correctly:

1. The "**Debug counter**" should be counting in hexadecimal for each drive connected to the system. This indicates that the drive is talking to the MPU11.
2. The **"Encoder OK**" is set to a one.
3. **Fatal Error** and **Warning** should be zero. If the AC/DC has any errors, use Appendix B to troubleshoot the drive.

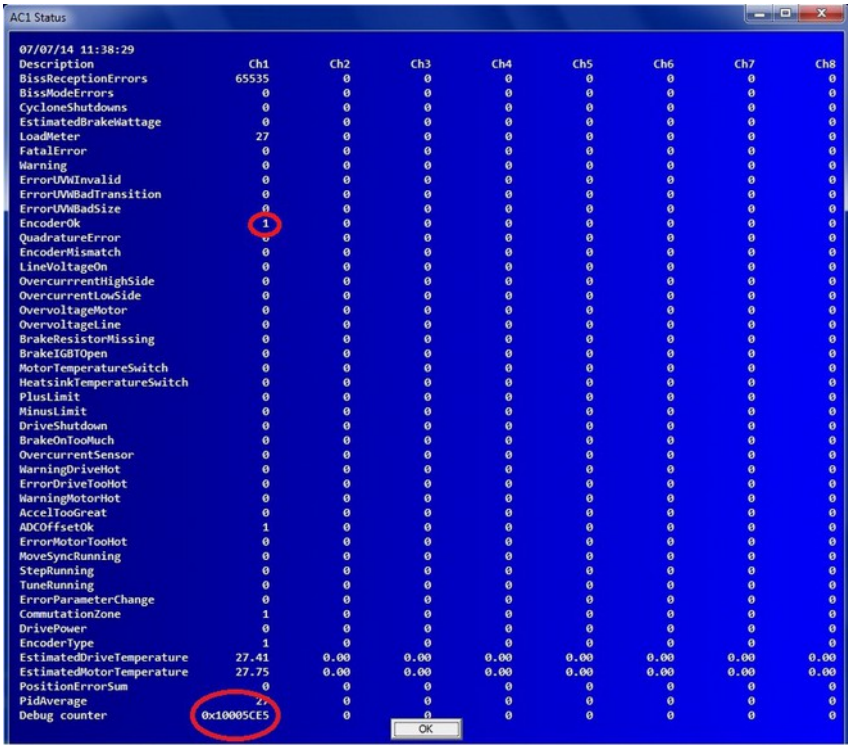


Figure 6.2.1
AC/DC HSC menu

6.3 Confirm Encoder Communication

1. **DANGER: DISCONNECT THE MOTORS FROM THE MACHINE.** The 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.
2. **Confirm Encoder Feedback on all axes**
   1. From the main menu, press **F1-Setup → F3-Config**. Password is **137**. Press **F4 PID**
   2. With the Estop pushed in, manually rotate each motor while watching the abs pos field (circled below) for that axis as seen in Figure 6.3.1. Confirm that you have smooth feedback on all axes and that X updates the X DRO, Y updates Y DRO etc.
   3. Confirm that the absolute position increases for an AC motor (decreases for a DC motor) while rotating the shaft clockwise.
      1. **NOTICE:** The AC/DC servo drive needs the encoder correctly connected/wired **before** attempting a move. If the encoder is not detected upon start up, you will need to restart both the AC/DC drive and the CNC11 software before trying to test the encoder again. Users can troubleshoot drive errors through the HSC bit screen definitions in Appendix B.

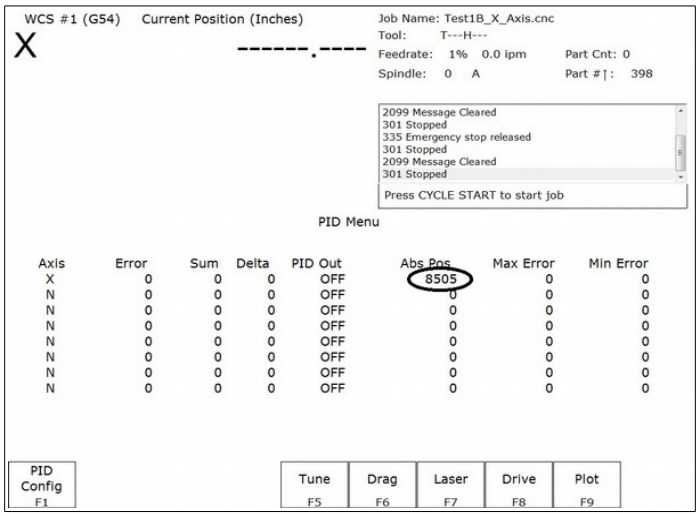


Figure 6.3.1
Confirm encoder rotation

Users with AC Motors Continue to Section 6.4 AC Encoder Alignment

Users with DC Motors Skip to Section 6.5 Jogging and Motor Direction

6.4 AC Encoder Alignment

Introduction

This same information can be found in Technical Bulletin #166, the latest version can be found here. (http://www.centroidcnc.com/usersupport/support_files/tbs/tb166.pdf)

AC drives rely on knowing the motor position in order to stay synchronized while driving the motor. Before the motor is mounted on a machine, the motor's encoder commutation tracks are aligned with the motor phases. During the “Move Sync” procedure, the drive applies sinusoidal voltages to rotate the motor shaft to a starting position. Typically, four “Move Sync” cycles will rotate the motor shaft one revolution.

The drive looks at the commutation lines from the encoder to give it a coarse position of the shaft for smooth movement on power up. These commutation signals are interpreted by the drive as zones 1 through 6. As the motor turns clockwise looking at the output shaft the commutation zone count should increase. Centroid AC motors use a differential, 8 pole, 5V, quadrature encoder with an index pulse. The encoder resolution depends on the motor and the drive (see below).

This procedure can also be repeated if you suspect the encoder alignment is incorrect. An incorrect alignment will show the following symptoms:

1. Axis is jumping.
2. Motor is running roughly.
3. Motor runs better in one direction than the other.
4. Motor has an uneven amount of current draw in one direction than the other.
5. Large current draw with a light load.

Prerequisites

- If connecting a motor to a drive for the first time, please complete the following steps:
  - Check for >100 MΩ between the motor chassis and power terminals.
  - With the motor connected to drive, confirm continuity between the drive chassis and motor chassis.
  - On the drive terminal, check for >100 MΩ between your power and shield terminals.
  - Check VM wiring for correct polarity
  - Additional information on motor testing can be found in Technical Bulletin 155.

Tools and Equipment for Encoder Alignment

- A set of metric and SAE hex keys.
- A small Philips head screw driver set.
- Loctite Blue 242 (Optional)
- If removing the motor from the machine, a set of clamps such as Irwin Quick Grips.
- If there is any contamination or debris inside the end cap, basic cleaning supplies such as a paper towel and all-purpose cleaner.
- If there is not a rubber O-ring or gasket between the end cap and motor, a non-corrosive RTV sealant (such as Dow Corning 3165) is needed.
- If changing the encoder, the correct replacement encoder and pigtail (see chart on next page).

The motor must be disconnected from the machine or have the machine drive belt removed for the alignment process. This procedure is best performed on a sturdy bench where you have good lighting and easy access to the encoder. If the motor is removed from the machine, the motor frame must be firmly secured to the bench using clamps or some other attachment method. The motor may try to jump around during the procedure (especially if something goes wrong during the alignment). Before starting the alignment procedure, the drive software must be configured correctly.

Alignment Procedure

DANGER: Do not jog the axis until instructed!

1. Remove the motor end cap.

    1. **NOTICE:** Any dust, dirt, coolant, or other contamination inside the motor end cap can get inside the sensitive internal components of the optical encoder and cause a premature failure. Make sure the inside of the motor end cap and encoder mounting plate are clean before continuing with encoder alignment.

       If there is a large amount of contamination inside the end cap, there is a high probability that the existing encoder will work unreliably and need to be replaced. If there is liquid inside the end cap, there may also be liquid inside the motor. A motor with liquid inside is a serious safety hazard, and will have to be replaced.

2. If installing a new encoder, remove the old encoder. Attach the new encoder. Snug the encoder set screws and encoder ears so that the encoder counts when the motor spins.

    1. **TIP:** Nylon washers between the encoder ears and the mounting bolts makes the motor much easier to align as shown below.

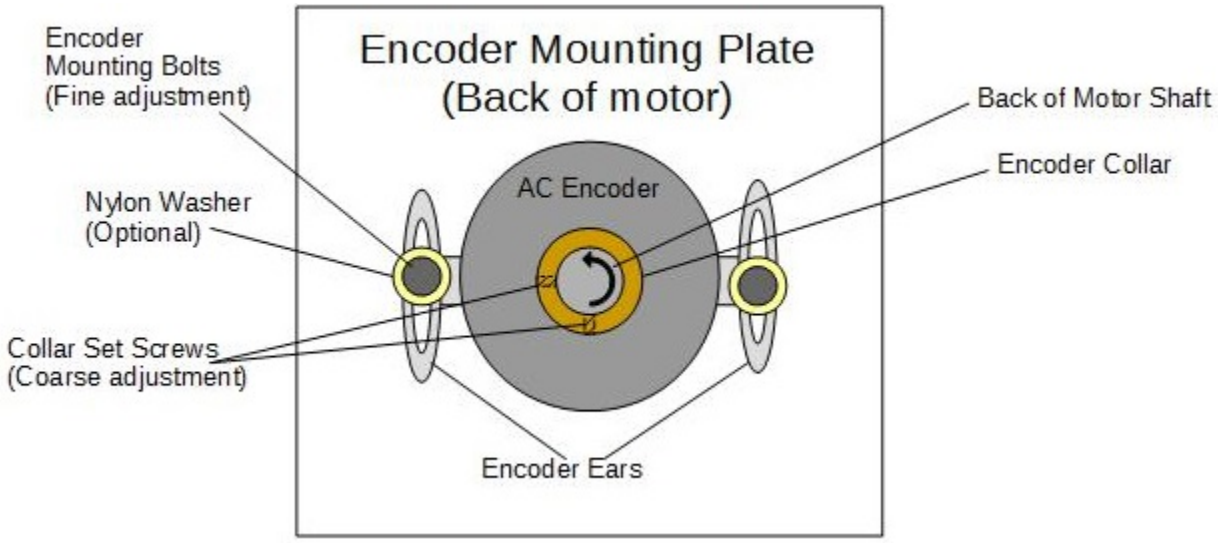


Figure 6.4.1
Parts of an encoder

3. Connect power cable and encoder cable from the drive to the motor.

4. Power up your drive and control system running Centroid CNC software

5. Go to the drive configuration menu. From the main menu press **F1-Setup** → **F3-Config**. Password is **137**. **F4 PID** → **F8-Drive** as shown below in on the next page. **Do not home the motor.**

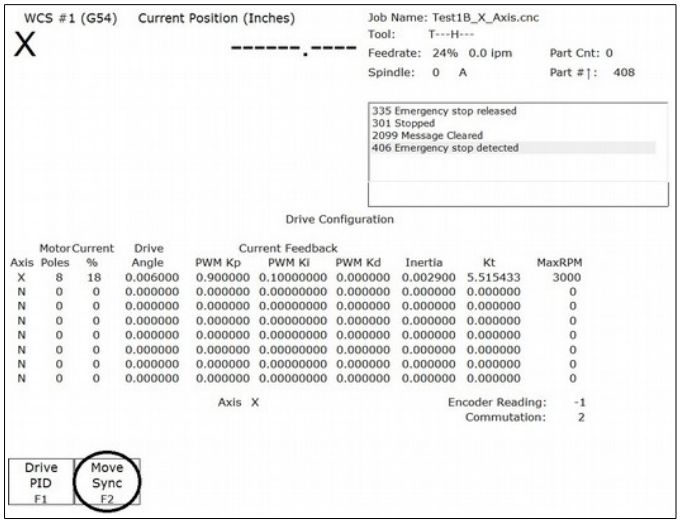


Figure 6.4.2
Drive Configuration Menu

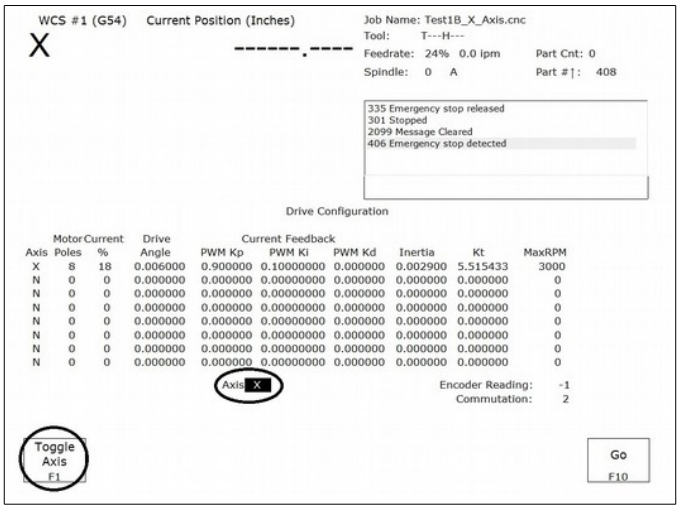


Figure 6.4.3
Toggle Axis

6. Press **F2-Move Sync** as circled in Figure 6.4.2**.** The axis selected is shown underneath PWM Kp as circled in Figure 6.4.3. If you are not on the correct axis, press **F1-Toggle Axis** until the correct axis label is on the screen. Finally press **F10-GO**. The shaft should rotate. The first move sync rotation may cause the motor to jerk or move roughly. Move sync a few more times by pressing **F2-Move Sync** then **F10-GO** repeatedly. All move syncs after the first sync should cause the shaft to rotate smoothly. **If the motor oscillates wildly, moves erratically, or makes loud unusual noises, kill the motor power immediately!**

1. **DANGER:** An incorrectly wired or configured motor may move violently or unpredictably when attempting move sync. Keep your body (and others) away from the motor when move syncing for the first time, and be prepared to hit the emergency stop.

2. **DANGER:** Large motors may have a tendency to oscillate during a move sync due to nature of the current feedback loop. It is recommended for **3KW and larger** motors that you adjust the motor current to half of the recommended value in the current feedback menu while move syncing. After the encoder alignment process is complete, set the current back to the recommended setting.

3. **NOTICE:** If no motor movement occurs, an error was encountered. AC/DC users can troubleshoot drive errors through the HSC bit screen definitions as described in Appendix D.

4. **TIP:** If the motor slightly oscillates after move syncing or continues to move a little rough while move syncing, grab the motor on the shaft carefully with your hand while wearing a leather glove. Move sync the motor while gently squeezing the motor shaft. If the oscillations and/or jerky movements go away after manually applying a small amount of load to the shaft, this is normal. This problem is caused by not enough load on the motor shaft during alignment and will <u>not</u> occur during normal motor operation. Do not fight with the motor! If a small amount of pressure on the shaft does not stop the oscillations, stop the motor. Double check your PID values. If PID values are correct try reducing the current to the motor and trying again.

5. **TIP:** If the motor moves out of control, double check your PID settings and encoder counts per revolution. Make sure the encoder is not wired backwards.

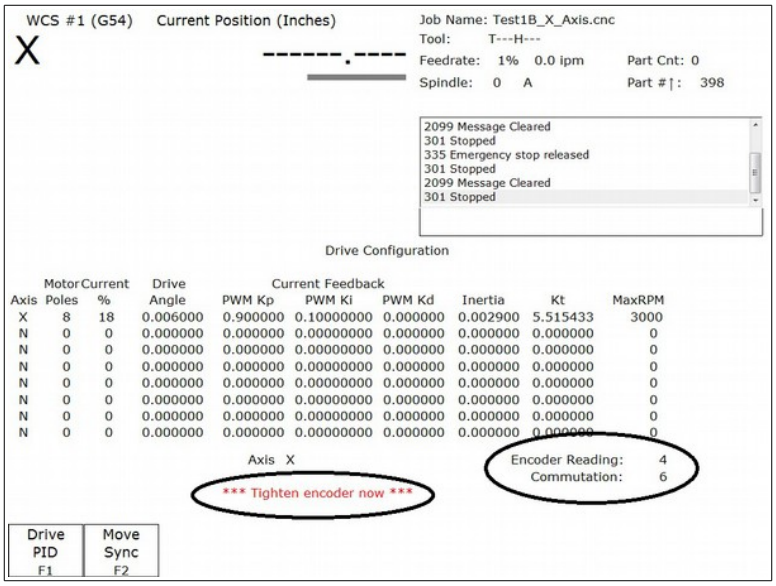


Figure 6.4.4
Encoder Alignment

Figure 6.4.5
Encoder Alignment

7. Keep running the move sync operation until the point where the encoder reading is closest to 0 or its maximum encoder count. The “Encoder Reading” is circled in above in Figure 6.4.4.

8. Loosen the encoder collar set screws as shown in Figure 6.4.5.

9. Move the encoder until the encoder reading is as close to zero as reasonably possible.

10. Tighten the encoder collar set screws. The encoder collar usually has two set screws on most encoders; make sure both are tight if applicable.

11. Loosen up the encoder ears and use them to fine tune the adjustment. When the encoder is within specifications, a red message will appear on the control saying “*** **Tighten Encoder Now** ***” as circled in Figure 6.4.4. For a 40,000 count encoder, it needs to be aligned with +/- 25 counts of zero. Tighten the encoder ears. The encoder mounting plate is usually made out of aluminum, so **DO NOT OVERTIGHTEN!** Loctite blue (242) or similar may be used to prevent loosening without over-torquing the screws.

12. Press **F2-Move Sync** and **F10 - Go** to rotate the motor shaft several full revolutions. Verify that the software still displays “*** Tighten Encoder Now ***” when closest to the zero position. Some encoder re-adjustment may be needed. Observe the commutation count goes 1 through 6 consecutively. The commutation count is displayed below the encoder reading as circled in Figure 6.4.4. At rest position the commutation zone should be either a 1 or a 6 only. A 0 or a 7 commutation value indicates a bad encoder or wiring problem. If the motor is stopping on a commutation zone other than 1 or 6 your phases are in the wrong order or the encoder is wired incorrectly.

13. Tighten the end cap onto the motor. Be careful placing the encoder cable in the end cap. If the cable is causing any strain or pushing on the encoder, it will twist the encoder out of alignment.

14. Reboot the drive and control system.

15. After a reboot, jog the motor in each direction to verify correct operation.
    1. Disable increment mode, by making sure the “incr cont” button on your jog panel is NOT lit up.
16. In the drive configuration menu, do a final move-sync check to verify that the motor is still aligned correctly. Look for the red message saying “*** **Tighten Encoder Now** ***” when the motor is closest to zero.
17. If there is not a rubber O-ring or gasket between the motor and the end cap, remove the end cap again. Apply a bead of non-corrosive RTV sealant (such as Dow Corning 3165) onto the end cap mounting surface as shown below in Figure 6.4.6. Reinstall the end cap. This step is not necessary for any motor bought from Centroid, but may be needed when performing retrofits to older systems.

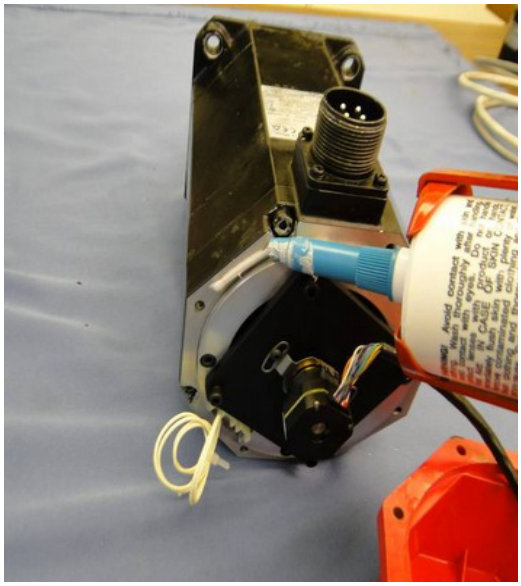


Figure 6.4.6
Sealing the motor endcap

The motor is ready for normal operation after the system has been rebooted again.

You are done aligning the encoder!

6.5 Jogging and Motor Direction

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

2. Set the feedrate to around 10%

3. Jog each motor while it is disconnected from the machine if you have not already done so. Disable increment mode while jogging by making sure the button on your jog panel labeled 'Incr Cont" is not lit up.

    1. **DANGER:** The first time jogging the motor it must be disconnected from the machine! *(Either by physically removing the motor, or disconnecting a gear or drive belt.)* This way if something goes wrong these is a minimal risk of damage to the machine.

    2. **NOTE:** It is normal if the motor is a little noisy or does not move smoothly. This will be fixed during tuning later in this chapter.

4. Power down the machine

5. Manually move all axes to the center of their travel to provide safe clearance when the motors are tested under power.

6. Reconnect the motors to the machine

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

8. **Check home configuration** During the board level test in Section 4.2 we changed the machine home at power up to jog. Double check to make sure it is still set to jog as demonstrated in figure 6.5.1.

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

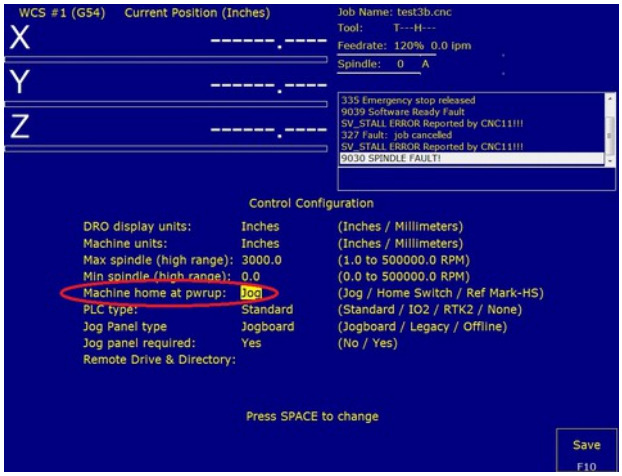


Figure 6.5.1
Checking home configuration

9. Make sure the feedrate is turned down to around 10%

10. Press the Start button on the jog panel, or Alt+S from the keyboard. This will cause the machine to set home right where it is.

11. **Configure motors to move in the correct direction** It is important to understand that correct motor direction is determined by the motion of the tool relative to the part, this is not necessarily the same as the motion of the table. This procedure is also covered in **Technical Bulletin #137**, which can be found here. (http://www.centroidcnc.com/usersupport/support_files/tbs/tb137.pdf)

    For axes 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 axes that move the tool, such as the quill on a knee mill, axis motion is the same as the tool motion. The Figures 6.5.2 and 6.5.3 below describe this concept.

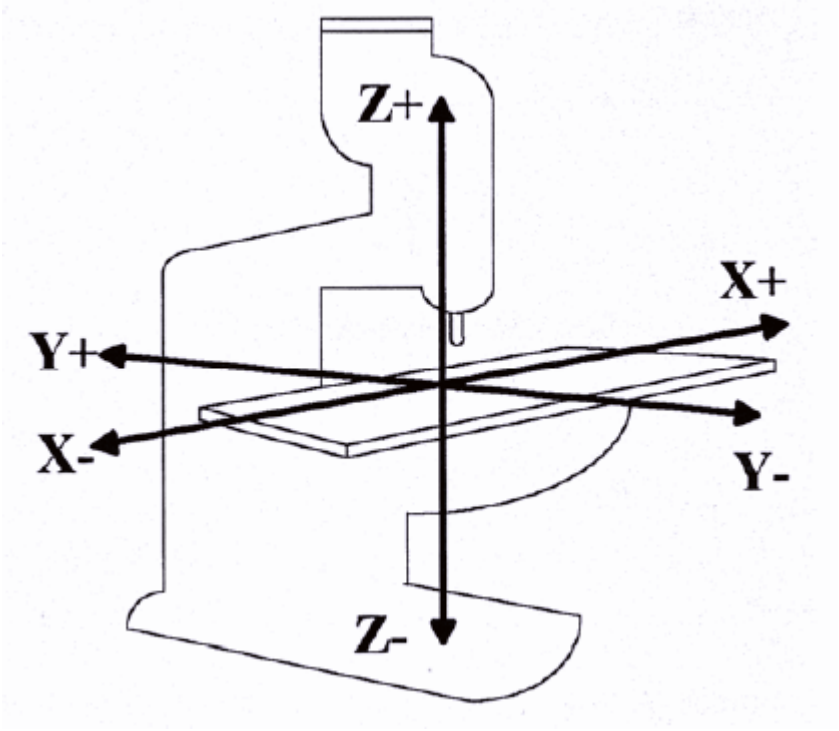


Figure 6.5.2
Difference between table motion and tool on a knee mill.

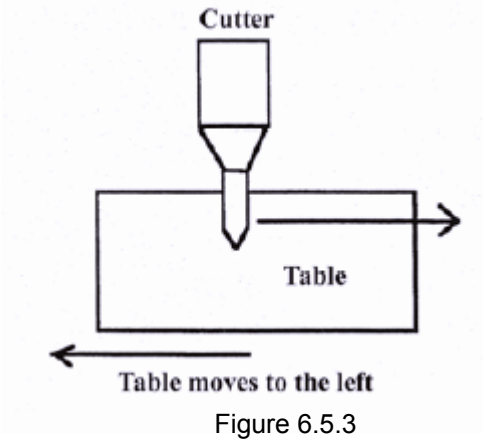


Figure 6.5.3
Table verses tool movement

In the above illustration 5.5.3, the tool is moving in the X+ direction relative to the part while the table moves to the left.

Configuring motors to move in the correct direction (continued)
Use MDI to move each axis and determine if the axis is moving in the correct direction. To determine this, observe that the DRO counts 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, from the main menu press **F1 -Setup → F3 Config**. The password is **137**, Press enter. Press **F2 Mach → F2 Motor**. Use the arrow keys to select the "**Dir Rev**" field for the axis that needs to be corrected and press the space bar to toggle it's current state as seen in Figure 6.5.4.

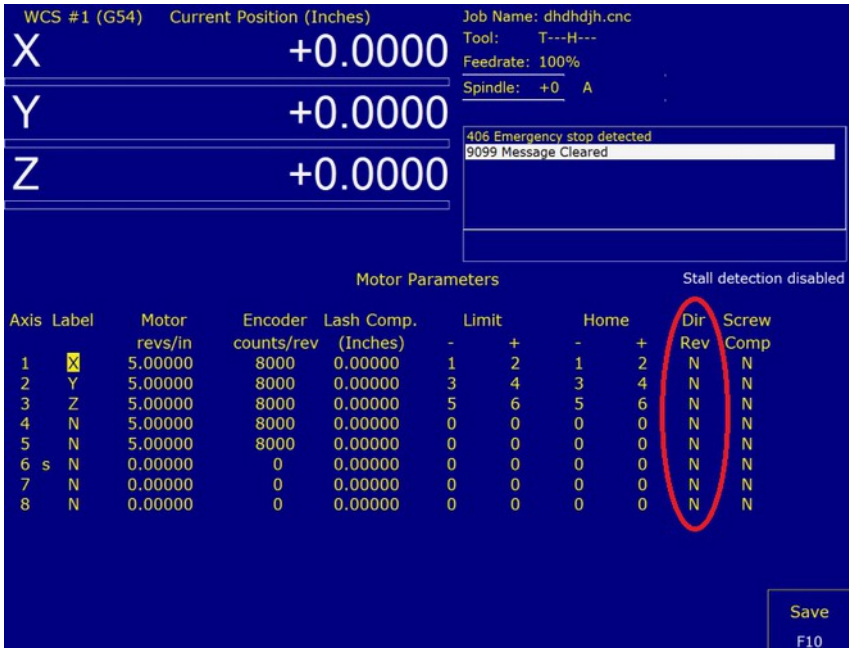


Figure 6.5.4
Direction reversal

6.6 Coarse Adjustment of DRO Position

NOTE: An alternative method is to use math to get a course estimation. This is described in the first part of Technical Bulletin #36, which can be found here. (http://www.centroidcnc.com/usersupport/support_files/tbs/tb036.pdf)

The value being displayed the DRO screen is calculated from knowing how much the motor moved, and the motor revolutions per inch/mm (usually controlled by the ball screw). Before we can continue to tuning, we need an estimated number.

Later in this chapter after tuning the motor, we will perform a fine adjustment on the motor revs/in (mm/rev for metric systems) to calculate an exact value.

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

2. **Zero the software** From the main menu, press **F1 – Setup** → **F1 Part** → **F10 Set Zero** as shown below in Figure 6.6.1.

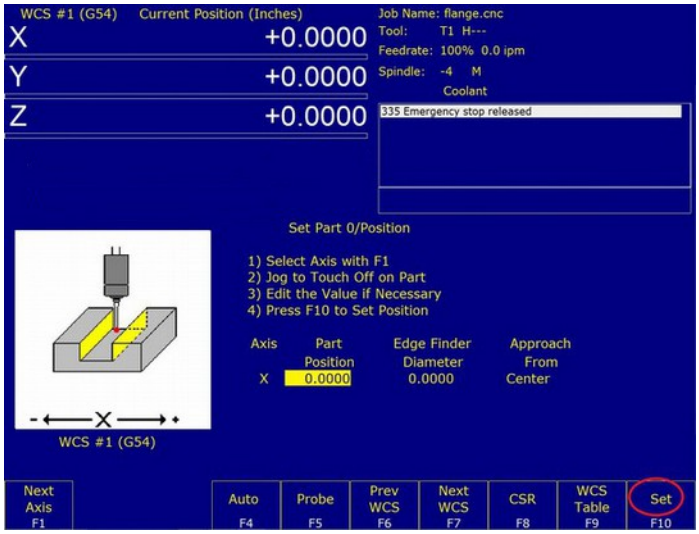


Figure 6.6.1
Setting Part Zero

3. **Set Up a Tape Measure on the Table** Set up a tape measure on the table so that 0” is lined up under the center of the spindle.

4. **Command the machine to move**. The longer the move the more accurate your final calculation will be. It is recommended that you move the machine at least 1 foot. Use the MDI command. From the main menu, press **F3 MDI**. If we were testing the X axis for example we could type “X 12”.

    1. **WARNING**: Turn the feed rate down and be prepared to hit E-stop. Since your limit switches have not been completely configured it is possible to crash the machine if it moves too far.

5. **Calculate the value** Enter into the motor parameters menu. From the main menu press **F1 -Setup → F3 Config**. The password is **137**, Press enter. Press **F2 Mach → F2 Motor**.

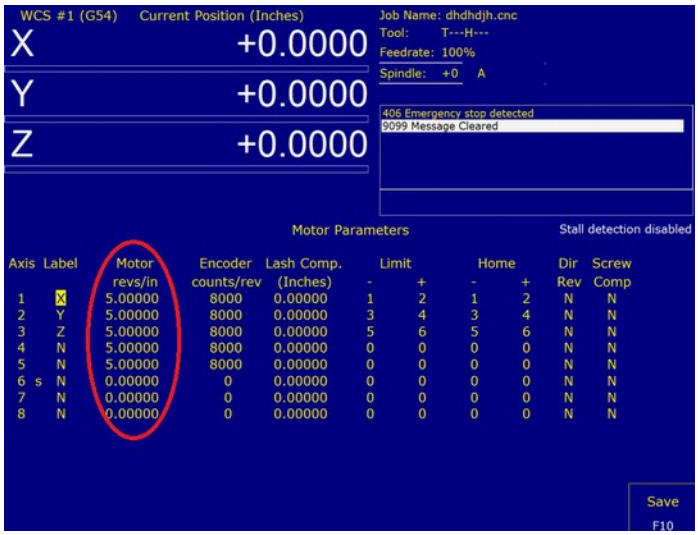


Figure 6.6.2
Adjusting motor revs/in or mm/rev

1. **Imperial Units** To calculate the value to be entered in the revs/inch field. Divide the distance moved (DRO value) by the distance that the axis actually moved (measuring tape). Multiply this result by the current value in the rev/inch field as circled in Figure 6.6.2.. This the new value that you will enter in the revs/inch field. If the axis traveled 6”, but the command was 7.5” 7.5/6 = 1.25, if the current revs/inch is 5.000 * 1.25 = 6.25 is the new value to enter in the revs/inch field.

2. **Metric Units** To calculate the value to be entered in the mm's/revs field. Divide the distance that the axis actually moved (measuring tape) by the distance commanded (DRO value). Multiply this result by the current value in the mm's/rev field as circled in Figure 6.6.2. This the new value that you will enter in the mm's/rev field. If the axis traveled 150mm”, but the command was 175mm, 150/175 = .85714, if the current mm's/rev is 5.08 * .85714 = 4.35428 is the new value to enter in the mm's/rev field.

