

1 Appendix E: Connecting a Delta VFD and Teknomotor

This documentation of a Delta Variable Frequency Drive (VFD) for use in combination with a Teknomotor is shown in this appendix. The Delta VFD is a device which can control the angular velocity of an electro spindle such as a Teknomotor. The Delta VFD can perform either stand-alone or controlled using USBCNC. Teknomotors are known for their high reliability, performance and low maintenance.

At the time of writing this appendix there are three popular Delta VFD types: VFD-E, VFD-EL, VFD-S (USA), and VFD C200 for high frequencies. Therefore small deviations in figures might be present, but the connection procedure is the same. The setup procedure of the Delta VFD and a Teknomotor is as follows:

- Connect a 230VAC / 400VAC euro cable
- Connect a brake resistor
- Program the VFD
- Remove power and wait several minutes
- Connect the Teknomotor



120VAC -> 3x 230VAC
Max 400Hz (USA)



230VAC -> 3x 230VAC
Max 600Hz



400VAC -> 400VAC
Max 600Hz



230VAC/400VAC
For high speed (2000Hz)

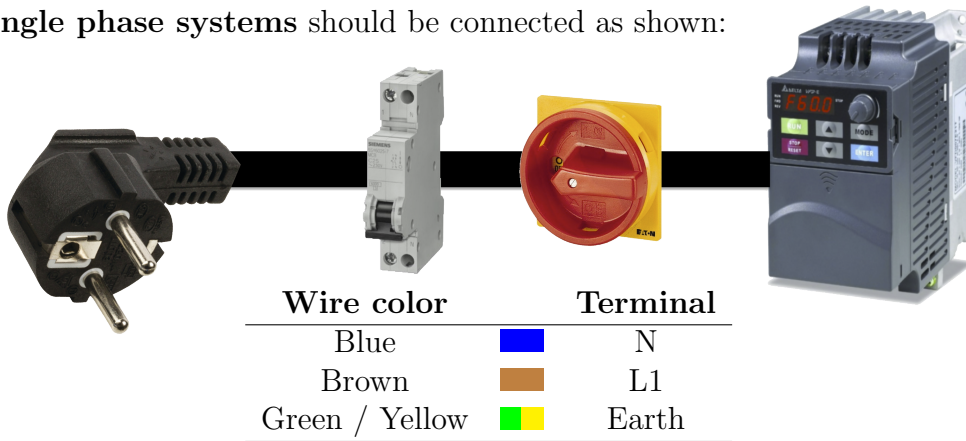
In this appendix you can find how to control your VFD and Teknomotor. This can be done by either using a potentiometer, or using the USBCNC interface with IMC-6A. It is advised to first setup your system using a potentiometer, afterwards proceed to the USBCNC settings section 15.2 of Industrial Motion Controller IMC-6A Manual.

Because the High Speed Delta VFD C200 has different settings, a separate section has been added for the C200 which can also be found in the Industrial Motion Controller IMC-6A Manual.

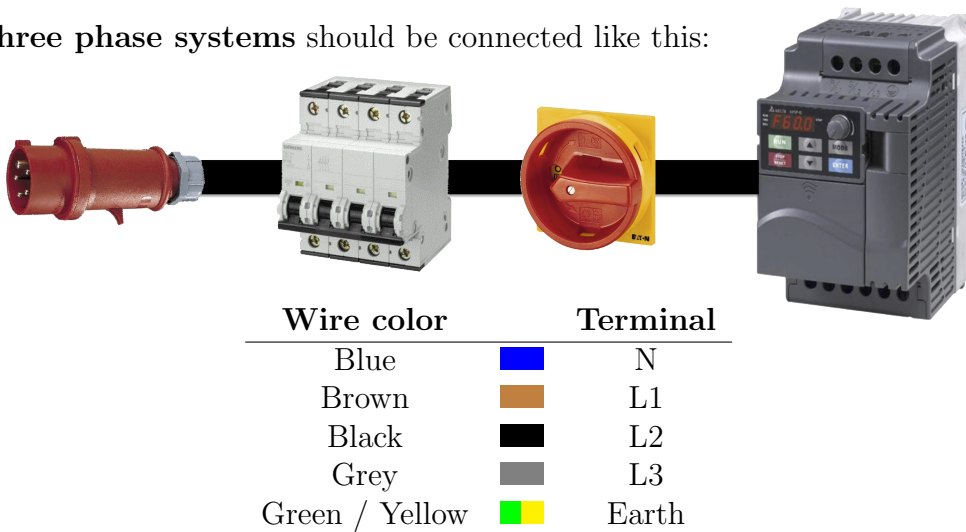
Connect a 230VAC / 400VAC euro cable

It is essential that the used 230VAC / 400VAC plug is grounded, you use a Circuit Breaker and that a Main Switch is implemented. Remove the Delta VFD plastic protection plate on the lower side of the VFD. Review the wiring diagram shown on the lid of the VFD and connect accordingly.

