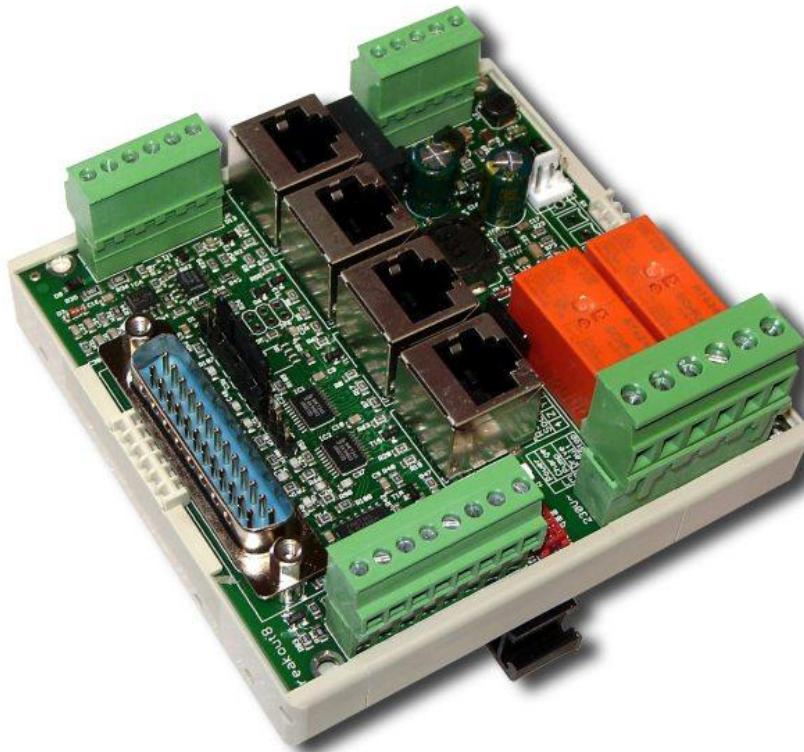


# Mini Breakout Board

Interface board for  
CNC control via LPT port

## Installation manual

Version 8



### Brief product description

The breakout board allows the operation of up to four stepper motor or servo output stages at the parallel port of a PC. For this purpose a control software like Beamicon2, Beamicon2-Basic (or e.g. *Mach3*, *CNC-FRS*, *WinPCNC*, *EMC* or similar) is required (not included). The board can be adjusted to many different configurations. Depending on the selected configuration, additional functions such as control of a frequency converter or speed controller, reference switches, up to 2 relay outputs, an output for a holding brake and a watchdog (so-called "charge pump") are available.

All signals of the PC port are buffered, so that a maximum of noise immunity is achieved. All machine-side signals are designed for 24V level, ensuring robustness and compatibility with industrial sensors. Ready-made connection cables for BEAST stepper motor power amplifiers, UHU-DC servo controllers and brushless servo systems from Sanyo-Denki are available (not included), so that quick and error-free wiring is possible.

**Attention, NEW:** Supply voltage maximum 75V! 5V- and 12V-output loadable up to 0,5A

Alternative Version "NETBOB" with Network connection available instead of LPT port (only with Beamicon2 software)



