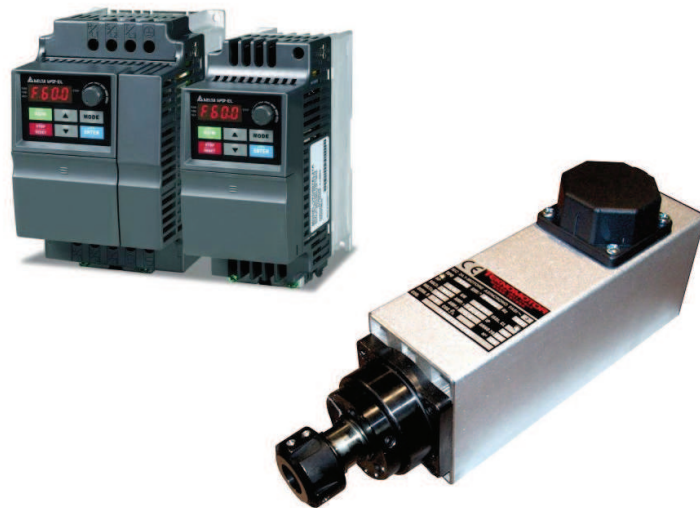


## Chapter 10

### Appendix E: Setup of a Delta VFD and a Teknomotor



## 10.1 Introduction

This section describes the setup of a Delta Variable Frequency Drive (VFD), in combination with a Teknomotor.

The Delta VFD is a device which can interface with USBCNC or stand-alone; allowing the user to control an electrospindle such as a Teknomotor.

Teknomotors are known for their high reliability, high performance and low maintenance.

This documentation is also included in the scope of delivery for a Delta VFD; this documentation can be used as a quickstart manual.

Please bear in mind that a factory manual is included with your Delta VFD. Please refer to this manual for additional information.

Since a VFD contains multiple capacitors, always be very careful! After unplugging the VFD device be sure to wait several minutes to ensure the VFD is discharged!

There are three Delta VFD types: VFD-S, VFD-E and VFD-L. Therefore small deviations in figures might be present, but the connection procedure is the same.

The setup procedure if the Delta VFD and a Teknomotor is as follows:

1. Connect a 220V / 380V euro cable
2. Connect a brake resistor
3. Program the VFD
4. Remove power and wait several minutes
5. Connect the Teknomotor
6. Testing procedure
7. FAQ

## 10.2 Connection procedure

### 1.1 Test setup: Connect a 220V / 380V euro cable

Strip a 220V / 380V euro cable and attach fork terminals on the wires. It is essential that the used 220V / 380V plug is grounded. Remove the Delta VFD plastic protection plate on the lower side of the VFD.

In case a 220V euro cable is used, the terminals must be mounted as can be seen in the figure 10.1 (observe the wiring diagram on the left).

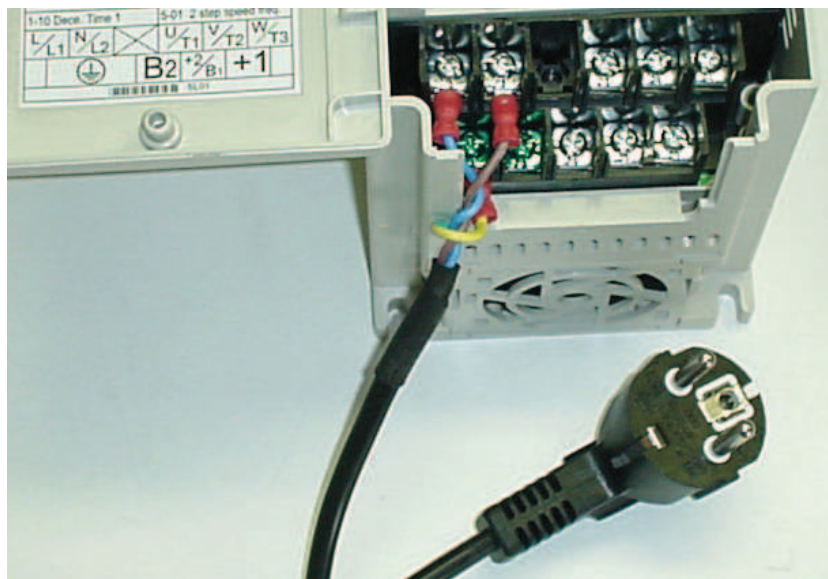


Figure 10.1: Mount the 220V blue, brown and yellow/green terminal cable on L/L1, N/L2 and GND (earth logo) respectively

This wiring diagram holds for any version of a 220V Delta VFD.

### 1.2 Permanent setup

If the Delta VFD is installed on a final permanent setup, it is necessary to implement a on/off (main) switch in between the power plug and the Delta VFD.

This important because if you don't do this, there is always a risk of experiencing an electric shock if the power plug is detached!

DamenCNC strongly recommends the following architecture of your Delta VFD connection:

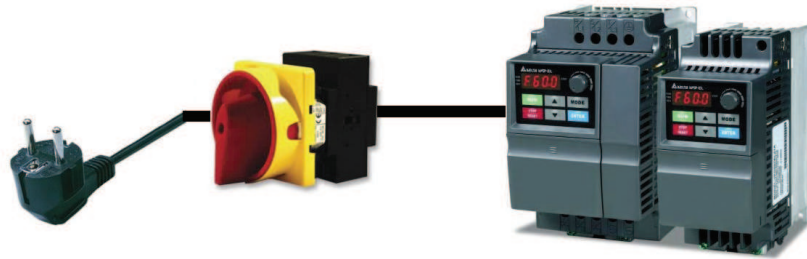


Figure 10.2: Safe operation of the Delta VFD requires a main switch

## 2. Connect a brake resistor

A brake resistor is a device which allows the Delta VFD to dump rotational energy into. This is necessary when quick variations in angular velocity are required.

