Mitsubishi D700 VFD Installation Guide

3/12/2012

Everything you need to know to set up your Mitsubishi VFD.

MachMotion
www.machmotion.com
14518 County Road 7240, Newburg, MO 65550
(573) 368-7399 • Fax (573) 341-2672

Overview

This installation manual is designed for Mitsubishi Variable Frequency Drives (VFDs) purchased from MachMotion. It was written to interface VFDs with the Apollo I Breakout Board. It provides all the information from wiring your VFD to troubleshooting it. Much of the wiring and many of the settings should already be configured correctly for your spindle motor. However, all the information is provided in case you ever need to disconnect or change something.

When the spindle is turned on inside Mach3, the Apollo I Breakout Board provides a 0-10V analog signal to the VFD and turns on one of two relay contacts for clockwise and counterclockwise rotation. The VFD then scales the analog signal to the maximum frequency of the spindle motor. For instance, if a spindle motor's max frequency is 60Hz, then 5V will give you 30Hz and 10V will give you 60Hz. The analog voltage is also scaled to the max pulley speed inside Mach3. In the previous example, if the maximum pulley speed is 1000 RPM, then 500 RPM will make the VFD output 30Hz and 1000 RPM will make it output 60Hz.

If you purchased a drive enclosure from MachMotion, then all you have to do is set up your VFD parameters and connect your spindle motor. Otherwise you will also have to wire up an enable circuit for your VFD.

We hope that this installation can be as quick and easy for you as possible. If you have any questions, please do not hesitate to give us a call.

Sincerely,

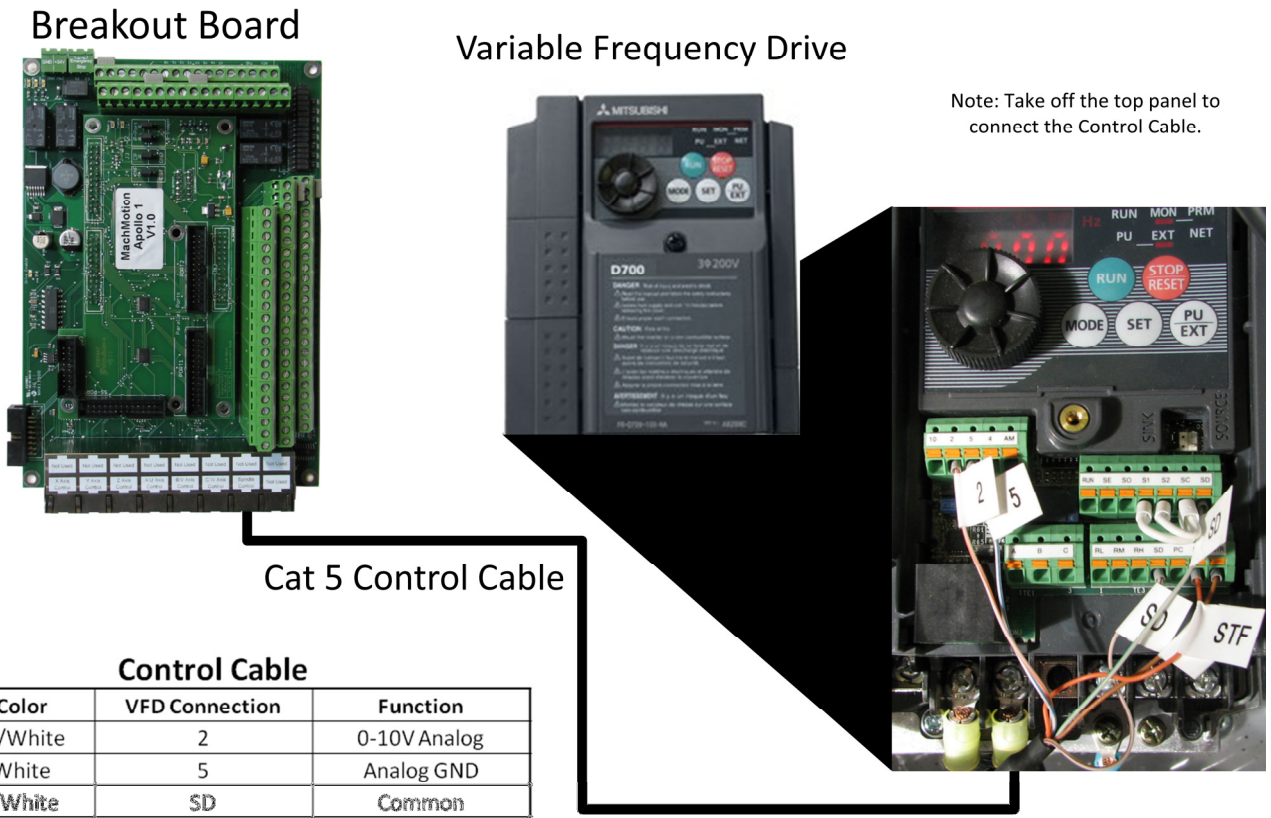
The MachMotion Team
http://www.machmotion.com
14518 County Road 7240, Newburg, MO 65550
(573) 368-7399 • Fax (573) 341-2672