## Safety Instructions

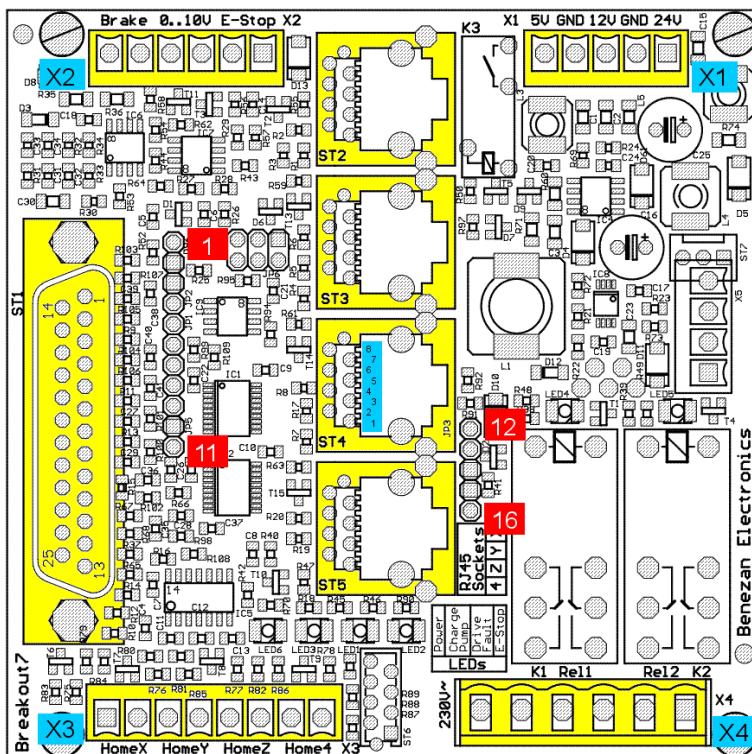
The Breakout Board may only be installed and put into operation by qualified personnel. Please read the operating instructions carefully and follow all instructions exactly. Improper installation or operation of the device can cause damage to the electronics or the machine and can result in dangers to the health of the operating personnel.



Depending on the hazard potential of the machine, additional safety measures may be required, such as door interlocks and standstill monitoring. As a rule, such safety functions must be implemented purely electromechanically with external circuits (not included in the scope of delivery) and must not depend solely on software and PC hardware. The system manufacturer, who assembles the breakout board and other components to form the overall system, and the system operator are responsible for compliance with the legal regulations.

## Connections

The connections of all terminals are numbered from left to right. The pins of the SUBD connector and the pins for the jumpers are numbered from top to bottom. *Please note:* The contacts of the RJ45 sockets are numbered from bottom (1) to top (8).



### Power supply (5-pole terminal X1, top right)

No.	Description
1	5V output (max. 0.5A)
2	Ground 0V
3	12V output (max. 0.5A)
4	Ground 0V
5	24V input (15 ... 75V, max. 1A)

**LPT port (SUBD25, left)**

No.	Description	No.	Description
1	Spindle, relay1, PWM	14	Cooling, relay 2
2	Direction X	15	Reference switch 4th axis
3	Step X	16	Watchdog, current reduction
4	Direction Y	17	PWM, current reduction
5	Step Y	18	
6	Direction Z	19	
7	Step Z	20	
8	Direction 4th axis	21	Signal ground
9	step 4th axis	22	
10	Reference switch Z	23	
11	Emergency stop	24	
12	Reference switch Y	25	
13	Reference switch X		

**Additional functions  
(6-pin terminal X2, top left)**

No.	Description
1	Ground 0V for brake
2	Holding brake Output
3	Analog output ground 0V
4	Analog output 0..10V
5	Emergency stop switch Input
6	Emergency stop switch +12V output

**Reference switch inputs (8-pin terminal X3, bottom left)**

No.	Description
1	Reference switch X voltage output (+12 or +24V)
2	Reference switch X Signal input
3	Reference switch Y Voltage output (+12 or +24V)
4	Reference switch Y Signal input
5	Reference switch Z voltage output (+12 or +24V)
6	Reference switch Z Signal input
7	Reference switch 4th axis voltage output (+12/24V)
8	Reference switch 4th axis Signal input

**Power stage outputs (4 x RJ45, center)**

Attention! Pin 1 is down, pin 8 up

No.	Description
1	Current reduction
2	Signal ground
3	Step
4	+5V
5	Direction
6	+5V
7	Status (0=ok, 1=error)
8	Signal ground

**Relay outputs**

(6-pole terminal X4, bottom right)

No.	Description
1	230V~ L Input
2	230V~ N Input
3	Relay 1 L Output
4	Relay 1 N Output
5	Relay 2 L output
6	Relay 2 N output

## Functional description

### LPT port, PC connection

The breakout board is connected to the PC with a parallel port cable (SUBD25 male/female). The cable should have all pins connected through 1:1, especially all ground pins (18..25). The recommended maximum length is 3m. Alternatively, a CNC-POD or Micropod can be plugged in directly to connect the PC via an Ethernet cable. In this case the software Beamicon2 or Beamicon2-Basic is required.