If you do not mount this brake resistor and your Delta VFD reports an over-voltage error message during operation. In this case you need a brake resistor.

As a rule of thumb, if you have a 18.000 RPM HF Spindle Teknomotor and do not have strict requirements with respect to acceleration and deceleration (i.e. if 3 seconds run up time is enough) you do not need a brake resistor.

A 24.000 Electrospindle Teknomotor will require a brake resistor.

DamenCNC offers two types of brake resistors:

- ERF 150W J101
- ERF 150W J401

The first brake resistor (ERF 150W J101) is suitable for a 220V Delta VFD. The latter brake resistor (ERF 150W J401) is suitable for a 380V Delta VFD.

These brake resistors can be installed by attaching fork terminals to the ends of the two wires. Be sure to perform some extra stripping of the sleeve in order to firmly connect the fork terminals).

These fork terminals should then be mounted on port **B2** and port **+2/B1** (it does not matter which wire goes onto which port) as shown in figure 10.3:

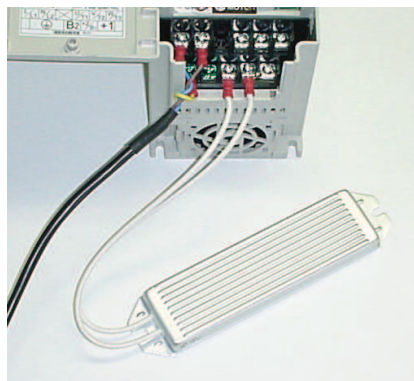


Figure 10.3: Wiring diagram for a brake resistor

### 3. Program the Delta VFD

The Delta VFD operating parameters which are set in the Delta factory need to be changed in order to control a Teknomotor.

In table 11.1 the user can find the parameters which need adjustments; afterwards we explain how you can change each parameter.

**Note:**

The maximum operating frequency parameter depends upon the used Teknomotor model: an 18.000 RPM HF spindle Teknomotor has a maximum operating frequency of 300Hz and a 24.000RPM Electrospindle Teknomotor has a maximum operating frequency of 400Hz.

You should always use the Delta VFD in an environment where your 220V socket is **NOT** attached to a group which supplies power to any important electronical (data) devices; the capacitors in a VFD might trigger your RCD (Dutch: aardlekschakelaar)!

In addition, **NEVER** use the 220V Tool or Flood socket at the back of your RTR set!

Instead, use a seperate wall socket.

On the next page you can find the parameters which need to be adjusted in order to program the Delta VFD.

The following parameters should be set on your Delta VFD drive.  
 On the next page you can find the instructions on adjusting a parameter.  
 Read these instructions carefully before programming your Delta VFD.

Parameter	VFD-E	VFD-L	VFD-S	Function
2-00	D4		D3	Potentiometer speed control
2-01	D0			Source of fist operation command
1-09	D3	D3	D3	Acceleration time in seconds
1-10	D3	D3	D3	Deceleration time in seconds

Table 10.1: Parameters which need to be changed for the Delta VFD

Depending upon the type of Teknomotor you have, the correct maximum RPM should be programmed into the Delta VFD.

The most common maximum RPM values are 18000 and 24000 RPM; please make sure that you know the maximum RPM of your motor. Usually this value can be found on the license / identification plate on your motor.

If you make a mistake with programming the correct maximum RPM value this can result in severe damage to both your (Tekno)motor and Delta VFD!

Parameter	60 RPM	6000 RPM	12000 RPM	18000 RPM	24000 RPM
1-00	D60	D100	D200	D300	D400
1-01	D60	D100	D200	D300	D400

Table 10.2: Parameters which need to be adjusted to select the correct RPM

## Setting a parameter

In this example it is explained how you can change the first parameter 2-00; all other parameters can be set in the same way.

1. Apply power by inserting the 220V / 380V plug in a socket which is **NOT** attached to a group which supplies power to any important electronical (data) devices; the capacitors in a VFD might trigger your RCD (Dutch: aardlekschakelaar)!
2. Press **Prog data** / **ENTER** button
3. Using the **Up** and **Down** buttons browse and select **2**
4. Press **Prog data** / **ENTER** button
5. The display should now read 2-00
6. For the first parameter you do not need to change the values after the **2-**, press **Prog data** / **ENTER** button again
7. The factory setting for the speed control is **D0**.  
Using the **Up** and **Down** buttons browse and select **D3**
8. Press **Prog data** / **ENTER** button
9. The display should now display **END**, which indicates that this parameter is programmed.  
In the case the message 'ERR' is displayed, the parameter has not been set. Most probably this is because you are in 'RUN' mode. Press the 'STOP' button and try again.
10. Verify that the adjusted parameter is now indeed correctly set. You can do this by trying to set the parameter again, verify that the parameter value is already present. In the case of trying to control the VFD using the potentiometer, you should see that after setting parameter 2-00 that this function works.

All other respective parameters can be set by repeating step 2-10.

After this programming, verify that if you press the **RUN** button, and rotate the potentiometer to its max value, the digits display the correct maximum frequency (300 for a 18.000 RPM HF spindle Teknomotor, or 400 for a 24.000 RPM Electerspindle Teknomotor).



## 4. Remove power and wait several minutes

The Delta VFD capacitors are still charged when you disconnect the 220V / 380V euro cable. Be very patient and wait several minutes until the Delta VFD is discharged.

Serious injury and damage to your components can occur!

