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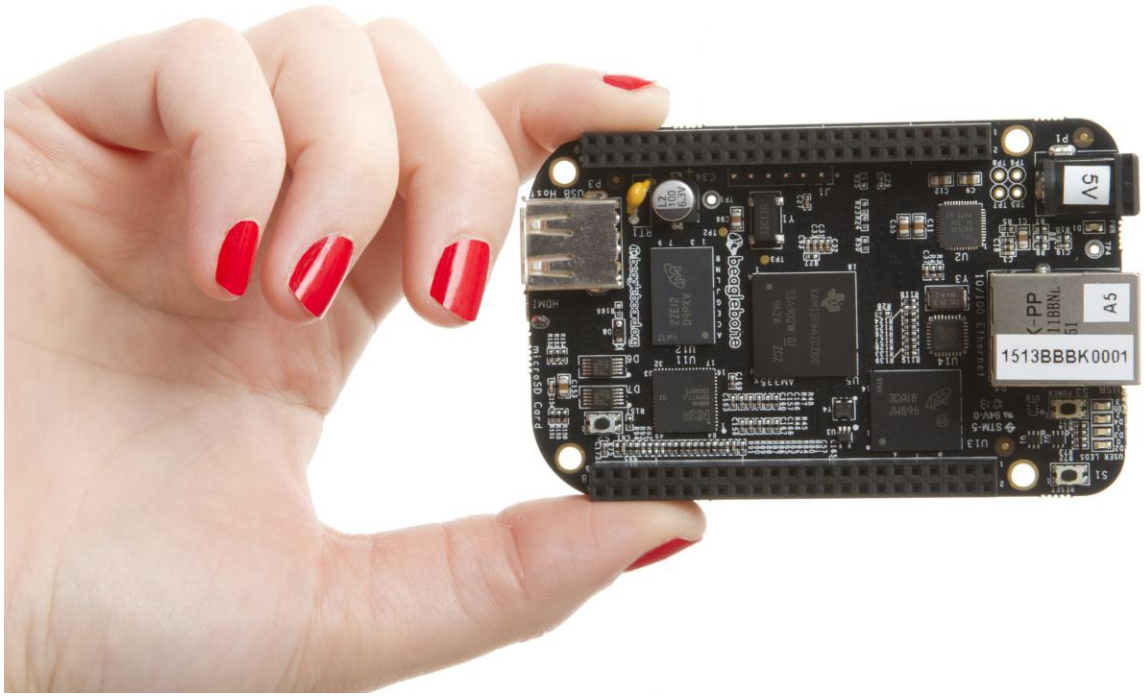

BeagleBone Black System Reference Manual

Revision B
January 20, 2014

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THIS DOCUMENT

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BeagleBoard.org
1380 Presidential Dr. #100
Richardson, TX 75081
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For up to date SW images and technical information refer to
http://circuitco.com/support/index.php?title=BeagleBoneBlack

All support for this board is provided via community support at
www.beagleboard.org/discuss

To return a defective board for repair, please request an RMA at
http://beagleboard.org/support/rma

Please DO NOT return the board without approval from the RMA team first.

All boards received without RMA approval will not be worked on.

Table of Contents

Figures

Tables

1.0 Introduction

This document is the **System Reference Manual** for the BeagleBone Black and covers its use and design. The board will primarily be referred to in the remainder of this document simply as the board, although it may also be referred to as the BeagleBone Black as a reminder. There are also references to the original BeagleBone as well, and will be referenced as simply BeagleBone.

This design is subject to change without notice as we will work to keep improving the design as the product matures based on feedback and experience. Software updates will be frequent and will be independent of the hardware revisions and as such not result in a change in the revision number.

Make sure you check the support Wiki frequently for the most up to date information.

http://circuitco.com/support/index.php?title=BeagleBoneBlack

2.0 Change History

This section describes the change history of this document and board. Document changes are not always a result of a board change. A board change will always result in a document change.

