/ ULTRA96

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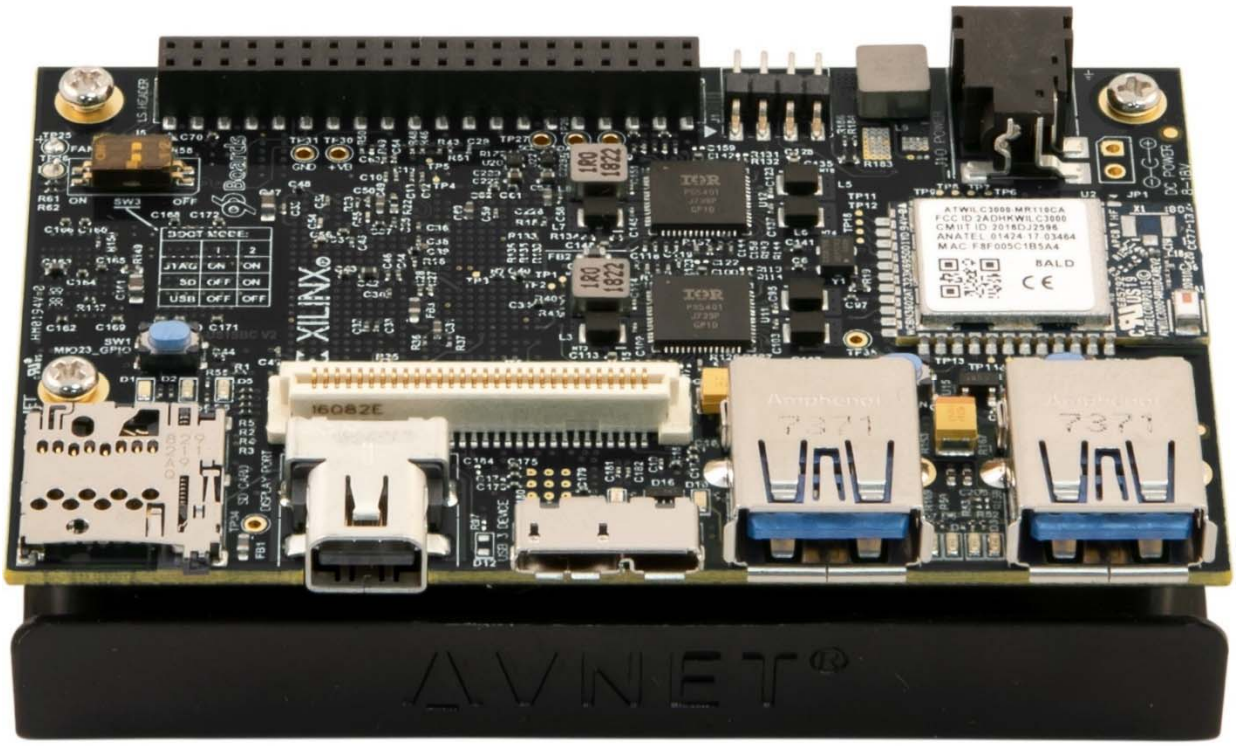

Ultra96-V2 Getting Started Guide

Version 1.0

LIT# Ultra96-V2-GSG-v1-0

Document Control

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Prior Version History

Version	Date	Comment
1.0	25 Jun 2019	Initial Ultra96-V2 Getting Started Guide (30 May 2019 image)

Contents

Figures

1 Getting Started with Ultra96-V2

The Avnet Ultra96-V2 enables hardware and software developers to explore the capabilities of the Zynq® UltraScale+™ MPSoC. Designers can create or evaluate designs for both the Zynq Processor Subsystem (PS) and the Programmable Logic (PL) fabric.

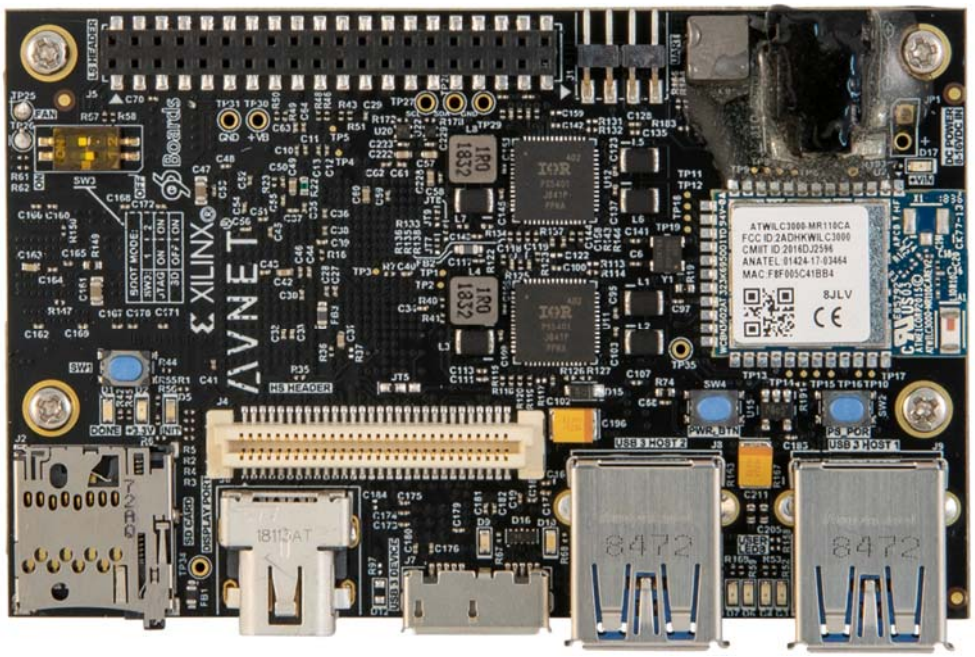


Figure 1 – Ultra96-V2

This Getting Started Guide will outline the steps to setup the Ultra96-V2 hardware. It documents the procedure to run a Linux design running on the Quad-core ARM Cortex-A53 MPCore Processing System (PS).

2 What's Inside the Box?

- Ultra96-V2 development board
- 16GB microSD card with SD adapter and jewel case
- Voucher for SDSoC license from Xilinx
- Quick Start Instruction card

2.1 Optional add-on items:

- External 96Boards compliant power supply kit (12V, 4A, International plugs)
  - AES-ACC-U96-4APWR
  - http://avnet.me/96boardpower4A
- USB-to-JTAG/UART pod for Ultra96-V2
  - AES-ACC-U96-JTAG
  - http://avnet.me/Ultra96JTAG
- 96Boards Click Mezzanine for adding Click boards to the Ultra96-V2
  - Mezzanine only -- AES-ACC-U96-ME-MEZ
  - Starter kit including 3 Click boards -- AES-ACC-U96-ME-SK
  - http://avnet.me/ClickMezzanine
- miniDP-to-HDMI adapter or cable
  - Must be an Active adapter or cable

See the **Ultra96-V2 Compatible Accessories** document and http://avnet.me/Ultra96_Accessories for other suggestions.

3 What's on the Web?

Ultra96-V2 is a community-oriented kit, with all materials being made available through the http://avnet.me/ultra96-v2 community website.

3.1 Official Documentation:

- Getting started guide
- Hardware user guide
- Schematics
- Bill of materials
- Mechanical drawing
- 3D Model
- Board definition files for Vivado integration available at https://github.com/Avnet/bdf.
- Programmable logic (PL) master user constraints

3.2 Tutorials and Reference Designs:

- TBD

3.3 Trainings and Videos:

- Live and On-Demand Technical Training Courses at http://avnet.me/TTC

4 Ultra96-V2 Key Features

- Zynq UltraScale+ MPSoC ZU3EG SBVA484
- Memory
    - Micron 2 GB (512M x32) LPDDR4 Memory
    - microSD Socket
        - Ships with Delkin Utility MLC 16GB card
- Wi-Fi / Bluetooth
- DisplayPort
- 1x USB 3.0 Type Micro-B upstream port
- 2x USB 3.0 Type A downstream ports
- 40-pin Low-speed expansion header
- 60-pin High speed expansion header
- Mounted on thermal bracket with fan

Note that there is no on-board, wired Ethernet interface. All communications must be done via USB, Wi-Fi, JTAG, or expansion interface.