## 5. Connecting the Teknomotor

The Teknomotor can be used in either **Star** or **Triangle** configuration.

If you use a monophase (220V) DamenCNC's Delta VFD in combination with a Teknomotor, the Teknomotor should be configured in a **Triangle** configuration as we have a 1 phase 220V input, and a 3 phase 220V output.

The Teknomotors are factory set in a **Star** configuration, which means that it is required to adjust the small metal connection plates such that the connection corresponds to the following figure 10.4:

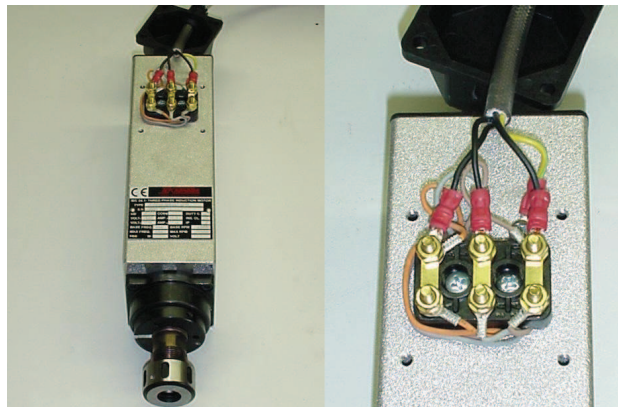


Figure 10.4: If you use a monophase 220V Delta VFD, mount the small gold metal connection plates as shown in order to configure the Teknomotor in **triangle** configuration

If you have a 380V 3 phase connection, leave the Teknomotor in the factory star setting. Please also verify if the motor is indeed in star setting. The metal connection plates should be as depicted in the following figure 10.5: Now that the configuration of the Teknomotor is set, we proceed to the wiring loom.

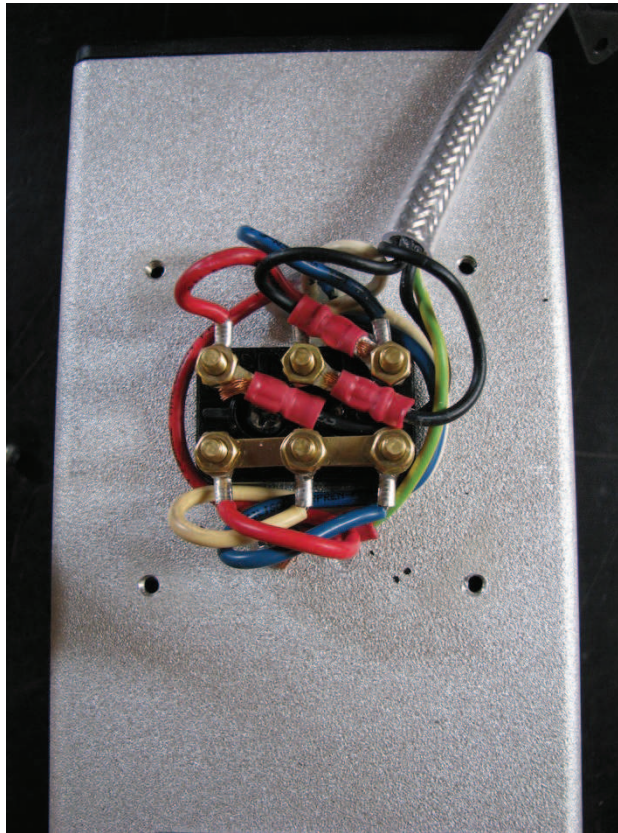


Figure 10.5: If you use a threephase 380V Delta VFD, mount the small gold metal connection plates as shown in order to configure the Teknomotor in **star** configuration

## Wiring loom

Prepare your 4-pole cable by cutting the (preferably shielded **4x 0.75mm<sup>2</sup>**) cable to the desired length, and trim away the sleeve of the cable on **5cm** of both ends such that the inner cables are visible.

Guide the cable through a cable gland with the corresponding black cover box.

On one end apply fork terminals to the four inner cables, to the other end apply cable ends. Now mount the cables as shown in table 10.3 and figure 10.6:

When you have completed the wiring loom assembly, screw the Delta VFD plastic protection plate back in to its original position, such that the wire connections are protected.

Wire number	Motor connection number
1	U <sub>1</sub>
2	V <sub>1</sub>
3	W <sub>1</sub>
G	Ground (casing of the Teknomotor)

Table 10.3: Wiring diagram of the Teknomotor

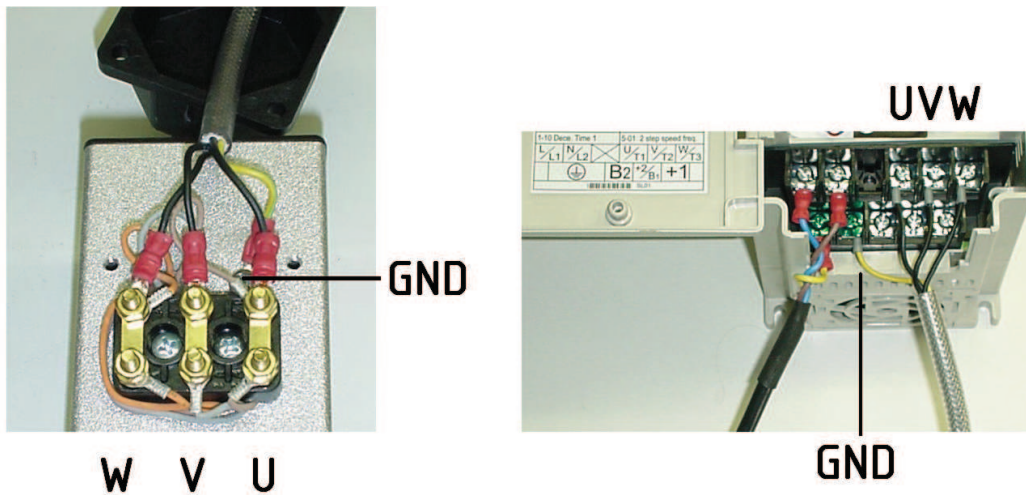


Figure 10.6: Wiring diagram on the Teknomotor (left) and Delta VFD (right)