Single phase systems should be connected as shown:



Three phase systems should be connected like this:



Danger:



Always be careful with a VFD, since a VFD contains multiple capacitors! After unplugging the VFD device be sure to wait several minutes to ensure the VFD is fully discharged!

Circuit Breakers and Cable thicknesses

It is of high importance that the Circuit Breaker and the cables you are using have the correct current rating for your application.

For your convenience DamenCNC recommends the following Circuit Breaker ratings and minimum cable thicknesses for use with TeknoMotor tools:

VFD Series	Power [kW]	Phases and Voltage	Cable thickness Breaker - VFD	Cable thickness VFD - Teknomotor	Breaker and type
VFD 004	0.4	1 - 230VAC	0.75 mm ²	0.75 mm ²	2A - type C
VFD 007	0.7	1 - 230VAC	0.75 mm ²	0.75 mm ²	4A - type C
VFD 015	1.5	1 - 230VAC	0.75 mm ²	0.75 mm ²	6A - type C
VFD 022	2.2	1 - 230VAC	0.75 mm ²	0.75 mm ²	10A - type C
VFD 007	0.7	3 - 400VAC	0.75 mm ²	0.75 mm ²	2A - type C
VFD 015	1.5	3 - 400VAC	0.75 mm ²	0.75 mm ²	4A - type C
VFD 022	2.2	3 - 400VAC	0.75 mm ²	0.75 mm ²	5A - type C
VFD 037	3.7	3 - 400VAC	1.5 mm ²	1.5 mm ²	10A - type C
VFD 055	5.5	3 - 400VAC	1.5 mm ²	1.5 mm ²	13A - type C
VFD 075	7.5	3 - 400VAC	2.5 mm ²	2.5 mm ²	16A - type C
VFD 110	11.0	3 - 400VAC	4 mm ²	4 mm ²	25A - type C
VFD 150	15.0	3 - 400VAC	6 mm ²	6 mm ²	35A - type C
VFD 185	18.5	3 - 400VAC	10 mm ²	10 mm ²	40A - type C
VFD 220	22.0	3 - 400VAC	10 mm ²	10 mm ²	50A - type C

The assumptions that are made within this table are:

1. Your High Speed Motor such as a TeknoMotors can withstand a 25 % overload. Beware that a VFD could provide a 300% overload, but high speed milling motors will not survive such inputs.
2. This information is intended for TeknoMotor use. If you want to use a different application, these values could potentially be wrong!
3. Your power cables are shorter than 25 meters. If you wish to use a longer power cable, select a thicker cable thickness to compensate.

Danger:



This information serves as a recommendation only.
DamenCNC can not be held not responsible for your installation specifications and potential damage.

Connect a brake resistor

A brake resistor is a device which allows the Delta VFD to dump rotational energy during deceleration of the spindle. This is necessary when quick variations in angular velocity are required such as an emergency stop. If you do not mount this brake resistor and your Delta VFD reports an over-voltage error message during operation. If you have this then 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 and down time is sufficient) you do not need a brake resistor.

Electrospindles which can rotate at 24.000RPM will always require a brake resistor. DamenCNC offers two different of brake resistors:

Brake type	Power Supply	Braking Power	Resistance	Part nr.
ERF J101	230VAC	150W	100 Ω	767
ERF J401	400VAC	150W	400 Ω	768

Connect fork terminals to the brake resistor wires and connect these to terminal B2 and terminal +2/B1:

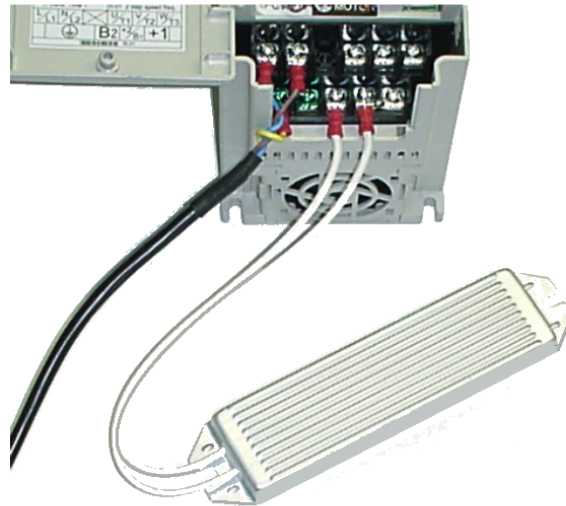


Figure 1: Connect the brake resistor on terminal B2 and terminal +2/B1

If you wish to decelerate e.g. a **Lathe** quickly, you require a larger resistor as a rotating chuck has too much rotational energy.

