

Panther

CNC Cape for Beaglebone Black

Users Manual

Version 1.1

Warning!

The CNC Cape is intended to build a CNC control. As a CNC control is an electronic device which includes working with high voltages and high currents, you should only build such a device, if you have the expertise to do so.

If you do not have the expertise to build such a device yourself, please find someone who has the necessary knowledge to help you!

Getting started

Thank you for purchasing our Panther CNC Cape for the Beaglebone Black computer.

To make the Panther cape work, please follow the steps described below:

1. Disconnect your Beaglebone Black computer from the power supply!
Inserting the cape while your computer is connected to the power supply may damage your board or the cape!
2. Insert your Panther cape into the connectors of your Beaglebone Black computer. Be careful to insert the board in the right direction! The ethernet connector must fit into the space of the cape. See Figure 1 below. All of the pins of the board must fit into the two sockets of the Beaglebone.
3. Insert the SD card with the Machinekit software into the SD card slot of your Beaglebone Black board.
4. Connect the power to the board and start the computer. The system will boot up and show the Linux desktop.
5. You will see three icons on the desktop: Machinekit, Setup and Docu.
6. To start Machinekit for the first time, just do a double click on the Machinekit icon.
7. After a short pause a selection screen will appear on the monitor. Please select the configuration you want to use (Panther-1-axis, Panther-2-axis, Panther-3-axis or Panther-4-axis) and click on the OK button.
8. Machinekit CNC software will appear on the screen.
9. To start the setup program click on the icon Setup.
10. Use the Docu icon to get further information.

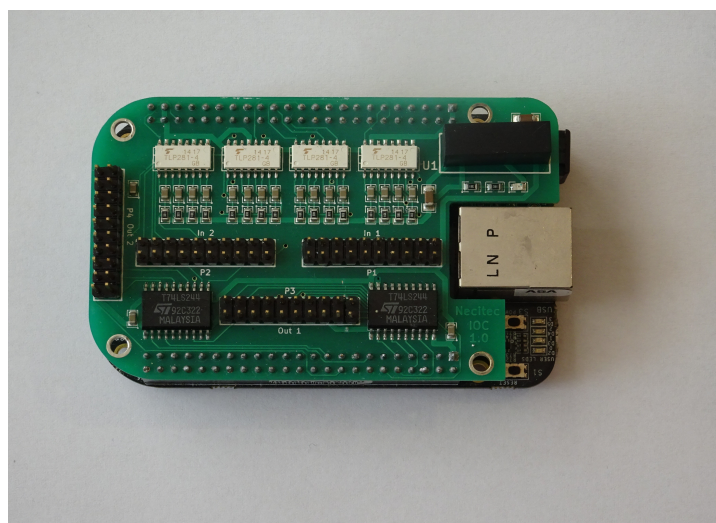


Figure 1: Panther cape inserted in a Beaglebone Black board.

Language Setting

Machinekit comes set to the English language. If you like to change the language setting to your language for example to German you have to do the following:

1. Edit the file: `/etc/default/locale`

```
LANG=de_DE.UTF-8
```

```
LANGUAGE=de_DE.UTF-8
```

2. Edit the file: `/etc/default/keyboard`

```
XKBLAYOUT="de"
```

Since you need administrator rights to edit those files you can start the editor the following way:

Start a command shell, then call the file manager with administrator rights by entering the command:

`sudo pcmanfm`. Next you can parse to the files to edit and open them by a right click and then selecting the Leafpad editor.

Connecting the Cape

Step and Direction outputs

To get your cape working you have to connect the cape with your motor drivers. The output ports of the cape are not opto coupled, but the inputs of professional motor drivers are. That way you get opto coupling at the outputs too.

Connect the output signals of Connector P3 to the inputs of your motor drivers. Connect the step and direction outputs to the (positive) inputs of your motor driver and connect the negative inputs of the step and direction signals on the driver board to the GND signals of P3.

There are 5 wires at P3 for each axis. They are arranged, so that there is a GND signal on each side of a step or direction signal. This is to minimize signal interference.