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

7. Repeat the test for each axis.

6.7 Homing the Machine

This same procedure is outline in Technical Bulletin #22, the latest version can be found here. (http://www.centroidcnc.com/usersupport/support_files/tbs/tb022.pdf)

1. **Creating and Editing the Homing File**

   Your software comes with a default homing file that will work for most cases. If you have a machine with an unusual number of axes (such as a rotary table, CNC controlled grinder, CNC controlled drill press, extra lathe axes, etc..) or an unconventional limit switch configuration editing the home file will be necessary.

   1. Exit CNC11.
   2. **Right click** on your **CNC11** desktop shortcut.
   3. Select **properties** as shown in Figure 6.7.1.
   4. In the shortcut tab, click on "**Open File Location**" as shown in Figure 6.7.2.
   5. Windows explorer will open up in a new window showing the contents of your CNC11 directory *(The directory will be called "CNCM" or "CNCT" depending on weather you have a mill or a lathe)*.
   6. If "***cncm.hom***" ("***cnct.hom***" for lathes) is present, double click on it. If not the file present, it will have to be created. To create this file,.right click on **cncm** folder in the Windows File Explorer. (**cnct** for lathes). Select "**new**", then select "**text document**". A file will be created named "**New Text Document.txt**". Rename this file "**cncm.hom**" ("**cnct.hom**" for lathes).
      1. **TIP** Centroid recommends using Notepad++ as your default text editor. Notepad++ can be downloaded here. (http://notepad-plus-plus.org/)
   7. Edit the file as needed as seen in Figure 6.7.3. There should be the correct number of axes defined in this file, and they should be listed in the correct order.
      1. **Centroid recommends that the Z positive axis is always homed first to prevent damage to the machine!**
   8. Make sure to save any changes that you make.

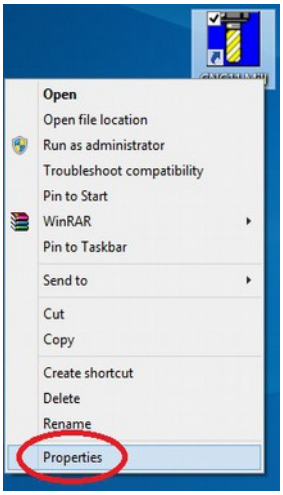


Figure 6.7.1
Steps 2 and 3

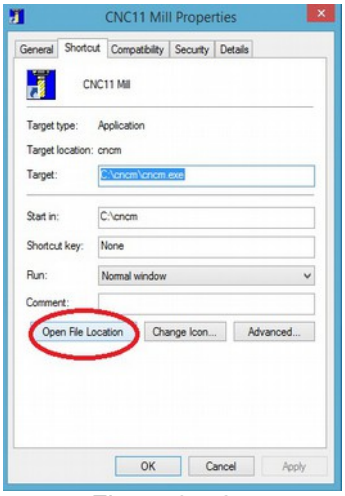


Figure 6.7.2
Step 4

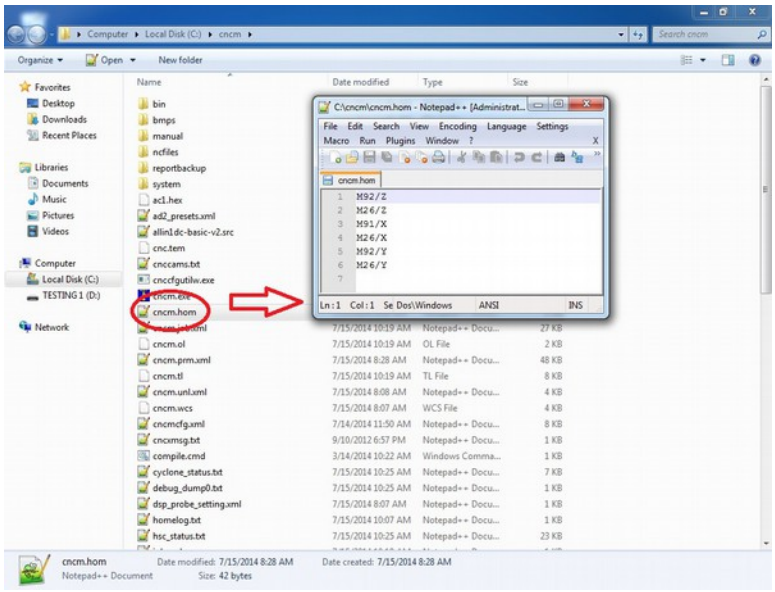


Figure 6.7.3
Steps 5, 6, and 7

2. **Start CNC11**

3. **Configure Limit Switches**

    1. **NOTE:** More information on Limit switches can be found in Technical Bulletin #127, which can be found here. (http://www.centroidcnc.com/usersupport/support_files/tbs/tb127.pdf)

    2. **Prerequisite:** The motor movement direction mentioned must be configured correctly before testing the limit switches!

    3. **Enter the motor parameters menu.** From the main menu press **F1 -Setup** → **F3 Config**. The password is **137**, Press enter. Press **F2 Mach** → **F2 Motor**.

    4. Move the machine so that the spindle is in the center of the table.

    5. Manually trip the minus limit switch for the X axis. Try to jog the machine. It should only move in the plus direction. If it does not, change the limit switch in software as shown below in Figure 6.7.4.

Axis	Label	Motor	Encoder	Lash Comp.	Limit		Home	
		revs/in	counts/rev	(Inches)	-	+	-	+
1	X	2.000000000	8000	0.000000	1	2	1	2
2	Y	2.000000000	8000	0.000000	2	4	3	4

Figure 6.7.4
Reversing limit switches in software

4. **Change the home type** From the main screen press press **F1-Setup** → **F3 -Config.** The password is 137. Then press **F3 Parms.** Using the keyboard spacebar change "**Machine home at power up**" to "**Limit Switch**".

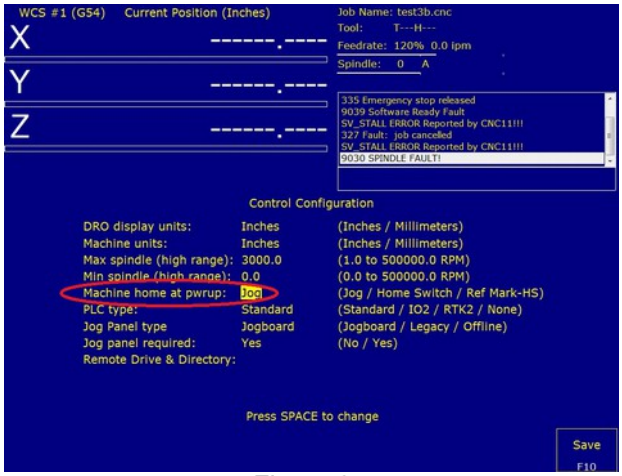


Figure 6.7.5
Enabling homing off limit switches

5. **Restart the Machine**

6. **Home the Machine:** From the main menu press "start" on the jog panel or "Alt+S" to home the machine. The machine should move slowly towards each jog switch.

    1. **DANGER:** Adjust the feedrate as needed so that the machine moves slowly. Be prepared to press E-stop if anything unexpected occurs.

    2. **NOTE:** If the machine stops homing and the main menu says "**Warning: Machine not homed**" a limit switch was pressed in the wrong order and the machine faulted out. Please check the order of your limit switches as shown above.

6.8 Calculating Maximum Feed Rate

In past Centroid products the maximum feed rate and acceleration was determined by autotune. At the time of this writing, the AC/DC does not support auto tune. Maximum feed rate will have to be found manually.

Use the following equation to get a estimation: **(maximum motor rpm / motor revolutions per inch) * 0.85 = maximum feed rate**.

Enter the maximum feed rate in the Jog Parameters menu (**F1 - Setup**, **F3 - Config**, **F2 – Mach.**, and then **F1-Jog**.).

The calculated maximum feedrate may be too high due to variations in supply voltage and load. Use MDI commands to test the calculated machine maximum feed rate. Gradually issue faster feed commands until the maximum is determined. If the machine is displaying the following symptoms the maximum feed rate is too fast and should be decreased:

- The load bar graph in the DRO display of the main menu is red, indicating excessive load on the motors
- The software is giving errors such as position errors.
- Motors are overheating.

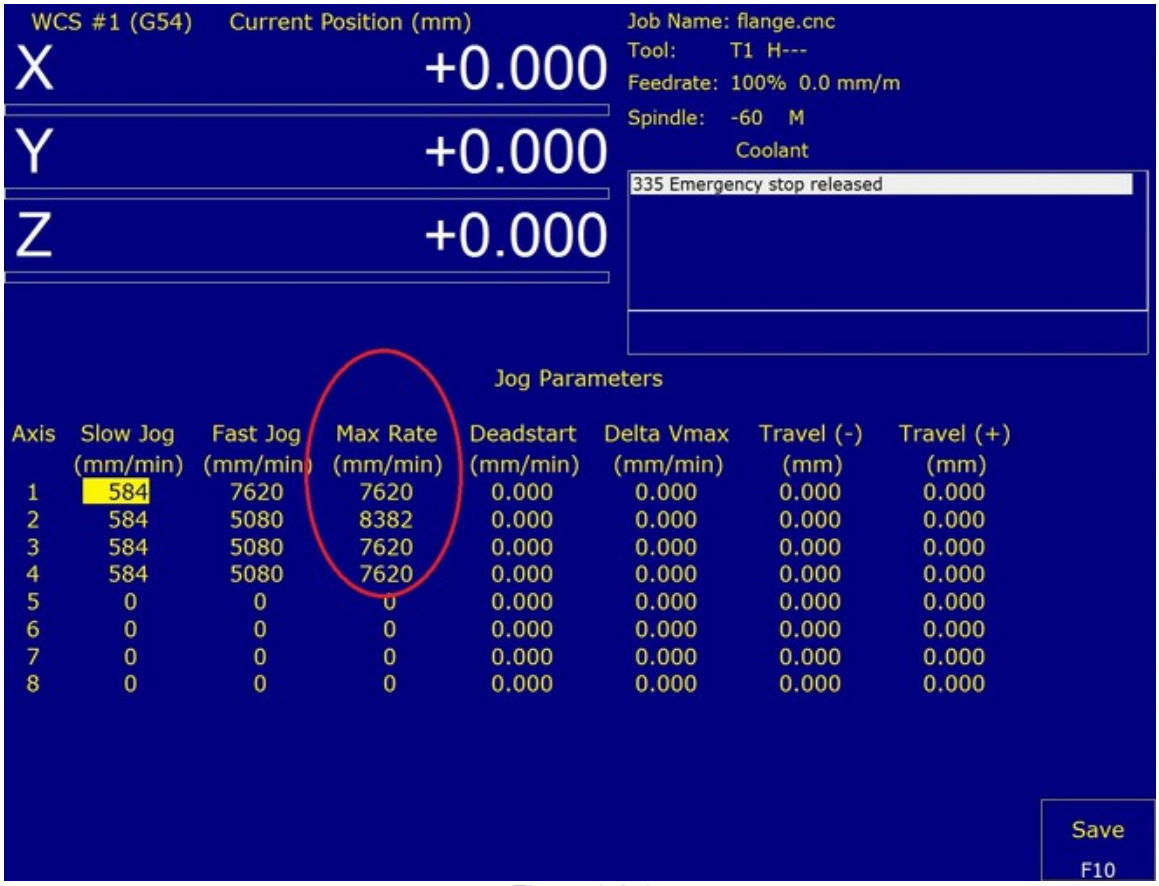


Figure 6.8.1
Adjusting maximum feed rate

6.9 Tuning Your AC/DC

6.9.1 A Basic Introduction to Tuning and PID

AC/DC uses a PID loop to control motor movement. PID stands for **Proportional**, **Integral**, and **Derivative**. A PID controller calculates an error value as the difference between a measured process variable (motor position) and a desired set point (expected motor position). The controller attempts to minimize the error by adjusting the power to the motor. The PID controller's calculation algorithm involves three separate parameters: the proportional, the integral and derivative values, denoted in the software as Kp, Ki, and Kd. Additionally, the motors inertia constant plays a large role in how the PID loop behaves.

The general idea of the tuning process is to minimize the Absolute Error (ErrAbs), which is measured in encoder counts. The inertia of the system varies from machine to machine, and the ideal PID values vary from motor to motor. To achieve optimal performance out of your motor, the inertia, position Kp, and position Kd values will have to be manually adjusted. Under most circumstances, the position Ki values do not need any adjustment. The current feedback Kp, Ki, and Kd (different from the position feedback Kp, Ki and Kd) should be left alone unless otherwise instructed.

Altering the PID values incorrectly could cause **DRAMATIC** changes in the way the servo system operates, leading to possible machine damage. Be cautious when adjusting the PID values, and be prepared to hit the E-stop as the motor may become unstable or move unpredictably if adjusted incorrectly.

Finally, PID tuning is not a black and white process. What is "good enough" of a value will depend on your accuracy needs and the capabilities of your system. Some experimentation is always required to find the ideal settings.

Centroid recommends using 40,000 counts per revolution encoders. Having lower resolution encoders is allowed, but might make the machine more difficult to tune.

6.9.2 Tuning Software Setup

Tuning should be done last once everything else is set up and the motor is connected to the machine. Before tuning, configure the software (and align the encoder if necessary) as discussed in the earlier sections of this manual.

First, home the machine. Move the machine so that the axes are in the middle of their travel. **Make sure the real time I/O display is <u>not</u> showing in the main menu** (press alt + I to toggle the real time I/O display). Go to the PID configuration menu by pressing **F1 - Setup**, **F3 - Config**, **F4 – PID**, and then **F1 – PID Config** from the main menu (as shown below). Press **F1-Edit Program** to bring up *PID_Collection_Moves.txt* in the default .txt editor. Edit the G-code so that the motor axis matches the axis of the motor to be tuned. For example, changing the line "*G1 w0.0*" to "*G1 x0.0*" will change the program to move the X-axis instead of the W-axis. Now you should be looking at the PID configuration menu as shown in Figure 6.9.2.1.

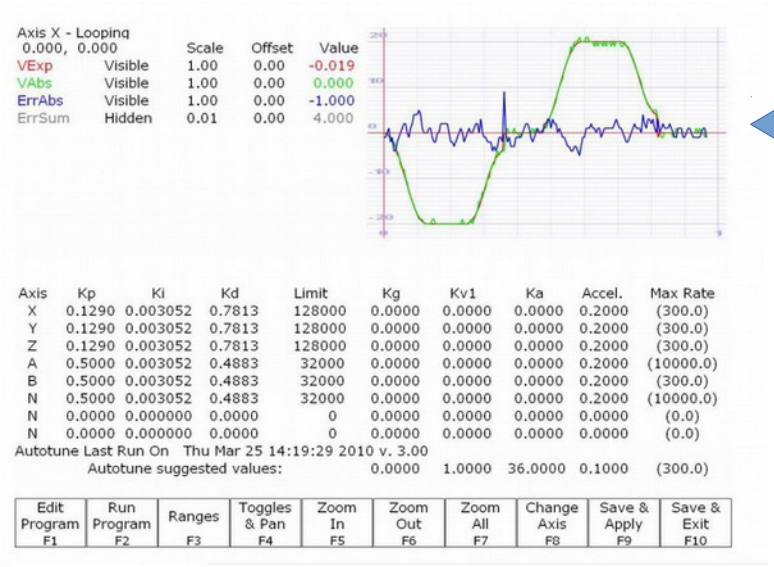


Figure 6.9.2.1
The PID Configuration menu

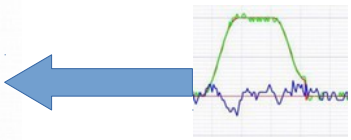


Figure 6.9.2.2

The colors of the text on the top left match the colors of the graphs on the right. For example, if you have a V abs value written in blue in the top left, the graph for V abs will be displayed on blue in the top right. For the rest of the tuning procedure when referring to motor velocity, we are referring to the **V Abs** value and the corresponding graph. When referring to position error, we are referring to the **Err Abs** value and the corresponding graph. The colors used in the graphs in this manual may be different from the colors shown on your screen.

The graph can be manipulated with a mouse by clicking, dragging, and scrolling. The graph can be manipulated with the keyboard by using the F3, F4, F5, F6, and F7 keys. Start by pressing **F7-Zoom All**, this will adjust the graph. This menu and these settings are covered in more detail in the CNC11 manual. Pressing **F8 – Change Axis** will toggle the axis being graphed and will change the error information displayed in the top left of the screen. If necessary, press F8 until the selected axis matches the motor to be tuned.

Press **F2-Run Program** to start the tuning process. The motor should run in a continuous loop and not stop until manually stopped. Values are adjust with the keyboard. If "***finished running program***" is immediately displayed, an error was encountered. Go back to the main menu, and check the message window for errors. Advanced AC/DC users can troubleshoot drive errors through the HSC bit screen definitions as described in the Appendix D.

NOTE In upcoming sections **6.9.4 Acceleration Tuning**, **6.9.5 Kp Tuning**, and **6.9.6 Kd Tuning** only movement in one direction will be shown in the examples to make it easier to interpret the graphs. Proper tuning involves movement in both directions. In sections 6.9.4 – 6.9.6 compare the positive half of graph to example as shown in Figure 6.9.2.2.

TIP When viewing the live tuning scope (graphs) be mindful of the scale. You can adjust the scale of the graphic. The encoder counts and the overall turns ratio of the machine will determine the counts per inch. Adjust the scale of the graph to a reasonable encoder count amount for the given encoder counts per inch of that axis. In other words, on a high count per inch system you may have errors as high as 100 counts, but 100 counts might only be representing 0.00005" on the machine.

6.9.3 Acceleration Tuning

Accel is the time for the axis to reach maximum velocity. An accel rate of 0.1 second is very fast, where an accel rate of 1.0 will be considered very slow.

Record the acceleration rate suggested by the software when the maximum feed rate was saved in the jog parameters menu (In Section 5.6). Entered this acceleration rate into the position PID menu (*Press **F1 - Setup**, **F3 - Config**, **F4 – PID,** and then **F1 – PID Config**.)* The rate provided is not the ideal acceleration rate, but a baseline number.

Press **F1-Edit Program**; adjust **PID_Collection_Moves.txt** so that it runs at the maximum feed rate as calculated in section 5.8 Save changes. **Press F2-Run Program**. Slowly decrease the acceleration time in 0.05 increments, testing the value in-between each change (Circled in 6.9.3.1). If you see any of the following symptoms the acceleration rate is too fast and needs to be slowed down:

- The acceleration rate is causing shock or vibration as the machine moves.
- The machine movement becomes bumpy, rough, or jerky.
- The machine creates unusual or loud noises such as thunks or rapping noises.
- The software is giving errors such as position errors.

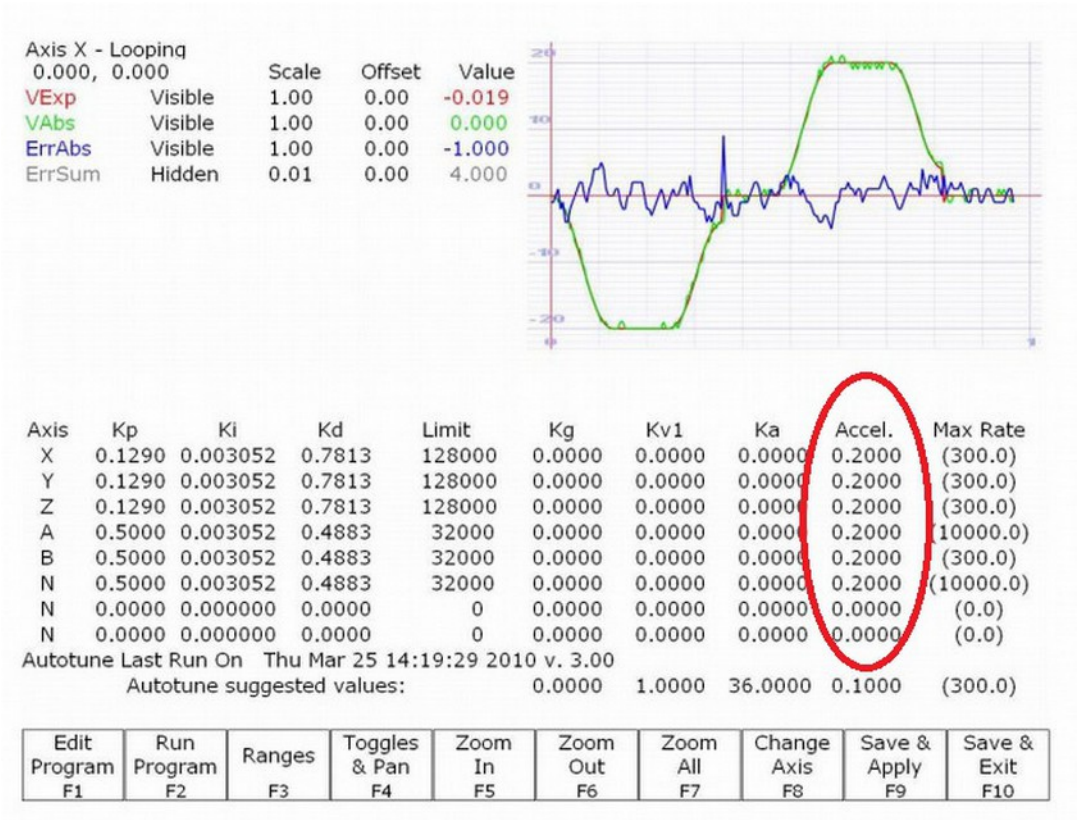


Figure 6.9.3.1
Acceleration tuning

6.9.4 Inertia Tuning

For Inertia tuning adjust the feed rate in *PID_Collection_Moves.txt* to the average rate during a typical machine operation.

The parameters in the **F8 – Drive** menu, with the exception of inertia, do not change based on machine type, and can therefore be set once from the provided charts. Inertia is set to the motor inertia as a starting point. Once the motor is mounted to a machine, the inertia value will need to be increased to compensate for the additional inertia of the mechanical drive components.

Inertia is adjusted in the drive configuration menu. From the PID configuration menu press **F10 – Save and exit**, **F8 – Drive**, and then **F1 – PID**. Throughout the tuning process make changes in the Drive configuration menu, and then go back to the PID configuration menu and run the collection moves program to see how those changes affect the graph. Repeat this process until results are acceptable.

The following plots demonstrate the effect of the inertia setting. The dark blue line is the motor velocity (V abs) and the red line is position error (Err Abs). In the first example, inertia is set to the motor inertia, but a load has been added, so the setting is too low. The error plot shows that the motor is behind the expected position on acceleration. In the second example, the inertia value has been increased too much. The motor moves ahead of its expected position during acceleration. In the third example, inertia has been set to a reasonably accurate value. The motor follows closely at the beginning of the move.

It is best practice to focus on the error around the rising edge of the motor velocity graph. Start adjusting the inertia in increments of 0.05 at a time, later switching to smaller increments as you approach your final value. Your graph will look slightly different than the graphs displayed below due to factors such as motor velocity, encoder count, other PID values being off, etc. The final inertia value should fall in the range of 0.5 to 0.005.

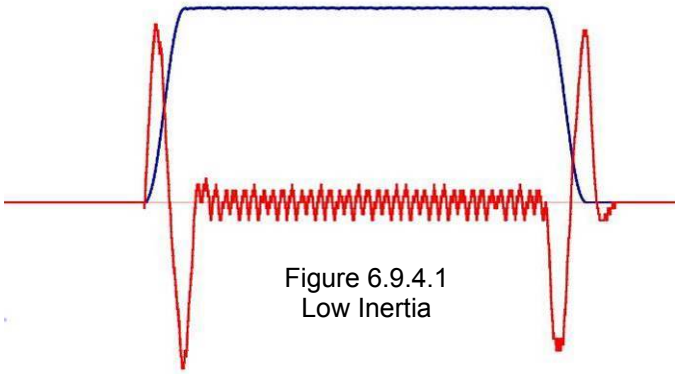


Figure 6.9.4.1
Low Inertia

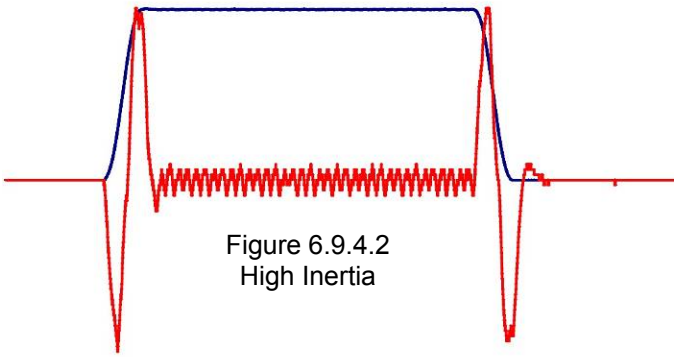


Figure 6.9.4.2
High Inertia

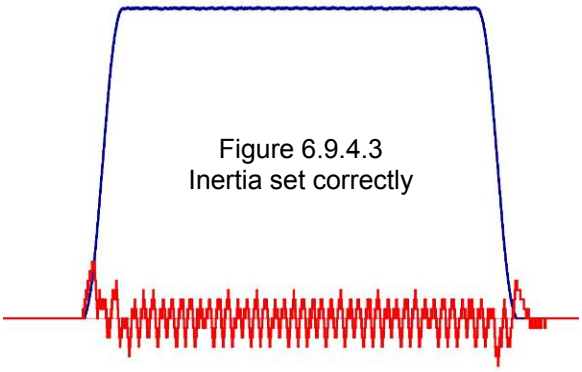


Figure 6.9.4.3
Inertia set correctly

6.9.5 KP Tuning

The PID Config menu (F1 **- Setup**, **F3 - Config**, **F4 – PID**, then **F1 – PID Config)** is used to tune the remainder of the motor control parameters. To adjust, either type in a new value, or use the “Page Up” and “Page Down” keys of your keyboard to increment or decrement the existing value. Increase Kp until some oscillation is heard or seen on the PID tuning graph. Reduce the setting below the oscillation point to give some headroom for stability.

The following examples show the effect of Kp. The dark blue line is the motor velocity (V abs) and the red line is position error (Err Abs). In the first example, Kp is set too low. Large error peaks show where the motor is not following the requested path. Increasing Kp leads to the second example, where error is low throughout the move. However, there is an increasing oscillation in the error plot, indicating that the motor will soon become unstable. The third example demonstrates a Kp reduction to improve stability. The error plot has nearly minimal error achieved during tuning and does not have signs of instability.

Start adjusting the Kp in increments of 1.0 at a time, later switching to smaller increments as you approach your final value. Your graph will look slightly different than the graphs displayed below due to factors such as motor velocity, encoder count, motor performance, etc. The final Kp value should fall in the range of 1 to 20.

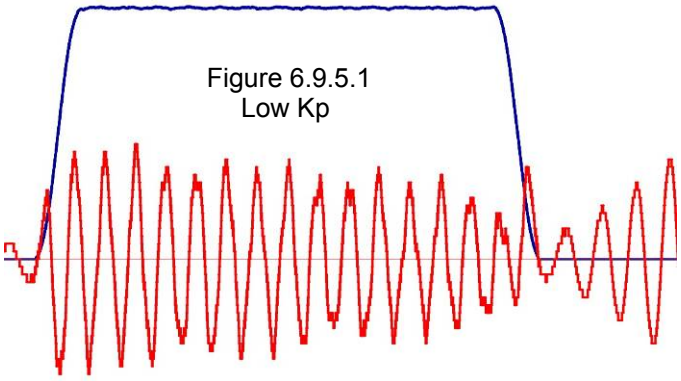


Figure 6.9.5.1
Low Kp

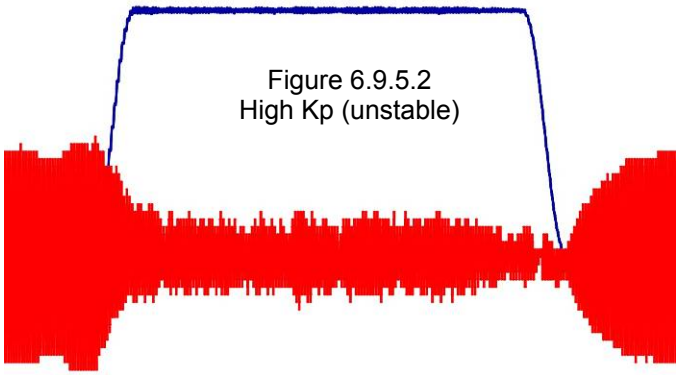


Figure 6.9.5.2
High Kp (unstable)

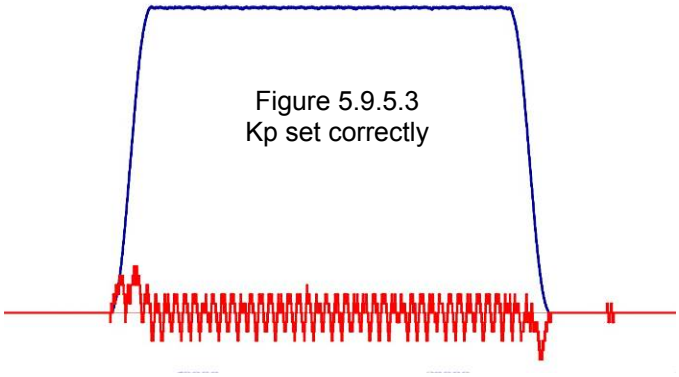


Figure 5.9.5.3
Kp set correctly

6.9.6 KD Tuning

After Kp has been adjusted, continue to tuning Kd. The Kd term adds stability to the effects of Kp. If Kp or Kd have been adjusted far from the default values, a second iteration of the tuning procedure is recommended. Because the two terms are dependent on each other, a better Kd setting may allow Kp to be adjusted for higher performance.

Incorrect Kd settings create oscillations. A low Kd setting creates low frequency oscillations. As Kd is increased, a high frequency oscillation will become noticeable. Often the high frequency oscillation will be audible before it is noticeable on the error plot. The example shows an extreme case of oscillation due to Kd set too high. When Kd is set properly, it will dampen the Kp contribution, giving a smooth error plot.

Start adjusting the Kd in increments of 1.0 at a time, later switching to smaller increments as you approach your final value. Your graph will look slightly different than the graphs displayed below due to factors such as motor velocity, encoder count, motor performance, etc. The final Kd value should fall in the range of 1 to 20.

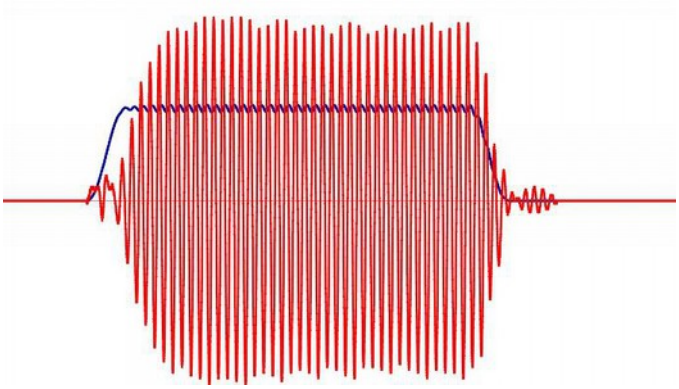


Figure 6.9.6.1
Low Kd

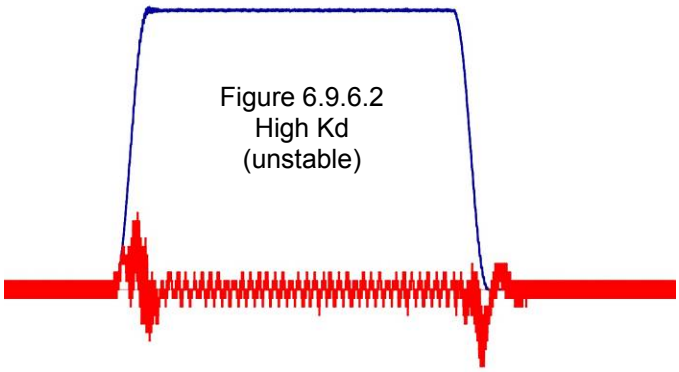


Figure 6.9.6.2
High Kd
(unstable)

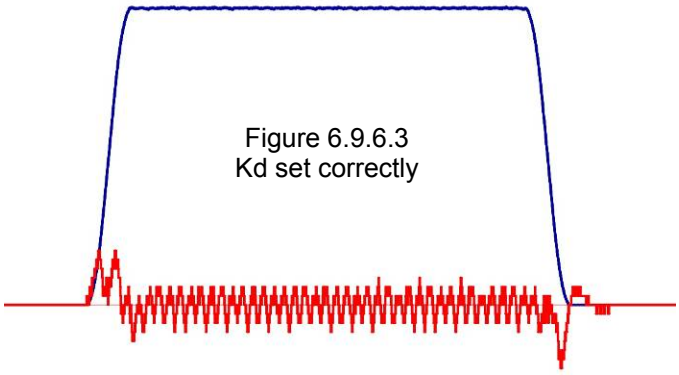


Figure 6.9.6.3
Kd set correctly

6.10 Fine Adjust of DRO Position

This method is also described in Method 2 of Technical Bulletin #36, the latest version can be found here. (http://www.centroidcnc.com/usersupport/support_files/tbs/tb036.pdf)

For **imperial** machine configurations the number of motor revolutions required to move 1" must be calculated.