2.1 Document Change History

Table 1. Change History

Rev	Changes	Date	By
A4	Preliminary	January 4, 2013	GC
A5	Production release	January 8.2013	GC
A5.1	1. Added information on Power button and the battery access points. 2. Final production released version.	April 1 2013	GC
A5.2	1. Edited version. 2. Added numerous pictures of the Rev A5A board.	April 23 2013	GC
A5.3	1. Updated serial number locations. 2. Corrected the feature table for 4 UARTS 3. Corrected eMMC pin table to match other tables in the manual.	April 30, 2013	GC
A5.4	1. Corrected revision listed in section 2. Rev A5A is the initial production release. 2. Added all the locations of the serial numbers 3. Made additions to the compatibility list. 4. Corrected Table 7 for LED GPIO pins. 5. Fixed several typos. 6. Added some additional information about LDOs and Step-Down converters. 7. Added short section on HDMI.	May 12, 2013	GC
A5.5	1. Release of the A5B version. 2. The LEDS were dimmed by changing the resistors. 3. The serial termination mode was incorporated into the PCB.	May 20, 2013	GC
A5.6	1. Added information on Rev A5C 2. Added PRU/ICSS options to tables for P8 and P9. 3. Added section on USB Host 4. Correct modes on Table 15. 5. Fixed a few typos	June 16, 2013	GC
A5.7	1. Updated assembly revision to A6. 2. PCB change to add buffer to the reset line and ground the oscillator GND pin. 3. Added resistor on PCB for connection of OSC_GND to board GND.	August 9, 2013	GC
A6	1. Added Rev A6 changes.	October 11, 2013	GC
A6A	1. Added Rev A6A changes	December 17, 2013	GC
B	1. Changed the processor to the AM3358BZCZ	January 20, 2013	GC

2.2 Board Changes

2.2.1 Rev B

- Changed the processor to the AM3358BZCZ100.

2.2.2 Rev A6A

- Added connection from 32KHz OSC_GND to system ground and changed C106 to 1uF.

- Changes C25 to 2.2uF. This resolved an issue we were seeing in a few boards where the board would not boot in 1 in 20 tries.
- Change required PCB revision to B6.

2.2.3 Rev A6

- In random instances there could be a glitch in the SYS_RESETn signal from the processor where the SYS_RESETn signal was taken high for a momentary amount of time before it was supposed to. To prevent this, the signal was ORed with the PORZn (Power On reset).
- Noise issues were observed in other design where the clock oscillator was getting hit due to a suspected issue in ground bounce. A zero ohm resistor was added to connect the OSC_GND to the system ground.

There are no new features added as a result of these changes.

2.2.4 Rev A5C

We were seeing some fallout in production test where we were seeing some jitter on the HDMI display test. It started showing up on out second production run. R46, R47, R48 were changed to 0 ohm from 33 ohm. R45 was taken from 330 ohm to 22 ohm.

We do not know of any boards that were shipped with this issue as this issue was caught in production test. No impact on features or functionality resulted from this change.

2.2.5 Rev A5B

There is no operational difference between the Rev A5A and the Rev A5B. There were two changes made to the A5B version.

- Due to complaints about the brightness of the LEDs keeping people awake at night, the LEDs were dimmed. Resistors were changed from 820 ohms to 4.75K ohms.
- The PCB revision was updated to incorporate the hand mod that was being done on the board during manufacturing. The resistor was incorporated into the next revision of the PCB.

The highest supported resolution is now listed as 1920x1080@24Hz. This was not a result of any hardware changes but only updated software. The A5A version also supports this resolution.

2.2.6 Rev A5A

This is the initial production release of the board. We will be tracking changes from this point forward.

3.0 Connecting Up Your BeagleBone Black

This section provides instructions on how to hook up your board. Two scenarios will be discussed:

1) Tethered to a PC and
2) As a standalone development platform in a desktop PC configuration.

3.1 What's In the Box

In the box you will find three main items as shown in **Figure 1**.

- BeagleBone Black
- miniUSB to USB Type A Cable
- Instruction card with link to the support WIKI address.

