Triple BEAST

Bene's Advanced Stepper Drive

3-Axis High Performance Stepper Motor Driver with Breakout Board

Installation Manual

Product Brief

The „Triple BEAST" is a full featured stepper motor controller. It not only includes motor drivers for three axes but also all interface electronics neccessary to control a small milling machine or lathe. Only an additional power supply is required and wiring and assembly work as well as space requirements are reduced to a minimum.

The Triple BEAST combines the advantages of the full size, single axis BEAST stepper drives, for example full protection and smooth rotation with true sine wave commutation, with low cost and small size of an integrated solution. Only maximum current and supply voltage are limited to 5A and 55V. If a fourth axis aor one bigger motor is required, theres a socket to connect an additional driver.

The new version has a special thermal design with low-loss MOSFETs to further reduce heating.

1 Safety Instructions

The installation of the Triple BEAST has to be carried out by qualified personel, only. Please read this manual thoroughly and carefuly obey all instructions. Failure to do so can result in damage to mechanics, electronics or in personal injury.

Depending on the level of risk of the machine it may be required to install additional protection devices like door locks or safe halt guards. All safety circuits must be implemented purely electromechanical or with certified electronic parts that are not included in the Triple BEAST. Relying on software or not certified electronic devices for critical safety functions is strongly disencouraged. The machine manufacturer who carries out the final assembly and the operator of the machine is responsible to meet all applicable safety standards and laws.

Caution! Use an isolated power supply, only. Be sure to operate the TripleBeast within the maximum ratings given in the technical data section. Make a protective ground connection to the machine frame and electrical cabinet. The connection to the mains line requires special knowledge of the obligatory safety precautions. If you don't have the required qualification please let a professional electrician do this job for you. For the first test run, remove the motor couplings or drive belts to avoid damage or injury due to unexpected movements.

2 System requirements

For a complete CNC drive system you need the following components additionally to the Triple BEAST controller:

1. one to three stepper motors with two phase windings. Nominal motor current can be between 1.4 to 5A (up to 6A with restrictions). Three or five phase motors or smaller motors with high winding resistance from printers or disk drives are not suitable.
2. A power supply with DC voltage between 24 and 55V. Voltage regulation is not necessary. See chapter 3.3 for detailed requirements.
3. A source for step and direction signals. This can be a PC with CNC software and LPT port or an external signal generator like a smoothstepper, for example.

2.1 Recommended Motors

The following table shows some motors that are recommended to be used together with the Triple BEAST. The motor size should be choosen according to the requirements of the application. If you need assistance for calculating motor sizes feel free to contact Benezan Electonics.

Motor Typ	Abmessungen	Phasenstrom	Betriebsspannung	Anwendung
HS56-0818	56 x 56mm	1,8A	24..48V	pick&place machines, pen or knife plotters
HS56-1442	56 x 76mm	4,2A	24..48V	small to medium sized milling or engraving machines
HS60-2150	60 x 90mm	5,0A	48..55V	
HS86-3263	86 x 78mm	5,0A	48..55V	bigger milling machines for metal work, plasma cutters

The TripleBeast also works with many types of motors from different brands. If possible, use modern hybrid steppers with neodymium magnets that are designed for microstepping. Best results are achieved with motor sizes from NEMA23 to 24 (56 to 60mm) and phase currents from 3 to 5A. Bigger motors (NEMA 34) can also be used but with some restrictions at speed and torque. Motors with high inductance (especially NEMA34 with 4A or less) do generally not run very well at speeds above 500/min.

If you need both high speed and hih torque you might consider using a single axis BEAST or Big BEAST driver instead which allows for a higher supply voltage and higher phase currents. A BEAST driver can be used together with the TripleBeast as fourth axis.

3 Setup and Connections

3.1 Terminals overview

All terminals are numbered from top to bottom (see picture to the right).