For **metric** machine configurations the number of mm's travelled during one revolution of the motor must be calculated.

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

    1. **NOTE**: If you purchased a probe from Centroid, there is an easier method of doing this. Use of the probe will not be covered in this document.

4. **Create a Test Fixture:** Create an "L" shaped block of material to act as a reference for measurement as seen in Figure 6.10.1. The material should be appropriately 6 inches to 12 inches in length. A longer material will give you better accuracy. The exact length of the "long" part of the "L" needs to be known. A gauge block attached to another gauge block is recommended. An example test fixture is shown below.

The long part of the "L" is from is guage block measuring 12.000"

Figure 6.10.1
Example test fixture

5. **Secure the test fixture** Attach the test fixture to your machine so that it runs parallel to the axis being tested.

6. **Move the dial indicator into position:** Start from away from the block and jog towards the top of the "L". Set jog panel mode to incremental when you get close. Move the spindle so that the dial indicator is reading as close to "0" as possible as demonstrated in Figure 6.10.2.

    1. **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 back way up and start again.

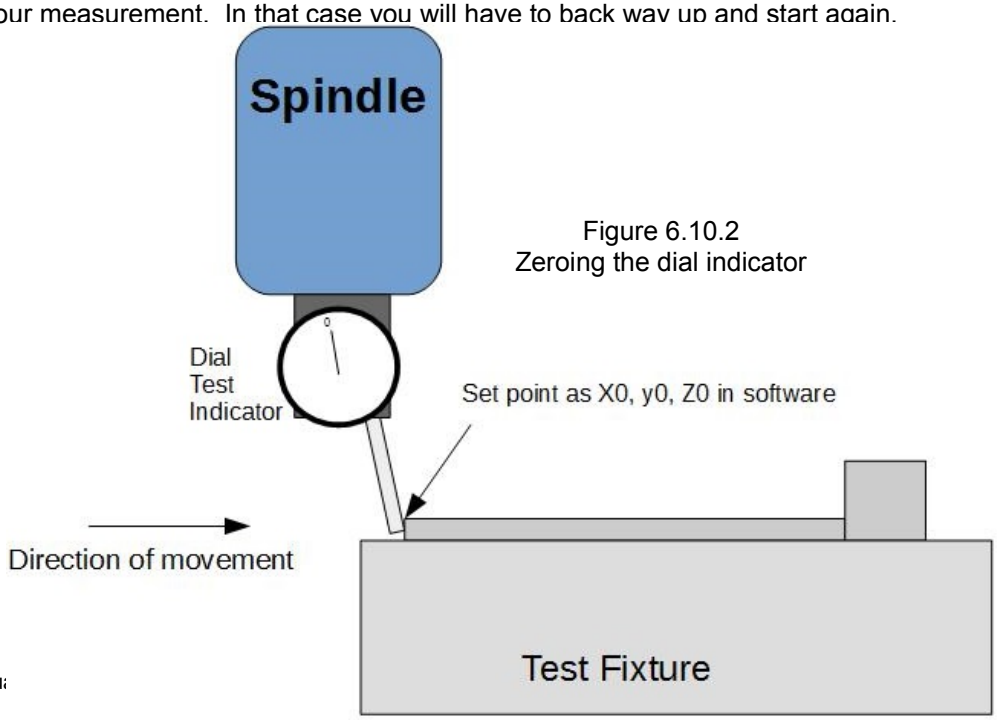


Figure 6.10.2
Zeroing the dial indicator

7. **Zero the software** From the main menu, press **F1 – Setup → F1 Part → F10 Set Zero** as shown below in Figure 6.10.3.

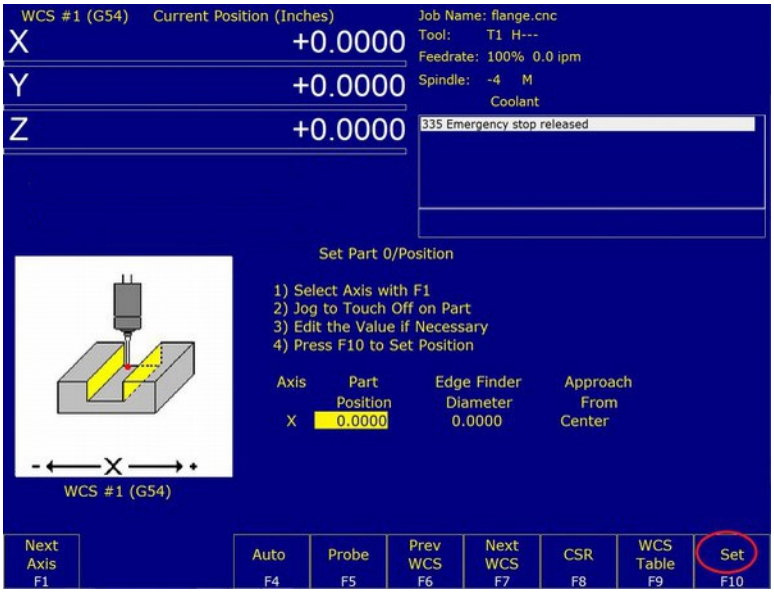


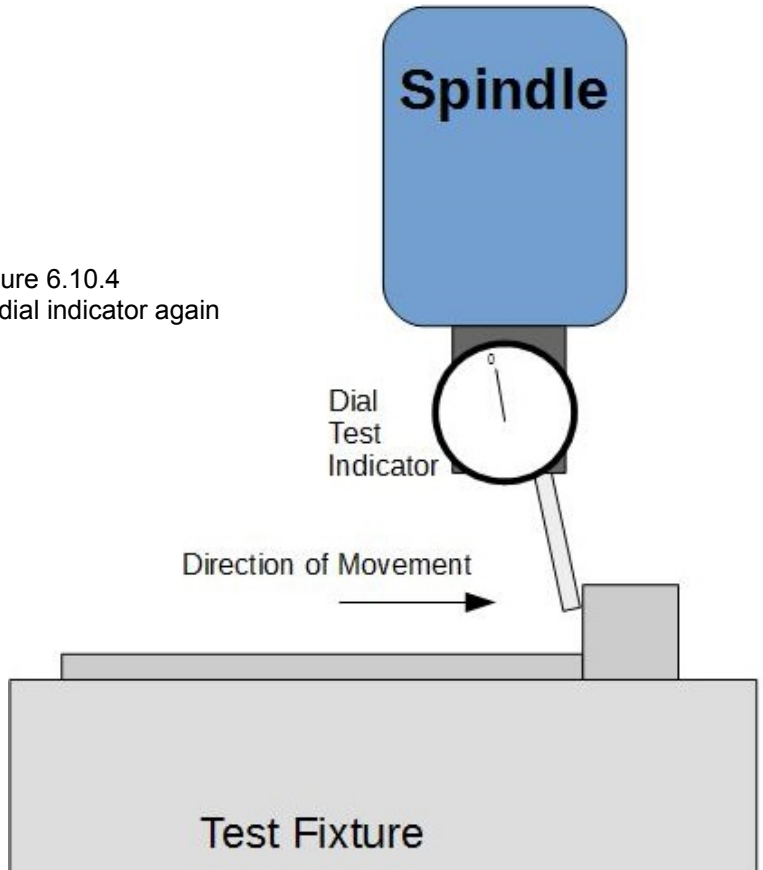
Figure 6.10.3
Setting part zero

8. **Raise the spindle:** Move the spindle so that it is away from the text fixture. If we are configuring the X or Y axes we need to the raise the Z-axis.

9. **Move to the base of the "L":** Jog towards the base of the "L". Set jog panel mode to incremental when you get close. Move the spindle so that the dial indicator is reading as close to "0" as possible as shown in Figure 6.10.4.

    1. **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.

Figure 6.10.4
Zeroing the dial indicator again



10. **Calculate Values:** Go into the motor parameters menu. From the main menu press **F1 -Setup** → **F3 Config**. The password is **137**, Press enter. Press **F2 Mach** → **F2 Motor**.

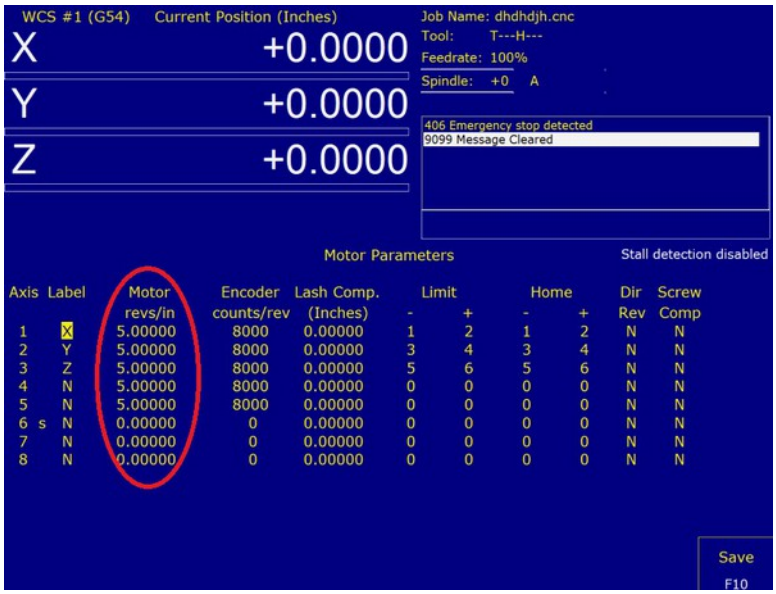


Figure 6.10.5
Fine adjustment of motor res/in or mm/rev

1. **Imperial Units:** To calculate the value to be entered in the revs/inch field. Divide the distance moved (DRO value) by the distance that the axis actually moved. Multiply this result by the current value in the rev/inch field. This the new value that you will enter in the revs/inch field. If the axis traveled 6", but the command was 7.5" 7.5/6 = 1.25, if the current revs/inch is 5.000 * 1.25 = 6.25 is the new value to enter in the revs/inch field.

2. **Metric Units:** To calculate the value to be entered in the mm's/revs field. Divide the distance that the axis actually moved by the distance commanded (DRO value). Multiply this result by the current value in the mm's/rev field. This the new value that you will enter in the mm's/rev field. If the axis traveled 150mm", but the command was 175mm, 150/175 = .85714285, if the current mm's/rev is 5.08 * 0.85714 = 4.35428 is the new value to enter in the mm's/rev field.

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

12. Repeat the test for each axis.

6.11 Removing Backlash

This same procedure is outlined in Technical Bulletin #37, the latest version can be found here. (http://www.centroidcnc.com/usersupport/support_files/tbs/tb037.pdf)

1. **Adjust Mechanical Lash:** Before configuring the backlash compensation in the control, every effort should be made to reduce the mechanical lash in your machine to less than 0.001". The "electronic" backlash compensation provided by the control will help, especially in point to point moves, but the overall accuracy of your machine is determined purely by the amount mechanical lash in the machine.

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

    1. **NOTE**: If you purchased a probe from Centroid, there is an easier method of doing this. Use of the probe will not be covered in this document.

3. **Zero Previous Backlash Values:** Enter into the motor parameters menu. *(From the main menu press **F1 -Setup** → **F3 Config**. The password is **137**, Press enter. Press **F2 Mach** → **F2 Motor**.)* Zero out any backlash that was previously entered into the control.

4. **Secure a Test Fixture:** Mount a piece of metal to the machine to act as a reference. A gauge block recommended. You may re-use the test fixture you created for configuring your motors to move the correct distance.

5. **Move the dial indicator into position:** Start from away from the block and jog towards it. Set jog panel mode to incremental when you get close. Move the spindle so that the dial indicator is reading as close to "0" as possible as demonstrated in Figure 6.11.1.

    1. **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 back way up and start again.

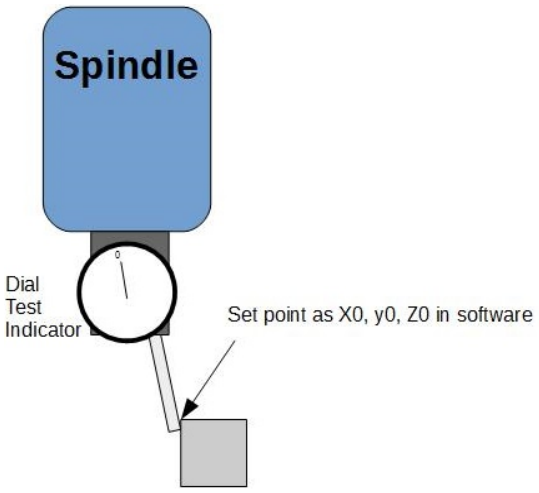


Figure 6.11.1
Zeroing the dial indicator

6. **Zero the software** From the main menu, press **F1 – Setup** → **F1 Part** → **F10 Set Zero** as shown below in Figure 6.11.2.

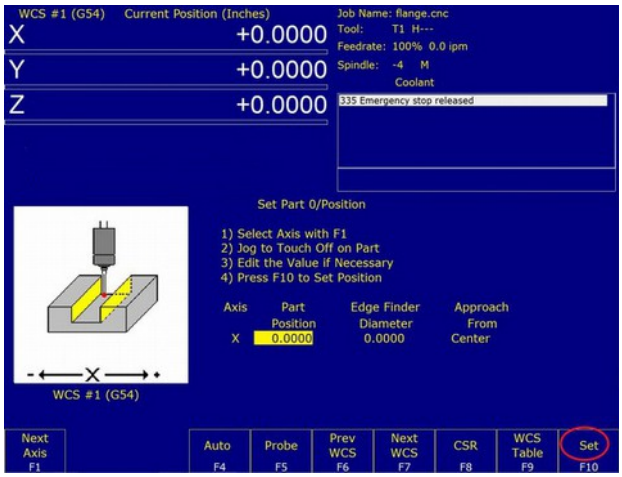


Figure 6.11.2
Setting part zero

7. Back the spindle 0.025 away from the gauge block at a feedrate of 0.5 inches per minute. This can be done by using the MDI menu (F3 from the main menu) and typing "**G1 X- 0.025 F0.5**" for the X axis.

    1. **NOTE:** Is is important that you use extremely slow feedrates. Faster feedrates will introduce inconsistencies due to the inertia of the table.

8. Move the axis back to the zero position. Type "**G1 X0 F.5**" in the MDI screen.

9. Enter the value shown into the "**Lash Compensation**" section of the motor parameters menu.

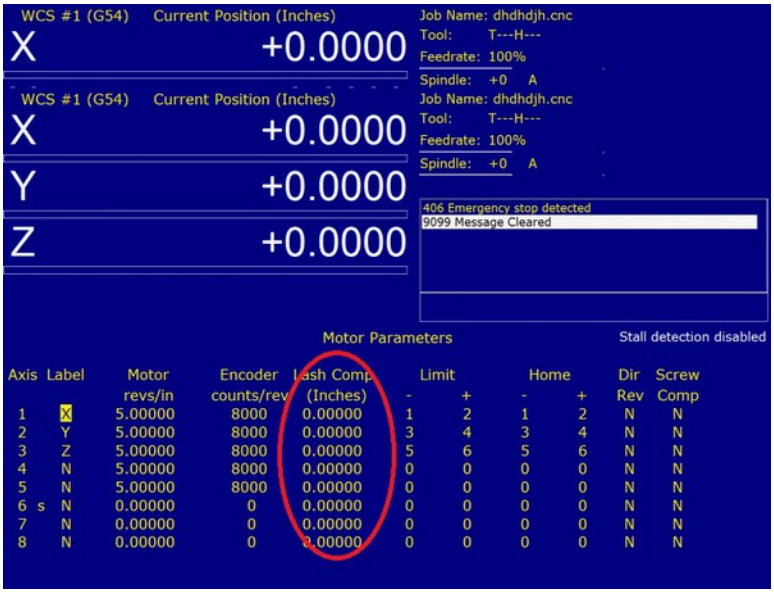


Figure 6.11.3
Adjusting backlash compensation

6.12 Deadstart

Deadstart is located in the jog parameters menu and has to do with direction reversal of an axis. The deadstart usually doesn't have to be changed from the default value on a Milling machine. Sometimes very light wood routing tables with very low friction and low inertia can benefit from a deadstart change along with other "hand tuning." Call in if you have this case.

6.13 Other Misc Tuning Information

Kg, Kv, and Ka in the PID position menu are not used and do not need adjusted. Ki does not need to be adjusted under most circumstances. After tuning the other values of the PID loop, experimentation with Ki values may sometimes help to reduce error. Adjust Ki in increments of 0.005, with the final value falling in the range of 0.001 to 0.25.

6.14 Performing a System Test

In some versions of CNC11 software, when finished, the main menu will display a message saying *"**Machine Setup Not Completed. Machine Is Not Ready To Run. Contact Your Dealer**"* as shown below.

At this point you will need to run the **System Test** to clear this message. Documentation on how to perform a system test is located here. (http://www.ajaxcnc.com/tech/downloads/manuals/install/Systemtest.pdf)

If the instructions outlined in system test do not apply to your system, contact technical support.

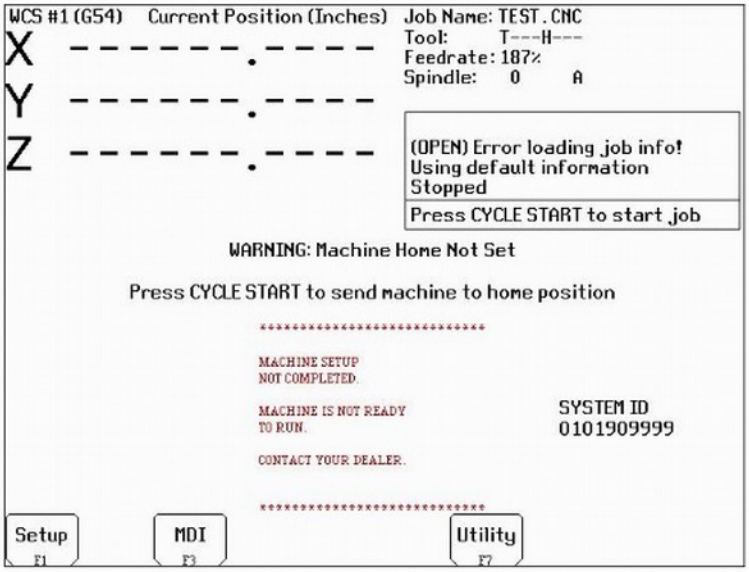


Figure 6.14.1
Machine Requiring a System Test

Appendix A - Windows 8 Preinstallation

The information contained in this procedure is also contained in Technical Bulletin #283, which can be downloaded here (placeholder)

Required Materials
- Samsung 120GB SSD
- USB or SATA DVD player
- USB mouse
- copy of Windows 8 Home Premium 64-bit
- copy of the latest version of CNC11 software

Instructions for Configuring Windows 8

1.) Install SSD and DVD player into servo PC/console. Make sure to plug the SATA cable from the SSD into SATA0 on the motherboard. Software **MUST** be loaded on the system that you are working on. It **CANNOT** be loaded onto an SSD remotely and then installed onto the control. Windows does not allow that.

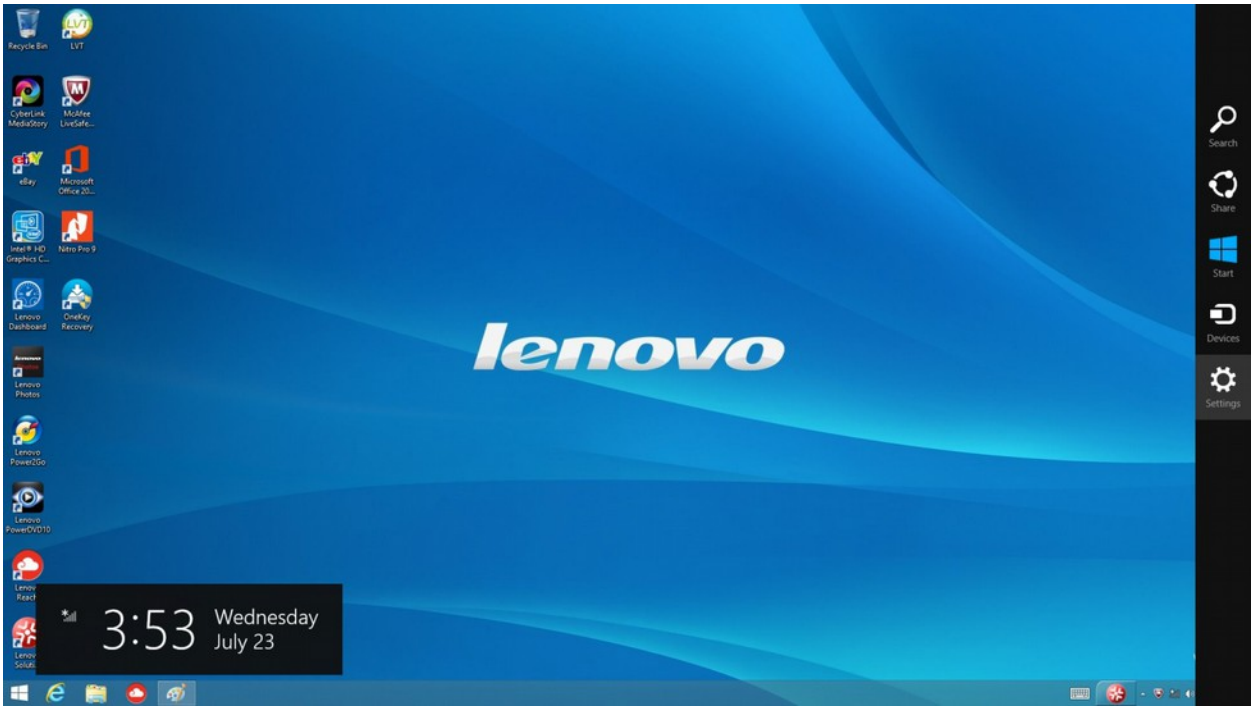
2.) Connect a **SHIELDED** CAT5/CAT6 Ethernet cable to the on-board Ethernet port and the MPU11.

3.) Power on the MPU11 and servo PC/console.

4.) Insert the Windows 8 DVD and install the Windows software.

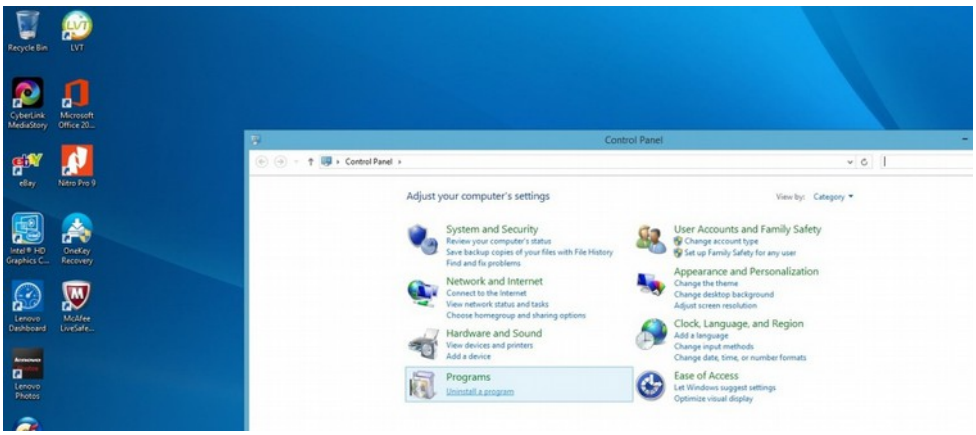
5.) Start at the desktop view.

6.) Move your mouse to the right corner of the screen to bring out the side tab and click on the "**Settings**" button.

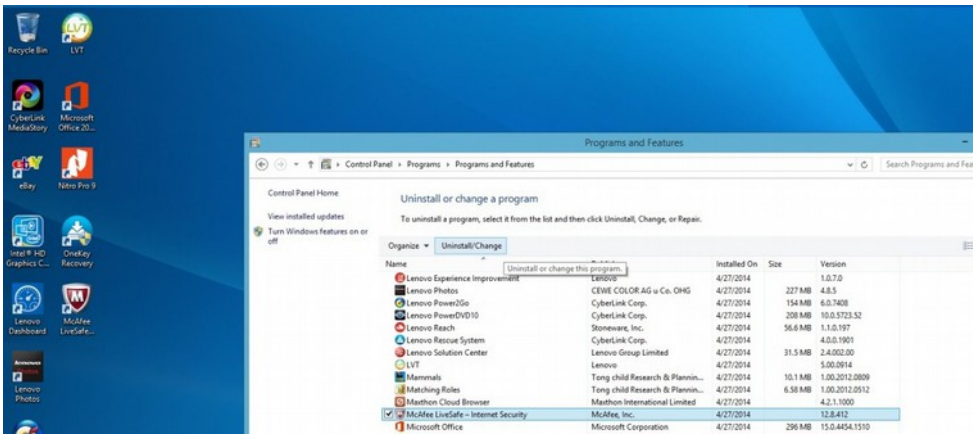


7.) Next click on the "**Control Panel**"

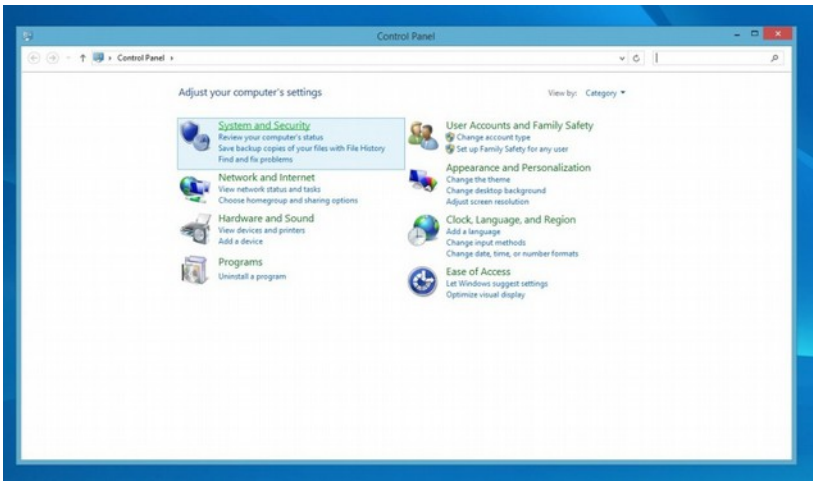
8.) Go to "**Uninstall a Program**" directly underneath "**Programs”**.



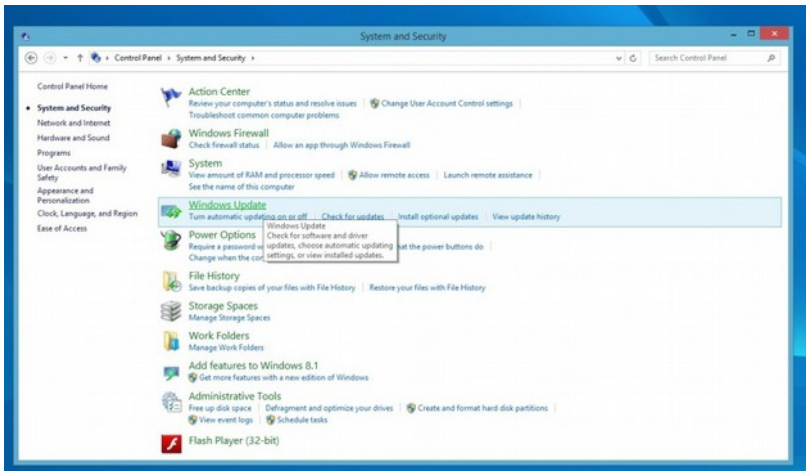
9.) Next uninstall any un-necessary programs that might have come from your computer manufacture. Some of these may include McCaffey Antivirus, various trial offers, etc.



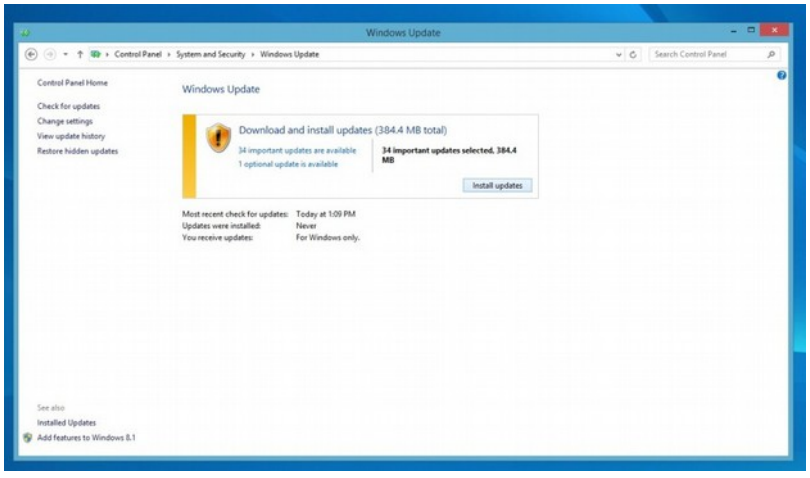
10.) Go back to the main "**Control Panel**" page and click on "**System and Security**".



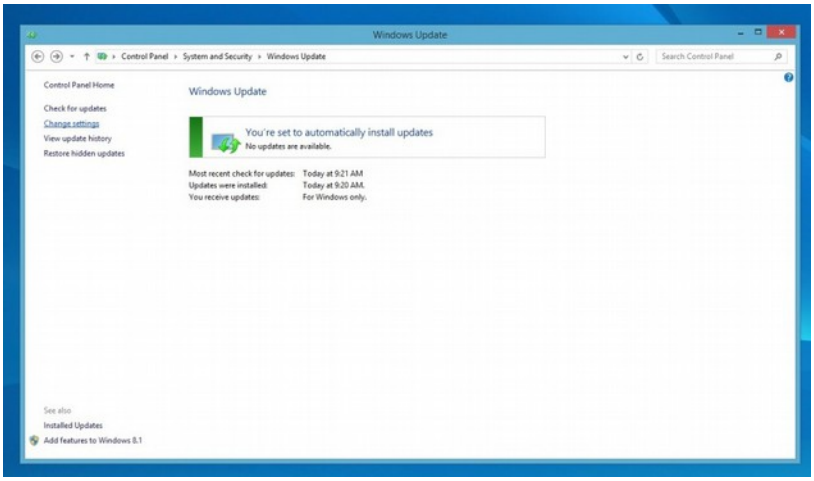
11.) Click on "**Windows Update**".



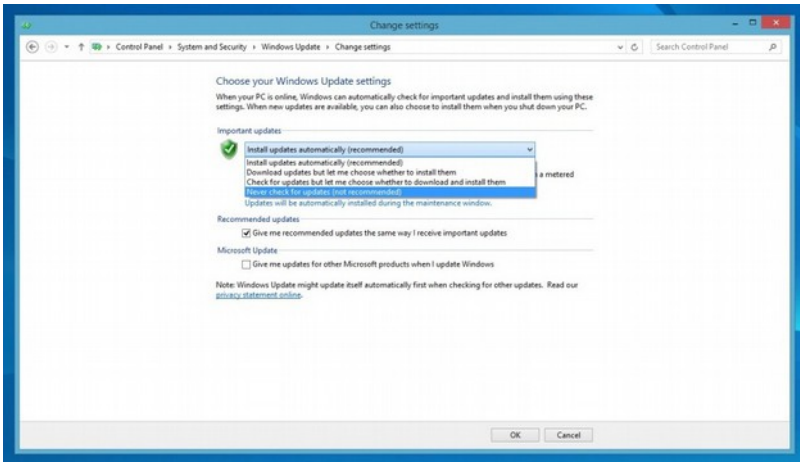
12.) Install the Updates. You may need to restart the computer several times.



