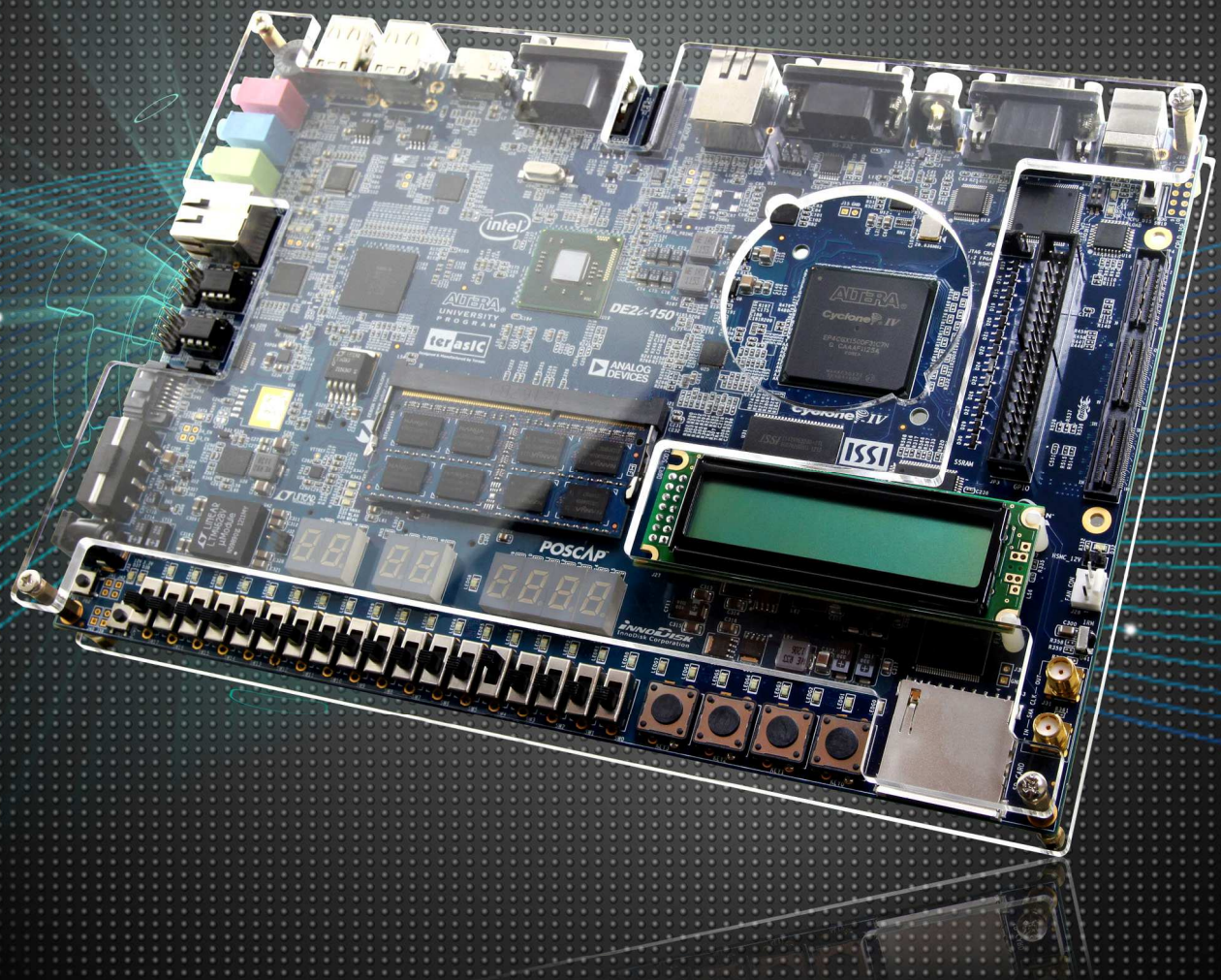
DE2i-150

DEVELOPMENT KIT

YOCTO USER MANUAL



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CONTENTS

Chapter 1

Operation Guide

This chapter describes how to use the Yocto OS, a Linux-based OS, installed on the SSD attached to the DE2i-150 board. For system startup, please refer to section 1.3.

1.1 Basic Operation

Sato is a GNOME Mobile based integrated user environment. Sato is designed for devices with VGA-sized high DPI touchscreen displays such as those found on smartphones and PDAs. Developed with a focus on efficiency and speed, Sato works smoothly on handheld and other embedded hardware. The Sato interface is the Graphical User Interface (GUI) of the DE2i-150 build-in Linux system. When system starts up, the Sato interface will appear on the screen. Here, we will introduce some basic operations for the Sato interface.

■ Switch Menu

Click the Tab or Arrow as shown in Figure 1-1 to switch the menu group.

Figure 1-1 Menu in Sato Interface

■ Linux Terminal

Click the "Terminal" icon on the desktop, as shown in Figure 1-2, to enter the Linux terminal as shown in Figure 1-3. In the terminal window, end user can type "exit" command to terminate the terminal.

Figure 1-2 Terminal Icon in Sato Interface Desktop

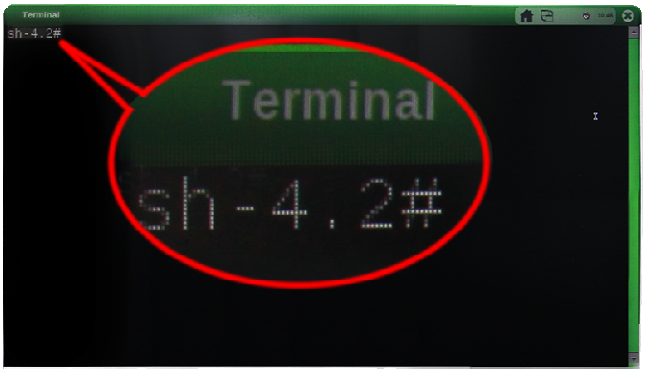

Figure 1-3 Terminal Windows

■ Shutdown

Click the "Shutdown" icon on the desktop, as shown in Figure 1-4, to shut down the Linux system.

Type "**poweroff**" under terminal window also can shutdown the Linux system. To completely "power off" the DE2i-150 board, the user must also hold down the Power button for 10 seconds.

Figure 1-4 Shutdown Icon on Sato Desktop

■ Switch Windows

Click the "Windows Swap" icon in **Figure 1-5,** and a pop-up menu will appear for users to select an active Windows.

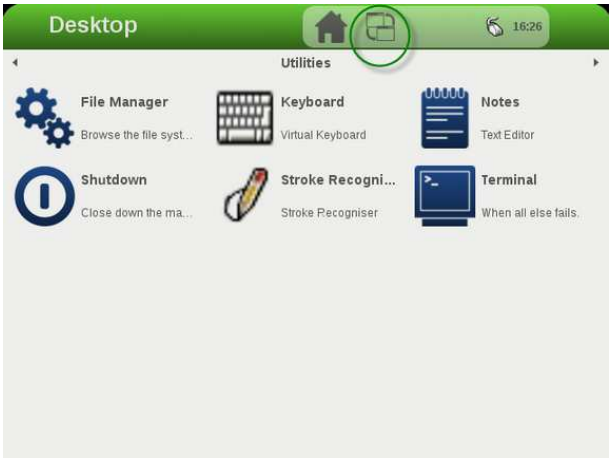

Figure 1-5 Task Swap Icon on Sato Desktop

■ Common Linux Shell Command

Table 1-1 shows a few common Linux commands. To execute these commands, users need to open a Terminal window first.

Table 1-1 Linux basic commands

Command	Description
ls	List all files and directories in the current directory
cd	Change to current directory
mkdir	Create a directory
cp	Copy file or directory (with -r)
rm	Remove file or directory
uname -a	Query system information
chmod	Change file access permission
mount	Mount storage devices, such as a USB storage
unmount	Unmount storage device
poweroff	Power off the Linux System
reboot	Restart the Linux System; Warm reset system.