Wiring

Control Cable

The VFD control cable is the Cat5 cable that runs from the breakout board to the Mitsubishi VFD. From the factory it is already wired correctly to the VFD. Plug the cable into the RJ45 connector labeled Spindle Control on the IO6 Breakout Board.

If for any reason you need to disconnect the control cable from the VFD, the wiring is shown below.



Control Cable

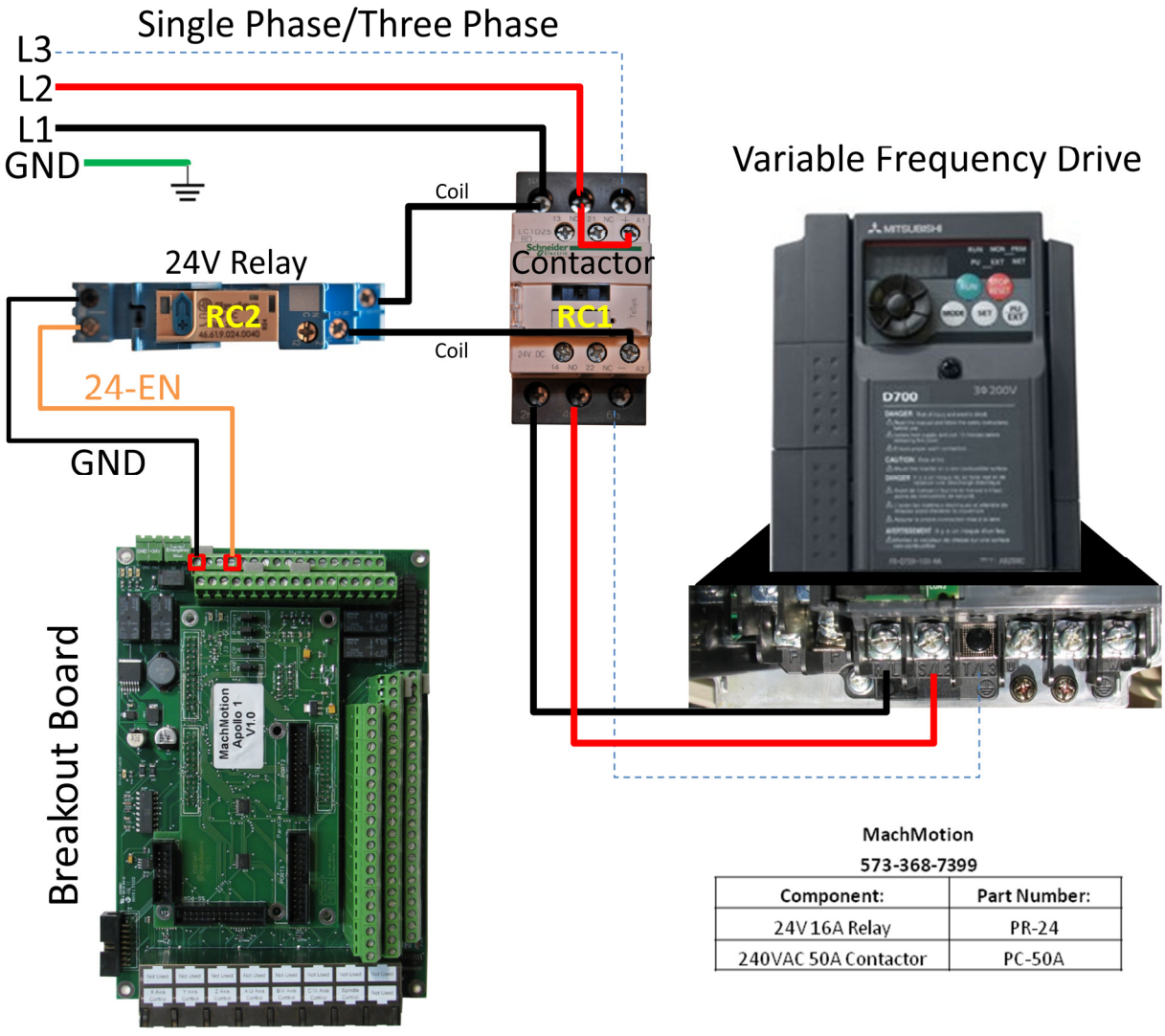
Wire Color	VFD Connection	Function
Orange/White	2	0-10V Analog
Blue/White	5	Analog GND
Green/White	SD	Common
Brown/White	SD	Common
Orange	STF	Forward
Brown	STR	Reverse