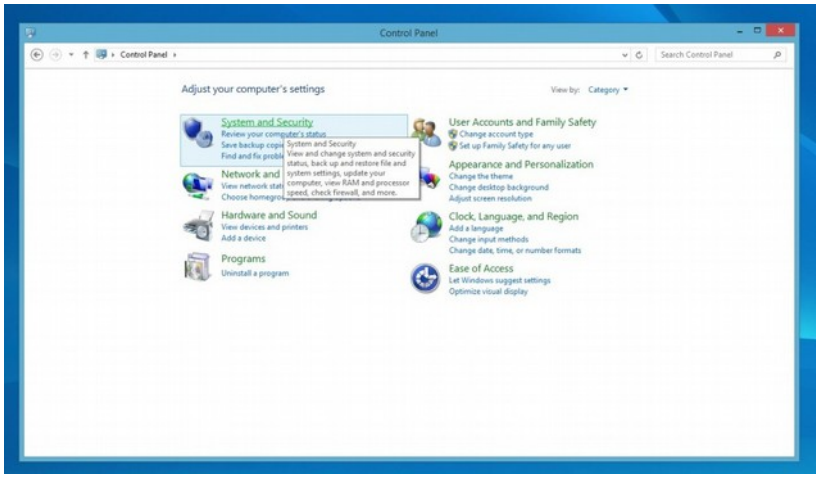
13.)Keep going until you see the below screen, stating that no more updates are available. Then click on the "Change settings" on the left side.



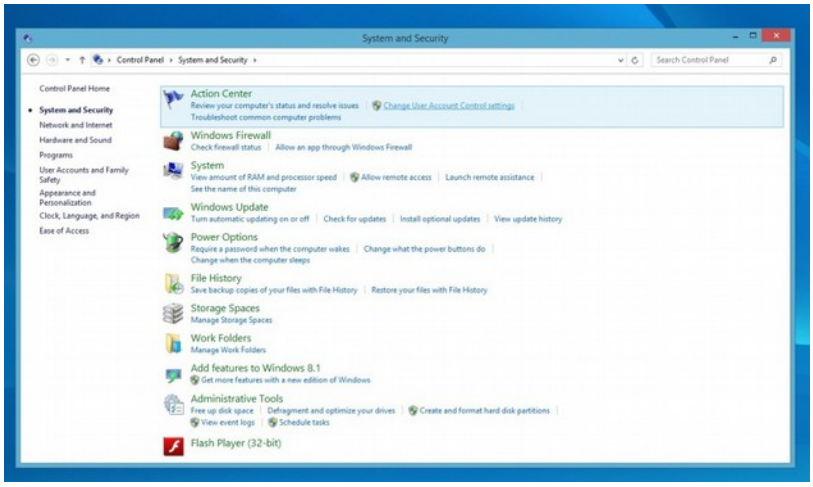
14.) From the dropdown under "**Important updates**" select "**Never check for updates**" and click **OK** at the bottom after.



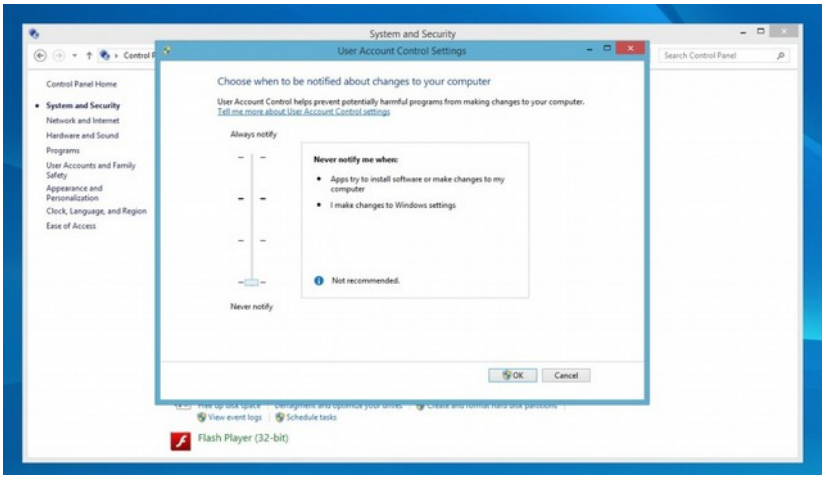
15.) Go back to the Control Panel view and click on "**System and Security**".



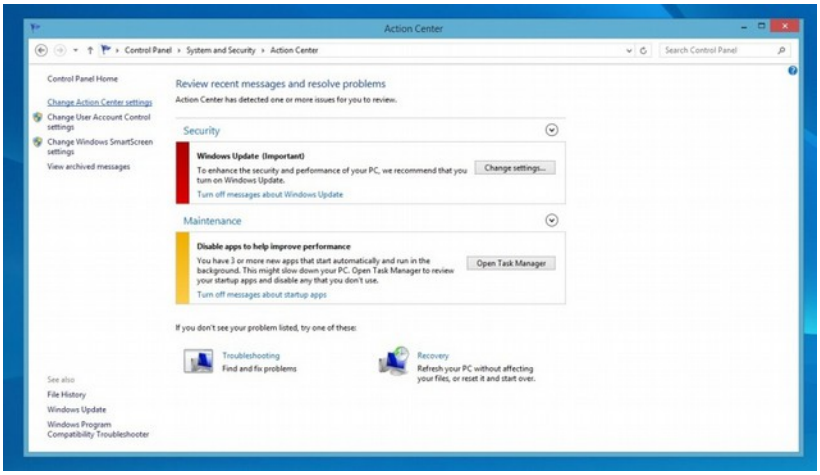
16.) Click on the "**Action Center**".



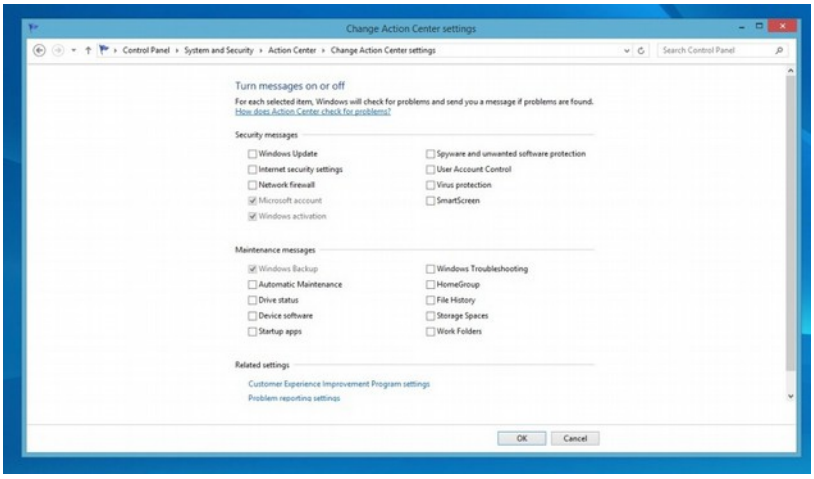
17.) Click on "**Change User Account Control Settings**" and then drag the bar to the "**Never notify**" at the bottom and click **OK**.



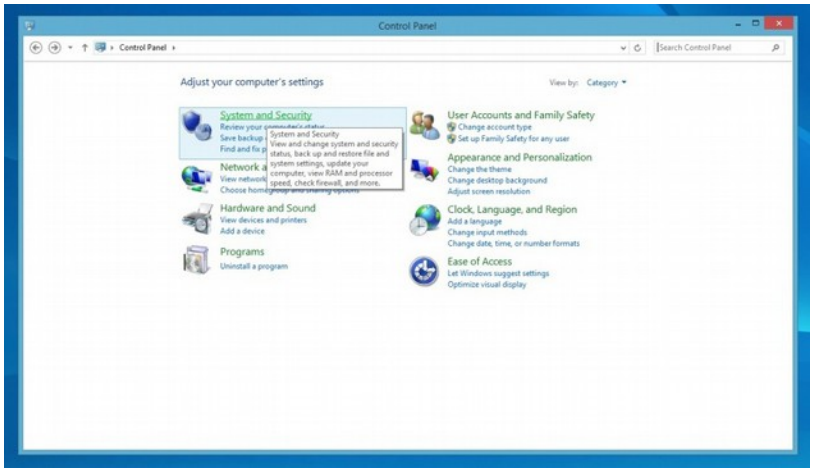
18.) Next click on "**Change Action Center Settings**".



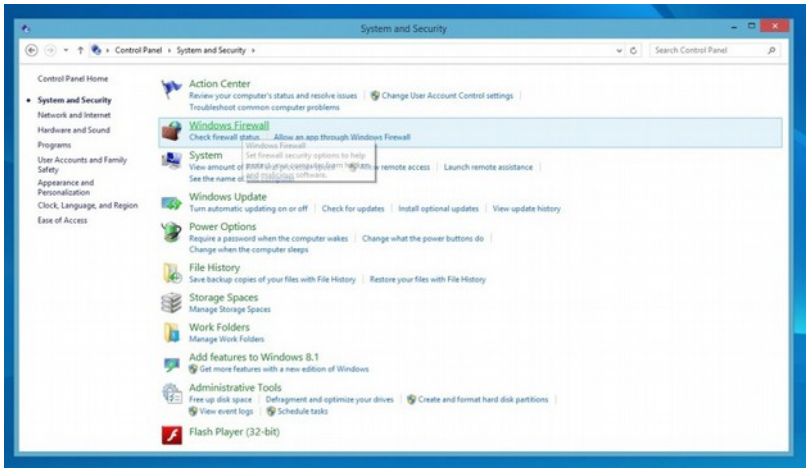
19.) Un-select every checkbox and click **OK**.



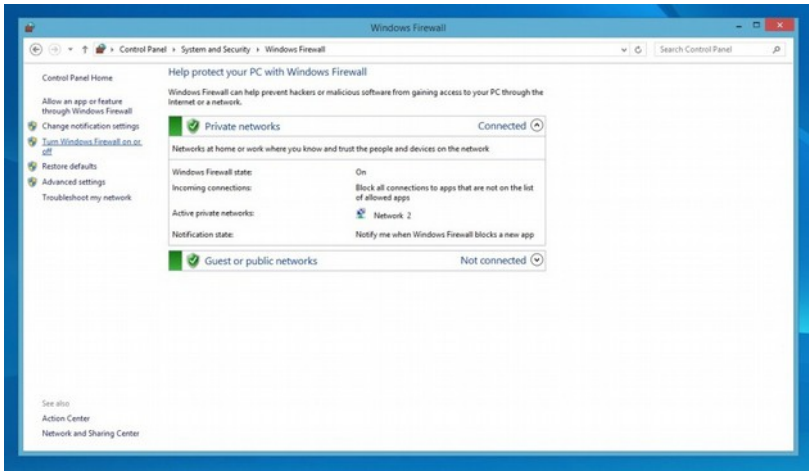
20.) Go back to the main Control Panel page and click on "**System and Security**".



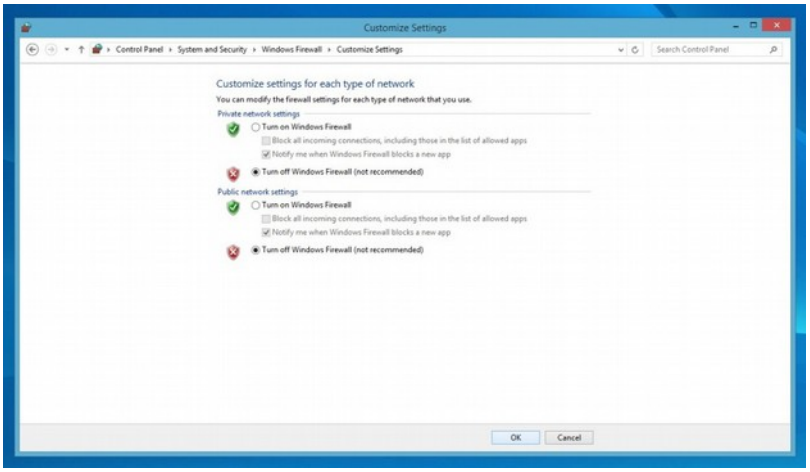
21.) Click on **"Windows Firewall"**.



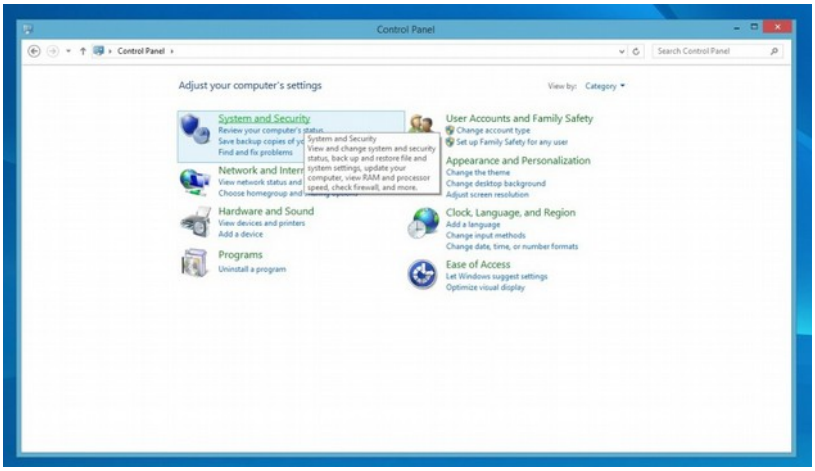
22.) Click on "**Turn Windows Firewall on or off**" on the left hand side.



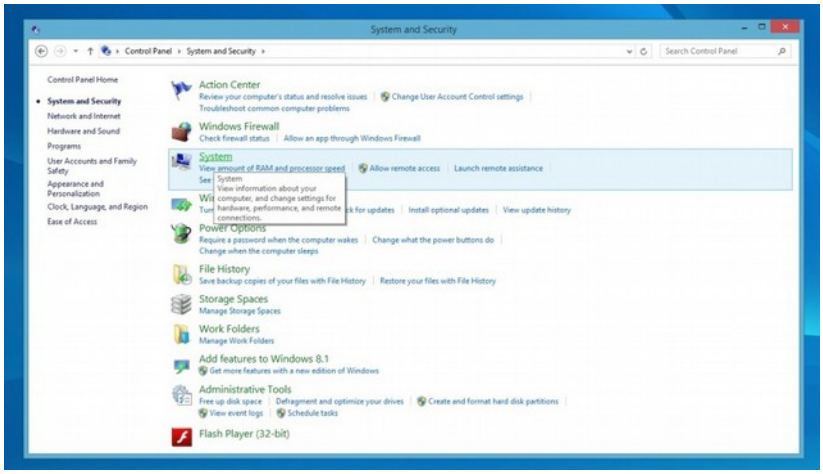
23.) Click on the "**Turn off Windows Firewall**" buttons on both the Private and Public network settings. Click **OK** at the bottom.



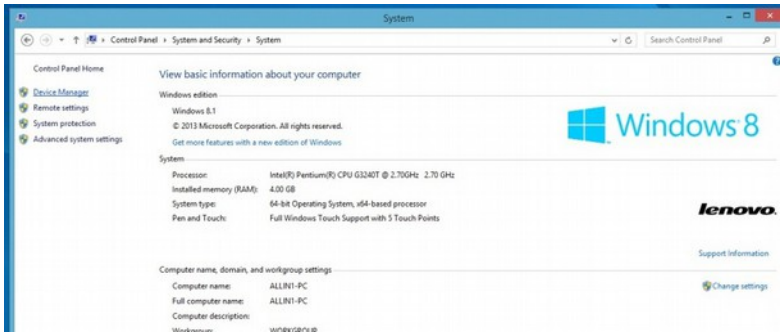
24.) Go back to the Control Panel Main page and click on "**System and Security**".



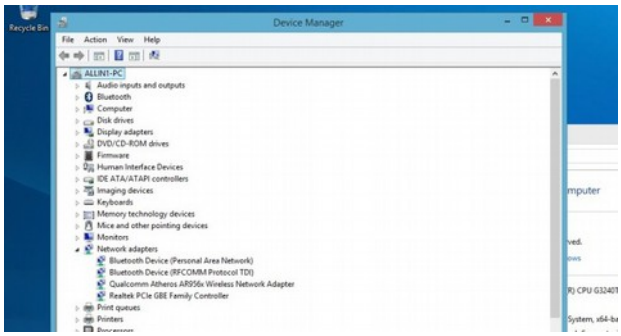
25.) Click on the "**System**" option.



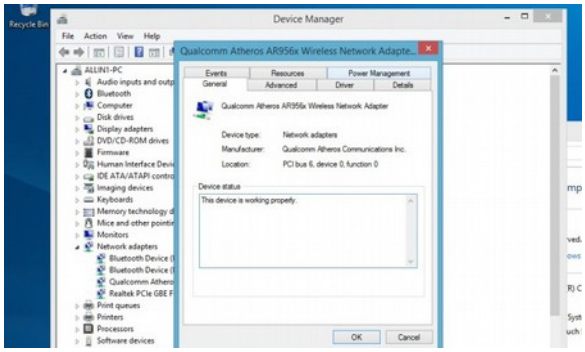
26.) Click on "**Device Manager**" on the left hand side.



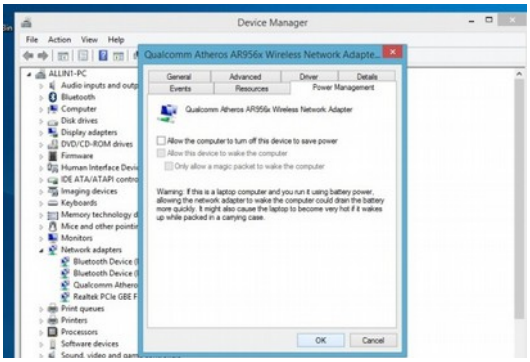
27.) Find the "**Network adapters**" and click to expand them.



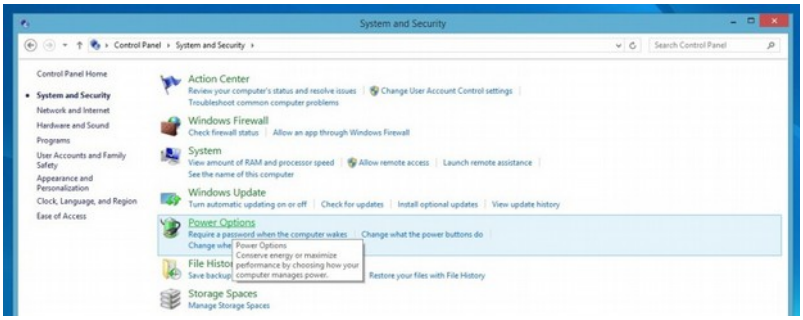
28.) Double-click on any Ethernet cards and the below should be displayed.



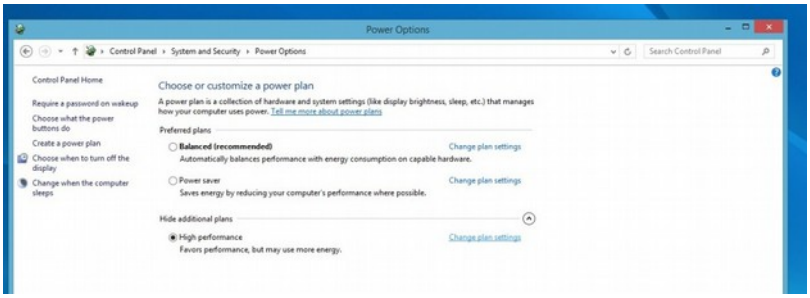
29.)Click on the "**Power Management**" tab and the uncheck all the boxes. Click **OK** and do the same for any other Ethernet Cards available.



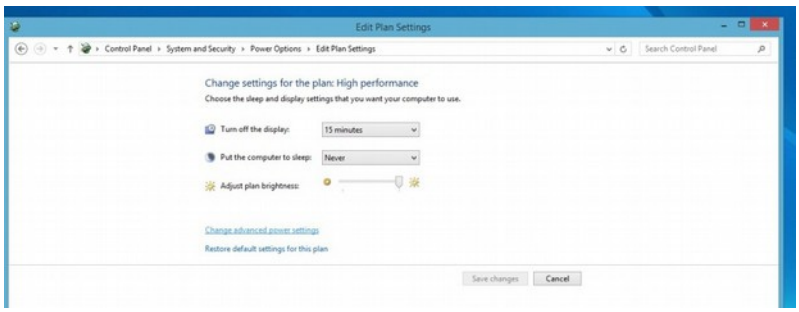
30.) Go back to the "**System and Security**" screen and click on "**Power Options”**.



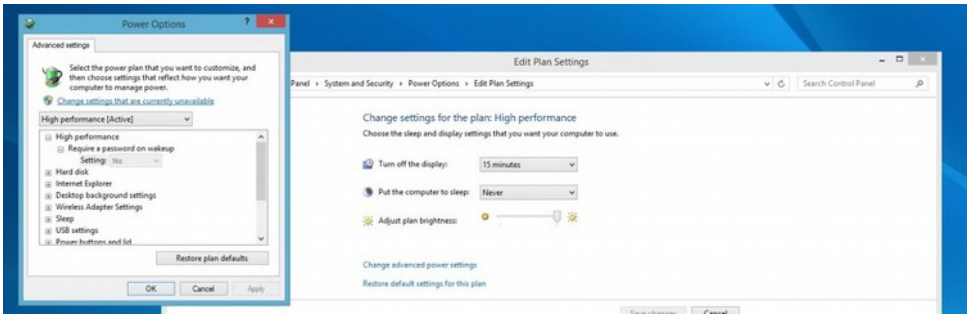
31.) Click on the circle with and arrow to bring up the "**additional plans**" then select "**High performance**" and click "**Change plan settings**".



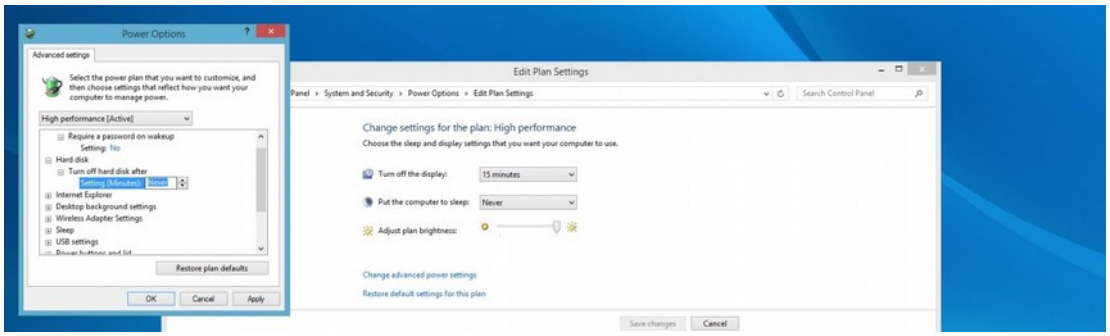
32.) Click on the "**Change advanced power settings**".



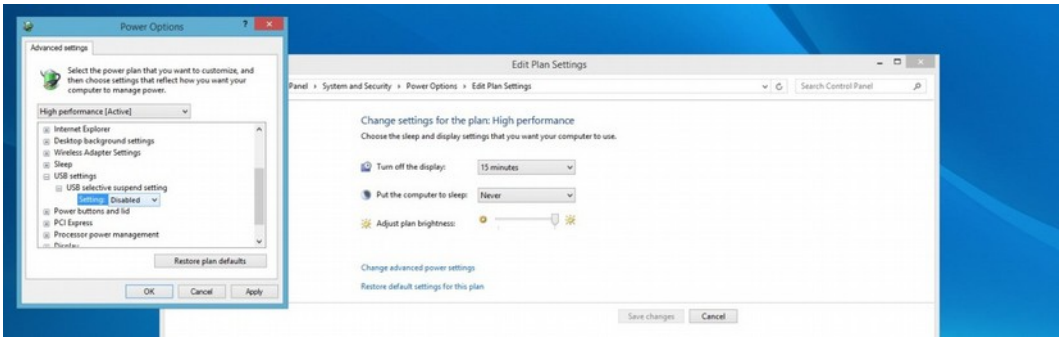
33.) Click on the "**Change settings that are currently unavailable**".



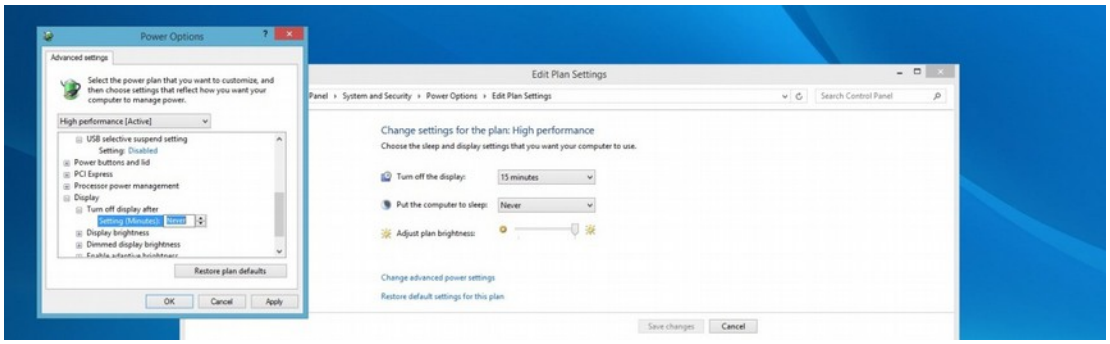
34.) Under "**Hard disk**" set "**Turn off hard disk after**" to "**Never**"



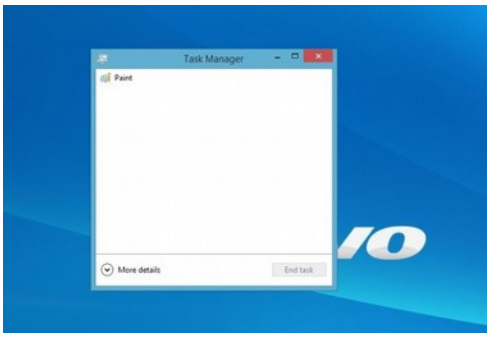
35.) Under the **"USB settings"** , for **"USB selective suspend setting"** select "**Disabled**"



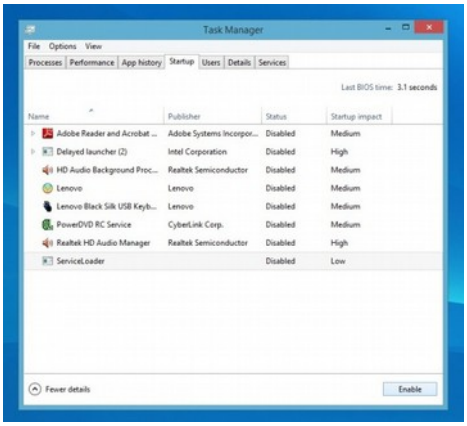
36.) Under "**Display**" set "**Turn off display after**" to "**Never**". Then click "**Apply**". Than close the open window.



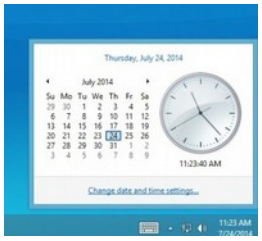
37.) Press "**Ctrl**" + "**Alt**" + "**Delete**" all at the same time. Select "**Task Manager**", then click on the more details button.



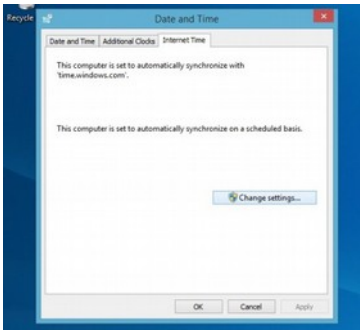
38.) Next click on the "**Startup**" tab and click on each Item and then click "**Disable**" at the bottom. Then close the window.



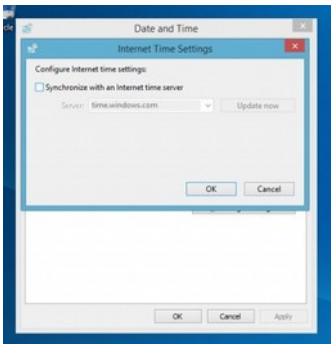
39.) Click on the "**Date and Time**" section of the taskbar on the lower right hand corner. Click "**Change Date and Time Settings**".



40.) Select the "**Internet Time**" tab and click on "**Change settings**..."



41.) Uncheck the "Synchronize with an Internet time server" box and click OK.



TIP: If you want to eliminate the scan & fix pop up and autoplay pop up when you plug in your USB stick, you will need to do the following. To suppress the scan & fix click on the Windows icon and type: **msconfig** and click on the "**Services Tab**" then scroll down and uncheck "**Shell Hardware Detection**". Click "**Apply**" then "**Ok**" and then you will need to power cycle the PC.

TIP: To suppress the autoplay, click on Windows start icon and type: **autoplay** then uncheck "**use AutoPlay for all media and devices**" and click "**Save**".

You may now continue to **Section 3.2, CNC11 and PLC Installation.**

Appendix B - Windows 7 Preinstallation

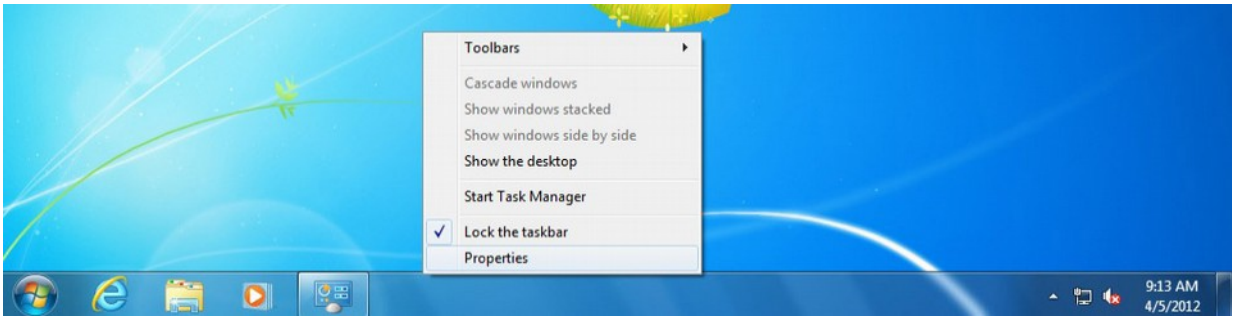
This procedure is outlined in Technical Bulletin 244, the latest version can be found here. (http://www.centroidcnc.com/usersupport/support_files/tbs/tb244.pdf)

Required Materials

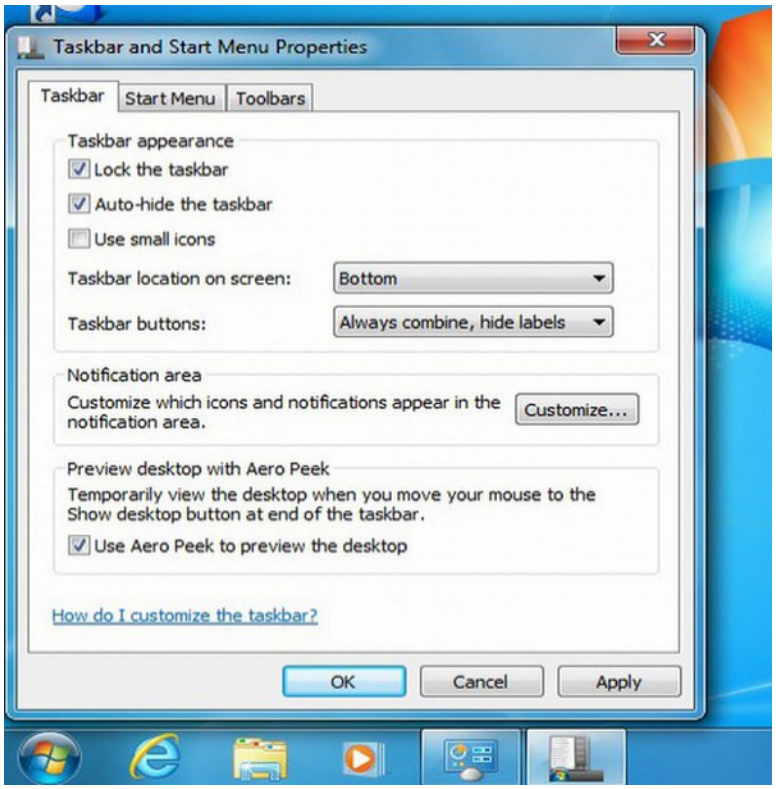
- OCZ Vertex Series 30Gb SATA II SSD
- USB or SATA DVD player
- USB mouse
- copy of Windows 7 Home Premium 64-bit
- copy of the latest version of CNC11 software

Instructions for Configuring Windows 7

1. Install SSD and DVD player into servo PC/console. Make sure to plug the SATA cable from the SSD into SATA0 on the motherboard. Software **MUST** be loaded on the system that you are working on. It **CANNOT** be loaded onto an SSD remotely and then installed onto the control. Windows does not allow that.
2. Connect a **SHIELDED** CAT5/CAT6 Ethernet cable to the on-board Ethernet port and the MPU11 as shown in Section 2.3.
3. Power on the MPU11 and servo PC/console.
4. Insert the Windows 7 DVD and install the Windows software.
5. Using the mouse, right click on the task bar, which is located on the bottom of the screen, and select “Properties” as shown below.

