emBRICK

emBRICK® - EPC

BeagleboneBrick Starterkit-1
Local Bus / Beaglebone Black

Starter Kit - Local-Bus

Rev. 7

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Content

1. The emBRICK® Mission

The idea of *emBRICK®*is to create **individual** electronic **controlsystems** by **assembling** (patching) small embedded **boards** (bricks) together via a simple interface (*brickBUS®*). Therefore, we call this class of controllers simply **EPC** = **E**mbedded **P**atchboard**C**ontroller.

emBRICK® combines in a perfect way the **cost-efficient** and **tailored** characteristics of a dedicated embedded system with the **ready to use** and **flexibility** of a PLC system.

To ensure a high acceptance, it is an **open** and **free** system. Besides buying existing devices everyone can develop his own components, to realize easily his individually tailored, cost-efficient and industrial-suitedmeasure and control system.

For more information and products visit www.embrick.de or see the detailed manuals.

1.1 Basic Characteristics

- **free** - also for commercial use in own appliances (for pure EMS with a small licence fee)
- **open** - supplying reference schematics, protocol source code, samples and starterkits
- **third...half price** compared to common control systems (complete system view)
- scaleable local and remote topologies, **1...>1000 I/Os**, up to **1ms update**, deterministic
- **low own power** consumption, average 50mW/slave module in operation (outputs inactive)
- global and sector specific modules for **direct connection** of various **sensors and actors**
- using **common, low cost** standard µCs / **components**
- **easy installation**, no configuration necessary, simply plug modules together and use
- works with / programmable by **various established**, well known **plattforms / languages**

1.2 Typical Applications

- Small, medium and largesize **measure and control systems**
- **Sectoral purpose**, with direct sensor/actor interface
- **Autonomous single box** control solutions i.e. with HMI and communication interfaces
- **Rapid hardware prototyping** system for control and measuring applications
- **PLC replacement** (i.e. with a Soft-PLC, IPC or anEmbedded controller)
- Medium and large size **distributed IO-systems** (i.e. building automation)
- Physical front-end for **Internet of things** (IOT)

For more details see*Product_Catalogue* and *Application_Manual*.

1.3 Programming, Host Plattforms, Connectivity

emBRICK® can be adapted to every plattform with almost every footprint/performance. For master units, implementations are currently available for/with the following systems:

Computer plattforms ..... PC, Embedded-PC, Modul-PC, Raspbery Pi, Beaglebone Black
µController plattforms..... ARM-Ax, ARM-Cortex-Mx, Microchip PIC24/PIC24
OS/RTOS..... Windows, Linux, FreeRTOS, proprietary
Programming languages..... C, C++, IEC61131, UML (with implementing expansion)
Develop. environments ..... MSVC, radCASE, Enterprise Architect, CODESYS, Cocox, MPLab, Geany (Raspberry Pi, Beaglebone Black), every other C/C++ IDE
Host Interfaces..... Ethernet, WLAN, CAN, RS232, RS485, others planned

For slave modules, actual Microchip PIC16/24 is used. Others (i.e. Cortex-M0) are planned.

2. Introduction

2.1 About this Manual

This manual leads step by step from the hardware mounting and software installation, to starting up the emBRICK® adapter starterkit, running the delivered sample application and creating your own applications.

Furthermore, it is used as an open reference plattform for the brickBUS® local-master protocol stack.

2.2 References / Manual Overview

For *emBRICK®* and *brickBUS®* the following documents are available. Before reading this document, it is recommended to read them in the given order:

System Manual	(*eB_System.pdf)* ... the basic system manual that contains the idea, the intention and the basic technical concept of *emBRICK®/ brickBUS®* like mechanics, electronics and communication protocol. It includes the glossary for all other documents.
Application Examples	(*eB_Applications.pdf)* ... overview of typical *emBRICK®* device configurations and sample constellations for different industrial applications. It gives an idea how to use *emBRICK®* as an alternative to a normal PLC or an individual PCB / embedded system.
Product Catalogue	(*eB_Products.pdf)* ... contains the overviews and detailed datasheets of all IMACS-available *emBRICK®* components and products. This includes electrical and mechanical characteristics, terminal assignment and notes about their usage.
Programmers Manual	(*eB_Programmer.pdf)* ... is the manual for application software programmers when using established programing systems like Embedded-IDEs, Soft-PLCs, CASE-Tools but also native C/C++-coding.
FAQ Manual	(*eB_FAQs.pdf)* ... contains answers to the most frequently asked questions about *emBRICK®* and its usage.
Developers Manual	is the manual for system developers, who like to create their own slave modules or master adaptions. It includes all technical details specifications of *brickBUS®* and also sample schematics and code samples of the software stacks. This document is only available on request from IMACS GmbH and needs the agreement on the *emBRICK®* free license conditions. Please contact support@embrick.de.

2.3 Before you start

- Check if you have received all starterkit parts, see Package contents
- Check if you need anything else which doesn't come with the starterkit in Additional required components
- Follow the instructions in Mounting and wiring for starterkit assembly
- If you don't know what software to download read The Software

2.4 Package contents

The BeagleboneBrick Starterkit-1 contains:

- Adapter board (Z-BeagleboneBrick-##)
- One slave module (CAE_P-2Rel4Di2Ai-0#)
- Carrier Board (CAE_Y-CHBoc200)

Note: If you want to try out radCASE with the starterkit the adapter board for the Beagelbone Black must be the fully populated version (Z-BeagleboneBrick-01) or else the software generated by radCASE will not work.

