Panther

CNC Cape for Beaglebone Black

Users Manual

Version 1.2

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 that kind of device, if you have the expertise to do so.

If you do not have the expertise to build this 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 the 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 two icons on the desktop: Machinekit 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-3-axis, Panther-4-axis, Panther-5-axis) and click on the OK button.
8. Machinekit CNC software will appear on the screen.
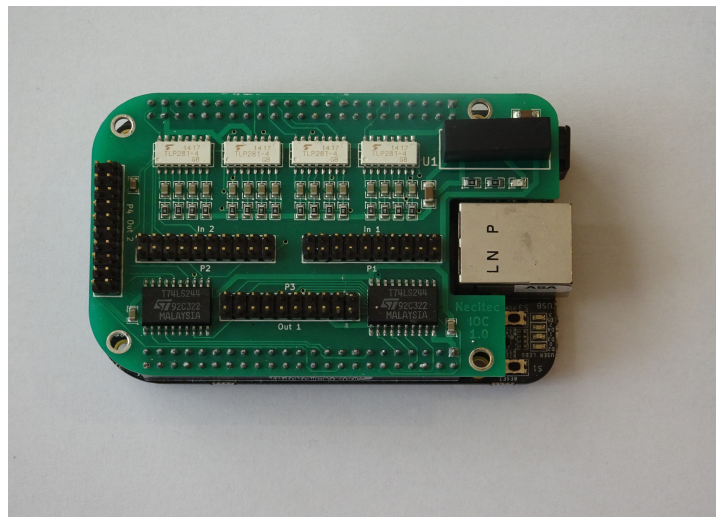9. Use the Docu icon to get further information.

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

Language Setting

There are two images for the Panther cape available. One configured for the English language and one image for the German 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-decoupled, 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. The reason for this is to minimize signal interference.

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

Home switches

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

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, you need to make the following steps:

1. Connect the opening contact of the switch between Connector P1 – Pin 19 (IN8) and P1 – Pin 20 (Ground - 0V)
2. You need to edit the configuration file you want to use to enable Emergency Stop processing

See in chapter "Configuration files" where to find the configuration files and how to configure them.

To enable hardware Emergency-stop, find the following lines in the configuration file you want to use (By default hardware Emergency-stop is not enabled):

```
# create a signal for the estop loopback

net estop-loop iocontrol.0.user-enable-out => iocontrol.0.emc-enable-in

# net estop bb_gpio.p9.in-26 => iocontrol.0.emc-enable-in

# setp bb_gpio.p9.in-26.invert 1
```

If you want to enable the hardware Emergency-stop, change the lines to the following:

```
# create a signal for the estop loopback

# net estop-loop iocontrol.0.user-enable-out => iocontrol.0.emc-enable-in

net estop bb_gpio.p9.in-26 => iocontrol.0.emc-enable-in

setp bb_gpio.p9.in-26.invert 1
```

Starting the system

After connecting the Step and Direction outputs to your motor drivers, the home switches and the emergency stop 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-3-axis, Panther-4-axis, Panther-5-axis) which fits to the count of axes 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 emergency stop is active you have to deactivate emergency stop first, either by pressing the emergency stop button on the screen (if you have no hardware Emergency-stop button) or by deactivating the hardware Emergency-stop switch.

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. If you have a hardware Emergency-stop switch connected, 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. Otherwise you can click on the Emergency-Stop button on the screen to activate or deactivate Emergency-Stop.

You can press the button „Home" to start a home move on the currently selected axis. You have to home all axes before the system will accept any G-codes.

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 G-code M66 as P0 to P3 are connected to the Panther input channels IN4 to IN7 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	X-Home	P9-11	62	28	30
3	GND				
4	Y-Home	P9-13	63	29	31
5	GND				
6	GND				
7	Z-Home	P9-15	80	16	48
8	GND				
9	A-Home	P8-17	59	11	27
10	GND				
11	GND				
12	B-Home	P9-23	81	17	49
13	GND				
14	IN1	P9-25	149	107	117
15	GND				
16	GND				
17	IN2	P9-27	147	105	115
18	GND				
19	IN3	P9-26	46	96	14
20	GND				

Connector P2

Pin	Signal	BB Port	PRU	$PIN
1	GND			
2	IN4	P9-24	47	97
3	GND			
4	IN5	P8-26		31
5	GND			
6	GND			
7	IN6	P9-12	92	30
8	GND			
9	IN7	P8-15	79	15
10	GND			
11	GND			
12	IN8	P9-42	39,15	89
13	GND			
14	IN9	P8-18		
15	GND			
16	GND			
17	IN10	P9-22		
18	GND			
19	IN11	P9-21		
20	GND			