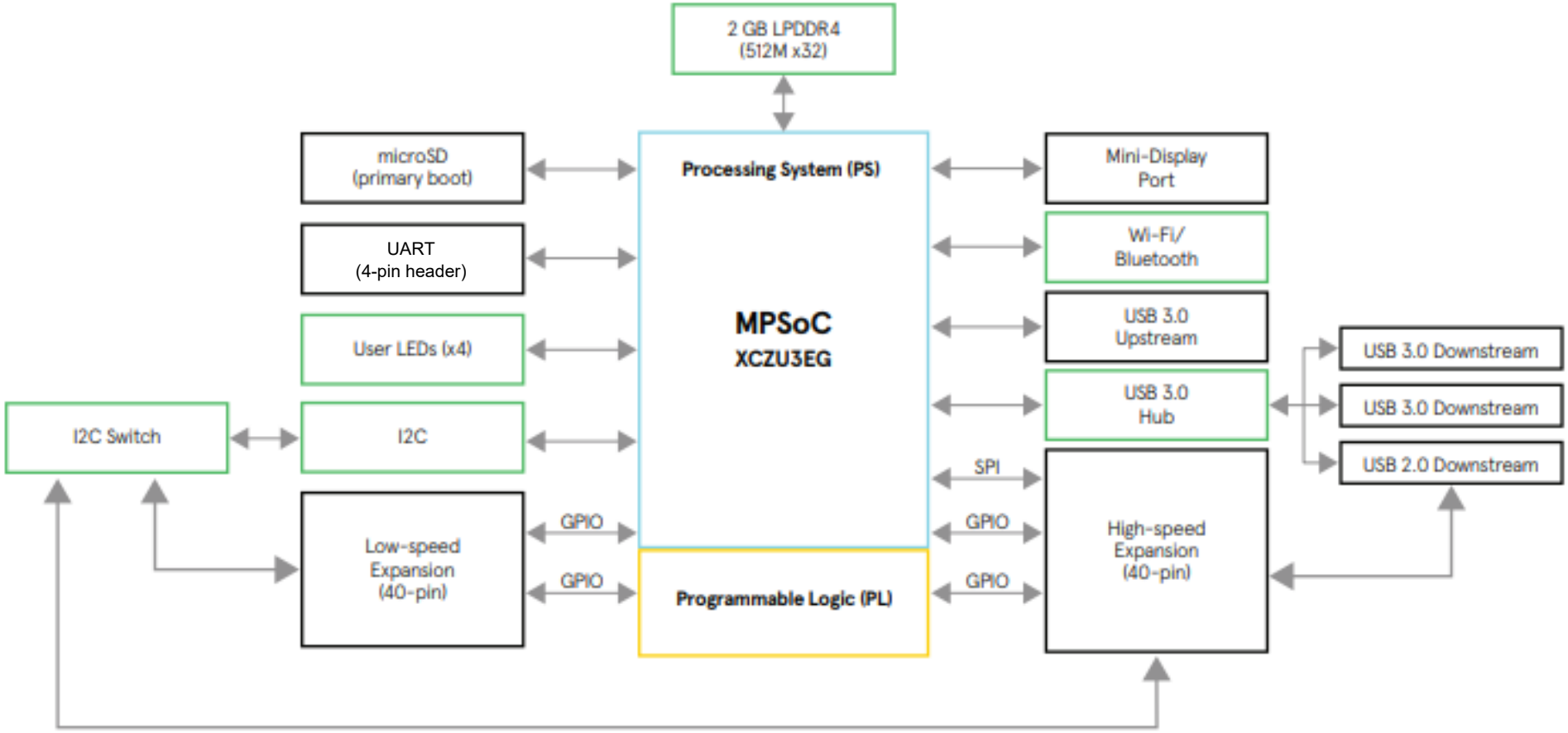


Figure 2 – Ultra96-V2 Block Diagram

5 Ultra96-V2 Basic Setup and Operation

The functionality of the Ultra96-V2 is determined by the application booted from the non-volatile memory – by default that is the microSD Card. This *Getting Started Guide* allows system developers to exercise and demonstrate multiple circuits through PetaLinux, including:

- SSH Terminal Access
- GPIO LEDs
- Wi-Fi

In addition to the items included in the kit, you will also need the following to complete the exercises in this tutorial.

- Ultra96 USB-to-JTAG/UART Pod (required for terminal access)
  - or
- Monitor (requires connection to miniDP port), keyboard, mouse

An Ultra96-V2 image in its expected out-of-box configuration is shown below along with various topology components highlighted.

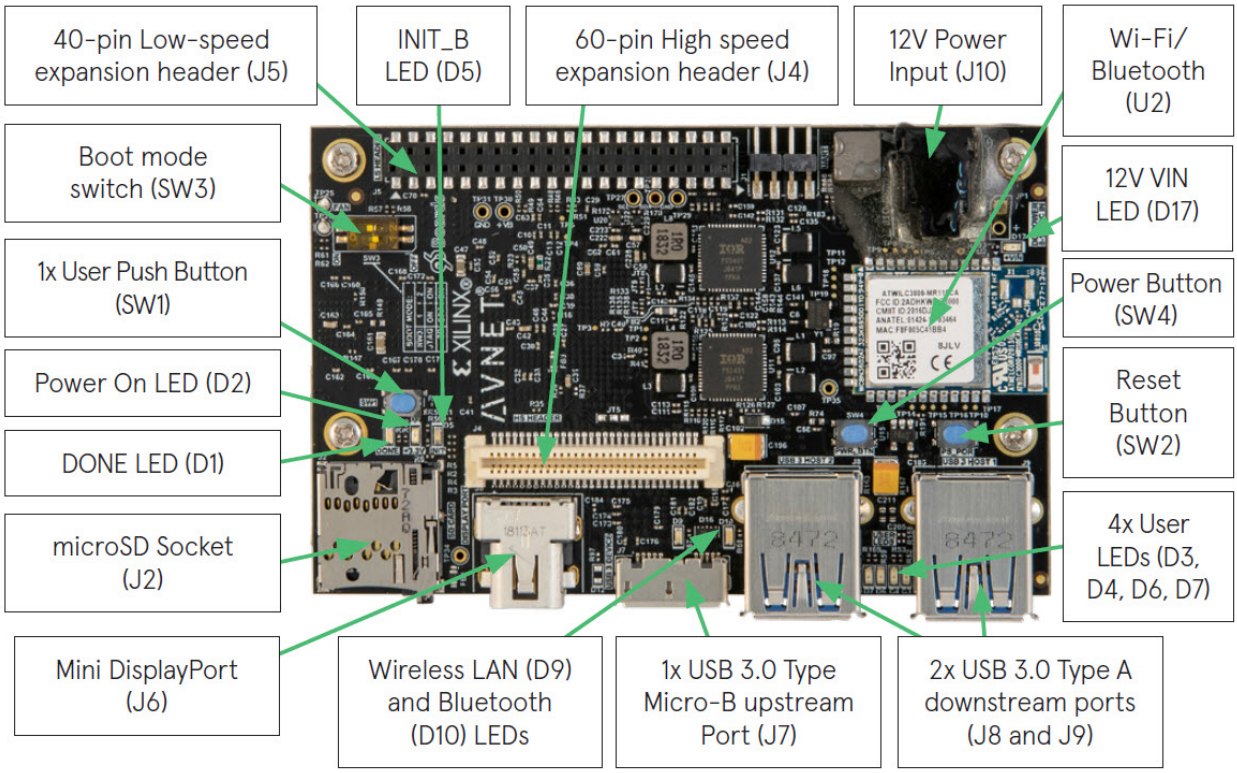


Figure 3 – Ultra96-V2 Topology

6 Example Design

The Ultra96-V2 example design must first be written to the 16GB microSD Card, which ships blank.

1. Please download the image and instructions at http://avnet.me/ultra96-v2-oob
2. Complete the process to write the image to your 16GB card.
3. Insert the microSD card into the Ultra96-V2 card cage J2.

7 Hardware Setup

1. A terminal program is required. TeraTerm was used in this example which can be downloaded from the TeraTerm project on the SourceForge Japan page: ttssh2.sourceforge.jp Install TeraTerm or another terminal program of your choice.

2. Set the Ultra96-V2 boot mode switch SW3 to SD Card boot mode as shown below with Switch 1 in the OFF position and Switch 2 in the ON position.