Note: Many of these commands require filenames or flag operators to work properly. The user should consult a Linux reference for more details

1.2 Using a USB storage device

To use a USB storage device, please plug the USB storage device into one of the 4 slots on the USB host port J2 or J3. Then, click the "**File Manager** " icon in Figure 1-6. In "Device Tree" navigator on the left side of File Manager, expand the path "/media/sdb1" (assumed the USB storage device is automatically mounted with the name "**sdb1**"). When "/media/sdb1" is selected, it's content is displayed in the folder content window located at right side of File Manager, as shown in Figure 1-7.

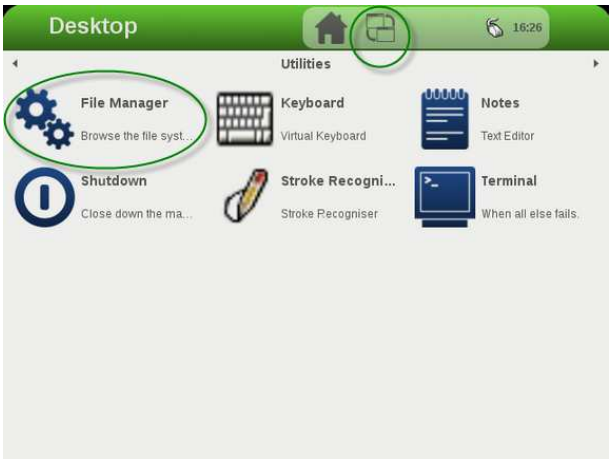

Figure 1-6 File Manager Icon on Sato Desktop

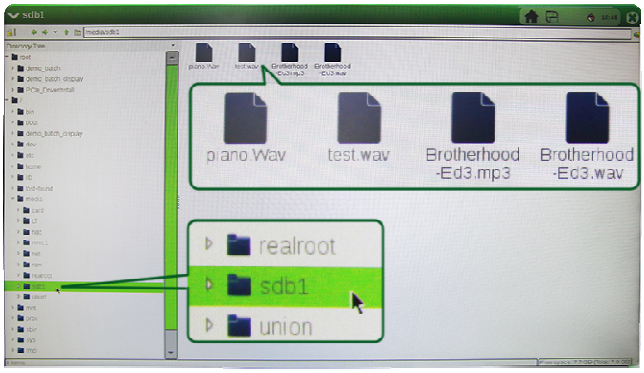

Figure 1-7 USB storage Content

To copy files from a USB storage device to the Linux file system, please follow the below procedures:

1. Plug a USB storage device into USB Port J2 or J3 on DE2i-150
2. Launch File Manager.
3. Browse the USB storage device by expanding the path "/media/sdb1 in the "Device Tree" navigator.
4. In the folder content window, use mouse to select source files (multiple files are allowed), right-click mouse button to popup a menu, and click the "Copy" item in the popup menu, as shown in **Figure 1-8**.
5. Select a target directory in the "Device Tree" navigator.
6. In the folder content window, right-click mouse button to popup a menu, and click the "Paste" item in the popup menu, as shown in **Figure 1-9**.

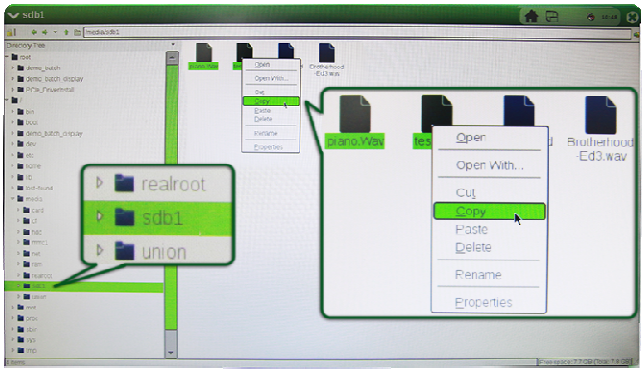

Figure 1-8 Click "Copy" Menu Item

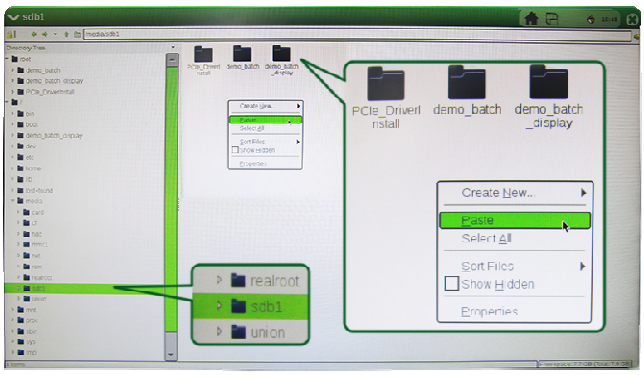

Figure 1-9 Click "Paste" Menu Item

1.3 Playing Music

Please make sure a speaker or a head phone is plugged into the green line-out phone jack on the DEi2-150 board. Click the "**Music Player** " icon shown in **Figure 1-10**, then click the add "+" icon as shown in **Figure 1-11** to add music files. Uncompressed .wav music files are recommended. In the "add music" window, choose the music file and click open button to add music. After music files are added, select the file you wish to play from the music file list and click the "Play" icon to start the music player as shown in **Figure 1-12** .

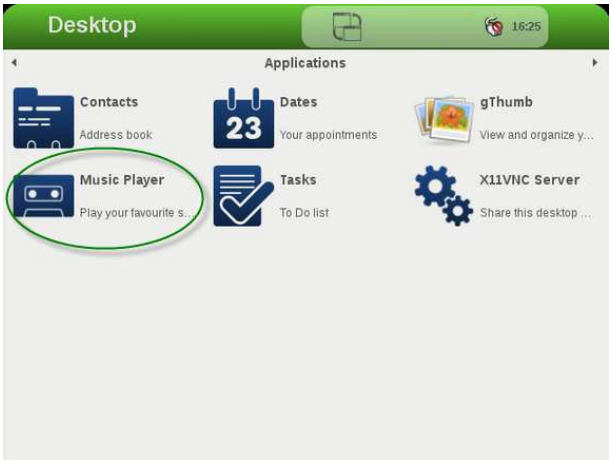

Figure 1-10 Music Player Icon on Sato Desktop

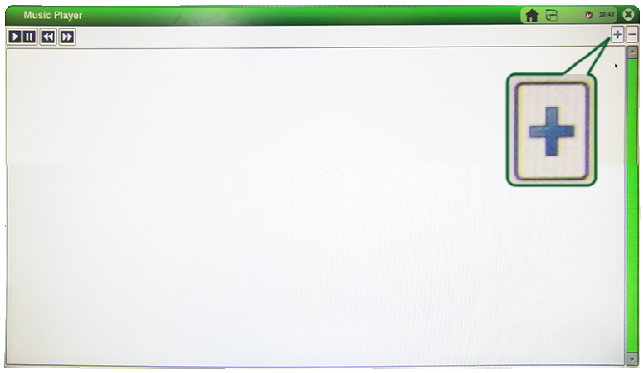

Figure 1-11 Music Player Interface

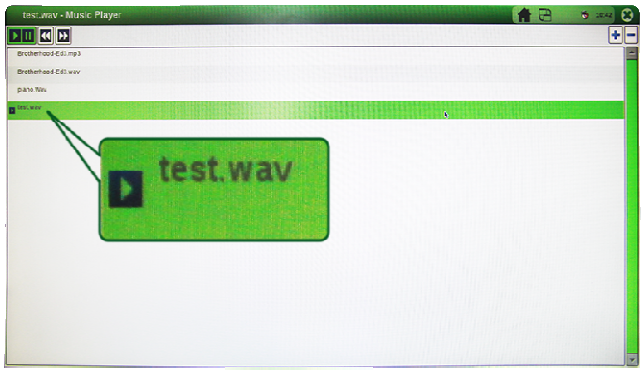

Figure 1-12 Play Music

Chapter 2

PCI Express

This chapter describes how to set up the two PCI Express demonstrations provided in the DE2i-150 System CD. The two demonstrations are "PCIE Fundamental Demo" and "PCIE Display Demo". Also, this chapter will illustrate how to compile these demonstration's application software under the Linux System of the DE2i-150.