2.5 Additional required components

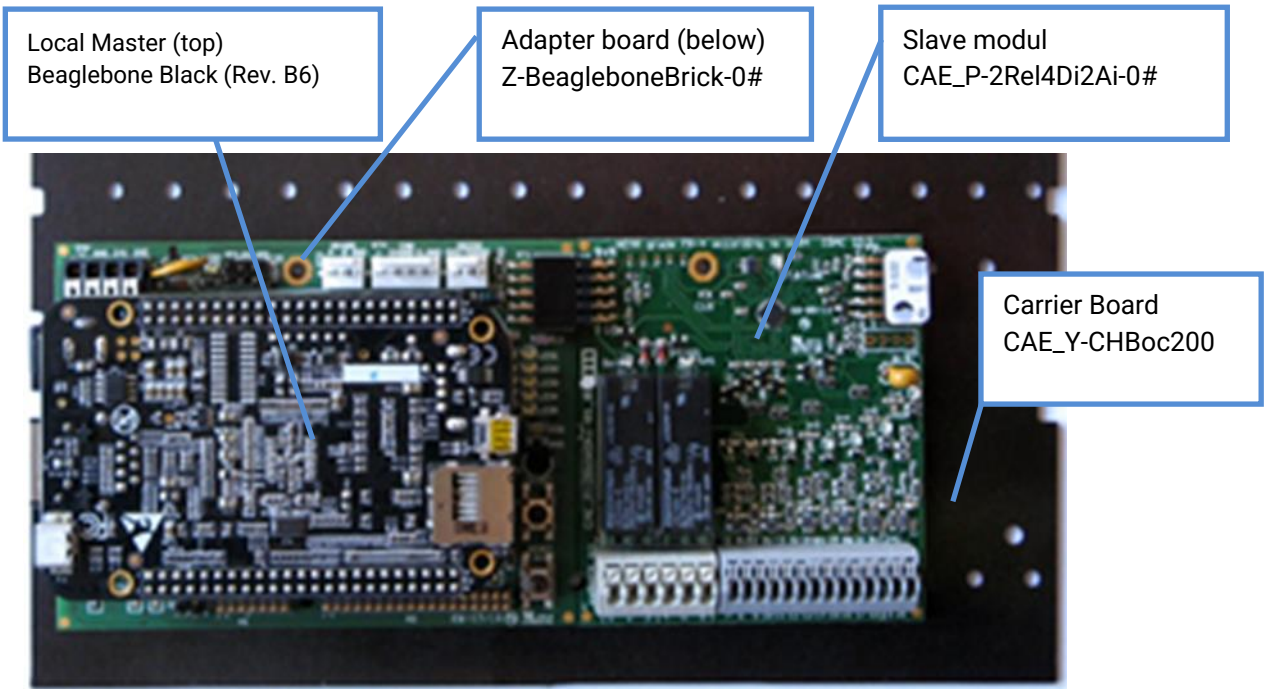
To operate the starter kit, the following additional items are required:

- Beaglebone Black, Rev. B6 or later (with SD card and preinstalled Debian). If your Beaglebone Black is already flashed with Debian Version 7.5-2014-05-14 or higher, you won't need the SD card.
- DC power supply 24V, > 500mA
- Monitor with HDMI port or suitable adapter. Note: Not all adapters will work with Beaglebone Black immediately – in some cases, a separate reset of the Beaglebone Black after a power-on is necessary. The monitor does not work with the custom image for radCASE (if you want to try radCASE with Beagelbone Black). The signals are relayed to the LCD interface instead.
- USB keyboard, USB mouse and a powered USB-Hub
- RJ45 cable for LAN connection and internet access for diverse downloads

Instead of working with the Beaglebone Black locally, you can also use a remote desktop environment. If you choose to do so, you will not need a separate monitor, keyboard, mouse and USB-Hub. However, in this case you will need a pc or laptop with a remote desktop client software. For further information, please refer to 6.4 Using a remote desktop.

2.6 The Hardware

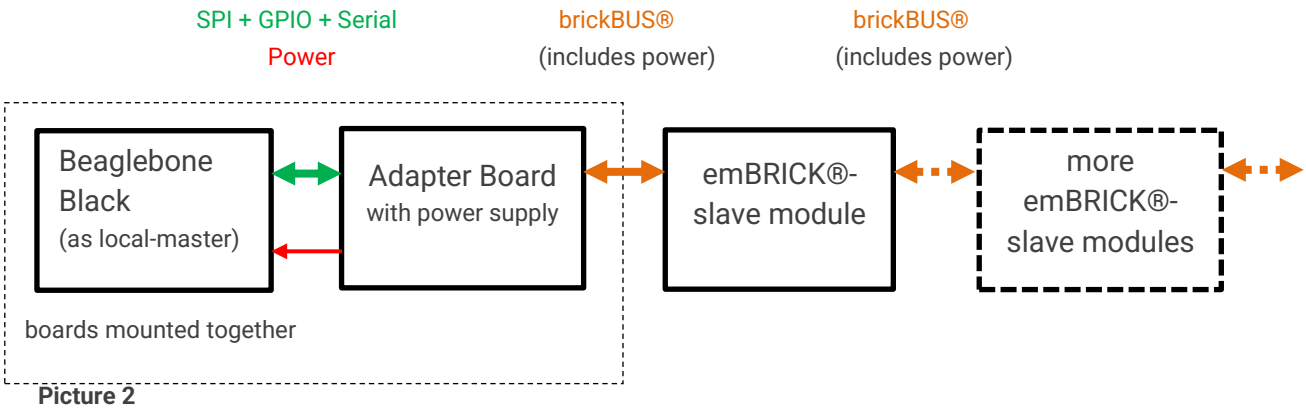
The adapter board is an electric coupler between the Beaglebone Black and an emBRICK®-*String*. The *String* consists of one or more *slave modules* which can be controlled via *brickBUS®*.



Picture 1

2.6.1 Communication structure

The Beaglebone Black acts as *local master* that exchanges data with the slave-modules via *brickBUS®*.



Picture 2

For detailed information, please read the description of the modules in the System Manual.