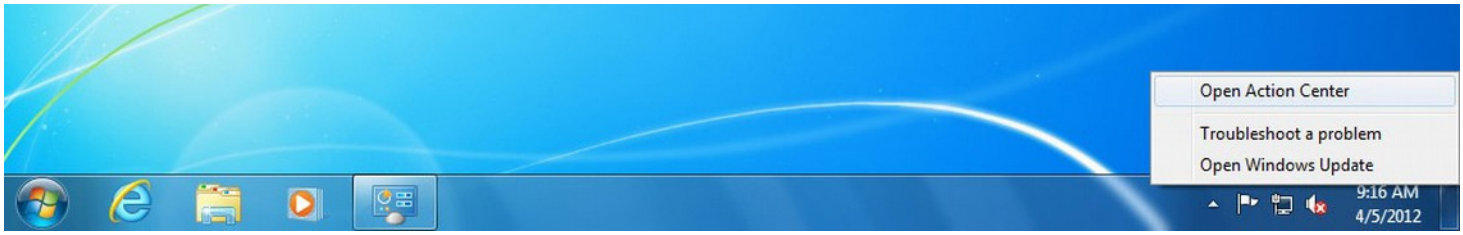


6. Check the “**Auto Hide**” option under the “**taskbar**” tab.

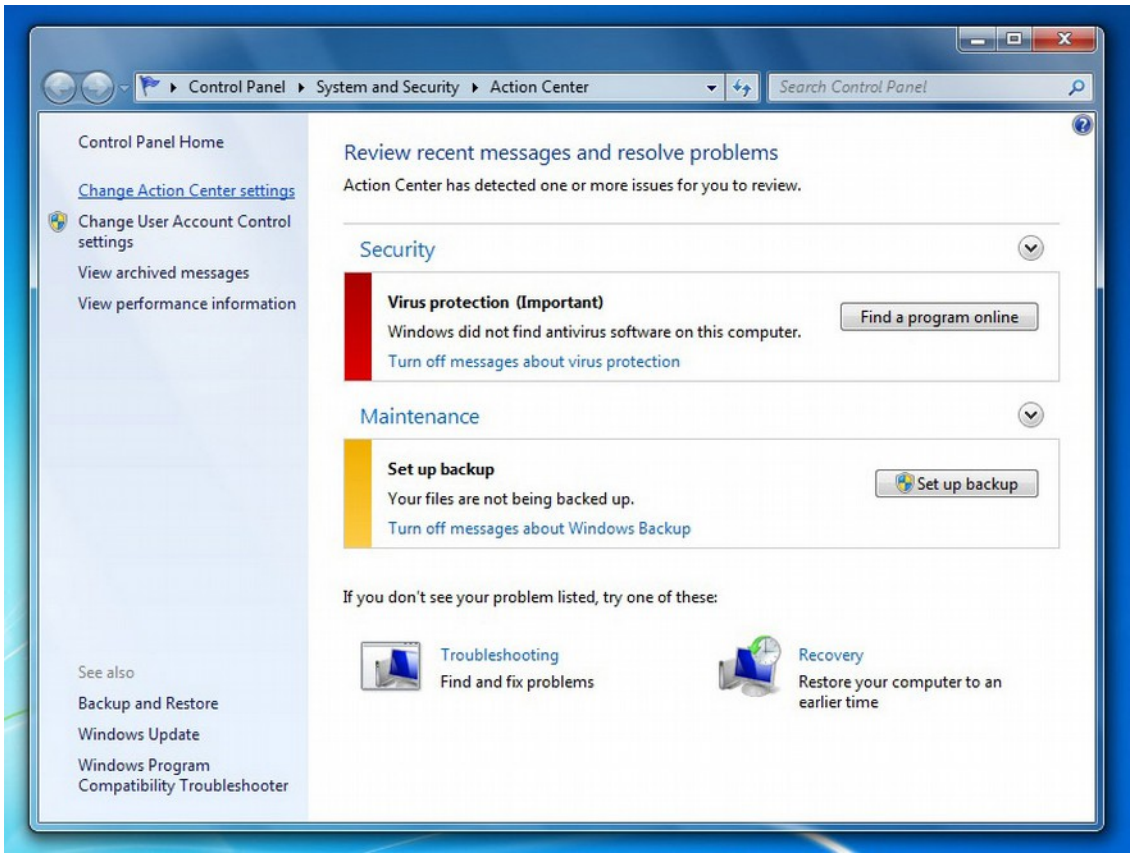


7. Right click on the "**Action Center**" icon, which is the green flag that is located on the right side on the task bar.

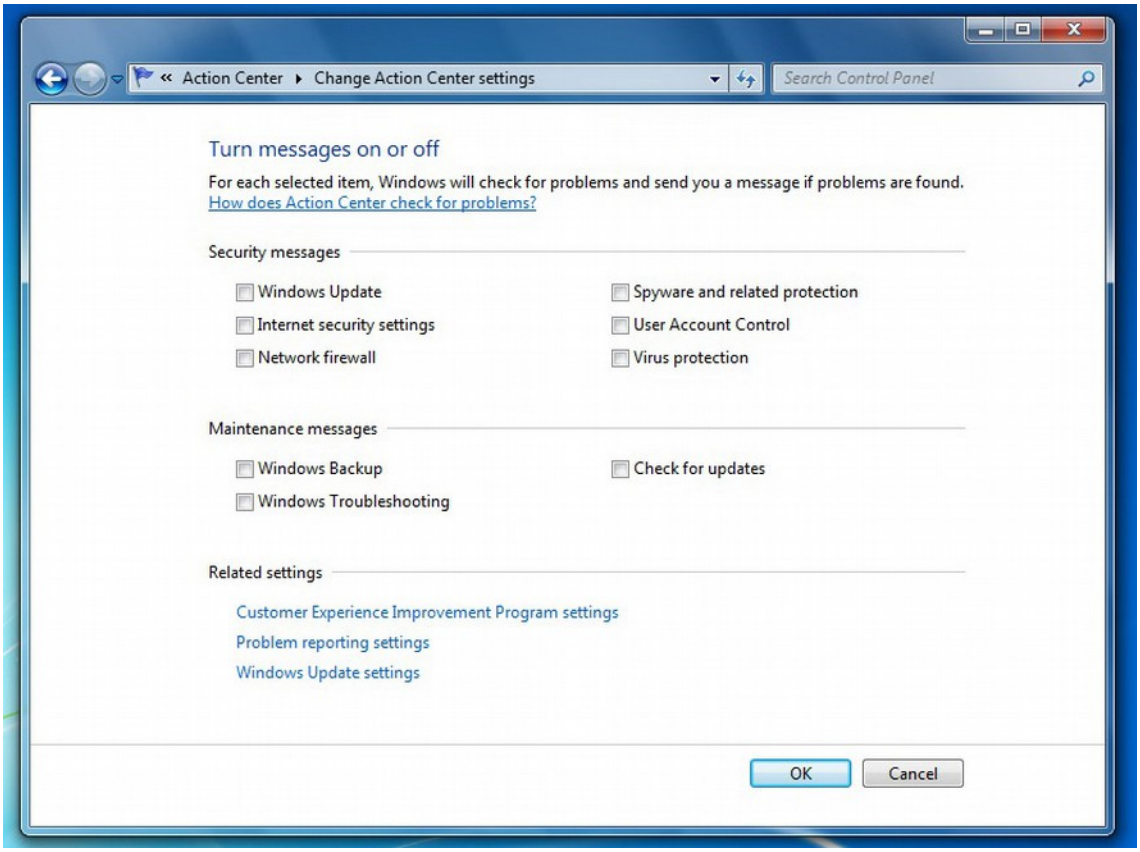
8. Select "**Open Action Center**".



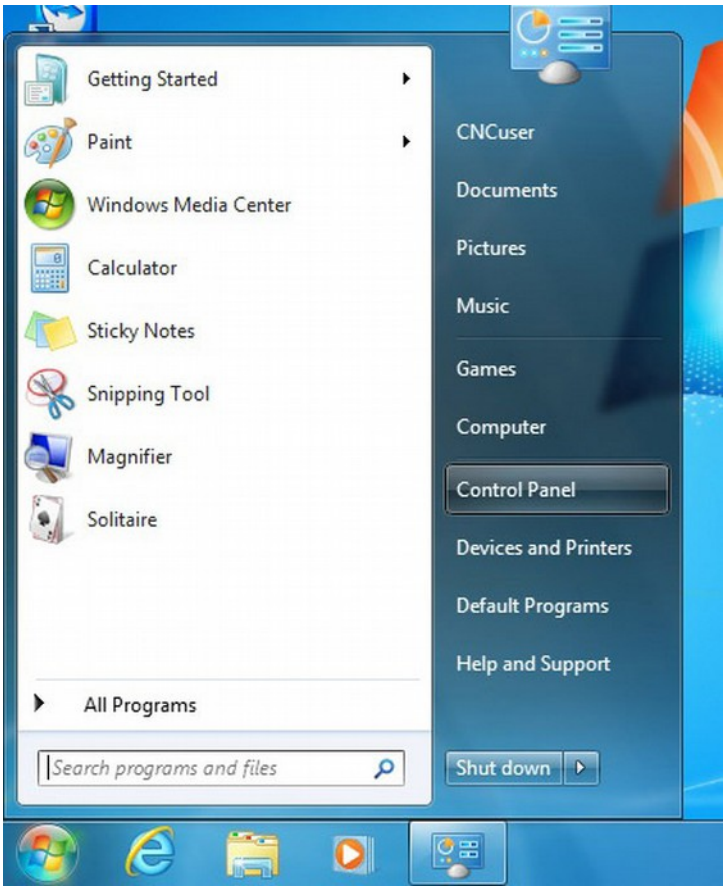
9. Click on "**Change Settings**".



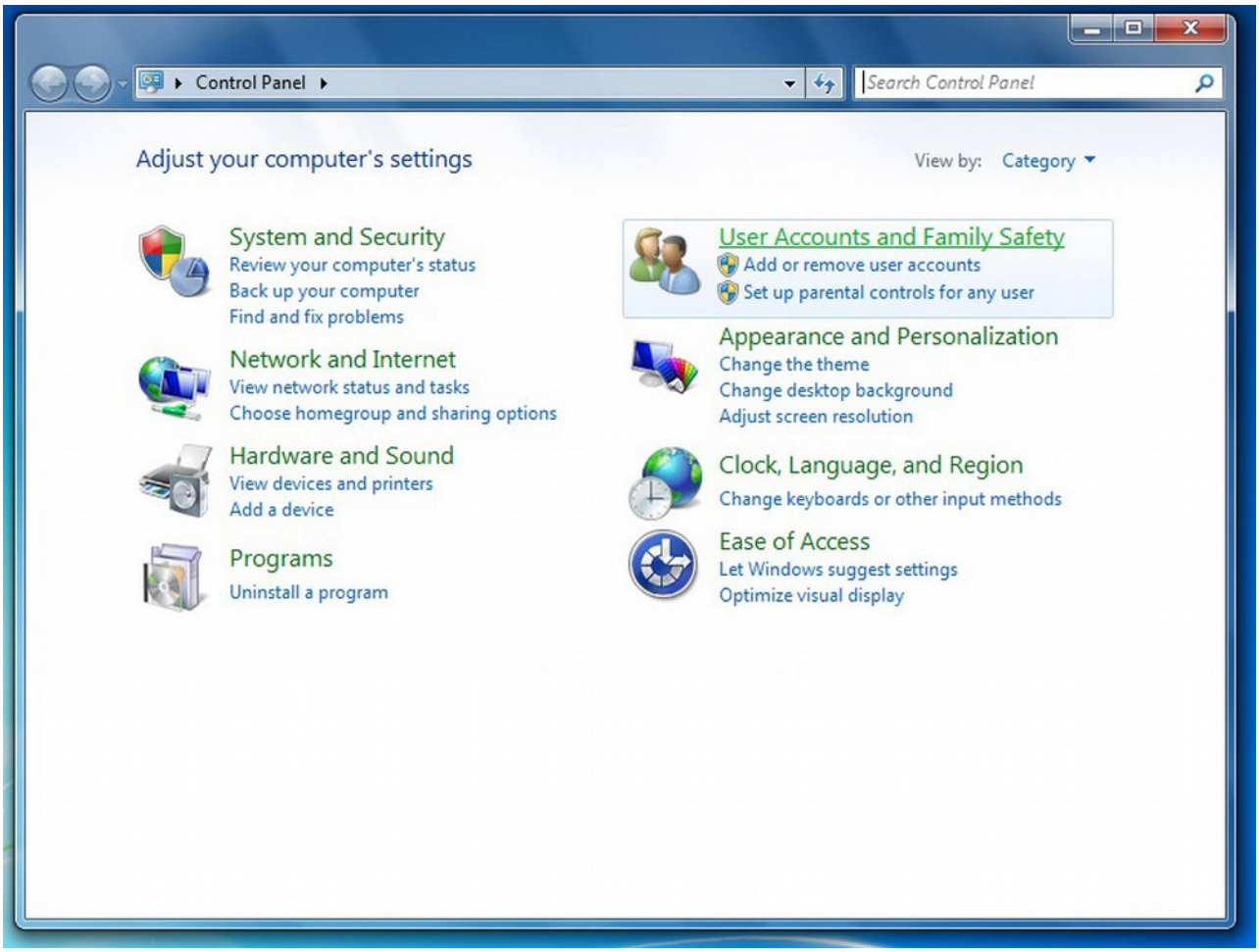
10. Make sure that all of the options have their respective boxes unchecked.



11. Click on the "**Start**" button and select "**Control Panel**".



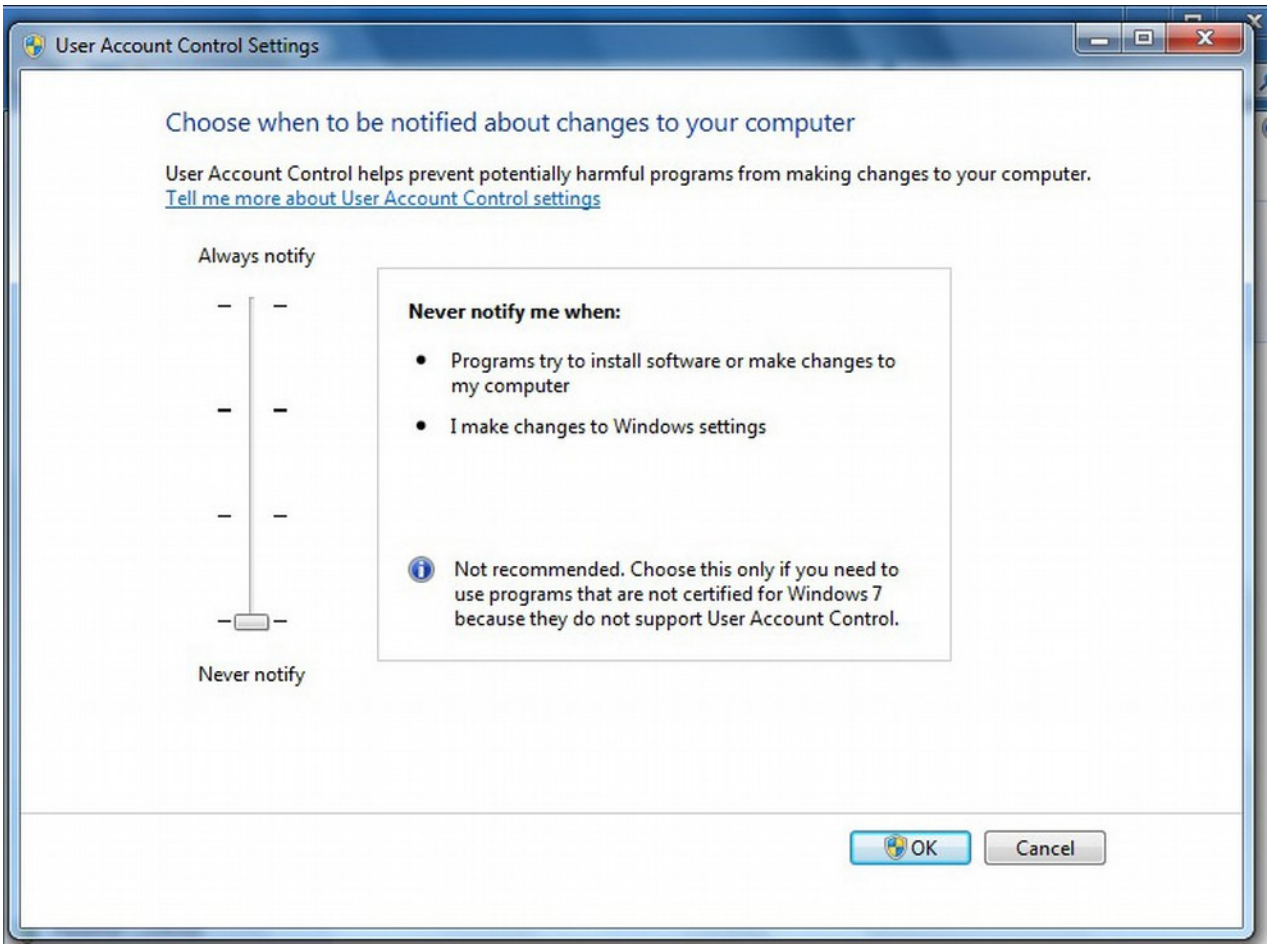
12. Select "**User Accounts & Family Safety**".



13. Click on "**User Accounts**"

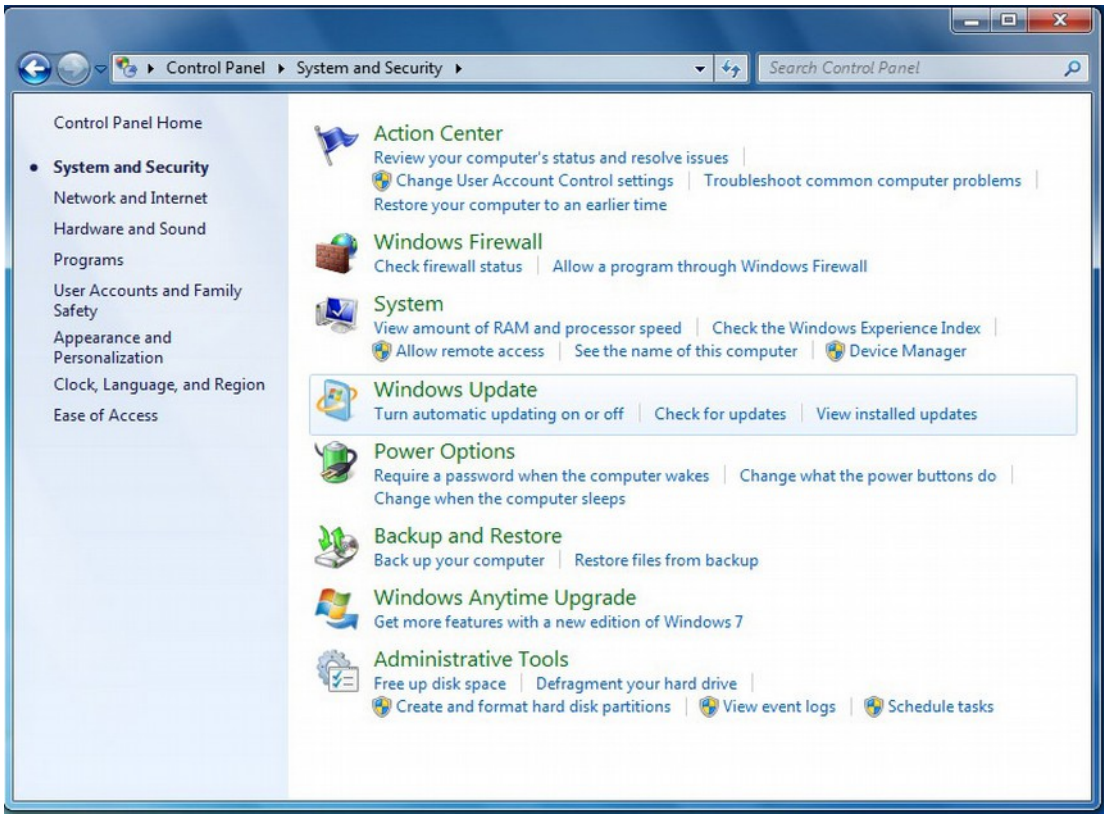
14. Create an administrative account with the name **CNCuser**.

15. Select "**Change User Account**" and lower the slider bar to "**Never Notify**".

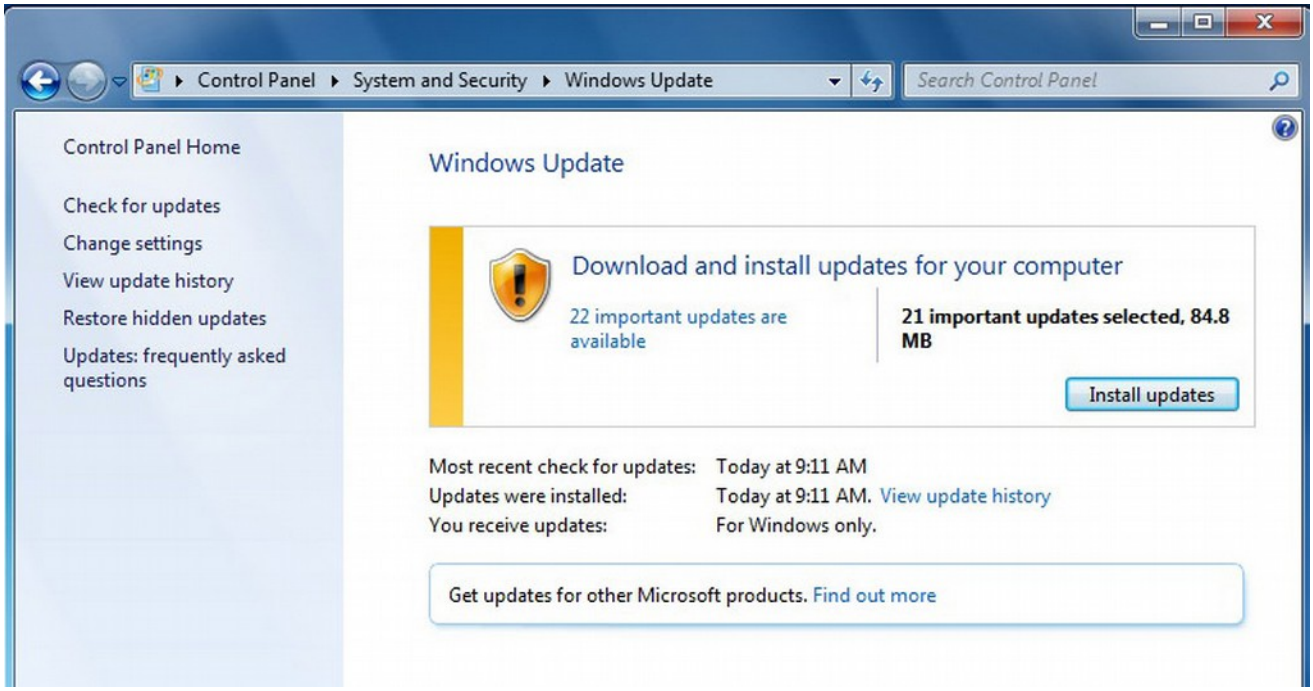


16. Go back to "**Control Panel**" and select "**System & Security**".

17. Select "**Windows Update**"

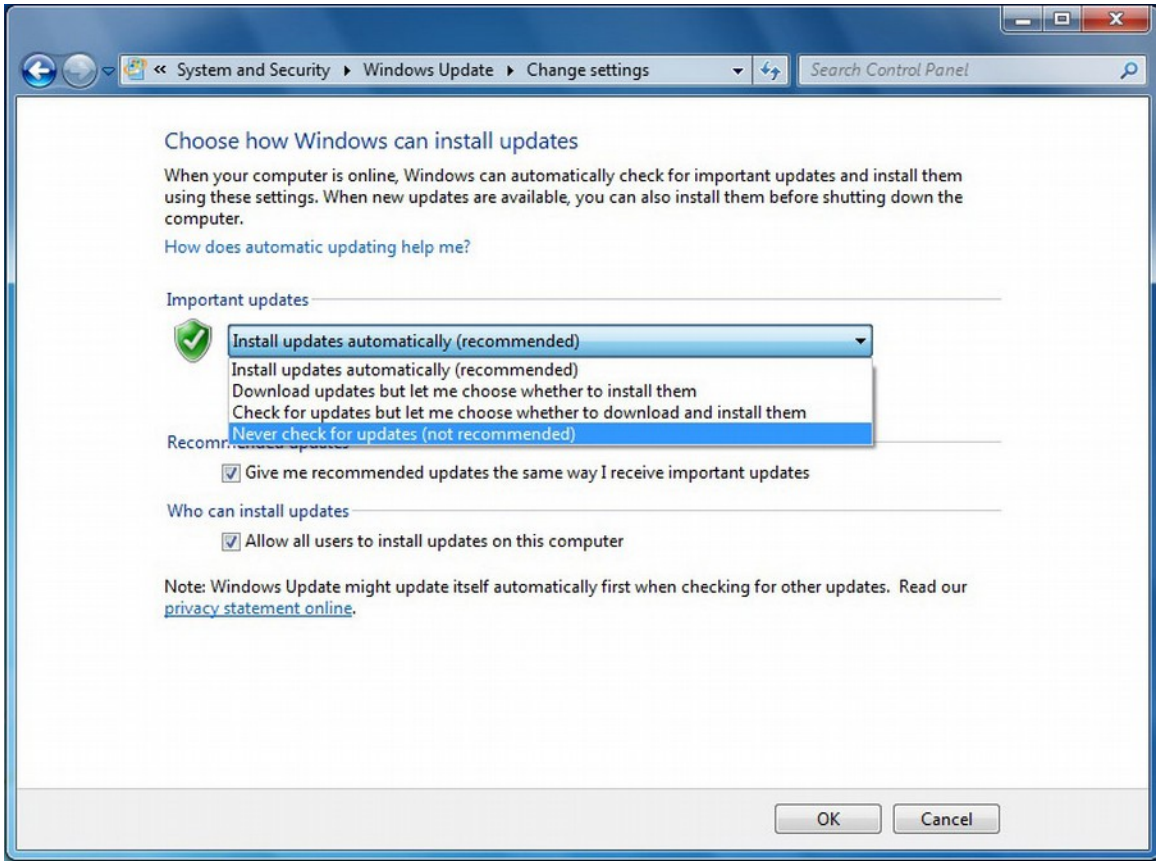


18. Click on “**Install Updates**”.



19. The computer may need to be restarted after the updates are done installing. Go back to the above screen and keep clicking “Install Updates” until you see the screen below. Next click on “Change Settings” on the left hand tab.

20. Select “Important Updates” and then select “Never Check for Updates”.

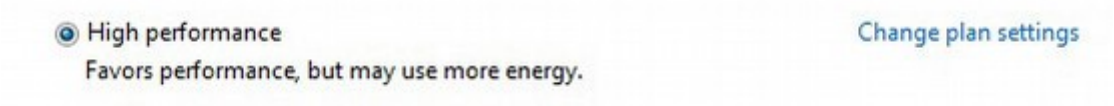


21. Go back to “**Control Panel**”, "**System and Securities**".

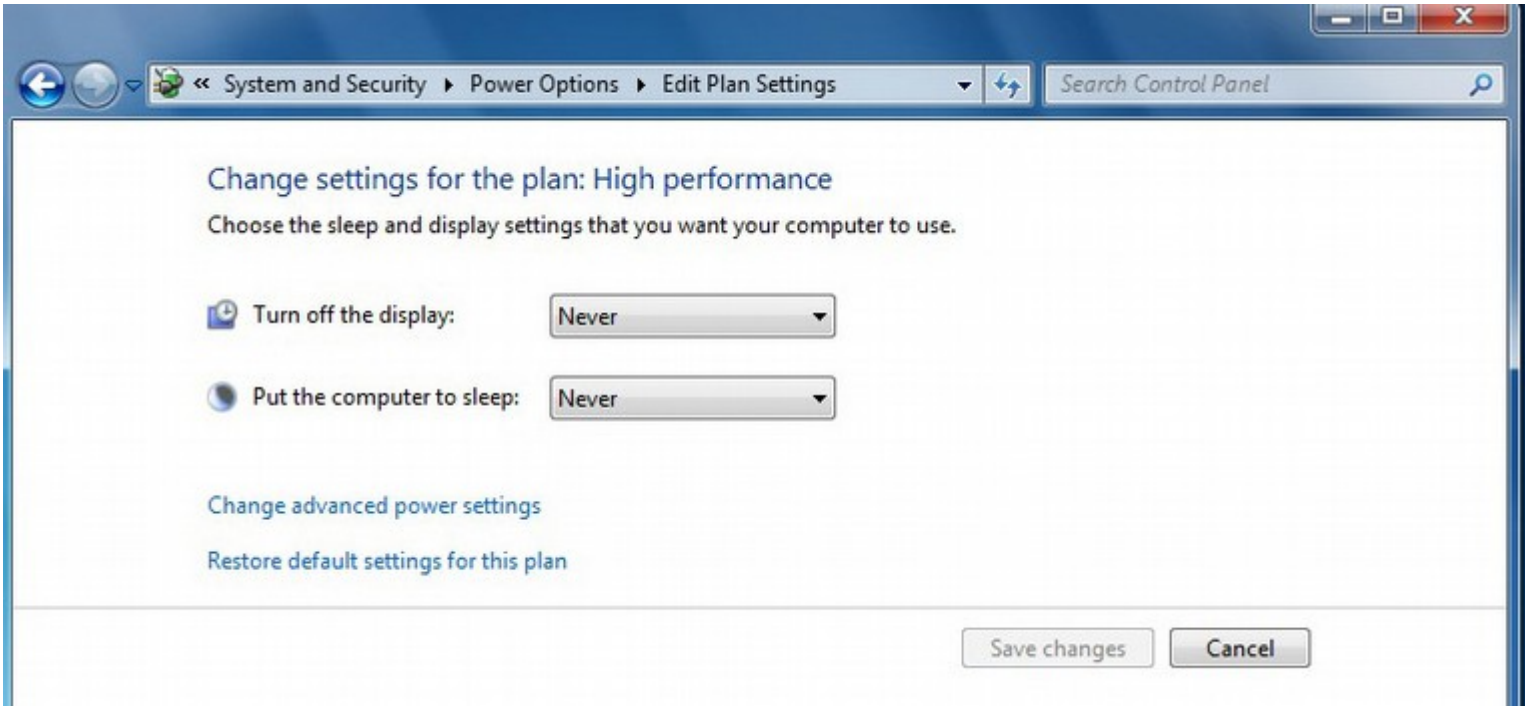
22. Select “**Power Options**”.