2.1 PCIE Fundamental Demo

This demonstration illustrates the PCI express basic IO control and high speed data transfer using a DMA port. DMA translation supports both memory type: memory mapped memory and FIFO memory. The setup procedures include three major steps:

- Copy demo files into the Linux system
- Programming FPGA and restart Linux system
- Start up PCI Express Driver
- Start Demonstration Application Software

■ Copy demonstration file

The pre-built Linux does not include the associated demonstration files, so users have to copy the demonstrations files from the DE2i-150 System CD to Linux system through an external USB storage device. Regarding how to use an external USB storage device, please refer to chapter one in this document. Here are the major copy procedures:

1. Prepare a USB storage device and insert it into your host PC.
2. Copy the folder "**Demonstrations/PCIe_SW_KIT/linux/PCIe_DriverInstall**" from the DE2i-150 System CD into the USB storage device.
3. Copy the folder "**Demonstrations/FPGA/PCIE_Fundamental/linux_app**" from the DE2i-150 System CD into the USB storage device.
4. Remove the USB storage device from your host PC and plug it into DE2i-150 USB-Port

5. Power on DE2i-150 and mount the USB storage device
6. Copy both folders **PCIe_DriverInstall** and **linxu_app** into the Linux File System. Presumably, they are copied into the "**\home\root**" folder.

■ Programming FPGA and Restart Linux System

Before Linux PCI Express can detect the FPGA PCI Express circuit, users need to first configure the FPGA with the demonstration .sof file. After FPGA is configured, system should be restarted so BIOS has a chance to detect the FPGA PCI express circuit and allocate. Here are the procedures to configure the FPGA with the demonstration .sof file from your host PC:

1. Make sure Quartus is installed on your host PC.
2. Use a USB cable to connect your host PC and DE2i-150 USB-Blaster USB Port.
3. Copy the folder "**Demonstrations/FPGA/PCIE_Fundamental/demo_batch**" to your host PC.
4. Launch "**sof_download.bat**" in the "**demo_batch**" folder to start FPGA configuration process.
5. When FPGA is configured successfully, you will see successful message as shown in **Figure 2-1**.

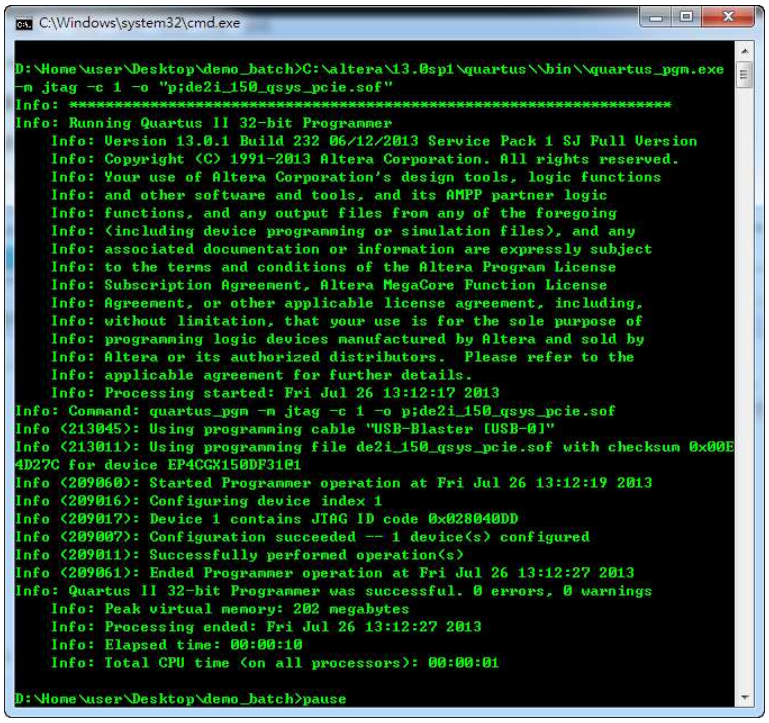

Figure 2-1 FPGA Configure Success

Here are the procedures to restart the Linux system.

1. Click "**Terminal**" icon on the Sato desktop to enter a terminal window.
2. In the terminal window, type "**reboot**" to start reboot process.

■ Start PCI Express Driver

Here are the procedures to start PCI Express driver for this demonstartion:

1. Click "**Terminal**" icon on the Sato desktop to enter a terminal window.
   Use "**cd PCIe_DriverInstall**" command to go to the "**PCIe_DriverInstall**" directory. (Assumed the " **PCIe_DriverInstall**" folder is located in the /home/root folder)
2. Type "**sh ./ load_terasic_qsys_pcie_driver.sh**" to load the driver.
3. If the driver is loaded up successfully and can detect the FPGA PCI Express circuit, users will see the return message "Matching Device Found".

■ Start Demonstration Application Software

When PCI Express driver started successfully, we now can set forth to execute the application software with the following procedures:

1. Click "**Terminal**" icon on the Sato desktop to enter a terminal window.

2. Use "**cd linux_app**" command to go to the "**linux_app**" directory. (Assumed the "**linux_app**" folder is located in the /home/root folder)
3. Type "**./app**" to launch the application software. A menu will appear as shown in **Figure 2-2**.
4. For the LED demo, please input "0" followed by pressing "ENTER" to enter LED control mode. The program will show "Please input LED control mask:" to ask user to input a control mask, as shown in **Figure 2-3**. User can input a decimal value between 0~15 to control the four LED LEG0/ LEDG1/ LEDG2/ LEDG3 on DE2i-150. A decimal value of 15 (hexadecimal "F") would cause all four LEDs to light up. A decimal value of 11 (hexadecimal "B") will cause LEDG0, LEDG2, and LEDG3 to light up. LEDG1 should remain off. A value 0 will light off four LEDs.
5. For the button status demo, please press the KEY0/KEY1/KEY2/KEY3 on the DE2i-150 board, then on the terminal input "1" followed by pressing "ENTER". The program will report the status of KEY0/KEY1/KEY2/KEY3 with a hexadecimal value. When no key is

pressed, the status value is fh (1111) as shown in **Figure 2-4**. If KEY0 is pressed, the status value is eh (1110).

6. For the DMA memory test, please input "2" followed by pressing "ENTER". The program will report test result as shown in **Figure 2-5**.
7. For the DMA FIFO test, please input "3" followed by pressing "ENTER". The program will report test result as shown in **Figure 2-6**.
8. To quit this demonstration program, type "99" followed by pressing "ENTER".

