

Getting Started Guide



Version 6.0



Revision History

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08/08/2012	2.0	Further clarified un-mounting of media
08/10/2012	3.0	Further clarified Processing System and Programmable Logic in diagrams. Provided other needed edits identified by ZedBoard.org forum users.
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08/14/2012	5.0	Updated Hardware Block Diagram.
09/04/2012	6.0	Updated Hardware Block Diagram.

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GETTING STARTED WITH ZEDBOARD

The ZedBoard enables hardware and software developers to create or evaluate Zynq™-7000 All Programmable SoC designs.

The expandability features of this evaluation and development platform make it ideal for rapid prototyping and proof-of-concept development. The ZedBoard includes Xilinx XADC, FMC (FPGA Mezzanine Card), and Digilent Pmod™ compatible expansion headers as well as many common features used in system design. ZedBoard enables embedded computing capability by using DDR3 memory, Flash memory, gigabit Ethernet, general purpose I/O, and UART technologies.

This Getting Started Guide will outline the steps to setup the ZedBoard hardware. It documents the procedure to run a simple Linux design to show a Linux application running on the ARM® dual-core Cortex™-A9 MPCore™ Processing System (PS) and interacting with the tightly coupled 7 series 85K Programmable Logic (PL) cells. Xilinx Embedded Development tools are also introduced where the design can be built from scratch and customization options can be discovered. If Xilinx ISE WebPACK or Design Suite software is not already installed, further resources to install the software, get updated and generate a license are provided in Appendix I.

WHAT'S INSIDE THE BOX?



ZedBoard Kit contents:

- ZedBoard
- 12 volt / 5 ampere power supply with US, European AC adapter
- USB-A to Micro-USB-B cable
- Micro-USB-B to Type A Female adapter cable
- 4GB SD card
- Software
 - Xilinx ISE WebPACK Edition DVD
 - Xilinx ChipScope™ Pro License Voucher for ZedBoard designs
- Documentation
 - Getting Started Card

WHAT'S ON THE WEB?

ZedBoard is a community-oriented kit, with all materials being made available through the ZedBoard.org community website.

Official Documentation:

- Schematics
- Layout
- Hardware manual

Tutorials and Reference Designs:

- Introductory material for beginners
- Design examples

ZEDBOARD KEY FEATURES

- Processor
 - Zynq™-7000 AP SoC XC7Z020-CLG484-1
- Memory
 - 512 MB DDR3
 - 256 Mb Quad-SPI Flash
 - 4 GB SD card
- Communication
 - Onboard USB-JTAG Programming
 - 10/100/1000 Ethernet
 - USB OTG 2.0 and USB-UART
- Expansion connectors
 - FMC-LPC connector (68 single-ended or 34 differential I/Os)
 - 5 Pmod™ compatible headers (2x6)
 - Agile Mixed Signaling (AMS) header
- Clocking
 - 33.33333 MHz clock source for PS
 - 100 MHz oscillator for PL
- Display
 - HDMI output supporting 1080p60 with 16-bit, YCbCr, 4:2:2 mode color
 - VGA output (12-bit resolution color)
 - 128x32 OLED display
- Configuration and Debug
 - Onboard USB-JTAG interface
 - Xilinx Platform Cable JTAG connector
- General Purpose I/O
 - 8 user LEDs
 - 7 push buttons
 - 8 DIP switches

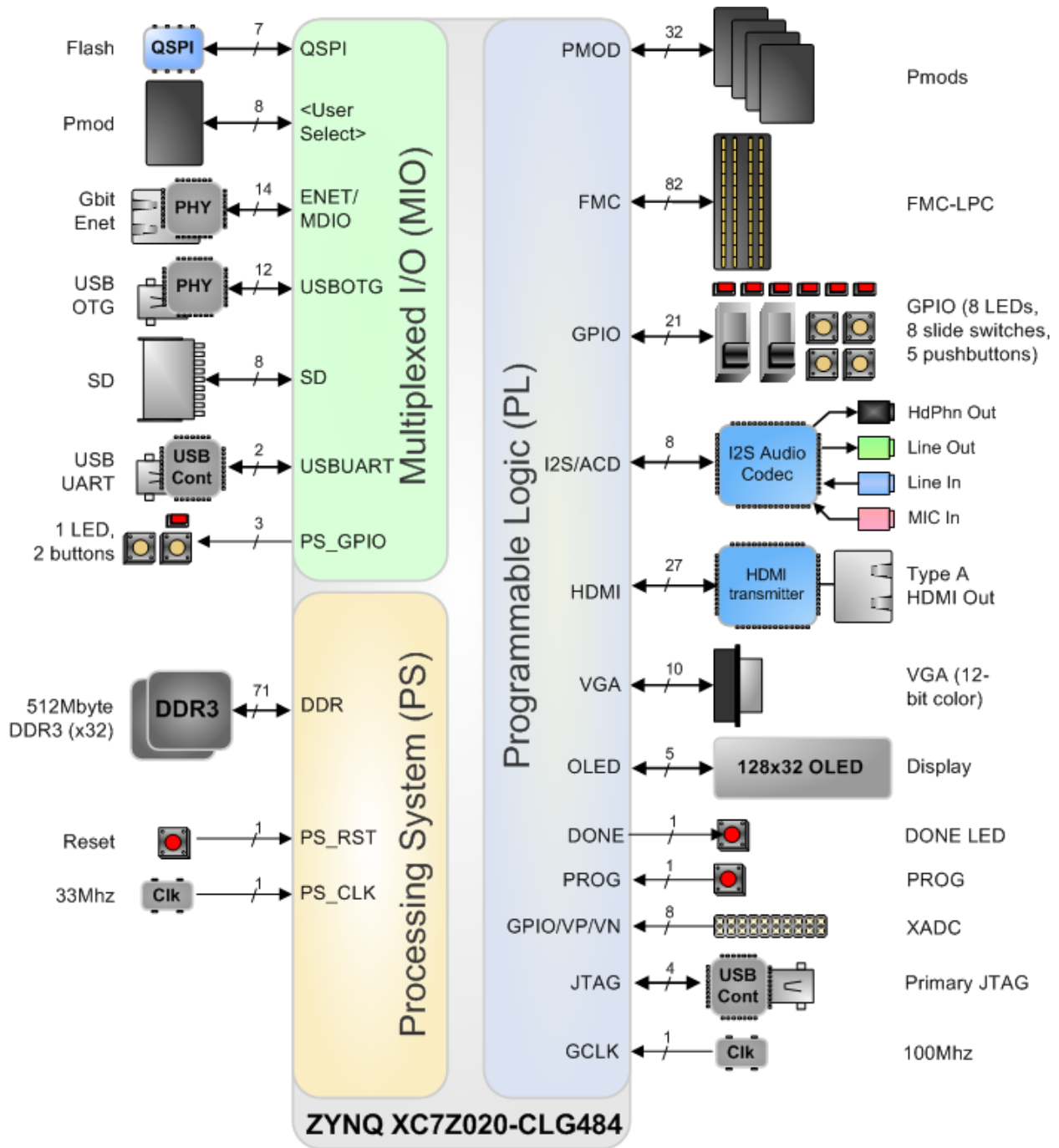


Figure 1 – ZedBoard Hardware Block Diagram

ZEDBOARD BASIC SETUP AND OPERATION

The ZedBoard SD card is preloaded with an example open source Linux build with a RAMdisk file system. This document was created using a host PC running Windows 7 and the instructions contained would apply directly to a Windows 7 host PC. See Appendix III for an example of how to connect a Linux host PC to ZedBoard. It is also recommended that the host PC also have a wired (RJ-45 connector) Network Interface Card (NIC) that can operate at 100 Mbps or 1000 Mbps.

Hardware Setup

1. Connect 12 V power supply to barrel jack (J20).
2. Connect the USB-UART port of ZedBoard (J14) which is labeled **UART** to a PC using the MicroUSB cable.
3. Insert the 4GB SD card included with ZedBoard into the SD card slot (J12) located on the underside of ZedBoard PCB. This SD card comes preloaded with demo software and contains a basic Linux configuration used to implement the demos listed in the later sections.
4. Verify the ZedBoard boot mode (JP7-JP11) and MIO0 (JP6) jumpers are set to SD card mode as described in the Hardware Users Guide.

www.zedboard.org/sites/default/files/ZedBoard_HW_UG_v1_6.pdf

5. Turn power switch (SW8) to the ON position. ZedBoard will power on and the Green Power Good LED (LD13) should illuminate.
6. The PC may pop-up a dialog box asking for driver installation.

ZedBoard has a USB-UART bridge based on the Cypress CY7C64225 chipset. Use of this feature requires that a USB driver be installed on your Host PC.

If Windows recognizes the USB-UART and loads the software driver, then amber LED D6 will light. Please skip ahead to the next section. However, if the host PC does not recognize the USB-UART and enumerate it as a COM port device refer to the "ZedBoard_USB-UART_Setup_Guide.pdf" document in the link below for instructions on installing this driver. When driver installation is complete, continue to the next step.

http://www.zedboard.org/sites/default/files/CY7C64225_Setup_Guide_1_1.pdf

7. Wait approximately 15 seconds. The blue Done LED (LD12) should illuminate, and a default image will be displayed on the OLED (DISP1).
8. Use Device Manager to determine the COM Port.

Note: Each unique USB-UART device attached will enumerate under the next available COM port. Here in this example, the Cypress CY7C64225 USB-UART device is enumerated as COM13.

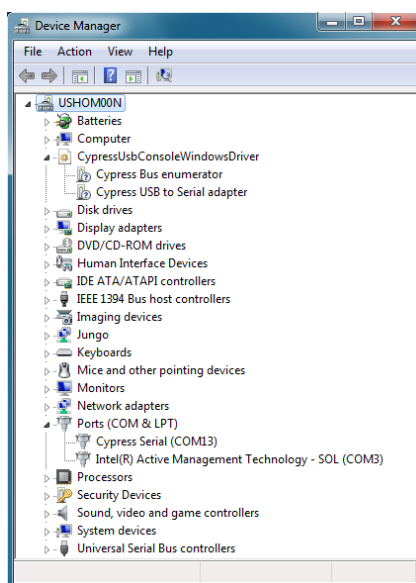


Figure 2 – Device Manager Showing Enumerated USB-UART as COM13

- On your PC, open a serial terminal program. For this demo, Windows 7 was used which does not come with a built in terminal application. Tera Term was used in this example which can be downloaded from the Tera Term project on the SourceForge Japan page: tssh2.sourceforge.jp
- Once Tera Term is installed, Tera Term can be accessed from the desktop or start menu shortcuts.



- To configure baud rate settings, open the Serial Port Setup window from the **Setup**→**Serial port** menu selection. Select the USB-UART COM port enumeration that matches the listing found in Device Manager. Also set the Baud rate option to 115200, the Data width option to 8-bit, the Parity option to none, the Stop bit option to 1 bit, and the flow control to none. Finally, assign the transmit delay parameters to 10 msec/char and 100 msec/line, and then click OK.

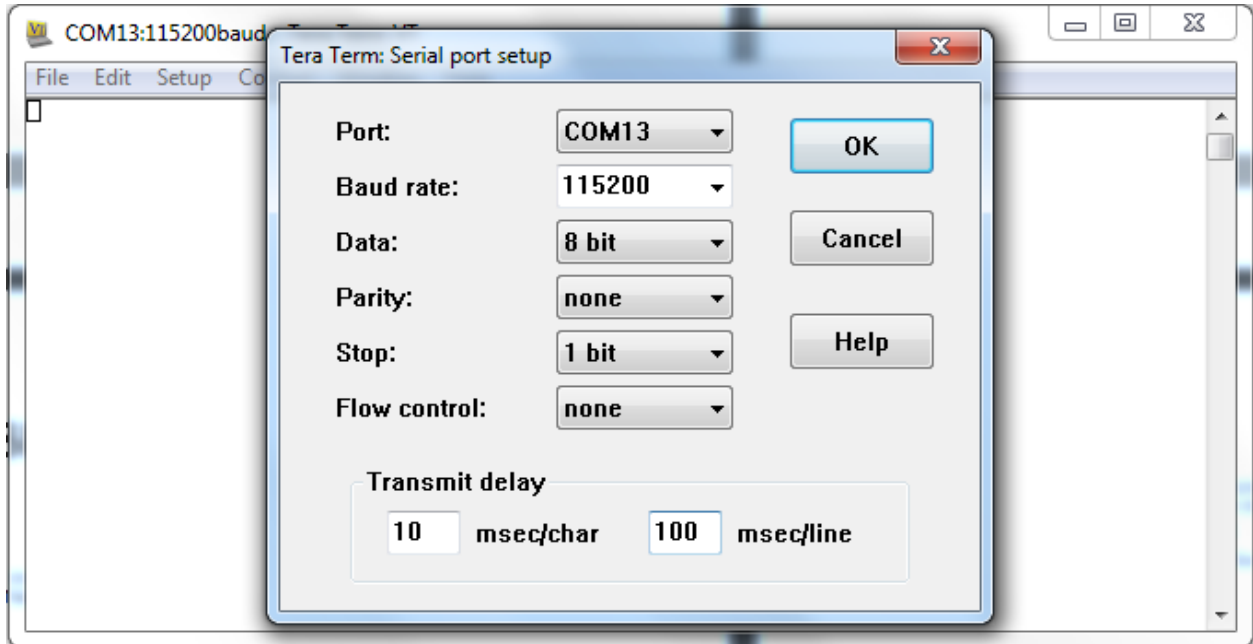
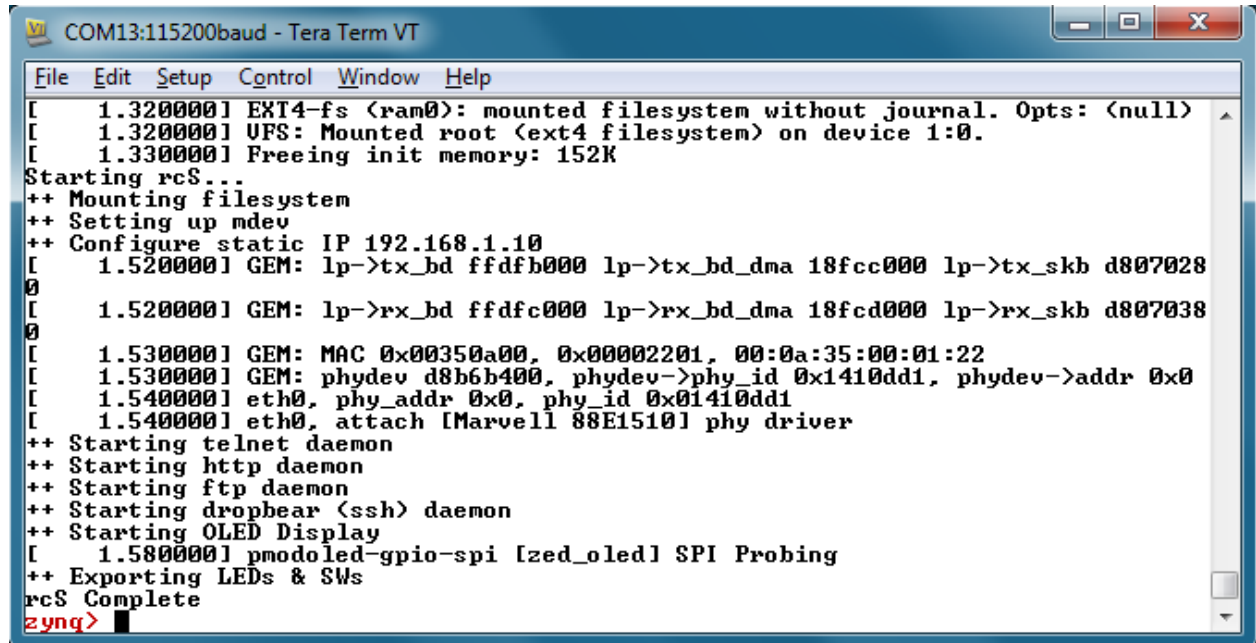