Limit/home switch inputs (8-way terminal X3, top left)

No	Description
1	Switch or sensor power supply (+12 or +24V)
2	X axis switch or sensor input
3	Switch or sensor power supply (+12 or +24V)
4	Y axis switch or sensor input
5	Switch or sensor power supply (+12 or +24V)
6	Z axis switch or sensor input
7	Switch or sensor power supply (+12 or +24V)
8	4th axis switch or sensor input

Relay outputs

(6-way terminal X4, bottom left)

No	Description
1	230V~ L line input
2	230V~ N line input
3	Relay 1 L load output
4	Relay 1 N load output
5	Relay 2 L load output
6	Relay 2 N load output

Power Supply motors

(2-way terminal V, right side)

No	Description
1	Motorspannung Eingang (+24..+55V)
2	Masse 0V

Auxilliary signals

(6-way terminal X2, top right))

No	Description
1	Ground for holding brake
2	Holding brake output
3	Analogue ground 0V
4	Analogue output 0..10V
5	E-Stop switch input
6	E-Stop switch +12V output

Power Supply interface

(5-way terminal X1, bottom right))

No	Description
1	5V Output (max. 150mA)
2	Ground 0V
3	12V Output (max. 0.3A)
4	Ground 0V
5	24V Input (15..55V, max. 0.5A)

Motor outputs

(4-way terminal M1 to M3, right side)

No	Description
1	winding 1
2	
3	winding 2
4	

3.2 Mounting

The drive is is supposed to be mounted on a DIN rail inside a closed cabinet. It is important to protect it from chips, dust and coolant fluid. In the case of damage due to metal chips or humidity the warranty will be void.

To fix the drive on a DIN rail hold it with the motor terminals upwards, hang in the hook at the rear side of the heatsink and firmly press onto the bottom until the clip is engaged. Alternatively, you can mount the heatsink on a panel with self-tapping screws (B3.5 x 10mm). If you remove and re-assemble the rail clip, make sure not to use screws longer than 16mm. Otherwise the internal circuit boards or components could be damaged.

Depending on the motor current the driver heats up more or les during operation. For this reason you should obey the following rules:

- Leave at leas 2cm (3/4“) of free space between the Triple beast and other devices, cable ducts or cabinet walls. Allow free air circulation around the driver.
- If possible, install the heatsink with the fins aligned vertically
- For motor currents up to 3 x 4.2A natural convection cooling is usually sufficient if there is enogh space for air circulation
- If the sum of all motor currents exceeds 13A it is recommended to use forced convection cooling. A small fan as used for PC CPUs is sufficient. You can connect it to the 12V output at pins 2+3 of terminal X1 (300mA max.).

Overheating does not destroy the TripleBeast because there's a thermal protection that shuts down the power stage. However, it is recommended not to operate the device near the maximum temperature for too long because it could shorten the lifetime.

3.3 Power Supply

The supply voltage can be anything between 24 and 55V DC. For most applications, a switch mode supply with 48V is perfectly suited because they are relatively cheap, small and lightweight. Furthermore they are short circuit proof and inrush current limiter and EMI filter is already included. However, it is not absolutely necessary to use a regulated supply. A conventional transformer, rectifier and electrolytic capacitor would also do. In this case, please plan for some headroom as voltage can rise or fall by 10% or more due to load and line fluctuations. Make also sure to install proper fuses, inrush limiter and filters if necessary.

The theoretical maximum current draw from the supply is 2/3 times the sum of all motor currents. The actual average current consumption is much lower in most of the cases. For example, to operate three motors of 4A each a supply capable of sourcing 8A peak and 5A average current is sufficient. If the load inertia is much higher than that of the motors it is recomended to connect a bypass capacitor of at least 4700µF in parallel to the DC supply to buffer returned braking energy (back EMF) caused by rapid decelleration

Connect the positive output of the power supply to the terminal V.1 marked „+24..55V“ at the right side (see picture above). Connect the negative output to V.2 marked „GND“. **Caution, reverse polarity can damage the driver**, especially if the supply is not fused or current limited properly. **Do not connect or disconnect the supply while it is powered. Do not switch the DC side of the supply**, this causes excessive arcing. Always switch the primary (AC) side of the power supply. Please also note that the negative supply is always connected to the case and the heatsink.

In most cases the motor supply can also be used to power the PC interface board. Connect the positive line to terminal X1.5 and the negative to X1.4. If you use inductive proximity switches that require 24V supply, however, you have to use a separate 24V supply, here. Please read the chapter „Limit switches“ below.

3.4 Motor connection

If you bought motors and cables from Benezan Electronics wiring is fast and easy. Simply connect the four wires marked „1“ to „4“ to the motor terminal M1 to M3. Push the spade of the grey ground wire on the metal pin next to the terminal. On the other side of the cable, connect the XLR connector to the motor, done.

