

# CENTIPEDE-BRK CNC Interface Board

KSI Labs, LLC

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# Safety Information and Legal Disclaimer

BRK board includes an off-line power supply so there are high, possibly lethal voltages on board. If you don't have experience working with such voltages please hire a professional for assembly and service work. Use reasonable caution when using this board.

***In no case KSI Labs, LLC should be liable for any damages or losses caused by customer failure to follow proper procedures and carelessness. If you don't agree to this please do NOT use our board. All risks are yours and you bear all the responsibility.***

For those competent enough the off-line universal voltage (92-276VAC) power supply primary side is contained within board area separated from the rest of the board with dual-line polygon on the silkscreen. This dual line also shows the safety keepout separating the high-voltage part from the rest of the board. High voltage part has no copper fills in internal layers and can be clearly seen when looking through the board against light—it is translucent. The rest of the board has no high voltage on it, it is all 5V.

Please do also be careful with relay terminals if those relays are used for switching high voltage loads.

For safety reasons this board (as well as other high voltage power components of the CNC machine) **MUST** be installed in an closed grounded cabinet preventing from accidental access to dangerous parts bearing high voltage.

The fuse used is 0.5A slow-blow ("T" type for Time lag) TR5 type fuse from Littelfuse. Those are available from e.g. Mouser, p/n 576-37405000410 or DigiKey, p/n WK4041BK-ND. Please do only replace it with the similar rated fuse in case it's blown.

***Once again—please use reasonable caution when using CENTIPEDE-BRK board!***

# Chapter 1

## Hardware Description

CENTIPEDE-BRK (simply BRK from now on) is a breakout and support board for CENTIPEDE-PCI CNC Interface Controller. It provides convenient screw terminals for connecting PCI Controller board to a CNC machine as well as some other functionality.

First of all the BRK has a Universal Input off-line 5V switching power supply. This power supply is used for all electronics on the BRK and as input power for PCI board Digital Input optocouplers. It is also routed to the BRK Extension Connector **J22** and **J23** screw terminal so it can be used for powering other CNC machine side equipment (limit switches, encoders, add-on boards etc.) It allows for up to **2 Amp** load on those terminals combined. As it was said it is Universal Input so it is rated to work from any input voltage from 92 to 267 VAC.

There is 4 groups of digital input and 4 groups of digital output terminals on the BRK. Each group is 9 terminals wide. Of those terminals one is the common power rail and remaining 8 are actual inputs or outputs. Each input/output terminal has a LED next to it that lights up when the connected optocoupler is energized.

Common rail for digital outputs is connected to +5V(PC) power supply that comes from the PC. Outputs are Open Drain outputs that are connected to the PC ground when '1' is written into corresponding bit of DATA\_OUT register. That means output optocouplers should be connected with their anodes to the common power rail while cathodes go to the corresponding outputs. There is no current limiting resistors anywhere in output circuits so those optocouplers should have proper series resistors themselves. Almost all stepper drivers and other such devices usually have built-in resistors for 5V operation but it won't hurt to check before connecting them to the BRK. All output power rails (all 4 of them) are tied together; 4 terminals for them (one per group of 8 outputs) are provided for wiring convenience only. ***Please note that this power comes from the PC so it should NOT be used for anything else except optocouplers.***

8 outputs (OUT24..31) can be used for onboard relays. There are 8 optocouplers on the BRK that has their outputs driving relay coils via small FETs

from onboard 5V power on their output side. Their input LEDs are connected to the 8-position DIP switch, SW1. The other side of this switch is connected to OUT24..31 output terminals. That allows for selective configuration of those outputs for use either as relay drivers or as outputs driving external circuitry if corresponding relay is not used. Relay is connected to the corresponding output when its switch is set to “On” and disconnected otherwise. Relays/Outputs to SW1 switch mapping is as follows:

**SW1.1** K5, OUT24

**SW1.2** K6, OUT25

**SW1.3** K7, OUT26

**SW1.4** K8, OUT27

**SW1.5** K1, OUT28

**SW1.6** K2, OUT29

**SW1.7** K3, OUT30

**SW1.8** K4, OUT31

Relays K1..4 are power relays with SPDT contacts rated at 12A/125V or 7A/250V and can be used for commutating relatively powerful loads. K5..8 are signal relays that supposed to work with low power signals. They have DPDT contacts. All relay contacts are routed to corresponding screw terminals (see connection drawing.)