The signals of the LPT port are not electrically isolated. However, this is also not necessary when using BEAST, UHU or comparable power amplifiers with integrated optocouplers. All signals are buffered so that PCs with low supply voltage (3.3V) can also be used.

The pin assignment of the LPT port is designed for Mach3, LinuxCNC (former EMC<sup>2</sup>) or WinPCNC. The control USB-CNC V5A can also be used with an adapter cable. When using other programs (e.g. CNC-Profi) an adapter plug may be required to adapt the pin assignment (so-called patch box). Please understand that Benezan Electronics cannot support every program available on the market. The perfect function is only guaranteed together with Mach3.

An alternative version with **network connection instead of LPT interface** is available under the name **"NETBOB"**. Please note that this version is not compatible with Mach3, but can only be operated with the CNC software "Beamicon2".



### Power supply

The breakout board can be supplied with an operating voltage of 15 to 75V DC. In most cases the power supply unit can be used for the motor voltage. Only if 24V is required for external consumers (inductive proximity switches, holding brake), an extra power supply unit is necessary.

For fans, external sensors or additional circuits the board provides regulated 5V and 12V outputs (terminal X1). A 3-pole plug-in socket is provided for standard PC fans with 12V (ST7). The outputs are short-circuit proof. However, since the same voltage regulators are also used for the internal supply, malfunctions can occur in the event of a short circuit. The load capacity of the 12V output has been increased from 350mA to 500mA to eliminate problems with the current consumption of some fan types.

### Power stage signals

The outputs of the step/direction signals are equipped with RJ45 sockets so that BEAST stepper motor power amplifiers and UHU servo controllers can be connected with standard Ethernet patch cables. Please note that all sockets must be assigned for correct function. An unoccupied socket is interpreted as cable break (status signal interrupted). The 4th axis can be deactivated with jumper JP4. If one or more of the axes X, Y and Z are to remain unused, a "dummy" plug with bridged pin 7-8 must be inserted there.

### Connection of BEAST output stages

The following options are available when using BEAST power amplifiers:

1. The current reduction signal is connected to LPT pin 16 or 17 (see configuration jumper JP1)
2. The automatic current reduction of the output stages is used (activate DIP switch 3 on the BEAST)
3. No current reduction is used (jumper open, DIP3 on BEAST off)



### Connection of UHU servo controllers

It is recommended to use the UHU version from Benezan Electronics (SMD-UHU). The current reduction signal should be deactivated for this purpose, otherwise the controller will make an uncontrolled emergency stop. In addition, make sure that the error output of the UHU is jumpered to "normally closed" (see UHU installation manual chapter 5.1). If BEAST and UHUs are to be used together *and* the current reduction signal is required, the current reduction signal (RJ45 connector pin 1) must be cut in the UHUs.

## Relay outputs

The relay outputs 1 and 2 can be used to switch 230V consumers such as spindle motor, coolant pump or chip extractor. The current consumption must not exceed 8A per relay, otherwise the load must be switched with an external contactor.

Instead of 230V~, 24V consumers can also be switched, such as contactors or pneumatic valves. However, 24V and 230V must not be used together, as in this case the required insulation distances cannot be maintained. The voltage source is connected to pins 1 and 2 of X4, the loads to pins 3+4 and 5+6.

If potential-free contacts are required instead, e.g. for the digital inputs of a frequency converter, relay 1 can be used as a make contact between pin 1 and 3, relay 2 between pin 2 and 6. Here, too, it should be noted that mixed operation with 230V is not permitted because of the insulation distance.