## 6. Testing procedure

Now the assembly is ready for testing, according to the following testing procedure:

1. Remove the clamping nut from the Teknomotor
2. Rotate the potentiometer counterclockwise to a minimum value
3. Apply power to the Delta VFD
4. Press **RUN** on the Delta VFD
5. You should now be able to control the RPM of the Teknomotor with the potentiometer

Always try to accelerate the spindle by quickly rotating the potentiometer to full speed, then decelerate the spindle by rotating the potentiometer to zero speed. If the Delta VFD reports an over-voltage error message while doing

so, you need a Brake resistor.

Details on how to install a brake resistor can be found in step 2.

Always be sure to verify if the Teknomotor rotates in the right direction. The right direction is indicated in figure 10.7:



Figure 10.7: The correct rotation for any Teknomotor

In the case that the electrospindle rotates the wrong direction, unscrew the plastic Delta VFD protection plate and switch the motor cable **U** with the motor cable **W**. Be sure to leave terminal **V** intact.

This operation will reverse the rotation.

## 7. FAQ

Frequently Asked Questions are dealt with in this section.

### **Q 1: Why does my motor runs erratic at low RPM values?**

A: Most probably you are using a different motor than a Teknomotor. In order to install your motor to the Delta VFD, try changing the parameters listed in table 10.4:

Parameter	Factory	DamenCNC setting	Function
6-00	D1	D0	Over voltage protection
7-02	D1	D0	Torque compensation

Table 10.4: Parameters which might solve an erratic operation at low RPM of your motor

Be sure to test one of these remedies at a time, as one of these settings might prove to be a solution.

### **Q 2: The Delta VFD returns an over voltage error during operation. How can I fix this?**

A: This error can be solved by installing a brake resistor.  
Please read Appendix 10.2.2 "Connect a brake resistor" on how to do this.

### **Q 3: The Delta VFD does not respond to the keypad. How can I fix this?**

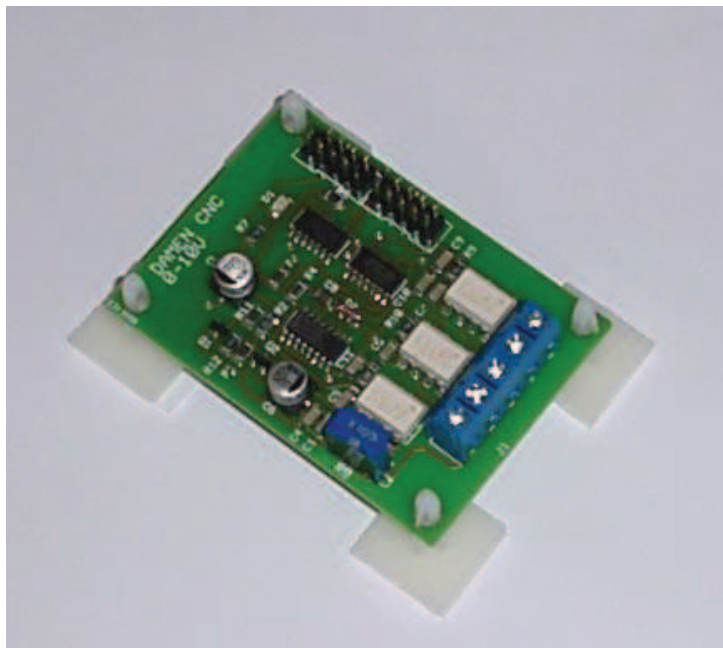
A: Parameter 2-01 is incorrectly set.  
Try changing this parameter to d0 (factory setting) and try again.

### **Q 4: The Delta VFD does not respond to the potentiometer. How can I fix this?**

A: Parameter 2-00 is incorrectly set.  
Try changing this parameter to d3 and try again.

## Chapter 11

### Appendix F: Connecting a 0-10V Spindle Speed Control



## 11.1 Introduction

In this chapter we explain how you can connect a 0-10V Spindle Speed Control. A 0-10V Spindle speed control is a small PCB which is able to interface with USBCNC V3, V4 and V5B; allowing USBCNC software to control a (Delta) Variable Frequency Drive (VFD) which in its turn can control a (Tekno)motor HF - or electrospindle.

In order to install the 0-10V Spindle Speed Control PCB it is highly recommended to first read and perform Appendix E: Setup of a Delta VFD and a Teknomotor.

By doing so the user can control the (Tekno)motor without USBCNC, which might already exclude any errors.

After the user has performed the entire Appendix E procedure, the system can be prepared in the following sequence:

First the **hardware connection** procedure will be discussed:

1. **I have a DamenCNC RTR Performance (standard with 0-10V Spindle Speed Control) set and a Delta VFD with a cable assembly**
2. **I have a DamenCNC RTR without a 0-10V Spindle Speed Control Delta VFD**
3. **I have a USBCNC CPU V4.0 and a Delta VFD**

Afterwards the **software setup** is explained. The software setup consists of the setup of the DELTA VFD, and the setup of USBCNC V5.