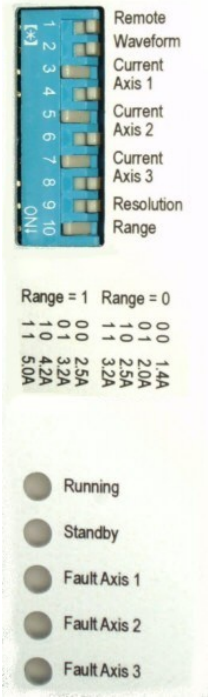
To connect motors of other manufacturers you have to check the data sheet. If the motor has four wires you can also use a multimeter (continuity tester) to identify the windings. The motor has two windings which are isolated from each other. Connect one winding to terminals 1 and 2, the other to terminals 3 and 4. Polarity doesn't matter and only affects the direction of rotation. For motors with 6 or 8 wires it's a bit more difficult. You

can connect a 6 wire motor half or full winding, an 8 wire motor in series or parallel connection. With series or parallel connection polarity of the windings matter. But the TripleBeast will not be damaged by a false winding connection. In the case of a misconnection the fault LED of the axis will light up.

3.5 Configuration and Status Display

On the left side the TripleBeast has so called „piano switches“ to set operating mode and phase current of the motors. The switch is open (0=OFF) in the neutral position (right in the picture) and closed (1=ON) when pressed down (left in the picture).

No.	Beschreibung
1	0 = standard, 1 = remote configuration (not supported)
2	Waveform: 0 = pure sine, 1 = sine wave with overtone
3	Phase current selection for axis #1 (X) (see table below)
4	
5	Phase current selection for axis #2 (Y) (see table below)
6	
7	Phase current selection for axis #3 (Z) (see table below)
8	
9	Microstep resolution: 0 = 1/10 (2000/rev) 1 = 1/5 (1000/rev)
10	Motor phase current, coarse range selection: 0 = 1.4..3.2A, 1 = 2.5..5A



Switch no. 10 is used to coarsly select the motor phase current range for all axes. This means that the minimum and maximum current can't be used at the same time. All motors must be either between 1.4 and 3.2 or between 2.5 and 5A. The fine adjustment can be selected with switches no. 3 to 8 seperately for each motor.

Switch no. 2 selects the current waveform. Some motors have a slightly distorted waveform instead a pure sine wave. Closing the switch adds a small overtone component to the current which reduces vibrations for those motors. It's hard to tell which setting is optimum for a given motor. The easiest way to find out is by trying out.

You can choose between two different microstep resolutions with switch no. 9. OFF means 1/10 microstep or 2000 steps per rovolution for a standard motor. ON means 1/5 microstep or 1000 steps per revolution.

Bereich ■□ = 1		Bereich □■ = 0	
□■ □■	2,5A	□■ □■	1,4A
□■ ■□	3,2A	□■ ■□	2,0A
■□ □■	4,2A	■□ □■	2,5A
■□ ■□	5,0A	■□ ■□	3,2A

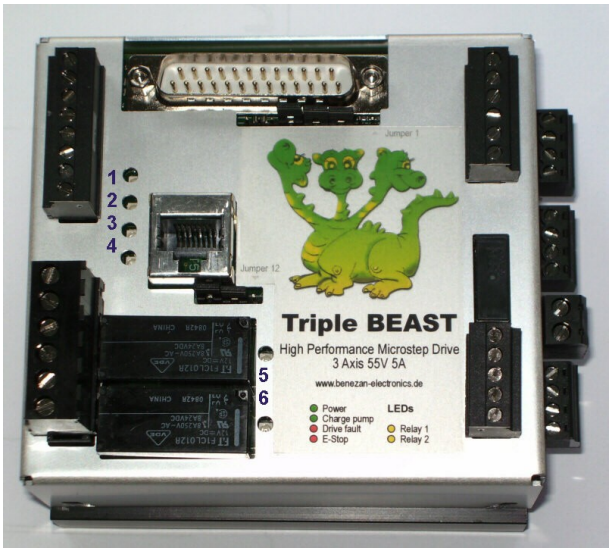
Stepper motor drivers from other manufacturers often have a bewildering number of resolution settings. Their idea is to select the highest possible resolution that doesn't require step rates above the frequency limit of the controller. In most cases, high resolution is not really necessary for accuracy but helps keeping noise and vibrations low. With the Triple Beast things are completely different. Even at the lowest resolution of 1/5 microstep there are no noise or viration of distinct steps at all. The drive always outputs a smooth sine wave instead of a staircase function. For most applications 1/10 microstep resolution is the optimum and allows speeds up to 1350rpm at 45kHz pulse frequency. Higher resolutions would result in no better accuracy because of the step tolerance of the motor (usually 5% of one full step). The 1/5 microstep setting is for controller software which is limited to around 20kHz pulse frequency.