Relay 1 (left) can be switched either via LPT pin 1 or the PWM function. Relay 2 (right) is controlled by pin 14. The switching status of both relays is indicated by one yellow LED each. The relays switch on at high signal on the LPT port. Attention, if the watchdog is deactivated, the relays may switch on uncontrolled at undefined levels.

## Reference switch inputs

Up to 4 switches or inductive sensors can be connected. If the 4th axis is not used or does not require a reference switch, a tool length sensor can be connected here, for example.

Mechanical switches or inductive proximity switches of the PNP type can be used. If proximity switches are to be used, JP3 must be set to 24V (top) and the board must be powered with 24V. The sensors should be connected as follows: brown (+24V) to terminal 1, 3, 5 or 7, blue to the ground connection of the power supply, black (signal) to terminal 2, 4, 6 or 8.

The inputs are inverting, i.e. the corresponding LPT pin is high when the switch input is open (low) and low when the switch input is closed (high). Normally closed or normally open contacts can be used if the polarity is selected accordingly in the PC software.

The switch inputs have a Schmitt trigger function and are interference suppressed with a low-pass filter, so that there is usually no need to fear interference even with unshielded cables. The inputs are overvoltage tolerant up to +80V.

Please note that the switch inputs are not suitable for fast signals (>1kHz) with 5V level, for example TTL encoder signals. However, it is possible to use an inductive or Hall sensor for spindle index (speed measurement or for thread cutting) if the sensor is operated with 12 or 24V.

## Emergency stop

The breakout board has several independent functions that are used to stop the machine in case of problems:

1. An emergency stop button (mushroom/panic button) must be connected to terminals X2.5 and X2.6. If the contact is opened, relays 1 and 2 are forcibly switched off. A push-button emergency stop is indicated by the right LED (red, LED1). Additionally an emergency stop is reported to the PC (LPT pin 11)
2. If the status output of one or more output stages reports an error or if this line is interrupted, an emergency stop signal is sent to the PC. The output stage error is indicated by the second LED from the right (red, LED2).
3. In case of an emergency stop (no matter if mushroom button or status error) the relay for the holding brake is switched off, so that the mechanical brake is blocked (if present).
4. In case of missing supply voltage, an emergency stop signal is sent to the PC, so that the software does not continue uncontrolled.
5. If the watchdog is active (see below), relay outputs and step signals are only enabled if a valid watchdog signal is detected.

## Watchdog (charge pump)

While the PC is switched off, during booting or whenever the control software (Mach3 etc.) is not started, the LPT signals are undefined. In unfavorable cases, such as when a dongle driver periodically polls the port, even recurring clock signals can be generated, which can trigger dangerous machine movements. To prevent this, the breakout board has a so-called watchdog circuit.

This circuit controls whether the control software outputs a regular signal of constant frequency (nominal 1 to 12kHz). If this signal is missing, the relay outputs and the step signals are blocked. A short interruption of the signal for a maximum of two periods (2ms), on the other hand, does not lead to a switch-off, because this could lead to creeping step losses. The status of the watchdog circuit is indicated by the second LED from the left (green, LED3). For proper operation the signal frequency should be between 1kHz and 20kHz.

If the control software does not support a watchdog signal, the function can be deactivated with jumper JP2. **Attention**, the watchdog function is not a safety function in the sense of the machinery directive. It is possible that the control software fails in such a way that the watchdog signal is still output despite the malfunction. Safety devices to protect the user from injury must therefore function independently of the watchdog.

For operation with USB-CNC, which does not support a watchdog signal but a static enable signal instead, a special adapter is required (see page 7, below).

## **Speed control (analog output)**

In order to be able to preset the speed for a frequency inverter, the breakout board has an analog output 0..10V. A voltage proportional to the duty cycle of the PWM signal (PWM = pulse width modulation) is output at pin 1 or 17 of the LPT port. Here 0% (low) corresponds to a voltage of 0V, 10% corresponds to 1V, 20% corresponds to 2V etc. up to 100% and 10V.