2.7 The Software

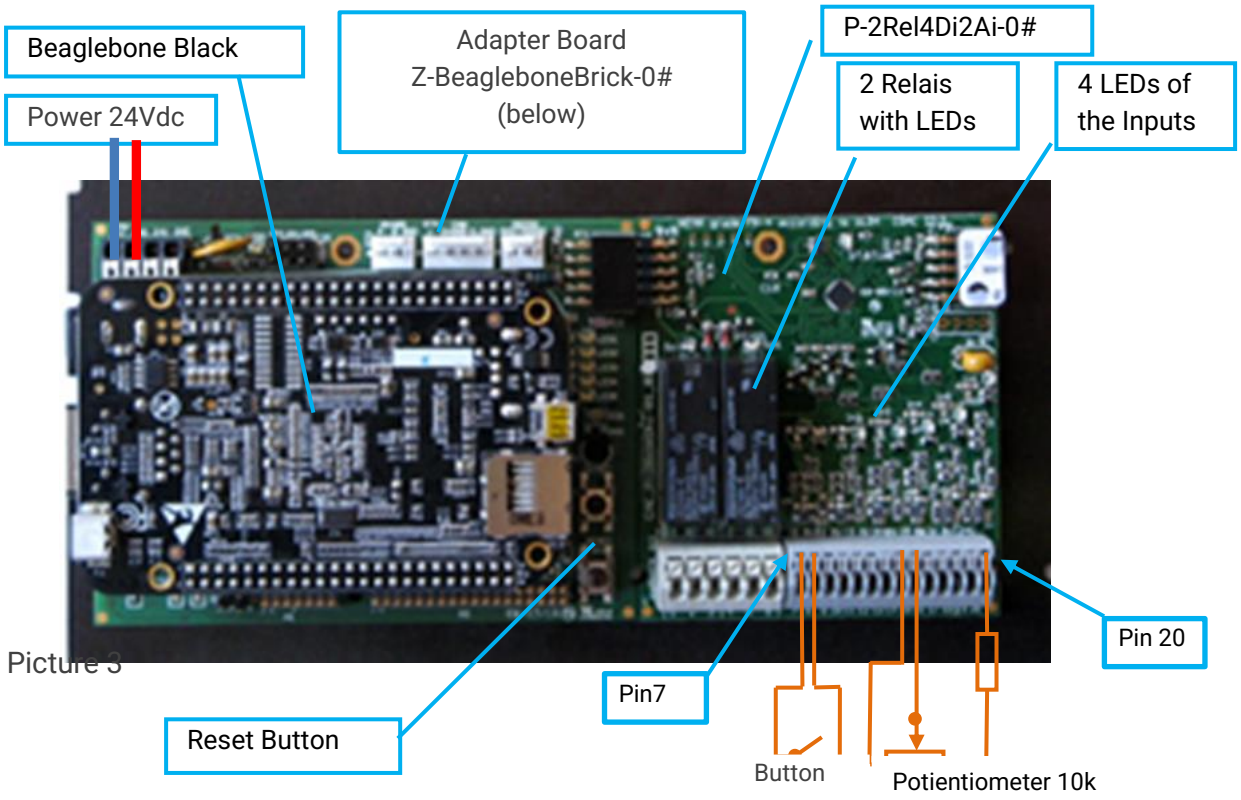
There are two Board Support Packages available for download at embrick.de for this starterkit.

The BSP Z-BeagleboneBrick-V## contains sources and examples in the programming language C. It includes an application, which you can compile and execute directly on the Beagelbone Black. If you want to try out Beagelebone Black and emBrick this way please use this package and go to the chapter Hands on Software – C Programming on Debian

3. Mounting and wiring

Please connect the *adapter board* to the *slave module* in the order shown in the picture below.

For more detailed information about the components (terminal assignment, electrical data etc.) refer to the Product Catalogue.



Picture 3

1. There should be two spacers on the adapter board, which prevent faulty mounting. **If not you need to make sure you mount the Beaglebone Black correctly!** The LAN connector must face the short side with the power connector. In addition, the shape of the Beaglebone Black is printed onto the adapter board, which shows the correct mounting position. Mount the Beaglebone Black on top of the Z-BeagleboneBrick-0# adapter board.
   Wrong installation can cause permanent damage to either device!
2. Connect the adapter board (Z-BeagleboneBrick-0#) with the *slave module* (P-2Rel4Di2Ai-01) in the shown order.
3. Mount the boards onto the carrier board.
4. Connect LAN cable (with internet access), HDMI monitor (Note: The monitor does not work with the custom image for radCASE. The signals are relayed to the LCD interface instead.), keyboard and mouse to the Beaglebone Black USB Port (you do not have to do this if you are going to work with a remote desktop instead).
5. Connect an external 24VDC (power off) to the Z-BeagleboneBrick-0#. Please refer to the *Product Catalogue* if you are unsure about the correct installation. Search for "Z-BeagleboneBrick-0#" and "CAE_P-2Rel4Di2Ai-0#".
6. Recommended: With three additional electronic parts, you can test the starter kit functionality.
   a) Connect a potentiometer (10kOhm) via a series resistor (22kOhm) on pin 14 (ground), pin 15 (analog input), pin 19 (24V) on slave module.
   b) Connect a button on I/Os pin 7 (digital input) and pin 8 (ground).

Result: Now the hardware is properly set up. Next up is the software installation.

4. Hands on Software – C Programming on Debian

4.1 Preparation

This section summarizes which releases/versions of hard and software is needed throughout this tutorial so that you can check if you have the proper hard or software if you encounter any troubles.

There are two sample applications with emBrick modules. If you execute the sample applications, a line for every module will be displayed.

For example: **module 01 ..... ID:2-181, Mod-Vers: 13, Prot-Vers: 11**

- "module 01" means that the module is the first module connected to the Beaglebone Black adapter board.
- "2-181" is the ID of the module
- "Mod-Vers: 13" is the version of the module
- "Prot-Vers: 11" is the protocol version of the module. Each module should have the same or higher protocol version which is currently 11.

The first sample application requires the following emBrick module:

Module Name	ID	Module Version	Prot.-Version
CAE_P-2Rel4Di2Ai	5-131	18	11

The second extended sample application needs the following modules:

Module Name	ID	Module Version	Prot.-Version
CAE_B-4DimLEDI	4-566	12	11
CAE_B-6Moti2LDR	4-411	16	11
CAE_P-2Rel4Di2Ai	5-131	18	11
CAE_G-8Di8DO	2-181	13	11

If you start a sample application (in section 4.5) it should display the same version numbers or higher for the respective module or the sample application might not work as described.

Software used on the Beaglebone for the tutorials:

- Geany 1.22
- GNU Make 3.81
- GCC 4.6.3 (GNU Compiler Collection)

If you already have an older version of any of these programs installed, you might encounter problems while using the sample applications. In that case, please update your Beaglebone's software using the commands "sudo apt-get update" and "sudo apt-get upgrade".

4.1.1 Install Debian

Turn on the 24VDC power supply. The Beaglebone Black will boot and display a desktop on the screen.

If you don´t have the Debian Wheezy Version click on the following link: Wheezy7.5

If your Beaglebone comes with an already preinstalled Debian Wheezy with Version 7.5 or 7.8 the examples and instruction in this manual should work. It could work with newer image re-

leases but this is not guaranteed. If you are unsure whether you have the right Debian version, just continue and test if everything's working fine.