This is sufficient for the tethered scenario and creates an out of box experience where the board can be used immediately with no other equipment needed.

Figure 1. In The Box

3.2 Main Connection Scenarios

This section will describe how to connect the board for use. This section is basically a slightly more detailed description of the Quick Start Guide that came in the box. There is also a Quick Start Guide document on the board that should also be refereed. The intent here is that someone looking t purchase the board will be able to read this section and get a good idea as to what the initial set up will be like.

The board can be configured in several different ways, but we will discuss the two most common scenarios as described in the Quick Start Guide card that comes in the box.

- Tethered to a PC via the USB cable
  - Board is accessed as a storage drive
  - Or a RNDIS Ethernet connection.
- Standalone desktop
  - Display
  - Keyboard and mouse
  - External 5V power supply

Each of these configurations is discussed in general terms in the following sections.

For an up-to-date list of confirmed working accessories please go to
http://circuitco.com/support/index.php?title=BeagleBone_Black_Accessories

3.3 Tethered To A PC

In this configuration, the board is powered by the PC via the provided USB cable--no other cables are required. The board is accessed either as a USB storage drive or via the browser on the PC. You need to use either Firefox or Chrome on the PC, IEx will not work properly. **Figure 2** shows this configuration.

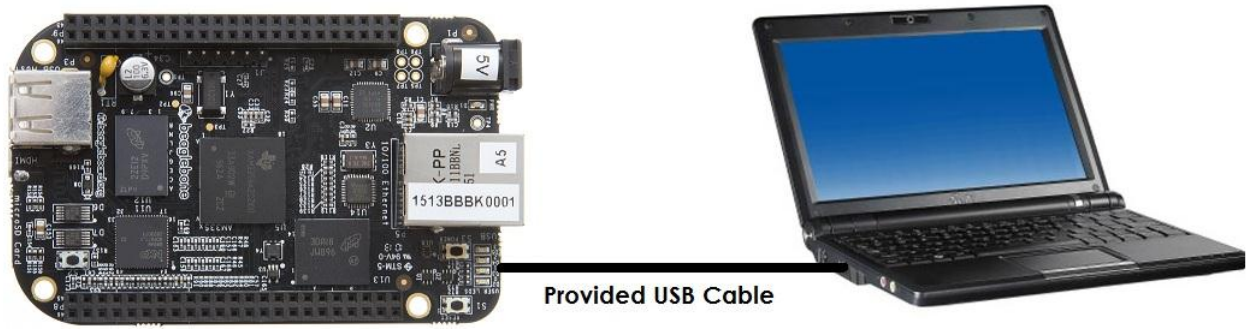

Figure 2. Tethered Configuration

All the power for the board is provided by the PC via the USB cable. In some instances, the PC may not be able to supply sufficient power for the board. In that case, an external 5VDC power supply can be used, but this should rarely be necessary.

3.3.1 Connect the Cable to the Board

1. Connect the small connector on the USB cable to the board as shown in **Figure 4**. The connector is on the bottom side of the board.