Figure 3 – Tera Term Serial Port Setup Settings

- Optionally, at this point, the terminal settings can be saved for later use. To do this, use the **Setup**→**Save setup** menu selection and overwrite the existing TERATERM.INI file.
- If the amber USB-Link Status (LD11) does not flicker to indicate activity, check the driver installation to determine if the device driver is recognized and enumerated successfully and that there are no errors reported by Windows.

Linux Startup and Shutdown

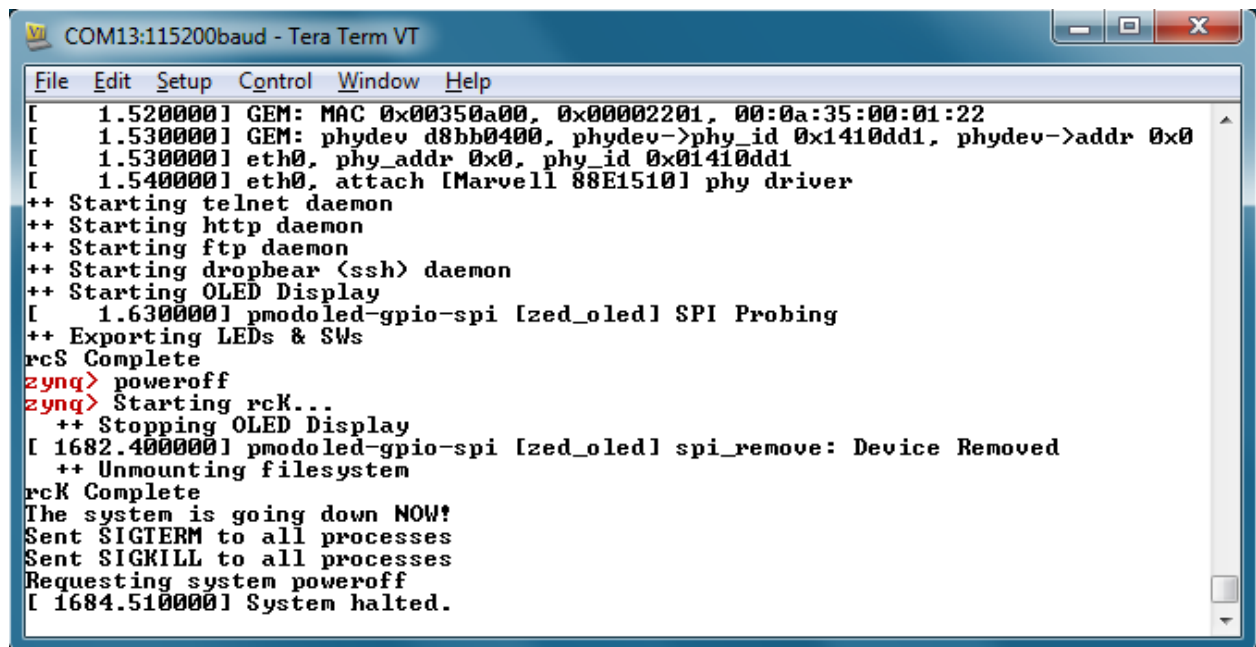
1. Cycle power once by turning the power switch (SW8) from ON to OFF and then back ON.
2. In the Terminal Window, a simple Linux image should boot with functionality that demonstrates the basic capabilities of ZedBoard.



```
COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
[ 1.320000] EXT4-fs (ram0): mounted filesystem without journal. Opts: (null)
[ 1.320000] UFS: Mounted root (ext4 filesystem) on device 1:0.
[ 1.330000] Freeing init memory: 152K
Starting rcS...
++ Mounting filesystem
++ Setting up mdev
++ Configure static IP 192.168.1.10
[ 1.520000] GEM: lp->tx_bd ffdfb000 lp->tx_bd_dma 18fcc000 lp->tx_skb d807028
0
[ 1.520000] GEM: lp->rx_bd ffdfc000 lp->rx_bd_dma 18fcd000 lp->rx_skb d807038
0
[ 1.530000] GEM: MAC 0x00350a00, 0x00002201, 00:0a:35:00:01:22
[ 1.530000] GEM: phydev d8b6b400, phydev->phy_id 0x1410dd1, phydev->addr 0x0
[ 1.540000] eth0, phy_addr 0x0, phy_id 0x01410dd1
[ 1.540000] eth0, attach [Marvell 88E1510] phy driver
++ Starting telnet daemon
++ Starting http daemon
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.580000] pmodoled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq>
```

Figure 4 – Linux Command Prompt Following Boot

3. When you are done using Linux, run the command `poweroff` and then switch off ZedBoard by positioning the power switch (SW8) from ON to OFF.



```
COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
[ 1.520000] GEM: MAC 0x00350a00, 0x00002201, 00:0a:35:00:01:22
[ 1.530000] GEM: phydev d8bb0400, phydev->phy_id 0x1410dd1, phydev->addr 0x0
[ 1.530000] eth0, phy_addr 0x0, phy_id 0x01410dd1
[ 1.540000] eth0, attach [Marvell 88E1510] phy driver
++ Starting telnet daemon
++ Starting http daemon
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.630000] pmodoled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq> poweroff
zynq> Starting rcK...
++ Stopping OLED Display
[ 1682.400000] pmodoled-gpio-spi [zed_oled] spi_remove: Device Removed
++ Unmounting filesystem
rcK Complete
The system is going down NOW!
Sent SIGTERM to all processes
Sent SIGKILL to all processes
Requesting system poweroff
[ 1684.510000] System halted.
```

Figure 5 – Linux Command Prompt Following Shutdown

Example Design Description

ZedBoard System Block Diagram

The following figure illustrates the system design that serves to demonstrate the subsequent interface demos.

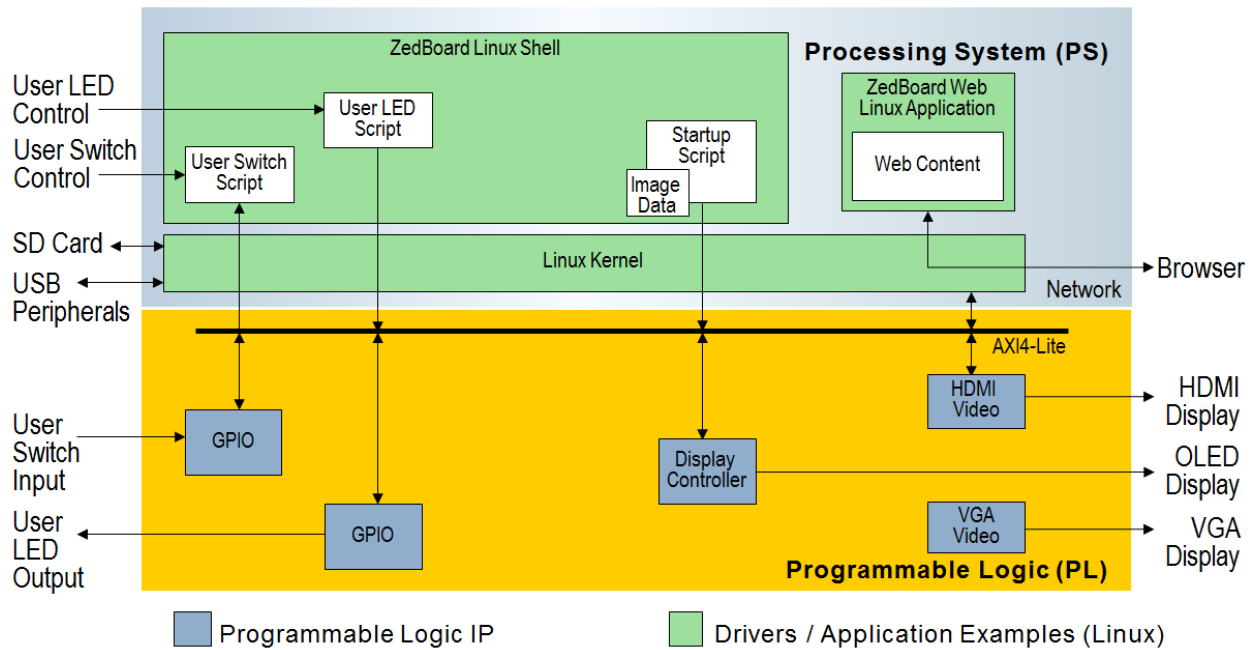


Figure 6 - ZedBoard Example Design Block Diagram

This example design platform is what is included (Programmable Logic provided in Bitstream form) on the ZedBoard SD card and can be used as one of the starting points from which custom designs can be built.

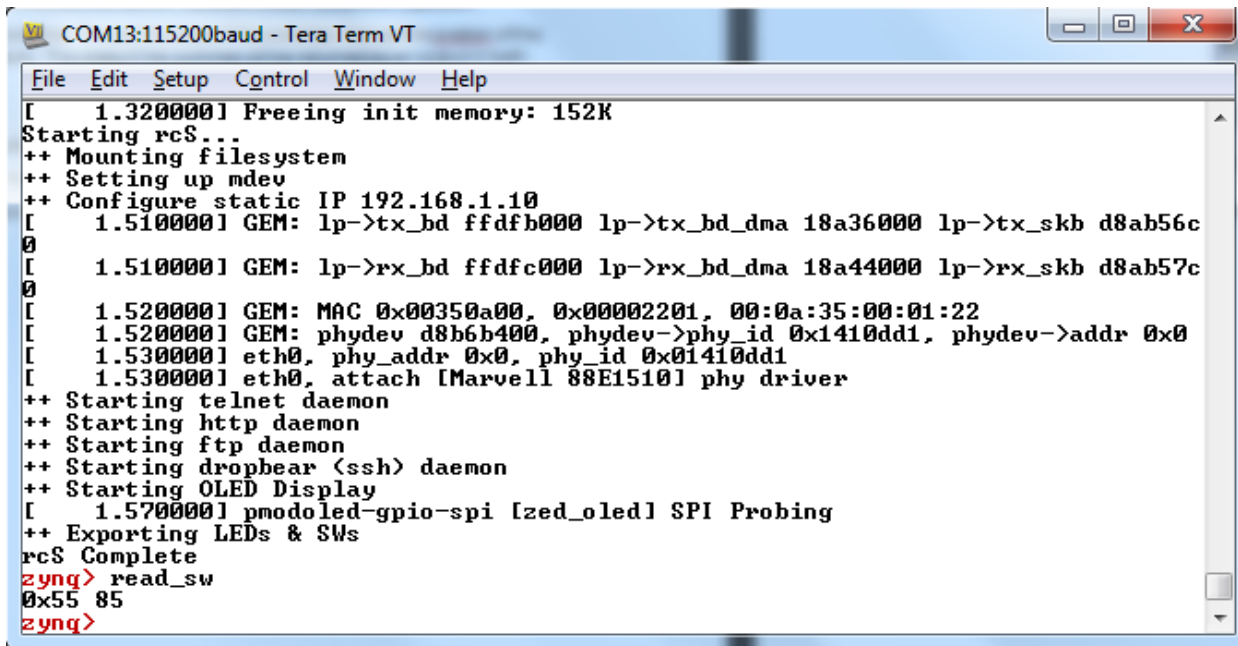
Demo 1 – Interacting with GPIO Switches and LEDs

Purpose

This demo shows how software running on the Processing System (PS) of Zynq-7000 AP SoC can interact with the Programmable Logic (PL) hardware to process inputs and outputs through the GPIO implemented in the programmable fabric. This section will also help demonstrate some of the Linux infrastructure that is operational right out of the box.