## 11.2 Hardware Connection procedure

### 1. I have a DamenCNC RTR Performance (standard with 0-10V Spindle Speed Control) set and a Delta VFD with a cable assembly

Observe the RTR set: The connection for the 0-10V Spindle Speed Control is located as follows:

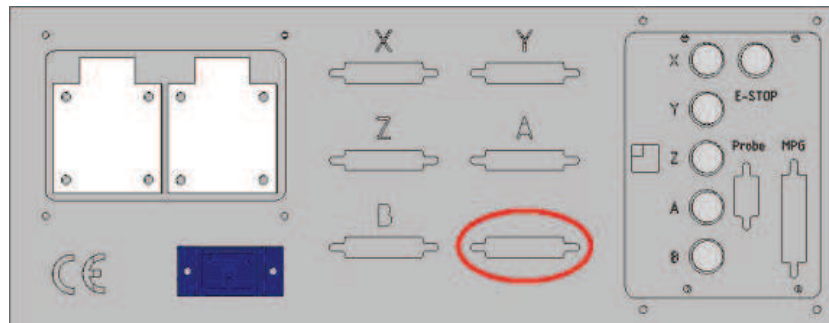
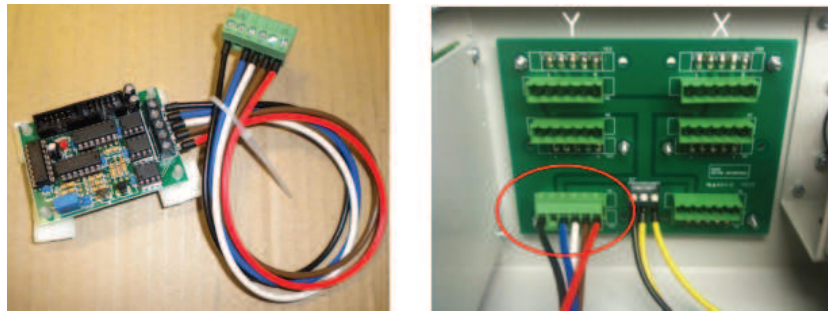


Figure 11.1: Connection for the 0-10V Spindle Speed Control on the RTR set

Visually verify that the connections are as follows:



Connect the 0-10V Spindle Speed Control to the DELTA VFD by plugging the 5-pole connector which is assembled to the DELTA VFD, into the 5-pole bus outside the RTR system as shown in the figure 11.1.

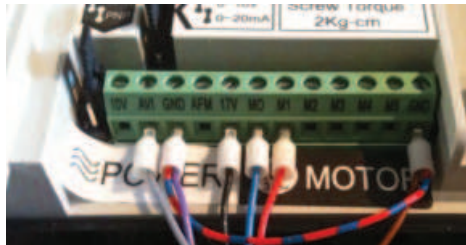


The cable which is connected to the DELTA VFD has the following wiring scheme, when shown from above:



Figure 11.2: Wiring scheme from above: black, blue, purple, red, grey

On the other end of the cable, where the cable is introduced in the DELTA VFD, there are two different lay outs. For the VFD 015 and the VFD 022 the wiring scheme is as follows:



- AVI - Grey
- GND - Brown
- 17V - Black
- M0 - Blue
- M1 - Red
- GND (left) - Purple
- GND (right) - Brown (solder to cable shielding, connect with purple)

This concludes the hardware setup. Please proceed to the test section.

## 2. I have a DamenCNC RTR without a 0-10V Spindle Speed Control Delta VFD

When there is no 0-10V Spindle Control PCB already built in the RTR system, it has to be built in first.

Connect the 0-10V Spindle Control PCB cable to the lower left socket of the interface print (view from inside the RTR system) using the supplied cable, as can be seen in figure 11.3.

The 0-10V Spindle Control PCB itself should be fixed using sticky feet on the backside of the USBCNC CPU holder (in figure 11.3, far left on the image on the right).

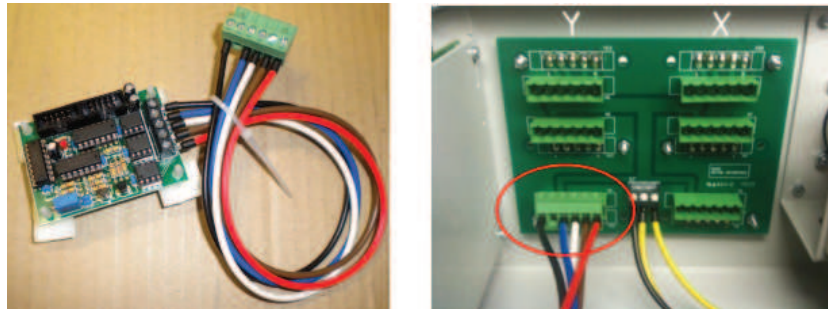


Figure 11.3: Plug the 0-10V Spindle Control PCB cable in the lower left cable slot

When you have an older version of the RTR, there might be not a interface print as shown in the photo above.

In this case one has to be make a custom connection.

This custom connection can be seen in the subsection which discusses

**I have a USBCNC CPU V3.0 or V4.0 and a Delta VFD.**

## Connecting the 0-10V Spindle speed control PCB to a USBCNC CPU

The OUT signal from the USBCNC CPUV4.0 has to be connected to USBCNC CPU V4.0 socket from the 0-10V Spindle Control as shown in figure 11.4:

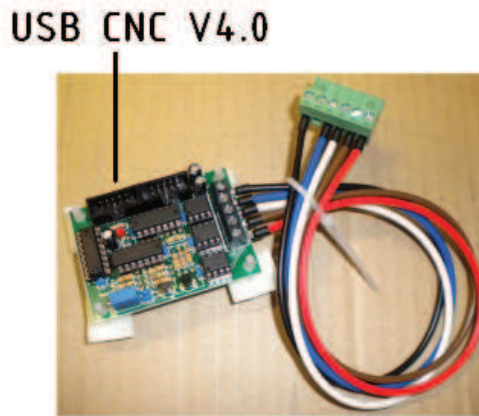


Figure 11.4: Terminal for USBCNC CPU V4.0

The OUT signal from the USBCNC CPU4.0 is connected to the same 10P ribbon cable which controls the relais PCB which controls Tool/Flood/Aux/Mist settings.