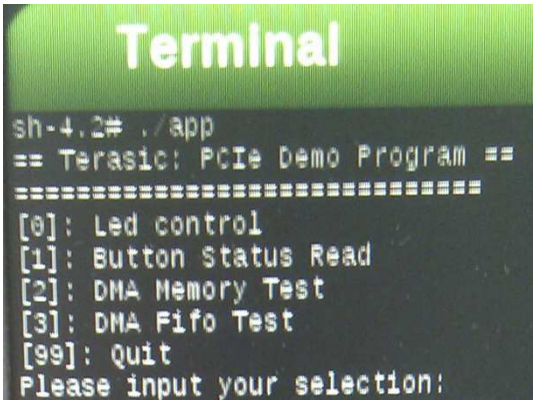

Figure 2-2 Menu for PCIE Fundamental Demo

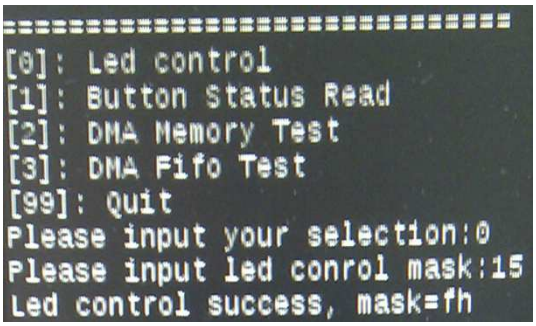

Figure 2-3 Led Control Demo

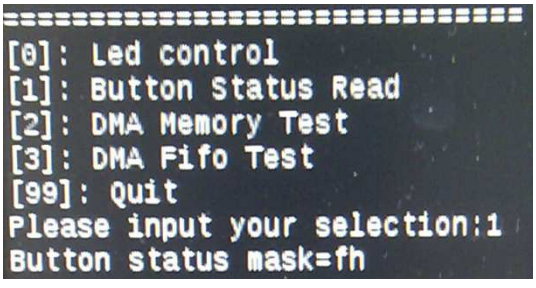

Figure 2-4 Button Status Read Demo

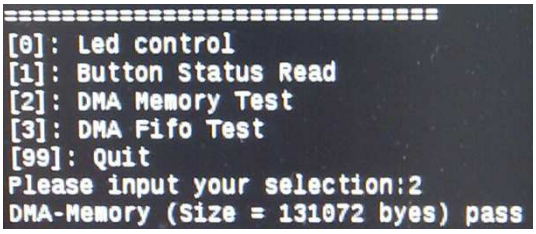

Figure 2-5 DMA Memory Test Demo

Figure 2-6 DMA FIFO Test Demo

2.2 PCIE Display Demo

This demonstration illustrates the PCI Express basic IO control and high speed data transferring for image data by DMA. The setup procedures include four major steps:

- Copy demo files into Linux system
- Programming FPGA and restart Linux system
- Start up PCI Express Driver
- Start Demonstration Application Software

■ Copy demonstration file

The pre-built Yocto OS image does not include the associate demonstration files, so users have to copy the demonstrations files from the DE2i-150 System CD to Linux system through an external USB storage device. For instructions on how to use an external USB storage device, please refer to chapter one in this document. Here are the major copy procedures:

1. Prepare a USB storage device and insert it into your host PC.
2. Copy the folder "**Demonstrations/PCIe_SW_KIT/linux/PCIe_DriverInstall**" from the DE2i-150 System CD into the USB storage device.

3. Copy the folder "**Demonstrations/FPGA/PCIE_Display/linux_app**" from the DE2i-150 System CD into the USB storage device.
4. Remove the USB storage device from your host PC and plug it into DE2i-150 USB-Port
5. Power on DE2i-150 and mount the USB storage device
6. Copy both folders **PCIe_DriverInstall** and **linux_app** into the Linux File System. Presumably, they are copied into the "**\home\root**" folder. Note, if the folder name "**linux_app**" already exists, please rename it first before copying the folder.

■ Programming FPGA and Restart Linux System

Before Linux PCI Express can detect the FPGA PCI Express circuit, users need to configure the FPGA with the demonstration .sof file first. After FPGA is configured, system should be restarted so BIOS has a chance to detect the FPGA PCI express circuit and allocate. Here are the procedures to configure the FPGA with the demonstration .sof file from your host PC:

1. Make sure Quartus is installed on your host PC.
2. Use a USB cable to connect your host PC and DE2i-150 USB-Blaster USB Port.
3. Copy the folder "**Demonstrations/FPGA/PCIE_Display/demo_batch**" to your host PC.
4. Launch "**sof_download.bat**" in the "**demo_batch**" folder to start FPGA configuration process.
5. When FPGA is configured successfully, you will see the message as shown in **Figure 2-7**.

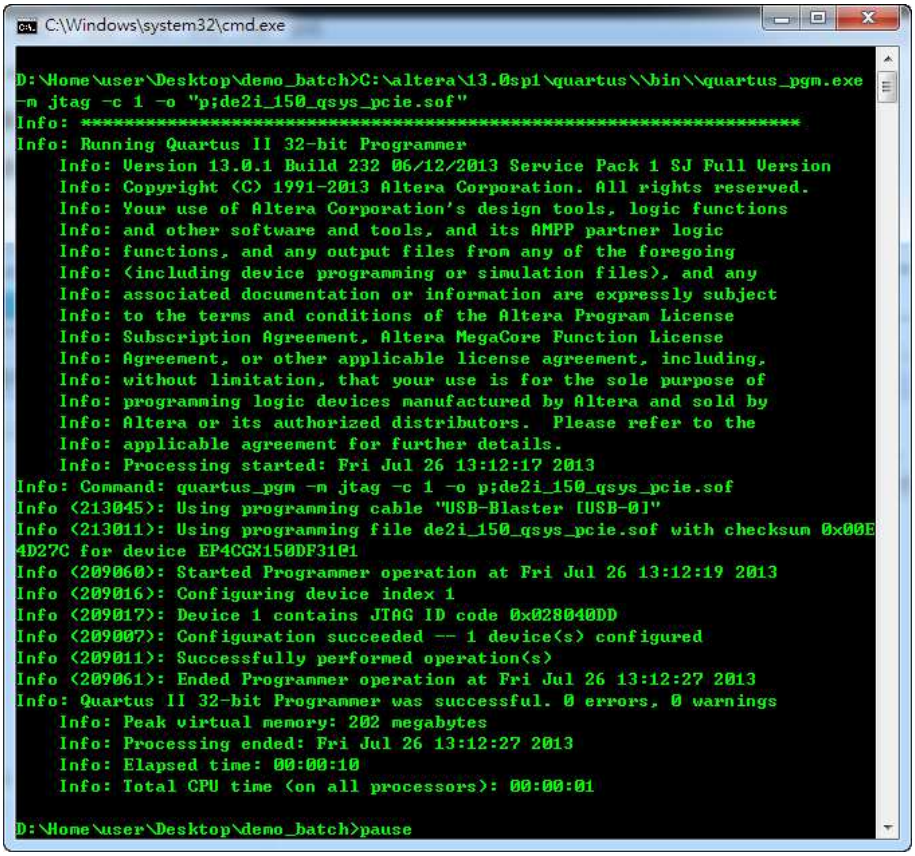

Figure 2-7 FPGA Configure Success

Here are the procedures to restart the Yocto OS,

1. Click "**Terminal**" icon on the Sato desktop to enter a terminal window.
2. In the terminal window, type "**reboot**" to start reboot process.

■ Start PCI Express Driver

Here are the procedures to start PCI Express driver for this demonstration:

1. Click "**Terminal**" icon on the Sato desktop to enter a terminal window.
2. Use "**cd PCIe_DriverInstall**" command to go to the "**PCIe_DriverInstall**" directory. (Assumed the " **PCIe_DriverInstall**" folder is located in the /home/root folder)
3. Type "**sh ./ load_terasic_qsys_pcie_driver.sh**" to load the driver.
4. If the driver is loaded successfully and can detect the FPGA PCI Express circuit, users will see the return message "Matching Device Found".

■ Start Demonstration Application Software

When the PCI Express driver is started successfully, we can now begin to execute the application software with the following procedures:

1. Make sure a LCD monitor is connected to the FPGA VGA port J8.
2. Click "**Terminal**" icon on the Sato desktop to enter a terminal window.
3. Use "**cd linux_app**" command to go to the "**linux_app**" directory. (Assumed the "**linux_app**" folder is located in the /home/root folder)
4. Type "**./app**" to launch the application software. The program will start to transfer image pattern by DMA and show the progress message as shown in **Figure 2-8**.
5. Also, users will see two test patterns displayed alternatively in the monitor shown in **Figure 2-9**.
6. Use Ctrl+C to terminate the program.