The frequency of the PWM signal (PWM base frequency) should be at least 45Hz so that the ripple of the analog signal is not too high. At Mach3 this allows a resolution of 10 bit at 45kHz kernel speed.

If all functions of the breakout board are needed at the same time, the number of available LPT pins becomes scarce. Therefore it is possible not to switch relay 1 via an extra pin, but always when the analog signal is higher than 1V (see configuration jumper JP1). This means that only a single, common pin is required for speed and spindle start. The minimum pulse width should be set to 10% in this case.

## **Holding brake**

When using ball screws, smooth-running servomotors or very heavy Z-axes, an electromechanical holding brake must be provided to prevent the vertical axis from moving down by itself when the drive is switched off. Such brakes are usually operated with 24V. They are blocked when no voltage is applied and open when the voltage is switched on.

The breakout board has a relay output for such a holding brake. The brake is always switched on (released) when the power supply is switched on and no emergency stop is active and no output stage reports an error (status signal).

The output has an integrated free-wheeling diode and is suitable for switching inductive loads. If the brake is to be operated pneumatically, hydraulically or with a voltage other than 24V, an external contactor or solenoid valve is required.

## **External LEDs**

Between terminals X3 and X4 there is a socket to which external status LEDs can be connected via a ribbon cable. This is useful if the breakout board is installed in a housing where the internal LEDs are not easily visible or accessible. A small circuit board with six LEDs and ribbon cable is available ready to use from Benezan Electronics.

## Configuration

The breakout board can be adapted to the different applications with jumpers. There are two fields with pin headers, one with 11 pins next to the SUBD25 connector and one with 5 pins to the right of the RJ45 sockets. The contact pins are numbered from top to bottom (see picture page 2).

No.	Description	Reference
1	Deactivation of the watchdog (open = active, plugged = deactivated)	JP2
2		
3	Analog output >1V	
4	relay 1	
5	LPT pin 1	
6	PWM signal	
7	LPT pin 17	
8	Current reduction	
9	LPT pin 16	
10		
11	Enable signal instead of current reduction	

JP1 is used to assign different signal sources (left) to the functions (signal sinks, right). For example, a bridge from stripe no. 4 to 5 means that relay 1 is switched with LPT pin 1. An erroneous multiple use of a signal source is thus automatically excluded<sup>1</sup>

No.	Description	Reference
12	Sensor supply 24V	JP3
13	Supply voltage for reference switch	
14	Sensor supply 12V	
15	Deactivation of the status signal of the 4th axis (open = 4th axis used, plugged = disabled)	JP4
16		

**Attention:** If the supply voltage (terminal X1 pin 5) is higher than 30V, jumper JP3 must **not** be set to 24V (pins 12-13).

### Recommended default settings

- Stepper motors, no speed control: 4-5, 7-8Relay 1 controlled with LPT-Pin 1, no PWM signal, current reduction Pin 17, Watchdog Pin 16
- Stepper motors and speed control: 3-4, 5-6, 7-8 (factory setting)Relay 1 via PWM>10%, PWM pin 1, current reduction pin 17, watchdog pin 16
- Servo motors and speed control: 4-5, 6-7Relay 1 at pin 1, PWM signal at pin 17, no current reduction, watchdog pin 16
- Special setting for leadshine power amplifiers: 4-5, 6-7, 10-11Relay 1 at pin 1, PWM signal pin 17, no current reduction, watchdog pin 16, enable signal

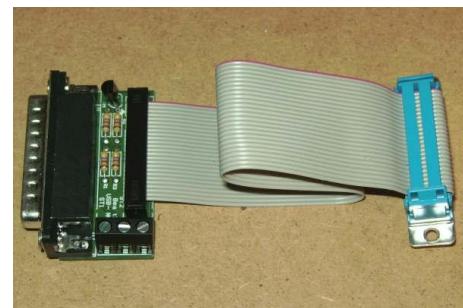
<sup>1</sup> Exception: With jumper 10-11 inserted, pin 8 must not be used at the same time