23. Click on the down tab next to “**Show additional plans**”.

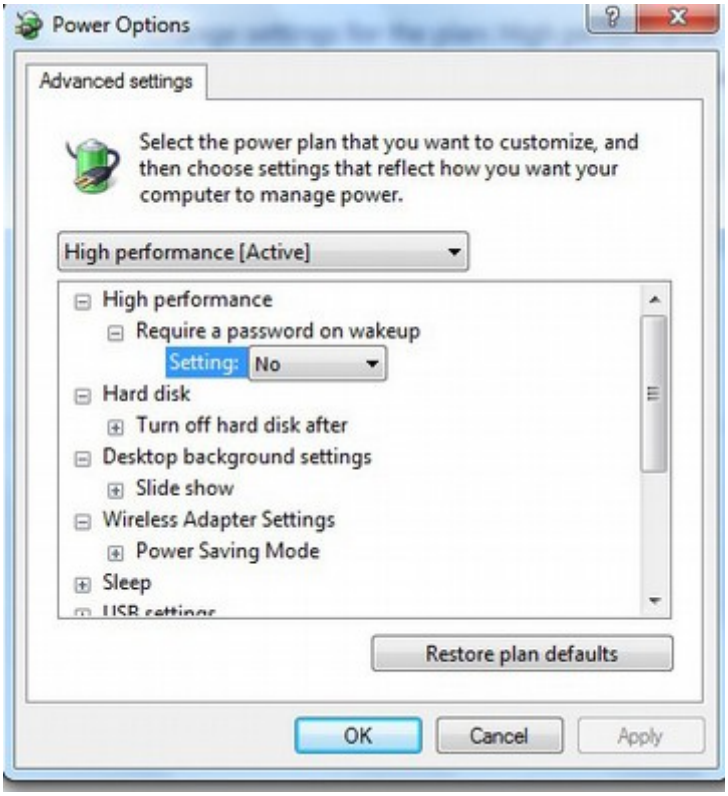
24. Next select “**High performance**” then select “**Change Plan Settings**”.



25. Then select “Change Advanced Power Settings”.

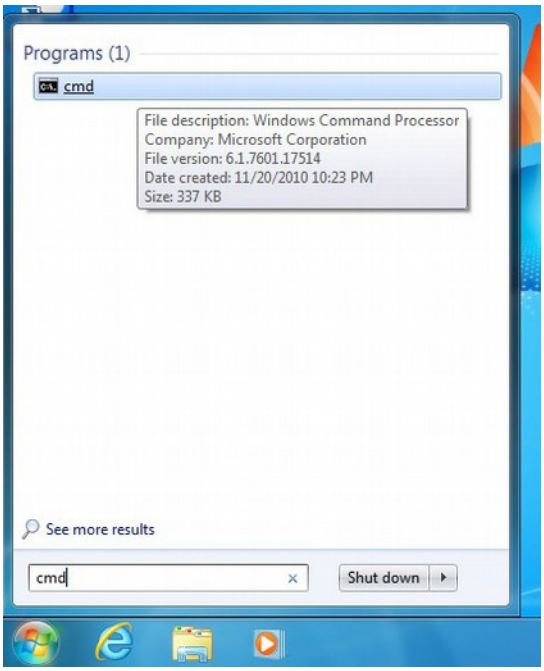


26. You should now be at the Power Options screen.

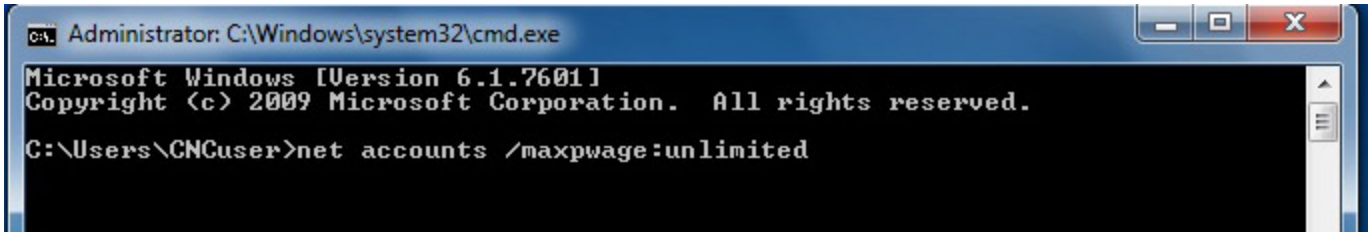


27. Make sure that the settings are as described below:
    1. High Performance
        1. Required password → NO
    2. HDD
        1. Turn off HDD → Never
    3. Desktop Background Settings
        1. Slide Show → Available
    4. Wireless Adapter Setting
        1. Power Saving mode → Maximum performance
    5. Sleep
        1. Sleep after → Never
        2. Allow hybrid sleep → ON
        3. Hibernate after → Never
        4. Allow wake times → Enable
    6. USB Settings
        1. USB selective suspend → Disable
    7. Power Buttons
        1. Power button action → Shut down
        2. Sleep button → Sleep
    8. PCI Express
        1. Link state power manage → OFF
    9. Processor Power Management
        1. Minimum processor state → 100%
        2. System cooling policy → Active
        3. Maximum processor state → 100%
    10. Display
        1. Turn off display after → Never
    11. Multimedia Settings
        1. When sharing media → Prevent idling to sleep
        2. When playing video → Optimize video quality

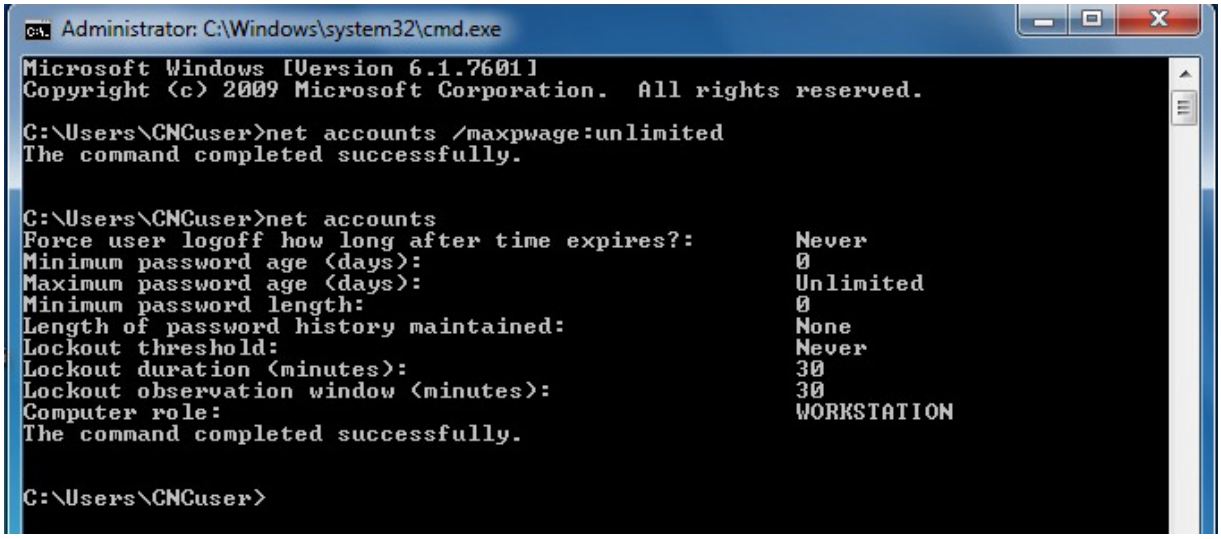
28. Next the user password expiration needs turned off. Click the Windows icon, then type: cmd to bring up the command prompt.



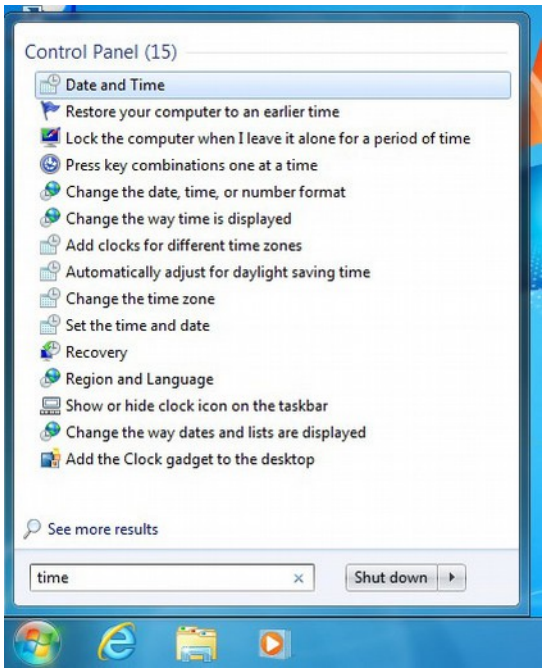
29. Make sure the title bar reads "**Administrator: C\Windows\system32\cmd.exe**",
    1. Then type: **net accounts** (press enter).
    2. Third line down will read " Maximum password age (days): 42",
    3. Confirm and then type: **net accounts /maxpwage:unlimited** (press enter).



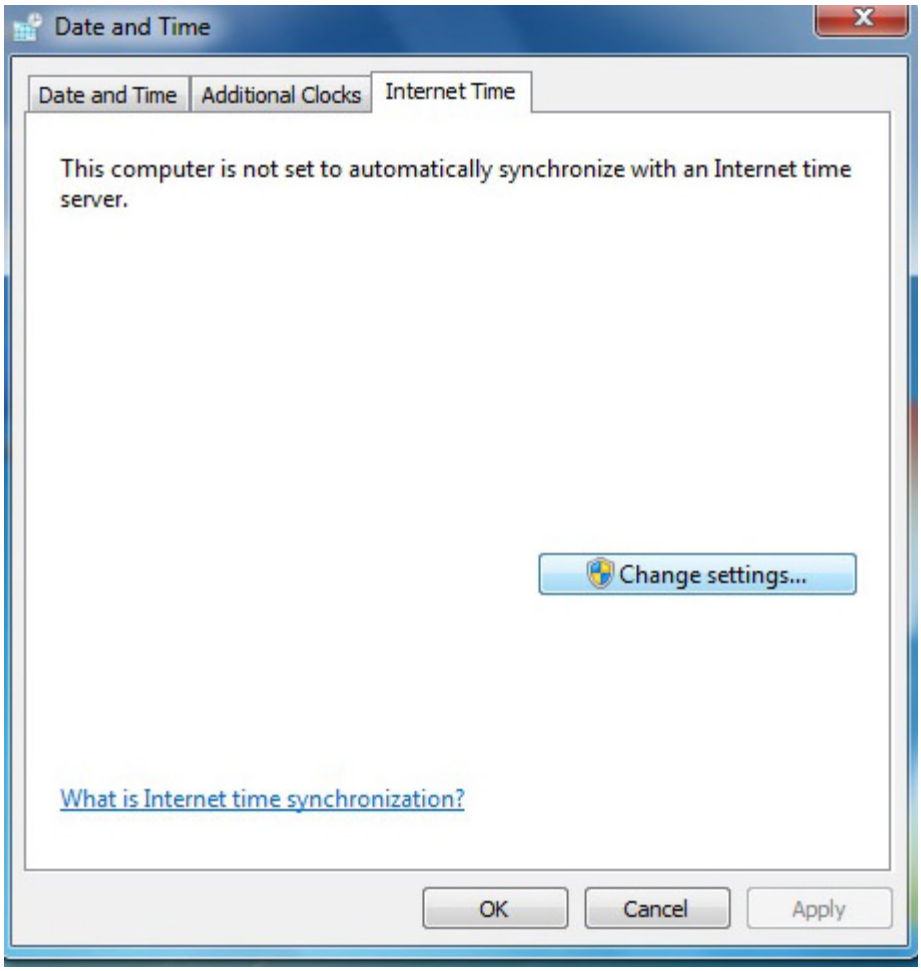
30. Type: **net accounts** again to verify that it says "**unlimited**" beside the "**Maximum password age**".
    1. If it does type: **exit** (press enter) to close the command prompt window.



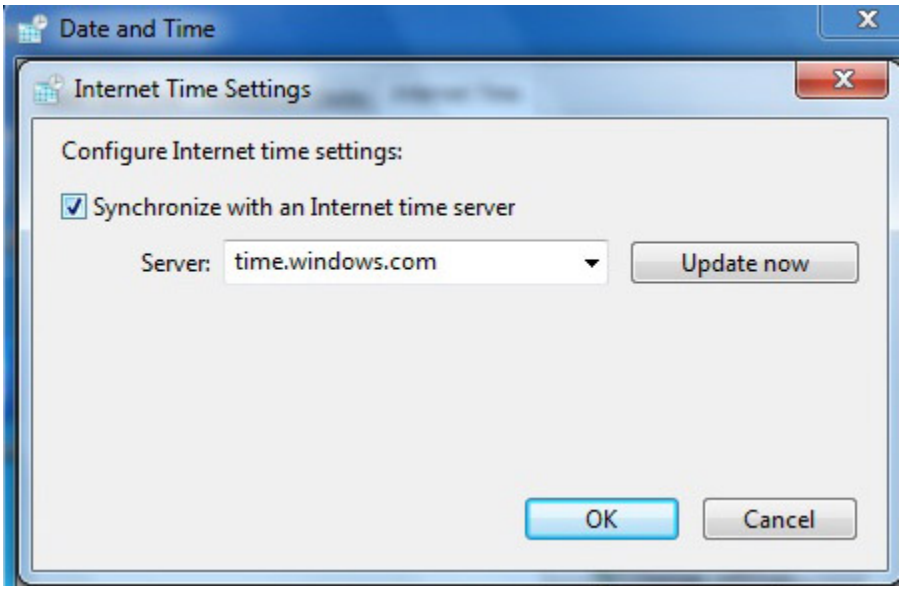
31. The "**Internet Time**" synchronization also needs turned off. To do this click on the Windows button and type: **time**, then click on "**Date and Time**" in the list.



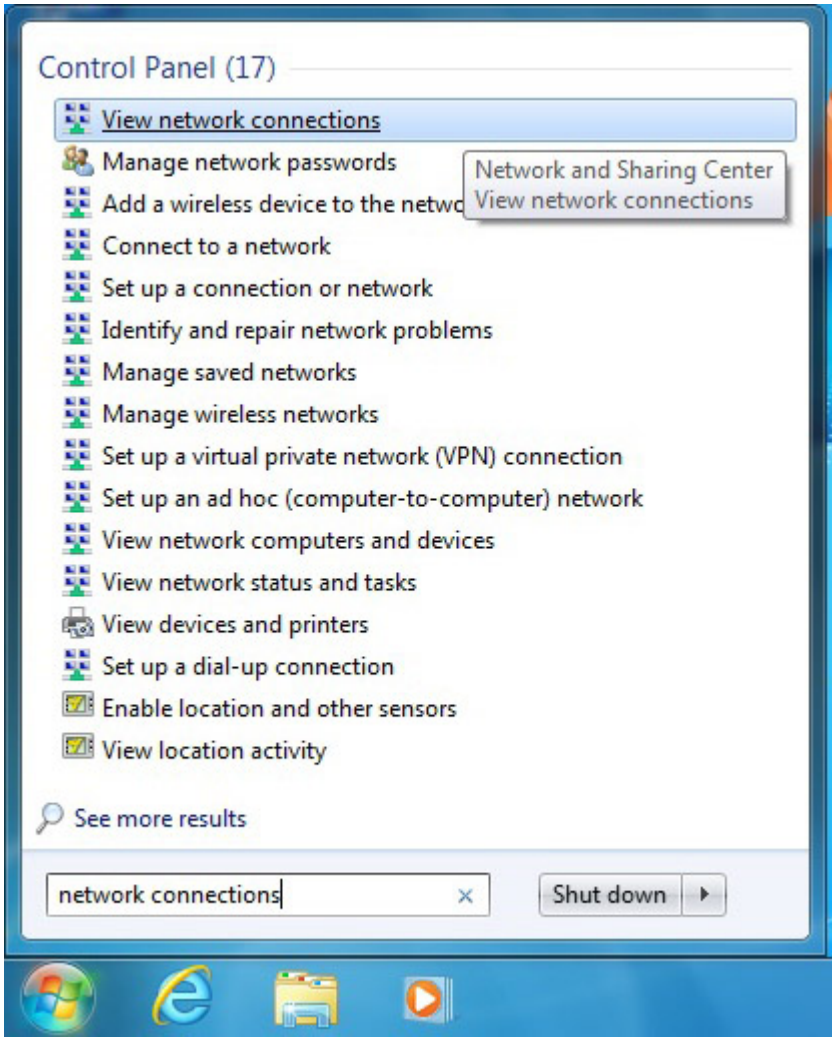
32. Click on the "**Internet Time**" tab and then click the "**Change Settings**" button.



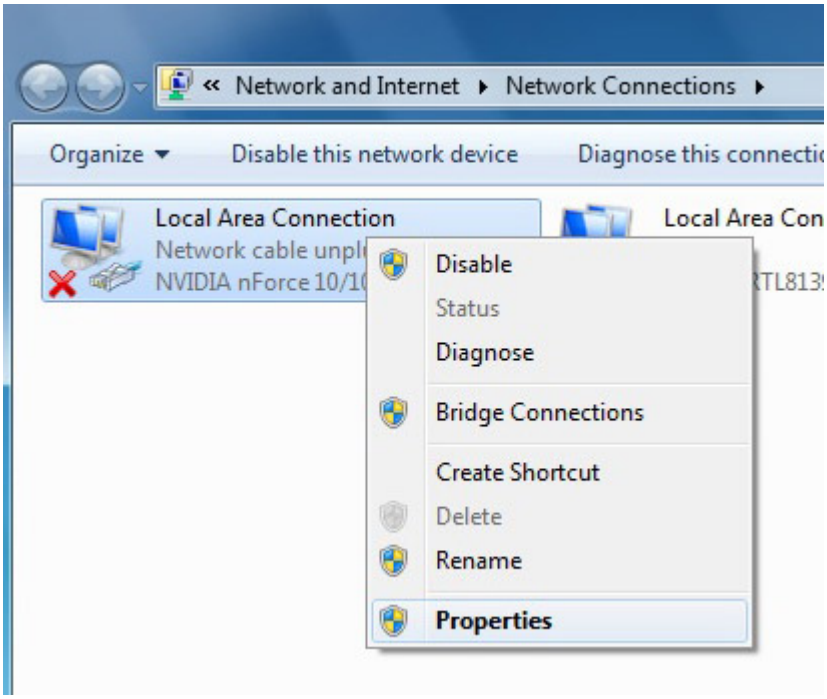
33. Uncheck the box for "**Synchronize with an Internet time server**", then click "**OK**" to close that window and click "**OK**" again to close the "**Date and Time**" window.



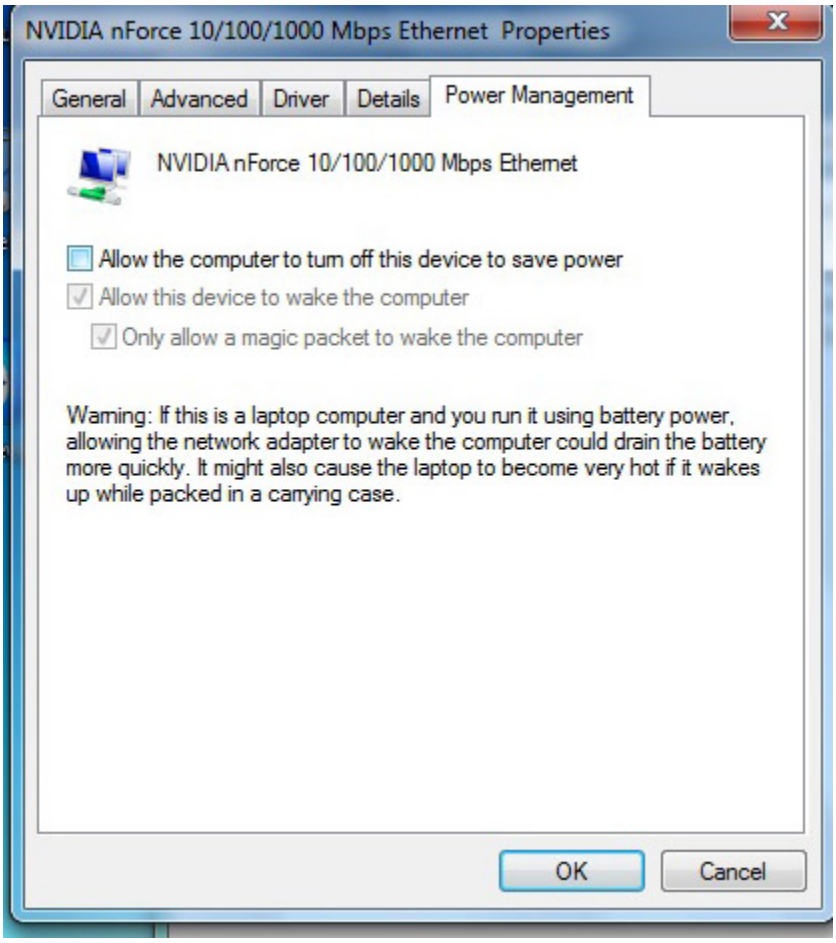
34. Click on the "**Start Button**" and type: "**network connection**" in the search window. Click on "**View Network**".



35. Right click on the network card. Click on "**Properties**".



36. Click "Configure". Click on the "Power Management" tab and make sure that the "Allow the computer to turn off this device to save power" box is unchecked.



37. After Windows 7 is configured the last thing you will need to do is activate Windows7, which can be done via the Internet or phone.

38. Open "**Windows Activation**" by clicking the "**Start**" button, then right click "**Computer**", then click "**Properties**", and then click "**Activate Windows now**".

    1. **Note: If you are installing a new SSD in which Centroid has installed the Windows7 operating system, you will NEED to change the product key before attempting to activate Windows7 by clicking on the "Start" button, then click on "Control Panel", then click on "System & Security", then click on "System", scroll all the way to the bottom and click on "Change product key".**

39. If using the Internet and Windows7 detects an Internet connection, click on "**Activate Windows online now**", type in the Windows7 product key when prompted, then click "**Next**" and follow the remaining instructions.

40. If activating Windows7 via the phone, click on "**Show me other ways to activate**", type in the Windows7 product key when prompted, then click "**Next**", then click "**Use the automated phone system**", then click on the location nearest you from the drop-down list, then click "**Next**". Call one of the phone numbers listed and an automated system will guide you through the activation process.

    1. When prompted, enter the installation ID that's listed on the screen into the phone's keypad.
    2. Type the confirmation ID that the phone system gives you into the space provided under Step 3, then click "Next", and then follow the remaining instructions.

41. **TIP:** If you want to eliminate the scan & fix pop up and autoplay pop up when you plug in your USB stick, you will need to do the following. To suppress the scan & fix click on the Windows icon and type: **msconfig** and click on the "**Services Tab**" then scroll down and uncheck "**Shell Hardware Detection**". Click "**Apply**" then "**Ok**" and then you will need to power cycle the PC.

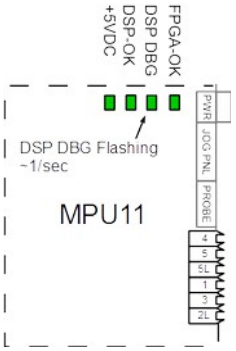
42. **TIP:** To suppress the autoplay, click on Windows start icon and type: **autoplay** then uncheck "**use AutoPlay for all media and devices**" and click "**Save**".

43. You may now continue to **Section 3.2, CNC11 and PLC Installation.**

Symptom or Error
Error Initializing MPU11

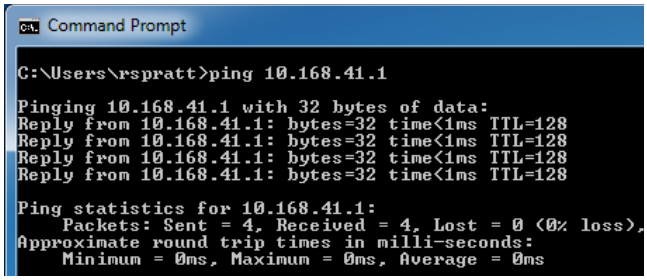
1. Does the MPU11 have power? Check that MPU11 power supply is receiving AC power (85-264VAC). Check that MPU11 is receiving 5VDC & +-12VDC. If the MPU11 power supply is receiving AC power but the MPU11 is not receiving any or all of 5 or +-12VDC signals, remove the power plug from the mpu11 and measure DC voltage between red & black = 5VDC, gray & orange = +12VDC, gray & purple = -12VDC. If any of these are missing, replace the power supply. If the signals all are present when the plug is disconnected, replace/repair the MPU11.

2. Are the MPU11 LED's in the correct states? Check that the LED's are initializing correctly. About 30 seconds after power is applied, the LED's states should be as shown below. If they are not, it indicates that the MPU11 hardware did not initialize correctly and that it needs to be replaced or repaired.



3. Is the network cable plugged in? Is the network cable plugged in to both the MPU11 and the PC? If so, is the green LED on where the network cable plugs into the MPU11 and also on the PC? If the LED's are off, try another shielded CAT5/CAT6 Ethernet cable. Note: A non-shielded cable can be used temporarily for testing purposes.

4. Can you ping the network adapter in the PC?
Open a command prompt Go to Start->All Programs->Accessories-> Command Prompt and type ping 10.168.41.1 and press enter. If the network adapter is working and configured correctly, you should see the screen(s) below. If you confirmed the configuration of the network adapter (step 5) in the PC, powered everything off and back up and still get timeouts, there is a problem with the network adapter in your PC. If you see the screen below (no timeouts) you can skip to step 6.

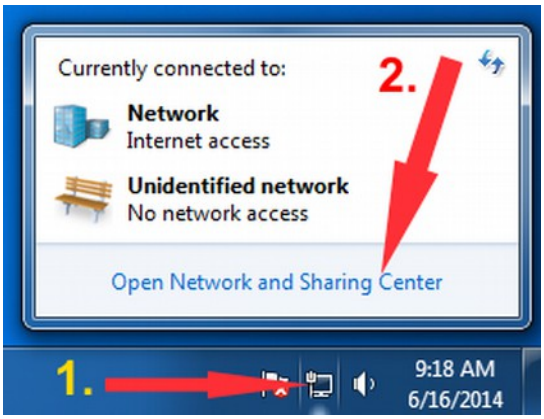


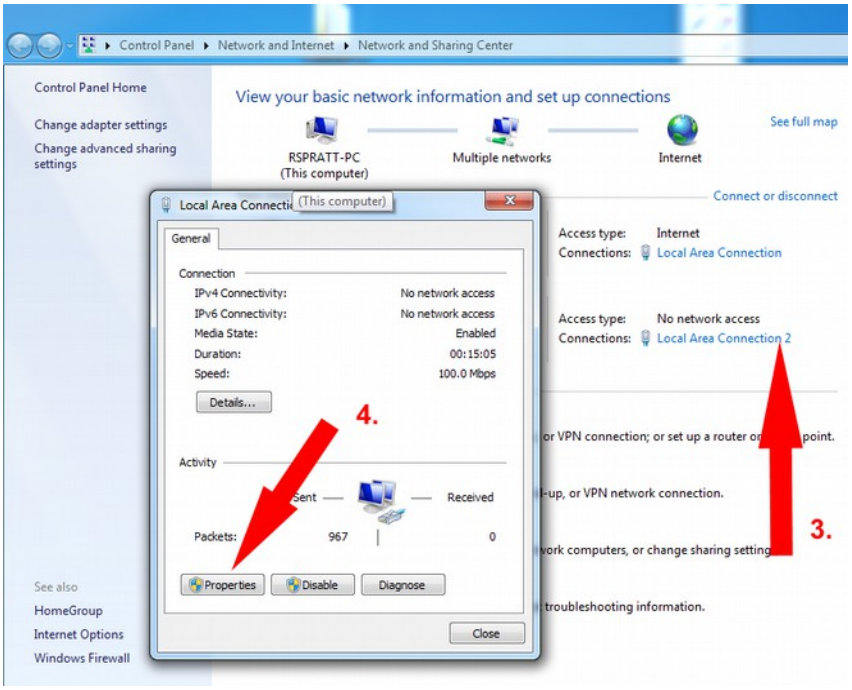
Symptom or Error
Error Initializing MPU11 (continued)

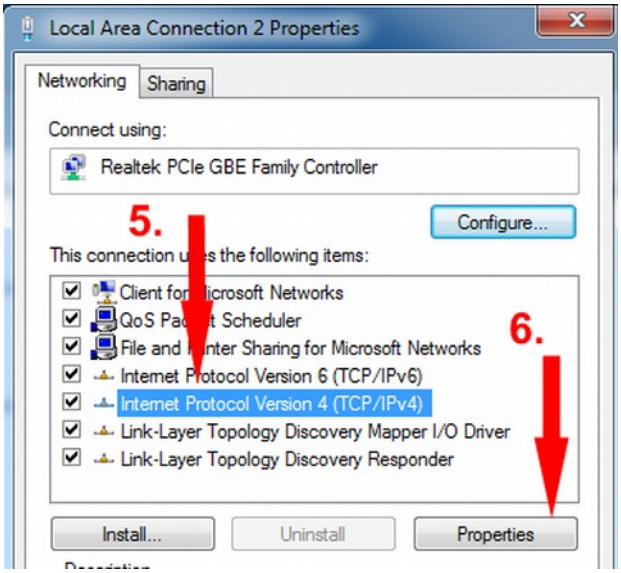
5. Is your network adapter configured correctly?

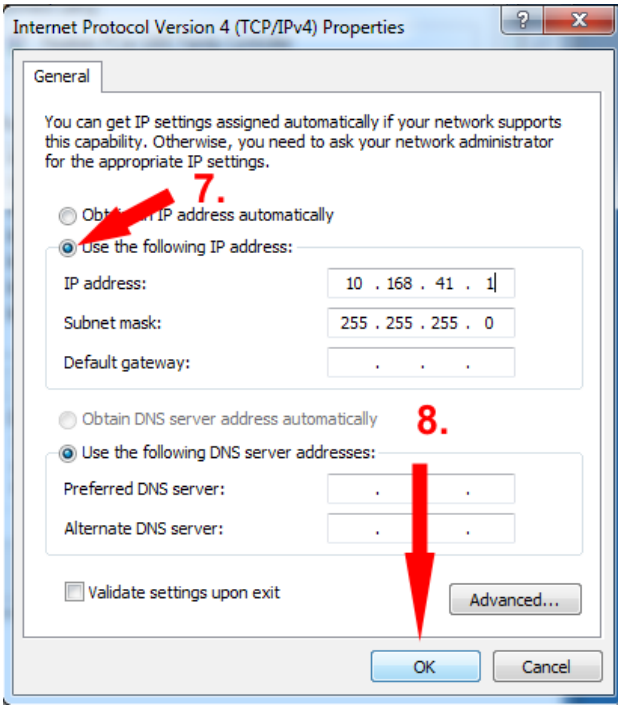
In the bottom right corner of your screen (taskbar):

1. Click on the Network and Sharing Center Icon.
2. Click on Open Network and Sharing Center.
2. Click on the network adapter that is connected to the MPU11
3. Click on “Properties”
4. Click on Internet Protocol Version 4 to highlight it
5. Click on the properties button
6. Click on Use the following IP address and fill in the values for IP address and Subnet Mask as shown.
7. Click OK to finish
8. Power Off The MPU11 and the PC and power them back on together
9. Repeat step 4 (ping test)



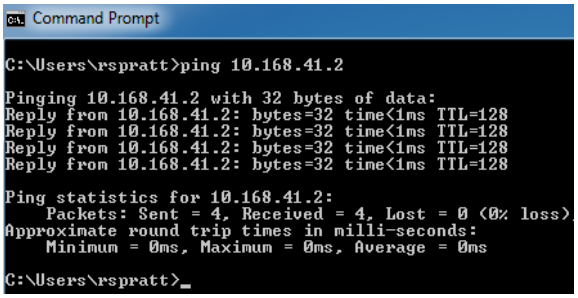






Symptom or Error
Error Initializing MPU11 (continued)

6. Can you ping the MPU11?
Open a command prompt. Go to Start->All Programs->Accessories->Command Prompt and type ping 10.168.41.2 and press enter. You should see the screen(s) below. If you get timeouts, there may be a problem with your firewall or anti-virus or it may be a problem with the MPU11 itself. Uninstall any anti-virus and disable all firewalls. And try to ping the MPU11 again. If you are sure there are no firewalls active and that all anti-virus has been uninstalled and you still can't ping the MPU11, the MPU11 may be defective. **NOTE: It is rare that communication problems are caused by a defect in the mpu11.**



7. Have you recently upgraded the CNC11 software from a very old version? (pre-v3.06)
There is a firmware incompatibility between versions prior to 3.06 and versions 3.08 and later. To fix this, download v3.06 here: v3.06 Once downloaded, install version 3.06 -but do not install a PLC program. Run CNC11 v3.06 until it initializes and enters DEMO/Options screen. You can now exit and install version 3.08 or later without issue

8. Are you sure all anti-virus and firewalls have been uninstalled?
If the MPU11 can be successfully pinged and does not have the compatibility issue between software versions prior to 3.06 and versions 3.08 or later, it is virtually unheard of for an MPU11 to be the cause of “Error Initializing MPU11” messages. Windows firewall, other firewalls and anti-virus will absolutely cause this fault even when they have been configured to allow cncm to communicate. Make sure they are completely disabled/uninstalled.