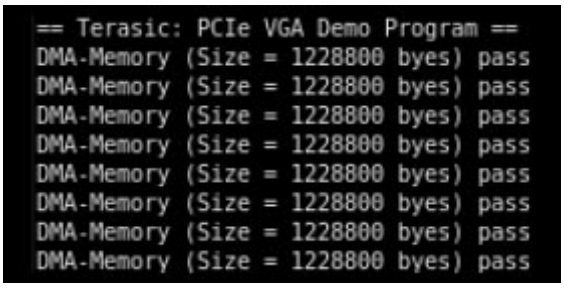

Figure 2-8 DMA Transfer Image Data

Figure 2-9 DMA Transfer Image Data

2.3 Compile PCIE Project

The pre-built Linux System already includes the GCC compiler, so developer can directly compile the application software for the PCI Express demonstration. Here are the procedures to compile the application software for the "**PCIE Fundamental Demo**":

1. Copy the folder "**Demonstrations/PCIE_Fundamental/linux_app**" from the DE2i-150 System CD into the Linux File System. (Assumed the folder is copied into the /home/root folder)
2. Click "**Terminal**" icon on the Sato desktop to enter a terminal window.
3. Use "**cd linux_app**" command to go to the "**linux_app**" directory.
4. Type "**make clean**" to clear all temporary files.
5. Type "**make**" to build the application software, as shown in **Figure 2-10**.
6. An executable file "**app**" will be generated if the make process is successful.

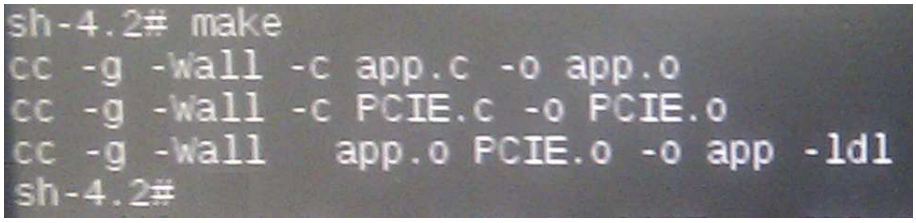

Figure 2-10 Build Application Software

Developer can build the application software of "**PCIE Display Demo**" with the same procedures.

Chapter 3

Operating System Installation

This chapter describes how to install the Yocto OS, a Linux-based operating system.

3.1 System Requirement

The following items are required to install Linux System on your DE2i-150:

- A host PC with Microsoft Windows installed
- UNetbootin software is installed on your host PC. This software can be downloaded from http://unetbootin.sourceforge.net/
- A USB Drive Disk, 2GB at least recommended.
- Linux .iso image file. The image file can be downloaded from download linux .iso

3.2 Installation Procedures

Installing Yocto onto the mSATA SSD on the Intel University board is a two-step process. First, we must create an installation USB, then we must use the USB to install to the SSD. To create the installation USB, you must have a separate Windows, Linux, or Mac system and a USB drive with a capacity of at least 1.5GB. Note that this USB drive will be **erased** by this process. The process is roughly the same regardless of whether you are using Windows, Linux, or Mac, but only the Windows process is documented here.

3.3 Formatting the USB Driver

Before we begin, the USB drive that will be used for installation must be formatted to FAT32 and files have to be erased from it.

Note: this section is Windows specific. For other operating systems, consult the operating

system documentation on how to format a USB drive to FAT32.

Right click on your USB disk in Windows Explorer (1) and select "Format…" (2) as shown in Figure 3-1.

Important: make sure you have selected the correct entry for your USB disk. Data on the drive you select here will be irreversibly lost.

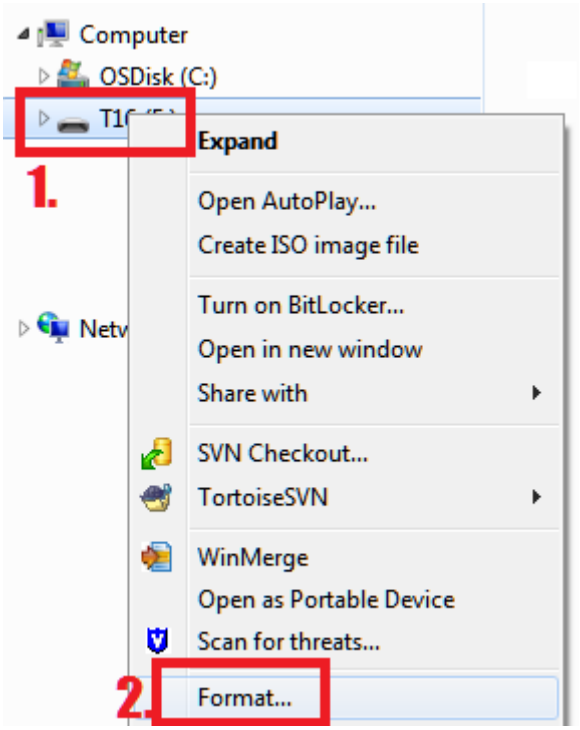

Figure 3-1 Launch Format Utility

Click "Restore device defaults" (1), make sure "Quick Format" is selected (2). Press "Start" (3) as shown in Figure 3-2.

Note: on older versions of Windows, the "Create an MS-DOS startup disk" option is not disabled. If you are using such a system, make sure the "Create an MS-DOS startup disk" option is not checked.

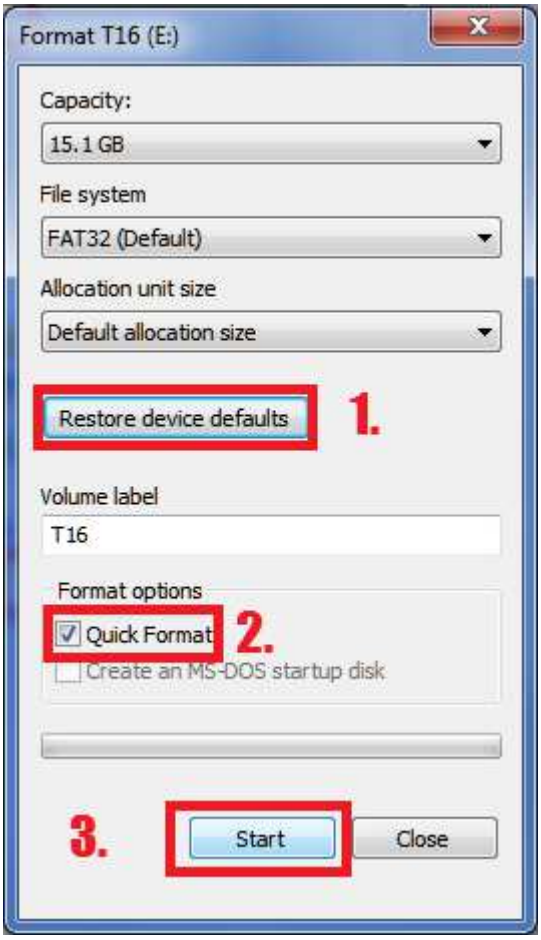

Figure 3-1 Start Format Process

If you are sure that there are no important files on the USB disk, press "OK" as shown in **Figure 3-3**.