Connector P3

Pin	Signal	BB Port			
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

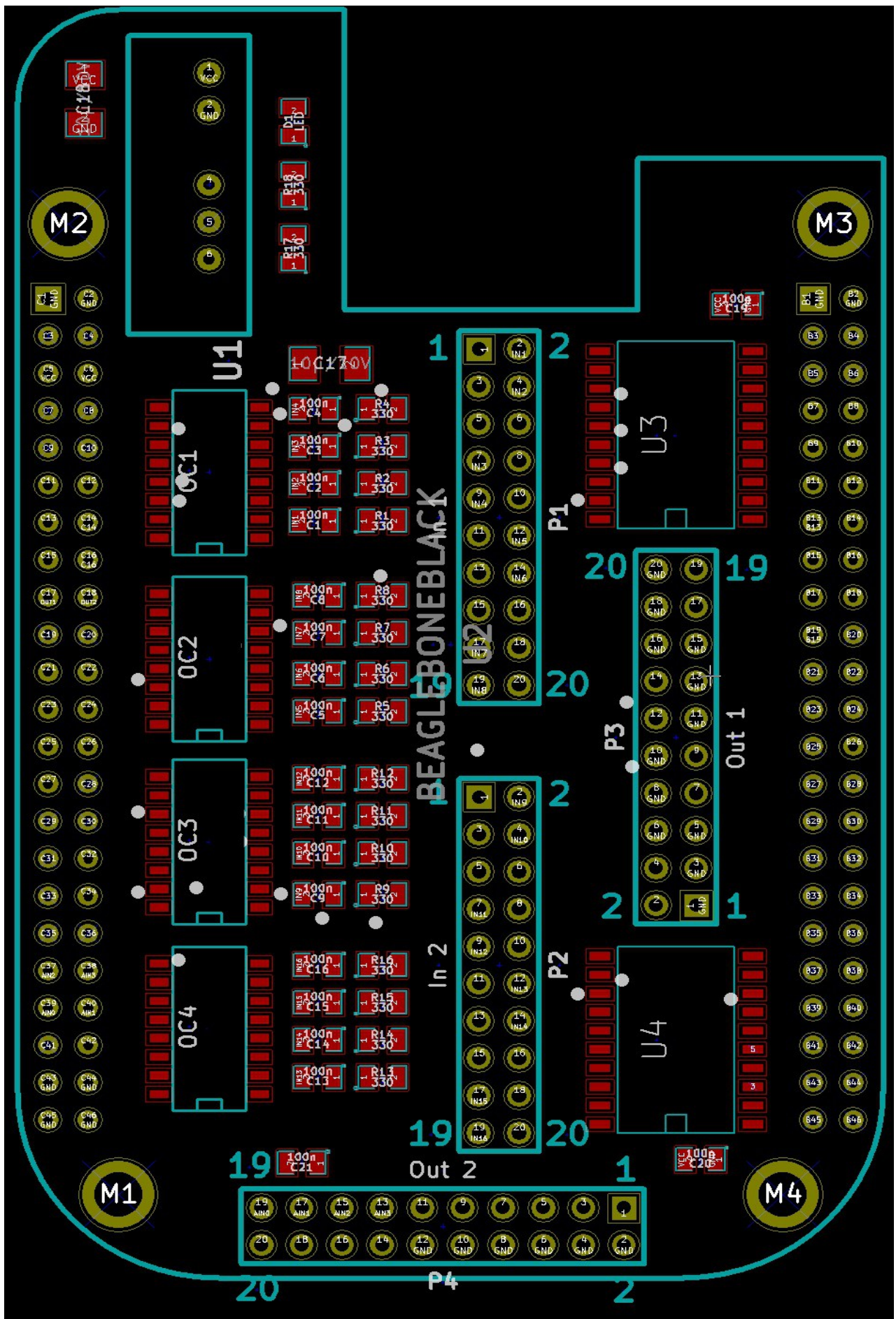| Pin	Signal	BB Port	
1	B-Step	P8-13	9
2	GND		
3	B-Dir	P8-19	8
4	GND		
5	Out1	P9-14	18
6	GND		
7	Out2	P9-16	19
8	GND		
9	Out3	P9-17	87
10	GND		
11	Out4	P9-18	86
12	GND		
13	AIN3	P9-38	
14	AVDD		
15	AIN2	P9-37	
16	AVDD		
17	AIN1	P9-40	
18	AGND		
19	AIN0	P9-39	
20	AGND		

Figure 2: Connector pinout

Figure 3: Board Layout

Configuration files

To adapt the Machinekit software to your individual CNC machine you need to edit the configuration file you want to use. This is one of Panther-3-axis.ini, Panther-4-axis.ini, Panther-5-axis.ini

The configuration files can be found at: /home/machinekit/machinekit/configs/ARM.BeagleBone.Panther You can use the Leafpad editor in the Accessories menu or any other text editor to change the ini files, for example the Panther-3-Axis.ini file.

To get your system working you have to change the following values to fit your needs:
In the section [TRAJ] you should set the value of
MAX_LINEAR_VELOCITY = 200.00
to the maximum velocity of your system. The unit is [mm/s]

For each of your axes you have to edit the following parameters to fit your system. For example in the section [AXIS_0] which represents the X-axis. [AXIS_1] stands for the Y-axis and so on.

Only the parameters that you have to change most likely will be described here. For a detailed description please refer to the Machinekit or LinuxCNC documentation.

MAX_VELOCITY = 200.0
The maximum velocity of this axis in mm/s.

MAX_ACCELERATION = 1000.0
The maximum acceleration in mm/s²

Also set the parameters STEPGEN_MAX_VEL and STEPGEN_MAX_ACC to a value 20% higher than the velocity/acceleration value.

SCALE = -200
This parameter setting means that the system has to make 200 steps for one mm movement. The sign of the value determines the direction of a positive move.

MAX_LIMIT = 300.0
The maximum valid coordinate of the axis.

HOME_SEARCH_VEL = 20
The speed of the home move in mm/s.

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 a shell by entering: linuxcnc or machinekit

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 As soon as you started the Machinekit software the overlay will be loaded too.

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 3 to 5 axis

- Step / Direction outputs for each axis

- 4 Additional outputs for special purposes for example spindle or cooling

- 4 Analog input ports

- 100 KHz Maximum step rate