Figure 1 Control Cable

Enable Circuit

To set up your VFD correctly, you only want power supplied to it while your control is enabled. Use the 24V enable signal (24-EN) from the breakout board, a 24V relay, and a contactor as shown below. If you purchased a drive enclosure, your enable circuit is already set up.

If your VFD is rated for your spindle motor (i.e. 3Hp VFD with a 3Hp motor), then anything above 3Hp must use 3 phase power. The blue dashed line in the diagram below shows the 3 phase wire.



MachMotion
573-368-7399

Component:	Part Number:
24V 16A Relay	PR-24
240VAC 50A Contactor	PC-50A

Figure 2 Enable Circuit

When the machine is enabled, the 24-EN signal turns on. This turns on RC2 which then connects 230 VAC to the coil of RC1. RC1 then turns on the power to the VFD. You can use the same enable circuit for your servo drives.

Spindle Motor

Connect your spindle motor to the terminals labeled U, V, and W as shown below. If your spindle moves the wrong direction when you turn it on, just swap any two of the spindle motor wires.

Figure 3 Spindle Motor

Brake Resistor

If you want a brake on your spindle, you will need a brake resistor. Use the table below to locate the correct resistor size. You can order them directly from Mitsubishi.

Motor (Hp)	Resistance (Ohms)	Continuous Power (W)	Mitsubishi Part #
1/2	200	60	FR-ABR-0.4K
1	100	80	FR-ABR-0.75K
2 & 3	60	120	FR-ABR-2.2K
5	40	155	FR-ABR-3.7K
7 1/2	25	185	FR-ABR-5.5K
10	20	340	FR-ABR-7.5K

If you have a brake resistor, connect it between PR and P/+ on the VFD.

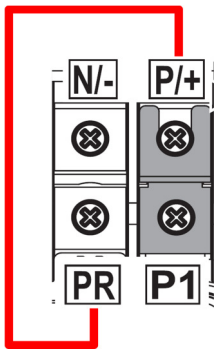


Figure 4 Brake Resistor

Note: Each VFD model is slightly different. Just make sure that you connect the resistor to the correct terminals (PR, P/+).

Programming

To setup your VFD, you will have to learn how to program it. The VFD user interface consists of a small screen, 5 buttons, a few status LEDs, and a scroll wheel as shown below.

Figure 5 VFD User Interface

To change any settings you must enter PU mode. Press the **PU/EXT** button once and the LED by PU should light up. When you are finished changing the settings, you must put the VFD back into EXT mode by pressing **PU/EXT** again. If the LED by EXT is not on, then the VFD will not work.

You can setup parameters by following the procedure below:

1. Make sure the VFD is in PU mode (LED by PU is on). If not press the **PU/EXT** button to turn it on.
2. Press the **Mode** button until you see “P 0”. This is parameter 0.
3. Use the scroll wheel to go to your parameter number (P18 for example).
4. Press the **Set** button once. The current value of the parameter should display.
5. Change the value by using the scroll wheel.
6. Press the **Set** button again. The screen will start to flash between the parameter and the value.
7. Repeat steps 3 to 6 until all your parameters are set up correctly.
8. Put the VFD back into EXT mode by pressing the **PU/EXT** button. Make sure that the LED near EXT is on.
9. Cycle the power to the VFD. Make sure to wait until the VFD completely turns off before repowering it.

Now you should be ready to run the VFD.

Note: If you see an Er1, Er2, Er3, or Er4 error, make sure to put the VFD in PU mode before changing the parameters!