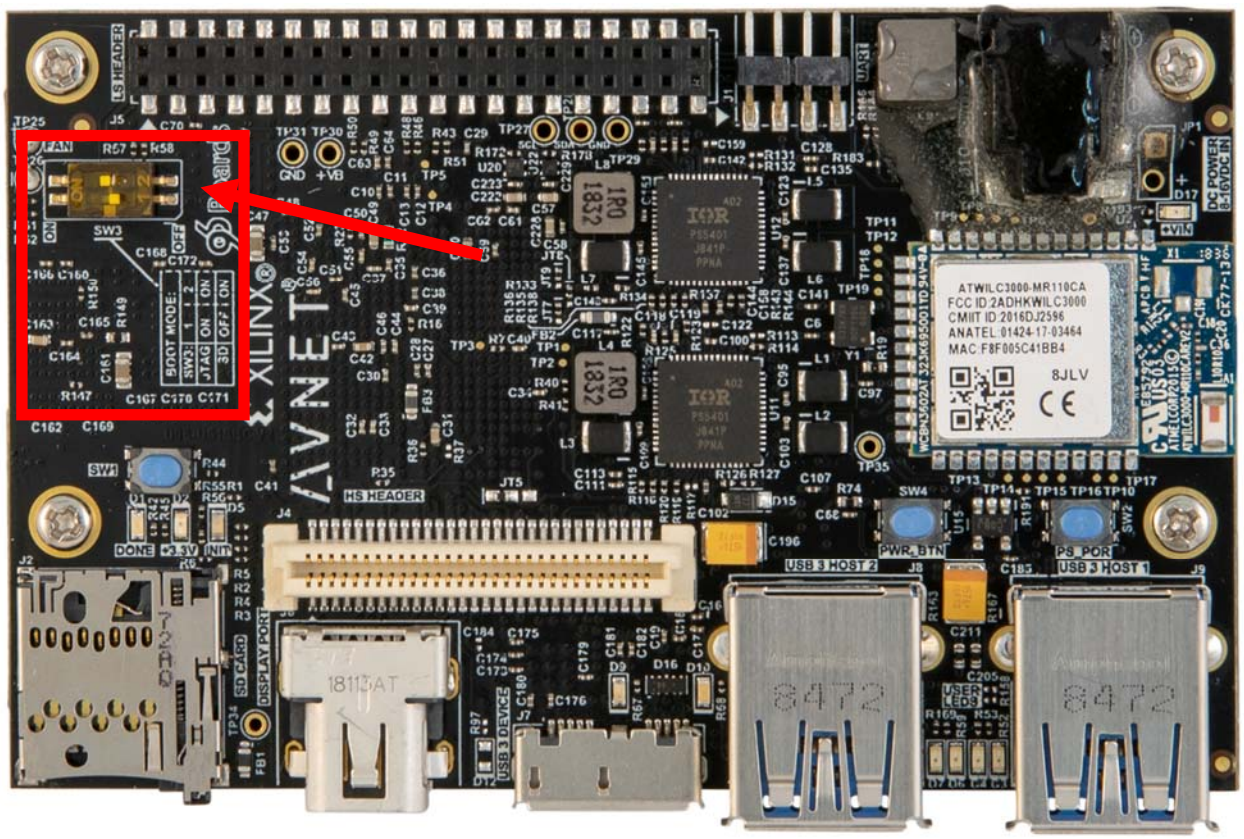


Figure 4 – Ultra96-V2 SW3 Boot Mode Switch Location

3. If you will be using a USB-to-JTAG/UART Pod, plug that into J1 and J3 before plugging in 12V power. Note that some Pods only have a 3-pin and 7-pin receptacles, which is compatible with the 4-pin and 8-pin headers on Ultra96-V2 (align as seen in Figure 6 below).

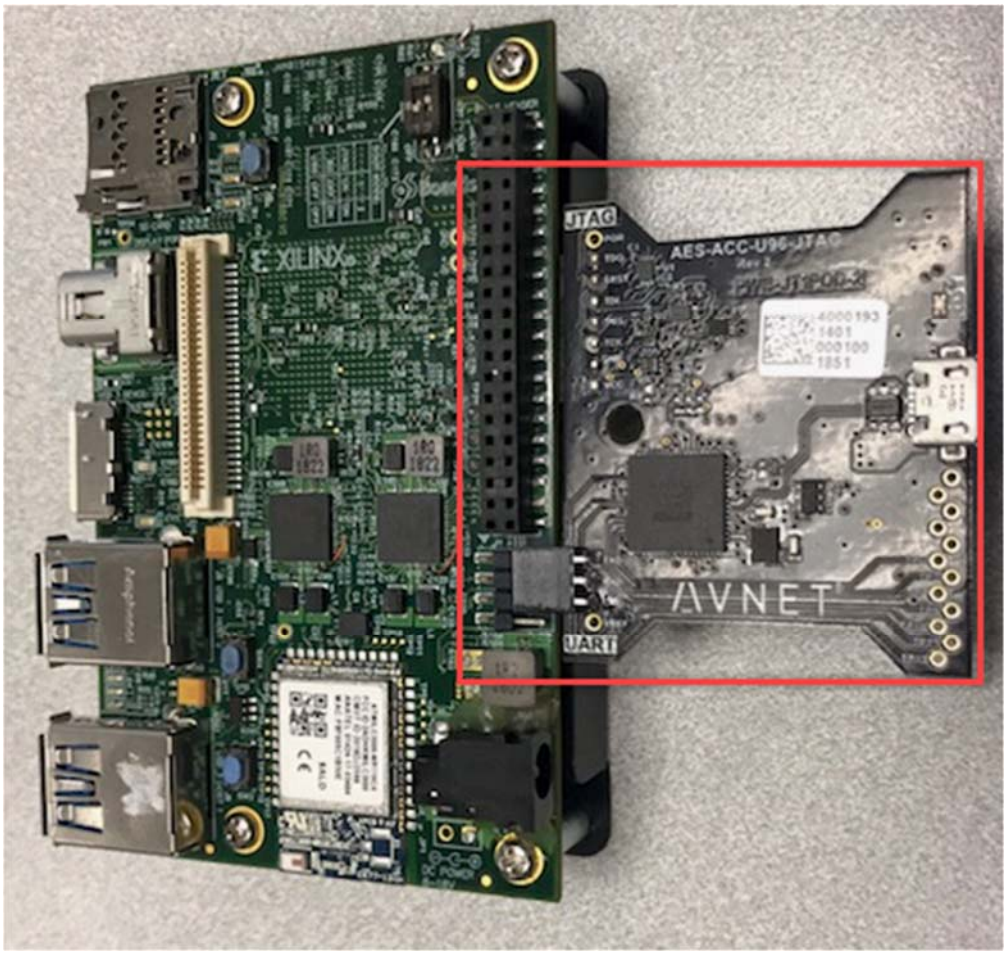


Figure 5 – Ultra96-V2 with JTAG/UART Pod

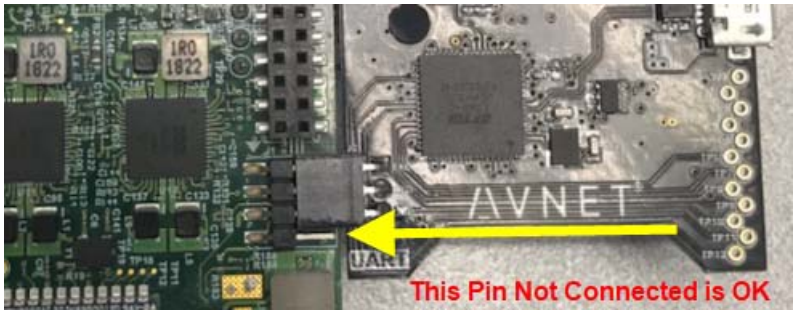


Figure 6 – JTAG/UART Pod Alignment

4. Plug in your 12V Barrel Jack power supply into a wall outlet and then connect the barrel jack to J10 on your Ultra96-V2. Green Vin status LED D17 will light, but the board is not yet powered on.

   Note: DC power supply is not included in the Ultra96-V2 kit but can be purchased separately.

The Ultra96 USB-to-JTAG/UART Pod ships with pre-programmed firmware that allows the JTAG interface to be recognized by Xilinx Vivado software. Additionally, most host machines will also automatically install the driver for the Serial Terminal interface.

5. Plug a microUSB cable between the Pod's microUSB Port (J1) and a host computer.
6. If the serial terminal drivers do not automatically install, you can manually install the driver for the FT2232H device. Visit www.ftdichip.com/Drivers/VCP.htm then download and install the appropriate driver for your operating system.
7. Launch your Serial Terminal with settings of 115200-8-N-1.

8 Power Up and Connect to Wi-Fi

1. Press and release the power button (SW4). The Green Power On LED (D2), Red INIT_B LED (D5) and the Green User LEDs should illuminate. After a few seconds, INIT_B LED will turn off and the Blue DONE LED (D1) will illuminate. You will immediately see output to the terminal screen as Linux boots. At ~30 seconds, the Green User LED D7 will blink in a heartbeat fashion.

2. You can ignore the Bluetooth warnings as shown below. Hit the enter key to get to the prompt.

```
PetaLinux 2018.3 ultra96v2-oob-2018-3 /dev/ttyPS0

ultra96v2-oob-2018-3 login: [   16.397160] Bluetooth: hci0 command 0x1001 tx tim
eout
[   24.589080] Bluetooth: hci0: Reading TI version information failed (-110)
[   24.595880] Bluetooth: hci0: download firmware failed, retrying...
[   27.149073] Bluetooth: hci0 command 0x1001 tx timeout
[   35.341080] Bluetooth: hci0: Reading TI version information failed (-110)
[   35.347883] Bluetooth: hci0: download firmware failed, retrying...
[   37.901076] Bluetooth: hci0 command 0x1001 tx timeout
[   46.093076] Bluetooth: hci0: Reading TI version information failed (-110)
[   46.099875] Bluetooth: hci0: download firmware failed, retrying...
[  608.181117] PLL: shutdown

PetaLinux 2018.3 ultra96v2-oob-2018-3 /dev/ttyPS0

ultra96v2-oob-2018-3 login:
```

Figure 7 – Ultra96-V2 Booted

3. Login using username = “root” and password = “root”

4. You should already be in the home directory /home/root. If not, then enter the following command:

```
cd /home/root
```

5. Now list the contents of that directory.

```
ls
```

6. You should observe that there are 4 files present. We will use both the wpa_supplicant.conf and wifi.sh files to bring up the Wi-Fi.
   a) ble.sh
   b) bt.sh
   c) wifi.sh
   d) wpa_supplicant.conf

7. Before bringing up the Wi-Fi interface you must first edit the **/home/root/wpa_supplicant.conf** file with the correct SSID and security password for your Wi-Fi access point. You can use the built-in vi editor to do this.

```
vi wpa_supplicant.conf
```

   a) If you are not familiar with vi, the easiest thing to do is to edit the SSID_here and password_here fields in the following lines in a text editor, then copy to your clipboard.

```
ctrl_interface=/var/run/wpa_supplicant
ctrl_interface_group=0
update_config=1

network={
        key_mgmt=WPA-PSK
        ssid="RCK_MY_WRLD"
        psk="AABBCCDDEEFF00112233445566"
}
```

   b) Enter the following commands into vi:
      i. 9dd
      ii. i
      iii. <paste command> -- in TeraTerm it is Alt-V
      iv. ESC key
      v. :wq