Running the Demo on ZedBoard Hardware

1. Setup the basic hardware and boot into Linux as described in the previous section ZedBoard Basic Setup and Operation.
2. A set of scripts are included in the `/usr/bin` directory for interacting with the hardware. To read the state of the user switches (SW0-SW7), first set the position of the switches as desired and then run the `read_sw` script. The state of the switches will be returned as an output in both hexadecimal and decimal formats.



```
COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
[ 1.320000] Freeing init memory: 152K
Starting rcS...
++ Mounting filesystem
++ Setting up mdev
++ Configure static IP 192.168.1.10
[ 1.510000] GEM: lp->tx_bd ffdfb000 lp->tx_bd_dma 18a36000 lp->tx_skb d8ab56c
0
[ 1.510000] GEM: lp->rx_bd ffdfc000 lp->rx_bd_dma 18a44000 lp->rx_skb d8ab57c
0
[ 1.520000] GEM: MAC 0x00350a00, 0x00002201, 00:0a:35:00:01:22
[ 1.520000] GEM: phydev d8b6b400, phydev->phy_id 0x1410dd1, phydev->addr 0x0
[ 1.530000] eth0, phy_addr 0x0, phy_id 0x01410dd1
[ 1.530000] eth0, attach [Marvell 88E1510] phy driver
++ Starting telnet daemon
++ Starting http daemon
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.570000] pmodoled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq> read_sw
0x55 85
zynq>
```

Figure 7 - ZedBoard Example Switch Input

3. The `read_sw` script handles the details of reading the GPIO states from the `/sys/class/gpio/gpio$sw/value` sysfs nodes. The position of the switches can be modified and the updated GPIO values read again by running the `read_sw` script.

- A script for changing the state of the LEDs is also included. To set the state of the user LEDs (LD0-LD7), use the script `write_led` and specify the byte value to be written to the LEDs. For example, running the script `write_led 0xFF` or even the command `write_led 255` will result in each of the user LEDs LD0-LD7 illuminating as seen in Figure 8.

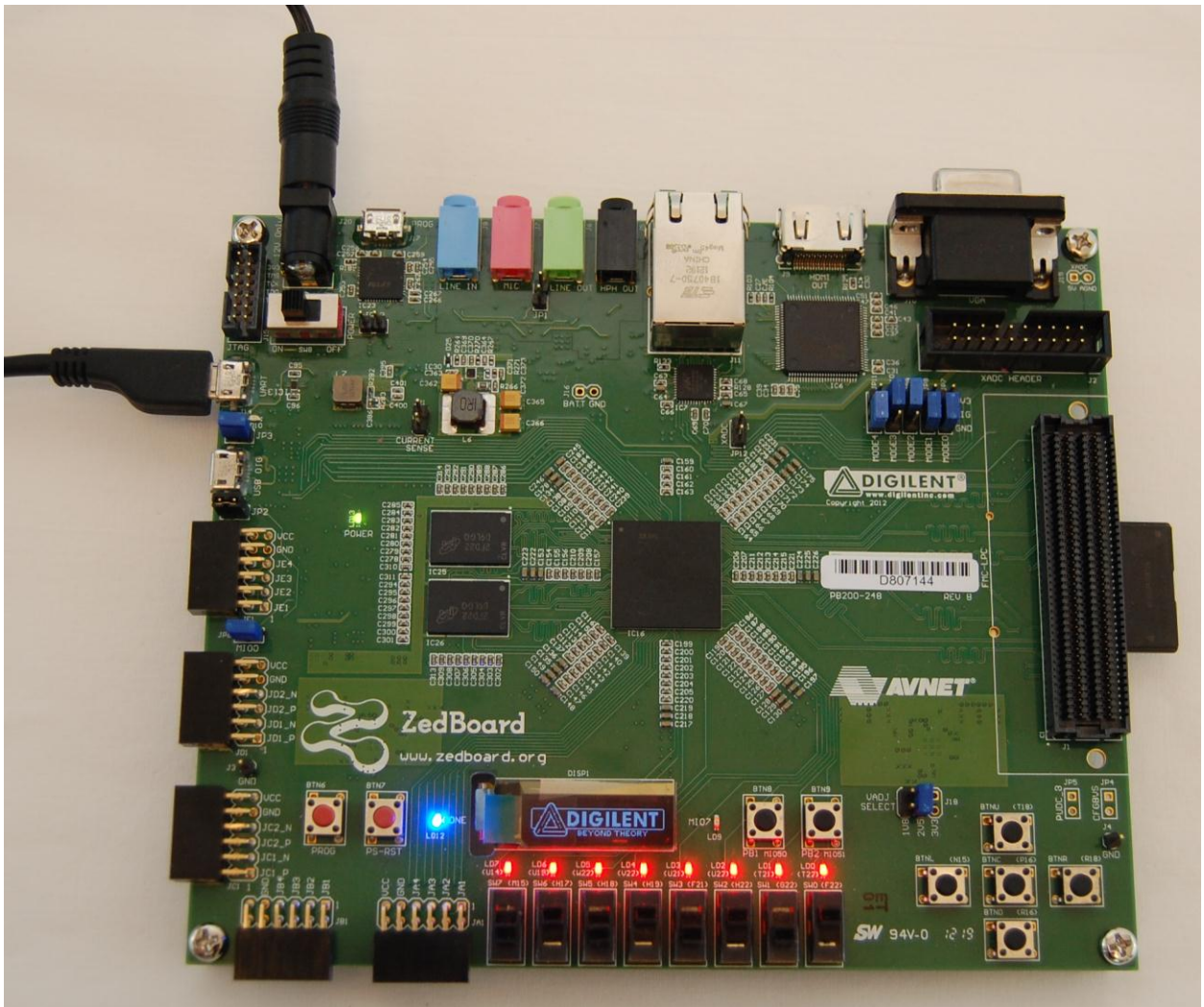


Figure 8 - ZedBoard Example LED Output

- The `write_led` script handles the details of writing the specified values to the `/sys/class/gpio/gpio$led/value` sysfs nodes. The state of the LEDs can be modified again by running the `write_led` script with another output value.
- This concludes Demo 1. Continue to experiment with this demo, proceed to another demo, or run the Linux command `poweroff` and then switch off ZedBoard.

Demo 2 – OLED Display

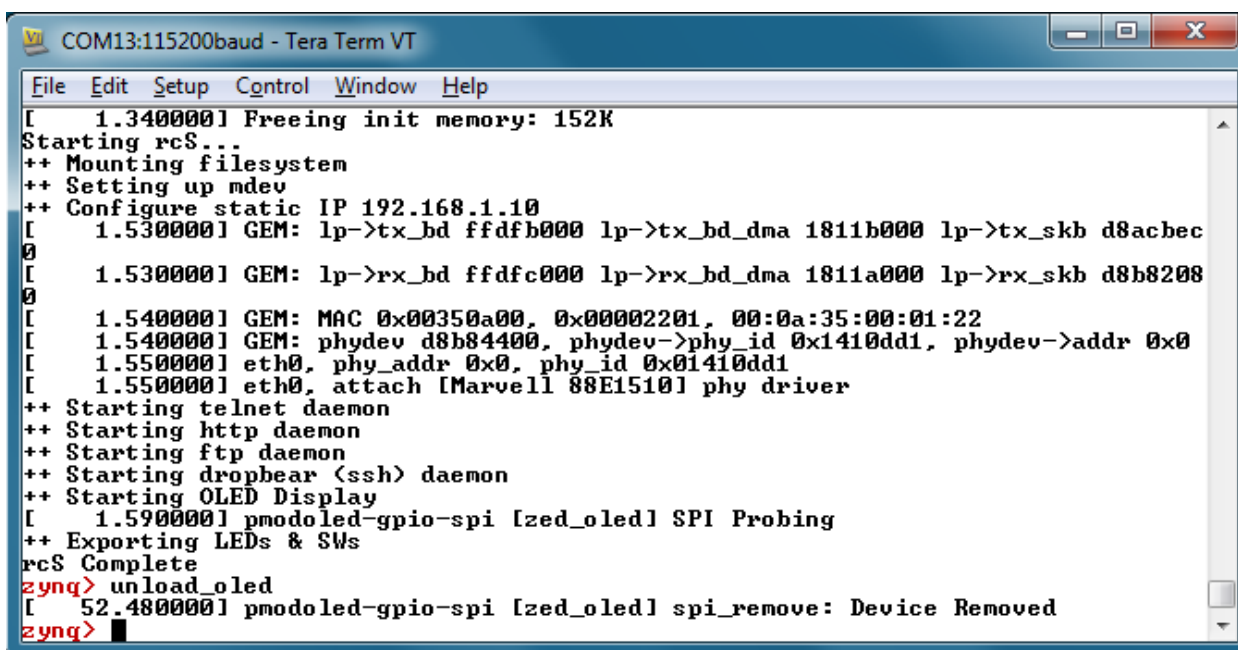
Purpose

This demo shows how software running on the Processing System (PS) of Zynq-7000 AP SoC can interact with the Programmable Logic (PL) hardware via a device driver.

A default Digilent Logo image is displayed on the OLED display (DISP1) after Linux has finished booting. In order to prolong the life of the OLED display, the manufacturer suggests that a specific powerdown sequence be used. Running the `poweroff` command before switching the ZED board off will ensure that this procedure is correctly followed. This section will help demonstrate some of the Linux infrastructure that is used to facilitate the OLED feature.

Running the Demo on ZedBoard Hardware

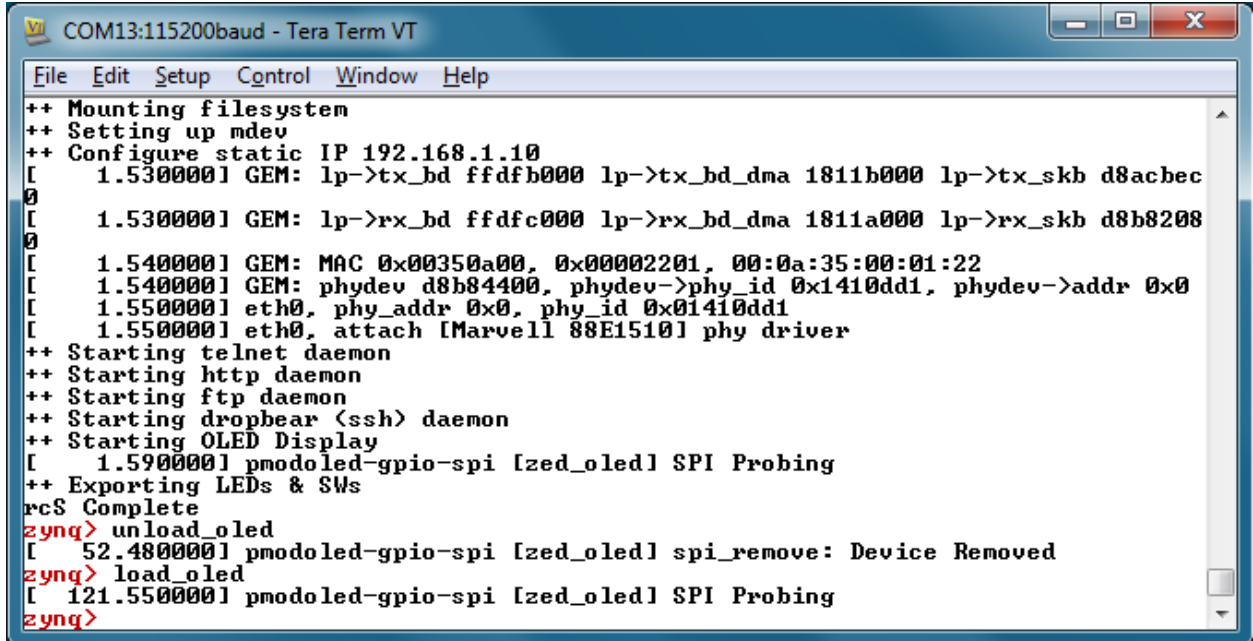
1. Setup the basic hardware and boot into Linux as described in the previous section ZedBoard Basic Setup and Operation.
2. A set of scripts are included in the `/usr/bin` directory for interacting with the hardware. To power off the OLED display, run the `unload_oled` script. By running this script, the OLED device driver module `pmdoled-gpio.ko` will be dynamically removed from the kernel during which the OLED is powered off using the recommended sequence and will no longer display the Digilent logo.



```
COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
[ 1.340000] Freeing init memory: 152K
Starting rcS...
++ Mounting filesystem
++ Setting up mdev
++ Configure static IP 192.168.1.10
[ 1.530000] GEM: lp->tx_bd fdfb000 lp->tx_bd_dma 1811b000 lp->tx_skb d8acbec
0
[ 1.530000] GEM: lp->rx_bd fdfc000 lp->rx_bd_dma 1811a000 lp->rx_skb d8b8208
0
[ 1.540000] GEM: MAC 0x00350a00, 0x00002201, 00:0a:35:00:01:22
[ 1.540000] GEM: phydev d8b84400, phydev->phy_id 0x1410dd1, phydev->addr 0x0
[ 1.550000] eth0, phy_addr 0x0, phy_id 0x01410dd1
[ 1.550000] eth0, attach [Marvell 88E1510] phy driver
++ Starting telnet daemon
++ Starting http daemon
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.590000] pmdoled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq> unload_oled
[ 52.480000] pmdoled-gpio-spi [zed_oled] spi_remove: Device Removed
zynq>
```