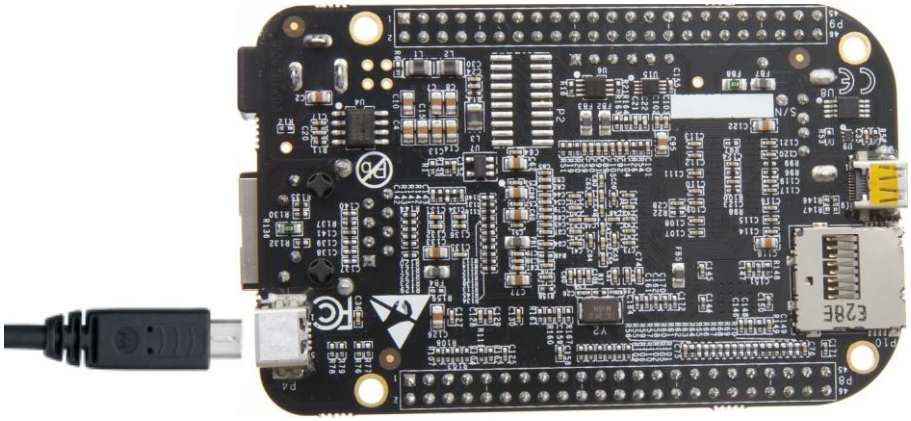

Figure 3. USB Connection to the Board

2. Connect the large connector of the USB cable to your PC or laptop USB port.

3. The board will power on and the power LED will be on as shown in **Figure 4** below.

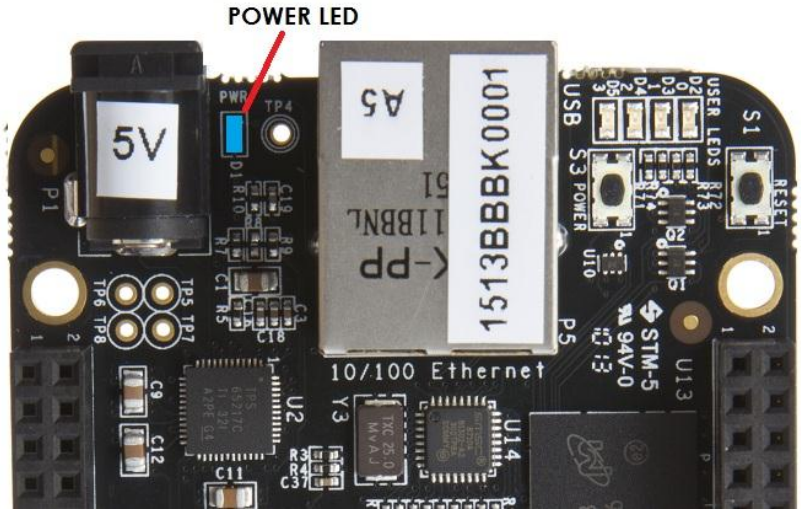

Figure 4. Board Power LED

4. When the board starts to the booting process started by the process of applying power, the LEDs will come on in sequence as shown in **Figure 5** below. It will take a few seconds for the status LEDs to come on, so be patient. The LEDs will be flashing in an erratic manner as it begins to boot the Linux kernel.

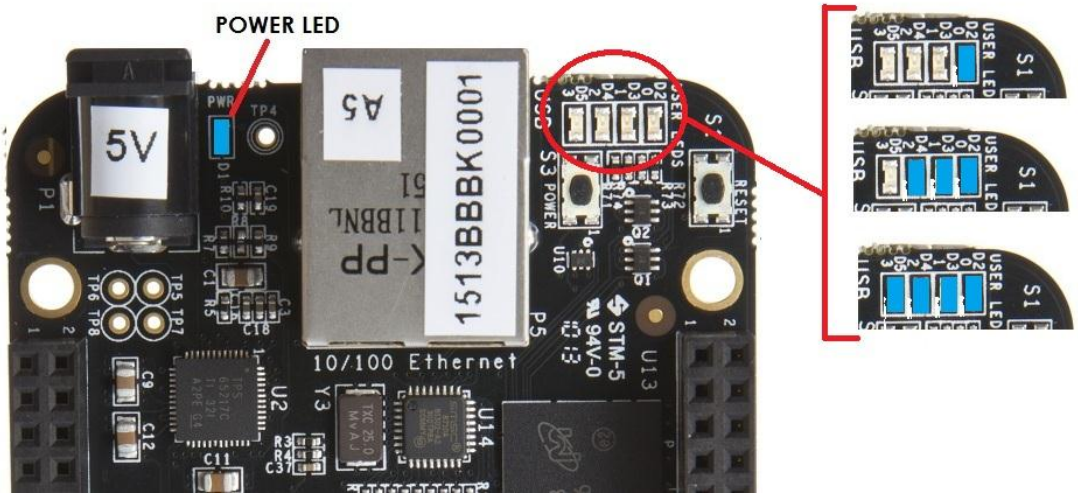

Figure 5. Board Boot Status

3.3.2 Accessing the Board as a Storage Drive

The board will appear around a USB Storage drive on your PC after the kernel has booted, which will take a round 10 seconds. The kernel on the board needs to boot before the port gets enumerated. Once the board appears as a storage drive, do the following:

1) Open the USB Drive folder.
2) Click on the file named **start.html**
3) The file will be opened by your browser on the PC and you should get a display showing the Quick Start Guide.
4) Your board is now operational! Follow the instructions on your PC screen.