Status Display

The status of the drive is displayed by five LEDs on the left side (see picture above). The meaning of combinations of different colors is listed in the following table:

LEDs	Beschriftung	Beschreibung
● (green)	Running	Motors running at full current
● (yellow)	Standby	Motors standing still at reduced current
● (red blinking)	Fault Axis ..	A single LED blinking indicates a short circuit, overload or false wiring at the corresponding motor. The remaining motors are still active as shown by the yellow or green LED.
●●● (red blinking)	Fault Axis ..	If all red LEDs are blinking simultanously the power stage is overheated and all motors are deenergized.
●●●● (yellow red alternately)	Fault Axis ..	If all red and yellow LEDs are blinking alternatively the power stage has been switched off due to overvoltage. The cause could be either the supply or too much back EMF at decelleration.

The LEDs on the top face diplay the status of the PC interface board.



LEDs	Beschriftung	Beschreibung
● 1 (green)	Power	Power supply ok
● 2 (green)	Charge Pump	Watchdog (charge pump) aktive
● 3 (red)	Drive Fault	Fault at one or more power stages
● 4 (red)	E-Stop	Emergency stop switch open or disconnected
● 5 (yellow)	Relay 1	Relay 1 on (spindle motor)
● 6 (yellow)	Relay 2	Relay 2 on (coolant or vacuum)

3.6 PC-Anschluss

For the connection of the breakout board to the PC or controller please use a parallel printer cable with 25 pin SUBD connectors (male/female). Each pin should be connected one by one, especially the ground pins (#18 to 25). The maximum recommended length is 3m.

The pion assignment is compatible to Mach3, EMC or WinPCNC. If you use different controller software it might be necessary to use an adaptor or patch box to change the pin assignment. Please note that Benezan Electronics is not able to know and support any software available. We only guarantee full functionality with Mach3.

The pinout is shown in the following table:

Nr.	Beschreibung
1	Relay #1 (spindle) or PWM
2	Direction X
3	Step pulse X
4	Direction Y
5	Step pulse Y
6	Direction Z
7	Step pulse Z
8	Direction 4th axis
9	Step pulse 4th axis
10	Home or limit switch Z
11	Emergency stop
12	Home or limit switch Y
13	Home or limit switch X

Nr.	Beschreibung
14	Relay #2 (coolant)
15	Home or limit switch 4th axis
16	Charge pump or current hi/low
17	PWM or current hi/low
18	Signal ground
19	
20	
21	
22	
23	
24	
25	

Some pins have more than one possible assignment to support different software or different machine configurations. The selection is made with the jumpers next to the SUBD-connector. The header pins for the jumpers are numbered from 1 on the right side to 11 on the left. A jumper always connects to neighbouring pins.

(2-1) A Jumper on pins 1 and 2 disables the watchdog, this means all functions are always enabled when the pins are connected, as if the charge pump signal was always present. This is required for software that does not support a charge pump or toggle signal. The drawback is that undefined or random states of the port pins during booting can accidentally cause unwanted switching of the relays or movement of the axes which could be dangerous. If the pins 1-2 are open the watchdog is active and prevents unwanted movements and switching.

(9..3) These pins are used for the configuration of the PWM, current reduction and relay signals. Choose one of the following configuration:

- 8-7, 6-5, 4-3: Relay #1 on if PWM>10%, current reduction at pin 17, PWM at pin 1, watchdog at pin 16
- 9-8, 7-6, 5-4: Relay #1 at pin 1, PWM at pin 17, current reduction at pin 16, no watchdog (jumper 1-2 has to be closed)
- 7-6, 5-4: Relay #1 at pin 1, PWM at pin 17, no current reduction, watchdog at pin 16
- 8-7, 5-4: Relay #1 at pin 1, no PWM, current reduction at pin 17, watchdog at pin 16
- 2-9 (jumper wire), 4-5, 6-7: special configuration for USB-CNC V5A, also see page 11

(16..12) Theese jumpers are used to select the supply voltage for the home or limit switches and to enable/disable the 4th axis (see below)

3.7 Home or limit switches

Up to 4 inputs for home or limit switches are supported. If a switch for the 4th axis is not needed you can alternatively use this input for a tool length measurement switch.