Figure 9 – Turning the OLED Display Off

- To power on the OLED display again, run the `load_oled` script. By running this script, the OLED device driver module `pmdoled-gpio.ko` will be dynamically inserted into the kernel during which it will power on the OLED display using the recommended sequence. Next, the source logo image file `/root/logo.bin` is transferred to the OLED display device node `/dev/zed_oled` and the driver configures the OLED in order to display the Digilent logo.



```
COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
++ Mounting filesystem
++ Setting up mdev
++ Configure static IP 192.168.1.10
[ 1.530000] GEM: lp->tx_bd fdfb000 lp->tx_bd_dma 1811b000 lp->tx_skb d8acbec
0
[ 1.530000] GEM: lp->rx_bd fdfc000 lp->rx_bd_dma 1811a000 lp->rx_skb d8b8208
0
[ 1.540000] GEM: MAC 0x00350a00, 0x00002201, 00:0a:35:00:01:22
[ 1.540000] GEM: phydev d8b84400, phydev->phy_id 0x1410dd1, phydev->addr 0x0
[ 1.550000] eth0, phy_addr 0x0, phy_id 0x01410dd1
[ 1.550000] eth0, attach [Marvell 88E1510] phy driver
++ Starting telnet daemon
++ Starting http daemon
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.590000] pmdoled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq> unload_oled
[ 52.480000] pmdoled-gpio-spi [zed_oled] spi_remove: Device Removed
zynq> load_oled
[ 121.550000] pmdoled-gpio-spi [zed_oled] SPI Probing
zynq>
```

Figure 10 – Turning the OLED Display On

- This concludes Demo 2. Continue to experiment with this demo, proceed to another demo, or run the Linux command `poweroff` and then switch off ZedBoard.

Demo 3 – VGA Display

Purpose

This demo shows how Programmable Logic (PL) can drive hardware independently of the software running on the Processing System (PS) of Zynq-7000 AP SoC once the PL Bitstream is loaded. During this demo a test pattern generated by the PL can be observed on a display connected to the video output on the VGA connector.

Running the Demo on ZedBoard Hardware

1. Setup the basic hardware described in the previous section ZedBoard Basic Setup and Operation.
2. Using a 15-pin D-subminiature VGA cable, attach a VGA display capable of displaying a resolution of at least 640x480 to the ZedBoard video output connector J10 which is labeled **VGA**.
3. Turn power switch (SW8) to the ON position. ZedBoard will power on and the Green Power Good LED (LD13) should illuminate.
4. Wait approximately 15 seconds. The blue Done LED (LD12) should illuminate, and a default image will be displayed on the OLED (DISP1). The VGA test pattern will also show on the display as seen in Figure 11.

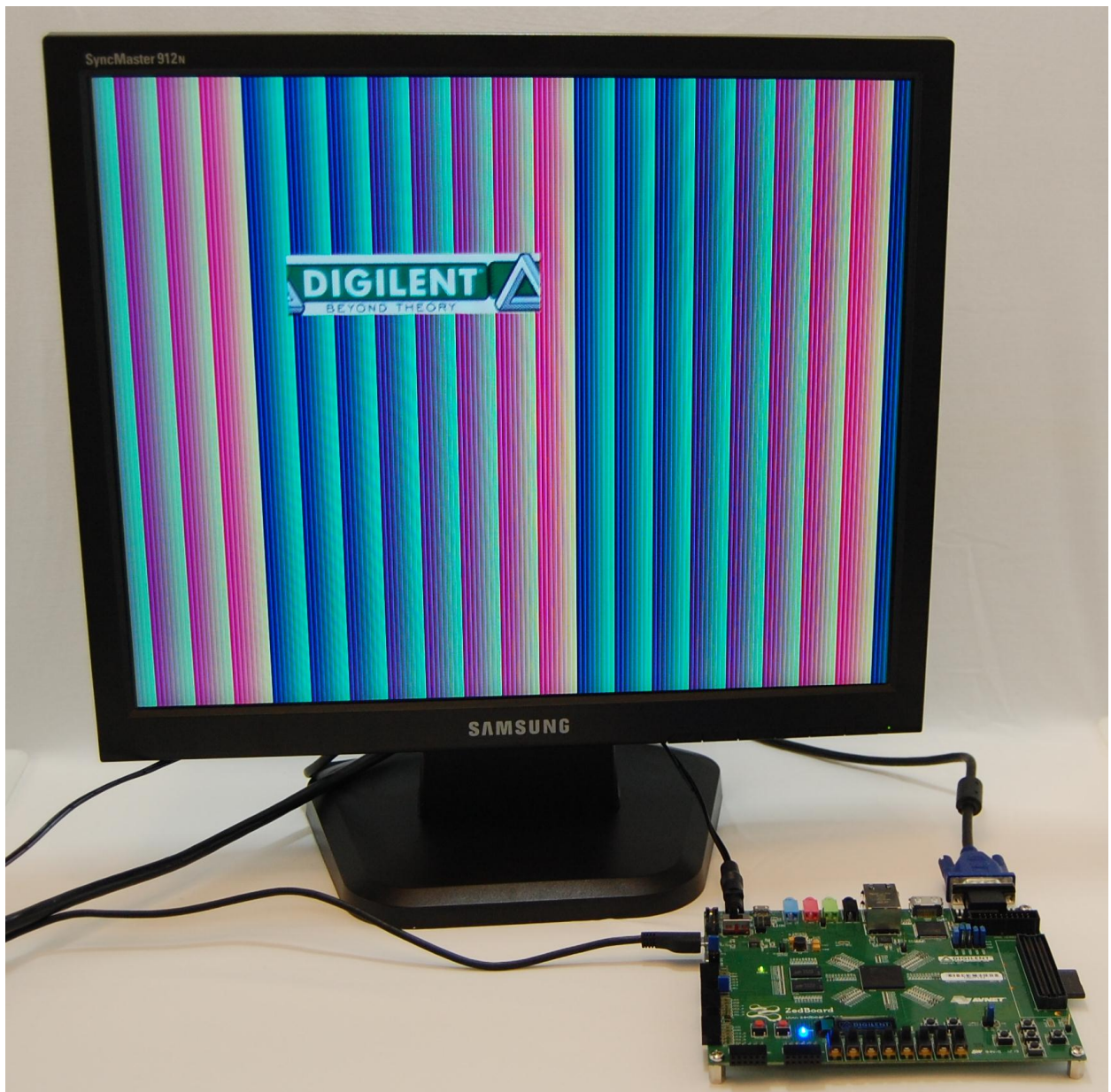


Figure 11 – VGA Output Test Pattern

5. This concludes Demo 3. Continue to experiment with this demo, proceed to another demo, or run the Linux command `poweroff` and then switch off ZedBoard.

Demo 4 – HDMI Display

Purpose

This demo shows how software running on the Processing System (PS) of Zynq-7000 AP SoC can interact with the Programmable Logic (PL) hardware via a device driver. During this demo, a default “Tux” Linux logo image is displayed to the HDMI display port after Linux begins booting.

Running the Demo on ZedBoard Hardware

1. Setup the basic hardware as described in the previous section ZedBoard Basic Setup and Operation.
2. Using an HDMI-to-HDMI cable, attach an HDMI display capable of displaying a resolution of at least 1080p60 to the ZedBoard HD video output connector J9 which is labeled **HDMI OUT**.
3. Turn power switch (SW8) to the ON position. ZedBoard will power on and the Green Power Good LED (LD13) should illuminate.
4. Wait approximately 15 seconds. The blue Done LED (LD12) should illuminate, and a default image will be displayed on the OLED (DISP1). The HDMI output pattern will also show on the display as seen in Figure 12.

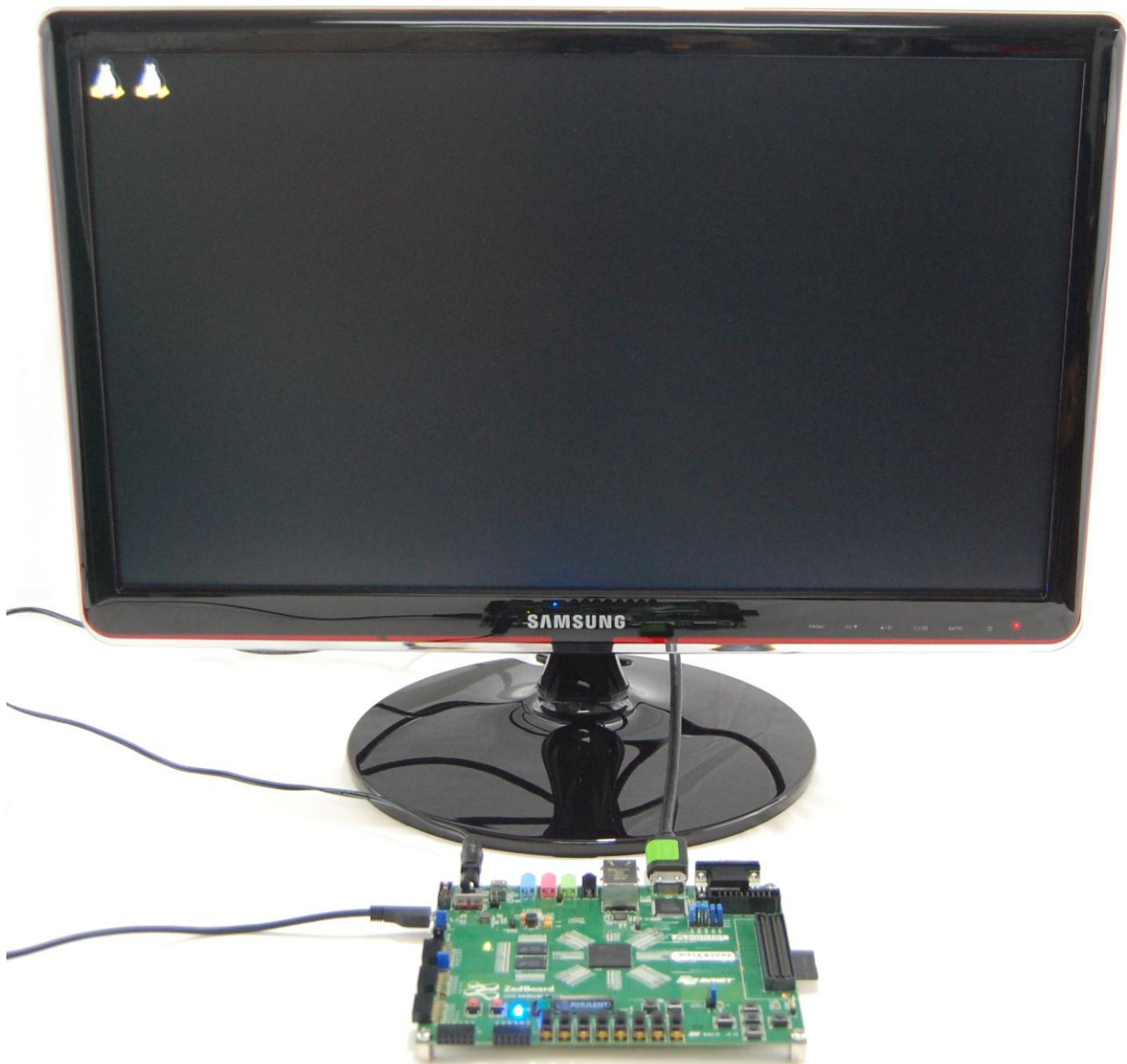


Figure 12 – HDMI Output Pattern

5. This concludes Demo 4. Continue to experiment with this demo, proceed to another demo, or run the Linux command `poweroff` and then switch off ZedBoard.

Demo 5 – Ethernet

Purpose

ZedBoard example Linux system found on the included SD card implements a Dropbear SSH server, ftpd FTP server, and Busybox httpd HTTP server at startup. Refer to the documentation on each of these server implementations if you are interested in using them beyond the scope of this document.

Host PC Networking Configuration

This demo shows the Gigabit Ethernet hardware and networking capability of ZedBoard. To run this demo, you may have to configure the network properties on your PC. The following steps will guide you through this process for a Windows 7 host PC.

1. Attach a standard Ethernet Cable between ZedBoard Gigabit Ethernet Port (J11) and the host PC network interface adapter.
2. Open the **Change adapter settings** from the **Start→Control Panel→Network and Sharing Center**.