When this component is built in correctly, and you have a Delta VFD cable assembly, follow the steps of

**I have a DamenCNC RTR Performance (standard with 0-10V Spindle Speed Control) set and a Delta VFD with a cable assembly.**

If you do not have a Delta VFD cable assembly, you can create one using preferably a **5 x 0.25mm<sup>2</sup>** shielded cable.

This cable should have the wiring scheme presented in figure 11.2:

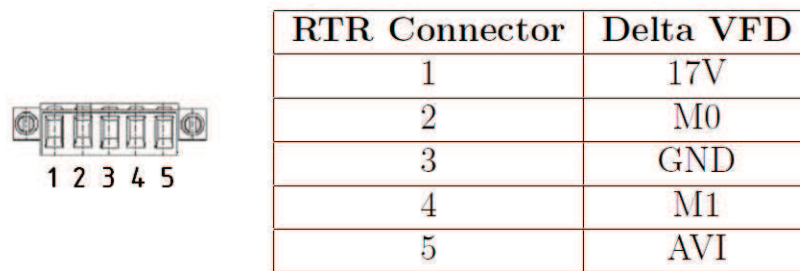


Figure 11.5: Wiring scheme for connecting the 0-10V Spindle speed control PCB to the Delta VFD

Be sure to connect RTR connector 3 to both Ground (GND) terminals on the Delta VFD.

Now you can proceed to the software setup.

### 3. I have a USBCNC CPU V3.0, V4.0 or V5.0 and a Delta VFD

#### Connection to USBCNC CPU

Connect the supplied 10 pole connector to the SV6 port of USBCNC CPU V3 PCB or for USBCNC CPU V4 users on the OUT slot of CPUV4.

Connect the other end to the 0-10V output card on the respective slot for your USBCNC CPU; see figure 11.6 for your correct terminal.

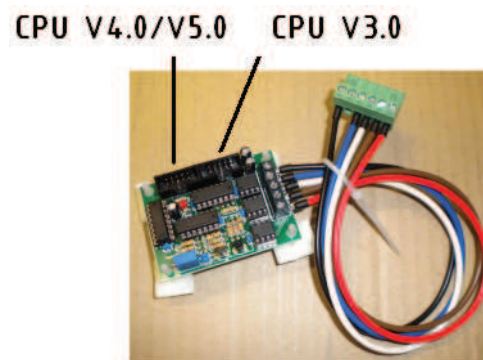


Figure 11.6: Terminals for USBCNC CPU V3.0 and USBCNC CPU V4.0

# Connecting a 0-10V Spindle Speed Control PCB to a Delta VFD

Make sure the Delta VFD and the RTR set are both turned off while making these connections. The wiring scheme can be seen in figure 11.7 and figure 11.8:

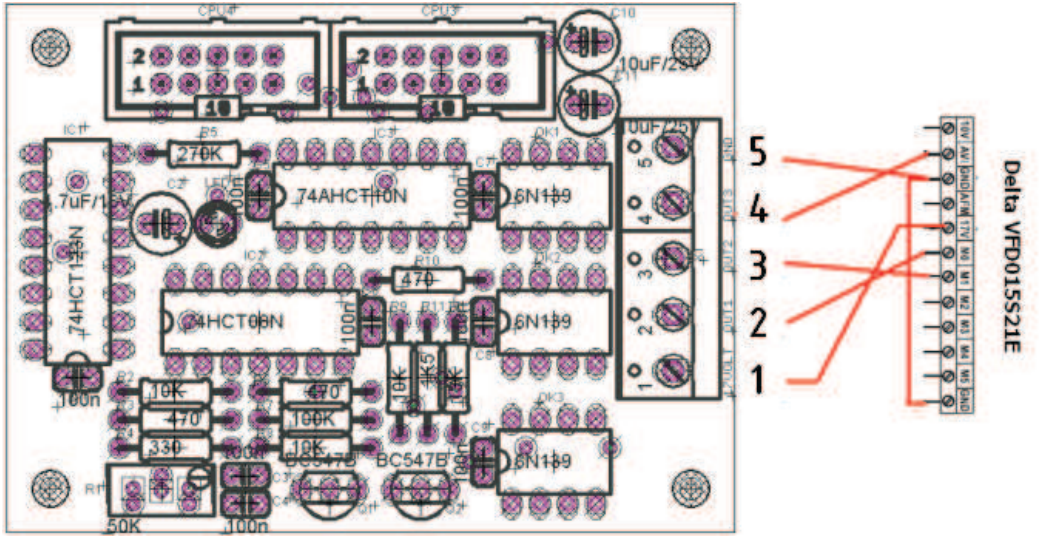


Figure 11.7: Wiring scheme for connecting a 0-10V Spindle speed control PCB to a Delta VFD

0-10V PCB	Delta VFD
1 17 V	17V
2 OUT 1	M0
3 OUT 2	M1
4 OUT 3	AVI
5 GND	GND

Figure 11.8: Wiring scheme for connecting a 0-10V Spindle speed control PCB to a Delta VFD

Be sure to attach 0-10V PCB pin 5 (GND) to both ground terminals on the Delta VFD connector.