8. Once that is done, run the supplied wifi.sh script to copy the wpa_supplicant.conf file to /etc, load the kernel modules for the driver, and bring up the Wi-Fi interface:

```
./wifi.sh
```

9. If successful, move on to step 13. If it fails due to bad SSID or password, you may see the following message. Work through the following steps to correct it.

```
Successfully initialized wpa_supplicant
ctrl_iface exists and seems to be in use - cannot override it
Delete '/var/run/wpa_supplicant/wlan0' manually if it is not used anymore
Failed to initialize control interface '/var/run/wpa_supplicant'.
You may have another wpa_supplicant process already running or the file was
left by an unclean termination of wpa_supplicant in which case you will need
to manually remove this file before starting wpa_supplicant again.
```

10. Enter this command to remove the reference to wlan0

```
rm /var/run/wpa_supplicant/wlan0
```

11. Edit /home/root/wpa_supplicant.conf again to correct the mistake

12. Run the wifi.sh script again.

```
./wifi.sh
```

13. A successful connection should appear like the following:

```
root@ultra96v2-oob-2018-3:~# ./wifi.sh
[  336.947874] wifi_pm : 0
[  336.950324] WILC DRIVER SETUP TO NOT TOUCH CHIP_EN and RESETN!
[  336.956197] wifi_pm : 1
[  336.958636] WILC DRIVER SETUP TO NOT TOUCH CHIP_EN and RESETN!
[  336.965518] wilc_sdio mmc1:0001:1: Driver Initializing success
[  336.977537] WILC POWER UP
[  336.980232] wilc_sdio mmc1:0001:1: SDIO speed: 50000000
[  336.985820] wilc_sdio mmc1:0001:1: chipid 003000d0
Successfully initialized wpa_supplicant
udhcpc (v1.24.1) started
Sending discover...
[  339.157445] NOHZ: local_softirq_pending 08
[  339.189434] NOHZ: local_softirq_pending 08
Sending discover...
[  340.843897] NOHZ: local_softirq_pending 08
[  341.838606] NOHZ: local_softirq_pending 08
[  342.838582] NOHZ: local_softirq_pending 08
[  343.406283] NOHZ: local_softirq_pending 08
Sending discover...
[  343.411600] NOHZ: local_softirq_pending 08
Sending select for 192.168.43.130...
[  343.532704] NOHZ: local_softirq_pending 08
[  343.540725] NOHZ: local_softirq_pending 08
Lease of 192.168.43.130 obtained, lease time 7200
[  343.548809] NOHZ: local_softirq_pending 08
/etc/udhcpc.d/50default: Adding DNS 192.168.43.1
root@ultra96v2-oob-2018-3:~#
```

Figure 8 – Successful Wi-Fi Connection on Ultra96-V2

14. Use ifconfig to determine the IP address assigned to the board.

```
ifconfig
```

```
root@ultra96v2-oob-2018-3:~# ifconfig
lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1%4882584/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:1272 errors:0 dropped:0 overruns:0 frame:0
          TX packets:1272 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:112337 (109.7 KiB)  TX bytes:112337 (109.7 KiB)

wlan0     Link encap:Ethernet  HWaddr F8:F0:05:C4:2B:D4
          inet addr:192.168.11.31  Bcast:192.168.11.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:366 errors:0 dropped:0 overruns:0 frame:0
          TX packets:517 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:27112 (26.4 KiB)  TX bytes:576022 (562.5 KiB)
```

Figure 9 – Find the IP Address

15. Open a browser using a machine connected to the same network, and then browse to the IP address of the board. The browser page will show like below.

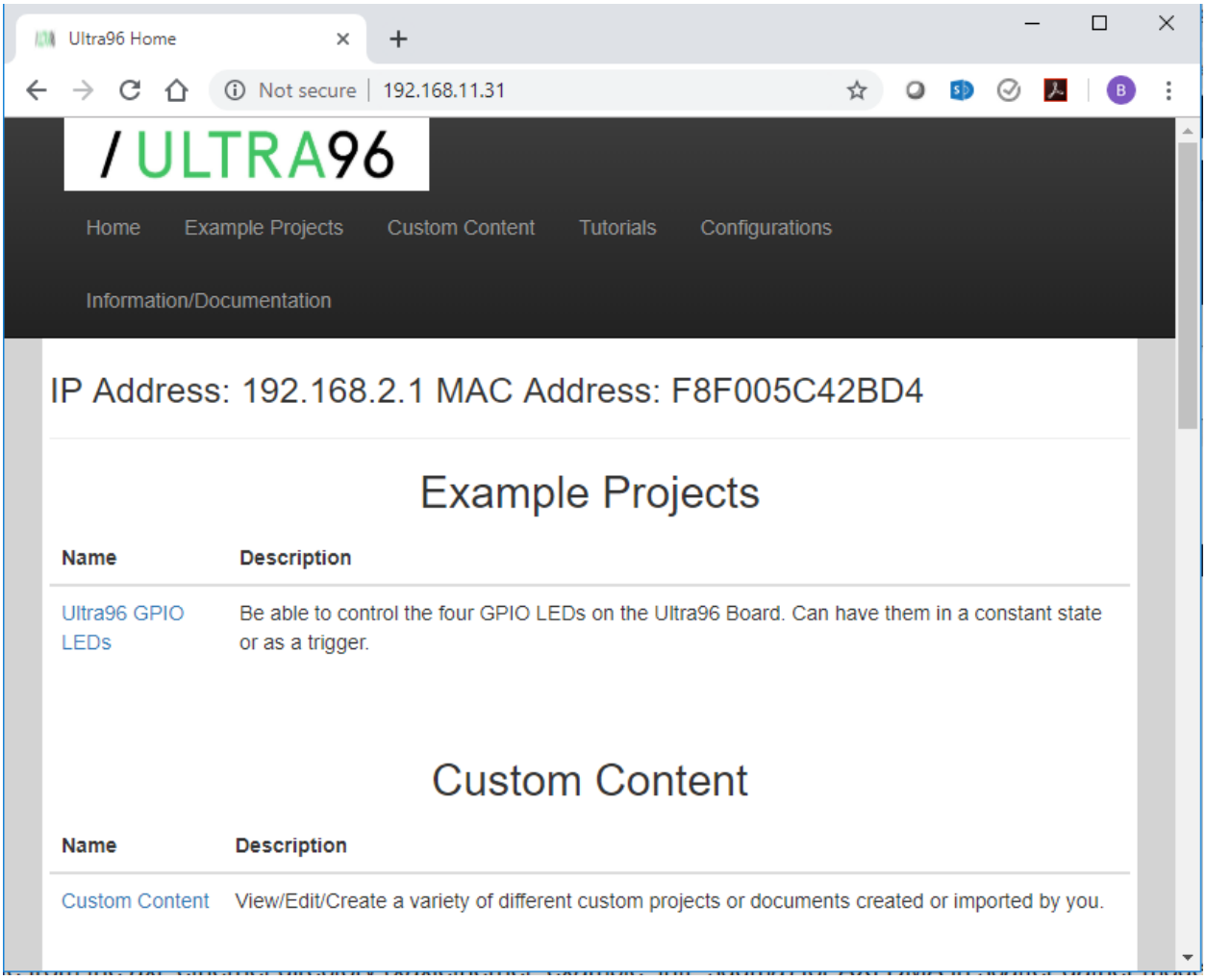


Figure 10 – Connected to Ultra96-V2 Webserver

Note that this design is still in the process of being updated. The MAC Address is correct, but the IP Address is not. Also, many of the tutorials are not functional yet. We will release a new image with updates and corrections in July 2019.