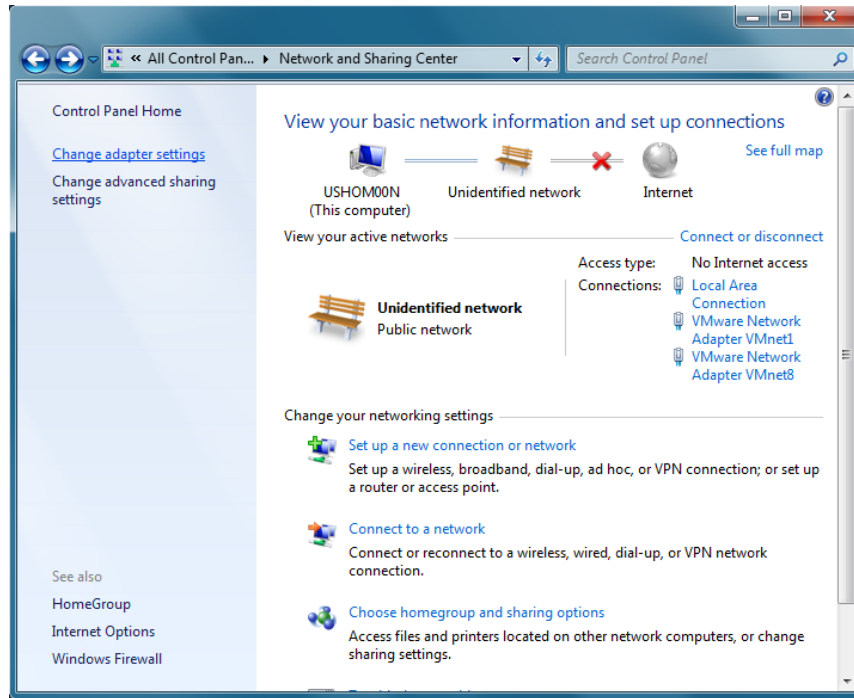


Figure 13 – Network and Sharing Center

3. In the **Network Connections** window, right-click on the Local Area Connection adapter entry corresponding to the network interface that is connected to ZedBoard and select **Properties**.

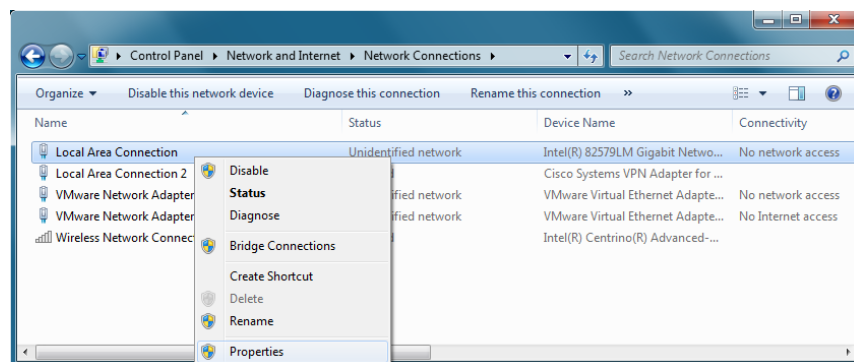


Figure 14 – Network Connections

4. In **Local Area Connection Properties**, select **Internet Protocol Version 4 (TCP/IPv4)**, then click the **Properties** button.

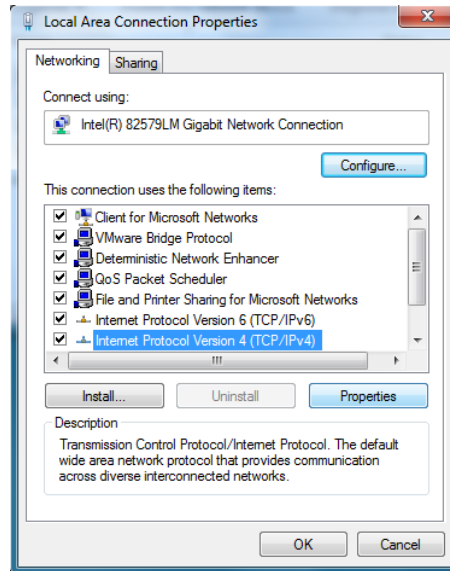


Figure 15 – Local Area Connection Properties

5. Set the IP address to 192.168.1.1 and the Subnet mask to 255.255.255.0 in the **Internet Protocol Version 4 (TCP/IPv4) Properties** window and then click the OK button.

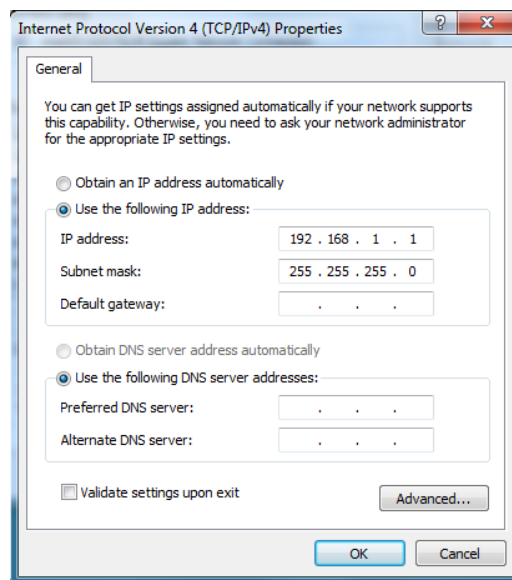


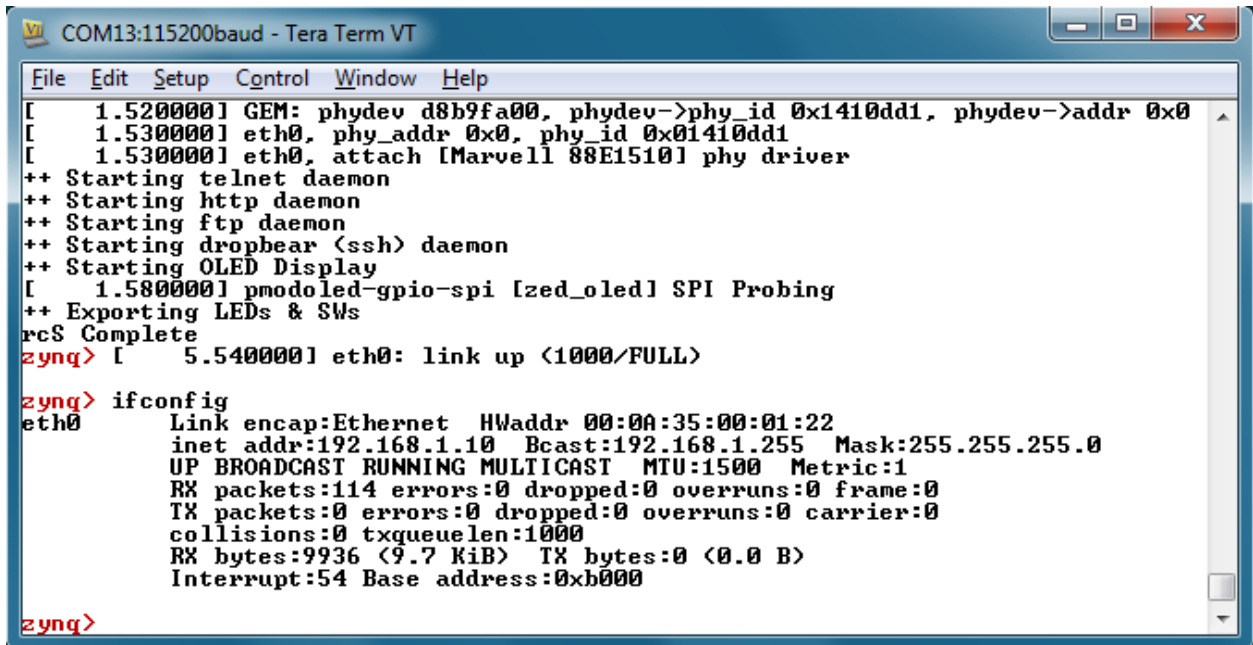
Figure 16 – Internet Protocol Version 4 (TCP/IPv4) Properties

6. The host PC networking is now configured and ready to proceed with the networking hardware demo.

Running the Demo on ZedBoard Hardware

1. Setup the basic hardware and boot into Linux as described in the previous section ZedBoard Basic Setup and Operation.
2. Verify that a standard Ethernet Cable is connected between ZedBoard Gigabit Ethernet Port (J11) and the host PC network interface adapter.

- The default IP address of ZedBoard Ethernet is set to 192.168.1.10 and this can be verified with the output returned by the `ifconfig` command.



```
COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
[ 1.520000] GEM: phydev d8b9fa00, phydev->phy_id 0x1410dd1, phydev->addr 0x0
[ 1.530000] eth0, phy_addr 0x0, phy_id 0x01410dd1
[ 1.530000] eth0, attach [Marvell 88E1510] phy driver
++ Starting telnet daemon
++ Starting http daemon
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.580000] pmodoled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq> [ 5.540000] eth0: link up (1000/FULL)

zynq> ifconfig
eth0      Link encap:Ethernet  HWaddr 00:0A:35:00:01:22
          inet addr:192.168.1.10  Bcast:192.168.1.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:114 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:9936 (9.7 KiB)  TX bytes:0 (0.0 B)
          Interrupt:54 Base address:0xb000

zynq>
```

Figure 17 – ZedBoard IP Address Revealed with `ifconfig` Command

- To view the ZedBoard embedded webpage, open a web browser (such as Firefox) and browse to the ZedBoard IP address <http://192.168.1.10> as the URL. The ZedBoard webpage should open in the browser to display as seen in Figure 18.

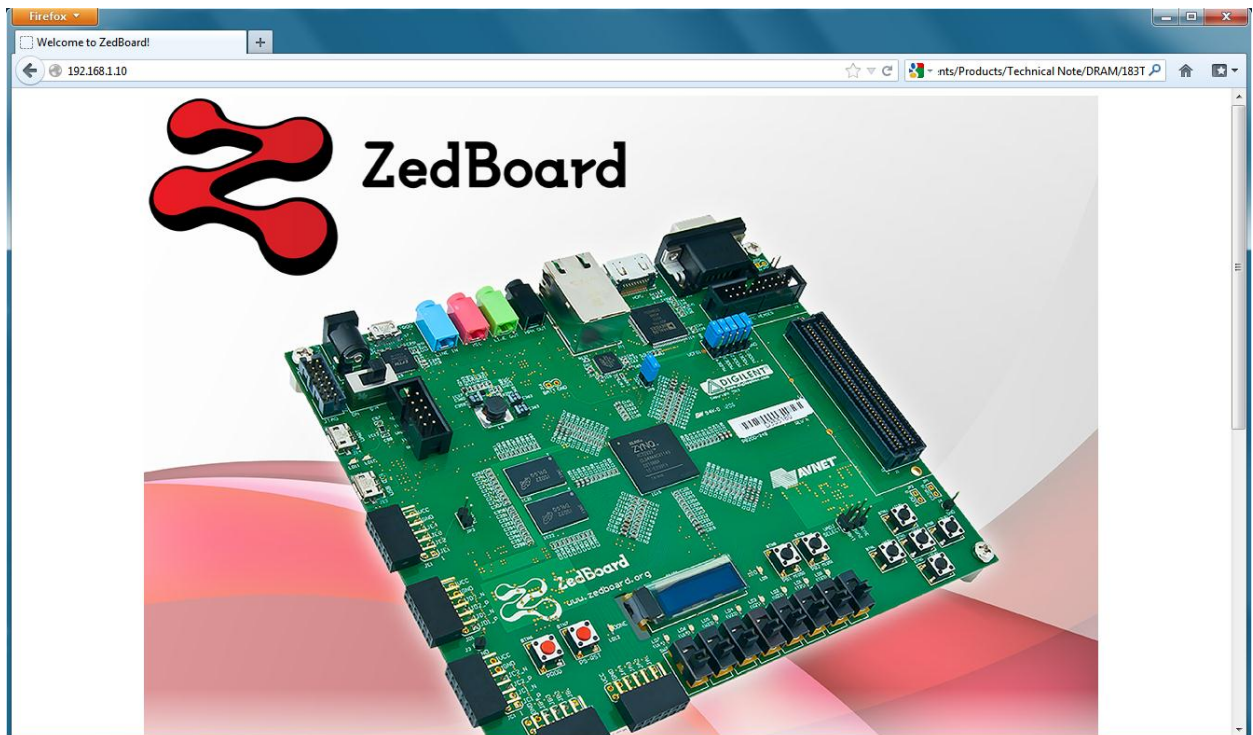


Figure 18 – ZedBoard Webpage Shown In PC Host Browser

- Using an SSH client, such as PuTTY SSH, open a secure terminal connection to the target ZedBoard using the 192.168.1.10 IP address.

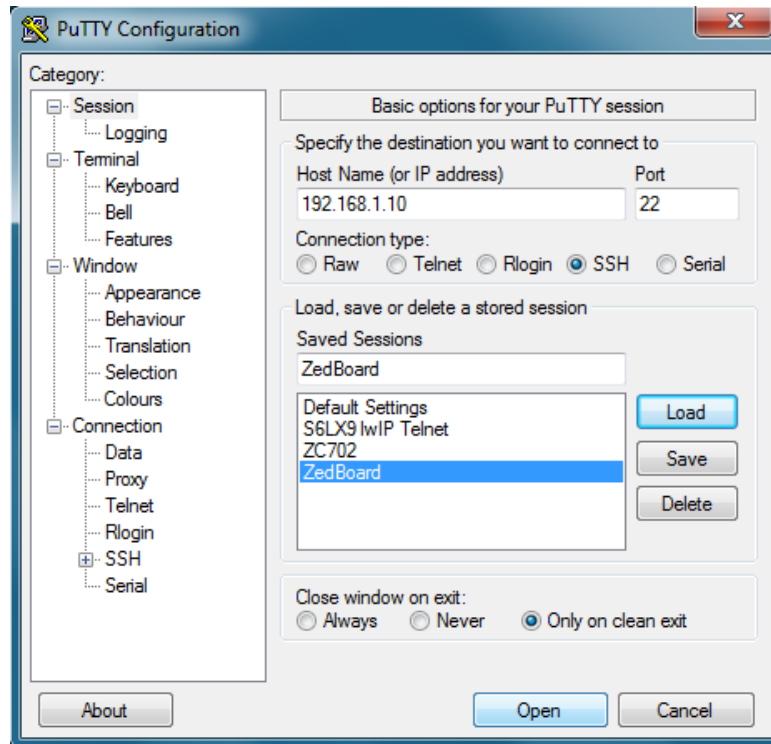


Figure 19 – ZedBoard Webpage Shown In PC Host Browser

- Once the terminal connects, the remote system will prompt for a login. Use the user login **root** and the password **root** to complete the connection.
- The session acts as a remote terminal and commands can be entered as you would on the local serial console.