DamenCNC offers two types of Delta high power brake Resistors, which can **only be used with Delta VFD-E and VFD-C200**:

Brake type	Power Supply	Braking Power	Resistance	Part nr.
BR 500W	400VAC	500W	100 Ω	2260
BR 1000W	400VAC	1000W	75 Ω	2275

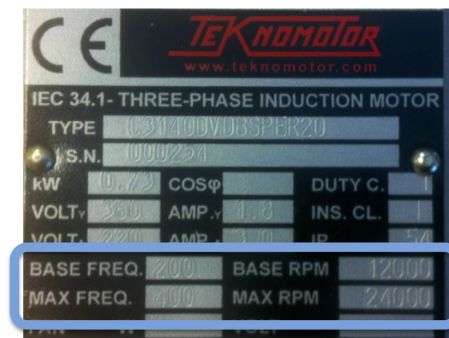
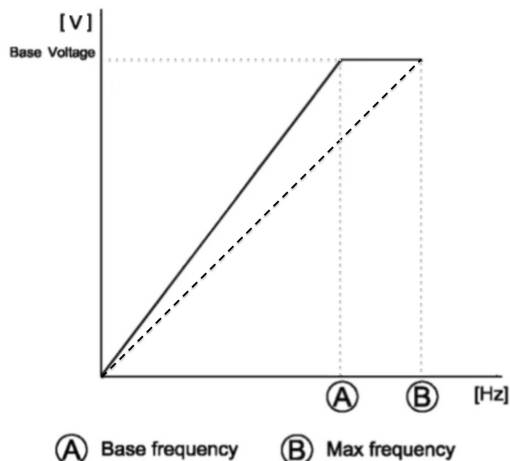
High power brake resistors are also connected to terminals B2 and +2/B1.

Teknomotor Base and Maximum Frequency difference

Teknomotors can be used at their maximum performance if you set the Base and Maximum frequency parameters correctly in your VFD parameters.

The base frequency is the frequency at which the maximum voltage is first reached. The maximum frequency is the maximum frequency at which this maximum voltage is applied.

When the Base frequency is correctly set your TeknoMotor has torque at lower RPM (solid line) compared to a TeknoMotor - VFD combination which does not distinguish between Base and Maximum frequency (dashed line):



1.1 Program Delta VFD for potentiometer control

The Delta VFD factory parameters need to be changed in order to control a Teknomotor. In the table on the next page you can find the parameters which need adjustments; afterwards we explain how you can change each parameter.

300Hz vs 400Hz

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

Power supply

You should always use the Delta VFD in an environment where your 230VAC socket is **NOT** attached to a group which supplies power to any important electrical (data) devices; the line filters in a VFD might trigger your RCD (Dutch: aardlekschakelaar)! In addition, **NEVER use the 230VAC socket from your RTR set!** Instead, use a separate wall socket.

Set parameters for Potentiometer control

Delta VFD's have many settings which can be set using parameters. You can find a full overview within the manual of your VFD. The following parameters need to be set as a minimum requirement for controlling Teknomotors using a Delta **potentiometer**. Check your Drive manual for potential updates:

Parameter	Default	12000rpm	18000rpm	24000rpm	Functionality
2-00	1	4	4	4	Potentiometer use
2-01	0	0	0	0	Source first operation
1-00	60	200	300	400	Max frequency
1-01	60	200	300	300	Base frequency
1-09	10	3	3	3	Acceleration [s]
1-10	10	3	3	3	Deceleration [s]

Table 1: Parameters for Delta VFD-E, EL, S, M. **Not for C200**

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 230VAC / 400VAC plug in a socket which is NOT attached to a group which supplies power to any important electrical (data) devices or your RTR set; the capacitors in a VFD might trigger your RCD (Dutch: aardlekschakelaar)!
2. Press **Enter** button
3. Using the **Up and Down** buttons browse and select 2
4. Press **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 **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 the **Enter** button
9. The display should display END, which indicates that this parameter is programmed.

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

Remove power and wait several minutes

The Delta VFD capacitors are still charged when you disconnect the 230VAC / 400VAC euro cable. Be patient and wait several minutes until the Delta VFD is discharged. Serious injury and damage to your components can occur!