VFD Setup

To setup your VFD you will need to know your spindle motor's frequency. It is also helpful to know the maximum current that your spindle motor should ever draw. You should be able to find both values on the motor's nameplate.

If you cannot locate the motor's frequency, the name plate should tell you how many poles there are on the motor. Using the motor's maximum RPM and its number of poles, you can calculate the frequency with the formula below.

Frequency = Max RPM * Number of Poles / 120

You are now ready to setup your VFD.

Standard Setup

Your VFD comes pre-programmed from MachMotion. The following parameters should never be changed.

Parameter #	Description	Default
73	Analog Input Selection	10
74	Input Filter Constant	6

You may, however, have to change the following parameters.

Parameter #	Description	Standard	Range
1	Maximum Frequency (If less than 120 Hz)	Max Motor Frequency	0-120Hz
2	Minimum Frequency	0	0-120Hz
3	Frequency	Motor Frequency	0-400Hz
7	Acceleration Time	1-3	0-3600 Sec
8	Deceleration Time	1-3	0-3600 Sec
9	Max Motor Current	Rated VFD Current	0-500
18	Maximum Frequency (If greater than 120 Hz)	Max Motor Frequency	120-400Hz
72	PWM Frequency Selection	10	0-15
125	Maximum Frequency	Max Motor Frequency	0-400Hz

All the frequency parameters (1 or 18, 3, and 125) will be the same value unless your maximum frequency is different from the frequency on the spindle motor's nameplate. Only set parameter 1 if your max spindle frequency is less than 120 Hz. Only set parameter 18 if your max spindle frequency is greater than 120Hz.

If your spindle motor does not mention a minimum frequency, leave parameter 2 at zero. Also, if you cannot find your max motor current, just set parameter 9 to the rated VFD current.

Parameter 72 may also have to be adjusted depending on how you VFD sounds. If it is very noisy or if it sounds like it is grinding, you can try changing this anywhere from 0 to 15.

If you get a regenerative error, you can lengthen the deceleration time (parameter 8).

Auto Tuning

If your spindle is not working well, you may need to use auto tuning. Most systems will not need this.

Parameter #	Description	Standard	Range
71	Applied Motor	13	0,1,3,13,23,40,43,50,53
80	Motor Capacity	Rated Motor kW	0.1-7.5kW

If you do not have a Mitsubishi spindle motor, just set parameter 71 to 13. Otherwise enter the motor code into the parameter.

To auto tune your VFD, follow the instructions below.

1. Set parameter 96 to 11.
2. Press the **Mode** button until the MON LED turns on.
3. Press the **Run** button. You should see 12 in the display while the spindle motor runs. If the auto tuning is successful, you will see the display change to 13.
4. Press the **Stop/Reset** button.

Auto tuning should now be complete. Make sure to exit PU mode! If your spindle is still not running well, please call MachMotion at 573-368-7399.

Brake Resistor

For a brake resistor, you must set up two other parameters.

Parameter #	Description	Standard	Range
30	Regenerative Function	1	1
70	Special Regenerative Brake Duty	15	0-30%

You will have to experiment with the regenerative brake duty. If you get a regenerative error (E.OV1 through E.OV3), then the duty is set too high. If your spindle does not stop fast enough, then the duty is too low.

Test Run

You can test your spindle motor directly from your VFD. Follow the sequence below.

1. Press **PU/EXT** to put the VFD into PU mode (make sure the PU LED is on).
2. Press the **Mode** button until the MON LED turns on.
3. Turn the wheel to set your frequency and press **Set**. The screen will flash between F and your frequency.
4. Press **Run** and the motor should begin moving.
5. Press **Stop/Reset** to stop the motor.

If it seems to be running well, you should continue by setting up Mach3. Make sure to exit PU mode!

Mach3 Setup

With your spindle wired and programmed, it is time to set up Mach3. You must enter in your maximum RPM for the spindle motor so Mach3 knows how to scale the analog voltage output. If you have different gears, you can set up multiple maximum speeds. Mach3 uses a different pulley for each different speed configuration. For example, one pulley could be set to 75 to 300 RPM for a low speed (at 300 RPM the control will output 10V). A medium speed pulley could go from 300 to 1200 RPM and high speed pulley could run from 1200 to 2400 RMP.

To change your pulleys, go to **Config -> Spindle Pulleys.** The *Pulley Selection* window will appear as shown in Figure 7.