3.4 Standalone w/Display and Keyboard/Mouse

In this configuration, the board works more like a PC, totally free from any connection to a PC as shown in **Figure 6**. It allows you to create your code to make the board do whatever you need it to do. It will however require certain common PC accessories. These accessories and instructions are described in the following section.

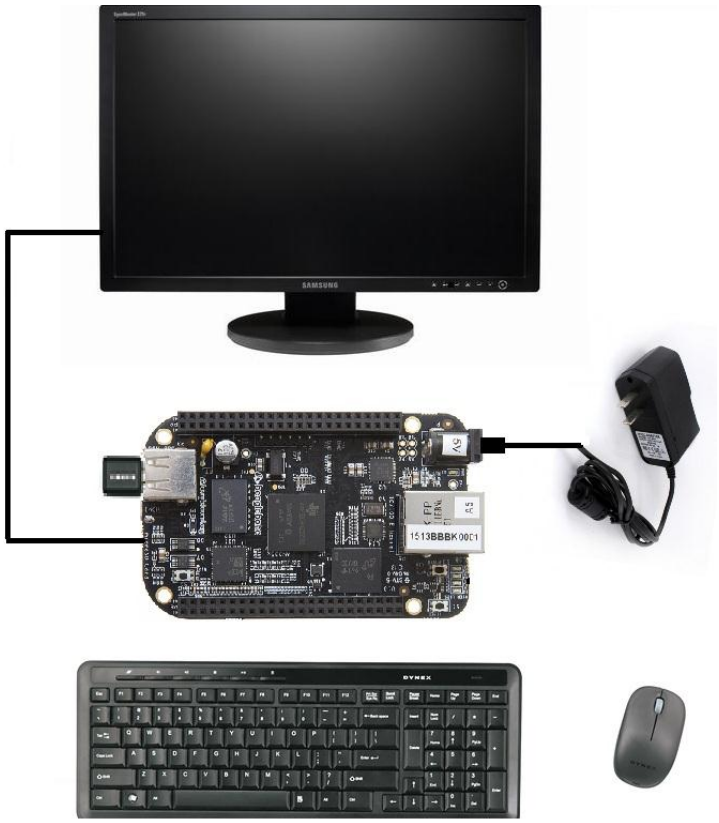

Figure 6. Desktop Configuration

Optionally an Ethernet cable can also be used for network access.

3.4.1 Required Accessories

In order to use the board in this configuration, you will need the following accessories:

- (1) 5VDC 1A power supply
- (1) HDMI monitor or a DVI-D monitor. (**NOTE:** Only HDMI will give you audio capability).
- (1) Micro HDMI to HDMI cable or a Micro HDMI to DVI-D adapter.
- (1) USB wireless keyboard and mouse combo.
- (1) USB HUB (OPTIONAL). The board has only one USB host port, so you may need to use a USB Hub if your keyboard and mouse requires two ports.

For an up-to-date list of confirmed working accessories please go to
http://circuitco.com/support/index.php?title=BeagleBone_Black_Accessories

3.4.2 Connecting Up the Board

1. Connect the big end of the HDMI cable as shown in **Figure 7** to your HDMI monitor. Refer to your monitor Owner's Manual for the location of your HDMI port. If you have a DVI-D Monitor go to **Step 3**, otherwise proceed to **Step 4.**

Figure 7. Connect microHDMI Cable to the Monitor

2. If you have a DVI-D monitor you must use a DVI-D to HDMI adapter in addition to your HDMI cable. An example is shown in **Figure 8** below from two perspectives. If you use this configuration, you will not have audio support.