9 Ultra96-V2 GPIO LEDs Example Project

1. Next we want to access the Ultra96-V2 GPIO LEDs example project. From the Ultra96-V2 home page select **Ultra96 GPIO LEDs** example project

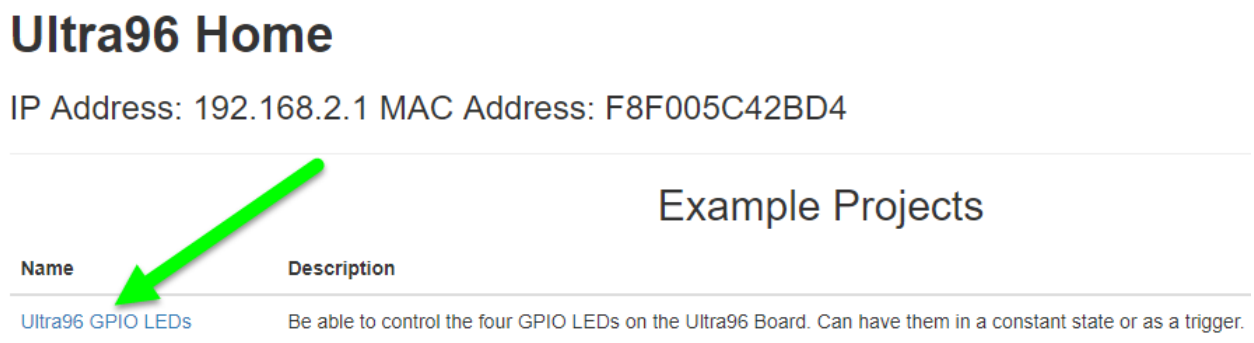


Figure 11 – Ultra96-V2 GPIO LEDs

Be aware that the photo on this page and the LED reference designators is the older Ultra96-V1. The new Ultra96-V2 LEDs are D3, D4, D6, and D7, shown below:

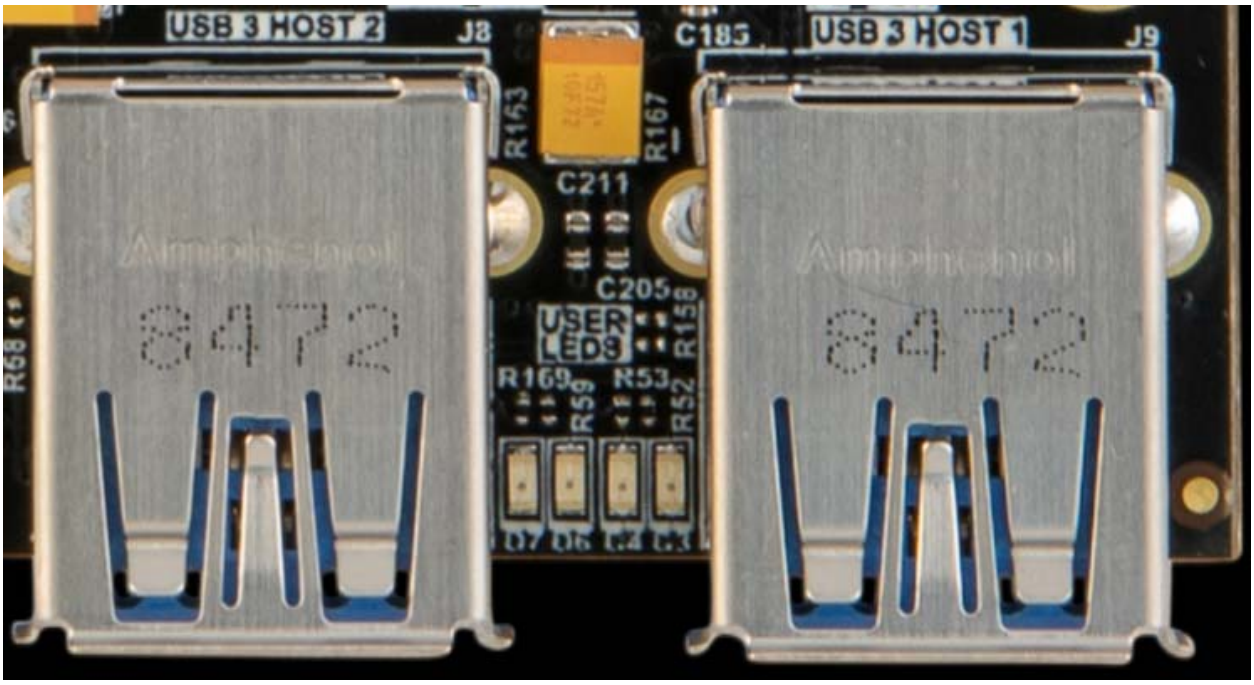


Figure 12 – Ultra96-V2 User LEDs

2. All LEDs will be at an unknown state to begin with. Select the drop down menus and begin changing the status of the GPIO LEDs. You will notice that the four LEDs (located in between the two USB connectors J8/J9) update in real time. See the mapping below. For example, if you change the pull-down for LED2/DS5, then LED D7 which is closest to USB Connector J8 will be the one to change.

Figure 13 – Mapping from Web Page to Actual LED

3. Scroll to the bottom of the webpage and you will see a definition table for various LED selection options.

10 Example Projects

Unfortunately, the **Example Projects** besides the GPIO LEDs are still under construction.

Example Projects

Information

On this page you can select a variety of example projects created for the Ultra96. Listed below is a table with the name of each project and its description. Clicking on the project (which should be blue and underlined) will send you to another page that will explain how to setup and run that specific project. For more information on the Grove Sensor Kit please visit Grover Starter Kit.

Project	Description
Ultra96 GPIO LEDs	Be able to control the four GPIO LEDs on the Ultra96 Board. Can have them in a constant state or as a trigger.
OpenAMP Matrix Multiplication	Provides a complex test that generates two matrices on the Linux master which are then sent to the remote to multiply them. Then they are sent back to the master to display the result.
OpenAMP Proxy Application	Application creates a proxy between the linux master and the remote core, which allows the remote firmware to use console and execute file I/O on the master.
Hello World with LCD	How to display text on the Grove RGB LCD module and change the color of the backlight (Linux IO).
Touch Sensor and Relay	A system that toggles a relay on and off when the touch sensor is tapped (Linux IO).
Drive LED with Button	Control an LED with the use of a button (Atmega IO).
Buzzer and Light Sensor	Use the Grove light sensor and Grove buzzer to be silent when there is light and emit noise when it is dark (Atmega IO).
Temperature and Humidity Display	Read data using the Digital Humidity and Temperature sensor and display the readings on the LCD Display (Linux/Atmega IO).
Tweeting Doorbell	Sends a message out to twitter every time the button is pressed (Linux/Atmega IO).

Figure 14 – Example Projects Under Construction

11 Custom Content Tutorial

1. Select the **Tutorial** tab at the top of the page. You will be directed to a Tutorials/Guides page

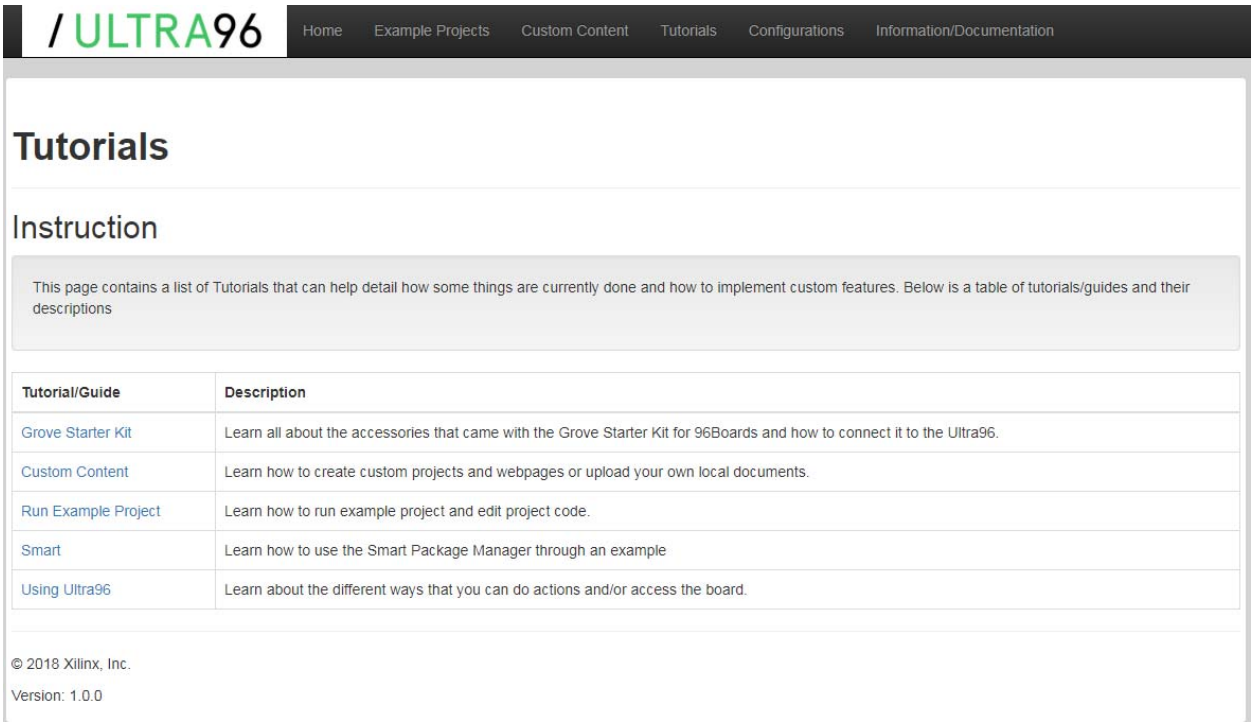


Figure 15 – Ultra96-V2 Tutorials/Guides

2. This section goes into how to get started with the microSD card image we have been exploring up to this point. As of now we have explored the **Run Example Projects** section.

3. Let's look at the **Custom Content** tutorial. Select **Custom Content**.

4. This Tutorial goes over the three different ways custom content can be added to this out of box image. The three different ways being

    1) Uploading custom files

    2) Making custom webpages

    3) Making custom projects

5. To access these options select the **Custom Content** tab at the top of the webpage.

12 Using Ultra96-V2 Tutorial

1. Click the **Tutorials** page. Select the **Using Ultra96** tutorial

2. This tutorial goes over the various ways you can interact with the Ultra96-V2. As of now we have interacted using the Webserver and UART on the Pod.