See Figure 2 and Figure 3 for the signal pinout of the Connectors on the cape P1 to P4.

Endstops

The endstop inputs are configured to work with opening switches (NCC). You have to connect the endstop switches between the endstop input pin and GND of the P1 connector.

All endstop switches are connected to the Connector P1.

The endstop switch for the X-Axis is connected to input IN1.

The endstop switch for the Y-Axis is connected to input IN2.

The endstop switch for the Z-Axis is connected to input IN3.

The endstop switch for the A-Axis is connected to input IN4.

Emergency Stop

The board and most drivers will work without an Emergency Stop connected. Nevertheless it is strongly recommended to supply your system with an Emergency Stop switch. To make the system secure you should connect the Emergency Stop switch to the Panther cape as well as to all enable inputs of your motor drivers. That way you will get a system with single fault safety because the driver will stop working and the Beaglebone will cease to produce step signals, when Emergency Stop is activated.

To connect the Emergency Stop switch to the Panther cape, connect the closing contact of the switch between Connector P1 – Pin 19 (IN8) and P1 – Pin 20 (Ground - 0V)

After connecting the Step and Direction outputs to your motor drivers, the endstop switches and the emergency switch to the inputs of your cape the system is ready for a first test.

Start Machinekit software by a double click on the Machinekit icon on your desktop. Machinekit will start up and ask you for the software configuration you want to use. Please select the configuration from the tree (Panther-1-axis, Panther-2-axis, Panther-3-axis, Panther-4-axis) which fits to the count of axis your system has. After you have selected a configuration, confirm the dialog with the OK button.

After Machinekit software has started up you will see the Machinekit window on your screen. To enable the system you have to press the On button on the toolbar at the left upper corner of the Machinekit window. (On the right of the emergency stop button).

If you push the emergency stop button you connected to the emergency stop input, the On button will be switched off again. Release the emergency stop button and press the on button again. (The Emergency Stop button you see on the screen, will not react on clicking, but only to the switch you connected to the emergency stop input on the board, because this is the way the system is configured.)

You can press the button „Home all axis“ to start a home move on all axis. When all axis are homed, your system is ready to work.

You will find a detailed description of the Machinekit software here: www.machinekit.io

Since Machinekit is a fork of LinuxCNC it may also be helpful to look at: www.linuxcnc.org

Inputs

The CNC inputs you can specify for example in the gcode M66 as P0 to P3 are connected to the Panther input channels IN9 to IN12 at the connector P2. (see Figure 2)

Outputs

The CNC outputs you can specify for example in the gcode M64 as P0 to P3 are connected to the Panther output channels Out1 to Out4 at the connector P4. (see Figure 2)

Connector P1

Pin	Signal	BB Port	PRU	\$PIN	GPIO
1	GND				
2	IN1	P9-11	62	28	30
3	GND				
4	IN2	P9-13	63	29	31
5	GND				
6	GND				
7	IN3	P9-15	80	16	48
8	GND				
9	IN4	P8-17	59	11	27
10	GND				
11	GND				
12	IN5	P9-23	81	17	49
13	GND				
14	IN6	P9-25	149	107	117
15	GND				
16	GND				
17	IN7	P9-27	147	105	115
18	GND				
19	IN8	P9-26	46	96	14
20	GND				

Connector P2

Pin	Signal	BB Port	PRU	\$PIN	GPIO
1	GND				
2	IN9	P9-24	47	97	15
3	GND				
4	IN10	P8-26		31	61
5	GND				
6	GND				
7	IN11	P9-12	92	30	60
8	GND				
9	IN12	P8-15	79	15	47
10	GND				
11	GND				
12	IN13	P9-42	39,146	89	7
13	GND				
14	IN14	P8-18			
15	GND				
16	GND				
17	IN15	P9-22			
18	GND				
19	IN16	P9-21			
20	GND				