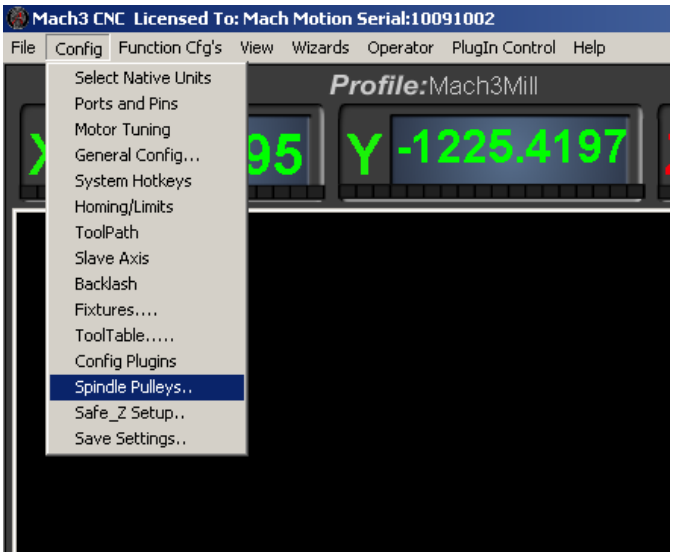


Figure 6 Spindle Pulleys

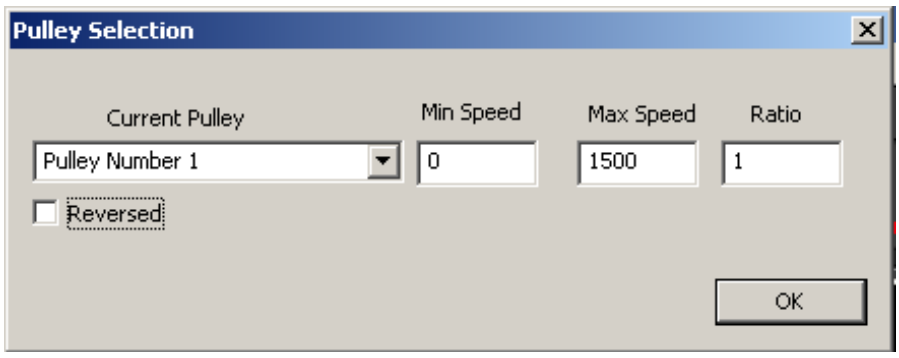


Figure 7 Pulley Speed Setup

Use the drop down menu titled **Current Pulley** to select the pulley you want to update. Enter in your maximum and minimum speeds for each pulley. Then select the pulley you want to load and press **OK**.

You can also change pulleys by using M41-M45. The macros can be used to just change pulleys in Mach3, or you could use them to automatically change gears on your machine. Outputs 12-16 are configured to shift between gears 1 and 5. To shift your machine into neutral, run M40. Open up the macros with the VB Script Editor for more details.

Mach3 should now be set up correctly.

Turning on Your Spindle

To turn on your spindle, begin by setting up your spindle speed. Navigate to **Prog Run** and click on the Spindle **S:** user input. Enter your speed and press **Send** as shown in Figure 8.

Figure 8 Setting up Spindle Speed

Note: If you don't have the MachMotion screen set, spindle speed can be changed right on the main screen of the Mill profile. Click on the user input, enter a new number, and then press enter.

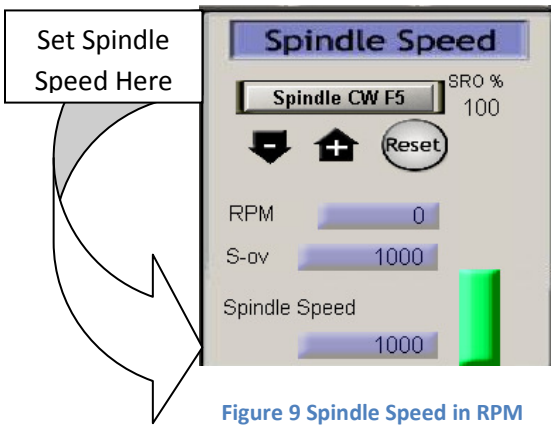


Figure 9 Spindle Speed in RPM

Control the spindle by pressing the **FWD** and **REV** buttons. The button will turn red when you press it once. Pressing the button again turns the spindle back off.