It is possible to use mechanical switches or electronic proximity sensors. For mechanical switches, both NC or NO types can be used. You can invert the signal in the software if necessary. The jumper for the switch supply should be set to 13-14 and the supply voltage of the board can be any DC voltage from 15 to 80V. Connect each switch to terminals 1 and 2, 3 and 4, 5 and 6 or 7 and 8.

If you use electronic sensors make sure to set jumper 12-13 for 24V sensor supply. As the board doesn't have a separate 24V voltage regulator it is required to use a 24V supply for the board. The motor supply can't be used in this case if it's higher than 24V. Sensors should be connected as follows: positive supply (brown wire) to terminal 1, 3, 5, or 7, negative supply (blue wire) to ground (at the 24V power supply), sensor signal (black wire) to terminal 2, 4, 6, or 8.

All inputs have an RC low pass filter and are protected against electromagnetic interference and voltage spikes up to 80V. Normally, shielded cables are not necessary for the switch inputs as long as EMC guidelines for motor cables and other high power devices (VFDs) are followed.

3.8 Auxilliary functions

At terminal X2 you can connect an emergency stop button and optionally a holding brake for a vertical axis and the nominal speed input of a variable frequency drive (VFD).

Emergency stop

The breakout board offers the following features to stop movement or program execution in the case of emergeny or hardware problems:

1. At the terminals X2.5 and X2.6 an emergency stop switch („mushrom button“) has to be connected. If the circuit is open relays #1 and #2 are forced off. The E-stop condition is signaled with LED #4 (red, see picture on page 6) and pin 11 of the LPT port goes low so that the software can stop program execution.
2. If one or more of the power stages (axes 1 to 3) or an external drive (4th axis if present) signals a fault condition, LED #3 („drive fault“, red) lights up and pin 11 of the LPT port also goes low. You can look at the status leds for each axis on the left side to see which axis caused the fault.
3. In the case of an emergency stop or drive fault the relay for the holding brake opens so that the brake (if present) engages.
4. If the watchdog is active (jumper 1-2 open) relay outputs and step pulse signals are only enabled if there's a valid charge pump (toggle) signal.

Please be aware that depending on the risk of injury it may necessary to install additional security devices. For example, it might be necessary to cut power to the motor drivers with a second E-stop circuit.

Analogue output (VFD speed signal)

Th TripleBeast has an analogue 0..10V output to control the speed of a VFD (variable frequency drive). The output signal is proportional to the duty cycle of the PWM (pulse width modulation) input signal at pin 1 or 17 of the LPT port. 0% duty results in 0V output, 20% in 2V and so on until 100% for 10V output.

The base frequency of the PWM signal should be 45Hz or higher. This allows a resolution of 10 bits at 45kHz kernel speed with Mach3, for example. If all of the features 4th axis, PWM, relays and current reduction have to be used at the same time it's likely to run out of pins at the LPT port. For this reason it is possible to use the same pin for PWM and relay #1. If jumper 3-4 is closed relay #1 switches on whenever the PWM signal has 10% duty or more. Therefore the minimum pulse width should be set to 10% for this case.

Brake for vertical axis

When low friction ball screws are used together with heavy weight or high pitch at vertical axes it may be required to use an electromechanical holding brake to avoid uncontrolled descending when power is off. Especially servo motors have nearly no detent torque and are sensitive to this phenomenon. For this reason, motors are available with brakes that are normally closed and open if 24V power is applied.

The TripleBeast has a relay output for such holding brakes. The output is active (brake open) whenever the TripleBeast is powered and there is no e-stop or drive fault condition. The output has a free wheeling diode and can be used to directly switch inductive loads up to 5A. The relay is directly connected to the supply voltage of

the breakout board. This means, you have to use a 24V supply if you have a 24V brake. If the brake is pneumatic, hydraulic or has a higher violtage you have to use an external relay or solenoid.

4th Axis Extension

A driver for a 4th axis can be connected to the RJ45 socket at the top. If you use a BEAST stepper driver or UHU servo drive from Benezan Electgronics you can simply use a standard network patch cable. Of course you can also use drivers from other manufacturers. For this case the following pinout applies:

No.	Beschreibung
1	current reduction
2	signal ground
3	step pulse
4	+5V
5	direction
6	+5V
7	status (0=ok, 1=error)
8	signal ground

If the driver has no status output pin 7 and 8 have to be connected or jumper no. 15-16 must be closed. If you use a BEAST or UHU drive please leave jumper 15-16 open.