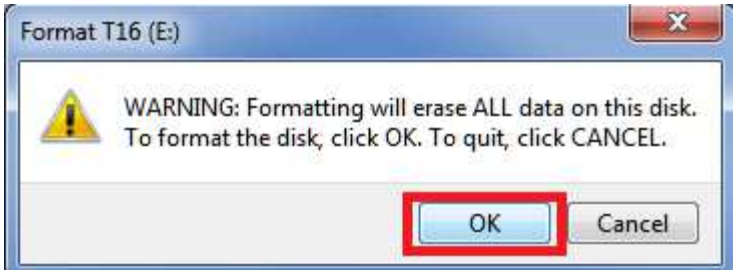

Figure 3-3 Formatting Process Confirmation

3.4 Copying the Installer to the USB Disk

Now start the "unetbootin-windows-583.exe" program as shown in **Figure 3-4**. Select the "Diskimage"(1), press the "…" button (2) to select the image file .iso. Make sure the selected drive

corresponds with the USB disk that was just formatted (3). Press “OK” (4).

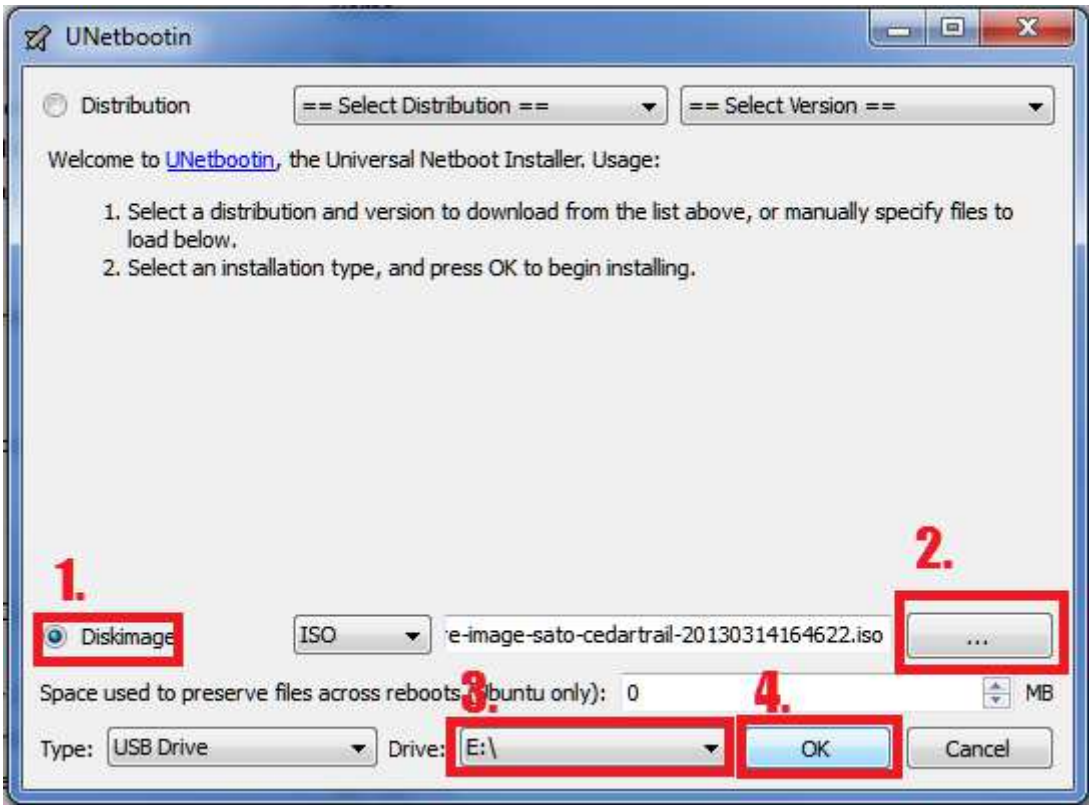

Figure 3-4 UNetbootin Utility

You will see a screen as shown in **Figure 3-5** while the installer is copied to your USB disk. This process may take as long as five minutes, depending on the speed of your USB drive.

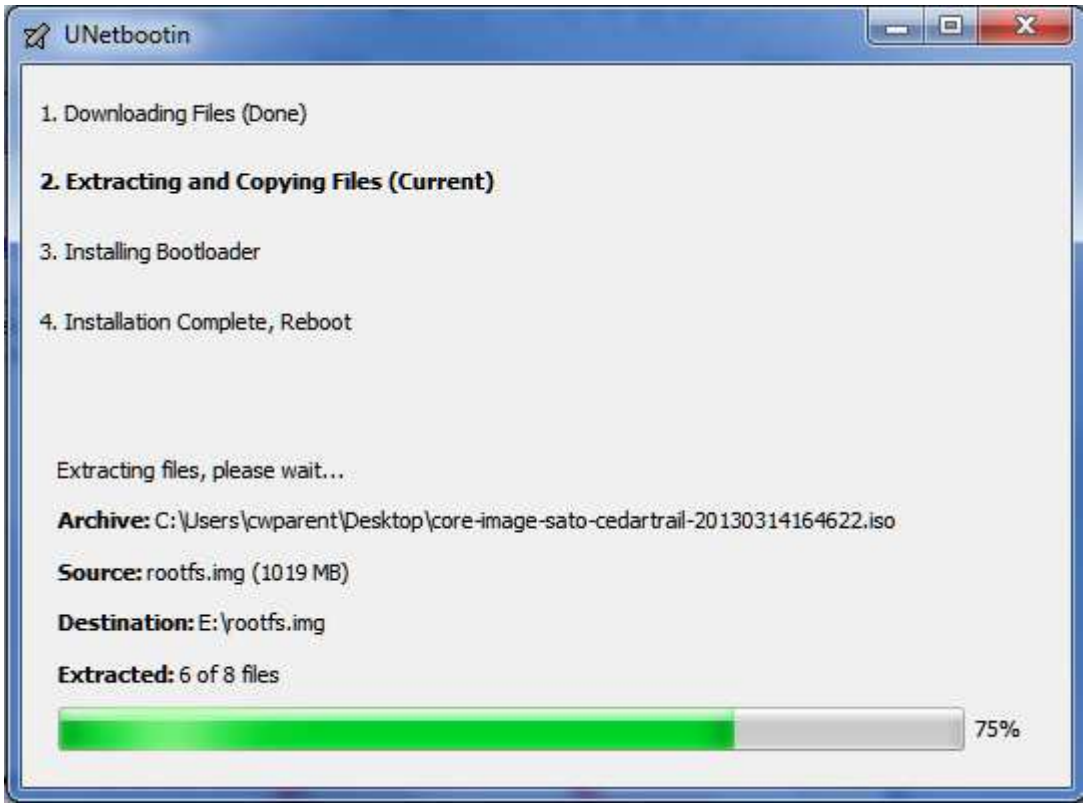

Figure 3-5 UNetbootin Creating Bootable USB Disk

When the installer finishes copying, you will be prompted to reboot, but you should press "Exit" instead as shown in Figure 3-6. You do **not** need to reboot the system at this moment.