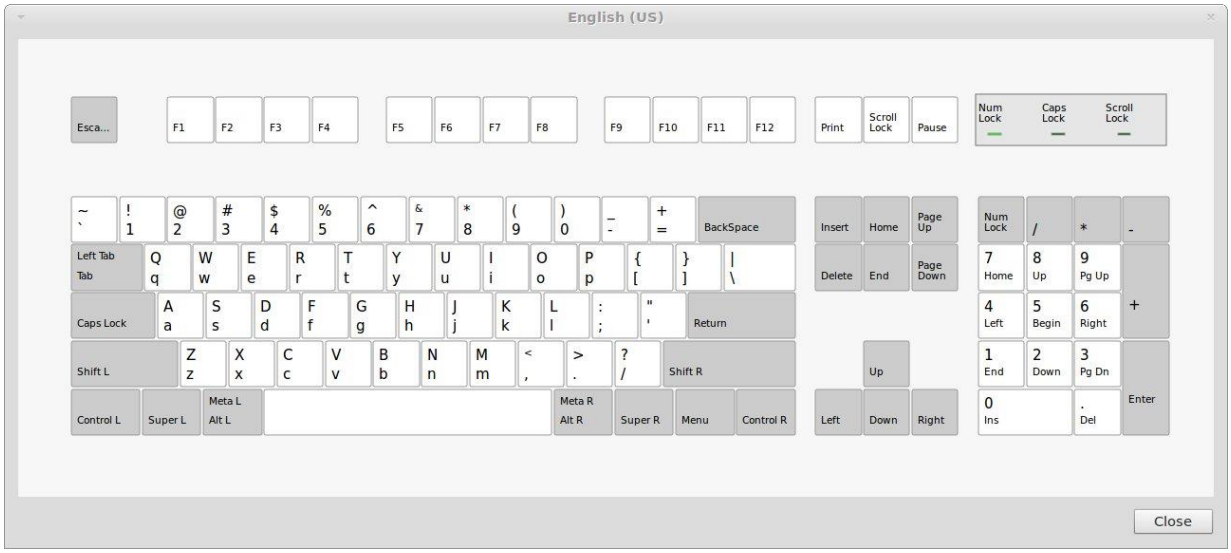
If you want to use a remote desktop instead of a real monitor and input devices, please go to 6.4 Using a remote desktop now and return to this point once you're done. In that case, you can skip the next chapter.

You might have difficulties typing commands because your keyboard has a non-English layout. Please use Picture 4 below if you don't know how your keyboard corresponds to the English layout.

If you start Debian for the first time your mouse and keyboard might not be recognized. The reason for that could be that your USB hub isn't powered. If it is powered, try to press the reset button on the adapter board (see picture 3). If mouse and keyboard still aren't recognized try to switch mouse and keyboard to other connectors of the USB hub.

4.1.2 Configure the Keyboard

If you have an English keyboard layout you don't need to do anything since the Beaglebone Black is already preconfigured for this layout. In case you want another keyboard layout you have to go through the following steps.



Picture 4

1. Execute the two following commands in the LXTerminal (located at Start Button → Accessories). These commands will install the necessary software packages from the debian repositories and therefore need internet connection. These packages might be already installed. Try to install them anyway to be sure.

```
# sudo apt-get install console-data
```

2. During the installation, a menu will be displayed in which you select your keyboard layout. As an example, the german layout will be configured. Select the following menu options.
   - Select keymap from full list
   - pc / quertz / German / Standard / latin – no dead keys

3. Then install the second package like follows.

```
# sudo apt-get install keyboard-configuration
```

4. Open another configuration menu.

 # sudo dpkg-reconfigure keyboard-configuration

Select the following menu options. This configuration is an example for the German keyboard layout.

- Generic 105-key (Intl) PC
- Other
- German
- German
- The default for the keyboard layout
- No compose key
- No

5. If you aborted the configuration in step 2 execute the command
 # sudo dpkg-reconfigure console-data
Again, configure the layout like in step 2.

6. Now you have to reboot Debian with the command
 # sudo reboot

Result: The keyboard is configured for your language.

4.1.3 Download the StarterKit Software

1. Start the Browser (usually you can find it in the menu in the lower left corner). This will start the Chromium Browser. Internet connection is required. If the message “Chromium can not be run as root” is displayed, reboot Debian using the start menu and the Logout command, this will start Debian without root rights. Then try to start the browser again. If this is not working, please consider downloading the software to another PC (like your local PC when using a remote desktop) and transferring it to the Beaglebone via sFTP. To do this, you can use any sFTP client (like FileZilla or WinSCP) and connect directly to the Beaglebone’s IP using the username root. We recommend putting the zip file in the folder /home/beagle. Please remember this path.
2. Open the emBrick download page (www.embrick.de/download) and download the board support package from the Download page.
3. The zip file shold be now in /home/debian/Downloads. You will need it later.

4.2 Setup the Development environment

4.2.1 Install the C-Programming IDE for Beaglebone Black

To write and compile your own applications you need a C-IDE. We recommend using Geany IDE. The Beaglebone Black will need access to internet for the installation.

If you already have Geany installed on your Beaglebone Black you can ignore this step.

Install the *Geany IDE* step by step:

- Open a LXTerminal (Symbol in lower left corner → Accessories → LXTerminal)
- Type in LXTerminal: **sudo apt-get install geany**. This will install the Geany IDE.

Result: Now you can create and edit C-applications and compile them.

4.2.2 Enable SPI

Note: The instructions below were tested with kernel version 3.8.13 (use the command "uname -a" to find out your kernel version). Other versions might work but this is not guaranteed.

The emBrick modules are controlled via SPI and this section shows how to do that.

Open the LXTerminal (Symbol in lower left corner → Accessories → LXTerminal) and type the following command.

 # echo 'BB-SPIDEV0' | sudo tee /sys/devices/bone_capemgr.9/slots

The asterisk is a number which will be different for every installation. You can just hit the TAB-key after you typed the dot before the asterisk and the right number will be added.

If you get an error message which says "No such file or directory" the file BB-SPIDEV0.dtbo might be missing. You can copy this file from the /home/beagle/emBone directory (or the directory you chose for the support package, see chapter 4.3 for unpacking instructions) to the directory **/lib/firmware** and then try to execute the command **echo 'BB-SPIDEV0' | sudo tee /sys/devices/bone_capemgr.*/slots** again.

This will activate the SPI0 only temporary i.e. as long as Debian isn't rebooted. To make it permanent open LXTerminal and type the command **sudo leafpad /etc/default/capemgr**. The leafpad text editor will pop up with the file capemgr opened. Add the following line at the end of the file

CAPE=ADAFRUIT-SPI0

and save the file and close the leafpad editor.

If you chose just edit the capemgr file, you will have to restart your Beaglebone to activate SPI.

Result: Now the SPI0 of the Beaglebone Black is enabled.