4 Commissioning and troubleshooting

If you set the controller into operation for the first time please check the following items before.

- Are all terminals properly aligned in their sockets
- Is the supply conected to terminal X1 with the correct polarity?
- If the supply voltage is more than 28V you have to select 12V as supply for the limit switches (jumper 13-14 closed, 12 open)
- Is the emergency stop switch connected? A jumper wire is only allowed for testing purposes if (and only if) there's no risk of injury.
- Please double check if all jumpoer settings match the pinout of the controller software.

If theese conditions are met you can connect the TripleBeast to the PC, switch on the power supply and start up the controller software. After startup the state of the LED lights should be as follows (some software requires clicking the reset button):

- Both green LEDs (power and charge pump) have to be lit,
- both red LEDs (drive fault and E-stop) must be off,
- the yellow LEDs (relay 1 and 2) must be off.

If this is not the case please read the chapter „troubleshooting“ below. If everything is OK you can proceed with testing the motors, relays and switches.

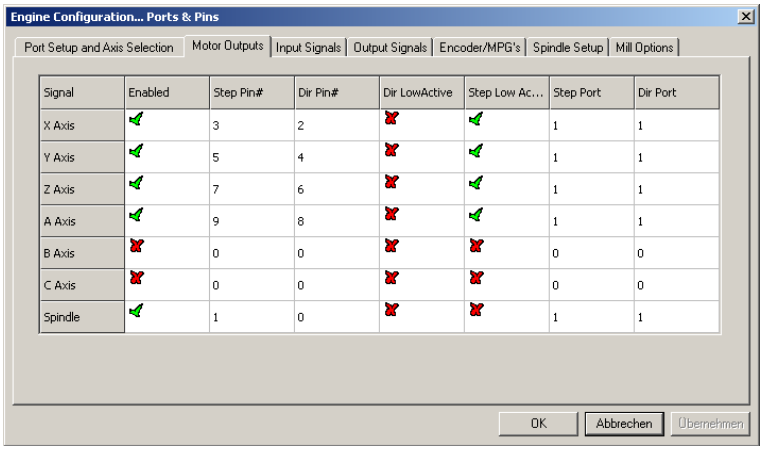
Troubleshooting

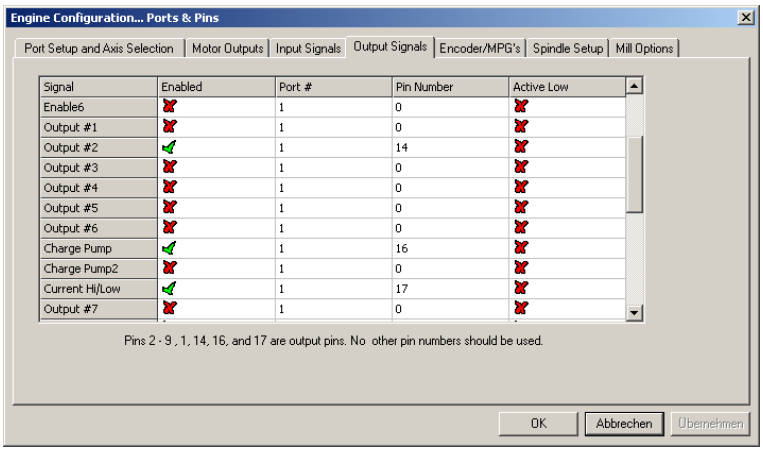
The following table lists the most comon errors and possible causes.