3. To explore your Ultra96-V2 over miniDP, you will need a compatible cable and monitor. For example, the following combinations work:

    - miniDP-to-DP cable with DisplayPort Monitor

    - Active miniDP-to-HDMI cable with HDMI Monitor

4. Read through the SSH section, it states we can access the Ultra96-V2 terminal using TeraTerm or a PuTTY terminal application.

5. Since we have already downloaded and installed TeraTerm at the beginning of this guide let's access the Ultra96-V2's Linux terminal over SSH using TeraTerm

13 Access Ultra96-V2 Linux Terminal over SSH

1. Open TeraTerm and then select **File → New connection…** as seen in the image below.

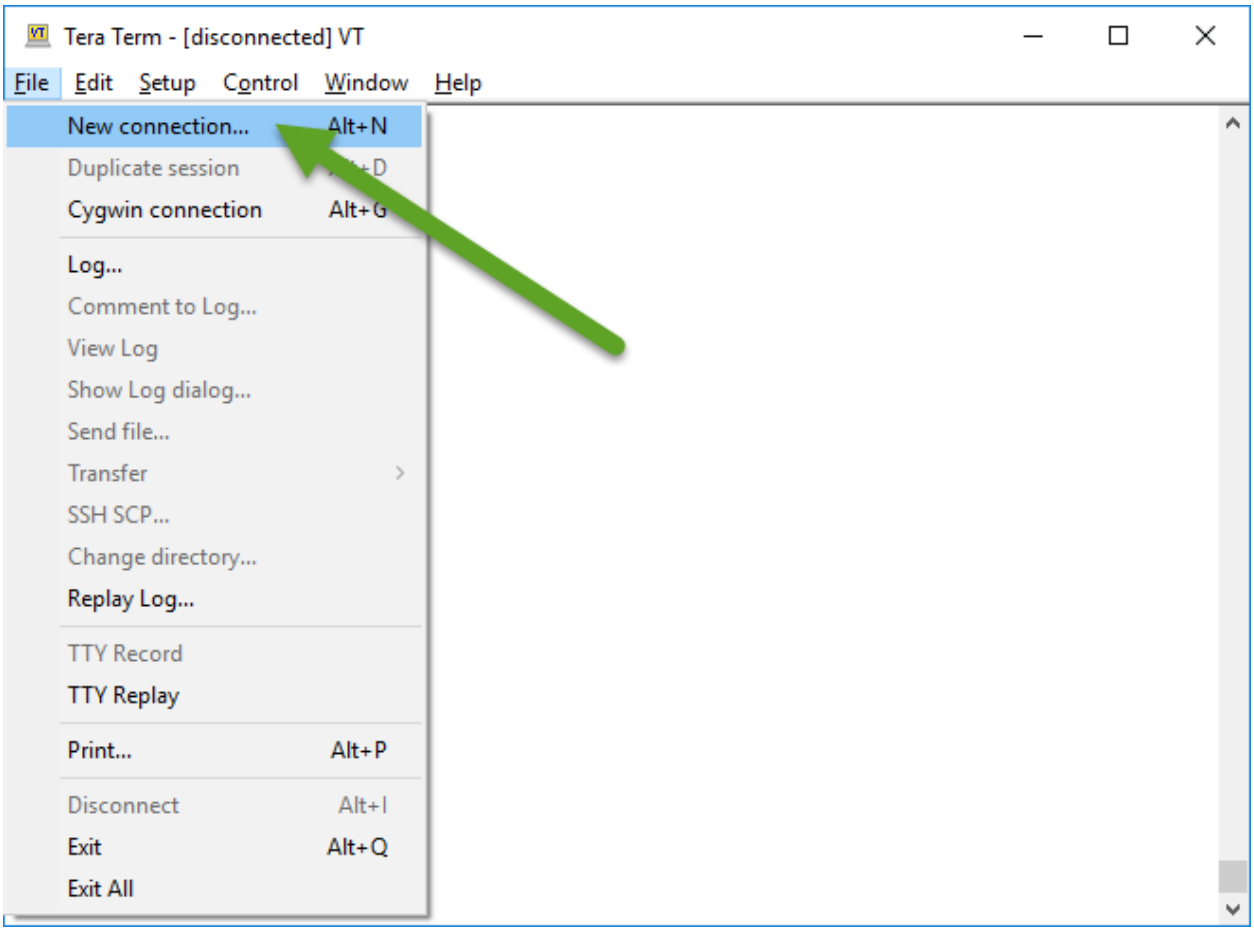


Figure 16 – TeraTerm New Connection

2. A new **TeraTerm: New connection** window will open. We now want to connect to Ultra96-V2 over SSH, select TCP/IP and then configure your Terminal settings to use the IP address that you discovered previously, similar to the below figure.

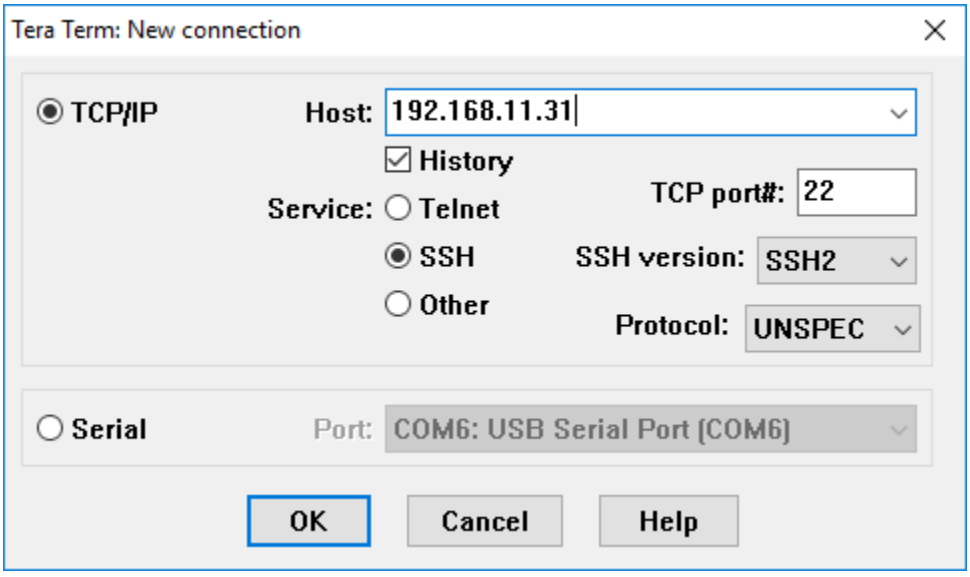


Figure 17 – SSH Terminal Settings

3. Select **OK**

4. If you get a SECURITY WARNING, click **Continue** to add this machine to the known hosts list.

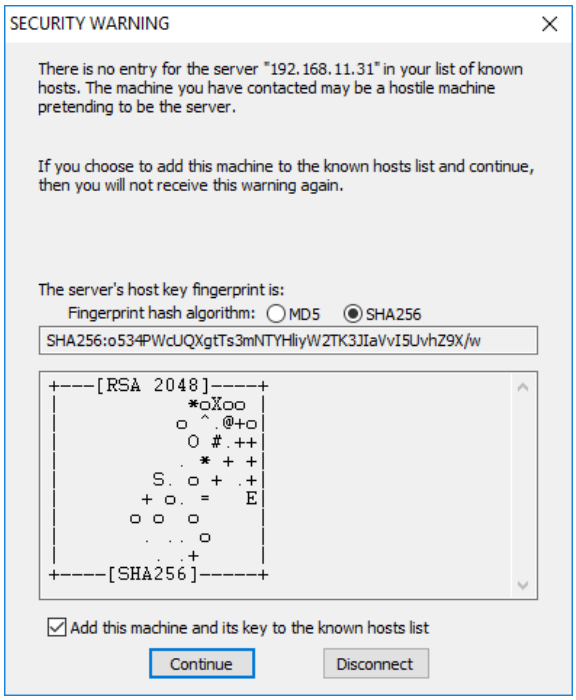


Figure 18 – Click Continue

5. You will then be prompted to enter *SSH Authentication* information. In our case it is looking for the Linux terminal's user name and passphrase which are **root** and **root**.

6. Please type in **root** for the *User name* and then type in **root** for the *Passphrase* as well. Then select **OK**.