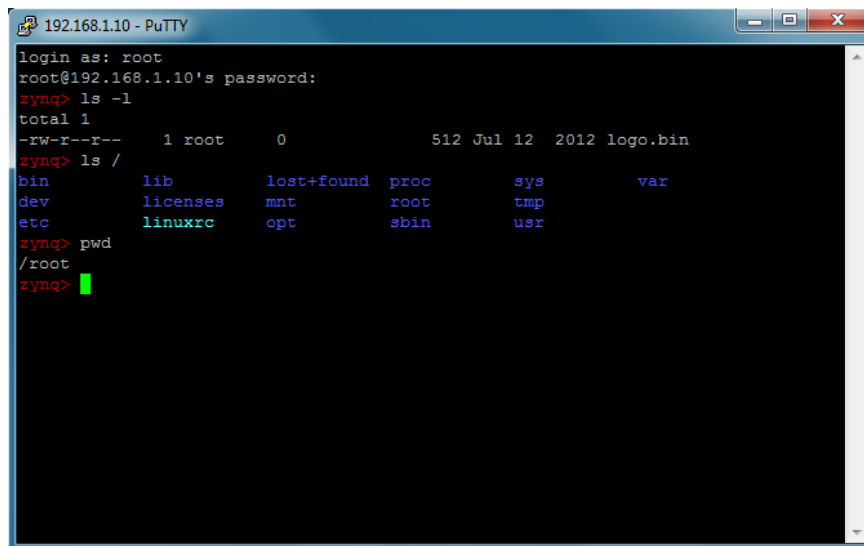
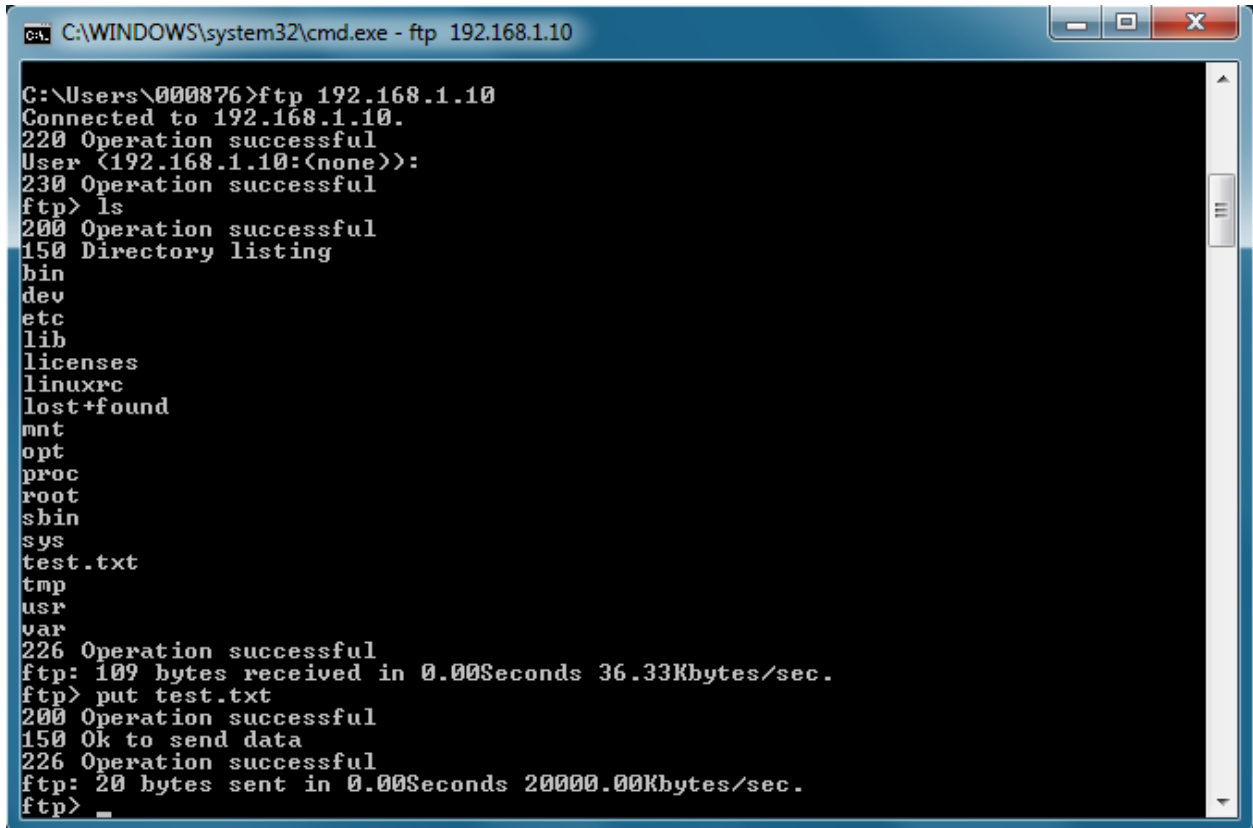


Figure 20 – Remote ZedBoard Terminal via SSH Session

- Logout and close the remote session with the `exit` command.
- Open a Windows Command Prompt.
- Connect an FTP session to the remote host with the command `ftp 192.168.1.10` and use the login **root**.

11. You can use the ftp session to transfer files back and forth across the network to ZedBoard.



```
C:\WINDOWS\system32\cmd.exe - ftp 192.168.1.10

C:\Users\000876>ftp 192.168.1.10
Connected to 192.168.1.10.
220 Operation successful
User (192.168.1.10:(none)):
230 Operation successful
ftp> ls
200 Operation successful
150 Directory listing
bin
dev
etc
lib
licenses
linuxrc
lost+found
mnt
opt
proc
root
sbin
sys
test.txt
tmp
usr
var
226 Operation successful
ftp: 109 bytes received in 0.00Seconds 36.33Kbytes/sec.
ftp> put test.txt
200 Operation successful
150 Ok to send data
226 Operation successful
ftp: 20 bytes sent in 0.00Seconds 20000.00Kbytes/sec.
ftp> _
```

Figure 21 – ZedBoard FTP Session

12. Close the ftp session using the `bye` command.
13. This concludes Demo 5. Continue to experiment with this demo, proceed to another demo, or run the command `poweroff` and then switch off ZedBoard.

Demo 6 – USB-OTG

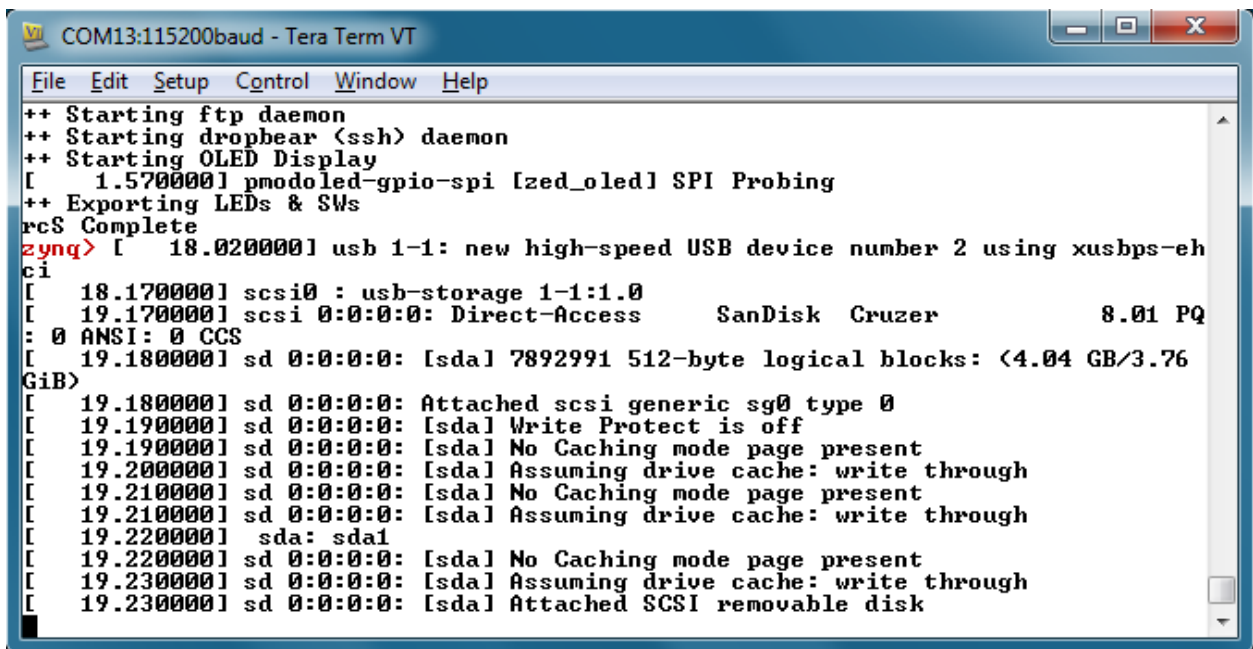
Purpose

This demo shows how a high speed communications peripheral connected to the Processing System (PS) of Zynq-7000 AP SoC can be used to extend the functionality of ZedBoard.

To connect additional USB devices with the ZED board, connect a powered hub to the USB-OTG port. USB devices attached to this hub can then also be accessed in Linux.

Running the Demo on ZedBoard Hardware

1. Set jumpers JP2 and JP3 to the 1-2 position. This will enable the OTG device for host mode and connect the ZedBoard USB 5V supply to the USB OTG (J13) VBUS line.
2. Setup the basic hardware and boot into Linux as described in the previous section ZedBoard Basic Setup and Operation.
3. Connect a USB thumb drive to the female end of the microUSB-to-Type A adapter cable included with ZedBoard.
4. Connect the microUSB end of the microUSB-to-Type A adapter cable to J13.
5. The USB thumb drive should enumerate and the device indication should display on the serial console. In this example, the primary partition of this USB thumb drive has been enumerated as device `/dev/sda1` as seen in Figure 22.



```
COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.570000] pmoduled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq> [ 18.020000] usb 1-1: new high-speed USB device number 2 using xusbps-ehci
[ 18.170000] scsi0 : usb-storage 1-1:1.0
[ 19.170000] scsi 0:0:0:0: Direct-Access SanDisk Cruzer 8.01 PQ
: 0 ANSI: 0 CCS
[ 19.180000] sd 0:0:0:0: [sda] 7892991 512-byte logical blocks: <4.04 GB/3.76 GiB>
[ 19.180000] sd 0:0:0:0: Attached scsi generic sg0 type 0
[ 19.190000] sd 0:0:0:0: [sda] Write Protect is off
[ 19.190000] sd 0:0:0:0: [sda] No Caching mode page present
[ 19.200000] sd 0:0:0:0: [sda] Assuming drive cache: write through
[ 19.210000] sd 0:0:0:0: [sda] No Caching mode page present
[ 19.210000] sd 0:0:0:0: [sda] Assuming drive cache: write through
[ 19.220000] sda: sda1
[ 19.220000] sd 0:0:0:0: [sda] No Caching mode page present
[ 19.230000] sd 0:0:0:0: [sda] Assuming drive cache: write through
[ 19.230000] sd 0:0:0:0: [sda] Attached SCSI removable disk
```

Figure 22 – USB Drive Enumeration After Device Insertion

6. Mount the enumerated device to the /mnt mount point using the `mount /dev/sda1 /mnt` command.

```

COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
++ Starting http daemon
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.590000] pmodled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq> [ 2.310000] scsi 0:0:0:0: Direct-Access      SanDisk  Cruzer      8
_01 PQ: 0 ANSI: 0 CCS
[ 2.320000] sd 0:0:0:0: [sda] 7892991 512-byte logical blocks: (4.04 GB/3.76
GiB)
[ 2.320000] sd 0:0:0:0: Attached scsi generic sg0 type 0
[ 2.330000] sd 0:0:0:0: [sda] Write Protect is off
[ 2.330000] sd 0:0:0:0: [sda] No Caching mode page present
[ 2.340000] sd 0:0:0:0: [sda] Assuming drive cache: write through
[ 2.350000] sd 0:0:0:0: [sda] No Caching mode page present
[ 2.350000] sd 0:0:0:0: [sda] Assuming drive cache: write through
[ 2.360000] sda: sda1
[ 2.360000] sd 0:0:0:0: [sda] No Caching mode page present
[ 2.370000] sd 0:0:0:0: [sda] Assuming drive cache: write through
[ 2.370000] sd 0:0:0:0: [sda] Attached SCSI removable disk
zynq> mount /dev/sda1 /mnt
zynq>

```

Figure 23 – USB Drive Mounted to /mnt

7. The USB drive is now mounted into the root file system at the mount point /mnt which enables read and write file operations to the devices file system. In this example, the thumb drive used has an NTFS file system format.

```

COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
[ 2.340000] sd 0:0:0:0: Attached scsi generic sg0 type 0
[ 2.350000] sd 0:0:0:0: [sda] Write Protect is off
[ 2.350000] sd 0:0:0:0: [sda] No Caching mode page present
[ 2.360000] sd 0:0:0:0: [sda] Assuming drive cache: write through
[ 2.370000] sd 0:0:0:0: [sda] No Caching mode page present
[ 2.370000] sd 0:0:0:0: [sda] Assuming drive cache: write through
[ 2.380000] sda: sda1
[ 2.380000] sd 0:0:0:0: [sda] No Caching mode page present
[ 2.390000] sd 0:0:0:0: [sda] Assuming drive cache: write through
[ 2.390000] sd 0:0:0:0: [sda] Attached SCSI removable disk
zynq> mount /dev/sda1 /mnt
zynq> cd /mnt/
zynq> ls -l
total 460
drwxr-xr-x 16 root 0 4096 Aug 15 2011 Avnet
drwxr-xr-x 3 root 0 4096 Aug 6 2012 Cypress
drwxr-xr-x 3 root 0 4096 Jan 12 2009 EPI
drwxr-xr-x 11 root 0 4096 Jan 23 2009 Tools
drwxr-xr-x 3 root 0 4096 Jan 12 2009 boot
-rwxr-xr-x 1 root 0 438840 Nov 2 2006 bootmgr
drwxr-xr-x 2 root 0 4096 Jan 12 2009 sources
drwxr-xr-x 3 root 0 4096 Jan 12 2009 winpe_x86
zynq>

```

Figure 24 – Directory Listing of USB Drive

14. The device should be cleanly un-mounted from the system using the command `umount /mnt` before it is removed or the board powered off.