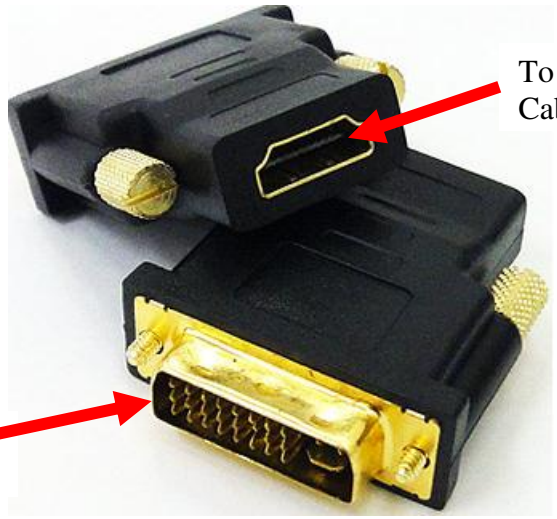

Figure 8. DVI-D to HDMI Adapter

3. If you have a single wireless keyboard and mouse combination such as seen in Figure **9** below, you need to plug the receiver in the USB host port of the board as shown in **Figure 10**.

Figure 9. Wireless Keyboard and Mouse Combo

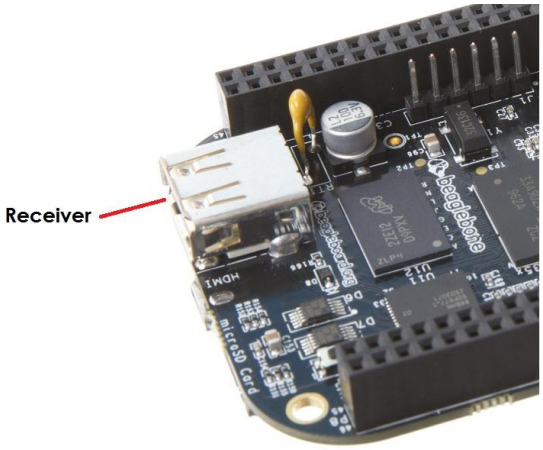

Figure 10. Connect Keyboard and Mouse Receiver to the Board

If you have a wired USB keyboard requiring two USB ports, you will need a HUB similar to the ones shown in **Figure 11**. You may want to have more than one port for other devices. Note that the board can only supply up to 500mA, so if you plan to load it down, it will need to be externally powered.

Figure 11. Keyboard and Mouse Hubs

4. Connect the Ethernet Cable

If you decide you want to connect to your local area network, an Ethernet cable can be used. Connect the Ethernet Cable to the Ethernet port as shown in **Figure 12**. Any standard 100M Ethernet cable should work.

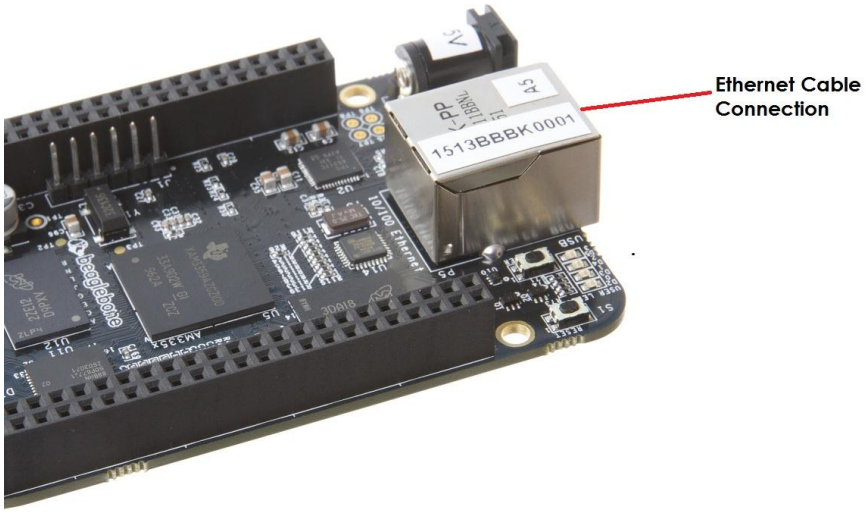

Figure 12. Ethernet Cable Connection

3.4.3 Apply Power

The final step is to plug in the DC power supply to the DC power jack as shown in **Figure 13** below.