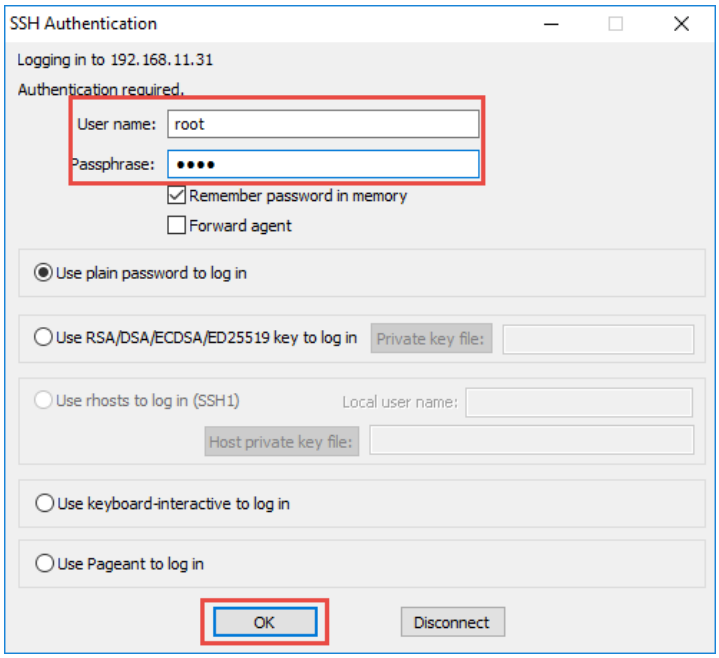


Figure 19 – SSH Authentication

7. You now have access to the Ultra96-V2 Terminal!

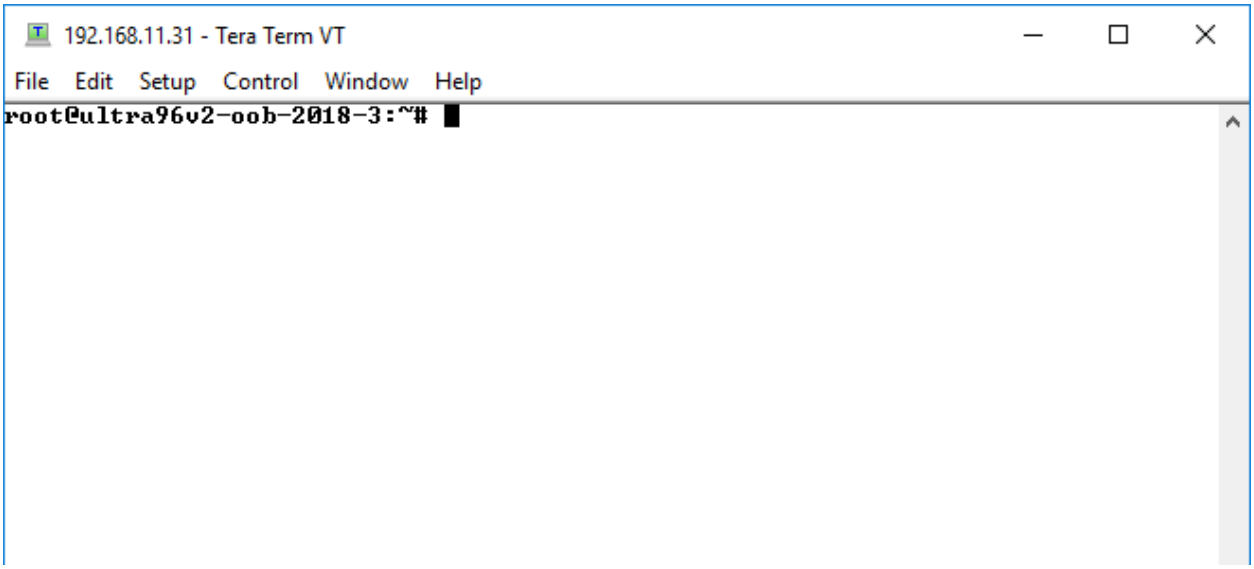


Figure 20 – Ultra96-V2 Terminal

14 Power Off

When you are done experimenting with your Ultra96-V2 and wish to power off the board, there are several ways to power off the board. You can do it from the command line with a 'shutdown -h now' command. However, we will have you take advantage of the on-board On/Off Controller that interacts with the MPSoC Power Management Unit to initiate a controlled shutdown.

1. Press and release the Power button (SW4) located on the top side of your Ultra96-V2 next to USB port J8.

2. You will notice your board does not power down immediately. It will take roughly 10-20 seconds for your board to completely power down. The reason behind this is it is adhering to the various power down sequencing requirements. See the message in the terminal as shown.

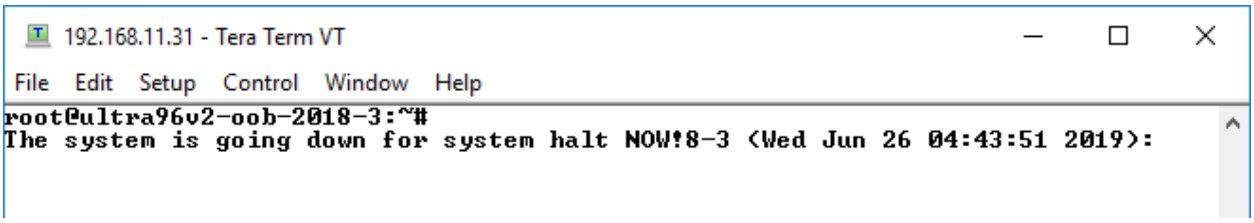


Figure 21 – Power Down Initiated Through Short Press of SW4

3. Please note, if you do not let your Ultra96-V2 power off as per the power down sequencing requirements (such as unplugging the barrel jack), your microSD Card may get corrupted or damaged.

4. To force poweroff of the Ultra96-V2, you can also press and hold SW4 for 10 seconds. This is useful for when the soft power-off doesn't work.

15 Getting Help and Support

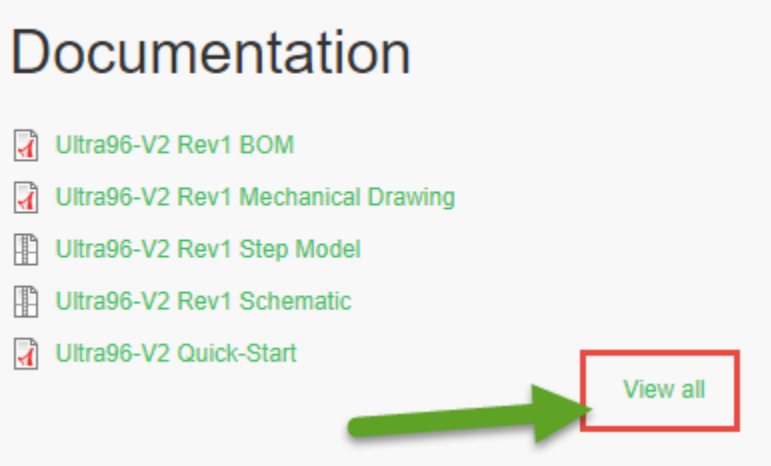
15.1 Avnet Support

The Ultra96-V2 is a versatile development kit that allows evaluation of the Zynq MPSoC, which can help you adopt Zynq into your next design. All technical support is offered through http://avnet.me/Ultra96_Forum. Ultra96-V2 users are encouraged to participate in the forums and offer help to others when possible.

To access the most current collateral for Ultra96-V2 please visit the community support page at:

http://avnet.me/ultra96-v2

To access the latest Ultra96-V2 documentation, click on the View All link under Documentation:



To access the latest reference designs for Ultra96-V2, click on the View All link under Reference Designs:

To access the Ultra96-V2 technical forums, go to http://avnet.me/Ultra96_Forum .

To view online training and videos, go to http://avnet.me/TTC.

15.2 Xilinx Support

For questions regarding products within the Product Entitlement Account, visit the Contact Support site for Xilinx:

https://www.xilinx.com/support/service-portal/contact-support.html

For technical support including the installation and use of the product license file, contact Xilinx Online Technical Support at www.xilinx.com/support. The following assistance resources are also available on the website:

- Software, IP and documentation updates
- Access to technical support web tools
- Searchable answer database with over 4,000 solutions
- User forums

16 Installing and Licensing Xilinx Software

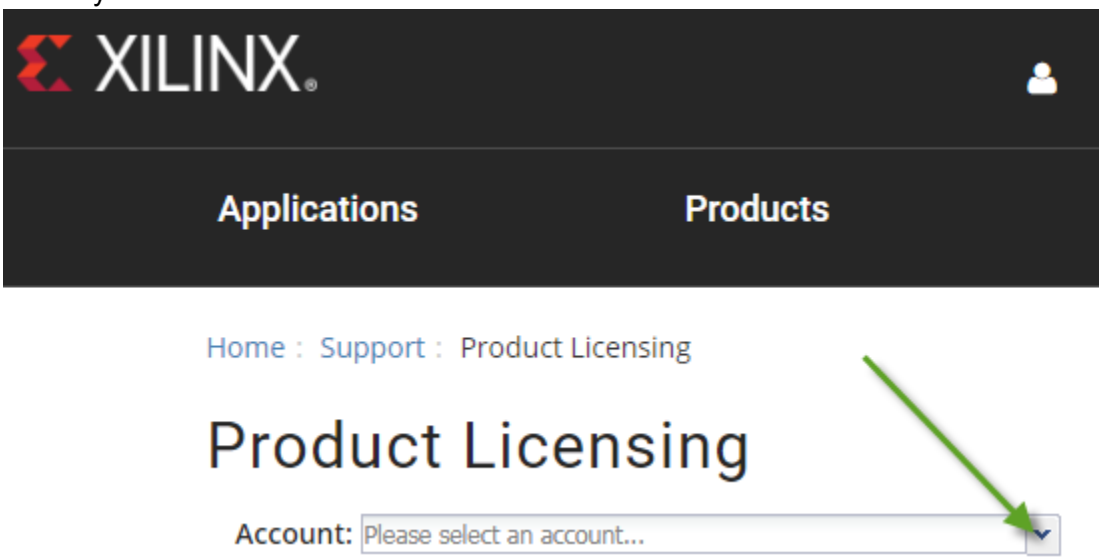
16.1 Install Vivado Design Suite, Design Edition

The Zynq device on the Ultra96-V2 is supported in Vivado Design Suite, Design Edition. Version 2018.1 or later is required to use the board definition file provided on the Avnet GitHub.