Connector P3

Pin	Signal	BB Port	PRU	\$PIN	GPIO
1	GND				
2	X-Step	P8-9	101	39	69
3	GND				
4	X-Dir	P8-7	98	36	66
5	GND				
6	GND				
7	Y-Step	P8-8	99	37	67
8	GND				
9	Y-Dir	P8-10	100	38	68
10	GND				
11	GND				
12	Z-Step	P8-12	76	12	44
13	GND				
14	Z-Dir	P8-11	77	13	45
15	GND				
16	GND				
17	A-Step	P8-14	58	10	26
18	GND				
19	A-Dir	P8-16	78	14	46
20	GND				

Connector P4

Pin	Signal	BB Port	PRU	\$PIN	GPIO
1	Out1	P8-13		9	23
2	GND				
3	Out2	P8-19		8	22
4	GND				
5	Out3	P9-14		18	50
6	GND				
7	Out4	P9-16		19	51
8	GND				
9	Out5	P9-17		87	5
10	GND				
11	Out6	P9-18		86	4
12	GND				
13	AIN3	P9-38			
14	AVDD				
15	AIN2	P9-37			
16	AVDD				
17	AIN1	P9-40			
18	AGND				
19	AIN0	P9-39			
20	AGND				

Figure 2: Connector pinout

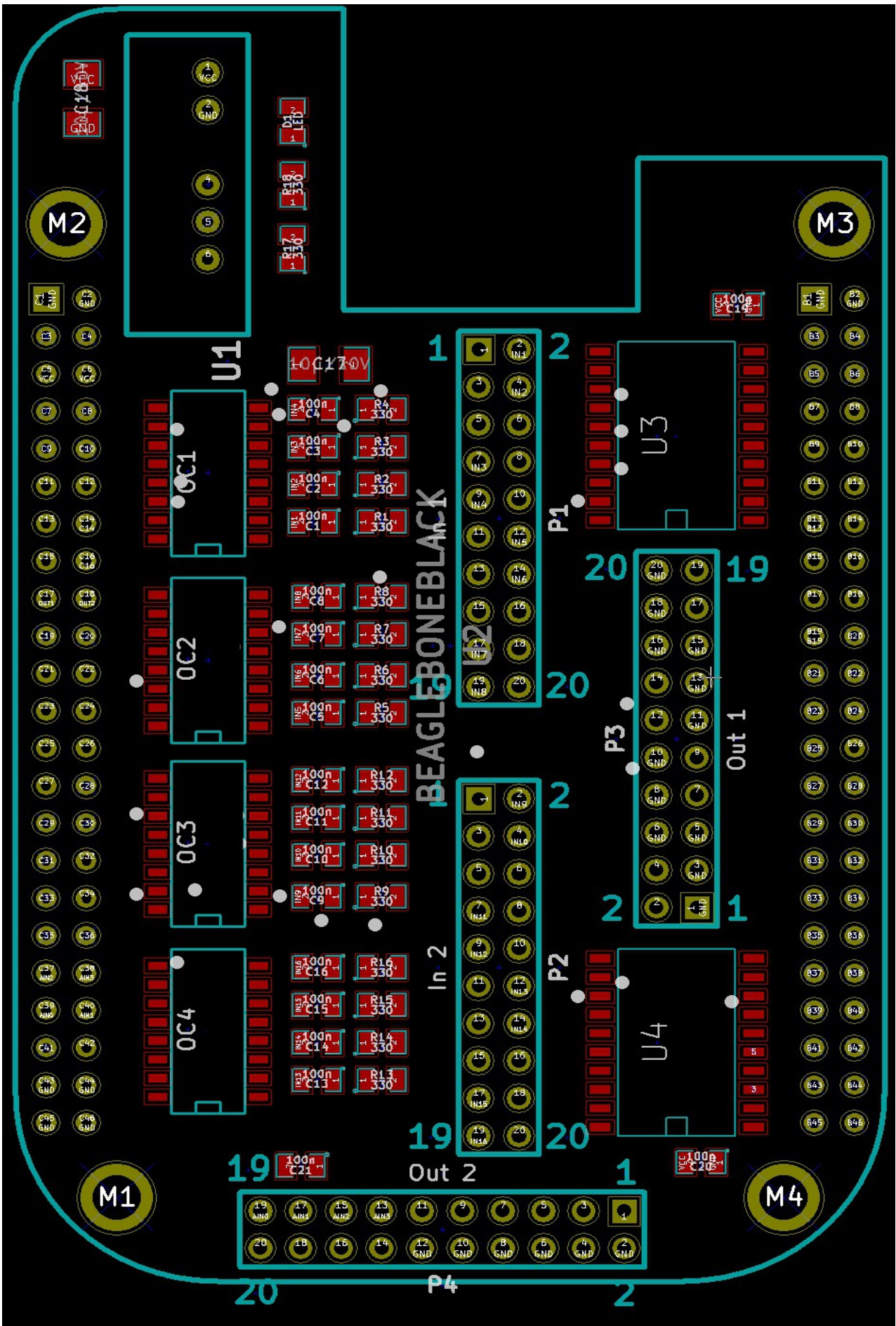


Figure 3: Board Layout

Software Configuration

The next step is to configure the Panther configuration, you want to work with. To do this, please double click the Configuration icon on your Desktop.

At first a window will open and ask you to enter the number of axis you want to use. Select the number of axis and confirm the dialog by pressing the OK button. All following data will be loaded/saved in the configuration file of the configuration which corresponds to the number of axis you selected before.

Please enter the data of your system in the dialog and press the save button to save the data you entered in the configuration file.

When you start Machinekit the next time your changes will become active.

To get more information about the configuration parameters, refer to the INI and HAL documentation of Machinekit. If you want to change parameters, that can not be edited with the configuration editor, you can edit the INI or HAL file with the Leafpad editor too.

Inside Machinekit

If you like to dig deeper into Machinekit software you can get detailed information at www.machinekit.io or www.linuxcnc.org as already mentioned before.

Nevertheless we like to provide some useful information here which will help you for a start.

Users

The system starts up with the user machinekit, password: machinekit