## Connection to USB-CNC

The breakout board can also be connected to the USB CNC controller V5A with an additional adapter. For a correct function of the watchdog the jumpers "WDCF" on the USB-CNC board must be plugged in as follows: upper jumper on the left, lower jumper on the left. The jumper "Volt-PWM" must be set to the right (PWM).

On the breakout board the jumper pin no. 9 must be connected to pin no. 2 with a wire jumper. The jumpers 4-5 and 6-7 must be plugged in, pins 1, 3 and 8 remain free. The remaining jumpers 10-11 and 12-16 can be set as described above depending on the application.

The load capacity of the 5V output at X1 has been increased from 150mA to 0.5A, so that the USB CNC board can be supplied from the breakout board and no extra 5V power supply is necessary. Please note that the load capacity of the 12V output (for fans) is reduced to 250mA when the 5V output is loaded to its maximum.



**NEW**

## Configuration in Beamicon2 and Beamicon2-Basic

In the Beamicon2 or Beamicon2-Basic control software only the CNC-Pod or Micropod module is selected. All settings are now preconfigured. Only for special applications or tasks are adjustments necessary. (plug & play)

### Example configuration Mach3

Engine Configuration... Ports & Pins

Signal	Enabled	Step Pin#	Dir Pin#	Dir LowActive	Step Low Ac...	Step Port	Dir Port
X Axis	✓	3	2	✗	✓	1	1
Y Axis	✓	5	4	✗	✓	1	1
Z Axis	✓	7	6	✗	✓	1	1
A Axis	✓	9	8	✗	✓	1	1
B Axis	✗	0	0	✗	✗	0	0
C Axis	✗	0	0	✗	✗	0	0
Spindle	✓	1	0	✗	✗	1	1

OK Abbrechen Übernehmen

Engine Configuration... Ports & Pins

Signal	Enabled	Port #	Pin Number	Active Low
Enable6	✗	1	0	✗
Output #1	✗	1	0	✗
Output #2	✓	1	14	✗
Output #3	✗	1	0	✗
Output #4	✗	1	0	✗
Output #5	✗	1	0	✗
Output #6	✗	1	0	✗
Charge Pump	✓	1	16	✗
Charge Pump2	✗	1	0	✗
Current Hi/Low	✓	1	17	✗
Output #7	✗	1	0	✗

Pins 2 - 9, 1, 14, 16, and 17 are output pins. No other pin numbers should be used.

OK Abbrechen Übernehmen

The pictures on the left show the settings for the standard configuration "Stepper motors and speed control (jumpers 3-4, 5-6, 7-8). Further settings

- XHome Pin 13
- YHome Pin 12
- ZHome Pin 10
- AHome or length sensor (sample) Pin 15
- RelayControl:M3 and M4 → Output#1M7 and M8 → Output#2
- Motor Control: ✓ Use Spindle Motor Output ✓ PWM Control PWM Base Freq. = 45Minimum PWM = 10%

## Technical data

### Absolute limit values

The following parameters must not be exceeded under any circumstances to prevent damage to the device:

Parameters	min.	max.	Unit
Operating voltage	-80	+80	V
Storage temperature	-40	+70	°C
Operating temperature	0	+70	°C
Voltage at digital inputs	-10	+100	V
Voltage at analog output	-0.5	+15	V
Voltage at the relay outputs X4	-	250	Veff
Current at the relay outputs X4	-	8	Aeff
Voltage at relay Holding brake	-	30	V
Current at relay holding brake	-	5	Aeff