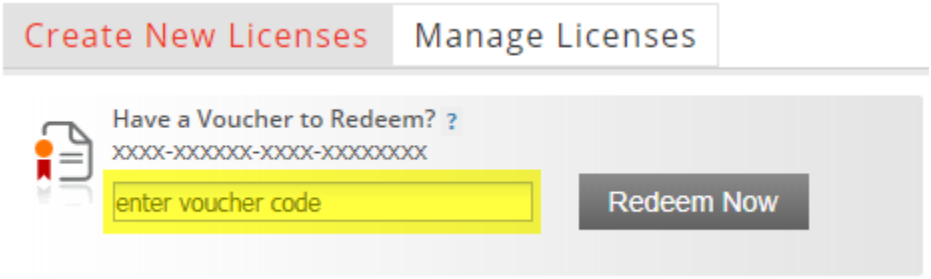
You must license your Vivado Design Suite, Design Edition with the license that came with your Ultra96-V2. To obtain your free license, visit the following website and insert the voucher code from the certificate included in your kit:

http://www.xilinx.com/getlicense

1. Log in
2. Fill out information at Product Licensing - Name and Address Verification, then click Next
3. Select your Account



4. Enter your voucher code here, then click Redeem Now.



5. At the confirmation screen, click Yes.

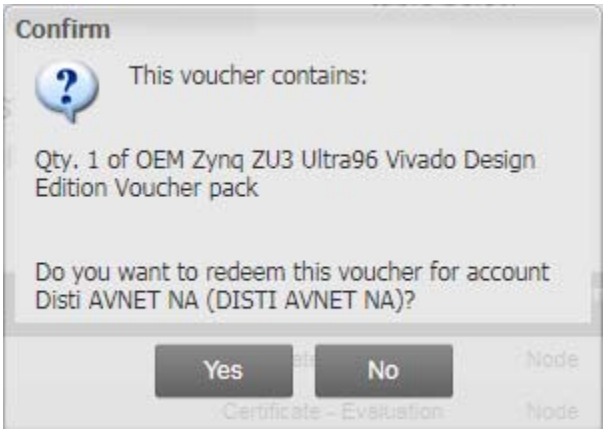


Figure 22 – Voucher Confirmation

6. Under Certificate Based Licenses, find OEM Zynq ZU3 Ultra96 Vivado Design Edition Voucher pack and check the box. Now click Generate Node-Locked License.

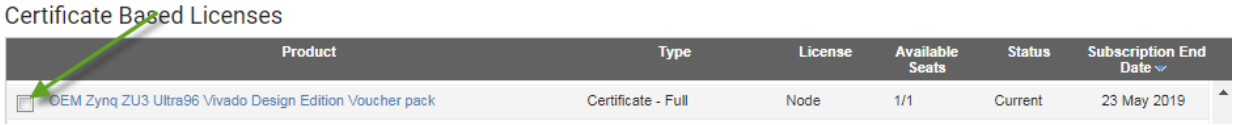


Figure 23 – Generate Node-Locked

7. Create or select your Host ID. Click Next.

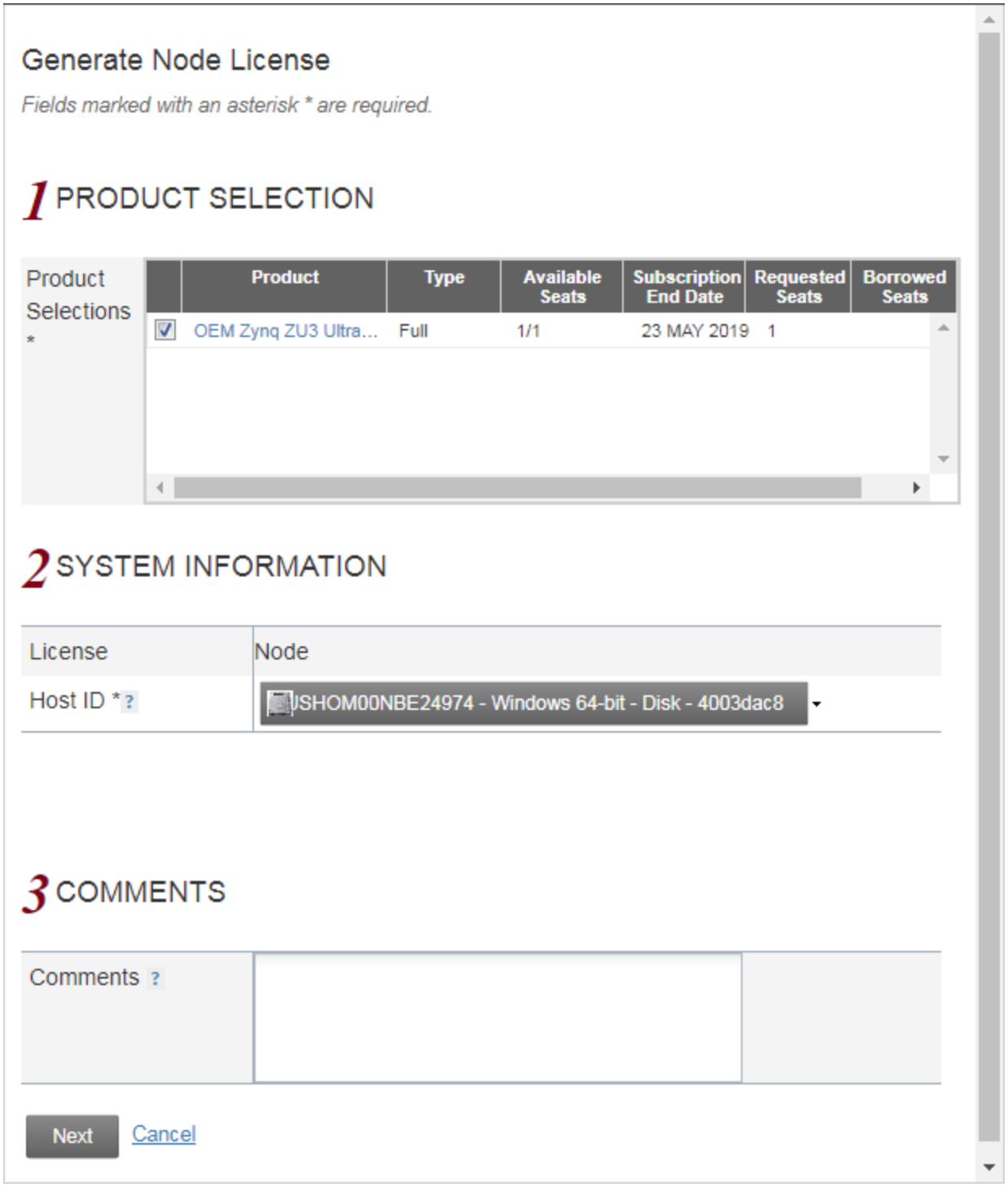


Figure 24 – Select Host Information

8. Review the license request, then click **Next** again.

If a full seat of Vivado System or Design Edition has already been installed, then no further software will be needed. Please check online for any updates at:

www.xilinx.com/support/download/index.htm

For detailed instructions on installing and licensing the Xilinx tools, please refer to the latest version of **Vivado Design Suite User Guide *Release Notes, Installation, and Licensing* (UG973)**.

17 Certification Disclaimer

Both CE and FCC certifications are necessary for system level products in those countries governed by these regulatory bodies.

Because Avnet boards are intended for evaluation kits only and destined for professionals (you) to be used solely at research and development facilities for such purposes, they are considered exempt from the EU product directives and normally are not tested for CE or FCC compliance.

If you choose to use your board to transmit using an antenna, it is your responsibility to make sure that you are in compliance with all laws for the country, frequency, and power levels in which the device is used. Additionally, some countries regulate reception in certain frequency bands. Again, it is the responsibility of the user to maintain compliance with all local laws and regulations.

This board should be used in a controlled lab environment by professional developers for prototype and development purposes only. The board included in the kit is not intended for production use unless additional end product testing and certification is performed.

18 Safety Warnings

This product shall only be connected to an external power supply that is 96boards compliant.

Only compatible plug-in modules shall be connected to Ultra96-V2. The connection of incompatible devices may affect compliance or result in damage to the unit and void the warranty.

This product shall be operated in a well-ventilated environment. If a case is used, it shall have adequate ventilation.

19 RF Certification

The frequency range is 2.412GHz ~ 2.472GHz (2.4GHz ISM Band).

The radio is IEEE 802.11 b/g/n (1x1) compliant for up to 72 Mbps PHY rate

The ATWILC3000-MR110CA has regulatory approval in more than 75 countries around the world. More information on RF certification for the Microchip ATWILC3000 module is available here:

http://ww1.microchip.com/downloads/en/DeviceDoc/ATWILC3000-MR110CA%20Worldwide%20Regulatory%20Information.pdf