4.3 Unzip the Z-BeagleboneBrick_VX.XX file

The emBone software package contains the *brickBUS®* protocol-stack, a simple hardware abstraction layer for the Beaglebone Black and a prepared small sample applicaton to test the starter kit which can also be used as a template for own applications.

In this step, the package you downloaded earlier will be unzipped to /home/beagle.

1. Execute the following command in the LXTerminal which will install unzip from the Debian repositories, therefore an internet connection is needed.

 # sudo apt-get install unzip

2. Go to the /home/debian/Downloads directory by executing the following command. If you saved the zip file to another folder, replace the given path with yours.

 # cd /home/debian/Downloads

3. To unzip the zip file Z-BeagleboneBrick_VX.XX.zip execute the following command. This creates the directory /home/beagle/emBone where the sourcefiles are stored. The parameter –d defines the directory where the zip file is unzipped.

 # sudo unzip Z-BeagleboneBrick_VX.XX.zip –d /home/beagle

The subdirectory Sources contains the following files:
- Appl.c : The main sorce file containing the main() function
- bB_EasyAPI.c / bB_EasyAPI.h : a bundle of functions to access the brickBUS in different formats
- bB_master.c / bBDefines.h: The brickBUS Stack implementation. This is a general file used in different constellations.
- brickbus.c / brickbus.h : The hardware application layer containing the hardware-/platform specific interface functions
- bBConfigs.h : a set of macros to connect the brickBUS Stack in bB_master.c with the HAL in brickbus.c

The subdirectory Examples contains examples for a customer specific version of Appl.c
The file BB-SPIDEV0-00A0.dtbo is a cape Mgr file, see http://elinux.org/Capemgr

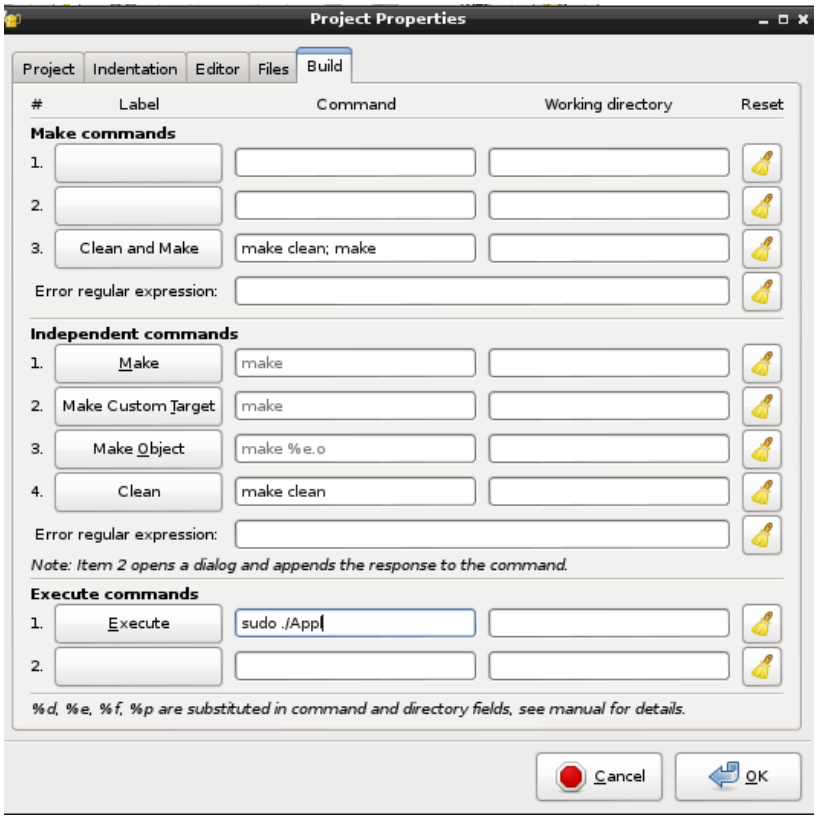
Result: Now you are ready to compile and start the sample application.

4.4 Load and compile the Sample Application

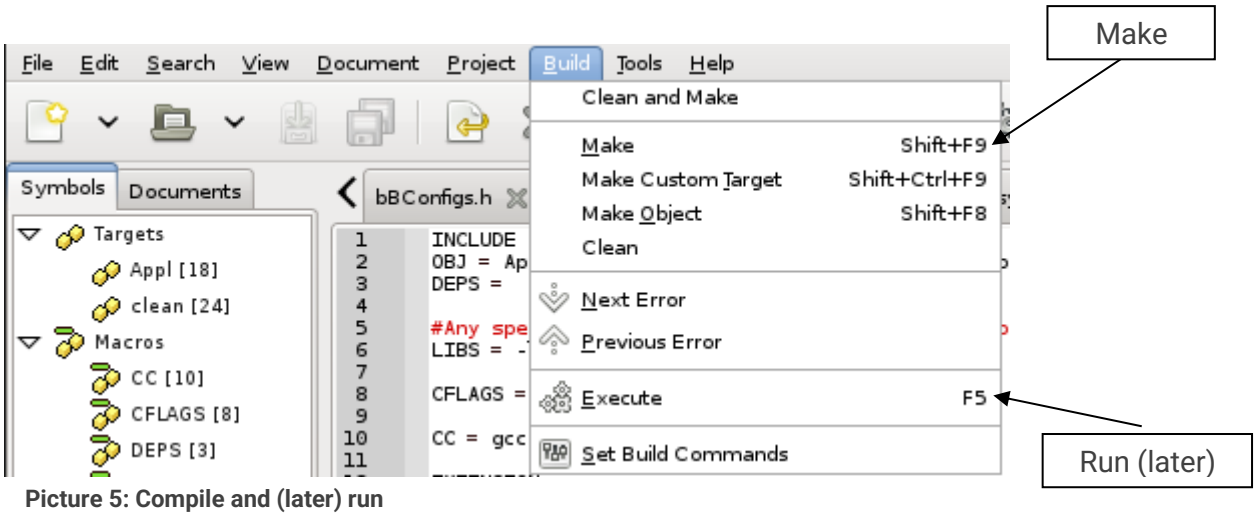
The main source file of the sample application is the *Appl.c.* It shows how to use the functions with a very simple API.