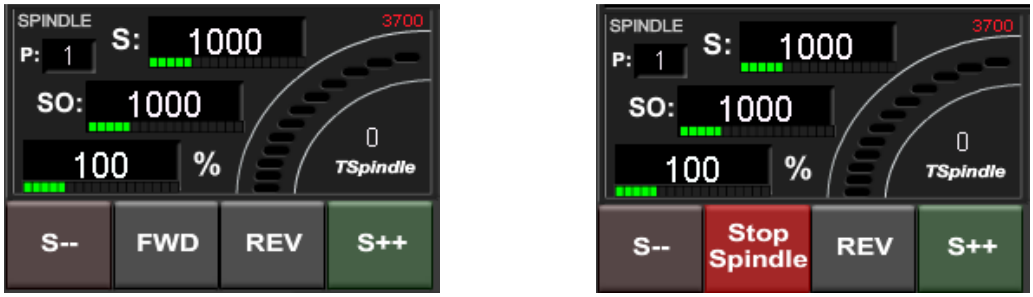


Figure 10 Spindle Buttons

*Note: If you don't have the MachMotion screen set, turn on the spindle by pressing the button **Spindle CW F5**. When the button is flashing, the spindle should be on.*

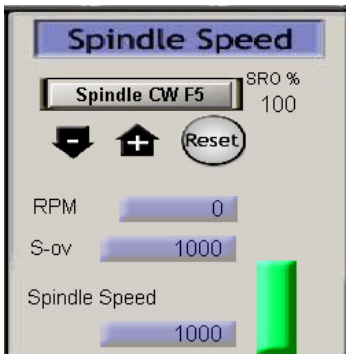


Figure 11 Spindle Speed

You can also control the spindle by using M-codes. As a reference use the table below.

M-Code	Function
M3	Clockwise
M4	Counter/Clockwise
M5	Stop

Test your spindle by commanding it to go half of the pulley's maximum speed. If it is working correctly, your VFD will be running at close to half of the maximum frequency. Next command it to move the pulley's maximum speed. Your VFD should now be running at the maximum frequency. If the frequency is very far off, check your calculations and make sure that the VFD was programmed correctly. If it still is not correct, you may have to calibrate your spindle.

If your VFD is not turning on or if it has a fault, see the trouble shooting section below.

Calibrating Your Spindle

For most systems you can completely skip this section. If your IO6 Breakout Board is not outputting the correct analog voltage, you can calibrate your spindle by using the procedure below.

There are two different methods to use depending on if you know the spindle speed or not. It is simpler to calibrate your spindle if you know the speed.

Begin by finding the current velocity of your spindle. On the top menu bar select **Config**, then **Motor Tuning**. You should see the *Motor Tuning and Setup* window as shown below.

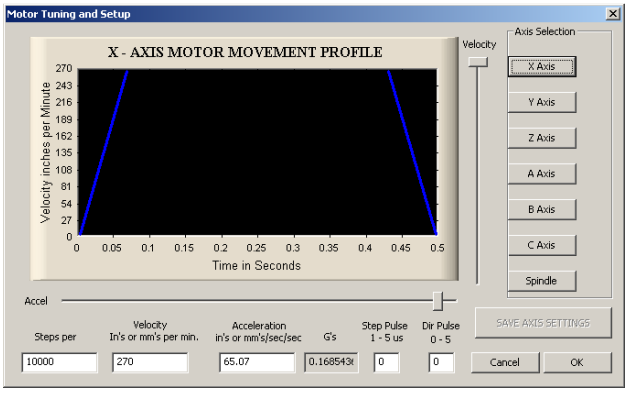


Figure 12 Motor Tuning and Setup

On the right column titled **Axis Selection**, press the **Spindle** button. The spindle parameters will be loaded. Now record the **Velocity** value located on the bottom right of the window. See the figure below.