Common rail for digital inputs is connected to the BRK ground that should be connected to the machine body (this very ground is also tied to the AC power ground wire at AC input connector.) Individual inputs are connected to the corresponding optocoupler cathodes on the PCI board. All their anodes are connected to the BRK +5V power rail with appropriate series resistors. That means that machine sensors should connect input terminal to the machine body or that common rail terminal (one per group of 8 inputs) in order to set input bit to '1.'

There are programmable debouncers on all PCI board input lines when Generic I/O (GPIO) firmware is used so simple mechanical switches can be directly connected to inputs, no special debouncing required. For Mach3 version most of the input signals are used in such a way that contact bouncing does not affect proper operation.

There is also 2-channel DAC and 4-channel ADC on the BRK. They are 10-bit devices designed for 0-10V analog signals. Please see connection drawing for their connection to screw terminals. NOTE: ***There is no protection on ADC inputs so please make sure you are not exceeding their 0-10V range and their input terminals are connected to POSITIVE input analog voltage.***

DAC and ADC get their analog +15V power from a secondary switching power supply that produces it from BRK main +5V power rail. This +15V voltage is also routed to the extension connector for use by analog circuits on add-on boards. **Please note that it is relatively low power supply so don't draw more than 100 mA from it on those boards.**

DAC and ADC are connected to the PCI board with SPI-like interface through LVDS differential signals. There are 2 separate interfaces with 3 chip selects each. One interface is used for DAC, another one for ADC. Only one chip select signal is used on each interface that allows for connecting additional devices. For this purpose those signals are routed to the extension connector and can be used for connecting add-on boards with e.g. additional relays, DACs, ADCs or other devices. There are receivers/transmitters for ALL LVDS signals on the BRK, not just for those used for DAC and ADC so signals on the Extension Connector are of regular TTL levels, no additional LVDS interface chips required on add-on boards.

## 1.1 Extension Connector

Here is the Extension connector pinout. AGND is analog ground for analog +15V voltage, the other one is main digital ground.

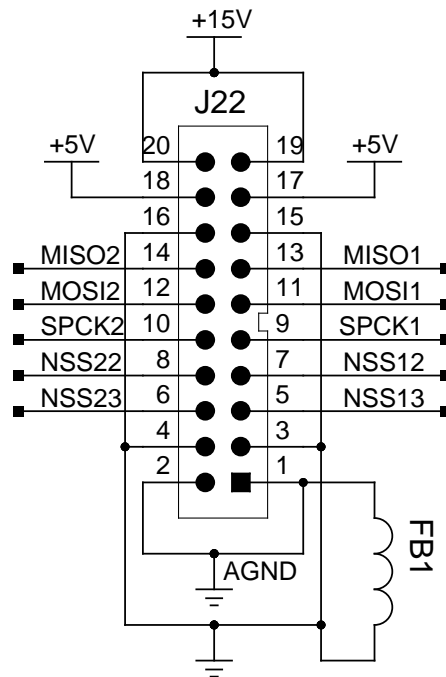


Figure 1.1: Extension Connector

## 1.2 External Connections

Here is the external connection drawing for CENTIPEDE-BRK board.