1. Open the LXTerminal
2. Type the command **sudo geany**. This opens geany with root rights so that it won't complain if it tries to compile the source code or execute an application.
3. Create a project with Poject→ New. Give the project the name emBrick or any other name you like and click create.
4. Next click File→Open from the menu and then navigate to **/home/beagle/emBone/Sources** or wherever you copied the starterkit sources and select all files with Ctrl+A. Click Open.
5. Set up the commands for compiling and executing the programm.
   Note: You probably only need to set up the Execute command, because the other commands are probably already set by default. If a command is not set up you have to set it up like described below.

   Go to Build→Set Build Commands, you will see a dialog. In the section "Make commands" click the 3. button and enter "Clean and Make" and then enter "make clean; make " in the text field to the right of the button you just clicked. In the section "Independent commands" click the 4th button and enter "Clean" and then enter "make clean" in the text field to the right of the button you just clicked. In the section "Execute commands" the 1. Button should already be named "Execute", in the text field right of this button enter "sudo ./Appl". Make sure your Build properties window looks like the screenshot below (if there's additional text in other fields, this doesn't matter), then click OK to save.



6. You can now compile the sample application by "Build"→"Make".
7. If you want to recompile the application completely regardless if the code changed or not execute Build→Clean and Make to do that.
8. And execute the application with Build→Execute.
9. If you want to open the project at a later point in time select Project→Open and select the project you want to work on.



Picture 5: Compile and (later) run

Result: The sample application is now compiled into the executable file *Appl* for the Beaglebone Black.

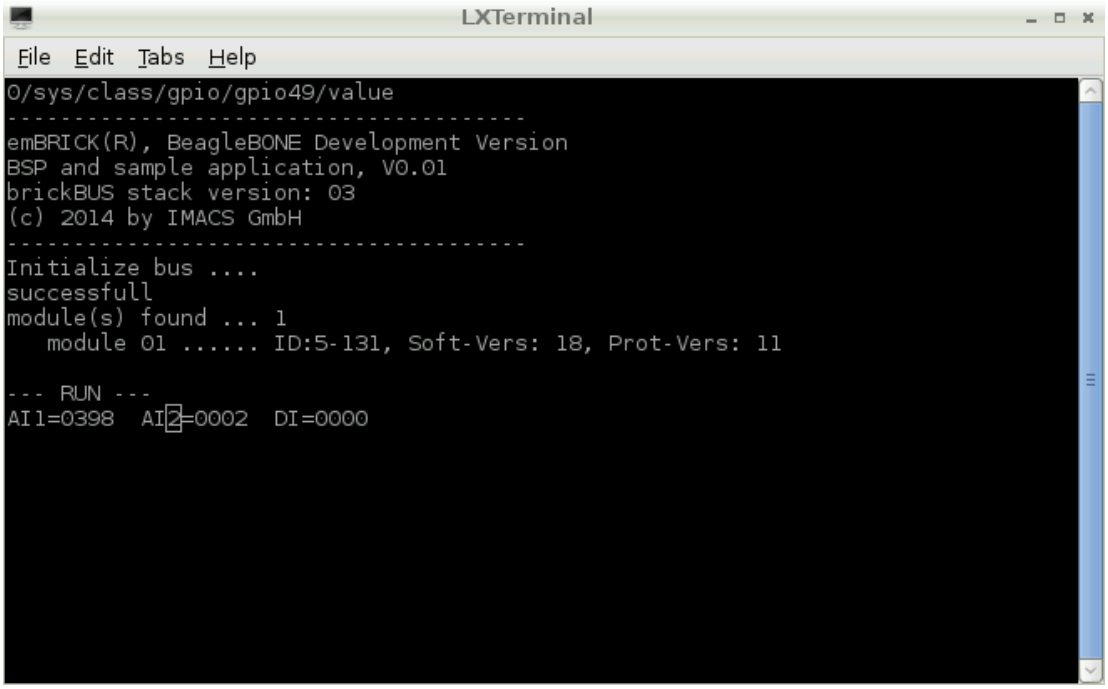
4.5 Start and explore the Functionality of "Appl"

Here we start/run the above compiled (and now executable) sample application *Appl*.

Start the Application via Geany's Menu→ Build → Execute. The shown screen display appears and the relay 1 starts alternating.

Note: As mentioned above, the application uses simple threads with i.e. sleep() functions and console output. There is no claim about realtime and fast screen output. Therefore, the permanent alternating relay could be shortly halted and the update of the input states/values is significantly delayed on the display. Feel free to modify and send us your enhancements.

With the starter kit (and the one I/O board) the application shows this screen:



Picture 6

The state of bus initialisation and the number of found slave-modules are shown. For every slave-module one additional line is printed with module-ID, the module software version and the *brickBUS®* protocol version.

The permanent execution loop in ***Appl.c***, function ***bB_Appl()***) starts with ...

- updating the two analog inputs 1 and 2 (AI1, AI2), 0...11V = 0...1023 digits
- updating the four digital inputs 1..4 ("DI=xxxx"). Note: n-switching input, 1=closed
- alternating the relay 2 with approx. 1s
- triggers LED1 (sign of life, you can see that the program runs)
- triggers relay 1 by the input state of DI1 (closed button forces activation of relay)

To stop the execution, press CTRL-C or close the window.

For more details about the hardware, see *Product Calatogue* (search for: "Z-BeagleboneBrick-0#", "P-2Rel4Di2Ai-0#"). For more details about the software see source code of Appl.c, the other files of emBerry and the scheduling information in chapter 5.

4.6 Create your own application

The complete sample application consists of multiple hierarchical files that are included and linked together. The easiest and fastest way to write your own application is to use and modify the sample application. For this purpose, you can start by changing the file ***Appl.C***. Once you have acquired some knowledge in the *emBRICK®* system you can also change ***bB_EasyAPI.c***().

Please follow the listed steps:

Note: Only LED1 can be used for testing purposes. LED2 and LED3 are already occupied.

1. Unzip the **Z-BeagleboneBrick_VX.XX.zip** again in **another** folder, i.e. ***/home/beagle/myappl***.
2. Open the ***Appl.c*** with Geany-IDE like before. (see section 4.4)
3. Application file ***Appl.c***, the inside content of ***bB_Appl()***.
4. Write your own application code inside the ***bB_Appl()***. For this, use the I/O-functions and I/O-assignment listed below.
5. Start the compilation and execution of your application as descriped in 4.5

4.6.1 Example

Currently, the application controls the relay 2 so that it alternates every second. Now we change the application so that relay 1 also alternates every second.