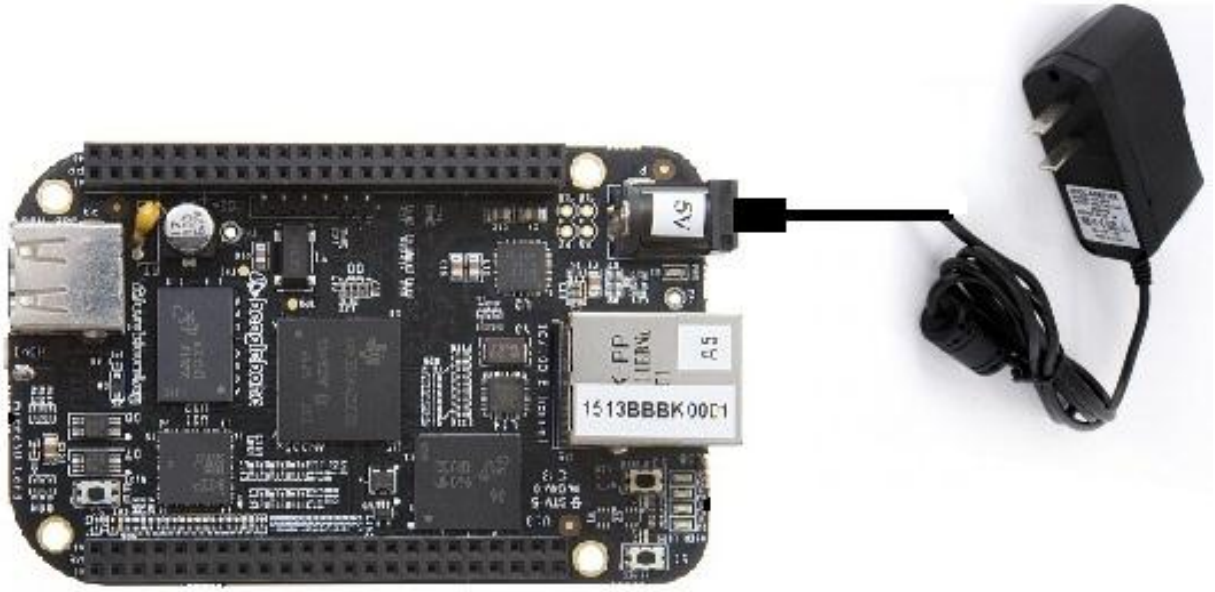

Figure 13. External DC Power

5. The cable needed to connect to your display is a microHDMI to HDMI. Connect the microHDMI connector end to the board at this time. The connector is on the bottom side of the board as shown in **Figure 14** below.