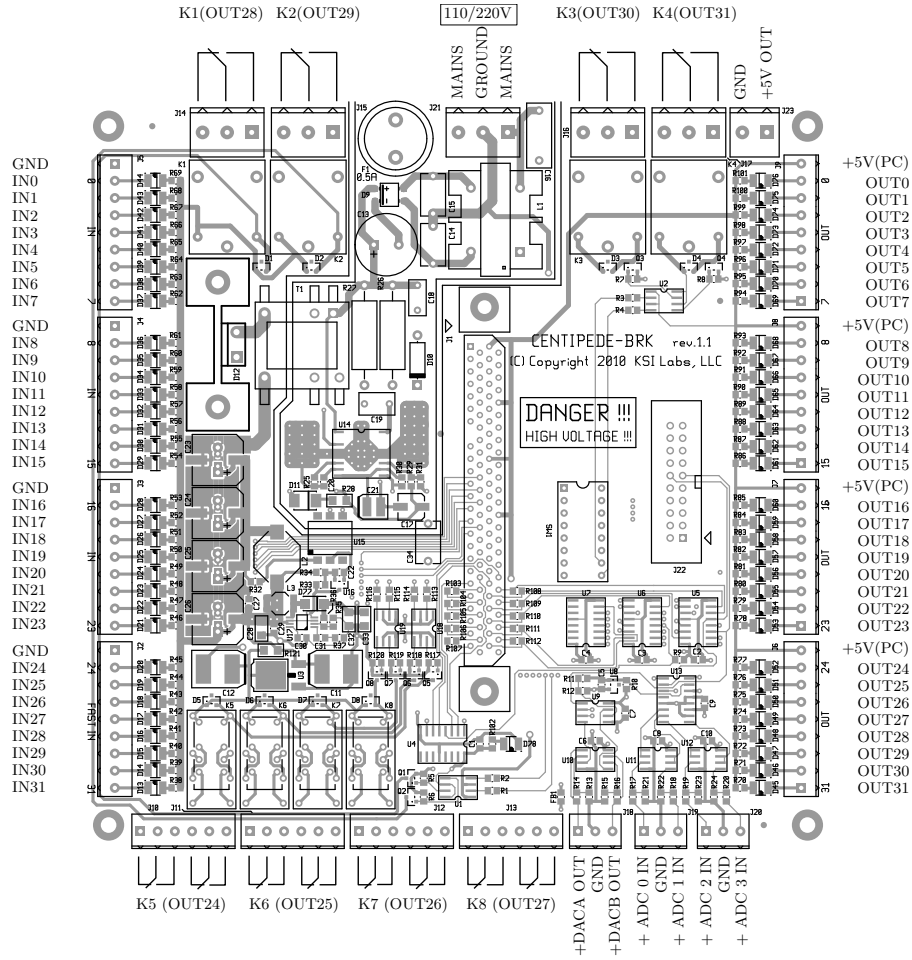


Figure 1.2: External Connections

# Appendix A - Hardware differences between rev.1.0 and rev.1.1

There are some differences between rev.1.0 and rev.1.1 boards. They are not significant for a matched PCI/BRK set but there are some caveats.

- **IMPORTANT!** Rev.1.0. CENTIPEDE-PCI board had PCI bus **GROUND** connected to pins 69 and 78 of the External Connector, NOT +5V power. It had 2 +5V power pins (51 and 60) and 2 GROUND pins (69 and 78.) On rev.1.0 CENTIPEDE-BRK board pins 69 and 78 of the mating connectors are **NOT CONNECTED** to anything so it works OK with rev.1.0 CENTIPEDE-PCI board. Rev.1.1 PCI board will also work just fine with rev.1.1 BRK board though 2 +5V conductors in the cable will not be used. *But rev.1.0 PCI board can NOT be used with rev.1.1 BRK board because the latter has pins 51, 60, 69, and 78 all connected together that will make a short circuit between PC +5V and ground.*
- Other than that there is NO differences schematicwise between those two revisions.
- Rev.1.1 BRK board has D9 bridge rectifier (between the fuseholder and tall electrolytic capacitor) rotated 90 degrees and that tall capacitor (C13) no longer has a plastic spacer underneath.
- DAC and ADC screw terminals moved towards the board edge to line up with the relays contacts terminals.
- Other than that those two revisions are identical.



# Appendix B - Hardware options

Boards can have different components installed due to parts availability. As one can see 4 +5V power supply capacitors and 4 low power signal relays have multiple options footprints. That is done to allow for different parts usage based on current availability.

Power supply capacitors are high quality very reliable Os-Con Conductive Polymer Aluminum Solid Electrolyte capacitors. However their supply is quite sporadic and unpredictable so your particular board can be supplied with one of the following:

- Sanyo Os-Con 330uF 10V SMD capacitors
- Sanyo Os-Con 330uF 6V SMD Capacitors
- Sanyo Os-Con 330uF 16V SMD Capacitors
- Sanyo Os-Con 220uF 10V SMD Capacitors
- Sanyo Os-Con 330uF 10V Thru-Hole capacitors
- Sanyo Os-Con 220uF 10V Thru-Hole Capacitors

All those capacitors are of the same high quality and reliability and they are within the power supply working requirements so there is no difference in device operation. There is also possible that one capacitor, the farthest one from the diode heatsink will differ from other three. That is normal, don't panic :)

It is also possible that your particular board will be supplied with different low power signal relays instead of default NAIS DS2E-S-DC5V. Most probably that might be smaller size (see that smaller footprint inside each NAIS relay?) FUJITSU FBR13HD03 parts. Those are lower voltage so there will be another difference if they are used—C11,C12,U3 components (now missing) will be installed and 0  $\Omega$  R121 resistor above U3 will be removed. That would not have any effect on device operation.