Symptom or Error
PC Receive Data Error

1. Are you using a shielded CAT5 cable?
This error is most often caused by noise. Make sure the cable connected between the MPU11 and the network adapter is shielded, a shielded CAT5 cable will have metal clips on each end. If it doesn't have metal clips on each end, it's not shielded.

2. Does the CAT5 cable run directly from the MPU11 to the PC?
The cable running between the MPU11 and PC should be a single shielded cable that does not connect to any switches, hubs or butt connectors. Any of these things will effectively defeat the shielding and introduce noise. They will also likely introduce propagation delays which will cause this error as well.

3. Does the CAT5 cable run next to any 3 phase or power cables?
The Cat5 cable should never be run alongside any 3 phase or power cables. Make sure the CAT5 cable is run well away from Spindle and servo motors and any other cables with inductive loads such as coolant and lube pumps, solenoids.

4. Do all your inductive loads have Quench Arcs installed on them?
Quench arcs are very important and must be installed across the coils of all relays, solenoids and motors. Quench arcs should be installed as close as physically possible to the load (coil) itself.

5. Are all firewalls and anti-virus are disabled/uninstalled?
The second most common causes of PC Data Receive Errors are firewalls and anti-virus programs. These programs intercept and delay the real-time data transmissions between the MPU11 and the PC. These delays can accumulate to the point that it triggers this fault.

6. Are Windows Updates or any other auto updaters turned on?
Windows Updates and other auto updaters dramatically slow down a PC. Make sure all updaters are turned off.

Symptom or Error
PC Receive Data Error (continued)

7. Are there any other network devices attached to the PC?
Very often, network traffic from other network devices can cause a dramatic decrease in PC and network performance. Remove all other network devices and connections to the PC, uninstall any hardware drivers or network utilities associated with network hardware not associated with the network adapter connected to the MPU11.

8. Does your PC hardware meet the minimum hardware specs?
The minimum recommended specs of Windows 7/8, a CPU with a single thread benchmark of 1000 or higher, and 4GB of RAM. The single thread benchmark referenced can be found here: http://www.cpubenchmark.net/

9. Are any other applications running on the PC?
The minimum hardware requirements specified above take into account running only the CNC11 software. If you are receiving PC Data Receive Errors, please terminate any other programs that may be running.

Symptom or Error
Jog Pannel Communication In Fault

1. Is the optional Jog Panel/Pendant plugged into the MPU11?
If the Jog Panel/Pendant is not plugged in to the MPU11, plug it in. Or, if the system is not utilizing a Jog Panel/Pendant, go into the Control Configuration Screen and change “Jog Panel Required” to “No”. To enter the “Control Configuration Screen” from the Main Screen press: F1-Setup->F3-Config (pw=137 enter)->F1-Control. Use the arrow keys to select “Jog Panel Required” and press the spacebar to toggle the setting to “No”. Power off and restart the control after changing this setting.

The quartz crystal from a jog board.

2. Did the LED's on the Jog Panel/Pendant flash on power up?
If the LED's did not flash immediately on power up, check the back of the jog board and confirm that the data cable is correctly plugged into the header labeled CPU10. If this cable is plugged in correctly and the LED's did not flash on power up, it is likely that the Jog Panel/Pendant will need to be returned for repair.

3. Does your jog board have a defective crystal installed?
Jog boards (the PCB used in jog pendants and consoles) that shipped in the spring of 2014 may need to have the quartz crystal replaced (circled in red) due to a manufacturing defect in the crystal.

Symptom or Error
PLC Communication In Fault

1. Does the GPIO4D have power?
Check the 3.3, 5v, 12V and -12V LED's, if not lit, check for 5V, 12V and -12V input on H6. If voltage is present, but the corresponding LED or the 3.3V LED is not lit, send the GPIO4D in for repair. If no voltage is present, check AC supply (85-264VAC) to the GPIO4D power supply. If AC supply voltage is present but any or all of the 5V, 12V or -12V signals are missing, replace the GPIO4D power supply.

2. Are the fiber optic cables plugged in and connected correctly?
Confirm that the fiber optic cables are connected at both the MPU11 and the GPIO4D. Confirm also that the fiber plugged into the fiber optic receiver labeled “1” on the MPU11 is connected to the receiver labeled “1” on the GPIO4D and that the fiber optic cable plugged into the fiber optic receiver labeled “3” on the MPU11 is connected to the receiver labeled “3” on the GPIO4D.

3. Are the fiber optics transmitting and receiving signals correctly?
Fiber optic cables being plugged into the blue fiber optic receivers on both the MPU11 and GPIO4D should have a “bright” red light visible at the end of the fiber if you unplug the fiber optic cable and look at the end of it. While “bright” is a relative term, if there is any doubt about whether the signal is “bright” or not, there is almost certainly a problem. Pull the fiber optic cable out of the blue receiver on the GPIO4D and confirm that the signal is bright and that the transmission media (the clear portion) of the fiber optic cable is flush with the plug on the end of the cable. While watching the signal, manipulate and flex the cable and confirm that the signal doesn't dim or blink while the cable is moved. Now, do the same thing at the receiver at the MPU11. If the signal dims or blinks, it indicates that the fiber optic cable is cracked and the cable will need to be

Symptom or Error
PLC Communication In Fault
(Continued)

replaced. If there is no signal at all, pull the fiber out of the transmitter (gray receptacle) on the other end and look into the transmitter, if there is a signal coming out of the transmitter, the fiber optic cable will need to be replaced, if there is no signal coming out of the transmitter, the board with the transmitter will need to be replaced.

4. Is the "PLC OK" LED on?
If the "PLC OK" LED is still off after following the other steps, there is a problem with either the MPU11 or GPIO4D board.

Symptom or Error
Encoder do not count
-or-
DRO does not update

1. Are the encoders mapped correctly?
DRO doesn't update: GPIO4D systems running with AC/DC drives should have the encoders connected to the AC/DC drives. These should be mapped in the parameters section as follows: 308 = 7, 309 = 8, 310 = 9, 311 = 10.

NOTE: Although your mapping may differ, for troubleshooting purposes, the default encoder mapping is described

After confirming that the encoders are mapped as described above, power the system completely off and then restart. When CNC11 has restarted, enter the PID screen to view the Abs Pos fields for each axis. To enter the PID screen from the main screen press:F1 -Setup → F3 Config, password = 137, Press enter → F4 PID . The Abs Pos fields display the raw encoder counts for each axis. With Estop pushed in, rotate the axis motor in question by hand while observing the ABS Pos field for that axis and confirm that it counts smoothly both negative and positive, receptively, while rotating the motor shaft CW and CCW. In the example below, testing is being done on the X axis. Note that the Abs Pos field for the X axis is updating while the motor shaft is rotated. If the Abs Pos field for the X axis does not update, it would indicate an encoder or wiring issue. If any Abs Pos field other than that of the X axis was updating, it would indicate that the encoder is plugged into the wrong encoder input or is mapped incorrectly.

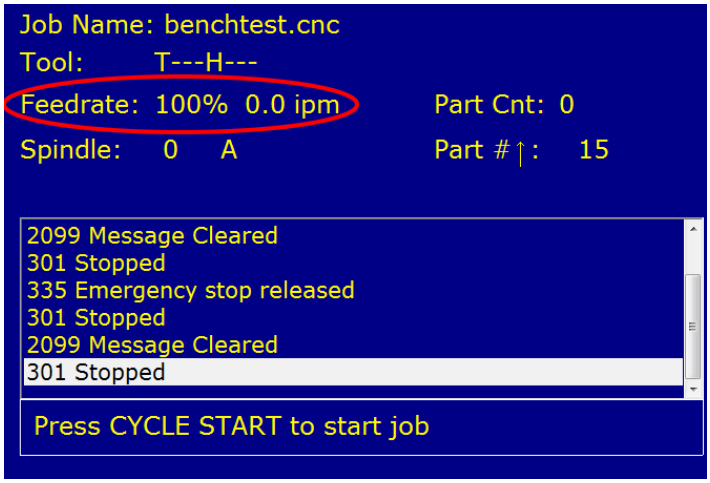
PID Menu

Axis	Error	Sum	Delta	PID Out	Abs Pos	Max Error	Min Error
X*	0	0	0	0	234678	0	0
Y*	0	0	0	0	0	0	0
Z*	0	0	0	0	0	0	0
N*	0	0	0	OFF	0	0	0
N	0	0	0	OFF	0	0	0
N	0	0	0	OFF	0	0	0
N	0	0	0	OFF	0	0	0
N	0	0	0	OFF	0	0	0

If you have an encoder that is working, plug it into the encoder input that is being used for the encoder that is not counting to confirm that the encoder input on the AC/DC is working correctly.

Symptom or Error
Motor does not move when commanded

1. Is the feedrate override turned down?
Check the feedrate override % and confirm that it is 100%



2. Is Estop pressed in?
If Estop is pressed in release it.

3. Are any faults preventing motion?
From the main screen, press F3-MDI. If the screen below is displayed, no faults are active. If the software kicks you back out to the main screen, please see the section: Troubleshooting Hardware And Program Errors Reported By CNC11, to correct and clear the fault.

4. Are the servo amplifiers mapped correctly?
AC/DC should have the drives mapped in the parameters section as: 300 = 1, 301 = 2, 302 = 3 and 304 = 4. To enter the parameter screen from the main screen press: F1-Setup →F3-Config, pw = 137, press enter→F3 Parms NOTE: Although your mapping may differ, for troubleshooting purposes, the default AC/DC drive mapping is described.

5. Is parameter 256 set to 2?
For AC/DC systems parameter 256 must be set to 2.

6. Are the PID values, acceleration rates and maximum speed set?
If a 0 value is present in acceleration rate, max rate, or Kp the motor won't move. If a 0 value is entered for any of the above fields, see section 6.9 “Tuning your AC/DC”.

Symptom or Error
Motor jumps in one direction and CNC11 immediately displays a fault (no oscillation)

1. Is the encoder rotation correct?
This symptom is often displayed when encoder A & B channels are reversed. To correct this, change the encoder wiring so that clockwise rotation results in an increasing count (AC motors looking at the motor mounting flange). DC motors should decrease the count with the same test. NOTE: While this symptom is often confused with a tuning issue, it can be easily differentiated by the fact that the motor "jumps" in only one direction, only a single "bang" (if any) will be heard and a fault is immediately reported by CNC11. Tuning issues are most often reflected by the axis going into oscillations. (back and forth movements) and/or rapid "banging" before faulting.

Symptom or Error
Motion is not smooth

1. Does your encoder meet the minimum resolution requirements?
Centroid recommends an encoder resolution of least 40,000 encoder counts per inch (1575 counts per mm). Centroid **requires** a minimum encoder resolution of 20,000 encoder counts per inch (788 counts per mm). If your encoders don't meet this requirement, replace them with higher resolution encoders or change the mechanical configuration of the machine to meet these requirements.

2. Are your motor and encoder values set correctly in the control?
Confirm that the following settings match your mechanical and motor/encoder specifications. From the main screen press: F1-Setup →F3-Config, pw = 137, press enter→F2 Mach->F2 Motor

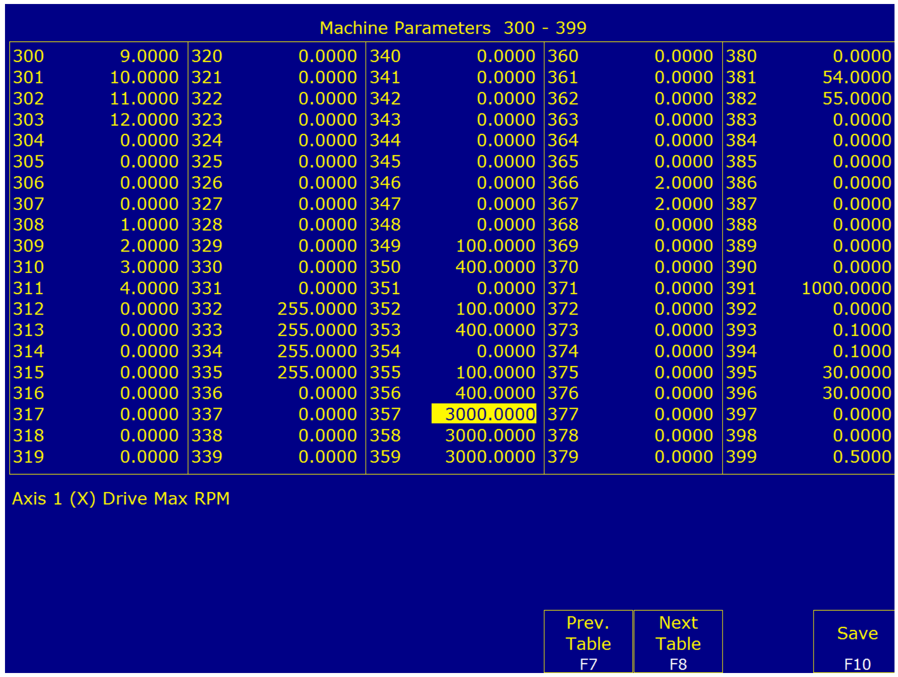
Motor Parameters

Axis	Label	Motor revs/in	Encoder counts/rev	Lash Comp. (Inches)	Limit -	Limit +	Home -	Home +	Dir Rev	Screw Comp
1	X	5.000000000	8000	0.000000	1	2	1	2	N	N
2	Y	5.000000000	8000	0.000000	3	4	3	4	N	N
3	Z	5.000000000	8000	0.000000	5	6	5	6	N	N
4	A	5.000000000	8000	0.000000	0	0	0	0	N	N
5	N	5.000000000	8000	0.000000	0	0	0	0	N	N
6	N	5.000000000	8000	0.000000	0	0	0	0	N	N
7	N	5.000000000	8000	0.000000	0	0	0	0	N	N
8	N	5.000000000	8000	0.000000	0	0	0	0	N	N

Symptom or Error
Motion is not smooth
(Continued)

NOTE: The Encoder counts/rev for a given encoder is fixed and should not be adjusted to change the distance that the motor travels. To calibrate the distance an axis travels, change Motor revs/in

In the parameters screen, confirm that 256 is set to a value of 2, and that the max motor rpm parameters (357-364) are set to match the max rpm of the motor(s) . From the main screen press: F1-Setup →F3-Config, pw = 137, press enter→F3 Parms



Machine Parameters 300 - 399

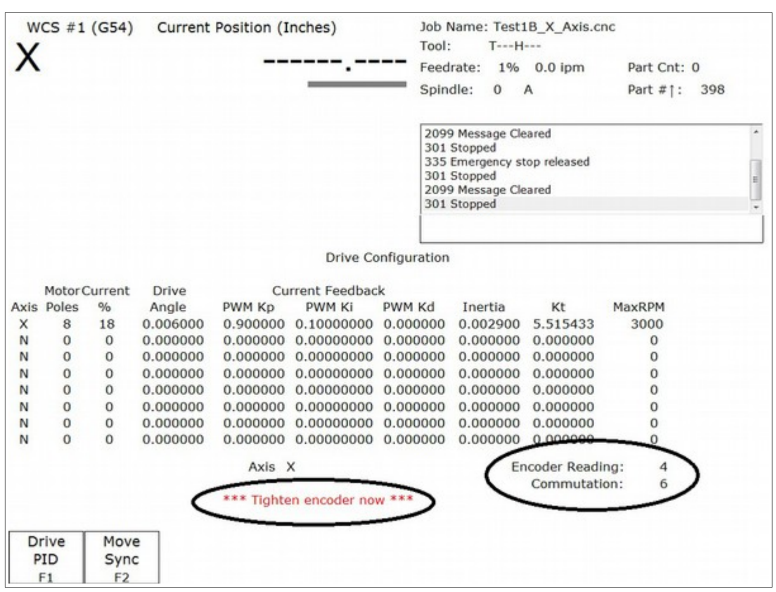
300	9.0000	320	0.0000	340	0.0000	360	0.0000	380	0.0000
301	10.0000	321	0.0000	341	0.0000	361	0.0000	381	54.0000
302	11.0000	322	0.0000	342	0.0000	362	0.0000	382	55.0000
303	12.0000	323	0.0000	343	0.0000	363	0.0000	383	0.0000
304	0.0000	324	0.0000	344	0.0000	364	0.0000	384	0.0000
305	0.0000	325	0.0000	345	0.0000	365	0.0000	385	0.0000
306	0.0000	326	0.0000	346	0.0000	366	2.0000	386	0.0000
307	0.0000	327	0.0000	347	0.0000	367	2.0000	387	0.0000
308	1.0000	328	0.0000	348	0.0000	368	0.0000	388	0.0000
309	2.0000	329	0.0000	349	100.0000	369	0.0000	389	0.0000
310	3.0000	330	0.0000	350	400.0000	370	0.0000	390	0.0000
311	4.0000	331	0.0000	351	0.0000	371	0.0000	391	1000.0000
312	0.0000	332	255.0000	352	100.0000	372	0.0000	392	0.0000
313	0.0000	333	255.0000	353	400.0000	373	0.0000	393	0.1000
314	0.0000	334	255.0000	354	0.0000	374	0.0000	394	0.1000
315	0.0000	335	255.0000	355	100.0000	375	0.0000	395	30.0000
316	0.0000	336	0.0000	356	400.0000	376	0.0000	396	30.0000
317	0.0000	337	0.0000	357	3000.0000	377	0.0000	397	0.0000
318	0.0000	338	0.0000	358	3000.0000	378	0.0000	398	0.0000
319	0.0000	339	0.0000	359	3000.0000	379	0.0000	399	0.5000

Axis 1 (X) Drive Max RPM

Prev. Table F7 | Next Table F8 | Save F10

3. Is the alignment correct on your AC encoder?

From the main menu press **F1-Setup → F3-Config**. Password is **137**. Press **F4 PID → F1-PID Config → F8-Drive.** Press **F2-Move Sync.** If you are not on the correct axis, press **F1-Toggle Axis** until the correct axis label is on the screen. Finally press **F10-GO**. The shaft should rotate. Repeat this until the shaft is in the closest position to zero. A red message will appear on the control saying "*** **Tighten Encoder Now** ***" if aligned correctly. While rotating the encoder commutation should count 1-6. For a 40,000 count encoder, it needs to be aligned with +/- 25 counts of zero. If you encoder is out of alignment, refer to the encoder alignment section earlier in this document.



Symptom or Error
Motion is not smooth (Continued)

4. Have the motors been tuned in the control?
Before doing any tuning in the control, it is recommended that the servo amplifier be set back to it's default configuration. Current configuration (PWM Kp, PWM Ki, and PWM Kd) can not be tuned by the customer. However, position Kp, Ki, and Kd must be tuned by the customer.

Symptom or Error
Axis does not move the correct distance

1. Are your encoder counts per motor rev set correctly?
The encoder counts per motor rev setting is a fixed value and does not get changed to adjust the distance that the motor travels with a given command. To determine the number of encoder counts per revolution of the motor, enter the PID screen and rotate the motor until the asterisk appears next to the axis label as shown in the below. Note the value of "Abs Pos", rotate the motor shaft exactly 1 revolution until the asterisk again appears next to the axis label again and note the new Abs Pos. Subtract the two, the result is the number of encoder counts per motor revolution for that axis. To get to the PID screen from the main screen press: F1-Setup →F3-Config, pw = 137, press enter→F4 PID

PID Menu

Axis	Error	Sum	Delta	PID Out	Abs Pos	Max Error	Min Error
X*	0	0	0	0	234678	0	0
Y	0	0	0	0	0	0	0
Z	0	0	0	0	0	0	0
N	0	0	0	OFF	0	0	0
N	0	0	0	OFF	0	0	0
N	0	0	0	OFF	0	0	0
N	0	0	0	OFF	0	0	0
N	0	0	0	OFF	0	0	0

2. Have you configured your motor revs/unit (imperial) or units/rev (metric) correctly?
Refer to section 6.10

Appendix D - AC/DC Troubleshooting

The most powerful AC/DC troubleshooting tool is the HSC screen. From the main menu press F7-Utility → F9 Logs → F5 – HSC. The HSC screen shows the state of the AC/DC status bits. This screen is organized by DriveBus channels, therefore the channel number at the top of a column matches LED1 on the AC/DC. The columns are **not** reorganized if drive drive mapping parameters change.

HSC Screen Bit Definitions		
Name	**Description**	**Notes**
BissReceptionErrors	BiSS Encoder Sensor Mode Reception Errors	Count of errors during normal running. Counter from 0 to 65535.
BissModeErrors	BiSS Encoder Register Mode Reception Errors	Count of errors during setup. Counter from 0 to 65535,
CycloneShutdowns	FPGA shutdown counter	The FPGA will shut down under the following conditions: two interrupts missed, DSP not started, reprogram enabled, or memory test in progress. Shutdowns should be 0 during normal operation. Could be caused if drive was interrupted on power up. If the error is repeatable, it could be the sign of a serious hardware failure.
EstimatedBrakeWattage	Minimum wattage rating for brake resistor	This value is updated from the time the drive is turned on until it is powered off.
LoadMeter	The greater of Total current or Current Request	Current reading shown by the load meters. Typically 0 to 65535, which corresponds to 0-30A for AC/DC-30 and 0-60A for AC/DC-60.
FatalError	Fatal error	A serious error has occurred and stopped operation. See other bits for cause of error. SV_MASTER_ENABLE rising edge in the PLC will clear the fatal error.
Warning	Warning bit	A condition exists which may become serious, but does not warrant stopping the AC/DC immediately.
ErrorUVWInvalid	Commutation invalid state	Commutation tracks are all on or all off. The most common cause is a disconnected encoder. Check the encoder wiring and restart the system.
ErrorUVWBadTransition	Commutation invalid state transition	Commutation tracks have changed by more than one zone. Check the encoder wiring and restart the system.
ErrorUVWBadSize	Incorrect number of encoder counts per zone	Counts per zone is incorrect by more than 6.25%. This may also be caused by incorrect encoder counts per revolution setting.
EncoderOK	Encoder is ready.	For BiSS, good data has been received in the last 0.2 seconds. For quadrature, A and B channels are differential. Check encoder wiring and restart the system.
QuadratureError	Encoder invalid state transistion	For quadrature encoder, A and B have changed at the same time. Encoder count is incorrect by at least one count.
EncoderMismatch	Requested encoder type does not match detected type	Not implemented
LineVoltageOn	Vm voltage is over 30V	DC motor voltage is applied

HSC Screen Bit Definitions (continued)		
Name	**Description**	**Notes**
OvercurrentHighSide	High side overcurrent	Current over 187.5A (AC/DC-60) or 150A (AC/DC-30) for 500ns. Check for phase to phase, phase to Vm-, or phase to shield short. If nothing is shorted and “OvercurrentHighSide” and “Over-CurrentLowSide” are tripping simultaneously, it could be the sign of a hardware failure.
OvercurrentLowSide	Low side overcurrent	Current over 187.5A (AC/DC-60) or 150A (AC/DC-30) for 500ns. Check for phase to phase, phase to Vm+, or phase to shield short. If nothing is shorted and “OvercurrentHighSide” and “Over-CurrentLowSide” are tripping simultaneously, it could be the sign of a hardware failure.
OvervoltageMotor	Motor regeneration too high	Voltage at motor has exceeded 430V
OvervoltageLine	Vm supply is too high	Voltage has exceeded 370V
BrakeResistorMissing	Brake resistor not attached or burned out	Triggered when the line voltage is on, brake IGBT is off, and collector voltage is low. This error can sometimes be caused by VM dropping below 30VDC during operation.
BrakeIGBTOpen	Brake IGBT blown	Brake IGBT is on and collector voltage is high
MotorTemperatureSwitch	Motor internal over temperature detector	Not implemented
HeatsinkTemperatureSwitch	Drive heatsink over temperature detector	Not implemented, uses temperature sensor instead
PlusLimit	Plus limit input to drive	
MinusLimit	Minus limit input to drive	
DriveShutdown	Drive shutdown due to serious error	OvercurrentHighSide, OvercurrentLowSide, OvervoltageMotor, or OvervoltageLine may cause a shutdown
BrakeOnTooMuch	Brake resistor on too much	Brake on 100% for a 10 interrupt interval. The brake resistor resistance (ohms) is too high for the application.
OvercurrentSensor	Current exceeded sensor range	Current on any phase has exceeded sensor range for 0.5ms
WarningDriveHot	Drive temperature exceeded warning temperature	Parameter 29 warning temperature
ErrorDriveTooHot	Drive temperature exceeded error temperature	Parameter 30 error temperature
WarningMotorHot	Motor temperature estimate exceeded warning temperature	Parameter 29 warning temperature
AccelTooGreat	Requested acceleration greater than physically possible	Requested acceleration is compared to calculated maximum from motor parameters
ADCOffsetOK	ADC offsets adjusted to 0 successfully	More than about 1% error will cause offset adjust to fail
ErrorMotorTooHot	Motor temperature estimate exceeded error temperature	Parameter 30 error temperature
MoveSyncRunning	Move sync procedure active	Used by alignment routines
StepRunning	Current step running	Not implemented
TuneRunning	Auto tune running	Not implemented
ErrorParameterChange	Critical motor parameters have been changed with power on	The drive must be allowed to release power before changing some parameters

HSC Screen Bit Definitions (continued)		
Name	**Description**	**Notes**
CommutationZone	Current commutation zone	Only applies to AC motors. Refer to the section on encoder alignment for an explanation of motor commutation.
DrivePower	Drive maximum power indicator	1 for AC/DC-60, 0 for AC/DC-30
EncoderType	Active encoder type	0 for none, 1 for quadrature, 2 for BiSS *not reported at this time*
EstimatedDriveTemperature	Drive temperature	Temperature reported by heatsink temperature sensor
EstimatedMotorTemperature	Estimated motor temperature	Temperature estimated by AC/DC software routine
PositionErrorSum	Sum of error	Sum of errors
PidAverage	Average of position PID	Average of 64 load meter values
Debug counter	Subject to change	Upper nibble is drive number. The remaining bits are the number of status packets received, switches to number of bytes received during firmware update. If the drive is properly communicating with the system this number should be constantly changing. A value

Is the debug counter not counting?

- Check LED states
- Check “wired input” jumper
- Check AC/DC parameters
- Power off system for 2 minutes, power the system back on

Updating The AC/DC DSP Firmware

The AC/DC DSP firmware can be upgraded by the end user.

1. Obtain the latest copy of the AC/DC ac1.hex. This can be obtained by getting the latest version of CNC11 software here Software download (http://ajaxcnc.com/tech/downloads/software/cnc11_windows/current/index.php)

2. Start CNC11 software.
3. Press F7-Utility → F9 Logs
4. Press **alt + F5-HSC** simultaneously.
5. The HSC menu will open. The debug counter should reset to zero and start counting. After about 30 seconds of counting the counter should pause for about 10 seconds, then continue counting.

    1. **NOTE:** If the counter does not pause as described above than you already have the most up to date firmware on your AC/DC.

Appendix E - Stock Centroid Encoders

Stock DC Encoders

Encoder Model	Centroid Part #	Encoder Description	Typical Application	Encoder Pigtail[1.]
Dynapar F142000/0334X03	3403	2,000 line, 0 Poles, 5V, 6mm shaft	DC motors in systems not using an AC/DC drive.	Drawing Number S14427
Dynapar F142000/0330X03	4127	2,000 line, 0 Poles, 5V 1/4” shaft		
Dynapar F182000/0333X09	4655	2,000 line, 0 Poles, 5V, 1/2” shaft		
Dynapar F182000/0331X09	2848	2,000 line, 0 Poles, 5V, 3/8” Shaft		
Quantum QR12-10000-0-A-B-D-A-A	6289	10,000 line, 0 Poles, 5V 6mm shaft	DC Motors used with the AC/DC drive	Drawing Number: S13244
Quantum QR12-10000-0-A-B-L-A-A	7032	10,0000 line, 0 Pole, 5V, 1/4” shaft		

1. **Encoder Pigtails:** Drawings are for standard pigtails using standard **Centroid** motors. These drawing might not apply to some rotary tables, retrofits/upgrades, or custom systems.

If you are replacing the encoder pigtail, inspect the condition of the rubber gasket around the MS connector. Worn gaskets need to be replaced. A replacement gasket is Centroid Part Number 4647.

Stock AC Encoders

Encoder Model	Centroid Part #	Encoder Description	Typical Application	Encoder Pigtail[1.]
Quantum Devices QR12-2048-8-A-B-E-A-A	6019	2,048 line, 8 pole, 5V, 8mm shaft	750W, 1KW, and 2KW motors in systems not using an AC/DC drive.	For 1KW and larger motors: Drawing Number: S13244 For 750W Leedan motors: Drawing Number: S13267
Quantum Devices[3] QR12-10000-8-A-B-E-A-A	7480	10,000 line, 8 poles, 5V, 8mm shaft	AC Motors used with the AC/DC drive	
Dynapar F144096/8395A	4814	4,096 line, 8 pole, 5V, 8mm shaft	3kW and 4KW motors in systems not using an AC/DC drive.	Drawing Number: S14427

1. **Encoder Pigtails:** Drawings are for standard pigtails using standard **Centroid** motors. These drawing might not apply to some rotary tables, retrofits/upgrades, or custom systems.

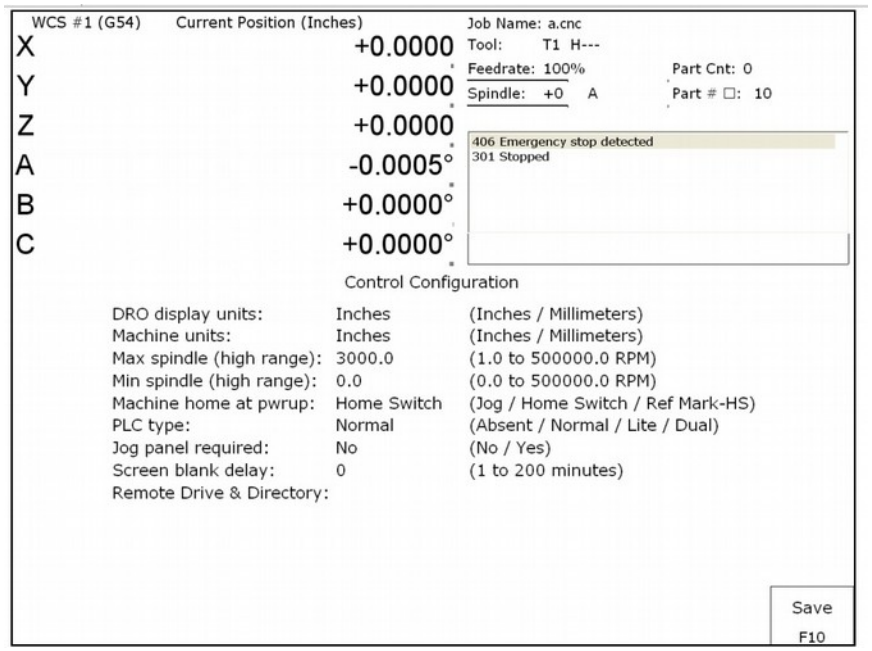
If you are replacing the encoder pigtail, inspect the condition of the rubber gasket around the MS connector. Worn gaskets need to be replaced. A replacement gasket is Centroid Part Number 4647.

Appendix F - Manual Configuration of AC/DC Motor Parameters

The machine parameters need to be adjusted for your drive before you can use it. Heating coefficients as well as temperature warning and error levels are calculated in imperial units. The machine units **must** be set to **inches** from the Control Configuration menu before entering or changing temperature parameters! After saving temperature parameters, the control may be set back to millimeters if desired. Changing the machine units from inches to millimeters will "automatically" convert temperature values.

NOTE: Cooling parameters do not change when switching from inches to millimeters because cooling parameters are calculated as a unit-less value.