No.	Symptom	Ursache
1	LED „Power“ (green) not lit	Power supply not connected or polarity wrong, check terminal X1 and V)
2	LED „Charge Pump“ (green) not lit	There must be a square wave signal of at least 5kHz at pin 16 of the LPT port. If your controller software doesn't support this, close jumper no. 1-2
3	LED „Drive Fault“ (red, on top) is on, LEDs „Fault Axis 1-3“ (red at the left side) is off	without 4th axis: jumper 15-16 is missing with 4th axis: driver not (properly) connected or not powered
4	LED „Drive Fault“ (red, on top) is on, LEDs „Fault Axis 1-3“ (red at the left side) blinking	One or more motor drivers have a fault condition (overheated or shorted, see page 6)
5	LED „E-Stop“ (red) is on, LED „Standby“ (yellow) blinking	E-stop switch not connected or activated (X2 pin 5-6 open)
6	Relays don't work	a) yellow LEDs on but relays not: see case no. 5 b) yellow LEDs off: jumpers or software configured incorrectly
7	Motors don't turn	a) green LED „ChargePump“ off: see case no. 2 b) step and direction signals swapped? (LPT pins 2,4,6,8 = dir, pins 3,5,7,9 = step)
8	VFD drive speed fluctuations	PWM base frequency too low (minimum 45Hz)
9	E-stop signal doesn't work (LPT pin 11)	pin 11 must be set as „active low“, LEDs „Drive Fault“ (see case 3) and „E-Stop“ (see case 4) must be inactive.
10	Motors move one step when E-stop switches	polarity of step signal wrong (toggle „active low“)

5 Software configuration

Mach3 config example





In the pictures on the left you can see the input and output assignments for the standard jumper setting (pins 3-4, 5-6 and 7-8 closed). Additional settings:

- XHome pin 13
- YHome pin 12
- ZHome pin 10
- AHome or probe switch pin 15
- RelayControl:
  M3 and M4 → Output#1
  M7 and M8 → Output#2
- Motor Control:
  √ Use Spindle Motor Output
  √ PWM Control
  PWM Base Freq. = 45
  Minimum PWM = 10%

In Mach3 the pins for step and dir outputs can be swapped arbitrarily. Therefore you can also assign the output for the 4th axis to the logical X, Y or Z axis. This is useful if you need a bigger motor (and an external, bigger driver) for one of those axes.

Configuration for USB-CNC

The Triple Beast can also be cennected directly to the USB-CNC controller V5A. For the watchdog to work properly the jumper „WDCF“ on the USB-CNC board has to be set like this: upper jumper to the right, lower jumper to the right. The jumper „Volt-PWM“ must also be set to the right.

At the TripleBeast, jumper pin no. 9 must be connected to pin no. 2 with a jumper wire. Jumpers 4-5 and 6-7 have to be closed, pins 1,3 and 8 have to be open. The remaining jumpers 12-16 can be set depending on the applicationn as described on page 8..9.

Other Control Software

The TripleBeast also works well with NCdrive, EMC², WinPCNC and other CNC software. It would be out of the scope of this manual to cover any possible configuration. If you have questions abaout the setup of your software or compatibility issues please contact your dealer or Benezan Electronics.

6 Specifications

6.1 Absolute Maximum Ratings

The following operating parameters have to be kept within their limits or otherwise irreversible damage could occur:

Parameter	min.	max.	Unit
Supply voltage	-0,5	+63	Vdc
Storage temperature	-40	+85	°C
ambient temperature	-20	+70	°C
Voltage at LPT port (SUBD25), any pin to ground	-0,5	+5,5	V
Voltage at switch inputs	-5	+63	V
Voltage at relay contacts (X4)		30	Vdc
		250	Vac
current per relay contact pair (X4)		8	Aeff
current at brake relay output (X2)		5	A
current at analoge output 0..10V		20	mA

6.2 Operating conditions

Parameter	min.	max.	Unit
Supply voltage	+24	55	Vdc
quiescent current consumption (no load)		80	mA
12V output max. load		300	mA
5V output ma. load		200	mA
ambient temperature (operating)	0	+50	°C
low level input (LPT port)	-0,5	+0,8	V
high level input (LPT port)	2,5	+5,5	V
current at input @0..5V (LPT port)	0	1	mA
step pulse width	2		µs
setup time direction valid to step[1]	2		µs
hold time direction valid after step	2		µs
low level output		0,8	V
high level output	3		V
step frequency	0	200	kHz
watchdog (charge pump) frequency	5	100	kHz
time delay step to current reduction	0,5	0,7	s
overtemperature threshold	70	85	°C
motor current accuracy	-10	+10	%
wire gauge supply voltage	0,5	2,5	mm²
wire gauge motor outputs	0,22	1	mm²
microsteps per full step	5	10	-
microsteps per revolution for standard motor[2]	1000	2000	-

1 step is executed at rising edge, e.g. at transition from low to high level
2 standard motor: 1,8° per full step, 200 full steps per revolution