Note: If the device cannot be un-mounted or if a “Device or resource busy” message is shown, make sure that no files or folders of the mounted file system are currently open or that the current working directory is not part of the mounted file system.

15. This concludes Demo 6. Continue to experiment with this demo, proceed to another demo, or run the command `poweroff` and then switch off ZedBoard.

Demo 7 – SD Card

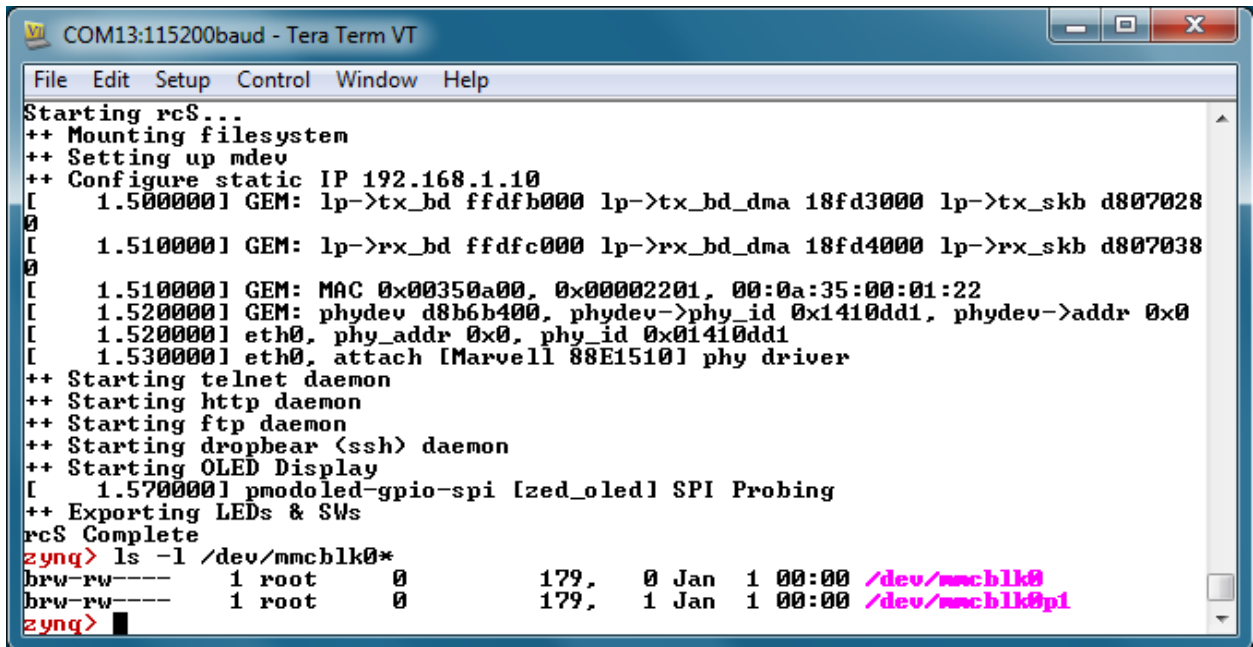
Purpose

This demo shows how a storage device connected to the Processing System (PS) of Zynq-7000 AP SoC can be used to extend the functionality of ZedBoard.

The root file system for the example design comes from a RAMdisk image stored on the SD card. This RAMdisk image is copied into a fixed location in DDR3 memory by u-boot prior to Linux boot. Once Linux begins booting, it mounts the RAM file system from the fixed location in DDR3. Any subsequent changes to this file system while ZedBoard is running will not persist through a power cycle or reset.

Running the Demo on ZedBoard Hardware

1. Setup the basic hardware and boot into Linux as described in the previous section ZedBoard Basic Setup and Operation.
2. The SD card is enumerated as MMC block device `/dev/mmcblk0` and the primary partition on the device is enumerated as device `/dev/mmcblk0p1` as seen in Figure 25.



```
COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
Starting rcS...
++ Mounting filesystem
++ Setting up mdev
++ Configure static IP 192.168.1.10
[ 1.500000] GEM: lp->tx_bd ffdfb000 lp->tx_bd_dma 18fd3000 lp->tx_skb d8070280
[ 1.510000] GEM: lp->rx_bd ffdfc000 lp->rx_bd_dma 18fd4000 lp->rx_skb d8070380
[ 1.510000] GEM: MAC 0x00350a00, 0x00002201, 00:0a:35:00:01:22
[ 1.520000] GEM: phydev d8b6b400, phydev->phy_id 0x1410dd1, phydev->addr 0x0
[ 1.520000] eth0, phy_addr 0x0, phy_id 0x01410dd1
[ 1.530000] eth0, attach [Marvell 88E1510] phy driver
++ Starting telnet daemon
++ Starting http daemon
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.570000] pmodoled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq> ls -l /dev/mmcblk0*
brw-rw---- 1 root 0 179, 0 Jan 1 00:00 /dev/mmcblk0
brw-rw---- 1 root 0 179, 1 Jan 1 00:00 /dev/mmcblk0p1
zynq>
```

Figure 25 – SD Card Block Device Enumeration

3. Mount the enumerated SD card primary partition block device to the /mnt mount point using the `mount /dev/mmcbk0p1 /mnt` command.

```

COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
++ Mounting filesystem
++ Setting up mdev
++ Configure static IP 192.168.1.10
[ 1.500000] GEM: lp->tx_bd ffdfb000 lp->tx_bd_dma 18fd3000 lp->tx_skb d807028
0
[ 1.510000] GEM: lp->rx_bd ffdfc000 lp->rx_bd_dma 18fd4000 lp->rx_skb d807038
0
[ 1.510000] GEM: MAC 0x00350a00, 0x00002201, 00:0a:35:00:01:22
[ 1.520000] GEM: phydev d8b6b400, phydev->phy_id 0x1410dd1, phydev->addr 0x0
[ 1.520000] eth0, phy_addr 0x0, phy_id 0x01410dd1
[ 1.530000] eth0, attach [Marvell 88E1510] phy driver
++ Starting telnet daemon
++ Starting http daemon
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.570000] pmodoled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq> ls -l /dev/mmcbk0*
brw-rw---- 1 root 0 179, 0 Jan 1 00:00 /dev/mmcbk0
brw-rw---- 1 root 0 179, 1 Jan 1 00:00 /dev/mmcbk0p1
zynq> mount /dev/mmcbk0p1 /mnt
zynq>

```

Figure 26 – SD Card Mounted to /mnt

4. The primary partition of the SD card is now mounted into the root file system at the mount point /mnt which enables read and write operations to files to the SD card file system. In this example, the SD card partition used has a FAT32 file system format.
Note: User LED LD9 is used to indicate read/write activity on the SD card.

```

COM13:115200baud - Tera Term VT
File Edit Setup Control Window Help
[ 1.520000] GEM: phydev d8b6b400, phydev->phy_id 0x1410dd1, phydev->addr 0x0
[ 1.520000] eth0, phy_addr 0x0, phy_id 0x01410dd1
[ 1.530000] eth0, attach [Marvell 88E1510] phy driver
++ Starting telnet daemon
++ Starting http daemon
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.570000] pmodoled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq> ls -l /dev/mmcbk0*
brw-rw---- 1 root 0 179, 0 Jan 1 00:00 /dev/mmcbk0
brw-rw---- 1 root 0 179, 1 Jan 1 00:00 /dev/mmcbk0p1
zynq> mount /dev/mmcbk0p1 /mnt
zynq> cd /mnt/
zynq> ls -l
total 10264
-rwxr-xr-x 1 root 0 4317256 Jul 31 2012 BOOT_BIN
-rwxr-xr-x 1 root 0 2779 Jul 31 2012 README
-rwxr-xr-x 1 root 0 5817 Jul 31 2012 devicetree_rawdisk.dtb
-rwxr-xr-x 1 root 0 3694108 Jul 31 2012 rawdisk8M.image.gz
-rwxr-xr-x 1 root 0 2479640 Jul 31 2012 zImage
zynq>

```

Figure 27 – Directory Listing of SD Card

5. The SD card device should be cleanly un-mounted from the system using the command `umount /mnt` before it is removed or the board powered off.
Note: If the device cannot be un-mounted or if a “Device or resource busy” message is shown, make sure that no files or folders of the mounted file system are currently open or that the current working directory is not part of the mounted file system.
6. This concludes Demo 7. Continue to experiment with this demo, proceed to another demo, or run the command `poweroff` and then switch off ZedBoard.

What's Next

Now that the pre-built ZedBoard example design has been explored, it is time to take a deeper dive into the ZedBoard and see how to modify this design or create a custom design.

To install the Xilinx ISE WebPACK Edition tools, please see the installation instructions in Appendix I: Installing and Licensing Xilinx Software.

Where To Get More Information

- Overview and Features of ZedBoard
 - www.zedboard.org/content/overview
- ZedBoard – Hardware User Guide
 - www.zedboard.org/content/documentation

Xilinx Website

- Zynq-7000 AP SoC Product Information
 - www.xilinx.com/zynq
- ISE WebPACK Design Software
 - www.xilinx.com/products/design-tools/ise-design-suite/ise-webpack.htm

Cypress Website

- CY7C64225 USB-to-UART Driver Download
 - www.cypress.com/?rID=63794
- CY7C64225 USB-to-UART Device Data Sheet
 - www.cypress.com/?docID=36208

Getting Additional Help and Support

Avnet Support

ZedBoard is a community-oriented kit, with all technical support being offered through the ZedBoard.org community website support forums. ZedBoard users are encouraged to participate in the forums and offer help to others when possible.

For questions regarding the ZedBoard community website, please direct any questions to:

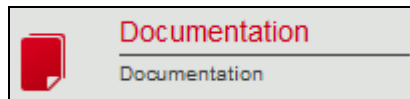
- ZedBoard.org Web Master – webmaster@zedboard.org

To access the most current collateral for ZedBoard please visit the community support page at:

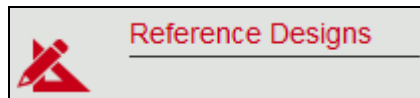
- www.zedboard.org/content/support

Once on the ZedBoard.org support page:

To access the latest ZedBoard documentation, click on the Documentation link:



To access the latest reference designs for ZedBoard, click on the following link:



To access the ZedBoard technical forums, click on the following link:



Xilinx Support

For questions regarding products within the Product Entitlement Account, send an e-mail message to the Customer Service Representative in your region:

- Canada, USA and South America - isscs_cases@xilinx.com
- Europe, Middle East, and Africa - eucases@xilinx.com
- Asia Pacific including Japan - apaccase@xilinx.com

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

Appendix I: Installing and Licensing Xilinx Software

Install ISE WebPACK or Design Suite

The ZedBoard XC7Z020-CLG484-1 Zynq-7000 AP SoC device development is supported by ISE WebPACK licensing. ZedBoard also comes with entitlement voucher to a seat of ChipScope™ Pro that is device locked to a XC7Z020-CLG484-1 Zynq-7000 AP SoC device. This software can be installed from the included DVD or the latest version can be downloaded online at:

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

If a full seat of ISE Embedded or System 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 **Xilinx Design Tools: Installation and Licensing Guide** available on the Xilinx website:

- www.xilinx.com/support/documentation/sw_manuels/xilinx14_1/iil.pdf

Note: If the 14.1 or 14.2 ISE tools are being installed, a full install of ISE Logic, Embedded, or System Edition is recommended even when using WebPACK licensing. See this Xilinx Answer Record for further details:

- www.xilinx.com/support/answers/47839.htm

Appendix II: QSPI Flash Example Application

Boot ZedBoard from QSPI

The ZedBoard comes from the factory with a very simple example application loaded into the Spansion QSPI Flash (IC14/IC15). If the contents of the QSPI flash are unaltered, it should be possible to boot the Zynq-7000 AP SoC device into the very simple application loaded from the QSPI Flash memory as described below.

Verify the ZedBoard boot mode jumpers (JP7-JP11) are set to QSPI flash mode as described in the Hardware Users Guide.

www.zedboard.org/sites/default/files/ZedBoard_HW_UG_v1_1.pdf

The example application will boot the Processing System using QSPI flash as the boot source and configure the Programmable Logic using a simple Bitstream file which displays a test pattern on User LEDs LD0-LD7 as seen in figure 28.