Connecting the Teknomotor

The Teknomotor can be used in either Star or Triangle configuration. Teknomotors are factory set in **Star** configuration for 400VAC use. If you are using a 230VAC power supply it is required to adjust the small metal connection plates such that a **Triangle** connection is established:

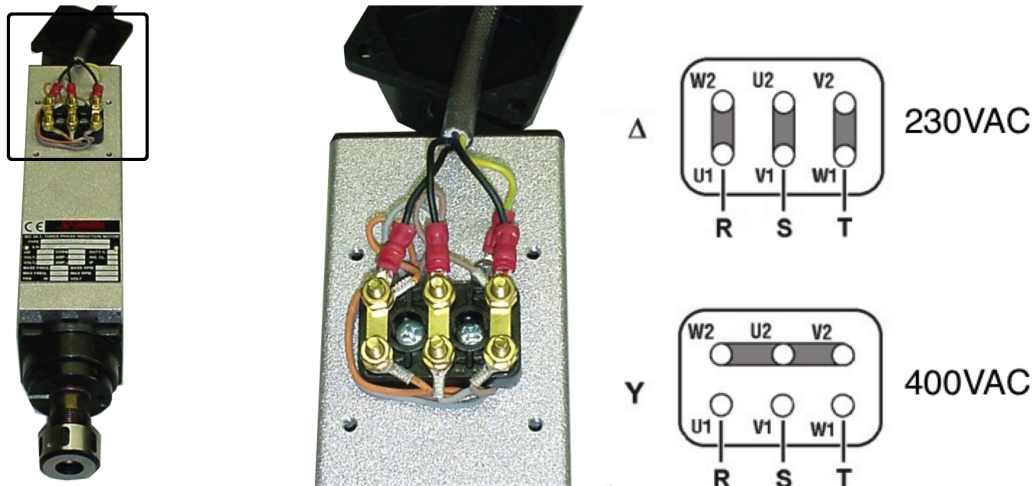


Figure 2: If you use a Delta VFD using 230VAC, mount the small gold metal connection plates as shown in order to configure the Teknomotor in triangle configuration

Wiring loom

Prepare your 4-pole cable by cutting the (use shielded 4x 0.75mm² for up to 2kW spindles, and shielded 4x 1.5mm² for up to 4kW spindles) 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 Teknomotor black topcover. Once the cables are through the cable gland, apply through-hole round cable terminals to the four inner cables on both sides. Now mount the cables as shown in the figures:

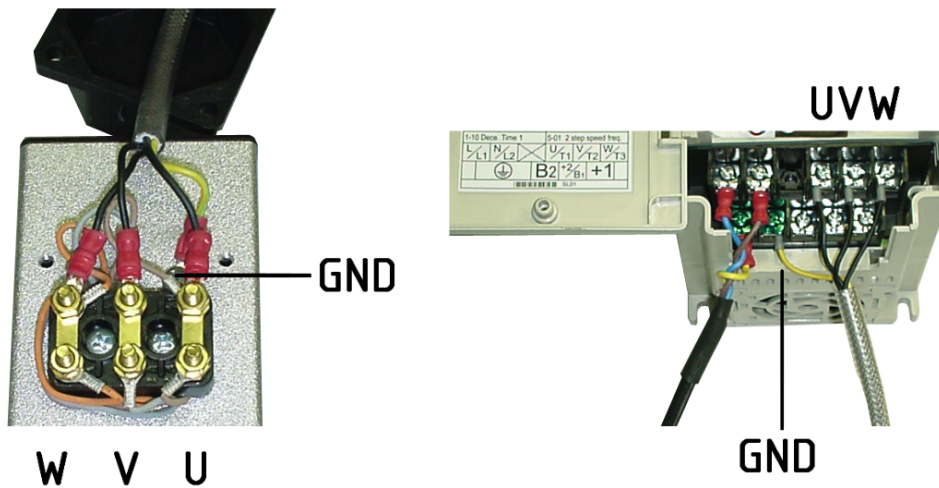


Figure 3: Wiring diagram on the Teknomotor (left) and Delta VFD (right)

Wire number	Motor connection
1	U
2	V
3	W
Earth	Ground (casing)

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.

Testing procedure

Now the assembly is ready for testing, use this 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, as the Teknomotor may by design only rotate in the Clockwise direction:



Figure 4: Correct rotation direction of Teknomotors

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

This modification will reverse the motor rotation.

FAQ

Q: 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 the table shown below. Be sure to test one of these remedies at a time, as one of these settings might prove to be a solution.

Parameter	Default	DamenCNC setting	Functionality
6-00	1	0	Over Voltage Protection
7-02	1	0	Torque Compensation

Q: The Delta VFD returns an over voltage error during operation.

A: This error can be solved by installing a brake resistor. Please read section B2 "connect a brake resistor" on how to do this.

Q: Q 3: The Delta VFD does not respond to the keypad.

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.

A: Parameter 2-00 is incorrectly set. Try changing this parameter to D3 and try again.