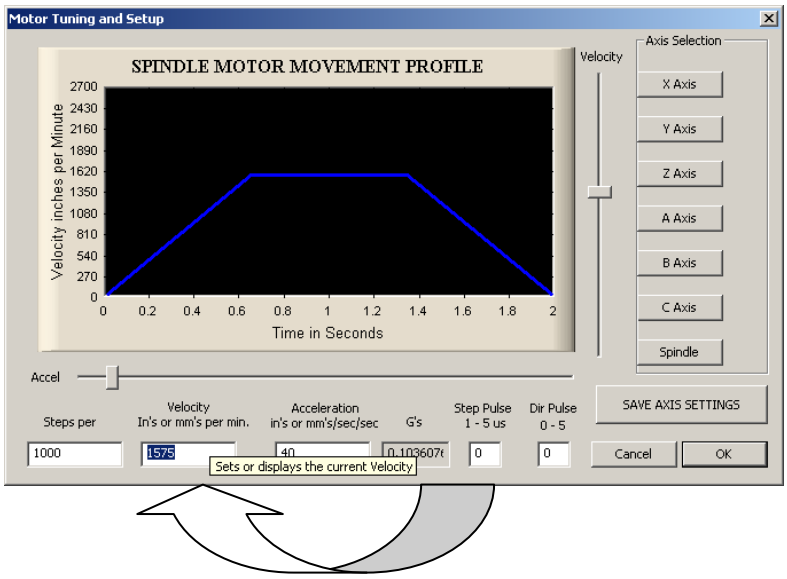


Figure 13 Spindle Velocity Value

In Figure 13 the spindle's current velocity is 1575.

With Spindle Feedback

If you have spindle feedback or a tachometer, you can use the shorter method to calibrate your spindle. Simply find the values shown below.

Current Velocity
Use the velocity value found above from the *Motor Tuning and Setup* window.

Commanded RPM
Enter in a spindle speed as shown above. Then turn the spindle on.

Actual RPM
Record the actual speed either using a tachometer or another method of spindle feedback.

Now plug these values into this formula:

New Velocity = **Current Velocity***(**Commanded RPM** / **Actual RPM)**

Your new velocity value should be fairly close to 1575. If not, check your calculation again.

With your new velocity calculation, go to the *Motor Tuning and Setup* window by selecting **Config**, then **Motor Tuning**. Press the **Spindle** button and enter in your new velocity. Press **SAVE AXIS SETTINGS** before pressing **OK**. Your spindle should now be calibrated.

Without Spindle Feedback

If you do not have a method to calculate your spindle speed, you can calibrate your spindle by using the frequency of your variable frequency drive (VFD). However, you need to find the five different values as shown below.

Current Velocity
Use the velocity value found above from the *Motor Tuning and Setup* window.

Pulley Max
Go to **Config** on the main menu bar, then select **Spindle Pulleys**… You will see the following window:

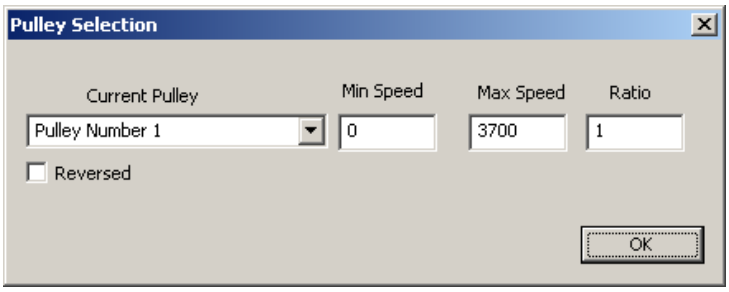


Figure 14 Max Pulley Speed

Your current pulley will be selected. Your **Max Speed** value is your pulley max needed for the spindle calibration.

Max VFD Hz

The maximum motor frequency is your Max VFD Hz (assuming your VFD is set up as shown above).

Commanded RPM

Enter in a spindle speed as shown above. Then turn the spindle on.

Actual Hz

Your VFD should display the current frequency in Hz, which is the Actual Hz value.

With the above information, you are ready to calculate your new velocity. Use the formula below:

New Velocity = **Current Velocity***(**Max VFD Hz *Commanded RPM**/**Pulley Max**)/**Actual Hz**.

Your new velocity value should be fairly close to 1575. If not, check your calculation again.

Now go to the *Motor Tuning and Setup* window by selecting **Config**, then **Motor Tuning**. Press the **Spindle** button and enter in your new velocity. Press **SAVE AXIS SETTINGS** before pressing **OK**. Your spindle should now be calibrated.

Trouble Shooting

If your spindle is not turning on, follow the procedure below.