**Note:**

Use a (twisted) shielded cable for the above mentioned connections.

The shielding of the used cable should only be connected at the connector at the side of the drive (or the RTR side of the cable).

Always connect the shielding of the used cable to the **Earth terminal** on the DamenCNC motor interface card.

Now you can proceed to the software setup.

## 11.3 Software setup

The software setup consists of two parts.

1. Setup of the Delta VFD
2. Setup of USBCNC Software



## Software setup of the Delta VFD

The Delta VFD should be set up such that there is a communication between the USB CNC Software and the Delta VFD. This communication can be established by performing the following steps:

Unplug the connection between the Delta VFD and the 0-10V Spindle speed control PCB.

Apply power to the VFD; please bear in mind that you should always use the Delta VFD in an environment where your 220V socket is **NOT** attached to a group which supplies power to any important electronical (data) devices. This is because the Delta VFD might trigger your RCD (Dutch: aardlekschakelaar)!

In addition, **NEVER** use the 220V socket from your RTR set; instead use a separate wall socket!

Usually a VFD obtains its inputs from the potentiometer and the interface. Since we want to control the speeds via a 0-10V input we need to change the parameters of the drives such that it takes the speed input at the 0-10V input. In table 11.1 one can find the parameters which need to be adjusted. After table 11.1 we explain how you can adjust each parameter.

Parameter	Factory	18.000 RPM	24.000 RPM	Function
2-00	D0	D1	D1	0-10V speed control
2-01	D0	D1	D1	External start / stop
1-00	D60	D300	D400	Maximum operating frequency
1-01	D60	D300	D400	Maximum frequency
1-09	D10	D3	D3	Acceleration time in seconds
1-10	D10	D3	D3	Deceleration time in seconds

Table 11.1: Parameters which need to be changed for the Delta VFD

## Setting a parameter

In this example it is explained how you can change the first parameter 2-00; analogous to all other parameters.

1. Apply power by inserting the 220V plug in a socket which is **NOT** attached to a group which supplies power to any important electronical (data) devices or your RTR set; the Delta VFD might trigger your RCD (Dutch: aardlekschakelaar)!
2. Press **Prog data** button
3. Using the **Up** and **Down** buttons browse and select **2**
4. Press **Prog data** button
5. The display should now read 2-00
6. For the first parameter you do not need to change the values after the **2-**, press **Prog data** button again
7. The factory setting for the speed control is **D0**.  
Using the **Up** and **Down** buttons browse and select **D3**
8. Press **Prog data** button
9. The display should now display **END**, which indicates that this parameter is programmed.

All other respective parameters can be set by repeating step 2-9.

There are two jumpers pre installed on a Delta VFD. These jumpers must be set such that 0-10V - and NPN are connected, as can be seen in figure 11.9:

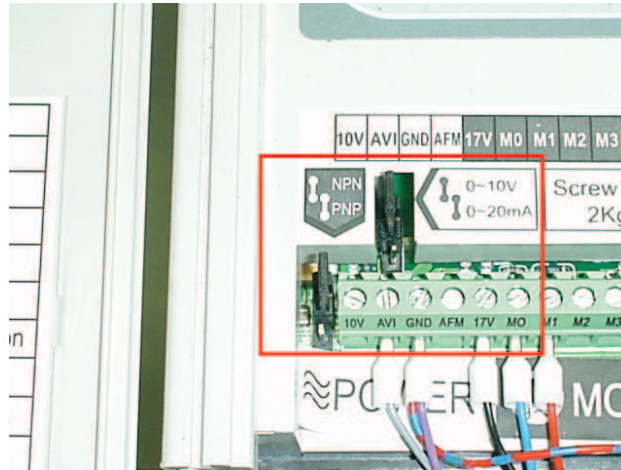


Figure 11.9: Jumper settings on 0-10V and NPN

Please proceed to the software setup of USBCNC Software.

## **Software setup of USBCNC Software**

The Software setup of USBCNC consists of three steps.

1. Set the correct outputs
2. Testing without a Teknomotor
3. Testing with a Teknomotor

## 1. Set the correct outputs

Navigate in the USBCNC environment to the Tab Setup.

Make sure that under the Spindle box the parameters PWM is checked.

The term Ramp up time indicates the time the spindle needs to start. The Ramp up time varies per spindle, but usually 0.5 to 2 seconds is sufficient. Furthermore Max S is the maximum allowable RPM of the spindle. In the case of a Teknomotor this is either 18000RPM or 24000RPM (this depends on the type of Teknmotor used).

It is also possible to indicate a minimum RPM value, as can be seen in figure 11.10.

As the name implicates, the option proportional ramp up time allows the user to poroportionally vary the acceleration time as a function of the required RPM value. So if you set the start up time to 2 seconds, it will require 2 seconds to reach 24000RPM; and 1 second to reach 12000RPM.

It might be required to adjust the USBCNC Software **Invert IO** functions. Ensure that the Tool Dir option is checked, and PWM is unchecked, as can be seen in figure 11.10.