- Unzip the **Z-BeagleboneBrick_VX.XX.zip** again in another folder, i.e. ***/home/beagle/example***.
- Open the ***Appl.c*** with Geany-IDE like before. (see section 4.4)
- Write the command "***bB_putBit(MOD1_REL1, (counter & 0x10) ? 1:0);***" inside the ***bB_Appl()***.
- Remove the commands ***"b = bB_getBit(MOD1_DI1);"*** and ***"bB_putBit(MOD1_REL1, b);"***
- Start the compilation and execution of your application as described in 4.4 and 4.5
- Now both relays 1 and 2 alternate every second.

4.6.2 IO-Assignment

The data of the I/O modules are organized in a byte buffer for each module (a separate one of in- and out-data). To access this data, you need to know the ...

bus number..... (here always 1 because we have only one local bus),
slave number (1...) ..... position of module in string,
byte position (0...) ..... relative position/offset of the data inside the module image. For details of each module refer to Product Catalogue, chapter 6.x.x.7, "process data image"
bit position (0..7)..... **only** in case of a bit access, indicates the bit in the selected byte

4.6.3 IO-Functions

The actual data access is performed by 6 simple functions that differ in the direction (read/write) and the data width (bit, byte, word).

read: **bB_getBit(), bB_getByte(), bB_getWord()**

write: **bB_putBit(), bB_putByte(), bB_putWord()**

Tipp: To avoid the manual input of the single digits in the function parameter, create a macro definition for each I/O you like to use that contains these digits.

For example:

#define MY_BUTTON 1,1,0,1 // Node 1, Module 1, Byte 0, Bit 1

this allows the coding: *bB_getBit(MY_BUTTON)* instead of *bB_getBit(1,1,0,1)*

Of course, there are more functions to control the *brickBUS*® stack and access to process and condition data. Read more about in the next chapter or the Programmers Manual.

The *bB_EasyAPI* is one possibility to access the stack. It is recommended to write your own set of API functions or modify the stack itself according to your requirements.

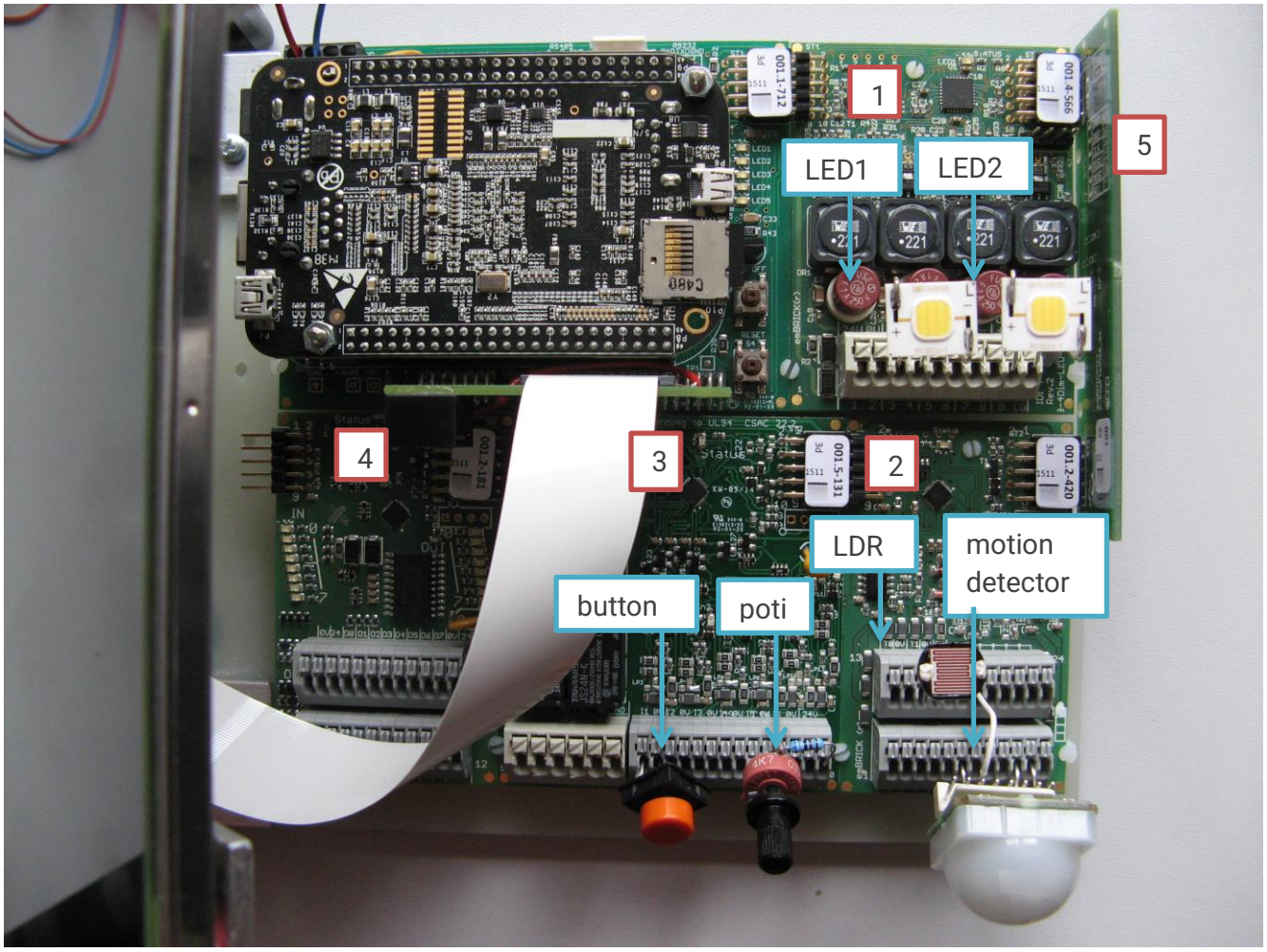
4.7 Extended Example

For this Example, you will need the following emBrick modules and components:

1. B-4DimLEDI with two LEDs which are connected to terminal 3 ("+"), terminal 4 ("-") and terminal 9 ("+"), terminal 10 ("-") respectively. You also need to connect a 24V power supply to terminal 1 ("24") and terminal 2 ("0").
2. B-6Moti2LDR with a **L**ight **D**ependent **R**esistor connected to terminal 15 ("T2"), terminal 16 ("0V") and a motion detector connected to terminal 11 ("I6"), terminal 12 ("0V").
3. P-2Rel4Di2Ai with a button connected to terminal 7 ("I1"), terminal 8 ("0V") and a potentiometer connected to terminal 17 ("I6"), terminal 18 ("0V").
4. G-8Di8Do (no components)
5. X-ExpFlatM10 Connector

Please connect these modules in this order. The first module is closest to the Beaglebone Black, see the numbers in the red boxes.