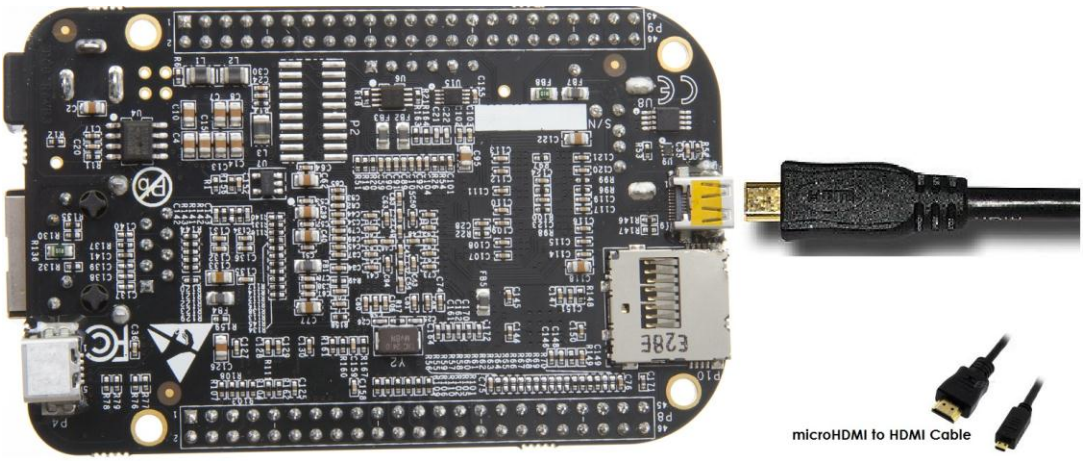

Figure 14. Connect microHDMI Cable to the Board

The connector is fairly robust, but we suggest that you not use the cable as a leash for your Beagle. Take proper care not to put too much stress on the connector or cable.

6. Booting the Board

As soon as the power is applied to the board, it will start the booting up process. When the board starts to boot the LEDs will come on in sequence as shown in **Figure 15** below. It will take a few seconds for the status LEDs to come on, so be patient. The LEDs will be flashing in an erratic manner as it boots the Linux kernel.

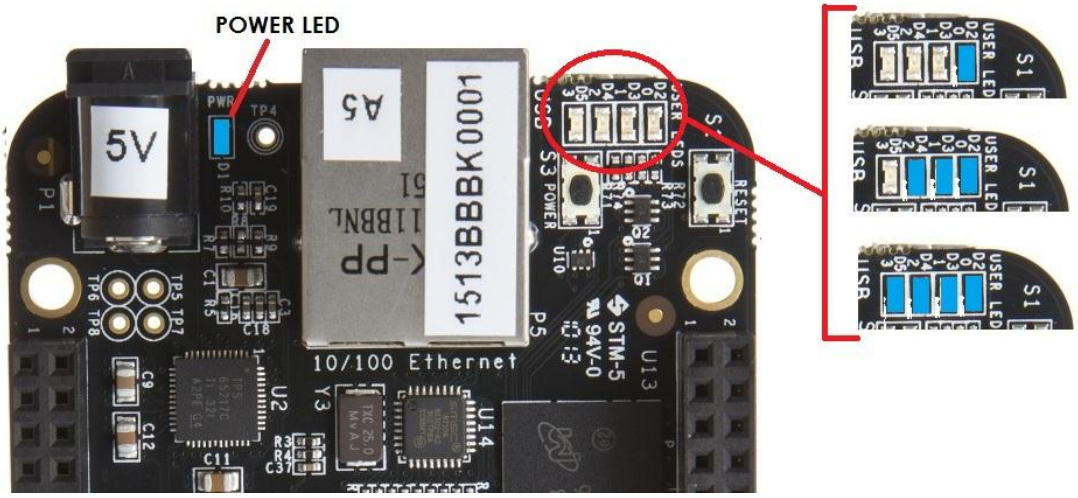

Figure 15. Board Boot Status

While the four user LEDS can be over written and used as desired, they do have specific meanings in the image that is shipped with the board once the Linux kernel has booted.

- **USER0** is the heartbeat indicator from the Linux kernel.
- **USER1** turns on when the microSD card is being accessed
- **USER2** is an activity indicator. It turns on when the kernel is not in the idle loop.
- **USER3** turns on when the onboard eMMC is being accessed.

7. A Booted System

1. The board will have a mouse pointer appear on the screen as it enters the Linux boot step. You may have to move the physical mouse to get the mouse pointer to appear. The system can come up in the suspend mode with the HDMI port in a sleep mode.
2. After a minute or two a login screen will appear. You do not have to do anything at this point.
3. After a minute or two the desktop will appear. It should be similar to the one shown in **Figure 16**. HOWEVER, it will change from one release to the next, so do not expect your system to look exactly like the one in the figure, but it will be very similar.
4. And at this point you are ready to go! **Figure 16** shows the desktop after booting.

Figure 16. Desktop Screen