To get to the control configuration menu, press F1-Setup. Next, press F3 – Config *(The default password is 137)*, then F1 – Contrl. Press F10-Save when finished.



Machine Parameters Menu

Recommended Parameters

Parameter Number	Setting	Setting Description
21-24	Motor dependent[1]	Motor heating coefficients axes 1-4
25-28	Motor dependent[1]	Motor cooling coefficients axes 1-4
29	212 (°F)	Motor temperature warning
30	260 (°F)	Motor temperature error
132-135	Motor dependent[1]	Motor heating coefficients axes 5-8
236-239	Motor dependent[1]	Motor cooling coefficients axes 5-8
256	2	Drive mode
284-291	Dependent on brake resistor	Brake resistor wattage (300 w typical)
300-307	1- 8, Depending on Machine	Drive axis mapping
308-315	7 -14, Depending on Machine	Encoder assignments
340-347	1.75	Precision mode delay
357-364	Motor Dependent[1]	Maximum RPM, may also be set from drive PID screen
374	255	Debug log axis inclustion (bitwise)
375	4000	Debug log size (samples) 0 to 32768
376	1	Data Log collection type: 1= current data, 2=position data

1. See the tables below

Temperature Coefficients for Centroid Motors (Measured in Imperial Units)

Series	Motor Type	Motor Model	Heating Coefficients Parameters 21-24 Parameters 132-135	Cooling Coefficients Parameters 25-28 Parameters 236-239
SEM AC Motors (Obsolete)	750 W	HDM82E8-76S	156.5817	6.4103
	1 kW	HJ130C8-64S	7.9778	3.3333
	2 kW	HJ130G8-88S	3.0612	2.7778
	3 kW	HJT155B8-110S	3.4830	2.7778
	4 kW	HJT155D8-110S	1.3287	2.7778
	Faster 4 kW	HJT155D8-88S	0.8962	2.7778
Mecapion AC Motors	1.0 kW	APM-SE15AXK1-CT2	2.5671	4.5045
	2.1 kW	APM-SE22A	1.3291	4.0650
	2.8 kW	APM-SF30G	0.8848	3.3333
	2.9 kW	APM-SE30AXK3-CT	0.8065	3.7037
	4.4 kW	APM-SF44G	0.1834	2.7778
Misc Motors	Leedan 750 W	LDSM85-CS	44.8672	5.5556

Temperature Coefficient for Miscellaneous Motors[1] (Measured in Imperial Units)

Motor Type	Motor Model	Heating Coefficients Parameters 21-24 Parameters 132-135	Cooling Coefficients Parameters 25-28 Parameters 236-239
Barruffaldi	130865/2003 BLQ 43 L 45 SP	55.6205	8.3333
Kollmorgen	MT306B1-2184	28.3408	5.3763
Estun 1kW	EMG-10APA22	?	?
Kollmorgen	MT504B2-F1B1	8.5001	4.1667
Gettys 16	Type 16-0375-70	0.2199	1.5873

1. This chart contains unsupported motors that successfully work with an AC/DC drive.

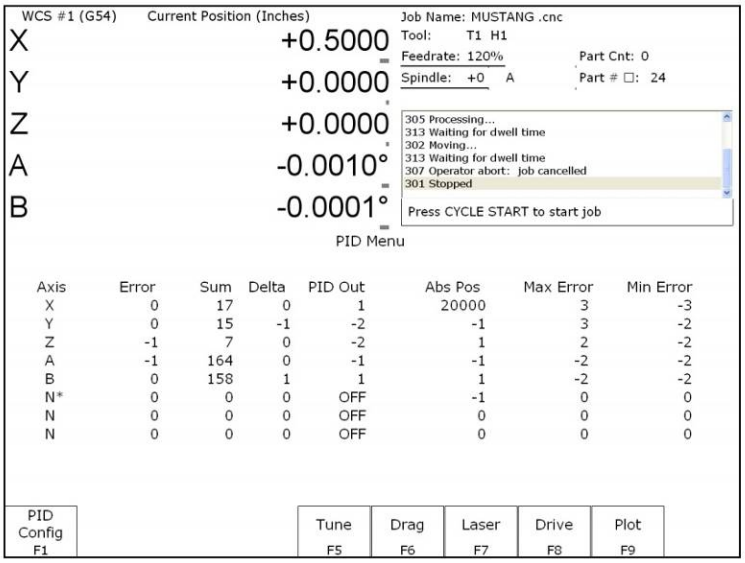
Temperature Coefficients for Fanuc Motors
(Measured in Imperial Units)

Series	Motor Type	Motor Model	Heating Coefficients Parameters 21-24 Parameters 132-135	Cooling Coefficients Parameters 25-28 Parameters 236-239
Fanuc Black End Cap (Fanuc ● Gettys)	0	A06B-0613-B0xx	4.0135	3.3333
	5	A06B-0614-Bxxx	3.6486	3.0303
	10	A06B-0601-Bxxx	0.5017	1.6667
	20	A06B-0602-Bxxx	0.2527	1.5873
Fanuc Yellow End Cap (M Series)	0M	A06B-0641-Bxxx	12.3874	0.0574
	5M	A06B-0642-Bxxx	7.1351	0.0517
	10M	A06B-0651-Bxxx	2.8668	0.0369
	20M	A06B-0652-Bxxx	1.1149	0.0323
	30M	A06B-0653-Bxxx	0.5902	0.0304
Fanuc S Series Red Cap & Fanuc Early Red Cap	0	A06B-0511-Bxxx	11.7374	3.7037
	5	A06B-0512-Bxxx	10.8766	3.3333
	10	A06B-0501-Bxxx	3.4637	2.7778
	20M	A06B-0505-Bxxx	1.7194	2.5641
	20S/1500			
	20	A06B-0502-Bxxx	0.9672	2.5641
	20S			
	30	A06B-0503-Bxxx	0.7993	2.5641
	30R	A06B-0506-Bxxx	0.4600	2.5641
	30/2000			
	40	A06B-0581-Bxxx	0.2965	1.8519
	0-0SP	A06B-0374-Bxxx	16.6116	8.3333
	0S	A06B-0313-Bxxx	26.4090	3.7037
	5S	A06B-0314-Bxxx	14.9505	3.3333
	5S/3000	A06B-0514-Bxxx	4.8340	3.3333
	6S	A06B-0316-Bxxx	6.3282	3.0303
	6S/3000	A06B-0320-Bxxx	4.0692	3.0303
	10S	A06B-0315-Bxxx	7.2561	2.7778
	10S/3000	A06B-0317-Bxxx	1.7904	2.7778
	20S	A06B-0502-B065	0.9969	2.5641
	20S/1500	A06B-0505-Bxxx	1.4384	2.5641
	30S	A06B-0590-Bxxx	1.5897	2.5641
	30/2000	A06B-0506-Bxxx	0.4730	2.5641
Fanuc α (Alpha) Series Red Cap & Fanuc αC Series Red Cap[1]	α3/3000	A06B-0123-Bxxx	26.4090	3.7037
	α6/2000	A06B-0127-Bxxx	16.0374	3.3333
	α6/3000	A06B-0128-Bx77	5.0293	3.3333
	α12/2000	A06B-0142-Bxxx	5.4121	2.7778
	α12/3000	A06B-0143-Bx75	1.7445	2.7778
	α22/1500	A06B-0146-Bxxx	2.4760	2.5641
	α22/2000	A06B-0147-Bx75	1.1063	2.5641
	α30/1200	A06B-0151-Bxxx	2.2628	2.3810
	α30/2000	A06B-0152-Bxxx	0.8804	2.3810
	α40/2000	A06B-0157-Bx75	0.4599	2.2222
	αC12/2000	A06B-0141-Bx75	12.0400	2.7778
	αC22/1500	A06B-0145-Bxxx	2.4760	2.5641
Fanuc β (Beta) Series Red Cap & Fanuc β*i*s Series Red Cap	β3/3000	A06B-0033-Bxxx	22.3805	4.1667
	β6/2000	A06B-0034-Bxxx	20.0468	4.1667
	β4/4000is	A06B-0063-Bx0x	56.9187	8.3333
	β8/3000is	A06B-0075-B203	34.9260	8.3333
	β12/300is	A06B-0078-Bx0x	9.6681	6.6667
	β22/2000is	A06B-0085-Bx0x	6.5645	5.5556

1. Most Fanuc documentation lists the αC Series as a member of the α Series, while some Fanuc documentation lists the αC Series as a member of the β series.

PID Menu Setup

From the main menu, Press **F1 - Setup**, **F3 - Config**, then **F4 – PID** to enter the PID Menu as shown below. Press **F1 – PID Config** to edit the configuration. Enter the settings for the PID loop from the tables below. The tables are intended to be used as a baseline of sample values to get started. The PID values shown need some fine tuning and adjusting before your motor can be used in a machine, which is covered in earlier sections. Press **F10-Save & Exit** when you are done.



PID Menu

Is Your Motor Not On The List?

Most motors with a continuous stall current of above 5 amps or below 30 amps can be adapted to work with the AC/DC. *(This gives the AC/DC an approximate range of 500 watts to 6,000 watts or 0.7 hp to 7.8 hp.)* For an evaluation fee, most unsupported motors can be sent into Centroid to have the parameters needed for CNC11 software calculated. After a motor model has been evaluated once, those software parameters work on all motors of that model number. Call sales for more information.

Centroid Motor Position PID Settings

Series	Motor Type	Motor Model	Position PID		
			Kp	Ki	Kd
SEM AC Motors (Obsolete)	750 W	HDM82E8-76S	0.3	0.002	0.1
	1 kW	HJ130C8-64S	1.0	0.020	3.0
	2 kW	HJ130G8-88S	3.0	0.020	3.0
	3 kW	HJT155B8-110S	1.0	0.020	3.0
	4 kW	HJT155D8-110S	2.0	0.020	5.0
	Faster 4kW	HJT155D8-88S	5.0	0.020	6.0
Mecapion AC Motors	1.0 kW	APM-SE15AXK1-CT2	1.5	0.020	3.0
	2.1 kW	APM-SE22A	0.0	0.000	0.0
	2.9 kW	APM-SF30G	0.0	0.000	0.0
	3.0 kW	APM-SE30AXK3-CT	2.0	0.020	3.0
	4.4 kW	APM-SF44G	0.0	0.000	0.0
Misc AC Motors	Leedan 750W	LDSM85-CS	0.5	0.010	0.3

Miscellaneous Motor PID Settings[1]

Motor Type	Motor Model	Position PID		
		Kp	Ki	Kd
Barruffaldi	130865/2003 BLQ 43 L 45 SP	0.5	0.020	0.4
Kollmorgen	MT306B1-2184	1	0.020	3
Estun 1kW	EMG-10APA22	2.2	0.020	2
Kollmorgen	MT504B2-F1B1	1	0.020	3
Gettys Type 16 (DC Motor)	Type 16-0375-70	8.5	0.002	5

1. This chart contains unsupported motors that successfully work with an AC/DC drive.

Fanuc α and β Motors

Series	Motor Type	Motor Model	Position PID		
			Kp	Ki	Kd
α (Alpha) Series & αC Series[2]	α3/3000	A06B-0123-Bxxx	1	0.02	1
	α6/2000	A06B-0127-Bxxx	2	0.02	3
	α6/3000	A06B-0128-Bxxx	3	0.02	5
	α12/2000	A06B-0142-Bxxx	3	0.02	5
	α12/3000	A06B-0143-Bxxx	5	0.02	7
	α22/1500	A06B-0146-Bxxx	10	0.02	12
	α22/2000	A06B-0147-Bxxx	10	0.02	12
	α30/1200	A06B-0151-Bxxx	10	0.02	12
	α30/2000	A06B-0152-Bxxx	10	0.02	12
	α40/2000	A06B-0157-Bxxx	10	0.02	12
	αC12/2000	A06B-0141-Bxxx	7	0.02	9
	αC22/2000	A06B-0145-Bxxx	10	0.02	12
β (Beta) Series & β*is* Series	β3/3000	A06B-0033-Bxxx	1	0.02	1
	β6/2000	A06B-0034-Bxxx	2	0.02	1.8
	β4/4000is	A06B-0063-Bx0x	1	0.02	1
	β8/3000is	A06B-0075-B203	2	0.02	1.8
	β12/300is	A06B-0078-Bx0x	5	0.02	7
	β22/2000is	A06B-0085-Bx0x	10	0.02	12

Fanuc DC Motors

Series	Motor Type	Motor Model	Position PID		
			Kp	Ki	Kd
Black End Cap (Fanuc • Gettys)	00	A06B-0631-B0xx	1	0.02	1
	0	A06B-0613-B0xx	1.25	0.02	2
	5	A06B-0614-Bxxx	1	0.02	3
	10	A06B-0601-Bxxx	9	0.02	10
	20	A06B-0602-Bxxx	10	0.02	12
Yellow End Cap (M Series)	00M	A06B-0632-Bxxx	0.35	0.005	0.35
	0M	A06B-0641-Bxxx	1	0.02	1
	5M	A06B-0642-Bxxx	2	0.02	1.8
	10M	A06B-0651-Bxxx	9	0.02	7.5
	20M	A06B-0652-Bxxx	10	0.02	12
	30M	A06B-0653-Bxxx	10	0.02	12

Fanuc S Series & Early Red Caps

Motor Type	Motor Model	Position PID		
		Kp	Ki	Kd
0	A06B-0511-Bxxx	2	0.02	3
5	A06B-0512-Bxxx	2	0.02	5
10	A06B-0501-Bxxx	5	0.02	7
20M 20S/1500	A06B-0505-Bxxx	10	0.02	12
20 20S	A06B-0502-Bxxx	10	0.02	12
30	A06B-0503-Bxxx	10	0.02	12
30R 30/2000	A06B-0506-Bxxx	10	0.02	12
40	A06B-0581-Bxxx	10	0.02	12
0-0SP	A06B-0374-Bxxx	2	0.02	3
0S	A06B-0313-Bxxx	2	0.02	3
5S	A06B-0314-Bxxx	2	0.02	3
5S/3000	A06B-0514-Bxxx	2	0.02	3
6S	A06B-0316-Bxxx	3	0.02	5
6S/3000	A06B-0320-Bxxx	3	0.02	5
10S	A06B-0315-Bxxx	5	0.02	7
10S/3000	A06B-0317-Bxxx	5	0.02	7
20S	A06B-0502-B065	10	0.02	12
20S/1500	A06B-0505-Bxxx	10	0.02	12
30S	A06B-0590-Bxxx	10	0.02	12
30/2000	A06B-0506-Bxxx	10	0.02	12

Drive Configuration Setup

From the main menu, press **F1 - Setup**, **F3 - Config**, **F4 - PID**, and then **F8 – Drive** to enter the Drive Configuration menu. Press **F1 – Drive PID** to edit the configuration. Enter the settings for the current feedback PID loop from the tables below. Press **F10-Accept** when you are done.

Centroid Motors

Series	Motor Type	Motor Model	Current PID									
			Poles	ACDC-30 Current	ACDC-60 Current	Angle	Kp	Ki	Kd	Inertia In-lb sec^2	Kt	Max RPM
SEM AC Motors (Obsolete)	750W	HDM82E8-76S	8	20%	Not Rec-om-mended	0.020	2.50	0.10	0	0.0009	5.64	3,900
	1kW	HJ130C8-64S	8	100%	50%	0.007	2.50	0.10	0	0.0140	4.67	4,000
	2kW	HJ130G8-88S	8	Not Recommended	80%	0.008	2.00	0.10	0	0.0230	6.36	3,400
	3kW	HJT155B8-110S	8	Not Recommended	80%	0.013	5.00	0.10	0	0.0290	8.06	2,727
	4kW	HJT155D8-110S	8	Not Recommended	100%	0.015	3.00	0.10	0	0.0480	8.06	2,727
	Faster 4kW	HJT155D8-88S	8	Not Recommended	100%	0.000	3.00	0.08	0	0.0480	6.38	3,400
Mecapion AC Motors	1kW	APM-SE15AXK1-CT2	8	67%	34%	0.007	1.50	0.10	0	0.0106	5.25	5,000
	2.1kW	APM-SE22A	8	Not Recommended	80%	TBD	TBD	TBD	TBD	0.0154	5.27	5,000
	2.8kW	APM-SF30G	8	Not Recommended	76%	0.000	2.50	0.08	0	0.0410	7.52	3,000
	2.9kW	APM-SE30AXK3-CT	8	Not Recommended	85%	0.000	1.50	0.07	0	0.0201	5.00	5,000
	4.4kW	APM-SF44G	8	Not Recommended	100%	0.000	1.50	0.04	0	0.0654	5.95	3,000
Misc Motors	Leedan 0750W	LDSM85-CS	8	36%	18%	0.006	0.90	0.10	0	0.0029	5.52	3,000

Miscellaneous Motors[1]

Motor Type	Motor Model	Current PID									
		Poles	ACDC-30 Current	ACDC-60 Current	Angle	Kp	Ki	Kd	Inertia In-lb sec^2	Kt	Max RPM
Barruffaldi	130865/2003 BLQ 43 L 45 SP	6	43%	22%	0.008	2.50	0.10	0	0.0040	3.70	4,500
Kollmorgen	MT306B1-2184	8	67%	34%	0.000	1.50	0.12	0	0.0010	5.40	4,600
Estun 1kW	EMG-10APA22	8	100%	50%	0.000	1.50	0.12	0	0.0161	6.70	3,000
Kollmorgen	MT504B2-F1B1		100%	50%	0.000	1.50	0.12	0	0.0161	6.70	3,000
Gettys Type 16 (DC Motor)	Type 16-0375-70	0	Not Recommended	100%	0.000	1.50	0.12	0	0.2750	6.73	2,000

1. This chart contains unsupported motors that successfully work with an AC/DC drive.

Fanuc DC Motors

End Cap Color	Motor Type	Motor Model	Current PID									
			Poles	(ACDC-30) Current	(ACDC-60) Current	Angle	Kp	Ki	Kd	Inertia In-lb sec^2	Kt	Max RPM
Black (Fanuc ● Gettys)	0	A06B-0613-B0xx	May Need Evaluated[1]									
	5	A06B-0614-Bxxx	0	80%	40%	0	2.00	0.100	0	0.0434	4.23	2,000
	10	A06B-0601-Bxxx	May Need Evaluated[1]									
	20	A06B-0602-Bxxx										
Yellow (M Series)	0M	A06B-0641-Bxxx	0	Not Recommended	100%	0	2.00	0.100	0	0.0220	3.73	2,000
	5M	A06B-0642-Bxxx	0	60%	30%	0	6.00	0.100	0	0.0320	5.80	2,000
	10M	A06B-0651-Bxxx	0	80%	40%	0	3.50	0.100	0	0.1130	8.85	1,500
	20M	A06B-0652-Bxxx	May Need Evaluated[1]									
	30M	A06B-0653-Bxxx										

Fanuc S Series & Early Red Caps

Motor Type	Motor Model	Current PID									
		Poles	ACDC-30 Current	ACDC-60 Current	Angle	Kp	Ki	Kd	Inertia In-lb sec^2	Kt	Max RPM
0	A06B-0511-Bxxx	May Need Evaluated[1]									
5	A06B-0512-Bxxx	8	70%	35%	0.006	2.00	0.100	0	0.0570	7.64	2,000
10	A06B-0501-Bxxx	May Need Evaluated[1]									
20M	A06B-0505-Bxxx										
20S/1500											
20	A06B-0502-Bxxx	8	Not Recommended	100%	0.000	2.50	0.080	0	0.1476	10.42	2,000
20S											
30	A06B-0503-Bxxx	May Need Evaluated[1]									
30R	A06B-0506-Bxxx										
30/2000											
40	A06B-0581-Bxxx										
0-0SP	A06B-0374-Bxxx										
0S	A06B-0313-Bxxx										
5S	A06B-0314-Bxxx										
5S/3000	A06B-0514-Bxxx										
6S	A06B-0316-Bxxx										
6S/3000	A06B-0320-Bxxx										
10S	A06B-0315-Bxxx										
10S/3000	A06B-0317-Bxxx										
20S	A06B-0502-B065										
20S/1500	A06B-0505-Bxxx										
30S	A06B-0590-Bxxx										
30/2000	A06B-0506-Bxxx										

1. **May Need Evaluated:** Evaluated motors have the software parameters needed for Centroid CNC11 software. For unevaluated motors, the customer may need to ship a motor to Centroid for evaluation. The evaluation process will provide the customer with the CNC11 software parameters. After a motor model has been evaluated once, those software parameters work on all motors of that model number. Call sales for more information.

Fanuc α and β Motors

Series	Motor Type	Motor Model	Current PID									
			Poles	ACDC-30 Current	ACDC-60 Current	Angle	Kp	Ki	Kd	Inertia In-lb sec^2	Kt	Max RPM
α (Alpha) Series & αC Series[2]	α3/3000	A06B-0123-Bxxx	May Need Evaluated[1]									
	α6/2000	A06B-0127-Bxxx										
	α6/3000	A06B-0128-Bxxx	8	100%	50%	0.003	1.50	0.050	0	0.0234	5.31	4000
	α12/2000	A06B-0142-Bxxx	May Need Evaluated[1]									
	α12/3000	A06B-0143-Bxxx										
	α22/1500	A06B-0146-Bxxx										
	α22/2000	A06B-0147-Bxxx										
	α30/1200	A06B-0151-Bxxx										
	α30/2000	A06B-0152-Bxxx										
	α40/2000	A06B-0157-Bxxx										
	αC12/2000	A06B-0141-Bxxx	8	60%	30%	0.010	4.00	0.075	0	0.0555	18.06	2000
	αC22/1500	A06B-0145-Bxxx	May Need Evaluated[1]									
β (Beta) Series & β*is* Series	β3/3000	A06B-0033-Bxxx										
	β6/2000	A06B-0034-Bxxx										
	β4/4000is	A06B-0063-Bx0x										
	β8/3000is	A06B-0075-B203	8	60%	30%	0.001	2.50	0.100	0	0.0103	10.27	3,000
	β12/300is	A06B-0078-Bx0x	May Need Evaluated[1]									
	β22/2000is	A06B-0085-Bx0x										

1. May Need Evaluated: Evaluated motors have the software parameters needed for Centroid CNC11 software. For unevaluated motors, the customer may need to ship a motor to Centroid for evaluation. The evaluation process will provide the customer with the CNC11 software parameters. After a motor model has been evaluated once, those software parameters work on all motors of that model number. Call sales for more information.

Appendix G - Compatible Motors

(Motor Torque, HP, and Wattage)

What if your motor is not on the list?

Most motors with a continuous stall current of above 5 amps or below 30 amps can be adapted to work with the AC/DC. *(This gives the AC/DC an approximate range of 500 watts to 6,000 watts or 0.7 hp to 7.8 hp.)* For an evaluation fee, most unsupported motors can be sent into Centroid to have the parameters needed for CNC11 software calculated. After a motor model has been evaluated once, those software parameters work on all motors of that model number. Call sales for more information.

Centroid Motors[1]

Series	Motor Type	Motor Model	Max RPM	Continuous Torque (in lb)	Peak Torque (in lb)	Mechanical Horsepower (Imperial)[2]	Power (kW)[2]	Rated RPM[2]
SEM AC Motors (Obsolete)	750W	HDM82E8-76S	3,900	13	33.8	0.45	0.34	2,200
	1kW	HJ130C8-64S	4,000	33.5	140.0	1.41	1.05	2,500
	2kW	HJ130G8-88S	3,400	71.3	305.5	2.04	1.52	1,800
	3kW	HJT155B8-110S	2,727	84.6	386.9	1.21	0.90	**900**
	4kW	HJT155D8-110S	2,727	137.0	483.7	2.61	1.95	1,200
	Faster 4kW	HJT155D8-88S	3,400	132.1	383.0	4.40	3.28	2,100
Mecapion AC Motors	1 kW	APM-SE15AXK1-CT2	5,000	57.8	105.6	2.75	2.95	3,000
	2.1 kW	APM-SE22A	5,000	84.3	252.9	2.67	1.99	2,000
	2.8 kW	APM-SF30G	3,000	120.2	343.1	2.86	2.13	1,500
	3.9 kW	APM-SE30AXK3-CT	5,000	105.0	225.1	5.00	3.73	3,000
	4.4k W	APM-SF44G	3,000	182.6	356.8	4.35	3.24	1,500
Misc Motors	Leedan 750W	LDSM85-CS	3,000	22.1	59.6	0.70	0.52	2,200

1. The numbers in this chart are calculated from the motor manufacturer data sheets. Centroid has not verified these numbers.

2. Motor power and motor mechanical horsepower in this chart is calculated at rated RPM, not maximum RPM. A better estimation of torque and power can be provided by the "**Centroid AC/DC Setup Wizard**" software, which is explained in section 3.3.

Unsupported Motors[1]

Motor Type	Motor Model	Max RPM	Continuous Torque (in lb)	Peak Torque (in lb)	Mechanical Horsepower (Imperial)[2]	Power (kW)[2]	Rated RPM[2]
Barruffaldi	130865/2003 BLQ 43 L 45 SP	4,500	16.3	47.7	1.16	0.87	
Kollmorgen	MT306B1-2184	4,600	28.9	108.5	2.11	1.57	
Estun 1kW	EMG-10APA22	3,000	42.3	126.9	1.34	1.00	2,000
Kollmorgen	MT504B2-F1B1	3,000	57.6	201.0	2.74	2.05	
Gettys Type 16 (DC motor)	Type 16-0375-70	2,000	222.1	403.8	7.05	5.26	

1. This chart contains unsupported motors that successfully work with an AC/DC drive.

2. Motor power and motor mechanical horsepower in this chart is calculated from rated RPM. If nothing is listed in the "rated RPM" column, then the motors rated RPM is the same as maximum RPM. A better estimation of torque and power can be provided by the "**Centroid AC/DC Setup Wizard**" software, which is explained in section 3.3.

Fanuc DC Motors[1]

End Cap Color	Motor Type	Motor Model	Max RPM	Continuous Torque (in lb)	Peak Torque (in lb)	Mechanical Horsepower (Imperial)[2]	Power (kW)[2]
Black (Fanuc●Gettys)	00	A06B-0631-Bxxx	2,000	8.7	18.2	0.2	0.15
	0	A06B-0613-Bxxx	2,000	25.4	50.8	0.5	0.4
	5	A06B-0614-Bxx	2,000	50.8	101.5	1	0.8
	10	A06B-0601-Bxxx	1,500	113.3	226.6	2	1.1
	20	A06B-0602-Bxxx	1,500	222.6	404.6	2.5	1.8
Yellow (M Series)	00	A06B-0632-Bxxx	2,000	8.8	17.6	0.2	0.15
	0M	A06B-0641-Bxxx	2,000	26.9	56.0	0.5	0.4
	5M	A06B-0642-Bxxx	2,000	52.2	104.4	1	0.8
	10M	A06B-0651-B012	1,500	106.2	212.4	1.5	1.1
	20M	A06B-0652-Bxxx	1,500	203.1	406.2	2.5	1.8
	30M	A06B-0653-Bxxx	1,200	333.3	666.6	4	2.8

1. The numbers in this chart are calculated from the Fanuc motor data sheets. Centroid has not verified these numbers. See the **Centriod Fanuc CNC Retrofit Installation Manual** for more information about adapting these motors to work on a Centroid System

3. Motor power and motor mechanical horsepower in this chart is calculated at rated RPM, which is the same as maximum RPM for the drives listed in this chart. A better estimation of torque and power can be provided by the "**Centroid AC/DC Setup Wizard**" software, which is explained in section 3.3.

Fanuc AC Motors[1]

Series	Motor Type	Motor Model	Max RPM	Continuous Torque (in lb)	Peak Torque (in lb)	Mechanical Horsepower (Imperial)[2]	Power (kW)[2]	Rated RPM[2]
S series & Early Red Caps	0-0SP	A06B-0374-Bxxx	3,000	26.2	72.2	0.67	0.5	
	0S	A06B-0313-Bxxx	3,000	26.1	68.0	1.0	0.75	
	5S	A06B-0314-Bxxx	2,000	51.8	134.1	1.2	0.9	
	5S/3000	A06B-0514-Bxxx	3,000	51.5	151.3	1.3	1.0	
	6S	A06B-0316-Bxxx	2,000	78.2	220.8	1.26[3]	0.94[3]	
	6S/3000	A06B-0320-Bxxx	3,000	78.2	221.3	1.70[3]	1.27[3]	
	10S	A06B-0315-Bxxx	2,000	103.6	286.2	2.4	1.8	
	10S/3000	A06B-0317-Bxxx	3,000	104.3	306.7	3.1	2.3	
	20S/1500 20M	A06B-0505-Bxxx	1,500	198.9	582.0	3.8	2.8	
	20S 20	A06B-0502-Bxxx	2,000	198.8	605.4	4.7	3.5	
	20S/3000	A06B-0318-Bxxx	3,000	200.9	366.4	4.7	3.5	
	30S	A06B-0590-Bxxx	1,200	330.0	951.9	4.4	3.3	
	30/2000 30R	A06B-0506-Bxxx	2,000	260.7	547.0	5.4	4.0	
	30S/3000	A06B-0319-Bxxx	3,000	261.8	456.7	6.0	4.4	
	40	A06B-0581-Bxxx	1,200	494.5	966.5	4.8	3.6	
	0	A06B-0511-Bxxx	2,000	25.8	78.4	0.79	0.6	
	5	A06B-0512-Bxxx	2,000	51.9	160.4	1.2	0.9	
	10	A06B-0501-Bxxx	2,000	105.0	315.1	2.4	1.8	
	30	A06B-0503-Bxxx	1,200	324.6	885.3	4.4	3.3	
α (Alpha) Series & αC Series	α3/3000	A06B-0123-Bxxx	3,000	26.5	69.0	1.3	0.9	
	α6/2000	A06B-0127-Bxxx	2,000	53.5	160.6	1.4	1.0	
	α6/3000	A06B-0128-Bxxx	4,000	53.1	159.3	1.9	1.4	3,000
	α12/2000	A06B-0142-Bxxx	2,000	105.9	317.8	2.8	2.1	
	α12/3000	A06B-0143-Bxxx	3,000	105.6	306.7	3.8	2.8	
	α22/1500	A06B-0146-Bxxx	1,500	194.7	579.5	4.0	3.0	
	α22/2000	A06B-0147-Bxxx	2,000	193.6	559.2	5.0	3.8	
	α22/3000	A06B-0148-Bxxx	3,000	193.2	361.1	5.9	4.4	
	α30/1200	A06B-0151-Bxxx	1,200	264.3	792.9	4.4	3.3	
	α30/2000	A06B-0152-Bxxx	2,000	264.6	785.9	6.7	4.5	
	α30/3000	A06B-0153-Bxxx	3,000	265.5	472.6	7.1	4.8	
	α40/2000	A06B-0157-Bxxx (without fan)	2,000	334.6	743.5	7.8	5.9	
	αC12/2000	A06B-0141-Bxxx	2,000	106.5	325.0	1.4	1	1,000
	αC22/1500	A06B-0145-Bxxx	1,500	194.7	579.5	2.1	1.5	
β (Beta) Series & β*is* Series	β3/3000	A06B-0033-Bxxx	3,000	26.3	74.3	0.7	0.5	
	β6/2000	A06B-0034-Bxxx	3,000	52.0	139.4	1.2	0.9	2,000
	β4/4000*is*	A06B-0063-Bxxx	4,000	31.2	79.7	1	0.75	
	β8/3000*is*	A06B-0075-Bxxx	3,000	61.6	184.8	1.6	1.2	2,000
	β12/3000*is*	A06B-0078-Bxxx	3,000	97.5	286.8	2.4	1.8	
	β22/2000*is*	A06B-0085-Bxxx	2,000	177.0	470.0	3.4	2.5	

1. The numbers in this chart are calculated from the Fanuc motor data sheets. Centroid has not verified these numbers. See the **Centriod Fanuc CNC Retrofit Installation Manual** for more information about adapting these motors to work on a Centroid System

2. Motor power and motor mechanical horsepower in this chart is calculated from rated RPM. If nothing is listed in the "rated RPM" column, then the motors rated RPM is the same as maximum RPM. A better estimation of torque and power can be provided by the "**Centroid AC/DC Setup Wizard**" software, which is explained in section 3.3.

3. Data sheet information on Hp and Kw power could not be found; instead these numbers are calculated from torque specifications.