It should look something like this



The needed Software for this example is in the Starterkit you downloaded earlier. "Appl_Demo2.c" is the one you need here. Copy the file "Appl_Demo2.c" in the folder Source which is also in the emBone folder. In the folder Source delete the file "Appl.c" and rename the copied file "Appl_Demo2.c" to "Appl.c". The easiest way to do that is to execute the two following commands:

 # cd /home/beagle/emBone/Sources

 # cp ../Examples/Appl_Demo2.c Appl.c

Next, compile and run the downloaded Example like you did in chapter 4.4.

Here is what the application does:

The LED1 adapts its brightness to the ambient brightness. Try to cover the LDR to see how the brightness of LED1 changes. The motion detector triggers a relay if it detects any movement. You can control the brightness of LED2 with the potentiometer. The potentiometer also controls the switching frequency of the second relay which can be turned on and off with the button. The output LEDs on the 8Di8Do are representing a binary number wich is counted up continuosly.

5. Extendend Informations for brickBUS® Stack

Currently you can only get this information on request.
Please contact: support@embrick.de

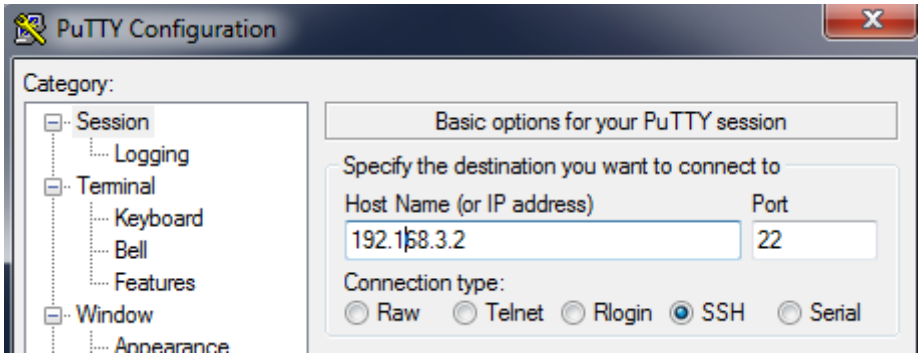
6. Appendix

6.4 Using a remote desktop

Here is how to connect to the Beaglebone via “PuTTY” to set up the software “tightvncserver” and how to use it.

When the Beaglebone is booting, it will try to fetch an IP address from your local network via DHCP. If you are using a USB to LAN adapter, you will need a local DHCP server running on your PC (we recommend the program DHCP Server by Uwe Ruttkamp, you can download it from www.dhcpserver.de). If you’re using an ordinary LAN, you can get the Beaglebone’s IP by using a network scanner like SoftPerfect Network Scanner (https://www.softperfect.com/products/networkscanner/) on another PC in that same network.

Once you’ve obtained the Beaglebone’s IP address, you can connect to it from a PC connected to the same network with the program PuTTY. You can of course use any other SSH client, too, but we recommend using PuTTY. You can download it from the following URL: http://www.putty.org/. Then you have to start putty.exe. Now enter the Beaglebone’s IP, enter 22 as Port and choose SSH as connection type.



Now click the “Open”-Button, PuTTY will then try to connect to the Beaglebone.

If the connection was established successfully, you can now enter your login credentials. You will know this by a black console window with the text “login as:” opening.

The standard username is **root**, you should not need a password.

Next, please execute the command “tightvncserver” in PuTTY.
You will be asked to specify a password for your VNC server, please do this. You do not need to setup a view-only password. You VNC server will be started automatically.

You will now need to download the software TightVNC Viewer to your PC and install it. You can find it here: http://www.tightvnc.com/download.php.

Once you’re done, start the TightVNC viewer and enter the following server address “xxx.xxx.xxx.xxx:1”, where xxx.xxx.xxx.xxx is your Beaglebone’s IP address. Click the connect button and enter the password you specified earlier. You should now have successfully initiated a remote desktop connection to your Beaglebone Black. If you want to use the remote desktop another time, you can start it simply by executing the command “tightvncserver”.

6.11 Configuring a static IP address

First you need to gather some information

7. Log in to the Beaglebone Black like described in section 2.3.

ifconfig

The following output will be shown:

```
eth0   Link encap:Ethernet  HWaddr 7c:66:9d:6d:02:ef
       inet addr:192.168.100.121  Bcast:192.168.100.255  Mask:255.255.255.0
       inet6 addr: fe80::7e66:9dff:fe6d:2ef/64 Scope:Link
       UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
       RX packets:5654 errors:0 dropped:0 overruns:0 frame:0
       TX packets:250 errors:0 dropped:0 overruns:0 carrier:0
       collisions:0 txqueuelen:1000
       RX bytes:2752213 (2.6 MiB)  TX bytes:35650 (34.8 KiB)
       Interrupt:56
```

Write down the following information:

Inet addr: 192.168.100.121
Bcast: 192.168.100.255
Mask: 255.255.255.0

You will need it later.

8. Next execute the following command

   # netstat –nr

   You will get the following output:

Kernel IP routing table

Destination	Gateway	Genmask	Flags	MSS	Window	irtt	Iface
0.0.0.0	192.168.100.100	0.0.0.0	UG	0	0	0	eth0
192.168.7.0	0.0.0.0	255.255.255.252	U	0	0	0	usb0
192.168.100.0	0.0.0.0	255.255.255.0	U	0	0	0	eth0

Look at the rows where Iface is “eth0”. Write down the Gateway and Destination.

Gateway: 192.168.100.100
Destination: 192.168.100.0

Now we have what we needed to configure the static IP address.

9. Open the the file /etc/network/interfaces with nano with the command. Nano is a small text editor which comes with the Debian distribution.

nano /etc/network/interfaces

10. Add the following lines at the end of the file

auto eth0

iface eth0 inet static
address 192.168.100.110
netmask 255.255.255.0
gateway 192.168.100.100
network 192.168.100.0
broadcast 192.168.100.255

The address can be any of the form 192.168.100.xxx except 192.168.100.255 (broadcast address), 192.168.100.100 (gateway addres) and 192.168.100.0 (network)

Of course your addresses may be different.

11. Press CRTL+X when you're finished this will quit nano, but ask you if you want to save. Press the Y key and then Enter to save and quit.

12. Now you have to reboot by executing the following command

reboot