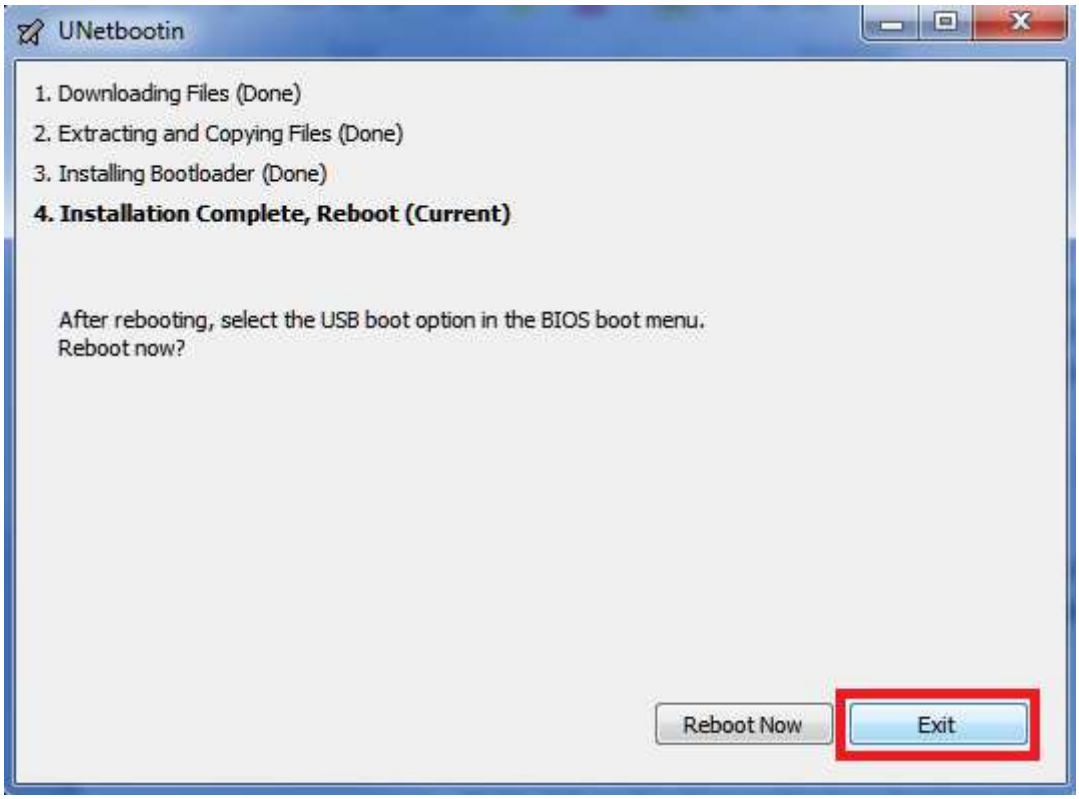

Figure 3-6 Exit UNetbootin

On newer versions of Windows, you may see a warning as shown below. It does not indicate an error with the process and can be safely ignored by pressing “Cancel” as shown in **Figure 3-7**.

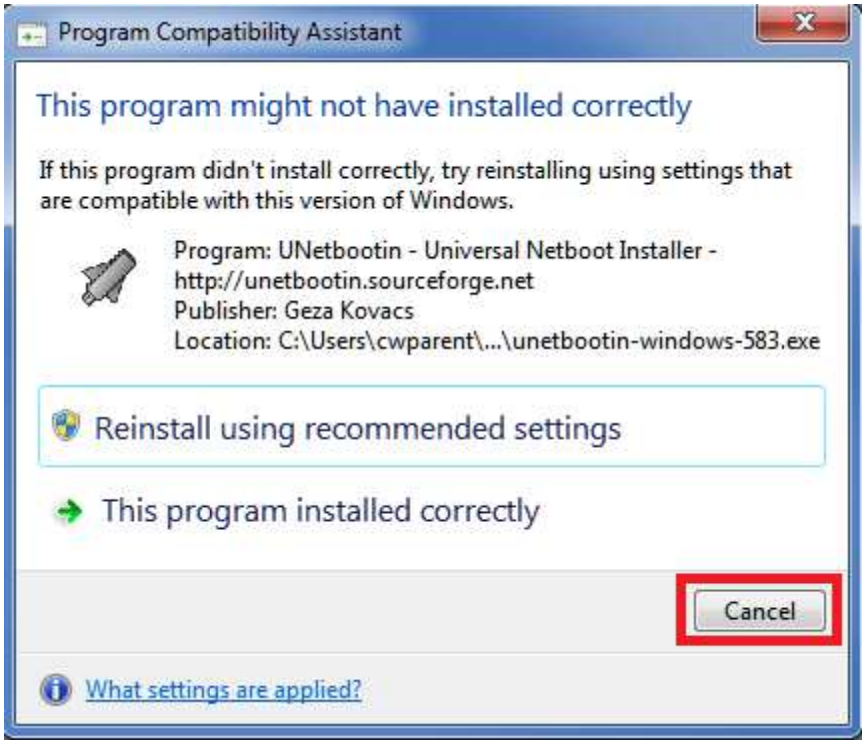

Figure 3-7 Canel the Compatibility Dialog

3.5 Installing from the USB Disk

Now insert the USB disk into the DE2i-150 system you wish to install on. You will also need a VGA monitor and USB keyboard and mouse for the installation process.

Power on the system and press F10 to access the boot menu. You will see a menu similar to the one pictured below **Figure 3-8**, but the names of the entries may be different. Select the one corresponding to your USB disk.

Important: the menu entry for your USB disk may or may not correspond to any branding visible on the outside of the drive. The entry for the DE2i-150's internal SSD is labeled "InnoLite mSATA D150Q"; you should not select this entry at this time. There will also be entries for "EFI Internal Shell" and "Enter Setup"; you should not select these options either.
Important: there may be two entries for your USB disk. If there are, one of them will start with "EFI". You should not select any option starting with "EFI" at this time.

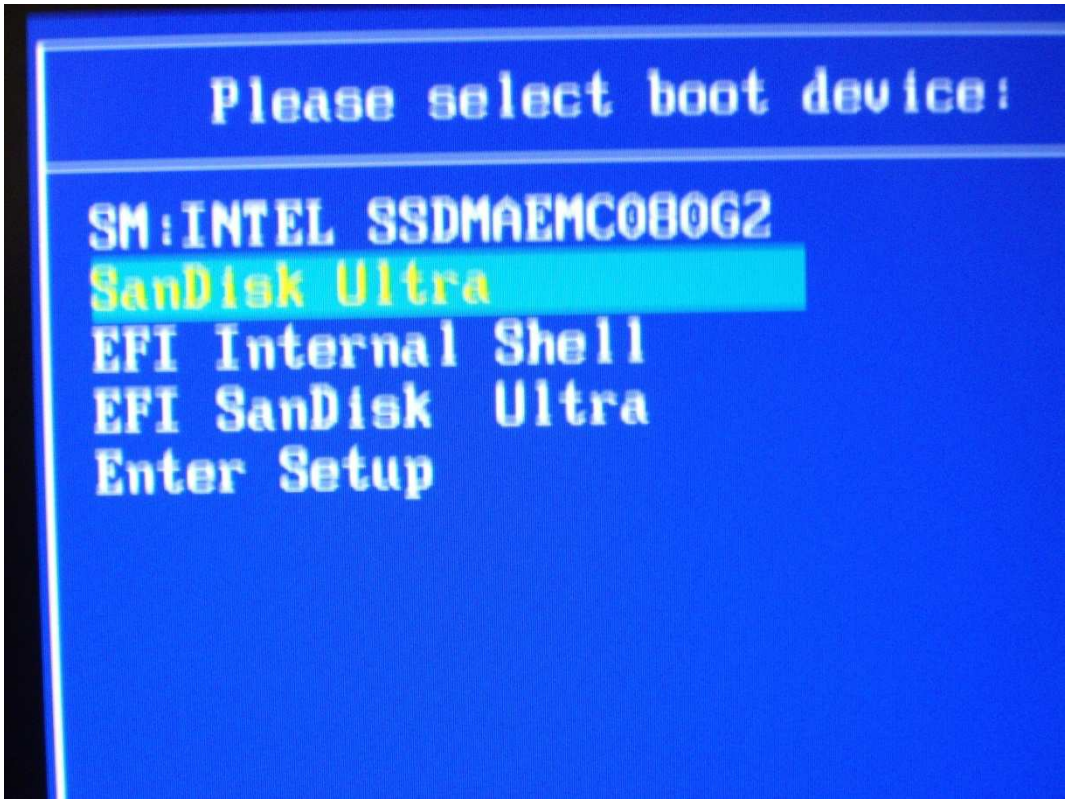

Figure 3-8 Select Boot Device

You will now see the Unetbootin boot menu as shown in **Figure 3-9**. Navigate to the "install" option and press enter.