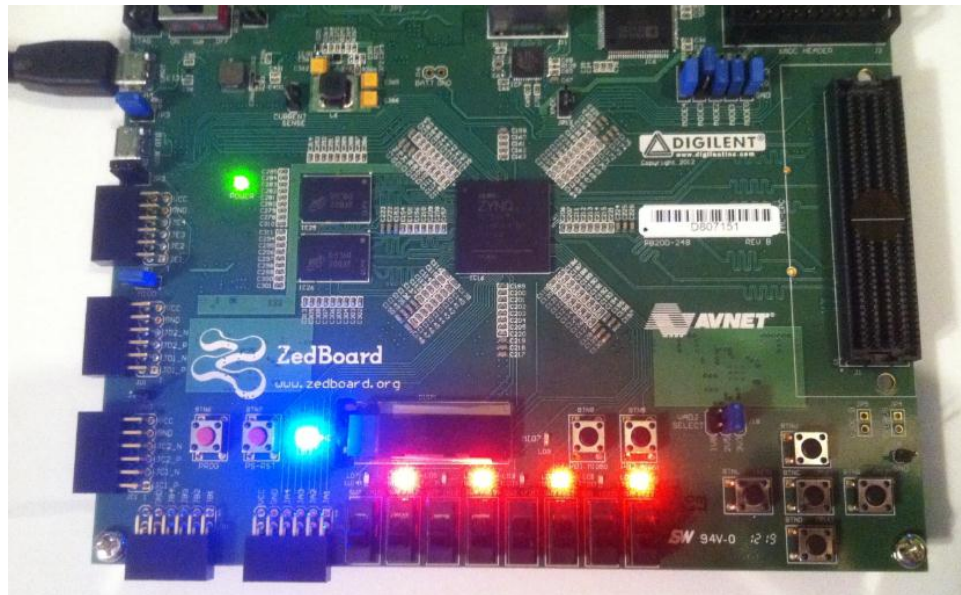


Figure 28 – QSPI Application Example Output

Appendix III: Using Linux Host PC

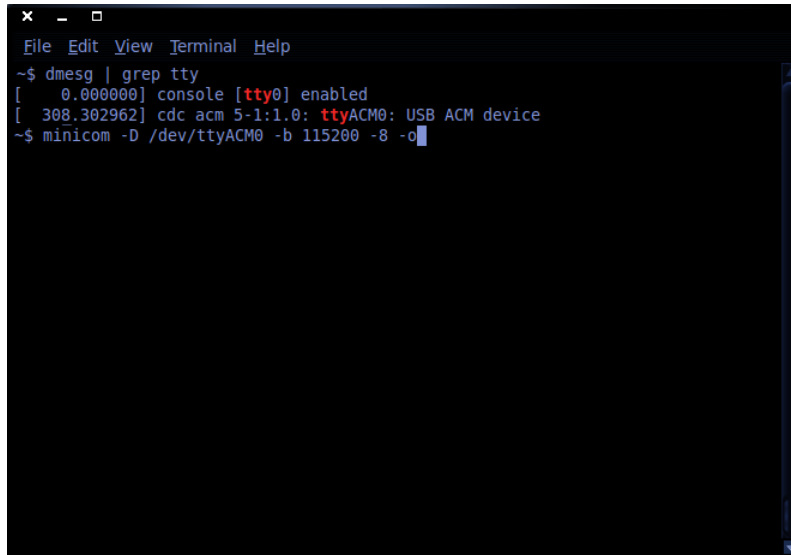
The instructions in this section were completed using an Ubuntu 10.04 LTS install running on an Intel MacBook Pro but results may vary for different host machine hardware and Linux distributions.

Connect Terminal to ZedBoard USB-UART

The ZedBoard Cypress CY7C64225 USB-UART device is capable of enumerating as a USB tty device on most Linux hosts.

After powering on and connecting ZedBoard to the host Linux machine, search the kernel messaging with the command `dmesg | grep tty` and look for indication that the USB-UART is enumerated as a device. In this example, the Linux host has enumerated the ZedBoard USB-UART as the `/dev/ttyACM0` device.

Using the attached USB-UART tty device, connect to the device with the minicom application. In this example, minicom is launched with the `minicom -D /dev/ttyACM0 -b 115200 -8 -o` command as seen in Figure 29.

A terminal window with a black background and white text. The window title bar shows 'x _ □' and menu options 'File Edit View Terminal Help'. The terminal content shows the following commands and output:

```
~$ dmesg | grep tty
[  0.000000] console [tty0] enabled
[ 308.302962] cdc_acm 5-1:1.0: ttyACM0: USB ACM device
~$ minicom -D /dev/ttyACM0 -b 115200 -8 -o
```

Figure 29 – Determining the Host tty Device and Launching minicom

The minicom terminal will connect and allow the ZedBoard terminal output to be interacted with as seen in Figure 30.

```

x _ □
File Edit View Terminal Help
[ 1.070000] mmcblk0: mmc0:e624 SU02G 1.84 GiB
[ 1.080000] mmcblk0: p1
[ 1.290000] EXT4-fs (ram0): warning: mounting unchecked fs, running e2fsck id
[ 1.300000] EXT4-fs (ram0): mounted filesystem without journal. Opts: (null)
[ 1.310000] VFS: Mounted root (ext4 filesystem) on device 1:0.
[ 1.310000] Freeing init memory: 152K
Starting rcS...
++ Mounting filesystem
++ Setting up mdev
++ Configure static IP 192.168.1.10
[ 1.500000] GEM: lp->tx_bd ffdfb000 lp->tx_bd_dma 18fce000 lp->tx_skb d807020
[ 1.500000] GEM: lp->rx_bd ffdfc000 lp->rx_bd_dma 18fcf000 lp->rx_skb d807030
[ 1.510000] GEM: MAC 0x00350a00, 0x00002201, 00:0a:35:00:01:22
[ 1.520000] GEM: phydev d8b6c400, phydev->phy_id 0x1410dd1, phydev->addr 0x0
[ 1.520000] eth0, phy_addr 0x0, phy_id 0x01410dd1
[ 1.530000] eth0, attach [Marvell 88E1510] phy driver
++ Starting telnet daemon
++ Starting http daemon
++ Starting ftp daemon
++ Starting dropbear (ssh) daemon
++ Starting OLED Display
[ 1.570000] pmodoled-gpio-spi [zed_oled] SPI Probing
++ Exporting LEDs & SWs
rcS Complete
zynq> ls -l
total 27
drwxr-xr-x 2 12319 300 2048 Jan 9 2012 bin
drwxr-xr-x 4 12319 300 3072 Jan 1 00:00 dev
drwxr-xr-x 4 12319 300 1024 Jan 1 00:00 etc
drwxr-xr-x 3 12319 300 2048 Jul 12 2012 lib
drwxr-xr-x 11 12319 300 1024 Jan 9 2012 licenses
lrwxrwxrwx 1 12319 300 11 Jan 9 2012 linuxrc -> bin/busybox
drwx----- 2 root 0 12288 Jan 9 2012 lost+found
drwxr-xr-x 2 12319 300 1024 Aug 21 2010 mnt
drwxr-xr-x 2 12319 300 1024 Aug 21 2010 opt
dr-xr-xr-x 48 root 0 0 Jan 1 00:00 proc
drwxr-xr-x 2 12319 300 1024 Jul 12 2012 root
drwxr-xr-x 2 12319 300 1024 Jan 9 2012/sbin
drwxr-xr-x 12 root 0 0 Jan 1 00:00 sys
drwxrwxrwt 2 root 0 40 Jan 1 00:00 tmp
drwxr-xr-x 5 12319 300 1024 Mar 30 2012 usr
drwxr-xr-x 4 12319 300 1024 Oct 25 2010 var
zynq> $
CTRL-A Z for help |115200 8N1 | NOR | Minicom 2.4 | VT102 | Online 00:02

```

Figure 30 – Using minicom to Interact with ZedBoard Console

Connect Networking to ZedBoard USB-UART

The ZedBoard Ethernet networking is capable of interacting with most Linux hosts. To run this demo, you may have to configure the network properties on your Linux machine and assign a static IP address of 192.168.1.1 to connect to ZedBoard.

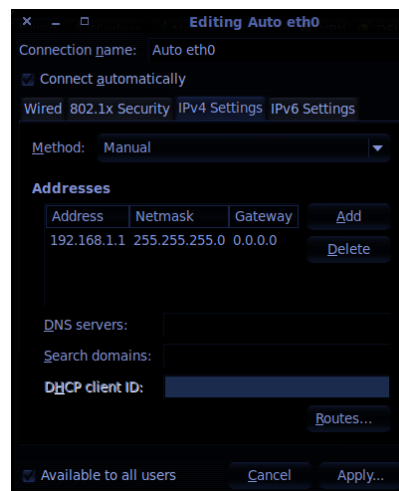


Figure 31 – Assigning Static IP Address to Linux Host Machine

The networking interface may need to be restarted for the IP address assignment changes to take effect. This can be done by running the `ifconfig eth0 down` and `ifconfig eth0 up` command sequences as seen in Figure 32.

```
File Edit View Terminal Help
~$ sudo ifconfig eth0 down
~$ sudo ifconfig eth0 down
~$ sudo ifconfig eth0 up
~$ ifconfig
eth0      Link encap:Ethernet  HWaddr 00:1b:63:a0:2e:6e
          inet addr:192.168.1.1  Bcast:192.168.1.255  Mask:255.255.255.0
          inet6 addr: fe80::21b:63ff:fea0:2e6e/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:428 errors:0 dropped:0 overruns:0 frame:0
          TX packets:289 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:601764 (601.7 KB)  TX bytes:30024 (30.0 KB)
          Interrupt:17

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:242 errors:0 dropped:0 overruns:0 frame:0
          TX packets:242 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:18684 (18.6 KB)  TX bytes:18684 (18.6 KB)

~$
```

Figure 32 – Restarting the Networking Interface

To view the ZedBoard embedded webpage, open a web browser (such as Firefox) and browse to the ZedBoard IP address <http://192.168.1.10/> as the URL. The ZedBoard webpage should open in the browser to display as seen in Figure 33.

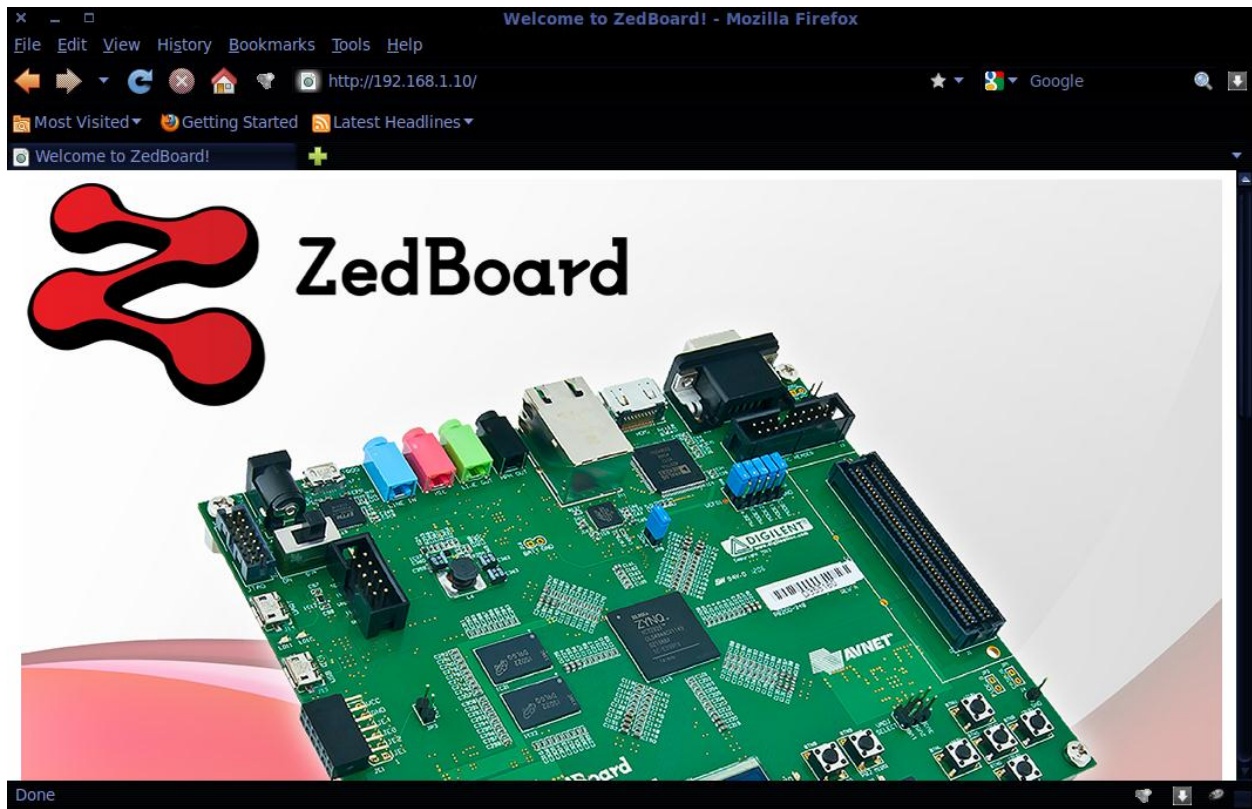


Figure 33 – ZedBoard Webpage Shown In Host Browser



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