1. Check the REV and FWD LEDs on the Apollo I Breakout Board.
    a. Neither REV nor FWD ever come on:
        i. Make sure your spindle is enabled (Config->Ports and Pins->Motor Outputs).
        ii. Set the spindle's **Step Pin#** to 1 and the **Step Port#** to 2 (Config->Ports and Pins->Motor Outputs).
        iii. Enable outputs 1 and 2, set both **Port#**'s to 2 and the **Pin#**'s to 14 and 16 respectively (Config->Ports and Pins->Output Signals).
        iv. Make sure the check box **Disable Spindle Relays** is unchecked and that the **Clockwise Output #** is 1 and the **Counterclockwise Output #** is 2. Also, select the check box **PWM Control** and set the **PWM Base Freq**. to 100 (Config->Ports and Pins->Spindle Setup).
    b. REV and/or FWD do work
        i. Set the spindle speed to the maximum pulley speed.
        ii. Check the 0-10V on **0-10** terminal on the Apollo I Breakout Board with a voltmeter. You should read 10V.
        iii. Check your wiring.

Alarm List

If your VFD has an alarm, use the lists below to figure out what to do.

Error Messages			
Alarm Code		**Description**	**Corrective Actions**
E---	E---	Faults history	
HOLd	HOLD	Operation panel lock	
LOCd	Er1 to 4	Parameter write error	
Er 1 to Er 4	LOCd	Password locked	
Err.	Err.	Inverter reset	

Warnings			
Alarm Code		**Description**	**Corrective Actions**
OL	OL	Stall prevention (overcurrent)	Increase parameters 7 and 8
ol	ol	Stall prevention (overvoltage)	Increase parameter 8
rb	RB	Regenerative break prealarm	
rH	TH	Electronic thermal relay function prealarm	Reduce the load and frequency of operation
PS	PS	PU Stop	
nr	MT	Maintenance signal output	
Uu	UV	Undervoltage	
SA	SA	Safety stop	

Alarms			
Alarm Code		**Description**	**Corrective Actions**
Fn	FN	Fan Alarm	

Faults			
Alarm Code		**Description**	**Corrective Actions**
E.OC 1	E.OC1	Overcurrent trip during acceleration	Increase parameter 7
E.OC2	E.OC2	Overcurrent trip druing constant speed	
E.OC3	E.OC3	Overcurrent trip during deceleration or stop	Increase parameter 8
E.Ou 1	E.EOV1	Regenerative overvoltage trip during acceleration	Increase parameter 7
E.Ou2	E.OV2	Regenerative overvoltage trip during constant speed	
E.Ou3	E.OV3	Regenerative overvoltage trip during deceleration or stop	Increase parameter 8
E.THT	E.THT	Inverter overload trip (electronic thermal relay function)	
E.THM	E.THM	Motor overload trip (electronic thermal relay function)	Verify that parameter 9 is setup correctly
E.FI n	E.FIN	Fin overheat	
E.ILF	E.ILF*	Input phase loss	
E.OLT	E.OLT	Stall prevention	
E. bE	E.BE	Brake transistor alarm detection	
E. GF	E.GF	Output side earth (ground) fault overcurrent at start	
E. LF	E.LF	Output phase loss	
E.OHT	E.OHT	External thermal relay operation	
E.PTC	E.PTC*	PTC thermistor operation	
E. PE	E.PE	Parameter storage device fault	
E.PUE	E.PUE	PU disconnection	
E.rET	E.RET	Retry count excess	
E. 5 / E.CPU	E.5/ E.CPU	CPU fault	
E.CdO	E.CDO*	Output current detection value exceeded	
E.IOH	E.IOH*	Inrush current limit circuit fault	
E.AIE	E.AIE*	Analog input fault	
E.SAF	E.SAF*	Safety circuit fault	

Warranty Information

MachMotion warrants all products to be free from manufacturer defects for a period of one year from the date of purchase. Products which prove to be defective under normal conditions and proper use during the warranty period will be replaced without charge. For warranty service, send the defective product to MachMotion, 14518 County Road 7240, Newburg, MO 65550. If the defect is found to be caused by improper use, then this warranty does not apply. Otherwise the product will be repaired or exchanged and shipped to the address located on the Product Repair Form. MachMotion will cover the return UPS ground shipping for the replaced/repaired product. When a product or part is exchanged, any replacement item becomes your property and the replaced item becomes MachMotion's property.

Congratulations on completing the Mitsubishi VFD Installation Guide. We hope that you have found this manual very helpful.

Please let us know if you have any questions.

Sincerely,

The Mach Motion Team
http://www.machmotion.com
14518 County Road 7240, Newburg, MO 65550
(573) 368-7399 • Fax (573) 341-2672