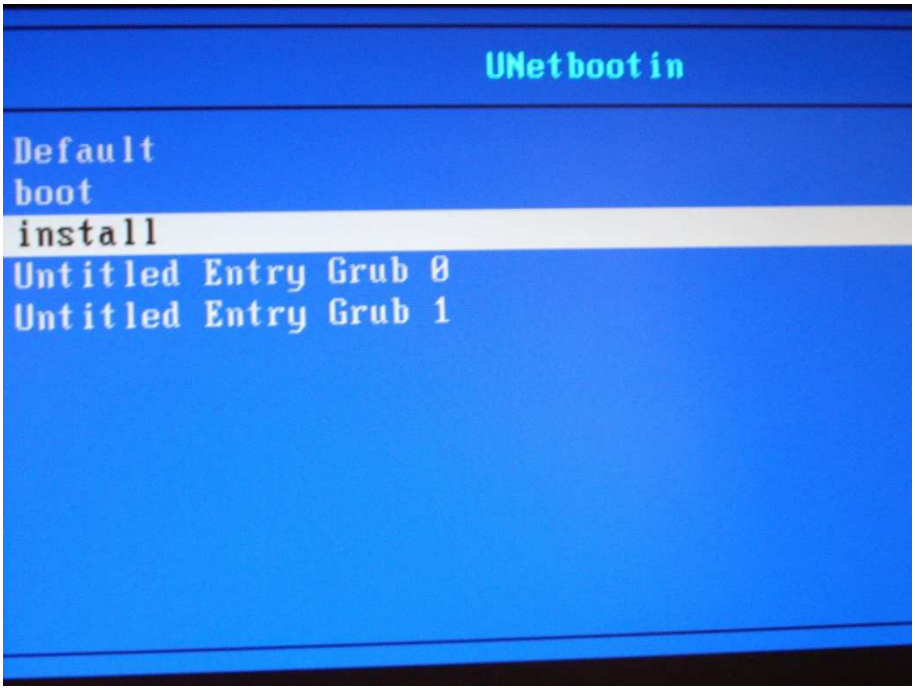

Figure 3-9 UNetbootin Boot Menu

The boot-up process should finish in less than a minute, and you will see the prompt picture in Figure 3-10. Press the "Y" key and hit enter to begin the installation process.

Note: if you do not see the prompt below, restart and make sure to select the "install" option at the UNetbootin menu – it is not the default option.

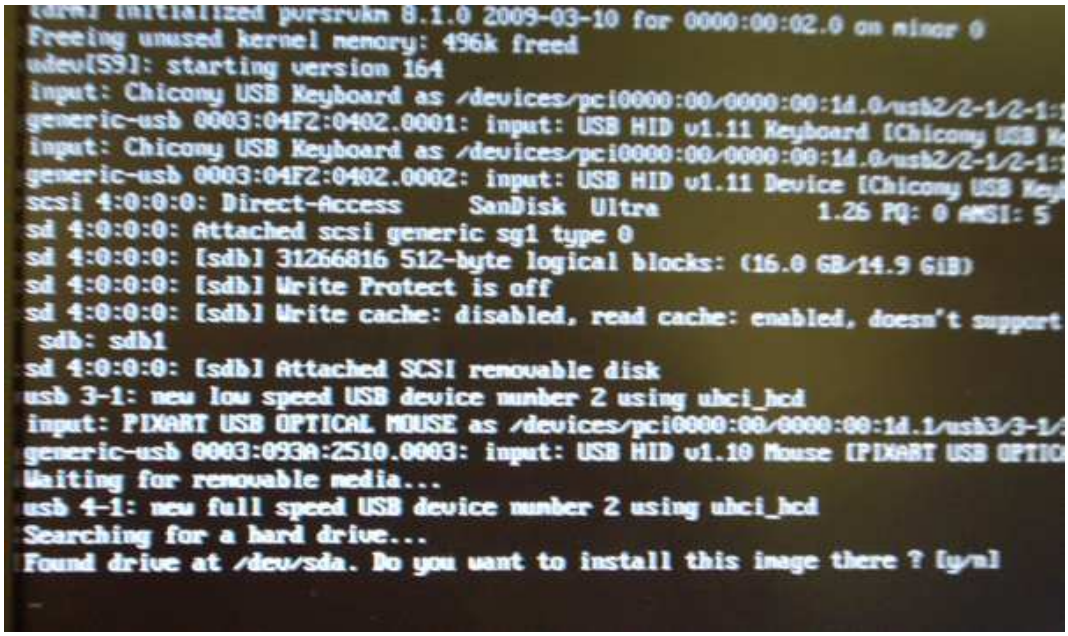

Figure 3-10 Yocto Bootup Process

The installation could take as long as 20 minutes, depending on the speed of your USB disk. When the installation process is finished, you will see the prompt shown in Figure 3-11. Remove the USB disk from the system and press enter. The system will reboot automatically. **Do not press F10 when it reboots**; allow it to boot from the internal SSD normally.

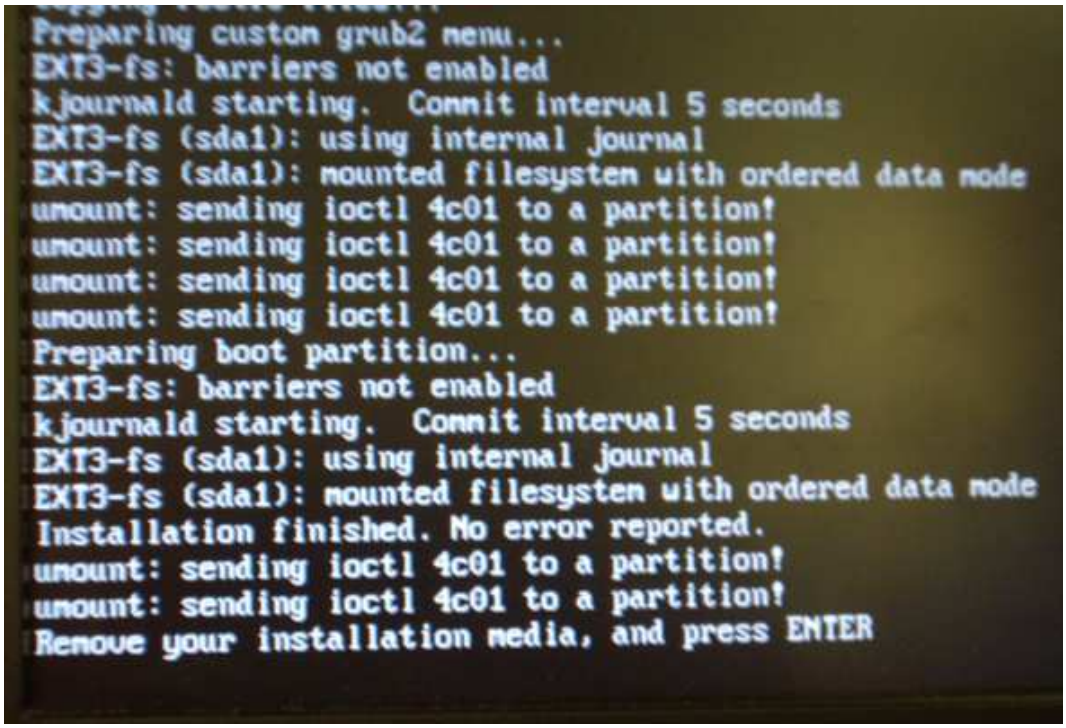

Figure 3-11 Installation Process Finished

Additional Information

Getting Help

Here are the addresses where you can get help if you encounter problems:

Terasic Technologies

9F., No.176, Sec.2, Gongdao 5th Rd,

East Dist, HsinChu City, 30070. Taiwan, 30070

Email: support@terasic.com

Web: www.terasic.com

DE2i-150 Web: DE2i-150.terasic.com

Revision History

Date	Version	Changes
2013.7	First publication	