### Electrical connection values:

Parameters	min.	max.	Unit
Operating voltage (nominal 24V)	+15	+75	V
Power consumption (without external consumers)	0.1	3	W
Ambient temperature	0	+50	°C
Threshold value for digital input	4	7	V
5V Output voltage	4.8	5.3	V
5V Output Current	0	0.5 <sup>1</sup>	A
12V output	11.5	12.5	V
12V output current	0	0.5 <sup>1</sup>	A
Full scale analog output	9.5	10.5	V
Linearity error analog output	-	1	%
Threshold for watchdog frequency (switch off)	5	10	kHz
Threshold for watchdog frequency (operation)	10	20	kHz
Driver Power Step/Dir Outputs	8	-	mA



### Dimensions:

Description	Width	Length	Height	Unit
Dimension of the board without housing and connector	93.3	93	20	mm
Hole spacing for fastening bolts	83.5	87	-	mm
Dimensions with housing and plug	96.5	96	60	mm

15V and 12V output together max. 6W

## Commissioning and troubleshooting

If you are using the interface board for the first time, please check the following points again before switching it on:

- Are all terminal blocks correctly aligned in the slots (X1 to X4)?
- Is the power supply (15 to 75V=) correctly connected (ground to pin 4 of X1, + to pin 5 of X1 right)?
- If the supply voltage is higher than 28V, jumper JP3 must be set to position 13-14 (limit switch supply 12V).
- Are all power amplifiers connected to the RJ45 sockets? If only 3 power amplifiers are used, jumper JP4 (15-16) must be plugged in. If less than 3 power amplifiers are connected, a "dummy plug" with a bridge between pin 7 and 8 must be inserted for the missing axes.
- Is the emergency stop switch connected? For test purposes only, a jumper may be connected between pins 5 and 6 of X2 as an alternative. An emergency stop switch is legally required on a machine.
- Check again whether the setting of the remaining jumpers matches the pin assignment of your control software.

If these conditions are met, you can connect to the PC, switch on the supply voltage and start the control software. After activating the software (at Mach3 you have to press the reset button) the state of the LED lights should be as follows

- the two green LEDs "Power" and "Charge Pump" must light up,
- the two red LEDs "Drive Fault" and "E-Stop" must be off
- the two yellow LEDs Relay 1 and Relay 2 must be off.

If this is not the case, please refer to the chapter "Troubleshooting" below. If everything is in order, you can now check the movement of the motors and the function of the relays and switches.

## Troubleshooting

The following table gives an overview of the most common errors and the possible causes.

No.	Symptom	Cause
1	LED "Power" (green left) is not lit	Power supply (ground at pin 4 of X1, +15 to +75V at pin 5 of X1, right) not connected or wrongly polarized.
2	LED "Charge Pump" (green right) is not lit	A square wave signal with $\geq 1\text{kHz}$ must be output at pin 16 of the LPT port. If the software does not support this, jumpers 1-2 must be inserted.
3	LED "Drive Fault" (red left) lights up	Not all power amplifiers are connected or not all are supplied with voltage.
4	LED "E-Stop" (red right) lights up	a) The emergency stop switch (X2 Pin 5 and 6) is not connected or pressed. b) The power supply is not sufficient or the 12V output is overloaded (maybe fans with too high power consumption connected?)
5	Relays do not switch	a) yellow LEDs light up, but relays do not switch: see 4a b) yellow LEDs do not light up: Jumper incorrectly inserted or software pin assignment not configured correctly
6	Motors do not turn	a) green LED "ChargePump" is not lit: see 2 b) Step/direction pins reversed? (LPT pins 2,4,6,8 = direction, pins 3,5,7,9 = step)
7	Frequency converter Speed fluctuates	PWM frequency (base freq.) too low, min. 45Hz
8	No function of the emergency stop signal (LPT pin 11)	Pin 11 must be configured as "active low" in the software, LED "Drive Fault" (see 3) and "E-Stop" (see 4) must be off.
9	In case of "Reset" or emergency stop the motors take one step	Polarity of step signal wrong (inverted)