There is an administrator account root, with password also root (very secure ;-)

You can open a command shell from: System menu, Accessories, LXTerminal

You can call the file manager with administrator access rights from a command shell entering:

```
sudo pcmanfm
```

You can start Machinekit software from the shell by entering: linuxcnc

which starts: `/home/machinekit/machinekit-dev/scripts/linuxcnc.sh`

The configuration files for the Panther cape that are edited by the setup program are stored in:

```
/home/machinekit/machinekit/configs/ARM.BeagleBone.Panther
```

You will find the original Panther config files in:

`/usr/share/linuxcnc/examples/sample-configs/ARM/BeagleBone/Panther`

You can copy them to the `/home/machinekit/machinekit/configs` directory by selecting one of the Panther configuration in the configuration tree at the startup screen of Machinekit. Open the Sample Configurations node and select ARM, BeagleBone, Panther and the configuration file you want to use.

In the directory `/home/machinekit/machinekit/iofunc` you find some useful shell scripts. Before using the scripts in this directory you have to load the Panther cape overlay. You can do this by running the `setup.bridge.sh` script in the directory `/home/machinekit/machinekit/configs/ARM.BeagleBone.Panther`

`testinputports.sh` will display the state of all input ports of the cape. To interrupt the script, please press `<ctrl>C`

`sudo ./testoutputports.sh` will switch all outputs of the connector P3 on. One port after the other each second one port is added. When all ports are on, all ports are switched off. Again each second one port.

`sudo ./testOutP4.sh` will do the same as `testoutputports.sh`, but with the 6 output ports on the connector P4.

Technical Data

- 16 Opto coupled digital inputs for end stops, software emergency stop and additional purposes
- Profiles for 1 to 4 axis
- Step / Direction outputs for each axis
- 6 Additional outputs for special purposes for example spindle or cooling
- 4 Analog input ports
- 100 KHz Maximum step rate