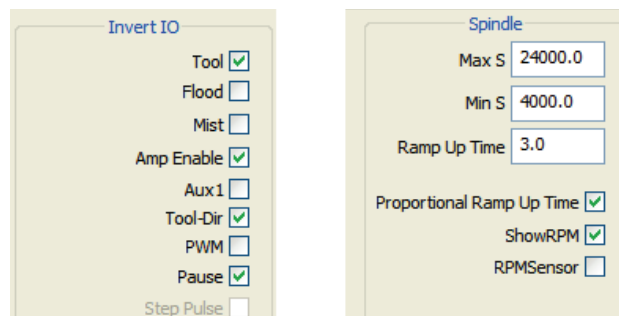


Figure 11.10: USBCNC V5 Setup tab: it is important to check Tool Dir, and uncheck PWM. Indicate the correct Teknomotor limits in the Spindle menu

## 2. Testing without a Teknomotor

In order to test the communication between USBCNC Software and your Delta VFD, follow this procedure:

1. Disconnect your Teknomotor from the Delta VFD
2. Connect your USBCNC CPU to your PC and connect the 0-10V Spindle speed control PCB to the Delta VFD
3. Apply power by inserting the 220V / 380V plug in a socket which is **NOT** attached to a group which supplies power to any important electronical (data) devices or your RTR set; the Delta VFD might trigger your RCD (Dutch: aardlekschakelaar)!
4. Open the MDI (Manual Data Input; F12; F6 in the Operate Tab) function. If you use a 18000RPM Teknomotor, input "M3 S18000" + Enter; as can be seen in figure 4

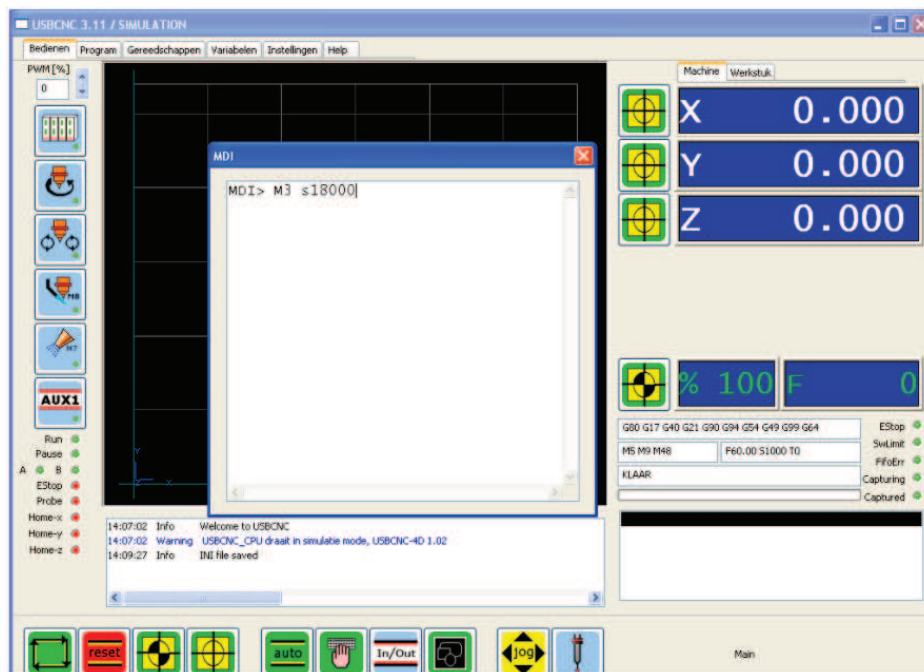
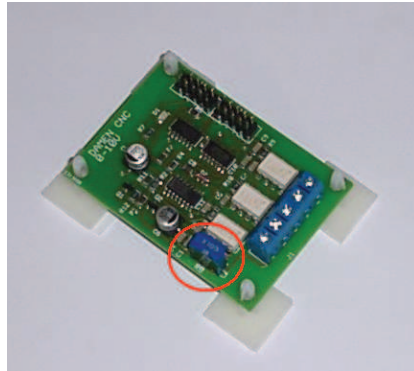
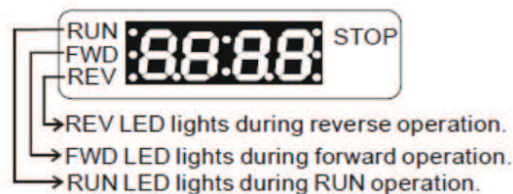


Figure 11.11: Open your MDI and type: "M3 S18000" + Enter

5. When the software is set to M3 S18000, the display on the VFD should read 300. If this is not the case please adjust the trim-potential meter (the blue component with the bronze screw on your 0-10V Spindle speed control PCB) such that the value 300 is acquired.



6. On the VFD-Display the RUN LED should be lit, and also the FWD LED
7. If you use a 24000RPM Teknomotor, the display of the Delta VFD should read 300 when you input "M3 S24000" + Enter in the MDI.



8. Now input M4 S18000 in the MDI (F12; F6)
9. On the VFD-Display the RUN LED should be lit, and also the REV LED
10. With the M5 command the spindle is turned off

If all of the above checks are correct you can continue to the next step: Testing with a TeknoMotor.

### 3. Testing with a Teknomotor

First remove the clamping nut from the Teknomotor spindle.

Afterwards open the MDI (F12; F6), and prompt the following sentence: M3 S4000.

Verify that the spindle rotates in the anti clockwise direction (if seen from the front of the spindle) as can be seen in figure 11.3:



Figure 11.12: The arrow indicates the correct forward rotating direction

In the case that the Teknomotor rotates the reverse direction, unplug the 220V / 380V plug.

After a few minutes you can unscrew the plastic Delta VFD protection plate and switch the motor cable **U** with the motor cable **W**. Be sure to leave terminal **V** intact.

This operation will reverse the Teknomotor's direction of rotation. Mount the plastic Delta VFD protection plate again and plug in your 220V / 380V plug, and try again. The system should now rotate in the correct direction.

**Note:**

Always make sure the Emergency Stop of the machine is working properly and run the machine with limit and home switches active.

Even a 1,6 kW motor can cause serious hazard to operators and spectators.